



Illinois Department of Transportation

Memorandum

To: ALL GEOTECHNICAL MANUAL USERS 05.2
From: Ralph E. Anderson *Ralph E. Anderson*
Subject: Structure Geotechnical Report Chapter 5 Manual Addendum
Date: September 26, 2005

This policy memorandum has been issued to provide districts, geotechnical consultants and structural consultants with the detailed requirements and general scope of work necessary to complete a Structure Geotechnical Report (SGR). The All Bridge Designers memorandum 05.4 now requires an SGR be completed on all major state structures to ensure that the geotechnical responsibilities are properly assigned, documented, and approved in a consistent manner statewide. The current sections of chapter 5 in the Geotechnical Manual almost exclusively address the report types and content requirements for the geotechnical issues related to roadway design and construction. As part of the Department's efforts to become ISO 9001 certified, the attached pages shall now be considered an addendum to the chapter 5 of the Geotechnical Manual and supersede section 5.2.11 to address the geotechnical issues and SGR requirements related to structures.

Given the variability in district staffing, workload, consultant availability, project schedule and complexity, the ISO BBSP-710-002 "Structure Geotechnical Report Approval" process has since been developed to provide clarification and flexibility in determining who will be accountable for the geotechnical responsibilities.

The District shall determine in advance who will be responsible for preparation of the SGR at the earliest point possible, since this will impact the Professional Transportation Bulletin (PTB) scope, consultant selection, man-hours negotiations and other issues.

One copy of the SGR and ISO form BBSF-710-003 "Structure Geotechnical Report Responsibility Checklist" must be submitted to the BBS by the Structure Consultant with their TSL submittal on all future projects, starting with those listed on PTB 139. The Geotechnical Report Responsibility Checklist can be found at <http://www.dot.il.gov/bridges/forms/bbs2602.exe>.

If you would like to receive copies of the ISO processes or if you have any general questions, please contact Bill Kramer of our Central Geotechnical Unit, at (217)-782-7773 or Kramerwm@dot.il.gov.

WMK/RMW/bb26616
cc- Regional Engineers
Eric Harm

5.3 STRUCTURE GEOTECHNICAL REPORTS

The previous sections of this chapter deal almost exclusively with the report types and content requirements to address the geotechnical issues related to roadway design and construction. With the exception of section 5.2.11, no guidance was provided regarding the geotechnical issues and report requirements related to structures. Although some information and geotechnical analysis in roadway geotechnical reports (RGRs) applies to structures, it was determined that a separate geotechnical report, to be known as a Structure Geotechnical Report (SGR), will be completed. This will help assure that all the geotechnical issues as well as the unique structure/foundation specific issues have been addressed and are accessible to the structure designer in single, comprehensive, easily referenced report. This new section provides detailed guidance on the requirements of a SGR and will supersede the existing section 5.2.11.

5.3.1 Application

The purpose of a SGR is to identify and communicate geotechnical considerations and foundation design recommendations to the structural engineer so they can be taken into account in the structure planning, final design and/or incorporated in the contract documents. The SGR will also address construction considerations and geotechnical recommendations to be used by construction/inspection personnel or the Contractor.

A separate SGR shall be prepared for each structure requiring a Type, Size and Location (TSL) plan. Generally, these include state owned and maintained structures such as bridges, three-sided structures, box culverts, and retaining walls. The general criteria on when a TSL plan is required are published in the Bureau of Bridges and Structures (BBS) Bridge Manual. Other projects may require a TSL plan and thus a SGR depending on complexity, site conditions, and scope of proposed work. Examples might include complex staging requirements, unconventional wall use, unique design constraints or uncommonly high loadings. Preparation of a SGR not generally required for local agency projects except when the project complexity and geotechnical issues are expected to be substantial. The structure designer, District planning and programming, or BBS Central Geotechnical Unit (CGU) may be contacted to determine if a TSL plan will be prepared, or if a SGR would be appropriate for a specific project.

The limits of geotechnical exploration/evaluation in a SGR extend: 1) back to back of a bridge's approach slabs including bridge cone side and end slopes; 2) start to finish a retaining wall and include the soil slopes in front of and behind the wall; and 3) head wall to head wall including wings, excavation, and backfill on both sides of existing and proposed three sided or box culverts.

5.3.2 Responsibility

The BBS ISO 9001 process BBSP-710-002 "Structure Geotechnical Report Approval" has been developed to provide clarification in how the geotechnical responsibilities may be assigned and to ensure they are consistently documented and properly approved. The process considers the variability in district staffing

and workload, consultant availability, as well as project schedule, budget and complexity and provides flexibility in how the geotechnical responsibilities may be assigned. Specifically, the DGE, a Geotechnical Consultant or the Structural Consultant may provide the SGR for structures designed by consultants while either the DGE or the CGU will prepare the SGR for structures designed by the BBS.

