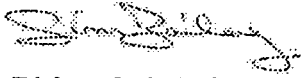




Appendix F: Aquifer Recharge Soils Report



MEMORANDUM

DATE: December 11, 2006 Job/Project Number: 75739
TO: Mr. Doug Connelly and Mr. Doug Campbell
FROM: Jim Bailey 
SUBJ: East Maple Ridge Subdivision Soil Infiltration Evaluation

This memorandum presents Kleinfelder's infiltration evaluation for the proposed East Maple Ridge subdivision development and provides an assessment of the infiltration considerations related to the project.

The objective of this study is to analyze subsurface soil and ground water conditions beneath the proposed site and evaluate the potential for infiltrating storm water. It also addresses the City of Blaine comments regarding aquifer recharge areas in their letter of February 21, 2006 to Mr. Doug Connelly.

1.0 INTRODUCTION

The East Maple Ridge Project is a Planned Unit Development (355 units) within the East Blaine Annexation area in Blaine, Washington. The approximately 88 acre project site is located north of H Street in Blaine (Whatcom, County), Washington, as shown on the Vicinity Map, Figure 1. In general, the site slopes from about elevation 300 to 340 feet on the east side to a low of about elevation 260 feet on the southwest side. A high voltage transmission line is located along the western site boundary. The north site boundary borders Cedar View street and Harvey street borders the eastern side of the site. The vegetation encountered on-site consisted of third growth Douglas firs, Big Leaf Maples, Alders and Western Red Cedars. Underbrush in many areas had been thinned out.

2.0 FIELD EXPLORATIONS

Kleinfelder explored subsurface conditions at the site by means of 9 test pits, designated TP- XY with X corresponding to closest survey marker and Y designating

one of multiple test pits at location X. Use of test pits provided more suitable data for evaluation of infiltration characteristics and bearing capacity of the site soils at a considerably lower cost than would be required for complete the same number of borings.

Survey control was available at the time of our explorations only in the vicinity of test pit locations TP-8B, Tp-10A and TP-15A. Accordingly, test pit locations shown on Figure 2 should be considered approximate. The test pits generally extended to depth of about 5 feet below the existing ground surface or until glacial till was encountered. The approximate locations were as follows:

- TP-8A,B, & C located within the footprint of the proposed storm water pond on the south side of the property across from the City cemetery,
- TP-10A located on the small strip of property touching H Street and west of TP-8;
- TP-15A was south of the water line right-of-way road;
- TP-15B and TP-15C was north of the water line right-of-way road in a cleared area (TP-15B) and close to the north property line (TP-15C);
- TP-22A was located in the northeast corner of the site.

