City of Bellevue

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GEOTECHNICAL REPORTING REQUIREMENTS

A geotechnical engineering report is required for all Clearing and Grading Permit applications submitted to the City of Bellevue. The reporting requirements for single-family permits may be waived if a report meeting the City of Bellevue's criteria for the site has been filed less than 5 years prior to the date of application and the Geotechnical Engineer prepares a written letter stating the report is still applicable to the site and currently proposed project. Similarly, reporting requirements may be waived for single-family permits if the applicant can demonstrate, to the satisfaction of the City of Bellevue, that soil or groundwater conditions at or near the site pose little or no risk for the project.

It shall be the responsibility of the Geotechnical Engineer to determine the actual scope of investigation, analysis, and reporting necessary to meet the Standard of Practice with respect to the project and its geotechnical requirements. The report shall be signed and sealed by the Geotechnical Engineer.

The attached report outline describes the basic elements the City of Bellevue requires in each geotechnical report. The thoroughness of each element will greatly depend on the nature and complexity of the project and site conditions. For example, a report for a single family residence on a glacial till site without groundwater issues warrants a short, simple report, while a high-rise structure with a deep excavation on an alluvial site warrants a longer, much more detailed report. All elements should be included in detail unless they are clearly not applicable. For example, slope stability could be excluded if there are no slopes on the site or surrounding area, or shoring and retaining walls could be excluded if there are no requirements for temporary or permanent soil or rock retention.

GEOTECHNICAL REPORT OUTLINE

SUMMARY

The summary shall present the major conclusions and their basis. This section should be included in all lengthy or complex reports.

1.0 INTRODUCTION

The Introduction sets the stage for the entire report and should contain the following sections:

1.1 OVERVIEW

- Present the formal project name used throughout the report and state the location.
- Briefly describe current or previous work used to form the basis for the conclusions and recommendations contained in the report.

1.2 BACKGROUND

- Provide a description of the project's history if it is important to understanding why the study was performed.

- List other reports completed for the site or adjacent sites and note whether any environmental site assessments or other environmental work has been completed for the site.

- Provide a general description and give dimensions of the project including the general nature of the proposed development, including grading, retaining walls, structures, construction materials, and utilities. Also, include proposed finish floor elevations, maximum depth of cut or fill, foundation and floor loads, etc.

- Describe all other details of the project which were assumed or relied upon in developing the conclusions and recommendations contained in the report.

1.3 PURPOSE AND SCOPE OF SERVICES

- State succinctly the primary purpose for the geotechnical engineering services.

- Summarize the scope of geotechnical engineering services which form the basis for the conclusions and recommendations contained in the report.

- Indicate any limitations to the scope of geotechnical engineering services provided, particularly if the scope represents a departure from services typically provided on similar projects.

1.4 INVESTIGATION SUMMARY

- Describe the dates, general nature, and extent of the geotechnical investigation. This section should include data research, borings, test pits, geophysics, physical laboratory testing, chemical testing, field instrumentation or testing, etc.

- If the investigation was complex, present a complete and detailed explanation and results in the form of an appendix.

1.5 REPORT OVERVIEW

- Introduce and describe other sections of the report, directing the reader to critical sections, if appropriate.

- Identify and describe all attachments and appendices.

2.0 SITE CONDITIONS

The Site Conditions shall describe all site features relevant to the study and the geotechnical engineering conclusions and recommendations. Terminology should be clear and consistent, and continue to be consistent through the entire report.

2.1 LOCATION AND SURFACE CONDITIONS

- ∃ Present the project's specific address, location and cross streets.
- ∃ Generally describe the site and adjoining properties, and indicate their current use.
- ∃ Describe surface elevation, topography and drainage. Clearly reference all elevations to City of Bellevue NAVD88 datum.
- ∃ Identify all current structures, subsurface utilities, wells, manmade fills, and other surface features.
- ∃ Describe vegetation, topsoil, paving, and other surface coverings.
- ∃ Describe any indications of historic geological processes or hazards on or near the site (i.e., slope instability, landslides, liquefaction, flooding, etc).
- ∃ Describe any indications of surface releases or other contamination, or potential contamination sources.
- ∃ Describe any planned changes to the surface conditions described above which will take place after the investigation.

