

APPENDIX "A" 2018

Services to be furnished by CONSULTANT:

The CONSULTANT shall make the necessary roadway geotechnical surveys, landslide investigations, and other special investigations and foundation exploration borings for this project or as directed by the INDOT Manager of Geotechnical Services.

Prior to entering upon private property for performing the work, the CONSULTANT shall follow IC 8-23-7-26 through IC 8-23-7-28. A copy of these instructions is on file with INDOT and is incorporated by reference.

The work shall be performed in accordance with the requirements set out in the current Geotechnical Manual.

The consultant may be required to do all work per project or only a portion thereof, as determined by the INDOT Office of Geotechnical Services. All services may not be required at all times.

If special services other than the Geotechnical (such as geophysical work, traffic control, etc.) are required, the Geotechnical CONSULTANT needs to obtain at least three (3) cost estimates before selecting the lowest bidder to perform the work. These estimates shall be submitted to INDOT Office of Geotechnical Services with the invoices for the payment purposes.

The CONSULTANT shall obtain and preserve samples of the subsoil as required, perform the necessary laboratory tests, perform the required geotechnical engineering analyses and prepare and furnish the necessary reports covering the information obtained. If the CONSULTANT is requested to perform the laboratory test on the soil samples and rock cores, these samples shall be delivered to its laboratory no later than at the end of each work week. If the samples are to be tested by INDOT they shall be delivered to the Office of Geotechnical Services, 120 S. Shortridge Road, Indianapolis, Indiana, no later than the following Monday of each work week. Each soil sample and rock core shall be clearly marked as to project number, contract number, structure number, road number, station, offset, boring number, sample number, core number, blow count depth, etc. INDOT shall determine who will do the laboratory testing and engineering during the drilling operations.

Upon completion of the laboratory testing all soil samples and rock cores shall become the property of INDOT and shall be disposed of as directed by INDOT.

Borings shall be made to the depth specified through whatever type of material is encountered, including boulders, fill and other types of obstructions. No measurements or payment will be made for borings abandoned or lost before reaching the specified depth except as provided below for "false starts". No boring shall be abandoned without first obtaining the approval from INDOT.

If a boring cannot be completed due to encountering underground utilities or structures, the existence and location of which were not previously known, the boring will be considered a “false start“ for which payment will be made. The depth of the false start will be measured and paid for at the unit price per foot established by this contract for the appropriate type drilling.

Sounding items in this contract when used for determining the depth and limits of questionable weak subsurface soils shall only be used when the questionable weak subsurface soils are buried. Other type borings shall be used in order to more accurately determine their extent, after approval has been given by INDOT.

The ground water level shall be measured upon completion of the drilling, at 24 hours after completion of the drilling, and at any later convenient times. After measuring the ground water level at completion of the borings, the boring holes shall be suitably covered, so that there will be no hazard to people, animals, or equipment. After 24 hours or later, when the ground water level has been measured and all other observations, records, and information have been obtained, the holes shall be filled in accordance with INDOT’s current “Aquifer Protection Guidelines” located in the Geotechnical Manual.

The CONSULTANT shall perform the following services as directed by INDOT:

GEOTECHNICAL FIELD

In certain locations, INDOT may require the CONSULTANT to perform geotechnical field drilling operations during the night. Work performed at night shall be paid under the item “Night Time”. Any work that is not performed at night shall be paid under the Standard item. No night time drilling shall be performed without obtaining INDOT Geotechnical Office’s approval.

1. a & b MOBILIZATION OF DRILLING, CORING EQUIPMENT AND MILEAGE

This work shall consist of mobilization of equipment to and from the drilling site and shall be paid for from Indianapolis or to the next drilling site under this contract on the basis of the mileage shown on the current official highway map to the nearest town. This item shall consist of a lump sum fee plus a mileage charge. If more than one site is to be drilled, INDOT may schedule the order in which the sites are to be drilled to minimize the total road mileage.

If a combination of truck mounted and skid/ATV-mounted borings exist on any project and each type of equipment is actually mobilized, then two mobilization fees shall be paid. If the additional cost of doing the truck borings with the skid rig is less than the additional cost of the second mobilization, then all borings will be paid as skid borings, and only one rig will be mobilized. The most cost-effective method should be used. However, if more than one rig type will be needed, a prior approval from INDOT is required.

If a site or a portion thereof is inaccessible due to flooding at the time of rig arrival or by the time other drilling that can be done is accomplished, and INDOT does not wish to

eliminate or relocate the boring location to an accessible location, remobilization will be paid if it is necessary to do the boring at a later date.

Remobilization shall be paid only with prior approval from INDOT.

Mobilization of barge (skid) drilling equipment is excluded from this item as it is part of the cost of barge set-up expense. It shall be the responsibility of the CONSULTANT to determine the equipment needs of each site and to mobilize equipment needed to perform the necessary work.

CPT rig and coring equipment mobilization shall be lump sum plus mileage charge as described above.

c. FIELD COORDINATION WITH UTILITIES

This work shall consist of coordinating the field work with utilities, subcontractors and getting any required permits other than railroad permits. This item will be paid as one lump sum per project regardless of the size of the project or the time spent on these activities.

d. FIELD COORDINATION WITH PROPERTY OWNERS

The property owners will be considered for payment if the boring is located on their property and will be paid for as a lump sum basis on the following categories:

- i. 1-10 property owners
- ii. 11-25 property owners
- iii. Over 25 property owners

Crop damage will be compensated as per Geotechnical Manual.

HAND AND TRUCK DRILLING

When the boring or sounding logs are first submitted to the INDOT Geotechnical Section (usually with the first submittal of the geotechnical report), the original field logs should be included. Copies of the field logs are acceptable if they are legible.

The cost of all Geotechnical Engineer services shall be included in the cost of boring, drilling and sampling. Engineering supervision during drilling will not be paid separately.

2. TRUCK MOUNTED BORINGS WITH SPLIT SPOON SAMPLING

This work shall consist of using a truck mounted drill rig to advance a hole of sufficient diameter for the purpose of taking 2.0 in. outside diameter (O.D.) split spoon samples and making standard penetration tests at 2.5 ft. intervals for the first 10 ft. and at 5 ft. intervals thereafter, including a sample at the bottom of the boring with the possibility of taking 3 in. O.D.

Shelby Tube and 2 in. diameter rock cores. This work shall be performed in accordance with AASHTO T-206 using an automatic hammer. Payment will be made from the ground surface to the maximum depth of penetration of the augers or casing.

Drilling fluid or other authorized practices shall be used in circumstances where sand heaves into the casing or as directed by INDOT. Any unusual sampling procedures or results shall be noted on the boring logs.

Driving of the split spoon will be discontinued when blow-counts reach one hundred for a penetration of 12 in. or less.

If a sample is not recovered upon retraction of the sampler, one additional attempt with appropriate trap shall be made in order to retrieve a sample for visual classification. No payment will be made for non-recovered samples, unless an additional attempt at recovery is made and recorded on the boring log.

3. TRUCK MOUNTED BORINGS USING DRILLING FLUID

This work shall consist of advancing an uncased hole using a Hawthorne rotary drag bit, Tri Cone Roller bit, etc., and drilling fluid to keep the hole open to a specified elevation for the specific purpose of obtaining undisturbed samples, or rock core samples.

4. TRUCK MOUNTED CORE DRILLING

This work shall consist of using a truck mounted drill rig for rock core drilling. Standard diamond core bits and series "NWG" or "NX" or larger double-tube or triple tube core barrels shall be required for making rock core borings. The minimum size of core shall be 2 in. in diameter, except INDOT may permit obtaining a 1.6 in. in diameter core if adequate recovery can be obtained. All solid rock shall be drilled with a diamond or saw tooth core bit. Depth of penetration shall be as directed by INDOT. This work shall be performed in accordance with AASHTO T 225.

5. a. TRUCK MOUNTED BORING THROUGH BEDROCK, BOULDERS, OR CONCRETE PAVEMENT

This work shall consist of advancing a hole using truck mounted equipment through bedrock, boulders, or concrete for subgrade investigation. This may require a Hawthorne Rotary Drag Bit, Tri-Cone Roller bit, or any suitable equipment and method to keep the hole open for the purpose of taking SPT or undisturbed samples.

b. BRIDGE DECK CORING AND RESTORATION

This work shall consist of penetrating a bridge deck with coring equipment or other means for the purpose of extending the augers through the deck. The work shall include

restoring the bridge deck by patching with quick set concrete or other equivalent means of restoration. A quantity of one shall be paid for each location of coring.

6. TRUCK MOUNTED CONE PENETROMETER TESTING (CPT)

Cone Penetrometer Test consists of pushing an instrumented Penetrometer into the ground while continuously recording the sleeve friction (f_s), cone resistance (q_c), pore pressure, and shearwave velocity. Cone Penetrometer testing shall be performed in accordance with ASTM D5778-12. CPT shall be performed if requested by INDOT along with SPT boring. Pore water pressure measurement will only be performed when requested. Following items shall be applicable to truck mounted CPT exploration services.

a. CPT: SET-UP

This item shall be paid for each set-up of the CPT truck.

b. CPT: SUBSURFACE PROFILING

This item shall consist of penetration cone resistance profiling and providing computer boring logs and ratio in addition to required geotechnical parameters such as soil types, undrained strength, relative density, angle of shearing resistance, etc. This shall be measured from the surface to the cone top and paid for in linear foot.

c. CPT: PROFILING WITH PORE PRESSURE MEASUREMENT

This work shall consist of adding a pressure transducer to the CPT Penetrometer for measuring soil pore water pressure response to penetration along with other geotechnical parameters.

