GRANDIS POND PUD
BLAINE, WASHINGTON

PRELIMINARY STORMWATER SITE PLAN

Prepared for:
Grandis Pond LLC
PO Box 30647
Bellingham, WA 98228

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April 2007

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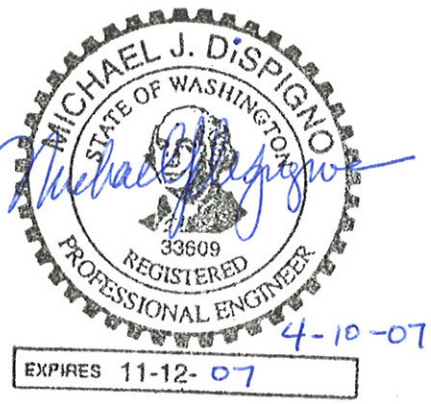

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BLMT0004

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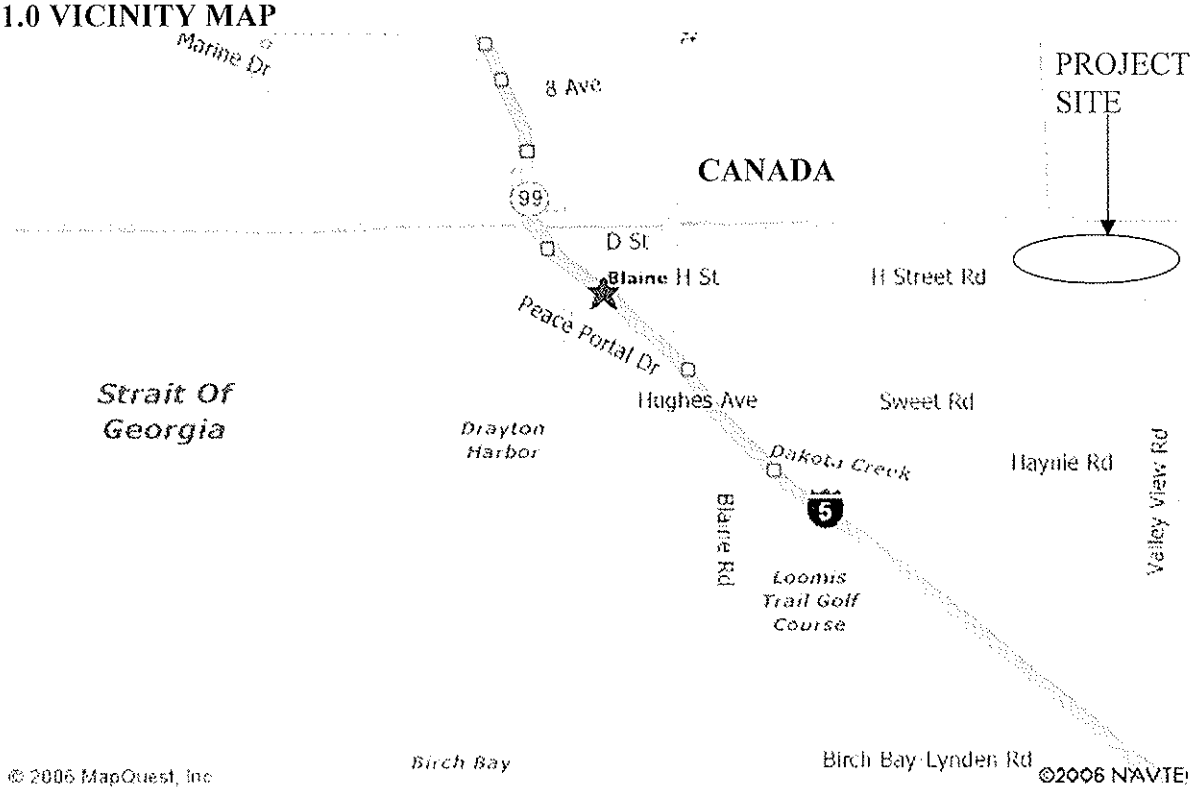
1.0 VICINITY MAP



2.0 PROJECT DESCRIPTION

Grandis Pond LLC is proposing to develop the property known as Grandis Pond (Grandis), a Planned Unit Development (PUD) in Blaine, Washington. This development site is approximately 440 acres and is located one mile east of Harvey Road, between the north side of 'H' Street Road and the Canadian border. The study area is within Sections 33 and 34, Township 41 North, Range 1 East, W.M. in Whatcom County.

The site is currently wooded with a network of old logging roads. Historically, the northeastern portion of the site was used for gravel mining. The site contains 52 wetlands for a total of 94 acres, varying in size from a few hundred square feet to the largest, at 58 acres, which includes a 16 acre pond. The sole structure on the site is an old wood dock along the north side of this four foot deep pond. In general, the eastern two-thirds of the site slopes toward this interior pond and surrounding wetland located in the approximate center of the property (see Figure 1). The pond outlets to the north into the headwaters of Jacobson Creek, which is part of the Little Campbell River watershed, and flows across the border into Canada. The western third of the site is within the Dakota Creek sub-basin of the Drayton Harbor Watershed, and slopes to the west and south.

The proposed development is designed to include single-family lots, cottage homes, duplex/paired housing units, and multi-family housing units, for a total of 1,030 residential units. In addition, 48,000 square feet of commercial building space is proposed. The

development is anticipated to be constructed in five development areas with an estimated 60 dwelling units constructed each year between 2009 and 2026. Along with the houses and other buildings, the development is proposed to include paved roadways with sidewalks and trails, water and sanitary sewer mains, dry utilities, and stormwater management facilities. Low Impact Development (LID) techniques will be used as much as practicable for managing the site's stormwater.