The CGU also developed BBS ISO 9001 process BBSP-622-002 "District Structure Geotechnical Report Qualification" so that with training and process reviews, Qualified District Geotechnical Personnel may provide approval of the SGRs prepared by the District or a Geotechnical Consultant. The CGU will provide approvals for SGRs prepared by Structure Consultants, SGRs prepared for structures designed by the BBS, and SGRs prepared in districts without qualified personnel. If requested by qualified districts, the CGU is also available to provide assistance or approval of SGRs.

Each IDOT District Geotechnical Unit has varying levels of resources available to perform subsurface investigations, and different comfort levels with providing geotechnical analyses and design recommendations regarding foundations. It is strongly recommended that the DGE be in communication with their district planning and programming personnel regarding what level of participation the District Geotechnical Unit will have on each project. This communication should occur at the earliest possible time, since the professional transportation bulletin (PTB), scope of consultant services, and man-hours negotiations may be affected.

Section 5.5.3 below provides an overall flow chart and outlines the five most common divisions of the responsibility for subsurface exploration, geotechnical analyses and foundation design recommendations that comprise the SGR.

5.3.3 Submittals

The specific flow of submittals varies, depending on the Districts assignment of responsibilities regarding the subsurface investigation, SGR preparation, SGR approval, and Structure Design. Furthermore, depending on the district specific practices, and on if the district has established their district specific ISO process for "District Structure Geotechnical Report Approval", additional requirements and variations are anticipated from district to district. However, the following five sections cover the most common divisions of responsibility and submittal requirements.

5.3.3.1 *Geotechnical Consultant Performs Subsurface Investigation and Provides SGR to Structural Consultant.* The Geotechnical Consultant must contact the Structure Consultant to discuss and document the anticipated structure type(s), substructure locations/elevations, existing and proposed foundations, and any fills or cuts which may be required. Accordingly, a subsurface exploration and testing program should be developed, to produce information sufficient to conduct the necessary geotechnical analyses and develop proper geotechnical and foundation design recommendations. A man-hours estimate, based on the proposed scope of services, is prepared and reviewed by the DGE. Upon approval, the

DGE provides a copy of scope and man-hours to the BBS CGU for project reference. The Geotechnical Consultant will need to continue discussions with the Structural Consultant to stay abreast of developments in the proposed structure or changes in the project schedule, and make the necessary exploration and testing adjustments. The Geotechnical Consultant will ultimately be responsible for providing the best possible geotechnical information using the most current plans prior to the required submittal date.

The Geotechnical Consultant will prepare the SGR and transmit it along with a SGR checklist (BBS-2602) to the Structural Consultant. The Structural Consultant will send the final SGR and their TSL plan to the BBS. Unless the checklist indicates SGR approval is to be provided by Qualified District Geotechnical Personnel, the CGU will provide SGR review and approval, which will coincide with the BBS Planning Unit's review and approval of the TSL plan. If the District has Qualified Geotechnical Personal and has indicated they will provide SGR approval, a copy of the TSL, SGR and Checklist must also be sent to the DGE. The professional services consultant evaluation for the Geotechnical Consultant will be provided by the unit who provides SGR approval. Copies of all correspondence, concerning District approval of the SGR and consultant evaluation, shall be sent to the CGU for project reference and process review.

5.3.3.2 IDOT District Performs Subsurface Investigation and Provides SGR to Structural Consultant. The DGE should contact the Structure Consultant to discuss and document the anticipated structure type(s), substructure locations/elevations, existing and proposed foundations, and any fills or cuts which may be required. Accordingly, a subsurface exploration and testing program should be developed, to produce information sufficient to conduct the necessary geotechnical analyses and develop proper geotechnical and foundation design recommendations. The DGE will need to continue discussions with the Structural Consultant to stay abreast of developments in the proposed structure or changes in the project schedule, and make the necessary exploration and testing adjustments. The DGE will ultimately be responsible for providing the best possible geotechnical information using the most current plans prior to the required submittal date.

The DGE will prepare the SGR and transmit it along with a SGR checklist (BBS-2602) to the Structural Consultant. The Structural Consultant will send the final SGR, and their TSL plan to the BBS. Unless the checklist indicates SGR approval is to be provided by Qualified District Geotechnical Personnel, the CGU will provide SGR review and approval, which will coincide with the BBS Planning Unit's review of the TSL plan. If the District has Qualified Geotechnical Personal and has indicated they will provide SGR approval, a copy of the TSL, SGR and Checklist must also be sent to the DGE. Copies of all correspondence concerning District approval of the SGR shall be sent to the CGU for project reference and process review.