- i. Piezometer Saturation – This work shall consist of meeting all of the requirements of penetrometers as set out in ASTM D-5778.
- ii. This item shall be similar as described in 6 (b).
- iii. This work consists of determination of pore water pressure dissipation rate and will be paid for at an hourly rate.
- iv. This work consists of determination of horizontal hydraulic conductivity and consolidation coefficient. This shall be paid for as each test.

d. CPT: PROFILING WITH SHEAR WAVE VELOCITY MEASUREMENT

This work shall consist of determining shear wave velocity in addition to geotechnical parameters and will be measured in linear feet from the surface to the cone top.

e. CPT: SAMPLE

This work shall consist of taking soil samples at the required depth which shall be paid for each sample. It shall not be paid if unsuccessful attempt was made.

7. HAND OR TRUCK SOUNDINGS

This work shall consist of making continuous auger borings with a truck mounted rig, or with a hand auger, for the purpose of determining the depth to rock, the depth through surficial peat, other exposed unstable materials, man-made waste deposits, etc.

This item shall also include borings advanced for the express purpose of making core borings in rock or obtaining undisturbed samples at a certain depth in which a casing or drilling fluid is not used to keep the hole open. Measurement shall be from the ground surface to the depth augured.

This item shall also include hand borings made in ponds or lakes for the purpose of determining the depth and thickness of unstable sediments. Measurement shall be made from the top of water to the maximum depth of drilling bit penetration and payment thereof shall be full compensation for the drilling work. It shall be the CONSULTANT's responsibility to determine the elevation and depth of the water at the time the drilling is performed.

8. HAND AUGER DRILLING

This work shall consist of using a hand auger, 1 in. (25 millimeters) retraction piston sampler, or a peat sampler to obtain samples for determination of the geotechnical profile. A hand guide power auger may be used for this item with prior approval from INDOT. This work shall be performed in accordance with AASHTO T-306.

SKID DRILLING

The following items (9 through 13) are to be used when site conditions are such that a skidmounted, dozer-mounted, or all-terrain vehicle drill rig is required to obtain the boring. Borings shall also be considered as one of these items when the CONSULTANT is required to use a dozer to get a truck rig to the boring location. If the CONSULTANT chooses to use a skid-mounted, dozer-mounted, or all-terrain vehicle rig to obtain borings which could have been obtained by a truck rig, they shall be considered as truck borings.

When the boring or sounding logs are first submitted to the INDOT Office of Geotechnical Services (usually with the first submittal of the geotechnical report), the original field logs should be included. Copies of the field logs are acceptable if they are legible.

The cost of the Geotechnical Engineer services shall be included in the cost of boring, drilling and sampling. Engineering supervision during drilling will not be paid separately.

9. SKID MOUNTED BORINGS WITH SPLIT SPOON SAMPLING

This work shall be the same as described in Item No. 2, except for the drilling equipment required.

10. SKID MOUNTED BORINGS USING DRILLING FLUID

This work shall be the same as described in Item No. 3, except for the drilling equipment required.

11. SKID MOUNTED CORE DRILLING

This work shall be the same as described in Item No. 4, except for the drilling equipment required.

12. SKID MOUNTED BORING THROUGH BEDROCK OR BOULDERS

This work shall be the same as described in Item No. 5a, except for the drilling equipment required.

13. SKID MOUNTED SOUNDING

This work shall be the same as described in Item No. 7, except for the drilling equipment required.

14. SKID MOUNTED CONE PENETROMETER TESTING (CPT)

This work shall be the same as described in Item No. 6, except for the drilling equipment required.

BARGE DRILLING

The following items (15 through 21) are to be used when flotation equipment is required to make borings over water. Flotation equipment is described as a barge, raft, boat, or platform of sufficient size to support properly and safely the drilling equipment and have sufficient work area for the storage of the necessary tools and supplies required to make water borings. The barge and drilling equipment shall be of sufficient size to operate on any body of water within, or bordering, the State of Indiana and be able to penetrate to depths as required by INDOT. The equipment shall also be capable of obtaining 3 in. O.D. Shelby Tube samples at depths requested by the CONSULTANT and approved by INDOT. Water borings shall be generally defined as those where water is 12 in. or more in depth and it is not feasible to doze or build a ramp to the

boring location, all subject to prior INDOT approval. It shall be the Consultant's responsibility to determine the elevation and depth of the water at the time the drilling is performed.

When the boring or sounding logs are first submitted to the INDOT Office of Geotechnical Services (usually with the first submittal of the geotechnical report), the original field logs should be included. Copies of the field logs are acceptable if they are legible.

The cost of all Geotechnical Engineer services shall be included in the cost of boring, drilling and sampling. Engineering supervision during drilling will not be paid separately.

15. FURNISHING OF A BOAT

This work shall consist of furnishing a boat for the purpose of making hand borings in streams, ponds, or lakes. The charges for the services will be actual cost and detailed documentation should be provided to support the charges.

16. BARGE SET-UP EXPENSE

This item shall consist of mobilization, demobilization, equipment rental and setting up of equipment required for barge boring at a drilling site. Only one barge set-up will be allowed per drilling site, unless two different barges are required (i.e., one type for navigable water and one type non-navigable water) in which case two barge set-ups will be allowed. A drilling site is defined for this item as one or more barge borings located less than 5 miles from any other barge boring. The drilling site shall be considered as being on navigable water or non-navigable water as defined by the jurisdiction of the United States Coast Guard.

a. NAVIGABLE WATER

i. BARGE SET-UP

ii. RENTAL OF SUPPORT EQUIPMENT AND/OR BOAT

This item shall consist of the rental of support equipment required to perform barge borings on navigable water. Support equipment such as the tug boats, cranes, additional special equipment, etc., shall be reimbursed at the actual invoice cost. The CONSULTANT shall obtain the written approval from INDOT before incurring any Support Equipment expenses.

iii. DRILL RIG DOWN TIME

This item shall include the down time required to move the barge from one boring to the next boring on navigable water. This does not include the initial

barge set-up on the first boring or the movement of the barge from the final boring (these moves shall be part of Item 16 a.i). This work will be reimbursed on a per hour basis.

b. BARGE SET-UP NON-NAVIGABLE WATER

Rental of support equipment for drilling borings on non-navigable water and the down time required to move the barge from one boring to the next boring are included in this item and will not be paid for separately.

17. ADDITIONAL DISASSEMBLY AND REASSEMBLY

a. NAVIGABLE WATER

This item shall consist of disassembly, moving and reassembly of barge equipment when the borings are not located on a continuous body of water. Navigable waters will be defined by the jurisdiction of the United States Coast Guard.

Each such move required will be considered as one additional disassembly and reassembly and INDOT will pay an additional lump sum for each such move required.

b. NON-NAVIGABLE WATER

This item shall consist of disassembly, moving and reassembly of barge equipment when the water is too shallow within the drilling site to float the barge from one drill location to the next if borings are not located on a continuous body of water. Each such move required will be considered as one additional disassembly and reassembly and INDOT will pay and additional lump sum for each such move required.

18. BARGE MOUNTED BORING WITH SPLIT SPOON

This work shall be the same as described in Item No. 2, except for the drilling equipment required.

19. BARGE MOUNTED CORE DRILLING

This work shall be the same as described in Item No. 4, except for the drilling equipment required.

20. BARGE MOUNTED BORING THROUGH BEDROCK AND BOULDERS

This work shall be the same as described in Item No. 5a, except for the drilling equipment required.

21. BARGE MOUNTED SOUNDINGS

This work shall consist of working a machine powered continuous flight auger boring from a barge, for the purpose of determining the depth to bedrock, the depth and thickness of surficial peat and other exposed unstable materials or man-made waste deposits, etc. Measurement shall be made from the top of the underlying ground to the depth penetrated. Hand auger or probe soundings may be made from a barge but payment will be made as set out in Item No. 7.

22. CASING THROUGH WATER

This item shall consist of furnishing and installing casing for water holes. The casing may be either a hollow stem auger or a driven casing for borings into the underlying material through water. Measurement for this item shall be from the water surface to the top of the underlying ground surface.

23. UNCASED SOUNDING THROUGH WATER

This item shall consist of that portion of barge soundings from the top of water to the top of underlying ground. Measurements of this item shall be from top of water to top of underlying ground.

24. SET-UP FOR BORINGS AND MACHINE SOUNDINGS

a. BORINGS AND MACHINE SOUNDINGS LESS THAN 20 FT. DEEP: This

Work shall consist of rig set-up for any borings or machine soundings less than 20 ft. deep.

b. ROCK CORING: This work shall consist of setting up equipment for rock core borings.

