ATC

ASSOCIATES INC.

Environmental, Geotechnical and Materials Professionals

GEOTECHNICAL ENGINEERING INVESTIGATION

PROPOSED INTERSECTION IMPROVEMENTS AT
U.S. ROUTE 50 AND C.R. 75 EAST (DEER CREEK ROAD)
INDOT PROJECT NO. NH-043-1 ( )
INDOT DES. NO. 9902610
JENNINGS COUNTY, INDIANA

ATC PROJECT NO. 86.70860.0347

JUNE 7, 2005

GEOTECHNICAL ENGINEERING INVESTIGATION

PROPOSED INTERSECTION IMPROVEMENTS AT
U.S. ROUTE 50 AND C.R. 75 EAST (DEER CREEK ROAD)
INDOT PROJECT NO. NH-043-1 ( )
INDOT DES. NO. 9902610
JENNINGS COUNTY, INDIANA

ATC PROJECT NO. 86.70860.0347

JUNE 7, 2005

PREPARED FOR:

INDIANA DEPARTMENT OF TRANSPORTATION
DIVISION OF MATERIALS AND TESTS
120 SOUTH SHORTRIDGE ROAD
P.O. BOX 19389
INDIANAPOLIS, IN 46219-0389

ATTN: MR. ATHAR A. KHAN, P.E.

ATC
ASSOCIATES INC.
Environmental, Geotechnical and Materials Professionals

7988 Centerpoint Drive, Suite 100
Indianapolis, IN 46256-3346
www.atcassociates.com
317-849-4990
Fax 317-849-4278

June 7, 2005

Indiana Department of Transportation
Division of Materials and Tests
120 South Shortridge Road
P.O. Box 19389
Indianapolis, IN 46219-0389

Attn: Mr. Athar A. Khan, P.E.

Re: Geotechnical Engineering Investigation
Proposed Intersection Improvements
U.S. Route 50 and CR 75 East (Deer Creek Road)
INDOT Project No. NH-043-1 ( )
INDOT Des. No. 9902610
Jennings County, Indiana
ATC Project No. 86.70860.0347

Dear Mr. Khan:

Submitted herewith is the report of our geotechnical engineering investigation for the referenced project. This study was authorized by the Indiana Department of Transportation, Division of Materials and Tests.

This report contains the results of our field and laboratory testing program in accordance with current INDOT Standards, an engineering interpretation of this data with respect to the available project characteristics and recommendations to aid in the design and construction of the earth-connected phases of this project.

We appreciate the opportunity to be of service to you on this project. If we can be of any further assistance, or if you have any questions regarding this report, please do not hesitate to contact either of the undersigned.

Sincerely,

ATC Associates Inc.

THOMAS JAMES STRUEWING
REGISTERED
No. 21494
STATE OF
INDIANA
PROFESSIONAL ENGINEER

Mark H. Bradford, P.E.
Project Engineer

Thomas J. Struewing, P.E.
Principal Engineer

Copies: (10) INDOT, Division of Materials and Tests Attn: Mr. Athar A. Khan, P.E.

SUMMARY OF GEOTECHNICAL ENGINEERING INVESTIGATION

Proposed Intersection Improvements
U.S. Route 50 and County Road 75 East (Deer Creek Road)
INDOT Project No. NH-043-1 ( )
INDOT Des. No. 9902610
Jennings County, Indiana
ATC Project No. 86.70860.0347

GENERAL INFORMATION

Plans are being developed by Farrar, Garvey & Associates, LLC for the improvement of the intersection at U.S. Route 50 and County Road 75 East (Deer Creek Road) in Jennings County, Indiana. A 169 ft long, three-sided pre-cast concrete culvert will be constructed perpendicular the roadway beneath U.S. Route 50. The three-sided culvert, which will be constructed along the alignment of Deer Creek, will replace the existing drainage structure. The project will include reconstructing the entire roadway between Station 83+25 and 111+45 Line PR-M and between Station 77+90 and 83+25 Line PR-M the roadway will be milled, widened and resurfaced to achieve the proposed superelevation grades for the new road. A portion of County Road 75 East (Deer Creek Road) will be relocated to the west of its existing alignment to match the existing alignment of Deer Creek Road south of U.S. Route 50. The proposed project also includes constructing a temporary runaround to the south of U.S. Route 50 to route traffic around the section of U.S. Route 50 being reconstructed. No more than 2 ft of cut and a maximum of 8 ft of fill will be required for U.S. Route 50. The temporary runaround will require a maximum cut of 22 ft and a maximum fill of 14 ft.

