

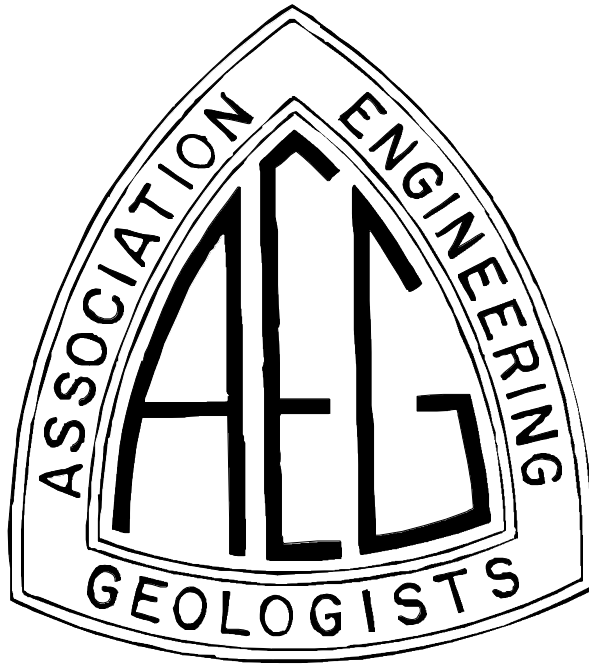
# PROFESSIONAL PRACTICE HANDBOOK

FIRST EDITION, 1981  
SECOND EDITION, 1985

Edited by  
Glenn A. Brown  
and  
Richard J. Proctor

THIRD EDITION, 1993

Edited by  
Seena N. Hoose



Special Publication #5

ASSOCIATION OF ENGINEERING GEOLOGISTS

1993

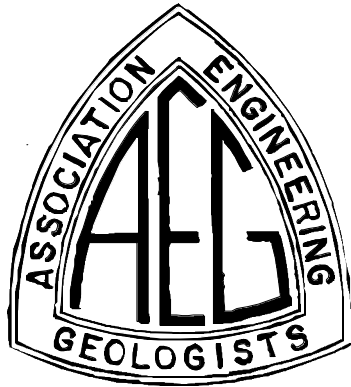
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Association of  
Engineering Geologists

Available from:

AEG Executive Director  
Edwin A. Blackey, Jr.  
323 Boston Post Road, Suite 2D  
Sudbury, MA 01776  
(508) 443-4639

Price \$35.00

Library of Congress  
Catalog Card No. 01-67376

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PREFACE TO THE FIRST AND SECOND EDITIONS  
AEG PROFESSIONAL PRACTICE GUIDELINES

More than half of the members of the Association of Engineering Geologists practice in the private sector, and many may not be aware of the legal implications in their work (geologists do get sued!). The information presented herein is directed not only to the veteran practitioners, but also will provide a valuable perspective to those just entering the profession.

We opted to provide a loose-leaf binder so that users may conveniently insert articles and other information under the appropriate headings.

The idea for these Guidelines originated at the AEG Board of Directors meeting held in conjunction with the 1978 Annual Meeting in Hershey, Pennsylvania. Here, Mavis D. Kent of Oregon expressed concern to then-President Richard J. Proctor about the lack of any guidelines or standards for the professional practice of engineering geology. The Oregon legislature had just approved registration for geologists and she felt that most practicing geologists were unaware of the legal ramifications that professional registration brings. She expressed her willingness to help prepare a manual or guidelines on professional practice. Mr. Proctor agreed and asked her to chair the Professional Practice Committee, with the main goal of identifying contributors for preparation of this publication.

This manual is the first step in summarizing some of the problems, standards, and pitfalls connected with the practice of engineering geology. We welcome your comments on this first edition.

Glenn A. Brown  
Richard J. Proctor  
Editors

Los Angeles, California  
July 1981  
Revised 1985

There is no intent, stated or implied, with these Guidelines to prohibit commercial advertising, price competition, or solicitation in the sale of engineering services, and that such advertising, price competition, or solicitation is not unethical, unprofessional, or contrary to any policy of AEG.

PREFACE TO THE THIRD EDITION  
AEG PROFESSIONAL PRACTICE HANDBOOK

By the early 1990's many Engineering Geologists had begun to practice in the area of clean-up of contaminated soil and groundwater and in the siting of hazardous waste disposal facilities. As is always the case, laws and requirements were also changing. The intent of the Guidelines was to provide a dynamic document that would change with the times, hence this revision. The Committee on Ethics and Professional Practice felt that changing the title to "Professional Practice Handbook" would reflect the contents and purpose of the document more clearly.

The loose-leaf format was retained for the same reason it was originally chosen, to allow you to add your own information to the various chapters.

Two chapters were renumbered and the 1st and 2nd edition Chapter 2 is now Chapter 3; Chapter 3 is now Chapter 4. First edition Chapter 4, Communication, has been divided into the revised Chapter 3, Professional Liability, and Chapter 5, Project Control. An entirely new chapter, Chapter 2, on Standards and Guidelines has been added. Chapter 7, The Expert Witness and Litigation, has been essentially re-written. Chapter 9, References and Suggested Reading, has been retained and expanded, while a reference section has been added to each chapter.

The contributors to the 3rd edition revision are identified on the title page of each chapter. Minor changes in wording were also suggested by C. Michael Scullin and R. Rexford Upp. Contributors to the First and Second Editions of the Professional Practice Guidelines have been listed on the first page of each chapter. The exception is Chapter 7 which was originally written by Eugene B. Waggoner, with the assistance of Stanfield Johnson on Suggestions for Witnesses.

As with the previous editions of this handbook, your comments, recommendations, and improvements are earnestly requested by the committee. This handbook is only as useful as you make it.

Seena N. Hoose  
Editor

Cupertino, California  
September 1993

## AIMS OF THE ASSOCIATION OF ENGINEERING GEOLOGISTS

The aims of the Association are to advance Engineering Geology and to:

- ! promote public safety and welfare;
- ! promote public understanding and acceptance of the field of Engineering Geology;
- ! establish and maintain high ethical and professional standards;
- ! monitor legal or other developments that would affect the profession of Engineering Geology, to provide information on their potential effect, and to provide an organization for concerted action when desired;
- ! provide for discussion of subjects and problems within the field of interest of the Engineering Geology profession;
- ! provide a medium for distribution of information and technical papers of interest to engineering geologists; and
- ! encourage all qualified individuals and organizations interested in furthering the field of Engineering Geology to apply for membership.

## ENGINEERING GEOLOGY

Engineering Geology is geologic work that is relevant to engineering, environmental concerns, and the public health, safety, and welfare.

"Engineering Geology" is defined by the Association of Engineering Geologists as the discipline of applying geologic data, techniques, and principles to the study both of a) naturally occurring rock and soil materials, and surface and subsurface fluids, and b) the interaction of introduced materials and processes with the geologic environment, so that geologic factors affecting the planning, design, construction, operation, and maintenance of engineering structures (fixed works) and the development, protection, and remediation of ground-water resources, are adequately recognized, interpreted, and presented for use in engineering and related practice. The Engineering Geologist utilizes specialized geologic training and experience to provide quantitative geologic information and recommendations based on it, as well as judgmental recommendations.

In recent decades the scope of Engineering Geology practice has grown beyond its original close connection to civil engineering practice. Engineering Geologists now work with and for land-use planners, environmental specialists, architects, public policy makers, and property owners to provide geologic information on which they base decisions.

Some of the major activities of Engineering Geologists include:

1. The investigation of foundations for all types of major structures, such as dams, bridges, power plants, pumping plants, airports, large buildings, and towers;
2. The evaluation of geologic conditions along tunnel, pipeline, canal, railway, and highway routes;
3. The exploration and development of sources of rock, soil, and sediment for use as construction material;
4. The investigation and development of surface and ground-water resources; ground-water basin management; protection and remediation of ground-water resources;
5. The evaluation of geologic hazards such as landslides, faults and earthquakes, radon, asbestos, subsidence, expansive and collapsible soils, expansive bedrock, cavernous rock, and liquefaction;
6. Evaluation of geologic conditions (including ground-water) affecting residential, commercial, and industrial land use and development.
7. Construction geology, including slope stability, dewatering, subdrains, grouting considerations, and excavatability;
8. Safe disposal of waste to the Earth;
9. Engineering Geologists participate in land-use planning, environmental impact report research, mined land reclamation, timber harvest planning, and insurance and forensic investigations.

The Engineering Geologist, in cooperation with the civil engineer, bears an important share of the responsibility for the public health, safety, and welfare insofar as engineering works are affected by geologic factors. The engineering profession has distinctly and effectively met its responsibility to the public through state registration laws throughout the United States. The Association of Engineering Geologists has published a Suggested Geologists Practice Act to assist in achieving professional registration for geologists.

The Association of Engineering Geologists is devoted to developing a spirit of professional responsibility on the part of Engineering Geologists. Through the Association, attention is focused on Engineering Geology and its expanding role. The Association seeks to maintain high professional standards and enhance awareness of the responsibility of the Engineering Geologist to the public in general.

In the final analysis, Engineering Geology is people geology. Engineering Geology exists because people want to modify the geologic environment for their use and convenience, want to live in harmony with it, and occasionally manage to come into conflict with it. Helping people understand their geologic environment, accommodate themselves to it, and correct their geo-environmental mistakes, is what Engineering Geologists do.

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# Chapter 1

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## **Chapter 1**

### **INTRODUCTION**

by  
Allen W. Hatheway  
and  
Mavis D. Kent

with contributions from  
William E. Cutcliffe and Douglas E. Moran

revised 1993 by  
Robert E. Tepel

#### **NEED for and SCOPE of PROFESSIONAL PRACTICE HANDBOOK**

Over the years, the need for a professional practice handbook for engineering geologists has been raised many times, and has been a matter of continuing interest to the Board of Directors of the Association. The need for a handbook has become more evident as the breadth of engineering geology expands and the number of practicing (and also state-registered/certified) engineering geologists increases. Annual Meeting papers often deal with the challenge and responsibility of professional practice in terms of providing the best work products according to current professional standards and in a manner least likely to engender litigation. Awareness of professional liability has become, along with increasing professionalism, recognized as an important aspect of professional practice. Because of this, the task of the Association to make the techniques of professional practice available to its membership has become more demanding.

The goal of this Professional Practice Handbook is to address professionalism and liability associated with professional practice in a general manner, and to bring the important aspects of professional practice to the attention of engineering geologists. This special publication of the Association of Engineering Geologists is designed for practical use as a handbook for professional practice. Several Resource Lists are provided at the end of this Chapter.

Engineering geologists, often within the framework of a team effort, provide professional services which consist of investigations, conclusions, and recommendations. Clients spend money to achieve desired goals which often are associated with public welfare, such as health, housing, transportation, or mineral extraction. It is of prime importance to the profession that engineering geologists understand the impact of their work on society. Engineering geologists must provide professional work in a form that is thorough and accurate within the limitations of current professional practice.

Professional liability should be an important issue to all engineering geologists, since recourse to legal action has unfortunately become commonplace in the settlement of disagreements which may arise during or after an engineering project is constructed. It has become abundantly clear that most of the legal actions that have involved, or may potentially involve, engineering geologists concern either the quality and/or competence of a work product, or are of the "third-party" variety. In third-party suits, all parties to a contract are brought to court in the plaintiff's effort to find monetary redress through blanket suits.

The best protection that engineering geologists can have in effectively reducing liability exposure, and costly and time-consuming involvement in legal actions, is to maintain competence in practice and to develop an awareness of professional liability. A job prudently conducted at the state-of-the-art level of technical competence, according to well-defined items of scope, and in good communication with the client, serves as both as a measure of the competency of the practicing professional and as an aid in loss prevention and reduction of liability exposure.

## **PROFESSIONAL DEVELOPMENT**

From the very start of professional practice, whether as an independent consultant or as an engineering geologist working for others, it is advisable that each engineering geologist evaluate his or her technical competence, in terms of abilities, experience, educational background, and chart a personal plan of ongoing professional development.

An important aspect of self-evaluation of technical competence is that each engineering geologist should establish the technical bounds of his or her competence. We **can** be held liable for not recognizing our own shortcomings and should either refrain from practice in certain applied fields, or strive to increase technical competence where necessary. Competence is gained through background study, participation in instruction or technical meetings, careful application of the techniques in practice, close cooperation with more knowledgeable colleagues, and demonstration of this understanding with and before others, such as writing and giving papers at Association meetings or publishing in other venues.

Personal professional development should be undertaken by assessing the key elements of professional practice important to each person's career and then establishing the means of attaining sequential goals in the area of each key element. A plan for professional development should address all of the elements of professional practice. The key elements include: 1) the techniques of technical practice, 2) a personal philosophy of application of each technique, 3) an ability to communicate with others, 4) a willingness to establish and meet deadlines, 5) a commitment to meet the full letter of agreements, and 6) an effort toward continuing education.

### ***Techniques of Technical Practice***

As professional engineering geologists, we are expected to be knowledgeable of current techniques and then be capable of applying these techniques to the satisfactory solution of problems or other needs of the client. An understanding of the basic theories and practices of allied fields, such as civil

(including structural, soils, environmental, mining and petroleum) engineering, architecture, and planning, provides a familiarity with what data are required by each type of client, and the ability to provide the client with answers and solutions.

### ***Philosophy of Application***

The professional engineering geologist should develop personal philosophies of understanding and application of each technique, theory or procedure that is used in daily practice. This may provide a basis for supplying expert testimony that is ethical, accurate, understandable, and to the point.

### ***Communication***

Effective communication is vital in professional practice in working with a client, within the profession, or with city/government agencies. Endeavors in which job-related communication skills are exercised include public speaking (e.g., city council meetings or hearings), effective coordination for group meetings, record-keeping practices and clear, objective writing.

### ***Establish and Meet Deadlines***

The essence of good professional practice is to understand the client's needs and then satisfy those needs in a competent manner, on time and within budget. Learned project management skills may be applied to achieve the client's goals and objectives. Meeting the established deadlines within budgetary restrictions of a project is aided by such management skills as organizing, administering, and controlling staff member participation.

### ***Commitment Agreements***

Incidents of professional liability to which engineering geologists have been a party, and for which they have been found neglectful (however few of these incidents have occurred), have generally been linked to a misunderstanding of the client's needs, poorly prepared proposals, negotiations and contracts, and work products which, in some way, did not meet the client's objectives of the terms of the contract.

## **CONTINUING EDUCATION**

A program of continuing education may include pursuit of graduate degrees, attending special or short courses and technical meetings, participation in field trips, and home study of journals and textbooks. The Association provides its Bulletin, Special Publications, field trip guide-books and its meetings and short courses as a means for each engineering geologist to grow professionally for the entire tenure of his or her professional practice. Additionally, each engineering geologist should acquire and maintain a professional library of reference materials that can be used as the basis of his or her state-of-the-practice / state-of-the-art technical assistance to the client. The resource lists at the end of this chapter, along with references in each chapter and in chapter 9, provide a starting point for developing a professional library.

The engineering geologist must recognize participation in the profession as a serious undertaking, which requires continued and substantial commitment beyond the baccalaureate degree. A plan for professional development is absolutely essential for an engineering geologist as a means of effectively reducing liability and of maintaining a professional standing.

## **ENGINEERING GEOLOGY as a PROFESSION**

Engineering geology is probably the most demanding of the fields of geoscience in terms of the breadth of academic knowledge required for successful practice. Engineering geologists provide assessments of a four-dimensional character, including assessments of physical properties of earth materials and assessments of the effects of natural elements on construction projects through time. They are also involved in efforts to mitigate natural hazards through planning and zoning as well as careful siting of structures, in developing provisions to restrict pollution and to dispose of man's waste, and in evaluations of our various natural resources. The breadth of engineering geology grows each year in response to the pressures of population expansion and diminishing resources, to increasing concern for attainment of environmental compatibility between Society and the Earth, and to increased governmental regulation.

Engineering geology cannot be taught by a set of strict rules, rather, as Kiersch (1955) said, it is "the art or technique of using geologic data and methods to solve problems inherent to engineering practice". While excellent textbooks have been published in recent years, access to a well-rounded reference library is essential to the engineering geologist in their daily practice.

Engineering geology has grown from roots in British civil engineering, over 200 years ago, and from a rich, developing tradition in the United States, beginning possibly with the works of William O. Crosby in Massachusetts in about 1875, and of Charles Peter Berkey in New York, beginning about 1895. The reader is referred to Kiersch (1991 and 1955) and to the Berkey Volume (Paige, 1950) for an appreciation of the development of engineering geology.

Some engineering geologists are also qualified geotechnical or mining engineers. Others are equally well qualified engineering geophysicists, hydrogeologists, geomorphologists, seismologists, and structural geologists. Ours is a profession with strong ties and links to these allied professions. Each engineering geologist is the product of personal goals, education, experience, and abilities. For each of us, it is important to assess personal professional strengths and weaknesses, and to offer services only where they meet the objectives of good professional practice.



## ***The Value of Professional Registration***

It is the opinion of the Association, by resolution of the Board of Directors, that professional registration of engineering geologists is a necessary and desirable aspect of the practice of geology in modern society. Registration legally implies a responsibility for quality of work. Individuals possessing professional registration may be presumed to be fully qualified professionals, and may also represent themselves as such. Registration is important as a means to protect the public by identifying those professionals that are fully qualified to offer their services as engineering geologists.

## ***Policy Statement on Registration for Engineering Geologists***

(Adopted by the Board of Directors on October 13, 1987).

The Association of Engineering Geologists has long been aware of the importance of geologic principles in predicting conditions that affect public health, safety, and welfare. The Engineering Geologist, in his partnership with other involved professions and disciplines, must bear a share of the responsibility where the works of man interact with the geologic environment insofar that geologic principles are used in the investigation, evaluation, and prediction of surface and subsurface water and contaminants, waste management, aggregate production, and geologic hazards; and in the evaluation, planning, design, construction, operation, and maintenance of fixed engineering projects.

Currently many states have passed registration laws requiring the licensing of geologists and Engineering Geologists. These laws are similar in format to those which exist in all states for the engineering profession. Recognizing the need for standard qualifications for Engineering Geologists throughout the United States, the Association of Engineering Geologists establishes this policy to promote the licensing of Engineering Geologists in each state by appropriate registration laws which rely on experience and examination. Where no laws currently exist, an active program shall be implemented to formulate the highest level of licensure for Engineering Geologists. Where existing laws that register geologists do not acknowledge the significance of the specialty of Engineering Geology, an active program shall be implemented to revise or amend such laws.

There are many specialties within the geologic profession. The active promotion of licensure for Engineering Geologists in each state is not intended to preclude individuals in any other geologic discipline from practicing their specialty. However, based on the potential for loss of life and property where the profession of Engineering Geology is involved, it is imperative that those geologists practicing this specialty have the necessary basic training and experience to apply geologic principles to ground-water and engineering problems and works involving surface and subsurface materials and conditions.

No registration law or licensing act can be effective unless there is a provision for disciplinary action against those violating the law or act. Because there are ample opportunities to subvert and take unfair advantage of the law, the Association encourages and promotes State

Registration Boards to take strong and decisive publicized steps involving reprimands as well as legal action, where justified.

The Association will provide a central file for all statutes from each state which refer to the practice of geology, engineering geology, or geological engineering. Each state has unique conditions that require different emphases in their laws. In addition, the Association will develop a model document to assist states in preparing, modifying, or amending registration and/or licensure laws. A uniformity in registration or licensure throughout the United States is to be strived for, in order to promote reciprocity based on equitable education, experience and examination, similar to that recognized between most states for the engineering profession. (AEG Directory)

## **LIMITATIONS of the ENGINEERING GEOLOGIST - A DISCUSSION**

The purpose of this discussion is not to list limitations that can be identified, but to serve as a reminder that they exist. While we should strive to educate the public regarding the services that we can and do provide, our limitations must be recognized and respected. Otherwise we risk creating an illusion that if a geologist is retained, nothing else need be feared. If such misconceptions are allowed to exist they will permit a false sense of security to evolve which would lead eventually to public disillusionment and unnecessary liability.

The engineering geologist must remain an objective scientist, even though, as a retained consultant, some sense of advocacy for a project may develop. Such advocacy may contribute to the desire to be innovative in alternative mitigation strategies. Similarly, engineering geologists in government service, particularly those in regulatory capacities, must remain objective scientists, even though some sense of opposition for a project may develop due to personalities or politics.

Engineering geologists should welcome objective peer reviews of their work. In many cases, it is appropriate and desirable for field meetings to be held among the client/owner, the consulting geologist, the design engineer, and the regulatory geologist and or engineer. Such meetings serve, not only as opportunities for open discussion of issues, but also to demonstrate a philosophy on the part of the client/owner (developer) of openness and good will towards compliance with regulations.

Fault rupture hazard investigations can be performed with one of two emphases: a) characterize a specific fault, and b) evaluate a specific site. Trenches can be excavated at selected locations along a fault to permit observation of faulted and unfaulted sediments that allow interpretation of slip history. Trenches can be excavated at a specific site to document presence or absence of fault traces in meaningfully old sediments. In keeping with scientific objectivity, trenches excavated at a site to evaluate presence or absence of fault traces must be placed where potential fault traces will be intersected. Otherwise, a statement that unfaulted stratigraphy was exposed does not support the conclusion that the site is free of fault-rupture hazards.

Engineering geologists also offer services to the hillside homeowner. Long-term stability of hillside homesites can be substantially improved and geologic hazards can be minimized by sound engineering

solutions of geologic problems that are recognized, described, and characterized by the engineering geologist. Engineering design of mitigation or stabilization must be done by a qualified engineer who has good cooperation and communication with the engineering geologist. Tremendous improvements have been made in solving these geologic problems, and more can be achieved in the future. However, the kind of assurance that is desired by the hillside homeowner can rarely be provided. It would be self-defeating deception to allow the public to believe that by retaining the services of a geologist, a guarantee against geologic difficulties is absolute. We, like medical doctors, cannot sell guarantees.

When the homeowners see the results of geologic failure displayed in the newspapers or on the TV screen, they acquire a strong desire for assurance that they will not be similarly affected. The homeowner who suffers a loss discovers that assurance inferred from soil and geologic reports has little substance. The homeowner probably never bothered to read the qualified statements of opinion that were included, nor complied with the recommendations that the reports contained. However, since the loss is not recognized as a fault of their own, the homeowner looks for compensation from someone they consider to be responsible. If the homeowner believes that having a site examined or approved by a geologist renders it stable, they will conclude that if it proved to be unstable the geologist did not provide the service they were paid for. Further, the individual homeowner and the general public may conclude that continued occurrence of landslides is *de facto* proof that the geologists really can do nothing to prevent such occurrences. The fact that recommended work which would have led to prevention of the occurrence may not have been performed, or that important cautions were ignored, is usually lost on the general public.

The services we offer are like those of the family doctor. We can examine geologic problems and recommend corrective treatment. The results may be helpful. But as marvelous as our powers may be, we cannot issue guarantees, any more than the family doctor can.

Life and health insurance policies provide compensation for losses that the medical profession cannot prevent. There is also a need for insurance to compensate homeowners for loss, damage, or injury suffered as a result of natural disasters which science and engineering knowledge cannot prevent.

The engineering geologist is able to provide information and advice which can be used to avoid or to minimize the threat of damage or loss that might be suffered if adverse geologic conditions were not recognized. Having an engineering geologist examine a site improves the chances that such adverse conditions will be recognized. Such examinations and the information and advice that they yield have prevented millions of dollars worth of property damage. Unfortunately, our achievements are less newsworthy than the occasional failure.

We can be justifiably proud of our achievements, and it is proper that we inform the public of our successes and our ability to serve them. However, we must also be aware of our limitations.

# PRINCIPLES OF ETHICAL BEHAVIOR

Adopted 1985 (AEG Directory)

## *Preface*

Engineering Geology is a profession that requires scientific knowledge, experience and good judgment to practice, and that serves the public as well as private concerns. Engineering Geologists have a professional responsibility to conduct themselves in a fair and honest manner, and with a commitment to the highest ethical standards and quality of their work. This responsibility extends to the health, safety, and welfare of the public at large, to clients and employers, to colleagues, and to their profession. The Principles of Ethical Behavior are intended to serve as a model for a way of professional life. Because adherence to any statement of ethical behavior is recognized as a matter of personal choice, individual members should regard these Principles as a voluntary guide to their professional practice and conduct.

## *Article I*

### *Responsibility to the Public Health, Safety, and Welfare*

Engineering Geologists have a responsibility to promote the public health, safety, and welfare by applying their specialized knowledge to mitigate geologic hazards and geologic constraints.

#### *Engineering Geologists should:*

- 1.1 Uphold the trust held in them by the public.
- 1.2 Be willing to serve in public service positions where professional experience and judgment can benefit the public.
- 1.3 Disclose, when making any public statement, whether the statement is based mainly on fact or is an opinion.
- 1.4 Practice their profession in a legal and ethical manner, with due regard to the public health, safety, and welfare.

## *Article II*

### *Responsibility to Clients and Employers*

Engineering Geologists have a responsibility to practice as faithful agents for clients and employers with loyalty that is consistent with legal obligations and ethical practice. Engineering Geologists also have a responsibility to serve with honesty and integrity, and place priority on quality of service.

#### *Engineering Geologists should:*

- 2.1 Maintain undivided loyalty with the client or employer, so far as is consistent with their obligations to the public.
- 2.2 Uphold the trust placed in them by the client or employer to practice with professional and fiscal responsibility.
- 2.3 Respect the confidential nature of the relationship that exists between Engineering Geologists and their clients or employers.

- 2.4 Promptly disclose to a prospective client or employer any existing or potential conflict of interest.
- 2.5 Avoid misrepresentations of their professional credentials and avoid false or misleading claims of their capabilities.
- 2.6 Accept only those assignments for which they are qualified.
- 2.7 Alert a client or employer when another professional's expertise will be required for an assignment.
- 2.8 Express only those professional opinions that have a sound basis in fact or experience.
- 2.9 Bring to the attention of a client or employer such potential consequences of their work as may have significant impact on the public health, safety, and welfare or operational success of the subject project.

*Article III  
Responsibility to Colleagues*

Engineering Geologists have a responsibility to interact with honesty and integrity toward all colleagues.

*Engineering Geologists should:*

- 3.1 Show professional respect and courtesy toward colleagues.
- 3.2 Avoid plagiarism by giving credit to others for their work.
- 3.3 Be willing to share professional knowledge with others.
- 3.4 Disclose the reason they are seeking information from a colleague if the purpose is to consider a lawsuit or claim based upon the information they may receive.

*Article IV  
Responsibility to the Profession*

Engineering Geologists, as the beneficiaries of accumulated scientific knowledge and experience, have a responsibility to advance the profession of Engineering Geology.

*Engineering Geologists should:*

- 4.1 Set a professional example for all colleagues.
- 4.2 Continue to upgrade their technical capabilities through education and participation in professional activities.
- 4.3 Encourage academic and professional development within the field of Engineering Geology.
- 4.4 Encourage qualified persons to enter the field of Engineering Geology.

In accordance with the consent decree entered between the U.S. Justice Department and AEG in 1984, nothing in these Principles of Ethical Behavior prohibits commercial advertising, price competition, or solicitation in the sale of engineering geology services. Such advertising, price competition, or solicitation is not unethical, unprofessional, or contrary to any policy of AEG.

## SELECTED REFERENCES

- American Society of Civil Engineers (ASCE), 1990, *Quality in the Constructed Project, A Guide for Owners, Designers, and Constructors, Volume 1: Manuals and Reports on Engineering Practice No. 73*, American Society of Civil Engineers, 345 East 47th Street, New York, New York 10017-2398. 144 pages, \$28.00.
- Association of Engineering Geologists, 1990, *Suggested Geologist Practice Act; a State Act to Register Geologists: based on the draft "Model Law" prepared by the Council of Professional Geological Organizations (CoPGO)*, 23 p.
- Association of Engineering Geologists (AEG), 1993, *Directory; Principles of Ethical Behavior and Policy on Registration: Association of Engineering Geologists*, p. 14-15 and p. 18.
- Kiersch, G.A., ed., 1991, *Heritage of engineering geology; first hundred years 1888-1988: Boulder, Colorado, Geological Society of America, Centennial Special Volume No. 3*, 605 p. (Includes chapters on: failures of engineered works; errors of judgment, controversies; geologist and legal responsibilities; and forensic geoscience.)
- Kiersch, G.A., 1955, *Engineering geology; historical development, scope, and utilization: Quarterly, Colorado School of Mines*, v. 50, no. 3, 122 p. (Early review of processes and features common to practice of engineering geology as a basis of litigation.)
- Tepel, Robert E., ed., 1990, *Proceedings, National Colloquium on Professional Registration for Geologists: Association of Engineering Geologists, 33rd Annual Meeting, Pittsburgh, Pennsylvania*. 259 P.
- Tepel, Robert E., 1993, *Issues in Professional Registration XI, Should state and local government geologists be registered?: Association of Engineering Geologists, AEG News*, v. 36, no. 3, Summer 1993, p. 38-41.
- Paige, S., ed., 1950, *Application of Geology to Engineering Practice (Berkey Volume): Geological Society of America, Boulder, Colorado*, 327 p. (First major book on engineering geology practice. See especially chapter by E.B. Burwell and G.D. Roberts, "The geologist in the engineering organization".)

## RESOURCE LISTS

The following resource lists are intended to provide an introduction to some of the organizations and agencies that might be of interest and use to engineering geologists. To save space, many organizations are referred to by their acronyms, so Resource List One is a list of Acronyms that will help the reader navigate through the other resource lists. Suggestions for additions to the resource lists are welcome and should be forwarded to AEG's Executive Director.

### RESOURCE LIST ONE

#### Some Organization Acronyms

AAPG	American Association of Petroleum Geologists
AASG	Association of American State Geologists
AEG	Association of Engineering Geologists
AGI	American Geological Institute
AGU	American Geophysical Union
AGWS&E	Association of Ground Water Scientists and Engineers (A division of NGWA, formerly NWWA)
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASBOG	Association of State Boards of Geology
ASDSO	Association of State Dam Safety Officials
ASFE	Association of Engineering Firms Practicing in the Geosciences (formerly Association of Soils and Foundation Engineers)
ASTM	American Society for Testing and Materials
ATC	Applied Technology Council
CLEAR	Council on Licensure, Enforcement, and Regulation
COGS	Computer Oriented Geological Society
CoPGO	Council of Professional Geological Organizations
EERI	Earthquake Engineering Research Institute
EERC	Earthquake Engineering Research Center
GSA	Geological Survey of America
IAEG	International Association of Engineering Geology
IGWC	International Ground Water Modeling Center
NCEER	National Center for Earthquake Engineering Research
NCSL	National Conference of State Legislatures
NGWA	National Ground Water Association
NOAA	National Oceanic and Atmospheric Administration
NOCA	National Organization for Competency Assurance
NRC	National Research Council
NSPE	National Society of Professional Engineers
SSA	Seismological Society of America
SIPES	Society of Independent Earth Science Professionals
USBR	U. S. Bureau of Reclamation
USCOLD	United States Committee on Large Dams

## RESOURCE LIST TWO

Selected Journals, Magazines, and Newsletters of Potential Value to Engineering Geologists.  
Add your favorites to this list! Acronyms are on list one and addresses are on list three.

