

## **Geotechnical Baseline Reports: State of the Practice**

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**ABSTRACT** By the early 1970s high and uncertain costs associated with underground construction in the US had made tunnel construction uncertain and almost infeasible. While availability of technology played some role in this situation, it was largely a problem resulting from one-sided contracting practices. Typically all risks for subsurface conditions were assigned to the tunnel contractor. To address this situation a national panel was formed to recommend changes in the industry. Two of the most significant changes proposed were for owner development of geological data and interpretations and the elimination of disclaimers of the geological information. From these recommendations has grown the concept of the Geotechnical Baseline Report or GBR. The GBR concept is currently being proposed for expansion to all projects involving subsurface construction, and it is in the best interest of the geoprosessionals community to formulate strategies to deal with the opportunities and risks associated with this expansion of the practice.

**Introduction:** The early 1970s was the time period when many major US urban mass transit projects were being begun and/or conceived, and there was a critical need for tunneling to build these systems. However this was a time when the cost of tunneling projects was virtually out of control. As a result, the National Academy of Sciences (NAS) formed a panel to study the issue, and in 1974 the NAS panel issued its landmark report entitled Better Contracting for Underground Construction. (USNCTT, 1974) Of the 17 recommendations that were presented in this report, the dominant issues involved the uncertainty and associated risks of natural and man-made subsurface conditions. From these recommendations came the concept of the Geotechnical Baseline Report.

GBRs are not typical geotechnical investigation reports. Neither are they pre-bid geotechnical evaluation reports developed for a contractor preparing a bid for a specific project. GBRs are charged with portraying a realistic interpretation of the subsurface conditions that are anticipated in the proposed construction. They should include not only the mean conditions of ground behavior and groundwater conditions anticipated during construction, but the report should also address the range of variances that is expected in these relevant geological characteristics. The purpose of a GBR is to establish a realistic, common basis for all contractors to use in preparing their bids and subsequently a basis for evaluating any contractor claims for differing site conditions that develop during construction. The GBR is the basis for equitable contractual risk sharing and risk allocation between the project owner and their selected contractor.

**GBRs and Predecessor Reports:** The Washington Metropolitan Area Transit Authority (WMATA) is credited with developing the earliest GBR-type reports during the early

1970s. These reports, which became known as Geotechnical Design Summary Reports (GDSRs) were developed for planned sections of subway tunnels. GDSRs were focused on spelling out the designer's understanding of the anticipated subsurface conditions and how those conditions were expected to affect construction of the designed facility. As is currently the case with GBRs, GDSRs were often accompanied by Geotechnical Data Reports (GDRs) that summarizes the field data. The GDRs were interpretive only to the point of assimilating and summarizing subsurface data and geological information into a site geological model.

Throughout the history of GBR-type reports, the primary objective has been to establish a "geotechnical baseline for all anticipated conditions." (UTRC, 1991) These reports included not only the interpretations of subsurface conditions, but also provided interpretations of the effects of the postulated geology on the excavation process, excavation support, ground water control and other relevant construction processes. The purpose of the GDSR/GBR is to provide a baseline for bidding, construction management, and when necessary, resolution of disputes involving claimed differing site conditions. As noted in UTRC, 1997, "The baselines are contractual baselines, not necessarily geotechnical fact. Preparation of baselines may involve the interpretation between, and extrapolation beyond the conditions depicted or inferred by the subsurface information." This statement has been misinterpreted or misunderstood by some to imply that owners and their GBR consultants could set baselines anywhere they chose. In truth the baseline must be within the bounds of a rational interpretation of all available geological and performance information. It is true that a strict interpretation of the available site data may not encompass the baseline, but there must be other site/vicinity information that leads to the establishment of a baseline drawn from a rational evaluation of all available information.

There are two additional contract provisions that must be implemented to support the GBR interpretive report. They are a Differing Site Condition clause and the absence of language that disclaims the right of the contractor to rely on the GBR.

**Conveying Subsurface Information:** For many small projects, a full GBR is not practical or necessary, but if disclosure and reasonable risk allocation are to be achieved, the GBR concept needs to be honored. The unique feature of GBRs is that they provide a realistic portrayal of actual, anticipated conditions. This is different from what is typically found in a design recommendation report. Factors of safety must be stripped out of the design data, and anticipated conditions must be presented in terms of average conditions and probable variances. It is the actual, anticipated range of values must be considered in the contractor's bid.

These reports are expected to "tell it like it is." For geoprofessionals, these reports are a potential source of expanded professional liability because it is much more difficult to predict actual performance than to establish an upper bounding case, as is typical of settlement estimates. The potential for increased liability exposure resides in failure of the GBR consultant to educate all members of the owner/designer/constructor team as to the residual uncertainty that exists for predictions related to subsurface conditions.

**Relevant Subsurface Information:** In the big picture of facility development, subsurface information is any and all information from below the surface of the site that is needed to support the design and construction of the facility, assuming use of ordinary or anticipated construction means and methods. Most of what is discussed herein relates to geotechnical information, however, other physical features such as underground utilities also fall within the "need to know" criteria for subsurface information. However what is "needed" information for the designer may not be "needed" by the constructor. This is a subtle, but important, point raised by many owners and designers.