25. ADDITIONAL 2 IN. SPLIT SPOON SAMPLES

This item shall consist of obtaining additional 2 in. O.D. split spoon samples as specified in Item No. 3 by the Standard Penetration Test Procedure in accordance with AASHTO T-206. Payment shall be for split spoon samples obtained in addition to those required in Item Nos. 2, 9, and 18, unless otherwise approved by INDOT.

26. 3 IN. SPLIT SPOON SAMPLES

The requirements listed in Item 3 shall apply except the split spoon shall have a 3 in. O.D.

27. 3 IN. SHELBY TUBE SAMPLES

This work shall consist of obtaining undisturbed samples by pressing a 3 in. O.D. thin walled tube into soil with a steady push. An attempt shall be made to push the tube 24 in. Payment will be made only when recovery is 50% or greater, with a minimum of 12 in., unless otherwise approved by INDOT. This work shall be performed in accordance with AASHTO T 207.

28. BAG SAMPLES

This work shall consist of obtaining disturbed samples of soils by any conventional equipment and preparing for lab testing (if outsourced for testing) for moisture density relations, CBR testing, Resilient Modulus, or other test. The total wet weight of sample shall not be less than a) 25 lbs. or b) 5 lbs. The sample shall be placed in appropriate bags and suitably labeled with identifying information.

If the top of the layer to be sampled lies within 5 ft. of the ground surface, a quantity of one will be paid. An additional quantity of one will be paid for each additional 5 ft. penetrated to reach the top of the layer of the material to be sampled.

29. FIELD VANE SHEAR TEST

This work shall consist of performing field vane shear tests in accordance with AASHTO T-223. A quantity of one will be paid for each test performed.

30. 4 ½ IN. CASED HOLE

This work shall consist of advancing a cased hole through soil, shale or rock to a specified elevation for installing field instrumentation, etc. Either hollow stem augers or driven casing may be used. Measurement shall be from the top of the ground to the depth of casing penetration. Larger diameter casing will be permitted at no additional cost to INDOT.

31. INSTALLATION OF GEOTECHNICAL INSTRUMENTS

a. INCLINOMETER CASING INSTALLATION

This work shall consist of providing all the tools, equipment and engineering services for installing inclinometer casing at locations and depths specified by the State in accordance with the Aquifer Protection Guidelines located in the Geotechnical Manual, and/or Contract Supplemental Specifications. A plastic flush-jointed casing of 2.75 in OD, or equivalent may be used. This item shall be paid for at the unit price per lineal foot of casing installed. The appropriate type of drilling used for the borehole, as specified by the State, will be paid for as a separate item. Backfilling around the casing shall be tremied neat cement grout and paid for by the item for Special Borehole Backfilling (Item No. 35) in accordance with the Aquifer Protection Guidelines located in the Geotechnical Manual. If the installation is in an area of proposed fill under construction,

then the length of pipe added shall be not more than 5 feet at a time as the fill height progresses. Lifts of fill around the casing shall be "B"-Borrow or sand. A Metal Protective Outer Cover for Inclinometer Casing shall be installed as described in Item Number 31, Section d.

b. PIEZOMETER INSTALLATION UP TO 25 FT. BELOW THE SURFACE.

This work shall consist of providing all tools and equipment and engineering services for installing piezometers at locations and depths specified by the State in accordance with the Aquifer Protection Guidelines located in the Geotechnical Manual and/or Contract Supplemental Specifications. These piezometers may be of the Pneumatic Type, or of the Hydraulic Cassagrande Type. The Hydraulic type must have provisions for attaching a Bourdon Gauge in case the pore pressure increases enough to raise the water level to above the top of the standpipe. If the piezometer installation is to be of the Cassagrande Type and in an area of proposed fill under construction, then sections of standpipe not longer than five feet shall be added as the fill height progresses, so that the piezometric water level can be measured at any time. Backfill around the standpipes in lifts of embankment shall be of "B"-Borrow material or sand. Each installation shall be marked with the words, "Monitoring well, do not fill". The installation shall be supplied with a Metal Protective Outer Covers for Piezometer Casing and shall be installed as described in Item 31, Section d. The appropriate type of drilling used for the borehole, as specified by the State, will be paid for as a separate item.

c. PIEZOMETER INSTALLATION DEEPER THAN 25 FT., BELOW THE SURFACE.

This item is same as Item b above except for depth involved and the pay item amount. The appropriate type of drilling used for the borehole, as specified by the State, will be paid for as a separate item.

d. METAL PROTECTIVE OUTER COVER FOR INCLINOMETER AND PIEZOMETER CASINGS.

This work shall consist of providing and installing a metal protective outer covers for inclinometer and piezometer installations. These shall be a minimum of 4 in. diameter pipe, or square metal casing, approximately 3 ft. long, and shall be anchored in a concrete pad 3 ft. in diameter and 1 ft. thick, and shall have less than 2 ft. exposed above the ground surface and shall be supplied with a padlockable metal cap. The top of the inclinometer casing or the piezometer tubes shall be between 2 in. to 4 in. below the inside of the cap of the metal protective outer cover. In instances where installation must be flush with the surface, such as in roadways or sidewalks, then standard Water-Meter-Type handhole boxes may be used, instead of the casing described above for the metal protective outer cover. This item shall be paid for at the unit price per each and shall include a metal lid and padlock. One key to the padlock shall be supplied to the INDOT Office of Geotechnical Services at completion of the installation. The keys shall be

numbered with the Boring Number of the Boring Log associated with the installation. Each installation shall be permanently marked with the words "Monitoring well, do not fill".

32. GEOTECHNICAL ENGINEER

This work shall consist of furnishing a qualified approved Geotechnical Engineer for work (field checks and meetings, etc.) that is not covered in other items (engineering analysis, report preparations, field coordination, checking shop drawings, reviewing final check prints, foundation review, etc.). It shall be paid for at the applicable hourly rate for the time actually spent at the job site/meeting plus travel time. Overnight expenses and the cost of mobilizing to the job site are included in this item, and are not paid for separately. The time accepted for payment shall be rounded to the nearest half hour and a time log should be submitted with the itemization to list the activities and time spent on the project. If the quantity of this pay item is expected to exceed ten hours then prior approval should be obtained from INDOT. This pay item should be used during field checks, during construction, etc. It should not be used during drilling operations, marking the borings, because these costs are included in the cost of drilling operations.

33. RAILROAD EXPENSE

Actual cost invoiced by the railroad for railroad permits, flagmen, right of entry. The CONSULTANT shall obtain the written approval from INDOT before incurring any Railroad expense.

34. TWENTY-FOUR HOUR WATER LEVELS a. FIELD MEASUREMENTS

This work shall consist of obtaining 24 hour water levels for any boring where it is considered essential for proper design. These shall include structure boreholes not under ponded water (Bridge, Retaining Wall, etc.) for cut sections where seepage and/or slope stability may be a problem, for embankment areas where slope stability analysis may be required, etc.

b. PVC SLOTTED PIPE

In cases where the borehole caves in, a slotted PVC pipe shall be installed before The casing is pulled. A 24 hour water level is critical in cut and at grade areas if cohesive soils are encountered in borings. In these cases, soundings shall be located outside of the shoulder in the median or behind the curb. The slotted PVC pipe shall be installed before augers are to be pulled. The hole shall be backfilled as per INDOT Aquifer Protection Guidelines after recording the 24 hour water elevation. A quantity of one shall be paid per borehole for item a, and the slotted pvc pipe will be paid per foot for item b.

35. SPECIAL BOREHOLE BACKFILLING

The work in items a and b shall be accomplished in strict compliance with INDOT's current "Aquifer Protection Guidelines" dated October 9, 1996, except where the borehole caves in. In this case the borehole shall be backfilled from the top of the cave-in to the ground surface using the "Aquifer Protection Guidelines". The paid depth is determined by the cave-in depth of the borehole at the time of backfilling.

a. Boreholes from 0.0 ft. to 30 ft. deep; backfilled in accordance with section II.C. Of the Guidelines. Includes all equipment, material and labor to complete the task.

i. SPT

ii. CPT

b. Boreholes greater than 30 ft., backfilled in accordance with Section II.C. Of the Guidelines. Includes all equipment, material and labor to complete the task.

i. SPT

ii. CPT

c. This work shall include restoring pavement after coring or drilling. Concrete pavement shall be patched with quickset concrete. Asphaltic pavement shall be patched with an asphalt mix. A quantity of one shall be paid at each location.

36. DOZER RENTAL

This item shall entail the procurement of a qualified subcontractor to provide and operate a bulldozer for clearing site, and when applicable, constructing pathways and benches for drill rig set-ups. The charge for this service will be actual cost. An invoice copy for the dozer contractor's services will be required to verify the charges. This item shall be used only with INDOT's prior approval.

