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Guidelines

for

Engineering Geologic Reports

and

Site-Specific Seismic Hazard Reports

Developed and Adopted

by the

Oregon Board of Geologist Examiners

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GUIDELINES FOR PREPARING ENGINEERING GEOLOGIC REPORTS IN OREGON

Adopted by
The Oregon State Board of Geologist Examiners
May 8, 1990

This is a suggested guide for the preparation of an engineering geologic report in Oregon. The engineering geologic report should include sufficient facts and interpretation regarding geologic materials, processes, and history to allow evaluation of the suitability of the site for the proposed use. Because of the wide variation in size and complexity of projects and scope of work, the guidelines are intended to be flexible and should be tailored to the specific project. The guidelines are intended to be fairly complete; however, not all items would be applicable to small projects or low-risk sites. In addition, some items may be addressed in separate reports prepared by a geotechnical engineer, geophysicist, structural engineer, or hydrologist.

The guidelines are based on a publication developed by the Guidelines Committee of the Utah Section of the Association of Engineering Geologists, a series of guidelines published by the California Division of Mines and Geology in the CDMG Note series, and the Bulletin of the Association of Engineering Geologists (Slosson, 1984).

I. GENERAL INFORMATION

The following items should be addressed:

A. Client or party that commissioned the report.
B. Name(s) of geologist(s) who did the mapping and other investigation on which the report is based, and dates when the work was done.
C. Location and size of area, and its general setting with respect to major or regional geographic and geologic features.
D. Purpose and scope of the report and geologic investigation, including the proposed use of the site. Also, identify level of the study, i.e., feasibility, preliminary, final, etc.
E. Topography and drainage within or affecting the area.
F. General nature, distribution, and abundance of exposures of earth materials within the area.
G. Nature and source of available subsurface information and geologic reports or maps. Suitable explanations of the available data should provide a technical reviewer with the means of evaluating the reliability. Reference to cited works or field observations should be made, to substantiate opinions and conclusions.
H. Disclosure of known or suspected geologic hazards affecting the area, including a statement regarding past performance of existing facilities (such as buildings or utilities) in the immediate vicinity.
I. Locations of test holes and excavations (drill holes, test pits, and trenches) shown on maps and sections and described in the text of the report. The actual data, or processed data upon which interpretations are based, should be included in the report to permit technical reviewers to make their own assessments regarding reliability and interpretation.
J. All field and laboratory testing procedures (by ASTM designation, if appropriate) and test results.
K. Disclosure statement of geologist's financial interest, if any, in the project or the client's organization.
L. The signature and seal of the certified engineering geologist who prepared the report.

II. GEOLOGIC MAPPING AND INVESTIGATION

A. Geologic mapping of the area should be done at a scale that shows sufficient detail to adequately define the geologic conditions present. For many purposes, available published geologic maps are unsuitable to provide a basis for understanding the site conditions, so independent geologic mapping is needed. If available 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 geologist to extend mapping into adjacent areas to adequately define significant geologic conditions.

B. 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 should be included on each map or photo.

C. The geologist doing the investigation and preparing the map should report the nature of bedrock and surficial materials, the structural features and relationships, and the three-dimensional distribution of earth materials exposed and inferred within the area. A clear distinction should be made between observed and inferred features and relationships.

D. The report should include one or more appropriately positioned and scaled cross sections to show subsurface relationships that cannot be adequately described in words alone. Fence or block diagrams may also be appropriate.

III. GEOLOGIC DESCRIPTIONS

The report should contain brief but complete descriptions of all natural materials 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. Describe all field mapping and exploration procedures (surface geologic reconnaissance, drilling, trenching, geophysical survey, etc.).

The following checklist may be useful as a general, though not necessarily complete, guide for descriptions:

A. Bedrock.

1. Identification of rock types.
2. Relative and absolute age and, where possible, correlation with named formations and other stratigraphic units.
3. Surface and subsurface expression, areal distribution, and thickness.
4. Pertinent physical characteristics (e.g., color, grain size, nature of stratification, strength, variability).
5. Distribution and extent of zones of weathering; significant differences between fresh and weathered rock.
6. Special engineering geologic characteristics or concerns (e.g., factors affecting proposed grading, construction, and land use).

B. Structural features—stratification, faults, discontinuities, foliation, schistosity, folds.

1. Occurrence, distribution, dimensions, orientation, and variability, both within and projecting into the area.
2. Relative ages, where pertinent.
3. Special features of faults (e.g., topographic expression, zones of gouge and breccia, nature of offsets, age of movements, youngest faulted unit and oldest unfaulted unit).
4. Other significant structural characteristics or concerns.

C. Surficial deposits—alluvial, colluvial, eolian, glacial, lacustrine, marine, residual, mass movement, volcanic (such as cinders and ash), and fill.