2.2 GEOLOGIC SETTING

- ∃ Provide an overview of regional geology, local stratigraphy, groundwater occurrence, etc.

2.3 SUBSURFACE SOIL CONDITIONS

- ∃ Describe each soil or geologic unit encountered by their classification and group units with respect to the properties that are most relevant to the conclusions and recommendations. Give each unit group a unique, clear, common title and consistently refer to this unit by its given title throughout the report.
- ∃ Provide important results of the laboratory physical property testing and its indications about soil behavior.
- ∃ Avoid detailed descriptions of the sequence of units found in individual borings; rather, focus on variations in the units across the site, if appropriate. Refer the reader to the exploration logs for details.
- ∃ Describe any expected changes in subsurface conditions that may occur with time after the investigation.

2.4 GROUNDWATER CONDITIONS

- ∃ Describe the nature and occurrence of groundwater.

- Provide an opinion on likely seasonal variations in groundwater levels or flows, and the possibility for changes from those encountered at the time of exploration.

- Show groundwater levels on soil logs.

2.5 SUBSURFACE CONTAMINATION

- Describe the nature and extent of soil and/or groundwater contamination as revealed by the explorations. Reference any applicable Environmental Assessments if performed.

- Provide important results of the analytical laboratory testing and indications about contamination distribution and concentration.

- Indicate limitations of knowledge on the nature and extent of contamination.

- Discuss possible changes that may occur in these conditions over time.

3.0 DISCUSSION AND CONCLUSIONS

The Discussion and Conclusions should set out major geotechnical issues and alternatives for the project, along with the Geotechnical Engineer's conclusions, in a succinct and clear manner. This section shall clearly describe the logic and reasoning supporting the recommended approach, or alternative approaches. Specific recommendations shall be very limited in this section; they should be presented in a separate Recommendations section.

Discussions and conclusions should:

- Build on information described in the previous sections.

- Use consistent terminology to describe project features, soils, and construction materials.

- Explain any apparent inconsistencies in the data or investigation.

- Clearly describe any limitations or restrictions to the conclusions and recommendations.

3.1 SLOPE STABILITY

- Summarize data and analysis used to evaluate slope stability.

- Provide an opinion regarding the risk of instability on the site or adjacent properties currently, during construction, and after the project is completed.

- Describe how design and construction recommendations will reduce or eliminate the risk of instability.

- Discuss any construction or post-construction measures necessary to verify slope stability.

3.2 SEISMIC CONSIDERATIONS

- ∃ Provide an opinion on the expected level of ground motion during a major earthquake.
- ∃ Describe any seismic risks associated with an earthquake such as liquefaction, lateral spreading, landslides, or flooding.
- ∃ Describe how design and construction recommendations will reduce or eliminate the impact of seismic risks.

3.3 SITE WORK

- ∃ Describe what is anticipated for site grading and earthwork and provide an opinion on the proper sequence and approach to accomplish the site work.
- ∃ Describe key issues which will impact proper earthwork, including short term slope stability, on-site and import fill materials, groundwater and drainage, rainfall and moisture sensitive soils, and erosion.
- ∃ Describe how these issues should be addressed during construction, including dewatering, temporary retaining structures, and erosion control.
- ∃ Include specific recommendations for on-site erosion control based on erosivity of site soils and presence of groundwater, surface water, and slopes.
- ∃ Include statements regarding the importance of construction monitoring by a geotechnical engineering firm.

3.4 RETAINING STRUCTURES

- ∃ If temporary retaining systems are necessary, provide an opinion as to the most appropriate type of temporary retaining system or systems.
- ∃ Summarize the data and analysis used to evaluate permanent retaining systems.
- ∃ If permanent refining systems are necessary, provide an opinion on the most appropriate permanent retaining system or systems and describe their expected performance with respect to stability and deflection.
- ∃ If reinforced soil slopes or reinforced soil backfill are to be used, clearly define all limitations on backfill materials, reinforcement, and drainage.
- ∃ If rockeries or other non-structural slope protection systems are expected, describe the limitations on such systems.
- ∃ Emphasize any aspects or site work, particularly with respect to native soil materials, backfill, and drainage, which could impact performance of the retaining structures.

