SNR Company

ENVIRONMENTAL, ECOLOGICAL,
HYDROGEOLOGY, AND
ENGINEERING GEOLOGY CONSULTANTS

March 2, 2009

Project Number: 05-09-001

Mr. Barend Van Zanten
PO BOX 7279
Olympia, WA 98507-7279

RE: Site Hydrology/Hydrogeology – Letter Report
1919 Berry Street
Olympia, WA
Thurston County Parcel Number: 4930050300

Dear Mr. Van Zanten:

Per your request, SNR Company has conducted field studies, research, and prepared this hydrologic/hydrogeology letter report for your property located at 1919 Berry Street, Olympia, WA (subject property).

OVERVIEW

SNR Company has conducted field studies on and in the vicinity of the subject property (February 19, 2009), has conducted research, and has reviewed the following documents:

- Evaluation of Apparent Slope Stability and General Recommendations for Proposed Construction of Four Contiguous Lots on Berry Street, Olympia, WA; Bradley-Noble Geotechnical Company, June 9, 1994,
- Geotechnical Report, 1919 Berry Street, Olympia, WA; Geotechnical Testing Lab, August 2, 2003,
- Subsurface Evaluation of Roadway Slope and Other Geotechnical Issues at 1919 Berry Street, Olympia; Bradley-Noble Geotechnical Services, April 30, 2005, and
- Drainage Recommendation Letter, Planned New Residence, 1919 Berry Street, Olympia, WA; E^{3}RA, November 7, 2008

Based on SNR's review of these documents, it is apparent that all of the Growth Management Act related potential critical areas issues have been addressed by the studies conducted by Geotechnical Testing Lab and that the engineering geology, and geotechnical engineering studies have been conducted on and in the vicinity of the site by Bradley-Noble and Geotechnical Testing Lab, and that all geotechnical firms have found that the site can be developed with a single family dwelling on natives soils or compacted fill materials.

The only apparent differing opinions among the geotechnical reports pertain to how to address the seeps that have been indentified to be present on the subject property. The Bradley-Nobel report recommends drainage of the seeps by excavating the foundation footprint down to firm native soils followed by the placement of a non-woven geotextile fabric over the exposed soils, then placing 2 feet of quarry spalls over the geotextile fabric, the placement of more non-woven geotextile fabric over the quarry spalls, and then the placement of 1 foot of 3 – 6 inch compacted basalt over the final layer of non-woven geotextile fabric.

The geotechnical report prepared by Geotechnical Testing Laboratories suggests that an 18" drainage zone be installed east of the proposed retaining wall that will also be used to support the street grade garage floor. Prior to completing the filling of the area east of the retaining wall, Geotechnical Testing Laboratories

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suggests that a 4" perforated pipe be installed immediately east of the retaining wall (at the base), and this perforated pipe be covered with an 18 inch width (east-west) of washed, (low fine content) coarse sand and gravel and that a non-woven geotextile fabric be placed between the drain material and the fill materials that will be used to fill the area east of the retaining wall. The drainage zone is to be built to within one foot of the top of the retaining wall.

The E³RA report recommends that the general drainage design offered in the Preliminary Building Plans be used with slight modifications. These plans stipulate that the fill material to be placed behind (east) of the retaining wall will be clean gravel. The drainage would be provided by a 6" diameter perforated pipe that would be placed at the upslope base of the retaining wall (east of the retaining wall) to address the seepage. However, E³RA report adds recommendations and clarifications regarding this drainage design and structural support. The E³RA recommendations and clarifications include:

- The gravel backfill will be 1 inch or larger drain rock and should in no instance be less than 3 feet in thickness behind the wall (east of the base of the wall);
- The wall footing, which will parallel the Berry Street fill embankment, should extend at least 2 feet below the existing grades everywhere to ensure that all of the seepage that emanates from the embankment is collected;
- The footing should be based on firm, non-yielding native soils;
- A non woven geotextile fabric be placed between the drain rock and other soils; and
- The collected seepage be directed to the existing storm water system on the site.
- The 12 inch thick concrete retaining wall depicted in the Preliminary Building Plans which has a foundation that extends east 6 feet into the hillside and west 2 feet from the wall, will adequately address lateral earth pressures presented by the drain rock backfill.
- The quarry spall drainage system under the house footprint is not recommended because the site seepage will be intercepted by the wall drain. The house foundation can simply be based on firm non-yielding native soils or on properly compacted structural fill.