PROPOSED FOOTING SUPPORTED PRE-CAST CONCRETE THREE-SIDED CULVERTS

It is recommended that the three-sided pre-cast concrete culvert and wing walls be supported on shallow spread footings. An allowable net bearing pressure for the foundations of these structures has been determined and is included in this report.

TEMPORARY RUNAROUND

The proposed project also includes constructing a temporary runaround to the south of U.S. Route 50 to route traffic around the section of U.S. Route 50 being reconstructed. The temporary runaround will require a maximum cut of 22 ft and a maximum fill of 14 ft. The existing natural soil encountered in Boring No. TR-4 is very soft to the auger refusal depth at 3.5 ft below the existing ground surface. The bedrock encountered at the auger refusal depth in the test borings is very hard and is either competent New Albany Shale or massive limestone or dolomite that will require special equipment (such as hoe-rams or blasting) to excavate the rock where required.

ROADWAY RECOMMENDATIONS

It is recommended that Type IA Subgrade treatment in accordance with INDOT Standard Specifications Section 207.04 be used for the pavement for the reconstruction of U.S. Route 50. For U.S. Route 50, a CBR value of 4.0 should be used for the design of the pavement.

It is recommended that Type II Subgrade treatment in accordance with INDOT Standard Specifications Section 207.04 be used for the pavement subgrade in the areas of new alignment for Deer Creel Road and Type IIA subgrade treatment be used in the reconstruction areas along the existing alignment. A CBR value of 3.0 should be used for the design of the pavement along Deer Creek Road.

Subsurface drains are not required for this project unless the existing roadway currently has subsurface drains. If subsurface drains are installed, a non-woven filter fabric would be required.

Report Prepared By:
Mark H. Bradford, P.E.
Project Engineer

Report Reviewed By:
Thomas J. Struewing, P.E.
Principal Engineer

TABLE OF CONTENTS

GEOTECHNICAL ENGINEERING INVESTIGATION

Proposed Intersection Improvements at
U.S. Route 50 and County Road 75 East (Deer Creek Road)
INDOT Project No. NH-043-1 ( )
INDOT Des. No. 9902610
Jennings County, Indiana
ATC Project No. 86.70860.0347

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering investigation for the proposed intersection improvements at U.S. Route 50 and County Road 75 East (Deer Creek Road) located in Jennings County, Indiana as shown on the Project Location Map (see Figure 1 in Appendix A) and the Vicinity Map (see Figure 2 in the Appendix).

This investigation was performed to characterize and evaluate the suitability of the soils beneath the project site surface and to develop recommendations relative to roadway subgrade treatment, as well as support of the proposed three-sided culvert and wing wall foundations. The investigation consisted of an exploratory drilling and sampling program, laboratory testing of soil samples obtained from the test boring locations, engineering analyses and preparation of this report.

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either express or implied. This company is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploration and laboratory test data presented in this report.

2.0 PROJECT DESCRIPTION

Plans are being developed by Farrar, Garvey & Associates, LLC for the improvement of the intersection at U.S. Route 50 and County Road 75 East (Deer Creek Road) in Jennings County, Indiana. A 169 ft long, three-sided pre-cast concrete culvert will be constructed perpendicular the roadway beneath U.S. Route 50. The three-sided culvert will be constructed along the alignment of Deer Creek replacing the existing drainage structure. The project will include reconstructing the entire roadway between Station 83+25 and 111+45 Line PR-M and between Station 77+90 and 83+25 Line PR-M the roadway will be milled, widened and resurfaced to achieve the proposed superelevation grades for the new road. About 10 ft of cut and a maximum of 18 ft of fill will be required along U.S. Route 50 for the improved roadway.

A portion of County Road 75 East (Deer Creek Road) north of U.S. Route 50 will be relocated to the west of its existing alignment to match the existing alignment of Deer Creek Road south of U.S. Route 50.

The proposed project also includes constructing a temporary runaround to the south of U.S. Route 50 to route traffic around this section of U.S. Route 50 while it is being reconstructed. The temporary runaround will require a maximum cut of 22 ft and a maximum fill of 14 ft.