AEG NEWS (Magazine, AEG)  
Boston Society of Civil Engineers Journal  
Briefings, NGWA  
Bulletin of the Association of Engineering Geologists, AEG  
Bulletin of the Geological Society of America  
Bulletin of the International Association for Engineering Geology, IAEG  
Canadian Geotechnical Journal, Toronto  
Civil Engineering (Magazine, ASCE)  
COGSletter (Newsletter)  
Earth Surface Processes (Elsevier)  
Earthquake Spectra, EERI  
EERI Newsletter  
Engineering Geology, Elsevier, Amsterdam  
Engineering Times (Newsletter, NSPE)  
Engineering News-Record (ENR, Magazine)  
EOS (Transactions of AGU) (Newspaper)  
Geological Society of America, Monographs and Special Papers  
Geology (GSA, Magazine)  
Geotechnique  
Geotimes (AGI)  
Ground Water (AGWS&E)  
Ground Water Modeling Newsletter (IGWC)  
Ground Water Monitoring Review (NGWA)  
Highway Research Record, Washington D.C.  
International Landslide Research Group Newsletter  
Institution of Civil Engineers, Proceedings; London  
Journal of Geophysical Research (AGU)  
Journal of the Construction Division, ASCE  
Journal of the Geotechnical Engineering Division, ASCE  
Journal of the Irrigation Division, ASCE  
Journal of Professional Issues in Engineering Education and Practice, ASCE  
Natural Hazards (Bulletin of the International Society for Natural Hazards)  
NCEER Information Service News  
NEWS - Earthquake Engineering Research Center  
Quarterly Journal of Engineering Geology, London  
Reviews in Engineering Geology (GSA)  
Tectonophysics (Elsevier)  
Tunnels and Tunneling, London  
Underground-Space (Elmsford, New York -- Pergamon Press)  
Water Well Journal, Ground Water Publishing Co. (See NGWA)



## RESOURCE LIST THREE

Some Professional Associations and Research Organizations with Publications,  
Educational Programs, or other Functions of Potential Interest to Engineering Geologists

American Association of Petroleum  
Geologists  
P.O. Box 979  
Tulsa, OK 74101-0979

American Society of Civil Engineers (ASCE)  
345 East 47th Street  
New York, NY 10017-2398

International Ground Water Modeling Center  
Institute for Ground-Water Research and  
Education  
Colorado School of Mines  
Golden, CO 80401-1887

Earthquake Engineering Research Institute  
499 14th Street, Suite 320  
Oakland, CA 94612-1902

U.S. Committee for IAEG  
Roger Islesly, Secretary  
R.I. Geotechnical, Inc.  
3494 N. Shepard Ave.  
Milwaukee, WI 53211

Association of State Boards of Geology  
P.O. Box 11591  
Columbia, SC 29211-1591

Computer Oriented Geological Society  
P.O. Box 370246  
Denver, CO 80237

National Center for Earthquake Engineering  
Research  
304 Capen Hall  
State University of New York at Buffalo  
Buffalo, NY 14260-2200

Larry D. Stephens  
Executive Director, USCOLD  
Bureau of Reclamation  
P.O. Box 15236  
Denver, CO 80215

ASFE  
8811 Colesville Rd., Suite G106  
Silver Spring, MD 20910  
(301) 565-2733

Earthquake Engineering Research Center  
University of California  
1301 South 46th Street  
Richmond, CA 94804

Publications Office  
U.S. Bureau of Reclamation  
P.O. Box 25007  
Denver, CO 80225

Association of State Dam Safety Officials  
450 Old East Vine, 2nd Floor  
P.O. Box 55270  
Lexington, KY 40507

Geological Society of America  
P.O. Box 9140  
Boulder, CO 80301-9140

National Academy of Forensic Engineers  
1420 King Street  
Alexandria, VA 22314

National Conference of State Legislatures  
1560 Broadway, Suite 700  
Denver, CO 80202

Applied Technology Council  
55 Twin Dolphin Drive, Suite 550  
Redwood City, CA 94065

National Geophysical Data Center  
NOAA, E/GC1  
325 Broadway  
Boulder, CO 80303

American Water Foundation  
P.O. Box 480632  
Denver, CO 80248-0632

American Geophysical Union  
2000 Florida Avenue, N.W.  
Washington, DC 20009

National Research Council  
2101 Constitution Avenue  
Washington, DC 20418

National Society of Professional Engineers  
1420 King Street  
Alexandria, VA 22314-2794

National Ground Water Association  
6375 Riverside Drive  
Dublin, OH 43017

American Geological Institute  
4220 King Street  
Alexandria, VA 22302-1507

Seismological Society of America  
201 Plaza Professional Building  
El Cerrito, CA 94530-4003

Association of Engineering Geologists  
323 Boston Post Rd., Suite 2D  
Sudbury, MA 01776

Environmental Education Enterprises  
2764 Sawbury Blvd.  
Columbus, OH 43235

Council on Licensure, Enforcement, and  
Regulation  
P. O. Box 11910  
Lexington, KY 40578-1910

The Geological Society  
Burlington House, Picadilly  
London W1V 0JU  
United Kingdom

International Landslide Research Group  
c/o William Cotton and Associates  
330 Village Lane  
Los Gatos, CA 95030

International Conference of Building  
Officials  
5360 S. Workman Mill Rd.  
Whittier, CA 90601

## RESOURCE LIST FOUR

### State Geological Surveys

ALABAMA 205/349-2852

Alabama Geological Survey  
P.O. Box O  
Tuscaloosa, AL 35486-9780

ALASKA 907/474-7147

Alaska Geological Survey  
794 University Avenue, Suite 200  
Fairbanks, AK 99709-3645

ARIZONA 602/882-4795

Arizona Geological Survey  
845 North Park Avenue, Suite 100  
Tucson, AZ 95719-4816

ARKANSAS 501/324-9165

Arkansas Geological Survey  
3815 West Roosevelt Road  
Little Rock, AR 72204

CALIFORNIA 916/445-1923

California Division of Mines and Geology  
Department of Conservation  
1416 9th Street, Room 1341  
Sacramento, CA 95818

COLORADO 303/866-2611

Colorado Geological Survey  
1313 Sherman Street, Room 715  
Denver, CO 80203

CONNECTICUT 203/566-3540

Connecticut Geological Survey  
Department of Environmental Protection  
Natural Resources Center  
165 Capitol Avenue, Room 553  
Hartford, CT 06106

DELAWARE 302/451/2833

Delaware Geological Survey  
University of Delaware  
DGS Building  
Newark, DE 19716

FLORIDA 904/488-4191

Florida Geological Survey  
Resources Management  
Gunter Building  
903 West Tennessee Street  
Tallahassee, FL 32304-7795

GEORGIA 404/656-3214

Georgia Geological Survey  
EP, Natural Resources, Room 400  
19 Martin Luther King Jr. Drive, S.W.  
Atlanta, GA 30334

HAWAII 808/548-7533

Hawaii Geological Survey  
Department of Land and Natural Resources  
Division of Land and Water Development  
Post Office Box 373  
Honolulu, HI 96809

IDAHO 208/885-7991

Idaho Geological Survey  
Room 332, Morrill Hall  
University of Idaho  
Moscow, ID 83843

ILLINOIS 217/333-4747

Illinois Geological Survey  
121 Natural Resources Building  
615 East Peabody Drive  
Champaign, IL 61820

INDIANA 812/855-9350

Indiana Geological Survey  
611 North Walnut Grove  
Bloomington, IN 47405

IOWA 319/335-1575

Iowa Geological Survey  
Department of Natural Resources  
Geological Survey Bureau  
123 North Capitol Street  
Iowa City, IA 52242

KANSAS 913/864-3965

Kansas Geological Survey  
1930 Constant Avenue, West Campus  
The University of Kansas  
Lawrence, KS 66047

KENTUCKY 606/257-5500

Kentucky Geological Survey  
228 Mining and Mineral Resources Building  
University of Kentucky  
Lexington, KY 40506-0107

LOUISIANA 504/388-5320

Louisiana Geological Survey  
Post Office Box G  
University Station  
Baton Rouge, LA 70893

MAINE 207/289-2801

Maine Geological Survey  
Department of Conservation  
Suite House Station #22  
Augusta, ME 04333

MARYLAND 301/554-5500

Maryland Geological Survey  
2300 St. Paul Street  
Baltimore, MD 21218-5218

MASSACHUSETTS 617/727-9800

Massachusetts Geological Survey  
Commonwealth of Massachusetts  
Executive Environmental Aff.  
100 Cambridge Street  
Boston, MA 02202

MICHIGAN 517/334-6923

Michigan Geological Survey  
Department of Natural Resources  
Geological Survey Division  
735 East Hazel Street  
Lansing, MI 48912

MINNESOTA 612/627-4780

Minnesota Geological Survey  
University of Minnesota  
2642 University Avenue  
St. Paul, MN 55114-1057

MISSISSIPPI 601/354-6228

Mississippi Geological Survey  
Department of Environmental Quality  
Post Office Box 5348  
Jackson, MS 39296

MISSOURI 314/364-1752

Missouri Geological Survey  
Department of Natural Resources  
Division of Geology and Land Survey  
Post Office Box 250  
Rolla, MO 65401

MONTANA 406/496-4180

Montana Geological Survey  
Bureau of Mines and Geology  
West Park Street  
Montana Tech  
Mail Hall  
Butte, MT 59701

NEBRASKA 402/472-3471

Nebraska Geological Survey  
Institute of Agriculture and Natural Resources  
Conservation and Survey  
University of Nebraska  
113 Nebraska Hall  
Lincoln, NE 68588-0517

NEVADA 702/784-6691

Nevada Geological Survey  
Bureau of Mines and Geology

University of Nevada  
Reno, NV 89557-0088

NEW HAMPSHIRE 603/862-3160

New Hampshire Geological Survey  
Department of Earth Sciences  
117 James Hall  
University of New Hampshire  
Durham, NH 03824-3589

NEW JERSEY 609/292-1185

New Jersey Geological Survey  
Division of Water Resources  
Department of Environmental Protection  
Post Office Box CN-029  
Trenton, NJ 08625

NEW MEXICO 505/835-5420

New Mexico Geological Survey  
Bureau of Mines/Mineral Resources  
Campus Station  
Socorro, NM 87801

NEW YORK 518/474-5816

New York Geological Survey  
State Museum  
Empire State Plaza  
3136 Cultural Education Center  
Albany, NY 12230

NORTH CAROLINA 919/733-3833

North Carolina Geological Survey  
Department of Environmental Health and  
Natural Resources  
Division of Land Reservoirs  
Post Office Box 27687  
Raleigh, NC 27611-7687

NORTH DAKOTA 701/224-4109

North Dakota Geological Survey  
University Station  
600 East Boulevard  
Bismark, ND 58505-0840

OHIO 614/265-6576

Ohio Geological Survey  
Department of Natural Resources  
Division of Geological Survey  
4383 Fountain Square Drive  
Columbus, OH 43224

OKLAHOMA 405/325-3031

Oklahoma Geological Survey  
100 East Boyd, Room N-131  
Norman, OK 73019-0628

OREGON 503/229-5580

Oregon Geological Survey  
Department of Geology and Mineral Industries  
910 State Office Building  
Portland, OR 97201

PENNSYLVANIA 717/787-2169

Pennsylvania Geological Survey  
Bureau of Topographic and Geologic Survey  
Department of Environmental Resources  
Post Office Box 8453  
Harrisburg, PA 17105-8453

RHODE ISLAND 401/792-2265

Rhode Island Geological Survey  
Department of Geology  
University of Rhode Island  
315 Green Hall  
Kingston, RI 02881

SOUTH CAROLINA 803/737-9440

South Carolina Geological Survey  
5 Geology Road  
Columbia, SC 29210-9998

SOUTH DAKOTA 605/677-5227

South Dakota Geological Survey  
Department of Water and Natural Resources  
University of South Dakota Science Center  
Vermillion, SD 57069-2390

TENNESSEE 615/742-6689

Tennessee Geological Survey  
Department of Conservation  
Division of Geology  
Customs House  
701 Broadway  
Nashville, TN 37243-0445

TEXAS 512/471-7721 or 512/471-1534

Texas Geological Survey  
Bureau of Economic Geology  
The University of Texas at Austin  
Box X  
University Station  
Austin, TX 78713

UTAH 801/581/6831

Utah Geological Survey  
606 Black Hawk Way  
Salt Lake City, UT 84108

VERMONT 802/244-5164

Vermont Geological Survey  
Agency of Natural Resources  
Division of Geology and Mineral Resources  
103 South Main, Center Building  
Waterbury, VT 05676

VIRGINIA 804/293-5121

Virginia Geological Survey  
Division of Mineral Resources  
Natural Resources Building  
McCormick Road  
Post Office Box 3667  
Charlottesville, VA 22903

WASHINGTON 206/459-6372

Washington Geological Survey  
Department of Natural Resources  
Geology and Earth Resources Division  
Mail Stop PY-12  
Olympia, WA 98504

WEST VIRGINIA 304/594-2331

West Virginia Geological Survey  
Mont Chateau Research Center  
Post Office Box 879  
Morgantown, WV 26507-0879

WISCONSIN 608/262-1705

Wisconsin Geological Survey  
3817 Mineral Point Road  
Madison, WI 53705-5100

WYOMING 307/766-2286

Wyoming Geological Survey  
Box 3008  
University Station  
Laramie, WY 82071

## RESOURCE LIST FIVE

### State Boards and Offices Regulating the Practice of Geology

**ALASKA 907/465-2540 Randall Burns, Division Director**

Alaska Dept. of Commerce and Economic Development  
Division of Occupational Licensing  
P. O. Box D  
Juneau, AK 99811-0800

**ARIZONA 602/255-4053 Ronald W. Dalrymple, Executive Director**

Arizona State Board of Technical Registration  
1951 West Camelback Road, Suite 250  
Phoenix, AZ 85015

**ARKANSAS 501/371-1488 Charles J. Hoke, Chairman**

Arkansas Board of Registration for Professional Geologists  
c/o Arkansas Geological Commission  
3815 West Roosevelt Road  
Little Rock, AR 72204

**CALIFORNIA 916/445-1920 Vacant, Executive Officer**

State Board of Registration for Geologists and Geophysicists  
400 R Street, Suite 4060  
Sacramento, CA 95814

**DELAWARE 302/571-3288 Donna M. Organist, Chairman**

Delaware State Board of Registration of Geologists  
Delaware State Office Building  
820 French Street - 3rd Level  
Wilmington, DE 19801

**FLORIDA 904/488-1105 Anna Polk, Executive Director**

The Board of Professional Geologists  
Dept. of Professional Regulation  
1940 N. Monroe Street  
Tallahassee, FL 32399-0750



**GEORGIA 404/656-3941 Barbara Wilkerson, Executive Director**

George State Board of Registration for Professional Geologists  
Secretary of State, Examining Boards Division  
166 Pryor Street S. W.  
Atlanta, GA 30303

**IDAHO 208/334-2268 Raymond W. Tekverk, Chairman**

Idaho State Board of Registration for Professional Geologists  
State House Mail  
Boise, ID 83720

**INDIANA 812/855-9350 Rebecca Covey, Certification Secretary**

Indiana Geological Survey  
611 North Walnut Grove  
Bloomington, IN 47405

**KENTUCKY 502/564-3296 David C. Scott, Chairman**

Kentucky Board of Registration for Professional Geologists  
Division of Occupations and Professions  
Post Office Box 455  
Frankfort, KY 40602

**MAINE 207/582-8723 Andrews L. Tolman, Chairman**

Maine State Board of Certification for Geologists and Soil Scientists  
Dept. of Professional and Financial Regulation  
State House Station 35  
Augusta, ME 04333

**NORTH CAROLINA 919/850-9669 Robert M. Upton, Administrator**

North Carolina Board for Licensing of Geologists  
P. O. Box 27402  
Raleigh, NC 27611

**OREGON 503/378-4180 Edward B. Graham, Administrator**

Oregon State Board of Geologist Examiners  
750 Fremont Street, N.E., #240  
Salem, OR 97310

**PENNSYLVANIA 717/783-7049 J. Robert Kline, Administrative Assistant**

State Board of Registration for Professional  
Engineers, Land Surveyors, and Geologists  
Bureau of Professional and Occupational Affairs  
P. O. Box 2649  
Harrisburg, PA 17105-2649

**SOUTH CAROLINA 803/253-4127 Ms. Sam Swinehart, Executive Director**

South Carolina Board of Registration for Geologists  
Post Office Box 11904  
Columbia, SC 29211-1904

**TENNESSEE 615/741-3449 Marilyn Evelyn Hand, Assistant Commissioner**

Tennessee Dept. of Commerce and Insurance  
Division of Regulatory Records, Geology Section  
500 James Robertson Parkway  
Nashville, TN 37243-4917

**VIRGINIA 804/367-8595 Peggy Wood, Administrator**

Virginia Board of Geology  
Commonwealth of Virginia  
Dept. of Commerce  
3600 West Broad Street  
Richmond, VA 23230-4917

**WYOMING 307/766-2490 Gary B. Glass, Secretary-Treasurer**

Wyoming Board of Registration for Professional Geologists  
P. O. Box 3008  
Laramie, WY 82071-3008

Certain states partially control the practice of geology by requiring some level of registration for groundwater work, notably for those working with underground storage tanks, sanitary landfills, and hazardous waste. Contact information is given below for these states. Geologists who wish to practice in these states in the general fields noted should be sure to make contact and follow applicable rules. There is no "Board of Registration" in these states. "Registration" is implemented by the state office noted.

In Iowa, certain ground water professionals must register with the UST program in the Department of Natural Resources. Contact: Iowa DNR, Underground Storage Tank Section, Wallace State Office Building, 900 East Grand, Des Moines IA 50319. Telephone (515) 281-8779.

In New Jersey, the UST regulations have a definition of qualified ground water consultant and a certification program is in place. Contact Ken Goldstein, Bureau of Underground Storage Tanks, Division of Natural Resources, CN-039, Trenton NJ 08625-0029. Telephone (609) 984-3156.

In Nevada, USTs and hazardous waste consulting come under the purview of the Division of Environmental Protection in the Department of Conservation and Natural Resources. Contact them at 123 West Nye Lane, Carson City NV 89710. Telephone (702) 687-5872.

Wisconsin has a definition of "hydrogeologist" in its solid waste codes, as well as a certification statement required for reports submitted to its Department of Natural Resources regarding landfills. For information, contact Paul M. Huebner, Site Evaluation Leader, Wisconsin Dept. of Natural Resources, Solid Waste Management Section, P.O. Box 7921, Madison WI 53707. Telephone (608) 267-7573.

Note: personnel, addresses, and telephone numbers, as well as extent of regulation, are subject to change.

## RESOURCE LIST SIX

### Some Sources of Out-of-Print Geological Publications

James Leishman, Bookseller  
P.O. Box 1529  
Jacksonville, OR 97530-1529

The Hannum Company  
P.O. Box 1505  
Ardmore, OK 73402

Michael Dennis Cohan, Bookseller  
502 W. Adler St.  
Missoula, MT 59802

Mount Eden Bindery and Books  
P.O. Box 1014  
Cedar Ridge, CA 95924

Peri Lithon Books  
P.O. Box 9969  
San Diego CA, 92169-1996

Bob Coffin Books  
3661 So. Maryland Parkway  
Maryland Square  
Las Vegas, NV 89109

Sam Wellers Zions Bookstore  
254 S. Main  
Salt Lake City, UT 84101

## Chapter 2

### STANDARDS AND GUIDELINES

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## Chapter 2

### STANDARDS AND GUIDELINES

by

Allen W. Hatheway, James E. Slosson, and Seena N. Hoose,  
with the assistance of others as indicated

#### INTRODUCTION

This chapter is intended as an initial focus for each engineering geologist to develop a collection of guidelines and standards useful for their individual practice and the locale where they do most of their work. It is not intended to be complete, as many guidelines for various types of work will be entirely local in nature. Guidelines and standards may not include items which are critical to particular investigations, and the alert engineering geologist is expected to recognize these situations and exercise prudent professional judgment.

This chapter is in part inspired by the ASCE publication, "Quality in the Constructed Project; A Guide for Owners, Designers and Constructors" (1990), and like that document is intended to be a living document, subject to ongoing review, revision, and addition. You are strongly encouraged to become a part of this continuing process by sending your comments and recommendations to the Manager of the Ethics and Professional Practices Committee, c/o AEG Executive Director, Edwin A. Blackey, Jr., 323 Boston Post Road, Suite 2D, Sudbury, MA 01776.

You are also encouraged to clip and insert articles and other information into this chapter to make it more practical and useful in your specific practice. As suggested later in this chapter you may even wish to develop a notebook containing the standards and guidelines you frequently use, in addition to the list of references and resource literature discussed in Chapter 1.

#### *Standards, Guidelines, and Standard-of-Care*

Nothing in this Handbook is intended to be a Standard-of-Care, nor does it represent a baseline or minimum standard for correct or appropriate professional engineering geologic work. Rather the intent is to provide a framework from which each individual can develop project approaches that are thorough and scientifically sound, taking into consideration local and site specific conditions.

A standard (used as a noun) is "an accepted measure of comparison for quantitative or qualitative value, a criterion." Used as an adjective, a standard is defined as "serving as a standard of measurement or value; commonly used and accepted as an authority" (Webster's II, 1984). Thus, when we are talking about standards we are discussing a method or procedure which will generate uniform or reproducible results. Examples of standards include analytical methods such as found in EPA SW-846, the Unified Soil Classification System (ASTM D 2487-92), the Standard Test Method

for Rock Mass Monitoring Using Inclinometers (ASTM D 4622-86), and many others. Generally speaking, deviation from a standard results in invalidation of the results or observations.

A guideline (noun) is "a statement of policy or procedure." A guide (noun) is "one who leads the way, directs, or advises; one employed to point out and give information about objects of interest; something serving to indicate or direct" (Webster's II, 1984). Thus, a guideline is clearly advisory and does not include the restriction from deviation inherent in a standard. Some guidelines are included in this chapter. Many guidelines are being developed for investigations of soil and groundwater contamination. It is particularly important to recognize that the various regulatory reviewers who will evaluate your work, are going to use their particular guideline for that evaluation. The report will be judged complete or incomplete, adequate or inadequate (Notice of Deficiency to the owner/client), on the basis of the guideline employed. The purpose of most guidelines is to: 1) avoid overlooking something normally of concern; 2) to list standard procedures and protocols; 3) to provide uniformity to the reports received by the reviewing agency; and 4) to increase the efficiency of the investigations for both the consultant and the regulatory reviewer, thereby saving both public and private monies. Consequently, when the consultant performing a site specific investigation determines that a particular item in the pertinent guideline is not necessary or appropriate at that site, the report should contain a specific statement that the item was not performed and provide the logic and basis for not performing that item. When this is done, the regulatory reviewer knows that the item was not left out of the report through negligence or incompetence on the part of the consultant, and a discussion of the reasons can begin if the regulatory reviewer does not agree with the consultant.

The use of standards and guidelines, as well as protocols, is an inherent part of the practice of engineering geology. However, the use of these tools does not absolve the professional engineering geologist from the responsibility to exercise scientific judgment, initiative, and creativity in the evaluation of engineering geologic problems and projects. Remember that conditions not envisioned by the authors of guidelines and standards may exist at your site. In addition, other approaches or methods of equal or superior merit may be developed.

### ***The Scientific Approach***

Engineering geology is a science, applied to the needs of mankind. Science and research are commonly confused. Research is the process that discovers new principles and relationships. Science is the systematic application of known principles in the "observation, description, experimental investigation, and theoretical explanation of natural phenomena" (Webster's II, 1984). When an engineering geologic investigation is performed in accordance with known scientific principles, fewer problems arise during the investigation, findings and conclusions are credible, and the conditions are corrected or a safe design developed with the least expense. Our profession can't afford "junk science", mere play-acting at being scientists, lip service to quality without the necessary thought and action (Hoose, 1992).

Careful forethought and consideration of the various possible geologic conditions at a specific site, or a thorough evaluation of all the implications of apparent inconsistencies in data, is unfortunately lacking in many reports. It appears that under the hurry to "get the job done" sometimes insufficient time is allowed for the necessary thinking processes. All of us are really being paid to think, to apply

geologic principles and knowledge to the problem at hand; to use multiple working hypotheses to evaluate the causes of the conditions we observe and thus find reasonable approaches to achieving the goals of the investigation. If you have not recently re-read T.C. Chamberlin's article, *The Method of Multiple Working Hypotheses* (1897), you may find it illuminating. This is where good geology begins. We all studied this article in school and learned it at the outcrop. Remembering to use this thought process from the beginning of a project to the end will save time and money and will result in a better project.



## **STANDARDS, GUIDELINES AND PROTOCOLS: KEEPING OUR HOUSE IN ORDER**

Perspectives No. 10 by Allen W. Hatheway  
(from AEG NEWS, 1992, v. 35, #1, pgs. 26-28)

Association President Garrison has asked the Committee on Ethics to undertake a revision of the 1981/1985 "Professional Practice Guidelines". The Guidelines were conceived by Mavis Kent in 1978 and were eventually edited by Past-Presidents Glenn Brown and Richard Proctor, with contributions from a number of Association members. The timing is now right for a thorough revision, through an expansion of the previous edition. The Committee has determined that one of the new topics for inclusion will be "Standards, Guidelines and Protocols", hence the topic of this Perspectives.

The manner in which we perform our professional work, both technical and administrative, is, and should be, subject to informed scrutiny as to its nature and completeness. Traditionally, academic training, published literature and personal experience have been the bases for how we accomplish our work. Along with the rapid growth of our professional technology has come a real and reasoned concern for the liabilities associated with professional practice. Development, assimilation and transfer of technologies and methodologies of engineering geology are a matter of concern to the Association. We must have the basis for constant reference access to such information both for the purposes of planning, preparing and conducting our work, but also to defend the scope and care by which we have performed our assignments.

This body of reference is contained in the standards, guidelines, and protocols that have been compiled by our own practitioners and those of allied fields of classical geology and engineering (Table 1; containing definitions by the author).

The definitions presented herein are my own, developed in the course of my own professional practice. Each of us should strive to collect or self-develop, understand and employ such standards, guidelines and protocols as are useful to his/her own practice. There is no single source, list or collection that will provide all of these references necessary for the breadth of any given practice. Your professional library should become the primary source. Behind this collection of books, periodicals, reports and proceedings should be an Individual Notebook of Practice. This Notebook is an individual collection of useful reference material that you have come to rely on in your daily work. A Notebook is best compiled and tabbed from a generic outline, made up by yourself, but including such materials as forms, checklists, tables and charts culled from the literature, or as developed by yourself and colleagues. AEG is in the process (Allen W. Hatheway and Richard J. Proctor) of compiling a set of Data Sheets, in the general format of the very useful Data Sheets of the American Geological Institute. A forthcoming Perspectives will be devoted to a more complete outline of the individual topics that might be considered in compiling an Individual Notebook of Practice and for which we will also be seeking contributions for the AEG Data Sheet series.

Each of these three successive levels of elements of professional technical practice require a relative difference in degree of adherence by the practitioner (Table 2).

TABLE 1  
**THE BODY OF REFERENCE FOR PROFESSIONAL PRACTICE**

Type	Definition	Example
Standard	A codification of technology or procedure developed, tested, peer-reviewed and published by a professional society or governmental agency; to be adhered to by members and subscribers; generally must be followed closely in attention to its prescribed detail	<ul style="list-style-type: none"> <li>o American Soc. Testing &amp; Matls.</li> <li>o International Soc. Rock Mech.</li> <li>o U.S. Nuclear Regulatory Comm.</li> <li>o Corporate QC/QA programs</li> </ul>
Guideline	Formalization presented by a technical society or governmental agency as the basis for voluntary adherence as the basis for acceptance of work product; requires additional thought and evaluation by the practitioner to implement on single project work	<ul style="list-style-type: none"> <li>o AEG Prof. Practice Guidelines</li> <li>o CA DMG Guidelines</li> <li>o ASCE geotechnical procedures</li> <li>o Waste Management, Inc. Site Assessment Manual</li> <li>o AASHTO Manual on Subsurface Investigation</li> <li>o Forthcoming AEG Data Sheets</li> <li>o USBR Engineering Geology Field Manual</li> </ul>
Protocol	The literature in general; whenever the author presents a formalized means of undertaking and producing accurate and reproducible work product; generally peer-reviewed but not subject to wide scrutiny or comment of the profession; requires significant individual thought to adapt to single-project use by the professional	<ul style="list-style-type: none"> <li>o AGI Data Sheets</li> <li>o Textbooks</li> <li>o Professional Soc. Journals</li> <li>o Conference Proceedings</li> <li>o Content of Individual Notebook of Practice</li> </ul>

TABLE 2

**LEVELS OF ADHERENCE TO ELEMENTS  
OF PROFESSIONAL TECHNICAL PRACTICE**

Type	Degree of Adherence
Standard	1) As prescribed by a governing authority in a regulation implemented to enforce the intent of a law. Regulations by themselves should not, and seldom do, prescribe the manner of achieving their technical goals; engineering geologists and geotechnical engineers should be allowed to employ Best Engineering Judgement through utilization of Best Engineering Practice, much of which will be found in the elements of professional practice.
	2) Self-imposed by the practitioner or employing organization as a means of assuring accuracy and/or reproducibility of factual data or interpretations.
Guideline	1) Self- or organizationally-imposed adherence in order to achieve accurate or reproducible results and to provide an understandable means of communication between practitioners.
	2) Client-prescribed as a means of assuring completeness of work product
Protocol	1) Self-imposed as the basis for independent thought applied to planning and scoping of work to be performed.
	2) Self-imposed as the basis of developing procedures for work not directly representing previous experience, either of a technical or regionally-specific nature.
	3) Self-imposed as the basis for assuring accuracy, completeness, and reproducibility of work product.

Any practitioner has the right to develop his/her own methodology or technique of performing professional work that is accurate and reproducible. Standards, guidelines and protocols can never and should never replace the product of individual technical competence and relevant experience. Individual work, when not directly performed in accordance with an established standard or guideline should be defensible in terms of a demonstrable self-produced methodology or technique. For instance, field notes should always be orderly, intelligible and complete to the detail necessary to achieve the objective of the work performed. Adherence to standards and guidelines are necessary for one or more significant reasons:

- 1) When regulation requires such adherence
- 2) When there is a need to communicate the work product in a readily understandable form, format, language, terminology or symbology
- 3) As a personal means of assuring accuracy, completeness and reproducibility of work product

Adherence to standards and guidelines is obviously a means of assuring not only accuracy and reproducibility but to portray one's work product in the most understandable fashion to colleagues and other users of such work (Table 3).

Standards, guidelines and protocols are the means by which we can more effectively conduct our professional practice. In the absence of specific regulatory or client-prescribed requirements, the choice of these elements of professional practice is the responsibility of the individual practitioner. Use of these elements of practice will make our work product more accurate and complete and will promote a wider understanding and usefulness of that product. We should all strive to improve our access to, understanding of, and frequent use of standards, guidelines and protocols.

## ABBREVIATIONS

AASHTO:	American Association of State Highway & Transportation Officials
AGI:	American Geological Institute
ASCE:	American Society of Civil Engineers
CA DMG:	California Division of Mines & Geology, Sacramento
USBR:	United States Bureau of Reclamation

TABLE 3

**RELATIVE SPECIFICITY OF ELEMENTS  
OF PROFESSIONAL TECHNICAL PRACTICE**

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Type	Relative Specificity as a Basis for Practice
Standard	Most specific; leaves little flexibility in the means by which work is performed or reported; employs well-defined descriptions of work method or technique, terms and symbols.
Guideline	Moderately specific; usually dwells on the general details of organization content, and scope of professional work; provides considerable flexibility in the manner in which the work is performed and in the detail of such work; requires moderate thought and effort to develop the means of data collection and interpretation required to complete the assignment.
Protocol	Least specific; requires considerable thought on the part of the professional, in terms of applying methods and procedures to specific work tasks; generally does not contain all of the elements or considerations required to produce a high degree of accuracy or reproducibility of work product.

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**THE TECHNICAL STANDARDS OF ENGINEERING GEOLOGY**  
*MOSTLY UNWRITTEN, YET THEY ARE IN PLACE AND SHOULD BE OBSERVED*

Perspectives No. 11 by Allen W. Hatheway  
(from AEG NEWS, 1992, v. 35, #2, pgs. 27-29)

Perspectives No., 10 (v. 35, no. 1, January 1992), addressed an important part of the Elements of Professional Practice, the hierarchy of standards, guidelines, and protocols that we use as references to plan and conduct our professional work. Much needed to be said about the topic and the space was limited. On that account, I now want to identify the categories of these references by which we can make our work meet our own needs as well as those of our clients, and generally help us produce a better work product.

This whole subject of what is "sufficient" in terms of site-related data and engineering geologic conclusions and recommendations is seldom discussed. The "bottom-line" answer is that the owner always expects to avoid problems that could be related to inaccuracies or gross errors in the site data that underlie our geotechnical recommendations for design, construction, operation and maintenance of the project. At the same time, these very same owners are generally poorly informed or downright ignorant of the time and funding requirements necessary to produce reasonably high-quality field data. The entire breadth of the geotechnical and environmental practices are under attacked from cost-cutting measures from uninformed or unthinking clients or their representatives (often structural, hydrologic, hydraulic, and environmental engineers, along with architects, and regrettably, all too often by administrators, purchasing agents, and accountants). These individuals all want the geotechnical work done in a hurry, at the worst possible seasonal times, at the cheapest possible cost, and with the greatest possible reproducibility and accuracy.

Relatively few of the procedures and techniques utilized in geotechnical and environmental field activities have been codified and peer-reviewed to create formal standards. Standards of Professional Practice, as discussed herein, include the standards, guidelines, and protocols discussed in Perspectives No. 10, and are broadly defined herein as "Reasoned, step-by-step, procedures by which technical works of a professional scientific or engineering nature are carried out so that the results are repeatable, reproducible, and of sufficient accuracy to meet the intent of the sponsoring organization".

A.E.G, along with a couple of other geotechnically-oriented organizations, is making progress toward development of standards. Its own Engineering Geology Standards Committee has the following charge:

- 1) holding symposia on means to increase the uniformity of our work, and seeing that such papers are published;
- 2) reviewing agency (such as USNRC) staff technical papers on procedures, as requested, and;
- 3) establishing technical standards for the engineering geology profession, as represented by the Association membership.

Engineering geologists and other geotechnical personnel should be familiar with the various forms of professional standards to which they can refer for guidance. I have found that there are 11 separate categories of these "standards" for engineering geological practice (Table 1).

The United States has been the world pioneer in development of technical standards for many purposes. Foremost among these efforts have been those of the American Society for Testing and

Materials (ASTM), organized in 1898, and currently producing a huge variety of Standards and other peer-reviewed procedural guidance for all manner of professional services, along with a greater variety of manufactured and constructed products. Since 1932<sup>1</sup> ASTM has served as a clearing house for professionals volunteering their time to formulate and discuss standardized procedures and techniques for making observations and/or collecting information of a geotechnical nature.

Relatively few ASTM standards are of importance to engineering geologists. Notably, the proposed standard<sup>2</sup> for groundwater monitoring wells, should prove to be the first of a line of potentially helpful standards.

Should problems occur during construction, operation or maintenance of the project, who is at first thought to be at the cause? The field personnel, of course, those who often work uncompensated for a goodly percent of their field time (making the site investigation is completed on time, and within a budget conceived by someone who has no commitment to go to the field, and often never does show up there).

Added to these pressures are the facts that the traditional professional engineer's ethical aversion to price competition (the odious practice of "bid-shopping" by clients) was struck down some ten years ago by the U.S. Supreme Court, sharpening the spear tip of the U.S. Justice Department, acting in the name of "anti-trust" improvements. Into this market stream younger graduate engineers, often incompletely oriented in terms of professional ethics, eager to become wholly-owned consultants and unwary of the foibles of bid-shopping. Result: There will always be someone else competing with you; leaner, hungrier, less informed of professional liability, or just downright ignorant of the complexities of field work.

These people, well-intentioned or not, poorly informed, or just plain ignorant, will take work from you, and they will do so on the basis of cost-cutting, vague scopes of work, unsupported claims, erroneous promises of work to be completed, and/or client ignorance. When these problems occur, the cost competitors will be judged against the Standards of Professional Practice. At the same time, successful and competent professional engineering geologists and geological and geotechnical engineers must compete, when necessary, with the bid-shoppers on the basis of their personal knowledge, decisiveness, commitment, and adherence to Standards of Professional Practice. You are urged to collect these standards, to become familiar with them, to reference them in your proposals for work assignments, and to educate your clientele about them.

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(1) In that year ASTM established Committee D-19, on Water, followed in 1937, by establishment of Committee D-18, Soil and Rock.

(2) Development of Ground Water Monitoring Wells and Aquifers, Subcommittee D-18.2105.

TABLE 1  
**CATEGORIES OF ENGINEERING GEOLOGICAL STANDARDS**

Category	Definition	Examples
Formal Technical Standards	Reasoned, step-by-step, procedures by which individual work of a professional scientific or engineering nature are carried out so that the results are repeatable, reproducible, and of sufficient accuracy to meet the intent of the sponsoring organization.	ASTM Standards USGS Map Symbols GSL EG Map Symbols AEG Tech. Stds. Comm.
Technical Handbooks and Manuals	Procedural descriptions of methods and techniques for use by members of the staff of organizations and agencies	USBR Engr. Geol. Manual USSCS Engr. Geol. Manual USN Fac. Eng Design Manuals WMNA SAM USGS Prof. Paper 373
Standard Technical Reference Books	Compendia of discussions, tables, and charts, relating to subjects defined by scientific phenomena or endeavor	Hunt's two manuals GSA EG Heritage Volume GSA Berkey Volume GSL E.G. Spec. Pubs. Legget & Karrow, 1982
Technical Textbooks	Descriptive qualitative and quantitative introductions to subjects making up the	Listed in AEG Bibliography of Engineering Geology
Technical Books	Topical technical treatments, relating either to phenomena or to broad areas of technique	Listed in AEG Bibliography of Engineering Geology
Topical Journal Papers	Descriptions and examples of procedural methods of a technical nature	Bulletin of AEG Bulletin, of IAEG Engineering Geology Quarterly Journal of EG Proceedings of ASCE
Proceedings of Technical Conferences	Especially conferences organized for the purpose of treating topical subjects	ASCE/GSA/AEG Joint Comm. Various professional societies ASTM D-18 (Soil & Rock) TRB A2L01 (Cl. Earth Matls.) TRB A2L05 (Engr. Geology) TRB TF A2T61 (Rev. SR 176)
Internal Technical Guidance	Method-description for conduct of data gathering, interpretation, and evaluation of geotechnical information	Army Engr Tech. Letters, USNRC Staff Technical Papers
Internal Procedural Guidance	Procedural-description for planning and of geotechnical projects; professional persons to employ Best Available Practice and Best Available Technology, on the basis of Best Engineering Judgement	USEPA Natl Contingency Plan AEG Man. Prof. Practice
Data Collection	Systematic, tabular formats for collection and orderly presentation of technical data	CDMG Guidelines WMNA Site Assessment Manual
Tabular/Graphic Data Sheets	Reference-format presentations of checklists and known reference materials	AGI Data Sheets AEG Data Sheets
Regulatory Guidance	Procedures developed by regulatory agencies to assist technical professional personnel in use of their own professional judgement	NUREGS , USRNC USEPA Directives USEPA Guidelines



**GUIDELINES FOR PREPARING  
ENGINEERING GEOLOGY REPORTS  
REVISED 1992**

by  
James E. Slosson

assisted by  
Thomas F. Blake, Jeffrey A. Johnson, Jeffrey R. Keaton,  
Robert A. Larson, C. Michael Scullin,  
Thomas L. Slosson, and Michael B. Phipps

These guidelines are intended to be a general aid to professional geologists evaluating site-specific conditions and geologic hazards and to regulatory agencies for review of reports. The guidelines do not include systematic descriptions of all available techniques or topics, nor is it suggested that all techniques or topics be utilized on every project. Variations in site conditions and purposes of investigations may require more or permit less effort than is outlined here. All elements of these guidelines should be considered during field analysis as well as the preparation and review of engineering geology reports.