This Stormwater Site Plan examines the post-developed stormwater runoff characteristics of the site and provides mitigating measures to compensate for potential impacts resulting from the proposed improvements.

3.0 DESIGN CRITERIA AND ASSUMPTIONS

3.1 Governing Guidelines

The project site is located within the City of Blaine. City stormwater regulations adopted in 2003 require that stormwater systems be designed to the standards of the most current Washington State Department of Ecology *Stormwater Management Manual for Western Washington* (WDOE Manual). The most current Manual is the August 2005 edition. The WDOE Manual is used to design the construction-phase and permanent stormwater management facilities for this project.

Since this project includes land disturbing activities greater than 5,000 square feet, the requirements for new development apply. These requirements include compliance with Minimum Requirements #1 through #10 as outlined in the WDOE Manual. These requirements are listed in Section 5 of this Plan, *Summary of Minimum Development Requirements*, along with a response of how these requirements shall be met. As specified in this ordinance, Best Management Practices (BMPs) shall be utilized to provide stormwater quality control.

3.2 Design Criteria

In accordance with the 2005 WDOE Manual, the site's hydrologic analysis was performed using the Western Washington Hydrologic Model version 2.f (WWHM2), a continuous simulation hydrologic model developed by the WDOE. As specified by the 2005 WDOE Manual, the pre-developed area was modeled as a forested condition.

The current zoning designation for the property is Planned Residential (PR) with a density of four dwelling units per acre.

3.3 Design Assumptions

Low Impact Development (LID) techniques will be used as much as practicable for managing the site's stormwater. Based on the Natural Resource Conservation Services (NRCS) soils maps for the project area, a substantial portion of the site has Type A and B soils which will enable stormwater infiltration – see Section 4.1 for additional information. In areas where infiltration is practical, LID techniques such as bioinfiltration swales and rain gardens will be used to treat and infiltrate runoff from pollution generating surfaces (roads). Runoff from

roofs and other non-pollution generating surfaces will be directed to infiltration facilities. In areas where infiltration is not practicable, modified LID facilities (such as rain gardens with under drain systems) and more traditional Best Management Practices (BMPs), such as detention ponds, will be used.

At this time, detailed soil information beyond the SCS soil maps is not available. Without more specific soil characteristics information in each basin, there may be areas where infiltration may not be practical. In order to adequately reserve enough area for detention facilities where infiltration may not be possible, detention ponds were sized for each basin (with the exception of two small basins - Basin 1 and 16) based on the basin having Type C/D soils. As the project progresses and design plans are prepared for each basin, specific soils tests will be performed to confirm that infiltration is practical. In the event that it is, the detention pond will be reduced or eliminated and the designated pond area converted to residential lots, open space, or a combination of the two.

A review of the site topography shows no streams and only one drainage from the pond at the center of the site discharging north to Canada. Stormwater runoff appears to sheet flow into the existing wetlands on site. Future detention ponds will be located consistent with the local topography and at the downstream end of its drainage basin. Collected runoff will be discharged from the detention ponds and dispersed onsite into the adjacent wetland buffers. Release rates will be below or at pre-developed condition runoff rates. The existing drainage out of each wetland will remain unchanged.

The project does propose filling portions of existing wetlands to maintain road connectivity. The total wetland fill is proposed to be less than 0.5 acres. (A mitigation plan will be prepared addressing the proposed wetland impacts.) Road right-of-way (ROW) and road width design criteria is assumed as follows:

Road Type	ROW Width	Road	Landscape Width
Collector	60 ft.	2-12 ft. lanes, 6 ft. sidewalk	30 ft.
Local Access	40 ft.	20 ft. road, 4 ft. sidewalk	16 ft.

Although the exact number of lots may vary over time as market conditions dictate, the proposed design has approximately 1,030 residential units. Lot and home characteristics are assumed as follows:

Lot Type	Lot Size	Roof Area	Driveway Area
Single Family	5,000 sf	1,750 sf	800 sf
Cottages	2,800 sf	1,035 sf	710 sf
Estate	> 8,000 sf	3,500 sf	1,000 sf

Offsite areas presently draining onto the Grandis property will continue to follow the existing drainage path and outfall. This flow may be collected and conveyed to the Grandis stormwater facilities, with the assumption that stormwater from a developed site will be treated and detained on the offsite property prior to entering the Grandis site. The Grandis facilities will allow the off site flows to either bypass or pass though the detention ponds with the pass through volume used in the pond sizing calculations.

3.4 WWHM Hydraulic Model Assumptions

Based on the existing topography, the site was divided into 17 different basins (see Figure 1). Basin lines were defined to exclude wetlands since each basin naturally drains into their respective wetland and the wetland will not be developed.

Due to the uncertainty in the amount of infiltration that can be utilized in the final design and the long range development schedule for Phases 2 and 3, only the Basin 2 –Basin 6 stormwater facilities in the Phase 1 development were analyzed in detail. This detailed analysis included pond sizing based on no infiltration using the WWHM model. Ponds for the remaining basins were sized using a scaling ratio based on comparing the basin areas and active storage volume of the Basins 2-6 ponds with the basin areas in the other basins. See Section 5.7 for additional information.

3.5 Site Information

A complete topographical survey of the site was completed by DeGross Aerial Mapping, using lidar technology in April 2006 – see Figure 1. Field surveying of the wetland delineation was done by David Evans & Associates, Inc. in 2005 and the summer of 2006. This topographical information was used in determining the storm basins.

A *Critical Areas Assessment Report: Wetland Delineation* was completed for Grandis Pond on October 18, 2006, by Cantrell & Associates, Inc.

A hydrogeologic investigation of the site and an evaluation of the impact of the development on the aquifer were performed by GeoEngineers. The results of this investigation are in their report, *Hydrogeologic Investigation*, March 5, 2007, and are discussed in Section 5.5 of this Plan.