3.0 PURPOSE AND SCOPE OF WORK

The purpose of this study was to determine the general subsurface conditions along the alignment of the proposed reconstructed roadways and at the structure location by drilling test borings and to evaluate these with respect to roadway construction and culvert support for the proposed project. A geologic map published by the Indiana Geological Survey ("Geologic Map of the Cincinnati Quadrangle Showing Bedrock and Unconsolidated Deposits", 1972) was reviewed as part of this study to assess the general soil conditions in the vicinity of the site. In addition, the site has been evaluated with respect to potential construction problems and recommendations are included that address matters of earthwork and quality control during construction.

3.1 Field Investigation

The subsurface conditions for the proposed roadway and three-sided culvert construction at the intersection of U.S. Route 50 and Deer Creek Road were investigated by ATC Associates Inc. (ATC) during the period of April 19, 2005 and April 25, 2005. Drilling was performed with truck and skid mounted drilling equipment using hollow-stem augers to advance the boreholes. Where split-spoon samples were taken, they were obtained by using standard penetration test (SPT) procedures (American Association of State Highway and Transportation Officials (AASHTO) T 206), generally at 2.5 ft and 5.0 ft intervals at the locations indicated on the Test Boring Logs in Appendix B. Where rock coring was required and core samples were taken, they were obtained by using standard rock coring procedures (AASHTO T 206).

Subsequent to drilling activities and obtaining 24-hour water level measurements at selected locations, each test borehole was backfilled in accordance with the specifications set forth by the INDOT document "Exhibit C" and the INDOT "Aquifer Protection Guidelines".

The number, locations and depths of the borings were selected by ATC and the soil boring locations were staked in the field, with approximate boring elevations estimated from topographic roadway plans generated by Farrar, Garvey & Associates, LLC. The borings were drilled at the locations noted on the boring logs in Appendix B.

Logs of all borings, which show visual descriptions of all soil strata encountered using the AASHTO classification system, are included in Appendix B. Sampling information and other pertinent field data and observations are also included on the boring logs. In addition, a sheet defining the terms and symbols used on the logs and explaining the standard penetration test (SPT) procedure is provided immediately preceding the boring logs in Appendix B.

3.2 Laboratory Investigation

The disturbed soil samples were visually classified by an engineer in accordance with the AASHTO Soil Classification System and the visual classification verified or modified based upon the results of laboratory tests. Final boring logs were subsequently prepared and are included in Appendix B. Soil index property tests including natural moisture content (AASHTO T265), grain size distribution and analyses (AASHTO T88), Atterberg limit determinations (AASHTO T89 and T90) and soil pH (AASHTO T200) were performed on representative samples. A standard Proctor moisture/density relationship test (AASHTO T-99) and California Bearing Ratio (CBR) test (AASHTO T-193) were performed on bulk samples. The results of all laboratory tests are included on the boring logs in Appendix B and/or on respective plots or summary sheets in Appendix C.

4.0 GENERAL SITE CONDITIONS

4.1 Regional and Site Geology

The project site is within the western half of the Muscatatuck Plateau portion of the Southern Hills and Lowlands Physiographic Region of the State of Indiana. This is broad till-covered uplands entrenched by major valleys. Late Devonian and Early Mississippian Age New Albany Shale overlays middle Devonian age limestone and dolomite. The unconsolidated overburden deposits consist of residual silty loam and silty loam till. Geologic mapping indicates that the bedrock surface is at relatively shallow depths (less than 50 ft) in central Jennings County.

4.2 Subsurface Conditions

The general subsurface conditions at the site were investigated by drilling nine (9) structure borings near the ends of the proposed three-sided culvert and other drainage structures, three (3) roadway borings along the existing alignment of U.S. Route 50 and six (6) temporary roadway borings for the temporary runaround. The subsurface conditions disclosed by the field investigation are summarized in the following paragraphs. Detailed descriptions of the subsurface conditions encountered in each test boring are presented on the Test Boring Logs in Appendix B. It should be noted that the stratification lines shown on the soil boring logs represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths and variations in the soil stratigraphy and ground water levels should be expected across this site.

Boring Nos. TB-1, TB-2, TB-5 and TB-6 were drilled for large diameter drainage structures beneath U.S. Route 50. The borings were drilled through the existing roadway and embankment materials and encountered silty loam fill soils to varying depths overlying the natural silty loam soils to varying depths. The test borings encountered auger refusal on the underlying shale or limestone bedrock at varying elevations.

