SPECIAL NOTES FOR LAKE BARKLEY BRIDGE PROJECT

SCHEDULED FOR DECEMBER 19, 2014 LETTING

SPECIAL NOTES (BRIDGE):
FOR DRILLED SHAFTS
FOR NON-DESTRUCTIVE TESTING IN DRILLED SHAFTS
FOR VIBRATION MONITORING
FOR STEEL ERECTION – ARCH SPAN
FOR STEEL ERECTION – APPROACH SPANS
FOR STAINLESS STEEL REINFORCEMENT
FOR BRIDGE STRAND HANGERS
FOR DISK BEARINGS
FOR LCE SEISMIC ISOLATION BEARINGS (TYPES A & B)
FOR VISCOUS DAMPERS
FOR FINGER EXPANSION JOINT
FOR MODULAR EXPANSION JOINT
FOR LIGHTING PROTECTION SYSTEM
FOR DECORATIVE FENCE PANEL
FOR INSTALL – DUCT BANK
FOR SHOP DRAWINGS & WELDING PROCEDURES
(6U) FOR STRUCTURAL MASS CONCRETE
(6J) FOR NON-EPOXY ADHESIVES

SPECIAL PROVISIONS (BRIDGE):
(69) FOR EMBANKMENT AT BRIDGE END BENT STRUCTURES

SPECIAL NOTES (GENERAL):
FOR HELPER BOAT
FOR REMOVAL OF EXISTING BRIDGE
FOR CONSTRUCTION TRAILER
FOR WEB CAMERA CONSTRUCTION MONITORING SYSTEM
FOR CPM SCHEDULING
FOR PROJECT INSPECTION BOAT
FOR CONSTRUCTION ACCESS
FOR ENGINEERING-RELATED CONSULTING SERVICES
FOR INTERMEDIATE MILESTONES
FOR AVIATION CONSTRUCTION PERMITS
FOR MAINTAINING EXISTING BRIDGE

SPECIAL NOTE FOR DRILLED SHAFTS
Trigg County –US68/KY80 Bridge over Lake Barkley

1.0 General

1.1 Description

This work consists of furnishing all tools, equipment, materials, services, labor and incidentals necessary for constructing drilled shafts in accordance with details shown on the plans. The Kentucky Standard Specifications for Road and Bridge Construction, current edition governs unless otherwise specified in this special note or in the plans. This Special Note completely replaces Special Note 11C, and Special Note 11C does not apply to this project.

For the purposes of this Special Note, “Department” refers to the Kentucky Department of Highways and/or consultants acting on behalf of the Department of Highways. “Engineer” is defined in Section 101.03 of the Standard Specifications.

1.2 Site, Subsurface Information and Samples Inspection

Bidders are cautioned to expect difficult subsurface conditions at this site. Bidders are encouraged to consult available geological literature including but not necessarily limited to the Canton Geologic Quadrangle Map and the U.S. Geological Survey Professional Paper 1151-H, “The Geology of Kentucky -- A Text to Accompany the Geologic Map of Kentucky”, Edited by Robert C. McDowell. Additional geotechnical information may be available via the KYTC Division of Construction Procurement Website under “Project Related Information”. The referenced geological literature and geotechnical information are for information only and are not contract documents. However, available subsurface data are included in the bridge plans which are contract documents.

Medium dense to dense sand and gravel layers and residual chert interbedded within the sand and gravel were encountered during geotechnical explorations. Some of this material was difficult to penetrate using conventional geotechnical rotary drilling equipment with diamond-impregnated casing bits and carbide tricone roller bits. Although sand- and gravel-sized chert particles were sampled, it is possible that chert particles which are larger than gravel-sized will be encountered during the construction. In addition, the limestone bedrock contains chert nodules and inclusions that made coring the limestone bedrock occasionally difficult.

Rock excavation in drilled shafts at other projects within the vicinity of this project have required reverse circulation drilling methods to successfully excavate the

limestone bedrock that contains various sizes and distribution of chert inclusions. Methods of seating of the permanent steel casing into the limestone bedrock should consider the limestone with chert inclusions encountered at all drilled shaft locations and the potential for vertical crevices and undulating bedrock surface at drilled shaft foundations.

Potential vertical crevices or pinnacled bedrock surfaces were encountered in Borings B5009, B5011, B5013W, B5066 and B5066A. At projects located at the north end of Kentucky Lake, vertical crevices were observed within the rock excavations and in borings associated with the subsurface grouting program. Limestone outcrops with vertical crevices are visible on the east bank of Lake Barkley at/near the End Bent 2 location. Based on the presence of vertical crevices observed in the spillway excavation for the Kentucky Lake Dam and the test boring results, it is anticipated that some vertical crevices will be encountered during construction of the drilled shaft foundations.

During the geotechnical exploration program, a casing advancer was lost in the soil column at Boring B5006, and core barrels were lost in the bedrock at Borings B5014 and B5066 (see Subsurface Data Sheets in the plans) and may be encountered when drilling the foundation shafts at these locations.

In addition, some of the borings drilled at the bridge pier and end bent drilled shaft locations encountered voids in the limestone bedrock due to karst conditions. The voids appear to be filled with either silty sand, sand, gravel, rock fragments or clay. However, some water-filled or air-filled voids could be encountered. In addition, voids in bedrock due to karst or variable top of rock conditions due to karst could be encountered at locations other than those encountered in the subsurface investigation borings. Such variations in voids or top of rock may exist between adjacent boring locations or within the footprint of a drilled shaft. Such variations will not be considered grounds for differing site conditions. Bidders are advised to factor any and all risks associated with the conditions at the site into their bids.

The prospective bidders are strongly encouraged to visit the project site and the drilled shaft contractors are required to inspect available rock cores prior to the letting date. Representatives of the prime contractor and the drilled shaft subcontractor(s) (if applicable) will be required to inspect the rock cores prior to beginning drilled shaft construction. Only the cores obtained in 2014 (B5000 series borings) will be available for inspection. To schedule a viewing of the rock cores, contact the Division of Structural Design, Geotechnical Branch (502-564-2374), a minimum of two business days in advance. The bidders are also responsible to familiarize themselves with the available geotechnical data, which provides further information regarding the anticipated soil and bedrock conditions that will impact the installation of the drilled shafts. Failure to inspect the project

site and view the available rock cores will result in the forfeiture of the right to file a claim based on site conditions and may result in disqualification from the project.

1.3 Disclaimer

Acceptance of any of the contractor's submissions required by this note does not constitute endorsement or approval. The acceptance is acknowledgement of the work performed and authorization for the contractor to proceed. The Department is not bound by acceptance of any of the submissions required by this note. Final acceptance will be contingent on the satisfactory completion of the work required by this note.

2.0 Submittals

Make submittals via SharePoint software in accordance with the Project requirements for submittals. See Table 1 below. The Department will respond to the Contractor regarding acceptability of submittals within ten (10) business days, unless indicated otherwise in this special note. A "Business Day" is defined as any day except Saturdays, Sundays and Holidays, as defined in Section 101.03 of the Standard Specifications.

Table 1 – Schedule of Drilled Shaft Submittals

Submittal Number	Submittal Item	Calendar Days	Event
1	Drilled shaft contractor/subcontractor to be used~~experience for qualification~~	30 After	Notice to Begin Work
2	Drilled shaft supervisor experience and qualifications	30 After	Notice to Begin Work
3	Subsurface Exploration Plan	30 Before	Start of Subsurface Exploration
4	Drilled Shaft Installation Plan (includes initial cavity remediation plan)	45 Before	Start of Drilled Shaft Construction
5	Concrete trial mix reports	20 Before	Start of Drilled Shaft Construction
6	Drilled shaft preconstruction meeting	10 Before	Start of Drilled Shaft Construction

Table 1 – Schedule of Drilled Shaft Submittals			
Submittal Number	**Submittal Item**	**Calendar Days**	**Event**
7	Revised Cavity Remediation Plan(s)	20 After	Completion of Subsurface Exploration and/or installation of technique drilled shafts and/or installation of production shafts requiring remediation
Provide all submittals and reports in .pdf format			

2.1 Contractor Pre-Qualification

The drilled shaft contractor for Piers 1-13 is required to be pre-qualified by the Department for "Marine Drilled Shafts" prior to beginning drilled shaft construction. Prime contractors or subcontractors who intend to perform drilled shaft construction are strongly encouraged to become pre-qualified prior to bidding. The drilled shaft contractor for End Bent 2 is required to be pre-qualified by the Department for "Drilled Shafts" prior to beginning drilled shaft construction. These pre-qualification requirements apply to both a prime contractor who self-performs drilled shaft construction and subcontractor(s) who perform drilled shaft construction. This prequalification is optional for placing reinforcing steel and concrete for the drilled shafts. However, the applicable Drilled Shaft pre-qualification is required in order to perform other drilled shaft operations such as drilling, casing installation, karst remediation, etc. If the prequalified drilled shaft contractor does not place concrete or grout for cavity stabilization then the drilled shaft supervisor is required to be present to oversee those operations.

2.2 Drilled Shaft Construction Personnel Experience

2.2.1 Drilled Shaft Supervisor(s)

Provide documentation that current company personnel who will be directly responsible for field operations at Piers 1-13 meet the requirements below:

1. A minimum of 10 years experience in drilled shaft and/or heavy marine construction including at least five (5) years of supervisory experience.

2. At least two (2) projects in the last 10 years installing drilled shafts in water 20 ft. or deeper with total drilled shaft lengths of 40 ft. or deeper in a marine environment using heavy marine equipment.
3. At least two (2) projects in the last 10 years constructing rock socket drilled shafts with rock socket diameters 5 feet or larger and at least 10 feet in length. At least one (1) of these must be a marine environment using heavy marine equipment.
4. At least one (1) project in the last 10 years constructing rock socket drilled shafts in hard bedrock with Karst type features.
5. At least one (1) project in the last 10 years constructing rock socket drilled shafts in hard bedrock where cavities/voids were encountered that required remediation and/or stabilization (e.g. sealing with steel casing, or pumping concrete and redrilling or a combination of steel casing and pumping concrete).

NOTE: Item 5 is in addition to the personnel requirements for Marine Drilled Shaft pre-qualification. The Contractor will be required to assign personnel meeting the requirements of Items 1-~~5~~ 4 specifically to this project and may need to hire additional personnel after meeting pre-qualification requirements. The personnel in Item 5 do not have to be assigned full-time to this project and may be consultants; however, they need to be familiar with and have visited the project.

Some or all of the experience may be with a previous employer. If necessary, more than one drilled shaft superintendent or foreman can be used to meet the requirements if all are actively involved in the project.

2.2.2 Project Engineer(s)

Provide documentation that current company personnel includes a licensed Professional Engineer(s) with at least five (5) years experience in design of concrete mixes and design of drilled shaft installations. Also provide documentation that the Professional Engineer(s) have experience designing installation plans within drilled shaft rock sockets in bedrock containing cavities due to karst conditions on at least 2 prior drilled shaft projects. The engineer(s) can be employees of the contractor or can be hired consultants. Multiple engineers can be used to satisfy the experience criteria in this section and are not required to be assigned full-time to this project; however, they need to be familiar with and have visited the project.

2.3 Subsurface Exploration Plan

No later than 30 calendar days prior to performing Subsurface Exploration described in Section 4.12 of this Special Note, submit a Subsurface Exploration

Plan for review by the Department. Include tables showing proposed borings/rock cores in the Subsurface Exploration Plan and anticipated location tolerances for the rock core borings. Include station, offset and coordinates of the proposed borings in the tables. Provide a drawing for each drilled shaft where subsurface borings/rock cores are required showing the proposed and existing borings/rock cores in the Subsurface Exploration Plan. Also include in the plan how the boring locations will be accessed, the drilling methods that will be used, and plans for United States Coast Guard (USCG) notification (if required under the USCG Construction Permit). Final acceptance by the Department will be subject to satisfactory performance in the field.

Submit documentation in the Subsurface Exploration Plan including a resume which addresses the specific experience of the subsurface exploration drill crew supervisor(s) and containing names and current phone numbers of owners' representatives who can verify the supervisor(s) meet the following requirements:

1. Meets personnel requirements for Drill Crew Supervisor as stated in the KYTC prequalification requirements, with a minimum 5 years drilling experience.
2. Minimum 3 projects with rock coring, with a minimum 1 project rock coring in karst bedrock.
3. Minimum 1 project barge drilling on water where casing is extended from the barge deck to the mudline or deeper
4. Minimum 1 project where casing advancer was used to advance the borings in the soil column.
5. Minimum 1 project where drilling mud was used to advance the borings in the soil column.

The Department will notify the contractor within 10 business days of the Subsurface Exploration Plan acceptance status.

2.4 Pre-Construction Submittals

No later than 45 calendar days prior to constructing drilled shafts, submit a Drilled Shaft Installation Plan for review by the Department. Final acceptance of the Drilled Shaft Installation Plan by the Department will be subject to satisfactory performance in the field of the Technique Drilled Shaft construction. Provide a plan containing detailed information regarding this project including the following:

(a) List and size of proposed equipment including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies or concrete pumps, casings, etc.
(b) Details of overall construction operation sequence and the sequence of shaft construction.

(c) Details of shaft excavation methods and method that will be used to ensure that rock socket is centered and method to ensure that soil and rock remain stable during shaft excavation.
(d) Details of casing to be used including calculations showing ability of casing to withstand anticipated hydraulic and earth pressures and to withstand stresses due to installation without undue deformation. Include detailed methods for casing handling, splicing, straightening, and out-of-round correction with any associated timetables.
(e) Details of slurry (if used). See requirements for Slurry Submittals in Section 3.4 of this Special Note.
(f) Details of proposed methods to clean shaft and inside of casing after initial excavation.
(g) Details of reinforcement handling, lifting, and placement including support and method to center in shaft, must include rebar cage support during concrete placement.
(h) Details of concrete placement including proposed operational procedures for concrete tremie or pump including initial placement (including method(s) to ensure the required minimum 10 feet tremie immersion is achieved), raising during placement, and overfilling of the shaft to expel contaminated concrete.
(i) Details of temporary casing removal if contractor elects to use temporary casing.
(j) Required submittals including shop drawings and concrete design mixes.
(k) Other information shown in the plans or requested by the Engineer.
(n) Special considerations for wet construction.
(o) Details of environmental control procedures to protect the environment from discharge of excavation spoil, dry polymer slurry (if used) and concrete overpour.
(p) Method for measuring and determining vertical and horizontal alignment during construction.
(q) How excavated material is to be disposed.
(r) Remediation plans for encountered voids within the excavated bedrock, including: 1. smaller voids (less than 12 inches in maximum dimensions) and 2. more cavernous type voids that would require excessive concrete placement. Include items required in Section 4.6 of this special note.
(s) Provide a plan to drill Drilled Shafts 6 and 66 where casing advancer was lost in the soil column and core barrel was lost in the bedrock, respectively during geotechnical exploration boring program.
(t) Proposed method to provide inspectors access to the top of permanent and/or temporary casing to allow inspection of the shafts.
(u) SID (shaft inspection device) or approved equal inspection of drilled shaft bottom, including name of subcontractor (if applicable) performing this work.
(v) Provide a plan to install the CSL tubes within the planned reinforcing cages as specified in the Special Note for Non-Destructive Testing.

(w) Method of inspection of the sidewalls of the drilled shaft rock sockets at End Bent 2 for horizontal cavities and vertical crevices.

Within 10 business days after receipt of the plan, the Department will notify the contractor of any additional information required and/or changes necessary to meet the contract requirements. Any part of the plan that is unacceptable will be rejected. Resubmit changes agreed upon for reevaluation to the Department. The Department will notify the Contractor within 10 business days after receipt of proposed changes of their acceptance or rejection. All procedural acceptance given by the Department are subject to trial and satisfactory performance in the field by the contractor and do not relieve the contractor of the responsibility to satisfactorily complete the work as detailed in the plans and specifications. Do not start construction on any items affected by the Drilled Shaft Installation Plan until the plan is accepted by the Department. No additional costs or time extensions from Delays due to resubmission of the Drilled Shaft Installation Plan will be accepted by the Department.

2.5 Concrete Trial Batch Reports

At least 20 days prior to starting drilled shaft construction, submit reports of concrete trial batches as specified in Section 3.1.2 of this Special Note. These reports will be subject to review and acceptance by the Department.

2.6 Drilled Shaft Pre-Construction Meeting

A pre-construction meeting to discuss drilled shaft construction will be required. This meeting will be held after all drilled shaft submittals have been received and reviewed by the Department and at least 10 working days prior to the beginning of drilled shaft construction. The purpose of the meeting is to discuss construction procedures, personnel, and equipment to be used. The following are required to attend:

1. Representing the Contractor – Project Superintendent, Drilled Shaft Superintendent or Foreman, and Foreman in charge of the following operations (if different than the Drilled Shaft Superintendent or Foreman): placing casing, excavating shafts, mixing slurry, tying and setting steel reinforcement, and pumping and placing concrete.
2. Representing KYTC – Drilled Shaft Inspector(s), Section Engineer, Central Office Construction Engineer, Geotechnical Branch and others as deemed appropriate by the Section Engineer.

If the Contractor’s key personnel change or if the contractor proposes a significant revision to drilled shaft construction procedures, an additional drilled shaft pre-construction meeting may be required at the discretion of the Engineer.

2.7 Revised Cavity (Karst) Remediation Plan(s)

After completing the subsurface exploration and evaluating the data, revise the cavity remediation plan for karst conditions in the bedrock, if revisions are determined necessary by the Contractor or Engineer. Submit the plan if the Contractor or the Engineer is of the opinion that the conditions encountered in the rock cores warrant modification of the original cavity remediation plan indicated in Item (r) of Section 2.4 of this Special Note. Submit the plan to the Department within 20 calendar days after completing the required subsurface exploration of the drilled shaft locations at Bridge Piers 1 to 6 and/or technique drilled shaft or production drilled shafts requiring remediation (See Section 4.6 for further requirements). The Department will notify the Contractor within 10 business days after receipt of proposed changes of their acceptance or rejection of the revised plan. All procedural acceptance given by the Department is subject to trial and satisfactory performance in the field by the contractor during installation of the second technique drilled shaft and drilled shafts where cavities were encountered in the bedrock and do not relieve the contractor of the responsibility to satisfactorily complete the work as detailed in the plans and specifications.