4.0 BASIN ANALYSIS

4.1 Soil Information

Soil information at the project site was obtained from the *Soil Survey of Whatcom County Area, Washington* published by the Soil Conservation Service (SCS). Figure 3 is an overlay of the soil information, basin boundaries, and proposed site development. Appendix A provides additional information from the SCS soils map.

A review of this figure shows the majority of the site is covered with Type A and B soils, which indicates infiltration is possible. The areas and rate of infiltration will be determined

from field investigations prior to final design. Wetland areas on the site roughly correspond to the locations of Type C and D soils.

As stated in *Section 3.4 WWHM Hydraulic Assumptions*, all of the onsite soils were assumed to be Type C and D in order to estimate the maximum pond size during this phase of design. Since Type C and D soils are relatively impermeable, the maximum amount of stormwater runoff will be directed to the detention pond. Final design of the stormwater management facilities will be based on more detailed soil information for each basin and development areas.

4.2 Pre-Development Conditions

Onsite

The 440-acre site is presently an undeveloped site, located approximately a mile east of the intersection of Harvey Road and 'H' Street Road, and occupies the entire area north of 'H' Street Road to the Canadian border. It is wooded and interspersed with wetlands and uplands. A 16 acre pond is located in the approximate center of the property. The site does not have a developed drainage systems of internal creeks or streams except for the pond's discharge creek that flows north to Canada. There are no existing buildings currently on the site. The only existing structure is a wood dock on the north side of the pond.

Historically, portions of the site were used for gravel mining and logging. A network of old logging roads are present on the site but most have not been maintained. Two roads access the site from 'H' Street Road: one enters the property approximately 350 feet east of Valley View Road. The other (known as the Old Mill Logging Road) enters the property near the western end of the Grandis site. In September 2006 the owners began clearing portions of the future road rights-of-ways (ROW) to gain easier access to the interior. Figure 1, Existing Conditions, shows the current pre-developed conditions of the site, along with the existing topography and wetlands.

The site contains 52 wetlands for a total of 94 acres, varying in size from a few hundred square feet to the largest, at 58 acres, which includes a 16 acre pond. Some of these wetlands drain offsite and a few are isolated and do not appear to be connected to any offsite drainage pathways.

The site was modeled as 17 storm basins with basin boundaries defined by the existing site topography and basin discharge locations. These basins are divided into three zones, the West, Central, and Northeastern. The basins in the West Area drain to internal wetlands with an overall drainage path to the west. The Central Area basins drain to the center pond or wetlands hydrologically connected to the pond. The Northeastern Area drains to an internal wetland and an infiltration pit in the northeast corner of the area. Each area is described below.

Western Area: Basins 1-9

The western area is approximately 150 acres of woods and wetlands. The overall site topography slopes to the west with average slopes between 2% to 12%. The wetlands report

identifies the southwestern portion of this area as being within the Dakota Creek Watershed, and the remainder as being in the Little Campbell River Watershed.

Central Area: Basins 11-16
The approximately 240 acre central portion of the site consists of a combination of woods, wetlands, and a 16 acre pond. The pond drains through a ravine to the northwest and is on of the headwaters to Jacobson Creek. A ridge along the western boundary separates this portion of the site from the Western Area. Topography generally slopes towards the pond in the center of the site. Slopes average from 3% to 7% along the west side of the area and 10% to 20% along the east side of the area. The wetlands report identifies this area as within the Little Campbell River Watershed.

Northeast Area: Basin 17
The Northeast Area consists of approximately 50 acres of a combination of woods and wetlands. Topography in this area slopes primarily to the central wetland and then north to an infiltration pit remaining from the gravel mining. Slopes average between 2% and 12%. A small portion of this area along the very eastern property boundary slopes to the east, and the very northeast corner slopes to the northwest. The wetlands report identifies the eastern area as being within the Little Campbell River Watershed.

Per the WDOE Manual, the pre-developed condition for the site was modeled as undisturbed forest.

Offsite
As shown in Figure 1, several offsite areas drain through the Grandis Pond property. The final stormwater design will account for these offsite flows and allow for pass-through in the Grandis system.

'H' Street Road Drainage
Along the site frontage, 'H' Street Road is currently a two lane road with drainage ditches along both sides that collect the stormwater runoff. The ditches drain west for approximately half a mile to a low point where there is a crossing culvert under the road directing runoff to the south. Runoff enters an unnamed intermittent stream that eventually joins Dakota Creek further south.

4.3 Post-Development Conditions

Onsite
The proposed project will create single-family and multi-family residential lots, a commercial area, roads, sidewalks, trails, parks, and open space. The proposed site plan is shown in Figure 2. The PUD will have 18 neighborhoods consisting of 14 single-family, two multi-family (condominiums and paired), one commercial, and one cottage-style neighborhoods, see Figure 4. Future phasing lines are also shown on this drawing. The pond and a Public Safety area (for a future fire and/or police station) make up the rest of the site. Each neighborhood will have open space that will include parks and a trail system that will link the entire site.

Like the Pre-development Condition, the site was modeled as 17 storm basins with the same basin boundaries used in both models. A summary of average basin impervious areas (roof, roads, hardscape), and pervious areas (lawn and parks) is provided in Table 1, *Summary of Basin Information*. Basin pond areas are also shown in the table.