5.3.3.3 *IDOT District Performs Subsurface Investigation and Provides SGR to BBS for In-house Structure Design.* The DGE should contact the BBS to discuss and document the anticipated structure type(s), substructure locations/elevations, existing and proposed foundations, and any fills or cuts which may be required. Accordingly, a subsurface exploration and testing program should be developed to produce information sufficient to conduct the necessary geotechnical analyses and develop proper geotechnical and foundation design recommendations. The DGE will need to continue discussions with the BBS to stay abreast of developments in the proposed structure or changes in the project schedule and make the necessary adjustments in exploration and testing. The DGE will ultimately be responsible for providing the best possible geotechnical information using the most current plans prior to the required submittal date.

The DGE will prepare the SGR and transmit it along with a SGR checklist (BBS-2602) to the BBS structure planning unit. The structural planning unit will send the final SGR, and their TSL plan to the CGU. The CGU will provide SGR review and approval, which will coincide with the BBS Planning Unit's development and approval of the TSL plan.

5.3.3.4 *IDOT District Performs Subsurface Investigation and BBS CGU Provides SGR to BBS for In-house Structure Design.* The DGE must contact the BBS to discuss and document the anticipated structure type(s), substructure locations/elevations, existing and proposed foundations being considered and any fills or cuts which may be required. Accordingly, a subsurface exploration and testing program should be developed to produce information sufficient to conduct the necessary geotechnical analyses and develop proper geotechnical and foundation design recommendations. The DGE will need to continue discussions with the BBS to stay abreast of developments in the proposed structure or changes in the project schedule and make the necessary adjustments in exploration and testing. The DGE will ultimately be responsible for providing the best possible geotechnical information using the most current plans prior to the required submittal date.

The CGU will use the District Subsurface Data and prepare the SGR. The SGR review and approval will be provided by the CGU concurrent with the BBS Planning Unit's development, review and approval of the TSL plan.

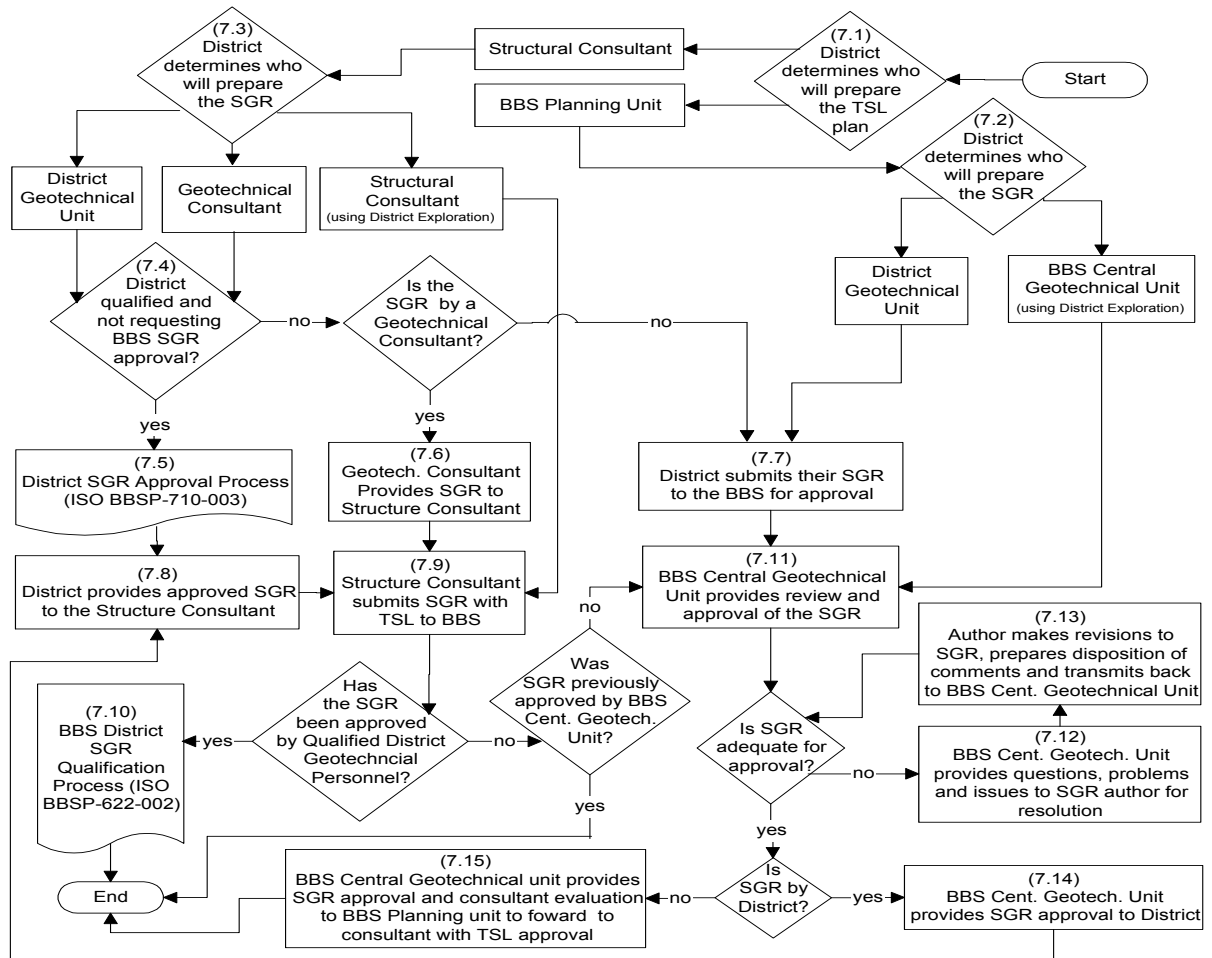
5.3.3.5 *IDOT District Performs Subsurface Investigation and Structure Consultant Provides SGR and Structure Design.* The DGE should contact the Structural Consultant to discuss and document the anticipated structure type(s), substructure locations/elevations, existing and proposed foundations, and any fills or cuts which may be required. Accordingly, a subsurface exploration and testing program should be developed to produce information sufficient to conduct the necessary geotechnical analyses and develop proper geotechnical and foundation design recommendations. The Structural Consultant SGR man-hours will be reviewed and approved by BBS Planning Unit as part of the TSL man-hours review and approval. The DGE will need to continue discussions

