GN Northern, Inc.

REPORT
OF
GEOTECHNICAL INVESTIGATION

TO

BELL DESIGN COMPANY
PO BOX 308
BINGEN, WASHINGTON

HARMONY HEAVEN
A PLANNED UNIT DEVELOPMENT
CASCADE LOCKS, OREGON

GN NORTHERN, INC.
CONSULTING GEOTECHNICAL ENGINEERS
YAKIMA, WASHINGTON
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GNN PROJECT NO. 205-623-1

July 2006

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Attention: Mr. Devry Bell, PE

cc: Mr. Frank Childs, PE/PLS, Pioneer Surveying and Engineering, Inc.

Reference: GNN Project No. 206-623-1

Subject: Report of Geotechnical Site Investigation
Harmony Heaven – A Planned Unit Development
City of Cascade Locks, Oregon

Gentlemen:

This report presents results of our geotechnical site investigation for Harmony Heaven, a planned residential lot development, to be located in the City of Cascade Locks, Hood River County Oregon.

This report describes in detail the results of our investigation, summarizes our findings, and presents our recommendations. It is important that we provide consultation during the design, and field compaction testing services during construction to review and monitor the implementation of the geotechnical recommendations.

If you have any questions regarding this report, please contact us at 509-248-9798.

Respectfully submitted,

Imran Magsi, PE
Senior Geotechnical Engineer

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7-13-06
Expires: 12/31/2006

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Enclosures

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FIELD EXPLORATION

The field exploration was conducted on June 16 and 19, 2006. A GN Northern geotechnical engineer selected the boring locations in the field based upon the previous work that was completed and the site conditions. Three borings were completed during this phase of work at locations near the top and base of slope. The approximate locations of the exploratory borings are shown on Figure 1.

The borings were logged by our engineering geologist. The borings were extended to depths of 48.5, 40 and 31.5 feet below the ground surface.

The test borings were completed using a drill rig equipped with hollow stem augers. Hollow stem augers were used to drill through the fine-grained soils and the overburden. A tri-cone bit was used in open holes with the air rotary technique; this allowed drilling to progress through dense and hard soil units. Samples of the subsurface materials were taken in the borings with a 1-3/8 inch ID split spoon sampler. The sampler was driven into the various strata using a 140-pound hammer falling 30 inches. The number of blows required to advance the sampler each successive six-inch increment is recorded and the total number of blows required to advance the sampler the second and third 6-inch increments is the penetration resistance (N value). This test is the standard penetration test (SPT) described by ASTM Method D1586. Penetration resistance values indicate the relative density or consistency of the soils. Depths at which the samples were taken and the penetration resistance values are shown on the attached boring logs.

Disturbed and undisturbed samples of the subsurface materials were collected to determine engineering and physical properties of the onsite soil. An undisturbed sample was taken in BH-3A within the upper 10 feet. This was obtained in 3-inch O.D. thin-wall Shelby tube by hydraulically pushing the tube into the undisturbed soil. The soil exposed at the end of the tube was examined and classified in the field. After field classification, the ends of the tube were sealed to preserve the natural moisture of the samples. The sealed tube was retuned to our laboratory for physical testing. Samples of the subsurface soils were collected in air tight plastic bags and in 5-gallon plastic buckets for appropriate laboratory testing. The soils observed during our field exploration were classified according to the Unified Soil Classification System (USCS), utilizing the field classification procedures as outlined in ASTM D2488. A copy of the USCS chart is included in the Appendix.

Depths referred to in this report are relative to the existing ground surface elevation at the time of our field investigation. The surface and subsurface conditions described in this report are as observed at the site at the time of our field investigation.

LABORATORY TESTING

Samples obtained during the field exploration were taken to our laboratory, where they were observed and visually classified in accordance with ASTM D2487, which is based on the Unified Soil Classification System. Representative samples were selected for testing to determine the engineering and physical properties of the soils in general accordance with ASTM procedures.

Laboratory tests were performed on undisturbed and bulk samples collected from exploratory borings. Laboratory tests performed included:

Test	To Determine
Particle Size Distribution	Soil classification based on proportion of sand, silt, and clay-sized particles.
Natural Dry Density	Dry unit weight of samples, representative of in place conditions.
Atterburg Limits	A method of describing the effect of varying water content on the consistency of fine-grained soils.
Unconfined Compression	General soil strength parameters of fine grained soils

Results of laboratory tests are included in the Appendix of this report. Results of laboratory unconfined compressive strength tests will follow as a supplement to this report.

SITE CONDITIONS

The project site is located in Cascade Locks, Oregon. The site is currently undeveloped but has been stripped of vegetation in preparation for grading and site development. The proposed development will be located within the southwestern city limits of Cascade Locks in an area of undeveloped land and residential properties. Undeveloped properties are located to the south and east of the site. Single family residential properties are located east of the site. Interstate 84 is located to the northwest of the site.

Access to the site is by Undine Street, a paved road. The plans call for extending this street along the western and northern property boundary. A cul-de-sac will be extended along the eastern site boundary.

The site slopes steeply from the north to the south with the steepest slopes of approximately 2:1 (H:V). A steep slope lies along the northwest property boundary between the site and Interstate 82 where slopes are in general 1.5 to 1.

<u>Regional Geology</u>
The site is situated within the Cascade Range along the Columbia Gorge. The Columbia Gorge has been formed by the Columbia River eroding primarily volcanic rocks of the Columbia River Plateau and the Cascade Range. The Columbia River Plateau was formed by a series of Miocene eruption in eastern Oregon. The lava from these eruptions flowed across much of eastern Oregon and Washington and extended westward beyond current day Cascade Locks.
Miocene sediments overlie some of the older basalt flows and are exposed along the Oregon side of the Gorge near Cascade Locks. Younger volcanic rocks overlie the Miocene sediments. Smaller landslides have occurred on the Oregon side of the Gorge as the Miocene sediments become saturated and excess pore pressures occur due to the weight of the overburden volcanics.

Larger landslides have occurred on the Washington side of the Gorge to the north of Cascade Locks. These landslides have been mass failures caused by liquefaction according to studies conducted by the Corps of Engineer. The largest of the slides, the Bonneville Landslide, appears to have blocked the course of the Columbia and deposited landslide debris to the south of the current river course.

Seismic Considerations

The project site will be Site Class D or E as defined by the International Building Code (IBC, 2003). The blow counts indicate a stiff soil profile (Site Class D), however laboratory testing may confirm an alternate Site Class E based upon the moisture content, plasticity index and undrained shear strength. We have provided the values of the more conservative Site Class E until laboratory analysis is complete. Based on the Mapped Spectral Response Acceleration provided in the IBC, S_S for the site is 0.63 and S_1 is 0.24. The corresponding Site Coefficient values for F_a and F_V are 1.3 and 3.0, respectively.

SUBSURFACE CONDITIONS

The subsurface profile encountered within the borings generally consists of alternating layers of sandy silt and silty clay. Some zones of silty sand were encountered in BH-2A and BH-3A. Gravel layers were present at the base of BH-2A and at a depth between 15 and 20 feet in BH-3A.

The fine grain silt and clay were generally hard with a slightly weaker consistency of stiff silty clay in BH-3A where wet to saturated soil was encountered. The fine grain soil varied in color from light brown to dark gray with some mottling. The soil generally showed slight plasticity.

The silty sand and gravel were dense to very dense, and slightly moist to moist. The silty sand was brown in color, while the gravel was brown in BH-3A and black in BH-2A. Detailed boring logs are attached to this report.

Groundwater

Groundwater was encountered in BH-2A and BH-3A at depths of 20 and 10 feet, respectively. The clayey consistency of the soil may indicate the groundwater encountered was perched water. Dryer soils were encountered beneath these saturated zones. Numerous factors contribute to groundwater fluctuations, and evaluation of such factors is beyond the scope of this report.

SLOPE STABILITY ANALYSIS

The analyzed slopes consist of a cut slope at Harmony Heaven Drive station 3+70 extending into south property line of lot 24 and lot 19; another slope at Harmony Heaven Drive station 2+20 extending into lots 29 and 14 comprising of cut and fill sections. Proposed site plan shows a 20 foot (+/-) cut at Harmony Heaven Drive station 3+70 extending into lots 24 and 19. Approximately 24 feet of fill to be placed in lots 13 and 14; fill extends further uphill to the north.

The "gross" or "global" stability of the slopes were analyzed under static and seismic conditions using the PCSTABL6H computer program that generates potential failure surfaces based on user-specified shear strength parameters and slope geometry. A circular surface generator, using the Modified Bishop Method, was chosen for the analyses. The analysis yielded a minimum factors of safety (FS) for static and pseudostatic (seismic) conditions. Pseudostatic horizontal inertial forces equal to 0.20 times the total weight of the potential sliding mass (slip circle) was used in the pseudostatic analysis.

The selection of soil unit weights and soil shear strength parameters for the various native earth materials exposed on the proposed cut and cut/fill slopes were based on our judgment, our site reconnaissance, results of our field exploration and laboratory testing and our previous experience with similar materials in similar geotechnical and geologic conditions. Engineering and geologic judgment must be applied to the results of shear tests because of lateral and vertical variations in the subsurface conditions such as degree of cementation, fracturing, planes of weakness and gradational characteristics. The selected shear strength parameters for the granular soils at the site are conservative values of considered consolidated-drained ('CD' or 'S') strengths appropriate for use in effective stress stability analyses. The following geotechnical parameters were used in the slope stability analyses discussed below:

Soil Units/Materials	Total Unit Weight (pcf)	Soil Shear Strength Parameters
Silt (ML) & Silty Clay (ML-CL)	105	$\phi = 28^{o}$ c = 200 psf
Silty Sand (SM)	110	$\phi = 30^{o}$ c = 200 psf

Results of the stability analyses, using the shear strength data as described above are presented on the following table. The factor of safety of against slope failures was computed for the slopes and conditions as given in the table below. The results of the slope stability analyses are attached to this report and summarized below:

Slopes Analyzed	**Design Condition**	**Computed Safety Factor (FS)**
Cut & Fill Slope - Harmony Heaven Dr. Station 2+20-Lots 29 &14	Static	1.90
Cut & Fill Slope Harmony Heaven Dr. Station 2+20- Lots 29 &14	Seismic Loading	1.22
Cut Slope - Harmony Heaven Dr. Station 3+70- Lots 24 &19	Static	2.27
Cut Slope - Harmony Heaven Dr. Station 3+70- Lots 24 &19	Seismic Loading	1.39

A FS of 1.5 or higher indicates overall static gross stability and a FS of 1.2 or higher indicate stable condition for seismic loading.

The results of our analyses indicate that at the proposed slope gradients, depicted on a January 12, 2006 site plan (with latest revision April 14, 2006) prepared by Pioneer Surveying and Engineering, Inc, the overall gross stability of the slopes should be sufficiently high. The critical slope failure mechanism during a seismic event will be the result of shallow surficial failures of the slope face. Surface slope protection will be necessary to mitigate surficial instability consisting of vegetation planting to provide root structure and ground cover.

Following the recommendation of this report, construction of the slope should provide a firm slope face and allow for adequate drainage collection above and below the slopes. We recommend that drainage measures be constructed at the top of the slopes to help retarding erosion of the slope face. Collected water should be conveyed to appropriate points of discharge in a non-erosive manner.