In general, the approach to stormwater runoff water quality treatment and flow control is to incorporate LID techniques wherever practical. Proposed road widths have been narrowed to minimize pollution generating surfaces. The roads and parking areas will be sloped to direct runoff to rain garden and bioinfiltration swales located in the center median in the main boulevards and along one side of the road in local access streets. In areas where infiltration is possible, the rain gardens and bioinfiltration swales will discharge directly to the ground below. In areas where infiltration is possible for low intensity storms, overflow catch basins will be installed that permit treatment and infiltration of the water quality flows and that bypass the higher flows to detention facilities. In areas where infiltration is not practical, rain gardens and bioinfiltration swales with underdrains, traditional wet detention ponds, and other techniques will be evaluated to determine the most practical management alternatives.

Runoff from non-pollution generating areas, such as roofs, will also be infiltrated where soil conditions make this practical. Based on site specific soil information these infiltration systems can include individual detention structures at each home or regional facilities. In areas where infiltration is not practical, traditional detention ponds and other techniques will be evaluated to determine the most practical management alternatives.

The Grandis conveyance system will include stormwater stubs to allow off site runoff presently crossing into the Grandis site to continue to pass through. Runoff from any development in these off site areas is assumed to be treated and detained prior to entering the Grandis system and that the Grandis stormwater management facilities will be sized accordingly. Figure 1 notes the connection points from off site influent flow.

'H' Street Road

As part of the improvements for Grandis Pond, portions of H Street Road will be widened to add turning lanes at the western and central entrances – see Figure 5. At this time, it is anticipated that runoff from the new pavement at the west Grandis entrance will be routed to the Basin 2 system for treatment and detention system. Runoff from the center entrance will be routed to the Basin 12 system. During final design this approach may change based on the final design configuration.

Utilities, including sanitary sewer, natural gas, and electrical, are proposed to be extended along 'H' Street Road. The stormwater impact for this construction is anticipated to be minimal and will be addressed in the construction stormwater pollution prevention plan.

4.4 Summary of Stormwater Model Analysis

Basin information and detention pond sizes are summarized in Table 1: Summary of Basin Information, below.

Table 1: Summary of Basin Information*

Basin	Total Basin Area (excluding wetlands) (ac)	Total Roof Area (ac)	Total Paved Area – Roads and Hardscape (ac)	Total Pervious Area (ac)	Top of Pond Area** (ac)	Pond Volume (acre-feet)	Ratio of Basin Area to Pond Volume (acre/acre-ft)
Basin 1	11.05				N/A+	N/A	
Basin 2	26.39	3.82	5.42	13.33	1.34	4.51	5.85
Basin 3	9.35	1.45	1.47	5.81	0.55	1.73	5.40
Basin 4	15.00	1.93	3.38	7.05	0.83	2.72	5.51
Basin 5	17.48	2.89	3.71	10.04	1.03	3.42	5.11
Basin 6	20.19	2.89	4.24	11.93	1.11	3.75	5.38
Basin 7	6.73				0.31	1.23	
Basin 8	4.52				0.21	0.83	
Basin 9	21.09				0.97	3.87	
Basin 10	17.49				0.80	3.21	
Basin 11	9.87				0.46	1.81	
Basin 12	34.69				1.60	6.36	
Basin 13	27.26				1.26	5.00	
Basin 14	26.00				1.18	4.77	
Basin 15	24.15				1.11	4.43	
Basin 16	16.34				N/A+	N/A	
Basin 17	41.71				1.93	7.65	

*Cells in this table that are not filled are from basins not modeled in WWHM. Pond sizes were estimated using an average ratio of basin area to pond volume equal to 5.45.

**Using typical pond design assumptions of 3:1 side slopes, 5-ft total depth, and a discharge structure of a single orifice and a weir.

+Basins 1 and 16 assume that the stormwater will be managed individually on each lot. If regional detention ponds are required for these basins, some redesign of the lots and roads will be required.

5.0 SUMMARY OF MINIMUM DEVELOPMENT REQUIREMENTS

5.1 Minimum Requirement #1: Preparation Of Stormwater Site Plans

This Preliminary Stormwater Site Plan is prepared in accordance with Chapter 3 of Volume I of the WDOE Manual. A final Stormwater Site Plan will be provided during the final design for each phase of the project.

5.2 Minimum Requirement #2: Construction Stormwater Pollution Prevention Plan
A Construction Stormwater Pollution Prevention Plan (SWPPP) will be provided as part of the final design documents for the site improvements. The SWPPP will provide erosion and sediment control information, locations where BMPs shall be implemented, and requirements that the contractor must follow throughout construction. BMPs will be selected from the WDOE Manual.

5.3 Minimum Requirement #3: Source Control of Pollution
The post-construction condition is anticipated to include only automobile and truck traffic as a pollution generating source. No other pollution generating sources have been identified at this time. Runoff treatment from road, driveways, and parking areas is addressed in Section 5.6 of this Plan.

During the construction phase of the project, source controls measures will be implemented in accordance with the SWPPP. As typically required in a SWPPP, the contractor will be required to develop a plan to control spills of oil, fuel, hydraulic fluids and other pollutants during the construction phase of the project.

5.4 Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls
The site's existing drainage patterns are proposed to be maintained and modified only in that, in areas of development, existing sheet flow is proposed to be routed to proposed infiltration, treatment, or detention facilities. From non-infiltration facilities, runoff will be routed to detention facilities located adjacent to the wetlands into which the basin presently drains. Wetland hydrology will be maintained by detaining the runoff and dispersing the pond's discharge into the wetland buffer.

The site is divided into two natural drainages: the majority within the Little Campbell River watershed, and a smaller portion located at the western end of the site within the Dakota Creek sub-basin of the Drayton Harbor Watershed.

