Winter 2011

Extension of Lake Whatcom phosphorus ban: environmental impact assessment

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Lake Whatcom Phosphorous Ban

Western Washington University

March 9, 2011

Authored by: Huxley College of the Environment

Environmental Impact Assessment

ESTU 436 Winter 2011

TITLE PAGE

EXTENSION OF LAKE WHATCOM PHOSPHORUS BAN
Environmental Impact Assessment
Bellingham, Washington

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CITIZEN LETTER

Dear Concerned Citizens,

If you are reading this, then you are probably from Whatcom County, which means your drinking water comes from Lake Whatcom. Lake Whatcom is the main source of drinking water for over 96,000 people in Whatcom County including 82,000 residents of the City of Bellingham. Unfortunately, Lake Whatcom is currently listed under the Washington State Department of Ecology's 303D list as an impaired water body due to lack of dissolved oxygen. The main cause of low oxygen levels in the lake is excess phosphorus. Phosphorus is a nutrient necessary for all plant life. However, when too much of it enters aquatic systems, it can cause an imbalance in the aquatic ecosystem. In the past, phosphorus that was used in fertilizers and detergents has entered Lake Whatcom watershed through stormwater runoff. Phosphorus in the lake has contributed to an increase in algal blooms. If these blooms are allowed to continue to grow in the lake, they will have a negative impact on drinking water quality, aesthetics, public services and utilities, recreation in Lake Whatcom, energy and natural resources, as well as quality of life for fish and other wildlife. This environmental impact assessment offers two alternatives to the no-action option regarding phosphorus in the watershed.

The first alternative (original ban) would be to return to the original 2005 ordinance restricting the use of phosphorus. This was a control ordinance on commercial fertilizers labeled as containing more than 0% phosphorus by weight. It was based on an honor system, and not enforced. There were also educational materials provided to people living in the watershed on how phosphorus affects the lake, with low phosphorus fertilizers for people to use. The use of phosphorus on first year planting is still allowed within the watershed under the "original ban" alternative. Additionally, many private land owners could still bring in other materials containing phosphorus such as composts, mulches, etc.

The second alternative is the new ordinance that was recently passed by the City Council in January 2011. This new ban limits the use of fertilizers, mulches, wood chips, composts, and other products containing phosphorus for all land uses (with the exception of forestry) within the Lake Whatcom watershed. It also requires retail to post signage notifying customers of the prohibited uses of soil amendments containing over 0% phosphorus on landscaping and horticultural applications.

There is already an adequate amount of phosphorus in the soil for plants to grow, and added nutrients are not actually necessary. If no action is taken to limit the amount of added phosphorus coming into the watershed, stormwater runoff will continue to carry more nutrients into the lake, degrading the quality of the water.

Sincerely,

Lake Whatcom Phosphorus Ban Group

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List of Abbreviations

BMC—Bellingham Municipal Code
EPA—Environmental Protection Agency
DO—Dissolved Oxygen
WTP—Bellingham Water Treatment Plant
THM—Trihalomethanes
PPB—Parts per billion
MG/L—milligrams per liter
TMDL—Total Maximum Daily Load
µG/L—Microgram per liter

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FACT SHEET

TITLE

Lake Whatcom Phosphorous Ban

DESCRIPTION OF PROJECT

City of Bellingham ordinance to amend Bellingham Municipal Code to prohibit the use of phosphorous fertilizers, mulches and composts containing phosphorus at levels greater than 0% phosphorus by weight, within the Lake Whatcom watershed.

LEGAL DESCRIPTION OF LOCATION

Lake Whatcom watershed, Whatcom County, WA Township 38 North Range 3E & Range 4E, WA Township 38 North Range 3E & Range 4E, Washington State, United States.

PROPOSER

City of Bellingham
Lake Whatcom Watershed Advisory Board
Public Works Department
210 Lottie Street
Bellingham, WA 98225

LEAD AGENCY

Leo Bodensteiner

PERMITS

No applicable permits

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Clarrissa Ernst: Elements of plants and animals, environmental health, intro/executive summary
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DISTRIBUTION LIST

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ACKNOWLEDGMENTS

Robin Matthews, Director, WWU Institute for Watershed Studies
Bill Reilly, Public Works Storm Water Utility Manager, City of Bellingham
Kim Wheel, City of Bellingham Planning, Lake Whatcom
Bill Evans, Public Works Water Treatment Plant, City of Bellingham

ISSUE DATE

March 11, 2011

PUBLIC PRESENTATION AND TIME

March 9, 2011 6:00 pm
Fairhaven Park Pavilion, Bellingham, WA.

INTRODUCTION

Lake Whatcom is a large natural lake located in Whatcom County. The northwest end of the lake lies within the City of Bellingham. The lake consists of three distinct lake basins separated by glacial sills. The arrangement of the basins and the long residence time of the water create a complex ecosystem with in the lake that supports a variety of plants and animals both terrestrial and aquatic. The northwest end of the lake is the most urbanized, while the southeast in the least developed. The land surrounding Lake Whatcom is predominantly urban, rural, residential, and forestry. The existing population within the watershed is about 13,000 but current zoning will allow growth in the watershed to increase to about 28,000 people.

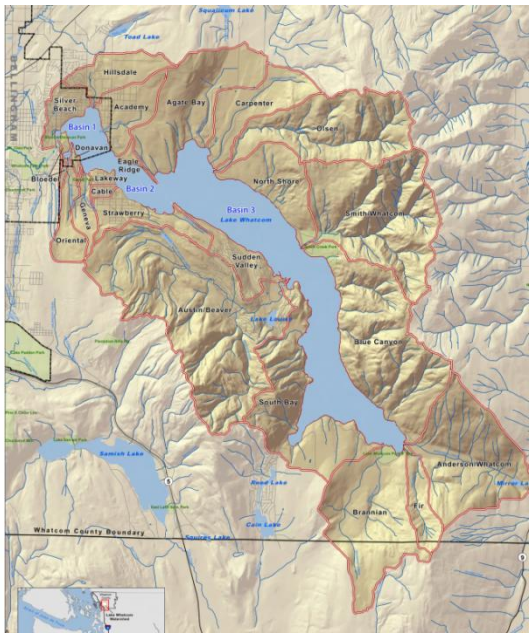


FIGURE 1: TOPOGRAPHICAL MAP OF LAKE WHATCOM WITH BASIN DIVISIONS, TAKEN FROM PARAMIX, 2007.

Water quality in Lake Whatcom, a source of drinking water for 50 percent of Whatcom County residents, has been a concern for many years. A commonly identified contributor to the decline of the lake's water quality has been urban stormwater runoff and entrained constituents such as suspended solids, metal and nutrients, that contain phosphorus entering the lake (Parametrix, 2007). Phosphorus plays the largest role in contributing to lake water quality due to its role in stimulating lake algal productivity. Enhanced algal growth, which lowers dissolved oxygen levels, can be associated with production of both toxic and nontoxic algae and can affect the taste of drinking water.

Phosphorus is a naturally occurring element in soil and is an essential nutrient for both plants and animals. Other sources of phosphorus include fertilizers, household detergents, industrial processes, as well as human and animal wastes. Phosphorus behaves as a fertilizer, accelerating plant and algae growth in aquatic systems, such as lakes, where it is a limiting nutrient. When plants and algae die, bacteria consume oxygen that is dissolved in the water, leaving less oxygen due to respiration. When additional phosphorus is added to a lake, the phosphorus fuels more growth of plants and algal blooms. With additional plant matter, there is an increase in waste when these plants die meaning a stimulation of bacteria and a greater consumption of oxygen. Oxygen is essential for the survival of fish and aquatic life and when there is less available, it threatens the continued existence of these organisms. Aside from the biological impact, the results of accelerated plant and algae growth in the lake due to phosphorus, phosphorus can cause an increase in drinking water treatment chemicals that form carcinogenic byproducts and add treatment costs.

In the state of Washington at least 260 bodies of water are polluted due to phosphorus decreasing the oxygen levels within the water (Pickett & Hood, 2008). Lake Whatcom is considered impaired and has been placed on the 303(d) list for impaired waterbodies due to the decreasing amount of dissolved oxygen within the lake. Meeting the standards under the federal Clean Water Act will ensure that the lake will continue to be a clean source of drinking water for 96,000 people in Bellingham and Whatcom County, support the watersheds ecosystem and provide aesthetic and recreational value to the community.

About the Lake

Lake Whatcom is the fourth largest lake in Washington, holding about 250 billion gallons of water, is located in Whatcom County surrounded by the Chuckanut Mountains and hills. The lake is 19.2 kilometers in length and 1.7 kilometers at the widest point (Pickett & Hood, 2008). Lake Whatcom was formed naturally by a glacier during the last Ice Age. The glacier scoured the less resistant rock, while leaving the two sills of resistant material that now divides the lake into its three distinct basins.

Table 1. Lake Whatcom Morphometric Data compiled by Pickett and Hood, 2008.

	Basin 1	Basin 2	Basin 3	**Entire Lake**
Volume (m^3x10^6)	19.4	18.0	883.5	**921**
% of Lake Volume	2.1	2.0	95.9	**100**
Maximum Depth (m)	29	21	103	**103**
Mean Depth (m)	9.2	11.2	54.0	**46**
Surface Area (km2)	2.1	1.6	16.6	**20.3**
Length (km)	2.2	2.5	13.3	**19.2**
Maximum Width (km)	1.1	1.0	1.7	**1.7**

The Geneva Sill separates Basin 1 and 2, while the Strawberry Sill separates Basins 2 and 3 (Appendix E). The morphological characteristics of each lake basin are summarized in Table 1. Basin 3, the largest and deepest of the three basins with a maximum depth of 103 meters, is located the furthest upstream and contains approximately 96 percent of the lake's volume. Basin 3's watershed consists primarily of public and private forestland; very little is developed however, it contains the community of Sudden Valley. Basins 1 and 2 are largely developed, with each containing 2 percent of the lake's volume. Basin 1, the Silver Beach Basin, is located within the city limits of Bellingham and has a maximum depth of 29 meters. Basin 2, the Geneva Basin, contains the Geneva neighborhood on the southern shore and mixed zoning of residential and rural forestry on the north shore. The Geneva Basin is responsible for providing the drinking water for the City of Bellingham's.

There are 9 annual streams and approximately 25 additional small creeks and tributaries that flow into Lake Whatcom as seen in Appendix D. A dam on the Middle Fork of the Nooksack River diverts water from the Deming glacier on Mt. Baker through Bowman Mountain and continues underground to Mirror Lake where it flows down Anderson Creek and eventually into the south end of Lake Whatcom. The diversion operates during the fall and winter when the lake is below 95.1 meters above mean sea level, and continuously during the spring and summer when sufficient water is available in the Middle Fork (Figure 2). This is the major source of water for the lake during the summer months. The lake's outlet, Whatcom Creek, is located on the western edge of Basin 1 and drains Lake Whatcom into Bellingham Bay. This dam is regulated at the head of Whatcom Creek by the City of Bellingham to maintain the level of the lake. The lake cannot exceed 96 meters or go below 94 meters. The Lake Whatcom watershed is located and managed within three political jurisdictions: the City of Bellingham, Whatcom County and the Lake Whatcom Water and Sewer district (Lake Whatcom Management Program).

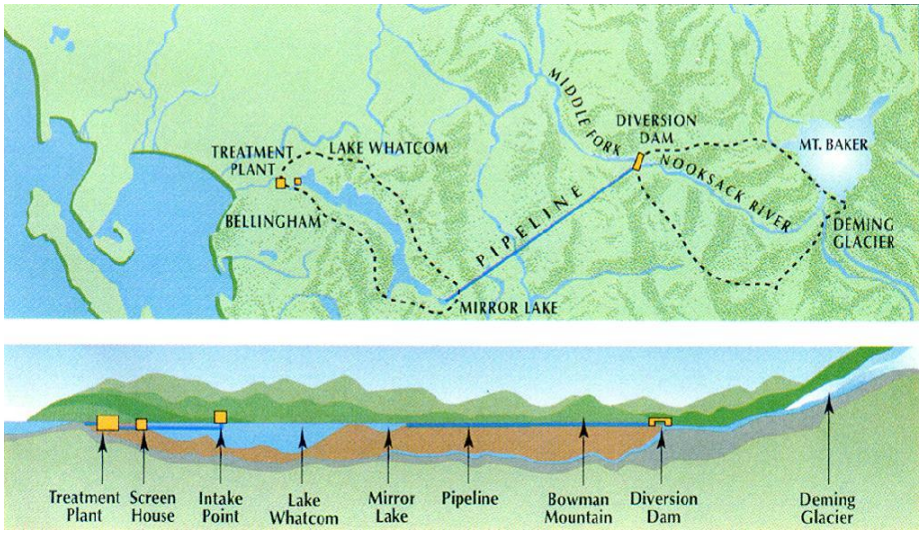


FIGURE 2. PATH OF THE INFLOW OF THE MIDDLE FORK DAMN FROM THE DEMING GLACIER TO LAKE WHATCOM, TAKEN FROM LAKE WHATCOM MANAGEMENT PROGRAM.

USES OF THE LAKE

As previously mentioned Lake Whatcom is an important source of drinking water to 95,000 people in Whatcom County including 82,000 served by the City of Bellingham. The City of Bellingham pulls their drinking water from Basin 2 while the Lake Whatcom Water and Sewer district of Sudden Valley pulls their drinking water from Basin 3 (Lake Whatcom Management Program). Along with this water treatment facilities there are about 250 homes that pull water directly from the lake. Aside from drinking water, the lake supplies water to two fish hatcheries: a kokanee hatchery located at the south end of the lake and a hatchery at Whatcom Falls Park. Both of these draw water from Basin 1 (Lake Whatcom Management Program).

The entire Lake Whatcom watershed is 31,127 acres, of which 629 (2 percent) is located in the City of Bellingham. The remaining 98 percent of the watershed is located in Whatcom County. Approximately 13 percent of the entire watershed is currently developed and an additional 18 percent of the watershed is available for development under current zoning. About 15,000 people live in the Lake Whatcom watershed in about 6,500 homes as of March 2007. The population surrounding the watershed in 2000 was about 13,000 residents. Full build-out within the watershed would result in approximately 16,000 more residents living in the watershed than in 2000. At the current rate of development rate of 270 new homes per year, the watershed will reach full build-out in approximately 12 years (Parametrix, 2007).

Lake Whatcom is also a nature preserve and recreational playground. There are about 200 species of animals that reside in the watershed. There is 1,178 acres of preserved land in the watershed. The lake is also used by fisherman, boaters, and swimmers during the summer time. Although a lot of the watershed is used as residential living or commercial forestry, there are also many trails that are utilized by both hikers and bikers.

LAKE PROCESSES

Lake Whatcom is a monomictic lake which means that for one part of the year the lake is stratified into layers (Pickett & Hood, 2008). This thermal stratification occurs in the lake during the summer months when the upper layer is exposed to more sunlight which heats the upper layer of water (Figure 3). The density difference between the warm top water and cooler water near the bottom create a stratification that lasts from late spring through summer into early fall. In the fall a process

called fall turnover occurs and breaks down the stratified lays, mixing the lake to a uniformed temperature from late fall through the winter until early spring. The depth and volume of Basin 3 causes this basin to become strongly stratified with a large portion of cold water isolated below the thermocline. Basins 1 and 2 have much smaller volumes of hypolimnetic water, but because these basins are shallower, the bottom waters interact more strongly with the water column (Pickett & Hood, 2008).

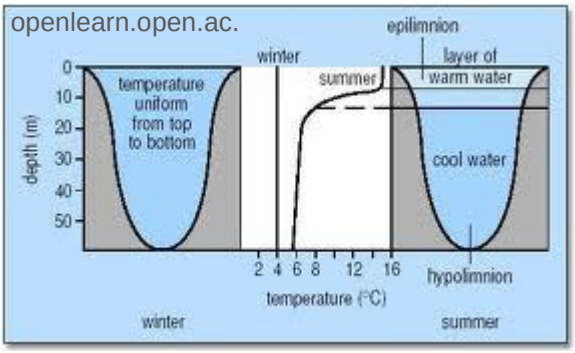


FIGURE 3. THERMAL STRATIFICATION IN A MONOMICTIC LAKE.

