

# SPECIFICATION - THE NATURE OF THE MAIN PROFESSIONAL WORK PRODUCT OF THE ENGINEERING GEOLOGIST

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**Abstract:** An inter-society debate is going on in the United States to further classify the legitimate areas of practice for engineers and engineering geologists. This effort has evolved because some engineers wish to provide services that may be considered within the realm of applied geology. The debate is friendly and was called by the Geo Institute (the former Geotechnical Engineering Division), of the American Society of Civil Engineers (ASCE, established at New York City, 1852). The convened body is the Joint Task Force on Areas of Practice (JTFAP) for Engineers and Geologists and the author is its Chairman. Also sponsoring are The Association of Engineering Geologists (AEG, of IAEG) and the American Institute of Professional Geologists (AIPG).

JTFAP will soon conclude its work by producing a set of Guidelines for use by the various legally constituted Boards of Professional Registration (of the individual States) and for AIPG's professional certification program. JTFAP does not have authority to levy any of the Guidelines on individuals but it is hoped that the licensure boards will take notice of the substance of this work product in their deliberations. JTFAP also hopes that the national legal system will employ the Guidelines for "Junk Science" screening of testifying experts (1999 "Daubert - Bridgestone" opinion of the U.S. Supreme Court).

Perhaps the greatest JTFAP accomplishment has been determination of a single-word term to express the work product of the Engineering Geologist: "specify." This appropriately contrasts with the historic "design" role of engineers in the constructed environment. The Engineering Geologist therefore "specifies" the nature of earth materials and the topographic, geologic and hydrologic environment, above and below ground, as they affect the optimal and most cost-efficient and reliable considerations for recognition of the engineers in their "designs."

"Spécifications" : La Nature Du Produit Professionnel Principal De Travail Du Géologue De Technologie

**Résumé:** Une discussion d'inter-société continue aux Etats-Unis pour classer plus loin les secteurs légitimes de la pratique pour des ingénieurs et des géologues de technologie. Cet effort a évolué parce que quelques ingénieurs souhaitent fournir les services qui peuvent être considérés dans le royaume de la géologie appliquée. La discussion est amicale et s'est créée par l'Institut de Geo (l'ancienne Division géotechnique de technologie), de la société américaine des ingénieurs (ASCE, établi à New York City, 1852). L'association qui assemblé est le joint Chargent la force sur des secteurs de la pratique (JTFAP) pour des ingénieurs et les géologues et l'auteur est son Président. Commanditent en outre l'association des géologues de technologie (AEG, d'IAEG) et l'institut américain des géologues professionnels (AIPG).

JTFAP conclura bientôt son travail en produisant un ensemble de directives à l'usage des divers conseils légalement constitués de l'enregistrement professionnel (des différents états) et pour le programme professionnel de la certification d'AIPG. JTFAP n'a l'autorité pour prélever aucune de ces directives sur des individus mais on l'espère que les conseils de licensure prendront la notification de la substance de ce produit de travail dans leurs discussions. JTFAP espère également que le système légal national utilisera les directives pour le criblage "de la Science d'ordure" des experts de témoignage (1999 opinions d'"Daubert - de Bridgestone" de la cour suprême des ETATS-UNIS).

Peut-être le plus grand accomplissement de JTFAP a été détermination d'une mot pour exprimer le produit de travail du géologue de technologie : "indiquez." Ceci diffère convenablement du rôle historique de "conception" des ingénieurs dans l'environnement construit. Le géologue de technologie donc "indique" la nature des matériaux de la terre et de l'environnement topographique, géologique et hydrologique, sur et sous la terre, car ils affectent l'optimal et les considérations coût-efficaces et les plus fiables pour l'identification des ingénieurs dans leurs "conceptions."

**Keywords:** education and training, engineering geology, environmental engineering, geotechnical engineering, site investigation.