37. TRAFFIC CONTROL

This work shall consist of providing traffic control services according to the INDOT "Work Zone Safety Manual", when traffic flow must be restricted in order to conduct drilling or coring operations. The charge for this service shall be a daily rate computed to the nearest one half day. All warning signs, traffic cones, or buffer trucks, etc., required to meet applicable safety standards, shall be provided by the CONSULTANT and paid by INDOT at actual cost.

a. FLAG CREW

As required per guidelines in "Work Zone Safety" manual, paid per crew, daily rate computed to nearest ½ day.

b. EQUIPMENT RENTAL AND PROFESSIONAL TRAFFIC SERVICES

As required per guidelines in "Work Zone Safety" Manual, paid at actual cost.

c. FLAG CREW WITH EQUIPMENT

This includes the flag crew and the equipment owned by the company. This item can be used on two lane roadway only. The traffic control set up shall be in accordance with INDOT's Work Zone Safety manual.

d. TRAFFIC COORDINATION WITH SUBCONTRACTOR

This work shall consist of coordinating the field work with traffic control subcontractors and getting any required permits other than railroad permits. This item shall be used mainly on Inter-state type projects and will be paid as one lump sum per project regardless of the size of the project or the time spent on these activities.

38. CENTERLINE SURVEYING

This work shall consist of locating the centerline of the road to accurately locate structure and roadway borings, with the use of instrumentation and a qualified survey crew when requested by the CONSULTANT and approved by INDOT. The charges for these services will be the actual invoice cost from the SUB-CONSULTANT.

GEOTECHNICAL LABORATORY

39. SIEVE ANALYSIS FOR SOILS

This work shall consist of determining the gradation of a sample in accordance with AASHTO T 88. Sieves used shall be U.S. Sieve sized 3.0 in., 2.0 in., 1.50 in., 1.0 in., 0.75 in., 0.5 in., and U.S. Sieve Nos. 4, 8, 10, 40, 200, and 270, decanted over #270. A grain-size distribution curve shall be provided for this item.

40. HYDROMETER ANALYSIS

This work shall consist of performing the Hydrometer Analysis in accordance with AASHTO T 88. The test also includes a specific gravity determination. Silt shall be defined as those soil particles from 0.074 to 0.002 mm in size. A grain size distribution curve shall be provided for Items 39 and 40 combined when both are performed.

41. SIEVE ANALYSIS FOR AGGREGATES

This work shall consist of performing sieve analysis to determine the gradation of aggregate particles and the amount of material finer than a 75- μ m (No. 200) sieve in accordance with:

- a. Analysis by washing per AASHTO T-11.
- b. Analysis by using AASHTO T-27.

The Coefficient of Uniformity and Curvature shall also be reported.

42. LIQUID LIMIT

This work shall consist of the determination of the Liquid Limit in accordance with AASHTO T-89, Mechanical Method only. Three points shall be determined and no payment will be made for Non-Plastic (N.P.) soil.

43. PLASTIC LIMIT AND PLASTICITY INDEX

This work shall consist of the determination of the Plastic Limit and Plasticity Index in accordance with AASHTO T-90.

44. LIQUID LIMIT RATIO (LRR)

This work shall consist of the determination of Liquid limit Ratio in accordance with ASTM D-2487. The Liquid Limit Ratio is an index-factor used to classify organic soils for engineering purposes. This ratio is obtained (LRR) by dividing the Liquid Limit of oven dried soil with the Liquid Limit of non-oven dried soil.

45. PH TEST

This work shall consist of performing the pH Test in accordance with AASHTO 289. The test should be performed on all classification test samples and others as necessary. When the test is performed on moderate to non-organic material, samples size should be 0.7 oz. of material passing the No. 4 sieve (4.75 mm). The samples shall be prepared in accordance with AASHTO T 87.

46. LOSS-ON-IGNITION TEST

This work shall consist of the determination of the Loss-on Ignition (Organic Content) in accordance with:

- a. Conventional Method (AASHTO T-267)
- b. Determining the percentage of calcium carbonate by Sequential Method (ITM-507).

c. Organic determination is based on AASHOT 21.

47. TOPSOIL TESTS

a. PHOSPHORUS

This test shall consist of determining Phosphorus in top soils and shall be performed in accordance with North Central Regional. Research Publication 221, Chapter 6, Mehlich 3 data Bray P equivalent. The result shall be reported in ppm.

b. POTASSIUM

This test shall consist of determining Potassium in top soils and shall be performed in accordance with the North Central Regional Research publication 221, chapter 7: The result shall be reported in ppm.

48. MOISTURE CONTENT TEST

This work shall consist of the determination of moisture content in accordance with AASHTO T-265 (Conventional) and ITM-506 (Microwave).

49. EXPANSION INDEX OF SOILS

This work shall consist of determining the expansion potential of soils in accordance with ASTM D-4829.

50. SPECIFIC GRAVITY TEST

This work shall consist of the determination of the Specific Gravity in accordance with AASHTO T-100. No payment will be made when performed in conjunction with item No. 40, 55, and 58.

51. UNIT WEIGHT DETERMINATION

This work shall consist of the determination of the Unit Weight by measurement of the length and diameter as performed in accordance with the appropriate part of AASHTO T-233. No payments will be made when performed in conjunction with Item Nos. 52, 54, and 55.

52. HYDRAULIC CONDUCTIVITY

This test is conducted to determine the rate of flow of water through the soil mass. Hydraulic conductivity and is determined to evaluate the drainage property of subgrade, base, and Subbase materials. It is determined as the following:

a. CONSTANT HEAD.

Constant Head Test, as described in detail in AASHTO T-215 (ASTM D-2434), is generally used to determine the hydraulic conductivity of granular materials. The sample for testing is selected and compacted into the mold. (The compactive efforts affect the hydraulic conductivity.) It is then saturated under vacuum to assure that there is no air in the sample.

b. FALLING HEAD.

Falling Head Test shall be performed in accordance with ASTM D-5084. The sample should be compacted and saturated as above for the constant head test.

53. UNCONFINED COMPRESSION TESTS ON SOILS & ROCKS a.
UNCONFINED COMPRESSION TEST (SOILS)

This work shall consist of performing the Unconfined Compression Test in accordance with AASHTO T-208. Unconfined strength at 1% strain rate will also be paid under this item. This test shall include initial and final moisture contents, and unit weight determination.

b. REMOLDING OF SOIL SAMPLES WITH CHEMICAL ADMIXTURES IN CHEMICAL SOIL MODIFICATION/STABILIZATION

This work shall consist of remolding of three blended specimens. Remolding of three samples shall be paid as one unit. If additional samples are necessary, INDOT must approve the quantity prior to the preparation of samples. Any additional samples will be paid at one third of this rate. These remolded samples could also be prepared for other test requirements.

c. POINT LOAD STRENGTH INDEX OF ROCK

This work shall consist of determining point load strength index of rock in accordance with ASTM D-5731 and it is used to classify rock strength.

54. COMPRESSIVE STRENGTH AND ELASTIC MODULI OF INTACT ROCK

This work shall consist of determining the strength of intact rock core specimens in uniaxial (compressive strength) and triaxial (Elastic Moduli) in accordance with ASTM D-7012. This is a very common method for the determination of uniaxial compressive strength and deformability.

55. CONSOLIDATION TEST

This work shall consist of performing the consolidation test in accordance with AASHTO T 216, except the initial load shall be 125 psf. This test also includes Specific Gravity, initial and final moisture contents, initial and final Degree of Saturation and Unit Weight (density). Time curves for all load increments and e-log-p curve shall also be furnished.

56. TRIAXIAL TEST

This work shall consist of performing the Triaxial Test in accordance with AASHTO T296 or 297. Each test shall consist of three points for plotting a Mohr Failure Envelope and determining the strength parameters. This test shall include initial and final moisture contents, initial and final degree of saturation and initial and final unit weights (densities). The test shall include a specific gravity determination. The specific type of Triaxial Test performed shall be as directed by INDOT. The test shall be the (a) Unconsolidated-Undrained (UU) test, (b) Consolidated Undrained (CU) test, (c) Consolidated-Drained (CD) test, or (d) Pore Pressure Measurement with the UU or CU test and use of back pressure for saturation.

57. DIRECT SHEAR TEST

This work shall consist of determining the consolidated drained shear strength of a sandy to silty soil in accordance with AASHTO T-236.

58. MOISTURE-DENSITY RELATIONSHIP TEST

This work shall consist of performing Standard or Modified Moisture-Density Relationship in accordance with Method A, or Method C whichever is applicable as part of AASHTO T-99 or AASHTO T-180. A minimum of four points on this curve with at least two points on each side of optimum shall be performed. When Standard Moisture - Density is performed in conjunction with CBR the samples shall be prepared and tested in accordance with AASHTO T-193, except the sample shall be mixed and then cured for 48 hours prior to molding the specimens.

59. SOIL SUPPORT TESTING

a. CALIFORNIA BEARING RATIO (CBR)

This work shall consist of the determination of the California Bearing Ratio (soaked) in accordance with AASHTO T-193 with the following exceptions:

- i. Six specimens shall be molded at optimum moisture content, two at approximately 90 percent, two at 95 percent, and two at 100 percent of the maximum dry density, respectively.
- ii. If the as-molded moisture content of any specimen is more than 0.8 percentage points above or below optimum, the specimen shall be remolded using fresh, compacted soil.
- iii. A minimum surcharge weight of 25 lbs shall be used while soaking the test specimens. The surcharge should be calculated based on the pavement crosssection. However, 25 to 30 lbs. have been found acceptable. A Dry Density (Abscissa) versus CBR (ordinate) curve shall be plotted and furnished for each sample tested.

b. SUBGRADE RESILIENT MODULUS (MR) on REMOULDED SOILS

This work shall consist of determination of the resilient modulus test in accordance with AASHTO T 307. This test shall be performed in accordance to laboratory procedure manual. This test shall be performed based on the following.