If the Contactor does not intend to revise the initial remediation plan, submit in writing that in the Contractor's opinion, no revisions are required to the initial remediation plan within 20 calendar days after completing the required subsurface exploration of the drilled shaft locations at Bridge Piers 1 to 6.

3.0 Materials

3.1 Concrete Mixes

3.1.1 Design concrete mixes for the drilled shafts having a minimum compressive strength at 28 days of 5000 psi with an air content of 5% +/- 2%. Maintain the slump of the concrete at the time of placement between 7.5 to 10 inches, the maximum coarse aggregate size is 3/8", and maintain the water/cementious material ratio not to exceed 0.45. Use water reducing and retarding admixtures as required. Type F high range water reducers used in combination with retarding admixtures or type G high range water reducers fully meeting trial batch requirements are permitted. Class F fly ash is permitted in conformance with Section 601. Design the concrete mix having gradual slump loss. Design the concrete mix to have a slump-time relationship ("slump loss") of the concrete exceeding 6 inches after 4 hours from initial mixing and also exceeding 4 inches at 10 hours after batching or 2 hours after estimated placement time per drilled shaft, whichever is longer. Use of a hydration

stabilizer that has been approved for experimental use in the Kentucky Product Evaluation List (KyPEL) is permitted for the purpose of controlling slump loss.

3.1.2 Perform trial batches prior to beginning drilled shaft construction in order to demonstrate the adequacy of the proposed concrete mix per Standard Section 601 and the modifications in this section. Through trial batches, demonstrate that the mix to be used will meet the requirements for temperature, minimum target slump, slump-time relationship ("slump loss"), air content, water/cementious material ratio, and compressive strength. Trial batch compressive strength requirements will be in accordance with ACI 318, Section 5.3.2. Develop trial batches using the ingredients, proportions and equipment (including batching, mixing, and delivery) to be used on the project. Produce at least two independent consecutive trial batches of 3 cubic yards each using the same mix proportions and meeting all specification requirements prior to the mix design being accepted by the Department. Department personnel will observe all phases of the trial batching. Submit a report containing the results for slump, air content, water/cement ratio, temperature, and compressive strength and mix proportions for each trial batch to the Engineer for review and acceptance. Failure to demonstrate the adequacy of the concrete mix, methods, or equipment to the Engineer is cause for the Engineer to require appropriate alterations in concrete mix, equipment, and/or method by the Contractor to eliminate unsatisfactory results. Provide any additional trial batches required to demonstrate the adequacy of the concrete mix, method, or equipment at no additional cost to the Department and with no extension of contract time.

3.1.3 Provide estimated concrete placement durations for each location. Adjust admixture dosages on a case-by-case basis as placement times and ambient temperature variables change. Perform additional trial batching to ensure dosage adjustments are correct.

3.1.4 Cavity stabilization concrete/grout – Provide concrete meeting the requirements of Sections 3.1.1 and 3.1.2 above or grout meeting the applicable requirements for "grout" in Section 601.03.03 B) of the Standard Specifications.

3.2 Permanent Casing

3.2.1 Provide permanent structural casing meeting the requirements of ASTM A252 Grade 3 or better unless specified otherwise in the plans. Manufacture the casing using ASTM A-1018, Grade 55, Class 1 steel or accepted equivalent. Furnish two copies of certification from the

fabricator detailing the designated specification with which the furnished casings comply. Welds made at a permanent manufacturing facility shall be made by either automatic fusion weld or electric resistance weld process. Visually inspect 100% of the inside and outside of all welds per AWS D1.1 Section 6.1. A minimum of 25% of each longitudinal, circumferential or spiral weld shall receive nondestructive testing by either radiographic, radioscopic, real time imaging systems or ultrasonic methods compliant with AWS D1.1.

3.2.2 Splice the permanent structural casing in accordance with Section 6.13.3 of the LRFD Bridge Design Specifications and AWS D1.1. Use only joint penetration groove welds for splicing. Produce casing splices that are true and straight. Do not use interior splice plates.

3.2.3 Provide permanent casing of ample strength to resist damage and deformation from transportation and handling, installation stresses, and all pressures and forces acting on the casing.

3.2.4 Where the minimum thickness of the permanent casing is specified in the Plans, it is specified so as to satisfy in-service structural design requirements only. Increase the casing thickness from the minimum specified thickness, as necessary, to satisfy the construction installation requirements with approval by the Engineer. In addition to "Permissible Variations in Widths and Dimensions" specified in ASTM A252, provide permanent casing meeting the following dimensional tolerance requirements: (1) Straightness: do not allow the straightness to vary more than 0.001 times the length of the pile (1/8 in. in any 10-ft length); (2) Radial offset (misalignment) of plate edges in weld seams: transition weld any offset exceeding 25% wall thickness with a 3 to 1 slope from both sides. Cut and realign any offset exceeding 33% of the wall thickness.

3.2.5 Ensure permanent casing that is smooth, clean, watertight, true and straight, and of ample strength to withstand handling, and the pressure of concrete, water and the surrounding earth materials. Provide casing with an inside diameter not less than the specified diameter of the drilled shaft. No extra compensation will be allowed for concrete required to fill an oversized casing or oversized excavation. Ensure casing field splices and fit-up conform to the current edition of AWS D1.1 with no exterior or interior splice plates and produce true and straight casing, as well as the following additional requirements.

a. Provide full penetration butt welds at all welds.
b. Visually inspect the full length of all welds.

c. Test 33% of the length of each circumferential field weld by radiographic, ultrasonic or other suitable methods. Conform with all testing, repair and acceptance to the requirements of AWS D1.1. If repairs are required, test all repairs using nondestructive testing on both sides of the repair for a length equal to 10% of the length of the casing outside circumference.
d. Subject all field welding of casings to the approval of the Engineer.
e. Space all field welds for permanent casing at a minimum of 60 feet along the length of the casing.
f. Produce final casing meeting the fit-up requirements of AWS D1.1, Section 5.22.3.1, “Girth Weld Alignment (Tubular),” when the project requires the material be spliced utilizing a girth weld.

3.2.6 At time of concrete placement to the top of the rock socket, protect the shaft concrete from water action during placement and curing of the concrete, which may include extending the permanent steel casing above the water level at the time of concrete placement. Concrete discharge into the lake is not permitted. Provide non-contaminated concrete from the bottom of rock socket elevation to the top of concrete elevation in each drilled shaft without a cold joint. Embed the permanent casing into the rock a sufficient amount to create and maintain a concrete tight seal and prevent collapse or excessive deformation of soil outside the permanent casing. Extend permanent casing or use other accepted methods when needed to remediate voids in bedrock. Cut off the casing at the prescribed elevation and trim to within tolerances prior to acceptance. Provide cutting teeth or cutting shoes capable of adequately embedding and sealing the casing into the limestone bedrock.

3.2.7 When accepted by the Department, installation of casing using rotating or oscillating methods will be permitted. Use this casing method in accordance with the equipment and procedures shown in the approved Drilled Shaft Installation Plan, and comply with all other requirements specified herein. Provide casing equipped with cutting teeth or cutting shoe when using rotator and/or oscillator methods to seal the casing into the bedrock. Provide cutting teeth or cutting shoes capable of adequately embedding and sealing the casing into the limestone bedrock. If used, cutting shoes shall conform to ASTM A148, Grade 90-60.

3.2.8 Submit details concerning the proposed casing design with the Drilled Shaft Installation Plan that are consistent with the minimum casing requirements indicated in the design drawings.

3.3 Temporary Casing

3.3.1 If the contractor elects to use temporary casing for any reason, provide temporary casing with smooth wall structural steel that is of ample strength to resist damage deformation from transportation and handling, installation stresses, and all pressures and forces acting on the casing. Prior to placement in the excavation, provide temporary casing that is watertight and clean. Provide temporary casing capable of being removed without deforming and causing damage to the permanent casing or completed shaft, and without disturbing the surrounding soil. The Department will not allow additional costs and will allow no extension of contract time for the use of temporary casings. Leave no temporary casing in-place without the prior acceptance of the Department. Provide temporary casing of uniform outside diameter not less than the specified diameter of the drilled shaft being installed. The method of temporary casing installation and removal must result in intimate contact between the permanent casing and the soil below the design scour elevation.

3.3.2 The annulus between temporary casing and the permanent casing must be completely filled with grout or other material allowed by the Department. Place all grout using a tremie tube inserted to the bottom of the temporary casing. As the temporary casing is withdrawn, maintain a sufficient head (minimum 5 feet) of fluid grout in the annulus between the permanent casing and the temporary casing to ensure intimate contact between the permanent casing, the grout and the adjacent soil. Extract temporary casing at a slow, uniform rate with the pull in the line with the shaft axis.

3.3.3 When allowed by the Department, installation of temporary casing using rotating or oscillating methods will be permitted. Use this casing method in accordance with the equipment and procedures shown in the approved Drilled Shaft Installation Plan, and comply with all other requirements specified herein. Provide casing equipped with cutting teeth or cutting shoe when using rotator and/or oscillator methods to seal the casing into the bedrock. Provide cutting teeth or cutting shoes capable of adequately embedding and sealing the casing into the limestone bedrock, if required as part of the Contractor’s plan.

3.3.4 Remove all temporary casings unless otherwise shown on the plans.

3.4 Slurries

If used, provide a sufficient quantity of slurry mix meeting the material

requirements. Provide slurry containing material not detrimental to the concrete or surrounding ground strata. Any use of polymer or any other slurry at the contractor's option will be included in the unit bid prices for Drilled Shaft, Common and Drilled Shaft, Rock. Slurry use and requirements in drilled shafts where karst conditions exist may depend on the cavity remediation method. If the Department decides that the slurry construction method is failing to produce the desired final results, discontinue operations and propose an alternate method for approval by and at no additional cost to the Department.

3.4.1 Slurry Submittals

As part of the Drilled Shaft Installation Plan, submit a Proposed Method of Slurry Use (if used), including the following prepared by the Slurry Supplier:

1. a detailed slurry mix design, specific slurry properties, time for hydration, and a discussion of suitability for the anticipated subsurface conditions;
2. methods to mix, circulate, and de-sand the slurry; details of the proposed testing, test methods, sampling methods, and test equipment;
3. the name and current phone number of the supplier's representative for the project; and
4. any other information the slurry supplier deems necessary.; and
5.4. a sample of the dry slurry (may be submitted separate from the Drilled Shaft Installation Plan).

Also, include the following, prepared by the Contractor or Slurry Supplier:

1. Proposed method and location to dispose of slurry without contaminating the lake.

3.4.2 Slurry Supplier Technical Representative

Provide a technical representative of the slurry supplier for the purpose of:

1. training project inspectors and contractor personnel regarding the slurry properties, handling, placement and proper testing procedures;
2. being at the site during premixing prior to introduction of slurry into the first shaft and during the first 8 hours of drilling or until the mix shows consistent behavior, as determined by the Engineer.
3. being available to provide technical assistance and consultation to the Contractor and/or the Department during construction of all shafts.

Allow direct communication between the technical representative and the Department at all times.

3.4.3 Polymer Slurry Materials – Dry Polymer and Emulsified Polymer

Provide PHPA Dry Polymer and mix with water without additives to form a slurry mix meeting the material requirements below. Note higher viscosities may be required to maintain excavation stability in loose or gravelly sand deposits.

Property	Allowable Range	Units	Test Apparatus
Marsh Funnel Viscosity	50-80	sec/qt	Marsh Funnel
pH	7-11		pH paper or pH meter
Density	≤ 64	pcf	Density Balance
Sand Content, at introduction	≤ 1	% by volume	API Sand Content Kit
Sand Content, Immediately prior to placing concrete	≤ 1	% by volume	API Sand Content Kit

Provide Emulsified Polymer and mix with water without additives to form a slurry mix meeting the material requirements below. Note higher viscosities may be required to maintain excavation stability in loose or gravelly sand deposits.

Property	Allowable Range	Units	Test Apparatus
Marsh Funnel Viscosity	33-43	sec/qt	Marsh Funnel
pH	8-11		pH paper or pH meter
Density	≤ 64	pcf	Density Balance
Sand Content, at introduction	≤ 1	% by volume	API Sand Content Kit
Sand Content, Immediately prior to placing concrete	≤ 1	% by volume	API Sand Content Kit

3.4.4 Mineral Slurry Materials

The Department will not allow mineral slurry materials on this project.

3.4.5 Water Slurry

Water may be used as slurry when casing is used for the entire length of the drilled hole, provided that the method of drilled shaft installation maintains stability at the bottom of the shaft excavation. Maintain the water as clean as possible during its use as a slurry. Maintain water slurry with the following requirements.

Property	Allowable Range	Units	Test Apparatus
Density	≤ 66	pcf	Density Balance
Sand Content	≤ 1	% by volume	API Sand Content Kit

3.4.6 Construction and Testing

Provide a set of slurry testing equipment, including a carrying case, which contains all equipment necessary to test the slurry properties in the applicable table(s) above. This testing equipment is for the exclusive use of project inspectors to perform comparison tests and is in addition to test equipment to be used by the Contractor. This testing equipment will become the property of the Department. Provide this testing equipment at no additional cost the Department.

Designate one person to be responsible for mixing and testing slurry.

Prior to beginning excavation in any shaft where slurry is designated in the Drilled Shaft Installation Plan, premix slurry in tanks using an approved water supply. Only use tanks for slurry mixing, the Department will not permit the use of slurry pits. Use water that does not have characteristics detrimental to the slurry, drilled shaft excavation, or concrete. Additives are not allowed unless approved in writing by the Engineer. Use air diaphragm pumps or other similar non-shearing mixing devices to mix the slurry and pump it into the shaft. Allow adequate time (as prescribed by the slurry supplier) for hydration prior to introduction into the shaft. Provide slurry tanks with adequate capacity for slurry mixing, circulation, storage, and treatment. Sample the slurry in the tanks at a rate of 1 sample per 10,000 gallons and perform control tests on the slurry to determine viscosity, pH, density, and sand content of the freshly mixed slurry. At the discretion of the Engineer, sand content tests may be omitted on selected samples. Representatives of the Department may perform comparison tests as necessary. If any portion of slurry is not within the specified ranges, adjust the mix and retest at no additional cost to the Department.

Prior to beginning drilling, pump slurry meeting the material requirements into the shaft, as directed by the Engineer. Pump slurry to the bottom of the shaft through a hose or tremie pipe. Pump until the slurry is at least 4 ft. above the lake water surface level, unless directed otherwise by the Engineer. Perform a set of tests to determine the properties of the slurry mix in the shaft and report the values to the Engineer immediately. (See the definition of a test set below.)

Perform tests to establish a consistent working pattern taking into account the mixing process and blending of freshly mixed slurry with previously used slurry. Perform a set of tests every 4 hours of slurry use, during drilling. Perform a set of tests immediately prior to and immediately after every drilling shift. Perform at least 1 test set per day after drilling is complete and prior to concreting. Representatives of the Department may perform comparison tests as necessary.

A set of tests is defined as: viscosity, pH, density, and sand content tests performed on samples extracted from the within 3 ft. of the shaft bottom, approximately mid-length of the shaft at the time of testing. At the discretion of the Engineer, sand content tests may be omitted on selected samples. Take samples using a sampling tool marked so that the depth of the slurry sample can be determined.

Report all test results to the Engineer immediately and add additional slurry, meeting the material requirements, and/or remove slurry to adjust the mix in the shaft when the slurry does not meet the requirements above; pump through a hose or tremie pipe

Take all steps necessary to prevent the slurry from caking along the sides of the shaft at no additional cost to the Department. Such methods may include but are not limited to agitation, circulation, re-reaming and or roughening with appropriate new bottom cleaning and slurry testing prior to placing concrete.

Prior to placing concrete in any shaft excavation, ensure that heavily contaminated suspensions which could impair the free flow of concrete have not accumulated in the bottom of the shaft excavation. Settling time after the completion of drilling may be necessary to accomplish this. Perform a set of tests after completing shaft excavation and initial cleanout. At no additional cost to the Department, remove suspended solids until all values of density and sand content are within the specification herein for the respective slurry type. Clean, re-circulate, de-sand or replace the slurry, as needed, in order to maintain the required slurry properties. Reuse of slurry will be permitted provided the slurry is cleaned, re-circulated, de-sanded, etc. to return the slurry to the specified properties.

Furnish written reports of all tests required above, signed by an authorized representative of the Contractor, to the Engineer on completion of each drilled shaft. Include shaft number, sampling and test times and dates, sample depths and elevations, and all test results.

3.4.7 Disposal

Dispose of all slurry after use. Dispose of slurry off site in areas approved by the Engineer at no additional cost to the Department and with no extension of contract time. Exercise care to ensure that slurry does not spill into the lake.

Take precautions to ensure that slurry within 15 to 20 ft. of the rising concrete head does not contaminate slurry to be mixed for subsequent shaft excavation. If this slurry is pumped into a mixing tank, use a separate tank. If this tank is to be for used for subsequent slurry mixing, clean the tank thoroughly after slurry disposal to ensure that concrete contamination has been removed. Verify that the tank has been sufficiently cleaned by filling it with water and performing a minimum of 3 pH tests. Continue cleaning the tank until the pH is below 9.

4.0 Execution

4.1 Equipment

Perform the excavations required for the shafts through whatever materials are encountered to the dimensions and elevations shown in the plans. Ensure the methods and equipment are suitable for the intended purpose and the materials encountered. Provide equipment capable of constructing shafts to a tip at Elevation 180 ft.

4.2 Construction Method

Construct drilled shafts as indicated in the plans or described in this Special Note. Propose a construction method on the basis of its suitability to the site conditions and submit it in the Drilled Shaft Installation Plan for acceptance by the Department. Provide a plan for installation of permanent casing from the top of the rock socket to a level capable of protecting the drilled shaft concrete from water action during concrete placement and curing, to a level required for the proposed drilling method, or to the casing cut-off elevation, whichever is higher. After shaft has been cast and reached a minimum strength of 2500 psi, remove permanent casing to the elevation indicated on the plans. Wet method construction techniques are anticipated at the bridge pier locations, and dry method techniques are anticipated at the End Bent 2 location.

4.3 Templates

Provide a fixed template, adequate to maintain shaft position and alignment during all excavation and concreting operations. Floating templates (attached to

a barge) will not be allowed. Design of templates is the responsibility of the Contractor. Keep templates in place as required to maintain the horizontal position of the drilled shafts.