- Include statements regarding the importance of construction monitoring by a geotechnical engineering fan.

3.5 ROCKERIES

- Emphasize that rockeries are not retaining walls or structures.

- Indicate that the primary function of a rockery is to protect the slope face by preventing soil erosion and sloughing. Rockeries should be considered maintenance items that will require periodic inspection and repair. Thus, rockeries should be located so that they can be reached by a contractor if repairs become necessary.

- Discuss what type of inspection and testing may be required during rock wall construction.

3.6 FOUNDATION SUPPORT

- Summarize the data and analysis used to evaluate foundation systems.

- Provide an opinion on the most appropriate foundation system and alternatives, along with the expected level of performance with respect to load capacity and settlement.

- Emphasize any aspects of site work which could impact the performance of foundations.

- Includes statements regarding the importance of construction monitoring by a geotechnical engineering firm.

4.0 RECOMMENDATIONS

The Recommendations should present all detailed geotechnical engineering recommendations for design and construction in a clear and logical sequence. For each item covered in the recommendations sections, present the following:

- Specific design recommendations along with their limitations, factors of safety, minimum dimensions, and effect of expected variations in actual conditions.

- Specific construction recommendations including definitions, materials, execution, monitoring, testing, or other quality control measures, and any other construction requirements to support the design recommendations.

- Responsibility for seeing that each recommendation is met, such as owner, geotechnical engineer, other design consultants, or contractor. The ultimate responsibility is held by the owner of the project, however, all design parties have shared responsibility. Construction responsibilities are directly related to the contractor.

4.1 SITE GRADING AND EARTHWORK

- Provide specific design recommendations for 1) depth of stripping, 2) soil excavation limits and slopes, 3) depth and lateral limits of over excavation to remove unsuitable materials, 4) preload fills, 5) location and thickness of particular fill material or compaction requirements, 6) maximum temporary and permanent slopes, 7) permanent surface and subsurface drainage systems, and 8) permanent erosion controls.

- Provide specific construction recommendations for 1) clearing, 2) on-site and/or import fill materials, 3) excavation and compaction equipment, 4) fill material moisture conditioning, placement, and compaction, 5) proof-rolling, in-place density testing, and other quality control measures, 6) temporary seepage and drainage control measures, 7) permanent surface or subsurface drainage system installation (as appropriate), and 8) temporary slope protection and erosion control measures.

- All design and construction methodologies should be specific and identifiable; no generalized or vague statements are acceptable.

4.2 TEMPORARY SHORING AND RETAINING WALLS

- Provide specific design recommendations for 1) active and passive earth pressures, 2) surcharge pressures, 3) bearing capacity, 4) minimum or maximum dimensions and depth of penetration, 5) lateral support, 6) wall or backfill drainage systems, and 7) any other appropriate structural details.

- If appropriate, provide specific design recommendations for tie-back anchors including 1) anchor inclination, 2) no load zones, 3) minimum anchor length, 4) anchor bond zone, 5) anchor adhesions, and 6) corrosion protection.

- Provide specific construction recommendations for 1) installation, 2) on-site and/or import backfill materials, 4) backfill material moisture conditioning, placement, and compaction, 5) in-place density testing or other quality control measures, and 6) seepage and drainage control.

- If appropriate, provide construction recommendations for tie-back anchors including 1) anchor installation methods, 2) anchor testing, and 3) monitoring.

4.3 ROCKERIES

- Provide recommendations as outlined in the Associated Rockery Contractors (ARC) Standard Rock Wall Construction Guidelines (December 1992).

- The geotechnical engineer should provide direct input to the design of the rockeries and provide construction monitoring and testing as appropriate. Specific design parameters may include: Rock quality, density, frequency of testing, slopes, keyways, surcharges, drainage, rock sizes, face inclination, and surface drainage.