with the Structural Consultant to stay abreast of developments in the proposed structure or changes in the project schedule and make the necessary adjustments in exploration and testing. The DGE will ultimately be responsible for providing the best possible geotechnical subsurface information using the most current plans prior to the required submittal date.

The Structural Consultant will use District subsurface data and prepare the SGR. The Structural Consultant will transmit the SGR, Checklist (BBS-2602), and their TSL plan to the BBS for review and approval. The CGU will provide SGR review and approval, which will coincide with the BBS Planning Unit's review and approval of the TSL plan. The professional services consultant evaluation for the Structural Consultant will be provided by the BBS CGU.

The following flow chart provides further clarification on the selection options available to districts when assigning the SGR responsibilities and the subsequent flow of submittals.

BBS Structure Geotechnical Report Approval Process Flow Chart



The DGE should discuss submittal procedures and the schedule with their Studies and Plans staff to insure complete and timely processing of all subsurface information and comments.

5.3.4 General SGR Issues:

The binding of SGR should be simple enough to allow it to be unbound, copied, faxed, scanned, rebound and filed with relative ease using a minimum of paper. Bulky binders, transparent or thick cover sheets, tabs, blank separator sheets, and envelopes containing loose sheets should be minimized. Standard sheets such as textural or AASHTO classification should be referenced rather than included when possible. Standard sheets of legal disclaimer are discouraged. However, project specific information that defines the accuracy of the data and recommendations is encouraged. Such information should be in conjunction with the structure information provided and any variability of subsurface conditions inherent to the site.

There must be one SGR for each TSL plan submitted, regardless of the number of structures covered under that TSL. In a single SGR, recommendations for the roadway or other adjacent structures, not covered under the SGR, should only be referenced or repeated when their treatment has bearing on the structures covered by the TSL plan. This rule must apply even if a single geotechnical consultant is retained to cover both roadway issues and multiple structures on the contract. In this case, the geotechnical consultant must prepare multiple SGRs in lieu of one large report. This procedure will help avoid any confusion when several structural and roadway consultants are required to sort through and extract the necessary recommendations during planning and then during design by the phase II consultant. It is very important to note that a single SGR should be as brief as possible. It should cover the minimum requirements discussed below, concisely and clearly to avoid confusing elaborations and excessive preparation time.

5.3.5 Minimum Requirements

The following issues should be addressed in every SGR. In some cases, depending on the nature of the proposed improvement, site and soils conditions or structure type being proposed, some issues will only require a brief comment in the SGR indicating why they do not need to be addressed.