Another process that is important to Lake Whatcom is the occurrence of seiches. A seiche is a slow "sloshing" of the water back and forth in the lake caused by variations in wind. A strong wind can push water to one end of the lake. When the wind stops the water may rock back and forth for some time, creating something like small tides that rise and fall at the extreme ends of the lake. The effect of a seiche in Lake Whatcom is to cause rhythmic rising and falling of the surface and thermocline, which in turn can at times allow cold water from the hypolimnion in Basin 3 to slop over the Strawberry sill into Basin 2 which can have strong influences on temperatures and oxygen dynamics in Basins 1 and 2 (Pickett & Hood, 2008).

A critical effect of the stratification of Lake Whatcom is the isolation of cold water in the hypolimnion. The hypolimnetic water receives little oxygen from the epilimnion as the diffusion rate of oxygen through the thermocline is slow. Oxygen in the hypolimnion is therefore limited. Oxidation in the sediments use up the part of the oxygen dissolved in the water. As a result, hypolimnetic waters are often very low in oxygen or completely anoxic. Phosphorus in the lake interacts with anoxic hypolimnetic waters in two important ways. First phosphorus entering the water column from the watershed increases algal growth in surface waters. As previously mentioned in the introduction, when algae settles to the bottom of the lake, where bacteria begin to decompose the organic matter, which uses oxygen as the bacteria respire, which in turn increases the volume of anoxic water and duration of anoxic conditions. Secondly, anoxic conditions in the hypolimnion can release phosphorus stored in the sediment in a bioavailable form into the water column (Parametrix, 2007). This phosphorus source is called internal loading and can add to algal growth. This cycling of phosphorus from the water column to the sediments and back to the water column can result in the creation of a phosphorus "bank" in the sediment. This bank can continue to add phosphorus to the lake for years or even decades after surface sources are reduced (Parametrix, 2007).

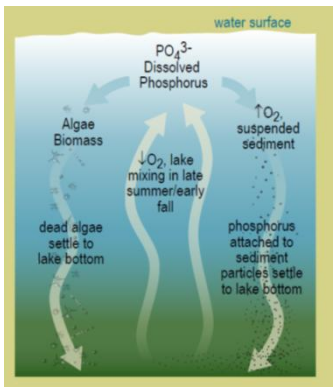


FIGURE 4. THE PROCESS OF INTERNAL LOADING OF PHOSPHORUS IN AN AQUATIC SYSTEM SUCH AS A LAKE (PARAMETRIX, 2007).

PHOSPHORUS AND DISSOLVED OXYGEN

Although phosphorus is an essential nutrient for all life, in healthy lake ecosystems only low concentrations of phosphorus are necessary. Phosphorus acts a limiting nutrient in freshwater environments, and due to the fact the element is in great demand, even a small increase in phosphorus can increase vegetation growth as well as promote algal growth. Therefore extra inputs of phosphorus disrupt the balance of a lake's ecosystem by fueling blooms of algae and aquatic weeds. As these blooms die, the vegetation sinks to the bottom of the lake where bacteria decompose it. During decomposition, these bacteria consume large amounts of dissolved oxygen, often depleting oxygen levels in the lower portion of the lake, creating an anoxic environment which can

lead to fish kills, foul odors, and poor tasting drinking water (Pickett & Hood, 2008).

Understanding sources of phosphorus and how phosphorus moves through the environment is critical. Sources of phosphorus and other pollutants to a lake can be divided into two categories: internal and external (Parametrix, 2007). Internal sources of phosphorus are derived from the lake's ecological processes. External sources originate from outside the lake or from upstream portions of a lake. Phosphorus is a common ingredient in household detergents and fertilizers and is used in many industrial processes and occurs naturally in soil as well as human and animal wastes. These external sources of phosphorus can be transported from the land during heavy rains as runoff or it can percolate into the soil. Once in the soil, phosphorus can be adsorbed onto soil particles or enter shallow interflow or deeper groundwater in dissolved form (Parametrix, 2007). Soil particles can be eroded into a stream, or interflow and groundwater can carry its phosphorus load to a stream which will then flow into the lake. All these process can also occur directly into the lake.

The Washington State Department of Ecology has adopted a specific set of lake phosphorus nutrient criteria based on region of the state and ambient total phosphorus levels. In the state of Washington at least 260 bodies of water are polluted because of phosphorus (Lake Whatcom Management Program). This listing is based on the lake's trophic state. The trophic state of a body of water is the level of nutrients and productivity of the lake. Lakes are typically one of three states: oligotrophic, mesotrophic, or eutrophic. Recent data from the Institute for Watershed Studies, show that Lake Whatcom is experiencing a negative trend in water quality, specifically an increase in phosphorus and Chlorophyll a, and decreased levels of dissolved oxygen, shifting the lake from an oligotrophic to a mesotrophic state. Lake phosphorus has exceeded 20 µg/L on an annual basis since 2003 at the lowest depth measured in Basins 1 and 2 (Pickett & Hood, 2008). The Department of Ecology has placed Lake Whatcom on its 303(d) list of impaired water bodies for dissolved oxygen and total phosphorus.

EXECUTIVE SUMMARY

Lake Whatcom is the source of drinking water for approximately half of the residents of Whatcom County and about 85,000 in the City of Bellingham. An overabundance of phosphorus has been identified as a significant factor contributing to excessive algal blooms creating low dissolved oxygen levels in certain portions of the lake at particular times of the year. Since 1997, Lake Whatcom has been listed, under section 303(d) of the Federal Clean Water Act, as an impaired water body due to excessive phosphorus discharges creating low dissolved oxygen levels. The City of Bellingham and Whatcom County are under direction by Washington Department of Ecology to substantially reduce the phosphorus content in Lake Whatcom, commonly referred to as TMDL. These conditions lead to increased treatment costs for drinking water and impair the other beneficial uses of the lake. Improper use of fertilizers, mulches, and soil amendments containing phosphorus is a known source of phosphorus contamination in water bodies.

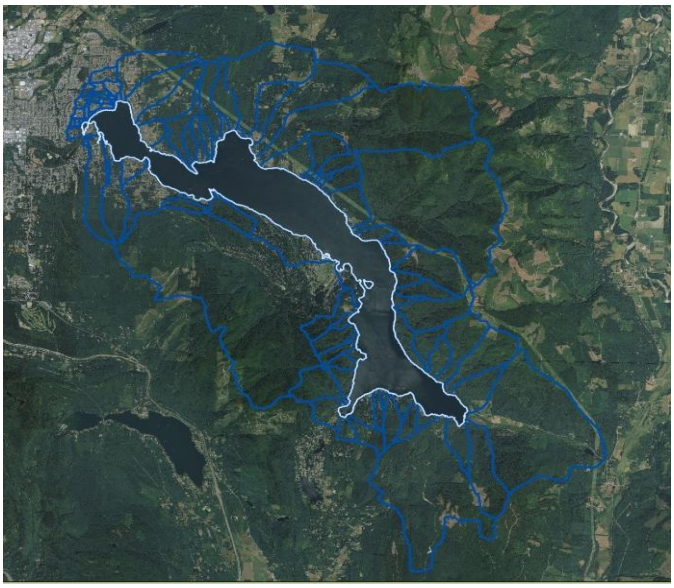


FIGURE 5: THE BOUNDARIES OF THE LAKE WHATCOM WATERSHED, CREATED BY KERRI LOVE, 2011.

The purpose of this report is to reexamine and reevaluate the environmental impacts of the Bellingham city ordinance to amend the Bellingham Municipal Code (BMC) 15.42.050D (Appendix B), which came into effect in the City of Bellingham as of February 1, 2011. In order to assess the environmental impacts of the amended BMC, this report compares the environmental impacts of two alternatives. First, leaving the current Whatcom County Ordinance #2005-038 (Appendix A) as the rule of prohibition of phosphorus into the watershed; and second, the environmental impacts associated with having no regulations on phosphorus around the watershed. The Whatcom County Ordinance will be referred to as the original ban, while the amended BMC will be referred to as the extended ban, and the removal of all phosphorus bans will be referred to as no action.

ORIGINAL BAN

In 2005, the City of Bellingham adopted the Whatcom County Council Ordinance #2005-03 restricting the use of phosphorus lawn fertilizer in the Lake Whatcom watershed. This original ban of phosphorus established regulations for fertilizer application on residential lawns and public properties within the Lake Whatcom watershed.

> *"Effective April 1, 2005 no person shall apply any commercial fertilizer to residential lawns or public agency properties within the unincorporated area of the Lake Whatcom watershed either liquid or granular that is labeled containing more than 0% phosphorus" (Appendix A).*

The exception to this ordinance being the use of commercial fertilizers when applied to newly established turf or lawn areas in the first growing season. The purpose of the original phosphorus ban was to limit the phosphorus entering Lake Whatcom watershed in hopes to improve the quality of the water in the lake.

The original ban is found to have a minor positive environmental impact in both the natural and built environment however; it is not the best alternative. The original ban reduces the amount of

phosphorus entering the lake but does not educate on the importance of limiting the use of phosphorus to the community around the watershed nor does the ordinance ban all use of phosphorus fertilizers as there is an exemption to this ban.

Extended Ban

The amended Bellingham Municipal Code 15.42.050D is designed to educate customers of the prohibited uses of phosphorus fertilizers, mulches and soil in the Lake Whatcom watershed and extends:

> *"…the prohibition from lawns and turf to include all gardening and horticultural applications, extending phosphorus fertilizer probations to commercial properties in the watershed and repealing the exemption for lawns in the first growing season" (Appendix B).*

Scientific research has shown that most soils contain adequate phosphorus and that addition of phosphorus is often not necessary for healthy plant grown and may detract from it (Appendix B). Soil tests in Lake Whatcom watershed have revealed that most soils in the area already contain levels of phosphorus adequate for healthy plant growth. By forcing such information to be advertised at the retail level, residents and business owners will become more conscious of their use of phosphorus and more aware of the City of Bellingham's prohibition on the use of phosphorus containing materials in the Lake Whatcom watershed.

The expanded ban will result in a decrease of non-point phosphorus pollution as all use of phosphorus fertilizer will be ban, which makes the expanded ban have a significant positive impact on the environment.

No Action

Removing both ordinances on phosphorus will result in less consideration on the use of phosphorus containing fertilizers, which will lead to in an increase of phosphorus pollution in the Lake Whatcom watershed. The increase in phosphorus is deemed to have a significant negative impact on the built and natural environment. The failure to reduce phosphorus and other pollutants in the lake will lead to substantial expenses for enlargement and upgrading of the City of Bellingham's water treatment plant. Phosphorus will negatively impact the natural environment by increasing algal blooms and depleting dissolved oxygen in the hypolimnion of the lake, which is important habitat for many of the fish of Lake Whatcom.

Conclusion

The expanded ban, eliminating all use of phosphorus containing fertilizers with no exceptions, is the favored action in this assessment. This option provides increased watershed protection through education and prohibition. The increased education will ensure the future of the lake as residents and business owners will be aware of the impacts of phosphorus on the watershed while the increased phosphorus prohibition limits the amount of phosphorus entering the lake immediately. This combination will be the most effective in preserving the resources of Lake Whatcom, and provide the City of Bellingham and Whatcom County with drinking water for years to come.

DECISION MATRIX

ENVIRONMENT	ORIGINAL BAN	EXTENDED BAN	NO ACTION
NATURAL ENVIRONMENT			
Earth	+	+	-
Air	0	0	-
Water	++	++	--
Plants and Animals	+	++	--
Energy and Natural Resources	+	+	--
BUILT ENVIRONMENT			
Environmental Health	+	+	--
Land and Shoreline Use	+	+	-
Transportation	0	0	0
Public Services and Utilities	+	++	--

KEY

Significant positive impact: ++
Minor positive impact: +
Significant negative impact: --
Minor negative impact: –
Neutral or no impact: 0

Elements of the Environment

(1) Natural Environment

(a) Earth

(i) Soils

Existing conditions:

Soils within the Lake Whatcom watershed contain a low level of naturally occurring phosphorus. Not all phosphorus is bioavailable. Phosphorus becomes available in two ways: decomposition and weathering. As bacteria strip organic phosphorus from the soil and decomposing organic matter the bacteria convert inaccessible organic phosphorus into bioavailable inorganic phosphorus accessible to plants and algae. Furthermore, geologic uplifting can bring sediments to land and weathering will convert organic phosphorus into inorganic phosphorus (Ophardt, 2003).

Although the phosphorus bans will not affect this process or any processes in the soil it is important to note these processes as an important source of phosphorus.

(b) Air

(i) Odor

Existing conditions:

Phosphorous levels in Lake Whatcom have a minimal impact on the air quality around the lake. Algal blooms caused by phosphorus loading have been known to cause unpleasant odors, but there have been no reports of algal blooms causing any odor in the recent past (Homann, 2010).

Original Ban:

With the original ban, the rate of algal blooms will remain the same.

Expanded Ban:

With an expanded ban on phosphorus, algal blooms would occur less frequently, lowering the potential for unpleasant odors. Decreased phosphorous loading would lower the chance of eutrophication which could cause malodorous fish kills.

No Action:

Were the ban to be lifted, algal blooms, which could cause odors, would occur more frequently. Increased phosphorus loading would also increase the probability of eutrophication of the lake, which would cause odors from fish kills and plant decay.

(c) Water

(i) Groundwater movement/Quantity/Quality

Existing conditions:

The Washington State Department of Ecology currently includes Lake Whatcom on the list of impaired waters for having low dissolved oxygen (DO) levels. This is due to both internal and external phosphorous loading in the lake (Pickett & Hood, 2008).

Internal loading occurs when bacteria in the sediments of the lake pull phosphorus out of anaerobic soil and release it into the water. External loading of phosphorus is when phosphorus from within the

watershed makes its way into the water. External sources make a significantly larger contribution of phosphorus to Lake Whatcom than internal sources, since Lake Whatcom is mesotrophic. The majority of the external loading of phosphorus comes from nonpoint sources, such as storm water runoff (Homann, 2010).

Phosphorus loading in Lake Whatcom has led to increased algal growth rates. This augmented algal growth is leading to lower DO levels within the lake (Pickett & Hood, 2008). As algae die, they sink and consume oxygen as they begin to decompose. This makes the lake a less suitable habitat for fish and increases the internal loading since the sediments become more anaerobic (Homann, 2010).

(II) PUBLIC WATER SUPPLIES

EXISTING CONDITIONS:

Phosphorous loading in Lake Whatcom has led to increased algae growth. This has caused the Bellingham water treatment plant to encounter problems. During the summer, water use in the City of Bellingham increases, putting a large stress on the water treatment plant to treat more water for distribution. The warmer temperatures and increased sunlight during the summer allow algae to grow rapidly (Homann, 2010). With the increased demand for water and the increased algae growth, the water treatment plant's filters clog frequently during the summer. This is a problem, as time and energy must be spent to backwash the filters (Pike, 2010). This issue is discussed further in section 1e.

Disinfectant byproducts may be produced when algae makes its way into the filters. Water is chlorinated at the water treatment plant before being distributed to make sure that the water is sterilized. When algae or other organic matter are present when the water is chlorinated, disinfectant byproducts may be produced. Some of these disinfectant byproducts, such as the trihalomethanes, are carcinogenic (Homann, 2010). This is discussed further in section 2a.

Original Ban:

With the original ban, phosphorous loading from runoff will continue, allowing more algae to accumulate in the lake. This accumulation of algae will continue to decrease the DO levels in the lake as decomposition takes place. Furthermore, the water treatment plant will continue to have problems with algae clogging the filters during the summer.

Expanded Ban:

An extension of the phosphorous ban would lead to a decrease in external phosphorus loading within the lake. This may decrease external loading to the point where algal growth rates would return to normal rates, allowing the DO to reach acceptable levels, enabling Lake Whatcom to be removed from the Washington State Department of Ecology's 303D list. This would lower the amount of algae that reaches the water treatment plant's filters, causing the filters to clog less frequently during the summer.

No Action:

With no ban on phosphorus, the external loading of phosphorus into the lake would have the potential to increase. This would lead to higher algal growth rates and a rapid decrease in DO levels. This would cause the filters at the water treatment plant to clog more often, putting a larger stress on the facility. This increase in algal biomass would also increase the chance of harmful disinfectant byproducts being created in the plant before distribution.