4.4 Technique Drilled Shafts

Install a technique shaft at Station 3181+00, at project centerline to determine if the methods and equipment used by the contractor are sufficient to produce a completed shaft meeting the requirements of the plans and specifications. Install the technique shaft at Station 3181+00 to a tip at Elevation = 249.0 feet. Install the first technique drilled shaft and receive acceptance of the technique shaft from the Department prior to any bridge pier drilled shaft construction.

Install a second technique shaft for demonstration of methods and equipment in an area of known cavities in the bedrock at Station 3160+79 at the project centerline to a tip Elevation = 199.0 feet. Refer to Boring B5014W for information regarding the cavity depth and thickness within the limestone bedrock. The technique shafts will be non-production shafts having a diameter of 7 feet in the soil and a 6.5 feet diameter in the bedrock. Install the second technique drilled shaft and receive acceptance from the Department prior to construction of any drilled shafts at Piers 1 to 6.

The Contractor's ability to satisfactorily execute proposed construction operations and meet required tolerances will be evaluated during construction of the technique shafts. Subject technique shaft(s) to the same non-destructive testing as the production shafts as indicated in the Special Note for Non-Destructive Testing. Revise the methods and equipment as necessary to satisfactorily construct the drilled shaft within tolerances.

While placing the reinforcement cage, demonstrate to the satisfaction of the Engineer that the fabrication and handling methods to be used will result in reinforcing cages placed in the proper position, with the proper clearances, and without permanent bending, squashing, or racking of the reinforcement cage. During placement, bring the top of the cage to an upright position, lower it into the shaft excavation, and support the reinforcing cage for concrete placement.

Failure to demonstrate the adequacy of the concrete placement methods, and/or equipment during construction of the technique shafts is cause for the Engineer to require appropriate alterations in equipment and/or methods by the Contractor to eliminate unsatisfactory results. Provide any additional technique shafts required to demonstrate the adequacy of revised concrete placement methods or equipment at no additional cost to the Department and with no extension of contract time.

If at any time during or after the construction of the technique shafts the Contractor fails to satisfactorily demonstrate the adequacy of his methods and/or equipment, the Engineer may require that additional technique shafts be constructed at no additional cost to the Department with no extension of contract time. A post-construction meeting ~~will~~ may be required after the successful completion of the first technique shaft and prior to the rock excavation of the first production drilled shaft or the second technique shaft, whichever occurs first. Once acceptance has been given to construct production shafts, no changes will be permitted to the methods or equipment that were used to construct the satisfactory technique shaft(s) without written approval of the Engineer.

Cut-off the technique shafts at the existing mudline elevation (+/- 6 inches) upon acceptance of each technique drilled shaft. Complete cutting-off the technique drilled shafts within 15 business days of acceptance of the technique shafts. The cost of cutting-off the technique drilled shafts at the mudline is incidental to the unit bid price.

4.5 Excavations

The plans indicate the expected bottom of rock socket, top of rock socket, and top of shaft/bottom of footing elevations. Drilled shafts may be extended deeper if the Engineer determines that the material encountered while drilling the shaft excavation is unsuitable and/or is not the same as anticipated in the design of the drilled shaft. Drilled shafts may be shortened if the Engineer determines the material encountered is better than that anticipated.

Cleanout will be by cleanout bucket, air lift or other approved method. If determined by sonar caliper testing upon completion of the drilled shaft that material is caked on the permanent casing, clean the inside of the permanent casing using brushes or other accepted methods. Maintain the fluid elevation in the drilled shaft above the adjacent water surface elevation at times during cleanout. The cost of replacing water or slurry removed during cleanout is the responsibility of the contractor.

If the Contractor fails to satisfy the cleanout criteria on a shaft, submit, in writing, a remedial plan to the Engineer. Until the plan is accepted by the Engineer, no additional drilled shaft excavations can be started on the project. No additional compensation or working days will be allowed for any delays for work stoppage associated with non-compliance of the cleanout criteria.

Do not excavate shafts or install casing within 50 feet of a shaft containing concrete less than 24 hours old. Do not excavate a rock socket within 3 shaft diameters of an existing open rock socket until the adjacent rock socket has been cleaned and filled with reinforced concrete at least 24 hours old. Where karst is

encountered in the bedrock, no more than one rock socket can be open in a single pier location at the same time.

Maintain a construction method log during shaft installation. Include the following information in the log, including but not limited to the description and approximate top and bottom elevation of each soil or rock material, and remarks. Refer to FHWA publication FHWA-NHI-10-016 dated May 2010 for sample forms in Appendix F for information to be recorded.
https://www.fhwa.dot.gov/engineering/geotech/foundations/nhi10016/nhi10016.pdf

Provide the Department with the following records:

(1) Drilled Shaft Excavation Log
(2) Record of bottom cleanout and reinforcement cage placement.
(2) Drilled Shaft Concrete Placement Log
(3) Field and Theoretical Concreting Curves
(4) Drilling Slurry test data, if used.

The Engineer may request the submittal of other records.

Dispose of excavated materials which are removed from the shaft in accordance with the Standard Specifications and requirements of other regulatory agencies.

In dry shafts, likely only at End Bent 2, do not permit workmen to enter the shaft excavation for any reason unless both a suitable casing has been installed and adequate safety equipment and procedures meeting applicable OSHA requirements have been provided to workmen entering the excavation. Recommended Procedures for the Entry of Drilled Shaft Foundation Excavations, prepared by ADSC: The International Association of Foundation Drilling, provides guideline recommendations for down-hole entry of drilled excavations.

If the Contractor intends to use divers for any reason to inspect wet drilled shafts or decides after the start of drilled shaft installation to use divers inside the drilled shafts, submit a plan meeting applicable OSHA requirements to the Department for review and acceptance.

4.6 Horizontal Cavity and Vertical Crevice Remediation

Horizontal cavities and vertical crevices are anticipated to be encountered in some of the drilled shaft rock sockets. Borings made at or near the proposed bridge pier locations are shown on the Subsurface Data Sheets. Voids are noted on the Subsurface Data Sheet drawings when encountered in the geotechnical

exploration programs. The borings have revealed the presence of occasional horizontal cavities and pinnacles and valleys at the rock surface.

Submit an initial plan to remediate karst (cavities) conditions based on the available boring and rock core information at the time of bidding, per Section 2.4 of this Special Note. After completing the required subsurface exploration at the drilled shafts in Piers 1 to 6, submit a revised cavity remediation plan based upon the conditions encountered ~~in the~~ during the Contractor's subsurface exploration program and/or installation of technique drilled shaft with remediation or during installation of production drilled shafts with remediation, per Section 2.7 of this Special Note. The revised cavity remediation plan only needs to be submitted if conditions are encountered in the Contactor's subsurface exploration that warrant revision of the initial cavity remediation plan, such as cavities/voids in areas that were not indicated in the borings available at time of bidding or voids that extend deeper than the elevations encountered in the borings available at time of bidding. Provide written details addressing the possibility of encountering cavities/voids in drilled shaft construction if they were not encountered in any boring performed by the Department or by the Contractor's drilling consultant, including at Piers 7 and 8. Address how the results of Sonar Caliper Testing will be used to make possible adjustments to drilled shaft remediation.

Seal all horizontal cavities encountered within the drilled shafts 12 inches in dimension or less at the perimeter of the drilled shaft socket sufficiently to prevent concrete loss or clay or other cavity-filling material from entering the drilled shaft during shaft construction. A possible method for sealing these horizontal cavities includes filling the cavities with concrete or grout and redrilling the rock sockets (See Sheets DS1 and DS2 in the Appendix to this Special Note for conceptual sketches of this method). Use sonar caliper testing to determine the presence and vertical dimension of any horizontal cavities are present along the perimeter of the rock socket that were not revealed by the test borings (See Special Note for Non-Destructive Testing in Drilled Shafts).

Seal all horizontal cavities encountered within the drilled shafts greater than 12 inches in dimension at the perimeter of the drilled shaft socket sufficiently to prevent concrete loss or clay or other cavity-filling material from entering the drilled shaft during shaft construction. Possible methods for sealing horizontal cavities include: 1.) installing a steel casing from the top of bedrock socket to some depth below the encountered void into competent bedrock to seal off the void and limit loss of concrete in the encountered void (See Sheet DS3 in the Appendix to this Special Note for a conceptual sketch of this method) or 2.) filling the cavities with concrete and redrilling the rock sockets. Include methods to regain circulation of drilling fluids during drilling when voids are encountered, such as possibly pumping concrete/grout to seal the excavation and reestablishing circulation of drilling fluids. These potential methods are for

information only. Include the method for sealing cavities proposed for use in the Drilled Shaft Installation Plan (Section 2.3, Item (r).). Sealing methods are subject to acceptance by the Department.

For drilled shafts encountering a vertical crevice greater than 6 inches wide below a depth of 5 feet below the top of bedrock as determined by the Contractor and with the acceptance of the Department, the horizontal cavity remediation procedure using casing shown on Sheet DS3 in the Appendix of this Special Note may be implemented. The Contractor may propose alternative remediation procedures for vertical crevice remediation. It is acceptable to propose alternative remediation procedures to provide sufficient lateral resistance. Alternative methods are subject to the acceptance of the Department.

At the End Bent 2 location, where dry construction methods are likely to occur, propose in the Installation Plan per Section 2.3 of this special note a method for detecting the presence of horizontal cavities in the sidewalls of the rock sockets and vertical crevices in the rock sockets. The use of a scratcher/feeler bar or video methods are considered suitable methods by the Department, but alternative methods of rock socket sidewall inspection would need to be accepted by the Department prior to performing the drilled shaft construction at End Bent 2.

4.7 Obstructions

Remove any subsurface obstructions as they are encountered. Such obstructions may include man-made materials such as old concrete foundations or natural materials such as boulders or trees. Employ special procedures and/or tools when the hole cannot be advanced using conventional augers fitted with soil teeth, drilling buckets, and/or underreaming tools. Such special procedures or tools may include but are not limited to rock augers, core barrels, air tools, hand excavation, temporary casing, or increasing the hole diameter. Blasting is not permitted. Removal of exploratory drilling tools at Drilled Shafts 6 and 66, or lost by the Contractor's drilling consultant at any other shaft locations, are incidental to drilled shaft construction. No extra payment will be made for obstruction removal and is incidental to the applicable unit price bid for "Drilled Shafts".

Remove all drilling tools which are lost by the Contractor in the excavation promptly without compensation. All costs due to tool removal are at the sole expense of the contractor including but not limited to costs associated with excavation degradation due to removal operations or the time the hole remains open.

4.8 Protection of Existing Structures

Take precautions to prevent damage of existing structures and any existing utilities. Such measures include, but are not limited to, monitoring and controlling the vibrations from driving/vibrating/oscillating/rotating casing or excavating the shafts, and selecting construction methods and procedures that prevent excessive caving of the shaft excavations. Refer to Special Note for Vibration Monitoring for information regarding required precondition surveys and threshold vibration values for the existing bridge structure.

4.9 Inspection of Excavations

Provide safe access and equipment for checking the dimensions and alignment of each shaft. Use a safe device with handrails meeting all applicable OSHA requirements and approved by the Engineer to provide access for project inspectors at the top of casing at the center and any plan location in the shaft. Determine the dimensions and alignment of the shaft under the observation and direction of the Engineer. Cooperate with the Department in the use of any inspection device.

Using a Shaft Inspection Device (SID), verify that the shaft bottom has been adequately cleaned. Perform SID inspection once the accepted bottom of drilled shaft excavation has been achieved and the bottom cleaning of the shaft has been performed. Use SID's with a high-resolution camera mounted in a watertight chamber and fitted with a depth gauge(s) to indicate the thickness of the debris on the shaft bottom. Mini-SID devices meeting the specified requirements of this section will be considered for acceptance by the Department. Have a horizontal gage(s) fitted to the SID in the event any fractures or crevices are observed at the base of the shaft excavation. Furnish all equipment necessary to conduct the SID inspection. Provide nitrogen gas or other means to pump the water out of the interior of the chamber such that the bottom of the shaft is visible. Do a minimum of nine (9) drops as follows: north, northwest, northeast, south, southwest, southeast, east, west, and center to measure sediment at the bottom of the shaft. Operate the SID camera and supporting equipment ~~under the direction of the Engineer~~ in such a manner as to obtain optimum clarity from the equipment acceptable to the Engineer. Use television cameras and lighting equipment capable of operating in submerged conditions encountered during the inspection. Record the observations for the shaft bottom on a DVD or flash drive in .mov, .avi or other acceptable electronic format specified by the Engineer to become the property of the Department upon completion of the project. Store DVD's or flash drives in proper containers with dust tight closures. Label DVD's or flash drives as to shaft number, project number, job piece, contract number, and contractor name.

Furnish DVD's or flash drives to the Engineer upon completion of the SID inspection.

Estimate sediment thickness at the bottom of the shaft in terms of percent of view with sediment thicknesses greater than ½ inch and percent of view with sediment thickness greater than 1 ½ inch at each location. If the average percent of view of sediment thickness greater than ½ inch between all nine locations is greater than 50%, or if the sediment thickness at any point is greater than 1 ½ inch, the SID test will be considered failed. Perform additional bottom cleaning of the failed shaft using air lift methods. After the Contractor has completed final cleaning, repeat the SID test. Use of weighted tapes to measure sediment at the bottom of the shafts will not be accepted by the Department. Report results of bottom inspection to the Engineer. Continue cleaning until the Engineer is satisfied that the shaft bottom is adequately cleaned and the excavation is approved.

During the SID inspection, report any fractures or crevices observed at the bottom of the shaft. Report any fractures or crevices to the Department. The Department will determine if any vertical crevice remediation will be required.

If the bottom profiling performed during Sonar Calipering Testing or bottom inspection methods approved by the Engineer indicates that excessive sediments as defined above are present on the bottom of the rock socket, perform additional cleanout at the direction of the Engineer.

The cost of inspection equipment and time, including SID inspection and inspection of the sidewalls of the rock sockets at End Bent 2, is incidental to the price per foot of shaft. Sonar Calipering, Crosshole Sonic Logging and Thermal Integrity Profiling, are separate pay items for production and technique drilled shafts, as defined in the Special Note for Non-Destructive Testing in Drilled Shafts.

At the End Bent 2 location, where dry construction methods are likely to occur, propose in the Installation Plan per Section 2.3 of this special note a method for confirming the bottom of the shaft has been adequately cleaned. SID inspection will be considered acceptable by the Department, but alternative methods of bottom inspection would need to be accepted by the Department prior to performing the drilled shaft construction at End Bent 2.

4.10 Construction Tolerances

The following construction tolerances apply to drilled shafts:

a) Provide drilled shafts within 3 inches of plan position in the horizontal plane at the top of the shaft. Provide drilled shafts within 3 inches of plan position in the horizontal plane at the top of the rock socket. Construct the drilled shaft such that the shaft between the top of the rock socket and the top of the shaft is within 1.5% of plumb. All three requirements will be applied simultaneously. Replace any additional steel reinforcement or concrete needed in the footing due to the misalignment of the shafts at no additional cost to the Department.

b) Provide vertical alignment of the rock sockets that do not vary from the plan alignment by more than 1/4 inch per foot of depth. (At the top of the rock socket, maintain the centerline of the rock socket within 1.5 inches, in the horizontal plane, of the centerline of the drilled shaft above it).

c) Extend the vertical reinforcement a minimum value into the footing, as shown on the plans. Extend the spiral reinforcement above the top of permanent casing into the footing as shown in the plans.

d) All drilled shaft diameters shown on the plans refer to inside casing dimensions. The contractor may provide a thicker-walled casing than shown in the plans at no additional cost to the Department, but do not increase the inside diameter of the casing shown on the plans. For out-of-round tolerance of steel casings before and after installation, the departure of any point on the periphery of the casing from the true circle, the maximum tolerable departure of any point is 1 inch measured radially.

e) Design excavation equipment and methods so that the completed shaft excavation will have a planar bottom. Maintain the cutting edges of excavation equipment normal to the vertical axis of the equipment within a tolerance of ± 3/8 inch per foot of diameter. Maintain the tip elevation of the shaft within 6 inches from final shaft tip elevation unless otherwise specified in the plans.

The Engineer will use the results of Sonar Calipering to evaluate the construction tolerances; refer to the Special Note for Non-Destructive Testing. Drilled shaft excavations and completed shafts not constructed within the required tolerances are unacceptable. Correct all unacceptable shaft excavations and complete shafts to the satisfaction of the Engineer. Furnish materials and work necessary, including engineering analysis and redesign, to complete corrections for out of tolerance drilled shaft excavations without either additional cost to the Department or an extension of the contract time.

The contractor is responsible for proposing, developing, and after acceptance by the Engineer, implementing corrective work when a shaft excavation is completed with unacceptable tolerances. Typical corrective work includes:

a) Overdrilling the shaft excavation to a larger diameter and/or depth to permit accurate placement of the reinforcing steel cage with the required minimum concrete cover.
b) Increasing the number and/or size of the steel reinforcement bars.
c) Removing the cage and drilling out the green concrete and reforming the hole.

The acceptance of correction procedures is dependent on analysis of the effect of misalignment and improper positioning. Submit redesigned drawings and computations that are signed by a Professional Engineer licensed in Kentucky.

4.11 Reinforcing Steel Cage Fabrication and Placement

Assemble the reinforcing steel cage, consisting of vertical bars, ties, spirals, cage stiffener bars, spacers, centering devices, and other necessary appurtenances, as a prefabricated unit and place the reinforcing cage immediately after the shaft excavation is inspected and accepted, and just prior to concrete placement. Extend the reinforcing cage to the elevation shown in the plans, but not less than 5 ft. above lake level. Provide steel reinforcement meeting the requirements indicated in the drawings.

Provide reinforcing steel 100% double-wire tied and supported so that it will remain within allowable tolerances for position. Use approved mechanical couplers for splicing the vertical reinforcement. Splice no more than 50% of the vertical reinforcing at any horizontal plane. Provide three feet clear between the couplers of adjacent splices. Provide enough steel reinforcement and mechanical couplers in the event the drilled shaft tip elevations are lowered to Elevation 180 feet. Use bands, temporary cross ties, etc. as required to provide a reinforcement cage of sufficient rigidity to prevent racking, permanent deformations, etc. during installation.