5.3.5.1 Cover Sheet Information

On the front page of the SGR, include the following information:

- a) Title: "Structure Geotechnical Report".
- b) Route, Section and County.
- c) Contract number and, for consultant prepared SGRs, PTB item number.
- d) Existing and proposed structure numbers.
- e) The author's name.
- f) District, Bureau or Consulting firm's name, address and phone No.
- g) The report date.

- h) The name and phone number of the structure engineer for whom the SGR was prepared.

5.3.5.2 Project Description and Proposed Structure Information

Provide a brief description of the overall project. Include major components of the project and the reason(s) for the work on this particular structure. Reference any other, related SGRs (by structure number) or RGRs that will be completed as part of this overall project. Obtain and include the following information from the structure planner:

- a) Proposed structure type(s) being considered.
- b) Foundation type(s) which may be preferred or required.
- c) Preliminary substructure locations.
- d) If a wall is involved, proposed exposed heights and backslope.
- e) Existing and proposed cross-sections when fills or cuts are proposed.
- f) Estimated foundation loadings and performance requirements.

5.3.5.3 Existing Information

Include any relevant existing subsurface information obtained to provide insight into the drilling conditions expected. Discuss the reliability of the existing subsurface data to determine whether or not it can be used to supplement or reduce the proposed exploration. Also, note the existing foundation types and allowable bearing pressure, shaft end bearing, or pile capacity indicated. In some cases, the actual driving records of each pile may be available to provide assistance in developing the depth of investigation required or the foundation recommendations. Note any other comments on the existing substructure, obtained from the bridge condition report, hydraulics report, or inspection reports that might affect the geotechnical investigation or recommendations.

5.3.5.4 Site Investigation, Subsurface Exploration and Generalized Subsurface Conditions

Discuss general topography and ground surface features that may have affected boring locations and may present construction access or foundation design problems. Contour map of the site should be included when available. Also, include a description of any project design constraints such as right-of-way, overhead or buried utilities, construction equipment/headroom limitations, ditches or water flow, scour erosion, and nearby buildings or structures (both private and public) that may affect the foundation recommendations.

Note any signs of distress or deformation in the existing substructure foundations that suggest past problems, which may need to be considered in the proposed foundation. Include such features as approach settlement, foundation exposure, wall deflection, bulges or scarps on slopes, tilting trees, or mine subsidence surface depressions.

Briefly describe the basis for exploration program developed (including boring locations and depths, rock probes, tests conducted and testing frequency) in relation to the preliminary soils and structure information provided. In addition, note any changes to the exploration program due to the site or access conditions or due to the actual subsurface conditions encountered during drilling.

Include a brief discussion of the site and bedrock geology only if they impact the proposed improvement, rock excavation, drilling into rock, or foundations bearing on the rock surface. Note issues such as probable rock type, rock surface slope or surface elevation variability, and apparent depth of weathering. If rock coring is part of the subsurface investigation, also discuss the bedding planes, compressive strength, spacing and thickness of discontinuities in the rock core, recovery and RQD (distinguishing between breaks caused by coring vs. natural discontinuities).

Groundwater conditions must always be discussed. Identify water bearing layers, artesian conditions, and perched groundwater as well as the elevation of any surface water (such as streams or lakes) observed at the site. Using the groundwater elevations encountered during drilling in each boring, at completion and at a later reading (normally 24 hours), discuss the expected ground water elevation variation across the site. Also, address how it may affect the foundation design and construction activities in the appropriate sections of the SGR below.

5.3.5.5 Geotechnical Evaluations

a) Settlement

Describe any increase in loading resulting from the placement of new embankment or structures. Discuss the potential impact on the structure and approach pavement or retaining wall. Discuss all appropriate treatment options, taking into consideration project constraints, subsurface conditions and the amount of settlement tolerated by the structure.

Provide estimates of the total amount of settlement at critical locations, along walls or at controlling substructures, and the associated time to reach 50% and 90% of that settlement. When preliminary settlement estimates indicate the need for substantial changes to the structure, expensive treatments, or unacceptable delays in the construction schedule, the estimates of settlements and times must be based on laboratory testing of undisturbed samples obtained using thin-walled (Shelby) tubes.

Treatment options might include removal and replacement, preloading/surcharging, wick drains/sand blankets, waiting periods with settlement platform monitoring, segmenting and cambering culverts, designing piles for negative skin friction, precoring piles, using pile

sleeves/bitumen coating, light weight fill/load balancing or other suitable treatments. In some cases, treatment involves a combination of options.

b) Slope Stability

Describe any existing slopes at the site (heights and angles) and indicate any proposed changes such as fills, cuts, or other modification that might affect stability of the slopes. Discuss the potential impact on the structure, the approach pavement or retaining wall. Note, all appropriate treatment options, taking into consideration project constraints, subsurface conditions and the amount of lateral and vertical deformations tolerated by the structure if the factor of safety (FOS) is less than required.

