DIVISION 8
GEOTECHNICAL ENGINEERING REPORTS

8.1 General

Geotechnical engineering reports shall comply with the requirements of this manual and the appropriate sections of the International Building Code, International Residential Code and Douglas County Code. Geotechnical engineering reports are required if one or more of the following conditions are met:

1. Grading in excess of 5,000 cubic yards
2. As required by the County due to special or unique site characteristics
3. As required by the Douglas County Development Code for hillside grading activities
4. Active faults or sufficiently active and well-defined faults are present on the site
5. As required by the International Building Code

8.2 Geotechnical Engineering Report

The geotechnical engineering report shall include a site plan showing the location and dimensions of the property, the existing topography, proposed grading, excavations for slopes, structures, faults, building setbacks from recognized active faults, special foundation zones, locations of proposed structures, surface and subsurface drainage facilities, paved surfaces, and other pertinent features. The geotechnical engineering report shall consider soils engineering, geologic and hydrogeologic conditions. It shall present recommendations including but not limited to site grading criteria, liquefaction, foundation design, slope stability for cut and fill slopes and development near slopes, lateral earth pressure, location and effects of storm drainage, and recommendations for testing and inspection. The geotechnical report shall consider all applicable and pertinent earth conditions at the site. The relationship of the site to the regional geologic framework shall also be discussed.

The geotechnical engineering report shall be prepared, signed, and wet stamped by a professional engineer licensed in the State of Nevada. The geotechnical engineering report shall be submitted to the County prior to or concurrent with the improvement plans for the development.

8.2.1 General Requirements

The geotechnical engineering report shall consider and present the following where applicable:

1. Description of the existing site and conditions.
2. A geologic map and cross sections shall be prepared in all bedrock areas. The cross sections should be oriented to best demonstrate site geologic structure. If desired an additional larger scale map may be used to illustrate site geology.
3. All subsurface exploration locations shall be shown on a map that utilizes the grading plan as a base. They may also be shown on the geologic map. The report shall include a description of subsurface exploration methods.
4. All subsurface explorations shall have a descriptive log. The log shall, at a minimum, provide ground surface elevation, the depth of all samples, unified soils classification, depth to ground water (if encountered, or clearly indicate if no ground water was encountered), all geologic measurements, soil density, and description of all encountered materials.

5. Sufficient geologic measurements taken from explorations, photo lineaments, outcrop or referenced studies shall be shown on the geologic map to define the geologic structure of the project.
6. The site earth materials and geologic structure shall be discussed.
7. Regional geology shall be discussed.
8. The presence of faults shall be evaluated. Table 8.1 presents the topics and contents of geologic reports on faults that should be considered.
9. Rippability shall be considered.
10. Large rock disposal and handling shall be discussed.
11. Seismicity of the region and site shall be evaluated.
12. Site grading details and specifications shall be discussed.
13. Disposal of surplus materials shall be discussed.
14. Soil erosive properties shall be discussed.

8.2.2 Slope Stability Considerations

The geotechnical engineering report shall, at a minimum, consider the following slope stability requirements:

1. Surface stability of slopes under saturated and unsaturated conditions shall be calculated for all slopes greater than 10 feet high.
2. All graded slopes shall be at a ratio of 2:1 (horizontal to vertical) or flatter unless steeper slopes are recommended in the geotechnical engineering report.
3. All slopes shall have a calculated safety factor of 1.50 or greater under static conditions, and a calculated safety factor of 1.1 or greater under pseudostatic conditions.
4. The geotechnical engineering report shall provide recommendations for control of erosion/surface deterioration for graded slopes.
5. All geologic structures (i.e., bedding, joints, fault surfaces etc.) shall be considered in the stability analyses.
6. Strengths utilized in the stability analyses shall be derived from laboratory tests on the material that is considered for hypothetical failure.
7. Representative geologic cross section(s) shall be developed for all slopes that have geologic structure and are analyzed for slope stability.
8. Recommendations for retaining methods shall be discussed.
9. Effects of surface water and ground water shall be discussed. Mitigation measures shall also be discussed.