These guidelines have been revised by the Association of Engineering Geologists in 1992 utilizing the original guidelines prepared by the Building Codes Committee of the Southern California Section in 1965 (Slosson & Phipps, 1992) and later modified by the Utah Section of the Association of Engineering Geologists for the Utah Geological and Mineral Survey in 1986. The California Division of Mines and Geology in 1975 formally adopted the original 1965 version of the guidelines for the purpose of addressing the provisions of Chapter 70 of the Uniform Building Code and for establishing good engineering geology practices, and protecting the health, safety, and welfare of the public. In 1984, the California guidelines (CDMG) were published in the Bulletin of the Association of Engineering Geologists (Slosson, 1984) making them readily available to geologists and reviewers throughout the United States and the world.

**I. GEOLOGIC MAPPING AND INVESTIGATION**

- A. Geologic mapping of the subject area should be completed at a scale which shows sufficient detail to adequately define the geologic conditions present. For many purposes, available geologic maps are unsuitable to provide a basis for understanding the site conditions and independent geologic mapping is needed. If available geologic maps are used to portray site conditions, they must be field checked and updated to reflect geologic, topographic, and/or cultural changes which have occurred since map publication. It is often necessary for the geologist to extend mapping into adjacent areas to adequately define geologic conditions relevant to processes active at the subject area.

- B. Mapping should be done on a suitable topographic base map at an appropriate scale with satisfactory horizontal and vertical control. The nature, date, and source of the base should be included on each map. In certain cases where topographic base maps at scales larger than 1:24,000 (U.S. Geological Survey 7½ minute quadrangle) are not available, geologic mapping may be done and presented on an aerial photograph base of suitable scale to permit documentation of pertinent features. On small-scale maps, 1 inch commonly equals 200 feet or more, whereas on large-scale maps 1 inch equals 100 feet or less.
- C. The geologist performing the investigation and preparing the map should pay particular attention to the type and geometry of bedrock and surficial materials, characteristics of these materials that may affect their engineering properties, structural features and relationships, and the three-dimensional distribution of earth materials exposed and inferred within the area. A clear distinction should be made on the map and within the report between observed and inferred geologic features and relationships. All seeps, springs, and marshes should be indicated with estimates of discharge rates, if any, at the time of observation.
- D. The report should include one or more appropriately positioned and scaled cross sections to show three-dimensional relationships that cannot be adequately described in words alone. Fence or block diagrams may also be appropriate for describing three-dimensional relationships. Cross sections should display the available data and the interpretation of conditions between exposures.
- E. The locations of all exploratory excavations (drill holes, test pits, and trenches) should be accurately 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.
- F. A field meeting among the geologist, the regulatory reviewer, and the owner or developer may be appropriate or desirable during the geologic investigation. Such a meeting will allow pertinent issues to be discussed and fundamental geologic information to be examined by the reviewer. The data from such a meeting and the names of those attending should be included in the report.

## II. GENERAL INFORMATION

Each report should include sufficient background information to inform the reader of the general site setting, the proposed land use, and the purpose and scope of the geologic investigation. The following items should be addressed:

- A. Location and size of subject area and its general setting with respect to major or regional geographic and geologic features.
- B. Name(s) of geologist(s) who did the mapping and logging on which the report is based, dates when the mapping was done and who did the graphic arts and when the graphic arts were completed. The report and map should be signed by the project engineering geologist and/or the supervising engineering geologist. In states in which licensing is required, such as California, those signing the engineering geology reports and maps shall be certified engineering geologists and their certification numbers and/or stamps or seals shall accompany their signature(s).
- C. Purpose and scope of the report and geologic investigation.
- D. Geomorphology and drainage within or affecting the subject area.
- E. General nature, distribution, and abundance of exposures of earth materials within the subject area.
- F. Basis of interpretations and conclusions regarding the geology of the subject area. Nature and source of available subsurface information and engineering geology reports or maps. Suitable explanations of the available data should provide a technical reviewer with the means of evaluating the reliability and accuracy of the data. Reference to cited works or field observations shall be made to substantiate opinions and conclusions. New or unique methods of analysis and interpretation should be indicated as such and appropriately documented. Summaries of technical discussions with reviewers in field meetings also should be provided.
- G. Disclosure of known or suspected potentially hazardous geologic processes affecting the project area. This should include a statement regarding past performance of existing engineered slopes, as well as engineered facilities (such as buildings or utilities) in the immediate vicinity.
- H. Discussion of the limitations of the investigation and analytical techniques used, effect on project of reasonable alternate assumptions and hypotheses, and disclosure of the chosen design-life of the project.

### III. GEOLOGIC DESCRIPTIONS

The report should contain an adequate description of all natural materials and structural features recognized or inferred within the subject area. Where interpretations are added to the record of direct observations, the basis for such interpretations should be clearly stated.

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

#### A. **Bedrock**

1. Identification of rock type (such as granite, sandstone, claystone, shale, slate).
2. Relative age and, where possible, correlation with named formations (e.g., Orinda, Modelo, Rincon, Wasatch).
3. Surface expression (geomorphology), areal distribution, and origin.
4. Pertinent physical characteristics (e.g., color, grain size, nature of stratification, strength of rock materials, variability of characteristics, presence or lack of cementation, spacing, type and continuity of fracturing).
5. Special physical or chemical features (e.g., pervasiveness of fractures, voids, gypsum veins, weathering, hydrothermal alteration).
6. Distribution and extent of zones of weathering; significant differences between fresh and weathered rock.
7. Engineering properties of bedrock material and special characteristics or concerns (e.g., factors affecting grading, construction, and maintenance potential for weathering upon exposure to air in cut slopes).
8. Description of geomorphology including origin of unique features.
9. Weaknesses and/or defects observed in earth materials that may affect stability, strength of material, erosion characteristics, and other factors.

#### B. **Structural features**-stratification, faults, fractures, foliation, schistosity, and folds.

1. Occurrence, distribution, dimensions, orientation and variability; projections into subject area.

2. Relative ages where pertinent.
  3. Special features of faults (e.g., topographic expression, zones of gouge and breccia, groundwater association, nature of offsets, timing of movements, youngest faulted unit and oldest unfaulted unit).
  4. Effects on rock materials that may alter strength and stability (i.e., spacing, continuity, and type of fractures and their origin, etc.).
  5. Special engineering characteristics or concerns.
- C. **Surficial or unconsolidated deposits**-alluvial, colluvial, eolian, alluvial fan, lacustrine, marine, glacial residual, mass movement, volcanic (such as cinders and ash), and historical fill (both engineered and non-engineered).
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 characteristics (e.g., color, grain size, lithology, compactness, cementation, strength, thickness, odor, pore size, permeability, shrink and swell potential).
  4. Special physical or chemical features (e.g., indications of volume change or instability, such as desiccation cracks, slickensides, gypsum, secondary cementation related to weathering processes).
  5. Special engineering characteristics or concerns.
  6. Potential for consolidation, hydroconsolidation (hydrocompaction) seismic settlement, collapse, erosion, and other forms of ground failure.

**D. Surface hydrologic and subsurface hydrogeologic conditions.**

1. Distribution, occurrence, and variations (e.g., drainage courses, ponds, swamps, springs, and seeps).
2. Identification and characterization of saturated zones and/or aquifers, depth to ground water and seasonal fluctuations.
3. Relationships to geomorphology and geologic features, recharge areas and discharge areas.
4. Groundwater flow patterns and hydraulic gradients.
5. Evidence for earlier occurrence of water at localities now dry (e.g., vegetation, mineral deposits, historic records, photographic).
6. Special engineering characteristics or concerns (such as fluctuating water table, cause and location of perched water, and chemical content of water).
7. Discuss possible changes in groundwater condition that may be caused by the proposed project or effects of other land use changes that may cause changes to this project (i.e., increases in groundwater elevation due to irrigation, ponding of surface waters, sewage efficiency, etc.).
8. Locate and discuss groundwater recharge.

**E. Seismic considerations.**

1. Description of the seismotectonic setting of the subject area (including size, frequency, duration and location of historic earthquakes).
2. Potential for subject area to be affected by surface rupture (including sense and amount of displacement and width of zone of surface deformation).
3. Probable site response to likely earthquakes (estimated ground motion, duration and response variability).
4. Potential for subject area to be affected by primary and secondary seismic hazards such as earthquake-induced landslides, liquefaction or other types of ground failure, including rock fall.

5. Potential for subject area to be affected by regional tectonic deformation (subsidence or uplift).
6. As an example, refer to CDMG Note 42 (formerly CDMG Note 37) and CDMG Note 43, as used in California as a support document.

#### IV. ASSESSMENT OF GEOLOGIC FACTORS

Assessment of geologic factors with respect to intended use constitutes the principal contribution of the report. It involves both 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 processes in the area.

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

- A. **General suitability** of proposed land use to geologic conditions.
  1. Areas to be avoided, if any.
  2. Effects of topography and slope on proposed land use and vice versa.
  3. Stability of earth materials.
  4. Flood inundation, erosion, and deposition.
  5. Problems caused by geologic features or conditions in adjacent properties.
  6. Effects of groundwater on project and vice versa.
  7. Other general problems.
- B. **Identification and extent of known or suspected geologic hazards** (such as flood inundation, shallow groundwater, storm surge, surface and groundwater pollution, rock or snow avalanche, various types of landslides, debris flow, rock fall, expansive soil, collapsible soil, subsidence, erosion, deposition, earthquake shaking, fault rupture, liquefaction, seiche, volcanic eruption, tsunamis).

**C. Recommendations for site grading.**

1. Prediction of what materials and structural features that will be encountered in proposed cuts and their potential for slope failure.
2. Prediction of stability based on geologic factors; recommended avoidance or engineering mitigation to cope with existing or potential landslide masses.
3. Excavation considerations (hard or massive rock, slope failure, groundwater, seepage).
4. General considerations for placement of proposed fill masses in canyons or on sidehills (i.e., benching, subdrains, backdrains).
5. Suitability of excavated material for use as compacted fill.
6. Recommendations for positioning fill masses, provisions for underdrainage, buttressing and the need for erosion protection on fill slopes.
7. Other recommendations required by the proposed land use, such as for reorientation of cut slopes, positions of drainage terraces, the need for rock-fall protection on cut slopes, the need for erosion protection on cut slopes.

**D. Drainage considerations.**

1. Relationship of property to FEMA flood zones.
2. Protection from inundation or wave erosion along shorelines, streams, etc.
3. Soil and rock permeability and the effect of infiltration and through flow on site stability.
4. Protection from sheet flood or gully erosion and debris flows, mud flows, and avalanches.

**E. Recommendations for additional investigations.**

1. Geophysical surveys, aerial photographic surveys, borings, test pits, and/or trenches needed for additional geologic information.
2. Percolation tests needed for septic system design.



3. Program of subsurface exploration and testing that is most likely to provide data needed by the geotechnical engineer or civil engineer.

**V. RECOMMENDED TECHNIQUES/SYSTEMS TO CONSIDER**

- A. Engineering geology mapping can be done using the Genesis-Lithology-Qualifier (GLQ) system rather than the conventional Time-Rock system. The GLQ system (Keaton, 1984; Compton, 1985) promotes communication of geologic information to non-geologists. The Unified Soil Classification System (U.S. Army Corps of Engineers, 1953, and American Society for Testing and Materials, 1990) has been used in engineering for many years and can be adapted for mapping. It 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.
- E. A number of the local governmental agencies have adopted specific ordinances regarding hillside development, citing issues with respect to proximity to fault traces, requirements for septic system designs, waste material disposal requirements, and others. The geologist should check with local agencies regarding such ordinances that might affect specific aspects of the project requirements.

**SELECTED REFERENCES for PREPARING ENGINEERING GEOLOGY REPORTS**

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- Uniform Building Code, 1991, Chapter 23, Part III--Earthquake Design: International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, CA 90601, p. 156 to 196.
- Uniform Building Code, 1991, Chapter 23, Division II--Earthquake Recording Instrumentation and Division III--Earthquake Regulations for Seismic-isolated Structures: International Conference of Building Officials, 5360 South Workman Mill Road, Whittier, CA 90601, p. 874 to 896.

**GUIDELINES TO GEOLOGIC/SEISMIC REPORTS  
AND TECTONIC EARTHQUAKE SITE ANALYSIS  
Revised 1992**

by  
James E. Slosson, Robert A. Larson,  
and Jeffrey A. Johnson

**I. INTRODUCTION**

These guidelines for geologic/seismic reports represent an updated modification of the original guidelines that were taken from "Geology and Earthquake Hazards: Planners guide to the seismic safety element" prepared by the Grading Codes Advisory Board and Building Code Committee of the Southern California Section, Association of Engineering Geologists, July 1973. These guidelines were in turn adopted by the California Division of Mines and Geology, Department of Conservation, in August of 1973 as guidelines for reports submitted for siting, design and construction of hospital and other critical structures in California (CDMG Note 37). In 1986 the Utah Section of the Association of Engineering Geologists utilized portions of the same guidelines for their guidelines for preparing engineering geologic reports in Utah. Utah's guidelines were adopted by the Utah Geological and Mineral Survey and printed and released as Miscellaneous Publication M.

This is a suggested guide or format for the seismic section of an engineering geology report or for a geologic/seismic report. The guidelines may be used for projects ranging in size from a single lot to a master plan for a residential planned development or scoped to be adequate for hospitals, schools, emergency service facilities and other critical facilities. The scope and degree of in-depth analyses should be programmed to complement the size and lateral extent of the proposed or existing structure(s) and the critical nature of the facility(s). It recognized that the extent of a study will be a much greater effort for a hospital than for a condominium complex. The scope should also be adjusted to the degree of the seismic exposure and resultant geologic/seismic hazard(s). It must be recognized that a site near or immediately adjacent to an active fault such as the San Andreas fault or lesser fault such as the Sierra Madre fault will be subject to a much greater seismic exposure and potential hazard than a site in Fresno. Because of this wide variation, the order, format, and scope should be flexible and tailored to the seismic and geologic conditions of the site and region as well as the intended land use. The following suggested format is intended to be relatively complete and it should be understood that not all items are applicable to small projects or low risk sites. Additionally, some articles may be covered in separate reports by geotechnical engineers, seismologists, or structural engineers but cross-referencing should be used to explain where such items are discussed and where redundancy occurs.

The geologic/seismic reports must discuss to the extent necessary all seismic-related factors such as, but not limited to, the past history and future potential for seismic strong motion, fault rupture, energy focusing, site specific ground acceleration, and seismically induced ground failures such as landslides, rock fall, liquefaction, lurching, subsidence, etc.

Prior to start of the investigation, it is recommended that all parties (owner, geologist, etc.) have a clear understanding, in writing, of the acceptable level of risk that is appropriate for the proposed facility. Design recommendations based on the appropriate acceptable level of risk will provide reasonable protection of public safety, though not necessarily providing for the continued use or functionality of the project following a major earthquake. Acceptable level of risk is commonly stated as a percent probability of exceedence for a particular structural design life (i.e., 10% probability of exceedence in 50 years).

## **II. THE INVESTIGATION**

### **A. Regional Review**

A descriptive analysis of the seismic or earthquake history of the region should establish seismic exposure and the relationship of the site to known faults, epicenters and the regional earthquake cycle. This would be based primarily on review of existing maps, technical literature, etc., and would include:

1. Complete list of all seismogenic faults at or within 50 to 100 km of the site. Location of major or regional faults should include a 100 km search for the more critical facilities such as emergency service buildings, police and fire stations, hospitals, schools, and high-rise buildings. Less critical, such as subdivisions, shopping centers, etc., should include a 50 km scan.
2. Complete list of all historic seismicity within 100 to 200 km of the site for magnitudes greater than 3 to 4.
3. Largest historic earthquake associated with each fault.
4. Complete list of historic seismicity associated with each fault including magnitude (i.e.,  $M_p$ ,  $M_s$ , etc.), and an estimate of the upper and lower bound significant earthquakes. A review of microseismicity may be necessary to establish or estimate fault location, activity, etc.
5. List of available paleoseismicity data for each fault.
6. Slip-rate data for each fault.
7. Review of fault-specific and regional tectonic earthquake cycle data including a plot of the Gutenberg-Richter frequency of earthquake occurrence.
8. Fault length, fault type, and location and extent of known or possible fault segments.

9. Review of regional Global Position Survey data.
10. Selection of appropriate strong-motion attenuation and magnitude vs. fault rupture length relationship(s).
11. Review of local and regional site conditions including a determination of the general site (i.e., soil, rock, etc.) and topographic (i.e., valley, ridge, etc.) conditions.
12. Review and collection of historic earthquake data including reports of damage at and/or near the site and recorded strong-motion data (strong motion data can either be recorded locally or under similar site conditions).
13. Review of published probabilistic estimates of earthquake occurrence.
14. Cataloging and production of support technical reports, maps, cross sections, graphs, attenuation curves, tables of historic earthquakes, etc.

As an example, basic references for the State of California could include, among others:

1. Bortugno, E. J. and Spittler, T. E., 1986, Geologic Map of the San Bernardino Quadrangle: CDMG Map No. 3A
2. Jennings, C. W., 1975, Fault Map of California: CDMG Map No. 1
3. Mualchin, L. and Jones, A. J., 1992, Peak Acceleration from Maximum Credible Earthquakes in California (rock and stiff-soil sites): CDMG Open-File Report 92-1
4. Scholz, C. H., 1990, The Mechanics of Earthquakes and Faulting: Cambridge University Press
6. Wallace, Robert E, editor, 1990, The San Andreas Fault System, California: USGS Professional Paper, 1515, 283 pp.
5. Ziony, J. E., editor, 1985, Evaluating Earthquake Hazards in the Los Angeles Region--an earth science perspective: USGS Professional Paper 1360

## **B. Site Investigation**

The site (and near site) investigation and analysis should include a specific descriptive (i.e., describe, measure and quantify) and kinematic analysis of geologic conditions that might indicate recent coseismic fault rupture and the existence or potential for ground failure. The

degree of detail of the study should be compatible with the type of development and geologic complexity. The investigation should include the following:

1. Location and paleoseismicity of local faults and the amount and type of slip estimated from historic records and stratigraphic relationships observed at or near the site and in trenches. Features normally related to activity such as pressure ridges, youthful fault scarps and fault line scarps, secondary or conjugate faulting, (estimates, geologic age or time related to development of fault line scarps, and alignment of landslide within fault alignment), sag ponds, alignment of springs, offset bedding, disrupted drainage systems, offset ridges, faceted spurs, dissected alluvial fans, alignment of landslides, groundwater barriers and vegetation patterns, to name a few, should be located on the geologic map and the text should discuss these observations and how the occurrences are best explained.
2. Locations and chronology of other earthquake-induced features caused by lurching, settlement, liquefaction, etc., or evidence related to the potential for ground failure. Evidence of these features should be accompanied with the following:
  - a. Map showing location relative to proposed construction.
  - b. Description of the features as to length, width and depth of disturbed zone.
  - c. Estimation of the amount of disturbance relative to bedrock and surficial materials and the kinematics of existing and potential ground failures.
3. Distribution, age, depth, thickness and nature of the various unconsolidated earth materials, including depth to the groundwater table, which may affect the seismic response and damage potential at the site should be adequately described. The potential for the groundwater table to rise following regional or local development should be reviewed.

### **C. Methods of Site Investigation**

1. Surface investigation
  - a. Study of aerial photographs and the construction of photogeologic maps. Air photos should be referred to during field mapping as well as during pre- and post-field studies. Air photos depict conditions during an instant of time. Best use of photos and interpretation can only be obtained by reviewing a series of photos taken at different times, dates, years and during different sunlight conditions.



- b. Detailed field geologic mapping.
  - c. Review of local groundwater data such as water level fluctuation, groundwater barriers or anomalies indicating possible faults.
2. Subsurface investigation
- a. Trenching across any known active faults and suspicious zones to determine location and recency of movement, including information on the earthquake cycle, width of disturbance, physical condition of fault zone materials, type of displacement, and geometry.
  - b. Exploratory borings to determine depth of unconsolidated materials and groundwater, and to verify fault-plane geometry. In conjunction with the soil engineering studies, obtain samples of soil and bedrock material for laboratory testing.
  - c. Geophysical surveys which may indicate types of materials and their physical properties, groundwater conditions, and fault displacements.

### **III. FINDINGS and CONCLUSIONS**

At the completion of the data-accumulating phase of the study, all of the pertinent information is utilized in forming conclusions of potential seismic exposure and hazard relative to the intended land use or development. Many of these conclusions will be revealed in conjunction with the soil engineering study. It is critical that the multiple working hypotheses method of analysis be used to check all conclusions and thereby derive the most plausible explanation of all significant observations.

#### **A. Potential Seismic Exposure**

- 1. Location of all significant seismogenic sources of damaging earthquakes.
- 2. Expected size and mean recurrence rate.
- 3. Estimated amplitude and duration of strong motion.

**B. Potential Primary Seismic Hazards**

1. Description of expected site specific primary seismic hazards, including location of active faults, etc.
2. Differentiate between rupture characteristics of strike slip faults and dip-slip (thrust and normal).
3. Description of expected regional uplift and/or subsidence, including pressure ridge deformation.

**C. Secondary Permanent and Transient Hazards**

1. Description of expected site-specific secondary permanent seismic hazards, including landslides and other modes of slope failure, liquefaction, differential settlement, etc.
2. Description of expected secondary transient seismic hazards, including strong-motion, focusing of energy, tsunamis, seiche, etc.

**D. Quantification of Seismic Hazards**

1. Complete kinematic analysis of expected seismic hazards noted above, including amount, direction and sense of expected coseismic fault rupture, amount and type of movement within liquefaction zones, direction, and amount of expected movement of slope failures, run-up associated with expected tsunami hazard, etc.

**IV. RECOMMENDATIONS**

Recommendations for Mitigation, Damage Control and Reasonable Protection of Public Safety include:

- A. Support for potentially unstable slopes or zones of expected lateral spreading.
- B. Alteration of site conditions (i.e., remove and recompact potentially unstable sediments, lowering of groundwater table, etc.).
- C. Move or relocate proposed structures and associated lifelines.

## **V. PRESENTATION of DATA**

Visual aids are desirable in depicting the data and may include, among other things:

### **A. General Data**

1. Geologic map of regional and/or local faults.
2. Map(s) of earthquake epicenters.
3. Strain map based on recent Global Position Survey data.

### **B. Local or Site Data**

1. Site-specific geologic map and cross-sections.
2. Map showing areas of real and/or potential geoseismic hazards
3. Map showing local fault and fracture pattern and expected kinematics of expected future coseismic ruptures.
4. Geophysical survey data.
5. Detailed logs of exploratory trenches and borings.
6. Preparation of a complete and detailed geologic seismic report.

## **VI. OTHER ESSENTIAL DATA**

### **A. Sources of Data**

1. Reference material listed in bibliography.
2. Maps and other source data referenced.
3. Compiled data, maps, plates included or referenced.

**B. Vital Support Data**

1. Basic methods used to estimate seismic exposure (i.e., historic seismicity, earthquake cycle, magnitude, slip rate, return periods, recurrence interval, attenuation of strong motion, etc.), and kinematics of expected ground failures and coseismic fault rupture.
2. Computer programs and appropriate technical references.
3. Investigations by others.
  - a. Geoseismic
  - b. Geologic
  - c. Geophysical

- C. Signature and license number of geologist registered in California, or the state where the work is performed.

**SELECTED REFERENCES for GEOLOGIC/SEISMIC REPORTS AND TECTONIC EARTHQUAKE ANALYSIS**

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California Division of Mines and Geology, 1986, Guidelines for evaluating the hazard of surface fault rupture: DMG Note 46, California Division of Mines and Geology, Department of Conservation, 1416 9th Street, Room 1341, Sacramento, CA 95818. (this document has a substantial reference list.)

Utah Section of the Association of Engineering Geologists, 1986, Guidelines for preparing engineering, Utah Geologic and Mineral Survey, Misc. Pub. M, 2 pp.

## ADDITIONAL HANDBOOK DEVELOPMENT NEEDED

At the beginning of this chapter you were invited to participate in the development of guidelines, standards, and protocols for AEG. Currently a guideline is under development for the conduct of **Regulatory Review**. This guideline is intended to cover the responsibilities of the regulatory reviewer, appropriate methods of regulatory review, and approaches to conflict resolution. Additional topics will be considered for inclusion in this guideline. The guideline is intended to apply to reviewers for development projects and reviewers for contaminant investigations. When the drafts have been developed, the committee will determine whether two or more guidelines are needed. One of the objectives for the guideline for regulatory review is to assist the reviewer to stand fast on technical issues when political factors enter the arena. Those who provide review on a contract basis, as well as those who work directly for reviewing agencies are encouraged to send in your ideas and comments. Those who have dealt with inadequate or inappropriate reviews also have important contributions to make. Let us hear from you!

Another guideline is in the planning. The intended focus of this guideline is **Hydrogeologic Investigations**. It has not been determined if water resource development and contaminant investigations will be included in the same guideline. Volunteers to work on this project are sought.

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- American Society for Testing and Materials, 1990, Standard Test Method for Classification of Soils for Engineering Purposes (D-2487-90), Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics: ASTM, 1916 Race St., Philadelphia, PA 19103-1187. (215) 299-5400.
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- Association of Engineering Firms Practicing in the Geosciences, 1990, OSHA: The new excavation regulations: Silver Spring, Md. Booklet reprints the Occupational Health and Safety and

- Health Administration trenching and shoring regulations published in the Federal Register of Tuesday, October 31, 1989. (\$7.50, see Chapter 1, Resource List 3 for ASFE address.)
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- United States Environmental Protection Agency, 1986, SW-846 3d ed., Test Methods for Evaluating Solid Waste: Washington D.C., 2 volumes.

See also the reference lists at the end of each guideline and Chapter 9.

## Chapter 3

### PROFESSIONAL LIABILITY

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## Chapter 3

### PROFESSIONAL LIABILITY<sup>1</sup>

by

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#### **AVOIDANCE of LIABILITY**

If you offer professional services to the public, there is a substantial possibility that you will be sued for malpractice during the course of your career, regardless of how carefully you conduct your work. Indeed, one is fortunate if he or she is involved only in a single suit. Claims arising from alleged professional malpractice are on the increase across the country. Not only geologists, but engineers of nearly all specialties, doctors, attorneys, dentists, accountants, real estate brokers, investment brokers, insurance brokers, and many others have been affected by the upsurge in malpractice litigation. Insurance, which is essential to protect your assets, often makes the professional the target of suits seeking "deep pockets".

The current trend in public policy is toward protection of the consumer. The days when *caveat emptor* (let the buyer beware) reflected public policy are doubtless gone forever.

There is no absolute way in which the engineering geologist can avoid liability. There are no magic words or trick phrases to be put in a professional report to avoid the possibility of being sued. Often the use of cleverly worded reports to avoid facing a problem head-on or to assist the client to obtain a building permit will form the basis for a suit against the engineering geologist.

Remember that the first duty of an engineering geologist is to himself or herself as a professional. The engineering geologist is not an advocate for the client who should present the client's position in the best possible light, but has a duty to make a complete and objective evaluation. Project cost estimates should not be permitted to limit the scope of an investigation when good professional

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<sup>1</sup>Adapted mainly from AEG Special Publication article by J. H. Patton, Jr., in "Geology, Seismicity and Environmental Impact", 1973, p. 5-14, published by the Southern California Section of the AEG.

judgment indicates otherwise. At a later time, after the occurrence of a landslide, it is no excuse that a critically located exploration excavation was not made because the project ran over the cost budget and the client would not authorize the additional expenditure. If something goes wrong on a project, the client is usually the first to point an accusing finger at the engineering geologist as the expert who they relied upon for guidance. If the client refuses to authorize necessary additional work, any report for the client should note the necessity of such work and recommend that it be accomplished. Examine all available data before expressing an opinion. Consider the impact of future developments on your project. Express yourself clearly and precisely in your professional reports. Document everything fully, using photographs where appropriate. Be conservative in your professional evaluations and opinions, recognizing that you are dealing with imperfect natural conditions and not with mathematical equations. Remember that there is no substitute for a well-documented professional job. All that is required to file a suit is a complaint and filing fee. Defending against the potential lawsuit is a portion of the professional's normal overhead costs.

A good speech that is given to entering first-year law students goes something like this: "So you've come to a noble and high profession, have you? So you've come to law school to learn great things and to be very important to society. Well you are crazy! That's not what you are here for at all. The courts, although they have very high front steps and use lots of mahogany, are kind of a trash bin of society. Nobody comes to court unless they have failed to work things out on their own. The court is a depository of the losers, not the winners. When all other human systems for solving conflict fail, then the courts come into play."

## **NEGLIGENCE**

The most common theory of liability alleged against engineering geologists is negligence. Negligence is the omission to do something which an ordinarily prudent person would have done under similar circumstances or the doing of something which an ordinarily prudent person would not have done under those circumstances. An engineering geologist is required to exercise that degree of care and skill ordinarily exercised in like cases by reputable members of his profession practicing in this or a similar locality at the same time and under similar conditions. They have the duty to exercise ordinary care in the course of performing their duties for the protection of any person who foreseeably and with reasonable certainty may be injured by their failure to do so. It should be noted that inappropriate contract language can impose a higher standard of care requirement. The engineering geologist should avoid statements in their proposals that include superlative adjectives in work scope items. Terminology such as "best, all, highest available degree of accuracy, most and least expensive" should be avoided.

Although failing to comply with a state statute or with county or municipal ordinances normally is considered to be negligence *per se*, the mere compliance with the letter of the law in such cases does not necessarily relieve one of liability, since it generally is recognized that statutes and ordinances set forth only minimum requirements, and circumstances may require more than the minimum. An engineering geologist cannot rely upon the approval of a project by an inspector for a governmental agency to relieve them of liability.

Commonly, liability for negligence arises where the engineering geologist either fails to recognize an existing geologic feature such as a landslide which will adversely affect future development, or where they fail to fully appreciate the impact of geologic features, such as the relationship of joints or faults with bedding planes, upon the proposed development. In such cases it is alleged that they could have determined the existence of the landslide if the engineering geologist had examined old aerial photographs and maps, had placed the exploratory excavation in different locations or had made them deeper. Unfortunately, engineering geologists, like most other professionals, are blessed with excellent hindsight, and a plaintiff's attorney will have little difficulty in finding another engineering geologist to interpret the cause of the problem and to explain to a jury how their predecessor did not comply with the standards of practice for engineering geologists.

Quite often, equally competent geologists evaluating the same data can arrive at widely differing interpretations. Over the past several decades, the practice of engineering geology has been evolving and standards of practice in the community have been in a state of change. The standard of practice of engineering geologists generally has been directly tied to the applicable building code, which may differ from county to county and from city to city within the same county. Failures often don't occur until years after completion of the project. By that time the practices of engineering geologists have improved, based upon lessons learned from past experiences. Many individuals, including engineering geologists, tend to confuse time, and often it is extremely difficult, if not impossible, to recall what was done years before. The plaintiff's attorney tends to attempt to apply current standards of practice to work done years before, often with the assistance of an expert. An attorney representing a defendant engineering geologist in such cases must constantly guard against this, and must be familiar with the evolution of engineering geology.

### **NEGLIGENT MISREPRESENTATION**

Negligent misrepresentation is a species of fraud along with intentional misrepresentation and concealment. Negligent misrepresentation is simply the assertion, as a fact, that which is not true, by one who has no reasonable ground for believing it to be true. Although misrepresentations of opinions generally are not actionable, they become actionable where the person making the alleged misrepresentation hold themselves to be specially qualified to render the opinion. In the event of a failure, a statement of opinion by an engineering geologist that no unsupported bedding occurs in a particular slope, could be actionable as negligent misrepresentation if they have no factual basis for that opinion. Under most circumstances the theory of negligence also would be applicable.

### **INTENTIONAL MISREPRESENTATION and CONCEALMENT**

Intentional misrepresentation (the assertion, as a fact, of that which is not true by one who does not believe it to be true) and concealment (the suppression of a fact or condition by one who is bound to disclose it) are species of fraud which are seldom if ever applicable to engineering geologists. Such conduct on the part of an engineering geologist is legally actionable with criminal penalties resulting.

## **STATUTE of LIMITATIONS**

Normally, the applicable statutes of limitations, as well as contributory negligence and assumption of risk, are alleged on behalf of the engineering geologist as defenses. Other defenses may be available depending on the particular facts of the case.

A statute of limitation merely prevents a plaintiff from seeking relief in Court because they waited too long in filing a suit. The statute of limitation is an affirmative defense and may be waived by the defendant if not raised in a timely manner. The time limits of this statute will vary from state to state. Also, the time when the clock starts ticking will vary. In some states the clock starts when a defect is discovered, in others, when construction is complete.

## **PROBLEMS with JURY DEFINITIONS of REASONABLENESS**

Regardless of the technical merits or a defense, the outcome of a jury trial is unpredictable. One of the more obvious problems involved in permitting lay jurors to define reasonableness is the inherently after-the-fact nature of this process. The defendant professional too often discovers their conduct did not measure up by observing a sickened expression flooding over their attorney's face as the foreman reads the verdict. Precautions the engineering geologist believed in good faith were unneeded have now been declared to be precautions a reasonably prudent engineering geologist would have taken. Errors in judgment and miscalculations which seemed impossible to eliminate completely if a job was to be completed at a reasonable cost and within a reasonable time frame appear, to the jury, as things which should have been eliminated.