Recommendations and guidelines for slope construction and protection are included in this report. Grading and Over-Excavation slope construction details figures 2 through 5 "Fill over cut condition", "Reconstructed cut slope stabilization fill", Fill over native condition and "Transition Condition" are included in the Appendix of this report. Adhering to the following recommendations will ensure adequate stability and protection of the constructed slopes.

GEOTECHNICAL RECOMMENDATIONS

The following geotechnical recommendations are based on our current understanding of the proposed project as depicted on a site plan dated January 12, 2006 (latest revision April 14, 2006) prepared by Pioneer Surveying and Engineering, Inc.. We recommend that we be engaged to monitor the earthwork site activities in order to provide revised, augmented, and/or additional geotechnical recommendations if necessary.

Conditions imposed by the proposed development have been evaluated on the basis of the proposed finished grades and engineering characteristics of the subsurface materials encountered in the test borings and their anticipated behavior both during and after construction. Recommendations presented for the design of future foundations along with site development recommendations and construction considerations are discussed in the following sections.

Development of the proposed site entails some potential soil problems with respect to the presence of moisture sensitive soils which could pose problems during site grading, the existence of perched water zones and relatively high in-situ moisture content of the near surface soils in low lying areas of the site.

Site Clearing

All topsoil, vegetation, organic rich material and wood debris from logging operations shall be removed from the development areas. Site preparation shall include the removal of the existing vegetation and soils with organic content. Based on the surface conditions at the time of the subsurface exploration, stripping on the order of 6 to 9 inches is expected to remove soils with significant organic content. If larger root zones are encountered, stripping shall be extended to a depth of 24 inches or deeper. <u>The topsoil with vegetation and wood debris from logging</u>

operations shall be removed from the site or stockpiled and shall not be used as fill to adjust grades. Additional stripping may be required to clear filled depressions or swales not evident from site appearance. Monitoring by a representative of our geotechnical engineer at the time of site clearing activities may allow reduction in the required quantity of stripping depending upon the encountered depth of organic material (roots) and the organic content of the soils.

Dry Weather Conditions

The near surface soils generally exhibit in-situ moisture contents which are above their optimum moisture content. Consequently, upon the completion of site stripping and clearing activities, subgrade preparation difficulties and possibly subgrade stability problems are expected to be encountered due to the in-situ moisture of the near surface soils particularly in low areas of the site. Proper preparation of the subgrade shall, therefore, be expected to require scarification and aeration to reduce the moisture content of the soils to an appropriate range to facilitate proper recompaction. The use of scarification and aeration is expected to be feasible during periods of generally fair, dry weather conditions. Scarification and aeration is anticipated to require 1 to 2 days of continuous working of the soils to reduce the moisture content. If the construction schedule does not permit the anticipated time period, specialized chemical or mechanical modification techniques and/or the use of overexcavation and replacement of the structural compacted fill as described under Wet Weather conditions may be used to accelerate subgrade preparation.

Wet Weather Conditions

During wet weather conditions, typically associated with early spring, late fall or winter construction, subgrade stability problems are expected to develop. As previously discussed, the in-situ moisture content of the near surface soils is above the anticipated optimum moisture content. Consequently, preparation of subgrade during wet weather conditions and exposure to additional moisture infiltration will require more extensive procedures to properly prepare the building and pavement subgrades. Undercutting on the order of 18 to 24 inches below the ground surface may be necessary during wet weather conditions, especially if disturbed by construction traffic. Upon completion of undercutting, the use of a coarse granular working mat or modification by the addition of hydrated lime or Portland Cement (depending upon soil type and plasticity) shall be expected to be necessary to develop a stable subgrade for placement of structural fill. The estimated overexcavation depth is based upon the moisture and disturbance sensitivity of the subgrade soils and the assumed effect during a wet weather grading period. If undercutting is necessary, it should be confirmed through continuous monitoring and testing by a representative of our geotechnical engineer.

We recommend that during periods of wet weather, plastic sheeting shall be kept reasonably accessible to prevent unprotected slopes from becoming saturated. Where necessary during periods of wet weather, the contractor shall install check drains, riprap, sand bags, or other methods necessary to control erosion and provide safe conditions. In slope areas where saturated soil and/or erosion gullies exist to depths greater that 1 foot; they shall be overexcavated and replaced as compacted fill. Where affected materials exist to depths of 1 foot or less, in place moisture conditioning followed by thorough re-compaction may be attempted. If the desired results are not achieved, all affected materials should be overexcavated and replaced as compacted fill.

Subgrade Preparation
Subgrade within the proposed building and pavement areas as well as areas to serve as the subgrade for placement of structural fill shall be proofrolled, in the presence of a representative of our geotechnical engineer with appropriate rubber tired mounted heavy construction equipment or a loaded dump truck to detect soft, yielding soils which must be removed to a stable subgrade. Following proofrolling and the completion of any necessary overexcavations, the pad and pavement subgrades shall be scarified to a depth of at least 9 to 12 inches, moisture conditioned if necessary and recompacted to at least 92 percent of the maximum dry density as determined by ASTM D1557. Low areas and excavations may then be backfilled in uniform lifts with suitable non-expansive structural fill. Significant reduction in grades in the low lying areas of the site may result in subgrade stability problems and possibly "boiling" subgrade conditions depending upon the water table at the time and the in-situ moisture content of the near surface soils. In addition the use of vibratory compaction could adversely affect subgrade stability due to relatively high in-situ moisture content of the native fine grained soils.

Due to presence of moisture sensitive near surface and subsurface soils and relatively high in-situ moisture content of soils in low lying areas, we recommend that site grading and preparation of subgrade shall be planned during a dry, fair weather season generally between June through September.

The moisture sensitive soil may rut or pump due to the in-situ moisture content. Rubber tired traffic shall be minimized across areas where subgrade has been prepared. If pumping or rutted soil is encountered or caused by site activities, the impacted area shall be removed and replaced with structural fill.

In low lying areas in the south center of the development (lots 13 and 14 and surrounding area), where the new fill placement is planned, the near surface soils are relatively soft and very wet to saturated based on our field observations. We recommend prior to new fill placement the native soils shall be overexcavated and replaced with imported granular fill to create a stable foundation for the new fill. At least 36 inches of the native soils shall be removed and replaced with 4-6 inches quarry spalls or large pit run material to provide a stable subgrade and to minimize built up of hydrostatic pressure from surface water seepage. The quarry spalls or pit run material shall be placed on a geotextile fabric such as Mirafi 600X or equivalent. Sides of excavation shall be wrapped with a filter fabric to prevent the migration of fines. A subdrain pipe(s) shall be hydraulically connected to the quarry spalls or the pit run material to carry and dispose water to the nearby detention pond.

Subgrade Protection
The degree to which construction grading problems develop is expected to be dependant, in part, on the time of year that construction proceeds and the precautions which are taken by the contractor to protect the subgrade. The soils which will be exposed by the subgrade preparation operations are considered to be moisture and disturbance sensitive due to their silt and clay content and may become unstable if allowed to increase in moisture content (from precipitation) and are disturbed (rutted) by construction traffic. The soils are also susceptible to erosion in the presence of flowing water. The site shall be graded to prevent water from ponding within

construction areas and/or flowing into excavations. Accumulated water must be removed immediately along with any unstable soil. Foundation concrete should be placed and excavations backfilled as soon as possible to protect the bearing grade. We further recommend that soils that become unstable are to be either:

- Dried and recompacted;
- Removed to a suitable bearing subgrade and replaced with structural compacted imported gravel fill;
- Mechanically stabilized with a coarse crushed aggregate (possibly underlain with a geotextile or geogrid) and compacted into the subgrade.

Suitability of the Native Soils

The native material may be reused as structural compacted fill within the proposed development and pavement areas. The use of native soils as structural compacted fill will, however, require careful control of moisture content at which compaction is performed due to significant silt and clay content. The fine grained soils will require compaction to be performed within a relatively narrow range (within +/- 1 percent) of optimum to achieve the proper degree of compaction. In addition, due to the relatively high in-situ moisture content of the near surface soils particularly in low lying areas of the site, reuse of this material as structural fill may require some aeration to reduce the moisture content to an appropriate range to facilitate proper recompaction. However, aeration will not be possible during periods of wet weather and may, therefore, require importing structural fill.

Fill Placement and Compaction Requirements

All fill or backfill must be approved by our geotechnical engineer, placed in uniform lifts and compacted to the following minimum compaction values as determined by ASTM D1557.

Structural Fill	95%
General Fill	90%
Footing Subgrade	90%
Utility Trenches	See Utility Excavation Below
Pavement Subgrade	90%

For areas receiving fill, lifts shall not exceed 8 inches and shall be roller compacted in a static mode or be wheel rolled with heavily loaded scrappers. The compaction shall meet the minimum requirements specified above.

The poorly graded gravel may be used for structural fill if cobbles in excess of 4" inches are selectively removed from the fill. If imported structural fill is needed, a well-graded gravel with sand mixture (a 3-inch minus well graded crushed gravel material) with 35 to 65 percent passing the #4 sieve size and less than 8 percent passing the #200 sieve size shall be used.

A moisture-density curve and an optimum moisture limit shall be established for each soil type prior to grading and filling in accordance with ASTM D1557 method. Field tests to determine the density of compacted fill material shall be conducted by a representative of the geotechnical engineer using a calibrated nuclear densometer in accordance with ASTM D2922 method.

The moisture content at the time of compaction shall be maintained within the limits to prevent dilatancy and bulking. In-place moisture content of fine-grained soils shall be within +/-1 percent and that of granular soils shall be within +/-3 percent of the laboratory optimum moisture content.

Site excavation(s) and/or subgrade preparation shall be completed before placing structural fill. The fill shall be placed such that the distribution of material is uniform throughout the entire fill and is free from lenses, pockets, streaks, frozen soil or layers of materials differing substantially from surrounding material. No fill shall be placed on a frozen surface.

Construction Dewatering

We recommend that the contractor be responsible for the control of ground and surface water within the limits of this project. Due to grade differential of the site, our observations indicate that groundwater may be encountered and, consequently, dewatering of excavations may be necessary. The use of filtered sump pumps placed within pits within excavations is expected to be a feasible method of dewatering during construction within shallow excavations above the water table. In deeper excavations below the groundwater table, dewatering wells or wellpoints may be more effective than sump pumps. Grain size curves of the water bearing soils shall be used in the design of deep well or wellpoint dewatering system.

The control of surface water runoff may also necessitate the use of interceptor trenches or French drains due to the grade differential of the site.

Temporary Excavations

Unsupported vertical slopes or cuts deeper than 4 feet are not recommended if worker access is necessary. The cuts should be adequately sloped, shored or supported to prevent injury to personnel from caving and sloughing. The excavation shall conform to applicable federal, state and local regulations. For temporary excavation purposes, a safe slope of 2(H):1(V) shall be maintained for Type C soil.

Where unstable soil or seepage zones are encountered, flatter slopes may be required. We recommend that exposed cut slopes be protected with waterproof covering during periods of wet weather to reduce sloughing and erosions. For safe working conditions and prevention of ground loss, excavation slopes should be the responsibility of the Contractor.

Deeper excavation for underground utilities shall either be sloped or externally supported with temporary shoring to provide excavation bank and bottom stability.

Erosion Control Measures

We recommend that that steep slopes greater than 15 percent be adequately protected against erosion by means of protective covering consisting of Turf Reinforcement Mats, pre-seeded burlap netting, burlap sheets covered with hydro-seeding at the appropriate time of the year or other appropriate erosion control products such as Miramat® TM8 manufactured by Mirafi.