DISCUSSION

The primary issues appear to be associated with the drainage of the seeps that occur at the base of the fill materials that were placed in what appears to be a Vashon Stade recessional relict meltwater channel. This channel was apparently filled when the area to the east was developed and Berry Street was constructed by the City of Olympia.

The subject property is apparently located in an unfilled portion of this relict meltwater channel that is believed to have drained to Budd Inlet during and shortly after the Vashon Stade glacial recession (12,000 – 10,000 years BP). During the development of this meltwater channel, the glacial till that is believed to have been present on the surface of the subject property was removed, exposing advance outwash deposits and in some cases the deeper pre-Vashon stade, non-glacial sandy deposits described on the Washington State Department of Natural Resources Geologic Map of the Tumwater 7.5' Quadrangle, Thurston County, WA, 2003, as Qps deposits (Figure 1 – Excerpt of the Tumwater 7.5' Quadrangle).

The Qps deposits are fine silty sands that have lower hydraulic conductivity and permeability than the advance outwash deposits and the fill materials that were placed in the relict meltwater channel. The developments that are built over the filled relict meltwater channel have created impervious surfaces (even more impervious than the glacial deposits that are shown to overly much of the area east of the subject

property); however, the dwellings will typically include foundation and roof drains that are often infiltrated. These residences are also landscaped which typically suggests that irrigation will occur during dry periods. Additionally these residences are provided with sewer and water service (and storm water drainage systems) that can develop leaks over time. The infiltration of these combined potential sources (below the glacial till) of artificial recharge is generally referred to as "nuisance" water because they are not directly associated with the "natural" infiltration of precipitation.