Little Campbell River Watershed
As noted in the wetland report, the area within the Little Campbell River watershed flows from the site "approximately 3.6 miles down Jacobson Creek to join Little Campbell River, than proceeds another 2.4 miles before emptying into Semiahmoo Bay just south of White Rock." This encompasses the eastern and central areas of the site, and the existing topography "slopes toward the center on all sides comprising a bowl shaped headwaters of Jacobson Creek to the northwest." Water draining off the slopes travels through an extensive network of wetlands and drainages and is detained in an approximately 16 acre shallow pond prior to discharging to Jacobson Creek, situated in a distinct ravine to the northwest of the pond. Stormwater runoff from Basins 1, 6, 9, and 10 through 17 discharges to the Little Campbell River watershed.

Dakota Creek Sub-basin of the Drayton Harbor Watershed

The western area of the site within the Drayton Harbor Watershed is separated from the Little Campbell River drainage to the east by a minor ridge. Topography slopes generally to the west and south with some relatively flat areas and minor depressions. This portion of the study area is a headwater contributing basin to the Dakota Creek portion of the Drayton Harbor watershed. Stormwater runoff from Basins 2 through 5, 7, and 8 discharge to the Drayton Harbor watershed.

5.5 Minimum Requirement #5: On-Site Stormwater Management

On-site stormwater management is proposed to be provided incorporating LID techniques such as narrower road widths (to reduce pollution generating impervious surfaces), the use of rain gardens and bioinfiltration swales (to treat and infiltrate runoff), and the use of localized lot infiltration systems (for managing roof runoff). The boulevard road sections propose a center rain-garden to collect and infiltrate the runoff, and the local access roads propose a rain-garden on the downhill side of the road. Runoff from roofs and pervious areas will infiltrate directly within the lots wherever practical. Runoff from pollution-generating surfaces is proposed to be collected and treated prior to being infiltrated.

Infiltration can only be done if the on-site soils are able to infiltrate the stormwater runoff. In case areas of the site are found to have impermeable soils, stormwater runoff is proposed to be managed using other techniques including on site detention ponds. Soil tests in each basin are proposed prior to final design.

Due to the site's proximity to the City of Blaine's well field and well recharge area, a hydrogeologic investigation was performed by GeoEngineers to evaluate the impact of the proposed development and to recommend strategies to mitigate any adverse impacts. The report reached the following conclusions:

1. The Grandis project is located upgradient of the City of Blaine's water supply well field.
2. The entire site is a groundwater recharge area. Surface soils consist mainly of the Everett soils series, which are generally well deep, excessively drained soils formed as glacial outwash deposits. Beneath the surface deposits, deposits of Bellingham Drift and other low permeability, fine-grained deposits are encountered that provide the City of Blaine's deeper source aquifers protection by preventing or inhibiting direct transport of potential contaminants downward.
3. The project site elevation ranges from approximately 380 to 500 feet. The completion elevations of the City's wells range from 150 feet above to 600 feet below MSL. The vertical separation and the occurrence of intervening low-permeability deposits reduce the potential for water quality impacts.
4. The Grandis Pond development may result in an increase in the amount of recharge. This is due to reduced evapotranspiration, the planned infiltration and detention of all stormwater on-site, LID stormwater management techniques, and the importing of water to the project area (for irrigation) that originates from the Shallow and Deep aquifers.

5. Potential sources of contamination will be reduced or eliminated by incorporating stormwater treatment BMPs and other LID practices, such as green roofs, rain gardens, and unlined bioswales.
6. The sanitary sewer system will substantially reduce the potential for adverse water quality impacts of nitrate loading or other household sources of contaminants. Removal of used domestic water from the project area will provide a benefit to water quality.
7. The potential adverse impacts from the Grandis Pond development will be reduced by incorporating these prevention techniques. Generally, the development will not adversely impact the City of Blaine's water supply source aquifers or wells, based on the available information.

5.6 Minimum Requirement #6: Runoff Treatment

This project proposes to incorporate LID techniques for runoff treatment. For single-family residential development, the WDOE Manual requires basic treatment of the collected stormwater runoff. Runoff treatment is proposed to be provided for pollution-generating surfaces using LID treatment systems such as rain gardens or bioinfiltration swales within the road ROW. Rain gardens and bioinfiltration swales will be designed in accordance with the 2005 *Low Impact Development Technical Guidance Manual for Puget Soun*d (LID Manual), Puget Sound Action Team and Washington State University.

Details for the proposed collector and local access road rain gardens are provided in Figure 6. The collector roadway rain gardens will be located in the center median, running continuously within the road. Assuming an infiltration rate of one inch per hour, typical rain garden width is 5 feet. The local access roads will be sloped to direct runoff to a rain garden on one side of the road. Assuming an infiltration rate of one inch per hour, typical rain garden width is 3.5 feet.

Areas of the project that are multi-family or commercial will be required to provide enhanced treatment of the stormwater runoff. LID techniques for enhanced treatment includes infiltration, constructed wetlands, filter strips, sand and/or cartridge-type filter units. Currently, Basins 10 and 12 are the only basins in the PUD that are proposing to contain multi-family residences and/or commercial areas. The remainder of the PUD is proposed to be single-family residential.

5.7 Minimum Requirement #7: Flow Control

This project proposes to incorporate LID techniques for flow control. In areas where infiltration is possible, the rain gardens, bioinfiltration swales, and/or retention structures will discharge directly to the ground below. In areas where infiltration is not practical, traditional detention ponds and other techniques will be evaluated to determine the most practical management alternatives.

As discussed in Section 3.3 *Design Assumptions*, in the event infiltration is not possible in a basin, adequate area must be reserved for detention facilities. Detention ponds were therefore sized for each basin based on non-infiltrating Type C and D soils.