8.2.3 Geotechnical Parameters

As a minimum, the geotechnical engineering report shall discuss and present soils engineering parameters as follows:

1. Geotechnical engineering studies shall be based on adequate and sufficient laboratory testing which should consist of, but not necessarily be limited to, soil compressibility, shear strength, dry density and optimum moisture content and expansion potential.
2. The potential for soil collapse and settlement shall be evaluated.
3. Subsurface explorations for the geotechnical engineering report shall be shown on a plan with a scale sufficient to describe their location.
4. Recommendations for soil removal, soil bearing pressures, foundation design, special foundation preparation requirements, retaining wall design, slope stability (deep and surface), compaction methods and specifications, suitability of soils for use as structural fill, special site or soil limitations, subgrade preparation, and other pertinent soils conditions shall be presented.
5. Liquefaction potential shall be considered where applicable or when required by the Community Development Department.
6. Potential soil erodibility and mitigation measures shall be discussed.
7. Recommendations for pavement design, and test results used in design shall be discussed.
8. Test results for soil infiltration, hydraulic conductivity and permeability rates based on laboratory or in-situ tests for all soil types present.
9. Recommendations for testing during grading and construction.

8.2.4 Rising Water Considerations

The geotechnical engineering report shall consider rising water potential as it affects the proposed development. Rising water is water that daylights as seepage, springs or flows at the earth's surface. It can be the result of landscape watering, irrigation, seasonal changes, natural rainfall and runoff or a rising ground water table. The following items shall be considered in the geotechnical engineering report:

1. All areas of fill over low permeability bedrock shall be evaluated for rising water potential. Recommendations for drainage of retaining structures shall also be presented.
2. Geologic boundaries (i.e. faults, formational contacts, etc.) shall be evaluated for rising water.
3. Subdrains shall be designed and specifications presented for control of rising water. They shall be shown on the improvement plans.
4. Recommendations to address pumping of fill during compaction shall be presented.
5. Recommendations to address water encountered in trenching operations. See also Pipeline Bedding and Dewatering in the Water, Sewer, and Storm Drainage sections of this Design Manual.

8.3 Post-Construction Report

A post-construction geotechnical engineering report shall be submitted to the County after the completion of construction as part of the record drawings for the project. The improvements will not be accepted by the County until the post-construction geotechnical engineering report is submitted and accepted by the County. The intent of the post-construction geotechnical engineering report is to document changed conditions encountered during construction, and changes from the approved soils report. The final post-construction geotechnical engineering report shall, at a minimum, contain the following information:

1. A general description of the grading operations and encountered conditions. Deviations from the design geotechnical engineering report shall be identified and explained.
2. A geologic map shall be provided which shows the record geologic conditions if conditions are different than or were not noted in the original report. It shall include mapping of faults, and geologic contacts.
3. Subdrain locations shall be shown on the record drawings.
4. Buttressed slopes shall be shown on the record drawings. If conditions other than those anticipated by the design geotechnical engineering report were encountered during grading, stability calculations shall be presented in the post construction geotechnical engineering report.
5. Over-excavated lots and the depth of soil over-excavation shall be identified in the post construction geotechnical engineering report.
6. Recommendations for mitigation of expansive soils and soluble sulfates shall be included in the post construction geotechnical engineering report.
7. Foundation design recommendations shall be in the post construction geotechnical engineering report, including seismic design criteria.
8. Results of laboratory and field tests.
9. Plan showing locations of soils tests.
10. Critical finished grades.

The post-construction report shall be prepared, signed, and wet stamped by a professional engineer licensed in the State of Nevada.

8.4 References

1. "International Building Code," International Code Council, Inc.
2. "International Residential Code," International Code Council, Inc.

Table 8.1
Contents of Geologic Reports on Faults

I. Text.

A. Purpose and scope of investigation; description of proposed development.

B. Geologic and tectonic setting. Include seismicity and earthquake history.

C. Site description and conditions, including dates of site visits and observations. Include information on geologic units, graded and filled areas, vegetation, existing structures, and other factors that may affect the choice of investigative methods and the interpretation of data.

D. Methods of investigation.

1. Review of published and unpublished literature, maps, and records concerning geologic units, faults, ground-water barriers, and other factors.

2. Stereoscopic interpretation of aerial photographs and other remotely sensed images to detect fault-related topography (geomorphic features), vegetation and soil contrasts, and other lineaments of possible fault origin. The area interpreted usually should extend beyond the site boundaries.

3. Surface observations, including mapping of geologic and soil units, geologic structures, geomorphic features and surfaces, springs, deformation of engineered structures due to fault creep, both on and beyond the site.