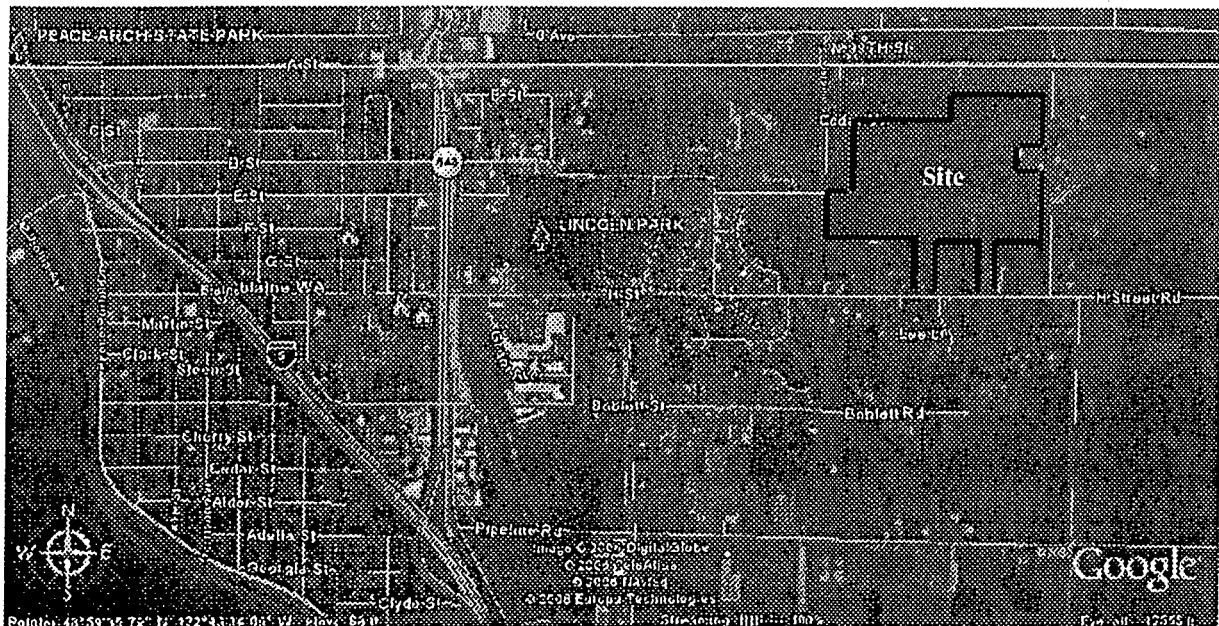


Figure 1 – Site Location

3.0 SUBSURFACE CONDITIONS

3.1 SOIL CONDITIONS

Based on our field investigations and review of previous hydrogeologic studies, Whatcom Soil Survey and our experience in the area, the proposed project site is located in an area covered by recessional glacial outwash underlain by glacial till.

Based on the previous and recent explorations, the soil conditions include a topsoil layer and weathered, disturbed outwash layer underlain by recessional outwash sand to a depth of about 3 to 5 feet below the current ground surface. In the test pits excavated on November 22, 2006, glacial till was encountered at the bottom of all the test pits. The soil types encountered are as follows:

- **Topsoil:** A layer of topsoil was encountered in all explorations and ranged from about 8 to 12 inches thick. The topsoil was composed of a loose mixture of roots, decomposed vegetation and sandy silt with varying amounts of gravel.
- **Weathered, Disturbed Outwash:** The topsoil layer was underlain by one to two feet of a loose brown silty sand with gravel and occasional roots. We believe that this zone likely represents an upper weathered zone of the underlying outwash has been partially disturbed over the years during historical logging and other activities on the site.
- **Recessional Outwash:** Recessional glacial outwash was encountered in all test pits. The outwash consisted of fine to coarse sand with varying amounts of sand and cobbles and some silt. Cobbles and boulders up to 6 inches in maximum dimension were observed in several of the test pits and boulders up to 3 feet in maximum dimension were observed on the surface in various areas of the site.
- **Glacial Till:** Glacial till was encountered in all the test pits at depths ranging from 3 to 5 feet bgs. This corresponded to an elevation of about 268 on the southwest portion of the site to an elevation of about 317 feet in the northeast portion. The glacial till extended to the maximum extent of all explorations, where encountered. It consisted of very dense cemented silty sands and gravels. Nearby well logs indicate the thickness of the till is at least 40 feet in the area.

3.2 GROUNDWATER CONDITIONS

Based on our interpretation of previous reports, and a review of well construction logs from the Washington State Department of Ecology, we conclude that the continuous (beneficial use) ground water table is relatively deep (over 100 feet), well below the depth of our explorations. However, our test pit excavations indicate there is a thin saturated zone of outwash underlain by a till aquitard layer. It appears that during the wet winter months there is a perched ground water table a few feet above the top of the till. During the dry summer months, the perched ground water may be limited or non existing.

Ground water was observed seeping into all of the test pits on the south side of the site including TP-8A, TP-B, TP-C, and TP-10A. The seepage was occurring in the courser segments of the recessional outwash deposits and rapidly filled the test pit with two to three feet of water within an hour (see Figure 3). No perched water was observed in the remaining test pits.