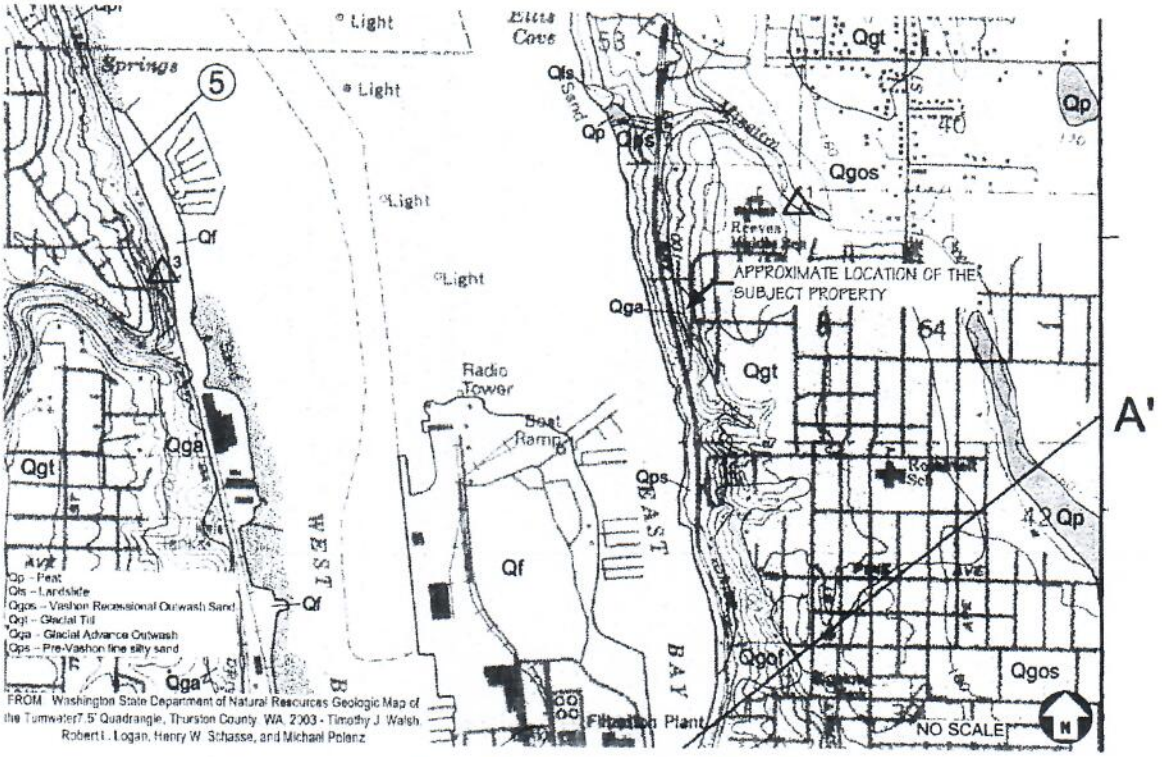


Figure 1 – Excerpt from the Geologic Map of the Tumwater 7.5' Quadrangle

Even compacted fill material can have higher hydraulic conductivity and permeability than the undisturbed Qps deposits. As the nuisance water (and precipitation, where the surface materials are not glacial till) infiltrates and intercept the Qps deposits, that generally have the characteristics of an aquitard, perched ground water conditions are created. The general dip of the Qps upper contact is to the east, towards the subject property where these deposits are exposed at the fill contact. The perched ground water becomes surface water at this point, in the form of seeps (prior to the infilling of the relict meltwater channel, there would have been ephemeral surface water drainage in this channel).

Due to the relatively low permeability and hydraulic transmissivity of the Qps materials, these materials do not typically have the characteristics of a ground water aquifer. Additionally, the subject property is located on the east wall of the Budd Inlet trough, which has an average slope of 26% where the subject property is located. This suggests that the surface elevation of any ground water present in the material or perched ground water on the material will drop downwards towards Budd Inlet and would not rise in the Qps materials (if present).

The Qps deposits are shown on the geologic map to be underlain by Qpg deposits; the Qpg deposits are older pre-Vashon Stade, deposits that are believed to be glacial deposits (advance?). These deposits are generally poorly sorted sand and gravel deposits that do have relatively high hydraulic transmissivity and

permeability. These deposits may be exposed or located near the ground surface on portions of the subject property, however, due to the similarity of these deposits to Vashon Stade glacial advance deposits, it is difficult to make this determination based on the boring logs that are currently available (the Geotechnical Testing Laboratory boring logs suggest that the Qpg deposits were encountered in several of the 8 borings that were conducted on the subject property, none of the other boring logs conducted by others apparently encountered the Qpg deposits).

FIELD STUDIES

The seeps that have been observed on the subject property by SNR during field activities conducted on February 19, 2009 and the geotechnical firms that have conducted studies on the subject property are apparently originating at what appears to be a contact with fill materials and the Qps deposits. It has been suggested that the fill materials were placed in the relict meltwater channel to construct Berry Street and residences to the east. The fill contact with the Qps deposits is somewhat irregular, which results in the seeps to be exposed at different elevations on the subject property, with the lowest elevation being located at the most western extent of the fill materials that were placed on the subject property (Figures 2 - 4 – Seeps). Based on the minor amounts of erosion observed where these seeps are occurring and the extent of the surface flow from these seeps, even during the wet season, it is suggested that there is relatively minor flow from the seep areas.

As can be seen in Figure 2, prior to the installation of a tightline (by Mr. Van Zanten) that carries the City of Olympia's storm water from the City's sewer system located east of the subject property; the City of Olympia discharged storm water from the City's Municipal storm sewer system directly onto the slopes of the subject property (two culverts). This storm water flowed into the relict meltwater channel cutting an erosion channel that has been classified as a storm water ditch by others.

The flows in this ditch entered a City of Olympia municipal storm sewer catch basin lower on the slope (Figure 5). The tightline now discharges to this catch basin. The municipal storm water that is now handled by storm water facilities installed by Mr. Van Zanten (at the request of the City) is generated by the City's Municipal storm sewer system that drains approximately 14 acres of developed residential urban land east of the subject property. There are very minor storm water surface water flows generated on the subject property due to the relatively small size of the subject property, relatively minor slope, and the lack of significant impervious surfaces.