As algal growth increases and DO levels continue to decrease, Lake Whatcom is undergoing eutrophication. Eutrophication is a process that occurs when algal growth rates raise so high that the DO within the lower layer of the lake drops to levels that cannot support aerobic life such as fish. This causes loss of habitat to cold water fish, such as salmonids, since they live

in the cold, lower level of lakes (New Hampshire Department of Environmental Services, 2010). Eutrophication of a lake is an irreversible process since it leads to a building biological oxygen demand. Biological oxygen demand is the amount of DO that would be required to decompose the matter within a lake. As algae continue to grow and die, they begin to decompose slowly due to the low amount of DO in the water. Since the rate of DO being used for decomposition would be greater than the amount of oxygen being dissolved into the water, the biological oxygen demand would continue to grow. The lake also becomes more nutrient rich due as sediments become more anaerobic, increasing the rate at which bacteria release phosphorus from the soils. Also, as algae decompose, phosphorus is released into the water, helping more algae to grow furthering the cycle of algal growth (Litke).

(D) Plants and Animals

(I) Habitat for and number or diversity of species of plants, fish or other wildlife

Existing Conditions:

Lake Whatcom supports a variety of fish and wildlife species. Both native and introduced fish reside in Lake Whatcom including the native kokanee (among other salmonids) and the illegally introduced largemouth bass (Lake Whatcom Management Program). The lake hosts two hatcheries operated by Washington Department of Fish and Wildlife that raise kokanee and rainbow trout. Different fish have specific requirements for particular dissolved oxygen (DO) levels, below which they will not reproduce, feed, or survive; for most fish this occurs when the DO levels drop below 5 mg/L (Homann, 2010). When fish become stressed they will often move to areas of higher DO; however most of the fish that reside in Lake Whatcom are cold water fish and cannot survive warmer, oxygenated surface water.

In addition to the fish that live in the lake, the watershed is home to a variety of wildlife species. There are 10 amphibian, 2 reptile, 125 bird and 49 mammal species found in the area; many of which are considered “species of interest” meaning concern exists for the future of their populations, generally due to habitat loss. The common loon, osprey, northern goshawk, great blue heron, bald eagle, pileated woodpecker, long eared myotis and the tailed frog are a few of these species (Appendix C). Most wildlife is dependent on and requires very specific types of habitat, especially while mating and caring for their young (Lake Whatcom Management Program).

Within Lake Whatcom watershed there are many different types of macroinvertebrates that can be found. Some of the common families include the mayfly, stonefly, caddisfly, beetle and true fly. These organisms are good indicators of water quality as they vary in their tolerance of pollution and are unable to survive in depleted oxygen conditions. In addition to being a good indicator macroinvertebrates provide a critical link in the food web and ecosystem (Lake Whatcom Management Program). As a major food source for all life stages of fish as well as birds and other wildlife, a lack of macroinvertebrates would eventually result in the reduction of many other species. Macroinvertebrates act as decomposers by breaking down organic matter into nutrients that can be easily utilized by other organisms.

Lake Whatcom watershed is comprised of forested areas dominated by stands of western hemlock and Douglas-fir interspersed with western red cedar. The riparian zones contain native and invasive species (Lake Whatcom Management Program). While there are limited wetland areas in the watershed, riparian areas are abundant and are associated with streams as well as areas of land that border the lake. These riparian zones provide critical habitat features of the resident wildlife, such as

lowering water temperatures through shading and providing cover from predators and extreme weather.

Oxygen depletion in the hypolimnion of Basins I and II of Lake Whatcom has been apparent since 1997. The current rates of oxygen depletion during periods of stratification are in the typical range for mesotrophic lakes. However, the increasing trends suggest that trophic state of Basin I may soon shift to a eutrophic condition (Pelletier, 1998). During decomposition, DO is consumed without replenishment. From June through mid-August the epilimnion (surface water) of the lake is heated and becomes less dense than the deeper, cooler water of the hypolimnion (bottom water).

This process blocks oxygen from entering the hypolimnion. At low DO concentrations, phosphorus is released from the sediment into the water. As summer progresses nutrients in the hypolimnion increase in concentrations and may be mixed into the lighted, warm epilimnion where they stimulate growth of algae in the process called internal nutrient loading. With no oxygen cycling through the layers and algae blocking the photosynthetic plants, the DO decreases throughout the summer until the fall when the surface cools and mixes again with the deeper water in the lake (Pickett & Hood, 2008). Fish such as the salmonids that prefer the cold water of the hypolimnion may be excluded from the lake due to low oxygen.

Original Ban:

With the original ban, phosphorus will continue to enter the lake from point and nonpoint source pollution and by internal loading. Aquatic organisms are very sensitive to reductions in the level of dissolved oxygen in the water. Growth rates, swimming ability, susceptibility to disease and the relative ability to endure other environmental stressors and pollutants are affected by DO levels (Pickett and Hood 2008). As fish are already beginning to be excluded from the hypolimnion, the continuation of external loading would increase the probability of fish kills. On a similar note with the decreased levels of oxygen, macroinvertebrates will find it harder to survive in their benthic environments. A decrease in macroinvertebrates will stress fish and the ecosystem.

Expanded Ban:

An expanded ban on phosphorus will decrease the external phosphorus entering the lake. The decrease in additional phosphorus will decrease the amount of phosphorus available for algal blooms. With fewer algal blooms, more sunlight will be able to reach the photosynthetic macrophytes, which will replenish the oxygen. This will result in an increased habitat for fish during times of stratification and fewer incidences of fish kills.

No Action:

With no ban on phosphorus, the amount of phosphorus will increase beyond levels that will sustain habitats. The increase of phosphorus from point and nonpoint source pollution paired with the internal loading of Lake Whatcom would increase the occurrence and severity of algal blooms. The increased algal blooms will ultimately lower the levels of DO in the lake. When algae die, they sink to the bottom of the lake and begin to decompose. Bacteria feed on the decomposing algae and consume oxygen in the water. The bacteria deplete the supply of dissolved oxygen needed by fish and plants. In addition dead algae create more nutrients that fertilize even more algal growth, accelerating the depletion of oxygen in the lake. Low oxygen levels cause sediments on the bottom of the lake to release mercury, which is then absorbed by fish and phosphorus, which stimulates growth of even more algae.

The increased algal production clouds the water and blocks sunlight from reaching photosynthetic macrophytes such as aquatic grasses. The depletion of photosynthetic

organisms also reduces the source of DO, leaving no replenishment as it depletes. The lack of DO in the hypolimnion would make the lake inhabitable by fish and benthic macroinvertebrates. Lake Whatcom would effectively become a eutrophic lake.

(II) Unique species

Existing conditions:

The kokanee, cutthroat trout, longnose sucker, peamouth chub, prickly sculpin, coast range sculpin and three-spine stickleback are all species that are native to Lake Whatcom. These species rely on a variety of food sources, including other fish, insects, and vegetable matter. Small amounts of phosphorus are naturally bound in wild fish. In fact, it even plays a significant role in the development of bone structure. However, unnaturally high amounts of phosphates have also been shown to impose a direct negative impact on the reproductive systems of freshwater fish (Guilaume & Reynolds, 1998). As far as oxygen depletion goes, it is most severe in Basins 1 and 2 which is why the lake is listed as an impaired water body. The deeper sections of these 2 basins are already below the levels of dissolved oxygen required to support aquatic life (Markiewicz, 2008). Only a few resistant species are able to survive in conditions of such low oxygen, and as species disappear, biodiversity declines. With the declining fish population, larger animals that rely on these species for their food source begin to decline in number.

Original Ban:

The first ban was not doing enough to reduce the effects of phosphorus on algal growths in the lake, as evidenced by the low oxygen levels in basins 1 and 2. However, longnose suckers actually eat algae, so the current amount of phosphorus adding to the algae levels comes with both advantages and disadvantages to them.

Expanded Ban:

Were all human-added phosphorus to be banned from the lake, the native species would more likely prosper than suffer. There would be less algal growth in the water, the lake temperatures would not rise at the current abnormal rate, and DO levels would return to normal.

No Action:

If phosphorus were to flow into the lake at a higher rate than it is now, the decaying process of the increased algae in the lake may deplete the dissolved oxygen to a point that is not suitable as a habitat for the remaining native fish. The peamouth chub, sculpin, and stickleback are three species which favor residing on the bottom of lakes and would be most affected (Lake Whatcom Management Program). However, illegally introduced, non-native fish, such as the brown bullhead which are highly adaptable and tolerate very low dissolved oxygen levels, will still thrive and continue competing for food and space with the less adaptable native species. Eutrophication of the lake would also threaten the food sources of the fish which eat native vegetation, because the excess algae would displace the native plants in the water by blocking sunlight from reaching the bottom of the lake and smothering the lake bed with organic matter (Sierra Club).

(III) Fish and wildlife migration routes

Existing conditions:

There are about 36 tributaries that flow into Lake Whatcom, 12 of which are being monitored for excess nutrients such as phosphorus (Lake Whatcom Management Program). Most of these are used

by the native migratory species of the lake. Migratory species in the watershed include cutthroat trout and kokanee.

Cutthroat trout spawn in the upper tributaries of coastal rivers such as Whatcom Creek and over 30 other streams surrounding the lake. Although the Cutthroat can be found in more streams in Whatcom County than any other salmonid, they are currently listed as a species of concern in the Puget Sound and the Strait of Georgia, and are a candidate for the endangered species list (NSEA). Kokanee migrate back to their natal stream for spawning as well. Some important spawning areas are Olson Creek in the northwestern portion of the lake, Anderson Creek in the south and cutthroat also in Austin Creek in the west (Whatcom County Water Resources, 2003). Kokanee travel much shorter distances than do cutthroat, only migrating partway up the streams. See Appendix E: Map of Migration Routes. The migration routes of these species have not been impacted by phosphorus thus far.

Original Ban:

Under the original ban, some phosphorus was getting into the streams where migratory species roamed, but not enough to have a significant impact.

Expanded Ban:

With an expanded ban on phosphorus, algae growth rates would no longer increase, decreasing their chances of having impacts the streams. This would be beneficial to the migratory species which are already stressed.

No Action:

Were the current ban to be lifted and more phosphorus were to be allowed into the lake, it would begin enter via the streams where these species spawn, making it even more difficult for them to thrive. Suspended solids, such as algae in streams, leads to an increase in water temperature, because turbid water tends to absorb more heat than non-turbid water (Agency). One of the main causes of population decline for migratory species is the warming of their waters, which suspended algal growth in streams would increase.

(E) Energy and Natural Resources

(I) Amount required/ Rate of Use/Efficiency

Existing conditions:

Lake Whatcom is the main drinking water source for approximately 96,000 people in Whatcom County, and over 82,000 people in the City of Bellingham. Water is the most important natural resource that the Lake Whatcom watershed offers (Weiner, 2007). Other natural resources include timber and animal biodiversity. Each year, the City of Bellingham water customers consume approximately 67% of the available water stored in Lake Whatcom (City of Bellingham, 2011). A large seasonal difference exists in water demands; water is in the highest demand during summer, when temperatures are the highest and there is less rainfall to replace the water that is consumed. About 30-35% of the total water used is consumed during the summer months. About 8 million gallons are dispensed per day in the winter months, and about 20 million gallons are distributed per day during the summer months (City of Bellingham, 2011). The more water required to be produced, the higher the costs for energy and chemical treatments, so costs for the treatment process are higher in the summer.

Original Ban:

With the original ban, the main eutrophication effects will continue to happen during the warm summer months. Algae blooms will still exist and increase in size and bulk, which will

clog water filters, increasing the amount of chemicals for treatment which increases costs, increasing the amount of water required to backwash. This in turn will limit the amount of water available to customers, and decrease the efficiency of the plant. Stricter water conservation measures will have to be adopted to compensate for the smaller amounts of water available to customers. Rate of use of the water will also decrease in order to not over draw from the lake.

Expanded Ban:

With the expanded ban, the watershed will have reduced phosphorus runoff into the lake. There will be less phosphorus in the water, which will limit plant and algae growth within the lake. The biggest effect that the extended ban will have on the amount of water required, rate of use, and efficiency will occur during the summer months. Summer algae blooms increase significantly and clog filters for water treatment. With less phosphorus, there will be smaller amounts of algae and the amount of water required for summer will decrease with decreasing amounts used for backwashing. The efficiency of the water treatment plant will also increase. Water conservation practices will lower the amount of water required and rate of use and raise efficiency and lower costs even more during summer.

No Action:

If the phosphorus ban is removed, there will be significant effects to the lake and water that is the principle drinking water source. These effects will be most evident in the warm summer months; effects will be present all year round if eutrophication occurs. If the bans are removed, the amount of water required during summer will increase because people will be watering lawns and fertilizing all summer, leading to algae blooms thriving on the lake, which will clog the water treatment filters more frequently, and decrease the WTP's efficiency. There will be less water available in the lake, and the water quality will suffer without a phosphorus ban. The amount of water required will increase also because more water would be required for backwashing. The efficiency of the plant could decrease so much that the plant might need to be significantly upgraded, which will be extremely costly.

(II) Source/Availability

Existing Conditions:

Lake Whatcom is the principle source of drinking water for the city of Bellingham and Whatcom County. Every year, water customers consume about 67% of the water that is stored in Lake Whatcom, and about 30-35% of that water is consumed during the warm summer months, and about 20 million gallons are consumed per day during summer (City of Bellingham, 2011). Water conservation is very important because of the seasonal fluctuations in water demand. Currently, for withdrawals of drinking water the total water level of the lake must be kept at a minimum of 311.5 feet Mean Sea Level (MSL) during the summer. Over the past few summers, when water has been in higher demand, increased withdrawals from the lake can lower the water level to 313 feet, which is close to the minimum (Stark & Paben, 2009).

Original Ban:

With the original ban, the source of the drinking water will be affected, with continued phosphorous runoff into streams, creeks and tributaries of the lake. The availability of the water may suffer, because the algae blooms will still be present and may continue to grow in size, limiting the amount of water that can be drawn out of the lake at a time. More water will be required for backwashing algae from the filters, and that means less water available for water customers.

Expanded Ban:

If the expanded ban is passed, the sources of the lake will be positively impacted; streams and creeks and tributaries within the watershed should have less phosphorus runoff content. The availability of the water will not be affected; there will always be water in Lake Whatcom with the passed ban.

No Action:

If the bans on phosphorus were removed, the sources of the drinking water will suffer. There would be large amounts of phosphorus runoff going into the lake from increased housing developments and phosphorous fertilizer uses, causing the lake's phosphorous levels to increase. The availability of the water will suffer because large amounts of water will be required for backwashing, leaving less water for customers, potentially leading to over withdrawals of the lake water in order to satisfy water demands. Water conservation practices might not even be effective if there is no ban on phosphorus in the watershed.

(2) Built Environment

(a) Environmental Health

(i) Releases or potential releases to the environmental affecting public health

Existing conditions:

The drinking water of the City of Bellingham pipes out to 82,000 people. Chlorination has made the U.S. water supply safe from waterborne illnesses produced by bacteria, viruses, and parasites. In late summer when algal blooms are most prominent, algae containing nontoxic but odorous chemicals alters the taste and smell of the drinking water. This algae reacting with the chlorine causes the drinking water to smell like chlorine even though no higher levels of chlorine have been added.

When there is an abundance of algae present in the water, the chlorination process creates byproducts as the algae reacts with the chlorine. These disinfectant byproducts include a group of chemicals known as Trihalomethanes (THMs). THMs include four chemicals: cholorform, bromodichloromethane, bromoform, and dibromochloromethane. The U.S. Environmental Protection Agency (EPA) has mandated public water systems check for THMs on a regular. The maximum level of THMs in drinking water should be less than 80 parts per billion (ppb). EPA has set standards for THMs in water because there is a slight possibility of an increased risk of bladder or colorectal cancer over a lifetime of drinking water with THMs above 80 ppb. EPA estimates that drinking two liters of water containing 100 ppb THMs every day for 70 years could result in three cases of cancer for every 10,000 people (Oklahoma Department of Environmental Quality, 2005). The slight risk of increased cancer occurs only after decades of drinking water with elevated THMs. There is no immediate risk from water containing low levels of THMs but they are an important water quality issue faced by public water supply systems.

The level of THMs has never approached the set limit of 80 ppb, but the levels of THMs increases in late summer when algal blooms are most abundant. Since 1998 levels have continued to grow. The highest level of THMs recorded was collected in 2004 at 49 ppb (Weiner, 2007).

Original Ban:

With the original ban, there would be need to continue to monitor levels to assure they do not exceed or reach the EPA determined critical level as algal blooms would continue to occur.

Expanded Ban:

The effects of the new ban may reduce the severity of algal blooms which will lessen the THM byproducts. Levels of THMs still need to be monitored as algal blooms are also a natural phenomenon.