- i-Testing shall be performed on remolded samples.
- ii-Two (2) remolded samples shall be tested to determine the modulus of either chemically modified soils or natural soils. Remolded samples shall be prepared to 95% of Maximum dry density and optimum moisture content. Mr Test on each sample shall be paid.

c. SUBGRADE RESILIENT MODULUS (MR) on SHELBY TUBE

This work shall consist of determination of the resilient modulus test on undisturbed sample (Shelby Tube) in accordance with AASHTO T 307. MR Test on each sample shall be paid as one test.

Sheet of MR test showing the stress sequence shall be provided. Data sheet includes: confining stress, deviator stress, resilient strain, permanent strain, resilient modulus, height and diameter of specimen, specimen preparation method, water content before and after the test, and initial dry density and wet density.

Plot of deviator stress vs. resilient modulus with respect to each confining stress shall be submitted.

Based on the resilient modulus test, 3 regression equations to predict resilient modulus shall be provided.

$$1)Mr = k_1 p_a (P_a \bar{\theta})^{k_2} (\bar{\sigma}_{da})^{k_3}$$

$$2)Mr = k_1 \theta^{k_2}$$

$$3)Mr = k_1 \sigma_{da}^{k_2}$$

Where, k_1, k_2, k_3 , = regression coefficients, θ = sum of principal stresses; p_a = reference pressure = 100 kpa \approx 2000 psf \approx 14.5 psi; and σ_{da} = deviator stress in the same unit as p_a . A reasonable resilient modulus for the proposed subgrade shall be recommended.

60. COLLAPSE POTENTIAL EVALUATION TEST

This work shall consist of measuring free swell, swell pressure and the magnitude of a onedimensional swell or collapsed of compacted or intact silty soils such as “Loess” in accordance with ASTM D-5333 and cohesive soils such as “Expansive clay” in accordance with ASTM D-4546.

61. WATER SOLUBLE SULFATE TEST

This work shall consist of determining the sulfate ion content in soil in accordance with AASHTO ITM 510.

62. WATER SOLUBLE CHLORIDE TEST

This work shall consist of determining the chloride ions content in the soil in accordance with AASHTO T-291, if the presence of sea or brackish water is suspected.

63. SOIL RESISITIVITY TEST

This work shall consist of determining the electric conduction potential of the subsurface environment. The resistivity test shall be performed in accordance with AASHTO T-288.

64. SHALE DURABILITY TESTS

Shale tends to slake when exposed to air and water. These tests are used to define weathering behavior (Rock disintegration) when it is subjected to drying and wetting conditions.

- a. SLAKE DURABILITY INDEX TEST OF SHALE This work shall consist of determining slake durability index of a shale or other similar rock in accordance with ASTM D-4644.
- b. JAR SLAKE TEST Jar Slake test per FHWA-TS-80-219.

GEOTECHNICAL ENGINEERING

The work described in Engineering (Items 64 through 72) shall include review and correlation of various test results related to embankment stability, material placement, and other geotechnical engineering considerations. Engineering analysis shall be performed after the CONSULTANT has determined an analysis is necessary and has received INDOT's approval to perform the analysis. All telephone conversations collecting information from, and coordinating with, other consultants, INDOT employees and other parties involved in the project shall be included under these engineering items.

65. GEOTECHNICAL REPORT

This work includes a discussion of Project Identification and background, Scope and Procedure, Topography, Geology, Drainage, Field and Laboratory Investigation Procedures, Proposed pavement cross section, General and Specific Analyses and Recommendations, as well as any other items needed to make a complete Geotechnical Report. Appendices to the report shall include roadway and bridge subsurface geotechnical profiles and cross-sections at key locations within the project limits with stratigraphic and geological interpretation. Shall also include boring location plans, summaries of the results of all laboratory tests performed, all boring and sounding logs, pavement core data if subgrade investigation is performed, sketches and computation for all final Structure, Settlement and Stability Analyses, etc.

After the report is accepted, and the design has been completed, the CONSULTANT will review the contract documents such as Foundation Review, Final Check Prints, Specification changes etc. to see that the design is in accordance with the geotechnical recommendations. The cost of this review shall be included in the cost of the report.

If a pavement soil subgrade investigation is required, it shall be performed in accordance with the requirements of INDOT Office of Geotechnical Services, "Geotechnical Manual" and the results shall be included in the Geotechnical Report. This work includes a discussion of field and laboratory investigation procedures, proposed pavement, cross-section, and possible causes of subgrade problems under the existing pavements, General and Specific Analyses and Recommendations, Soil Subgrade Investigation Drawings, etc.

A pdf copy of the Geotechnical Report shall be furnished to INDOT. The review process shall follow utilization of SharePoint and ERMS formats. **The format for the reports and drawings/logs should be a Windows based version and compatible with INDOT's existing programs and should be as specified in the Geotechnical Manual with the addition that all borings shall have northern and eastern coordinates in a global system and the name of the**

system utilized. Scanning should be kept to a minimum unless absolutely necessary such as hand calculations, and drawings, etc. A lump sum payment will be made for up to one mile of roadway. Additional lengths of roadway will be rounded off to the nearest mile and payment will be made per mile. Round up for 0.50 mile or more and round down for less than 0.50 mile. Secondary lines will be included in this quantity only when there is at least one boring on the “S” line and when the “S” line is for an interchange or an intersection with the main line. Numerous additional lines in rest areas and parking lots, additional lines adjacent to and parallel to the mainline, and multiple lines for EB & WB or NB & SB divided highways will not be counted as additional mileage except where the two sides of the divided highway diverge on separate alignments.

When a Geotechnical Report is not required, the CONSULTANT shall furnish INDOT with a pdf copy of the Roadway and/or Structure Borings and this cost shall be included in the drilling process. Geotechnical Report pay items shall be differentiated in accordance with the following:

- (a) Without Soil Subgrade Investigation: This pay item shall include geotechnical reports that include investigation and recommendations for structures only.
- (b) With Soil Subgrade Investigation: This pay item shall include geotechnical reports that include investigations and recommendations for both structures and Pavement Subgrade.
- (c) Soil Subgrade Investigation: This pay item shall include geotechnical reports that include investigations and recommendations for only Pavement Subgrade.
- (d) Soil Profile Drawing: This item shall only be used for soil profile drawings completed in Microstation for inclusion in the final letting plans.

66. **GEOTECHNICAL DATA REPORT FOR DESIGN BUILD PROJECTS**

Geotechnical contract documents provided as part of a design-build or design-build best value project shall include the Geotechnical Data Report (GDR), and Technical Memoranda (TM), and other related Reference Documents. Often Pavement Subgrade Soils recommendations are included with the GDR.

A GDR shall present factual geotechnical and geological information obtained through site and subsurface investigation, and laboratory testing, for the project, and shall not include interpretive information.

Technical Memoranda and other reference documents include other geotechnical information, interpretations, and preliminary designs that were used as the basis for evaluating the feasibility of the project design concept, possible design alternatives, and to assess areas of geotechnical risk. The Technical memoranda shall not be included as part of the contract documents. However, they can be made available to Proposers in an appendix to RFP for information only, and not to be used as the basis for their proposal.

A lump sum payment will be made for up to one mile of roadway. Additional lengths of roadway will be rounded off to the nearest mile and payment will be made per mile. Round up for 0.50 mile or more and round down for less than 0.50 mile. Secondary lines will be included

in this quantity only when there is at least one boring on the "S" line and when the "S" line is for an interchange or an intersection with the main line. Numerous additional lines in rest areas and parking lots, additional lines adjacent to and parallel to the mainline, and multiple lines for EB & WB or NB & SB divided highways will not be counted as additional mileage except where the two sides of the divided highway diverge on separate alignments.

67. SETTLEMENT ANALYSIS AND RECOMMENDATIONS FOR EMBANKMENT

This work shall consist of performing settlement analysis at a specified embankment crosssection based on consolidation test results. The CONSULTANT shall furnish computations for total estimated settlement (cross section of up to 3 points if requested), a plot of percent total estimated settlement vs. time (at the centerline) assuming the most likely drainage conditions, etc. A quantity of one will be paid for each section analyzed and quantity of one-third (1/3) will be paid for each additional point, for each of the following types of analysis:

68. GROUND MODIFICATION DESIGN

- a. PROPOSED EMBANKMENT
- c. PROPOSED AND EXISTING EMBANKMENT
- d. GROUND MODIFICATION DESIGN

This work shall consist of a complete analysis and recommendations for a ground improvement technique such as Wick Drains, Pressure Grouting, Stone Columns, etc. The CONSULTANT shall furnish all the information needed for a complete design.