Utility Excavations

Utilities should be placed on bedding material, which meets the manufacturer's specification. Placement of bedding material is particularly critical where maintenance of precise grades is essential. Backfill placed within the first 12 inches above utility lines should be compacted to at least 90 percent of the maximum dry density (ASTM D 1557), such that the utility lines are not damaged during backfill placement and compaction. In addition, rock fragments greater than 1 inch in maximum dimension should be excluded from this first lift. The remainder of the utility excavations should be backfilled and compacted to 95 % of the maximum dry density (ASTM D 1557. Perched groundwater was encountered in the exploratory borings completed at the site. Dewatering may be required to create conditions suitable for utility installation. Alternatively, quarry spalls or pea gravel could be used for backfill below the water level.

Native soils are considered suitable for utility trench backfill provided they can be adequately compacted. However, if cobbles are encountered in deep utility excavations they can damage buried utilities. Therefore, we recommend that a minimum of 4 inches of bedding material be placed above and below all utilities that are supported on cobbly soils or in general accordance with the utility manufacturer's recommendations and local ordinances. All excavations shall be wide enough to allow for compaction around the haunches of pipes. Otherwise, materials such as controlled density fill (CDF) or pea gravel could be used to eliminate the compaction effort required.

Some excavation bank stability problems for utility construction may occur where excavations extend into the cohesionless channel deposits. Relatively flat slopes, benching, or temporary bracing may be needed. Conventional trench box shoring is also an option for the project.

Future Foundations

Increased depths to suitable bearing soils may be encountered in some isolated areas due to lower strength soils and a natural variance in soil conditions. Structural fill placed and compacted under engineering controlled conditions is considered to be suitable for direct foundation support. If unsuitable bearing soils are encountered, we recommend that they shall be excavated to a suitable bearing soil with the excavation backfilled with structural fill to develop a uniform bearing grade. Isolated excavations required to remove zones of unsuitable soils can also be backfilled with lean concrete slurry to reduce the extent of lateral excavations required to encompass the zone of foundation influence.

The foundation may consist of either independently poured spread footings or monolithically poured foundation and floor slab (thickened slab) with longitudinal reinforcing within the strip footings continued through column footings. Foundations shall be founded at least 12 inches into suitable bearing native soils and or newly placed structural gravel fill. Foundations may be designed for maximum, net, allowable soil-bearing pressure of 1,500 psf. The allowable bearing pressure value assumes that footing subgrade has been prepared and compacted in accordance with the recommendation of geotechnical report and that the footing bearing grades have been inspected by a representative of geotechnical engineer to insure that the assumptions made in this section are consistent with field conditions. Minimum footing widths shall be 14 and 24 inches for wall and columns, respectively, for bearing considerations. Trench footing construction is considered suitable provided the excavations remain stable. Prior to placing the structural fill, the native subgrade within the footings excavations shall be compacted to a non-yielding surface and to at least 90% of the laboratory modified compaction efforts.

The local building codes require a minimum 24-inch foundation embedment depth. Therefore it is recommended that all exterior footings extend at least 24 inches below the adjacent exterior grade for frost protection. Interior footings may be supported at nominal depths below the floor. All footings must be protected against weather and water damage during and after construction, and must be supported within suitable bearing materials as described above.

Lateral forces on foundation from short term wind and seismic loading would be resisted by friction at the base of foundations and passive earth pressure against the buried portions. Passive pressure and friction may be used in combination, without reduction, in determining the total resistance to lateral loads. A one third (33%) increase in these values may be used for short duration wind and seismic loads. We recommend an allowable passive earth pressure of 225 pcf in compacted structural backfill or poured against undisturbed existing soils. This lateral foundation resistance value includes a factor of safety of 1.5. The maximum recommended allowable passive pressure is 1500 psf. We recommend a coefficient of friction of 0.35 be used between cast-in-place concrete and undisturbed native soil or non expansive structural fill. An appropriate factor of safety should be used to calculate sliding resistance at the base of footings.

In our opinion, foundation constructed in accordance with the recommendations of this report will settle approximately ½ inch, with differential settlement less than half that magnitude. The estimated differential movement is anticipated to result in an angular distortion on the order of 0.002 inches per inch on the basis of a minimum clear span of 20 feet.

Granular foundation soils should be compacted with a smooth vibratory compactor. However, no vibratory action should be utilized during compaction of the fine-grained native soils.

In addition to the above footing recommendations, the following parameters shall also be followed during house construction on each lot to provide an adequate foundation for the intended residential homes:

In accordance with Chapter 4 of the International Residential Code (Section R403.1), the lots shall be graded to drain surface water away from foundations. The minimum grade shall fall at least 6 inches within 10 feet of the foundation wall. If slopes prohibit this fall rate then swales or drains shall be constructed to divert water away from the structure.

Maximum cut excavation shall not exceed 2 feet. Basements or footings placed in deeper cuts shall not be constructed without being designed by a structural engineer that has been informed of the presence of a shallow groundwater table.

Setback from slopes in excess of 33 percent shall be a minimum of 15 feet for ascending slopes or 40 feet for descending slopes. The building official may amend the slope setback based on the specific height to Height/2 for ascending slopes or Height/3 for descending slopes.

Exterior foundation shall extend 12 inches plus 2 percent above the street gutter except as permitted by the building official.

Foundation wall shall not be backfilled until the wall has sufficient strength or has been anchored to the floor above. Backfill shall be placed in lifts not exceeding 4 inches loose and compacted with a hand operated compaction device.

Under floor space ventilation shall be critical due to the shallow groundwater table and should adhere to the IRC Section R408 requirements or Hood River County requirements whichever is more restrictive.

A representative of our geotechnical engineer should observe footing excavations and verify the placement and compaction of structural fill prior to concrete form placement.

Pavement Subgrade Stabilization

Considering native subgrade soils conditions for the proposed roadways and potential wet weather and wet subgrade conditions, stabilizing the subgrade with a geotextile fabric such as Amoco 2006 or Mirafi 600X, or equivalent will be necessary. Proper geotextile fabrics will maintain segregation of the subgrade soil and base course materials. If the subgrade soils are allowed to migrate upwards into the base course, the result would be decreased pavement support. The use of stabilization fabric will not reduce the necessary base rock thickness, as fabric does not provide structural strength at such shallow depths. If the subgrade is disturbed when wet, overexcavation may be required and backfill with imported structural gravel fill.

For the Harmony Heaven Drive, we recommend a minimum base layer thickness of 15 inches with 12 inches of 1 ½" crushed aggregate base course and 3 inches of ¾" crushed aggregate top course.

The pavement design shall incorporate both surface and subsurface drainage. If possible, we recommend that construction traffic should be limited to unpaved and untreated roadways, or specially constructed haul roads. If this is not possible, the pavement design should include an allowance for construction traffic.

General

Develop and maintain site grades that will rapidly drain precipitation and surface runoff away from the foundation and subgrade soils both during and after construction.

Recommended Guidelines for Slope Construction and Protection

In the following paragraphs we have summarized some of the more typical (generic) slope stability recommendations that we use to address cut, fill, and surficial stability issues. However, the actual stability analyses results may change the geotechnical recommendations. We have also included some of our typical slope section details (Figures 2, 3, 4 and 5) for your review as well.

Fill slopes shall be constructed at a maximum slope of 2:1 (horizontal to vertical). Fill slopes should be constructed with suitable structural fill soil that has been properly moisture conditioned and compacted as recommended in the geotechnical report. Fill slopes should be overfilled and trimmed back to uniformly compacted material. The final slope surface should be track-walked or grid rolled to improve the slope's resistance to erosion.

Cut slopes may require over-excavation and reconstruction including sub-drains based of safety factors determined from the slope stability analysis.

Proper slope protection and maintenance should help minimize slope erosion and improve the stability of the project slopes. The project soils are prone to erosion and will require protection and maintenance.

As the site soils are susceptible to erosion, it is strongly recommended that erosion control measures, such as planting, erosion control blankets or fabrics, sprayed tackifiers, or some combination of these, be utilized on all slopes within this project. A qualified landscape contractor should be retained for slope planting. Landscaping should take into consideration the engineering characteristics of the slopes, especially with regards to the surficial stability.

It is critical to provide periodic maintenance and repair of all slopes and drainage structures. Drainage inlets, outlets, and spillways should be periodically inspected and cleaned of soils and debris. All slopes should be periodically inspected for evidence of cracking, erosion, and rodent infestation. Any problems should be repaired immediately.

Key Fill Material onto the Native Cut/Existing Ground

Soft, muddy, and/or organic rich soils within the foundation of new fill slope shall be completely removed and replaced with approved structural compacted fill material. The foundation surface upon or against which new fill is to be placed shall be thoroughly broken up to a depth of at least 12 inches prior to the placement of the first lift of fill. This helps ensure a good bond between the foundation and new fill and to eliminate a plane of weakness at the interface. The foundation surface shall be kept drained and not scarified until just prior to fill placement in order to avoid saturation from rainfall.

Fill Placement on Cut Slope

When placing fill in horizontal lift adjacent to areas sloping steeper than 5:1 (horizontal: vertical), horizontal keys and vertical benches should be excavated into the adjacent slope. Keying and benching should be sufficient to provide minimum 5' wide benches and a minimum of 3' vertical bench height within the firm natural ground. No compacted fill should be placed in an area subsequent to keying and benching until the area has been reviewed by the geotechnical engineer. Benches shall be formed in the entire face of the natural sloping ground. Benching should proceed in at least 3 foot vertical increments until the desired finished grades are achieved. To key the fill into the native cut bench, fill shall be placed on the surface of each native cut bench in uniform lifts and each lift shall be compacted to at least 95 percent of the maximum dry density as determined by ASTM D1557.

If excavations for cut slopes expose loose, cohesionless, significantly fractured or otherwise unsuitable material, over-excavation and replacement of the unsuitable materials with compacted fill shall be accomplished as recommended by the geotechnical engineer.

Fill Slopes

Compacted fill slopes shall be overbuilt and cut back to grade, exposing the firm, compacted fill inner core. The actual amount of overbuilding should vary as field conditions dictate. The degree of overbuilding should be increased until the desired compacted slope surface condition is achieved. Care should be taken by the contractor to provide thorough mechanical compaction to the outer edge of the overbuilt slope surface. Fill placement should proceed in thin lifts (8" loose thickness). Each lift should be moisture conditioned and thoroughly compacted. The desired moisture condition should be maintained during the period between successive lifts. Each lift should be tested to ascertain that desired compaction is being achieved. Each lift should extend horizontally to the desired finished slope surface or more as needed to establish desired grades. Grade during construction should not be allowed to roll-off the edge of the slope. The outer edge of the slope may be slightly elevated. Slough resulting from the placement of individual lifts should not be allowed to drift down over previous lifts. At intervals not exceeding 4' in vertical slope height or the capability of available equipment, whichever is less, fill slopes should be thoroughly back-rolled utilizing a conventional sheepsfoot roller. Care should be taken to maintain the desired moisture conditions as needed prior to back-rolling. Upon achieving final grade, the slopes should again be moisture conditioned and thoroughly back-rolled. The use of a side boom roller will be necessary and vibratory methods are required. Without delay, the slopes should then be grid-rolled to achieve a relatively smooth surface and uniformly compact condition. Slope construction procedures shall be monitored, moisture and density tests shall be taken at regular intervals.