Conformity to the standards of the profession, even if the engineering geologist has been able to clearly show what those are and that they were adhered to, will not necessarily protect the defendant. Juries have in the past declared, and will no doubt in the future declare, that certain standards of care are simply not enough. The growing suspicion of the lay public that certain industries operate on the basis of some sort of conspiratorial alliance, is a fertile field in which plaintiff's attorney can nurture the argument that the only "custom" proven by the defendant is a custom of carelessness, indifference, cost-cutting, and corner cutting. Sometimes judges get into the act and declare the industry custom negligent as a matter of law. In a case decided in 1884 in Maine, for example, the plaintiff had fallen through a hole in a dark mine shaft platform which had been cut for a ladder. The mine operator clearly established that no one in the industry put guards or other forms of warnings around such holes. The thoroughly unimpressed judge refused to let the jury even consider the issue, declaring, "If the defendants had proved that in every mining establishment that has existed since the days of Tubal-Cain it had been the practice to cut ladder holes in their platforms ... without guarding or lighting them, and without notice to contractors or workmen, it would have no tendency to show that the act was consistent with ordinary prudence ... The gross carelessness of the act appears conclusively upon its recital."

Another, but increasingly important, problem with the jury's role is the increasing complexity of the issues juries will be presented with in the future, as our nation's technology increases in sophistication.

It is one thing to say the average layman is capable of deciding how fast a driver should drive a vehicle on a public road under given conditions. It is quite another though, for a jury to ponder the question of how much dynamic stress an engineer should have allowed in the design of a building in a thrust-fault earthquake zone erected on soil. Jurors have some degree of experience in driving vehicles. Few have the slightest understanding of how a "safe" building should be designed, or the principles of metal fatigue, or the operating characteristics of nuclear reactors. Cases involving claims of professional negligence are inherently complex and require lengthy trials; and the quality of the jurors who either are willing to serve in such lengthy proceedings or who can muster no reasonable basis for being excused, drops off distressingly. It is not being snobbishly intellectual to suggest that complicated issues be judged by persons who have some modicum of the education and training required to comprehend the subject. But in fact, the trend is away from any system which provides for the selection of jurors better equipped to deal with the complicated issues typically raised in cases involving claims of professional negligence. This trend takes the form of increasing restrictions upon the *voir dire* process by which lawyers typically try to reject jurors who have obvious biases and prejudices, or who simply could not possibly understand the case.

## **SUGGESTIONS FOR IMPROVING THE DEFENDANT PROFESSIONAL'S PROSPECTS**

Public relations is a concept many engineers, scientists and technical people seem to reject. But at times it is necessary, and at times it works. If the lay public is ever to come to the jury box generally mindful that cavalier expansion of professional liability is to be avoided and that the public's interest is not served by standards which sweep so broadly as to engulf even the genuinely competent and conscientious professionals, the professions involved have to get the message out.

A certificate of merit is required in California prior to filing a lawsuit against a design professional. This statute (Code of Civil Procedure 411.35) primarily provides protection to civil engineers by requiring that an anonymous civil engineer review the facts and conclude that "there is reasonable and meritorious cause for the filing of the action" (Day, 1993). This type of legislative protection from frivolous lawsuits is an area where engineering geologists can cooperate with civil engineers to develop new laws which will help to protect both professions.

### ***Loss Prevention***

Every practicing engineering geologist is exposed to some degree of professional liability. To defend against this type of risk, there are three basic alternatives: 1) insurance, 2) not entering into private practice, and 3) loss prevention. Professional liability insurance, or errors and omissions coverage, is generally not available to the engineering geologist in private practice. Only the engineering geologist who is employed by the larger geotechnical firms is covered under the umbrella of the soils and foundations engineers coverage. It is difficult to find an insurance company offering professional liability insurance for the small engineering geology firm. It is therefore an absolute necessity to enter upon a program that will lessen the risk of professional liability claims. Such a program is called "Limitation of Liability" (see ASFE 1992).

Professional liability claims often stem from poorly chosen words, exaggerations, losing control over emotions in a stress situation and failure to establish rapport with clients and colleagues.

The main problems arise from negligence and the implications of strict liability. Negligence may be committed by not utilizing state-of-the-art information or techniques or practicing without utilizing the standards of care of the time. The doctrine of implied warranty is generally applied to manufactured products such as toasters and automobiles; however, it has been attached to other mass produced items such as lots and streets in hillside grading projects.

It is important for the engineering geologist to keep abreast of technical developments within his or her field of expertise. It is equally important to be aware of what other engineering geologists are doing within the field of engineering geology. With the above considerations, every report issued should contain a statement similar to the following:

The opinions presented herein have been developed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable engineering geologists practicing in this or similar localities. No other warranty, expressed or implied, is made as to the professional advice included in this report.

After a report is completed and submitted, it is essential that you enhance your rapport with the client by making a follow-up call to determine if he was satisfied, and if there were any problems noted with your work product. This minor courtesy can reduce misunderstandings and possible claims.

For a more complete discussion on the limitation of professional liability, please refer to the 1992 ASFE publication on the Limitation of Liability.

### ***Environmental Work Certification***

The U.S. Environmental Protection Agency (U.S. EPA) and many state and local agencies require a perjury statement to accompany contaminant investigation and remediation reports. This perjury statement must be signed by the **land owner** or **responsible parties**. The typical U.S. EPA wording for the perjury statement is:

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment for knowing violations.

The perjury statement is intended to verify that the client discussed with the consultant (qualified personnel) how the work was performed and that the client accepts legal responsibility for the results

of that investigation. Legally it is the client's report to the agencies. The consultant is a technical and scientific expert who assists the client in preparing their report to the agencies. Do not accept a responsibility which is greater than the law requires.

If the consultant is going to submit the copies of the report to the agencies for the client, the consultant should draft a letter containing the perjury statement, as a transmittal letter to the agencies involved, and have the client sign that letter. It has happened that a client hired a consultant to investigate their underground tanks. The investigation was performed by the consultant based on information from the client about the location of the tanks. The consultant found no contamination and reported those findings **under penalty of perjury**. Later the consultant learned that tanks which had leaked were located elsewhere on the property. At that point the consultant could be held liable for the contamination from those tanks because of having signed the perjury statement that the site was clean.

What then is the consultant really responsible for and how should it be stated? The consultant is usually required to sign a **professional certification**. The professional certification should be bound into the report, either at the front or the end. Critical information to be certified is that: 1) the work was actually performed in the manner described in the report, 2) the report contains all data collected and is complete, 3) the person signing the certification was in responsible charge of the work, and 4) that they are a qualified person under the legal definition in that state. In many states a licensed (registered or certified) geologist or a licensed civil engineer must be the person who signs the professional certification, and that individual should be the direct supervisor of the people doing the field work. In some situations it is necessary for the registered geologist to sign and stamp the drilling logs to indicate the accuracy of this critical data. Never sign drilling logs produced by another firm at an earlier stage of work, or drilling logs where the logging was not under your direct supervision, or where you did not have access to the samples to verify that the logging is accurate. This also applies to maps and cross sections.

Professional certification of environmental reports is discussed further in Hoose (1992). A wide variation in wording for a professional certification statement is generally acceptable and the loss prevention statement above, or something similar to it, can be included in the certification. It is wise to discuss the form of the certification statement your firm will use with an attorney who specializes in environmental law. You should also determine any specific state or local requirements for the professional certification, including the definition of a "qualified person" for the particular law or laws the investigation is intended to satisfy.

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## Chapter 4

### CONTRACTS, PROPOSALS AND NEGOTIATIONS

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## **Chapter 4**

### **CONTRACTS, PROPOSALS AND NEGOTIATIONS**

by  
Allen W. Hatheway

#### **INTRODUCTION**

The most pressing concern involving professional practice for engineering geologists is the stream of activities that leads to awards of contracts for project work, to the successful and accurate completion of such work and to the return of a satisfied client. This Professional Practice Handbook has been compiled for the express purpose of assisting the practicing engineering geologist in securing and completing professional assignments and to do so in reasonable and efficient ways. The heart of the relationship between the engineering geologist and his or her client lies in the actions necessary to define the work needed by the client and to see that such work is accomplished according to the needs and resources of the client. Contracts, proposals and negotiations are the formal methods for prescribing what is to be performed, the manner in which it is to be performed, and the legalities under which the professional work will be judged for acceptability and payment.

This chapter's purpose is to detail the need for these legalistic controls over our professional work product, and to present a selection of actions and alternatives that should be considered before entering into any agreement for conduct of professional engineering geological work.

Nearly all of our present-day professional assignments warrant careful consideration of contractual relationships. This is because of the increase in complexity and size of most projects, with the entry of multiple partners in the design and construction aspects, and with a host of potential environmental impairment considerations. These serve to specify exactly what is felt necessary by the owner, promised for delivery by the engineering geologist, and agreed to for payment by the client. A good contractual relationship will promise nothing that is undeliverable, will not prescribe guarantees of any sort in relation to natural conditions, and will leave no room for unanticipated surprises.

The profession has always struggled with the task of convincing its members that there is a need for contractual relationships. This difficulty stems from the fact that engineering geologists are seldom trained academically to understand the need for entering into legal agreements, and are often led to believe that professional practice should be conducted on a basis of honor and word among professionals. The following presents the components of contract relationships, and gives the practicing engineering geologist a number of options and alternatives in specifying the nature and degree of components to consider for a variety of needs.

## GOALS OF CONTRACTUAL RELATIONSHIPS

Most work performed by an engineering geologist is linked in some way to a facility proposed for construction by an owner, to be created in concept and detail by a design professional (an architect or engineer), built by a contractor, and operated by the owner. In order to prepare for design and construction, a team of experts from the professions is convened. Not only must the operational needs of the owner be met, but the design and construction of the facility must be accomplished within the financial resources of the owner. For the owner to receive full value for funds allocated, the design professional prepares drawings and written specifications for site preparation, foundations, structural and architectural components, and ancillary facilities (such as drainage, water supply, utilities, access, parking, and landscaping). Potential contractors are identified, screened, and asked to submit priced proposals (bids) for completion of the facility according to the design drawings and specifications. The need for a legal document (contract) binding performance of the contractor to the required facility specifications is obvious. At the same time, both the contractor and the owner need to know the amount of funds that will be required to pay for work performed, and the manner in which such funds will be released during construction.

Construction contracts, therefore, are the means of providing assurance of completion of construction (for the owner), and completion of payment for the contractor. The owner is concerned with receiving the following products:

- ! A functional facility
- ! Quality of construction
- ! Safety in design and operation
- ! Avoidance of cost overruns.

The contractor is invariably concerned with the following issues:

- ! Making a profit
- ! Maintaining his reputation
- ! Providing appropriate health and safety conditions for their workers.

In order to meet these requirements, contracts are drawn up to provide legal assurance for the following goals:

- ! Define working relationships and responsibilities between parties to the contract
- ! Establish responsibilities for each party to the contract
- ! Ensure completion of construction
- ! Ensure quality of construction and the field information and design upon which it is based
- ! Minimize the owner's costs
- ! Establish a method to accommodate reasonable changes in the specifications as to the nature of work as the project proceeds.

## CONSTRUCTION CONTRACTS

Contracts between owner and contractor, dealing with projects having a direct contact with the earth's surface are, or should be, written with heavy dependence on work products provided by engineering geologists. There are virtually no aspects of such construction contracts that do not involve raw data, observations, or recommendations that are provided by engineering geologists. In some cases, contracts are written entirely on the basis of information provided by qualified geotechnical engineers who are assuming responsibility, in that connection, for providing information that might also be reasonably provided by an engineering geologist. These cases are governed by assessment of subsurface conditions by the geotechnical engineer, and an assumption of the responsibility inherent in providing such information to the owner and contractor without participation of an engineering geologist.

Engineering geological inputs for the project begin with site reconnaissance, and feasibility-level and preliminary investigations by engineering geologists and geotechnical engineers. These data and recommendations are necessary for the various design professionals to fit the owner's concept to observed site geological conditions. As the owner's development concept is refined against the geotechnical engineer's findings, the design is finalized in size and geometry and layout of the facility, and a design-level investigation is undertaken for the purpose of developing detailed design provisions and specifications for use in award of a construction contract (Pierce and Oliensis, 1976).

The engineering geologist and geotechnical engineer are continually plagued with the very difficult decisions involved in determining how much information is necessary for the design professionals and for the bidding contractors (Hatheway, 1979).

By spending project funds, through a geological consultant, the owner hopes to procure an accurate and reasonably complete subsurface data package for use in design and as the basis for bidding by contractors. In spending the owner's money, the consultant has two primary goals. He or she is to provide:

- 1) Data to produce a suitable and cost-effective design
- 2) Data clear and concise enough to lead to a narrow spread of low-value construction bids not containing large-risk dollar contingencies.

The owner is spending money to save larger amounts of contract expenditures or eventual "extras"; such money should be allocated for:

- 1) Providing a detailed assessment of conditions at and below the site; i.e., to avoid missing high-impact features
- 2) Determination of enough representative physical properties/characteristics to define a "best" set of geological/geotechnical design parameters
- 3) Avoidance of design features that may later prove ineffective or cost-prohibitive.

The list of necessary elements for even major construction projects is generally not long:

- 1) Description of groundwater occurrence
- 2) Identification of engineering-significant soil/rock units
- 3) Determination of a sufficient number of property tests to provide for reasonable geotechnical design parameters
- 4) Identification of top-of-rock
- 5) Accurate recording of standard rock quality indicators
- 6) Measurement of attitudes and other features of various structural discontinuities
- 7) Recognition of reasonably apparent evidence of geologic hazards that could impact the project.

The degree to which raw data of exploration are interpreted is subject to the owner/consultant concept of which is **necessary** for design and what is **required** to produce a cost-effective structure that meets design objectives. The contractor needs and deserves accurate subsurface data presented in the raw form and interpreted so as to identify trends and sets. The contractor uses these data to estimate the effect of each variable on the construction effort.

The contractor should be given some latitude to produce an acceptable product with desirable performance characteristics according to clear and concise specifications provided by the owner's engineer.

### *Contracts for Professional Services*

Professional engineering geological services are provided to a variety of clients. Most services are provided to the owner for use by design professionals. Some engineering geologic services are performed for contractors, in support of their bid estimations, or in mitigating construction problems such as working with conditions not foreseen (changed conditions).

The use of contracts for professional services should always be considered at the beginning of negotiation for work to be performed. Some clients will expect to enter into such agreements, others will not. It is always in the best interest of the engineering geologist to consider the merits of formal contractual arrangements for services to be performed. Opinions vary with experience as to this necessity. This chapter is written with the expressed opinion that some form of contractual relationship is highly desirable for the practicing engineering geologist.

The engineering geologist should view contracts for professional services as:

- 1) A means of preventing unwarranted liability exposure
- 2) To reduce the possibility of misunderstanding as to what will and will not be provided to the client
- 3) To provide a basis for receiving compensation for work performed.

## ***The Contractual Process***

Engineering geologists normally seek or respond to indications of the client's need for their professional assistance. At the time of contact concerning a specific project, the engineering geologist collects specific project-related information concerning the location, general layout, and functional purpose of the proposed project. The engineering geologist then develops a scheme of providing engineering geological information that will satisfy the client's direct needs, or that will be provided to the geotechnical engineer for use in foundation-related design recommendations. In developing this scheme, the engineering geologist will relate design and functional requirements to topography and what is known to him or her concerning general site geologic conditions. In order to formulate the site-specific engineering geologic work to be recommended, some form of **project data sheet** should be prepared, in which the following information is collected:

- 1) Client organizational and contact data
- 2) Consultant's file reference
- 3) Project characteristics: location, structural configuration, function, type of design recommendations required, expected site geologic characteristics, special considerations
- 4) Information/services to be provided by the owner
- 5) Schedule for completion of services
- 6) Professional service work items to be recommended to client
- 7) Estimated subcontract exploration services and budget
- 8) Quoted fee; special care is given to the manner and terms under which the fee is computed and arranged
- 9) Billing instructions.

When the project information has been collected and analyzed, a letter proposal should be prepared and submitted to the client. The proposal can be formulated on a standard form, can be written as a letter, or can be a combination of letter proposal and Schedule of Fees and Conditions. The latter option becomes a contractual agreement between the consultant and the client.

## ***Typical Terms for Short-Term Contract***

### Degree of Care

In performing their professional services, \_\_\_\_\_ (hereinafter called Consultant) will use that degree of care and skill ordinarily exercised, under similar circumstances, by reputable members of their profession practicing in the same or similar locality. No other warranty, express or implied, is made or intended by this proposal for consultant services, or by furnishing oral or written reports of the findings made. Consultant is to be liable only for damage proximately caused by consultant's sole negligence, error or omission.

## Subterranean Structures

In performance of their work, consultant will take all reasonable precautions, but will not be responsible for damage or injury resulting from damage to subterranean utilities or other installations which are not called to consultant's attention or are not correctly shown on any plans furnished by client or client's representative.

## Claims by Client

In the event the client makes a claim or brings an action against consultant for any act arising out of the performance of consultant's professional services, and the client fails to prove such claim or action, then the client shall pay all legal and other costs incurred by consultant in defense of such claim or action.

## Payment

Statements of services of consultant will be submitted at our option either upon completion of work or on a monthly basis. Statements will be mailed to the addressee of this letter, and will be due immediately. Payments are to be made not later than the 10th day following the end of the month during which the statement is dated. If payment is not so made, interest will be due on the amount of the statement at the rate of (e.g.) eighteen (18) percent per annum from the date of the statement until the same is paid. It is further agreed that if suit is filed or informal proceedings are needed to obtain or to enforce payment of the statement, addressee is to pay in addition to the amount of the statement and interest thereon, all costs of collection including court costs, and such reasonable attorney's fees as the court may fix. Alternatively, if collection is obtained without court action, then in the amount of (e.g.) fifteen (15) percent of the total amount due, including accrued interest.

## *Formal Contracts for Services*

Contracts for services are usually encountered when dealing with public agencies or large industrial corporations. The contracts are usually formed from standard provisions known in the profession as "boiler plating," with the addition of project-specified Scope of Work statements. If the selection is by negotiation or on a sole-source basis, the consultant is often asked to assist the client in formulating the Scope of Work or Statement of Work, in mutual agreement. This type of statement is quite similar to the Scope of Work section of letter proposals.

Contracts come in many varieties of length and complexity. Short-form variants are often termed **Work Authorizations** or simply **Purchase Orders** and should list, at a minimum, the following elements of understanding:

- 1) Project description
- 2) Scheduling
- 3) Cost estimate
- 4) Other direct expenses



- 5) Expenses to be carried by client
- 6) Items to be supplied by client
- 7) Items to be furnished by consultant
- 8) Estimated total charges
- 9) Authorized signatures of client and consultant.

Long-form contracts for engineering geological and geotechnical services come in an even greater variety of forms. Such contracts are generally referred to by the type of cost estimation and reimbursement that they represent. The more common types of contracts are as follows:

- 1) **Fixed-price** (or lump sum) in which the consultant agrees to deliver according to a scope of work; cost items are not usually accountable and work performed short of the budgeted amount represents additional accrued profit; such contracts are attractive to the client only when unanticipated conditions or contingencies are thought probable or when there is a desire to hold costs to an absolute and predictable amount.
- 2) **Cost-Plus** contracts are probably the most common of all to be encountered by engineering geologists; there are a variety of sub-types:
  - a) **Direct salary times a multiplier** representing salary costs, general and administrative costs and employee fringe benefits (the most common industrial contract basis)
  - b) **hourly charge** incorporating general and administrative costs, fringe benefits and a competitive profit
  - c) **with fixed fee** such that authorized extensions of work can be authorized by the client, but without award of additional fee (profit); this is favored by the federal government and is quite protective of the client
  - d) **with ceiling** or **upset budget** amount beyond which the project work cannot extend without justification and approval of the client.

Salary and cost elements to be included in contract or proposal estimates are made up of the five items inherent in operating the consulting business: **direct salary, general administrative and overhead costs, fringe benefits, fee** (profit) and **reimbursable direct expenses**. These costs include the following costs and reimbursables:

- 1) **Direct salary:** actual payments to personnel for time spent on the project
- 2) **General and Administrative (G&A) Costs:** clerical, administrative, payroll and secretarial time not otherwise charged to the project; also includes rent, utilities, office supplies and depreciation of certain equipment; varies widely between firms, some of whom charge for secretarial time and, hence, have a lower G&A cost
- 3) **Fringe Benefits:** represents a reimbursable charge made up of the averaged percentage of hourly wages that are assigned to providing health, life insurance, retirement and profit-sharing benefits to employees
- 4) **Fee:** payment as interest on invested capital, for readiness to serve, and as profit for risks undertaken in the course of professional service.

Direct costs are recorded and charged to the client at cost plus a designated percent for handling and finance fees.

### ***General and Special Conditions Clauses***

Contracts for engineering geological services, like those for other professional work, should be tailored to fit the requirements of individual practice. Many of these requirements are provincial in terms of traditional methods of practice in various regions of the country. Some of these optional condition clauses are:

- 1) **Right of entry** stating that the client will provide authorization to enter and operate on the site property or will incur the costs incidental to gaining such authority
- 2) **Buried utilities and other subterranean structures** plans of which are generally furnished by the client or the client's representative, and which require only the exercise of reasonable care and diligence by the consultant in avoidance and for which the consultant is held harmless and indemnified in the instance of damage
- 3) **Insurance coverage** of the consultant is specified, in terms of workmen's compensation and general liability
- 4) **Limitation of liability** for damages in excess of the consultant's fee or an otherwise specified amount
- 5) **Manner of Invoicing and Payment** for work performed includes:
  - a) Schedules for payment
  - b) Delinquency and charges
  - c) Notice of suspension of service for cause
  - d) Attorney fee reimbursable for unsubstantiated claims by client against consultant
- 6) **Uncontrollable Conditions** such as Acts of God, strikes, lockouts and accidents
- 7) **Stipulation of Services Not Provided Under Contract** such as excluded types of design, and the design and construction review as relates to safety precautions during construction
- 8) **Third-party Litigations** specifies an absence of liability from litigations associated with distribution of consultant-generated documents to a third party, at the request of the client
- 9) **Damages to Field Sites or Explorations** worded so as to specify client reimbursement for losses of geophysical or test equipment in boreholes or for damages to field sites during reasonable conduct of field explorations
- 10) **Termination of Work** a specified written notice (in days) for suspension of consultant activities, with payment of consultant for work performed to that date and termination expense (in percentage of contract estimate)
- 11) **Warranty of Authorization to Sign** a statement by the persons signing the contract that they have such corporate authority or personally assume liability for all breaches of contract.

These are among a number of general and special conditions clauses that are available for selection by the consultant, with the counsel of his or her attorney. Many firms who deal with highly reputable clientele may not find it necessary to use all of these clauses.

### ***Confidentiality and Duty to Report***

Consultants performing investigations of contaminated or potentially contaminated property may face a dilemma between their responsibility for confidentiality to their client and their professional duty to protect the public health, safety, and welfare. The fundamental assumption in the current environmental laws, both federal and state, is that the owner will self-report in accordance with the law. In most instances the owner is criminally liable if they do not report as required. A few ill advised owners are willing to take this risk. The consultant having knowledge of the contamination is then placed in an untenable position. Some firms are now adding a clause to their contracts which addresses this situation directly. They state that they will hold their findings confidential, **except** if necessary to comply with professional standards of conduct for the preservation of the public health, safety, and welfare. Generally the consultant agrees to notify the client before they disclose the information. When the client understands this clause, normally there will be no difficulty about it, since the purpose is to keep both of you out of jail.

### ***Selection of Clientele***

Many of the contractual difficulties and legal liabilities arising from professional engineering geological work stem from poor communications (including poorly written proposals and contracts), and from dealing with high-risk clientele. The matter of communications is treated in Chapters 3 and 5. Client selection is one of the most difficult aspects of a consulting practice. Some firms and individual consultants, particularly those who have small or new practices, take on work for clients whose operations are wholly speculative, or who do not intend to pay for professional services rendered unless a favorable result is achieved. These high-risk clients should be serviced only with extreme caution. One form of protection is to request a retainer from the client prior to performing any work, and to inform the party that services will be suspended unless invoices are paid promptly. In California and other states, high-risk clients are served with a notice of lien such as **California Preliminary Notice** (in accordance with Sec. 3097, 3097.1 and 3098 of the State civil code) informing them of the consultant's right to file a lien in the event of fee-collection difficulties.

### ***Implied Contractual Relationships***

**Privity** is a legal term for the existence of a contractual relationship. The lack of privity will not prevent a claim from including the consultant. Some implied relationships are held by the courts to be valid during the conduct of contracts, even if they have not been specified in writing. The consultant is generally held to be responsible to exercise due care in his or her work and, in the instance of the failure of earth structures (such as retaining walls or slopes), third-party suits are not unknown. As an example, legal action could be brought to bear against the engineering geologist who mapped the site or described the slope conditions, or against the project engineer.

## PROPOSALS FOR PROFESSIONAL SERVICES

The proposal is an expression of the understanding of project information and conditions by the consultant, the goals and objectives of the subject engineering geological professional work, the manner in which such work will be undertaken and completed, the type and extent of products to be delivered in interim and final reports, the manner in which costs will be billed and the estimated, budgeted, or guaranteed costs of such work. The proposal may also contain limitations of liability and other specialized information.

Requests for Proposals (RPFs) are documents issued by the owner or his client, in which the nature of professional engineering geological or geotechnical services are specified. On receiving the RFP the engineering geologist should read its contents carefully, identifying the objectives of the owner and the selection process, if to be on the basis of qualifications and negotiation, or a qualifications and a price-based selection. After discussing the RFP internally, the consultant should contact the client with the purpose of posing questions necessary to resolve questions that are apparent in a thorough reading of the document. Industrial clients are generally responsive to such questions. Government agencies often prove more difficult to deal with because of the need to interface directly with contracting or procurement personnel, who are generally neither technically qualified or concerned with technical questions. Some agencies will not identify technical project managers, and the questions must be accommodated by **assumptions** written into the proposal by the consultant.

After posing the necessary questions, the proposal writer tries to balance costs against the technical level-of-effort that is specified or indicated by his or her professional experience. Site visits are usually essential to the formulation of accurate and responsive proposals. Seldom do the site topographic maps provided with proposals provide an appreciation necessary to formulate a site-specific exploration plan, or to assess the ease or difficulty of access for drilling rigs, trenching equipment and geophysical surveying.

Many consulting firms have developed forms in which blanks are filled in or paragraphs are selected for use in proposal compilation. The forms represent a universally sound concept; the proposal writer using a well-organized form will likely not create a liability of communication problem. A suggested, comprehensive format for letter proposal is as follows:

- 1) **Background to the submittal:** statements relating to the nature of the proposal request, client contacts, dates and location and general nature of the project
- 2) **Statement of the problem:** the consultant's understanding of how the project is to function, and the general objectives of the client in engineering geological investigations
- 3) **Technical discussion:** relating to the specific objectives of the engineering geological investigation
- 4) **Scope of Work:** the methodology under which the consultant proposed to complete the engineering geological investigation
  - a) Work items
  - b) Assumptions

- c) Staffing considerations
- d) Named project personnel
- e) Related experience
- f) Work products.

An alternative arrangement would be to define the methodology separately, and then list the work items.

- 5) **Exceptions:** mention of the occurrence of unanticipated conditions and possibility of extension of scope and budget; an example would be the delay of a project field work until seasonally-inclement weather passes
- 6) **Cost estimate or budget:**

Professional Services

- Field Investigations
- Office Analyses
- Report Writing
- Clerical Support/Drafting
- Computer Applications

Laboratory and Field Testing

Subcontract Services

- Drilling Costs
- Other Equipment
- Geophysical Surveys  
(if not internal)

Equipment Charges

- Geophysical Equipment
- Health Protection  
(hazardous waste assignments)

Other Direct Costs

- Travel fares
- Per diem or subsistence for travel  
and field-work
- Auto Rental
- Aerial Reconnaissance Flights
- Long Distance Communications
- Reproductions
- Aerial and Ground Surveys
- Additional Authorized Insurance
- Jurisdictional Fees

- 7) **Scheduling Estimate:** giving anticipated response time on notification to proceed, anticipated length of field work; time required for report writing, submission of final report
- 8) **Appendices:**
  - a) **Schedule of Fees and Conditions** under which the work will be performed and, in effect, constituting the remainder of the contractual agreement
  - b) Other contractual terms
  - c) Corporate Qualifications and Experience statement
  - d) Resumes of key personnel.

## SELECTION PROCEDURES

Engineering geologists are selected by their clients to perform services using any of several different approaches, which will vary with the nature of client, its sophistication and sensitivity to the nature of the work to be performed, and its financial objectives. Direct selection occurs most frequently when the engineering geologist has been recommended to the client by someone familiar with his or her work, or is doing repeat work for a client with which the engineering geologist has previously done business. Clients most likely to adopt this approach are engineering firms which need the expertise of the engineering geologist to fulfill their obligations to their clients. This is often the ideal method of selection for the engineering geologist, because it involves little in the way of marketing or preparation of proposals, being based instead on a prior record of satisfactory performance and reasonable fees. It is widely believed that this selection method results in the best kind of professional relationship with the client.

A **negotiated selection** process occurs where an initial selection of the engineering geologist is made on the basis of professional qualifications, experience and other factors indicating an ability to perform the services required for a particular project. Usually this will involve the ranking of a number of potential consultants. Once the initial selection is made, the client and the engineering geologist will meet to negotiate the scope of services and the fee; if an agreement cannot be reached, negotiations are terminated and the client will enter into negotiations with the second-ranked consultant. This procedure, which is frequently referred to as a "Brooks Bill" method of selection, is used by the Federal government and most state governments to obtain architectural and engineering services under applicable procurement laws, and is universally endorsed by professional societies. It insures that professional services will be procured on the basis of demonstrated qualifications, rather than on favoritism or cronyism, and at a fee that the client determines to be fair and reasonable. This selection method involves more in the way of preparation by the professional, but each is assured that competition will occur on an equal basis, without respect to fees.

A **competitive selection** process may be similar to a "Brooks Bill" process, except that in addition to qualifications, consultants are also required to submit fee proposals, which are considered along with qualifications. Although the request for proposals may outline a general scope of work, it may be difficult for the engineering geologist to quote a meaningful fixed fee unless the proposal also

includes a detailed work plan. Once a number of firms have been tentatively selected or "short listed", one or more may be invited to enter into contract negotiations.

Many design professionals believe that when fee proposals are required, the fee becomes the dominant factor in the selection process. Where there is no further negotiation of the fee and the scope of services, this selection method can work to the detriment of either the professional who finds him or herself locked into a fee which is inadequate for the services ultimately required, or the client, who may be required to spend additional amounts to obtain the necessary services or who is deprived of services which should have been included in the original proposal. On the other hand, if further negotiation on fees occurs before the contract is awarded, the argument can be made that a competitive selection process can involve unfair competition, rewarding those who minimize or understate the amount of services required with the opportunity to negotiate a contract, and penalizing those whose professional judgment suggests the need for a greater degree of investigation.

The proponents of competitive selection procedures will claim that they are sophisticated enough to know what services are required, that they can protect themselves against deceptively low bidding, that price only becomes a factor among equally ranked firms, and that the price element insures that they will receive the best value for their dollars.

**Competitive bidding** is the term which is applied to competition based on a specific scope of services prepared by the client, where selection will be based primarily, if not exclusively, on fees. In such cases, the opportunity to negotiate the contract may only arise where the need for a change in the scope of services becomes apparent after the work has begun. Clients utilizing this method of selection generally have invited proposals from a number of consultants that they judge to be equally (or at least adequately) qualified to do the work. If a general request for proposals has been issued, some clients will rely on the registration laws or professional standards to insure a minimum level of competence, and regard price as the critical factor remaining to be determined. Although many professionals report that they avoid engaging in competition based strictly on fees, the existence of fee bidding indicates that many others have found this to be a normal and acceptable way of doing business.

It is doubtful that the debate over price competition will ever be resolved. As a result of actions brought by the U.S. Department of Justice, professional architectural and engineering societies including AEG have removed any provisions from their codes of ethics limiting price competition by their members. As a result, the decision to engage in price competition is entirely a matter of business judgment and preference for the individual practitioner.

## PROFESSIONAL LIABILITY RELATION TO CONTRACTS

As pointed out in Chapter 3, liability for professional engineering geologists has been on the increase, and has roughly expanded by about 300 percent in claim frequency since 1960. According to C. Roy Vince (1979), insurance claims specialist of Evanston, Illinois, about 12.5 percent of construction contracts went to court in 1960, and by 1970 this percentage had risen to about 35 percent of all contracts. **Large** claims, those in excess of \$100,000, were increasing at the rate of about 20 percent annually during 1979.

The best possible protection for engineering geologists is care in developing contractual relationships and care exercised in the field. Whenever negligence exists and can be proven in court, the accused is held accountable for the recovery of losses by the plaintiff. Some of the most applicable common-sense protection is as follows:

- 1) Prepare careful proposals; review and rewrite prior to release to the client
- 2) Do not undertake work without some sort of formal agreement with the client
- 3) Do not oversell your abilities to solve problems
- 4) Try to spell out risks inherent in problem solving at the site or which may be encountered during site investigation
- 5) Use reasonable limitation of liability statements and clauses, where applicable
- 6) Take care in specifying what you will deliver and what you will expect the client or other contractors to deliver.

Contracts signed by officers of consulting firms should be signed by these persons, with their titles, on behalf of the firm. Further, the company name should appear above the signature and include the indication that the firm is incorporated, if such is the case. Contracts signed without this corporate precedent can be construed to represent personal liability between the signatory and the client.

### *Limitation of Liability*

Certain phrases and actions are appropriate for consideration and use in terms of reducing the liability of the consultant or consulting firm. These are most appropriate for inclusion in the proposal or contract. Many firms place standard **limitation of liability** clauses in the text of their Schedule of Fees and Conditions under which the work will be undertaken by the engineering geologist. The elements of limitation of liability are as follows:

- 1) Exercise a degree of care and skill that is common to work produced by members of the engineering geological profession in your locale and at the time of the work
- 2) Offer no warranties, express or implied in connection with the contract or the work undertaken
- 3) Include a limitation of liability statement to the effect that your client agrees to limit your firm to subsequent damages, incidental to work performed under the contract, to not more than \$50,000 or the total fee for services rendered under the contract, whichever is greater



- 4) Insure that the client agrees to the limitation of liability statement prior to undertaking **any** work under terms of the contract
- 5) If necessary, seek to provide a means of offering additional insurance, as a direct reimbursable from the client
- 6) Investigate, if necessary, waiving the liability limitation statement only if you can purchase additional insurance to cover this exposure and then ask the client to pay an extra percentage of the total billing for this coverage.