1. Identification of material, grain size, relative age, degree of activity of originating process.
2. Distribution, dimensional characteristics, variations in thickness, degree of soil development, surface expression.
3. Pertinent physical and engineering characteristics (e.g., color, grain size, lithology, compactness, cementation, strength, thickness, variability).
4. Special physical or chemical features (e.g., indications of volume change or instability, such as expansive clays or peat).
5. Other significant engineering geologic characteristics or concerns.

D. Surface and shallow subsurface hydrologic conditions, including groundwater, springs, and streams and their possible effect on the site. Indicate how conditions may be affected by variations in precipitation, temperature, etc.

1. Distribution, occurrence, and variations (e.g., drainage courses, ponds, swamps, springs, seeps, aquifers).
2. Identification and characterization of aquifers; depth to groundwater and seasonal fluctuations, flow direction, gradient, recharge and discharge areas.
3. Relationships to topographic and geologic features.
4. Evidence for earlier occurrence of water at localities now dry (e.g., vegetation, mineral deposits, historical records).
5. Other significant engineering geologic characteristics or concerns, such as fluctuating water table and the effects of proposed modifications on future hydrologic processes.

E. Seismic considerations.

1. Description of the seismotectonic setting of the area (including size, frequency, and location of historic earthquakes), current seismic zoning, and expected seismic risk.
2. Potential for area to be affected by surface rupture (including sense and amount of displacement, and width of surface deformation zone).
3. Probable response of site to likely earthquakes (estimated ground motion).
4. Potential for area to be affected by earthquake-induced landslides or liquefaction.
5. Potential for area to be affected by regional tectonic deformation (subsidence or uplift).

IV. ASSESSMENT OF GEOLOGIC FACTORS

Assessment of existing geologic conditions and processes with respect to intended use of the site constitutes the principal contribution of the report. It involves (1) the effects of the geologic features upon the proposed grading, construction, and land use and (2) the effects of these proposed modifications upon future geologic conditions and processes in the area.

The following checklist includes topics that ordinarily should be considered in discussions, conclusions, and recommendations in geologic reports:

A. General suitability of proposed land use to geologic conditions.

1. Areas to be avoided, if any, and mitigation alternatives.
2. Topography and slope.
3. Stability of geologic units.
4. Flood and tidal inundation, erosion, and deposition.
5. Problems caused by geologic features or conditions in adjacent properties.
6. Other general problems.

B. Identification and extent of known or probable geologic conditions that may result in risk to the proposed land use (such as flood inundation, shallow groundwater, storm surge, surface- and groundwater pollution, snow avalanche, landslide, debris flow, rock fall, expansive soil, collapsible soil, subsidence, erosion, deposition, earthquake shaking, fault rupture, tectonic deformation, liquefaction, seiche, tsunami, volcanic eruption)**.**

C. Recommendations for site grading.

1. Prediction of what materials and structural features will be encountered in proposed cuts.
2. Prediction of stability based on geologic factors; recommended avoidance or mitigation alternatives to cope with existing or potential landslide masses.
3. Excavation considerations (hard or massive rock, groundwater flows).
4. General considerations of proposed fill masses in canyons or on sidehills.
5. Suitability of on-site material for use as compacted fill.

6. Recommendations for positioning fill masses, provision for subdrainage, buttressing, and the need for erosion protection on fill slopes.
7. Other recommendations required by the proposed land use, such as the angle of cut slopes, position of drainage terraces, need for rock-fall and/or erosion protection on cut slopes.

D. Drainage considerations.

1. Protection from inundation or wave erosion along shorelines.
2. Soil permeability, suitability for septic systems.
3. Protection from sheet flood or gulley erosion, and debris flows or mud flows.

E. Limitations of study, and recommendations for additional investigations. Considering the scope of work and intended use of the site, provide a statement of the limitations of the study and the need for additional studies outside the stated scope of work**.**

1. Borings, test pits, and/or trenches needed for additional geologic information.
2. Percolation tests needed for design.
3. Program of subsurface exploration and testing that is most likely to provide data needed by the soils or civil engineer.
4. Program for long-term monitoring of the site to evaluate geologic conditions (survey hubs, inclinometers, extensometers, etc.).

V. RECOMMENDED TECHNIQUES/SYSTEMS TO CONSIDER

A. 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. The Unified Soil Classification System (U.S. Army Corps of Engineers, 1960; American Society for Testing and Materials, 1984) has been used in engineering for many years and has been incorporated into the GLQ system.

B. The Unified Rock Classification System (Williamson, 1984) provides a systematic and reproducible method of describing rock weathering, strength, discontinuities, and density in a manner directly usable by engineers.