CONTINUING SERVICES

Two additional elements of geotechnical engineering services are important to the successful completion of this project.

Consultation with GN Northern during the design phase: This is essential to ensure that the intent of our recommendations is incorporated in design decisions related to the project and that changes in the design concept consider geotechnical aspects.

Observation and monitoring during construction: GN Northern should be retained to observe the earthwork phase of the project, including soil densification; site grading and footing excavations, to determine that the subsurface conditions are compatible with those used in our analysis and design.

LIMITATIONS

This report has been prepared in accordance with generally accepted soil and foundation engineering practices in this area for use by the client and their design consultant and earthwork contractor for site development and design purposes. The findings and recommendations submitted in this report are based upon the data obtained from three exploratory borings completed at the site. The nature and extent of subsurface variations across the site may not become evident until construction. If during construction, fill, soil, rock, or water conditions appear to be different from those described herein, we should be advised at once so re-evaluation of the recommendation can be made. The information indicated on the test boring logs represents subsurface conditions at the location of the test borings at the time of excavation. Subsurface conditions may differ at other locations and may change at this location with the lapse of time.

Kashif Ali
Project Engineer

Imran Magsi, P.E.
Senior Geotechnical Engineer

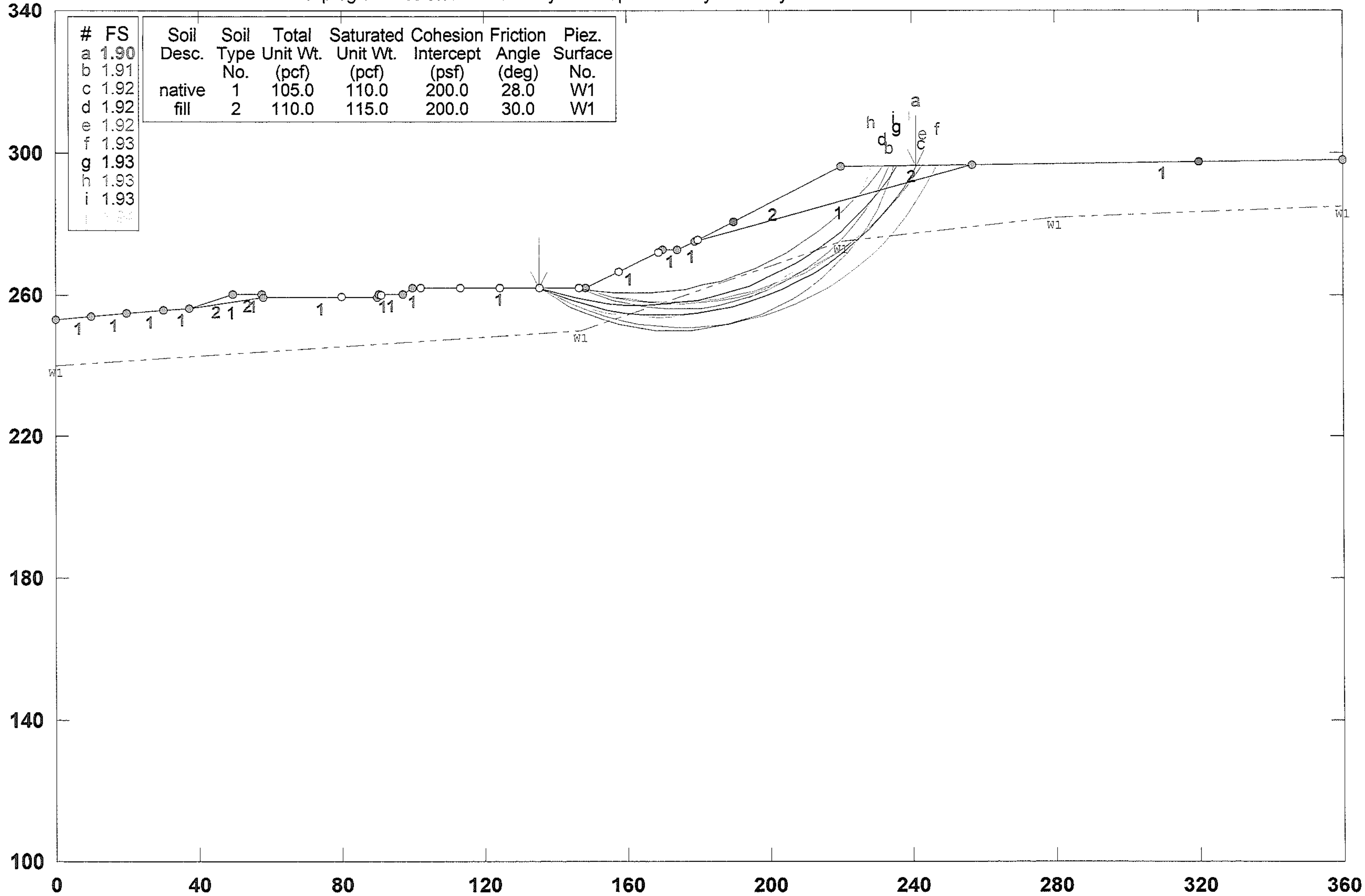
APPENDIX

RESULTS OF SLOPE STABILITY ANALYSIS

Northern, Inc.

Harmony Heaven - Harmony Heaven Dr. 2+20- Lots 29 & 14 - Static

c:\program files\stedwin\harmony\2914st.pl2 Run By: Earth Systems Northwest 7/12/2006 12:46PM



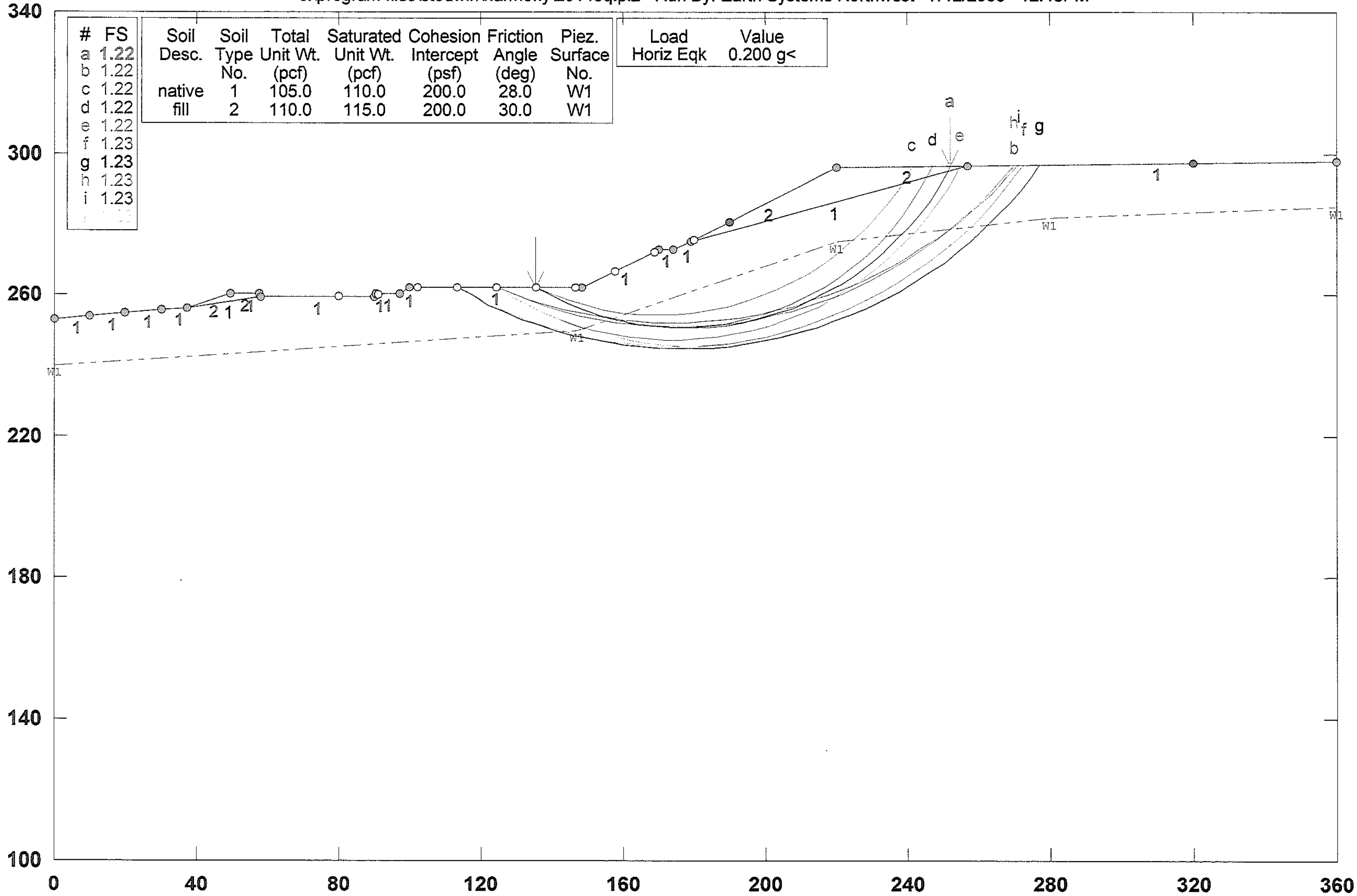
PCSTABL5M/si FSmin=1.90

Safety Factors Are Calculated By The Modified Bishop Method

STED

Harmony Heaven - Harmony Heaven Dr. 2+20- Lots 29 & 14 - Seismic

c:\program files\stedwin\harmony\2914eq.pl2 Run By: Earth Systems Northwest 7/12/2006 12:48PM



