The Role of the Geoscientist in Assuring the Safety and Integrity of Infrastructure

Position Statement. Geoscientists have a fundamental role in the engineering and architectural design, planning, construction, and maintenance of infrastructure systems in the built environment, and in understanding the functionality and sustainability of natural infrastructure, with respect to their relationship to local geology, hazards, and the environmental setting.

Purpose. This position statement (1) summarizes The Geological Society of America's consensus view on the importance of geoscientists' contribution to infrastructure concerns; (2) describes geoscientists' roles in addressing aging and expanded infrastructure; and (3) recommends actions to incorporate geoscientists, expand consistency of skills, and educate the public on the natural resource setting for infrastructure systems.

Recommendations

1. **Governments at all levels are encouraged to incorporate licensed geologists or geological engineers in the infrastructure design and planning process.**[1] In some municipalities, geologists are required to provide recommendations and participate in the design process for development on steep slopes in known landslide hazard areas. Similar planning-level participation from geologists is essential for construction in flood zones, earthquake-prone regions, and karst environments. Geoscientists' involvement with planning and design will raise awareness and consideration of geologic conditions that will both affect the integrity of the constructed public works and how the construction design may affect or alter the natural environment.

2. **Legislative bodies and government agencies are encouraged to include geoscientists within the public policy process.** If not properly planned, the basic infrastructure of communities can be quickly overwhelmed, especially in the face of disaster. Inclusion of geoscientists in legislative forums, especially those concerning policy, can provide needed awareness and relevance of the role the earth sciences play in the planning of public works.

3. **Increase decision-maker and stakeholder awareness about natural hazards in high-risk communities.**[2] The scientific knowledge afforded by geoscientists is essential in guidance of infrastructure design when building in areas that are threatened by natural hazards and extreme events (e.g., floods, earthquakes, landslides, tsunamis, and storm surges).

4. **Establish and promote consistent requirements of professional geologist licensure programs.** Some countries, notably Canada, Australia, and parts of the United States and Europe, require licensure or comparable certification if geosciences activities are to be performed in the public domain[*]. In the United States, several states are members of the National Association of State Boards of Geology (ASBOG®), which uses standardized examinations to license professional geologists and provide guidance in maintaining a professional geologist licensure program. Licensure requirements promote technical consistency in the profession as well as reinforce best practices to ensure public safety and welfare.

5. **Institutions of higher learning are invited to partner with applied earth-science professionals to contribute practical curricula with a focus on infrastructure systems.**[1] Increasing urbanization and projected expansion into geologically

[*] Licensure and certification are different in scope and implementation. Licensure has governmental authority and oversight; certification is conferred by a professional association. Certification may or may not include testing of knowledge.

hazardous areas and vulnerable coastal zones, and the demands for improvement in existing infrastructure, require a highly skilled, versatile, and innovative workforce of applied earth-science professionals. Given the growing demands with infrastructure needs, the role of the applied geoscientist—especially one who has geotechnical and engineering expertise—will be crucial in helping to educate the next generation of the infrastructure workforce.

RATIONALE

Society depends on well-built, functional infrastructure every day, from structures like roads, rail lines, pipelines, bridges, dams, and navigable waterways to public works that deliver critical services to the public, like water-supply systems, electrical grids, and telecommunications. These systems provide services and resources essential to maintaining the health, safety, and sustainability of communities. Natural infrastructure, such as forests and wetlands and other open spaces that conserve or enhance ecosystem values and functions, provide similar benefits.

A large portion of existing infrastructure in the built environment was constructed over the past century; however, without ongoing maintenance and improvement, infrastructure systems deteriorate over time. In many locations, existing infrastructure is approaching and even exceeding its original design life. Additionally, recent gains in prosperity and population in emerging economies has caused increased demand for improvement and expansion of infrastructure systems. The viability and integrity of public works is also dependent on the quality and availability of industrial minerals and rocks used in the construction process. While it is clear that society's infrastructure needs crucial assessment, maintenance, and upgrades, future infrastructure likely will require new design approaches and priorities.