Borings TB-3 and TB-4 were drilled for the proposed pre-cast concrete three-sided culvert with wing walls at Station 97+55 Line PR-M. Boring No. TB-3 and TB-4 encountered about 0.8 ft and 1.0 ft of topsoil, respectively, overlying very soft to soft silty loam to depths of about 6.9 ft and 3.5 ft, respectively, below the existing ground surface. Boring No. TB-4 encountered weathered limestone bedrock at a depth of 3.5 ft, but did not encounter auger refusal until a depth of 6.0 ft below the ground surface. The rock was cored in TB-4 between depths of 6.0 ft and 11.0 ft below the ground surface, revealing light gray limestone or dolomite.

Boring Nos. TB-7, TB-8 and TB-9 were drilled for the two concrete box culverts and wing walls located at 12+13 Line S-1-M and 20+00 Line S-1-M. Boring Nos. TB-7 and TB-8 were drilled near the ends of the proposed box culvert and encountered about 0.5 ft of topsoil at the ground surface. Boring TB-8 encountered visually classified sandy loam to a depth of about 3 ft below the topsoil. Boring No. TB-9 encountered about 0.3 ft of asphalt at the ground surface. Below the materials described above, the test borings encountered silty loam fill or silty loam natural soils to the termination depths of the test borings. Auger refusal was encountered these test borings at varying depths of about 5.5 ft to 11.0 ft. The table below summarizes the depth to the top of bedrock and the auger refusal elevation encountered in Boring Nos. TB-1 through TB-9. It is important to note that the depth to the top of the bedrock is not necessarily coincident with the depth to auger refusal since the test borings can often penetrate several feet into the upper, more weathered bedrock

Summary of Test Boring Auger Refusal Depths (TB-1 through TB-9)

Boring No.	Ground Surface Elevation	Depth to Bedrock, ft	Bedrock Surface Elevation	Auger Refusal Depth, ft	Auger Refusal Elevation
TB-1	745.1	19.5	725.6	23.8	721.3
TB-2	744.8	16.5	728.3	18.7	726.1
TB-3	705.5	6.9	968.6	6.9	698.6
TB-4	710.0	3.5	706.5	6.0	704.0
TB-5	736.0	12.5	723.5	15.5	720.5
TB-6	737.0	12.5	724.5	14.5	722.5
TB-7	717.4	6.0	711.4	7.0	710.4
TB-8	717.2	11.0	706.2	11.0	706.2
TB-9	705.0	5.5	699.5	5.5	699.5

Roadway Boring Nos. RB-1 and RB-3 encountered very soft to very stiff silty loam to the termination depth of 7.5 ft. Boring No. RB-2 encountered stiff to very stiff silty loam to a depth of about 4.5 and then encountered black weathered shale between depths of 4.5 and 6.2 ft below the ground surface. At a depth of 6.2 ft below the existing ground surface, Boring No. RB-2 encountered auger refusal on the underlying bedrock. The consistency of the soils was estimated based on the results of the standard penetration test (ASTM D-698).

The borings drilled for the temporary runaround encountered a relatively thin crust of silty loam soils overlying shale and limestone bedrock of varying weathered conditions. The depth to bedrock varied from as shallow as 1.1 ft to as great as 6.0 ft below the existing ground surface. The consistency of the natural cohesive overburden soils was typically very stiff to hard; however, softer zones were noted in Boring No. TR-4.

Summary of Test Boring Auger Refusal Depths (TR-1 through TR-6)

Boring No.	Ground Surface Elevation	Depth to Bedrock, ft	Bedrock Surface Elevation	Auger Refusal Depth, ft	Auger Refusal Elevation
TR-1	738.6	1.5	737.1	8.7	729.9
TR-2	740.0	1.1	738.9	4.0	736.0
TR-3	742.0	3.0	739.0	NA	NA
TR-4	708.0	3.5	704.5	3.5	704.5
TR-5	741.0	6.0	735.0	16.0	725.0
TR-6	732.0	2.0	730.0	4.0	728.0

Boring No. TR-5 encountered auger refusal at a depth of about 16 ft and the bedrock was cored to a depth of 9 ft below the auger refusal depth. Coring the rock in TR-5 revealed black New Albany Shale bedrock.