4.4 REINFORCED SOIL STRUCTURES

- Geogrid or geotextile fabric may be used to reinforce a fill. Reinforcement results in a more stable slope and helps reduce the risk of significant long term maintenance. If reinforced slopes are used, the geotechnical engineer should specify, at a minimum, the fill soil materials, vertical

spacing of the reinforcement, the specific type of reinforcement and the distance to which it must extend into the fill, the amount of overlap at reinforcement joints, and the construction sequence. Additional design parameters will be required for each specific site.

4.5 STRUCTURE AND FOUNDATIONS

- Provide seismic design recommendations for 1) 1994 UBC Site Coefficient, and 2) any specific recommendations to reduce the risk of damage due to earthquakes.

- Spread footing foundationsXprovide design recommendations for 1) bearing soils, 2) bearing capacity, 3) minimum footing depths and widths for both interior and exterior footings, 4) lateral load resistance, and 5) foundation drainage system.

- Mat foundationsXprovide design recommendations for 1) bearing soils, 2) bearing capacity, 3) modulus of subgrade reaction, 4) minimum dimensions, and 5) lateral load resistance.

- Pile foundationsXprovide design recommendations for 1) type of pile, 2) means of support (end or friction), 2) minimum dimensions and depths, 3) allowable vertical and uplift capacity, 4) allowable lateral loads and deflections, and 5) group effects and minimum spacing.

- Spread footing or mat foundationsXprovide construction recommendations for 1) foundation subgrade preparation and protection, 2) verification of bearing capacity, and 3) installation of foundation drainage system.

- Pile foundationsXprovide construction recommendations for 1) pile driving equipment, 2) pile installation, 3) pile load tests or verification piles, and 4) monitoring and testing during pile installation.

4.6 FLOORS

- Slab-on-Grade FloorsXprovide design recommendations for 1) slab base rock thickness, 2) capillary break, 3) vapor barrier, and 4) floor system drainage.

- Supported Wood FloorsXprovide design recommendations for 1) vapor barrier, and 2) crawl space drainage.

- Slab-on-Grade FloorsXprovide construction recommendations for 1) subgrade preparation, 2) slab base rock placement and compaction, 3) capillary break and vapor barrier installation, and 4) floor drainage system installation (if appropriate).

4.7 PAVEMENTS

- Provide design recommendations for 1) pavement design section, and 2) pavement drainage.

- Provide construction recommendations for 1) pavement subgrade preparation and verification, and 2) pavement base and subbase materials, placement, and compaction.

4.8 UTILITIES

- Provide construction recommendations for 1) utility excavation, 2) bedding material placement, and 3) backfill material, placement, and compaction.

4.9 DRAINAGE

- Recommend provisions for subsurface drainage at walls, floors, and footings.

- Evaluate permanent and temporary surface and subsurface drainage for both walls and floors if applicable. Provide approximate flow rates in gallons per minute and pipe sizes if required by design.

4.10 HAZARDS

- Present additional information if natural or man-made hazards exist on the property. King County Map Folio of Sensitive Areas delineate hazards in the categories of wetlands, streams and flood hazard, erosion, landslide, seismic, and coal mine hazards. Recommendations should be general and further studies may be required.

REPORT FIGURES AND ILLUSTRATIONS

1. VICINITY MAP

The report shall include a Vicinity or Location Map which presents adequate street and/or other physical references to allow clear identification of the project location. This map may be an individual figure or be included on the Site Plan.

2. SITE PLAN

The Site Plan shall include the project boundaries, property lines, existing features and the proposed development and structures. A north arrow and scale should be included along with all subsurface exploration locations. The accuracy of exploration locations should be indicated on the Site Plan or in the report.

3. EXPLORATION LOGS

Include logs of all explorations describing soil units encountered, soil classification, density or stiffness, moisture conditions, groundwater levels, stratigraphic sequence, common geologic unit name, and other descriptive information.