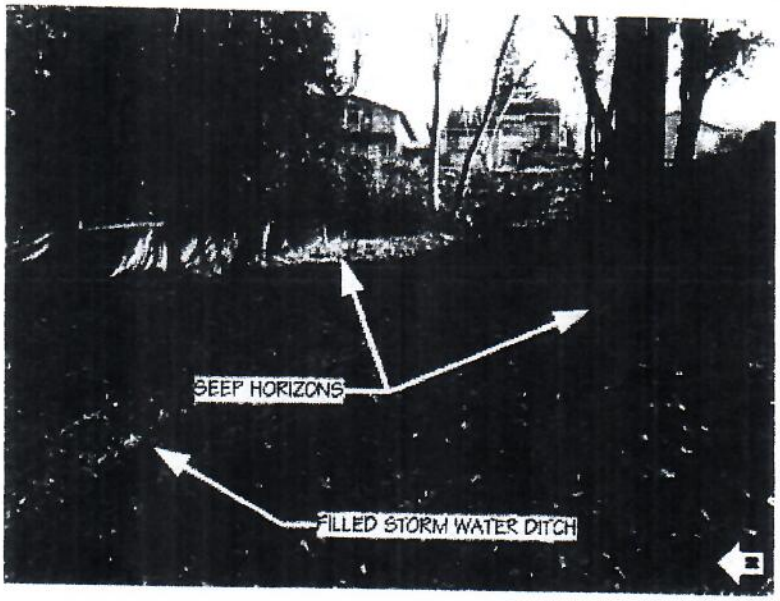


Figure 2 – Seep Horizons

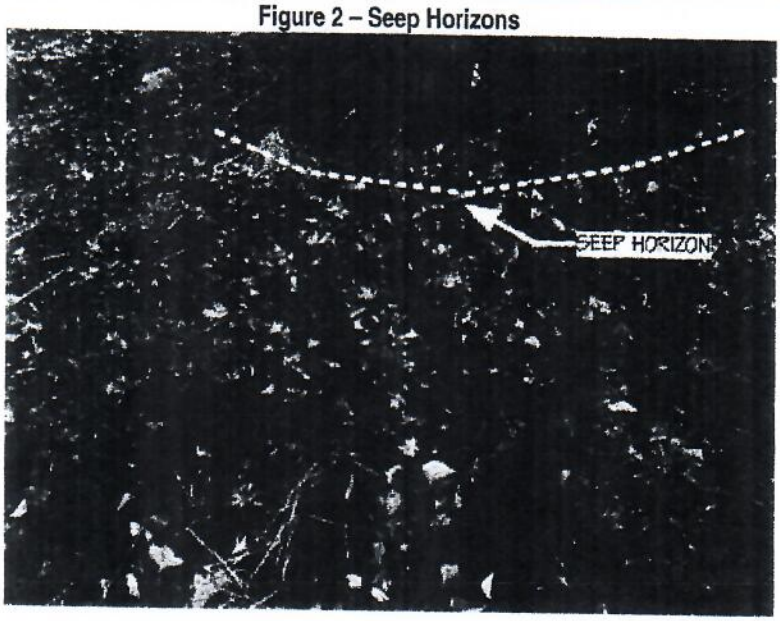


Figure 3– Central Seep Horizon – the lowest Elevation and most Westerly Placement of Fill

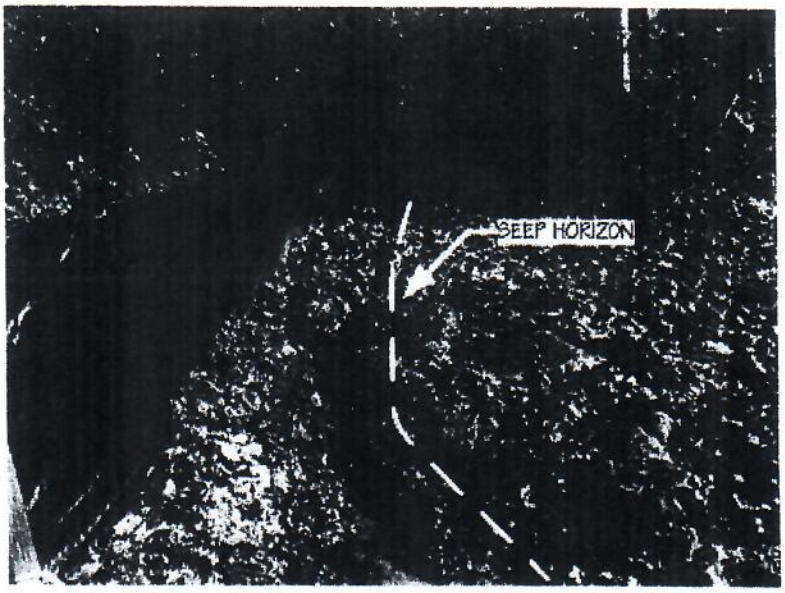


Figure 4 – North Seep Horizon

The City of Olympia Municipal Sewer catchbasin that receives the storm water from the tightline the City required Mr. Van Zanten to install discharges into the storm sewer system on East Bay Drive NE via a buried tightline. The catchbasin is accessed from East Bay Drive NE on a series of cut wooden rail road ties that are used as steps to reach the catch basin on the slope above this street (Figure 6).