## INTRODUCTION

The author serves as elected Chairman of the *Joint Task Force on Areas of Practice (JTFAP) for Engineers and Geologists*, as convened by the three leading American professional societies representing the professional practice of geology and engineering in what has become known as the *applied geosciences*.

The Task Force has three members each appointed by the three constituent societies, as well as several ex-officio members representing the elected management of the societies. The effort appears to be taking about three years to work through the issues and to make summary and detailed recommendations to the each of the constituent societies.

There is no way to predict exactly what those recommendations will advise and of what measures the societies will select, and possibly modify.

The author therefore is not reporting on behalf of the JTAFP, but is merely reporting a sense of what issues appear to be recognized in terms of how the practices of geology and engineering are being conducted in the United States, within the general practice area of the applied geosciences.

The author further does not speak for the Task Force, but merely lays the issues before the international body of the two professions, to provide a sense of the general status of interaction as it now exists in the United States. The author therefore takes full responsibility for these declarations and wishes to note prominently that this is a highly fluid and changing dynamic of the practice of geology and engineering in the applied geosciences.

## **THE THREE CONSTITUENT SOCIETIES**

The three societies bridge the spectrum between classical geologic knowledge, through applied geology, and into the realm of professional engineering as is based in the engineered environment as deals with the classic earth materials (soil, weak rock, rock, and groundwater, perched and vadose).

On the scientific side is the American Institute of Professional Geologists (AIPG), founded in 1963 and has about 5,000 members. The Institute also sponsors a certification program based on demonstration of adequate academic training and meaningful practical experience under the tutelage of more senior, qualified professional geologists.

Representing the practice of engineering in the applied geosciences is the Geotechnical Institute (GI) of the American Society of Civil Engineers (ASCE). ASCE as the mother society of more than 100,000 members, was formed in 1852, though GI is the current form of its specialty membership of geotechnical engineers, numbering about 9,700. GI stems from the first "Division" of ASCE, that of the Soil Mechanics and Foundations.

The area of practice between AIPG and ASCE is occupied by the Association of Environmental and Engineering Geologists, formed in 1957 as the Association of Engineering Geologists, and only changing its name in 2005. AEG has about 3600 members, mainly engineering geologists and geological engineers, with some geotechnical engineers who possess especially strong geological training and experience.

The final work product of the JTAFP will be presented to the executive bodies of the three constituent societies for appropriate action.

## **THE COMPELLING ISSUE UNDER DELIBERATION**

It is the author's sense that the most compelling situation that led to formation of the Joint Task Force is that of matching personal qualifications of licensed professional geologists and engineers to specific tasks encountered in the practice of the applied geosciences. Said another way, clients and other consumers of professional expertise in the applied geosciences may, at one time or another, question if a particular registered professional has the competence and experience to qualify to provide services in some narrow sense of application.

These questions appear to occur in particular in the following general instances:

- Forensic testimony before courts of law or legally-established forums such as commissions and regulatory boards
- Forensic testimony by registered professional engineers, other than of the geological or geotechnical specialties, on matters dealing with groundwater flow and contaminant transport in the earth media
- Site characterization details by registered professional engineers, requiring geologic expertise in detection of properties or characteristics that are inimical to the proposed construction process for the intended engineered works
- Site characterization details by registered professional engineers, requiring geologic expertise in detection of properties or characteristics that are inimical to the operation, maintenance or other performance behavior of engineered works
- Recommendations of a design nature, as provided by registered geologists, and
- Forensic testimony by registered geologists, on matters dealing with or equating to design for engineered works.

With these generic incidents we have the general scope of difficulties in and by which professional engineers and professional geologists might find themselves practicing outside of their demonstrated and recognized levels of competence.

### ***Who is Likely to Practice Outside of Qualified Areas of Practice***

Task Force Members are by no means unified on whom among registered professional geologists and engineers are likely to be found practicing outside their demonstrated and legally-recognized areas of practice. As is the point of this paper, none of the Task Force Members, including the author, question that the main point of concern is that the individual under consideration must possess a license as either or both geologist or engineer.