Loss prevention programs are an essential element of limitation of liability. These programs are aimed at reducing the incidence of actions or statements by the consultant which may lead to legal exposure. The leaders in loss prevention programs and instruction have been the Risk Analysis Research (RAR) Company of San Francisco, which has provided this service for about 15 years, largely under contract to the Association of Engineering Firms Practicing in the Geosciences (ASFGE) of Silver Spring, Maryland. Many engineering geologists are owners or employees of firms that are members of AFSE. Many of these geologists are also graduates of the Institute of Professional Practice (IPP), a home study and weekend seminar course sponsored by ASFGE and member firms and conducted by RAR once yearly on each coast.

John P. Gnaedinger of Soil Testing Services has prepared a list of items which can be considered as candidates for limitation of liability clauses to be inserted in contracts or binding proposals, as needed. These items, as modified for use in engineering geological consultation, are as follows:

- 1) There shall be no liability for failure to perform beyond the scope of services agreed to between the consultant and the client
- 2) The owner must assume liability for changed conditions that result in additional costs of performing the project contract construction, including variations in geological conditions
- 3) The engineering geologist has no liability for the performance of work by the construction contractor or his suppliers, even though the engineering geologist may be performing inspection or observation services during construction
- 4) The engineering geologist has no liability for variations in cost estimates or their control as related to the construction process, even though estimates of such costs may have been provided as information to the client, in the course of the consulting contract
- 5) The engineering geologist has no liability for difficulties that result from changes in plans or specifications made subsequent to submittal of the consultant's engineering geological information or recommendations
- 6) The engineering geologist does not assume liability due to actions by other parties to the project contracts
- 7) The engineering geologist does not assume liability if their recommendations are ignored or otherwise not properly incorporated in the plans or specifications, either by designer or contractor

- 8) The engineering geologist has no liability for natural variations in the water content of surficial soil units, variations in ground water levels, variations in precipitation, variations in frost penetration, or variations in other physical conditions at the site
- 9) The engineering geologist assumes no liabilities for the negligence of others, indemnification and hold-harmless clauses notwithstanding.

### ***Liability Relating to Hazardous Waste Disposal***

Engineering geologists should be aware that exploration of many field sites may entail exposure to previously disposed or unknown quantities of hazardous or otherwise toxic materials. Many of the elements or gases are marginally detectable. Loss prevention machinery relative to these sites has been developed among most firms and consultants. The following guidelines are presented for initial consideration of the practitioner; care and individual attention must be exercised:

- 1) Carefully investigate the possibility of the existence of hazardous materials at all industrial sites or known disposal sites before entering agreements to undertake work
- 2) If the decision is made to undertake hazardous waste site investigations, develop a safety plan and safety procedures, buy protective health equipment for all employees assigned to the site, instruct the employees in the procedures and use of the equipment, as required by OSHA and state law
- 3) Budget for compensating reductions in production time of all field exploration, in terms of continuous waste monitoring, explosive and toxic gas emissions, suiting-up in protective equipment, and decontamination activities for personnel and equipment
- 4) Be aware of local, state and federal health protection regulations and recent changes to these regulations
- 5) Include contingency actions and costs in your proposal or contract with the client
- 6) Do not bring soil samples into the office or laboratory until they are chemically certified as being nontoxic. Samples are best stored on the client's property until the analytical results are reviewed.

Engineering geologists undertaking field explorations at known waste disposal sites should exercise care in maintaining the containment integrity of the facility and of the data collected. **Environmental impairment** insurance may be required to adequately protect the client and he or she should be made aware that the engineering geologist does not accept liability for such impairment. Be sure that the client approves of your site exploration plans, and that there are no significant deviations from this plan by your personnel in the field. Take care to observe and report any possible environmental impairment during your field work.

### ***Having Charge***

Personnel operating in the field, in the presence of workers belonging to other parties to the contract, must exercise due caution against assuming operational responsibilities not ordinarily a part of their scope of work. For instance, in an urban locale the driller should be guided to a general part of the site, but should not be **directed** to drill at a specific location until clearance has been obtained from

various utilities, and he has been warned to exercise caution in advancing the borehole so as not to damage underground piping, mains, or telecommunications lines.

Use of the word **supervision** should also be avoided in all proposals, contracts, memoranda or dealings with other parties to the contract. The word supervision often connotes a standard of duty similar to **general administration** and can be construed by the courts to represent the acceptance of responsibilities that lie outside the scope of work representing the engineering geologist's contractual duties.

Any wording that appears in contracts or proposals such as gives the engineering geologist the right to direct the actions of other parties to the contract, or their personnel, can also be construed to represent the assumption of responsibility for the conduct of the work of others and for liability resulting from accidents.

### ***Responsibility for Job-Site Safety***

Injured construction workmen often sue professionals in order to obtain payment over and above what is received from Worker's Compensation or Industrial Insurance because they are precluded by law from suing their employers for job-related injuries. The professional can become such a target because of (1) contract language, or (2) field activity, and lawsuits against professionals by injured workmen have served to indicate the specific procedures which will either prevent such litigation or strengthen your defense if it happens.

1. **Contract language** in your agreements with owners and contractors should include an explicit disclaimer of any responsibility for the contractors' safety methods. The following is an example of such a disclaimer:

The consultant has not been retained or compensated to provide design and construction review services relating to the contractor's safety precautions or to means, methods, techniques, sequences or procedures required for the contractor to perform his or her work.

This disclaimer can be very helpful when a court is attempting to decide whether the authority to stop a project also created a responsibility for correcting unsafe conditions when observed by the professional. In addition to the use of a disclaimer, your contracts should avoid certain terms such as "supervision" and "ensure completion" which can allow a plaintiff attorney to establish that the professional had a duty beyond what is normally intended or expected.

2. **Field activity** involving job site inspection should be limited as follows when an unsafe condition is observed:

- a) Notify the contractor of the condition but do not recommend any corrective action
- b) Document carefully any such notification
- c) Notify owner if contractor does not act to correct hazardous condition
- d) Leave the site.

### *Certifications*

Engineering geological and geotechnical personnel are frequently asked to **certify** conditions in the field that are generally under their observation. Under the guise of concern for public safety, many public agencies are asking for certifications of construction of project elements in accordance with plans and specifications. It is conceivable that engineering geologists, working as owner's representatives on construction projects, may be asked to make these certifications. Consideration should be given to avoiding these requests or to simply make available the observations made during the term of representation, but, in no case, to serve judgment on the quality of the construction. For instance, an engineering geologist observing the installation of a foundation element resting against natural ground or fill might simply report the dimensioned contacts of structural elements with the various types of earth or rock present. This can be made with reference to the plans and specifications, and the owner or other authorized person can judge the degree of actual compliance, if desired.

The main concern for unnecessary exposure to liability is through the meaning of the word **certification**, which tends to imply or express a degree of warranty. Consider use of the word **declaration** if such a statement is deemed necessary. See Chapter 3 for discussion of professional certification by consultants and perjury statements by owners for hazardous waste work.

### **CONTRACT SPECIFICATIONS AND CHANGED CONDITIONS**

Contract specifications are not generally written by engineering geologists; however, we are sometimes called upon to contribute portions of the specifications or to review them. The wording employed in contract specifications is a constant source of later claims, many of which come about through the observance of changed conditions. Specifications should be written in clear and concise descriptions of what is desired in terms of site preparation and construction. Words that cannot be defined by a construction operation should not be used in specifications.

The purpose of well-written specifications should be to provide information that will allow bidding contractors to make reasonable estimates of the cost required to complete the project. Certain types of construction activities, particularly rock excavation for tunnels and underground structures, will require additional information such as rock hardness and other parameters of interest to tunnel boring machine and rock blasting experts.

All information prepared for a specific project should be made readily available to the bidding contractors. An effort should be made by the owner/client to insure that the bidding contractors have acknowledged receipt or have reviewed such information.

**Changed conditions** claims (see Chapter 8) are probably the most frequent of all legal issues involving the engineering geologist. The provision for changed conditions is usually placed in construction documents in order to avoid shifting the entire responsibility for risk assumption on the contractor. Changed condition clauses written to recognize the possibility of occurrence of variations in geologic conditions that affect the manner in which construction is undertaken or in the stability measures employed on the project.

Engineering geologists should be aware of the potential for such claims on their project, especially if the geologist is assigned duties as owner's representative during construction. Two main lines of protection are available and should be employed against changed conditions. In the first, site exploration should be planned to anticipate and encounter a variety of geologic conditions which may be expected to occur on the basis of regional geology, physiography, geomorphology, stratigraphy, etc. Secondly, the individual assigned the task of site representative must be alert and continually making observations of all types during construction. In this connection, the owner's geological or geotechnical representative should make frequent inspections of all open faces or surfaces as they are exposed, and should photograph (including an appropriate scale object) these surfaces. Indications of pending changed conditions claims are centered about any slowdown in the rate at which the contractor has been proceeding on the project, or at a given segment of the site, or in difficulties that the contractor may be experiencing in meeting his or her schedule production goals. These delays mean financial loss to the contractor, and the owner's representative must be aware of these conditions and notify his or her superiors and the owner at the earliest instance.

If the owner's representative is an engineering geologist, the observations and photographs should be accompanied by frequent face and wall maps showing the lithologic type of rock, its state of weathering or alteration and its structural features (discontinuities) and their attitudes. A record of the size of muck produced in rock excavation projects may also prove extremely useful in later defense of the client.

## **CORRECT USE OF WORDS**

Communications on one sort or another are the root source of many of our problems in professional practice. Each engineering geologist should take care in selection of words for proposals and contracts. The essence of this care is discussed in Chapters 5 and 6, so suffice to say that words that imply a warranty or guarantee of conditions must be avoided at all costs; these are words such as **all, certainty, is, will, can**. Think of the damaging implications of, "In **all** aspects at the site, Modelo Formation beds **can** be seen to represent **stable** conditions and **are** an **ideal** medium for construction cut slopes."

## **SUMMARY**

Proposals, negotiations and contracts should be written or undertaken with a careful mind toward the reasonability of what is being said and what will be attempted according to the words with which such actions and documents are constituted. **Care** is the single most important underwriting effort that can be made to make these documents and meetings fruitful endeavors for the engineering geologist. Professional work should not be undertaken without a carefully-executed, written agreement between the consultant and the client. The agreement is one of a number of forms of communications that are necessary to engender a good and stable relationship between the consultant and the client, one which will bring continued opportunities for professional work in the future.

## **ACKNOWLEDGMENTS**

This chapter (Chapter 3 in the 1st and 2nd editions of the Professional Practice Guidelines) was written from the experiences of practice on the part of the primary author (A.W. Hatheway) and members of the profession who provided comments, suggestions and examples of documents, some of which were originally reproduced in the earlier editions of the Guidelines.

It is most appropriate to make note of the influence in this writing that has come from the presence and publications of the Association of Soil and Foundation Engineers (ASFE) of Silver Spring, Maryland, which is now known as the Association of Engineering Firms Practicing in the Geosciences. ASFE has sponsored the successful Institute of Professional Practice (IPP) for a number of years. The primary author has been strongly influenced by his attendance at IPP and by the series of loss-prevention materials that have been published by ASFE.

We are especially indebted to the following members of the Association who responded to the call to assist in the original (1981) compilation. Raymond T. Throckmorton, Jr., Franklin, Tennessee, a past president of AEG, identified the contributors and managed their most helpful participation.

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## Chapter 5

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## **Chapter 5**

### **PROJECT CONTROL**

by  
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Local Agency Review of Grading Projects by  
Arthur G. Keene

Communications Control by  
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Communication is one of the key tools of the professional engineering geologist. A geologist who finds it difficult to communicate with his or her co-workers, colleagues and clients will not be as successful as one who sharpens his or her skills at oral and written communication on a daily basis. Furthermore, a poor communicator runs a greater risk of incurring professional liability losses than an individual who learns to use good communication as a loss prevention tool. Good communication is the essential means by which effective project control is achieved.

Some of the concepts presented in this chapter were originally discussed in greater detail by the Institute for Professional Practice of ASFE. Also recommended is the ASFE publication "A Guide to Establishing Quality Control Policies and Procedures for Engineering Firms Practicing in the Geosciences".

### **ADMINISTRATIVE CONTROL**

Administrative control of project work represents an overall effort to provide the client with all of the essential answers necessary to meet the scope of work, as promised in accordance with the contract to perform the work. The client additionally deserves to receive the work product in a timely manner within the expenditure agreed upon in the contract. Without administrative control, it is highly unlikely that the average professional organization will meet these objectives.

Administrative control is exercised through the application of management principles not unlike those of any professional service organization. The most important controls are:

- Phasing: Phases or stages of work are established so that data are developed in a logical sequence for review, interpretation, and analysis.
- Staffing: The most qualified, available personnel are chosen to perform the work indicated.

- Orientation:** Project members are briefed as to the nature of the project, its scope of work and the way in which the project manager visualizes the work to be conducted.
- Communication:** Project members are instructed how, when, and to whom to report; the items of communication expected are established (e.g. briefings, interim reports, telephone contacts, daily reports, etc.).
- Responsibility:** Each project team member is made aware of to whom he or she is to report and who is to report to them, as well as who they are to work with laterally or with whom they should coordinate activities during the project.
- Scheduling:** Mileposts of timely completion of actions or delivery of work projects within the project team and between the team and the client are established.
- Financial Accounting:** A means of fast and accurate recording and reporting, to and from team members, of financial expenditures is created. The system is usually enhanced by a simple means of flagging the rate of expenditure versus milestones, scheduling, or completion of project deliverables. Computer software for these purposes should be selected with care.
- Review:** A system for evaluation of the completeness, accuracy, reasonability and significance of all project observations, findings, interpretations, conclusions and recommendations, must be made at regular intervals in order to achieve the basic goals of delivery of quality work, on time and within the financial budget.

In professional technical service organizations, such as those employing engineering geologists, administrative control is generally best conducted by trained professionals who have learned to work with the principles of management. It is normal in the course of professional career development to encounter more and more use of these principles as the engineering geologist takes on more and more complicated professional assignments. While not all engineering geologists will wish to practice management at the higher levels, it is in the best interests of any engineering geological organization that all of its practitioners at least are aware of these principles and their application, so that they individually will be able to function as a valuable and trusted member of the organization and each project team to which they are assigned. The ASCE publication "Quality in the Constructed Project" (1990) provides substantial information regarding project organization and control. We recommend you obtain and use this book.

The framework of administrative control must be established before a project can be properly undertaken. An efficiently and economically run investigation must be subject to controls on costs and contents of reports. It is the objective of this section to present some of the various types of controls and their purposes. These controls are suggested for use by the small engineering geology firm. It is not the intent of this section to be all inclusive and replace a person with skills in business administration. The several types of controls to be discussed include: policy and procedure, insurance, fee schedules, cost estimates, project setup, billing and administrative forms.

## ***Policy and Procedure***

Every engineering geology firm with employees should develop a Policy and Procedure Manual. This manual serves as a daily working guide. It sets forth the basis for compensation, work schedule, sick leave, vacation and time off. It should also describe the procedures to be followed in case of an accident or damage to company-owned equipment. The Policy and Procedure Manual will include a basic Health and Safety Plan and depending upon the size of the firm, an Affirmative Action Plan. Firms doing environmental work must provide 40 hours of health and safety training for all field employees and an 8 hour refresher course annually in order to meet OSHA requirements. Additional training requirements for employees (such as trench safety) may be required in various states.

The Institute of Business Planning and other similar organizations have typical manuals, which can be modified to meet the small organization's needs. The preparation of an up to date Policy and Procedure Manual should be given high priority by those in administrative charge of the firm.

## ***Insurance***

With the growing patterns of complexity in our society, there is a greater and greater need for insurance. The types of insurance which should be included in the firm's portfolio include: Worker's Compensation (mandatory by law), comprehensive general liability and property damage, comprehensive fire and theft casualty coverage, contractual liability insurance, valuable papers and records policy, automobile liability insurance, and general professional office equipment floater.

There is also a need for professional liability (errors and omissions) coverage. However, this latter coverage is generally not available to the firms that practice only engineering geology. The National Water Well Association (now the Association of Ground Water Scientists and Engineers - AGWSE) has available professional liability coverage for its members, who are primarily hydrogeologists, engineering geologists, engineers, and related scientists. The Association of Engineering Firms Practicing in the Geosciences (ASFE) also has information available regarding professional liability insurance (see Chapter 9).

The administrator of an engineering geology firm should check with an insurance agent to determine the firm's coverage requirements.

## *Fee Structure*

Many firms have established schedules of charges or billing rates which are used to estimate fixed fees, or which are provided to clients and incorporated into contracts and proposals for services provided on an hourly or daily basis. Such schedules may list billing rates for specific individuals in the firm or for various position classifications, such as Chief Engineering Geologist, Project Engineering Geologist, Staff Engineering Geologist, Field Technician, Draftsmen, and Clerical personnel. Although the billing rates of principals in the firm are generally determined by market conditions, those of employees are frequently based on a multiple of direct salary expense or of salary and benefits combined ("direct personal expense"). Some clients, particularly governments agencies, will require information as to how such rates are derived and limit overhead and profit margins.

Development of a billing rate may be based on an analysis similar to the following. The firm will analyze its financial performance periodically, and segregate its costs into categories representing salaries and benefits directly attributable to services provided; salaries and benefits representing overhead, including marketing, firm administration, etc.; cost of employee benefits; direct and reimbursable project expenses; and overhead expenses. In addition, the firm's profit goal and contingencies are estimated. To establish the billing factor, the firm would assume that all services were provided under an hourly billing arrangement. If, for example, the total of direct salaries during a year's time was \$200,000, indirect salary expense was \$100,000, employee benefits (15% of \$300,000 in salaries) were \$45,000, direct expenses were \$50,000, overhead expenses were \$60,000, and contingencies and a profit goal were \$45,000, there would be \$300,000 in revenues which must be earned on a base of \$200,000 of direct salaries. Billing rates might then be established at a multiple of 2.5 times direct salary expense, so that an individual being paid an hourly equivalent of \$14.00 per hour would be billed out at \$35.00 per hour.

Some firms base their charges on a multiple of direct salary expense, while others use a multiple or direct personnel expense. Using figures from the example above, the "direct personnel expense" would be \$230,000 (direct salaries plus 15% in benefits), and an additional \$270,000 in earnings would be required. The multiplier would be \$500,000 divided by this \$230,000 base or 2.174 times the direct personnel expense. If this were to be converted into flat billing rates, the hourly personnel expense for an individual earning \$14.00 per hour would be \$16.10 per hour. Multiplying this by a factor of 2.175 achieves the same \$35.00 per hour billing rate.

Use of flat billing rates for various categories of personnel is clearly the easiest to administer. Furthermore, if the minimum rates necessary to sustain the firm are lower than those generally charged for the various skill levels, actual billing rates can be adjusted upward without impairing the competitive posture of the firm. Where fees are based on multiples of actual costs, it is more difficult for the firm to take advantage of the difference between the cost of services rendered and the market value of those services.

Some governmental clients may require the use of multipliers based either on actual direct salary expense or direct personnel expense, will limit the overhead factor to a specific percentage, and may not allow profit and certain other costs to be included in the multiplier. Instead, a percentage "fee"

is allowed on top of direct and indirect costs; this fee must cover not only the firm's profit, but also those costs which are not covered in the multiplier. Multipliers and billing rates must be based on auditable costs for many governmental clients.

In addition to hourly charges based on time spent by the firm's personnel, firms should consider separate daily rates; charges for travel time; rates charged for overtime work (whether or not the firm is required to pay overtime); rates for specialized services such as preparing for and giving expert testimony; and rates for the use of seismic, resistivity, gravity, and other types of equipment, including computers, owned or leased by the firm. To the extent that the firm can charge separately for these items, it can keep its hourly billing rates lower and present a more competitive basic fee.

Most professionals require that certain other types of expense incurred on behalf of a client be reimbursed directly; some apply a markup to the actual cost to cover their own overhead involved in administering these expenses, most of which must be prepaid by the firm. Again, a greater number of reimbursable charges will reduce the basic fee proposal without affecting profitability. In order to reduce the impact of these expenses on the firm's cash flow where a substantial amount of reimbursable expenses will be incurred, the firm should consider requesting that the client deposit sufficient funds with the firm to cover these expenses. Since these are the client's funds, they should be kept in a separate account and not commingled with those of the firm.

Typical reimbursable items include: fees paid to outside consultants and testing laboratories; rental and operation of drilling, bulldozing, and other field equipment; cost of tools and equipment consumed in or specially purchased for the project (less any residual value); reproduction charges; long distance communications; travel and subsistence charges, including vehicle mileage and auto rentals; postage, shipping, delivery, and freight charges; and charges for any special permits and inspections required by governmental authorities.

In order to avoid any misunderstanding with the client, the firm should provide a written schedule of its charges and the items which will be directly reimbursable. If a fixed fee is to be paid, care should be taken to define the services which will be included in the fixed fee, and those that will be subject to additional charges.

### ***Cost Estimates and Proposal***

After discussions have been held with a prospective client or upon receipt of a request-for-proposal, the administrator studies the client's need for services. Usually based on past experience, a program is put together detailing the number of hours that will be required of each job title, the equipment to be utilized and a listing of reimbursable expenses. This endeavor is usually expedited through the use of a standardized "Cost Estimate" form. The use of such forms helps prevent the inadvertent omission of a cost item. This form also contains spaces for the charge items from the fee schedule. Standard cost-estimating computer software is available which can be adapted for this purpose. When the cost estimate is prepared, the proposal can be finalized.

If the duration of the project is more than 45 days, it is usually prudent to include a statement that progress billings will be made at monthly intervals.

The cost estimate portion of the proposal should be clearly stated, whether the fee will be charged on a time and expense basis, or as a guaranteed maximum which will not be exceeded without prior authorization from the client or as a lump sum.

### ***Project Setup***

Once a proposal has been authorized the project should be set up. Generally a project is assigned a project number. The pertinent details are generally listed on a "Job Information Sheet". This form contains the client's name, contacts in other firms that will be working on the project, a brief description of the work to be performed, the location of the project, reference materials and previous reports in the vicinity.

Most importantly, billing information should be presented--who is to be billed, and any special billing instructions. The accounting and clerical functions within the company should receive copies of the "Job Information Sheet" so they can open up their appropriate files.

There are numerous job numbering and coding systems. The writer, based on years of experience, prefers one which readily identifies the year. This aids greatly in the retrieval of closed files and reports.

Once the paper work portion of the setup is completed, the file containing the proposal and job information sheet is given to the project geologist for action.

### ***Billing***

Billings are understandably the life blood of any service business. Every attempt should be made to submit accurate invoices at the close of the project. This is usually immediately after submittal of the final report. Follow-up statements should be made at intervals of 30, 45, 60, 75, and 90 days if the invoices are not promptly paid. The older past-due accounts should receive more attention in order to obtain payment. There is an old axiom which states, "The older the invoice, the less likely you are to receive payment."



### *Administrative Forms*

The use of standardized forms will smooth out the day to day administrative operations of a firm. Such forms should include but not be limited to those on the following list:

- |   |                     |   |                          |
|---|---------------------|---|--------------------------|
| ! | Time Sheets         | ! | Job Information Sheets   |
| ! | Expense Forms       | ! | Transmittal Forms        |
| ! | Cost Estimate Forms | ! | Schedule of Charges Form |

Every form should have a separate identification number for administrative control and reordering purposes.

The above listing illustrates some of the diverse types of information that can be orderly presented in a repetitive manner. The forms should be 8 1/2 x 11 inches in size. The use of odd types and sizes of scrap paper should be discouraged.

All project oriented forms should contain the name of the originator and the date prepared. If multiple sheets are required, the total number of pages should be indicated, for example: "Page 1 of 8 pages".

Computations should be carefully planned and organized, not only to assist others, but also to assist the one making the studies in clarifying and coordinating his or her thoughts and approach to the problem. A memorandum outline of the study should be prepared giving objectives, methods, etc., and filed with the work sheets, computations, and computer output.

The following items should be indicated:

- ! The objective
- ! What was done
- ! Why it was done
- ! When it was done
- ! By whom it was done
- ! What data were used
- ! What assumptions were made and why
- ! What computer program was used (if any) and the basis for that choice; the assumptions and constraints inherent in the computer program should be listed also
- ! What constants, coefficients or other factors were used and the basis therefor
- ! Units used
- ! The answer obtained

All computations should be double checked. Computer output should be checked for reasonableness of the results.

## *Communications Control*

Communication can be thought of in terms of a model composed of five steps. The sender of a message frames his or her thoughts; analyzes his or her receiver; selects the medium for the idea transfer (oral, written, graphic or physical); prepares and sends the message to the receiver, who decodes the message and responds. Problems in communication may develop at any step along the way.

### Oral Communication

Speaking with others face-to-face or over the telephone is a daily requirement for the engineering geologist. Oral communication is nothing more than an idea transfer composed of the sending of an oral message to a receiver. This idea transfer may be either blocked or facilitated by a number of factors.

Our language itself is a major inhibitor to good communications (both oral and written). The 500 most frequently used English words have over 14,000 meanings. Because so many words have multiple meanings, it is very easy to see that erroneous use of words, resulting in a failure to communicate, may lead to misunderstandings. In speaking with others we must therefore choose our words carefully, taking into consideration who is receiving the oral message and fitting our language to the level of understanding of the receiver.

Telephone communications are extremely important and should always be accompanied by written documentation. The professional geologist who employs others should take care to encourage good telephone manners in his or her employees.

Face-to-face communications with others, whether at meetings or in the course of daily work, are most satisfactory, as misunderstandings can usually be resolved on the spot.

As memories can be faulty, it's a good idea to make a written record of important oral discussions.

### Project Conflict Resolution

Poor communications often lead to conflict among parties engaged in working together on a project. The anatomy of a conflict can be seen as having four phases: crisis, escalation, confrontation and resolution. First a crisis occurs, emotional turbulence results, the parties to the conflict retreat to adversary positions of self-interest. Escalation of the conflict occurs and the project suffers. Finally a confrontation takes place between the conflicting parties, and the conflict is resolved. The engineering geologist on a project may find himself in a position as a third party, in a position to help resolve conflicts on projects with which he is associated by virtue of the contract with the owner. In the role as the client's agent the geologist may serve as an information source, an interpreter or an arbitrator during the confrontation and resolution stages of a conflict. However, the geologist should strive to avoid personal involvement in the crisis and escalation phases of a conflict on a project. If

the geologist does become a major participant in a conflict situation, he or she should avoid becoming rigid and uncompromising and communicate with others in order to resolve the conflict satisfactorily.

### Written Communication

Written communications, in the form of letters and reports, form the basis of our service to our clients. Report writing is discussed in depth in Chapter 6; however, in general, the good use of language (avoidance of jargon and extreme expressions) is just as important in written communications as in oral.

The business letter is a primary form of written communication which can enhance one's professional image and help maintain professional standards when carefully drafted. Letters from others deserve a prompt, carefully considered response as a good business practice.

Engineering geologists are not normally known for their expertise in semantics. The problem of poorly chosen words can be diminished through the restriction of words that are absolutes, such as all, none, always, certain, never, maximum and minimum (see Chapter 6). Words which imply a warranty, such as guarantee or promise, should be avoided. Omit exaggerations from your communications. To promise more than conformance with generally accepted standards of geologic practice is to invite future claims. Avoid loss of control of emotions in stress situations so that you won't admit to others that a failure was your fault. This may result in severe financial penalties which you alone should not have to bear if the failure was not entirely your fault.

The professional geologist should cultivate a writing style which is readable and comprehensible just as carefully as he or she cultivates a technical image as a professional. A good writing style is one of the most important tools of a good communicator (see Cochran, et al., 1979, and Hansen, 1991).

### Record Keeping

Record keeping is of primary importance to the professional geologist. Paperwork is anathema to many, but essential to the maintenance of a professional business practice. Records form the accurate basis of communication, especially for telephone conversations and meetings.

The Importance of Documentation:

Documentation at all stages of a project--from the proposal stage through the completion of construction--is necessary and an essential loss-prevention tool for geologists.

Documentation practices, both in the office and in the field, should be standardized within a firm to the extent that each individual is aware of his or her responsibilities with respect to record keeping.

Incoming mail and project data should be stamped with a date received with the internal routing clearly indicated. The project number should also be shown. All data, borrowed maps, etc., should be returned utilizing transmittal forms. Project numbers should appear on these forms also. This procedure allows the establishment of a "paper trail" of records which is very helpful in establishing

a chronology on a project. It also helps clarify "who got what, when", in the event of a misunderstanding or dispute.

#### Office Records:

In the office, the professional geologist must have his or her pencil poised to record essential details of telephone conversations. Not only will telephone memos serve to remind him or her what was said by both parties to a telecon, but a phone memo will stand up in court as permissible evidence in the event of a professional liability claim. Telephone memos should be kept in chronological order with other project data in the project file.

A filing system for project data is essential in firms of all sizes. During the proposal stage of a given project, a file should be set up containing essential data, including facts about the client and all information used in preparing the proposal and/or contract for the project. As work on the project proceeds, all correspondence, telephone memos, letters of transmittal, notes and minutes of meetings, etc., should be inserted in the file in chronological order. Subfiles should be set up for technical data (such as subsurface information, laboratory data, and engineering calculations) as well as correspondence and paperwork relating to the business and administrative aspects of a project. Project files within an office should be situated such that all those with a "need to know" have easy access to required information. Reproduction and dissemination of data to project participants while work is in progress is facilitated by a central filing system for active projects. Documents sent to others outside the firm should be copied and represented in the files, along with a transmittal letter or form of record.

A file for non-active or completed projects should be maintained, and an information retrieval system set up to facilitate location of non-active files. A tri-partite system, which permits retrieval by project number, client name and location works well and assures that files are not lost and can be accessed years after work has been completed.

### **FIELD CONTROL**

Projects live by budgets, goals, and deadlines. The end result of project work is a match in which goals are reached by deadlines and within budgetary limitations. Control of activities in the field are crucial to attaining these goals. It is in the field that expenditures in the form of subcontracted field services (drilling, test pit excavation, trenching, in-situ tests, etc.) consume project funds at a high rate. Problems with weather in the field can also cost the project thousands of dollars in lost productivity within a short period of time.

Field control must be maintained over personnel and equipment. Most of the control can come from assignment of reliable and competent people to the various levels of supervision and the requirement that these persons communicate with each other and with the home office. Daily telephone, fax, or modem communication is generally a must; the act itself forces each level of control to prepare the daily report and to review its impact on project planning and objectives.

The next most important aspect of control is the development and issuance of clear and concise goals and objectives for the field activities. This should be discussed with field personnel by the project manager, in conference with the field leader and his or her crew. The goals and objectives should be reviewed from all aspects of terrain, weather, equipment, and expected geological conditions. Field personnel must understand what the project management needs, must know the time constraints under which these activities will be conducted, and must have the means of reporting progress.

Progress reports, in addition to being presented frequently in verbal form, should be followed with simple written records. The written record should be quantitative and contain running totals of expenditures of time and funding against the available time and funding. Both the field manager and the project manager should be able to detect when individual activities are not meeting projected goals and then be able to determine what effects of weather, machine or personnel productivity, or subsurface conditions are producing negative impacts. The quality of data produced must be continually assessed toward final goals and field personnel should never be so overtaxed that they are not able to review the quality and nature of their findings in terms of the desired objectives.

Field personnel should be allocated time to prepare visual summaries of their findings, in map, log, or cross-sectional form; to inspect for correlations, or lack thereof, between individual borings, test pits, trenches or outcrops. If more than a predetermined number of personnel are in the field, it is highly desirable that a supervisor be assigned to control the cooperative aspects of the field work, to inspect the quality of data being produced, and to see that correlations and graphical summaries are being produced on a daily basis. This supervision will help to see that machine and other subcontract expenditures are not allowed to go a day beyond time when deviations in performance or product are noted.

Many firms and organizations are preparing and issuing Manuals of Field Procedures, which relate the manner in which these activities will be undertaken and the format in which the results will appear. Important references are usually cited and graphical examples included to depict the format for plotting results. Individual initiative, however, must be stimulated, so that the many questions which are not directly answered in the procedures will be recognized and asked verbally.

Interim copies of field compilations should be returned to the office frequently, so that office personnel and the project manager can assess the results, keep the client informed and react to changes in scope or direction initiated by the client.

Field visits by project management should be included in budgetary estimates and conducted on a frequent basis so as to foster a better understanding of project goals by the field personnel and to allow the project manager to fully appreciate the conditions under which the field work is being conducted. Often the project manager will be able to detect important facets of the work and work product that may not be apparent to the field personnel due to their having been too close to the project.

### ***Field Chronology of Events***

Documentation of events occurring in the field is another essential aspect of good professional practice. The engineering geologist should maintain a comprehensive notebook of all field observations for ready reference at all times.

During exploration and construction phases of a project, documentation of activities on a daily basis is essential. The daily report of field activities prepared by a field representative should be a chronology of events including all essential details of work completed that day. Copies of this report should be transmitted on a regular basis to project participants in order to maintain communications between all concerned parties. Daily reports include data which permit monitoring of costs on a regular basis. Dated and titled photographs or color transparencies are a powerful supplementary record form.

Perhaps the primary function of the field chronology is to make personal observations and to record details of the activities of others, particularly with respect to construction work and "as-built" geologic conditions. When possible differing site conditions (changed conditions) are observed in the field by a field representative, the potential problem should be reported through prearranged channels to the contractor and the owner. Written letters, memos to file and daily reports should be prepared to document these occurrences and will provide information which may be crucial to a defense in the event of a professional liability claim. The procedure to be followed in the event of the observance of possible changed conditions should be provided for in the contracts between the owner and the contractor, and the owner and the engineer or engineering geologist.

The owner should be made aware of potential changed conditions long before construction on a project begins. When changed conditions at a site become apparent, the professional geologist should not express his or her opinions, but should document the state of construction at the claim location, and report the occurrence through the proper channels to the client.

In the event of a failure, the geologist should be careful not to make a statement until he or she has reported the incident to the client or supervisor, as well as to his or her insurance agent and attorney so that they make take steps at an early stage in order to minimize losses from a professional liability claim associated with the failure.

### **LOCAL AGENCY REVIEW of GRADING REPORTS** (using Los Angeles County as an example)

#### ***Independent Geotechnical Review***

The primary function of the review process by a local agency should be to review geotechnical reports pertaining to proposed grading conditions for their adequacy and reliability prior to issuing a building permit. For a discussion of responsibilities of regulatory reviewers and the need for registration of public agency engineering geologists see Tepel (1993). This review function is

normally performed by an independent geotechnical review group which advises the permit issuing agency, such as a Building and Safety Department, or a Public Works Agency, or even a Planning Commission, relative to zoning and proposed subdivisions. It should be kept uppermost in mind that the review group consequently performs an advisory function to the permit issuing agency, and nothing more. A distinct division of purpose as outlined above is important in order to prevent undue agency pressure precipitated by special interest parties.