C. Systems for mapping landslide deposits are described by Wieczorek (1984) and by McCalpin (1984).

D. Commonly accepted grading requirements are described in Chapter 70 of the Uniform Building Code.

REFERENCES CITED

American Society for Testing and Materials, 1984, Standard practice for description and identification of soils (visual-manual procedure): ASTM Standard D-2488-84, p. 409–423.

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GUIDELINES FOR SITE-SPECIFIC SEISMIC HAZARD REPORTS FOR ESSENTIAL AND HAZARDOUS FACILITIES AND MAJOR AND SPECIAL-OCCUPANCY STRUCTURES IN OREGON

Adopted by
The Oregon State Board of Geologist Examiners
September 6, 1996.

I. INTRODUCTION

These guidelines were prepared by the State of Oregon Boards of Geologist Examiners and Examiners for Engineering and Land Surveying to assist those who prepare reports for site-specific seismic hazard reports for essential facilities, hazardous facilities, major structures and special occupancy structures as provided in Oregon Revised Statutes 455.447(2)(a) and Oregon Administrative Rules 918-460-015. The guidelines describe the general content of these reports and are not intended to be a complete listing of all the elements of a site-specific seismic hazard report as outlined in Section 2905 of the Oregon Structural Specialty code.

These guidelines are intended to be used as a checklist for projects of varying size and complexity including hospitals, schools, and emergency-response facilities. The preparer and the reviewer of site-specific seismic hazard reports are expected to tailor the scope of work and interpretations to the size, occupancy, and critical use of the proposed structure. It is recognized that the techniques used to evaluate a site for a larger and more critical facility will be more complete and detailed than for a smaller and less critical building or other structures. The site-specific investigations vary according to the local geologic conditions that may affect the performance of the proposed or existing structure and to the proximity to faults that are expected to be seismogenic. The investigator(s) is (are) expected to be knowledgeable about the current practice of seismic geology and earthquake engineering and should be aware of the need to provide designers of buildings and other structures with information that can be readily utilized in construction or remodeling projects to reduce seismic risk.

The professional who is performing, signing, and stamping the site-specific investigation is responsible for the adequacy of investigative procedures and reporting that will adequately characterize seismic risk for the proposed use of the subject site. The report should clearly state the techniques used in the investigation, the data acquired, and the findings and recommendations, so that peer reviewers and users of the resulting reports will have a basis for judging the adequacy of the investigation.

In Oregon, the complexity of local geology, limited geologic exposure, variety of earthquake types, and the potential for multiple seismic hazards, including ground shaking, fault rupture, amplification, landsliding, liquefaction, uplift and subsidence, seiche, and tsunami generation, necessitate a choice of investigative techniques that will vary from site to site and that must be chosen based on the geologic hazards and subsurface conditions and on the intended use of the structure.

The following guidelines are intended to be applicable for projects with a wide range in size, cost, and utility. Flexibility in the use of the guidelines is expected, and professional judgment is needed in the selection of work elements for the investigation and in the thoroughness of the resulting report. The preparer and the reviewer of site-specific seismic hazard reports are expected to be familiar with the use of such reports by engineers engaged in the geotechnical and structural design of buildings, so that the reports are designed to be routinely used by designers to maximize the reduction in seismic risk, as structures are constructed or retrofitted.

State law, related administrative rules, and state and local building codes are evolving in an effort to mitigate seismic risk. The preparers, supervisors, and reviewers of site-specific seismic hazard reports are expected to be knowledgeable about relevant laws, rules, and codes.

Some cities and counties in Oregon have ordinances requiring geologic hazard reports. The content of these reports may overlap with the guidelines for the site-specific seismic hazard reports. The geologic hazard reports typically are required for areas mapped by the Oregon Department of Geology and Mineral Industries as landslide or potential landslide areas or as tsunami inundation areas. The geologic hazard reports required by local government ordinance may cover a broader range of facility uses, sizes, and occupancy levels than the site-specific seismic hazard reports that are the focus of these guidelines. The geologic hazard reports range in scope from reconnaissance level investigations to more intensive site-specific seismic hazard studies.

These guidelines are intended to be informal and not regulations. The guidelines are expected to evolve, as the relevant seismic hazards are better defined and as building codes and engineering practices change.

II. CONTENT OF SITE-SPECIFIC SEISMIC HAZARD REPORTS

The following information should be considered in preparing site-specific seismic hazard reports in Oregon.

A. Purpose and scope of the investigation, including a brief description of the proposed site use, size of the proposed building or other structure, occupancy, and current seismic zonation (UBC).

B. Regional geologic and tectonic setting, including a complete list of all seismogenic faults that could impact the site and a description of the crustal, intraplate, and subduction-zone earthquake hazards.

C. Site conditions, including elevation, subsurface conditions, landforms, site grading, vegetation, existing structures, and other features that may influence the investigation.