A thorough understanding of how earth dynamics and geologic materials affect infrastructure over the construction and design life cycle is imperative in the built environment; conversely, any construction alters the natural environment, and geologists are well-positioned to consider the effects of infrastructure on future risk probabilities for slope instability and altered rates of groundwater recharge and surface-water runoff, among other environmental changes, especially in light of increased frequency of extreme weather events. Flood damage from levee failures along the Mississippi River in 2011, damage to power grids and transportation systems in the northeastern United States due to Hurricane Sandy in 2012, hindering of post-typhoon aid to the Philippines due to substantial airport damage from Typhoon Haiyan in 2013, and the 2017 Oroville dam (California) spillway failure are reminders of the havoc resulting from poor planning and infrastructure disrepair.

Geoscientists are essential in assessing how the natural environment functions and interacts with the lifecycle of built infrastructure in many ways: (1) characterization of subsurface geological conditions with respect to their effect on the planning, design, construction, maintenance, and on-going sustainability or modernization of infrastructure projects; (2) planning for new infrastructure and the assessment of existing infrastructure, with respect to environmental impact, natural resource availability, and the incorporation of regional and site-specific natural-hazard analysis; (3) evaluating and monitoring construction methods in high-risk areas (for example: unstable slopes, high water table, sensitive soil conditions, karst); (4) continual monitoring of potential geologic hazards and environmental conditions in sensitive and critical facilities (e.g., power plants, dams, pipelines, landfills); and (5) awareness of increasing frequency of extreme weather events that may increase the probability of conditions that severely stress any given infrastructure system.

Resilient infrastructure is not only dependent on the geologic conditions where it is built but also on the expertise of the geoscientist involved in the environmental and geotechnical study that complements the engineering. This expertise is the result of education, experience, and qualification. Licensure or a similar form of certification of applied geologists ensures minimum criteria of knowledge and work history necessary to promote consistent best practices and ethical conduct.

REFERENCED GSA POSITION STATEMENTS THAT SUPPORT RECOMMENDATIONS IN THIS POSITION STATEMENT:

1. Promoting Earth Science Literacy for Public Decision Making, revised May 2018, https://www.geosociety.org/documents/gsa/positions/pos21_ESLiteracy.pdf.

2. Improving Natural Hazards Policies through Geoscience, GSA, revised October 2017, https://www.geosociety.org/documents/gsa/positions/pos6_natHazards.pdf.

3. Managing U.S. Coastal Hazards, GSA, revised November 2018, https://www.geosociety.org/documents/gsa/positions/pos22_CoastalHazards.pdf.

4. Climate Change, revised April 2015, https://www.geosociety.org/documents/gsa/positions/pos10_climate.pdf.

Adopted October 2014, Revised May 2019

ABOUT THE GEOLOGICAL SOCIETY OF AMERICA

The Geological Society of America, founded in 1888, is a scientific society with more than 20,000 members from academia, government, and industry in more than 100 countries. Through its meetings, publications, and programs, GSA enhances the professional growth of its members and promotes the geosciences in the service of humankind. Headquartered in Boulder, Colorado, GSA encourages cooperative research among earth, life, planetary, and social scientists, fosters public dialogue on geoscience issues, and supports all levels of earth-- science education.

Opportunities for GSA and GSA Members to Help Implement Recommendations

- Work with local and regional planning boards or institutions to educate them on the value of geoscientists in the planning and design of infrastructure systems. This might include field trips to illustrate pertinent engineering and environmental issues.
- Encourage and provide expert input on public policy that will improve society's resilience to natural hazards.
- Licensing geologists, or certifying geologists where licensure laws are absent, is an important component for increasing public and political recognition and support for the science and profession. Professional geoscientists in countries or provinces without licensure should consider developing accreditation programs. In the United States, geologists in states without licensure are encouraged to contact ASBOG® to learn how to bring licensure into their states or obtain professional certification from a national organization such as the American Institute of Professional Geologists (AIPG) or a comparable professional organization relevant to the practice of geological engineering. Members can also contact legislatures to promote the addition of geologist licensure to state or national legislation.
- Support government geologic surveys. These institutions provide essential knowledge and resources needed for the development and building of infrastructure.
- Promote partnerships among geology departments, especially those working in tandem with civil engineering programs, and practicing professional geoscientists to review academic curricula with a focus on skills used in infrastructure planning, development, and maintenance. Encourage experienced earth-science professionals with pertinent industry knowledge to share their knowledge and perspective with geology and geologic engineering programs. Fostering such partnerships would provide useful insight into developing pertinent curricula that would prepare college graduates to meet the future challenges of society. As part of the curriculum review, consider coursework that would satisfy educational requirements in countries or regions where certification or licensure is required to practice geology in the public domain.