Both the designer and the constructor need to know the initial subsurface conditions at the site, i.e., the initial geologic model of the site. Additionally both need information that allows them to use the model to predict subsurface behavior under specified future conditions. For design, the time frame in question is typically a design life of 50 to 100 years. For the constructor the time frame is more likely to be a six months to two-year construction period. In summary, there is a common need for the site geologic model but possibly different needs for predictive characteristics. For example, the designer may need to predict the maximum groundwater flow into a basement underdrain system for the 100-year design period. Whereas the constructor needs to predict the groundwater flow into the excavation until the permanent system is in place, which maybe a period of less than six months.

Owners and designers have expressed considerable concern about providing predictive design information to the contractor for fear that it can be misused, either inadvertently or purposely. For example, the writer is familiar with a differing site condition claim that was based on a conservative design bearing value used by the designer of a slurry wall. The contractor subsequently claimed that this low bearing value led them to anticipate easy digging in the clay formation where the slurry wall was founded.

**Communicating the Information** - There is a concept in education known as "Values Clarification." Values Clarification states that information is made up of three categories, namely, facts, interpretations and judgments. Test boring logs and surface outcrop mappings are the most notable examples of facts developed from a geotechnical investigation. Interpretations of site facts, in conjunction with area geology information, must be made in order to develop a site geologic model, such as subsurface profiles. These interpretations are necessary subsurface information that must be made available to both the designer and the contractor. From facts, interpretations, past experience and other sources designers make judgments regarding such things as foundation design bearing values. These judgments are the professional's predictions regarding future behavior of the system. This class of information should be provided to the contractor for completeness, but could be disclaimed in the contract documents because of its lack of direct relevance to the matter of construction and to prevent the contractor from relying on it.

However, the GBR concept says that the contractor needs comparable interpretative information to use as a basis to bid and do the work. This information should come with an owner warrantee that the bidders/contractor can rely on the accuracy and sufficiency the GBR provided specifically for

their use in the contract documents, with confidence that the owner will recognize and pay for deviations from this information.

Small to Medium Projects - On projects of this size, selective use of the typical geotechnical report (with some restructuring of the report) can be used in the contract documents to convey much of the necessary information. However it will most likely have to be supplemented by a construction interpretative information document written after the design is essentially complete.

The key to structuring the geotechnical design report is to meet inclusion requirement is to separate the report into two major sections based on the "Values Clarification" approach. Section 1 should contain the presentation of site investigation data and the geologic interpretation of that data. These efforts would result in the development of a model of the site, as it existed prior to construction. The model would include material properties based on field and laboratory testing. Section 1 would be placed in the contract as information the constructor could rely on.

Section 2 of the report would contain the predicative analyses, professional judgments that lead to recommendations for design of the facility. Since the entire geotechnical design report, Sections 1 and 2 would be completed early in the design cycle some of the Section 2 materials may not be relevant to the final design of the facility as depicted in the contract documents. Therefore Section 2 would be available to the bidders for their inspection, but would not be placed in the contract as information the contractor could rely on.

After the geotechnical elements of the design are established, the subsurface information should be reviewed to determine if it is adequate for a reasonable and prudent contractor to develop a bid for the project. The information most likely to be lacking relates to (1) groundwater control during construction and (2) excavation issues such as ease of excavation and excavation support. If the construction costs related to geotechnical the contractor cannot reasonably assess conditions with the information gather during the design studies, then additional subsurface studies should be undertaken to develop the construction supplement for inclusion in the contract documents.

Large or Complex Projects - Several major subway agencies have pioneered implementation of owner development of all relevant design and construction subsurface information. Essentially all of these studies/reports follow the concept of the GBR. The GBR reflects the design geoprofessional's expectations as to how the ground will behave during construction and operation of the facility. The GBRs are typically included in the contract documents with a differing site condition clause and without disclaimers that attempt to negate the contractor's ability to rely on the information.

The GBR approach works well for other types of large or complex projects. The first major GBR-type report developed by this writer was for an earth dam and reservoir project in the early 1980s. This project was completed with all contractor claims being settled at the level of the construction manager. The total claims for this project were only slightly over 2% of the bid price, and most of the claims were for non-geotechnical issues. The goals of disclosure and reliance on owner provided geotechnical information can be achieved for non-tunnel projects with a document that addresses the information relevant to the needs of the size and type of project being undertaken. The guidelines for

GBRs provide a good starting point for development of more general guidance for other types of projects.

**Summary:** The concepts and guidelines for GBRs are well documented for large underground projects in: USNCTT, 1984; UTRC, 1984; UTRC, 1989; UTRC, 1991; and UTRC, 1997. There is a growing effort to make similar geotechnical information available for all projects. The premise for providing this type of information for all projects is that the site and the facility concept belong to the project owner; therefore the owner should be responsible for providing relevant and sufficient information to both the designer and the bidders/contractor. These baseline reports are not the same as the common design geotechnical reports. As such these types of investigations and reports present geoconsultants with both the opportunity of expanded involvement in projects and the risk of increased liability associated with predicting actual design and construction performance. It is in the best interest of all members of the constructed facilities community to look to the GBR as a proven concept that can and should be extrapolated to meet the needs of all underground design and construction, from drilled shafts to earth dams.

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