Given the fact that individual professional engineers and geologists are the subject of the Task Force deliberations, there is a general agreement that the following situations are most likely to fall into question as to having competence to practice:

- Individuals licensed in one but not both of the profession;
- Individuals who are in sole practice;
- Small firms not possessing licensed members of both professions, or choosing to make use of project consultants in the area or field not covered by staff members;
- Larger firms, with multiple offices, for which the management does not provide appropriate licensed staffing and/or oversight for work performed within the disputed area of practice, and;
- Government agencies that do not seek, recognize or honor staff for holding professional licensure.

### ***Reasons Why Licensed Professionals May Practice Out of Their Area of Expertise***

Well-known tenets of basic human behavior can be cited for literally dozens of reasons why licensed professional engineers or geologists might tend to practice outside their competed areas of practice. That is not the subject of this paper. There are, however, other current reasons that have been observed to lead to such inappropriate practice by licensed professional engineers or geologists:

- In the opinion of the author, the greatest controlling factor in North America is that of priced competition, otherwise known as “bid-shopping,” in which the prospective client places price before quality;
- In strong second place, in the author’s opinion, is the poor-to-lacking concept of professionalism, as a calling to career practice, of recent graduates, not otherwise seasoned in the ethics and actual ways of practice of a licensed professional geologist or engineer.
- The root cause for this shortcoming is that university teaching faculty are, in general, poorly prepared to teach the ethics of professional practice in the applied geosciences, and;
- Much of the reason for this condition stems directly from the afore-mentioned bid-shopping, in which priced-competition leaves no room for quality assurance or quality management activities that might otherwise (as in past times) rendered real-world experience for faculty as consultants and peer reviewers.

## **DEFINITION OF AREAS OF PRACTICE**

Task Force members were attracted to the notion that a comprehensive list of *Areas of Practice* would provide a basis for judgment of the competence of individual geologists and engineers practicing in the applied geosciences. These Areas of Practice constituted one-line descriptions of the various technologies that are well known to describe the breadth of the field. We had a head start on this endeavor when we considered the *Fields of Expertise for Civil & Geotechnical Engineers* document and listing developed by the California Geotechnical Engineers Association (a practice advocacy group) in 2003.

As a result of this incite, the Task Force has prepared perhaps the most extensive listing yet available on *Fields of Expertise* as one of the means for consideration in defining *Areas of Practice*. It is likely that our final report will be published with this extensive list as an Appendix.

## **THE QUESTION OF STABILITY ANALYSES**

Traditionally, in the United States, quantitative stability analyses of slope masses have been within the general area of practice of engineers, though the analysis of and by itself is not a true “design” function. Hill slopes of coastal California are particularly susceptible to failures, both in natural ground and under engineered and other developments. These conditions generally are triggered by sustained springtime rainfall, but also are influenced by a variety of saturated soil conditions. Consequently, an area-of-practice issue had been brewing for decades, and had generally been decided in the 1980s that competent members of both professions could provide such services, under the conditions of their professional registration.

## **HATHEWAY’S PERSONAL NOTION THAT GEOLOGISTS “SPECIFY” AS THEIR ROLE**

Strictly speaking, and apart from his duties as Chairman of JTFAP, the author has come to believe that in the imperfect world of professional practice before the public, there has been a definite, developed proof that professional engineers provide a service broadly known as “design” and this applies to “engineered works.”

### ***“Design” as an Endeavor and Contribution of the Professional Engineer***

This “design” is the work product of the professional engineer and it is employed in the form of contract drawings and specifications related to construction, by others, nominally members of the building trades, of “engineered works.”

In the sense of contract documents, the engineer gathers the objectives of the owner, in terms of performance, operation and maintenance of the engineered works and converts those parameters into the details by which the works can be fabricated building trades people.