69. SLOPE STABILITY ANALYSIS

This work shall consist of making Slope Stability Analyses (Sliding Block or Rotational) at specified sections to analyzed proposed or existing conditions. One analysis will be authorized for payment for each section for each model analyzed. For nonsymmetrical cross-sections where more than one part of the cross-section is analyzed, a quantity of one will be authorized for payment for each separate analysis performed. Additional analysis will be authorized for each corrective measure to be analyzed. A Stage Construction alternate will be considered as one additional analysis regardless of the number of stages analyzed. All corrective measures shall be defined as to the limits of the correction.

Factor of Safety computations shall be made until a minimum factor of safety has been established. All models will be approved by INDOT prior to performing the analysis.

70. BRIDGE FOUNDATION ANALYSIS AND RECOMMENDATIONS

This work shall consist of Bridge Foundation Analysis and Recommendations as per current INDOT's LRFD foundation design policy. All models will be approved by INDOT prior to performance of the analyses.

a. SHALLOW FOUNDATION

This item shall include all analyses and computations required to make complete recommendations for a satisfactory shallow foundation to support the proposed loading conditions at each pier location, except for settlement analysis. Shallow foundations are defined as spread footings, reinforced concrete mats, etc. Each pier analyzed shall be considered as one analysis.

b. DEEP FOUNDATION

i. This item shall include all analyses and computations required to make complete recommendations for a satisfactory deep foundation to support the proposed loading conditions including axial and lateral analyses at each pier location, except for settlement analysis. Deep foundations are defined as piles, drilled shafts, etc. Each pier analyzed shall be considered as one analysis.

iii. This item shall include a Wave equation analyses using latest "GRLWEAP" and computations required to make complete recommendations for pile drivability. One analysis shall be performed per structure. Any additional analyses shall be approved by the Engineer in writing.

iv. This item shall include all analyses and computations required to make a complete recommendation for liquefaction potential performed for each bridge structure, where necessary.

v. This item shall include a complete design stage Group analysis. Each pier analyzed shall be considered as one analysis.

c. SETTLEMENT ANALYSIS FOR BRIDGE PIER FOUNDATIONS

This work shall consist of performing Settlement Analysis (cross section if requested by INDOT) at a specified bridge pier foundation based on consolidation test results. The CONSULTANT shall furnish computations for total estimated settlement, a plot of percent total estimated Settlement vs. Time assuming the most likely drainage conditions, etc. A quantity of one will be paid for each bridge pier foundation analyzed, for each of the following conditions:

i. BRIDGE PIER

ii. EMBANKMENT-PLUS-PIER

iii. EMBANKMENT-PLUS PIER-PLUS ALL OTHER LOADS

d. FOUNDATION ON BEDROCK

This work shall consist of making bridge recommendations when the foundation should be placed on bedrock, whether the foundations are deep or shallow. This item will be used only when no analysis is required for any support of the bridge structure. A quantity of one will be paid for each bridge.

71. RETAINING STRUCTURE ANALYSIS AND RECOMMENDATIONS

This work shall consist of Retaining Structure Analysis and Recommendations.

Included are conventional retaining walls, bridge abutments, piles or drilled-in piers, or any other retaining type structures. The analyses and recommendations shall include all computations necessary to assure the stability of the retaining structure, except for settlement analysis. Each section of a retaining structure analyzed shall be considered as one analysis. All models will be approved by INDOT prior to performance of the analysis.

a. CONVENTIONAL RETAINING STRUCTURE

Conventional retaining structures including cantilever concrete retaining walls, bridge abutments, and other retaining-type structures such as MSE Walls or binwalls, except for pile or drilled-in-pier types.

i. SHALLOW FOUNDATION

This item shall include all analyses and computations required to make complete recommendations for a satisfactory shallow foundation to support the proposed loading conditions at each section, except for settlement analysis. Shallow foundations are defined as spread footings, reinforced concrete mats, etc.

ii. DEEP FOUNDATION

This item shall include all analyses and computations required to make complete recommendations for a satisfactory deep foundation to support the proposed loading conditions at each section, except for settlement analysis. Deep foundation is defined as piles, drilled-in piers, etc.

iii. SETTLEMENT ANALYSIS FOR RETAINING WALL FOUNDATIONS

This work shall consist of performing Settlement Analysis (cross section if requested) at a specified section based on consolidation test results. The CONSULTANT shall furnish computations for total estimated settlement, a plot of percent total estimated Settlement vs. Time assuming the most likely drainage conditions, etc. A quantity of one will be paid for each section analyzed.

b. PILE RETAINING STRUCTURE ANALYSIS AND RECOMMENDATIONS i. FREE STANDING STRUCTURE

This item shall include the analyses and computations required to determine the lateral loads which will be imposed on the structure elements, the depth of embankment required for stability of typical section, etc. The final recommendations shall include the station limits of the structural elements, their offsets, penetration depths, the soil and/or rock stresses for which the elements of the retaining structure should be designed, etc. Any other design parameters which are pertinent to the recommendations for such a retaining structure should also be included as part of this item.

ii. RETAINING STRUCTURE WITH TIE-BACK SYSTEM

This work shall be the same as described above under Item 70 (b-i) except for the additional recommendations pertaining to a tie-back system. The recommendations for the tie-backs shall include the capacity of the tie-backs, the penetration required for stability, the spacing of the tie-backs, any other design perimeters pertinent to the tie-back system recommendations, etc.

c. DRILLED-IN-PIER RETAINING STRUCTURE ANALYSIS AND RECOMMENDATIONS i. FREE-STANDING STRUCTURE

This item shall include the analyses and computations required to determine the lateral loads which will be imposed on the structural elements, the depth of embedment required for stability of a typical section, etc. The final recommendations shall include the station limits of the structural elements, their offsets, penetration depths, the soil and/or rock stresses for which the elements of the retaining structure should be design, etc. Any other design parameters which are pertinent to the recommendations for such a retaining structure should also be included as part of this item.

ii. RETAINING STRUCTURE WITH TIE-BACK SYSTEM

This work shall be the same as described above under Item 70 (c-i) except for the additional recommendations pertaining to a tie-back system. The

recommendations for the tie-backs shall include the capacity of the tie-backs, the penetrations required for stability, the spacing of the tie-backs, any other design parameters pertinent to the tie-back system recommendations, etc.

d. SOIL NAILING WALL

This work shall consist of analyses and recommendations for a soil nailing wall. The analyses shall consider all the forces and moments acting on the wall and the nailing system. The final recommendations shall include the size, capacity and spacing of the nails, the penetration parameters pertaining to the soil nailing system. A quantity of one shall be paid for each typical section analyzed.

72. SEEPAGE ANALYSIS

This work shall consist of performing seepage analysis including recommendations at specific sections to estimate the quantity of seepage through and/or underneath the embankment, etc. Stability against piping and any other related analyses shall be analyzed as a part of the seepage analysis. However, prior approval must be obtained before performing the analysis.

The CONSULTANT shall furnish computations for estimated seepage, calculated factor of safety against piping and all necessary curves and sketches. Additional analysis will be authorized for corrective measures at specific sections.

Quantity of seepage factor of safety against piping, etc. shall be made until tolerable limits of seepage and an adequate factor of safety are achieved while analyzing a corrective measure. Each section analyzed shall be considered as one analysis for payment purposes.

73. DEEP DYNAMIC COMPACTION ANALYSIS

This work shall consist of Deep Dynamic Compaction Analysis including recommendations, etc. This shall include all necessary analyses and computations required to make complete recommendations for a satisfactory foundation to support the proposed loading of the embankment and/or to minimize the future settlement to a tolerable limit. Prior approval must be obtained before performing the analysis.

The CONSULTANT shall furnish computations for densification of foundation soils or material and all necessary curves and sketches, etc. The CONSULTANT shall prepare the curves to show the relationship between the weight, height and number of drops, etc. and the densification of the soil or material to facilitate the operation during construction. Each site analyzed shall be considered as one analysis for payment purposes.

CONSTRUCTION INSPECTION AND MONITORING

Under this section, the consultant will provide services in the field during construction to inspect, perform compaction testing and monitor geotechnical related construction activities.

This work shall consist of:

- a. Furnishing qualified inspectors in the field during construction of specialized geotechnical structures such as drilled piers and tie-back walls.
- b. Monitoring geotechnical instruments such as piezometers inclinometers and settlement plates.
- c. Integrity testing such as crosshole sonic logging, impulse response spectrum test, video logging, pressuremeters and pile dynamic load tests.
- d. Compaction testing such as Dynamic Cone Penetration Testing (DCPT) and Light Weight Deflectometer (LWD) testing is used to measure in-situ strength of soil and a measure of deflection of soils and aggregate respectively.

The consultant will be reimbursed for this work in accordance with the following items:

74. PRESSUREMETER TEST (PMT)

Pressure meter test is performed to obtain specific strength and deformation properties in accordance with ASTM D 4719. These services include the mobilization, equipments, testing, the entire incidental and its interpretation. A graph for pressure verses volume shall be plotted for each test.

This item will be paid for each day of testing.