Provide concrete centering devices or other acceptable noncorrosive centering devices at sufficient intervals along the length of the reinforcement cage to insure concentric spacing for the entire cage length. Provide, as a minimum, a set of non-corrosive centering devices at intervals not exceeding 10 feet throughout the length of the shaft. As a minimum, provide a set of centering devices within 2 feet of the top and 2 feet of the bottom of the shaft. In addition, provide one set of centering devices 2 feet above and 2 feet below each change in shaft diameter. As a minimum, provide non-corrosive centering devices at sixty degree intervals around the circumference of the shaft to maintain the required reinforcement clearances. Provide the centering devices with adequate dimension to maintain the specified annular clearance between the outside of the reinforcing cage and the side of the excavated hole or casing.

Concrete centering devices and feet will be constructed of concrete equal in quality and durability to the concrete specified for the shaft. Provide acceptable cylindrical feet (bottom supports) to insure that the bottom of the cage is maintained a minimum of 3 inches clear above the bottom of the drilled shaft excavation. The feet are not intended to support the weight of the cage.

In the event that the shaft has been excavated below the anticipated tip elevation, extend the reinforcing cage at the bottom with mechanical connectors in conformance with the Standard Specifications, using the specified staggering requirements.

During concrete placement, support the reinforcing cage at or near the top of shaft such that the bottom of the vertical cage reinforcing bars are positioned approximately 3 inches above the bottom of rock socket elevation. Top of cage supports may be removed twenty-four (24) hours after the completion of concrete placement, but not before shaft concrete has reached a compressive strength of 2500 psi.

Check the elevation of the top of the reinforcing cage before and after the concrete is placed. If this reinforcing cage is not maintained within the specified tolerances, correct the reinforcing cage location to the satisfaction of the Engineer. Do not construct additional shafts until the contractor has modified the reinforcing cage support to obtain the required tolerances.

4.12 Concrete Placement

Perform concrete placement in accordance with applicable portions of the Standard Specifications and with the requirements set forth herein. Do not apply the provisions of structural mass concrete requirements to concrete placement of the Drilled Shafts.

Begin concrete placement as soon as practicable after reinforcing steel placement but no later than forty eight (48) hours after completion of the shaft excavation. Maintain continuous concrete placement from the bottom to above the top elevation of the shaft. If the Contractor would like to pour the drilled shaft to an elevation different than indicated on the plans, submit a request and the reason for a different top of concrete elevation in the drilled shaft to the Engineer for review and acceptance. The Contractor is responsible for ensuring that sound concrete is present at the top of the shaft and will be required to remove any unsound concrete at no additional cost to the Department. Carefully remove any remaining concrete and excess casing above plan top of shaft after curing.

Maintain the slump requirements in Section 3.1.1 of this Special Note. Adjust the admixtures, when accepted for use, in the concrete mix for the conditions encountered on the project so that the concrete remains in a workable plastic state throughout the placement. Satisfactorily perform slump loss tests that demonstrate that the concrete will maintain the requirements in Section 3.1.1 of this Special Note. Conduct the slump loss tests using concrete and ambient temperatures appropriate for site conditions.

Provide an acceptable backup plan that accounts for potential breakdowns in placement equipment or the batch plants equipment that will permit the operation to continue with a maximum of one hour delay.

Failure to demonstrate the adequacy of the concrete placement methods, and/or equipment during construction of any production shafts is cause for the Engineer to require appropriate alterations in equipment and/or methods by the Contractor to eliminate unsatisfactory results. Provide any additional technique shafts required to demonstrate the adequacy of revised concrete placement methods or equipment at no additional cost to the Department and with no extension of contract time.

Place concrete through a tremie. Provide tremies used to place concrete consisting of a tube of sufficient length, weight, and diameter to discharge concrete at the shaft base elevation. The tremie pipe needs to be located within 3 ft. of the center of the shaft. Tremies containing aluminum parts that will be in contact with the concrete are not acceptable. Provide a tremie with an inside diameter of at least 6 times the maximum size coarse aggregate to be used in the concrete mix but not be less than 10 inches. Provide tremie pipes with inside and outside surfaces that are clean and smooth to permit both flow of concrete and unimpeded withdrawal during concreting. Provide tremies with a wall thickness that is adequate to prevent crimping and without sharp bends that restrict concrete placement.

Construct tremies to deposit concrete so that they are watertight and will readily discharge concrete. Provide tremies with sufficient weight so that it will rest on the shaft bottom before start of concrete placement. Provide a tremie with sufficient length to extend to the bottom of the excavation. Do not begin underwater placement until the tremie is at the shaft base elevation. Valves, bottom plates, or plugs may be used only if concrete discharge can begin within approximately 2 inches above the excavation bottom. Remove plugs from the excavation, or provide plugs consisting of a material accepted by the Engineer that will not cause defects in the completed drilled shaft if not removed. Construct the discharge end of the tremie to permit the free radial flow of concrete during placement operations. Keep the tremie discharge end at or near the bottom of excavation as long as practical during concrete placement. Sustain the tremie discharge end immersed as deep as practical in the concrete but not less than 10 feet at all times. Excessive immersion may cause the rebar cage to rise. Maintain continuous flow of the concrete during placement. Maintain the concrete in the tremie at a positive pressure differential at all times to prevent water or slurry intrusion into the shaft concrete.

If at any time during the concrete pour the tremie line orifice is removed from the fluid concrete column and discharges concrete above the rising concrete surface, the entire drilled shaft will be considered defective. In such case, remove the reinforcing cage, concrete, and repour the shaft. Replacement of defective shafts and all associated costs are the responsibility of the contractor at no additional cost to the Department and with no extension of contract time.

Concrete pumps and lines may be used for concrete placement. Five inches is the minimum diameter for all pump lines. Construct all pump lines with watertight joints.

Drilled shafts which are completed but do not meet the concrete placement requirements of this Special Note or contract plans are unacceptable. Correction of all unacceptable completed shafts to the satisfaction of the Engineer is the responsibility of the Contractor. Furnish materials and work necessary, including engineering analyses and redesign, to complete corrections for unacceptable concrete placement without additional cost to the Department or an extension of the contract time. Propose, develop, and implement corrective work, after acceptance by the Engineer. Typical corrective procedures are outlined in Section 4.9 of this Special Note.

4.13 Subsurface Exploration

Exploratory borings with rock coring were performed by the Department prior to letting of the construction contract. Information regarding the exploratory borings and the boring logs are available via the KYTC Division of Construction Procurement Website under “Project Related Information”. The referenced geological literature and geotechnical information are for information only and are not contract documents. However, available subsurface data are included in the bridge plans which are contract documents.

Prior to the construction of the drilled shafts and under the ~~direction~~ observation of the Department, perform subsurface exploration borings with rock core at locations accepted by the Department based on the Subsurface Exploration Plan per Section 2.3 of this Special Note. Select subsurface exploration borings locations based on the following table, location requirements in this section of the Special Note and Sheet DS4 in the Appendix of this Special Note, or as the Engineer directs to determine the characteristics of the material that the shaft extends through and the material directly below the shaft excavation. When directed by the Department, due to unanticipated voids/cavities in the bedrock during drilled shaft installation, complete subsurface exploration borings prior to continuing excavation for any remaining drilled shafts in the bridge pier where subsurface exploratory borings have been requested.

Bridge Pier/End Bent Location	Drilled Shaft Number	Station	Offset	Alignment
Pier 1	1	See Sheet DS4 attached to this Special Note		
Pier 1	2	See Sheet DS4 attached to this Special Note		
Pier 1	3	See Sheet DS4 attached to this Special Note		

Bridge Pier/End Bent Location	Drilled Shaft Number	Station	Offset	Alignment
Pier 2	4	See Sheet DS4 attached to this Special Note		
Pier 2	5	See Sheet DS4 attached to this Special Note		
Pier 2	6	See Sheet DS4 attached to this Special Note		
Pier 3	7	See Sheet DS4 attached to this Special Note		
Pier 3	8	See Sheet DS4 attached to this Special Note		
Pier 3	9	See Sheet DS4 attached to this Special Note		
Pier 4	10	See Sheet DS4 attached to this Special Note		
Pier 4	11	See Sheet DS4 attached to this Special Note		
Pier 4	12	See Sheet DS4 attached to this Special Note		
Pier 5	13	See Sheet DS4 attached to this Special Note		
Pier 5	14	See Sheet DS4 attached to this Special Note		
Pier 5	15	See Sheet DS4 attached to this Special Note		
Pier 6	16	See Sheet DS4 attached to this Special Note		
Pier 6	17	See Sheet DS4 attached to this Special Note		
Pier 6	18	See Sheet DS4 attached to this Special Note		
End Bent 2	54	3186+00	27’ Left	US68/80

Unless directed otherwise, extend subsurface exploration borings with rock core a minimum depth of 35 feet below the bottom of the lowest encountered void in the boring being performed (a void is considered to be a cavity in the rock core having a thickness of 3 inches or greater) or to the elevations in the table below, whichever is deeper. Where no voids are encountered, extend the borings with rock core to the elevations in the table below. Refer to the following table for estimated top of bedrock and bottom of rock core elevation at each Bridge Pier Location, actual depths may need to be adjusted based on the encountered lowest void in the rock cores. Do not drill more than 100 feet below the encountered top of bedrock elevation without contacting the Department. Refer to the bottom of lowest encountered void elevations in the existing borings on the Subsurface Data Sheets in the plans and Sheet DS5 in the Appendix to this Special Note to estimate boring depths where cavities in the bedrock were encountered in previously performed borings.

Substructure Unit	Estimated Top of Bedrock Elevation (ft.)	Highest Allowable Bottom of Rock Core Elevation (ft.)*
Pier 1	269 to 263	215
Pier 2	261	215
Pier 3	244 to 260	190
Pier 4	250 to 259	215
Pier 5	258	170
Pier 6	258	215
End Bent 2	365	336

*May need to core deeper based upon actual conditions encountered in the rock cores.

Perform the borings/rock cores located at each drilled shaft within Bridge Piers 1 to 6 using appropriate access means, such as a barge to access these locations or a trestle structure. Access the land borings at the bridge end bent drilled shaft locations with rotary drill equipment mounted on an appropriate carrier. Develop a plan proposing two rock core boring locations at each specified drilled shaft at Bridge Piers 1 to 6 such that both borings are located within the proposed drilled shaft rock socket perimeter. Include in the plan a boring at the center of Drilled Shaft 54 located at End Bent 2. Submit the plan for acceptance by the Department. Locate borings within a distance of 1 foot in the east/west direction and 1 foot in the north/south direction of the planned location. Maintain final proposed boring/rock core locations a minimum edge-to-edge distance of 1.5 feet from previously performed boring/rock core locations and within the perimeter of the proposed drilled shaft rock socket perimeter. Obtain data for the previously performed boring locations on the Subsurface Data Sheets and Sheet DS5 in the Appendix to this Special Note.

Perform rock soundings though the soil (drilling without sampling), since the drilled shafts extend into the bedrock. Perform rock core drilling according to the Department's Geotechnical Manual. When the Engineer directs, perform additional subsurface exploration borings prior to drilled shaft construction. Measure rock cores and visually identify and describe them on the subsurface log according to the Department's current Geotechnical Manual. Subsurface exploration borings must be performed by contractors/consultants prequalified by the Department's Division of Professional Services for Geotechnical Drilling Services at the time that field work begins. Submit the driller's logs for each rock core boring to the Department within 3 business days of completing each rock core boring. Allow access by the Department during drilling operations to observe and log the collected rock core at the project site.

The Department representative(s) may be on-site during the subsurface exploration process to evaluate the soil and/or rock core samples. The representative(s) will determine the need to extend the borings to depths greater

than the depths previously specified. Handle, label, identify, and store soil and/or rock samples according to the Department's current Geotechnical Manual and deliver them with the subsurface logs to the geotechnical branch's rock core lab in Frankfort within 3 business days of completing all of the required borings, unless directed otherwise.

The Engineer will inspect the cores and determine the final depth of required excavation (final drilled shaft tip elevation at drilled shaft foundations in Bridge Piers 1 to 6) based on evaluation of the material's suitability. The Engineer will establish the final tip elevations for shaft locations based on the results of the subsurface exploration. Within 15 business days after completion of the subsurface exploration borings, the Engineer will notify the contractor of the final tip elevations for shaft locations. The final drilled shaft tip elevations may require additional modification based on any revised cavity remediation plans submitted by the Contractor per Section 2.7 of this Special Note.

5.0 Method of Measurement

5.01 Drilled Shaft, Common and Drilled Shaft, Rock

The drilled shafts will be measured for payment to the nearest 0.1 foot of shaft in place. Drilled shaft top of rock elevation is shown in the plans. For pay purposes, the length of any drilled shaft installed above the Drilled Shaft Top of Rock Elevation (Design) as defined in the plans and measured in the field will be measured and paid for at the unit price bid for 'Drilled Shaft, Common'. Drilled shaft installed below the Drilled Shaft Top of Rock Elevation (Design) shown in the plans will be measured and paid for at the unit price bid for 'Drilled Shaft, Rock'.

5.02 Technique Drilled Shafts

The designated technique drilled shaft(s) will be measured for payment at the unit price of each. Technique Shaft unit bid price will refer to the technique shaft at Station 3181+00. Technique Shaft with Remediation unit bid price will refer to the technique shaft at Station 3160+79. Additional technique shafts required due to the Contractor's failure to demonstrate the construction methods will result in an acceptable drilled shaft will be at no cost to the Department.

5.03 Slurry and Temporary Casing

The use of "Polymer Slurry" or "Temporary Casing" will be incidental to the drilled shaft installation. There will be no payment for water used as a drilling slurry. The permanent steel casing indicated in the plans is incidental to the Drilled Shaft-Common unit price. Grouting between any temporary steel casing and

permanent steel casing is incidental to the unit price bid for 'Drilled Shaft Common'.

5.04 Remediated Drilled Shaft – Common and Rock

Horizontal cavity remediation for karst or remediation of encountered vertical crevice remediation using permanent steel casing or other methods to seal off the cavities ('Remediated Drilled Shaft-Common') will be measured for payment to the nearest 0.1 foot from the top of shaft elevation in the plans to the top of bedrock for all diameters of drilled shafts for the piers shown on the plans. Horizontal cavity remediation for karst or remediation of encountered vertical crevice remediation using steel casing or other accepted methods to seal off cavities in the rock ('Remediated Drilled Shaft-Rock') will be measured for payment to the nearest 0.1 foot from the top of bedrock to the bottom of the remediated drilled shaft for all diameters of drilled shafts for the piers shown on the plans. Any splicing of permanent steel casing or reinforcing steel is incidental to the Remediated Drilled Shaft-Common and Remediated Drilled Shaft-Rock unit bid prices. Any required concrete or grout pumped to reestablish drilling fluid return will be paid under the unit bid price for 'Cavity Stabilization' in Section 5.0.5 of this Special Note.

For 'Remediated Drilled Shaft-Common' and 'Remediated Drilled Shaft-Rock' there are three cases as follows:

A. Where horizontal cavities are anticipated from the existing borings and are indicated on the plans, the unit bid price for 'Remediated Drilled Shaft-Common' will be used in lieu of~~replace~~ the 'Drilled Shaft, Common' unit bid price and the 'Remediated Drilled Shaft-Rock' unit bid price will be used in lieu of~~replace~~ the 'Drilled Shaft, Rock' unit bid price on shafts where 'Remediated Drilled Shaft-Common' and 'Remediated Drilled Shaft-Rock' are indicated in the plans.

B. Where 'Rock Corings' performed by the contractor encounter cavities in the bedrock that were not indicated on the plans or by the existing borings and are greater than one foot in vertical dimension, the unit bid price for 'Remediated Drilled Shaft-Common' will be used in lieu of~~replace~~ the 'Drilled Shaft, Common' unit bid price and the 'Remediated Drilled Shaft-Rock' unit bid price will be used in lieu of~~replace~~ the 'Drilled Shaft, Rock' unit bid price. On these drilled shafts, the Contractor will be paid by deducting the quantity of unit bid price for 'Drilled Shaft, Common' and 'Drilled Shaft, Rock' and adding the quantity of unit bid price for 'Remediated Drilled Shaft-Common' and 'Remediated Drilled Shaft-Rock' based upon the revised quantities provided by the Engineer for these drilled shafts.

Where 'Rock Corings' performed by the contractor do not encounter cavities in the bedrock and quantities were assigned for 'Remediated Drilled Shaft-Common' and 'Remediated Drilled Shaft-Rock', the pay items will revert back to the 'Drilled Shaft-Common' and Drilled Shaft-Rock' pay items.

~~B.~~C. Where horizontal cavities are encountered (at locations where the existing or construction-phase borings did not indicate cavities in the bedrock) requiring remediated drilled shaft, the 'Remediated Drilled Shaft-Common' and 'Remediated Drilled Shaft-Rock' unit bid price will be paid in addition to the already performed unit bid price for 'Drilled Shaft, Common' and 'Drilled Shaft, Rock' to depth on that drilled shaft where the voids are encountered.

Permanent steel casing used within the bedrock to seal cavities and any required temporary steel casing will be incidental to the contract unit bid price for 'Remediated Drilled Shaft-Common' and the unit bid price for 'Remediated Drilled Shaft-Rock'. Grouting between any temporary steel casing and permanent steel casing is incidental to the unit price bid for 'Remediated Drilled Shaft-Common' and the unit bid price for 'Remediated Drilled Shaft-Rock'. The rock socket excavation below the 'Remediated Drilled Shaft-Rock' will be paid at the unit bid price for 'Drilled Shaft, Rock' for the specified rock socket diameter indicated in the contract plans.

5.05 Cavity Stabilization and Redrilling Cavity Stabilization

Concrete or grout used to seal cavities in the bedrock between 3 inches and 12 inches in thickness will be measured in cubic yards. Concrete or grout used to seal cavities in the bedrock to resume lost drilling fluid return during 'Remediated Drilled Shaft-Rock' will be measured in cubic yards. Redrilling through the cavity stabilization will be measured to the nearest 0.1 foot from the top of the concrete/grout to the elevation in the bedrock where the Contractor stopped drilling prior to placing cavity stabilization.

5.06 Rock Soundings and Rock Corings

Rock Soundings for subsurface exploration will be measured to the nearest 0.1 foot from the top of the encountered mudline or ground surface to the top of encountered bedrock. Depth from the barge deck to the mudline is incidental to the Rock Soundings unit bid price. Rock Corings for subsurface exploration will be measured to the nearest 0.1 foot from the top of encountered bedrock to the depth the rock core is extended below the top of encountered bedrock, including voids/cavities.