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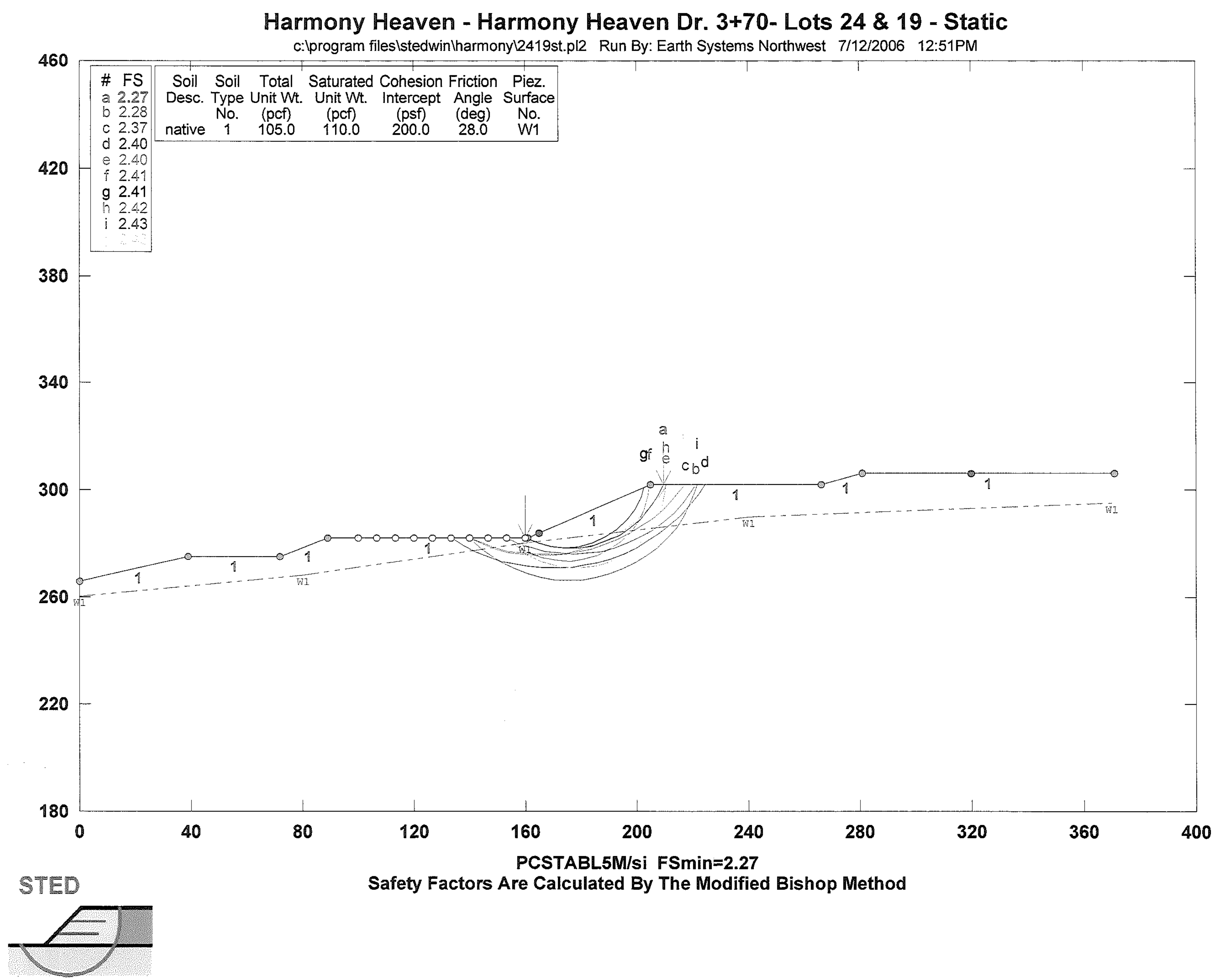
Safety Factors Are Calculated By The Modified Bishop Method

STED

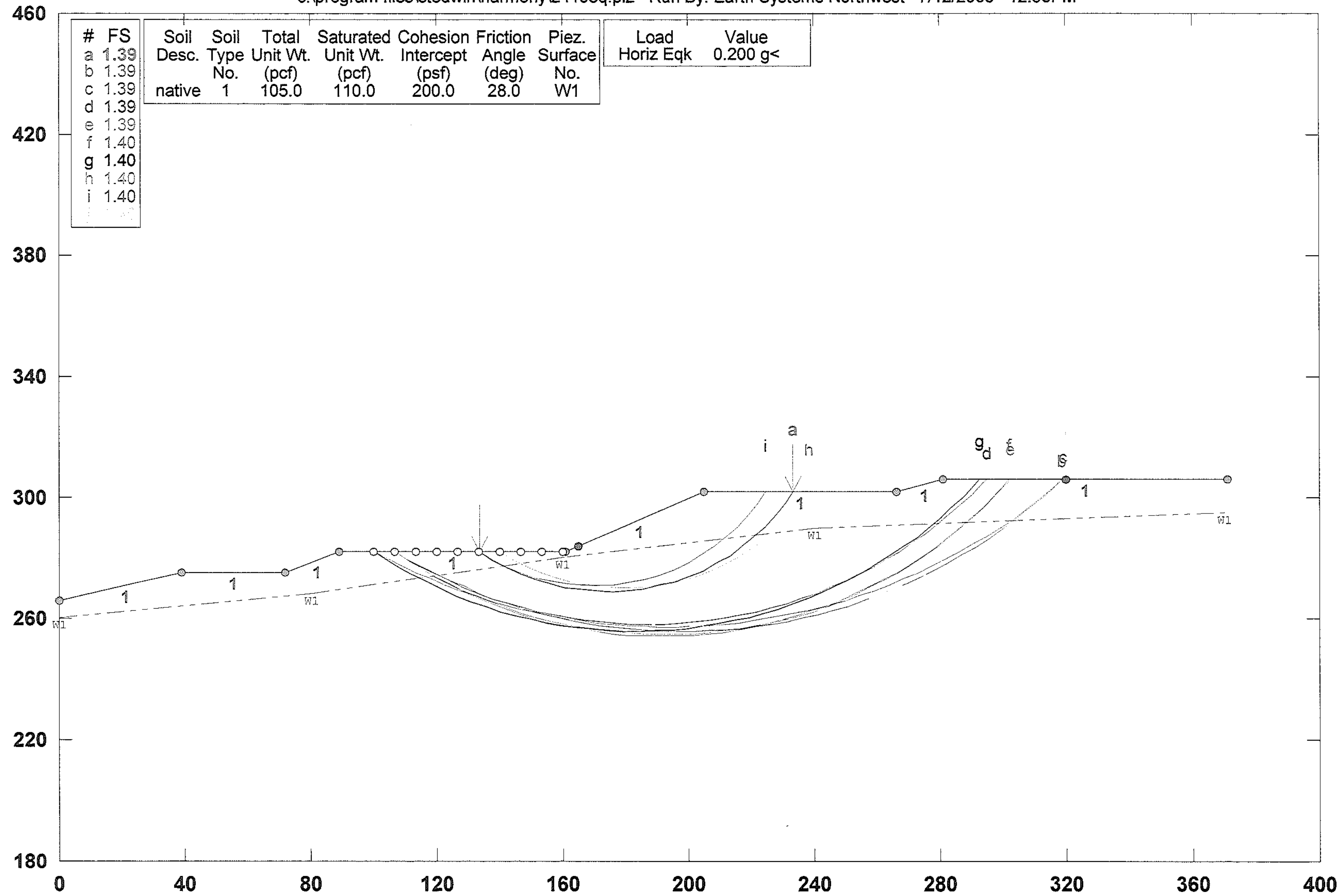
GN Northern, Inc.



Northern, Inc.

Harmony Heaven - Harmony Heaven Dr. 3+70- Lots 24 & 19 - Seismic

c:\program files\stedwin\harmony\2419eq.pl2 Run By: Earth Systems Northwest 7/12/2006 12:53PM



PCSTABL5M/si FSmin=1.39

Safety Factors Are Calculated By The Modified Bishop Method

STED

ASFE INFORMATION SHEET

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

GEOTECHNICAL SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND PERSONS

Geotechnical engineers reports are prepared to meet the specific needs of specific individuals. A report prepared for a consulting civil engineer may not be adequate for a construction contractor, or even some other consulting civil engineer. Unless indicated otherwise, this report was prepared expressly for the client involved and expressly for purposes indicated by the client. Use by any other persons for any purpose, or by the client for a different purpose, may result in problems. *No individual other than the client should apply this report for its intended purpose without first conferring with the geotechnical engineer. No person should apply this report for any purpose other than that originally contemplated without first conferring with the geotechnical engineer.*

A GEOTECHNICAL ENGINEERING REPORT IS SUBJECT TO MISINTERPRETATION

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical engineering report. To help avoid these problems, the geotechnical engineer should be retained to work with other appropriate design professionals to explain relevant geotechnical findings and to review the adequacy of their plans and specifications relative to geotechnical issues.

BORING LOGS SHOULD NOT BE SEPARATED FROM THE ENGINEERING REPORT

Final boring logs are developed by geotechnical engineers based upon their interpretation of field logs (assembled by site personnel) and laboratory evaluation of field samples. Only final boring logs customarily are included in geotechnical engineering reports. *These logs should not under any circumstances be redrawn* for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process. Although photographic reproduction eliminates this problem, it does nothing to minimize the possibility of contractors misinterpreting the logs during bid preparation. When this occurs, delays, disputes and unanticipated costs are the all-too-frequent result.

To minimize the likelihood of boring log misinterpretation, *give contractors ready access to the complete geotechnical engineering report* prepared or authorized for their use. Those who do not provide such access may proceed under the *mistaken* impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes which aggravate them to disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY

Because geotechnical engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. The situation has resulted in wholly unwarranted claims being lodged against geotechnical consultants. To help prevent this problem, geotechnical engineers have developed model clauses for use in written transmittals. These are *not* exculpatory clauses designed to foist geotechnical engineers' liabilities onto someone else. Rather, they are definitive clauses which identify where geotechnical engineers' responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your geotechnical engineering report, and you are encouraged to read them closely. Your geotechnical engineer will be pleased to give full and frank answers to your question.

OTHER STEPS YOU CAN TAKE TO REDUCE RISK

Your consulting geotechnical engineer will be pleased to discuss other techniques which can be employed to mitigate risk. In addition, ASFE has developed a variety of materials which may be beneficial.. Contact ASFE for a complimentary copy of its publications directory.

ASFE

THE ASSOCIATION OF ENGINEERING FIRMS PRACTICING IN THE GEOSCIENCES

IMPORTANT INFORMATION
ABOUT YOUR
GEOTECHNICAL ENGINEERING REPORT

More construction problems are caused by site subsurface conditions than any other factor. As troublesome as subsurface problems can be, their frequency and extent have been lessened considerably in recent years, due in large measure to programs and publications of ASFE/ The Association of Engineering Firms Practicing in the Geosciences.

The following suggestions and observations are offered to help you reduce the geotechnical-related delays, cost-overruns and other costly headaches that can occur during a construction project.

A GEOTECHNICAL ENGINEERING REPORT IS BASED ON A UNIQUE SET OF PROJECT-SPECIFIC FACTORS

A geotechnical engineering report is based on a subsurface exploration plan designed to incorporate a unique set of project-specific factors. These typically include: the general nature of the structure involved, its size and configuration; the location of the structure on the site and its orientation; physical concomitants such as access roads, parking lots, and underground utilities, and the level of additional risk which the client assumed by virtue of limitations imposed upon the exploratory program. To help avoid costly problems, consult the geotechnical engineer to determine how any factors which change subsequent to the date of the report may affect its recommendations.

Unless your consulting geotechnical engineer indicates otherwise, *your geotechnical engineering report should not be used:*

- When the nature of the proposed structure is changed, for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one;
- when the size or configuration of the proposed structure is altered;
- when the location or orientation of the proposed structure is modified;
- when there is a change of ownership, or
- for application to an adjacent site.

Geotechnical engineers cannot accept responsibility for problems which may develop if they are not consulted after factors considered in their report's development have changed.

MOST GEOTECHNICAL "FINDINGS" ARE PROFESSIONAL ESTIMATES

Site exploration identifies actual subsurface conditions only at those points where samples are taken, when they are taken. Data derived through sampling and subsequent laboratory testing are extrapolated by geotechnical engineers who then render an opinion about overall subsurface conditions, their likely reaction to proposed construction activity, and appropriate foundation design. Even under optimal circumstances actual conditions may differ from those inferred to exist, because no geotechnical engineer no matter how qualified, and no subsurface exploration program, no matter how comprehensive, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than a report indicates. Actual conditions in areas not sampled may differ from predictions. *Nothing can be done to prevent the unanticipated, but steps can be taken to help minimize their impact.* For this reason, *most experienced owners retain their geotechnical consultants through the construction stage,* to identify variances, conduct additional tests which may be needed, and to recommend solutions to problems encountered on site.