As discussed in Section 3.3.2, *WWHM Hydraulic Model Assumptions*, due to the uncertainty in the amount of infiltration that can be utilized in the final design and the long range development schedule for Phases 2 and 3, only the Basin 2 –Basin 6 stormwater facilities in the Phase 1 development were analyzed in detail. Pervious and impervious areas for Basins 2-6 were estimated based on the number and type of lots (Single Family), the lot characteristics, and the length of boulevard and local access roads. Parks and open space areas were estimated from the neighborhood plans. The active storage volume of each of these five detention ponds was estimated based on this information using WWHM and assumed four foot active storage depth. The ratio of the basin area (in acres) to the pond's active storage volume (in acre feet) was found to range between 5.11 and 5.85 for the five basins. The active storage volume for the detention ponds in the remaining basins was estimated based on the basin's area and an average ratio value of 5.45. Pond areas were estimated based the active storage volume, a five foot pond depth (four foot active depth and 1 ft freeboard), and 3(H):1(V) side slopes, and a combination orifice and weir control structure and riser. Table 1 provides a summary of the Basins 2-6 information and the ratio derived for each of the five basins. Appendix B provides the modeling results for the five basins and supporting information for Table 1.

Stormwater runoff from homes in Basins 1 and 16 are assumed to be handled locally on each lot due to the larger lot size and the proximity to wetland areas. This assumption will be verified and modified accordingly during final design.

To ensure the combined treatment and detention pond serves its intended function, an Operation and Maintenance Manual shall be provided in the final Stormwater Site Plans.

5.8 Minimum Requirement #8: Wetlands Protection

Wetlands have been identified on this site. Figure 1: *Existing Conditions* shows the pre-developed site with location of the wetlands, and Figure 2: *Proposed Development shows* the proposed developed site. Wetlands impacts are minimal, with an estimated 0.5 acres of wetlands to be fill (approximately 0.1% of the 440 acre site.)

All stormwater facilities are proposed to be built outside of the existing wetlands and their buffers. The design intent is that stormwater released from any detention pond will be dispersed along the buffer adjacent to the wetland to which the basin presently drains. In the event infiltration is possible, the basin does not have a detention pond, and the basin has a wetland, roof drains from homes adjacent to the wetland will be diverted to the wetland in order to maintain the wetland hydrology.

Wetland protection will include designing facilities that will disperse collected runoff such that wetland hydrology will be maintained and not adversely impact the hydraulics of the wetland. A future version of the WWHM model is proposed to have the capability to model the water level fluctuations in a wetland. As Grandis site is developed, final stormwater design may be able to use this newer version of WWHM to model the wetlands and possibly use them for detention.

5.9 Minimum Requirement #9: Basin/Watershed Planning

The site is located within two watersheds: the Little Campbell River Watershed, and the Dakota Creek sub-basin of the Drayton Harbor Watershed (1). Approximately 75% of the site area is within the Little Campbell River Watershed, and the remaining 25% is within the Drayton Harbor Watershed.

5.10 Minimum Requirement #10: Operation and Maintenance

The Grandis Pond Homeowners Association is proposed to be responsible for operating and maintaining the proposed stormwater facilities outside the public ROW. The association will also responsible for maintaining stormwater facilities within the right-of-ways, such as rain-gardens and bioinfiltration swales to the extent of maintaining the vegetative cover and cutting the grass. The City of Blaine is proposed to be responsible for maintaining the stormwater conveyance piping and catch basins within the ROW.

A Stormwater Facilities Operation and Maintenance Manual shall be provided to the homeowner association with each final Stormwater Site Plan.

REFERENCES

1. **Critical Areas Assessment Report: Wetland Delineation, Grandis Pond, Blaine, WA, by Cantrell & Associates, Inc., October 18, 2006.**

2. **Hydrogeologic Investigation, Grandis Pond Project, Blaine, Washington, File No. 15995-002-00, March 5, 2007, by GeoEngineers.**

FIGURES

- Figure 1: Existing Conditions
- Figure 2: Proposed Development
- Figure 3: Soils Overlay Map
- Figure 4: Neighborhoods and Development Phasing Plan
- Figure 5: H Street Road Intersection
- Figure 6: Typical Road Sections and Rain Garden Details

APPENDIX A
Soils Information

- SCS Soil Map
- SCS Soils Numbers and Hydrologic Group

Soil types

West

- 140 - C
- 120 - A
- * 48 - B
- 19 - A
- 50 - A
- 51 - A/B
- 31 - C
- 165 - C
- 72 - D
- 156 - B

93 - D
120 - A
141 - C

A

B

C

D

A/B - #51

SOILS MAP

Table K1. - Water Features - Continued

Whatcom County Area, Washington

Map Symbol and Soil Name	Hydrologic Group	Month	Water Table		Ponding			Flooding	
			Upper Limit	Lower Limit	Surface Depth	Duration	Frequency	Duration	Frequency
			Ft	Ft	Ft				
29:									
URBAN LAND	---	Jan-Dec			---	---	None	---	None
30:									
CLENDENEN	D	January	1.0-1.5	1.5-2.0	---	---	None	---	None
		February	1.0-1.5	1.5-2.0	---	---	None	---	None
		March	1.0-1.5	1.5-2.0	---	---	None	---	None
		April	1.0-1.5	1.5-2.0	---	---	None	---	None
		May	1.0-1.5	1.5-2.0	---	---	None	---	None
		June	1.0-1.5	1.5-2.0	---	---	None	---	None
		November	1.0-1.5	1.5-2.0	---	---	None	---	None
		December	1.0-1.5	1.5-2.0	---	---	None	---	None
31:									
CLIPPER	C	January	2.0-4.0	>6.0	---	---	None	---	None
		February	2.0-4.0	>6.0	---	---	None	---	None
		March	2.0-4.0	>6.0	---	---	None	---	None
		April	2.0-4.0	>6.0	---	---	None	---	None
		November	2.0-4.0	>6.0	---	---	None	---	None
		December	2.0-4.0	>6.0	---	---	None	---	None
32:									
COMAR	C	January	1.5-3.5	2.0-4.0	---	---	None	---	None
		February	1.5-3.5	2.0-4.0	---	---	None	---	None
33:									
COMAR	C	January	1.5-3.5	2.0-4.0	---	---	None	---	None
		February	1.5-3.5	2.0-4.0	---	---	None	---	None
34:									
COMAR	C	January	1.5-3.5	2.0-4.0	---	---	None	---	None
		February	1.5-3.5	2.0-4.0	---	---	None	---	None
35:									