4.3 Ground Water Conditions

Ground water observations were made during drilling operations (by noting the depth of water on the drilling tools), in the open boreholes following withdrawal of the drilling augers and at 24 hours after the completion of drilling activities. Free ground water was noted in most of the test borings drilled for this project except for Boring Nos. TB-1, RB-1, TR-3, TR-4 and TR-5. Some of the test borings were dry during drilling; however, after a 24 hour period water was noted in the majority of the borings. The water level in the test borings was as high as 2.0 ft below the ground surface and as deep as 12.0 ft below the ground surface.

It should be noted that short term water level readings are not necessarily a reliable indication of the ground water level and that fluctuations in the level of the ground water will occur due to variations in rainfall and other factors not evident at the time of our investigation. Water level readings were made in the drill holes at the times and under the conditions stated on the boring logs in Appendix B.

5.0 DESIGN RECOMMENDATIONS

The following recommendations for the three-sided concrete culvert structure, the concrete box culverts, the wing walls and the roadway design have been developed on the basis of the previously described project characteristics (Section 2.0) and subsurface conditions (Section 4.0). If there is any change in these project criteria, including changes in the roadway alignment and profile or changes in structure types and locations, a review should be made by this office.

5.1 Three-Sided Pre-cast Concrete Culvert Footings

Our findings show that the proposed three-sided concrete culvert and wing walls (Structure No.15 at Station 97.55 Line PR-M) can be supported on shallow spread footings bearing at about El 702 provided that all soils are first removed at the footing locations to expose competent bedrock and that the footings are protected from scour. Boring Nos. TB-3 and TB-4 encountered auger refusal on the underlying bedrock at about El 698.6 and 704.0, respectively. Based on the auger refusal elevations encountered in the test borings, it appears that there will be less that 3 ft of soil between the bottom of footings and the bedrock surface at the north end of the three-sided culvert, but that the southern end of the culvert should bear directly on sound bedrock. It is recommended that the existing natural soils (which are mostly soft in consistency based on the results of the test borings) should be completely removed from beneath the proposed footings to expose competent bedrock and replaced with either lean concrete or structural fill to reestablish the bearing elevation. The following table summarizes the recommended design properties for the three-sided pre-cast concrete culvert and wing walls.

Design Parameters for Three-Sided Pre-cast Concrete Culvert Footings

Bridge Location	Borings	Bottom of Footing Elevation	Allowable Net Bearing Pressure, lbs/sq.ft*	Minimum Footing Width, ft
Structure No. 15, Station 97+55, Line PR-M	TB-3 and TB-4	702.0	4,000	4

* Based on the assumption that the footings will bear on competent bedrock or on either lean concrete or structural fill placed over competent bedrock after removal of the overburden soil.

Design Parameters for Three-Sided Pre-cast Concrete Culvert Wing Walls

Bridge Location	Allowable Net Bearing Pressure, lbs./sq.ft	Angle of Internal Friction of Bearing Soils	Friction Factor of Foundation Soils	Friction Angle of Backfill Soils*	Ultimate Cohesion of Bearing Soils, lbs./sq.ft*	Ultimate Adhesion of Bearing Soils, lbs./sq.ft.*
Structure No. 15, Station 97+55, Line PR-M	4,000	34°	0.45	26°	0	0

* Assuming Structural backfill material.

The backfill around the three-sided pre-cast concrete culvert should consist of structural backfill placed and compacted in accordance with Section 211 of the INDOT Standard Specifications. When the fill reaches the top of the structure, two lifts of structural backfill should be placed over the structure before compacting. The backfill level should be maintained at or near the same level on both sides of the culvert at all times so that the fill on either side should not be higher than one lift thickness above the other side. Only light compaction equipment should be used until the fill is at least 2 ft above the top of the culvert. The operation of compaction equipment should be in accordance with the manufacturer's specifications.

Positive scour protection at the entry and exit as well as along the entire length of the three-sided culvert structure is essential to maintaining the integrity of materials that support the shallow spread footings. If riprap is used for scour protection, the natural subgrade soils should first be covered with a non-woven geotextile fabric.