No Action:

The effects of removing the phosphorus ban would cause an increase in algal blooms. With this increase it would increase the carcinogenic byproducts created by the chlorination treatment. This is a risk to public health and safety as THMs are cancer group B carcinogens causing cancer in the liver, kidney, colon, bladder, rectum and reproductive organs (Weiner, 2007).

(b) Land and Shoreline Use

(i) Relationship to existing land use plans and to estimated population

Existing Conditions:

Lake Whatcom is valued for its recreational uses, scenic lakeside, and vicinity homes which are in high demand. Currently there are around 15,000 residents within the watershed. Land within the watershed is utilized primarily for residential use with a mixture of logging and conservation units. There are 30 miles of shoreline along Lake Whatcom. The City of Bellingham includes 629 acres or roughly 2 percent of the of the 31,127 acre watershed.

Original Ban:

The original phosphorous ban of 2005 addressed phosphorous use within the watershed which banned land owners and lawn care companies from using fertilizers with more than 0% phosphorous. There was a first-year exemption of the ban allowing new plantings to receive fertilizers containing phosphorous. The ban did not have a direct effect on land and shoreline use, with the exception of reduced phosphorous levels allowed for fertilization of lawns and gardens.

Expanded Ban:

Land and shoreline use would not be affected in terms of development. However with the expanded ban, new landscaping would not be granted a first-year exemption from the phosphorous ban. The expanded ban would move to include commercial properties that are currently exempt. The soils of the Lake Whatcom watershed are naturally rich with phosphorus so phosphorous additives are unnecessary. It has been shown that landscaping within the Lake Whatcom watershed often prospers more without phosphorous fertilizers (City of Bellingham, 2010). The expanded ban addresses and discourages the use of compost that isn't fully composted as well as fertilizers such as manure, wood chips and decorative barks that contain naturally occurring high levels of phosphorous that leach into Lake Whatcom. Educational outreach programs are encouraging landowners to research the best mulches available with low phosphorous levels, such as hog fuel, a waste material derived from forest clearing processes.

No Action:

If the current ban were to be lifted a change in land or shoreline use would not likely occur, with the exception of algal blooms impeding recreational uses due to increasing lake phosphorous levels or unsavory drinking water for homes that draw water directly from the lake.

(II) Housing

Existing Conditions:

The Lake Whatcom watershed is a desirable place to live for its proximity to lake recreation, forested areas and trails, all while being just a short 15 minute drive from downtown Bellingham. Most houses are located on the north and western shores of Lake Whatcom. Currently 15,000 people live within the Lake Whatcom watershed and under current zoning about 2,160 more single-family houses could be built in the watershed, on 5,552 acres of undeveloped land. At the current rate of construction — about 270 homes per year — the remaining developable land in the watershed will be fully built out in about 8 years. (Weiner, 2007, p. 8)

Development creates disturbed land as well as impermeable surfaces that contribute high levels of run-off into Lake Whatcom. Run-off containing phosphorous can originate from sources found in developed areas such as soil exposed during construction and landscaping, lawn and garden fertilizers, animal waste, failing septic tanks, automobile exhaust, car washing, as well as phosphorus-

based soaps, detergents, and chemicals (Whatcom County and Lake Whatcom Water and Sewer District, 2010).

Original Ban:

The original ban would not limit housing development or redevelopment. It is important to recognize that a 2001 city ordinance exists that restricts impervious and partially pervious surfaces in the following way: owners have the option to leave 75% of existing forest on their lot or can plant to recreate 75% of forested area on their property; the second option is to leave a minimum of 30% of their property forested or create such conditions with the additional steps including planned engineering of storm water systems and soil remediation that can be shown to reduce runoff at the same level as a mature forest. Impervious surfaces are limited to 15% or 2000 square feet of the property, whichever is greater.

Expanded Ban:

The expanded ban does not change the current impervious and partially pervious surface restrictions, nor does it address the amount or type of designated allowable housing.

No Action:

If no action is taken addressing the amount and type of surface alterations to the Lake Whatcom watershed, then it is anticipated that excess levels of phosphorus will continue to leach into Lake Whatcom via surface run-off at an even greater rate than it currently is, while the amount of development would remain the same.

(III) AESTHETICS

EXISTING CONDITIONS:

Land and shoreline use within the Lake Whatcom watershed is interspersed with residential and natural densely vegetated areas. Lake Whatcom receives approximately 43 inches of rain per year rendering the natural landscape to be green and well vegetated (City of Bellingham). Shoreline use is primarily recreational with most shoreline areas serving as private and public beach access and picnic areas.

Original Ban:

If the current ban is to remain there would be no noticeable change in the aesthetics of the landscape and the phosphorous levels in the lake would remain consistent with current levels, meaning that warm weather eutrophic events can be expected.

Expanded Ban:

It has been claimed that landscaping will thrive in the same manner or potentially better without phosphorous additives so the expanded ban should not have any negative aesthetic effects. The expanded ban would help to reduce the amount of phosphorous loading of the lake thus reducing algal blooms and eutrophication which is aesthetically desirable due to visual and olfactory nuisances.

No Action:

If the ban of all phosphorous containing commercial fertilizers and detergents were lifted it is expected that the levels of phosphorous run-off into the lake would increase and eutrophication would increase without any added benefits to lawn or gardens. A phosphorous induced increase in algal blooms and fish kills would result in poor aesthetics and sanitation.

(IV) Recreation

Existing Conditions:

Lake Whatcom and the Lake Whatcom watershed is a recreational playground offering a variety of recreational opportunities to pleasure seekers. Parks such as Bloedel Donovan offer ball fields, beach access, swimming areas and boat launches to its visitors while Lake Whatcom's Hertz trail provides interpretive stations and 3.1 miles of shoreline access. Anglers can fish for Cutthroat Trout, Kokanee Salmon, Large Mouth Bass and Small Mouth Bass and Yellow Perch in the waters of Lake Whatcom. Hiking and mountain biking are popular activities on Galbraith Mountain and in the nearly 400 acres of the Stimpson Family Nature Preserve. Sudden Valley located on the south end of Lake Whatcom also has an 18-hole golf course that is open to the public. Lake Whatcom itself is a playground for watercraft such as sailboats, motor boats, canoes, kayaks and jet skis.

Original Ban:

With the current ban in place the lake does exhibit some eutrophication during the warm summer months, which can contribute to kills of aquatic species and the growth of algal blooms both of which inhibit water based recreational activities such as swimming and fishing.

Expanded Ban:

With the expanded ban it is expected that the lake will become healthier, making it more desirable for recreational activities such as swimming, boating and fishing.

No Action:

If the current ban were to be lifted, algal blooms and fish dies offs could severely affect recreational activities such as fishing, swimming and boating.

(V) Agricultural Crops

Existing Conditions:

The Lake Whatcom watershed is not an intensive agricultural area. The watershed within city limits is primarily zoned residential with some public and small parcels of commercial property. Due to the terrain of the Lake Whatcom watershed it is not a highly desirable area for agricultural endeavors. The current ban or expanded ban does not have a significant impact on agricultural areas within the watershed primarily because the agricultural areas are insignificant in size or number.

(c) Transportation

Although Lake Whatcom is surrounded by roads, many of which carry moderate levels of traffic, the bans on phosphorus that are under advisement with this EIA will not have any impact on transportation.

(d) Public Services and Utilities

(I) Maintenance

Existing Conditions

The Water Treatment Plant located near Whatcom Falls Park filters and treats the water from Lake Whatcom, and supplies it to the city and the county for drinking water. The water treatment process includes screening, disinfecting, filtering, settling, and coagulation. The largest effect that phosphorus has on maintenance is on the filtering and coagulation processes (City of Bellingham, 2011). The more phosphorus in the water, the more algae there is which clog up filters and do not settle to the bottom

of the tank during coagulation, so they are not removed by filtration. The more water that is used, especially in the summer, the more the city has to pay for energy and chemical treatment practices. Normally, backwashing filters (maintaining that they work properly) uses about 500,000 gallons of water per day, but in the summer when algae blooms are large and common, it takes more than three times the amount of water to backwash the filters, over 1.7 million gallons per day, because it must be done more frequently throughout the day (Public Works, 2009). The more water that has to be used for backwashing means the less water available for customers, so water conservation during the summer has a large effect on maintenance.

Original Ban:

With the original ban, maintenance costs would gradually increase every summer, because the filters would need to be continuously backwashed to remove the algae that is clogging the filters so that the drinking water is up to the state's standard. More and more water would be needed to backwash and more and more chemical treatments would need to be added to the water to kill the algae, which could raise the amount of trihalomethanes in the drinking water, which would decrease the quality of our drinking water and eventually render it unsafe to drink.

Expanded Ban:

With the extended ban passed, the efficiency of the water treatment plant will improve. The ban will lessen phosphorus runoff into the lake, which will decrease the amount of algae during the summer, so the filters will get clogged less often, and less water will be required for backwashing and maintaining the filters.

No Action:

If the extended ban is removed, algae levels in the lake will be driven up because of the increased phosphorus level s in the water, which will continually clog the filters requiring more water for backwashing and require more energy and chemicals to treat the water correctly, which will raise maintenance costs significantly. Without a ban on phosphorus in the watershed, the WTP may have to upgrade significantly to more advanced treatment equipment, which would be expensive.

GLOSSARY

303(D) LIST

Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which beneficial uses of the water—such as drinking, recreation, aquatic habitat, and industrial use—are impaired by pollutants. These ware water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years (Pickett & Hood, 2008).

AEROBIC

Containing or utilizing oxygen.

ALGAE

Photosynthetic, unicellular organisms occurring in near the surface of fresh or salt water, as well as in moist terrestrial environments.

ALGAL BLOOM

The rapid increase or accumulation in the population of algae on the surface of lakes, streams, or ponds; stimulated by nutrient enrichment. Heavy growth of algae in and on a body of water as a result of high phosphate concentration such as fertilizers. It is associated with Eutrophication and results in deterioration in water quality (Battle Creek Watershed Conservancy, 2010).

ANAEROBIC

Without oxygen.

BACKWASHING

In a wastewater or water treatment facility it is the flow of clean water in a direction opposite (upward) to the normal flow of raw water through rapid sand filters in order to clean them.

BENTHIC

The bottom of a body of water (Battle Creek Watershed Conservancy, 2010).

BIOAVAILABILITY

The capacity of a chemical constituent to be taken up by living organisms either through physical contact or by ingestion (Battle Creek Watershed Conservancy, 2010).

BIODIVERSITY

Diversity of plants and animals in a particular habitat.

BIOLOGICAL OXYGEN DEMAND (BOD)

A measure of the amount of biodegradable organic matter in a body of water, usually expressed in term of how much dissolved oxygen would be required to decompose the matter.

BIOMASS

The amount of living matter in a given habitat expressed either as the weight of organisms per unit area or as the volume of organisms per unit volume of habitat (Dictionary.com, LLC, 2011).

BROMODICHLOROMETHANE

Member of the trihalomethane family of organic compounds with formula $CHBrCL_2$.

BROMOFORM

A member of the trihalomethanes that is pale yellowish liquid with a sweet odor. Known carcinogen with chemical formula $CHBr_3$.

CARCINOGEN

A substance that leads to an increased risk of developing cancer.

CHLORINE

A naturally occurring element added to water as a disinfectant.

CHLOROFORM

A colorless, sweet-smelling organic compound in the trihalmethane family that is considered to be somewhat hazardous. Chemical formula is $CHCl_3$.

CLEAN WATER ACT

Federal act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the CWA establishes the TMDL program (Pickett & Hood, 2008).

COAGULATION

The process of causing small particulate matter that is suspended in water to clump into larger pieces which more easily filter or settle out.

COLORECTAL CANCER

A disease in which malignant cancer cells are found in the colon or rectum.

DECOMPOSITION

The biochemical process of organic material being broken down into smaller particles, chemical compounds and elements by bacterial or fungal action.

DISINFECTANT BYPRODUCTS

When the water treatment plants disinfect the water, typically by use of chlorine, natural organic matter (decaying vegetation) present in the source water react to form unwanted products. Disinfection byproducts for which regulation has been established include trihalomethanes.

DISSOLVED OXYGEN (DO)

The concentration of gaseous oxygen dissolved in water, usually measured in milligrams per liter. Oxygen enters water via the atmosphere and from photosynthetic plants. Respiration by aquatic animals and decomposition consume oxygen. If more oxygen is consumed than is produced, dissolved oxygen levels decline and sensitive animals may experience habitat loss resulting in immigration or death of species (EPA, 2010).

DIBROMOCHLOROMETHANE

A colorless trihalomethane also known as chlorodibromomethane ($CHBr_2Cl$).

ECOSYSTEM

The interacting populations of plants, animals, and microorganisms occupying an area, within their physical environment (Battle Creek Watershed Conservancy, 2010).

Environmental Protection Agency (EPA)

An independent federal agency established to coordinate programs aimed at reducing pollution and protecting the environment.

Epilimnion

The warm upper layer of a body of water with thermal stratification, which extends down from the surface to the Thermocline, which forms the boundary between the warmer upper layers of the epilimnion and the colder waters of the hypolimnion. The epilimnion is less dense than the lower waters and is wind circulated and essentially homothermous (Battle Creek Watershed Conservancy, 2010).

Eutrophic

Waters, soils, or habitats that are high in nutrients; in aquatic systems, associated with increases in limiting nutrients such as phosphorus or nitrogen, wide swings in dissolved oxygen concentrations occurs along with frequent algal blooms (USGS, 2010).

Eutrophication

The degradation of water quality due to over-enrichment by nutrients, primarily nitrogen and phosphorus, which results in excessive plant and algal growth and decay. Low dissolved oxygen in the water is a common consequence (Battle Creek Watershed Conservancy, 2010).

External loading

When phosphorus is introduced to the lake from external sources such as runoff.

Fall Turnover

The mixing of thermally stratified waters that commonly occurs during early autumn.

Fish Kills

Localized die-off of fish populations which may also be associated with more generalized mortality of aquatic life due to a variety of factors including but not limited to lack of dissolved oxygen or rapid changes in temperature or salinity.

Geological Uplifting

The process of shifting sediment due to a rise of land to a higher elevation.

Groundwater

Any water that exists beneath the land surface, but more commonly applied to water in fully saturated soils and geologic formation (Battle Creek Watershed Conservancy, 2010).

Hypolimnetic

Refers to the cold bottom water zone below the thermocline in a lake.

Hypolimnion

The lower most, non-circulating layer of cold water in a thermally stratified lake or reservoir that lies below the thermocline, which remains perpetually cold and is usually deficient of oxygen.

Impaired Water

Water bodies that cannot reasonably be expected to attain or maintain applicable water quality standards and at least one beneficial use shows some degree of degradation (Battle Creek Watershed Conservancy, 2010).

Impervious Surfaces

Areas in urban and developed areas that prevent or impede the infiltration of stormwater into the soil.

Indicator Species

Biological species that are unique environmental indicators as they signal changes of biological conditions in a watershed. Can be used as early warning signs of pollution or degradation in an ecosystem. Indicators are actually groups or types of biological resources that can be used to assess environmental condition and assess the water quality conditions. Major indicator groups are fish, invertebrates, and macrophytes (EPA, 2011).

Inorganic Phosphorus

A non-carbon based form of phosphorus that is not bioavailable.

Internal Loading

The recycling of watershed derived phosphorus that is stored in lake sediment. It occurs over decades and centuries after considerable volume of sediment phosphorus is accumulated.

Invasive Species

Any species that has been introduced to an environment where it is not native, and that has since become a nuisance through rapid spread and increase in numbers often to the detriment of native species.

Leaching

The loss of water-soluble plant nutrients from the soil due to rain and irrigation.

Limiting nutrient

A factor or resource that controls a process, such as growth, species population size and distribution. An example of a limiting factor is sunlight in a lake where growth is limited to plants the further in the lake they are. An example of a limiting resource would be phosphorus.

Macroinvertabrates

An animal without a backbone, large enough to see without magnification, more commonly known as insects, worms, snail, zooplankton and many other “critters” (Battle Creek Watershed Conservancy, 2010).

Macrophytes

Aquatic plants that grow in or near water and are either emergent, submergent, or floating. In lakes macrophytes provide cover for fish and substrate for aquatic invertebrates, produce oxygen and act as food for some fish and wildlife.

Mean Sea Level

A measure of the average height a body of water above sea level half way between mean high tide and mean low tide.

Mercury

A heavy toxic metallic element (Dictionary.com, LLC, 2011).

