Oregon State Board of Geologist Examiners

Guideline for Preparing Engineering Geologic Reports

Second Edition
May 30, 2014

Disclaimer

This guidance document is intended to provide general information about the Oregon State Board of Geologist Examiners (Board) and its regulation of the public practice of geology in Oregon. This guidance document does not replace, supersede, or otherwise override statutes, rules, orders, or formal policies pertaining to the public practice of geology. The information herein does not and is not intended to make or create any new standard, requirement, or procedure for which rulemaking or other legal process is required. This guidance document is not intended to address every possible situation or question regarding the Board's regulation of the public practice of geology. This document is updated and revised at the Board's discretion. This document does not and is not intended to provide legal advice. No rights, duties, or benefits, substantive or procedural, are created or implied by this guidance document. The information in this guidance document is not enforceable by any person or entity against the Board. In no event shall the Board, or any employee or representative thereof, be liable for any damages whatsoever resulting from the dissemination or use of any information in this guidance document.

For more information about the Board, visit: https://www.oregon.gov/osbge/Pages/default.aspx.

You may also contact the Board at:

Email Address:	osbge.info@bgelab.oregon.gov
Physical/Mailing Address:	707 13th St. SE, Suite 114 Salem, OR 97301
Telephone:	503-566-2837

I. BACKGROUND ON THE BOARD & PURPOSE FOR GUIDELINE

A. BOARD MISSION & AUTHORITY

The Oregon Board of Geologist Examiners (OSBGE, or the Board) was created in 1977 to oversee the registration (licensing) of persons who engage in the public practice of geology in the State of Oregon.

The mission of the Board is to help assure the health, safety, and welfare of Oregonians with regard to the public practice of geology through:

1. Licensing of those engaged in the public practice of geology;
2. Response to complaints from the public and members of the profession;
3. Public education directed at appropriate regulatory communities;
4. Cooperation with closely related boards and commissions;
5. Attention to ethics; and
6. Systematic outreach to counties, cities, and registrants

The Board is authorized under Oregon Revised Statute (ORS) 672.515, and operates in accordance with Oregon Administrative Rules (OAR) Division 809. The Board's responsibility is to govern the practice of geology and to insure that ORS 672.505 to ORS 672.705, ORS 672.991 and (OAR) Division 809 are administered fairly and effectively throughout the state. The Board is a semi-independent state agency subject to ORS 182.454 to ORS 182.472.

ORS 672.505 defines geology as:

- That science that treats of the earth in general;
- Investigation of the earth's crust and the rocks and other materials that compose it; and
- The applied science of utilizing knowledge of the earth and its constituent rocks, minerals, liquids, gases and other materials for the benefit of humanity.

The Board regulates the public practice of geology, including engineering geology as a specialty certification. The laws require those who publically practice geology to be registered with the Board unless specifically exempted. A "Geologist" means a person engaged in the practice of geology, and an "Engineering Geologist" means a person who applies geologic data, principles and interpretation to naturally occurring materials so that geologic factors affecting planning, design, construction and maintenance of civil engineering works are properly recognized and utilized.[1] No person, other than a Registered Geologist (RG) or a Certified Engineering Geologist (CEG) shall provide or prepare for the public practice of geology any geologic maps, plans, reports, or documents except as specifically exempted in ORS 672.535. The Board maintains a list of geologists currently registered to legally engage in the public practice geology in the State of Oregon, as well as a sub-list of CEG's who can engage in the practice of engineering geology.

[1] ORS 672.505(3) and (4)

B. PURPOSE FOR GUIDELINE

The following guideline is intended to encourage best practices in the field of engineering geology in Oregon. Such best practices optimize and support protection of Oregonians and their interests. To this end, the guideline is intended as a tool for the preparation, use and review of engineering geologic reports and geotechnical reports prepared by engineering geologists licensed in the State of Oregon. These reports should include sufficient data, analysis, and interpretation regarding geologic materials, structure, processes, and history to support conclusions, identify potential risks, and establish recommendations regarding the proposed activity, design, modification, or use of the site. This guideline proposes recommended contents and suggested formats for reports and attempts to incorporate the major topics normally encountered in such studies. This guidance does not include a theoretical or technical background to each area of engineering geology addressed. Possession of the technical proficiencies required to prepare such reports is the responsibility of the CEG author. The actual scope of services documented in an engineering geologic report or a geotechnical report will vary depending on the level of detail, accuracy, and complexity needed for the intended application.