5.2 Pre-cast Reinforced Concrete Box Culverts

Our findings show that the proposed pre-cast concrete box culverts can be supported on the natural soils below the proposed bearing soils provided all unsuitable soils are first removed at culvert locations and that the base is protected from scour. Boring Nos. TB-7 and TB-8 were drilled for Structure No. 24 beneath Deer Creek Road near the west and east ends, respectively, of the proposed structure. Auger refusal was encountered at about El 710.4 and El 706.2 in Boring Nos. TB-7 and TB-8, respectively.

Boring No. TB-9 was drilled near the location of Structure No. 27 and encountered auger refusal at about El 699.5, which is about 1 ft below the anticipated bottom of footing elevation for the proposed wing walls for this structure. The table on the following page summarizes the recommended design properties for the pre-cast box culvert wing walls.

Based on the auger refusal elevations encountered in the test borings there will be less that 3 ft of soil between the bottom of footings and the bedrock surface. It is recommended that the existing natural soils (which are mostly soft in consistency based on the results of the test borings) are completely removed from beneath the proposed footings to expose competent bedrock and replaced with either lean concrete or structural fill to reestablish the bearing elevation.

Design Parameters for Pre-cast Concrete Box Culvert Wing Walls

Culvert Location and Borings	Allowable Net Bearing Pressure, lbs./sq.ft	Angle of Internal Friction of Bearing Soils*	Friction Factor of Foundation Soils*	Friction Angle of Backfill Soils*	Ultimate Cohesion of Bearing Soils, lbs./sq.ft	Ultimate Adhesion of Bearing Soils, lbs./sq.ft.
Structure No. 24, Station 12+13, Line S-1-M, TB-7 and TB-8	4,000	34°	0.45	26°	0	0
Structure No. 27, Station 20+00, Line S-1-M, TB-9	4,000	34°	0.45	26°	0	0

* Assuming B-Borrow backfill material.

It is extremely important that the materials at the base of the excavations for the pre-cast concrete box culverts be carefully inspected to verify that suitable bearing soils exist at the design bearing elevation below the concrete bock culvert. Any sediment from the streams, organic material, soft or loose natural soils or otherwise unsuitable material must be undercut beneath the box culvert. Recommendations for inspection of the soils at the bases of the culverts are provided in Section 6.2 of this report.

The backfill around the pre-cast concrete box culverts should consist of "B" borrow placed and be compacted in accordance with Section 211 of the INDOT Standard Specifications. When the fill reaches the top of the structure, two lifts of "B" borrow should be placed over the structure before compacting. The backfill level should be maintained at or near the same level on both sides of the culvert at all times and the fill on either side should not be higher than one lift thickness above the other side. Only light compaction equipment should be used until the fill is at least 2 ft above the top of the culvert. The operation of compaction equipment should be in accordance with the manufacturer's specifications.

Positive scour protection at the entries and exits as well as along the entire lengths of the box culvert structures is essential to maintaining the integrity of materials that support the base of the culverts and wing wall footings. If riprap is used for scour protection, the natural subgrade soils should first be covered with a non-woven geotextile fabric.

5.3 Grading

It is our understanding that the proposed embankments and cut slopes will be made at 3 (horizontal) to 1 (vertical). Based upon the soil conditions encountered in the test borings, permanent cut and fill slopes that are no steeper than 3 (horizontal) to 1 (vertical) should have a suitable factor of safety relative to slope failure.

5.4 Pavements

It is our understanding that U.S. Route 50 will be completely reconstructed between Station 83+25 and 111+45 Line PR-M. U.S Route 50 between Station 77+90 and 83+25 Line PR-M the roadway will be milled, widened and resurfaced to achieve the proposed super elevation grades for the new road. No more than 2 ft of cut and a maximum of 8 ft of fill will be required for U.S. Route 50.

A portion of Deer Creek Road from Station 10+65 Line "S-1-M" to Station 15+49.23 Line "S-1-M" will be reconstructed south of U.S. Route 50 and Deer Creek Road from Station 15+49.23 Line "S-1-M" to Station 22+81 Line "S-1-M" will be realigned and reconstructed north of U.S. Route 50. There is about 60 ft of incidental construction each at the beginning and ending point of the project where the existing pavement may be milled and overlain with new pavement to transition the new construction to the existing pavement.

Based on our experience with the soil types encountered during this study and the results of the CBR test, a CBR value of 4.0 is recommended for use in the design of the pavements for U.S Route 50. Recommendations for the removal and replacement of any unsuitable subgrade materials that may be encountered during construction are provided in Sections 6.2 and 6.3 of this report.