5.1 Basis of Payment

5.1.1 Drilled Shaft, Common and Drilled Shaft, Rock

Payment for the accepted quantities of drilled shafts will be paid for at the contract unit price bid per linear foot of drilled shaft of the size and type shown. This will constitute full compensation for all material, labor and incidental costs necessary to complete the drilled shafts. No additional compensation will be permitted for shafts constructed larger in diameter than those shown on the plans.

5.1.2 Technique Drilled Shafts

Payment for the designated technique drilled shafts will be paid for at the contract unit price bid per each of the size and type shown in the plans for 'Technique Shaft' and 'Technique Shaft with Remediation'. This will constitute full compensation for all material (including, but not limited to, permanent casing, temporary casing, grout infill between casings, drilled shaft remediation, concrete and reinforcing steel), labor and incidental costs necessary to complete the technique drilled shafts, including excavation through soil and the rock drilling and any drilled shaft remediation to complete the designated rock socket length in the plans. No additional compensation will be permitted for a technique shaft constructed larger in diameter than that shown on the plans. Cavity stabilization and redrilling through cavity stabilization will be paid per the bid unit prices described in Section 5.1.4.

5.1.3 Remediated Drilled Shaft

Payment for the accepted quantities of remediation of horizontal cavities greater than 12 inches in thickness in the bedrock, including remediation of vertical crevices, will be paid for at the contract unit price bid for linear foot of remediated drilled shaft-common and remediated drilled shaft-rock for all diameters of drilled shafts shown on the plans.

5.1.4 Cavity Stabilization and Redrilling Cavity Stabilization

Payment for Cavity Stabilization to stabilize cavity excavation in the bedrock or for drilled shaft remediation will be paid at the contract unit price shown. Redrilling through the cavity stabilization will be paid at the contract unit price for Redrilling Cavity Stabilization for all diameters of drilled shafts shown on the plans.

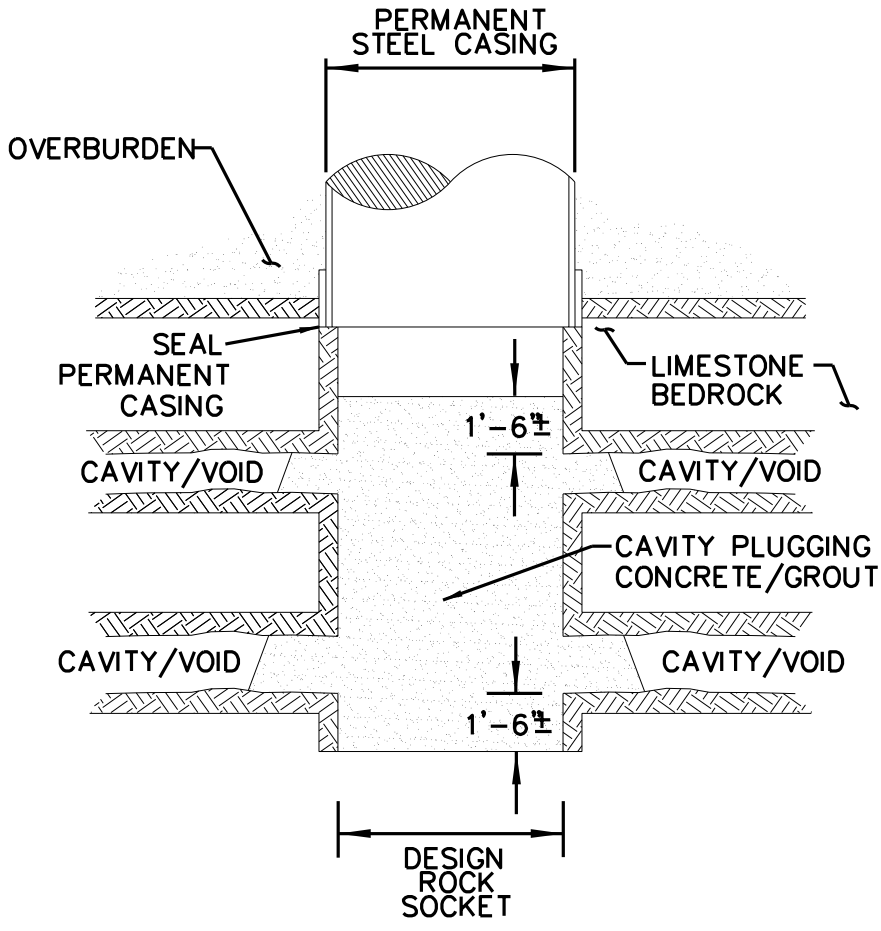
5.1.5 Rock Soundings and Rock Corings

The Department will measure Rock Soundings (advancing the boring to bedrock) and Rock Corings shown on the plans, as specified in Section 5.0 of this Special Note, and as the Engineer directs, in linear feet to the nearest 0.1-foot. The Department will not measure or pay for subsurface exploration performed deeper than the elevations indicated on the plans and/or in this Special Note, unless directed by the Engineer, and will consider it incidental to these items of work. Additionally, the Department will consider all mobilization, equipment, labor, incidental items, and operations necessary to complete the boring operations incidental to these items of work.

Payment will be made under:

Code	Pay Item	Pay Unit
23583EC	Drilled Shaft-48 IN-Common	Linear Foot
23584EC	Drilled Shaft-42 IN-Rock	Linear Foot
23249EC	Drilled Shaft-72 IN Common	Linear Foot
23000EX	Drilled Shaft-66 IN (Rock)	Linear Foot
24732EC	Drilled Shaft-84 IN-Common	Linear Foot
24733EC	Drilled Shaft-78 IN-Rock	Linear Foot
22588NN	Technique Shaft	Each
24734EC	Technique Shaft with Remediation	Each
24735EC	Remediated Drilled Shaft-Common	Linear Foot
24736EC	Remediated Drilled Shaft-Rock	Linear Foot
24737EC	Cavity Stabilization	Cubic Yard
24738EC	Redrilling Cavity Stabilization	Linear Foot
20745ED	Rock Soundings	Linear Foot
20746ED	Rock Corings	Linear Foot

APPENDIX



STEP 1

FOR INFORMATION ONLY

THE PROCEDURE DESCRIBED ON THIS DRAWING IS ONE FEASIBLE CAVITY SEALING REMEDIATION PROCEDURE. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO SUBMIT THE PROPOSED CAVITY SEALING PROCEDURE AS PART OF THE DRILLED SHAFT EXCAVATION PLAN SUBMITTAL.

STEP 1:

1. INSTALL PERMANENT CASING THROUGH OVERBURDEN INTO TOP OF LIMESTONE. SEAL OVERBURDEN/ROCK INTERFACE. EXCAVATE MATERIAL FROM CASING.
2. ADVANCE ROCK SOCKET TO AN ELEVATION 1'-6" BELOW BOTTOM LIMITS OF LOWEST CAVITY ENCOUNTERED IN BORINGS. A CAVITY IS DEFINED AS A VOID 3" TO 12" IN DIMENSION AT THE PERIMETER OF THE ROCK SOCKET. SONAR CALIPER ROCK SOCKET TO CONFIRM VOID DIMENSIONS.
3. TREMIE POUR CONCRETE OR GROUT MIX (CONCRETE/GROUT CAVITY STABILIZATION) AND SOCKET TO AN ELEVATION 1'-6" ABOVE LIMITS OF UPPERMOST CAVITY.

SCALE: NOT TO SCALE

ITEM NUMBER
01-180.60

DATE: 11/07/14	CHECKED BY
DESIGNED BY:	
DETAILED BY:	

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: TRIGG

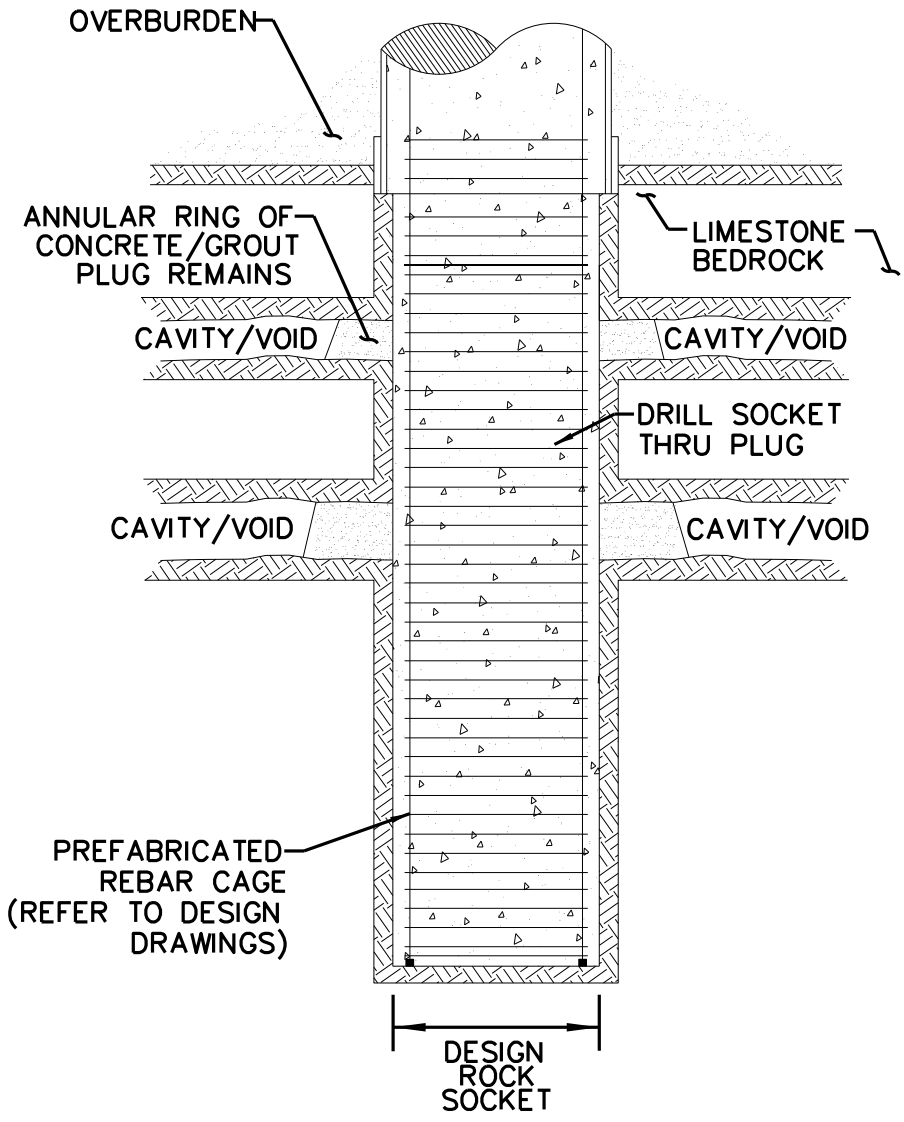
ROUTE	CROSSING
US 68	LAKE BARKLEY

SCHEMATIC-CAVITY REMEDIATION

PREPARED BY: Terracon Consulting Engineers and Scientists

SHEET NO. DS1

DRAWING NO.



STEP 2

FOR INFORMATION ONLY

THE PROCEDURE DESCRIBED ON THIS DRAWING IS ONE FEASIBLE CAVITY SEALING REMEDIATION PROCEDURE. IT IS THE RESPONSIBILITY OF THE CONTRACTOR TO SUBMIT THE PROPOSED CAVITY SEALING PROCEDURE AS PART OF THE DRILLED SHAFT EXCAVATION PLAN SUBMITTAL.

STEP 2:

1. AFTER INITIAL SET (MINIMUM 1,000psi COMPRESSIVE STRENGTH) DRILL OUT CONCRETE/GROUT PLUG AND REMAINING SOCKET DEPTH TO DESIGN SOCKET DIAMETER AND ELEVATION.
2. PERFORM SONAR CALIPER TEST TO VERIFY ANNULAR CONCRETE RING REMAINS IN THE PLUG AREA, AND VERIFY THAT NO ADDITIONAL CAVITIES ARE ENCOUNTERED BELOW CONCRETE PLUG.
3. INSTALL PREFABRICATED REBAR CAGE WITH GUIDES FOR CENTERING IN SOCKET AND CASING PER SPECIAL NOTE.
4. PLACE SHAFT CONCRETE PER SPECIAL NOTE.

SCALE: NOT TO SCALE

ITEM NUMBER
01-180.60

DATE: 11/07/14	CHECKED BY
DESIGNED BY:	
DETAILED BY:	

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: TRIGG

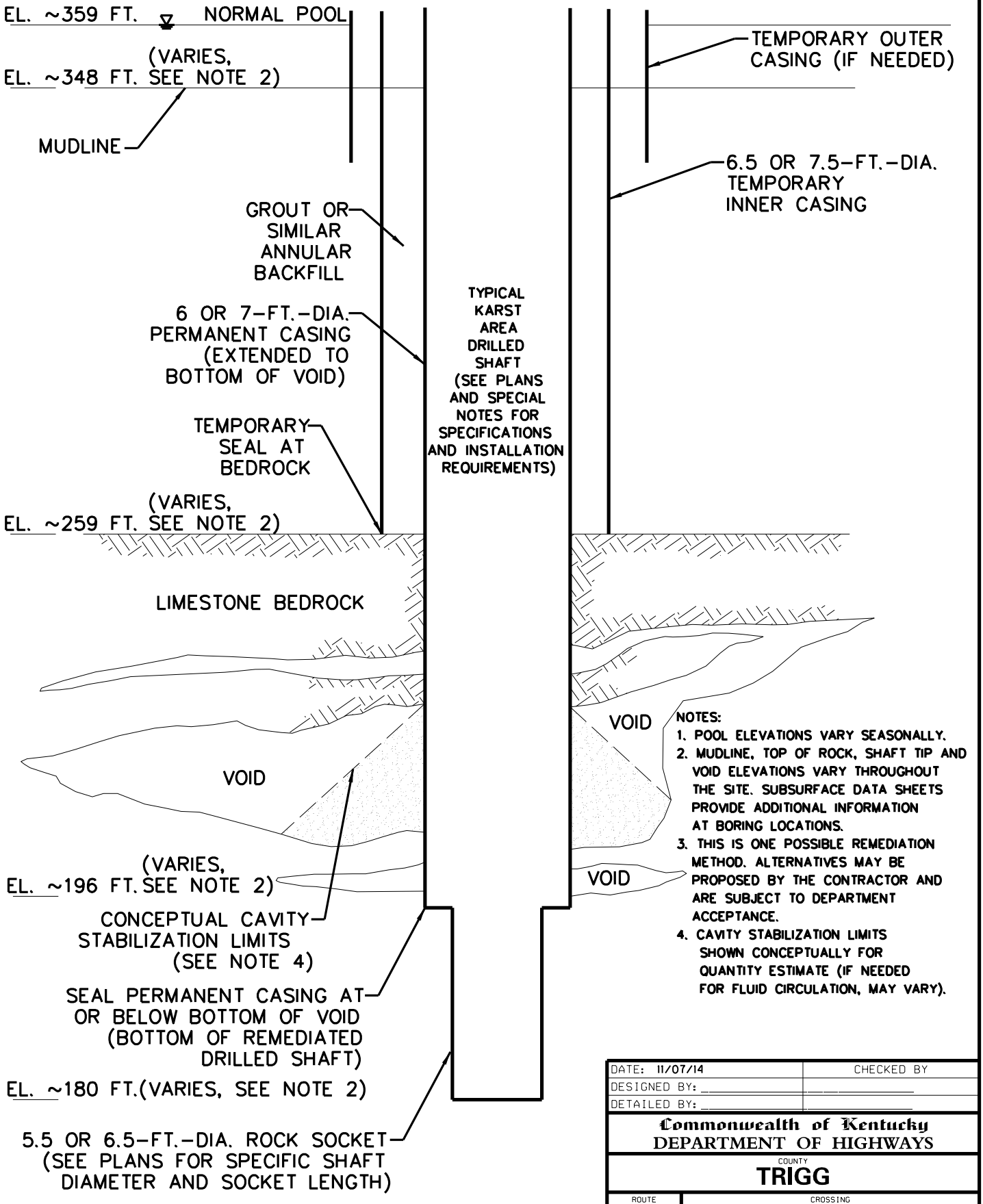
ROUTE: US 68 | CROSSING: LAKE BARKLEY

SCHEMATIC-CAVITY REMEDIATION

PREPARED BY
Terracon
Consulting Engineers and Scientists

SHEET NO. DS2

DRAWING NO.



NOTES:
1. POOL ELEVATIONS VARY SEASONALLY.
2. MUDLINE, TOP OF ROCK, SHAFT TIP AND VOID ELEVATIONS VARY THROUGHOUT THE SITE. SUBSURFACE DATA SHEETS PROVIDE ADDITIONAL INFORMATION AT BORING LOCATIONS.
3. THIS IS ONE POSSIBLE REMEDIATION METHOD. ALTERNATIVES MAY BE PROPOSED BY THE CONTRACTOR AND ARE SUBJECT TO DEPARTMENT ACCEPTANCE.
4. CAVITY STABILIZATION LIMITS SHOWN CONCEPTUALLY FOR QUANTITY ESTIMATE (IF NEEDED FOR FLUID CIRCULATION, MAY VARY).