The question becomes: How does this independent review, for adequacy and reliability, relate to the liability of the agency when failure occurs? It must be presumed that (1) the geotechnical report was reviewed and approved, (2) the responsible permit issuing agency was advised that the recommendations of the consultant were reasonable and technically well founded, and (3) they were properly implemented as proven by physical inspection. The test of this advice lies in the adequacy or thoroughness of the geotechnical review itself. This thoroughness is further controlled by a code utilized by the local agency as enacted by the responsible governmental body (mayor, city council, or board of supervisors).

### ***Code Restrictions***

#### Origin of Building Codes Relative to Geologic Hazards

How do laws come about? Many times they are precipitated by the abuse of man against man. Nature also plays its part, resulting in disasters that could have been prevented by the application of common sense coupled with an understanding of the earth's physical properties. Codes develop as a result of natural crises, or as a result of political pressure on our local community leaders. At other times, professional groups get together and agree on what is a reasonable approach to controlling "natural" disasters, or limiting the impact of man's influence on nature's inherent stability. One example of this approach is the Uniform Building Code (UBC), a general code of guidance originally authored in California by the Pacific Coast Building Conference, now known as the International Conference of Building Officials (ICBO). This is a code that can be adopted by any community throughout a state if the responsible local agency chooses to do so. Chapter 70 of this code, concerning grading controls, was first included in the 1964 edition.

Because of heavy rainfall in 1951-52 that caused 7.5 million dollars damage in Los Angeles City the first grading code was adopted by the City of Los Angeles, thus assuming a pioneering role in the control of man's modification of natural urban terrain. A modified version of the UBC was published in the 1970 edition (Chapter 70), to prevent destruction of homes and other structures due to landsliding, uncontrolled grading practices, severe erosion, mudflows, and flooding. These versions of the UBC have undergone some modifications in later years as a result of continued natural disasters and from the expressed hue and cry of the community demanding greater protection against geologic hazards. The City of Los Angeles and the County of Orange, California, have adopted a modified Chapter 70, UBC that is more prescriptive than the general UBC.

## The Meaning of "Safe" Relative to Geologic Hazards

The word "safe" is basic to many building codes. For example, the Los Angeles County Code reads: "The building official may require a geological or engineering report, or both, where in his opinion such reports are essential for the evaluation of the safety of the site", and an evaluation "regarding the effect that the proposed building or grading construction will have on the geologic stability of property outside the building site".

### "Slide Waiver" and Its Use

A "slide waiver" is an agreement between the applicant and the permit issuing agency, in which the agency is not held responsible for issuing the permit. However, the building site must appear to be safe for the proposed use. Los Angeles County's "slide waiver" requirement (Section 308(b) 3C) reads thus: "A permit may be issued when the applicant has submitted a geologic report complying with the provisions of Section 309 which report indicates that the site appears to be geologically safe for the proposed use, but is located in an area subject to a hazard of geological nature. Before a permit is issued, the owner first shall record in the Department of Registrar-Recorder the findings of such report or reports, together with an agreement relieving the County and all officers and employees thereof of any liability for any damage or loss which may result from the issuance of such report". This is a politically expedient method to avoid political pressure.

These waivers should only be issued on sites whose development will not affect offsite property. This means the geologic hazard must be self-contained within the boundaries of the property in question. Other property owners rights cannot be waived. The use of waivers has been contested in court and the courts have determined that the waiver is an encouragement and the issuing agency was required to pay the loss (Salton Bay Marina Inc. vs Imperial Irrigation District C.A. 4th, 4 civil 26949 Sept. 30, 1985 by Staniforth, J.).

It must be understood that the use of the word "appear" is generally predicated on sound adequate data, incorporating calculations to show a landslide (geological hazard) has a safety factor in excess of at least 1.10 or more, and less than 1.5 against failure. This range is determined by local agency policy.

### Should Grading Codes be Specific?

Generally, there are two types of codes: (1) a performance code, which specifies minimum requirements, and (2) a prescriptive code. Both codes state the desired result to be achieved after construction. A performance code specifies basic minimum requirements and overall performance objectives for the project, and provides for the performance by professional consultants during stage approvals. A prescriptive code is more definitive and states the exact method and design desired, requires the professional consultant to do their work in a specific manner and tells them that they are responsible for the results after doing it the prescribed way. If the completed construction fails to comply with certain regulations, penalties are exacted of the constructor.



Los Angeles City enforces a prescriptive grading code while the Los Angeles County's building laws are a performance code, integrating certain grading specifications to make it meaningful. This is necessary as grading takes place in materials which are not uniform in texture or mineralogical composition. Minimum standards can be uniformly prescribed with comfortable margins of safety. Either a prescriptive or a performance-oriented code, backed by minimum specifications, and reinforced by quality assurance grading inspectors and reports from professional geotechnical consultants is the primary way to secure any modicum of comfortable safety margin against postgrading failure. Such inspection should be required on a full-time basis, to preclude the occurrence of weak-link non-conformance. Liability would thus be transferred to the consulting firms where it belongs. Site approvals should be based upon stage approvals by the professional consultant and the governmental agency. The site is not considered a safe site until approved and justified by the geotechnical consultant as a safe site.

A local agency needs experienced grading inspectors to fully verify code specification conformance with field inspection. The private geotechnical consultant needs well trained and experienced field personnel to be their eyes on the site during grading to assure that all geotechnical hazards are found and remedial correction and control has eliminated the hazard potential. Investigation, evaluation and analysis by professional geotechnical consultants should provide the design parameters for safe design by civil engineers.

### ***What Constitutes an Adequate Review of a Geotechnical Report?***

#### **Professionalism**

Various states now register and certify professional geologists based upon very restrictive qualifications (see Chapter 1). This indicates that being a state licensed professional lends credence to his or her stated opinions, and so it should be. If opinions were well supported by factual data, the incidence of geologic failures, such as landslides, debris flows, severe erosion, subsidence, and settlement, would be minimized. However, where judgement is pre-empted by lack of supportive data, the opinions could well be faulty.

#### **Surface Substantiation**

Obviously, subsurface data are essential to adequately describe geologic hazards. Three-dimensional geometry of a landslide cannot be otherwise determined; creep-prone colluvium cannot be evaluated, let alone be properly identified; mudflow potential discerned. Strength of materials, the geotechnical engineer's purview, must be known. Thickness of deposits, and proper identification of geologic units, such as fluvial deposits as opposed colluvium, stream or wave-cut terraces as opposed to a landslide depression, to mention only a few, must be professionally ascertained, and can often only be done by sufficient exploratory work. Unsubstantiated opinions can only go so far toward justifying the alleged safety of a site.

### Assumed Soils Parameters

There are various means to test the strength of a soil, or slideplane, or gouge in a shear plane or brecciated fault zone. Shear test values, for instance, vary between laboratories. Of similar importance is the location of the test material along the slide plane, or the sheared gouge of a fault zone. A statistical average of the strength parameters of tested materials within the three-dimensional slideplane, for example, may be more meaningful than the test procedure. However, this can only be done with high cost and with many samples taken from many borings and exploratory trenches. The cost-benefit ratio hence begins to play a large role in the adequacy of a report. This ratio is very difficult for a reviewer to evaluate. The author of the report thus mitigates his or her analysis of stability using assumed values verified by selective tests, and submits the results for review. As there are no specified test procedures in a performance code for shear strength, it becomes obvious that the safety of a proposed cut is dependent upon the accuracy of the laboratory tests, the investigating geologist's three-dimensional description, and the judgment of the geotechnical analyst. Figures may be manipulated to show a safety factor greater than seems probable, based on field evidence. Yet minimum code requirements are met. Now one might ask: "Where does the reviewer go from here?"

### Minimal Code Requirement

The minimum requirement presents problems accordingly. The review and approval of technical reports by a governmental agency involves many considerations other than those geological or geophysical. For instance, the agency's discretion may be limited by ordinance or code and if a report meets those requirements, it must often be approved, even though the reviewer suspects that it is not adequate, in his or her individual judgment, in other respects.

In such a situation, the reviewer would have no discretion to disapprove the report. In California, for example, a negative response may cause the decision to be evaluated by the County Geologic Board of Appeals or a Geologic Peer Review Board of some type.

### Consultant's Wiles

Having a minimal code provides fertile ground for minimal reports. Often, knowing the review agency will disapprove the report, a consultant will submit his or her findings with the purpose of "landing the job". This practice is unabashedly common, and leads to poor professional relationships with the consultant's peers, both fellow consultants and reviewing engineering geologists. A request for additional information prior to approval is almost automatic.

Another facet of some consultant's wiles is the policy of circumventing a positive conclusion upon which rests a recommendation for corrective action. The use of phrases such as "appear to be safe", "grossly stable", "I believe it is safe", are very difficult for agency reviewers to approve if minimal data are submitted.

Consultant reports often include limitation of liability statements such as (1) "Notwithstanding the extent of the investigation, it is possible that latent defects may be concealed by earth materials, and

that such defects, if present, are beyond the scrutiny and analysis of the engineering geologist", and (2) "Recommendations, and conclusions, and graphic illustrations presented are based on interpretations of subsurface exploration and surface exposures, and are believed to be adequate for purposes of this investigation. However, variations of subsurface conditions may be expected to a reasonable extent."

The reviewer should not be required to evaluate the legality of such warranties. However, when the wording of such warranties is accompanied only by poorly substantiated opinions and recommendations, the report probably will not be approved, especially where off-site property might become involved.

#### Common Deficiencies Encountered by the L. A. County Reviewing Staff

- 1) Undue pressure to expedite a review, as exerted by the consulting geologist, at the request of his client.
- 2) The use of students to perform unsupervised field mapping. This too often leads to errors not detected by the responsible registered geologist, who may not review the work in sufficient detail before it is submitted for approval.
- 3) Tendency to downgrade evidence, such as to label landslide debris as colluvium, and slide gouge as fault gouge. Dismissing evidence by statements that ancient landslides won't ever move again.
- 4) Lack of appropriate exploratory trenching; or, alternatively, trenches placed at a location that will provide little data on the boundary of a slide. Alternatively borings which are not deep enough, such as a few flight auger holes to 30 or 50 ft. to investigate a major complex landslide.
- 5) Data points located too far apart to support a reliable conclusion. Borings should be placed for optimum correlation of geologic units, not on a grid pattern.
- 6) The consultant may not be knowledgeable of local geology, published references, and local agency procedures and requirements, thus causing undue delays and submission of clarifying addenda prior to approval of the owner's plans.
- 7) Cross-sections used in the Slope Stability Analysis submitted are at such a small scale that accurate measurements by the reviewer are difficult or impossible. The unwarranted use of small pieces of paper, where oversize sheets are more appropriate.
- 8) Reports often do not include sufficient data to justify recommendations. Numerous reports have been lacking in detailed geologic structure (e.g. 6 attitudes mapped within a 250 acre hillside area).

- 9) Consultants sometimes place complete reliance on laboratory test data to establish design parameters. These parameters often have to be modified to meet field geologic conditions. Limited landslide surface shear strength data should not be projected from locations several hundreds of feet distant.
- 10) Consultant use of only selected data to allow for advantageous calculations.
- 11) Some reports fail to show the location of critical project elements, such as slopes analyzed, areas where unsatisfactory soil is to be removed, and restricted-use areas.
- 12) Temporary cuts are recommended that could endanger existing structures and off-site property, and which are chosen without proper geotechnical analyses.
- 13) Subdrainage systems that are not thoroughly analyzed for size, characteristics or dimensions.
- 14) Neglect to address settlement potential or settlement potential is estimated without justification. This includes the effect of settlement on underground utilities.
- 15) Failure to evaluate liquefaction susceptibility.
- 16) Recommendations regarding the design of retaining walls are sometimes based on standards that may not be applicable to the proposed development. Backfill, cohesion, geologic conditions, and structural design are sometimes ignored when establishing the design recommendations.
- 17) Design plans may not incorporate geological report recommendations, or may be in conflict with them.
- 18) Reports may not state whether or not the site is safe for the intended use in accordance with code requirements.

Recent articles by Scullin (in press) and by Slosson and Larson (in press) indicate little change in these common report deficiencies between 1980 and 1993.

### ***Report Guidelines***

Many guidelines for the approval of geologic reports have been established by various communities. Chapter 2 contains more generalized guidelines for Seismic and Engineering Geology Reports. Each community stresses its most important interests and priorities. Such a guideline is presented below. It was originally compiled as a standard for consultants practicing in Los Angeles County, with the primary intention of helping to expedite the review process.

It is recognized that different physical situations will require reports of different length, scope and orientation, but all conclusions and recommendations must be substantiated with well-qualified data.

A field inspection may be part of the review. These minimum standards are inclusive of most geologic problems and situations that may occur in Los Angeles County hillside developments. Authors of reports are expected to fully comply with those standards germane to the particular project.

#### General Information Required

1. A location map, showing the boundaries of the area being investigated, and its general setting with respect to major geographic and geologic features.
2. The full name of the geologist responsible for geologic mapping upon which the report is based, and the dates during which the mapping was accomplished.
3. A bibliography of all references used. (The engineering geologist is expected to be familiar with all available references dealing with the area being investigated.)
4. Topography and drainage characteristics of the area.
5. Abundance and distribution of exposures of earth materials within the subject areas and indication of their competency.
6. Explanations regarding the nature and source of any available subsurface information. Such explanations must provide any technical reviewer with the means of assessing the probable reliability of such data.
7. All reports must be signed by a State-certified (licensed) engineering geologist who was "in responsible charge" of the investigation.
8. A minimum of two copies of each report are required by the Engineering Geology Section.

#### Types of Geologic Reports

1. Tentative Tract and Parcel Plan Reports: All initial reports of an area which are submitted for review by the L.A. County Engineering Geology Section must be based on the latest tentative plan for the subject development. In those cases in which the geologic report predates the submission of the tentative tract or parcel plan, the tentative stage geologic report cannot be considered for approval until the tentative plan has been reviewed.
2. Grading-Plan Geologic Reports: The geologic report shall clearly refer to the latest date on the grading plan upon which his or her report is based. After the plans are reviewed to incorporate the consultant's recommendations, the consulting engineering geologist shall sign and date copies of the grading plan. The consultant's signature, stamp, and license number on the plans indicate that all of his or her recommendations are incorporated in the grading design.

3. In-grading Geologic Reports: Based on the complexity of the geologic conditions affecting a site, the Engineering Geology Section may ask for periodic in-grading geologic reports. The time interval may vary from bimonthly to semimonthly, depending on the project.

The primary purpose of these in-grading reports is to inform the Engineering Geology Section of (1) the grading status, (2) such unanticipated geologic conditions as are encountered, (3) the fact that the consultant's recommendations are being followed, and (4) new recommendations or corrective measures.

4. Final Geologic Report and As-Built Geologic Map: At the completion of the rough grading, the consulting geologist may be required by the Grading Ordinance to submit a final report and an as-built (as-graded) geologic map. The purpose of this report is to obtain the consultant's specific approval of the rough grading.

The as-graded geologic map should show all the geology as exposed by the grading and show all geologic corrective measures as actually constructed. The as-graded geologic map must be based on a contour map which represents the pre- and post-site grading. These data will become a permanent record and can be used to assess any further grading modification or geologic problem which may develop in the future. The as-graded geologic map must include, but not be limited to, the following:

- a. The geology as exposed by the grading in sufficient detail to justify the consultant's conclusions.
- b. The cut-fill daylight line must be clearly drawn and labeled; preferably colored.
- c. The location of geologic cross-sections, subdrains, shear keys, buttresses, special replacement fills, restricted-use areas, foundation setback lines, landslides not removed by grading, the geology of the adjoining natural terrain, exploratory excavations not removed by grading, areas of over-excavation, and sufficient geologic symbols to clearly depict the geologic structure and lithologies.
- d. Tract and lot numbers and their boundaries that correspond with the latest available FINAL MAP for legal recording.

### ***Contents of Detailed Geologic Reports***

The primary purpose of the geologic report shall be an accurate evaluation of the geologic parameters as related to the proposed design. The following check list is used by the Engineering Geology Section as a general guide for review of geologic reports. Chapter 2 of this Handbook includes revised guidelines for seismic and engineering geologic reports. Chapter 6 provides information on report writing.

## Need for Subsurface Exploration

Detailed logs of all subsurface exploratory excavations shall be included in the report. When soil or unconsolidated geologic units are encountered, size descriptions should be based on a well-known gradation scale, such as Wentworth (1922), or the Unified Soil Classification (ASTM D-2487 and D-2488). Other descriptions to be included in the logs are rock types, bedding attitudes, joints, faults and the physical properties relating to foundation and slope stability. All logs should indicate the full name of the field geologist who performed the logging and the full name, license number, and signature of the Engineering Geologist who was "in responsible charge" of the project, and who directly supervised the field geologist.

As an aid for those responsible for the preparation and review of geological reports, the following are some of the circumstances requiring subsurface exploration.

- a. All landslides, slumps, colluvial deposits, and related features.
- b. All areas which (a) do not contain sufficient natural exposures to establish a clear, statistically reliable structural picture, or (b) which contain unreliable natural exposures (e.g., affected by creep).
- c. The traces of all fault zones, representing potential ground-water conduits or barriers, or which may affect the stability of proposed cuts or fills.
- d. All proposed cuts or fills exceeding 20 feet in height, unless data gathered in the immediate vicinity permit an accurate prediction of stability.
- e. All cut slopes exceeding 50 feet in height will require test borings drilled at least 10 feet below the elevation of the toe of the cut. If fills are proposed above the cut, the height-of-slope value must include the fill portion and the vertical component of its six-foot setback.
- f. All areas near or adjacent to existing landslides which are suspected of possessing bedrock conditions similar to those found within a slide area.
- g. All areas of known or suspected high water table.
- h. All areas shown on tentative tract maps as upgraded or "site" lots, unless data gathered in the immediate vicinity permit an accurate prediction of stability.

## Bedrock

- a. Identification of rock type.
- b. Relative age and, where possible, correlation with named formations (e.g., Modelo Formation, Altamira Shale).

- c. Areal distribution and attitudes.
- d. Dimensional features (e.g., thickness, outcrop, breadth, vertical extent).
- e. Physical characteristics (e.g., color, grain size, hardness, coherence).
- f. Special physical or chemical features (e.g., calcareous, ferruginous, or siliceous cement; concretions; friability; mineral deposits; alteration other than weathering).
- g. Distribution and extent of weathered zones; significant differences between fresh and weathered rock; resistance or relative competency.
- h. Response to natural surface and near-surface processes (e.g., raveling, gullying, mass movement).
- i. Relative geologic stability of various bedrock units.



## Structural Features

Stratification, folds, anticlines or synclines, foliation, schistosity, zones of contortion or crushing, joints, shear zones, faults, old slide planes, unconformities, etc., should be shown and discussed. Specific features of faults, including the occurrence of gouge and breccia; nature of offsets; timing of movements; data regarding fault activity in either the geological or the historical sense should be shown and discussed.

## Surficial (unconsolidated) Deposits

Surficial unconsolidated deposits include but may not be limited to, artificial fill, topsoil, paleosols, streamlaid alluvium, beach sands and gravels, residual debris, lake and pond sediments, swamp accumulations, dune sands, marine and non-marine terrace deposits, talus accumulations, creep and slope-wash materials, various kinds of slump and slide debris, including colluvium and colluvium filled swales.

- a. Distribution of general types of materials relative to stability.
- b. Distributions, occurrence, and relative age; relationships with present topography.
- c. Dimensional characteristics (e.g., thickness, variations in thickness, shape).
- d. Surface expression and correlation with features such as terraces, swales, dunes, undrained depressions, anomalous protuberances.
- e. Physical characteristics (e.g., color, grain size, hardness, compactness, coherence, cementation).
- f. Special physical or chemical features (e.g., expansive clay minerals, alteration, desiccation cracks and fissures, fractures).
- g. Distribution and extent of weathered zones: significant differences between fresh and weathered materials.
- h. Response to natural surface and near-surface processes (e.g., raveling, subsidence, creep, slope washing, slumping and sliding, and debris flows and mudflows or avalanches).
- i. Relative stability of the surficial units and how they may affect the stability of the proposed design.

### Drainage - Surface Water and Ground Water

- a. Distribution and occurrence (e.g., streams, ponding, sagponds, swamps, springs, seeps, subsurface basins).
- b. Relationship to topography.
- c. Relationship to geologic features (e.g., previous strata, fractures, faults).
- d. Sources, variations in amounts of water and permanence (e.g., intermittent springs and seeps, floods).
- e. Evidence for earlier occurrence of water at dry localities (e.g., vegetation, mineral deposits, historic records).
- f. The effect of water on the properties of the in-place materials.

### Special Adverse and Hazardous Conditions

- a. Soil slumps, mudflows originating in colluvium, and slide masses in bedrock and/or surficial deposits; distribution, geometric characteristics, correlation with topographic and geologic features, and age and rate of movement
- b. Evidence of subsidence or settlement (e.g., fissures, scarplets, offset reference features, historic records and measurements).
- c. Evidence of creep (e.g., fissures, scarplets, distinctive patterns of cracks and/or vegetation, ridges or bulges, displaced or tilted reference features, historic records and measurements).
- d. Topographic indications of accelerated erosion (e.g., cliff re-entrants, badlands, advancing gully heads).
- e. Deposits related to recent floods (e.g., talus aprons, debris ridges, canyon- bottom debris).
- f. Active faults and their recent effects upon the proposed development.
- g. Potential for debris avalanche at heads of ravines or small canyons.

### Conclusions and Recommendations in Geologic Reports

This section must be presented separately. It normally constitutes the most important contribution of the report, and should be clear, positive and concise. Statements must be made regarding both (1) the effects of geologic features upon the proposed grading, construction, or land use, and (2) the effects of the proposed development upon future geologic processes.

**Conclusions** must be based on the most logical interpretation of the data presented in the report, and presented in a clear manner. **Recommendations** must be as specific as possible, commensurate with the quantity and reliability of the data presented. (Example: In a geologic report which is submitted for the review of a grading plan, the engineering geologist shall indicate by lot number which cut slopes must be designed for artificial retention, rather than indicating that "all north-facing cut slopes" must include support retention.) The recommended corrective measures shall be clearly depicted on all geologic maps.

### *The Geologic Map and Sections*

As a rule, a detailed geologic map will be required as part of all geologic reports. Some exceptions:

- a. **Geologic sketches** may be acceptable as maps of small land parcels in which the nature and distribution of the significant geologic features can be fully and effectively described in words alone.
- b. **Supplemental reports** for a particular area may omit a geologic map provided that the supplementary information presented does not produce a change in the original geologic map.

### Base Map for Geologic Maps

Information shown on the base map must include, but may not be limited to:

1. The scale of the map; it must be sufficiently large to clearly show all pertinent geologic features
2. A north arrow
3. The source and date of the base map
4. Dates of any revisions of the base map
5. Legend of engineering and geologic symbols used
6. All proposed grading by contour lines
7. A site location inset sketch showing related tract development
8. Elevations of individual house pads and streets
9. Key geographic features which can be identified in the field
10. Contour interval

## Geologic Sections, Boring Logs and Other Supporting Data

In most cases, three-dimensional geologic relationships cannot be adequately described without the aid of structural cross-sections. It is the responsibility of the consulting engineering geologist to determine this need and to include the necessary drawings in the report. In addition, fully descriptive logs of all test borings (Wentworth scale or other standard description method, where appropriate) and test pits shall be included in the report and shown in the cross-sections. Locations of geophysical traverses and related data shall be included.

The use of stereographic pairs of aerial photographs is considered standard procedure in engineering geologic practice. In all cases, a summary list of all the photos used by the engineering geologist in his or her investigation should be included in the report. Prints of critical or particularly revealing aerial photographs should be included in the report.

### ***Field Inspection***

Visual Inspection - If deemed necessary by the Engineering Geology Section, visual inspection of any or all of the exploratory test pits by personnel of the Engineering Geology Section may be required. Consulting engineering geologists typically invite the regulatory reviewers to visit test pits, trenches, and large diameter borings while the excavations are open.

Key, Bench and Cut-slope Inspections - If deemed necessary by the County Geologist, post-grading inspection of bedrock to receive designed fills shall be performed by the County Geologist. Notice shall be provided by the consulting geologist or geotechnical engineer prior to placement of fill.

In-Grading Inspections - In grading reports, whether weekly, bimonthly, monthly or however designated by the Engineering Geology Section, shall be submitted on a punctual basis to keep the County Geologist informed of the grading status.

The submittal of in-grading reports is designed to expedite approval of rough grading for the issuance of building permits. Their timely submittal will reduce unwanted delays in the final review process.

### **ADDITIONAL HANDBOOK DEVELOPMENT NEEDED**

Project control for environmental investigations includes a number of additional items, for example chain-of-custody sheets, which are unique to contaminant investigations. This handbook should be expanded to include project control information for contamination investigations. Your questions, suggestions, and recommendations are sought. Please send them to AEG Executive Director Edwin Blackey Jr., at 323 Boston Post Road, Suite 2D, Sudbury, MA 01776. (508) 443-4639, or to Seena Hoose, Manager, AEG Committee on Ethics and Professional Practice, at 10394 Bret Ave., Cupertino, CA 95014, (408) 252-5811.

## SELECTED REFERENCES

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## Chapter 6

### REPORT WRITING

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## Chapter 6

### REPORT WRITING

by

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with contributions from

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### GENERAL

Engineering geologic report writing, just as any other scientific and engineering writing, should be exact, direct and to the point. Any writer's first duty is to be intelligible. The following format is designed to help avoid pitfalls that lead to litigation or possible regulatory enforcement against the client. There are no phrases or words, interpretive or otherwise, that an author can use in a report to completely insure against litigation. Disciplined use of proper words and phrases can, however, help avoid misunderstandings and misinterpretations that generally lead to litigation in the first place.

Written reports should be so clearly and simply written that they are easily read and understood by the audience to which they are directed. Remember, your report is written primarily for your client--generally a layman--and not to impress your colleagues.

Communication problems in report writing generally stem from not planing and expressing what we know clearly in our minds. Even when we do the best we can in organizing our thoughts (i.e., discussion of results of lab test data), there remains some attenuation when the message (report) is sent.

When the message is received but then is interpreted further by the reader, additional loss in meaning or misinterpretation often occurs.

Aside from the writing of a report, the next most important step in the transformation of the work is a technical or critical review. Authors are too close to their work sometimes to be completely objective. Technical reviews, prior to sending the report to the client or regulating agency, are essential in order to spot:

- a) errors in fact or interpretation (reasoning)
- b) inconsistencies
- c) poor organization
- d) presentation style that may obscure what the author has tried to say.

Every manuscript will benefit from a conscientious technical review, preferably by two people--one who is thoroughly familiar with the subject matter (technical editor), and one who is not (non-technical editor) but who can more nearly represent the average reader.

A good rule to follow in writing a formal report is to construct a well-thought-out, written outline, by topic, by paragraph and even by individual sentence. Most misunderstandings and misinterpretations by readers occur in sentences (the meaning of a sentence) than in any other part of a report. Once the outline is written, major topics can be relocated easily within the structure to the author's satisfaction using word processing software. The various sections of the message should divide subject matter into a logical, well-defined pattern. Each section heading in a report should be clear and identify the information contained in that section of the report. Section headings are of special value to non-professionals who understand very little of the text and who have little or no interest in the detailed or specialized parts of your report. Regulatory reviewers will use section headings to speed the report review process.

Section headings and table of contents in a report should lead the reader to the information of real importance in the text of the report. A good, well written report will always keep in mind the following:

- (1) the receiver; the client, regulatory reviewer, insurance adjustor, etc.
- (2) his/her degree of understanding and technical background
- (3) his/her interests
- (4) his/her vocabulary
- (5) his/her communication habits
- (6) the writer's own "personal" intention.

Paragraphs and sentences are the basic building blocks of any message, written or otherwise. A paragraph should deal with one subject, one idea and one object or activity.

The key point -- the theme of the message -- should be announced in the first sentence of the paragraph (sometimes referred to as the topic sentence). Everything else in the paragraph usually defines, delineates, or modifies the key point. Long, drawn-out paragraphs should be avoided. Unfortunately, short paragraphs do not often appear in technical reports. Brief paragraphs are much more effective in drawing attention to an important statement, somewhat like an exclamation! Long, drawn-out sentences and paragraphs are more liable to lead to misinterpretation and misunderstanding. Guidelines for good report writing should include the following:

- (1) Express yourself clearly and as precisely as possible; less room for misinterpretation.
- (2) Be as factual as possible, but remember that an engineering geologist works primarily with natural earth materials and they may have unique properties. Errors of fact are the single biggest contributor to liability.
- (3) Avoid using "absolute" terminology, if possible, as this kind of wording often leads to different interpretations by other professionals, as well as laymen.

- (4) Be somewhat conservative in your professional evaluations, opinions and judgments.
- (5) All data included in your report should be backed up with documentation, i.e., dated photographs, signed and dated memos, laboratory test data, or field notes and maps.

Experience tells us that engineering geologic reports are usually written for or used by three different people or groups of people: (1) the client, (2) the reviewing agency, (3) other geologists.

Problems often arise because each group will have a somewhat different interest in the written report. It is also reasonable then to expect that the report be both technically correct and clearly understandable to readers with quite different abilities to comprehend and interpret it. The report writer, and probably the regulatory reviewer, may be the only technical people who read the report; often times the client has no technical background. The burden is always on the report writer to get approval for the report or to prove, to the satisfaction of the reviewing agency, that the information contained in the report is accurate, valid, and clearly presented.

In engineering geologic reports, problems often arise in making a clear separation of the descriptive part of the report (i.e., properties of earth materials, geologic structure, tables of calculations, cross sections, geologic maps) from conclusions and recommendations. The descriptive part of the report (body of the report) must include enough data, documentation, and description to provide a basis for the conclusions and recommendations part of the report. The descriptive section should contain enough detailed information so that other professionals would probably draw the same conclusions and make the same recommendations as the report preparer. Technical terms and geologic concepts, not easily understood by a client, should be included in the descriptive section of the report. It is essential in most cases to describe things in technical terms in this section for the report preparer and the reviewing agency to come to some mutual agreement. It is less important for details and technical terms to be used in the conclusions and recommendations section, which is of more interest to the client.

### ***Purpose of Report***

The purpose of the report should contain clear, concise statements on the use for which the report was prepared. If the report is preliminary or a feasibility study, make sure that this is clear to the reader and state just exactly what "preliminary" and "feasibility" means to the writer.

Be specific and discuss what the report includes as well as the limitations of the work and therefore the report (i.e., this report does not include test results from penetration rate testing by xyz company on tract 1, 2, 3). It is good practice to underline statements or parts of sentences that need emphasis.

It is also important that all geologic work necessary for carrying out the purpose of a report be completed. This should be clearly stated in the descriptive part of the report, and it should especially be emphasized in the conclusions and recommendations. For example, if the purpose of the report states that: "Special emphasis was placed on ascertaining fault hazards of the property," then the various fault prospecting methods should be described in the body of the report. In addition, especially for the sake of the client, explicit statements such as: "Fault rupture is not anticipated on

the property", or "Fault rupture is expected during the life of the property, and setbacks of 50 feet will be required for dwellings", should be clearly stated.

Unfortunately, some of the words used to describe the purpose and scope of an investigation are not standardized among clients, reviewers and report preparers. Thus a client may try to use a "Geologic Reconnaissance" report for a "Tentative Tract Report" in order to gain tentative tract approval for his or her project. The reviewer then may write an adverse review sheet which can cast doubt on the competence of the engineering geologist, even though the limitations of the report are clearly defined by the investigator. It seems that there is always some confusion with reviewers, clients and report writers regarding the amount of detailed geologic work needed for different stages of project approval. This "purpose" section of the report is also a good place to indicate the identity of the commissioning party or organization. It is also good practice to include a cover letter. In order to avoid confusion, misinterpretation or misuse of engineering geologic reports by clients, some standardized definitions should be noted for report titles and types. The following are suggested:

Reconnaissance Report: A concise statement of observations made from a brief field visit to the site under consideration. Only general conclusions are made, with no factual data to substantiate them. Emphasis of the report should be on recommendations for future work. This type of report should be used only as a guide for further decision making. It is often presented in a letter format.

Preliminary Report: A more complete report based on data collection from library searches, report reviews, field data and test data. Conclusions are tentative. Emphasis of the report should be based on recommendations for further work, but with some substantial conclusions based on initial work.

Final Report: A comprehensive report that includes all information and technical data relevant to the project. It should include the information contained in earlier reconnaissance and preliminary reports. Emphasis of this report should be on conclusions.

Chapter 5 contains a list of types of reports, specifically defined. It is helpful to identify the report names and content that a reviewing agency normally expects. Environmental work also has a group of commonly used report names. Check with the reviewing agency and use the report names and agency guidelines for content of reports, that are specific to the agency receiving your report. Particularly, it is important not to use the words final or closure in an environmental report when the report is actually an interim report. Do not use the word closure to describe an underground tank removal report, this is extremely confusing to the client.

### ***Data Presentation (Factual vs Interpretive)***

The presentation and discussion of data is the main body of most reports; it should be above all: (a) factual, (b) concise, (c) accurate, (d) valid, and (e) clearly presented. If litigation or expert witness testimony is expected, then it obviously should also be reviewed by legal counsel.

Factual data should be listed in tables, figures, charts or in graphical form. There should be little or no interpretive leeway in the use of "meaning" of data. It generally represents hard facts obtained by

laboratory and field test procedures. These kind of data cannot be changed or modified by the author, as they often are not his/her data, but more often represent test results from independent laboratories.

It is important that data be presented clearly and simply so that any interpretation that is made allows little confusion. If the data are from an independent lab it is often best to quote the data, with the original copy in the appendix.

Interpretations are subjective information that are more vulnerable to individual interpretation. It is important that the author interpret data very carefully and avoid excessively strong affirmative assertions.

Litigation is often brought against an individual in the form of express warranty, if the engineering geologist renders a report that contains errors of fact. Whether they are known to be erroneous by the engineering geologist is unimportant. The liability is not necessarily based on negligence, nor is it based upon fraud. It is based upon the making of an affirmative assertion of fact and making it in the form of an assurance upon which the client relies.

The writer should interpret only as much as is required by his scope of work and to the degree that is warranted by factual data. Review by competent, professionally trained people knowledgeable of the subject matter should be used. The reviewers can be in-house professionals or outside consultants who have expertise in the subject area. A reviewer's prime responsibility will be to distinguish fact from fiction or detect unsubstantiated conclusions. Data should be sufficient to reconstruct the facts in case of changes in design or for litigation proceedings long after the project has been completed.

Experience tells us that reviewers will often differ with report writers in interpretation of data. For example, in cases where differences in interpretation can mean the difference between stability and instability of a slope, the reviewer has the right to challenge the interpretation of data and perhaps require more work, at the risk of holding up development and construction which, in turn, could lead to litigation.

For engineers and contractors, the nature and the specific location of rock DEFECTS is infinitely more important information than the classical geological descriptions of rock TYPES and boundaries between rock TYPES. This is because substantially all sound rocks have compressive strengths greater than 3000-5000 psi, which is the strength of concrete. Hence it is the rock DEFECTS -- faults, joints, schistosity, weathering, slaking, etc. -- which cause headaches in design and construction, and these rock DEFECTS can and should be shown in detail on the geologic map. Summarized information is not useful (Rose, 1965).