It is recommended that Type IA subgrade treatment in accordance with INDOT Standard Specifications Section 207.04 be used for the pavement subgrade for the reconstruction of U.S. Route 50.

It is recommended that Type II subgrade treatment in accordance with INDOT Standard Specifications Section 207.04 be used for the pavement subgrade in the areas of new alignment for Deer Creek Road and Type IIA in the reconstruction areas along the existing alignment. For these cases, a CBR value of 3.0 should be used for the design of the pavement.

5.5 Subsurface Drainage

Subsurface drains are not required for this project unless the existing roadway currently has subsurface drains. If subsurface drains are installed, a non-woven filter fabric would be required.

5.6 Corrosion Protection

The soil samples tested for pH during the laboratory investigation indicate that the soil at the site has the potential to cause some corrosion to concrete as evidenced by the pH values included in the table below and in Appendix C. However, since the scope of work did not include a thorough investigation into the corrosion potential of the soils at this site relative to specific construction materials, corrosion protection should be considered for all metallic pipes and drainage structures. Typically, this consists of coating the structures with a bituminous material and encasing with gravel or the use of a proprietary method or system of protection from corrosive soils.

Summary of Soil pH Values

Boring Number	Depth, ft	pH Value
TB-7	1.0 – 2.5	7.4
TB-1	8.5 – 10.0	5.8
RB-3	6.0 – 7.5	5.4

6.0 GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS

Since this investigation identified actual subsurface conditions only at the test boring locations, it was necessary for our geotechnical engineers to extrapolate these conditions in order to characterize the entire project site. Even under the best of circumstances, the conditions encountered during construction can be expected to vary somewhat from the test boring results and may, in the extreme case, differ to the extent that modifications to the foundation recommendations become necessary. Therefore, we recommend that ATC be retained as geotechnical consultant through the earth-related phases of this project to correlate actual soil conditions with test boring data, identify variations, conduct additional tests that may be needed and recommend solutions to earth-related problems that may develop.

6.1 Shallow Foundation Excavations

The soil at the base of each shallow foundation excavation should be completely removed down to the bedrock surface. The excavations should then be backfilled with either lean concrete or structural fill to reestablish the original bearing elevation or the proposed footings can bear directly on the underlying competent bedrock surface. The bedrock encountered at auger refusal depth is hard and is either competent New Albany Shale or massive Devonian Age limestone or dolomite. Excavation of the bedrock will likely require the use of a hoe-ram or blasting. Conventional earth moving equipment such as excavators may possibly be used to excavate the upper weathered zones of shale at some locations to minimal depths.

If structural fill is used to reestablish the footing bearing elevation the dimensions of the excavation base should be determined by imaginary planes extending outward and down on a 2 (vertical) to 1 (horizontal) slope from the base perimeter of the footing. The entire excavation should then be refilled with a well-compacted structural fill. Special care should be exercised to remove any sloughed, loose or soft materials near the base of the excavation slopes. In addition, special care should be taken to "tie-in" the compacted fill with the excavation slopes, with benches as necessary, to insure that no pockets of loose or soft materials will be left in place along the excavation slopes below the foundation bearing level.

The bases of all satisfactory foundation excavations should be protected against any detrimental change in condition such as from disturbance, rain and freezing. Surface run-off water should be drained away from the excavation and not allowed to pond. If possible, all footing concrete should be placed the same day the excavation is made. If this is not practical, the footing excavations should be adequately protected.

6.2 Site Preparation and Earthwork

All topsoil, wet, soft, loose or otherwise unsuitable surficial bearing soils should be stripped from the project site within the construction limits prior to construction of the roadway. Proofrolling of the natural ground surface should be performed using suitable rolling equipment in accordance with the INDOT Standard Specifications Section 203.26 within all areas where new fill will be placed. Care should be exercised during grading operations at the site. Due to the nature of the near-surface soils, the traffic of heavy equipment, including heavy compaction equipment, may create pumping and general deterioration of the shallower soils, especially if excess surface water is present. The grading, therefore, should be done during a dry season, if possible.