Estimate the critical FOS against slope or wall failure, considering the short- and long-term strength parameters of the soils. When preliminary stability estimates indicate substantial changes to the structure, expensive treatments, or unacceptable delays in the construction schedule, the stability analysis must utilize soil parameters determined from laboratory testing of undisturbed samples obtained using thin-walled (Shelby) tubes.

Treatment options might include removal and replacement, slope flattening, berm inclusion, wick drains/sand blankets, stone columns, soil reinforcement, limited fill placement with piezometer monitoring, wall/piles/anchored systems, light weight fill/load balancing, and other suitable treatment or ground modification systems. In some cases, treatment involves a combination of options.

c) Seismic Considerations

Provide seismic data (Peak Ground Acceleration, site amplification, seismic category) and identify any potential design issues that might impact the structure during and after the design seismic event. Some issues might include slope stability, liquefaction, seismic settlement, lateral embankment deformation, and foundation stiffness parameters. Discuss how these issues might affect embankment configuration, foundation type selection and their design.

d) Scour

Indicate the total scour depth calculated in the Hydraulics Report for the 100 yr event at each substructure. Also, note any existing data and site observations that might indicate past scour, degradation, or channel meander that would provide insight on future events. Discuss the differences between the soils indicated in the borings at each substructure with the assumed soils (normally well graded medium sand) in the Hydraulics Report scour computations. Determine the reduction in scour depth which should be used in foundation design for

cases where the actual soils are less scour prone than sand and provide a table of design scour elevations at each substructure. Address how the final design scour depths may affect foundation type selection, footing elevations, pile capacity loss, and lateral load capacity. Note any scour prevention measures recommended in the Hydraulics Report or by the structure planner and provide comments on the long term effectiveness of that protection measure.

e) Mining Activity

Indicate if the proposed structure is located over mapped mines by checking the ISGU web site at http://www.isgs.uiuc.edu/coalsec/coal/index_onlinepubs_coal.htm. Also, note any past reports or site observations that might indicate past subsidence or mining activity which might reflect on the probability of future events. Mine type, mining method, years of operation, are commonly available at the web site and should be provided. Include any additional information if available, such as mine depth, mine thickness, bedrock type below and above the mine, the thickness of both bedrock and soil above the mine, as well as the spacing and diameter of mine pillars. Discuss the potential or impact of subsidence on the proposed structure.

5.3.5.6 Foundation Evaluations and Design Recommendations

Evaluate the feasibility of the various foundation types, based on a thorough analysis of the proposed structure information as well as soils data, and provide the design parameters, plan details, notes, or provisions required with each. Discuss any differences between the alternatives in terms of constructability and construction time, cost, equipment access, or performance, to assist the planner in selecting the most appropriate foundation type or treatment. Provide the designer with all the information necessary to complete the final design and specifications.

Below are the most common methods of foundation support and several typical issues that may arise with each. The SGR should indicate which of these issues may be pertinent, discuss them as appropriate, and provide recommendations for the most appropriate foundation type(s).

- a) Spread Footings. When Spread footings are considered a feasible alternative, the SGR should provide a table indicating the allowable bearing capacity (not net capacity) values and the corresponding footing elevation for each substructure or station range the values are applicable. Indicate any assumptions and soils parameters used to determine, or that would substantially affect, the allowable bearing pressures. Such assumptions may include the footing width and embedment depth, the applied horizontal and vertical loadings and the eccentricity or moment. Provide any required remedial treatment such as removal of unsuitable material, replacement material type, silt or

shale mud slab (sealcoat), or other ground improvement. Indicate the minimum embedment for frost, scour, bearing, sliding or other issues.

Provide recommendations to the designer on the on the coefficient of friction or adhesion available for sliding resistance. Indicate if proof rolling, additional course aggregate, or other treatments are necessary to use the recommended values. Also, indicate if the soils and site conditions are conducive to a shear key, if any minimum embedment in rock is necessary, or if the footing is deep enough to include a portion of the passive pressure in the resistance calculation.

Driven Piling. Indicate what pile types are considered feasible and include a table with several design capacities, corresponding required bearings, and resulting estimated lengths. The difference in the design capacity and the required bearing should reflect any reductions in design capacity resulting from geotechnical losses such as negative skin friction, liquefaction, scour, or H-pile use. Provide possible treatment options to avoid those reductions. The recommended option, if any, should be based on constructability, schedule, cost, site conditions and effectiveness.