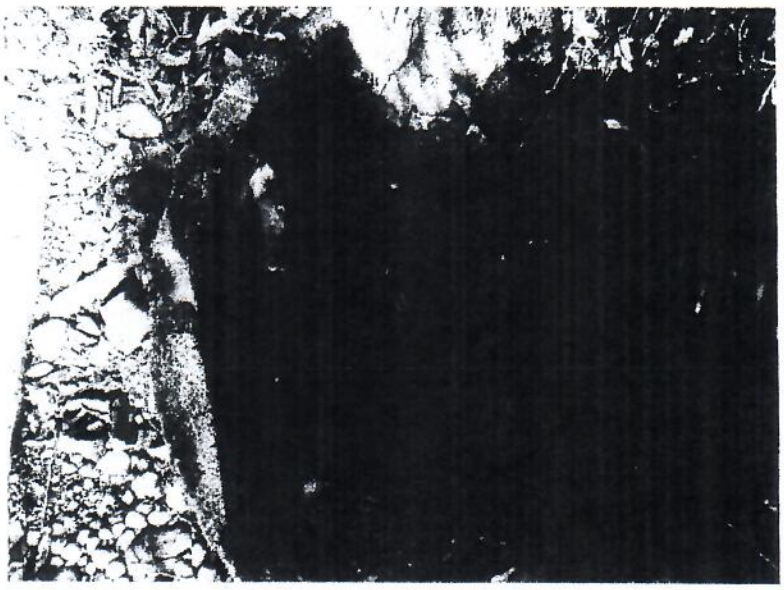


Figure 5– City of Olympia required Tightline Discharging into City Municipal Storm Sewer Catchbasin

Figure 6 – Looking West towards East Bay Drive NE from the City's Municipal Storm Sewer Catchbasin

SNR's did not observe any other seeps on the slope west of the subject property, however, there is evidence of potential seeps on the east wall of Budd Inlet to the north and south of the subject property, although some of the surface water observed on this slope may be associated with storm water facilities up slope of East Bay Drive NE (Figure 7 – Seeps North of Subject Property).

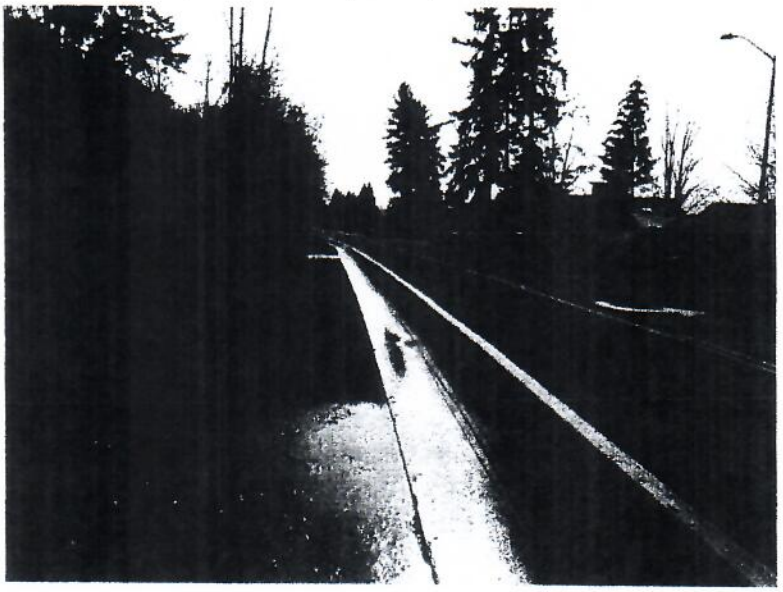


Figure 7 – Looking South at Potential "Seeps" Located North of Subject Property

FINDINGS

The "seeps" on the subject property are technically, "artificially" created by the fill material that was placed in what is believed to be a relict meltwater channel. Had fill not been placed in this channel, ephemeral surface water flows would be expected to be present in this channel during periods of precipitation. However, to allow residential development to the east of the subject property and to allow access to this

residential development, the channel was filled with appears to be glacial till and possible advance outwash deposits. Based on the boring logs (the presence of wood debris in observed in some borings) SNR has reviewed it is suggested that the placement of fill may have been directly on the ground surface with minimal grubbing prior to placement.