Figure 3 – Perched Ground Water TP-8B

4.0 STORM WATER INFILTRATION AND AQUIFER RECHARGE

For an infiltration system to perform as designed, several geotechnical conditions must be met:

- **ADEQUATE INFILTRATION RATES:** The soils at the base of the infiltration pond must have an adequate infiltration rate to allow the ground water to seep into the ground.
- **CAPACITY OF THE GROUND TO TRANSMIT THE INFLOWS:** The ground must have adequate permeability, aquifer thickness, and unsaturated aquifer thickness to transmit the design inflows away from the soils below the pond without backing up into the pond.

Based on the soil conditions and the results of the test pit excavations, the ground at the site does not have a sufficient thickness of unsaturated soil above the water table or the low permeability glacial till to be a candidate for direct storm water infiltration. Our interpretation of the soil conditions observed in the test pits indicate that for any reasonable set of assumptions the groundwater inflow rates beneath an infiltration pond would form a ground water mound which would eventually rise up into the pond preventing further infiltration.

Blaine Municipal Code (BMC) Title 17.82.060 designates the site as located in an aquifer recharge area. According to the BMC "Classification of recharge areas shall be based upon the susceptibility of the aquifer. High susceptibility shall be defined as those areas where surficial geology and soils information both indicate high recharge potential." The United States Department of Agriculture, Soil Conservation Service, Soil Survey for Whatcom County identifies the site soils as an Everett Series, which is defined as "deep and very deep, somewhat excessively drained soils formed in a mixture of volcanic ash and alluvium over glacial outwash and glacial till."

The site excavations performed for this study indicate that although the shallow soils are in places moderately drained the presence of a thick shallow till layer and perched ground water indicate that the site is not a significant source of direct recharge to beneficial aquifers located beneath the glacial till. The Glacial till, if continuous across the site, will act as a significant impediment for infiltrating storm water. The very conditions that make the site unsuitable for an infiltration pond indicate the site does not appear to have surficial geological conditions that are highly permeable.

5.0 LIMITATIONS

This report may be used only by the client and only for the purposes stated within a reasonable time from its issuance, but in no event later than one year from the date of the report. Land or facility use, on and off-site conditions, regulations, or other factors may change over time, and additional work may be required with the passage of time. Any party other than the client who wishes to use this report shall notify Kleinfelder of such intended use. Based on the intended use of the report, Kleinfelder may require that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by the client or anyone else will release Kleinfelder from any liability resulting from the use of this report by any unauthorized party and client agrees to defend, indemnify, and hold harmless Kleinfelder from any claim or liability associated with such unauthorized use or non-compliance.

5.0 REFERENCES

City of Blaine Public Works Department, East Maple Ridge Subdivision Project Public Works Preliminary Plat Review, Letter to Mr. Doug Connelly, February 21, 2006.