D. Description of the investigation

1. Regional seismic history and tectonic setting

a. Significant historic earthquakes and tsunamis in the region and locations and magnitudes of seismic events in the vicinity of the site. Crustal earthquakes, intraplate, and interface subduction zone events should be included.
b. Evidence of prehistoric earthquakes and tsunamis that may have affected the site.
c. Map showing the location of seismic features relative to the proposed project and an estimate of the amount of disturbance relative to bedrock and surficial materials.
d. Selection for appropriate strong-motion attenuation relationships for the site.
e. Published probabilistic estimate of earthquake occurrence.
f. Geodetic and strain measurement, microseismicity monitoring, or other monitoring.

2. Interpretation of aerial photography and other available remotely sensed images relative to the geology and earthquake history of the site, including vegetation patterns, soil contrasts, and lineaments of possible fault origin.

3. Site investigation

a. Detailed field mapping of soils, geologic units and structures, and topographic features indicative of faulting, such as sag ponds, spring alignments, disrupted drainage systems, offset topographic and geologic features, faceted spurs, vegetation patterns, and deformation of buildings or other structures.
b. Review of local groundwater conditions including water depth and elevation.
c. Trenching and other excavating to permit the detailed and direct observation and logging of continuously exposed geologic units, including soils and features that are relevant to seismic hazards. Trenching should cross known or suspected active faults in order to determine the location, timing, and recurrence rate of past movements, the area disturbed, the physical condition of fault zone materials, and the geometry of faulting.
d. Exploratory drilling and/or test pits designed to permit the collection of data needed to evaluate the depth, thickness, and types of earth materials and groundwater conditions that may identify past seismicity or could contribute to damage potential at the site. Drill holes and/or pits should be located and spaced sufficiently to allow valid interpretations of the resulting data. Subsurface testing could include Standard Penetration Tests (SPT), Cone Penetrometer Tests (CPT), undisturbed tube samples, and collection of bulk samples for laboratory testing.
e. Surface and subsurface geophysical surveys as appropriate to determine the dynamic properties of the sub-

surface materials, including shear-wave velocity, shear modulus, and damping.

4. *Subsurface investigation*
   a. Laboratory testing of samples for moisture content, grain size, density, dynamic properties, and other pertinent parameters.
   b. Radiometric analysis of geologic units, study of fossils, mineralogy, soil-profile development, paleomagnetism, or other age-determinating techniques to characterize the age of geologic units.
   c. Estimates of expected magnitude, acceleration, and duration of strong motion for the design earthquakes for crustal and intraplate and interface subduction-zone sources and for other defined earthquakes if required by statute or regulation of the proposed project. The rationale for earthquake-source selection for the relevant types of events should be provided. The design basis earthquakes and ground acceleration maps available from the State of Oregon should be consulted and described.
   d. Determination of appropriate UBC site-specific soil-profile coefficients.
   e. Analytic dynamic soil response analyses to evaluate potential amplification or attenuation of subsurface soil deposits to the underlying bedrock motions.
   f. Evaluation of the liquefaction potential of the subsurface deposits at the site and, if applicable, estimation of liquefaction-induced settlement and liquefaction-induced lateral spreading.
   g. Evaluation of other seismic hazards, including earthquake-induced landslides, generation of tsunamis or seiches, regional subsidence, and fault displacement.

E. Conclusions and recommendation

1. *Summarize the results of the seismic study*, including the review of regional seismicity, site investigations, selection of the design earthquakes, and office analysis, including the evaluation of ground response, liquefaction, landsliding, and tsunamis on the proposed structure and use of the site. The report should be stamped and signed by a certified engineering geologist or by a registered professional engineer experienced in seismic hazard design or by both, when the work of each can be clearly identified.
2. *Recommendations for site development to mitigate seismic hazards*. The recommendations could include: ground modification to reduce amplification of ground shaking or liquefaction-induced settlement and lateral spreading potential, remedial treatment options for slope stability, and foundation alternatives to minimize seismic impact to structure.

F. References and appendices

1. *Literature and records reviewed.*
2. *Aerial photographs or other images used*, including the type, scale, source, date, and index numbers.
3. *Maps, photographs, plates, and compiled data* utilized in the investigation.
4. *Description of geophysical equipment and techniques* used in the investigation.
5. *Personal communications or other data sources.*

G. Illustrations

1. *Location map* to identify the site locality, significant faults, geographic features, seismic epicenters, and other pertinent data.
2. *Site development map* at a scale appropriate to show the site boundaries, existing and proposed structures, graded and filled areas, streets, and proposed and completed exploratory trenches, geophysical traverses, drill holes, pits, and other relevant data.
3. *Geologic map and sections* showing the distribution of soils, geologic units, topographic features, faults and other geologic structures, landslides, lineaments, and springs.
4. *Logs of exploratory trenches, borings, and pits* to show the details of observed features and conditions. Groundwater data should be included.

III. ACKNOWLEDGMENTS

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