SUBSURFACE CONDITIONS CAN CHANGE

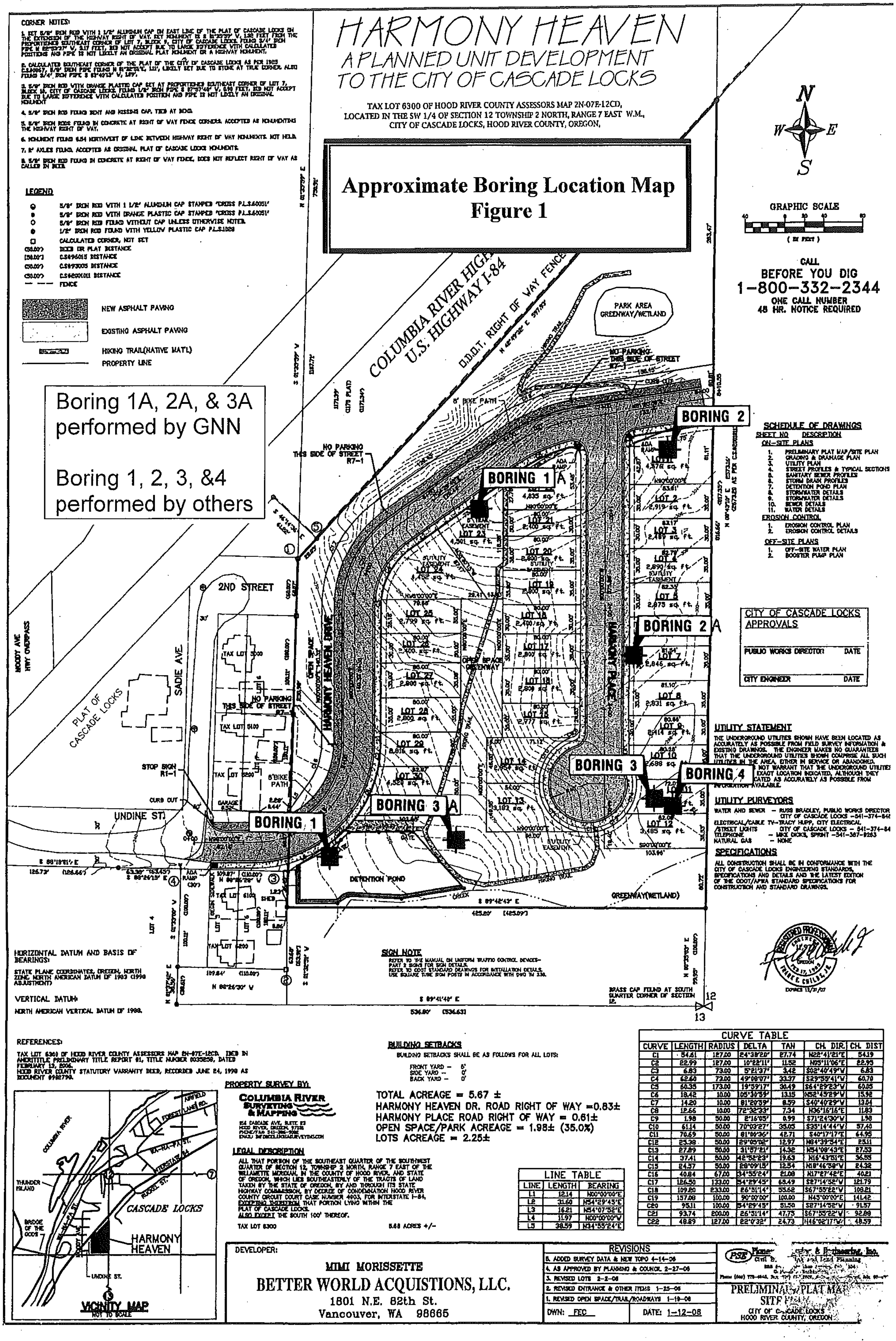
Subsurface conditions may be modified by constantly changing natural forces. Because a geotechnical engineering report is based on conditions which existed at the time of subsurface exploration, *construction decisions should not be based on a geotechnical engineering report whose adequacy may have been affected by time.* Speak with the geotechnical consultant to learn if additional tests are advisable before construction starts.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes or groundwater fluctuations may also affect subsurface conditions and thus the continuing adequacy of a geotechnical report. The geotechnical engineer should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

ASFE

THE ASSOCIATION OF ENGINEERING FIRMS PRACTICING IN THE GEOSCIENCES

APPROXIMATE BORING LOCATION MAP



CURVE TABLE						
CURVE	LENGTH	RADIUS	DELTA	TAN	CH. DIR.	CH. DIST
C1	54.61	127.00	24°38'20"	27.74	N22°41'21"E	54.19
C2	22.99	127.00	10°22'11"	11.52	N05°11'06"E	22.93
C3	6.83	73.00	5°21'37"	3.42	S02°40'49"W	6.83
C4	62.60	73.00	49°08'07"	33.37	S29°55'41"W	60.70
C5	60.35	173.00	19°59'17"	30.49	S64°29'23"W	60.05
C6	18.42	10.00	105°30'59"	13.15	N52°45'29"W	15.92
C7	14.20	10.00	81°20'39"	8.59	S40°40'29"W	13.04
C8	12.66	10.00	72°32'33"	7.34	N36°16'16"E	11.83
C9	1.98	50.00	2°16'05"	0.99	S71°24'30"W	1.98
C10	61.14	50.00	70°03'27"	35.05	S35°14'44"W	57.40
C11	70.69	50.00	81°00'36"	42.71	S40°17'17"E	64.95
C12	25.38	50.00	29°05'02"	12.97	N84°39'54"E	25.11
C13	27.89	50.00	31°57'21"	14.32	N54°08'43"E	27.53
C14	37.41	50.00	42°52'23"	19.63	N16°43'51"E	36.55
C15	24.57	50.00	28°09'15"	12.54	N18°46'58"W	24.32
C16	40.84	67.00	34°55'24"	21.08	N17°27'42"E	40.21
C17	126.50	133.00	54°29'45"	68.49	S27°14'52"W	121.79
C18	109.20	233.00	26°51'14"	55.62	S67°55'22"W	108.21
C19	157.08	100.00	90°00'00"	100.00	N45°00'00"E	141.42
C20	95.11	100.00	54°29'45"	51.50	S27°14'52"W	91.57
C21	93.74	200.00	26°51'14"	47.75	S67°55'22"W	92.89
C22	48.89	127.00	22°0'32"	24.73	N46°02'17"W	48.59

LINE TABLE		
LINE	LENGTH	BEARING
L1	12.14	N00°00'00"E
L2	31.60	N54°29'45"E
L3	16.21	N54°07'52"E
L4	11.97	N00°00'00"W
L5	38.59	N34°55'24"E

BORING LOGS

Northern, Inc.

BH-1A

Harmony Heaven Development **Residential Development** **Cascade Locks, Oregon**	
Driller: R&R Drilling	Client: Bell Design Company
Drilling Method: Hollow Stem Auger	Project Number: 206-623-1
Location: Northwest Corner	Date: June 16, 2006
Diameter: 8.25 / Water Table : Not Encountered	Logged by: GH

See Site Diagram

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log		Material Description	Remarks
						GWT not encountered	0		ML	Sandy Silt, light brown, moist, hard, slighlty plastic.	
1				18,20,25	45		5				P. P. = 1.5 TSF
2				17,23,31	>50		10				P. P. = 1.5 TSF
3				16,29,35	>50				ML	Increasing fines	P. P. = 2.0 TSF
							15				
4				13,19,26	45		20				P. P. = 2.5 TSF
5				13,22,24	46				ML	Silt with Sand, light gray, moist, hard, slightly plastic.	P. P. = 3.5 TSF - Sieve/Moisture
							25				
6				14,25,25	50		30				
7				25,30,35	>50				ML	Sandy Silt, dark gray, slightly moist to moist, hard, slightly cemented, slightly plastic.	P. P. = 2.5 TSF

Northern, Inc.

BH-1A

Harmony Heaven Development
Residential Development
Cascade Locks, Oregon

Driller: R&R Drilling	Client: Bell Design Company
Drilling Method: Hollow Stem Auger	Project Number: 206-623-1
Location: Northwest Corner	Date: June 16, 2006
Diameter: 8.25 / Water Table : Not Encountered	Logged by: GH

See Site Diagram

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	USCS	Material Description	Remarks
							35		ML	Sandy Silt, dark gray, slightly moist to moist, hard, slightly cemented, slightly plastic.	
8				15,18,27	45						Sieve/Moisture
							40		ML	Silt with Sand, blue green to blue gray, moist, hard, slightly cemented, and slightly plastic	
9				30,38,43	>50						
							45				
10				29,50/6"	>50						
										End of Boring at (feet BGS): 48.5	
							50				
							55				
							60				
							65				

Northern, Inc.

BH-2A

Harmony Heaven Development
Residential Development
Cascade Locks, Oregon

Driller: R&R Drilling	Client: Bell Design Company
Drilling Method: Hollow Stem Auger	Project Number: 206-623-1
Location: Center - East Side	Date: June 19, 2006
Diameter: 8.25 / Water Table : 20'	Logged by: GH

See Site Diagram

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Material Description	Remarks
						GWT not encountered	0		**ML** Silt with sand, brown, slightly moist to moist, very stiff to hard.	
1				6,13,18	31					
2				19,20,27	47		5		**SM** Silty Sand, brown, moist and dense.	
3				19,30,31	>50					
4				19,23,30	>50		10		**ML** Sandy Silt, dark gray, slightly moist to moist, hard, slightly cemented, and slightly plastic.	
5				11,16,16	32		15			
6				12,20,19	39		20		**ML** Silt with Sand, brown, wet, hard, and slightly plastic.	
7				17,25,35	>50		25		**ML** Sandy Silt, brown, moist, hard, and slightly plastic.	
8				23,23,39	>50		30		**ML** Silty with Sand and Gravel, dark gray, moist, hard, and slightly plastic.	

Northern, Inc.

BH-2A

Harmony Heaven Development

Residential Development
Cascade Locks, Oregon

Driller: R&R Drilling	Client: Bell Design Company
Drilling Method: Hollow Stem Auger	Project Number: 206-623-1
Location: Center - East Side	Date: June 19, 2006
Diameter: 8.25 / Water Table : 20'	Logged by: GH

See Site Diagram

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log		Material Description	Remarks
							35				
9				23,40,50/5"	>50				ML	Silty with Sand and Gravel, dark gray, moist, hard, and slightly plastic.	
10				50/1"	>50		40		GP	Poorly Graded Gravel, black, moist, very dense.	
										End of Boring at (feet BGS): 40.08	
							45				
							50				
							55				
							60				
							65				

Northern, Inc.