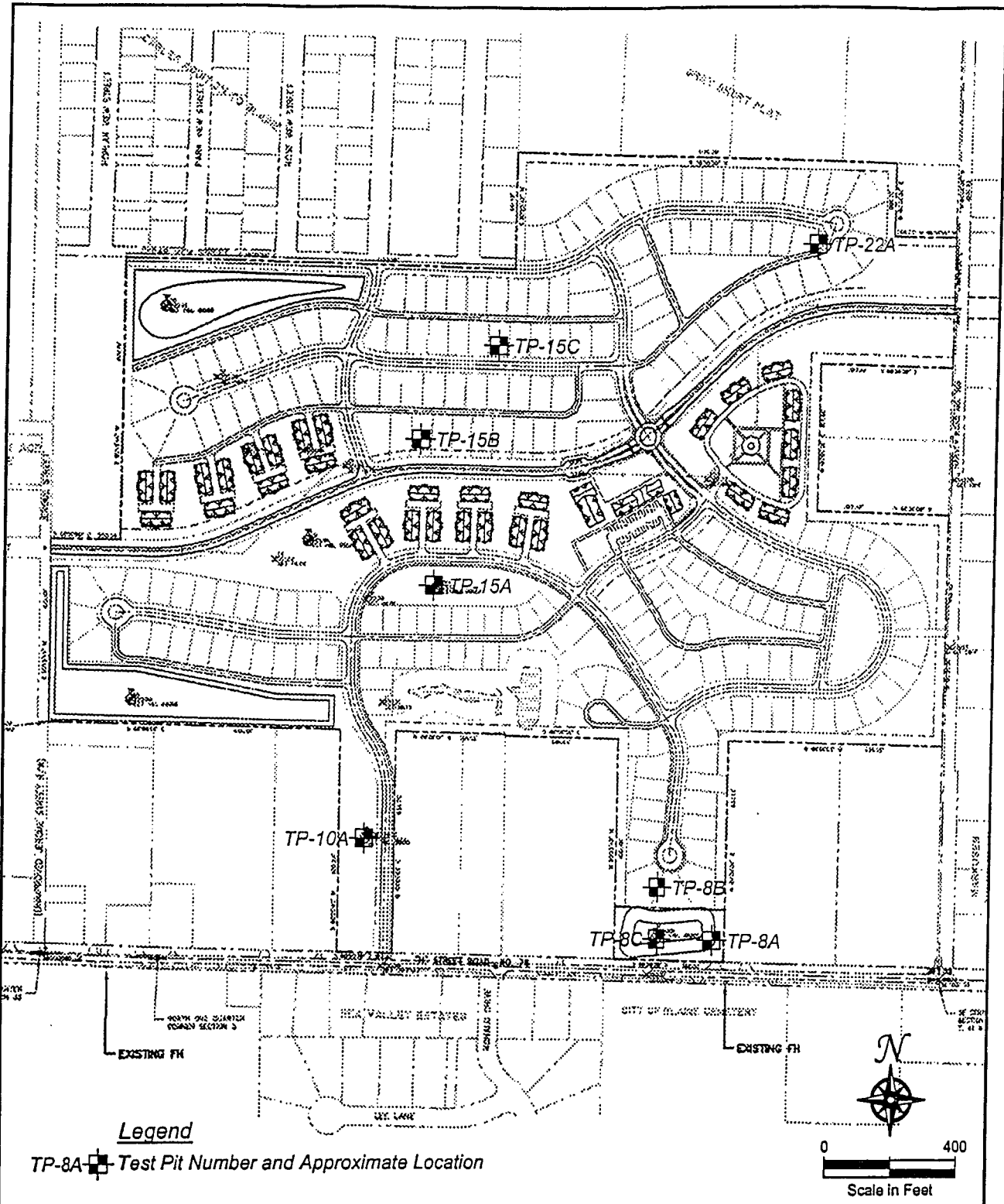
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Soil Survey of Whatcom County Area, Washington, United States Department of Agriculture, Soil Conservation Service, May 1992.

Evaluation of Aquifer Vulnerability Proposed East Blaine Annexation Area, EMCON Northwest, September, 1992.

ATTACHED IMAGES: Images: 120506 SURVEY STAKED TEST PITS.tif
 ATTACHED XREFS:

CAD FILE: G:\175739\ LAYOUT: Layout1



KLEINFELDER 2405 140th Avenue NE, Suite A101 Bellevue, WA 98005-1877 PH: (425) 562-4200 FAX: (425) 562-4201 www.kleinfelder.com	Test Pit Locations		DRAWN BY: J.Stewart
	East Maple Ridge Blaine, Washington		REVISED BY:
DRAWN December 2006 APPROVED BY: _____	PROJECT NO. 75739	FILE NAME: Test Pit Locations.dwg	CHECKED BY: Figure <div style="font-size: 2em; font-weight: bold; text-align: center;">2</div>