Soft, loose or otherwise unsuitable bearing soils (such as those encountered in Boring Nos. TB-3, TB-4 and TR-4near Structure No. 15) encountered during the proofrolling operations should be removed and replaced with "B" borrow to a depth of at least 2 ft above the ground water level (if free ground water is encountered within an excavation). If removal and replacement is not feasible, aeration and compaction of the soils should be considered or it may be necessary to stabilize the subgrade using other procedures. It is recommended that the proper subgrade treatments be determined at the time of construction, since the actual subgrade condition can be properly assessed at that time. The placement of fill should be accomplished in accordance with Section 203.09 of INDOT Standard Specifications. "B" borrow material, for use in conjunction with this project, should be as defined in INDOT Standard Specifications, Sections 203.08 and 211.02.

The bedrock encountered in the test borings is hard and is either competent New Albany Shale or Devonian Age limestone or dolomite. Excavation of the bedrock will likely require the use of a hoe-ram or blasting. Conventional earth moving equipment such as excavators and dozers equipped with a ripping blade may possibly be used to excavate the upper weathered zones of shale at some locations to minimal depths.

6.3 Placement and Compaction of Engineered Fill

Engineered fill should be placed in lift thicknesses not to exceed about 8 in. and compacted to a minimum of 95 percent of the standard Proctor maximum dry density (AASHTO T99) as specified in the current INDOT Standard Specifications. It is possible that some drying of the fill material will be required before being placed in order to meet the INDOT Specification for fill placement. However, adequate moisture conditioning may be difficult during wet seasons and, during such seasons, a granular material may be necessary to satisfy the minimum compaction requirements.

Where the alignment of the roadway crosses existing drainage ditches, the soft sediment in the base of the channels should be removed and replaced with structural fill to a thickness of at least 2 ft above the free ground water level. Otherwise, backfilling should be done in accordance with Section 203.09 of the INDOT Standard Specifications.

6.4 Fill Sections

Where fill material is placed on existing slopes, benches should be cut into the existing slopes subsequent to fill placement so as to preclude a shear plane from developing at the interface. Benches having a minimum width of 10 ft should be cut into the natural slopes and existing embankment side slopes that are 4 (horizontal) to 1 (vertical) or steeper before new engineered fill is placed. These benches should be excavated in accordance with Section 203.21 of the INDOT Standard Specifications.

6.5 Erosion Protection

Highly erodible, granular material (such as "B" borrow) should not be used in proposed ditches or within 12 in. of the required final grade of side slopes. The material required to encase the embankment should be non-erodible, cohesive material that is free from debris and other deleterious materials and suitable for sustaining vegetation. The final slopes should be seeded or sodded for erosion control. If seeded, the slope should be protected with an erosion control blanket to provide for adequate seed germination and rooting.

All topsoil and any soft sediments should be removed along the entire length of all proposed drainage structures and replaced with engineered fill to an elevation 2.0 ft above the ground water level or to the invert elevation of the proposed structure, whichever is higher. The outer 10 ft of structural fill under the ends of the structure should be enveloped with a continuous length of permeable non-woven geotextile. This geotextile should extend the entire width of the excavation. All the soils surrounding the drainage structures should be compacted to at least 95 percent of the maximum dry density as determined in accordance with section 203.24 of the INDOT standard specifications. The soil in the bottom of the excavation, any bedding material, and the structural backfill, should be tested to insure compliance with this density criteria. If during construction, soft soils are encountered at depths that make removal impractical or if 95 percent of the maximum dry density cannot be obtained at the bottom of the excavation or in other areas, this office should be contacted for additional recommendations.

6.6 Construction Dewatering

Based upon the ground water data obtained during drilling operations and the level of Deer Creek, it appears that some dewatering may be required in the proposed excavations during construction. In cases where cohesive soils are encountered in the base of excavations, it is expected that such dewatering can be handled by conventional dewatering methods such as pumping from sumps. The best dewatering system for each case must be determined at the time of construction based upon actual field conditions.

6.7 Temporary Runaround

The borings drilled for the temporary runaround encountered a relatively thin crust of silty loam soils overlying shale and limestone bedrock of varying weathered conditions. The existing natural soil in the fill area where Boring TR-4 was drilled is very soft to a depth of 3.5 ft where auger refusal was encountered. The bedrock encountered at auger refusal depth is very hard and is either competent New Albany Shale or Devonian Age limestone or dolomite. Excavation of the bedrock will likely require the use of a hoe-ram or blasting. Conventional earth moving equipment such as excavators and dozers equipped with a ripping blade may possibly be used to excavate the upper weathered zones of shale at some locations to minimal depths.