The term "geotechnical" as used in this guideline is a term for applied scientific work involving soil and rock mechanics, geology, geophysics, hydrology or related sciences as applied to the solution of civil works problems. The field of geotechnics is practiced by both engineering geologists and geotechnical engineers. A few examples of geotechnics work are the prediction, prevention or mitigation of natural hazards such as landslides and rockslides and the application of soil, rock and groundwater mechanics to the design of earthen or other man-made structures. This guideline does not address geotechnics work by professional engineers as the Board does not regulate the practice of engineering. This guideline focuses on engineering geology work by CEGs.

A CEG produces reports that are sometimes interchangeably called engineering geologic reports and geotechnical reports. A CEG also provides the engineering geology content of a geotechnical engineering report. A report containing engineering geologic interpretation must be signed and stamped by a CEG pursuant to OAR 809 Divisions 020 and 050. A report containing work by a CEG and geotechnical engineer should be signed and stamped by both professionals and include a description of individual responsibilities for the work addressed in the report. From here on out, the guideline uses the terminology of engineering geology report to refer to any report involving engineering geology work that is prepared by a CEG.

Considering that a CEG must become a RG first, the CEG may also work in areas of geology beyond engineering geology and contribute to or prepare other types of geologic reports, such as hydrogeologic reports and mineral resource evaluation reports. Such geologic work is not addressed in this guideline. See the Board's separate guidelines on geologic reports and hydrogeologic reports.

1. Registrants

This guideline provides a general list of items that could be included in an engineering geologic report. All elements of this guideline should be considered during the preparation and review of reports prepared by engineering geologists. The guideline does not include systematic descriptions of all available techniques or topics, nor is it suggested that all techniques or topics necessarily be applied to every project. Because of the wide variation in size and complexity of projects and scope of work, this guideline is intended to be flexible, and the CEG's report should always be tailored to the specific project. For example, not all topics covered in this guideline would be applicable to small projects or low-risk sites.

2. Report End Users and Reviewers

End users and reviewers of engineering geologic reports can use this guideline in their reading, review, and utilization of a particular report for their proposed project. However, this guideline is not intended as a "checklist" for the contents of any particular engineering geologic report. The actual scope of services and topics presented in a particular engineering geologic report will vary depending on the level of detail, accuracy, and complexity needed for the intended project. Each report should include sufficient data, analyses, and interpretation regarding geologic materials, structure, processes, and history to support conclusions regarding potential risks, considerations, and recommendations regarding the proposed activity, modification, or use of the site.

C. ACKNOWLEDGEMENTS

This guidance document was prepared for the Board by Stephen P. Palmer, RG, CEG (E2155) under the auspices of LEI Engineering and Surveying, LLC. The second edition has been substantially updated compared to the 1990 first edition based on input from Board members, Board registrants, Board staff, and other public participants. In addition, this guideline has been prepared after review of other guidelines and recommendations for geologic and engineering geologic reports developed by other state and provincial agencies, registration and licensing authorities, and professional organizations. A list of these publications is presented in the reference section of this document.

Palmer worked with a peer review panel of Oregon CEGs in crafting the document: Susan Bednarz (E1681), Charles Clough (E1865), Curtis Ehlers (E1610), Thomas Horning (E1131), and Christopher Humphrey (E1692). Palmer also assisted the Board with revisions in response to public comments received on a draft posted for public review. The Board recognizes the contributions of Palmer, the review panel CEGs and all Oregon RGs and others who took the time to weigh in on this guideline. Through comments and recommendations, these individuals made a significant contribution to development of this guideline. Board Member Peter Stroud (E0975) assisted with editing.

II. REPORT CONTENT AND PREPARATION

A. CONTENT OF AN ENGINEERING GEOLOGIC REPORT

The following topics are provided as a guide for the content of an engineering geologic report and should be considered and addressed in detail where essential to support interpretations, analyses, designs, conclusions, and recommendations. A CEG may not need to address all of these topics in a particular report, as there is a wide range in the level of detail, accuracy, and complexity needed in reports depending on the intended application.