Table K1. - Water Features - Continued

Whatcom County Area, Washington

Map Symbol and Soil Name	Hydrologic Group	Month	Water Table		Ponding			Flooding	
			Upper Limit	Lower Limit	Surface Depth	Duration	Frequency	Duration	Frequency
			Ft	Ft	Ft				
47:									
TACOMA	D	January	0.0-1.0	>6.0	---	---	None	Long	Frequent
		February	0.0-1.0	>6.0	---	---	None	Long	Frequent
		March	0.0-1.0	>6.0	---	---	None	Long	Frequent
		April	0.0-1.0	>6.0	---	---	None	Long	Frequent
		November	0.0-1.0	>6.0	---	---	None	---	None
		December	0.0-1.0	>6.0	---	---	None	Long	Frequent
48:									
EVERETT	B	January	3.5-5.0	3.0-5.0	---	---	None	---	None
		February	3.5-5.0	3.0-5.0	---	---	None	---	None
		March	3.5-5.0	3.0-5.0	---	---	None	---	None
		April	3.5-5.0	3.0-5.0	---	---	None	---	None
		December	3.5-5.0	3.0-5.0	---	---	None	---	None
49:									
EVERETT	A	Jan-Dec			---	---	None	---	None
50:									
EVERETT	A	Jan-Dec			---	---	None	---	None
51:									
EVERETT	A	Jan-Dec			---	---	None	---	None
EVERETT	B	January	3.5-5.0	3.0-5.0	---	---	None	---	None
		February	3.5-5.0	3.0-5.0	---	---	None	---	None
		March	3.5-5.0	3.0-5.0	---	---	None	---	None
		April	3.5-5.0	3.0-5.0	---	---	None	---	None
		December	3.5-5.0	3.0-5.0	---	---	None	---	None
52:									

Table K1. - Water Features - Continued

Whatcom County Area, Washington

Map Symbol and Soil Name	Hydrologic Group	Month	Water Table		Ponding			Flooding	
			Upper Limit	Lower Limit	Surface Depth	Duration	Frequency	Duration	Frequency
			Ft	Ft	Ft				
52:									
EVERETT	B	January	3.5-5.0	3.0-5.0	---	---	None	---	None
		February	3.5-5.0	3.0-5.0	---	---	None	---	None
		March	3.5-5.0	3.0-5.0	---	---	None	---	None
		April	3.5-5.0	3.0-5.0	---	---	None	---	None
		December	3.5-5.0	3.0-5.0	---	---	None	---	None
URBAN LAND	---	Jan-Dec			---	---	None	---	None
53:									
EVERSON	D	January	1.0-3.0	>6.0	---	---	None	---	None
		February	1.0-3.0	>6.0	---	---	None	---	None
		March	1.0-3.0	>6.0	---	---	None	---	None
		April	1.0-3.0	>6.0	---	---	None	---	None
		November	1.0-3.0	>6.0	---	---	None	---	None
		December	1.0-3.0	>6.0	---	---	None	---	None
54:									
FISHTRAP	D	January	1.5-2.5	>6.0	---	---	None	---	None
		February	1.5-2.5	>6.0	---	---	None	---	None
		March	1.5-2.5	>6.0	---	---	None	---	None
		April	1.5-2.5	>6.0	---	---	None	---	None
		May	1.5-2.5	>6.0	---	---	None	---	None
		October	1.5-2.5	>6.0	---	---	None	---	None
		November	1.5-2.5	>6.0	---	---	None	---	None
		December	1.5-2.5	>6.0	---	---	None	---	None
55:									
GALLUP	B	Jan-Dec			---	---	None	---	None
56:									
GALLUP	B	Jan-Dec			---	---	None	---	None
57:									

Table K1. - Water Features - Continued

Whatcom County Area, Washington

Map Symbol and Soil Name	Hydrologic Group	Month	Water Table		Ponding			Flooding	
			Upper Limit	Lower Limit	Surface Depth	Duration	Frequency	Duration	Frequency
			Ft	Ft	Ft				
67:									
ROCK OUTCROP	D	Jan-Dec			---	---	None	---	None
68:									
HEISLER	B	Jan-Dec			---	---	None	---	None
69:									
HEISLER	B	Jan-Dec			---	---	None	---	None
70:									
HINKER	C	Jan-Dec			---	---	None	---	None
71:									
HINKER	C	Jan-Dec			---	---	None	---	None
72:									
HISTOSOLS	D	January	0.0	>6.0	0.0-1.0	Very long	None	---	None
		February	0.0	>6.0	0.0-1.0	Very long	None	---	None
		March	0.0	>6.0	0.0-1.0	Very long	None	---	None
		April	0.0	>6.0	0.0-1.0	Very long	None	---	None
		May	0.0	>6.0	0.0-1.0	Very long	None	---	None
		June	0.0	>6.0	0.0-1.0	Very long	None	---	None
		July	0.0	>6.0	0.0-1.0	Very long	None	---	None
		August	0.0	>6.0	0.0-1.0	Very long	None	---	None
		November	0.0	>6.0	0.0-1.0	Very long	None	---	None
		December	0.0	>6.0	0.0-1.0	Very long	None	---	None
73:									

