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www.geoengineers.com

1550 Woodridge Drive Southeast, Port Orchard, Washington 98366 TELEPHONE: (360) 769-8400, FAX: (360) 769-8700

To: Mike DiSpigno
David Evans and Associates, Inc.
119 Grand Avenue, Suite D
Bellingham, Washington 98225

Date: 3/5/2007

File: 15995-002-00

Email Address: mjdi@deainc.com

Regarding: Grandis Pond Project in Blaine, Washington

Date	Description
3/5/2007	Report

Remarks: Please call if you have questions.

Copy To:

Signed: Nicole Broady for

Joel W Purdy
jpurdy@geoengineers.com

GeoEngineers

March 5, 2007

David Evans and Associates, Inc.
119 Grand Avenue, Suite D
Bellingham, Washington 98225

Attention: Michael DiSpigno

Subject: Report
Hydrogeologic Investigation
Grandis Pond Project
Blaine, Washington
File No. 15995-002-00

INTRODUCTION

This report presents a summary of the hydrogeologic assessment conducted by GeoEngineers, Inc. (GeoEngineers) related to the development by Blossom Management Corporation of the property known as Grandis Pond in Blaine, Washington. GeoEngineers evaluated of the potential impacts of the Grandis Pond project on aquifers that are the source for the City of Blaine's water supply wells. This report provides a discussion of the existing knowledge pertaining to hydrogeology in the area, considers whether this information is sufficiently current to support the assessment, evaluates the vulnerability of the source aquifers, and presents general recommendations on project approaches to reduce the potential impacts due to the development of the property.

Grandis Pond is a Planned Unit Development (PUD) of approximately 440 acres located within Sections 33 and 34, Township 41 North, Range 1 East, W.M. in Whatcom County. The proposed development will include new single-family lots, cottage homes, duplex/paired housing units, and multi-family units for a total of approximately 1,000 residential units. In addition, approximately 30,000 square feet (sf) of commercial building space is proposed. Along with the houses and other buildings, the development will include paved roadways, water and sanitary sewer mains, miscellaneous utilities, stormwater conveyance and detention systems, and stormwater treatment through low-impact development (LID) techniques such as rain gardens.

SCOPE OF SERVICES

The intent of this report is to provide an assessment of the potential hydrogeologic impacts of the Grandis Pond project on the site and surrounding areas, specifically the potential impacts to the source aquifer for the City of Blaine's water supply wells. The services provided by GeoEngineers, Inc. (GeoEngineers) consisted of:

1. Reviewed two available hydrogeologic reports, *Hydrogeological Characterization Study East Blaine Annexation Area* (EMCON 1995) and *Evaluation of Aquifer Vulnerability Proposed East Blaine Annexation Area* (EMCON 1992), to evaluate the local hydrogeology in the East Blaine area and assess their applicability to current understanding based on more recent well drilling and other relevant hydrogeologic information.

1550 Woodridge Dr SE telephone 360.769.8400
Port Orchard, WA 98366 facsimile 360.769.8700
website www.geoengineers.com

2. Collected and reviewed well log information from the Washington Department of Ecology's (Ecology) Well Log Viewer web site to investigate wells that were drilled in the area post-dating the two EMCON reports. We reviewed the new information to evaluate whether there were significant changes that may be contrary to EMCON's hydrogeologic characterization.
3. Reviewed available published reports that are more recent than 1995 that apply to the East Blaine area, including the Nooksack WRIA 1 Watershed Assessment reports and Wellhead Protection Plans.
4. Reviewed current regulatory constraints, such as pertinent county and City of Blaine Critical Area Ordinances related to Critical Aquifer Recharge Areas and Wellhead Protection Areas. Reviewed the City's Wellhead Protection Program and Groundwater Management Program reports for the City's wells, which are located to the south and west of the subject project.
5. Provided this letter on the findings of our investigation as they apply to the conceptual plans for project development, stormwater management and infiltration, which are prominent features of the proposed project. Provided an assessment of the degree of conformance achieved through the application of Best Management Practices (BMPs) for stormwater infiltration and other applicable development practices that are required under the Stormwater Management Manual for Western Washington (Ecology 2005).