1. Introduction

Each report should include an introductory section containing adequate background information to inform the reader of the purpose for the engineering geologic work and report. Specific items that should be addressed in the introduction include:

- The purpose and objectives of the engineering geologic investigation and report, including the level of the study (i.e., feasibility, reconnaissance, preliminary, final.);
- The client or party that commissioned the report.
- The time period over which the investigation was performed;
- The location of the site with specific reference to a map included within the report that shows the site in context of known geographic features such as roads and water bodies;
- A description of the proposed land use or development activities needing an engineering geologic study, including the regulatory framework and requirements that are addressed by the report;
- The defined scope of work for the engineering geologic investigation and report, including specific tasks that were performed as part of the work;
- A description of prior work on the site or in the immediate area that has been reviewed or relied upon in the geologic investigation and preparation of the engineering geologic report.

2. Physiographic Setting and Regional Geology

A description of the physiographic setting of the site and regional geology provides a framework for the evaluation of site specific conditions. The discussion of physiographic setting may include:

- Physical characteristics such as topography, climatic conditions, vegetative characteristics, latitude and longitude, township-range-section, landmarks, political boundaries, geomorphic features of the province, faults and seismicity, natural resources, water bodies, drainage patterns, and other physical features of the site and surrounding area;
- Anthropomorphic data, such as land use(s), community development, and effects of human activity.

The discussion of regional geology may include:

- Nature and source of available published geologic reports or maps;
- Stratigraphy and lithology of regional formations or geologic map units;
- Geologic structure, including folding, faulting, and discontinuity or fracture characteristics;
- Historical seismicity;
- Surface water features and regional drainage patterns;
- Groundwater conditions, including aquifer systems and aquitard units;
- Geomorphology and surficial processes;
- Regional geologic hazard identification and mapping.

3. Site Characterization

Site characterization is intended to provide adequate and accurate information to support the interpretations, analyses, designs, conclusions, and recommendations addressing the scope and objectives of the engineering geologic report. Site characterization is at the heart of the engineering geologic study and is a crucial part of the geologic investigation and report. The focus of the engineering geologic report is the potential effects and impacts of geologic conditions on the proposed civil development. The following items provide an example of a comprehensive scope for the site characterization section of an engineering geologic report.

3.1 Site Description

A description of the project site is crucial in providing the report reader with an understanding of the conditions that influence the proposed activity addressed by the engineering geologic study. A detailed map (or maps) of the site should be used as reference for the site description section. The site description should include:

- Topographic and geomorphic conditions of the site and vicinity, including minimum and maximum elevations, total relief, slope grade, form, and aspect;
- Vegetation, including ground and tree cover, density, etc.;
- Surface water features, including existing drainage pattern, streams, ponds, seeps and springs, areas of wet or soft ground, etc.;
- Existing development such as buildings, structures, roadways, and utilities and evidence of past development activities like areas of cut or fill or abandoned foundations;
- Previous site uses that could impact the proposed uses of the site;
- Evidence of past or current geologic processes and hazards, such as soil creep, landsliding, soil erosion, settlement, channel avulsion and migration, and flooding;
- Known or suspected engineering geologic conditions and geologic and seismic hazards that could impact the proposed land use or development activities, including a statement regarding past performance of existing facilities in the immediate vicinity;
- Photographs showing relevant site features;
- Known or suspected soil or groundwater contamination.

3.2 Site Investigation

A wide range of methods may be employed in characterization of the site, and the following topics are not intended as a comprehensive listing. Other appropriate methods or approaches should be utilized if appropriate.

- Remote sensing, including aerial photographic interpretation, time sequential photographs, lidar data, infrared imagery, and other available data;
- Field reconnaissance and geologic mapping, with discussions of results referencing previous mapping of the site, if available;
- Subsurface investigation, including hand auger, test pit, trench, and drilling explorations, with locations of subsurface explorations shown on a detailed site map and complete logs of the explorations provided with the report, along with a key to interpretation of the logs;
- Installation and monitoring of in situ instrumentation such as slope inclinometers, piezometers, extensometers and settlement devices, and borehole accelerometers;
- Measurements performed during field reconnaissance and subsurface exploration, and laboratory testing of collected samples;
- Geophysical surveys such as by seismic refraction/reflection, electrical resistivity, ground penetrating radar, or magnetometer.