4. LABORATORY TEST DATA Include figures or tables of laboratory test results if presentation of all the data, in the text, would require more than a simple paragraph to supplement the data provided in the exploration logs.

5. CROSS SECTIONS

Include cross sections to visually present all but the most simple subsurface conditions.

6. TYPICAL DETAILS

Include figures, graphs, and other visual aids to clearly present detailed recommendations. Provide design details (stamped by a professional engineer) on drawings such as: rockeries, reinforced earth, interceptor trenches, wall and footing drains, utility backfill, and other details used for a particular design.

GEOTECHNICAL DEFINITIONS

Backfill : Soil or rock material placed behind retaining walls, rockeries, and foundations to return the site to finish grade.

Base Rock : A layer of clean, free draining gravel or crushed rock placed and compacted beneath pavements, foundations, rockeries, or floor slabs.

Capillary Break : A layer of free-draining granular material placed beneath floor slabs to break the upward movement of liquid water produced by capillary action in the underlying soil (as opposed to a vapor barrier to prevent the migration of water vapor).

Clays : Fine-grained mineral soils with particles less than .005 mm in size that can be made plastic by the adjustment of water content; natural or otherwise. These soils also exhibit considerable strength when air dried.

Colluvium : A soil deposit derived from down slope movement of material from other soil formations. These deposits are most often found on the walls of ravines or on steep hillsides.

Contour : Lines of equal elevation on topographic map showing variations in land surface elevation.

Contour Interval : The vertical spacing between contour lines. The larger the horizontal space between contour lines shown on a contour map, the more gentle the change in elevation.

Culvert : An enclosed/solid drain crossing under a road or an embankment.

Downcutting : The erosive action by flowing water that removes surface material and cuts into the ground surface. This term is usually associated with stream action in ravines.

Engineered Fill : Fill which is wetted or dried to near its Optimum Moisture Content, placed in lifts of 12 inches or less, compacted to a minimum Percent Compaction specified by a Geotechnical Engineer, all under observation and testing by the Geotechnical Engineer to verify compaction.

Erosion : Wearing away of soil or rock by wind, water, ice, or gravity.

Fill or Manmade Fill : All artificially placed deposits of soil or rock.

Fine-grained Soils : Mineral soils that include clays and those silts exhibiting clay-like behavior.

Footing Drain : A drainage system at the outside of footings used to collect water moving through the adjacent soil or rock and carry it to a controlled discharge point. Typically, a footing drain will consist of a perforated drain pipe and free-draining granular material laid at a uniform gradient to a positive discharge point. Surface or roof drains should never be connected to footing drains.

Free-draining Granular Material : Clean, free-draining gravel or crushed rock generally containing no more than 5 percent fine-grained Soil (particles passing No. 200 sieve) based on the fraction passing the 3/4-inch sieve.

Geotechnical Engineer : A Professional Engineer currently registered in the State of Washington, qualified by experience and education in the practice of geotechnical engineering, and designated by the owner as the Geotechnical Engineer of record for the project.

Granular Soils : Mineral soils that include sands and gravels and those silts exhibiting sand-like behavior.

Impervious Surfaces : Surfaces resistant to infiltration by or absorption of moisture. Generally, they are man-made paved or hardened surfaces such as roofs, streets, sidewalks, and parking lots.

Mass Movement : Any sizeable natural displacement of a hillside; slump; landslide.

Mat Foundation : A mat or raft foundation is a combined footing that covers the entire area beneath a structure and supports all the walls and columns.

Moisture-sensitive Soil : Soil which is easily made unsuitable for fill or backfill by the addition of small amounts of moisture. Fine-grained soils are typically moisture sensitive.

Optimum Moisture Content : The moisture or water content of a soil, expressed as a percent by dry weight of the soil, at which it is most easily compacted. The optimum moisture content depends on the soil type and percent compaction desired.

On-site Fill Material : Soil obtained at the project site during excavation (following clearing and stripping) which is then used for fill. Typically, only the portion of the excavated material which is free of organic contaminants, perishable material, and rocks or lumps greater than 6 inches in maximum dimension is considered suitable for use as on-site fill material.