SCALE: NOT TO SCALE

DATE: 11/07/14	CHECKED BY
DESIGNED BY:	
DETAILED BY:	

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: TRIGG

ROUTE: US 68 | CROSSING: LAKE BARKLEY

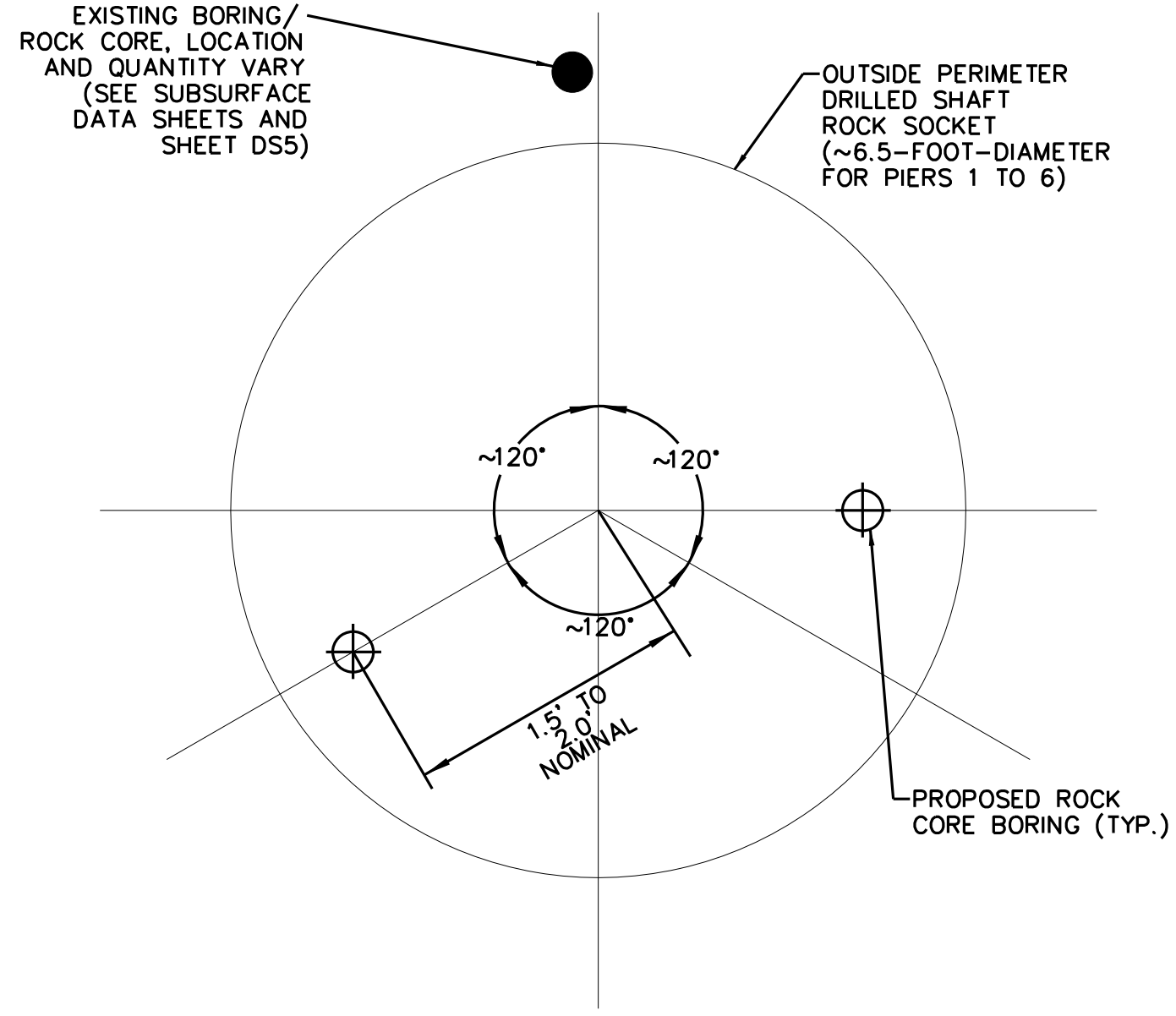
SCHEMATIC-KARST REMEDIATION

ITEM NUMBER: 01-180.60

PREPARED BY: Terracon Consulting Engineers and Scientists

SHEET NO.: DS3

DRAWING NO.:



TYPICAL ROCK CORE BORINGS
PIERS 1 TO 6 – DRILLED SHAFTS

NOTE:
1. REFER TO SUBSURFACE DATA SHEETS AND SHEET DS5 IN THIS SPECIAL NOTE FOR EXISTING BORING/ROCK CORE LOCATIONS. ADJUST PROPOSED BORING/ROCK CORE LOCATIONS TO MAINTAIN A MINIMUM EDGE TO EDGE DISTANCE OF 1.5 FEET FROM EXISTING BORING LOCATIONS. LOCATE TWO BORING LOCATIONS SUCH THAT BOTH BORING LOCATIONS ARE WITHIN THE PERIMETER OF THE PROPOSED DRILLED SHAFT ROCK SOCKET. DRILLED SHAFT LOCATIONS, OTHER THAN THOSE SPECIFIED IN THIS SPECIAL NOTE (I.E. PIERS 1 TO 6), MAY REQUIRE BORINGS/ROCK CORE IF VOIDS ARE ENCOUNTERED AT THOSE SHAFT LOCATIONS DURING CONSTRUCTION. REFER TO SECTION 4.13 OF THIS SPECIAL NOTE FOR MAXIMUM HORIZONTAL LOCATION TOLERANCES AND ROCK CORE DEPTH CRITERIA.
2. SKETCH IS FOR ILLUSTRATION PURPOSES ONLY. CONTRACTOR WILL SUBMIT A PLAN SHOWING THE PROPOSED BORING LOCATIONS AND PROPOSED LOCATION TOLERANCES FOR ACCEPTANCE BY THE DEPARTMENT.

SCALE: NOT TO SCALE

DATE: 11/07/14	CHECKED BY
DESIGNED BY:	
DETAILED BY:	

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY: TRIGG

ROUTE	CROSSING
US 68	LAKE BARKLEY

PIERS 1 TO 6 ROCK CORE

ITEM NUMBER	PREPARED BY	SHEET NO.
01-180.60	Terracon Consulting Engineers and Scientists	DS4
		DRAWING NO.

As-Drilled Locations						Bottom of Lowest Encountered Void Elev (ft.)
Pier	Boring	Northing	Easting	Latitude	Longitude	
1	B 5001	3459118.90	4267804.72	36.801490443	-87.981824860	No Voids Encountered
1	B 5002	3459095.642	4267795.27	36.801425963	-87.981855221	No Voids Encountered
1	B 5003	3459070.455	4267787.647	36.801356309	-87.981879190	No Voids Encountered
2	B 5004	3459029.813	4268060.50	36.801262639	-87.980944297	No Voids Encountered
2	B 5005	3459007.50	4268052.36	36.801200853	-87.980970267	No Voids Encountered
2	B 5006	3458981.234	4268044.61	36.801128217	-87.980994589	No Voids Encountered
3	B 5007	3458941.53	4268315.104	36.8010370	-87.9800678	No Voids Encountered
3	B 5008	3458918.98	4268307.812	36.8009746	-87.9800909	No Voids Encountered
3	B 5009	3458893.35	4268298.50	36.8009036	-87.9801206	225.9
4	B 5010	3458856.19	4268570.534	36.8008194	-87.9791888	No Voids Encountered
4	B 5011	3458829.43	4268563.848	36.8007455	-87.9792095	237
4	B 5012	3458805.68	4268554.359	36.8006797	-87.9792399	No Voids Encountered
5	B 5013E	3458758.12	4268844.886	36.8005681	-87.9782441	No Voids Encountered
5	B 5014E	3458735.48	4268835.949	36.8005054	-87.9782728	208.5
5	B 5015E	3458710.84	4268828.97	36.8004373	-87.9782946	No Voids Encountered
6	B 5016	3458678.88	4269079.823	36.800365983	-87.977435568	No Voids Encountered
6	B 5017	3458655.656	4269074.26	36.800301855	-87.977452667	No Voids Encountered
6	B 5018	3458627.79	4269064.366	36.800224698	-87.977484176	No Voids Encountered

Notes:
1. Location data is for the center of the boring.
2. Borings where no voids were encountered within the explored depth are indicated by "No Voids Encountered".

DATE: 11/07/14 | CHECKED BY
DESIGNED BY: _____
DETAILED BY: _____

Commonwealth of Kentucky
DEPARTMENT OF HIGHWAYS

COUNTY
TRIGG

ROUTE
US 68

CROSSING
LAKE BARKLEY

EXISTING BORING LOCATIONS

ITEM NUMBER
01–180.60

PREPARED BY
Terracon
Consulting Engineers and Scientists

SHEET NO.
DS5

DRAWING NO.

SPECIAL NOTE FOR NON-DESTRUCTIVE TESTING IN DRILLED SHAFTS

Trigg County –US68/KY80 Bridge over Lake Barkley

The following sections provide the requirements for non-destructive testing (Sonar Caliper, Crosshole Sonic Logging and Thermal Integrity Profiling) of the drilled shaft foundations, including technique shafts, schedule requirements for submittals, reporting requirements and Contractor/Testing Subcontractor/Department responsibilities. The purpose of the non-destructive testing is to evaluate whether the Contractor's means and methods are suitable for proposed drilled shaft foundation construction and to potentially detect air-, clay- or debris-filled voids or other discontinuities along the perimeter of the drilled shaft rock sockets.

1.0 Sonar Caliper Testing of Drilled Shafts

1.1 Description

Sonar Caliper (SC) Testing will be used to evaluate verticality, to detect any void spaces along the perimeter of the shaft design diameter, and to provide a written record and rock socket profile for each shaft prior to reinforcement or concrete placement. The Contractor will be responsible for obtaining the services of a SC Testing Firm experienced with SC testing and approved by the Engineer. The Contractor will be responsible for scheduling and coordinating the testing and presentation of data to the Engineer.

The calipering system will use one or more radial-spaced ultrasonic transceivers to transmit and receive acoustic signals between the tool and the borehole wall.

As directed by the Engineer, perform SC Testing after rock excavation is completed to the design bottom of shaft. If karst or other features are detected, additional SC testing may be directed by the Engineer.

1.2 SC Testing and Evaluation of Test Results

Make submittals via SharePoint software in accordance with the Project requirements for submittals. See Table 1 below. The Department will respond to the Contractor regarding acceptability of submittals within ten (10) business days, unless indicated otherwise in this special note. A "Business Day" is defined as any day except Saturdays, Sundays and Holidays, as defined in Section 101.03 of the Standard Specifications.

Table 1 – Schedule of SC Submittals			
Submittal Number	Submittal Item	Calendar Days	Event
1	Technical Proposal with SC Testing Firm qualifications	60 before	Start of Drilled Shaft Construction
2	SC Preliminary Testing Reports	6 HOURS After	Completion of testing on an individual drilled shaft
3	SC Final Testing Reports	10 After	Completion of testing on an individual drilled shaft
Provide all submittals and reports in .pdf format			

1.2.1 Technical Proposal

Submit a technical proposal prepared by the SC Testing Firm that addresses the testing procedures and qualifications and experience of the testing firm (Submittal No. 1 in Table 1.) Include at least ~~3~~ 2 similar deep foundation projects for which the testing organization has been engaged in SC Testing. Include an example of a 3 dimensional wire frame computer file with a verticality analysis prepared according to the criteria defined below. Use personnel having a minimum of ~~one year of experience~~2 similar deep foundation projects experience in SC Testing and interpretation. Within 10 business days, the Department will review the proposal and report to the Contractor whether the SC Testing Firm is approved.

1.2.2 Testing

Perform the SC Testing using the following steps:

1. Caliper is positioned over drilled hole along with lowering assembly (provided by SC Testing Firm).
2. Caliper is reset and calibrated at the zero degree reading.
3. Profile is taken in casing with known diameter to calibrate acoustic velocity.
4. Depth increment is set into software.
5. Caliper measures 360-degree profile.
6. Vertical and angular head position and range to shaft wall is captured.

7. Complete point profile is transferred to CAD program in dgn format.
8. Caliper is lowered at desired depth increment.
9. Steps 4 to 8 are repeated until the bottom of shaft socket is reached.
10. Upon reaching the bottom of the shaft, rotate the caliper 90 degrees, and scan the bearing surface at the base of the shaft.

To acquire verticality information, the caliper head will be affixed to a guide cable that is weighted near the bottom of the shaft and positioned plumb.

Perform the SC Testing process on all finished excavated shafts. Provide access to the top of shaft for testing personnel and equipment. Perform the SC Testing process in accordance with generally accepted SC Testing methods. At a minimum, take caliper readings every 10 feet in casing and every 6 inches in rock strata. If a feature is identified on the real time visual display, the Engineer may decrease the testing interval as necessary to improve the definition of the feature at no additional cost. Perform the SC testing along the base of the shaft by turning the sonar head 90 degrees and mounting it in a manner that allows profiling of the shaft base. Determine the top of casing elevation and calculate the station and offset of the geometric center of the top of casing, and provide this information to the Engineer and to the SC Testing Firm. Provide these services at no additional cost to the Department.

Employ the services of an experienced SC Testing company to record a 360-degree profile of the finished rock socket for each drilled shaft. After each rock socket is completed, use the SC Testing process to measure the gross diameter and shape of each drilled shaft for the entire shaft length in the rock socket.

1.2.3 Test Reports

Provide real-time data regarding the shaft verticality, shaft wall profile, and bottom profiling to the Engineer on site as the SC Testing is in progress.

Within 6 hours after completing the SC Testing, perform all required filtering and analyses required to provide a 3 dimensional wire frame computer file in Microstation format (.dgn) and transmit the computer file to the Engineer (Submittal No. 2 in Table 1.) If testing is completed between 3:00 pm and 3:00 am prevailing local time, transmit the computer file to the Engineer no later than 9:00 am prevailing local time the following morning. Include a verticality analysis with the wire frame computer file consisting of the following:

1. The vertical alignment vector (magnitude and direction of tilt) of the casing from the top to the bottom of casing.

2. The vertical alignment vector (magnitude and direction of tilt) from the top to bottom of the rock socket (when the rock socket is profiled);
3. The magnitude and direction of the offset of the geometric center of the rock socket relative to the geometric center of the casing at the transition between the casing and the rock socket (when the rock socket is profiled).

In addition, provide the following in pdf format:

1. Screen shots of the bottom profiling; and
2. Any cavities, cracks or void in the rock socket wall, including a general description with depth and elevation of the cavities, cracks or voids.

Within 10 business days after completion of each test, provide a pdf copy of the final report to the Engineer (Submittal No. 3 in Table 1), including, as a minimum, the following information:

1. Date of test;
2. Shaft No., and reference elevation,
3. Wire frame plots of the shaft from representative view points,
4. A plot of shaft volume vs. depth,
5. Analysis of shaft verticality (as defined above),
6. Discussion of the bottom profile results; and
7. Description and plot of any shaft wall voids, cracks, or cavities encountered.
8. A narrative which explains all aspects of the test, results and analyses.

1.2.4 Evaluation of SC Test Results

Allow direct communication between the SC Testing Firm and the Department. If the SC Testing Firm is different than the CSL and TIP testing firms, allow direct contact between the SC and CSL/TIP testing firms.

The Engineer will review the “real-time” data collected by the SC Testing Firm during the testing process at each shaft. If the bottom scan performed during SC Testing indicates that excessive sediment is present on the bottom, perform additional cleanout at the direction of the Engineer.

The Engineer will evaluate the wire frame computer file, including verticality analysis, and determine if the construction tolerances have been met and inform the Contractor. If the casing is not within the specified tolerances, adjust the casing at no cost to the Department. Perform additional SC Testing from the bottom of casing to the top of the casing at no cost to the Department. Continue adjustment and testing at no cost to the Department until the construction tolerances have been met.

If discontinuities or features noted by the testing firm in the shaft excavation are deemed sufficient by the Engineer to potentially cause concrete loss or soil intrusion during concrete placement, or loss of nominal resistance, the Engineer will meet with the Contractor to discuss remediation.

Continue with placement of reinforcement and concrete in the shaft only after receiving written approval from the Engineer to do so, based on evaluation of the SC test results.

2.0 Crosshole Sonic Logging

2.1 Description

Crosshole Sonic Logging (CSL) is a nondestructive method to test the integrity of drilled shafts. It is the responsibility of the Contractor to supply all equipment and materials necessary to perform this testing and for obtaining the services of a CSL Testing Firm, which is experienced with CSL testing and approved by the Engineer, to perform the testing.

The Contractor will be responsible for providing:

1. access tubes to be used for CSL testing of the drilled shafts;
2. watertight shoes, watertight caps, and non-shrink grout;
3. suitable working space and access to every shaft;
4. a reliable 600 watt (minimum) generator; and
5. any other equipment or materials necessary to accomplish the testing.

2.2 Materials

2.2.1 Access Tubes

1. Provide access tubes meeting the requirements below:
   a. 2 inch ID schedule 40 steel pipe conforming to ASTM A 53, Grade A or B, Type E, F, or S;
   b. contains round, regular internal diameters free of defects or obstructions, including any at pipe joints;
   c. capable of permitting the free, unobstructed passage of a 1.5-inch-diameter source and receiver probes; and
   d. watertight and free from corrosion with clean internal and external faces to ensure passage of the probes and a good bond between the concrete and the tubes.
2. Provide watertight shoes on the bottom and removable watertight caps on the top of the tubes.
3. The Engineer will accept access tubes based on visual inspection and certification and the steel pipe meets the requirements above.

2.2.2 Grout

Provide non-shrink grout to fill the access tubes and any cored holes at the completion of the CSL tests. Use grout conforming to Section 601.03.03 of the Standard Specifications.

2.3 Execution

2.3.1 Access Tube Installation

1. Install 6 access tubes as shown in Section 2.4.2 of this Special Note in each of the drilled shafts having a rock socket diameter of 5.5 feet or greater, unless directed by the Engineer to omit any access tubes. Install 4 access tubes as shown in Section 2.4.2 of this Special Note in each of the drilled shafts having a rock socket diameter of 3.5 feet to 5 feet, unless directed by the Engineer to omit any access tubes.
2. Securely attach the CSL tubes that are along the inside periphery to the spiral reinforcement. Wire-tie the tubes a minimum of every 3 ft. so they will stay in position during placement of reinforcement and concrete. Place the tubes so they will be parallel with each other and as near to vertical as possible in the finished shaft. Even moderate bending of the tubes will result in large regional variations in the data.
3. Place the tubes from 6 inches above the shaft tip to at least 3 ft. above the top of rebar cage, at least 3 ft. above water level, at least to the top of concrete, and at least 3 ft. above the top of casing. Under no circumstances may the tubes be allowed to come to rest on the bottom of the excavation.
4. Ensure that any joints in the tubes are watertight.
5. During placement of the reinforcement cage, exercise care so that the tubes will not be damaged to the extent that would prevent a 1.5 inch diameter probe from passing through them.
6. After placing the reinforcing cage and before beginning concrete placement, **fill the tubes with clean potable water** and cap or seal the tube tops to keep debris out of the tubes. Replace the watertight caps immediately after filling the tubes with water.
7. Before placing concrete, investigate at least one tube per shaft to make sure that there are no bends, crimps, obstructions or other impediments to the free passage of the testing probes.
8. During removal of the caps from the tubes, exercise care so as not to apply excess torque, hammering, or other stresses which could break the bond between the tubes and concrete.
9. After concrete placement and before the beginning of CSL testing, inspect the access tubes and report any access tubes that the 1.5 inch diameter test probe cannot pass through to the Engineer. The Engineer will make an evaluation to determine if the CSL testing can be successfully performed without the tube(s); the Engineer may require the contractor to, at its own expense, replace one or more

tubes with 2-inch-diameter holes cored through the concrete for the entire length of the shaft, excluding the bottom 6 inches. Unless directed otherwise by the Engineer, locate core holes approximately 6 inches inside the reinforcement such that it does not damage the reinforcement. For each core hole drilled, record a log with descriptions of inclusions and voids in the cored holes and submit a copy of the log and photographs to the Engineer. Preserve the cores, identify as to location and make available for inspection by the Engineer.