75. MOBILIZATION OF TESTING EQUIPMENT

This work shall consist of mobilization of equipment needed to perform required testing and or inspecting construction activities as above. This item shall be paid as a lump sum fee. The mileage shall be included in this item. One mobilization shall be considered for each project.

76. a. MONITORING GEOTECHNICAL INSTRUMENTATION

This work shall consist of recording data from instruments installed for monitoring the subsurface conditions and the performance of geotechnical structures.

This work shall be paid in accordance with Item #64 above, except that the travel time will also be paid. Monitoring that takes place during construction, while the field inspector is on the project site, will not be paid separately.

b. FIELD INSPECTOR

This work shall consist of furnishing an approved inspector for field work. The inspector will have a minimum of five years of experience in the same field, inspecting or supervising construction of structures similar to the structures under contract. Prior approval will be required for each inspector before construction.

The inspector's duties should include sampling, testing, inspecting and assisting the INDOT Project Supervisor in approving the Contractor's work.

This work shall be paid for at the applicable hourly rate for the time actually spent at the project site. Overnight expenses and the cost of travelling to the project site are included in this item, and are not paid for separately. The time accepted for payment shall be rounded to the nearest half hour.

For payment, the consultant will prepare an itemization of pay quantities, get it approved by the INDOT Project Supervisor, and submit it to the INDOT Office of Geotechnical Services.

If redesign is required during construction, the analyses will be paid for at one half the rates listed under the Engineering Section if the same consultant prepared the original geotechnical report. Otherwise, the analyses will be paid at the rates listed under Section III.

77. INTEGRITY TESTING

This work shall consist of the performance of special tests to insure the integrity of drilled shaft foundations during construction. These tests may include crosshole sonic logging (CSL), impulse response spectrum test (IRS Test), video logging, and/or pressuremeter testing, etc.

The consultant shall be reimbursed at the actual cost including furnishing the testing instruments, after-test analysis, and preparation of the report.

78. FIELD COMPACTION TESTING

- a. Dynamic Cone Penetration Test (DCPT): This work shall consist of measuring the in-situ strength of subgrade soils in accordance with ITM-509.
- b. Light Weight Deflectometer (LWD): This work shall consist of measuring the deflection and estimating a modulus value of in-situ soil and aggregate in accordance with ITM-508.

79. DYNAMIC PILE ANALYSIS

This work shall consist of performing a wave equation analysis using a computer program (GRLWEAP 2010 or latest version or others as approved by INDOT) and writing

recommendations. This shall include all analyses and computations required to make complete recommendations for an adequate pile driving system at each bridge structure for the proposed loading conditions.

All necessary curves shall be prepared for each pile driving system with a specific pile to show the conditions during driving operations. "Blows per foot" vs. "Ultimate resistance" and "Blows per foot" vs. "Driving Stress" shall be plotted. Based on the maximum allowable compressive stress, blow count per foot at ultimate resistance and minimum driving time required to achieve ultimate resistance, an adequate pile driving system shall be recommended. Also, any other information or recommendations required by INDOT shall be provided.

INDOT will provide for the CONSULTANT the information on the proposed pile driving system adequate to fill out the upper portion of Form 2 (Driving System, Pile and Soil Data). The CONSULTANT will determine soil parameters based on the Geotechnical Investigation.

Each pile driving system analyzed at a bridge shall be considered as one analysis, with prior approval from INDOT.

When this work is complete as a part of Item 79 (Dynamic Pile Load Test), it will not be paid for separately.

80. STATIC LOAD TEST

This work shall be done by a professional geotechnical engineer and shall consist of performing the static load test on designated foundations (piles, drilled shafts, etc.) According to INDOT Standard Specs., Section 701 (2012, or latest). The work shall include furnishing the gauges and related accessories, attaching the gauges to the test pile, directing and monitoring the performance of the test up to the prescribed loads as per standard specs. And preparing and submitting the report on the load test.

A quantity of one shall be paid for each foundation tested for furnishing the gauges, test analysis and preparation of test report etc. The presence of the test engineer in the field for the test shall be paid in hours as per item (32).

81. DYNAMIC PILE LOAD TEST

This work shall be done by a professional geotechnical engineer and shall consist of a dynamic pile load test done with PDA (Pile Driving Analyzer) according to INDOT Standard Specs., Section 701. The work shall include furnishing the PDA instrument and necessary accessories such as transducers and wires, attaching the transducers to the test pile and connecting them to the PDA, operating the PDA during pile driving up to the required load and recording the data on magnetic tape or computer disk. After the initial driving is over, a restrike will be done after a minimum of 24 hours or up to 72 hours and a dynamic load test will be required. This work shall include doing the CAPWAP analysis in accordance with the requirements in this appendix and the WEAP analysis as per Item 77 herein. The work shall also include submitting the report on

the dynamic test as per Standard Specs., Section 701 and a computer diskette containing the results of PDA, CAPWAP, and WEAP, all within 72 hours after restrike. The report shall conform to ASTM D-4945 and shall include the evaluation of hammer and pile driving system performance, pile driving stresses, pile structural integrity and load bearing capacity of the pile.

A quantity of one shall be paid for each pile tested including furnishing the instrument, the after-test analyses and preparation of report etc. The presence of the test engineer in the field for the test shall be paid in hours as per Item 32 herein.

82. CAPWAP-C ANALYSIS REQUIREMENTS

Each test pile receiving a Dynamic Pile Load Test shall also receive a Case Pile Wave Analysis Program, or CAPWAP-C, analysis. This analysis shall be performed on a single blow from the original pile driving and shall be compared to the analysis done on one of the first 2 blows of the restrike test. The cost of this analysis shall be included in the cost of dynamic measurements and analysis.

Each CAPWAP-C analysis shall include the information as follows:

- i. Graph showing the bearing capacity versus blow count and pile stress versus blow count.
- ii. Simulated static load test curves for the tip and the top of the pile, if applicable.
- iii. Re-Evaluation of the soil parameters used in the original wave equation analysis by means of matching the measured and computed values of forces, velocities, and displacements.
- iv. Static resistance distribution along the length of the pile.

83. FINAL CONSTRUCTION INSPECTION REPORT

This work shall consist of preparing a report summarizing the scope of the work, the results of construction inspection and monitoring, recommendations made for proposed changes during construction, and copies of geotechnical test reports (load tests and integrity tests) for the entire project. A quantity of one will be paid for each report. This payment will also cover administrative costs.

FOUNDATION EVALUATION BY NON-DESTRUCTIVE METHODS

84. FOUNDATIONS

The problem of unknown foundation is of major concern for the Department of

Transportation. Bridge inventory does not have design, as-built plans available to document the type, depth, geometry, or material incorporated in the foundation of bridges or other highway structures. This evaluation is also needed for scour pier. Without foundation type and depth information, it is impossible to evaluate accurately the scour potential of these structures. This work consists of foundation depth, type, geometry, materials, integrity and stiffness around the foundation and preparation of a final report. NDE may include ultra seismic vertical profiling, parallel seismic, GPR, and parallel seismic with cone penetrometer performed by a qualified and approved engineer. These evaluations may be performed by the surface borehole method and/or the surface testing method. Both methods shall be paid per pier or foundation and only as actual invoice cost. This work shall be reported in electronic format (Windows version) with drawings and sketches.

An appropriate or combination of methods may be used for successful evaluation. Other proven methods may be considered if approved by the Manager of the Office of Geotechnical Services. If requested, the proven method shall require a case history of similar work, location, personnel qualifications and experience. Other items associated with this work, such as drilling, sampling, etc., shall be paid for in accordance as described in the Geotechnical Field, and Laboratory Sections.

GEOPHYSICAL INVESTIGATIONS

85. **GEOPHYSICAL INVESTIGATIONS**

This work shall consist of performing the required geophysical investigation by using surface geophysical and/or borehole geophysical methods (such as: shear wave seismic reflection or refraction, GPR, etc.) or combination of methods which may be used for successful evaluation. This work shall be reported in electronic format (Windows version) with drawings and sketches. This work shall be performed by a qualified geophysical SUB-CONSULTANT when requested by the CONSULTANT and approved by INDOT

The geophysical SUB-CONSULTANT shall submit a case history of similar work, location, personnel qualifications and experience. Other proven methods may be considered if approved by the Manager of the Office of Geotechnical Services.

The charges for these services will be the actual invoice cost from the SUBCONSULTANT. Other items associated with this work, such as drilling, sampling, etc., shall be paid for in accordance as described in the Geotechnical Field, and Laboratory Sections. This item shall be used only with INDOT's prior approval.

GEOTECHNICAL PROJECT MANAGEMENT

This work consists of managing the complete Geotechnical Investigation on a project and shall be performed by a Lead Geotechnical CONSULTANT. The Geotechnical Project Management will be the responsibility of the Lead Geotechnical CONSULTANT where the work is carried out by more than one Geotechnical CONSULTANT. The Lead Geotechnical CONSULTANT

shall be responsible for providing a complete set of recommendations for the design and construction of the project. The management includes project coordination, general oversight, updating information on the project website (ProjectWise /SharePoint/similar site), scheduling, prioritizing, monitoring scheduled performances, providing general and technical support, and review of all geotechnical analyses and recommendations prepared by other team members (Geotechnical CONSULTANTS). All the work shall be performed in accordance with the latest INDOT guidelines and procedures.