PREVIOUS STUDIES REVIEWED

GeoEngineers reviewed available information pertaining to the hydrogeology in the Blaine area. Documents reviewed included general studies such as:

- Geologic map of western Whatcom County, MAP I-854-B (Easterbrook 1976);
- Water Resources of the Nooksack River Basin and Certain Adjacent Streams (Water Supply Bulletin No. 12 Washington Department of Conservation 1960);
- WRIA 1 Groundwater Management Project (Utah Water Research Laboratory 2001); and
- Unpublished consultants' reports including:
  - Evaluation of Aquifer Vulnerability Proposed East Blaine Annexation Area (EMCON 1992);
  - Hydrogeological Characterization Study East Blaine Annexation Area (EMCON 1995);
  - Electrical Resistivity Report (Geo Recon 1994, as part of EMCON 1995);
  - Blaine Groundwater Management Program (Golder and Associates 1995);
  - Report to the City of Blaine on Wellhead Protection Program (Golder and Associates 1996); and
  - Installation and Testing of Production Well 2, Birch Bay, Washington (GeoEngineers 2001).

Other information collected and reviewed included Ecology Water Well Reports from Ecology's Well Log Viewer website, United States Geological Survey (USGS) topographic maps and Washington Department of Health's Source Water Program (SWAP) map website.

HYDROGEOLOGIC SETTING

The surface deposits of the Grandis Pond project site consist mainly of gravel and sand deposits that overlie the Bellingham Drift, a glacio-marine drift deposit that mantles upland areas (Easterbrook 1976). Surface soils consist mainly of the Everett soils series, which are generally deep, excessively drained soils formed as glacial outwash deposits. Very poorly draining, organic-rich soils occur within and on the edges of the ponded area in the central portion of the Grandis Pond project. Golder Associates (1995) developed a generalized recharge potential map based on soil permeability and depth to water table. Approximately half of the site is classified as having low recharge potential and the other half has high recharge potential.

Golder Associates (1996) groups the general hydrogeology of the Blaine Watershed and east Blaine area into three main aquifer systems: the Perched, Shallow and Deep Aquifers. Below is a brief discussion of these aquifer systems in descending order.

The Perched Aquifer consists of glacio-fluvial sands and gravels deposited by glacial meltwater streams and is generally encountered at elevations from 200 to 380 feet above mean sea level (MSL), approximately 50 to 150 feet below ground surface in the vicinity of project area. The deposits form an unconfined aquifer of a thickness ranging from 10 to 80 feet. Some domestic water supply wells are completed in the Perched Aquifer.

The Shallow Aquifer is stratigraphically below the Perched Aquifer and consists of sand and gravel deposits that form a semi-confined to confined aquifer generally encountered at elevations between 100 feet above and 100 feet below MSL. Where both are present, the Perched and Shallow Aquifers are separated by low-permeability deposits of the Bellingham Drift (Easterbrook 1976) that forms an aquitard. City of Blaine Wells 3, 4, 5, 6, 7, 8 and 9 are completed in the Shallow Aquifer.

The Deep Aquifer, a confined aquifer encountered at 450 to 560 feet below MSL, consists of sand and gravel deposits that are separated from the Shallow Aquifer by a thick aquitard comprising 400 to 600 feet of low-permeability silt and clay deposits. City of Blaine's Well 1, 1R, 2 and 3R are completed in this aquifer.

A resistivity survey of the project area by Geo Recon (1994) was interpreted to be consistent with the observed lithology of the area. In some areas the interpretation shows a layer of fine-grained deposits at the surface and another 100-foot-thick layer of fine-grained deposits at about 100 feet below ground surface. This fine-grained deposit is likely the aquitard between the Perched and Shallow Aquifers.

Golder Associates (1996) indicate a groundwater-flow divide, which generally bisects the topographic ridge where the project is located, occurs such that groundwater in the Perched and Shallow Aquifers flows to the northwest and southwest (see Attachment). The groundwater flowing to the southwest represents a source of recharge for the City of Blaine's wells.

REGULATORY ASPECTS

The City of Blaine Municipal Code for Land Use (Chapter 17) establishes the Critical Area Ordinances (CAO) pertaining to Critical Aquifer Recharge Areas (CARAs). The ordinances are established, per the Growth Management Act, to provide guidelines regarding development activities that may impact or be impacted by geologic hazards, flooding, aquifer recharge areas, wetlands, and fish and wildlife

conservation areas. The City of Blaine's ordinance defines the CARA based on susceptible aquifer recharge areas and highly permeable surface geology (Blaine Municipal Code 17.82.060). Whatcom County CARAs are based on susceptible recharge areas and wellhead protection areas (WHPAs). Golder Associates (1996) estimates the WHPA of the City of Blaine's wellfield, located southwest of the Grandis Pond project, encompasses the southern half of the project site. The northern boundary of the WHPA's capture zone for 10-year time of travel corresponds to the east-west groundwater divide previously discussed herein. However, the Washington Department of Health's (DOH) Source Water Assessment Program website shows fixed radii for the City's WHPAs that do not intersect the project site. It is possible that, since the City's WHPP report is in draft form, DOH has not finalized the site-specific WHPAs that Golder established using analytical modeling.