3.2.1 Remote Sensing

The report should include the source and date of any remote sensing data utilized by the CEG in preparation of the report. Interpretations and analyses of remote sensing data should be described in the report text and presented on detailed maps of the site.

3.2.2 Field Reconnaissance, Geologic Mapping, and Subsurface Investigation

The CEG should describe all field mapping, subsurface exploration, and field and laboratory testing procedures including but not necessarily limited to surface geologic reconnaissance, drilling, trenching, and geophysical survey. Results of the field reconnaissance and geologic mapping of the site area should be done at a scale that shows sufficient detail to adequately define the existing geologic conditions. Mapping should be done on a suitable topographic base or aerial photograph, at an appropriate scale with satisfactory horizontal and vertical control. The date and source of the base map should be included on each map or photo. For many purposes, available published geologic maps are unsuitable to provide a basis for understanding the site conditions, and independent geologic mapping will be necessary. If published geologic maps are used to portray site conditions, they must be updated to reflect geologic or topographic changes that have occurred since map publication. It may be necessary for the engineering geologist to extend mapping into adjacent areas to adequately define significant geologic conditions.

The nature of bedrock and surficial materials, the structural features and relationships, and the three-dimensional distribution of earth materials, including groundwater, exposed and inferred within the area should be discussed in the report with reference to appropriate figures presenting these data and interpretations. These reference figures could include but not necessarily be limited to detailed site maps, cross-sections, and fence diagrams. The report should typically include one or more appropriately positioned and scaled cross-sections to show subsurface relationships. A clear distinction should be made between observed and inferred features and relationships.

3.2.3 Geologic Descriptions

The report should contain brief but complete descriptions of all geologic rock, soil units, any fill, and structural features recognized or inferred within the subject area. Where interpretations are added to the recording of direct observations, the basis for such interpretations should be clearly stated. In providing descriptions and characterization of rock and soil units and the mapping of this data, the CEG should consider using the following standardized methodologies:

- The Unified Soil Classification System (USCS) is a standard procedure for classification of soil material in engineering studies (ASTM, 2009, 2011, or the current revision);
- The Unified Rock Classification System (URCS) provides a systematic and reproducible method of describing rock weathering, strength, discontinuities, and density applicable in engineering studies (Williamson, 1984; ASTM, 2008, or the current revision);
- The International Society for Rock Mechanics (ISRM) Basic Geotechnical Description of Rock Masses provides a standard method to communicate an overall assessment of rock masses, particularly with regard to its anticipated mechanical behavior (ISRM, 1981, or the current revision).
- Engineering geology mapping can be done using the Genesis-Lithology-Qualifier (GLQ) system (Keaton, 1984), rather than the conventional Time-Rock system commonly used in geologic mapping. The GLQ system promotes communication of geology information to non-geologists;
- Systems for mapping landslide deposits are described by Wieczorek (1984), McCalpin (1984), and Resource Inventory Committee, (1996).

The engineering geologic report should include documentation of laboratory and field testing including any geophysical surveys with reference to standard testing procedures. Test or survey procedures, data, and analytical results should be presented in report appendices. Subcontractors responsible for the field and laboratory testing, data processing, and data interpretation should be identified in the report.

The following items may be useful as a general, though not necessarily complete, guide for geologic rock and soil unit descriptions.

Rock Units

- Identification and classification of rock types, using either published classification systems (e.g., URCS or ISRM) or with documentation of other classification procedures used;
- Relative and/or absolute age and, where possible, correlation with named formations and other stratigraphic units;
- Surface and subsurface expression, areal distribution, and thickness;
- Pertinent physical characteristics such as color, grain size, mineralogy, nature of stratification, strength, and variability;
- Distribution and extent of zones of weathering; significant differences between fresh and weathered rock;

- Structural features and their characteristics, including stratification, jointing and fractures, foliation, schistosity, faults, and folds;
- Geomorphic expression of bedrock lithologies and structural features;
- Other significant engineering geologic characteristics or concerns.