86. PROJECT MANAGEMENT:

a. PROJECT COORDINATION: This work shall consist of coordinating with INDOT, Design Team Consultants, other Geotechnical Consultants within the team, and Specialty Consultants, (i.e., Surveyors, Geophysical work specialists, etc.) in order to complete the project in accordance with the Department's guidelines and procedures in an efficient and timely manner. A quantity of one will be paid for each mile of roadway work involved. The measurement of length of the roadway will be in accordance with Item No. 65 of the Appendix A of this contract.

b. PROJECT WEBSITE: This work shall consist of updating the information on a shared ProjectWise/SharePoint/internet web-site, posting minutes of meetings, technical memorandum, schedule of geotechnical investigations, geotechnical investigation data, revisions, other project related information, geotechnical plans and profiles, etc. as appropriate. A lump sum payment will be made for this work.

87. GEOTECHNICAL REVIEW:

a. STRUCTURE REPORT: This work shall consist of Preliminary review by the lead Geotechnical Consultant of the work performed by the other team members (Geotechnical Consultants) before submitting to the INDOT Office of Geotechnical Services for their review and approval. A quantity of one will be paid for each structure report, regardless of the size of the structure. All twin bridge structures shall be considered as one unit. Other structures such as retaining structures, drainage structures shall not be considered for payment under this item.

b. ROADWAY REPORT: This work shall consist of Preliminary review by the lead Geotechnical Consultant of the work performed by the other team members (Geotechnical Consultants) before submitting to the INDOT Office of Geotechnical Services for their review and approval. A quantity of one will be paid for each mile of roadway. The measurement of length of the roadway will be in accordance with Item No. 65 of the Appendix A of this contract. The review of retaining structure, drainage structures will be included in the roadway report review and no additional payments will be made.

PAVEMENT INVESTIGATION

1. MOBILIZATION OF CORING EQUIPMENT

This work shall consist of mobilization of coring equipment to and from the project site. This item will be used when pavement cores are obtained independently of geotechnical sampling.

2. MOBILIZATION MILEAGE FOR CORING EQUIPMENT

This work shall consist of the travel mileage of the coring equipment. The authorized mileage will be the distance from the State Capitol Building to the middle of the project site. This item will be used when pavement cores are obtained independently of geotechnical sampling.

3. PAVEMENT CORE (PARTIAL DEPTH)

This work shall consist of obtaining pavement cores to the depth of asphalt overlay on Portland Cement Concrete pavements.

4. PAVEMENT CORE (FULL DEPTH)

This work shall consist of obtaining pavement cores the full depth of pavement such as a Portland Cement Concrete pavement, a Portland Cement Concrete pavement with the asphalt overlay, or a full depth asphalt pavement.

5. SUBBASE SAMPLE

This work shall consist of sampling of the subbase. This work is to be accomplished in conjunction with full depth pavement cores.

6. PORTLAND CEMENT CONCRETE PAVEMENT CORE DENSITY DETERMINATION:

When required, the hardened concrete unit weight of the Portland cement concrete portion of the core shall be determined in accordance with ASTM C-642. Prior to the determination of the density, the specimen shall be submerged in lime-saturated water for at least 24 hours. The density shall be determined by bulk specific gravity after immersion, except boiling of the specimen will not be required. The report shall include the core number; the weight of the surfacedry sample in air after immersion, the weight of the sample in water after immersion, the unit weight of the sample in pcf to the nearest 1.0 pcf, and the presence of reinforcing steel shall be noted, if present in the tested sample.

7. CEMENT CONCRETE CORE COMPRESSIVE STRENGTH TEST:

When required, the compressive strength of the Portland cement concrete portion of the core shall be determined in accordance with ASTM C-42, and if a 2:1 height/diameter ratio is not

achieved, the compressive strength shall be adjusted. Prior to testing, the specimen shall be submerged in lime-saturated water for at least 40 hours. The report shall include the core number, the core diameter, the capped core height, the adjustment factor (when required), the maximum load in pounds, the compressive strength calculated to the nearest 10 psi and any defects in either the specimens or caps.

8. BITUMINOUS EXTRACTION TEST:

This work shall consist of performing a quantitative extraction of bitumen from asphalt paving mixtures in accordance with Indiana Test Method No. Ind. 571-08T .

9. SIEVE ANALYSIS OF EXTRACTED AGGREGATE TEST:

This work shall consist of the following:

After the bitumen content has been determined, as specified in Item 8, a sieve analysis of the extracted aggregate shall be made using the following procedure:

- a. Nest the sieves in sequence, No. 200 (0.0029 in.) on the pan, then the #100 (0.0059 in.) #50 (0.0118 in.), #30 (0.0236 in.), #16 (0.046 in.), #8 (0.093 in.), and #4 (0.187 in.). Place the coarse aggregate sieves, in sequence from the smallest to the largest used, on top of the fine aggregate sieves. The largest sieve used will be the one controlling the maximum size of the coarse aggregate being used in the mixture.
- b. Carefully pour the sample on the top sieve, attach the cover and fasten the assembly to the mechanical shaker.
- c. Shake the sample for ten minutes. In no case shall fragments in the sample be turned or manipulated through the sieves by hand.
- d. Starting with the largest sieve used, weigh and record the aggregate weight retained on each individual sieve, including that in the pan. If you have more than 7.0 ounces retained on an 8 in. (200) round sieve then the sieves are overloaded. The sample should then be split and rerun.
- e. Using results obtained in (d) above, calculate and record the percentage passing each sieve to the nearest one tenth percent (0.1%).

10. RECOVERY OF ASPHALT FROM SOLUTION BY ABSON METHOD:

This work shall be accomplished in accordance with AASHTO T-170 for the Abson Method, AASHTO T-49 for the Asphalt Penetration Test and AASHTO T-201 and T-202 for the Asphalt Viscosity Test.

11. THEORETICAL MAXIMUM SPECIFIC GRAVITY TEST:

This work shall be accomplished in accordance with AASHTO T-209.

12. BULK SPECIFIC GRAVITY TEST:

This work shall be accomplished in accordance with AASHTO T-166.

13. AIR VOIDS CALCULATIONS:

This work shall be accomplished in accordance with AASHTO T-269.

14. CORE REPORT FOR PARTIAL DEPTH CORE

15. CORE REPORT FOR FULL DEPTH CORE:

The work for items 14 and 15 shall be in accordance with the following:

The recovered core shall be reassembled and photographed with a measuring tape or ruler such that the thicknesses of the various materials, such as asphaltic concrete, Portland cement concrete, location and size of any reinforcing steel, etc... are clearly visible and discernable. The photograph shall be oriented to show maximum detail. Photos shall also be taken of the coring location prior to coring, the core hole following core extraction, and recovered subbase sample. All four photographs shall be included in the final core report. The total core depth shall be measured from the recovered core in accordance with INDOT Standard Specification, Section 501.26. Additionally, individual layers within the core shall be measured and recorded. Each core shall be numbered and the location shall be determined for each core including; Route, RP, State Plane Coordinates, Latitude, Longitude, Direction of Traffic, and Lane. A description of the subbase sample shall also be included. The core hole shall be adequately patched using Portland Cement Concrete Mix Design in accordance with INDOT Standard Specifications, Section 506.10 or an equal INDOT approved procedure. In addition to the core report all data shall be collected and submitted utilizing the Departments "Collector" application for iPad/iPhone devices. Data collected within the application shall be in accordance with the requirements set forth in this pay item and the Core Collector Guidance document. The CONSULTANT shall retain all core samples for a period of one year after coring, or as directed by the Department, in an easily identifiable state and shall notify INDOT prior to disposal of the core samples. Payment shall be made per each core report furnished.

16. PAVEMENT ANALYSIS AND REPORT

The CONSULTANT shall make a general evaluation of the existing pavement conditions, the cores obtained and the results of all laboratory tests performed and evaluate their impact on the proposed design. This analysis will be performed only with prior approval from INDOT Pavement Engineer.

Upon completion and final approval of the work by INDOT, the CONSULTANT shall deliver to INDOT the following, which shall become the property of INDOT:

- a. A final electronic copy of the Soils Report and the Soils Profile for the Roadway Soil Survey shall be submitted to INDOT on each project. **The format for the reports and drawings/logs should be a Windows based version and compatible with INDOT's existing programs.**
- b. An electronic copy of the Structure Boring Report at each site including the following: **The format for the reports and drawings/logs should be a Windows based version and compatible with INDOT's existing programs.**
- c. A plan showing the location of all holes referenced to the survey centerline.
 - i. A true cross section of each boring showing thickness, soils classification, and position and penetration resistance of each soil stratum found between the surface and the bottom of the hole.
 - ii. Free water elevations at completion and 24 hours after completion of the drilling.
- d. Reports covering special tests and analysis listed in Section A2 of Appendix "D" are to be furnished in quantities as designated by INDOT at the time the work is authorized.

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