Mesotrophic

A lake or other body of water characterized by moderate nutrient concentrations such as nitrogen and phosphorus and resulting in significant productivity. Such waters contain algal blooms and period of oxygen deficiency (Battle Creek Watershed Conservancy, 2010).

Monomictic

Lakes or reservoirs which are relatively deep, do not freeze over during the winter, and undergo a single stratification and mixing cycle during the year (usually in the fall). (Battle Creek Watershed Conservancy, 2010).

Natal Stream

Stream in which the fish was born. Salmonids return to their natal stream for spawning.

Non Point Sources

A pollution source that cannot be defined as originating from discrete points such as pipe discharge. Areas of fertilizer and pesticide applications, atmospheric deposition, manure, and natural inputs from plants and trees are types of nonpoint source pollution (Battle Creek Watershed Conservancy, 2010).

Olfactory

The sense of smell.

Oligotrophic (Water)

Pertaining to a lake or other body of water characterized by extremely low nutrient concentrations such as nitrogen and phosphorous and resulting very moderate productivity. Oligotrophic lakes are those low in nutrient materials and consequently poor areas for the development of extensive aquatic floras and faunas. Such lakes are often deep, with sandy bottoms and very limited plant growth, but with high dissolved oxygen levels. This represents the early stages in the life cycle of a lake (Battle Creek Watershed Conservancy, 2010).

Outlet

Point of water disposal from a stream, river, lake, tide water or artificial drain.

Oxygen Depletion

The removal of Dissolved Oxygen from a body of water as a result of bacterial metabolism of degradable organic compounds added to the water, typically caused by human activities (Battle Creek Watershed Conservancy, 2010).

Parts per Billion (PPB)

The number of "parts" by weight of a substance per billion parts of water. Used to measure extremely small concentrations.

Phosphorus

A naturally occurring nutrient essential for growth that can play a key role in stimulating aquatic growth in lakes and streams. (Battle Creek Watershed Conservancy, 2010)

PHOTOSYNTHESIS

The process in green plants and certain other organisms by which carbohydrates are synthesized from carbon dioxide and water using light as an energy source. Most forms of photosynthesis release oxygen as a byproduct. Chlorophyll typically acts as the catalyst in this process (Battle Creek Watershed Conservancy, 2010).

POINT SOURCES

Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal storm water systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land (Pickett & Hood, 2008).

POLLUTION (WATER)

Such contamination or other alteration of the physical, chemical, or biological properties of any body of water. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any body of water. This definition assumes that these changes will or is likely to, create a nuisance or render waters harmful detrimental or injurious to (1) public health, safety or welfare or (2) domestic, commercial, industrial, agricultural, recreational or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish or other aquatic life (Pickett & Hood, 2008).

RIPARIAN ZONE

The zone of interaction between the terrestrial and aquatic ecosystems. This zone is usually encompassed by a stream's or lake's floodplain.

RUNOFF

Excess rainwater or snowmelt that is transported to streams by overland flow, tile drains, or ground water (Battle Creek Watershed Conservancy, 2010).

SALMONID

Fish family that includes salmon, trout, whitefish and grayling.

SCOURED

Eroded or worn away by water or ice or wind.

SEDIMENTS

Soil, sand, and minerals washed from the land into water, usually after rain. They pile up in reservoirs, rivers, and harbors, destroying fish and wildlife habitat, and clouding the water so that sunlight cannot reach aquatic plants. Careless farming, mining, and building activities will expose sediment materials, allowing them to wash off the land after rainfall (Battle Creek Watershed Conservancy, 2010).

SILL

Submerged ridge of relatively shallow depth separating two bodies of water.

SPAWNING

Reproduction process of fish.

Species of Interest

Those plant or animal species susceptible or vulnerable to activity impacts or habitat alterations. Species not yet officially listed but undergoing status review for listing on the U.S. Fish and Wildlife Service's (USFWS) official threatened and endangered list; species whose populations are small and widely dispersed or restricted to a few localities; and species whose numbers are declining so rapidly that official listing may be necessary (Battle Creek Watershed Conservancy, 2010).

Surface Water

An open body of water such as a stream, lake, or reservoir.

Thermocline

A thin but distinct layer in a large body of fluid water in which the temperature rapidly changes with depth than it does in the layers above or below (Battle Creek Watershed Conservancy, 2010).

Thermal Stratification

The layering of warmer waters over colder waters that can occur in lakes, usually during the summertime. This layering occurs because as surface waters are warmed they become less dense than the underlying colder waters (Battle Creek Watershed Conservancy, 2010).

Total Maximum Daily Load (TMDL)

A distribution of a substance in a water body designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: (1) individual waste load allocations for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided (Pickett & Hood, 2008).

Tributary

A stream which joins another stream or body of water, surface or underground (Battle Creek Watershed Conservancy, 2010).

Trihalomethanes (THMs)

A group of low-molecular-weight, halogenated hydrocarbons, derivatives of methane, CH4, in which three halogen atoms (chlorine, bromine, or iodine) are substituted for three of the hydrogen atoms. The subsequent substances typically include the compounds of chloroform (CHCl3), dichlorobromomethane (CHCl2Br), dibromochloromethane (CHClBr2), and bromoform (CHBr3). The sum of these four compounds is referred to as Total Triholomethanes (TTHMs). The group includes suspect human Carcinogens. Small amounts of THMs have been detected in raw water collected from surface sources used as a public water supply, and concentrations have been shown to be increased during the chlorination phase of the water purification process. The most marked increase during chlorination of drinking water has been recorded in water containing suspended particles (Battle Creek Watershed Conservancy, 2010).

Trophic State

A term used to describe the productivity of a lake ecosystem classifying it as one of three categories based on algal biomass: oligotrophic, mesotrophic or eutrophic.

Turbidity

A measure of water clarity and its ability to absorb heat. The more suspended particles in the water, the more heat it is able to absorb. (EPA 2011)

Waterborne Illnesses

Diseases caused by pathogenic microorganisms which are directly transmitted when contaminated fresh water is consumed.

Water Column

The water in the lake which extend from the bottom sediments to the water surface.

Water Quality

A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose (Battle Creek Watershed Conservancy, 2010) .

Water Treatment

Processes undertaken to purifier water acceptable to some specific use, e.g., drinking. Most water treatment processes include some form, or combination of forms, of sedimentation, filtration, and chlorination (Battle Creek Watershed Conservancy, 2010).

Water Treatment Plants

Facilities that treat water to remove contaminants so that it can be safely used (Battle Creek Watershed Conservancy, 2010).

Watershed

A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation (Pickett and Hood, 2008).

Weathering

The physical disintegration or chemical decomposition of rock due to wind, rain, heat, freezing, thawing, etc. The ultimate outcome is the generation of soil (Battle Creek Watershed Conservancy, 2010).

Zoning

The partition of a city, county, township, or other governmental unit or area by ordinance into sections reserved for different land-use purposes, such as residential, business, manufacturing, greenbelt, or agriculture (Battle Creek Watershed Conservancy, 2010).

APPENDIX A. WHATCOM COUNTY COUNCIL ORDINANCE #2005-038

WHATCOM COUNTY COUNCIL AGENDA BILL NO. 2005-171

CLEARANCES	Initial	Date	Date Received in Council Office	Agenda Date	Assigned to:
Originator:		3/18/05	RECEIVED MAR 22 2005 WHATCOM COUNTY COUNCIL	3/29/05	Intro
Division Head:				4/12/05	Hearing
Dept. Head:	MR	3/18/05			
Prosecutor:	DA	3/18/05			
Purchasing/Budget:		3/22/05			
Executive:	BR	3-22-05			

TITLE OF DOCUMENT:
Draft Ordinance for the addition of Chapter 16.32 to the Whatcom County Code, Establishing Regulations for Fertilizer Application on Residential Lawns and Public Properties within the Lake Whatcom Watershed

ATTACHMENTS:
Proposed Ordinance

SEPA review required? ( ) Yes ( ) NO ***SEPA review completed?*** ( ) Yes ( ) NO	***Should Clerk schedule a hearing ?*** (X) Yes ( ) NO ***Requested Date: April 12, 2005***

SUMMARY STATEMENT OR LEGAL NOTICE LANGUAGE: ***(If this item is an ordinance or requires a public hearing, you must provide the language for use in the required public notice. Be specific and cite RCW or WCC as appropriate. Be clear in explaining the intent of the action.)***

This proposed chapter is recommended by Whatcom County under the authority of the police power granted to political subdivisions of the State by Article XI, Section 11 of the State Constitution and provides for the establishment of regulations for fertilizer application on residential lawns and public properties within the Lake Whatcom watershed. This proposed ordinance will apply to the unincorporated areas within the Lake Whatcom watershed as defined by the Surface Water Delineation Boundaries in WRIA 1 – Version 3

COMMITTEE ACTION:	***COUNCIL ACTION:***
	3/29/2005: Introduced 4/12/2005: Amended and adopted 6-0 Nelson absent, Ord. #2005-038

Related County Contract #:	***Related File Numbers:***	***Ordinance or Resolution Number:*** Ord. #2005-038

Please Note: Once adopted and signed, ordinances and resolutions are available for viewing and printing on the County's website at: www.co.whatcom.wa.us/council.

ake_Whatcom\Phosphorus\Ordinance\AGENDA_BILL_2005.doc

SPONSORED BY: Barbara Brenner

PROPOSED BY: Executive Kremen

INTRODUCTION DATE: 3/29/2005

ORDINANCE NO. 2005-038

AN ORDINANCE ESTABLISHING REGULATIONS FOR FERTILIZER APPLICATION ON RESIDENTIAL LAWNS AND PUBLIC PROPERTIES WITHIN THE LAKE WHATCOM WATERSHED

WHEREAS, Lake Whatcom is the source of drinking water for approximately half the residents in Whatcom County; and

WHEREAS, an overabundance of phosphorus has been identified as a significant factor contributing to excessive algal growth and low dissolved oxygen conditions in certain portions of the Lake at particular times of the year; and

WHEREAS, these conditions may lead to increased treatment costs for drinking water and impair other beneficial uses of the lake; and

WHEREAS, Whatcom County Council is authorized under Article XI, Section 11 of the State Constitution to restrict the use of fertilizers containing phosphorus within the Lake Whatcom watershed;

NOW, THEREFORE, BE IT ORDAINED by the Whatcom County Council that Whatcom County Code Chapter 16 is amended consistent with attached "Exhibit A". :

ADOPTED this 12 day of April, 2005.

ATTEST:

Dana Brown-Davis, Council Clerk

WHATCOM COUNTY COUNCIL
WHATCOM COUNTY, WASHINGTON

L. Caskey-Schreiber

Laurie Caskey-Schreiber, Council Chair

Civil Deputy Prosecutor

Pete Kremen, County Executive

Date: 5/2/05

EXHIBIT A

CHAPTER 16.32
ESTABLISHING REGULATIONS FOR FERTILIZER APPLICATION ON RESIDENTIAL LAWNS AND PUBLIC PROPERTIES WITHIN THE LAKE WHATCOM WATERSHED

16.32.010 AUTHORITY. This chapter is recommended by Whatcom County under the authority of the police power granted to political subdivisions of the state by Article XI, Section 11 of the State Constitution.

16.32.020 PURPOSE AND INTENT. The Lake Whatcom Reservoir is the source of drinking water for approximately half of Whatcom County residents and supports multiple beneficial uses including recreation and fisheries. These benefits enhance the environmental, recreational, cultural, and economic resources of the area and contribute to the general health and welfare of the public. Excess phosphorus entering Lake Whatcom has been identified as a significant factor contributing to algal growth and low dissolved oxygen conditions in certain portions of the lake at particular times of the year. These conditions may lead to increased treatment costs for drinking water and impair other beneficial uses of the lake. The purpose of this Chapter is to promote improvement in lake water quality by limiting phosphorus entering Lake Whatcom due to the application of commercial fertilizers to residential lawns and public properties within the Lake Whatcom watershed.

16.32.030 APPLICABILITY. This ordinance applies to the unincorporated areas within the Lake Whatcom watershed as defined by the Surface Water Delineation Boundaries in WRIA 1 – Version 3 (Attachment).

16.32.040 DEFINITION.

For purposes of this chapter, the following terms shall be defined as stated[1]:

A. "Commercial fertilizer" means a substance containing one or more recognized plant nutrients and that is used for its plant nutrient content or that is designated for use or claimed to have value in promoting plant growth, and shall include limes, gypsum, and manipulated animal and vegetable manures. It does not include unmanipulated animal and vegetable manures, organic waste-derived material, and other products exempted by the department by rule."

B. "Department" means the department of agriculture of the state of Washington or its duly authorized representative.

C. "Manipulation" means processed or treated in any manner, including drying to a moisture content less than thirty percent.

16.32.050 REGULATION OF THE USE AND APPLICATION OF LAWN FERTILIZERS.

(1) Effective April 1, 2005, no person shall apply any commercial fertilizer to residential lawns or public agency properties within the unincorporated area of the Lake Whatcom watershed, either liquid or granular, that is labeled as containing more than 0% phosphorus or other compound containing phosphorus, such as phosphate, except as provided in section 16.32.060.

(2) No commercial fertilizer of any type shall be applied when the ground is frozen.

(3) No person shall apply, spill, or otherwise deposit commercial fertilizer on impervious surfaces. Any fertilizer applied, spilled, or deposited, either intentionally or accidentally, on impervious surfaces shall be immediately and completely removed.

16.32.060 EXEMPTIONS

The prohibition against the use of commercial fertilizers under section 16.32.050 shall not apply to newly established turf or lawn areas in the first growing season.

16.32.070 ANNUAL REVIEW

On at least an annual basis for the first five years, the County shall review water quality data and implementation activities associated with this ordinance to determine if any changes to the ordinance are needed. Such changes could include expanding the ordinance to include properties and applications that are not currently included.

16.32.080 PENALTIES AND ENFORCEMENT

(1) Any person who violates any of the provisions of this chapter shall be guilty of a civil offense and may be fined a sum not to exceed $1,000 for each offense. After a notice of violation has been given, each day of site work in conjunction with the notice of violation shall constitute a separate offense.

(2) The penalty provided in subsection (A) shall be assessed and may be imposed by a notice in writing either by certified mail with return receipt requested or by personal service to the person incurring the same. The notice shall include the amount of the

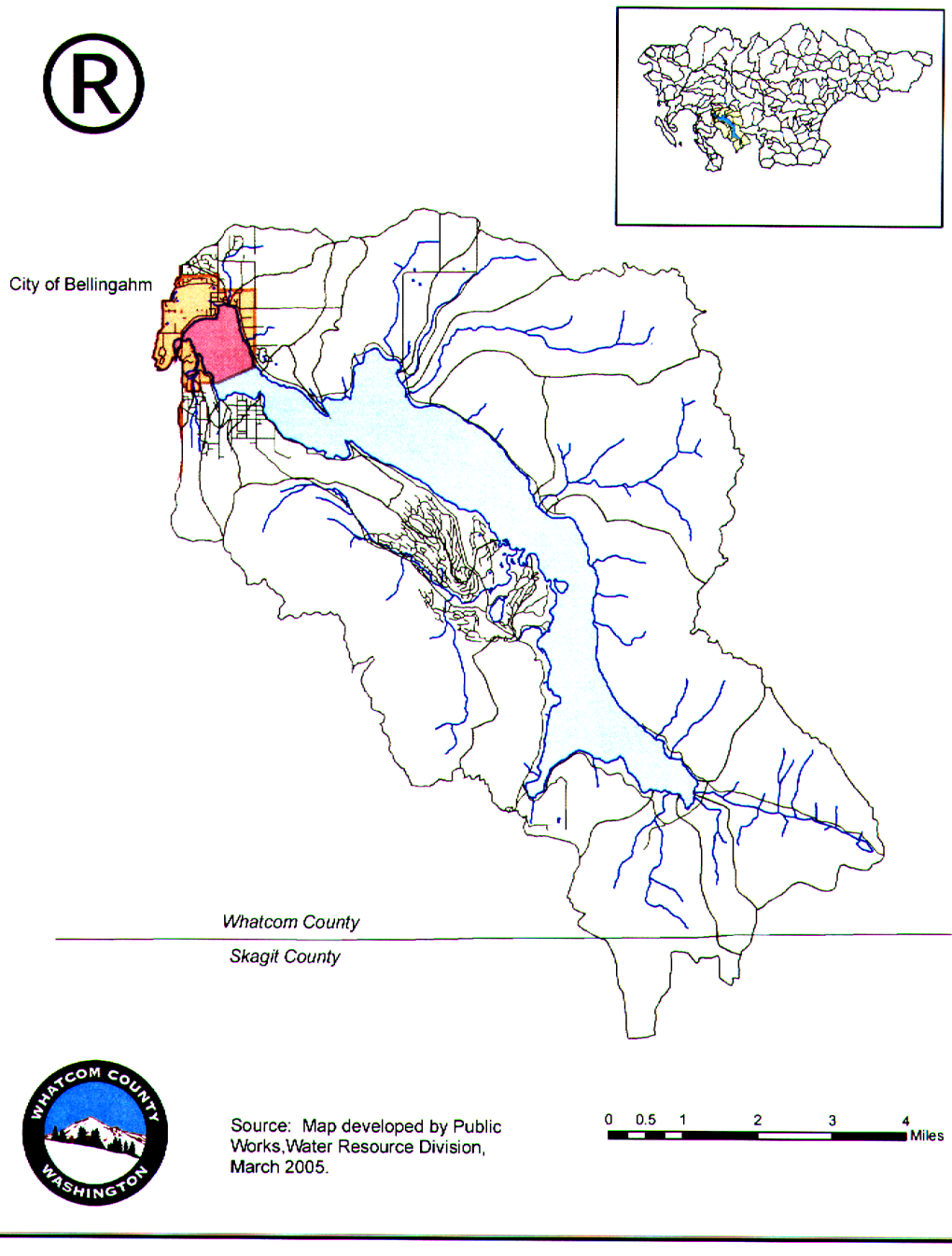
[1] Definitions from Chapter 15.54, Revised Code of Washington.

penalty imposed and shall describe the violation with reasonable particularity. In appropriate cases, corrective action shall be taken within a specific and reasonable time.
(3) Within 20 calendar days after the notice is received, the person incurring the penalty may apply in writing to the county for remission or mitigation of such penalty. Upon receipt of the application, the county may remit or mitigate the penalty upon whatever terms the county in its discretion deems proper. The county's final decision on mitigation or revision shall be reviewed by the hearing examiner if the aggrieved party files a written appeal therewith of said decision within 10 calendar days of its issuance.
(4) The prosecuting attorney may enforce compliance with this chapter by such injunctive, declaratory or other actions as deemed necessary to ensure that violations are prevented, ceased, or abated.