Soil Units

- Identification and classification of soil material, using either published classification systems (e.g., USCS) or with documentation of other classification procedures used ;
- Distribution, dimensional characteristics, variations in thickness, degree of soil development, soil genesis, evidence of past disturbance and fill placement, and surface expression;
- Pertinent physical and engineering characteristics such as color, grain size, grain lithology, density/consistency, cementation, structure, strength, thickness, and variability;
- Special physical or chemical features, which could include indications of volume change or instability, such as expansive clays or peat, corrosivity, or the presence of contamination;
- Other significant engineering geologic characteristics or concerns.

3.2.4 Surface and Groundwater Occurrence

- Distribution, occurrence, and variation in surface waters such as drainage courses, ponds, swamps, springs, seeps, and aquifers;
- Identification and characterization of aquifers; depth to groundwater and seasonal fluctuations, perching condition, aquicludes and aquitards, flow direction, gradient, recharge and discharge areas;
- Relationship of surface and groundwater to topographic and geologic features;
- Evidence for past occurrence of water at localities now dry including vegetation, mineral deposits, erosional and depositional features from flash flooding, or historical records;
- Seasonal or long-term variations in surface and groundwater, including fluctuations in groundwater elevation, recharge and discharge of surface water features, response of surface and groundwater due to variations in precipitation, temperature, or other factors;
- Potential impacts of existing or future surface water or shallow groundwater conditions ;
- Riverine or coastal flood potential, including 100-year and 500-year flood elevations, mean high water, and other pertinent data;
- Potential for channel migration or avulsion;
- Other significant engineering geologic characteristics or concerns.

3.2.5 Seismicity and Earthquake Occurrence

- Description of the seismotectonic setting of the site area, including size, frequency, and location of historic earthquakes, and understanding of prehistoric earthquake activity;
- Potential for site to be affected by surface rupture, including sense and amount of displacement, and width of surface deformation zone;
- Potential for area to be affected by regional tectonic deformation;
- Estimated bedrock ground motion, either probabilistic and/or deterministic, as appropriate, and site class modification of bedrock ground motion;
- Potential for tsunami and seiche flooding, including estimated tsunami inundation area, water elevation, and velocities as applicable;

- Potential for area to be affected by earthquake-induced ground failures, including duration of shaking, soft soils, liquefaction, cyclic soil strength reduction, lateral spreading, settlement, and landslides;
- Special engineering geologic characteristics or concerns affecting proposed land use and development activities.

3.2.6 Mass Wasting and Erosional Occurrence

- Review of State guidelines and local ordinance requirements regarding mass wasting hazards and grading;
- Review of available information on mass wasting and soil erosion, including landslide hazard mapping, geologic maps, and National Resource Conservation Service soil mapping;
- Review of remote sensing data as described in Section 3.2 of this guideline;
- Review of current site conditions relevant to mass wasting and soil erosion, including detailed descriptions of landslides or areas of soil erosion affecting the site; Description of geomorphic features indicative of mass wasting and soil erosion, including anomalous landforms, vegetative indicators, and distress to existing structures and utilities;
- Review of surface mapping and subsurface investigation results of mass wasting features, including earth materials, groundwater conditions, extent and rates of movement, etc.;
- Potential for coastal erosion or riverine bank erosion to affect long-term slope stability;
- Other significant engineering geologic characteristics or concerns identified during site investigation.

4. Assessment of Engineering Geological Conditions and Factors

Assessment of existing engineering geological conditions, processes, and hazards, and their related risks and impacts with respect to the intended use of the site constitutes the principal contribution of the report. The engineering geologic assessment includes evaluation of the effects of these geologic features upon the proposed development activity within the site and adjacent area, and consideration of the effects of these proposed modifications upon future geologic conditions, processes, and hazards. The assessment should cover with equal importance the possible onsite and offsite effects of the proposed development based on the engineering geology evaluation.

This section of the engineering geologic report is the synthesis of existing geologic data and the information obtained during site characterization as it relates to the proposed land use or development activities. The synthesis includes interpretation of the geologic information and appropriate analyses of site-specific data necessary to support the report conclusions and recommendations.