BH-3A

Harmony Heaven Development
Residential Development
Cascade Locks, Oregon

Driller: R&R Drilling	Client: Bell Design Company
Drilling Method: Hollow Stem Auger	Project Number: 206-623-1
Location: Center - South Side	Date: June 19, 2006
Diameter: 8.25 / Water Table : 10'	Logged by: GH

See Site Diagram

Sample No.	Sample Type	Recovery (%)	RQD (%)	Blow Count per 6 inches	Blows/Foot (N)	Water Table	Depth (ft BGS)	Graphic Log	Material Description	Remarks
						GWT not encountered	0		ML-CL Silty Clay, reddish brown, wet to saturated, stiff, and slightly plastic.	
1				5,5,6	11		5			Shelby Tube
2				5,5,5	10		10			
3				11,17,17	34		15		GP Poorly Graded Gravel with sand and silt, brown, and dense.	
4				14,23,24	47		20		SM Silt Sand with occassional Gravel, brown, moist, and dense.	
5				40,21,33	>50		25			
6				16,20,14	34		30		ML Sandy Silt, dark gray to black, moist, hard,	
									End of Boring at (feet BGS): 31.5	

LABORATORY TEST DATA

Client: Bell Design Company
PO Box 308
1000 E Steuben
Bingen WA 98605

Date: July 7, 2006
Job Number: 206-623-1
Work Order: Yakima
Sample No.: 260272

Project: Harmony Heaven, Cascade Locks, Oregon

Material Description: Silty Sand
Date & Time Sampled: June 16, 2006
Date Received: June 16, 2006
Sample Location & Depth: BH-1A at 22.5-24'

Weather: Rainy
Sampled By: GH
Date Tested: June 22, 2006

Sieve Analysis Test Results
Standard(s): ASTM D1140 & D422

Sieve Size	Percent Passing	Spec Limits
No.4	97	
No. 10	95	
No. 20	92	
No. 40	89	
No. 80	79	
No. 200	49.3	

Testing Results:

In Conformance with Plans and Specifications: NA

Out of Conformance with Plans and Specifications: NA

Approved By: [signature] for
Gerald Harper, Division Manager

Client:	Bell Design Company PO Box 308 1000 E Steuben Bingen WA 98605	**Date:** **Job Number:** **Work Order:** **Sample No.:**	July 7, 2006 206-623-1 Yakima 260273

Project: Harmony Heaven, Cascade Locks, Oregon

Material Description:	Silty Sand	**Weather:**	Rainy
Date & Time Sampled:	June 16, 2006	**Sampled By:**	GH
Date Received:	June 16, 2006	**Date Tested:**	June 22, 2006
Sample Location & Depth:	BH-1A at 37.5 - 39'		

Sieve Analysis Test Results
Standard(s): ASTM D1140 & D422

Sieve Size	Percent Passing	Spec Limits
No.4	100	
No. 10	100	
No. 20	99	
No. 40	96	
No. 80	78	
No. 200	45.0	

Testing Results:

In Conformance with Plans and Specifications:	NA
Out of Conformance with Plans and Specifications:	NA

Approved By: [signature] for
Gerald Harper, Division Manager

Client:	Bell Design Company PO Box 308 1000 E Steuben Bingen WA 98605	**Date:** **Job Number:** **Work Order:** **Sample No.:**	July 7, 2006 206-623-1 Yakima 260276

Project: Harmony Heaven, Cascade Locks, Oregon

Material Description:	Sandy Silty	**Weather:**	Sunny
Date & Time Sampled:	June 19, 2006	**Sampled By:**	KA
Date Received:	June 19, 2006	**Date Tested:**	June 22, 2006
Sample Location & Depth:	BH-3A at 5'-6 1/2'		

Sieve Analysis Test Results
Standard(s): ASTM D1140 & D422

Sieve Size	Percent Passing	Spec Limits
No.4	100	
No. 10	100	
No. 20	98	
No. 40	95	
No. 80	85	
No. 200	56.0	

Testing Results:

In Conformance with Plans and Specifications: NA

Out of Conformance with Plans and Specifications: NA

Approved By: [signature] for
Gerald Harper, Division Manager

Northern, Inc.

Client: Bell Design Company
PO Box 308
1000 E Steuben
Bingen WA 98605

Date: June 16, 2006
Job Number: 206-623-1
Work Order: Yakima
Sample No.: 260284

Project: Harmony Heaven, Cascade Locks, Oregon

Material Description: Silt with Sand
Date & Time Sampled: June 16, 2006
Date Received: June 16, 2006
Sample Location & Depth: BH-1A at 22.5-24'

Weather: Rainy
Sampled By: GH
Date Tested: July 10, 2006

Sieve Analysis Test Results
Standard(s): ASTM D1140 & D422

Sieve Size	Percent Passing	Spec Limits
No. 10	100	
No. 20	100	
No. 40	94	
No. 80	84	
No. 200	79.3	

Hydrometer Test Results

Particle Size (mm)	Percent Passing	Spec Limits
0.032	50.7	
0.021	47.3	
0.012	42.4	
0.009	37.4	
0.006	32.4	
0.003	28.2	
0.001	22.4	

Liquid Limit/Plastic Limit (ASTM D4318): Granular Non Plastic

Testing Results:

In Conformance with Plans and Specifications:	N/A
Out of Conformance with Plans and Specifications:	NA

Approved By: [signature] for
Gerald Harper, Division Manager

Northern, Inc.

Client: Bell Design Company
PO Box 308
1000 E Steuben
Bingen WA 98605

Date: June 16, 2006
Job Number: 206-623-1
Work Order: Yakima
Sample No.: 260286

Project: Harmony Heaven, Cascade Locks, Oregon

Material Description: Sandy Silt
Date & Time Sampled: June 16, 2006
Date Received: June 16, 2006
Sample Location & Depth: BH-1A at 37.5'-39'

Weather: Rainy
Sampled By: GH
Date Tested: July 10, 2006

Sieve Analysis Test Results
Standard(s): ASTM D1140 & D422

Sieve Size	Percent Passing	Spec Limits
No. 10	100	
No. 20	100	
No. 40	96	
No. 80	84	
No. 200	69.2	

Hydrometer Test Results

Particle Size (mm)	Percent Passing	Spec Limits
0.033	45.4	
0.022	37.5	
0.013	30.6	
0.009	27.1	
0.007	23.6	
0.003	17.5	
0.001	13.1	

Liquid Limit/Plastic Limit (ASTM D4318): Granular Non Plastic

Testing Results:

In Conformance with Plans and Specifications:	N/A
Out of Conformance with Plans and Specifications:	NA

Approved By: [signature] for
Gerald Harper, Division Manager

KEY CHART FOR SOIL CLASSIFICATION

GN Northern, Inc.

Kirkland, Yakima, Kennewick, Hermiston (OR)

KEY CHART

RELATIVE DENSITY OR CONSISTENCY VERSUS SPT N-VALUE					
COARSE-GRAINED SOILS			FINE-GRAINED SOILS		
DENSITY	N (BLOWS/FT)	FIELD TEST	CONSISTENCY	N (BLOWS/FT)	FIELD TEST
Very Loose	0 – 4	Easily penetrated with ½-inch reinforcing rod pushed by hand	Very Soft	0 – 2	Easily penetrated several inches by thumb
Loose	4 – 10	Difficult to penetrate with ½-inch reinforcing rod pushed by hand	Soft	2 – 4	Easily penetrated one inch by thumb
Medium -Dense	10 – 30	Easily penetrated with ½-inch rod driven with a 5-lb hammer	Medium-Stiff	4 – 8	Penetrated over ½-inch by thumb with moderate effort
Dense	30 – 50	Difficult to penetrate with ½-inch rod driven with a 5-lb hammer	Stiff	8 – 15	Indented about ½-inch by thumb but penetrated with great effort
Very Dense	> 50	penetrated only a few inches with ½-inch rod driven with a 5-lb hammer	Very Stiff	15 – 30	Readily indented by thumb
			Hard	> 30	Indented with difficulty by thumbnail

USCS SOIL CLASSIFICATION				
MAJOR DIVISIONS			GROUP DESCRIPTION	
Coarse-Grained Soils <50% passes #200 sieve	**Gravel and Gravelly Soils** <50% coarse fraction passes #4 sieve	**Gravel** (with little or no fines)	GW	Well-graded **Gravel**
			GP	Poorly Graded **Gravel**
		Gravel (with >12% fines)	GM	Silty **Gravel**
			GC	Clayey **Gravel**
	Sand and Sandy Soils >50% coarse fraction passes #4 sieve	**Sand** (with little or no fines)	SW	Well-graded **Sand**
			SP	Poorly graded **Sand**
		Sand (with >12% fines)	SM	Silty **Sand**
			SC	Clayey **Sand**
Fine-Grained Soils >50% passes #200 sieve	**Silt and Clay** Liquid Limit < 50		ML	**Silt**
			CL	Lean **Clay**
			OL	Organic **Silt** and **Clay** (low plasticity)
	Silt and Clay Liquid Limit > 50		MH	Inorganic **Silt**
			CH	Inorganic **Clay**
			OH	Organic **Clay** and **Silt** (med. to high plasticity)
Highly Organic Soils			PT	**Peat** / **Top Soil**

LOG SYMBOLS	
2S	2" OD Split Spoon (SPT)
3S	3" OD Split Spoon
NS	Non-Standard Split Spoon
ST	Shelby Tube
CR	Core Run
BG	Bag Sample
TV	Torvane Reading
PP	Penetrometer Reading
NR	No Recovery
GW	Groundwater Table

MODIFIERS	
DESCRIPTION	RANGE
Trace	<5%
Little	5% – 12%
Some	>12%

MOISTURE CONTENT	
DESCRIPTION	FIELD OBSERVATION
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but not visible water
Wet	Visible free water

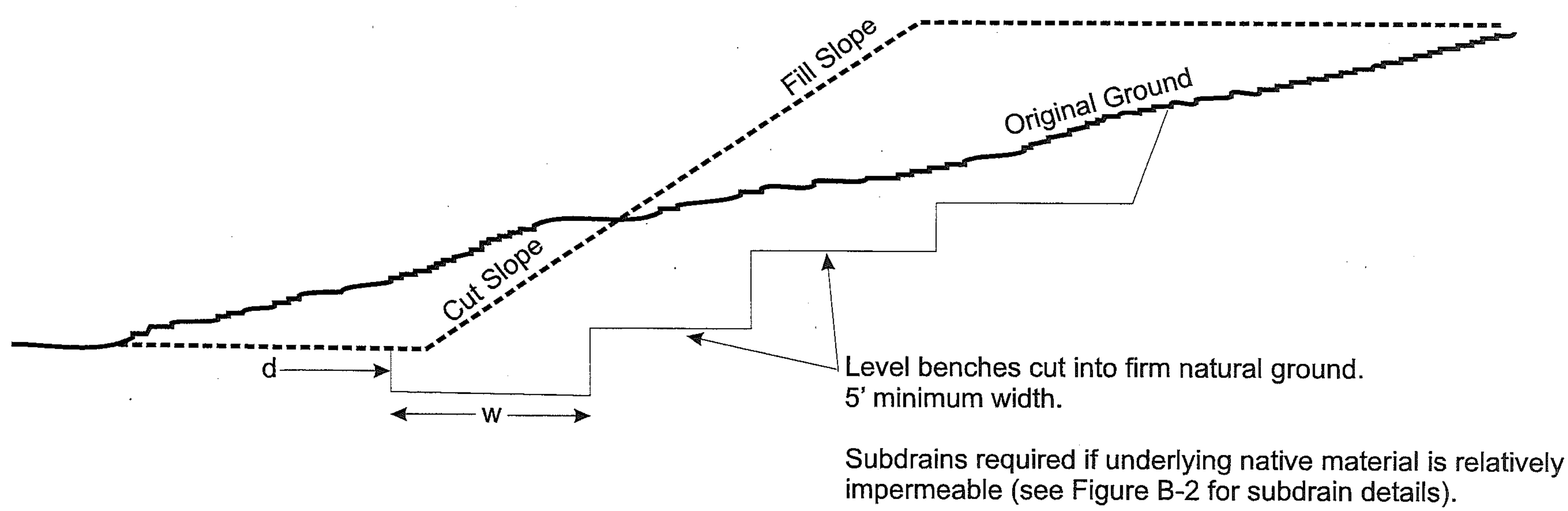
SOIL CLASSIFICATION INCLUDES

1. Group Name
2. Group Symbol
3. Color
4. Moisture content
5. Density / consistency
6. Cementation
7. Particle size (if applicable)
8. Odor (if present)
9. Comments

MAJOR DIVISIONS WITH GRAIN SIZE							
SIEVE SIZE							
12"	3"	3/4"	4	10	40	200	
GRAIN SIZE (INCHES)							
12	3	0.75	0.19	0.079	0.0171	0.0029	
Boulders	Cobbles	Gravel		Sand			Silt and Clay
		Coarse	Fine	Coarse	Medium	Fine	

Conditions shown on boring and testpit logs represent our observations at the time and location of the fieldwork, modifications based on lab test, analysis, and geological and engineering judgment. These conditions may not exist at other times and locations, even in close proximity thereof. This information was gathered as part of our investigation, and we are not responsible for any use or interpretation of the information by others.