The placement of fill in this relict channel changed the hydrologic regime from ephemeral surface water flows to perched ground water flows beneath the filled areas. The development over the filled areas provides a significant amount of impervious surfaces that limit the amount of infiltration from precipitation; however, this development can also provide a moderate amount of nuisance water infiltration that will result in a perched aquifer being created above the Qps deposits. This perched ground water is apparently following the original course of the infilled relict meltwater channel. This perched ground water is creating seeps on the subject property at the western boundaries of the fill material that was placed in this channel.

Based on field observations, it appears that the flows from the seep horizon are relatively minor. These seeps can be collected in collection system and diverted to the City's Municipal Storm Sewer System catchbasin located downslope of the subject property.

SNR generally agrees with the recommendations made by E^{3}RA regarding the design for a drainage system at the base of the proposed retaining wall (east of the wall). However, SNR believes that an additional drainage system should placed in a "V" bench excavated along the contact horizon with the fill and the Qps soils. This drainage system should located east of the retaining wall (upslope) and will provide an additional opportunity to intercept the perched ground water and remove this perched ground water from the proposed fill area east of the retaining wall.

RECOMMENDATIONS

SNR recommends the methodology suggested by E^{3}RA for the retaining wall drainage and believes that this system would be sufficient to drain the existing seep flows in the proposed backfill area. SNR does not recommend the quarry spall and crushed basal methods suggested by Bradley-Nobel. The characteristics of the Qps sand and the drainage of the subject property (topography) do not suggest that near surface ground water aquifer is present in the Qps deposits, which suggests that a rising ground water table in these deposits is unlikely. Observations made on the subject property suggest that even during the rainy season, the flow of surface water from the seep horizon is minimal and the drainage design proposed by E^{3}RA should have a higher drainage capacity than the anticipated high flows from the seep horizon.

However, as an added precaution SNR also recommends that the slope area be "V" benched along a topographic contour upslope of the retaining wall. This "V" bench would be excavated to the fill/Qps contact and would extend from the northern boundary to the southern boundary of the proposed fill area upslope of the proposed retaining wall. This added drainage precaution would provide additional drainage capacity that should reduce the amount of perched ground water that may need to be collected in the drainage system to be placed behind the proposed retaining wall and it would provide additional capacity to remove perched ground water should the volume of the seep flows increase sometime in the future.

A "burrito" drain system would be placed in the "V" bench ditch. This is a 6" diameter SCH 40 perforated drainage pipe, 1" – 1 ¾" clean gravel, and non-woven geotextile fabric wrapped drainage system (see Attachment). This drainage system would connect to a 6" drain line on the downslope (minimum 0.5% slope) portion of the drain line. The drainage line would be buried in a trench that trends to the west to a tie in point with the existing tightline installed by Mr. Van Zanten directly to the City of Olympia's Municipal Storm Sewer System catchbasin that is located downslope of the subject property.