The WRIA 1 Technical Report (Utah Water Research Laboratory 2001) shows a map of "critical aquifer recharge areas" (their Figure 1.1.9). However, the definition of critical aquifer recharge areas within the WRIA 1 Technical Report does not relate to the CARAs of the City's CAO, but is simply defined as areas where recharge occurs. Their map shows the entire project area as a critical aquifer recharge area on this basis, which is reasonable since recharge likely occurs throughout the project site, even in areas with surface soils of relatively low permeability.

Given that a portion of the Grandis Pond project is located within the City's WHPA and is a recharge source for the City's wellfield, considerations should be made to reduce any potentially adverse project impacts to aquifer recharge. These considerations are discussed in detail below.

POTENTIAL IMPACTS

The Grandis Pond project is located upgradient of the City of Blaine's water supply wells. The southern half of the project site is likely within the recharge area and WHPAs of the City's wellfield located to the southwest. The following section discusses the potential impacts of the project to the source aquifers and these water supply wells.

GROUNDWATER RECHARGE

The aquifers in the area receive recharge from the amount of precipitation that does not runoff, evaporate or is transpired by plants. There is potential that the development could reduce the amount of groundwater recharge due to increasing the surface runoff from impervious surfaces. This impact can be reduced by collecting, treating and infiltrating stormwater runoff on site. The clearing of some of the vegetation could reduce the amount of evapotranspiration and increase infiltration. In addition, the water supply will be imported from the City's wells and outdoor irrigation may increase the groundwater recharge. Thus, by infiltrating stormwater, reducing evapotranspiration and importing water to the site, the post-development recharge may be increased, providing a positive impact in terms of water quantity.

WATER QUALITY

Development of the site may adversely impact groundwater quality through the infiltration of paved-area runoff and over-application of fertilizers and pesticides. As noted earlier, the potential water quality impacts from stormwater infiltration are reduced by collecting and treating the stormwater runoff, and promoting the infiltration of treated runoff, using applicable BMPs.

The project avoids the use of septic tanks and will include sanitary sewers that will therefore substantially reduce potential impacts such as nitrate loading or other household sources of contaminants. Also, pollution-producing businesses are not planned for the development. The soils and geologic deposits beneath the site, such as the low-permeability deposits of the Bellingham Drift and silt and clay aquitards, provide protection from contaminant transport to the Shallow and Deep Aquifers. There is a large vertical separation between the project's ground surface and the Shallow and Deep Aquifers, with hundreds of feet of intervening low-permeability layers and confining units.

RECOMMENDATIONS TO REDUCE POTENTIAL IMPACTS

Since a portion of the site is located within the recharge source area of the City of Blaine water supply wells, we recommend that development practices be used that reduce the potential impacts to the recharge rate and groundwater quality. The following is a list of recommendations to reduce potential groundwater impacts:

- Collect, treat and infiltrate stormwater on site. Collect the runoff from impervious surfaces such as paved areas and treat the stormwater using techniques such as bioswales.
- Collect and infiltrate roof runoff directly, wherever this is considered to be non-pollution generating.
- Restrict types of home-based businesses within the development, based on recommendations with the City's Wellhead Protection Program.
- Use Low Impact Development (LID) practices such as green roofs, rain gardens, unlined bioswales, downspout infiltration trenches or drywells.
- Incorporate BMPs that conform to Ecology's Stormwater Manual. All infiltration should meet BMPs to protect groundwater quality.

SUMMARY AND CONCLUSIONS

GeoEngineers reviewed available hydrogeologic information and reviewed applicable development regulations related to aquifer recharge and protection. We conclude that:

- The Grandis Pond project is located upgradient of the City of Blaine's water supply wellfield.
- The hydrogeologic information available in earlier reports is consistent with subsequent reports and studies pertinent to the project area.
- 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.
- 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.
- 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 practices, stormwater management techniques, and the importing of water to the project area that originate from the Shallow and Deep aquifers.

- 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.
- 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.

The potential adverse impacts from the Grandis Pond development will be reduced by incorporating the prevention techniques given above. Generally, the development will not adversely impact the City of Blaine's water supply source aquifers or wells, based on the available information.

LIMITATIONS

GeoEngineers has developed this report in general accordance with the scope and limitations of our proposal dated December 7, 2006. Within the limitations of scope, schedule and budget, our services have been executed in accordance with the generally accepted practices for hydrogeologic investigation in this area at the time this report was prepared. No warranty or other conditions express or implied, should be understood.

This report has been prepared for the exclusive use of David Evans and Associates, and their authorized agents and regulatory agencies following the described methods and information available at the time of the work. No other party may rely on the product of our services unless we agree in advance to such reliance in writing. The information contained herein should not be applied for any purpose or project except the one originally contemplated.