TYPICAL GRADING AND OVEREXCAVATION DETAILS FOR SLOPE CONSTRUCTION



d = Minumum downslope key depth into fim natural ground approved by project engineering geologist or geotechnical engineer.

w = Width of key: Half the slope height or 10' minimum.

Grading Detail: Fill Over Cut Condition
Figure No. 2

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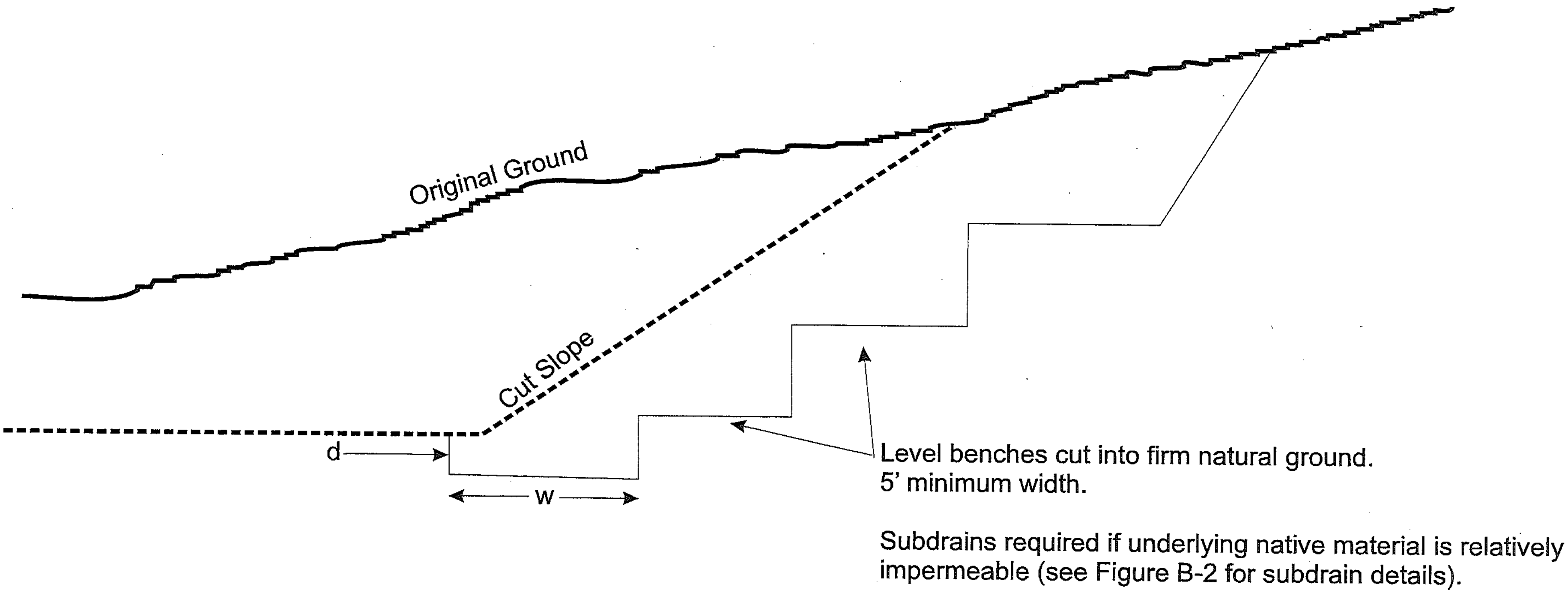

d = Minumum downslope key depth into fim natural ground approved by project engineering geologist or geotechnical engineer.

w = Width of key: Half the slope height or 10' minimum.

Grading Detail: Reconstructed Cut Slope Stabilization Fill

Figure No. 3

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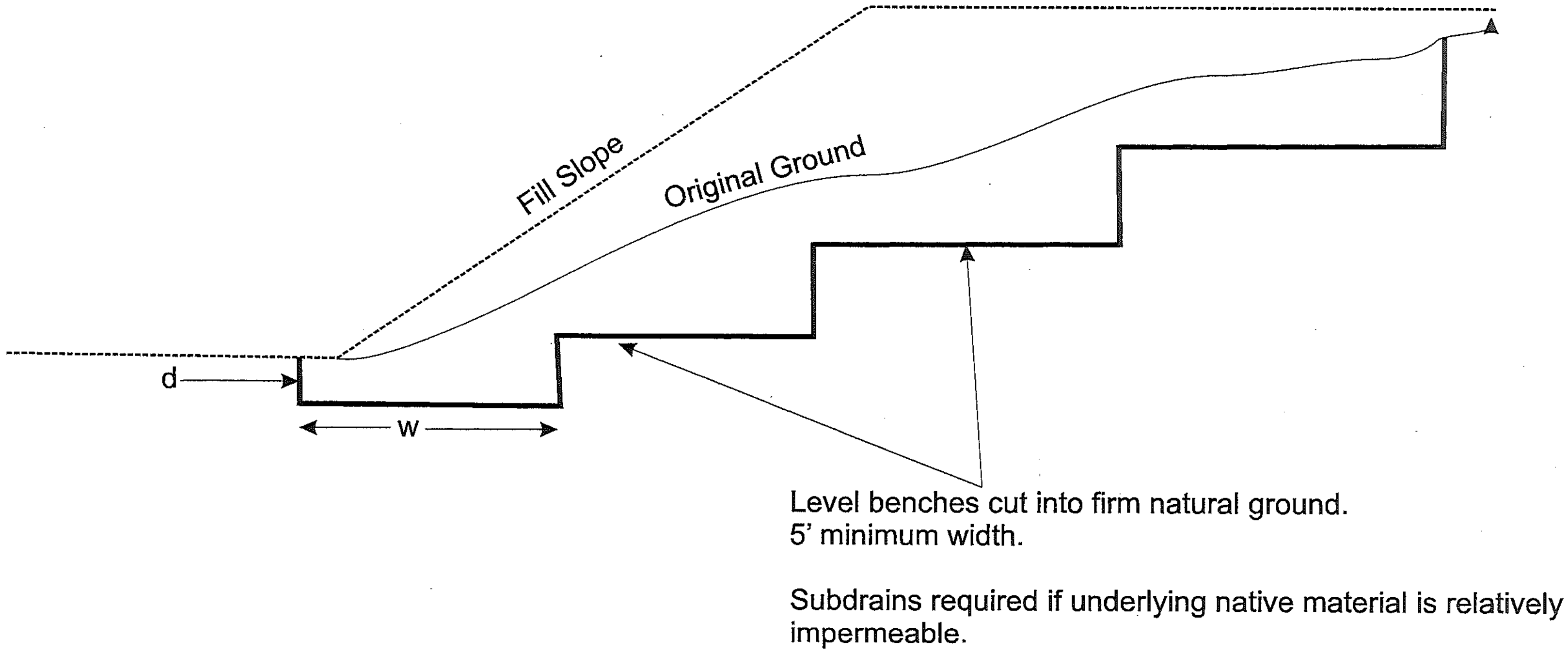

d = Minumum downslope key depth into fim natural ground approved by project engineering geologist or geotechnical engineer. 2' Minimum.

w = Width of key: Half the slope height or 10' minimum.

Grading Detail: Fill Over Native Condition
Figure No. 4

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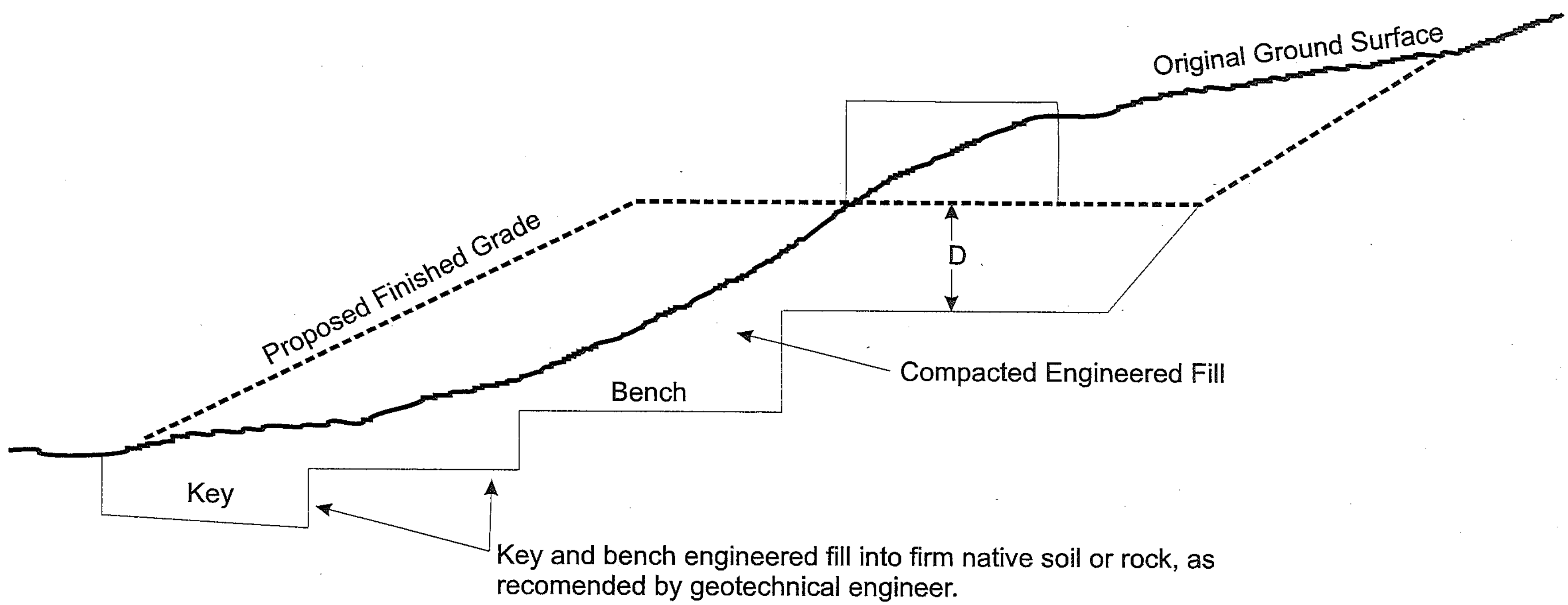

D = Depth of overexcavation and recompation as recommended in report. Minimum depth of fill under structure is 5'. Maximum fill thickness differential ratio under structure is 3:1.

Over-Excavation Detail
Transition Condition
Figure No. 5

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