Table K1. - Water Features - Continued

Whatcom County Area, Washington

Map Symbol and Soil Name	Hydrologic Group	Month	Water Table		Ponding			Flooding	
			Upper Limit	Lower Limit	Surface Depth	Duration	Frequency	Duration	Frequency
			Ft	Ft	Ft				
90:									
KLINE	C	January	3.0-5.0	>6.0	---	---	None	---	None
		February	3.0-5.0	>6.0	---	---	None	---	None
		March	3.0-5.0	>6.0	---	---	None	---	None
91:									
KULSHAN	C	Jan-Dec			---	---	None	---	None
92:									
KULSHAN	C	Jan-Dec			---	---	None	---	None
93:									
LABOUNTY	D	January	0.0-1.0	0.5-1.5	---	---	None	---	None
		February	0.0-1.0	0.5-1.5	---	---	None	---	None
		March	0.0-1.0	0.5-1.5	---	---	None	---	None
		April	0.0-1.0	0.5-1.5	---	---	None	---	None
		May	0.0-1.0	0.5-1.5	---	---	None	---	None
		November	0.0-1.0	0.5-1.5	---	---	None	---	None
		December	0.0-1.0	0.5-1.5	---	---	None	---	None
94:									
LABOUNTY	D	January	1.0-3.0	1.0-3.0	---	---	None	---	None
		February	1.0-3.0	1.0-3.0	---	---	None	---	None
		March	1.0-3.0	1.0-3.0	---	---	None	---	None
		April	1.0-3.0	1.0-3.0	---	---	None	---	None
		May	1.0-3.0	1.0-3.0	---	---	None	---	None
		November	1.0-3.0	1.0-3.0	---	---	None	---	None
		December	1.0-3.0	1.0-3.0	---	---	None	---	None
95:									

Table K1. - Water Features - Continued

Whatcom County Area, Washington

Map Symbol and Soil Name	Hydrologic Group	Month	Water Table		Ponding			Flooding	
			Upper Limit	Lower Limit	Surface Depth	Duration	Frequency	Duration	Frequency
			Ft	Ft	Ft				
152:									
SNOQUALMIE	C	January	3.0-5.0	>6.0	---	---	None	Brief	Occasional
		February	3.0-5.0	>6.0	---	---	None	Brief	Occasional
		March	3.0-5.0	>6.0	---	---	None	Brief	Occasional
		April	3.0-5.0	>6.0	---	---	None	Brief	Occasional
		November	3.0-5.0	>6.0	---	---	None	Brief	Occasional
		December	3.0-5.0	>6.0	---	---	None	Brief	Occasional
153:									
SORENSEN	B	Jan-Dec			---	---	None	---	None
154:									
SORENSEN	B	Jan-Dec			---	---	None	---	None
155:									
SPRINGSTEEN	C	Jan-Dec			---	---	None	---	None
156:									
SQUALICUM	B	January	3.5-5.0	3.0-5.0	---	---	None	---	None
		February	3.5-5.0	3.0-5.0	---	---	None	---	None
		March	3.5-5.0	3.0-5.0	---	---	None	---	None
		April	3.5-5.0	3.0-5.0	---	---	None	---	None
		December	3.5-5.0	3.0-5.0	---	---	None	---	None
157:									
SQUALICUM	B	January	3.5-5.0	3.0-5.0	---	---	None	---	None
		February	3.5-5.0	3.0-5.0	---	---	None	---	None
		March	3.5-5.0	3.0-5.0	---	---	None	---	None
		April	3.5-5.0	3.0-5.0	---	---	None	---	None
		December	3.5-5.0	3.0-5.0	---	---	None	---	None
158:									

Table K1. - Water Features - Continued

Whatcom County Area, Washington

Map Symbol and Soil Name	Hydrologic Group	Month	Water Table		Ponding			Flooding	
			Upper Limit	Lower Limit	Surface Depth	Duration	Frequency	Duration	Frequency
			Ft	Ft	Ft				
163:									
TACOMA	D	January	0.0-1.0	>6.0	---	---	None	Long	Frequent
		February	0.0-1.0	>6.0	---	---	None	Long	Frequent
		March	0.0-1.0	>6.0	---	---	None	Long	Frequent
		April	0.0-1.0	>6.0	---	---	None	Long	Frequent
		November	0.0-1.0	>6.0	---	---	None	---	None
		December	0.0-1.0	>6.0	---	---	None	Long	Frequent
164:									
TACOMA	D	January	1.0-2.5	>6.0	---	---	None	Brief	Frequent
		February	1.0-2.5	>6.0	---	---	None	Brief	Frequent
		March	1.0-2.5	>6.0	---	---	None	Brief	Frequent
		April	1.0-2.5	>6.0	---	---	None	Brief	Frequent
		November	1.0-2.5	>6.0	---	---	None	Brief	Frequent
		December	1.0-2.5	>6.0	---	---	None	Brief	Frequent
165:									
TROMP	C	January	1.5-2.5	>6.0	---	---	None	---	None
		February	1.5-2.5	>6.0	---	---	None	---	None
		March	1.5-2.5	>6.0	---	---	None	---	None
		April	1.5-2.5	>6.0	---	---	None	---	None
		November	1.5-2.5	>6.0	---	---	None	---	None
		December	1.5-2.5	>6.0	---	---	None	---	None
166:									
TWINSI	C	January	1.5-3.0	2.0-3.0	---	---	None	---	None
		February	1.5-3.0	2.0-3.0	---	---	None	---	None
		March	1.5-3.0	2.0-3.0	---	---	None	---	None
		April	1.5-3.0	2.0-3.0	---	---	None	---	None
		November	1.5-3.0	2.0-3.0	---	---	None	---	None
		December	1.5-3.0	2.0-3.0	---	---	None	---	None
167:									