CONCLUSIONS

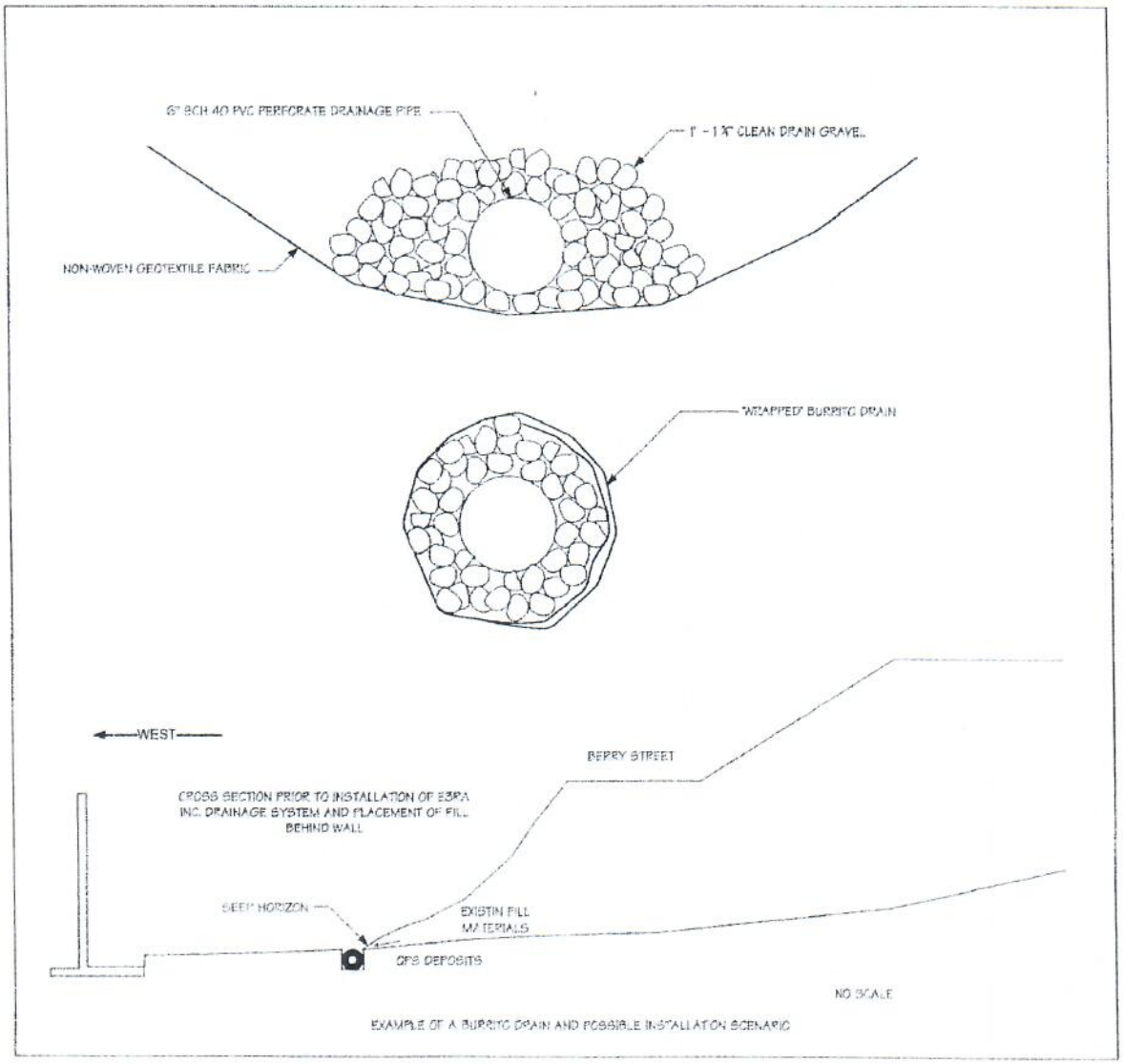
Because a rising water table is unlikely and the only recognized source of perched ground water is what is believed to be nuisance water that is infiltrating into filled relict meltwater channel and is emerging as surface water at the western extend of the fill material as "seeps", SNR does not believe the design proposed by Bradley-Noble is required. The proposed drainage design by E^{3}RA should be adequate to insure that perched ground water does not accumulate "behind" the proposed retaining wall.

However, as an added precaution, SNR recommends the excavation of a "V" bench along a topographic contour near the fill/Qps contact (SNR can mark this location in the field) and that a "burrito" drain be placed in this "V" bench to drain the perched ground water at this drainage point. This will provide an extra margin of safety and will provide added capacity to the drainage system.

If you have any questions, or require more information, please contact me at your convenience at 425-788-3015, ext 205 or on my cell at 206-291-5556.

Sincerely,
SNR COMPANY

Steven F. Neugebauer
Principal Hydrogeologist/Engineering Geologist
Washington State Hydrogeologist/Engineering
Geologist License Number 00347
Expires 08/2009
Attachment: Example of a "Burrito" Drain Design



EXAMPLE OF A BURRITO DRAIN AND POSSIBLE INSTALLATION SCENARIO