We appreciate the opportunity to work with you on this project and look forward to working with you on future projects. If you have any questions regarding this report, please contact our office at (360) 769-8400.

Sincerely,

GeoEngineers, Inc.

Joel W. Purdy, LG, LHG
Senior Hydrogeologist

Michael A.P. Kenrick PE, LHG
Principal

JWP:MAPK:jl:jm
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JOEL W. PURDY

Attachment

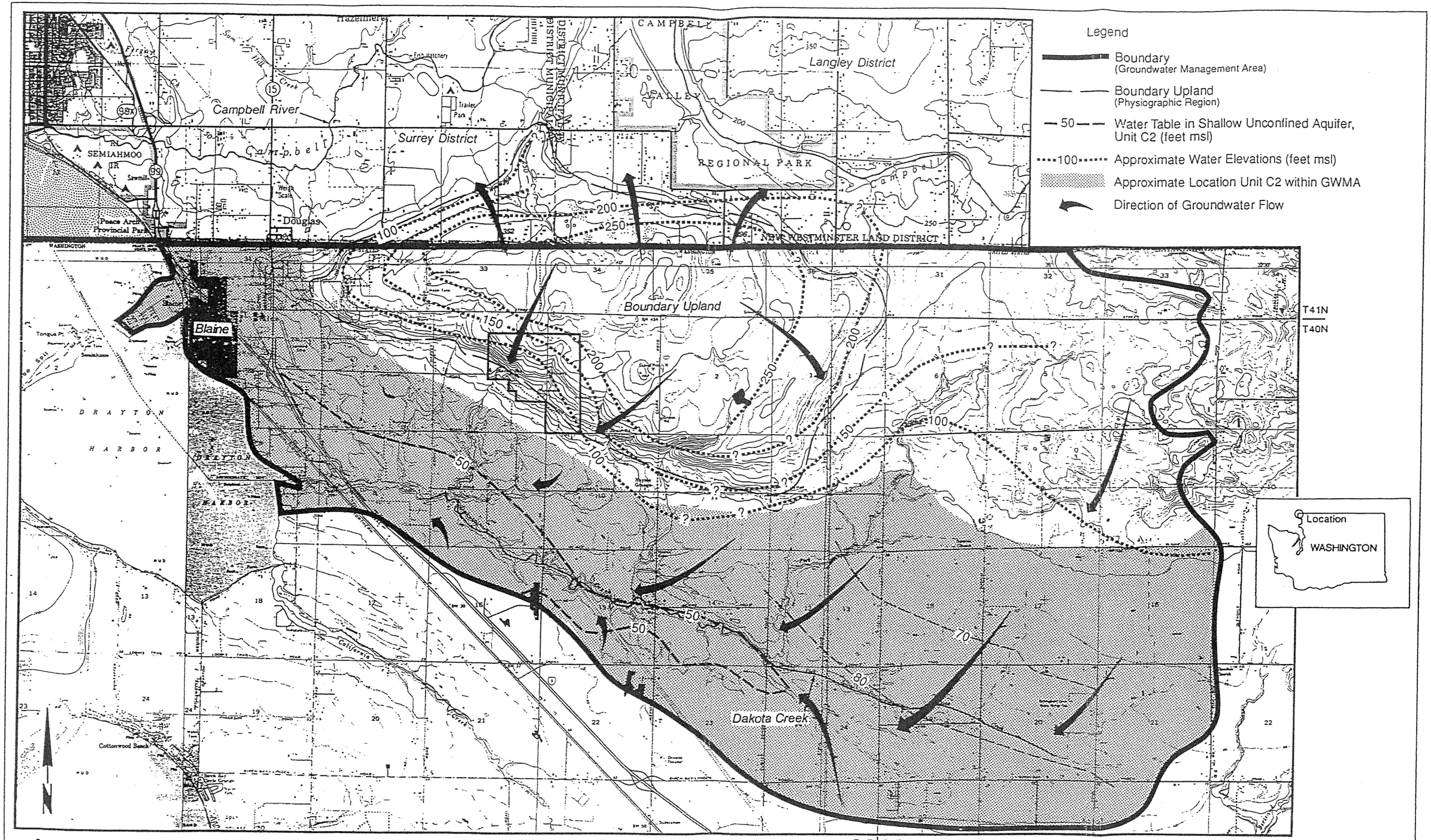

FIGURE 3-7
GENERALIZED WATER TABLE ELEVATION MAP
BLAINE/FINAL REPORT/WA

PROJECT NO. 903 1060.800 DRAWING NO. 49859 DATE 6/17/94 DRAWN BY CB

Golder Associates