2.3.2 Grouting

After completion of the CSL and TIP testing, evaluation of results and upon being directed by the Engineer, remove the water from the access tubes and any cored holes, completely fill the tubes and holes with approved grout. After grouting, cut the tubes flush with the tops of the drilled shafts.

2.4 CSL Testing and Evaluation of Test Results

Make submittals via SharePoint software in accordance with the Project requirements for submittals. See Table 2 below. The Department will respond to the Contractor regarding acceptability of submittals within ten (10) business days, unless indicated otherwise in this special note. A “Business Day” is defined as any day except Saturdays, Sundays and Holidays, as defined in Section 101.03 of the Standard Specifications.

Table 2 – Schedule of CSL Submittals

Submittal Number	Submittal Item	Calendar Days	Event
1	Technical Proposal with CSL Testing Firm qualifications	60 before	Start of Drilled Shaft Construction
2	CSL Testing Reports	5 After	Completion of testing on an individual drilled shaft
Provide all submittals and reports in .pdf format			

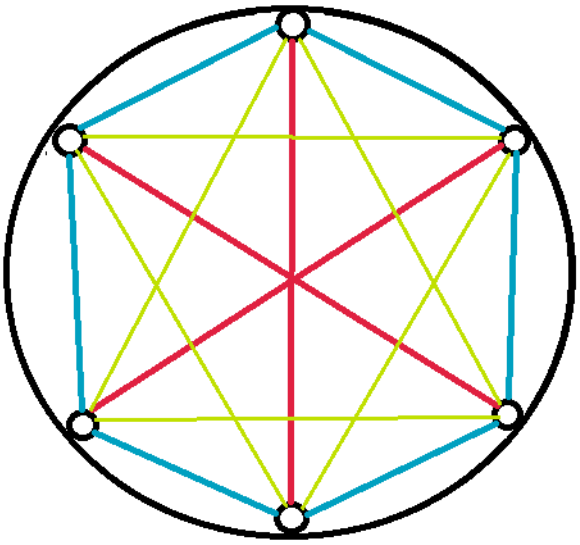
2.4.1 Technical Proposal

Submit a technical proposal prepared by the CSL Testing Firm that addresses the testing procedures and qualifications and experience of the testing firm. Include at least 3 similar deep foundation projects for which

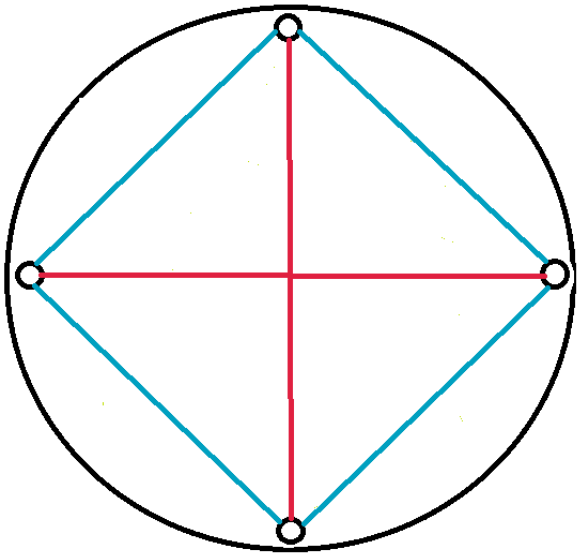
the testing organization has been engaged in CSL Testing. Use personnel having a minimum of 3 similar deep foundation projects ~~five years of~~ experience in CSL Testing and interpretation. Within 10 business days, the Department will review the proposal and report to the Contractor whether the CSL Testing Firm is approved.

2.4.2 Testing

1. Provide access to the top of the shaft for testing personnel and equipment.
2. Perform CSL testing on all shafts, unless directed otherwise by the Engineer.
3. Perform CSL testing in general accordance with ASTM D 6760.
4. Perform CSL testing on all completed shafts designated for testing by the Engineer, after the shaft concrete has cured at least 72 hours and has obtained a minimum strength of 2500 psi.
5. For drilled shafts with diameters of 5.5 feet and greater, obtain a minimum of 15 CSL logs per shaft (6 perimeter, 3 major diagonal and 6 minor diagonal logs), unless otherwise directed by the Engineer (see figure below). For drilled shafts with diameters of 3.5 feet to 5 feet, obtain a minimum of 6 CSL logs per shaft (4 perimeter and 2 major diagonal logs), unless otherwise directed by the Engineer (see figure below).
6. If the CSL testing firm believes that additional testing is required (such as Angled CSL, Crosshole Tomography, Singlehole Sonic Logging, or Sonic Echo/Impulse Response, etc.), contact the Engineer immediately. The Department will determine if additional testing is required, and such testing, if not due to a drilled shaft defect, would be paid for using a change order.



Proposed CSL Tube and Reading Configuration
5.5 ft. to 7 ft. Diameter Shafts – 6 CSL Tubes
3 Major Diagonal Readings
6 Perimeter Readings
6 Minor Diagonal Readings



Proposed CSL Tube and Reading Configuration
3.5 ft. to 5 ft. Diameter Shafts – 4 CSL Tubes
2 Major Diagonal Readings
4 Perimeter Readings

2.4.3 Test Reports

1. Submit a test report prepared by the CSL Testing Firm within 5 business days of completion of testing which, as a minimum, contains:
   a. Date of test;
   b. Plan Shaft No. and Reference Elevation;
   c. Schematic showing a plan view of the access tube locations;
   d. CSL logs with reference elevations;
   e. CSL logs presented for each tube pair tested with any discontinuity. zones indicated on the logs and discussed in the report as appropriate;
   f. Analyses of initial pulse arrival time versus depth or velocity versus depth and
   g. Analyses of pulse energy/amplitude versus depth.
   h. A narrative portion of the report will be used to present items a through f.
2. Complete all reports using English units.

2.4.4. Evaluation of CSL Test Results

1. Allow direct communication between the CSL Testing Firm and the Department.
2. The Department will evaluate the CSL test results in the test report to determine whether or not the drilled shaft integrity is acceptable. Within 5 business days after receiving a test report, the Engineer will report to the Contractor whether the construction is acceptable or additional analyses are needed. Thermal Integrity Testing (TIP) as described in Section 3.0 will also be used by the Department to determine the presence of anomalies.
3. Perform CSL testing on the first shaft constructed. Continue with subsequent drilled shaft rock socket excavation and concrete placement only after receiving written approval and acceptance of the first shaft of each specified diameter, based on the results and analysis of the CSL testing for the first shaft. Drilled shaft operations such as casing placement and overburden excavation will be allowed during the waiting period.
4. Continue with construction of the structure above the drilled shafts only after receiving written approval from the Engineer to do so, based on evaluation of the CSL test results.
5. If the CSL records are inconclusive (e.g. records do not clearly indicate discontinuity, good conditions or missing data), the Engineer may require additional testing, such as Angled CSL, or Singlehole Sonic Logging or concrete cores to sample the concrete in question to verify shaft conditions. If core samples are needed, obtain cores with a minimum diameter of 2 inches using a double tube core barrel at a minimum of 4 locations selected by the Department, unless directed otherwise by the Engineer. Unless directed otherwise by the

Engineer, locate core holes approximately 6 inches inside the reinforcement such that they do not damage the reinforcement. For each core hole drilled, record a log with descriptions of inclusions and voids in the cored holes and submit a copy of the log to the Engineer. Place the cores in crates properly marked showing the shaft depth at each interval of core recovery. Transport the cores and logs to the Geotechnical Branch in Frankfort for inspection and testing. Grout the core holes in accordance with Section 2.3.2 above.

6. If the additional testing or evaluation of cores indicate that concrete for any drilled shaft on which additional testing or coring was required is acceptable, the Department will pay for the direct cost of additional testing and concrete coring and grouting by change order. If the additional testing or evaluation of cores indicates that the concrete for any drilled shaft concrete is unacceptable, the additional testing and concrete coring and grouting will be at the expense of the Contractor.
7. If discontinuities are found, an independent structural and/or geotechnical consultant hired by the Contractor will perform structural and/or geotechnical evaluation at the expense of the Contractor. Hire consultants who are prequalified by KYTC in applicable areas. Based on the design criteria established for the structure and the evaluation of the independent structural engineer, the Engineer will assess the effects of the defects on the structural performance of the drilled shaft. If the results of the analyses indicate that there is conclusive evidence that the discontinuity will result in inadequate or unsafe performance under the design loads, as defined by the design criteria for the structure, the Engineer will reject the shaft.
8. If any shaft is rejected, provide a plan for remedial action to the Engineer for approval. Any modifications to the foundation shafts and/or other substructure elements caused by the remedial action will require calculations and working drawings by consultant(s) hired by the contractor, at the expense of the Contractor, which will be subject to review by the Engineer. Begin remediation operations only after receiving approval from the Engineer for the proposed remediation. All remedial action will be at no cost to the Department and with no extension of contract time.

3.0 Thermal Integrity Profiling

3.1 Description

Thermal Integrity Profiling (TIP) will be used as part of the program to test the integrity of drilled shafts. The Contractor will be responsible for supplying all equipment and materials necessary to perform this testing, and obtaining the services of a TIP Testing Firm, experienced with TIP testing and approved by the Engineer, to perform the testing. TIP testing will be performed using the CSL

tubes installed in the drilled shafts. Proposed alternate methods of performing the TIP testing may be considered by the Department.

Alternate methods of performing the TIP testing would be subject to acceptance by the Department, and installation of any sensors/instrumentation to the reinforcing cage would be incidental to the applicable contract unit bid price for TIP Testing. Ensuring that the TIP instrumentation is operational and provides the required information is the responsibility of the TIP Testing Firm. Overseeing the installation of the TIP testing instrumentation and properly training the Contractor in the installation of the TIP testing instrumentation is the responsibility of the TIP Testing Firm and is incidental to applicable unit bid price for TIP Testing. Any additional training for the Contractor is required for the TIP instrumentation, it is the responsibility of the TIP Testing Firm and is incidental to applicable unit bid price for TIP Testing.

The Contractor will be responsible for providing:

1. wires or probes which will be used for TIP testing of the drilled shafts;
2. dewatering equipment for CSL tubes if probes will be used;
3. suitable working space and access to every shaft;
4. a reliable 600 watt (minimum) generator; and
5. other equipment or materials necessary to accomplish the testing.

3.2 Materials

Refer to Section 2.2 for CSL tube materials.

3.3 Execution

3.3.1 Access Tube Installation

1. Refer to CSL access tube installation in Section 2.3.1 of this Special Note.

3.3.2 Grouting

After completion of the TIP and CSL testing, evaluation of results and upon being directed by the Engineer, remove the water from the access tubes and any cored holes, completely fill the tubes and holes with approved grout. After grouting, cut the tubes flush with the tops of the drilled shafts.

3.4 TIP Testing and Evaluation of Test Results

Make submittals via SharePoint software in accordance with the Project requirements for submittals. See Table 3 below. The Department will respond to the Contractor regarding acceptability of submittals within ten (10) business days, unless indicated otherwise in this special note. A “Business Day” is defined as

any day except Saturdays, Sundays and Holidays, as defined in Section 101.03 of the Standard Specifications.

Table 3 – Schedule of TIP Submittals			
Submittal Number	Submittal Item	Calendar Days	Event
1	Technical Proposal with TIP Testing Firm qualifications, including any alternate testing methods and information required for alternate methods discussed in Section 3.1	60 before	Start of Drilled Shaft Construction
2	TIP Testing Reports	5 After	Completion of testing on an individual drilled shaft
Provide all submittals and reports in .pdf format			

3.4.1 Technical Proposal

Submit a technical proposal prepared by the TIP Testing Firm that addresses the testing procedures and qualifications and experience of the testing firm. It is acceptable for the TIP and CSL Testing Firm to be the same firm, provided they meet requirements for both TIP (this Section) and CSL (Section 2.4.1) Testing Firms. Include at least 3 similar deep foundation projects for which the testing organization has been engaged in TIP Testing. Use personnel having a minimum of 3 similar deep foundation projects ~~two years of~~ experience in TIP Testing and interpretation. Within 10 business days, the Engineer will review the proposal and report to the Contractor whether the TIP Testing Firm is approved.

3.4.2 Testing

1. Provide access to the top of the shaft for testing personnel and equipment.
2. Perform TIP testing on all shafts, unless directed otherwise by the Engineer.
3. Perform TIP testing in accordance with generally accepted TIP Testing methods.
4. Perform TIP testing on all completed shafts designated for testing by the Engineer, within the time frame indicated by the TIP testing firm after of the completion of concrete placement in the drilled shaft. Do not exceed 60 hours after completion of the placement of the drilled shaft concrete.
5. If wires are used, verify the length of the tubes and install weights on the wires at the bottom to ensure adequate tension along the length of the wire as they are lowered and secured at the top of the access tube.

6. If probes are used, verify the length of the tubes and pump water from the tubes prior to testing.
7. Perform TIP testing in each CSL tube located in shaft designated for testing.
8. Immediately report potential local discontinuities indicated by locally low temperatures relative to the average temperature at that depth, or average temperatures significantly lower than the average temperatures at other depths to the Department.
9. If discontinuities are detected in the field, perform any confirmatory TIP testing deemed necessary by the TIP Testing Firm at no additional cost to the Department.

3.4.3 Test Reports

1. Submit a test report prepared by the TIP Testing Firm within 5 business days of completion of testing which, as a minimum, contains:
   a. Date of test;
   b. Plan Shaft No. and Reference Elevation;
   c. Schematic showing a plan view of the access tube locations;
   d. Graphical displays of all temperature measurements versus depth;
   e. Indication of unusual temperatures, particularly significantly cooler local deviations of the average at any depth from the overall average over the entire length;
   f. The overall average temperature. This temperature is proportional to the average radius computed from the actual total concrete volume installed (assuming a consistent concrete mix throughout). Radius at any point can then be determined from the temperature at that point compared to the overall average temperature;
   g. Variations in temperature between wires (at each depth) which may correspond to variations in cage alignment (where concrete volume is known, the cage alignment or offset from center should be noted); and
   h. Where shaft specific construction information is available (e.g. elevations of the top of shaft, bottom of casing, bottom of shaft, etc.), these values should be noted on all pertinent graphical displays.
   i. Drilled shaft radius calculations and the shaft quality, based upon the collected data, as well other available data, such as, as shaft alignment and wall profile from the SC Testing, top/bottom shaft/concrete elevations and concrete volume records collected during construction of the drilled shaft.
   j. A narrative portion of the report which addresses items a through i above.
2. Complete all reports using English units.

3.4.4 Evaluation of TIP Test Results

1. Allow direct communication between the TIP Testing Firm and the Department.
2. The Engineer will evaluate the TIP test results in the test report to determine whether or not the drilled shaft integrity is acceptable. Within 5 business days after receiving a test report, the Engineer will report to the Contractor whether the construction is acceptable or additional more detailed analyses are needed.
3. Perform TIP testing on the first shaft constructed. Continue with subsequent drilled shaft rock socket excavation and concrete placement only after receiving written approval and acceptance of the first shaft, based on the results and analysis of the TIP testing for the first shaft. Drilled shaft operations such as casing placement and overburden excavation will be allowed during the waiting period.
4. Continue with construction of the structure above the drilled shafts only after receiving written approval from the Engineer to do so, based on evaluation of the TIP and CSL test results.
5. If the TIP and the CSL records are inconclusive, the Engineer may require additional testing (such as Angled CSL, Crosshole Tomography, Singlehole Sonic Logging, or Sonic Echo/Impulse Response, etc.) or concrete cores to sample the concrete in question to verify shaft conditions. If either the TIP or CSL records are inconclusive, the Engineer may elect to require additional testing, based on the results of the conclusive TIP or CSL records. If core samples are needed, obtain cores with a minimum diameter of 2 inches, double tube core barrel at a minimum of four locations specified by the Department, unless directed otherwise by the Engineer. Unless directed otherwise by the Engineer, locate core holes approximately 6 inches inside the reinforcement such that they do not damage the reinforcement. For each core hole drilled, record a log with descriptions of inclusions and voids in the cored holes and submit a copy of the log to the Engineer. Place the cores in crates properly marked showing the shaft depth at each interval of core recovery. Transport the cores and logs to the Geotechnical Branch in Frankfort for inspection and testing. Grout the core holes in accordance with Section 3.3.2 above.
6. If the additional testing or evaluation of cores indicate that concrete for any drilled shaft on which additional testing or coring was required is acceptable, the Department will pay for the direct cost of additional testing and concrete coring and grouting by change order. If the additional testing or if evaluation of cores indicate that the concrete for any drilled shaft concrete is unacceptable, the additional testing and concrete coring and grouting will be at the expense of the Contractor.
7. If defects are found, the original structural designer will perform structural and/or geotechnical analyses, at the expense of the

Contractor, based on the design criteria established for the structure to assess the effects of the defects on the structural performance of the drilled shaft. If the results of the analyses indicate that there is conclusive evidence that the defects will result in inadequate or unsafe performance under the design loads, as defined by the design criteria for the structure, the Engineer will reject the shaft.

8. If any shaft is rejected, provide a plan for remedial action to the Engineer for approval. Any modifications to the foundation shafts and/or other substructure elements caused by the remedial action will require calculations and working drawings by independent consultant(s) hired by the Contractor, at the expense of the Contractor. The calculations and working drawings will be reviewed by the Engineer. Begin remediation operations only after receiving acceptance from the Engineer for the proposed remediation. All remedial action will be at no cost to the Department and with no extension of contract time.