16.32.090 SEVERABILITY CLAUSE

If any section, provision or portion of this ordinance is ruled invalid by a court, the remainder of the ordinance shall not for that reason be rendered ineffective or invalid.

Lake Whatcom Surface Water Delineation Boundary



APPENDIX B. AMENDED BELLINGHAM MUNICIPAL CODE 15.42.050

City of Bellingham
CITY COUNCIL AGENDA BILL

An ordinance to amend BMC 15.42.050 to revise current restrictions on the use of phosphorus-containing garden products in the Lake Whatcom watershed.	12-13-10 01-10-11	LK WHATCOM RSVR & NE THIRD & FINAL ORD	18995
ATTACHMENTS Phosphorus Garden Products Ordinance Draft Guidelines for Gardening Materials and Practices	10 mins.	Mark Gardner	
	...iquist, Lake ...hatcom		12/8/10
	G. Knutson, Council President		
	Legal		12/7/10
	Mayor or CAO		12.7.10

CATEGORY

- ☐ Public Hearing
- ☐ Evening Presentation
- ☐ Committee Briefing
- ☐ Mayor's Report
- ☐ Consent Agenda
- ☐ Other
- ☐ Special Meeting

Ordinance:

- ☐ Briefing/Discussion
- ☒ Introduction or Expedited

SUMMARY STATEMENT:

In 2005, the Bellingham City Council passed an ordinance restricting the use of phosphorus lawn fertilizer in the Lake Whatcom watershed. In 2008, The Bellingham City Council voted to direct staff to research options for strengthening the restrictions on phosphorus fertilizers. The revised ordinance would apply restrictions to all properties in the watershed, expand the ban on products to include all fertilizers, mulches, and soil amendments tested and labeled as containing more than 0% phosphorus by weight, and create new requirements for signage and literature at retail stores that sell phosphorus fertilizers, mulches, and soil amendments. A set of guidelines for gardening and horticultural practices in the watershed will be separate from, but linked to the ordinance on the City's web site.

Previous Council Action: 08/10/09, Directed staff to prepare ordinance. 10/11/10, Directed staff to revise guidelines.

FISCAL IMPACT:

Total Fiscal Impact:

None. Revised procedures can be managed within existing budgets and with existing staff.

Source of Funds:

RECOMMENDED ACTION:

- ☐ **Information only;** no action required
- ☒ **Move to adopt** ordinance or resolution
- ☐ Other
- ☐ **Provide direction** to staff
- ☐ **Move to approve appointment**
- ☐ **Award Bid** to lowest bidder

COMMITTEE RECOMMENDATION / ACTION:

12-13-10 BB/SF MOVED TO RECOMMEND APPROVAL. ML & SS concurred.

COUNCIL ACT :

12/13/10 ML/SS MOVED APPROVAL FOR FIRST AND SECOND READING. MOTION CARRIED 7-0.

CB 13673

ORDINANCE NO. _____

AN ORDINANCE AMENDING BELLINGHAM MUNICIPAL CODE SUBSECTION 15.42.050 D AND ADDING BELLINGHAM MUNICIPAL CODE SUBSECTION 15.42.050 E TO ADD REQUIREMENTS THAT RETAIL ESTABLISHMENTS SELLING FERTILIZERS, MULCHES, AND SOIL AMENDMENTS CONTAINING PHOSPHORUS PROVIDE SIGNAGE AND LITERATURE NOTIFYING CUSTOMERS OF PROHIBITED USES OF PHOSPHORUS FERTILIZERS, MULCHES, AND SOIL AMENDMENTS IN THE LAKE WHATCOM WATERSHED, EXTENDING THE PROHIBITION FROM LAWNS AND TURF TO INCLUDE ALL GARDENING AND HORTICULTURAL APPLICATIONS, EXTENDING PHOSPHORUS FERTILIZER PROHIBITIONS TO COMMERCIAL PROPERTIES IN THE WATERSHED, AND REPEALING THE EXEMPTION FOR LAWNS IN THE FIRST GROWING SEASON.

WHEREAS, Lake Whatcom is the source of drinking water for 90,000 people in the City of Bellingham and Whatcom County; and

WHEREAS, the protection of the Lake Whatcom Reservoir is of utmost importance to those citizens for public health reasons, and

WHEREAS, pursuant to section 303(d) of the federal Clean Water Act, the Lake Whatcom Reservoir is listed as an impaired water body due to excessive phosphorus discharges into it, and the Silver Beach Creek is listed as well due to fecal coliform; and

WHEREAS, the City of Bellingham and Whatcom County are under direction by the Washington Department of Ecology to substantially reduce the phosphorus content in the waters of the Reservoir, commonly referred to as TMDL ("Total Maximum Daily Load"); and

WHEREAS, the failure to reduce phosphorus and other pollutants in the waters of the Reservoir will lead to substantial expenses for enlargement and upgrading of the City of Bellingham's water treatment plant, which can be avoided by immediate actions; and

WHEREAS, improper use of fertilizers, mulches, and soil amendments containing phosphorus is a known source of phosphorus contamination in water bodies; and

WHEREAS, scientific research has shown that most soils contain adequate phosphorus, and that addition of phosphorus is often not necessary for healthy plant growth and may actually detract from it; and

WHEREAS, soil tests in the Lake Whatcom watershed have revealed that most soils in the area already contain levels of phosphorus adequate for healthy plant growth; and

WHEREAS, knowledge by residents and businesses of the City of Bellingham's prohibition on use of phosphorus-containing materials in the Lake Whatcom watershed, and of

City of Bellingham
City Attorney
210 Lottie Street
Bellingham, Washington 98225
360-778-8270

gardening materials and practices appropriate for the Watershed, will be improved if such information is provided at the retail level;

THEREFORE, THE CITY COUNCIL OF THE CITY OF BELLINGHAM DOES ORDAIN:

Section 1. BMC 15.42.050 D is hereby amended as follows:

D. Restrictions on Application of Fertilizers, Mulches, and Soil Amendments containing phosphorus, and requirements for retail stores selling such materials:

1. No person shall apply any fertilizer, mulch, or soil amendment to properties within the Bellingham city limits area of Basin One of the Lake Whatcom Watershed that is labeled as containing more than 0% phosphorus or other compounds containing phosphorus, such as phosphate.

2. No fertilizer of any type, mulch, or soil amendment, shall be applied when the ground is frozen.

3. No person shall apply, spill, or otherwise deposit fertilizer, mulch, or soil amendments on impervious surfaces. Any fertilizer, mulch, or soil amendment applied, spilled or deposited, either intentionally or accidentally, on impervious surfaces shall be immediately and completely removed.

4. Retail stores selling fertilizer, mulch, or packaged or bulk soil amendments labeled as containing more than 0% phosphorus or other compounds containing phosphorus, such as phosphate, must display prominently, and within ten feet of the area containing such products, a sign, with content and layout provided by the City of Bellingham, and of a minimum dimension of 2 feet by 3 feet, explaining the City of Bellingham code provision prohibiting application of phosphorus-containing materials in the Lake Whatcom watershed.

5. Retail outlets selling fertilizers, mulches, or soil amendments labeled as containing more than 0% phosphorus or other compounds containing phosphorus, such as phosphate, must make available for distribution to customers educational materials that explain the provisions of the City of Bellingham's code provision, describe the need for the elimination of phosphorus sources in the watershed, and summarize guidelines for materials and practices. Such materials must be available within 5 feet of the area containing such products. The content and layout of these educational materials will be created by the City of Bellingham and made available to retail stores via the City of Bellingham's web site.

6. The City of Bellingham shall make available to the public guidelines for gardening materials and practices in the Lake Whatcom watershed. Such guidelines may change from time to time as required by the development of new products or scientific knowledge of best practices to reduce phosphorus pollution in water bodies.

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Section 2. A new subsection, BMC 15.42.050 E is added to the Bellingham Municipal Code to read as follows:

This ordinance shall go into effect on February 1, 2011.

PASSED by the Council this _____ day of _____, 2010.

_____
Council President

APPROVED by me this _____ day of _____, 2010.

_____
Mayor

ATTEST:_____
Finance Director

APPROVED AS TO FORM:

_____
Office of the City Attorney

Published:

_____

City of Bellingham
City Attorney
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Bellingham, Washington 98225
360-778-8270

Guidelines for Gardening Materials and Practices in the Lake Whatcom Watershed

Revised 12/06/10

Overview. Bellingham Municipal Code 15.42.050 prohibits use of fertilizers, mulches, and soil amendments tested and labeled as containing more than trace amounts of phosphorus in the Lake Whatcom Watershed. All labeled products should list a "0" for the content of phosphorus by weight. For mulches, bulk soil amendments, and fertilizers, a range of locally available materials have been identified that, when used properly, are consistent with reducing watershed pollution and with enhancing plant growth and health. This set of guidelines identifies recommended soil amendments and mulches and also those that are not recommended, on environmental and plant health grounds. The document lists acceptable practices for organic materials originating on parcels in the watershed (e.g. yard waste). It also identifies some general gardening and horticultural recommendations to reduce pollution and soil erosion and improve soil health.

Note: A soil test by a certified lab is recommended to determine the need for additional organic materials or nutrients. See information at http://whatcom.wsu.edu/ag/homeigat/Soil_Sampling.pdf or call WSU Extension at 360-676-6736).

Recommended Materials:

I. Commercial fertilizers and soil amendments labeled as containing 0 percent phosphorus.

II. Wood-Based Mulches. There are a number of wood-based mulches available. Wood-based mulches help retain moisture in the soil, impede weed growth, protect roots from freezing, and sustain the growth of healthy soil organisms. While the names of these products may be somewhat confusing, nursery or garden staff can usually direct you to the right product. The following list describes a number of variants that have proven to perform well in horticultural applications.

- **Hardwood chips** – Wood chips from hardwood trees.
- **Cedar chips** -- Wood chips from Cedar trees.
- **"Hog Fuel"** - Trees and other tree parts, often including roots, derived from grinding instead of chipping.
- **"Black Mulch"** -- Weathered, screened wood chips with minimal fine organic material.
- **Arborist chips** -- Chipped tree parts, hardwood or softwood, resulting from tree pruning or removal, and often available directly from a tree service company. *Since the phosphorus content of arborist chips can vary substantially by source, we recommend obtaining chips from a tree service company knowledgeable of watershed gardening, or from certified arborist.*

III. Soil Amendments

- Compost. Compost materials can provide beneficial soil bacteria important to root health and water absorption. They can also contain excessive phosphorus, fecal coliform or pesticides that could be detrimental to Lake Whatcom. Request a completely composted product suitable for use in gardening in the Lake Whatcom watershed from your local garden supply outlet. If used, compost should be turned into the soil, or immediately covered with a mulch from the recommended products list.
- Composted Manure. Choose completely composted dairy manures only. Proper composting is essential to assuring the destruction of fecal coliform bacteria. *Because of recent problems*

with pesticide contomination of dairy compost, consumers should choose this product with caution.

- Topsoil. Choose topsoils with a relatively low level of organic material content (ideally, with organic content of a maximum of 10% by volume). Topsoils can be highly variable in phosphorus content and fecal bacteria depending on their source and composition.
- Home-generated materials. Materials such as yard waste or home-created compost may be acceptable *when applied according to the following practices*:

Grass clippings.

- ✓ Send to "Clean Green" or SSC yard waste collection. If this is not possible, mow with mower set high (2" or higher for most types of turf) to improve capture of the grass particles in the turf structure. If possible, use a mulching mower.
- ✓ Composting of grass is not recommended due to excessive phosphorus content and the inability of home composting systems to sufficiently compost materials for use.
- ✓ Grass clippings should not be used as a landscaping mulch.
- ✓ Any grass that may end up on impervious surfaces (walkways, patios, etc.) or near drainage systems should be promptly swept or blown into the lawn area.

Home composting.

- ✓ Home composting areas or equipment should be contained, covered from rainfall, and located away from slopes, hard surfaces or drainage systems to control runoff.
- ✓ Compost, if used, should be turned into the soil, or immediately covered with a recommended mulch (see recommended product types above).
- ✓ Do not apply excessive amounts of compost to the soil. Optimal amounts are around 10% of soil volume. *Perennial landscape soils do not need continuous incorporation of compost materials.* Excess organic materials can cause soil subsidence, excessive nutrient concentration, and nutrient and pollutant runoff.

Materials NOT Recommended:

- Fresh or incompletely composted manure of any sort. This is likely to contain fecal matter and is likely higher in soluble phosphorus.
- Bark groundcover of all grades and sizes (e.g. "beauty bark."). Bark may contain excessive phosphorus and some types can impede movement of water into the soil, increasing runoff.
- Sawdust, when used as a mulch. Sawdust can impede movement of water into the soil, increasing runoff.

Recommended Landscaping and Gardening Practices:

Minimizing impacts during construction or soil disturbance:

- ✓ Avoid or limit removal of topsoil.
- ✓ To avoid soil compaction, use wood mulches in areas where equipment and vehicles will have access, and under the drip line or canopy of trees.
- ✓ Limit equipment access to one entry and exit point to reduce track out of soil.
- ✓ To prevent erosion on sloped areas, use hog fuel, jute matting and ground cover plantings for permanent stabilization, or plastic tarps anchored with sandbags for temporary stabilization.

- ✓ Cover all exposed soil with 3-4 inches of recommended mulch as soon as possible, preferably covering worked areas as they are created during the clearing and grading process.
- ✓ Store mulch, soil, and other landscape materials on a soft surface and cover with a plastic tarp secured with sandbags or heavy rocks. Never store or stage materials in roads or sidewalks.

Vegetable gardens:

- ✓ Vegetable gardens may need organic materials and nutrients to compensate for the effect of harvesting. Berming around garden areas to keep exposed soils on site is recommended.
- ✓ Vegetable gardens should be located to avoid creating runoff. Locate garden on the flattest area available and berm soil around the garden to contain runoff and reduce erosion.
- ✓ Cover bare vegetable gardens in the winter with a cover crop or straw.

Horticulture and landscaping:

- ✓ Install native plants, or native/ornamentals, on the site to enhance infiltration capacity and slow surface runoff. Use wood-based mulches for soil health.
- ✓ Use cedar chips for high-travel areas or under decks.
- ✓ Never use beauty bark or uncomposted manure, including products which explicitly list bark or uncomposted manure as a primary component.
- ✓ Consider using a mulching method (6-8" minimum) to replace lawn with native or ornamental landscaping.
- ✓ Avoid "weed and feed" products. The use of wide broadcast granular pesticides is strongly discouraged. Spot application of pesticides according to manufacturer guidelines is preferred.