When the professional geologists seeks to practice in the applied geosciences, this person is engaged, or should be engaged, to characterize the earth media on or in which the engineered works sites, and with which some of its

elements will be constructed. As with all other materials employed in constructing engineered works, certain engineering design assumptions must be made of their characteristics and properties, in terms of assuming loads and forces applied during the active life of the works, as they are to perform to meet the owner's objectives. Certainly, we must not neglect to take note of the role of the architect, whose work product results in choice of the form and dimension of the works, again as are suited to meet the owner's objectives.

### ***"Specification" as the Design-Input of the Professional Geologist***

Considering that engineered works are constructed of, on, and in earth media, each engineered works project requires such information be gathered; observed, measured and sampled in a representative fashion respecting three-dimensional variations. For most purposes, the geological information are arrayed in some statistical or quasi-statistical (i.e. visual) form so that the geologist can present these deformational controlling parameters (factors) to the engineer.

An important part of the evaluation process for geologic data supporting engineering design is that the geologist should impart some sense of "goodness" of the data population and to identify which, if any, of the parameters may have a tendency to experience alteration of the measured properties or characteristics, with time and with imposition of climatic environmental factors such as temperature, atmospheric pressure, and various forms of moisture.

This points out that most applications of geologic data to engineering design of engineered works also requires some form of field and/or laboratory testing or instrumentation, again to detect conditions which may cause changes in parametric properties or characteristics.



**Figure 1.** Today's appearance of the mitigated remains of the "Dirty Shame" rock slide of 1970, located at the immediate left abutment of Libby Dam, northwest Montana. This failure occurred during construction and was unanticipated in the course of collection and evaluation of site geologic observations and rock structural data and constitutes a major "lesson learned" in the annals of American engineering geology. The remaining failure trough speaks eloquently for the geologic character of the bounds and properties of the pre-failure rock mass. There were no fatalities. (Image by the author, 2005)

Table 1 presents some of the ways in which geologists specify conditions critical to the engineer's decision-making process and selection of design parameters for application to the overall design. While the architect and associates such as planners and landscape architects offer trial dimensions to suit the owner's plan of development, the actual design engineer must work through alternative design candidates in order to achieve a theoretical stability in the reception and balance of force.

**Table 1.** Typical Participation of the Engineering Geologist in Providing Specifications to Support Design and Construction of Engineered Works

Specification Product	Purpose	Essential Elements
Earth Materials at and Around the Site	Define character, properties, extent and reasonable variations in properties of each named earth material	Such physical properties, characteristics, and volumetric assessment as is necessary for selection and design for use of such earth materials for construction of the project. Some of the materials will necessarily be directly incorporated in the project as elements of the facility.
Site Hydrogeological Assessment	Identification and location of the presence and bounds of perched water and ground water	Provide the design engineer with information needed to accommodate the presence of the project without damage to or from site ground water.
Character of Foundation Materials	Define elements of the subsurface necessary for selection and design of the foundation support system	Geologic determination of the foundation materials is accompanied by evaluation of properties, characteristics, and of their lateral continuity to serve as adequate support for project bearing loads.
Control of Ground and Ground Water During Foundation Excavation and/or Installation	Provide bounds and engineering and/ or hydraulic properties of earth media surrounding and underlying the proposed excavation	Shear strength and active earth pressure for earth retention and Hydraulic properties for control of ground water
Characterization of Rock Masses for Above-Ground Construction	Specify host parameters for incorporation into design	<ul style="list-style-type: none"> <li>o Identification of engineering rock types</li> <li>o Define the bounds of each mass</li> <li>o Identify rock-mass discontinuities and define their 3-dimensional character and intrinsic properties</li> <li>o Describe hydrogeological character</li> </ul>
Characterization of Tunneling Ground	Provide: <ul style="list-style-type: none"> <li>o Excavation parameters</li> <li>o Estimated stand-up time</li> <li>o Estimate control needs perched and ground water</li> <li>o Locate rock retention points</li> <li>o Provide as constructed geologic map for purposes of contract administration</li> <li>o Properties of the muck necessary to removal and proper environmental disposal</li> </ul>	These data allow the owner's engineer to include in the contract documents such information as is critical to the bidding contractor in selection of whatever construction methods are not otherwise prescribed and to formulate its bid, as based on elements of construction and of construction machinery necessary to complete the project.  These geological specifications also address other conditions bearing on the successful completion of construction and installation of project components essential to optimal performance of the project over its design life.
Environmental Restoration Projects	Site and waste characterization: <ul style="list-style-type: none"> <li>o Geologic host units</li> <li>o Individual bodies of waste</li> <li>o Temporal and spatial positions of perched and ground water</li> <li>o Definition of migrated contamination</li> <li>o Geologic pathways for contaminant transport</li> </ul>	Geologic specifications define the nature and character of the ground to be remediated and additionally provide the parameters necessary for engineered design of temporary and permanent measures to bring the site to an environmentally satisfactory regulatory closure as well as to specify the parameters necessary for out-year performance monitoring.
Natural Hazards Mitigation	Geological evidence of the past and likely future paths and, durations, and force magnitudes of dynamic hazards	Provides engineers with the means of devising resisting systems to meet and overcome the disruptive forces of recurrent events, based on careful field explorations and best scientific judgment