For pile supported footings, indicate the footing elevations assumed or recommended, the number and location of any test piles deemed necessary, the need for metal shoes, the depth and diameter recommended for pre-coring through hard layers or consolidating soils, and any minimum pile length recommended for scour, pile fixity, or lateral loading. When recommending piles to be drilled and set into rock, provide the drilled diameter, embedment in rock, and the estimated top of rock elevations to be used by the designer. Also, note any pile type limitations based on structure and soil types, pile spacing limitations or anticipated vertical or lateral loadings. When necessary, indicate any hammer size limitations/requirements or increases in the pile strength necessary to minimize the potential for pile driving damage.

- b) Drilled Shafts. When subsurface conditions, site limitations, or structure type indicate that drilled shafts are feasible and possibly cost effective foundation type, design recommendations should be provided. This will allow the structure planner complete cost comparisons to select the most appropriate structure and foundation as well as provide the structure designer with the parameters necessary to complete the final plans, if drilled shafts are selected.

When the shafts are founded in rock, provide recommendations on the estimated top of rock elevation, allowable end bearing and/or skin friction in the rock socket, at each substructure. When the shafts are founded in soil, provide recommendations on the allowable end bearing at corresponding tip elevations, allowable skin friction, and the feasibility of using bells. Indicate any limitations on the use of such design values as diameter, spacing, minimum embedment, diameter to

depth ratios, and their influence on the vertical and lateral load carrying capacities of the shafts.

Address any potential for downdrag, liquefaction or scour that will affect the vertical or lateral capacities, and any site or subsurface conditions that would necessitate the use of permanent casing. Temporary Casing or Surry or other temporary soil retention technique is the contractors' decision.

5.3.5.7 Box Culvert and Retaining Wall Evaluations and Design Recommendations

Culverts and retaining walls are two examples of common highway structures that, in addition to the "Foundation Evaluations and Design Recommendations" discussed above, have structure specific geotechnical issues, which must also be addressed in the SGR. A few of specific issues related to these structures are discussed below:

- a) Box or Three Sided Culverts. Provide an evaluation of the existing overburden and existing structure position (skew, width, and length), compared to those proposed, to determine the change in foundation soils loading and adequacy of these soils to carry that loading. Deficient soils will necessitate recommendations for the use of settlement collars and pre-settlement camber heights/locations or removal and replacement of the foundation soils below or adjacent to the box. Note any special backfill requirements adjacent to the box. The SGR must identify any problems with the use of a precast box culvert alternative (available to the contractor as a substitution) and what additional foundation soil modifications, if any, would be required.

For three sided boxes, provide evaluation of the anticipated vertical and horizontal loadings along the length of the structure to determine the required foundation type and design parameters.

Provide wing wall type and design parameter recommendations for both the short and long wings. In addition to considering the horizontal, L-type, and T-type wings, non-standard wing alignments, use of a precast box or three sided culvert, subsurface soil or constructability issues may require that a sheet pile, soldier pile, CIP apron and/or gabion type wing walls also be evaluated.

Discuss the design flood velocity and the need for any erosion, down cutting, or scour countermeasures.

- b) Retaining Walls. Evaluate the feasibility of various wall types considering the project design constraints, cross sections, preliminary wall size/location information provided by the structure planner, and subsurface conditions. Discuss the different wall types, the foundation treatment required for each, and resulting cost differences. Provide design parameters for those recommended as feasible, cost-effective alternatives. When an anchored wall is an alternative, evaluate and

discuss the feasibility and capacity limitations of using various types of deadman anchors, helical anchorage, and permanent ground anchors.

Provide general lateral earth pressure design recommendations for the insitu material being retained or the proposed fill to be placed behind the wall. Take into consideration the differences that occur in backslope angle and backslope height along the wall length. Also, recommend a drainage system to avoid hydrostatic pressure build up behind the wall and the method of out-letting collected water (most often by weep holes or a longitudinal pipe underdrain system).