4.1 Engineering Geological Interpretation

Interpretation of the information gathering during background research and site characterization is a necessary part of the overall engineering geological assessment. The engineering geologic report should clearly identify areas of data interpretation and factual information. Often the available data is insufficient to allow an unequivocal interpretation, and the concept of multiple working hypotheses should be utilized. Reasonable alternate interpretations of the available data should be discussed in the report, particularly if these alternative interpretations have significant consequences regarding the proposed development activities. In such instances, recommendations for additional data collection should be considered in order to resolve alternative interpretations.

4.2 Engineering Properties of Soil and Rock

A summary of the engineering properties of the soil and rock material encountered in the investigation should be included in the engineering geologic report. This summary should provide the basis for subsequent analyses. The engineering properties may be determined by analytical testing, or be estimated by correlation with index tests performed during the investigation, and should be documented in the engineering geologic report.

4.3 Analytical Analyses and Computer Modeling

Analytical methods for evaluation of slope stability or soil erosion should be appropriately used to support the conclusions and recommendations presented in the engineering geologic report. Analytical analyses can range from simple calculation based on a set of discrete equations to sophisticated computer modeling. Regardless of the form of the computations, the assumptions behind the analytical method being utilized should be described along with the required data and the limitations of the analytical results.

Generally, the results of an analytical computation or computer model are single valued such as a factor of safety or sediment yield and reflect the uncertainty of the input data. In many geological applications there may be a range of valid data values resulting from the accuracy of the data measurement techniques, as well as the inherent variability of geologic properties. Also in many instances, data input values may be based on interpretation of geologic conditions or may be based on generic information obtained from published literature. Consequently, analytical results that are critical to evaluation of site impacts should include a sensitivity analysis based on reasonable ranges of input data.

5. Conclusions and Recommendations

These sections of the engineering geologic report present the outcome of the study, based on the background research, site characterization, and data analyses and interpretations conducted as part of the scope of work.

5.1 Conclusions

The Conclusions section should be focused on the geologic constraints for the proposed land use or development activity of the site. This section should include a discussion of the results of the site characterization, data analyses and interpretations, including the uncertainties or ambiguities of this work. Special engineering geologic characteristics or concerns affecting proposed land use and development activities should be clearly presented in this section. Also, the potential impacts of the development activities on geological conditions and processes, both onsite and offsite, should be addressed in this section. Limitations and potential risks related to the layout and construction of the proposed development such as location of roads and utilities, staging of grading and filling operations should be discussed in this section and cross-referenced in the recommendations section of the report.

5.2 Recommendations

The Recommendations section should provide specific items regarding site use and development and project designs that are the outcome of the site study, and the recommendations should be consistent with the report conclusions. Recommendations for mitigation approaches that address the limitations and potential risks associated with site development may be proposed as appropriate. This section may include recommendations regarding additional work needed to supplement the report, including but not limited to monitoring of geological conditions (i.e., groundwater, slope movement, settlement), review of plans and specifications, and construction monitoring.

B. PREPARATION OF AN ENGINEERING GEOLOGIC REPORT

The following topics are provided as a guide in the preparation of an engineering geologic report. Not all of these topics may need to be included in a particular report depending on the scope of the report and its intended application.

1. Report Format

The body of the engineering geologic report should include the items discussed above in the Content of an Engineering Geologic Report, as appropriate to the specific geologic study, and the date the report was submitted to the client. The engineering geologic report must address all of the requirements of the regulatory agency or agencies that will receive the report as part of their licensing or permitting process. For example, a local government may have specific requirements that must be addressed in an engineering geologic report that supports a land use application. A recommended practice is for the CEG to have qualified individuals review the report for technical content and editorial consistency before the report is finalized.

1.1 Illustrations

An engineering geologic report typically will include maps, annotated photographs, cross-sections, logs of subsurface explorations, field test results, geophysical test results, remotely sensed imagery, and laboratory test data. A vicinity location map identifies the project site in relation to known or familiar locations, and is important for report end-users in easily identifying the site locale. A detailed site map should show the existing and proposed site development, topographic contours and additional important information such as property boundaries, easements, etc.. The site map may be modified for use as a template for additional figures showing geologic features and conditions, locations of subsurface explorations and cross-sections, areas potentially affected by geologic hazards design drawings, or other pertinent data. The source date and origin of the information used in developing the report illustrations should be referenced on the illustrations. Maps need to include North arrows and bar scales or other methods of dimensioning.