Organic Soils and Peat : Soils composed of a high percentage of decaying and decomposed plant matter mixed with varying percentages of mineral soil material.

Overexcavation : Excavation beyond the depth that is required to achieve the minimum subgrade elevation. Typically, the material over excavated is replaced with fill suitable to support the above pavement section, foundations, or floor systems.

Overstory : Vegetation above 10 feet in height.

Pavement Section : A sequence of materials placed and compacted to support vehicle traffic and parking loads. Typically, the pavement section consists of asphalt concrete or cement concrete, base rock, subbase, and a properly prepared soil subgrade.

Percent Compaction : The required in-place dry density of a soil or rock material, expressed as a percentage of the maximum dry density of the same material as determined in the

laboratory by an ASTM Test Method. The specific test method should be clearly defined.

Permanent Slope : A slope at the geometry proposed after final grading of a site for long-term use.

Pile Foundation : Piles are structural members of small cross-sectional area compared to their length, and are usually installed by vibrating, driving, or drilling in the case of augercast piles. Pile foundations are used where loads must be transferred to more suitable material at a greater depth.

Plasticity : The ability to deform rapidly without cracking, crumbling, or changing in volume when a force is applied. There will be very little rebound to the original shape when the force is removed.

Reinforced Soil : Soil or rock fill or backfill which includes reinforcement consisting of metal or synthetic materials in bars, strips, or sheets. Typically, reinforced soil requires select fill material.

Rockery : A rockery is not a retaining wall or structure. The primary function of a rockery is to protect the slope face by preventing soil erosion and sloughing. Rockeries should be considered maintenance items that will require periodic inspection and repair. They should be located so that they can be reached by a contractor when repairs become necessary.

Select Fill Material : Imported or on-site soil consisting of clean, free-draining granular material.

Silts : Fine-grained mineral soil shaving particles ranging in size from .005 mm to .05 mm. This material may or may not exhibit plastic behavior.

Slide : The movement of a mass of loosened rocks or earth down a hillside or slope.
Slab-on-grade : A slab-on-grade floor is a typically a reinforced concrete slab that is supported by the ground.

Slope : An inclined ground surface the inclination of which is expressed as a ratio of horizontal distance to vertical distance.

Slope Failure : The downward and/or outward movement of slope-forming materials (natural rock, soils, artificial fills, or combinations of these materials) constituting the group of slope movements wherein shear failure occurs along a specific surface or combination of surfaces.

Slope Steepness or Inclination : Percent slope is related to the generalized inclination of the land by the following formula:

$$\text{slope (in percent)} = \frac{\text{vertical rise}}{\text{horizontal distance}} \times 100\ \%$$

Another method of measuring the inclination of the land surface is by measuring the angle of the surface above a horizontal plane. The following chart shows the equivalents between

these two methods of measurement for several slopes.

Slope in Percent	Angle in Degrees
8.7	5.0
15.0	8.5
30.0	16.7
40.0	21.8
50.0	26.6
100.0	45.0

Slump : The collapse or sinking of a hillside.

Soils : Unaggregated or uncemented deposits of mineral and/or organic particles or fragments derived from the breakdown of massive rocks or decay of living matter.

Spread Footing Foundation : A footing is an enlargement of the base of a column or wall for the purpose of transmitting the load to the subsoil at a pressure suited to the properties of the soil. A footing that supports a single column is known as a spread footing.

Standard of Practice : Performing engineering services in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession currently practicing under similar conditions in the same geographic region.

Structural Fill : Fill material placed and compacted in areas that underlie structures or pavements. Typically, structural fill consists of select fill material compacted to a relatively high Percent Compaction.

Subbase : A layer of select fill material placed and compacted beneath base rock to provide better support for pavements, foundations, rockeries, or floor slabs than that provided by the native soil subgrade.

Substrate : A part or substance that lies beneath and supports another.

Subgrade : The soil on which conventional spread footings, a pavement section, or a floor slab support system is placed. Typically it consists of either undisturbed on-site soil exposed by excavation or engineered fill placed after overexcavation.