4. Subsurface investigations.

a. Trenching and other excavations to permit detailed and direct observation of continuously exposed geologic units, soils, and structures; must be of adequate depth and be carefully logged.

b. Borings and test pits to permit collection of data on geologic units and ground water at specific locations. Data points must be sufficient in number and spaced adequately to permit valid correlations and interpretations.

c. Cone penetrometer testing (CPT). CPT must be done in conjunction with continuously logged borings to correlate CPT results with on-site materials. The number of borings and spacing of CPT soundings should be sufficient to adequately image site stratigraphy. The existence and location of a fault based on CPT data are interpretative.

5. Geophysical investigations. These are indirect methods that require knowledge of specific geologic conditions for reliable interpretations. They should seldom, if ever, be employed alone without knowledge of the geology.

a. High resolution seismic reflection.

b. Ground penetrating radar.

c. Other methods include: seismic refraction, magnetic profiling, electrical resistivity, and gravity.

6. Age-dating techniques are essential for determining the ages of geologic units, soils, and surfaces that bracket the time(s) of faulting.

a. Radiometric dating (especially 14C).

Table 8.1
Contents of Geologic Reports on Faults (Continued).

b. Soil-profile development.

c. Rock and mineral weathering.

d. Landform development.

e. Stratigraphic correlation of rocks/minerals/fossils.

f. Other methods — artifacts, historical records, tephrochronology, fault scarp modeling, thermoluminescence, lichenometery, paleomagnetism, dendrochronology, etc.

7. Other methods should be included when special conditions permit or requirements for critical structures demand a more intensive investigation.

a. Aerial reconnaissance overflights.

b. Geodetic and strain measurements.

c. Microseismicity monitoring.

E. Conclusions.

1. Location and existence (or absence) of hazardous faults on or adjacent to the site; ages of past rupture events.

2. Type of faults and nature of anticipated offset, including sense and magnitude of displacement, if possible.

3. Distribution of primary and secondary faulting (fault zone width) and fault-related deformation.

4. Probability of or relative potential for future surface displacement. The likelihood of future ground rupture seldom can be stated mathematically, but may be stated in semiquantitative terms such as low, moderate, or high, or in terms of slip rates determined for specific fault segments.

5. Degree of confidence in and limitations of data and conclusions.

F. Recommendations.

1. Setback distances of proposed structures from hazardous faults. The setback distance generally will depend on the quality of data and type and complexity of fault(s) encountered at the site. In order to establish an appropriate setback distance from a fault located by indirect or interpretative methods (e.g., borings or cone penetrometer testing), the area between data points also should be considered underlain by a fault unless additional data are used to more precisely locate the fault. State and local regulations may dictate minimum.

2. Additional measures (e.g., strengthened foundations, engineering design, flexible utility connections) to accommodate warping and distributive deformation associated with faulting.

3. Risk evaluation relative to the proposed development.

4. Limitations of the investigation; need for additional studies.

Table 8.1
Contents of Geologic Reports on Faults (Continued).

II. References.

A. Literature and records cited or reviewed; citations should be complete.

B. Aerial photographs or images interpreted — list type, date, scale, source, and index numbers.

C. Other sources of information, including well records, personal communications, and other data sources.

III. Illustrations — these are essential to the understanding of the report and to reduce the length of text.

A. Location map — identify site locality, significant faults, geographic features, regional geology, seismic epicenters, and other pertinent data; 1:24,000 scale is recommended.

B. Site development map — show site boundaries, existing and proposed structures, graded areas, streets, exploratory trenches, borings, geophysical traverses, locations of faults, and other data; recommended scale is 1:2,400 (1 inch equals 200 feet), or larger.

C. Geologic map — show distribution of geologic units (if more than one), faults and other structures, geomorphic features, aerial photographic lineaments, and springs; on topographic map 1:24,000 scale or larger; can be combined with III(A) or III(B).

D. Geologic cross-sections, if needed, to provide3-dimensional picture.

E. Logs of exploratory trenches and borings — show details of observed features and conditions; should not be generalized or diagrammatic. Trench logs should show topographic profile and geologic structure at a 1:1 horizontal to vertical scale; scale should be 1:60 (1 inch = 5 feet) or larger.

F. Geophysical data and geologic interpretations.

IV. Appendix: Supporting data not included above (e.g., water well data, photographs, aerial photographs).

V. Authentication: Investigating geologist's signature and registration number with expiration date.