## **VOCABULARY**

Generally, engineering geologists do not avail themselves of the vast reservoir of words available to them. Technical writers tend to use well-worn words with which they are familiar and comfortable, especially geological terms. Unfortunately, many of these commonly used words have a great many

meanings, thus causing misinterpretation. It has been said that 500 of the most common words have 14,000 meanings. *Suggestions to Authors* (Hansen, 1991) has very helpful sections on word use, terminology, clarity in writing, and sentence structure. The new version of *Suggestions to Authors* has particularly useful new chapters on groundwater and on ethics in writing.

Engineering geologic report writers should be mindful of expressing both the positive and negative aspects of the data, or use cautious expressions. They should avoid making promises that are unreasonable and cannot be produced (implied warranty), or are made to protect a nice-guy or "best" consultant image so prevalent in professional ranks. Indeed, there may be overwhelming reasons in engineering geologic work not to make promises. Cautious expressions or phrases should be the signpost of all engineering geology writing.

The use of inappropriately chosen words, words of many meanings, polarized words, affirmative assertions, implied phrases, optimistic expressions, promises and confessions creates an extremely litigious situation.

The tone and wording of an engineering geologic report should fit the audience and purpose of the report. Remembering that many geologic terms are unfamiliar to engineers and laymen clients alike, their use should be considered only for good cause. When it is appropriate to use the geologic specialty terms, it may be well to underline the word and to briefly define its meaning in the text. An alternative or supplemental treatment would be to include a glossary of geologic terms as an appendix to the report. Reports written for routine purposes or for minor types of approval, such as grading reports or foundation reports for structures to be sited on geologically non-complex sites, are probably the best candidates for avoidance of many geologic terms. Reports dealing with technically complex projects, (such as tunnels, dams, nuclear plants, and hazardous waste management facilities), often require the use of geologic terms to portray a more strict and critical meaning. Supervisors should make every effort to brief project personnel on the level of importance of every project, and to point out specific items of scope that will require very careful attention to detail and the appropriate use of geologic terminology in order to bring out important details, and to specify geologic conditions that represent a relatively high degree of impact on cost, scheduling and function of project.

### *Choice of Words*

Some words are so susceptible to misinterpretation, so affirmative and assertive, so difficult to explain to a layman, client, or a jury, that it would be wiser to use another word altogether to describe that particular activity or result. Most experienced authors avoid using "gobbledygook" (inflated, involved, obscure verbiage). In other words, omit needless words!

In engineering geology, code words or code interpretations are often used by county and federal agencies (regulatory reviewers), and perhaps the codes themselves have become so stringent that it forces the report preparer to use more absolute words than he/she feels comfortable using. Projects are often delayed and construction not approved by lead agencies until engineering geologists (report preparers) make "absolute" statements.

The choice of proper word usage can literally be the difference between litigation and no litigation. Some of the more important word usages, do's and don'ts for better word usage (ASFEE, 1980) are as follows:

<u>Common Word Usage</u>	<u>Preferable Word Usage</u>
Approve	Review (decide, consider)
Certification	Memorandum
Certify (the engineer will)	Engineer <u>will advise</u>
Estimate	Approximate
Control, regulate, direct manage	Control tests, guide
Equal	Equivalent
Essential	Considered, advised, suitable, satisfactory
Examination	Observation, review, study, look over, evaluate

<u>Common Word Usage</u>	<u>Preferable Word Usage</u>
Inspection	Observation, review, study, look over
Insure	So that
Investigation	Exploration, reconnaissance, probe, search
Necessary	Considered, advised, study, observe
Required	Considered, advised
Supervise	Observe, review, look over, guide
Assure (to insure)	So that
Assure (the owner)	Advise (the owner)

Use of polarized or "absolute" words should be avoided at all times. Some examples are as follows:

Superlatives/Absolutes

Suggested Substitutes

All

Some, most, usually

At least, all times,  
all circumstances

All if practicable, sometimes,  
in most cases

Any

When practicable

Best

Better

Complete (investigation)

Scope limited to

Critical

Might, or may be

Essential (it is)

Recommended, advised

Unequivocally

Delete or use probably is

Extremely

Delete or use with caution

Final

Delete or use with caution

Superlatives/Absolutes

Suggested Substitutes

Inevitably

Delete or use with caution

Maximum

Delete or use with caution

Minimum

Delete or use with caution

Must

Should

Must always

Should

Must do

Should

Shall

Should

Never

Usually

No, none

Usually

Not less than

Usually



Obvious	Apparent
Possible	Practicable
Properly	Recommended
Readily	May be
Safe, unsafe	Qualify statement, explain or define
Sound	Qualify statement, explain or define
Stable	Qualify statement, explain or define
Suitable	Qualify statement, explain or define
Sufficient	Qualify statement, explain or define
Thorough	Qualify statement, explain or define

### *Usage of Technical Terms*

Geological reports are easily read and understood by other professional geologists, and engineering reports are read and understood by professional engineers. Clients such as contractors, architects, land planners, or politicians generally have trouble with technical terms commonly used and understood by engineers and geologists. It is sometimes difficult for professional engineers and geologists to write using simple terminology. Word usage should be as simple as possible without losing meaning. They should be practical words, not too theoretical nor too sophisticated. The idea is to communicate the meaning of technical information to readers so that there is little room to misunderstand and/or misinterpret the meaning.

Experience indicates that even the simplest of terms mean different things to different people. Soil and rock are as simple as one can get, yet there are many non-technical people who believe they mean the same thing. This is especially evident in a university classroom where civil engineers are studying geology. Don Rose (1965) noted the importance of proper use and definition of "technical adjectives" in reports. The meaning of technical adjectives may be different for a geologist than it is for a civil engineer (i.e., "well indurated" rock may be defined by an engineer as completely competent rock).

The following is a list of common words/terms used by geologists and engineers that are often misunderstood and/or misinterpreted.

### Some Geologic Terms

lacustrine	surficial
aeolian	agglomerate
lit-par-lit	eluvial
aphanitic	alluvial
porphyritic	colluvial
anomalous	cataclastic
structure	fissile
well graded (layered)	glaciofluvial
well sorted	

### Some Civil Engineering Terms

cut & fill structure	bulking	progressive failure
arcuate	desiccation	well graded (mixed)
transition lot	diaphragm wall	infilling material
daylight line	bead scarp	
overbreak	heaving	
surficial	incipient failure	

## **GEOLOGIC MAPS, SECTIONS AND BORING LOGS**

### ***Preparation***

Of equal importance to the text of your report is the information shown on the drawings and presented in the logs of borings and trenches. Great care must be exercised in plotting information on drawings because, generally, your work is later copied by a drafter onto a final drawing. This is a common place where errors and omissions occur. Depending on the scale of your map, a geologic contact drawn a fraction of an inch away from its true location can have serious consequences if the two units are dissimilar, e.g., a cut/fill contact. Always provide an explanation key on your drawing, showing the degree of confidence you have -- solid lines for known and observed data, dashed and queried lines for uncertainty or inference.

It may be helpful to laymen and engineers to improvise geologic map symbols that are more expressive than the traditional "age-formation" symbols. The reader is referred to the suggestions of Richard Galster (1977), to the many articles in the June 1977 Bulletin No. 19 of the International Association of Engineering Geology, and to Keaton (1984). The discussion by Varnes (1974) is useful for developing a mapping approach useful for a particular engineering geology project.

In the preparation of geologic sections, it is rarely beneficial to connect subsurface contacts between borings unless your knowledge of local geology warrants such interpolation. The literature is replete with costly embarrassments of the undiscovered buried channel, or the hard sandstone bed that occurred between otherwise monotonous boring logs. It may be advisable to include the following statement in your report:

The lines designating the interface between soil or rock materials on the geologic sections are determined by interpolation and are, therefore, approximations. The transition between the materials may be sharp or gradational. Only at boring locations should profiles be considered as reasonably accurate, and then only to the degree implied by the notes on the boring logs.

When drilling exploratory borings, always instruct the field geologist doing the logging to note the reasons why a sample or a core was not recovered. For example, it is critical to know if a sample was washed away by the drilling mud or by an inflow of groundwater. Also, this infers that the missing sample was soft or unconsolidated. If a boring has encountered otherwise firm material, the missing sample can be more important than the sample sent to the lab for testing. Techniques for logging core have been evaluated and recommended by Deere and others (1977), and good discussions on subsurface exploration may be found in ASCE (1974).

## *Disclaimers*

Boring Logs There is a trend currently to include only a final, edited set of boring logs in the report. Distinction should be made in your report between field logs and the final logs that appear in your report. One of the following statements should be included:

"A field log was prepared for each boring by our field representative. The log contains information concerning the boring methods, samples attempted and recovered, indications of the presence of various materials, and observations of groundwater. It also contains the field representative's interpretation of the soil conditions between recovered samples. Therefore, these logs contain both factual and interpretive information. The copies are on file in our office."

"We must emphasize that our recommendations are based on the contents of the final logs and the information contained therein, and not on the field logs."

"The final logs represent our interpretation of the contents of the field logs, and the results of the laboratory examinations and tests of field samples. The final logs are included in this report."

It is also advisable to place a disclaimer directly on the boring logs, to explain what the logs do not mean. An example is:

"The boring logs show subsurface conditions at the dates and locations indicated, and it is not warranted that they are representative of subsurface conditions at other locations and times. Also, the passage of time may result in a change in the soil conditions at these boring locations."

Many firms have adopted a policy of retaining in the permanent files only those final, edited logs that appear in the report for that particular phase of the project. This practice may cause serious problems for a firm if the field logs are subpoenaed by a court and the field logs are not available.

Changed Conditions (differing site conditions) clauses should be considered for inclusion in proposals and reports. Two examples are:

- ! The analyses, conclusions, and recommendations contained in our report are based on site conditions as they existed at the time of our investigation, and further assume that exploratory borings are representative of the subsurface conditions throughout the site. If, during construction, different subsurface conditions from those encountered during our explorations are observed or appear to be present in excavations, we must be advised promptly so that we can review these conditions and reconsider our recommendations where necessary.
  
- ! If a substantial lapse of time occurs between the submission of our report and the start of work at the site, or if conditions have changed due to natural causes or construction

operations at or adjacent to the site, we urge that our report be reviewed to determine the applicability of the conclusions and recommendations considering the changed conditions and time lapse.

Chapter 8 provides a fuller discussion of differing subsurface conditions, formerly described as "changed conditions".

## **IN-HOUSE REPORT REVIEW PROCESS**

Engineering geology is often characterized by projects of an unusual nature. Unlike many other professions, the engineering geologist seldom sees a follow-up project that is identical to previous work in his/her experience. For this reason, each report takes on site-specific significance, and many are variable in outline detail beyond the basic headings. Reports should be drafted by the lowest professional-level project member participating in the actual phase of work (usually the field engineering geologist), and reviewed at consecutively higher levels in the organization. The objectives of review are to insure that the client receives the full impact of the project work, and that the wording is accomplished in a manner that portrays what the client needs to know in an unambiguous manner. Report reviewers should read each line, carefully trying to understand the meaning of each sentence, and should use plain writing to portray each concept clearly.

Particularly important in the review process is that all items of scope as presented in the proposal or contract are answered to the detail promised, and that unwarranted statements are not made. Many unwarranted statements involve the use of absolute words which do not apply to the level of work undertaken.

If the client is especially well known to the organization, it may be possible to have a completed draft of the report reviewed by the client for wording and to develop the client's understanding of the implications of the recommendations and conclusions, before the report is finalized for submittal to the regulating or permitting agency. A face-to-face meeting is often desirable between the project manager and the client, after the client has had a day or two to review the report.

All professional staff members should be aware of the established report review process and special requirements for review by levels of management (based on total value of the project or its complexity level). Contributing authors who are not regular project team members should be provided with a review copy of the report containing their materials in context, prior to report completion.

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## Chapter 7

### THE EXPERT WITNESS AND LITIGATION

by  
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#### EARLY ACTIVITIES

Throughout the nineteenth century and the early part of the twentieth, the involvement of geologists in legal matters was rare. One of the earliest recorded cases of geological litigation and the as-encountered site conditions, involved excavation to enlarge the Erie Canal Locks at Lockport, New York, in 1839. James Hall of the New York Geological Survey was asked to evaluate and classify a "Slate Rock and Shale" sequence; the engineer's contract quoted a unit price for "solid rock" and a lower price for "Slate Rock and Shale." Terms of the 1839 contract made a clear distinction between the rock types impossible.

The use of geological evidence in crime detection originated, as did the use of other kinds of physical evidence, with Sherlock Holmes in fictional detective stories written by Sir Arthur Conan Doyle between 1887 and 1893. In 1893 Hans Gross, an Austrian professor of criminology, published the Handbook for Examining Magistrates, which had a profound effect on the development and use of science in criminal investigation (Thornwald, 1967) For example, Gross stated that "dirt on shoes can often tell us more about where the wearer of those shoes had last been than toilsome inquiries." In 1904, George Popp, a chemist, microscopist, and earth scientist in Frankfurt, Germany, examined the evidence in a murder case in which the victim had been strangled with her own scarf. When confronted with foreign soil evidence on the scarf, the suspect admitted the crime, and the Frankfurt newspapers carried headlines proclaiming "The microscope as the Detective." Today the Federal Bureau of Investigation laboratory in Washington, D.C., one of the first forensic laboratories in the United States to have geologists study physical evidence, such as soils and related material, is a worldwide leader in forensic geology (Saferstein, 1982).

On rare occasions the highly respected early geologists for engineered works in North America were invited to serve in litigation, but not as part of a large-scale claim or changed conditions argument so common since the 1960's. Rather, the early cases where geology was critical for legal purposes

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Thanks are due Donald R. Coates, John F. Mann, F. Beach Leighton, and Allen W. Hatheway for comments that improved the text and Seena N. Hoose for editorial review and reproduction of the manuscript.

were usually restricted to a single geological entity such as the two problems of a geological flavor in the early 1900s solved by Professor Charles Berkey, of Columbia University:

"The Ward Steamship Company carried a shipment of goods from Italy, but the goods were stolen enroute and rocks were substituted. By identifying the petrographic details of rock, Berkey was able to demonstrate the theft occurred in Naples, Italy. On a second occasion, a shipment of rubber from the Amazon was transported via the New York Central railroad to its destination in the midwest. On arrival a portion was found to consist of "rocks", actually concrete made from Cow Bay Sand. The theft had occurred in Brooklyn, and the concrete came from a nearby dock undergoing repairs (Sanborn, 1950, p. 40).

Geology began to play an important part in litigation for engineered works when geologists were brought into the planning, design, and construction of projects during the 1930s and 1940s by Federal, State, and local public agencies. As the projects became larger and more complex, geological information became more and more critical for site selection and assistance in designing engineering works. Consequently, with the expansion, contractors found themselves more frequently encountering unexpected geologic conditions at complex sites. As a result, geologists were called upon more frequently to assist contractors in preparation of unit-bid costs or to testify, at a later stage, in arbitration, evaluation of differences of opinion and judgmental factors, or adjudication of construction-related claims. Because of this, the U.S. Bureau of Reclamation created a formal engineering geologic staff by 1944 in anticipation that the staff of geologists assigned to serve the design and construction branches would be effective in both improving designs and reducing potential construction claims.

## **OVERVIEW**

The extensive use of geological experts to aid in the settlement of legal controversies related to engineered works today is a direct outgrowth of the socioeconomic "environmental movement" initiated in the 1960s. Today, these controversies increasingly look to the law and arbitration for a resolution of conflicting goals and less to the principles of science and engineering. This summary provides a background on the relevant technical literature, should the geologist unfamiliar with the practices of litigation seek an understanding of how the geosciences are utilized in the practice of law. Topics include an introduction to the common geo-related problems and principles as they may relate to the "rules of law". The text is briefly instructive and some appropriate case histories are referenced for further review, should the reader desire more insight into how the law must and does change to meet new social, political, and economic needs. For example, "Acton vs Blundell Revisited" (Grover, and Mann, 1991) is a recent decision that will lead to changes in the groundwater laws in California, and thereby accommodate the improved factual geologic circumstances, as well as the economic and social conditions undergoing change there. Very frequently, such litigation is concerned with rocks and soil masses, their inherent physical properties, and changes with time when impacted by an operating engineered works that sometimes extends to the database of surrounding earth materials and the geologic setting. The importance of input based on the mature, field-experienced geological

judgment of an expert witness is critical in such complex cases, both as advisor to the attorney and as source of specialized testimony.

By the 1980s, countless courts had opened their doors to claims based on methods or theories not generally accepted as reliable by any scientific discipline--and the law extended equal dignity to the opinions of charlatans and Nobel Prize winners (Huber, 1991, p. 17). Since 1975, attorneys may use "hired gun" experts who advocate and provide scientific hokum testimony and who are usually persons with minimal geologic experience and capability. Such "experts" may cloak their testimony with elaborate computer-analysis sheets and other fanciful means in an attempt to document the causes for and mitigation of a natural process or hazard impacting on engineered works. This "junk science" approach is allowable in the courts--"if the scientific and other specialized knowledge will assist the trier of fact to understand the evidence or determine a fact". The 1923 Frye Rule, that required an expert's testimony be based on accepted theories considered valid among practitioners, underwent change in 1960s when common law became an instrument of social change. The Federal Rules of Evidence in 1975 omitted reference to Frye Rule, consensus did not matter anymore--any iconoclast whose views might prove "helpful" to the jury would be welcomed in court (Huber, 1991, p. 9-23).

The opposing attorney can use the assistance and advice of a knowledgeable geological expert during the courtroom testimony and with this corroborative assistance, destroy the "junk science" advocate by a tough, in-depth cross-examination of the witnesses. The best protection against "junk science" attacks is testimony that demonstrates a scientific theory or concept is well founded and accepted by geological practitioners. The author encountered such hokum-fakery approaches in two recent litigations. One involved a major man-induced landslide and destruction of a pristine forested slope by extended water flow from a mountain-side ditch in the Aspen-Snowmass region of Colorado. Ditch owners simply tried to move more water than the ditch could carry safely, yet their "expert" calculated that deep-seated stresses caused massive Pre-Cambrian beds to be arched which affected the ditch flow in the area of the slide causing the overflow and destruction. The second, a rockfall fatality case in northern Arizona, was due to stress-relief actions and fracturing over time that detached the rock-block from a high cliff of massive sandstone. An attempt was made to characterize this common geologic 'event' as related to unique climatic conditions, and other nebulous causes.

Although the reader may have already concluded that most managers and professionals feel the best way to master a serious geological problem is to engage a group of experts, this is not necessarily true. A forthcoming review of expert input in evaluating earthquake probability for engineered works points out numerous disadvantages (Krinitzsky, E.L., 1993).

Many aspects of litigation today involve the geosciences, because an increasing percentage of legal cases are concerned with contractual obligations that relate to the earth and its processes. The most significant categories have been--water rights, mineral law, and surficial processes--if judged by the number of past civil disputes. However, other geo-related processes and reactions with time are becoming equally important and frequently of more concern to the professional geoscientist, such as, the features and processes that impact the planning-construction-and-operation of engineered works. Although geoscientists and geengineers contribute to an understanding of the earth, its processes,

and on-going changes, our human endeavors are impacted by both the natural and man-induced hazards and risks of the earth processes and related changes. The legal profession has been traditionally apprised of the consequences of failure associated with engineered works, and have apportioned responsibility for the damages as reviewed elsewhere (Leighton, 1992; Olshansky, 1989; and Brainerd, 1980).

It is the intent of this Chapter to acquaint the reader with the nature and principal duties of an expert witness: what is involved and the professional responsibilities, along with guidelines and/or cautions for geoscientists who have not previously served as expert witnesses. The materials herein are from publications and references which are the outgrowth of lectures, testimony, and practice for over five decades by the cited practitioners and the writer relative to the main problems of engineered works as pertinent to litigation and arbitration at all judicial levels.

Consistent with the growth and variation in the forms of litigation over past decades, the professional liability of the engineering geologist has increased. Today this includes losses from "errors of judgment", the "privity of contracts," man's impact on the environs, and an inadequate enforcement of OSHA regulations, besides the traditional categories of responsibility for: differing (changed) or unknown conditions; failure to disclose; misinterpretation of conditions; omission of critical facts; failure to perform as predicted or intended; condemnation - actual and reverse; and the apportionment of risk. The circumstances and principal conditions surrounding this group of forensic categories and possible liability losses for an engineering geology practitioner are described at length and documented or illustrated with case histories elsewhere for the reader (Waggoner and Kiersch, 1991; Dunn, 1991; Leighton, 1992; and Shuirman and Slosson, 1992).

Although there are several different surroundings in which the engineering geologist may have to present findings in which the environs may differ legally, emotionally, and sociologically, the common thread is that the geologist is the one professional familiar with the "as-is" of the site and its areal surroundings throughout the history of the project and is thoroughly prepared to answer questions in depth. Furthermore, the geoscientists will usually be asked to express an opinion as to the interpretation of data. Again experience and maturity are usually critical requirements in making credible responses.

## **WHEN ARE GEOLOGIC EXPERTS NEEDED?**

There are many categories of litigation that involve geological experts and testimony besides typical lawsuits before a jury and/or judge in court. Today, legal arguments are presented at hearings before local boards or committees such as legislative groups and planning-zoning boards, at administrative hearings sponsored by Federal, State, or County regulatory agencies, before special boards of engineers (as the U.S. Corps of Engineers and Bureau of Reclamation) to settle contract disputes, and before arbitrators (often attorneys) engaged to settle disputes associated with construction (Dunn, 1991). A recent option, mini-trials to resolve disputes arising during construction, is demonstrated by the settlement of claims involving the Tennessee Tombigbee Waterway (Henry, 1988). Fortunately, past tendencies by many to resort to litigation at the hint of a problem in a contract is being challenged. In these litigious times the legal profession is finding new approaches and cost reduction measures through: arbitration before a retired judge; summary trial before judge and jury with decision advisory to initiate settlement; early neutral evaluation--attorneys assess merits--promote settlement; rent-a-judge, private decision maker but can appeal judge's decision. Many feel the loser's should pay the winner's fees as a way to discourage frivolous suits. By the year 2,000 parties may be directed to an appropriate procedure when appearing in court (Business Week, 1992; Leighton, 1992, p. 101-112).

The litigation very commonly served by an expert witness will seek extra compensation, beyond the limits of the contract agreement, by a contractor who alleges that "differing or unknown conditions" were encountered at a project site. Such contractor's claim allege that the geologic conditions encountered were substantially different than could have been reasonably anticipated from the geologic database provided with the bid plans and documents of the owner/sponsor. Such "differing conditions" may be due to excessive water, or contamination, both surface or underground, a higher percent of hard rock excavation than given with design drawings, material excavated is softer and more "difficult" to work than described with bid proposal; tunnel supports were not anticipated, excavation slopes were not stable, geologic logs with drawings are misleading or incorrect, and insufficient geologic data were included in contract relevant to other common construction problems associated with the rock mass, soils, unconsolidated deposits, and groundwater conditions, including unanticipated soil and groundwater contamination.

Once you are engaged as an expert, you work directly and closely with attorney-in-charge, captain of the team of staff members and likely other specialists, according to the nature of the litigation. If your attorney has had previous experience with preparing and presenting geo-related litigation and the manner in which geological expertise can be best utilized, you are fortunate. In any event, you should prepare a rather detailed outline early-on, that sets forth the database needed for your testimony and indicate how this essential information will be discovered, collected, and documented for your eventual testimony. In addition, submit a companion outline of the estimated costs and time involved for your services and those of any associates or special-task personnel required. Your approach and plan-of-action outlined for providing the pertinent geological services should reflect and include the materials specified in items 4 and 5 under General Procedural Guidelines for Preparation of Court Cases, provided below. This includes recommendations for conduct by the expert witness during the litigation and proceedings beginning with The Deposition; Procedural

Guidelines; Court Appearance--Testimony; Court Appearance--Cross-Examination of Testimony; Actions in and About Court; and Post-Court Actions. Recommended measures by which the geological expert can reduce the inherent contractual risk of liability and separate litigation that alleges errors of judgment, omissions of data, or malpractice are reviewed elsewhere (Waggoner and Kiersch, 1991, p. 569-571).

## **INVOLVEMENT--PREPARE TO SERVE**

The following guidelines--Preparation for Court Cases--is from Kiersch (1969, 1977) with some modifications after Dunn and Kiersch (1974) and Waggoner (1981). As an expert your services are rarely restricted to testimony only. Involvement may be lengthy and complex or it may require a short preparation and a partial day of testimony. Frequently a case is settled by arbitration or pre-trial type hearings, and the expert may not appear in a civil court; but remember your geological report, documents, and deposition-testimony may have been a major factor in the out-of-court settlement. Under the current laws of evidence discovery and revelation required of attorneys before trial--a majority of cases are being settled without a trial.

If a case is taken to a civil court, the decision may be appealed and the litigation stretched out for years. Cases involving governmental agencies are usually presented before special hearing boards and progressively passed through higher appeal boards until a decision is accepted by both parties, or the plaintiff takes the matter to a civil court; such cases require an expert's services for some years.

Involvement as an expert usually begins with an invitation by an attorney to discuss the nature and circumstances of the case, and ask questions on your background and experience, specifically as relevant to the case. Likely the attorney will ask if you feel qualified and capable to serve the case, and whether you might have a conflict of interest arising from previous litigation served, confidential relationships, or the like, which prevent you from testifying. Be forthright and explain any matters which might bring about a conflict, whether business or ethical, as they could hurt you and/or the attorney's client.

The expert's testimony should be prepared in close cooperation between the attorney and expert. An expert serving for the defense can and should assist counsel in preparing for discovery depositions, and most importantly, for the plaintiff's expert (Cushman, and others, 1987, p. 379-380).

### *The Deposition*

During the course of your serving a case, your attorney must reveal to the opposing attorney by a specified date your participation as an expert for his client. Likely this will bring forth a call for your pre-trial deposition proceedings, which may be made by subpoena or arrangement between the opposing attorneys. Your oral deposition is recorded by a court-qualified reporter and is taken in presence of your attorney, who endeavors to keep questioning confined to matter of fact, rather than opinion. Although the opposing attorney usually attempts to ask for an opinion based on some facts and/or selected hypothetical "facts"--a suitable response is--I am here for discussion of facts related to the case--avoid hypothetical questions.

Today's expert should be as prepared for the deposition as for the infrequent court-jury appearance. The trend to promote alternatives to law suits began in the mid-1980s as part of the legal reform of the civil justice system--to speed settlements and revolt against excessive lawyering costs and delays. By 1992, over 600 top corporations and 800 major law firms had pledged to promote alternatives to litigation (Business Week, 1992). Litigants frequently spend as much as 80 percent of their overall legal costs on the tools of discovery. Consequently, an expert's deposition combined with reports prepared on findings and conclusions become major instruments in an out-of-court settlement.

The deposing attorney's job is to make the witness uncomfortable and doubtful, gain a psychological advantage by positioning the witness on the defense, and finally assert his client's views of reality over the expert. If the opposing attorney is obnoxious and repetitive with inane questions the experienced witness may spar-back, asking for an explanation/clarification of the question (Sanger, 1989).

Likely the witnesses' testimony will follow one of two common approaches:

- ! Give a minimal response only; *yes* or *no*, if possible. This attitude requires opposing counsel to labor for every detail of your findings and opinions. Such an approach was widely used in past decades before the discovery tools (as in California) permitted everything not privileged to be discovered, which means an exchange of all documents, reports, and file data of the expert (Patton, 1992, p. 348).
- ! Assert your civil liberties. If meaningful questions are not being asked by opposing counsel, it may be necessary to state your point-of-view in whatever detail suitable to assure the record truly reflects your credentials and opinions. Opposing counsel will try to thwart such effort of expression, because the meaningful testimony is significant and helpful should the litigation be settled out-of-court. The deposition and your reports then become the major sources of related data and record of your opinion and findings, usually critical when geologic conditions and related events are central to the litigation.

If your attorney requests assistance with questions on specific items or areas to explore in the deposition of the opposing expert, related actions can substantially assist your counsel. For example:

- ! Prepare a flow-chart for the series of questions. For each, predict the opposing expert's answer--*yes*, *no* or *possibly*. Include a statement on each question as to the true situation or your interpretation of facts for counsel.
- ! If there are two or three possible answers to a question, each one should be indexed to the proper follow up question. Overall the series of questions should be organized to exploit weaknesses in the opponent's case. The series should build to a culmination which establishes the strength of your facts and case. The opponent's deposition can then serve as a supportive document, if negotiations and settlement occur later.

## ***General Procedural Guidelines for Preparation of Court Cases***

The following suggestions may assist the inexperienced witness in preparing their testimony and avoiding some difficulties common to litigation.

1. Do not accept participation in a case against your best judgment. If circumstances and facts do not appear consistent, and you cannot willingly and ethically support them, withdraw. For example, pre-formed objectives set by a steering committee.
2. Investigate the client before agreeing to work for them, even though the case is judged worthy. The client may be objectionable as an unethical operator.
3. Do not risk your reputation with a careless attorney. An ignorant attorney is bad, a careless attorney is a menace to the profession--avoid employment with the latter.
4. Prepare yourself adequately for the case with the necessary field or office investigations, or both. Attorneys frequently want to restrict severely the amount of time the expert spends on preparation, in order to reduce costs. Prior to accepting participation, have a definite understanding regarding the need for adequate geologic investigations. The attorney may mistakenly feel that geologic facts are less than critical to the outcome of the case and they can simply "out-argue" the opposition. Remember, the opposing attorney may assemble a set of strong geological arguments to support the opponents contentions--**be prepared**. Moreover, a likely early question by both sides will be, "How long did you spend investigating the site conditions?" and "What did you observe?" relevant to the case in dispute.
5. Profusely document conditions bearing on the case with drawings, maps and photographs that clearly demonstrate the facts, your interpretations and conclusions; these can be used to demonstrate geologic principles, origin of features, changes induced to natural (*in situ*) conditions by works of man, changes incurred with time, and/or operating engineered works, and the like. Where possible use three-dimensional drawings to document subsurface geologic conditions and demonstrate their legal relevance to the surface features, processes, and events; through the use of colors, transparent overlays, models, samples of materials or fluids. A chronological history, both geologic and man-induced events, aids clarification.
6. Review your findings and interpretation-conclusions with the attorney well in advance of court date. Do not forget--it is part of your job to educate the attorney regarding the way in which geologic circumstances and processes are decisive to the case.
7. Do not go into court until sure your attorney and team know all of your findings and conclusions. Refuse to go if they are not fully aware of all your conclusions.
8. Plan your presentation of testimony in a general way with the attorney prior to court date. It may prove advantageous for the attorney to prepare an outline (with your help) and questions, so that the relevant facts and your conclusions can be brought forth in logical



sequence. This will insure that your testimony is complete (as is warranted). Remember, however, not to load testimony with "filler" and unnecessary information. Remain strictly within the bounds of the case and present data only to elucidate.

9. Do not take the stand unless you have carefully prepared your testimony. At that time be ready to face skilled, and sometimes unfair, cross-examination of your testimony. Consequently, to assist your preparation, review all work and reports on the project (yourself and others), as well as your professional writings that may have a bearing. This may constitute 10 or more hours of preparation for each hour on the witness stand.
10. Because the attorney is the captain of the professional team for the case; be directed by their requests and lend your full support and loyalty.
11. Co-ordinate your testimony with the conclusions of the supporting experts of your team through discussions with the attorney, and if directed, with the other experts.
12. Where appropriate, study the pre-trial deposition of any witnesses or experts concerned with your area of testimony, both for the plaintiff and defense.
13. If the opposing attorney takes your deposition (pre-trial "testimony") as an expert, be aware that they are authorized to request copies of your notes, correspondence, reports, and so on, which you may have in your possession at the time of taking the oral deposition. Furthermore, if your attorney requests a recess and offers private counsel, the deposing attorney is authorized to ask you what transpired--on the record.
14. For background on a lengthy case, study the transcript of relevant court proceedings given prior to your appearance.
15. Use notes to refresh your memory on a technical point or series of data; these are permissible if reference to them is prefaced by appropriate remarks. (An outline of testimony is not permissible however). The court may ask to inspect such notes, so be prepared.
16. Remember your purpose is to help the jury, judge, or hearing officer to understand the facts relative to your field of specialty that are critical to your attorney and the client's case. To assist in this, your attorney should inform you as to the pertinent legal ramifications and views of both sides in the dispute.
17. Review with your attorney the main questions to be asked during your testimony and the likely questions that opposing counsel will raise in cross-examination.

## **THE EXPERT WITNESS**

### ***Court Appearance--Testimony***

Be respectful of the judge and opposing attorney. Judges are human and tend to exalt their position; cultivate this by addressing the judge with "your honor" or "sir". Furthermore, do not wisecrack or make light of the proceedings; the judge may take personal offense (as a former attorney) if you show contempt for opposing counsel.

1. On answering questions--keep your eyes on attorney, listen carefully throughout the question. Then direct your attention and answer straight to jury (trial) or judge (hearing), not to your attorney who should know what you are going to answer. If you lose the attention of the jury (or the judge) you can easily lose the case.
2. State your professional qualifications clearly and completely (as appropriate); present professional qualifications that have bearing on the case. Include education, practical experience, and whether you are professionally registered (licensed) as a geologist or engineer. Important professional society activities and technical publications may be appropriate in some instances.
3. Display total impartiality. Remember you are testifying for the party because you are convinced the facts support them and their contentions are justified. Also, you are sworn to tell the truth. Tell it. False or inaccurate statements harm your credibility.
4. One of two methods for the presentation of direct testimony is generally followed by an expert witness: (a) set forth all evidence bearing on case during direct examination by your attorney; (b) give a synopsis of the main evidence in your direct testimony. Do not enumerate some of the details damaging to the opposing side in anticipation they will "rise-to-the-bait" and request it during cross-examination, in the belief that you omitted a statement on the details because it contradicts your conclusions. This further introduction of evidence has the effect of both strengthening your case and reducing the opposition's enthusiasm for additional questioning. If, however, the opposition does not ask questions on the omitted details, your attorney should then question you on these points following the cross-examination, in re-direct examination.
5. Do not speak in low tones. You have something worth hearing, so raise your voice and speak to the jury or judge in an authoritative and confident manner. Speak slowly enough so reporter taking verbatim testimony is able to record what you actually say. Sometimes cases are decided entirely on the transcript so give a complete statement, not halting, choppy, half sentences.
6. Omit uncommon words and wherever possible technical terms in your testimony. Use the plainest language possible to convey your ideas. To explain the technical points essential to the case, employ well-thought-out illustrations as exhibits.