Surficial : Of the surface or top level; not at depth.

Temporary Slope : A slope that exists for a relatively short period of time, typically during construction, such as a backcut made during a slope repair or utility/footing installation.

Till : Glacial deposits consisting of a heterogeneous mixture of sand, silt, and clay forming a matrix in which granules to large boulders are firmly embedded. May contain lenses and layers of sand and gravel. The upper few feet may be loose, sandy, and stoney with fewer silt or clay-sized particles than at greater depth.

Toe of Slope : The lowermost portion, bottom, or base of a slope.

Top of Slope : The uppermost portion, top, or crest of a slope.

Topography : Surface features including relief and rivers, lakes, etc. and man-made features such as roads, bridges, canals, etc.

Uncontrolled Fill : Fill which has been placed under unknown conditions or without any controls.

Vapor Barrier : A barrier preventing the vertical or lateral migration of water vapor (as opposed to a capillary break or wall drain to prevent the migration of liquid water) beneath floor systems or behind retaining walls. Typically, it consists of an impermeable membrane of reinforced plastic or equivalent material.

Wall Drain : A drainage system behind retaining walls and rockeries used to collect water moving through the retained soil or rock and carry it to a controlled discharge point. Typically, a wall drain will consist of free-draining granular material or a free-draining synthetic material and a perforated drain pipe.

STANDARDS FOR SLOPE STABILITY ANALYSES

STUDY REQUIREMENTS

The geotechnical engineer should review and evaluate the stability of natural, temporary, and permanently constructed slopes on or adjacent to the property to be developed. Such review should, at a minimum, include:

- Review of published geologic data referencing or including the site.
- Review of previous studies of the site performed by geotechnical engineers.
- Reconnaissance of the site for signs of slope instability.

Where such review, in the opinion of the engineer or the City, indicates that the stability of the slopes are reduced by the proposed development, or that the natural slopes may have a factor of safety of less than 2.0 in the static case or 1.5 in a dynamic (seismic) case, then the geotechnical engineer shall perform additional, more detailed review and evaluation of the stability of the slope. Such additional review and evaluation should, at a minimum, include:

Drilling and sampling of test borings to a depth necessary for the evaluation of slip surfaces with factors of safety lower than the above criteria, or to at least 15 feet or 10 percent of the slope height (whichever is less) beyond the most critical slip surface for the design.

- Laboratory shear testing of soil samples which are representative of all significant zones or layers of soil and/or rock though which the potential slip surfaces pass.

- Performing a limit equilibrium analyses or other approved analyses of all significant critical slip surfaces associated with the slope. Approved analyses may be conducted by a computer program if the methodology and assumptions are clearly delineated and the name, version number, and solution methodology of the program are clearly presented in the report. All analyses should include a cross section of the slope(s) and critical slip surfaces.

- Other analyses as required by the City.

DESIGN REQUIREMENTS

For a limit equilibrium analyses, design factors of safety for slopes shall be no less than the following:

	Temporary Slope	**Permanent Slope**	
		Low Threat Upon Failure[1]	High Threat Upon Failure[2]
Static	1.25	1.40	1.50
Dynamic	1.05	1.10	1.15

The analysis should consider the impact of groundwater in the modeling of soil strength and density parameters, and in other ways considered appropriate by the engineer. A conservative wet season analysis should be used for permanent slopes and those temporary slopes which will be constructed at any time between, and including, the months of October and May.

Alternative analyses may be proposed by the geotechnical engineer and accepted by the City, provided that they are based upon accepted and published methodologies which evaluate static and dynamic loading cases, as well as the consequences of the type of slope failure under consideration. Other design requirements remain the same.

1. Permanent slopes termed "Low Threat Upon Failure" are those slopes whose failure will not impact buildings or other structures inhabited by humans.
2. Permanent slopes termed "High Threat Upon Failure" are those slopes whose failure will impact or have a reasonable engineering probability of impacting building or other structures inhabited by humans.