Note: The City of Bellingham has tested certain garden products to identify those with very low phosphorus content that are suitable for gardening and horticultural use in the watershed. These tests do not guarantee the current phosphorus content of any particular product from any particular source. To obtain a copy of this list, please contact the City of Bellingham Public Works Stormwater Division at 360-778-7700 or call the Stormwater Hotline at 360-778-7979 to leave a message after business hours.

Definitions

Compost. A mixture of organic materials, decomposed by bacteria and other soil organisms, usually containing well-aged leaves, woody material, herbaceous green matter and sometimes manure and kitchen scraps, used to enrich soil.

Mulch. Organic material that covers and protects topsoil from erosion or colonization by weed species, retains soil moisture, and stimulates soil improvements. This layer may add organic material to the topsoil by decomposition, so periodic replacement or addition may be necessary to long term functioning of the mulch layer. An organic mulch layer can provide microorganisms beneficial to plant and soil health. These organisms are crucial to healthy root systems that encourage infiltration and the uptake of nutrients. Improperly selected mulches can also be a source of pollution of surface or ground water.

Definitions, continued.

Pesticide. A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling or mitigating any pest. A pesticide may be a chemical substance, biological agent (such as a virus or bacterium), antimicrobial, disinfectant or device used against any pest. Pests include some insects, plant pathogens, weeds, animals, and microbes that destroy property, spread disease or are a vector for disease or cause a nuisance.

Soil Amendments. Materials imported to increase the capacity of soil to filter and treat stormwater runoff or to improve nutrient content or soil structure. These amendments can be tilled into existing soils on-site, and amended soils that are produced off-site can be imported. Both subsoil and topsoil can be amended.

Subsoil. Mineral layer below topsoil consisting of generally small sized organic and inorganic particles not normally subject to erosive forces. Healthy and biologically active subsoil is critical for long term infiltration and treatment of stormwater.

Soluble Reactive Phosphorus. Phosphorus in a dissolved state that is immediately available to plant growth. Runoff containing this form of phosphorus will fuel unwanted algae blooms in lakes. Phosphorus bound to organic materials that slowly decay to release phosphorus to plants is preferred.

Topsoil. Top 10" of soil comprised of active nutrients and larger soil particles, providing void space for absorption of surface water. Water and the associated nutrients in topsoil are available for plant growth, transmission into the groundwater table, or both. Topsoil can be impacted by erosive forces.

APPENDIX C. LIST OF PLANTS AND ANIMALS OF LAKE WHATCOM WATERSHED

Animal and plant species of Lake Whatcom complied from Washington State Department of Ecology, Fish and Wildlife, and Lake Whatcom Management Program. The listings are current as of 2010.

Keys:

FISH:
i-introduced
ii-illegally introduced
n-native

DISSOLVED OXYGEN TOLERANCE OF MACROINVERTEBRATES:
0-10; 0=most sensitive

LISTING STATUS:
FSC-Federal Species of Concern
FT-Federal Threatened
FE- Federal Endangered
SM-State Monitor
SS-State Sensitive
SC-State Candidate
ST-State Threatened
SE-State Endangered

AMPHIBIANS (10 SPECIES: 1SM; 1FSC; 1SC):

- Bullfrog (Rana catesbeiana)
- Oregon Ensatina (Ensatina eschscholtzi oregonensis)
- Pacific tree frog (Hyla regilla)
- Roughskin newt (Taricha granulosa)
- Western redback salamander (Plethodon vehiculum)
- Northwestern salamander (Ambystoma gracile)
- Pacific giant salamander (Dicamptodon ensatus)
- Red-legged frog (Raha aurora)
- Tailed Frog (Ascaphus truei) *SM
- Western toad (Bufo boreas) *FSC; SC

BIRDS (125 SPECIES: 7SM; 3FCO; 2SS; 6SC; 1FSC):

- American coot (Fulica Americana)
- American dipper (Cinclus mexicanus)
- American kestrel (Falcosparverius)
- American wigeon (Anas americana)
- Band-tailed pigeon (Columba fasciata)
- Barred owl (Strix varia)
- Bewick's wren (Thryomanes bewickii)
- Black-capped chickadee (Parus atricapillus)
- Black-headed grosbeak (Pheucticus melanocephalus)
- Brewer's blackbird (Euphagus cyanocephalus)
- Brown-headed cowbird (Molothrus ater)
- Bushtit (Psaltriparus minimus)
- Cedar waxwing (Bombycillia cedrorum)
- Chipping sparrow (Spizella passerina)
- Common goldeneye (Bucephala clangula)
- Common merganser (Mergus merganser)
- Common raven (Corvus corax)
- Common yellowthroat (Geothlypis trichas)
- Dark-eyed junco (Junco hyemalis)
- Downy woodpecker (Picoides pubescens)
- European starling (Sturnus vulgarus)
- Fox sparrow (Passerella iliaca)
- Glaucous-winged gull (Larus glaucescens)
- Golden-crowned kinglet (Regulus satrapa)
- Gray jay (Perisoreus canadensis)
- Great horned owl (Bubo virginianus)
- Green-winged teal (Anas crecca)
- Hairy woodpecker (Picoides villosus)
- American crow (Corvus brachyrhychos)
- American goldfinch (Carduelis tristis)
- American robin (Turdus migratorius)
- Bald eagle (Haliaeetus leucocephalus) *SM
- Barn swallow (Hirundo rustica)
- Belted kingfisher (Ceryle alcyon)
- Black swift (Cypseloides niger) *FCo; SM
- Black-throated gray warbler (Dendroica nigrescens)
- Blue grouse (Dendragapus obscurus)
- Brown creeper (Certhia bamericana)
- Bufflehead (Bucephala albeola)
- Canada goose (Branta Canadensis)
- Chestnut-backed chickadee (Parus rufescens)
- Common barn owl (Tyto alba)
- Common loon (Gayia immer) *SS
- Common nighthawk (Chordeiles minor)
- Common snipe (Gallinago gallinago)
- Cooper's hawk (Accipiter cooperii)
- Double-crested cormorant (Phalacrocorax auritus)
- Eared grebe (Podiceps nigricollis)
- Evening grosbeak (Coccothraustes vespertinus)
- Gadwall (Anas strepera)
- Golden eagle (Aquila chrysaetos) *SC
- Golden-crowned sparrow (Zonotrichia atricapilla)
- Great blue heron (Ardea herodias) *SM
- Green-backed heron (Butorides striatus)
- Gyrfalcon (Falco rusticolus) *SM
- Hooded merganser (Lophodytes cucullatus)

- House finch (Carpodacus mexicanus)
- Hutton's vireo (Vireo huttoni)
- Lesser scaup (Aythya affinis)
- MacGillivray's warbler (Oporornis tolmiei)
- Marsh wren (Cistothorus palustris)
- Mourning dove (Senaida macroura)
- Northern flicker (Colaptes auratus)
- Northern harrier (Circus cyaneus)
- Northern pygmy owl (Glaucidium gnoma)
- Northern saw-whet owl (Aegolius acadicus)
- Olive-sided flycatcher (Contopus borealis) *FSC
- Osprey (Pandion haliaetus) *SM
- Peregrine falcon (Falco peregrinus) *FCo; SS
- Pileated woodpecker (Dryocopus pileatus) * SC
- Purple finch (Carpodacus purpureus)
- Red crossbill (Loxia curvirostra)
- Red-breasted sapsucker (Sphrapicus ruber)
- Red-winged blackbird (Agelaius phoeniceus)
- Ring-necked duck (Aythya collaris)
- Ruby-crowned kinglet (Regulus calendula)
- Rufous hummingbird (Selasphorus rufus)
- Snowy owl (Nyctea scandiaca) *SM
- Song sparrow (Melospiza melodia)
- Spotted sandpiper (Actitis macularia)
- Stellar's jay (Cyanocitta stelleri)
- Townsend's solitaire (Myadestes townsendi)
- Tree swallow (Tachycineta bicolor)
- Varied thrush (Ixoreus naevius)
- Violet-green swallow (Tachycineta thalassina)
- Warbling vireo (Vireo gilvus)
- Western screech owl (Otis kennicottii)
- Western wood-pewee (Contopus sordidulus)
- Wilson's warbler (Wilsonia pusilla)
- Wood duck (Aix sponsa)
- Yellow-rumped warbler (Dendroica coronata)
- •House wren (Troglodytes aedon)
- •Killdeer (Charadrius vociferus)
- •Long-eared owl (Asio otus)
- •Mallard (Anas platyrhynchos)
- •Merlin (Falco columbarius) *SC
- •Nashville warbler (Vermivora ruficapilla)
- •Northern goshawk (Accipiter gentilis) *FCo; SC
- •Northern pintail (Anas acuta)
- •Northern rough-winged swallow (Stelgidopteryx serripennis)
- •Northern shrike (Lanius excubitor)
- •Orange-crowned warbler (Vermivora celata)
- •Pacific slope flycatcher (Empidonax difficilis)
- •Pied-billed grebe (Podilymbus podiceps)
- •Pine siskin (Carduelis pinus)
- •Purple martin (Progne subis) *SC
- •Red-breasted nuthatch (Sitta canadensis)
- •Red-tailed hawk (Buteo jamaicensis)
- •Ring-billed gull (Larus delawarensis)
- •Rock dove (Columba livia)
- •Ruffed grouse (Bonasa umbellus)
- •Sharp-shinned hawk (Accipiter striatus)
- •Solitary vireo (Vireo solitarius)
- •Sora rail (Porzana carolina)
- •Spotted towhee (Pipilo erythrophthalmus)
- •Swainson's thrush (Catharus ustulatus)
- •Townsend's warbler (Dendroica townsendi)
- •Turkey vulture (Cathartes aura) *SM
- •Vaux's swift (Chaetura vauxi) *SC
- •Virginia rail (Rallus limicola)
- •Western grebe (Aechmophorus occidentalis) *SC
- •Western tanager (Piranga ludoviciana)
- •White-crowned sparrow (Zonotrichia leucophrys)
- •Winter wren (Troglodytes troglodytes)
- •Yellow warbler (Dendroica petechia)

FISH (13 SPECIES; 1FC)

- Blue Gill (Lepomis macrochirus)n
- Cutthroat trout (Oncorhyncus clarkii)ii
- Largemouth bass (Micropterus salmoides)ii
- Peamouth Chub (Mylocheilus caurinus)n
- Rainbow trout (Oncorhyncus mykiss)I
- Smallmouth bass (Micropterus aculeatus)I
- Yellow perch (Perca flavescens)ii
- •Brown Bullhead (Ictalurus nebulosis)i
- •Kokanee (Oncorhyncus nerka)n *FC
- •Longnose sucker (Catostomus catostomus)n
- •Pumpkinseed sunfish (Lepomis gibosusii)
- •Sculpin (Cottus spp)n
- •Three-spine stickleback (Gasterosteus aculeatus)n

MACROINVERTEBRATES (33 SPECIES):

- Alderflies (Megaloptera Sialidae)4
- Biting midges (Diptera ceratopogonidae)6
- Black Quills (Ephemeroptera leptophlebiidae)3
- Crane fly (Diptera tipulidae)3
- Crawling water beetles (Coleoptera haliplidae)5
- •Apple caddis (Trichoptera brachycentridae)1
- •Black fly (Diptera simuliidae)6
- •Blue-winged olives (Ephemeroptera baetidae)5
- •Common net-spinning caddisflies (Trichoptera hydropsychidae)4
- •Dance flies (Diptera empididae)6

- Dixid midges (Diptera dixidae)1
- Golden stones (Plecoptera perlidae)2
- Green Sedges (Trichoptera rhyacophilidae)1
- Green-winged stoneflies (Plecoptera perlodidae)2
- Little black caddisfly (Trichoptera glossosomatidae)1
- Moth fly (Diptera psychodidae)8
- Non-biting midges (Diptera chironomidae)6
- Predacious diving beetles (Coleoptera dytiscidae)5
- Rolled-winged stoneflies (Plecoptera leuctridae)0
- Stream mayflies (Ephemeroptera heptageniidae)3
- Tiny winter blacks (Plecoptera nemouridae)2
- Winter stoneflies (Plecoptera taeniopterygidae)2
- Flathead mayflies (Ephemeroptera siphlonuridae)4
- Giant water scavenger beetles (Coleoptera hydrophilidae)5
- Green stoneflies (Plecoptera chloroperlidae)0
- Ligustrum weevil (Coleoptera curculionidae)5
- Little brown-green sedge (Trichoptera lepidostomatidae)1
- Net-veined midges (Diptera blephariceridae)0
- Northern caddisflies (Trichoptera limnephilidae)3
- Riffle beetles (Coleoptera elmidae)4
- Salmonflies (Plecoptera pteronarcyidae)0
- Spiny crawler mayflies (Ephemeroptera ephemerellidae)1
- Trumpet-net caddisfly (Trichoptera polycentropodidae)6

MAMMALS (49 SPECIES; 2SM; 1SC; 1FSC; 1FCO):

- Beaver (Castor canadensis)
- Black-tailed deer (Odocoileus hemionus columbianus)
- Bobcat (Lynx rufus)
- California myotis (Myotis californicus)
- Deer mouse (Peromyscus maniculatus)
- Eastern cottontail (Sylvilagus floridanus)
- Hoary bat (Lasiurus cinereus)
- Little brown myotis (Myotis lucifugus)
- Long-legged myotis (Myotis volans)*SM
- Long-tailed weasel (Mustela frenata)
- Mountain beaver (Aplodontia rufa)
- Muskrat (Ondatra zibethicus)
- Norway rat (Rattus norvegicus)
- Pacific jumping mouse (Zapus trinotatus)
- Pacific water shrew (Sorex bendirii)
- Porcupine (Erethizon dorsatum)
- Red fox (Vulpes vulpes)
- Shrew-mole (Neurotrichus gibbsi)
- Snowshoe hare (Lepus americanus)
- Spotted skunk (Spilogale putorius)
- Townsend's chipmunk (Tamias townsendii)
- Townsend's mole (Scapanus townsendii)
- Trowbridge's shrew (Sorex trowbridgii)
- Virginia opossum (Didelphis virginiana)
- Yuma myotis (Myotis yumanensis) *FSC
- Big brown bat (Eptesicus fuscus)
- Black bear (Ursus americanus)
- Bushy-tailed woodrat (Neotoma cinerea)
- Coyote (Canis latrans)
- Douglas' squirrel (Tamiasciurus douglasii)
- Ermine (Mustela erminea)
- House mouse (Mus musculus)
- Long-eared myotis (Myotis evotis) *SM
- Long-tailed vole (Microtus longicaudus)
- Mink (Mustela vison)
- Mountain lion (Felis concolor)
- Northern flying squirrel (Glaucomys sabrinus)
- Oregon vole (Microtus oregoni)
- Pacific mole (Scapanus orarius)
- Pika (Ochotona princeps)
- Raccoon (Procyon lotor)
- River otter (Lutra canadensis)
- Silver-haired bat (Lasionycteris noctivagans)
- Southern red-backed vole (Clethrionomys gapperi)
- Striped skunk (Mephitis mephitis)
- Townsend's big-eared bat (Plecotus townsendii)* FCo; SC
- Townsend's vole (Microtus townsendii)
- Vagrant shrew (Sorex vagrans)
- Water shrew (Sorex palustris)

PLANTS (31 SPECIES):

- Black hawthorn (Crataegus douglasii)
- Common serviceberry (Amelanchier arborea)
- Curly leaf pondweed (Potamogeton crispus)
- Eurasian milfoil (Myriophyllum spicatum)
- Fragrant waterlily (Nymphae odorata)
- Hardhack spirea (Spiraea douglasii)
- Horsehair (Gordius robustus)
- Japanese knotweed (Polygonum cuspidatum)
- Morning glory (Ipomoea purpurea)
- Pacific willow (Salix lasiandra)
- Common ninebark (Physocarpus opulifolius)
- Common snowberry (Symphoricarpos albus)
- Dwarf Oregon grape (Berberis nervosa)
- Flowering red currant (Ribes sanguineum)
- Hairy willow herb (Epilobium hirsutum)
- Himalayan blackberry (Rubus armeniacus)
- Huckleberries (Vaccinum spp.)
- Mock orange (Philadelphus lewisii)
- Oceanspray (Holodiscus discolor)
- Parrotfeather (Myriophyllum aquaticum)