5.3.5.8 Construction Considerations:

- a) Temporary Sheet piling and Soil Retention. Include a description of the assumed construction sequence or stage construction. Indicate the feasibility of temporary cantilevered sheet pile wall or, if not feasible, the pay item "temporary soil retention system" will be required to allow the contractor to develop a retention system design. In fill conditions, discuss the use of a temporary geotextile wall or temporary mechanically stabilized earth (TMSE) wall. Discuss the feasibility of using temporary construction slopes to avoid the use of a retention system. Evaluate any proposed slopes for temporary stability, considering the soils indicated and slope angles required.
- b) Cofferdams and Underwater Structure Excavation Protection. Discuss the need for cofferdams or an underwater structure excavation protection system at the various substructure locations. Indicate if a minimum seal coat thickness will be required for the cofferdam or if the sheet piling can be driven to a minimum tip elevation to prevent water from entering the cofferdam. Discuss if the subsurface conditions permit well points, or if limited pumping and water diversion might allow construction.
- c) Site and Soil Conditions. Discuss the need for any granular working platforms, proof rolling, inspection/testing/verification, construction staging, monitoring, equipment access and clearances.
- d) Foundation Construction. Discuss the anticipated pile driving conditions and driving equipment limitations, anticipated need for temporary casing or slurry drilling to install drilled shafts, or any other miscellaneous issues that would affect the contractor's selection of construction method and sequence of scheduling.

5.3.5.9 Computations

Only the critical computations shall be included to support the major design recommendations made in the SGR. They should document design parameter assumptions, analysis methods, and provide insight behind how judgments were made. Analysis such as settlement, stability, pile length, shaft friction, footing capacity, Geotechnical losses (downdrag, scour

liquefaction), removal depth, replacement material strength, wick drain, preloading, stone columns, and wall feasibility should be provided if it is not apparent how the SGR recommendations were developed. Do not include every analysis conducted or program results whose answers do not appear controversial.

5.3.5.10 Geotechnical Data

This section of the report shall contain the borings, cores and laboratory data obtained for the SGR. It also shall include a "subsurface data profile" that plots the exploration logs and laboratory soil parameters measured, organized in a manner and format to allow the provide to be incorporated into the contract plans.

- a) Soil Borings, Rock Cores, and Laboratory Test Results. The SGR shall include all soil boring logs, rock core logs (with core pictures) and Shelby Tube Test Data Sheets, if any, developed for this structure. These forms are available at www.dot.state.il.us/bridges/bridgforms.html and supersede the example shown on figure 5.3 in the existing chapter 5. In addition, include any existing borings that were of sufficiently detail to be used to supplement or reduce the number of new borings required.
- b) Subsurface Data Profile. Each soil boring, rock core and laboratory soils testing must be plotted in a continuous column from ground surface to the bottom of each boring or core. Borings shall be placed adjacent to each other, to scale in elevation axis, to create a "subsurface data profile". This profile will also be placed in the final structure plans and thus must be prepared using a font which, when presented on 11"x17" contract plan sheets, results in a minimum font height of 3/32 inches. To maximize the number of borings per plan sheet, the borings should normally not be plotted to scale in the horizontal axis but should follow the general sequence in station (or offset for culverts) along the long axis of the structure. When multiple plan sheets are required, the same vertical scale shall be used on each plan sheet.

The intent is to present all the subsurface exploration data on the contract plans with no interpretation. Thus, avoid extrapolating lines between adjacent boring to represent variation in soil type, water table, ground surface or rock profile. The following is a list of information expected and format requirements for presenting the subsurface data profile:

- 1) Boundaries denoting a change in the soils description should be indicated as horizontal lines not connected to the adjacent boring. The soil description as indicated on the boring log shall be printed between the horizontal lines. Soil type hatching is not an acceptable alternative to using typed descriptions delineated by horizontal lines.

- 2) To either the right or the left of the descriptions, the SPT N-value blow count shall be presented. Do not show the seating blows in the first 6" of penetration. Do not show the second and third blows/6" as separate values to avoid each of them being mistaken as an individual SPT N-value.
- 3) The unconfined compressive strength should be shown to the right of the blow count and include a "B" or "S" indicating failure type. When an unconfined test is not possible, a pocket penetrometer reading may be substituted but a "P" must be placed next to the strength reading.
- 4) Moisture content should be shown to the right of the unconfined compressive strength column.
- 5) When unit weight or other test information is available, it should be to the right of the moisture column.
- 6) Rock core unconfined compressive strength, core run limits and specific descriptions shall be plotted at the elevation where they occur; either in the description or the unconfined compressive strength columns. More general items that represent the entire core run such as recovery, RQD and general rock descriptions should be placed in the description column.
- 7) The water surface and ground water elevations encountered during drilling, at completion, and after 24 hours shall be indicated in the description column at the elevations at which they were indicated.

The boring number, station, offset, and ground surface elevation should be shown just above the top of each boring. Preferably, column headings (N, Qu, or w%) should also be provided. Provide a legend defining all symbols or abbreviations. Add critical notes to each subsurface data profile sheet when clarification is required.