1.2 Appendices

Large bodies of data, such as laboratory test results, exploration logs, or the results of geophysical surveys, and explanatory keys should be presented in appendices to the report, and should be cross referenced in the body of the report. The results of data analyses, in particular computer model output, should also be presented in appendices. Large engineering geologic reports containing numerous illustrations and appendices should include a table of contents.

1.3 Report References

All published or other information not developed as part of the site characterization that is used in the report should be listed using standard bibliographic citations. Such information could include:

- Literature, maps, and records cited and reviewed;
- Aerial photographs or images interpreted, listing the type, scale, source, and index numbers etc.;
- Other sources of information, including well records, personal communications, or other data sources.

1.4 Report Limitations

The limitations section should briefly restate the location, intended purpose, intended audience of the report, and what tasks were accomplished in meeting these ends. The report limitations should include a statement regarding the limits of the intended use of the report, including scope and extent, and should restate any additional needs beyond the stated scope of work.

1.5 Signature and Seal

All final reports or other documents must be signed and stamped by the CEG who prepared and was in responsible charge of the engineering geology study and report, as required by ORS 672.605 and OAR 809 Divisions 20 and 50.

REFERENCES

American Society for Testing and Materials, 2008, Standard guides for using rock-mass classification systems for engineering purposes: American Society for Testing and Materials ASTM Standard D-5878-08, 30 p.

American Society for Testing and Materials, 2009, Standard practice for description and identification of soils (visual-manual procedure): American Society for Testing and Materials ASTM Standard D-2488-09, 11 p.

American Society for Testing and Materials, 2011, Standard practice for classification of soils for engineering purposes (Unified Soil Classification System): American Society for Testing and Materials, ASTM Standard D-2487-11, 11 p.

Association of Engineering Geologists, 1996, Professional Practice Handbook: Association of Engineering Geologists Special Publication #5, 3rd edition, S. N. Hoose, editor, 203 p.

California Geological Survey, 2007, Guidelines for reviewing geological reports: CGS Note 41, originally published by the State Mining and Geology Board, 1996. Accessed at: http://www.conservation.ca.gov/cgs/information/publications/cgs_notes/note_41/Pages/Index.aspx

California Geological Survey, 2013, Guidelines for preparing geological reports for regional-scale environmental and resource management planning: California Geological Survey Note 52, 7 p.

ISRM, 1981, Basic geotechnical description of rock masses, prepared by the Commission on Classification of Rocks and Rock Masses, International Society for Rock Mechanics; published in the International Journal of Rock Mechanics, Mineral Sciences, and Geomechanics Abstracts, v. 18, p. 85-110.

Keaton, J.R., 1984, Genesis-lithology-qualifier (GLQ) system of engineering geology mapping symbols: Bulletin of the Association of Engineering Geologists, v. 21, no. 3, p. 355–365.

McCalpin, J., 1984, Preliminary age classification of landslides for inventory mapping: 21st Annual Symposium on Engineering Geology and Soils Engineering, Proceedings, University of Idaho, Moscow, ID, p. 99–111.

Oregon State Board of Geologist Examiners, 1990, 1st Ed., Guidelines for preparing engineering geologic reports in Oregon, 6 p.

Resource Inventory Committee, 1996, Guidelines and standards to terrain mapping in British Columbia: Surficial Geology Task Group, Earth Sciences Task Force, British Columbia, 131 p.

Slosson, J.E., 1984, Genesis and evolution of guidelines for geologic reports: Bulletin of the Association of Engineering Geologists, v. 21, no. 3, p. 295–316.

Utah Section of the Association of Engineering Geologists, 1986, Guidelines for preparing engineering geologic reports in Utah: Utah Geologic and Mineral Survey Miscellaneous Publication M, 2 p.

Washington State Geologist Licensing Board, 2006, Guidelines for preparing engineering geology reports in Washington: Washington State Geologist Licensing Board, Department of Licensing, 15p.

Wieczorek, G.F., 1984, Preparing a detailed landslide-inventory map for hazard evaluation and reduction: Bulletin of the Association of Engineering Geologists, v. 21, no. 3, p. 337–342.

Williamson, D.A., 1984, Unified rock classification system: Bulletin of the Association of Engineering Geologists, v. 21, no. 3, p. 345–354.