- Red alder (Alnus rubra)
- Redosier dogwood (Cornus sericea)
- Snowbrush ceanothus (Ceanothus velutinus)
- Tall Oregon grape (Mahonia aquifolium)
- Vine maple (Acer circinatum)
- Yellow floating heart (Nymphoides peltata)
- Red elderberry (Sambucus racemosa)
- Salmonberry (Rubus spectabilis)
- Sword Fern (Polystichum munitum)
- Thimbleberry (Rubus parviflorus)
- Wild Rose (Rosa woodsii)

REPTILES (2 SPECIES):

- Northwestern garter snake (Thamnophis ordinoides)
- Common garter snake (Thamnophis sirtalis)

APPENDIX D. MAP OF LAKE WHATCOM WATERSHED

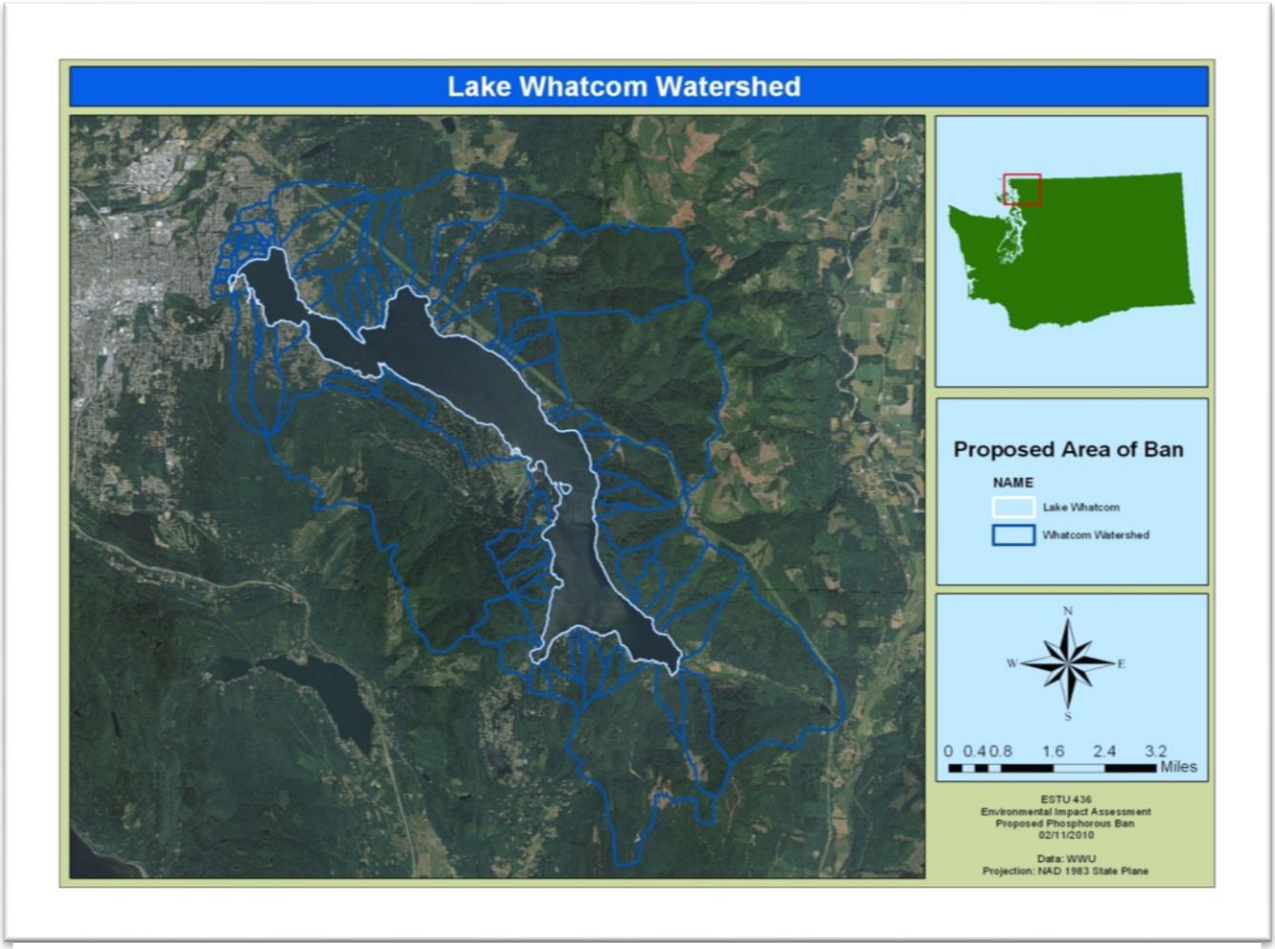

FIGURE 6. LAKE WHATCOM WATERSHED WITH SUB-WATERSHEDS, IMAGE PROVIDED BY KERRI LOVE.

Appendix E. Map of Lake Whatcom with Lake Basins

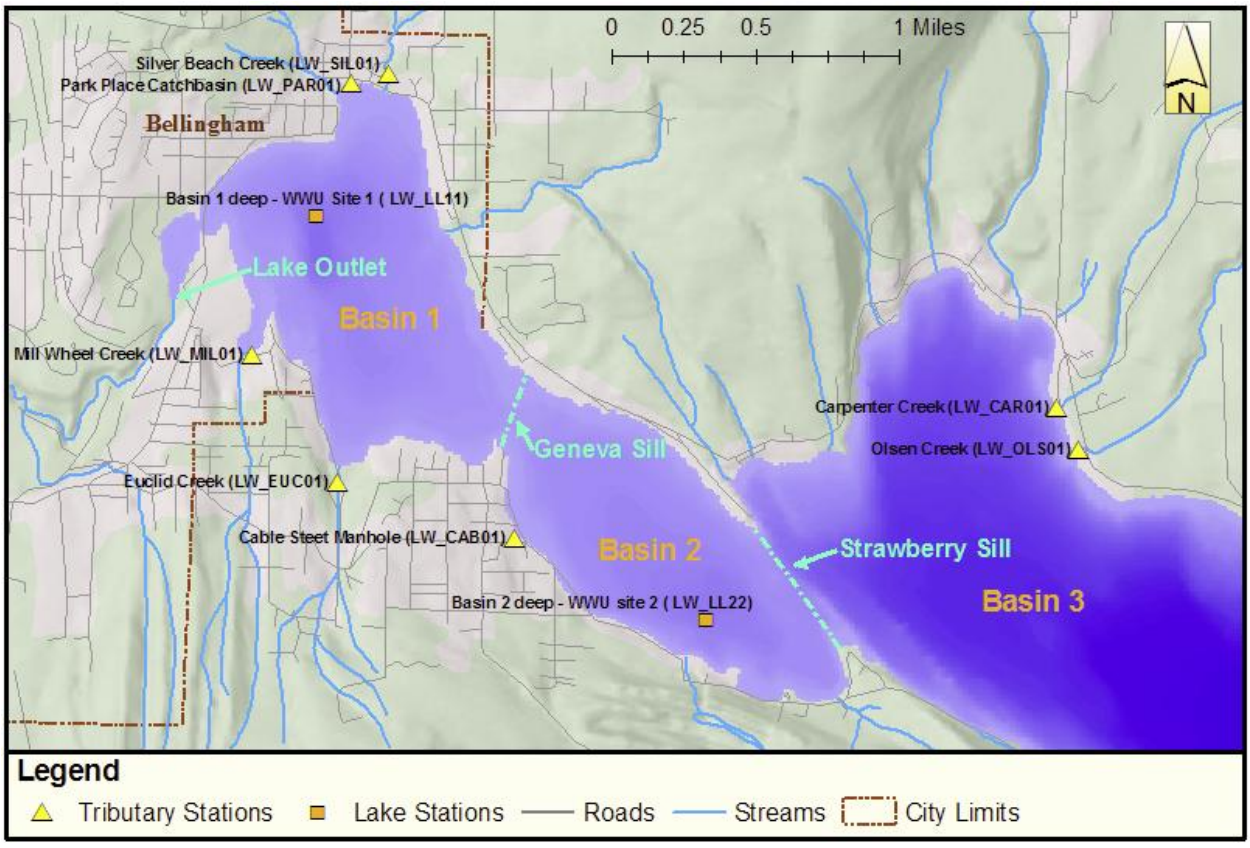

Figure 4. Lake Whatcom watershed with lake basins, image provided by State of Washington Department of Ecology (Ecology, 2008)

APPENDIX E. SOURCES OF PHOSPHORUS

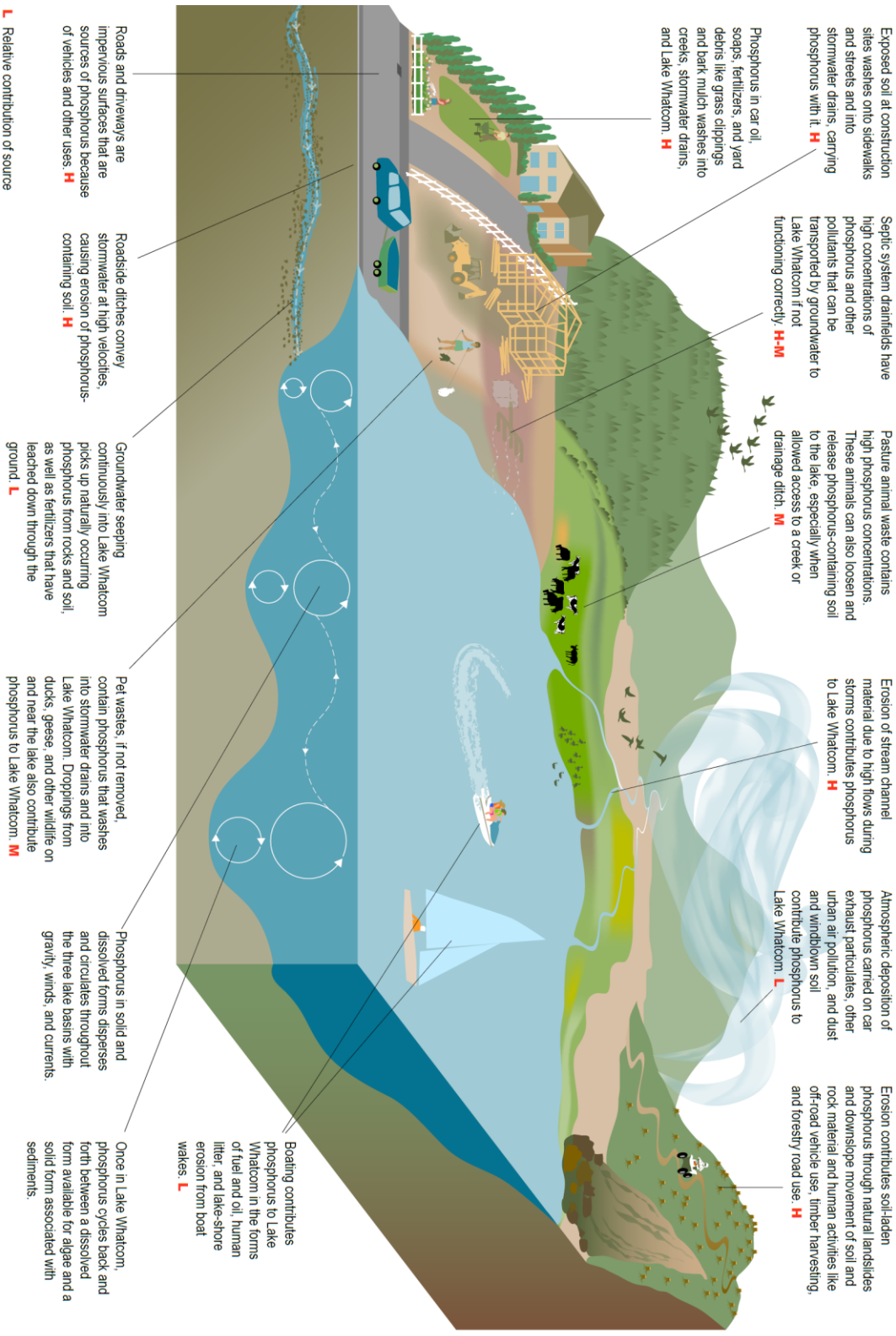

FIGURE 7. MAP OF ALL PHOSPHORUS SOURCES INTO LAKE WHATCOM, (PARAMETRIX, 2007).

APPENDIX F. MAP OF MIGRATION ROUTES

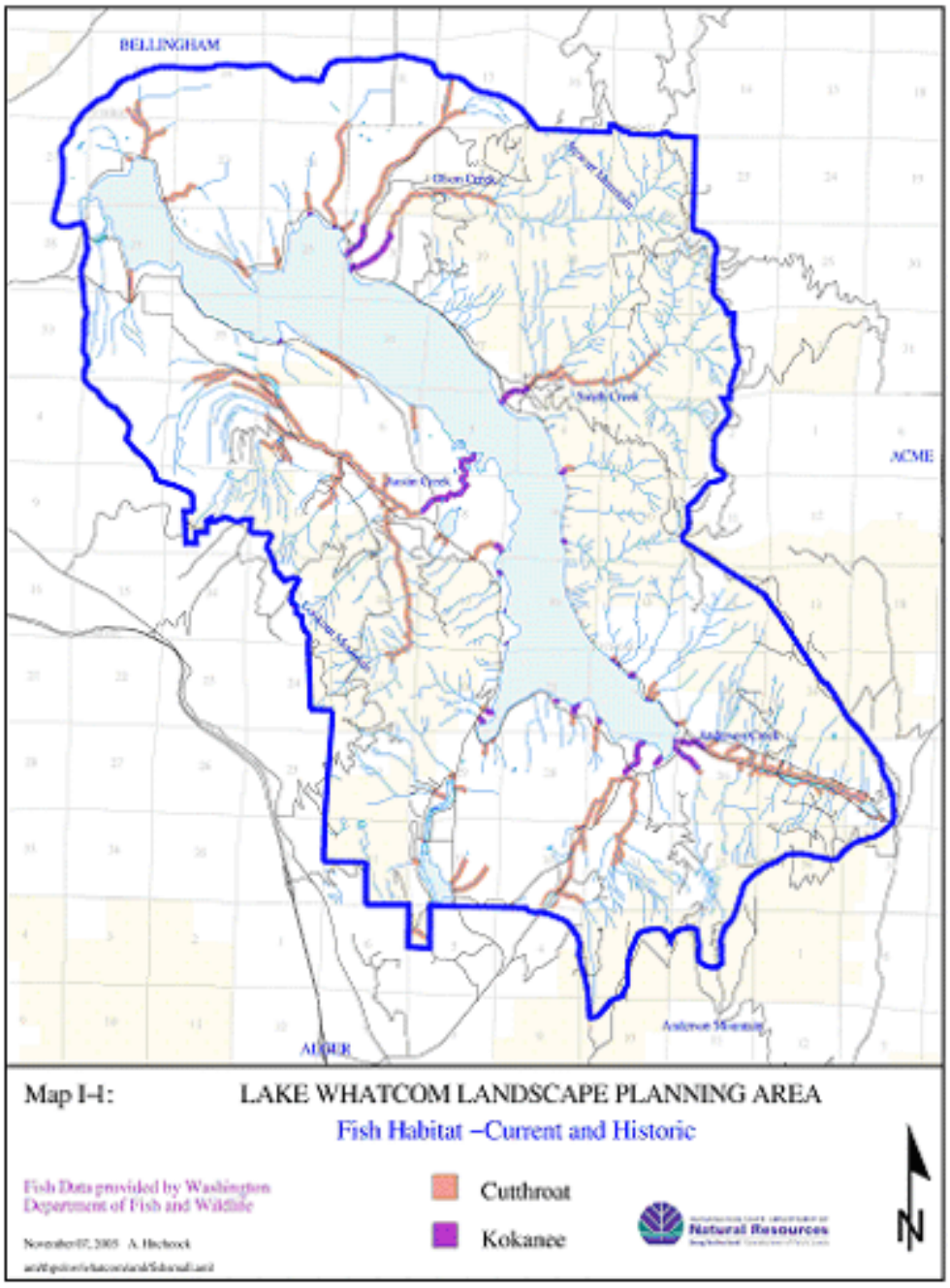

FIGURE 5. Fish Habitats of Cutthroat and Kokanee. Image provided by Lake Whatcom management Program (Lake Whatcom Management Program 2005)

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