The design iteration of candidate parameters generally operates with some sort of allowance (Factor of Safety, “slack,” or other assumptions, possibly levels of exceedence magnitude related to assumed risks.

In any sense, the final selection of design parameters is a process of steps:

- The owner expresses a development concept and functionality objectives, generally to the architect;
- The architect or associated planner then develops a few alternatives for achieving the owner’s objectives; these are called design concepts;
- The geologist then goes to the field and characterizes the ground of the project “footprint” and assesses also such surrounding ground the behavior of which may affect the proposed engineered works, either in resisting or supporting the presence of the project, or threatening its functionality should the surrounding ground become unstable in some way. This step of the process also includes the potential for hydraulic events, volcanic eruptions, earthquake ground motion or loss of ground, and other foreseen potentials for placing the project functionality in “harms way” due to the occurrence of natural hazards;
- Efforts of the geologist are limited only by the scope of work afforded for field, laboratory and office work and the relevant competence of the geological staff assigned to characterize the site and its relevant surroundings;
- The Engineer takes the architect’s requirements of dead load and live load, and any other impositions of force, static or dynamic, and proceeds to work both engineered synthetic or industrial materials, as well as and engineered earth materials into such a three-dimensional configuration of engineering properties and characteristics, into a series of design elements capable of safely resisting the loads and forces expected to be associated with construction, operation, and maintenance of the facility, or at least within the owner’s stated design life of the project;
- The engineer joins with the architect in creating the construction drawings and specifications, which are then placed before qualified contractors, who offer bids for completion of the project, and;
- The project is completed and turned over to the owner for operation and maintenance for its nominal design life.

Counting these seven steps, the geologist normally operates in item number three, unless called at an earlier or later date for supplemental activities. It is a proper rule of professional engineering that the engineering design is to be utilized only for the owner’s stated concept of use and that the design becomes invalid if and when changes are made to that stated basis for engineering.

## SUMMARY

It is the author’s contention that the role of professional engineers in the fields of applied geosciences has been well defined for decades, as dealing with design as it affects construction, operation and maintenance of engineered works. These works can be made to serve for human life support, transportation and other infrastructure, resource recovery, natural hazards mitigation and protection and environmental protection and remediation. On the other hand the role of geologists in the applied geosciences has traditionally and rightfully been that of characterization of the environment of these engineered works and the specifications of those physical and chemical characteristics and properties for use by engineers, and others, in construction of the aforementioned engineered works.

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