7. Answer the question as asked (if you can). Do not enlarge upon the requested answer with "BUT".
8. Do not, however, be content with a cursory answer to a complex question; present the reasons for reaching your conclusions if those reasons clarify the basic points in question.
9. Do not fail to help the attorney who is examining you by rephrasing a question, the meaning of which is not precisely stated. You can say: "Do you mean ...?" You may find a cross-examiner asking a misleading question or one who is ignorant of the subject matter.
10. Do not exaggerate in your response; it is a potential trap during cross-examination. Yet be positive, give definite answers whenever possible. Avoid "I think", "I believe", or "As best I can remember". Rather--state "in my opinion" or "in my judgment".
11. Appear modest on the stand; a jury or judge is inclined to be suspicious of undue assertiveness. Rely on your professional credentials to reveal your authority in the field.
12. Do not guess; if you do not know the answer, say so.
13. Do not be afraid to admit a mistake or qualify an answer; an impression of and reputation for honesty and sincerity is valuable.
14. Do not forget that you may compel an attorney to delve more deeply into the subject. If you answer "sometimes", "usually not," or "under certain circumstances," the attorney is almost forced to ask you to explain and the door is opened for a complete statement.
15. Keep notes to refresh your memory about your own testimony and that of others from day to day. If possible, read the transcript of the preceding day's trial and study your testimony before returning to the witness stand the next day.

### ***Court Appearance--Cross-Examination of Testimony***

1. The opposing attorney will treat an expert witness in one of three ways during cross-examination: (a) as if the expert does not know his subject or the facts of the case, and being ignorant is not an expert; thereby he discredits the witness; (b) as if the expert is unsure about important facts or aspects of the case; thereby he discredits the testimony and obtains conflicting statements for the record; or, (c) as if the expert is well prepared and truly an expert; in this event he asks few questions because he fears damaging answers. It is this attitude an expert should try to elicit from the opposing attorney.

2. Do not rush your answers; never allow an attorney to force you to hasty conclusions. Theoretically you have unlimited time to answer a question. For example, a correct answer may require several hours of calculations; if so, state and await court's instructions.
3. Do not accept confusing rapid-fire questions; be deliberate and selective. Try to phrase your answer in a way that will be most helpful to your case. The opposing attorney gains nothing by asking questions which are not answered. Keep your composure.
4. Do not attempt to answer several questions at once; have the attorney choose the one you are to answer. Be patient under cross-examination and firm; stick to the answers you have already given. If you realize a mistake on some point of your testimony, admit it. The truth is more important than a stubborn consistency.
5. Do not hesitate if an answer is obvious. It is highly effective to answer promptly as this leaves the jury or judge waiting for the opposing attorney.
6. Beware of trick questions by opposing counsel. You may properly be compelled to answer "yes" or "no" as the trick question indicates, but meet it this way. "Yes, I can explain that." If the opposing attorney avoids the explanation, the jury is immediately awakened to the attempted trick. When your attorney hears you say "I can explain that" they will take note; rely on them to call forth the explanation on re-direct examination. Another approach to trick questions requiring a "yes" or "no" is to reply: "I will be happy to answer if the court will allow me to qualify my answer."
7. Do not allow the opposing attorney to disturb your composure; just grin and be courteous to the attorney and the court. (The jury or judge likes to see a badgering counsel fail.)
8. Do not try to be "clever"; the attorney is playing on home ground and has the advantage. If you forget this, they'll show you a few tricks that you might not have heard about.
9. Do not forget that the opposing attorney may be better informed on some point than you are. However uninformed they may seem, do not underestimate their grasp of the facts; some attorneys act uninformed with a witness in order to catch them on a technical point and discredit the witness.
10. Do not be too eager to agree with authorities in your field or accept a book as authoritative unless you know its contents. (The attorney may have a copy under the table.) (a) Do not hesitate to question statements in text books by alleged authorities, if you disagree. If you know it is an old book and out of date, ask "When was that book written?" or "What edition do you find that statement in?" or "I'm afraid the author had no practical experience when that was written," or "You can find authority for almost anything in books that won't stand up upon close examination," or fall back on "I can explain that." If called upon to explain, name the books which are most authoritative and which support your "expert opinion."

11. Do not be surprised if certain stock questions are asked, such as: (a) "Have you talked with anybody about this case?" Answer: "Certainly. I talked it over at length with the attorney who called me here." (b) "How much are you being paid to testify?" The judge is now quite likely to intervene to protect you. If he does not, state the amount frankly and matter of factly and add: "That is what my time is worth." (c) "You knew what you were going to say before you took the stand, did you not?" Answer: "If the evidence disclosed certain facts, yes, for then there would be only one reasonable conclusion--the one I have stated." (d) "Have you not frequently differed from other experts?" Answer: "Perhaps, but in the present instance I see no basis for any difference of opinion" or "Perhaps, but I was then and still am convinced that my opinion was correct." In close cases there may be room for such differences.
12. Generally, limit yourself to questions asked and offer only your own opinions. When attorneys object to questions, remain silent. Wait until the judge decides whether you may answer or not.
13. Do not risk confusion with a long, involved, hypothetical question. If in any doubt, ask the court reporter to "read the question" and then be ready to answer promptly and deliberately. It will not hurt the jury (or judge) to hear the question twice; it will emphasize the importance of the forthcoming answer. Impress the jury with your desire to be accurate and careful in answering questions. According to circumstances, answering involved, hypothetical questions should be avoided. You are on the stand to discuss the facts.
14. Do not be misled by compound questions. If an attorney asks you two questions in one, say "as to the first question 'yes' and the second question 'no,'" or just say "yes and no." You may be asked to explain; the attorney is not likely to ask many more such questions.
15. Do not hesitate to admit (if it is a fact) that you have been called upon to testify as an expert many times. The fact that your opinion is much sought after is proof of your knowledge of a specialized subject. Add, if true, "And I am called in consultation very often." The inexperienced attorney will ask, "How often?"; give the details.

### ***Actions In and About Court***

1. From the time you enter the courtroom until you leave the witness stand, attention is focused on you. Your testimony may be decisive as to whether your team succeeds or fails in the case.
2. Do not appear in court until instructed to do so. On the witness stand, do not slump in the chair, cross your legs, or appear tired. Sit straight up and be alert at all times. Remember, you are being closely observed and evaluated by all those who are present in the courtroom.
3. The jury will be critical of your appearance. Experts who are leaders in the profession command high fees; look accordingly.

4. While the rules of evidence and court procedure may seem restraining or inexplicable, follow them closely. Each has an important relation to the just determination of the controversy.
5. Do not discuss any aspect of the case whatever in the corridor or the courtroom. Remember, you are being paid to give your expert opinions to the jury (or judge) from the witness stand. Some attorneys post clerks near opposing witnesses in the hall, and at recesses, to use what is overheard to the detriment of witnesses on cross-examination.
6. Do not attract attention by effusively greeting the opposing expert, even an old college friend; by so doing you are enhancing their image. You are being paid, rather, to make little of them and to destroy their opinion (rightfully) by your superior opinion.
7. Do not consult with the opposing expert or experts. If you know your subject why consent to prime the opposition?
8. Unless otherwise requested by your attorney, leave the court when you have completed your testimony.
9. Unless asked to do so, do not sit at your counsel's table within the railing.
10. If your attorney asks you to remain during the trial and advise them on the testimony given by the opposing experts, do not engage in lengthy note passing with your attorney, unless requested. Provided the matter is not urgent, wait until the next recess--then be aware of who may be listening when you talk.

## ***Post-Court Actions***

Besides a settlement of the statement(s) for geological services rendered--which are preferred on an itemized daily basis with fee and expenses listed separately--the engineering geologist should arrange to meet with the attorney and review the quality of your testimony. Such a critique has many benefits for the expert; and some typical aspects to be covered are given elsewhere (Dunn and Kiersch, 1974, and Kiersch, 1977).

## **GENERAL COMMENTS**

There is no reason to be hesitant or nervous before testifying, if you are well prepared and know the facts critical to your testimony. Furthermore, do not allow the trappings of a deposition, hearing, or trial by jury or judge with their question-answer formats to upset or distract from your basic purpose to testify and display total impartiality. Remember, you are testifying because you are convinced the facts support the attorney's client.

Your oral deposition is recorded by a legal reporter. Insist on a personal review and editing of the text. Any misunderstanding of your oral testimony by the reporter can be corrected and any revised pages inserted in the text of the deposition. This is a critical item. Be certain your final (corrected) deposition-text fully reflects the facts and your interpretation of circumstances related to the case. Often a reporter omits or misstates technical remarks or terms and frequently does not ask the witness for a clarification, restatement, or assistance with the text. Although your attorney should watch this closely, it is not uncommon to receive the text of testimony with omissions and confusing language weeks after the deposition. Be certain the opposing attorney has a fully corrected copy of your text before the court proceedings; otherwise it could work to the opposition's advantage to introduce remarks based on your incorrect text. One problem is cost. Many attorneys want to minimize the corrections of a text because of the additional costs and can make it difficult for the witness to distribute a fully corrected text.

Although it is widely recognized that insurers play an important role in the matters of legal responsibility of engineering geologists, their role is "paid for protection" regardless of the geologist's actual responsibility. Thus insurance issues become more a matter of business than a directive of how to perform one's services, and belongs in a business practice discussion, not in a review of geosciences relevant to litigation.

Since engineering geologists are usually a member of a professional team responsible for the design and construction of a project, they may be included in liability suits or construction claims regardless of their personal actions. This catch-all approach is a common practice of the plaintiff with "shot gun" suits to assure catching someone. Also, geologists may be used by plaintiffs to prove that someone else's geologic reports, maps, or statements have damaged them. This can place the expert witness/geologist in the position of being a "hired gun." Since contractual liability is almost unavoidable to some aspects of geological practice, many professionals rely on written contracts and others on habits of practice to mitigate the potential effects of liability. The basic rules should include: know what you need to do; plan how to do it; know who you are providing information to;

and how the recipient plans to use it (Waggoner, 1981). Likewise, be familiar with current practice according to the "state of the art" and "standard of practice" (this and similar manuals) as well as the importance of semantics of key report and contractual words, their legal connotation, and particularly the meaning of such words as guarantee, warranty, certify, and assure. Finally, consider the degree of certainty of your statements and predictions and let your employer, client, or associate know what the degree of probability is (UTRC, 1987).

Often attorneys serve their clients on a contingent basis--no win no fee, and are paid a third or more of the settlement awarded. Ethical experts can not agree to serve or accept their payment on a contingent basis. Obviously, such an agreement will likely influence the expert and result in advocacy and biased testimony. A contingent arrangement is equivalent to a geologist accepting stock in a mine/prospect for an evaluation report on the property. When exposed, a contingency fee arrangement seriously damages an expert's credibility with the court.

You were contacted by and agreed to serve your attorney, after an investigation of client and attorney as described on page 7-8, Nos. 2 and 3. The attorney is wholly responsible for the payment of your fee and expense statements. You are serving at the attorney's request. Some attorneys attempt to shift responsibility for payment from their office to the client. Do not allow this.

### **GLOSSARY - COMMON COURTROOM TERMS<sup>3</sup>**

Although these terms are well known to most readers, their connotations relative to a prospective expert witness may be of use. The definitions are not necessarily those given in a dictionary, but rather reflect discussions with attorneys.

Admit - Allowance by the court to include a statement or exhibit in the official court record

Advocacy - Testimony that is biased or slanted and suggests the witness is more concerned with winning than being truthful

Arbitration - Settlement of a controversy by pre-set procedures outside of court

Brief - A written post-trial summary of the case by opposing attorneys and submitted to the court for use in making a decision

Bench - The judge's chair and table

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<sup>3</sup>Modified after; Waggoner, E.B., 1981, p. 37-38.



Binding (arbitration) - The decision must be accepted by both parties without further appeal

Box - The area set aside for jurors to hear a case

Cite - To name a person as for contempt or a case as a precedent

Closing (statement) - Final summary by each attorney

Contempt - Refusal to comply with a court ruling or warning

Cross (examination) - Questioning by an attorney of an opposing witness

Defendant - The party responding to the plaintiff's suit

Deposition - Pre-trial questioning by an attorney of a person on the opposing side of a case

Direct (examination) - Questioning by an attorney of one of his or her own witnesses

Discovery - The right of an attorney to examine any non-privileged files or other materials of his or her client's adversary prior to a trial; may transmit relevant facts to the expert

Dismiss - A ruling by the court that a case is permanently closed or that a witness may be excused

Ethics - The personal and professional moral criteria guiding one's behavior

Evidence - Materials and testimony used in presenting a case

Exhibit - A physical object such as a written document, map, photograph, or model which becomes part of a court record

Expert - Highly trained, educated, skilled, and experienced in a special field

Frivolous (Nuisance) - Those suits judged lacking in technical merit.

Hypothetical (question) - A suppositional question, usually containing some facts relative to the case at trial; posed to the expert witness for an opinion

Interrogatory - A list of questions given by an adverse attorney to an expert witness prior to a trial

Objection - An attorney's request in court to stop a particular line of questioning of a witness

Opening (statement) - First brief preview of a case presented by each attorney

- Plaintiff - The complaining party asking equity or redress
- Privileged - Information given to an attorney in confidence, not subject to discovery
- Qualified - Accepted by the court to testify as an expert witness
- Rebuttal - Testimony given to refute or counter an opposing witness
- Rest - An attorney's statement that he has completed his case
- Stand (witness) - The chair where a witness sits during his or her testimony
- Standard-of-Care - A combination of legal requirements, regulations, and guidance at the time work was performed--the minimum acceptable
- Stipulate - To agree to some point or matter without argument
- Subpoena - An instrument of the court which demands a person's or some evidence's presence in court
- Trier (of fact) - The person or persons who hear a case and judge the facts leading to a decision
- Voir Dire - Questioning and examination concerning the competence of prospective witness in court. Usually by opposing attorney to try and discredit qualifications of witness.
- Witness (expert or lay) - A person testifying to facts within his or her personal knowledge relative to a case. If the witness is qualified as an expert in a specialty, the witness may also give opinions related to that special field.

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For additional references on general engineering geology topics, appropriate to the expert witness, see the references section in Chapter 9 at the end of this handbook.

Remember to add here, references and ideas you have found useful in your own reading and practice on this topic.

## Chapter 8

### CHANGED SUBSURFACE CONDITIONS

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## Chapter 8

### CHANGED SUBSURFACE CONDITIONS

by  
Bruce Vandre and Eugene B. Waggoner

#### INTRODUCTION

Representations regarding subsurface conditions are included in most construction contracts. Geologists make representations as to their abilities to determine subsurface conditions. When soils or geologic conditions differ from those presented to the client, litigation may result.

The term "changed conditions" refers to clauses inserted into bidding documents to inform a prospective bidder that the owner is willing to share, to some reasonable degree, the risk of encountering construction difficulties not anticipated. By including such clauses the contractor is induced to minimize the contingencies in his or her bid. This should result in lower construction costs if no difficulties are encountered, yet compensate the contractor if an unforeseen adverse condition occurs. The term "changed conditions" is somewhat misleading since geologic conditions are not apt to change in the period between site investigation and construction. The better and more common term now in use is "differing site conditions", meaning site conditions are different than what the site investigation indicated. For use in contracts, the most commonly used clauses have "*differing site conditions*" described with two parts:

- (a) Subsurface or latent physical conditions at the site differing materially from those indicated in this contract, and
- (b) Unknown physical conditions of an unusual nature at the site, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this contract.

Research of construction claims indicates that the major part, both in numbers of claims and in dollars, have their basis in some unforeseen or unanticipated geologic condition encountered in the construction of the project.

The legal issue examined here is as follows: When an owner or engineer has induced someone to act upon geotechnical representations that are false in fact, though not dishonestly or negligently made, and damage has directly resulted from the action taken, who should bear the loss?

This chapter presents research findings which should not be confused with findings of law. Legal interpretations and recommendations are not presented or intended. See references.

## **RISK AND PROFESSIONAL LIABILITY**

The owner of a construction project generally has three objectives: low cost, specified quality, and rapid completion. The owner's objective of high quality is better described by the term "serviceability" in dealing with the engineer. In similarly simplified terms, the contractor's objectives include accomplishment and profit. The engineer's employment objectives can be identified as satisfaction and compensation.

This may be defined as the possibility of not having objectives met. The owner's risks are usually controllable because he is the author of a contract which can assign or transfer risk. Many owners recognize that by assuming some risk, they may better achieve their objective of minimum cost.

We have the option of reducing some of our risks by purchasing insurance. Generally, a risk is insurable if it is subject to statistical analysis. Common insurable construction risks include property damage, public injury, contract default, and professional liability. The risk of encountering unforeseen adverse soil or rock conditions is inherent to most subsurface construction projects. However, this risk is not known to be insurable. The extent of this risk varies inversely with the degree of subsurface exploration which obeys the law of diminishing returns, and judgment dictates a stopping point.

If varying subsurface conditions occur, the geologist or engineer frequently receives criticism from both the contractor and the owner. The owner tends to consider the engineer responsible when changed conditions result in unanticipated and increased costs.

In design and construction, the contracting parties may agree as to who should bear the risk of loss. When the contract terms are not negotiable, ambiguous, or contradictory provisions exist, litigation frequently occurs. Many construction contracts are non-negotiable because government agencies tend to use standard forms and contract awards are based on competitive bids.

An implied warranty of fitness of occupational services generally has been limited to real estate transactions. California has considerable precedent in implied warranties for professional services. In Miller v. City of Burbank (1972) 102 CA R 599, the court indicates the doctrine of strict liability of mass builders does not apply to isolated transactions. Whether the designation "mass producer-seller" includes a contractor who is not a seller, or an engineer (or geologist) who is not a seller, is not clear.

In Swett v. Gribaldo, Jones and Associates (1974) 115 Cal Rptr 99, the court of appeals held a soils engineer was not strictly liable to the purchaser of a house founded on a compacted fill which developed major cracks. The court said those who sell their services for the guidance of others are not liable in the absence of negligence or intentional misconduct, but they are expected to exercise reasonable care and competence. The clients purchase service, not insurance.

The area of case law governing professional liability appears to be undergoing rapid development. A sense of unwarranted security should not be assumed from the prevailing view which rejects the

theory of implied warranties for occupational services. Most legal complaints against engineers or geologists allege negligence or failure to meet code or reasonable practice level rather than strict liability. Site investigations are performed under extreme time demands. Time for thinking is limited and favors hindsight rather than foresight. Consequently, omissions may occur or significant details can be missed which may be a basis for a claim of negligence. Although the appellate courts have rejected recovery based upon claims of strict liability, it is wondered whether or not the plaintiffs subsequently could have recovered if claiming negligence.

The California Bar Association Jury Instruction, BAJI 6.37, Duty of Professional, states, "In performing services for a client, a \_\_\_\_\_ has the duty to have that degree of learning and skill ordinarily possessed by reputable \_\_\_\_\_, practicing in the same or a similar locality and under similar circumstances. It is his or her further duty to use the care and skill ordinarily used in like cases by reputable members of his or her profession practicing in the same or a similar locality under similar circumstances and to use reasonable diligence and his or her best judgement in the exercise of his professional skill and in the application of his learning, in an effort to accomplish the purpose for which he or she was employed. A failure to fulfill any such duty is negligence."

Also BAJI 3.16, Evidence of Custom in Relation to Ordinary Care, states, "Evidence as to whether or not a person conformed to a custom that had grown up in a given locality or business is relevant and ought to be considered, but is not necessarily controlling on the question whether or not he exercised ordinary care, for that question must be determined by the standard of care that I stated to you." (See BAJI 6.37)

## **CHANGED CONDITIONS CLAUSE**

Most construction contracts contain a "changed conditions" clause. This clause is the result of the U. S. government determination in 1930 that construction requirements can most economically be satisfied by accepting responsibility for pre-bid exploratory data and assuming the risk of differing or unknown conditions discovered during performance. The changed conditions clause also provides for administrative recovery for increased construction costs occasioned by varying subsurface conditions. In 1968, the name "changed conditions" was replaced by "differing site conditions" in most U. S. government construction contracts, part of which is reproduced here:

The contractor shall promptly, and before such conditions are disturbed, notify the Contracting Officer in writing of: (1) subsurface or latent physical conditions at the site differing materially from those indicated in this contract, or (2) unknown physical conditions at the site, of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in work of the character provided for in this contract. The Contracting Officer shall promptly investigate the conditions, and if he finds that such conditions do materially so differ and cause an increase or decrease in the contractor's cost of, or the time required for, performance of any part

of the work under this contract, whether or not changed as a result of such conditions, an equitable adjustment shall be made and the contract modified in writing accordingly.

The language of this clause authorizes either an increase or a decrease in the contract price, enabling the contracting officer to reduce the contract price if the conditions encountered were more favorable than those indicated by the plans and specifications. Price reductions have rarely occurred. Basically, this clause provides compensation for two types of changed conditions: (1) misrepresented conditions (including misleading data), and (2) unusual or unknown conditions.

### ***Misrepresented Conditions***

There needs to be some contractual misrepresentation to bring a case within the coverage of this type of changed conditions. For a misrepresentation there must first be a representation. In Ragonese v. United States. (1954) 120 F. Supp. 768, the court said that conditions do not vary materially from the drawings or specifications, but the specifications say nothing about the particular conditions.

The government's misrepresentation of conditions in its contract solicitation need not be specific for a changed condition claim. A claim may be based upon inference. For example, it has been held that a contractor could infer that the subsurface would support an 80-foot fill. A changed conditions was encountered when a 10-foot subsidence occurred after 25 feet of fill had been placed, Appeal of Gardiner Construction Co. (1973) 73-2 BCA 10342. Another example of inferred conditions is Montrose Contracting Co. v. County of Westchester (1936) 80 F.2d 841. The plans and specifications set forth various features of construction work required of the contractor which could be used only in a free-air tunnel. The contractor was entitled to compensation after most of the tunnel was constructed using compressed air.

The government has an affirmative duty to divulge site information to a contractor when such information can be classified as superior, as it is vital to the success of the job, and silence would put the contractor at a significant disadvantage. The courts applied the doctrine of superior knowledge in the following case:

The government contracted for the manufacture of a novel disinfectant which had not been mass produced before. The government, having sponsored research, knew of grinding requirements. Specifications also erroneously implied that grinding would not be necessary. The court of claims held the government had a duty to share this knowledge with bidders. The end-product contractor was entitled to recover for losses attributable to grinding. Helene Curtis Industries v. United States (1963) 312 F. 2nd. 774.

Claims may be based both on changes in the quality of work and changes in the quantity of work. The following fact situations entitled the contractor to compensation due to change in the quality of work:

An excavating contractor encountered rock where the government specifications indicated the presence of clay only and notes on the drawings identified the "nearest rock outcrop was two blocks west of the site". Ruff v. United States (1942) 96Ct. Cl. 148.

The specified rock quality for riprap and dry rock paving could not be obtained within the area identified by the vicinity map included in the specification. Morrison-Knudson Co. Inc. v. United States (1949) 84 F.Supp. 282.

The contractor had free access to use two quarries owned and approved by the U. S. government. Approximately 60 percent waste was encountered in the first quarry used and this quarry was subsequently abandoned. The second quarry was suitable. Kaiser Industries Corp. v. United States (1965) 349 F.2d 322. In contrast the contractor was unable to recover when the contract drawings showed seven borrow pit locations estimated to produce 52,000 cubic yards, and which actually supplied 60,000 cubic yards notwithstanding the fact that two of the originally listed pits were found to be inadequate and two highly productive pits not mentioned in the contract but nearby, were substituted. There were no representations in the contract that the earthwork design was balanced. Pacific Alaska Contractors Inc. v. United States (1971) 436 F.2d 461.

The specified rock size to be used in the construction of a dike could not be obtained from a designated source identified as a solid rock formation. The rock was quite friable, and it proved impossible to get the required size without excessive waste. Tobin Quarries, Inc. v. United States (1949) 84 F.Supp. 1021.

### ***Unknown or Unusual Conditions***

The word "unknown" is strictly construed. If a reasonable investigation would disclose an unusual physical condition, a failure to examine the site may be fatal to the contractor's claim. In Western Well Drilling Co., Ltd. v. United States (1951) 96 F.Supp. 377, it was said the term "unusual" does not refer to a condition which would be deemed a geological freak, but rather a condition which would not be anticipated by the parties to the contract in entering into their initial agreement.

The following fact situations entitled the contractor to compensation due to an unusual condition:

The drilling contractor could not penetrate an extremely hard rock formation to reach the depth specified in the contract. Western Well Drilling Co., Inc. v. United States (Supra).

The contractor encountered wet conditions in excavating for an airfield. The specifications and plans were based on surface conditions and no representation regarding subsurface conditions were made. The plans indicated considerable

excavation above the finished grade lines for fills but no subexcavation. A provision in the specifications identified excavation materials as being unclassified and required the removal of all material regardless of type or class. Loftus v. United States (1948) 76 F.Supp. 805.

The contractor encountered 216,755 cubic yards of hard shale not indicated by the borings and contract drawings, General Casualty Co. of America v. United States (1955) 127 F.Supp. 805.

### *Disclaimers*

Although the purpose and intent of a changed conditions clause is clear from the contract language, construction specifications quite often include general disclaimers of liability which attempt to restrict or nullify the changed condition clause. Such disclaimer clauses have frequently been disregarded by the courts.

In Loftus v. United States (1948) 76 F.Supp. 816, the court disregarded the following specification provision stating, "Unclassified excavations shall include the removal of all material encountered regardless of type and/or class of material." Also in the Appeal of Calvada, Inc. (1956) 56-2BCA 1033, the board saw nothing in the unclassified excavation provisions which superseded the promise of an equitable adjustment in the changed condition clause.

In United Contractors v. United States (1966) 368F.2d 585, the plans and specifications furnished to the contractor contained a clause cautioning that high groundwater existed in the area and the drawings showed pools and water ditches. The boring profiles did not indicate the presence of significant amounts of groundwater. The contract contained a clause requiring completion of excavation at the bid unit price unless the actual quantity of work performed under any item varied from the estimated quantity by more than 25 percent. The contractor encountered considerable groundwater when excavating 5 1/2 to 9 foot depths for utility tunnels. The court considered the groundwater notes as indefinite and ambiguous warnings in view of the boring information and found the presence of water was a changed condition within the provisions of the contract. The court considered the variation in quantity clause a ready vehicle for adjusting, with a minimum of haggling, the compensation received for doing more or less quantity of work than could be estimated. However, the changed condition in this case involved quality of work rather than quantity.

### **CHANGED CONDITIONS CASE HISTORIES**

A few case histories are offered here to provide food for thought in helping to reduce the number of "changed conditions" claims. The specific names of projects are avoided to eliminate any embarrassment to anyone and because the point is not who did it, but what happened, why it happened, what was the impact, and what lesson was learned. Not all of the cases ended in court, most were settled by negotiation.



As you read these changed conditions case histories, try to put yourself in the shoes of the contractor. Remember that he must accept your data and opinions most of the time because he does not have time to do otherwise. He must decide, from your data, what equipment and methods he will use and, most importantly, he must "quantify" into specific dollars to do the job based on your data. Consider if you could do this yourself from your data.

### *Case 1*

A quarry site for protective rock on a major dam was designated by the owner. Drill hole logs and cores were provided but no tests were made on the rock to see if it would perform as specifications required. The owner apparently assumed that the rock as exposed in outcrops was satisfactory. Unfortunately, the contractor was told that if he did not use the designated quarry, any other one he used would have to meet stringent specific tests before it would be approved. The contractor agreed to use the designated quarry, but it did not perform acceptably and much excess excavation was needed to obtain sufficient rock. The claim was large, requiring 9 years through legal channels to settle. Had the owner made tests such as the contractor would have been required to do, or had even a single test blast been made, the problem may well have been foreseen and avoided.

### *Case 2*

An interstate highway was to be built. Specifications were issued showing the alignment and some designated quarries from which road-base rock and asphalt aggregate was to be taken. After award of contract, the owner belatedly noticed that the alignment passed through a large basalt flow outcrop. Instructions were issued to the contractor not to use the previously indicated quarry, but to use the road cut rock as the quarry for road base. Geologic data made available at the road cut consisted of a previous small road cut in basalt, plus 3 or 4 offline borings ranging from 7 to 21 feet deep, which had been drilled to determine the depth of overburden and its suitability for backfill material. When the contractor opened the road cut, the basalt proved to be a relatively thin flow cap overlying an earlier mudflow. The volume of rock was insufficient and almost impossible to work. Another pit several miles away had to be used. The ultimate claim paid was between \$1 and \$2 million.

A few pre-bid borings to determine the real depth of rock and a trial blast, probably not exceeding \$25,000 cost, would have averted this delay and claim cost.

### *Case 3*

A major dam was to be built in a very rugged and difficult access area. The site investigations included a very thorough job for the dam and appurtenant structures. No geologic study was made of the access road, only an alignment was indicated. The contractor assumed no problems when he bid, but when the access road was constructed much of it encountered sidehill dipping rock layers that were unstable when the road undercut them. The contractor was delayed months in beginning work on the dam because of the difficulty in reaching the site.

The lesson to be learned is that you first have to get to a site before you can start building. Take time to geologize the access to a site as well as the site itself.

#### *Case 4*

A cut-and-cover section was to be constructed for a rapid transit system. The material to be excavated was alluvial overburden covering transitional residual soil, grading into hard metamorphic rock. Boreholes were located at approximately 300-foot intervals. All of the boreholes, except one near the middle of the route, indicated bedrock fairly shallow. The one anomalous hole indicated soft soil below the invert and ended in soil. An interpretive bedrock profile in the geologic report seemed to indicate a broad, deep swale in bedrock. During construction, the one anomalous hole proved to be located in a narrow vertical fault zone and the bedrock was found to be at a nearly flat grade through the area. The result was extra rock excavation, time delays and expensive changed condition costs.

Lesson to be learned -- never leave an unsolved anomalous bit of geologic data in your site investigation. Two or three additional check holes around the anomalous hole would have shown the real bedrock surface elevation.

#### *Case 5*

A deep cut-and-cover, large-diameter pipeline was to be built. Borings along the route were made from 500 to 1000 or more feet apart and many of them were 50 to 100 feet off the direct trench line. The materials were described in general terms as lightly consolidated alluvial fan and outwash materials, lenticular in nature and containing lenses of hard cemented caliche. Water table measurements were made and shown on the logs. With one or two exceptions, the water table was shown to be below invert or only slightly above it. Bids for construction were let about two years after the site investigations. Construction encountered high groundwater through much of the trench and a tremendous amount of caliche type rock excavation where soils had been anticipated. A changed conditions claim of considerable magnitude was submitted.

In this case, the borehole exploration was totally inadequate to permit reasonably accurate estimates of the amount of caliche to expect and plan for. Secondly, subsequent to the site investigation, some of the originally open country crossed by the pipeline route was gradually developed for housing. Thus, an area previously of very low precipitation was being subjected to year round irrigation with consequent rise of the water table. A claim resulted.

Lesson learned is that it is important to convey to bidders what we think they will encounter at the time of actual construction. We cannot expect them to make such predictions or interpretation for themselves.

### *Case 6*

A major building structure was to be built in a broad alluvial valley. Some twenty or more 4- to 6-inch diameter borings were made for the foundation investigation. From those data it was decided to put the structure on caissons placed into the alluvial soils. All of the boring logs were included with the bid documents. Since no boulders were encountered in the borings, none of the logs showed any boulders. During construction, nearly every caisson drill hole (36" diameter) hit one or more large boulders. The cost for changed conditions adjustment was large.

In this case, the geotechnician for the drilling confined his efforts to accurately logging the small diameter boreholes and did not look around the area surrounding the job site. Had he looked around, he would have seen boulders exposed on the surface within 100 yards and seen that the site lay in the path of discharge from an adjacent canyon with an intermittent stream.

The lesson is that we must always look beyond the site being investigated as well as within it and under it.

### *Case 7*

A long tunnel was to be constructed for a sewer for a large midwestern city. Approximately 28 borings were made. The area is in a broad area of glacial deposits. None of the logs showed any boulders. Subsequently, the tunnel boring machine which was selected for this job (because no boulders were indicated) encountered much trouble and delay from boulders. It is true that the logs were accurate, but they were obviously misleading. In this case the city entered into a contract with a local firm of consultants to make the site investigation. In the contract, the consultants were told that, in addition to the specific factual data, their report should, because of their familiarity with the area, indicate any opinions concerning possible problems a contractor might have in constructing the tunnel, such as water or boulders, etc. The report included no opinions on boulders, although the consultants presumably were aware that the morainal material of the area commonly contained boulders.

In this case the contractor, instead of submitting a differing site condition, filed a "third party, breach of promise suit" alleging that the consultant's failure to fulfill the terms of the contract with the city resulted in damage to the contractor. In this case the contractor lost, but the situation could occur again. We should furnish our pertinent opinions as well as our data to contractors.

### *Case 8*

A submarine launching facility was to be built on the East Coast. A limited number of borings were made to determine the nature of the overburden and the depth of the bedrock. The bidders were given a simple, non-detailed, contour drawing of the bedrock. The structure was to be constructed by setting contiguous sheet-pile coffer cells in rows extending outward from the shore and closed by a connecting row across the ends. The cells were to be filled with soil materials of low permeability. The contractor assumed from looking at the contour drawings and logs that the piles could be easily

driven to top of bedrock and would form a tight seal there. The cells were constructed, as it turned out, with great difficulty and the inside area was dewatered with up to 80 feet of water outside the cells. Excavations began, and before completion, a blow-in occurred under the base of one cell, filling the area with water and driving the workers out. Ultimately, the leak was sealed with tremie concrete plus underwater work with divers. Final cleanup and completion of excavation showed the details of the bedrock topography and the considerable difference from what had been previously indicated. The nature of the contacts of sheet piles with bedrock was such that it was surprising that more leaks did not occur.

Considering the magnitude and complex nature of this structure, a much more detailed site investigation and analysis of geologic data should have been made.

### **CHANGED CONDITIONS CHECK LIST**

The following is a brief check list that may minimize future "changed conditions" headaches:

1. Do a complete job. Think of a completed, functioning project as the end goal. This should be kept in mind throughout site selection, design investigations, bidding data preparation and construction.
2. Never leave an unsolved anomaly in a site investigation.
3. Do not just be a data gatherer. Express your interpretive opinions.
4. Look outside of the site as well as within it for geologic information.
5. Put yourself in the contractor's place and see if you can make his decisions regarding methods, equipment, and estimated construction cost.
6. Ask yourself, will the project function for the owner without geologic problems after construction is completed?

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See also Chapter 7 references on differing/changed conditions, claims, and risks.  
Remember to add your own useful references and ideas here.

## Chapter 9

### SELECTED GENERAL REFERENCES

#### and SUGGESTED READING

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## **Chapter 9**

### **SELECTED GENERAL REFERENCES**

#### **and SUGGESTED READING**

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A professional Engineering Geologist maintains several lists of useful references and usually has a substantial personal library of frequently used source documents. The references provided here are not exhaustive on the various subjects but are intended to give you a start. Add your own favorite references to this list, keep updating it, and let AEG know about the helpful new references you have found. Additional reference lists are found at the end of each chapter.

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