4.0 Measurement and Payment

4.1 Method of Measurement Sonar Calipering

The Department will pay for the authorized and accepted quantities of “Sonar Calipering” at the contract unit price per test for both production and technique drilled shafts. This will constitute full compensation for all costs associated with providing access for testing personnel and equipment, performing the SC Testing, and reporting the results to the Engineer. Payment for the SC Testing will be at the contract unit price per SC Test. Payment for each test required by the Engineer will be the same regardless of whether the testing is performed after casing installation and overburden excavation or after rock excavation. Turning the sonar head and profiling the bottom of the excavation is incidental to the SC Testing unit bid price. If the Engineer requires both tests on the same shaft, payment will be for 2 tests. Any additional testing required to verify verticality after casing adjustments will be at the expense of the Contractor.

4.2 Method of Measurement CSL Testing

The Department will pay for the authorized and accepted quantities of “CSL Testing” at the contract unit price per each shaft tested (production and technique drilled shafts). This will constitute full compensation for all costs associated with providing access for testing personnel and equipment, performing the CSL Testing in a single shaft, and reporting the results to the Engineer.

Installation of CSL Access Tubing is incidental to the applicable contract unit bid price for Drilled Shaft, Common, and Drilled Shaft, Solid Rock. This will constitute all costs and delays associated with installing the CSL Access Tubing

in a single shaft, including but not limited to providing and installing access tubing, providing and installing all required bracing for access tubes, providing and placing grout in access tubes.

The Department will pay for the direct cost of additional testing and concrete coring, authorized by the Engineer, required to investigate shafts with inconclusive CSL records if evaluation of the additional testing or cores indicates that concrete for that drilled shaft is acceptable using a change order. This will constitute full compensation for all costs and delays associated with performing additional tests, obtaining and delivering concrete cores to the Geotechnical Branch, and grouting core holes.

4.3 Method of Measurement TIP Testing

The Department will pay for the authorized and accepted quantities of "TIP Testing" at the contract unit price per each shaft tested (production and technique drilled shafts). This will constitute full compensation for all costs associated with providing access for testing personnel and equipment, performing the TIP Testing in a single shaft, and reporting the results to the Engineer.

Installation of CSL/TIP Access Tubing is incidental to the applicable contract unit bid price for Drilled Shaft, Common, and Drilled Shaft, Solid Rock. This will constitute all costs and delays associated with installing the CSL Access Tubing in a single shaft, including but not limited to providing and installing access tubing, providing and installing all required bracing for access tubes, providing and placing grout in access tubes.

The Department will pay for the direct cost of additional testing and concrete coring, authorized by the Engineer, required to investigate shafts with complex or inconclusive TIP records on a if evaluation of the additional testing or cores indicates that concrete for that drilled shaft is acceptable using a change order. This will constitute full compensation for all costs and delays associated with performing additional tests, obtaining and delivering concrete cores to the Geotechnical Branch, and grouting core holes.

4.4 Payment

The Department will pay for the completed and accepted quantities under the following. The Pay Unit of “Each” refers to each individual shaft.

Code	Pay Item	Pay Unit
24741EC	Sonar Caliper Testing	Each
21322NC	CSL Testing (6 tubes)	Each
21321NC	CSL Testing (4 tubes)	Each
24742EC	TIP Testing (6 tubes)	Each
24743EC	TIP Testing (4 tubes)	Each

The Department will consider payment as full compensation for all work required under this Section.

SPECIAL NOTE FOR VIBRATION MONITORING

Trigg County Item No. 1-180.60
Lake Barkley Bridge

1.0 GENERAL

Vibration-producing construction activities (primarily pile driving, drilled shaft construction or operation of other heavy construction equipment) will be required during the construction and testing activities related to the Lake Barkley bridge construction. The Contractor is advised that existing bridge structures are located close to the proposed work and that construction activities ~~shall~~ are to be conducted so as to preclude damage to same. ~~The Contractor shall be responsible for any~~ Any damage caused by construction activities on this contract is the responsibility of the Contractor.

1.1 Scope of Work

The scope of work includes furnishing all labor, equipment and analyses associated with surveys of the pre- and post-construction condition of the existing Henry Lawrence bridge piers located adjacent to the new Lake Barkley bridge piers, and performing crack and vibration monitoring during the construction activities as specified in this Special Note.

2.0 PERSONNEL QUALIFICATIONS

Perform the services described below using the services of qualified personnel assigned to this project as described below.

2.1 Pre- and Post-Construction Surveys

Employ a licensed Professional Engineer to conduct pre- and post-construction condition surveys, with ~~. The licensed Professional Engineer shall have~~ at least 4 years of experience in pre- and post-construction condition surveys, and who has~~have~~ conducted a minimum of 4 pre- and post-construction condition survey projects on transportation facilities.

2.2 Vibration Monitoring

~~Employ a qualified vibration specialist to establish Safe Vibration Levels for the existing Henry Lawrence Bridge piers for Spans 1 through 4 and End Bent 1. The Contractor's vibration-monitoring personnel shall include~~Employ a qualified Vibration Instrumentation Engineer (specialist) who is a licensed Professional Engineer, and who has at least 4 years of experience in the installation and use of vibration-monitoring instrumentation and in interpreting instrumentation data for ground vibrations caused by heavy construction, and who has conducted a minimum of 4 vibration monitoring projects for ground vibrations caused by heavy construction. Using ~~This~~ this specialist ~~shall also,~~ supervise the Contractor's vibration-monitoring program and establish Safe Vibration

Levels for the existing Henry Lawrence Bridge piers for Spans 1 through 4 and End Bent 1.

3.0 SUBMITTALS AND REPORTS

Make submittals via SharePoint software in accordance with the Project requirements for submittals. See Table 1 below for a list and schedule of required Submittals and Reports. The Department will respond to the Contractor regarding acceptability of Submittals and Reports within 10 business days. A "Business Day" is defined as any day except Saturdays, Sundays and Holidays, as defined in Section 101.03 of the Standard Specifications.

Table 1 – Schedule of Submittals and Reports

Submittal Number	Submittal Item	Calendar Days	Event
1	Proposed licensed Professional Engineer for pre- and post-construction surveys, and proposed vibration specialist. Also include a listing of assigned personnel and their experience and qualifications.	30 After	Notice to Begin Work
2	Vibration Monitoring Plan and Pre-Construction Condition Survey	30 Before	Start of Pile Driving or Drilled Shaft Construction and/or Monitoring
3	Condition Survey and Vibration Monitoring Monthly Status Reports as defined in Sections 5 and 6	30 After and each month until pile driving or drilled shaft construction is complete	Start of Pile Driving or Drilled Shaft Construction and/or Monitoring
4	Vibration Monitoring Summary Report and Post-Construction Condition Survey Report as defined in Sections 5 and 6 of this Special Note.	30 After	Completion of Pile-Driving and/or Drilled Shaft Construction Activities
Provide all submittals and reports in .pdf format			

4.0 MONITORING LOCATIONS AND EQUIPMENT

At a minimum, the piers for Spans 1 through 4 and End Bent 1 on the existing Henry Lawrence Bridge will be monitored during pile-driving and drilled shaft construction activities. Provide equipment for monitoring existing cracks and vibration monitoring as outlined in Sections 5 and 6. Establish recommended monitoring locations in the Pre-Construction Condition Survey and Vibration Monitoring Plan.

5.0 CONDITION SURVEYS

Conduct Pre- and Post-Construction Condition Surveys (PCS) on the piers for Spans 1 through 4 and End Bent 1, prior to the commencement, and after the completion, of pile-driving and drilled shaft construction activities. Include documentation of the Piers as viewed from the waterline. Detail (by engineering sketches, video, photographs, and/or notes) any existing structural or cosmetic damage.

Submit a Pre-Construction Condition Survey report that summarizes the pre-construction condition of the structure(s) and identifies areas of concern, including potential personnel hazards (falling debris) and structural elements that may require support or repair such as, but not limited to, existing visible cracks. Submit a full report in digital form condensed to a pdf file size less than 100 Megabytes. If higher resolution photographs or other records resulting in larger file sizes are required for detail, submit higher resolution versions using a CD or USB-drive media.

Install crack displacement monitoring gages (visual or remote sensing) as appropriate across any significant existing cracks as defined by the Pre-Construction Condition Survey (PCS) engineer to help verify any additional structure distress if it should develop. The appropriate location, number, and type of gages will be established by the Contractor and/or the Department. Read the gages prior to vibration-producing activities, as well as during these activities. Obtain data on a monthly basis for as long as vibration-producing activities are being conducted. Submit a brief monthly report that confirms the data was obtained. Submit a final summary report which summarizes the data obtained on a monthly basis. Alert the Department if any significant movement as defined by the PCS engineer is detected by the monitoring gages.

Conduct a Post-Construction Condition Survey within 10 calendar days after the pile-driving and drilled shaft construction activities for the bridge construction have been completed. The survey will follow the same procedures used for the Pre-Construction Condition Survey. Submit a report using the same format as the Pre-Construction Survey Report.

6.0 VIBRATION CONTROLS

Submit a written Vibration Monitoring Plan to the Engineer, which includes, but is not limited to the following: planned vibration monitoring activities (including the format for reporting the vibration readings), monitoring equipment, anticipated and Safe Vibration Levels (which may be established from a baseline monitoring program) at the closest structures, and communications activities.

During all pile-driving and drilled shaft construction activities, monitor vibration levels at the piers for Spans 1 through 4 and End Bent 1, and establish controls so that Contractor does not exceed the Safe Vibration Level established in the Contractor's Vibration Monitoring Plan to preclude damage to these structures. Collect and store data daily to confirm all equipment is operating within calibration requirements.

Provide vibration monitoring equipment capable of continuously recording the peak particle velocity, recording and transmitting a permanent record of the entire vibration event, transmitting alarms when threshold values are exceeded, and recording / transmitting a time history for alarm exceedance events. Provide vibration monitoring equipment with the following minimum features:

1. Seismic range: 0.01 to 4 inches per second with an accuracy of +5 percent of the measured peak particle velocity or better at frequencies between 10 Hertz and 100 Hertz, and with a resolution of 0.01 inches per second or less.
2. Frequency response (+3 dB points): 2 to 200 Hertz.
3. Three channels for simultaneous time-domain monitoring of vibration velocities in digital format on three perpendicular axes.
4. Two power sources: internal rechargeable battery and charger and backup power source.
5. Capable of internal, dynamic calibration.
6. Capability to transfer data from memory to permanent digital storage. Instruments must be capable of transmitting vibration data readings to the Contractor within 15 minutes of obtaining the readings. Provide computer software to perform analysis and produce reports of continuous monitoring.
7. Continuous monitoring mode must be capable of recording single-component peak particle velocities, and frequency of peaks with an interval of one minute or less.

Submit a monthly report that confirms vibration monitors are working and contains the highest vibration level peak particle velocities (PPV) and frequency observed at each monitoring location, starting after the first vibration monitor is installed, and continuing until vibration monitoring is terminated.

Submit a final report which summarizes the data collected. Include copies of all vibration records and associated construction activity (pile driving) data in the final report, submitted to the Engineer, in a format approved by the Engineer, within 14 calendar days of completing vibration monitoring. Submit a full report in digital form condensed to a pdf file size less than 100 Megabytes. If higher resolution photographs or other records resulting in larger file sizes are required for detail, submit higher resolution versions using a CD or USB-drive media.

~~The Contractor's Vibration Instrumentation Engineer shall interpret~~ Interpret the data collected, including making correlations between seismograph data and specific pile-driving and drilled shaft construction activities. Evaluate the data to determine whether the measured vibrations can be reasonably attributed to construction activities. Include these evaluations in the final report.

~~Unless otherwise provided for in the Vibration Monitoring Plan, the Response Values for vibration shall include~~ Use a Threshold Value of 0.4 inches per second and a Limiting Value of 0.5 inches per second for vibration Response Values, unless otherwise provided for in the Vibration Monitoring Plan. The actions associated with these

Response Values are defined below. Plans for such actions are referred to herein as plans of action, and actual actions to be implemented are referred to herein as response actions. Response Values are subject to adjustment by the Engineer as indicated by prevailing conditions or circumstances.

If a Threshold Value is reached, take the following actions:

1. Immediately notify the Engineer.
2. Meet with the Engineer to discuss the need for response action(s).
3. If directed by the Engineer during the above meeting that a response action is needed, submit within 24 hours a detailed specific plan of action based as appropriate on the generalized plan of action submitted previously as part of the vibration-monitoring plan specified in Section 3.
4. If directed by the Engineer, implement response action(s) within 24 hours of submitting a detailed specific plan of action, so that the Limiting Value is not exceeded.

If a Limiting Value is reached, take the following actions:

1. Immediately notify the Engineer and suspend activities in the affected area, with the exception of those actions necessary to avoid exceeding the Limiting Value.
2. Meet with the Engineer to discuss the need for response action(s).
3. If directed by the Engineer during the above meeting that a response action is needed, submit within 24 hours a detailed specific plan of action based as appropriate on the generalized plan of action submitted previously as part of the vibration-monitoring plan specified in Article 2.
4. If directed by the Engineer, implement response action(s) within 24 hours of submitting a detailed specific plan of action, so that the Limiting Value is not exceeded.

7. COMMUNICATIONS

Maintain a log of any complaints and make this available to the Engineer on request. Notify the Department at least 2 weeks prior to commencement of any vibration-producing activity that might affect the structure.

8. MEASUREMENT

Payment for Vibration Monitoring is for all work described in this special note including but not necessarily limited to surveys, instrumentation, monitoring, and reports.

9. PAY ITEMS

Payment will be made under:

BID ITEM CODE	ITEM	UNIT
24550EC	VIBRATION MONITORING	LS

SPECIAL NOTE FOR STEEL ERECTION – APPROACH SPANS

1.0 STEEL ERECTION RESPONSIBILITY

The stability of the structure during erection, and the final geometry of the structure, is the responsibility of the contractor. The contractor shall retain an erection engineer for the purpose of evaluating the stability, state of stress and geometry of the structure during and after erection. The contractor shall erect the bridge in a safe manner without over stressing the structural components during erection and shall leave the structure in a state of stress compatible with the design.

Structural steel shall be in conformance with Section 607 of Kentucky Transportation Cabinet's standard specifications for road and bridge construction. Steel erection shall be in general conformance with the AASHTO/NSBA steel bridge erection guide specification, S10.1-2007.

2.0 CONSTRUCTION LOADING

Load capacity and stability of the steel girders has been verified only for the completely erected steel superstructure, prior to deck placement. Load capacity in the fully-erected state has been checked using AASHTO LRFD bridge design specifications, section 3.4.2 with a load factor of 1.25 for dead loads and for wind. A construction phase horizontal wind pressure of 50 psf, representing the mean-hourly wind speed with a 10-year return period has been used. Allowable lateral deflection under construction wind loading is ℓ/150 (span/150).

Formatted: Font: Script MT Bold

The load capacity and stability verification of partially completed girders in the various stages of erection prior to installation of all girders, crossframes, and lateral bracing is the responsibility of the contractor. A minimum construction horizontal wind pressure of 50 psf shall be used in the design of temporary shoring / falsework and for checking partially erected girders.

Girders and their bearing stiffeners should be vertical under full dead load. Uplift at bearings shall be prevented in each construction phase.

3.0 CHANGES TO THE STRUCTURE

Any changes to the structural steel system shown in the contract plans requires reanalysis for load capacity and stability for both construction and permanent load conditions. Diaphragm action of the stay-in-place forms shall be neglected in all analyses.

Dead load deflection, girder haunch thickness, and verified construction stresses are based on the slab pouring sequence shown in plans. Any deviation from the plan slab pouring sequence will need to be evaluated by the engineer of record to determine the effect on haunch, dead load deflection, and girder stress.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

4.0 CONCEPTUAL ERECTION SEQUENCE

The need for and location of falsework has been estimated for one conceptual erection sequence. The contractor may choose and develop any sequence that can safely erect the bridge without overstress or damage to the structural steel. The design of any needed shoring / falsework and their foundations is the responsibility of the contractor.

5.0 ERECTOR QUALIFICATIONS

Structural steel shall be erected by a qualified, competent erection contractor. To establish qualification, the erection contractor shall submit to the owner documented previous, equivalently complex erection projects which, at a minimum, include the following:

A. Any one lift using two or more cranes/derricks/poles,

B. Spans over water or active railroad/rapid transit tracks,

C. Erection with floating equipment,

D. Field splicing primary members while held in place by erection equipment

The owner shall determine whether the submitted evidence is satisfactory to establish qualification and competency.

6.0 ERECTION PROCEDURE

6.1 GENERAL: The contractor shall submit a detailed erection procedure to the owner for each bridge structural unit, prepared and sealed by a professional engineer licensed in the Commonwealth of Kentucky. The professional engineer who prepares the erection procedure and calculations shall have experience in steel erection of similar size, complexity, and scope. The procedure shall address all requirements for erection of the structural steel into the final designed configuration and satisfy all written owner comments prior to the start of erection. The procedure, as a minimum, shall include the following information:

A. DRAWINGS:

i. Plan of the work area showing permanent support structures (piers and abutments), roads, waterways (including navigational channel), overhead and underground utilities, and other information pertinent to erection

ii. Erection sequence for all members noting any temporary support conditions, such as holding crane positions, temporary supports, falsework, etc. Member reference marks, when reflected on the erection plan, should be the same as used on shop detail drawings

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

iii. Primary member delivery location and orientation

iv. Location of each crane for each primary member pick, showing radius and crane support (barges, mats, etc.)

v. Capacity chart for each crane configuration and boom length used in the work

vi. Center of gravity locations for primary members

vii. Detail, weight, capacity, and arrangement of all rigging for primary member picks

viii. Lifting weight of primary member picks, including all rigging and pre-attached elements

ix. Details of any temporary lifting devices to be bolted or welded to permanent members, including method and time (shop or field) of attachment, capacity, and method, time and responsibility for removal.

x. Bolted splice assembly requirements

xi. Lifting/handling procedure for any primary member that has a lifted length divided by width (l / b) greater than 85

xii. Blocking details for bridge bearings

B. CALCULATIONS:

i. Design calculations indicating the load capacity and verifying the stability of temporary supports for structure and crane(s) for each pick and release

ii. Calculations to substantiate structural adequacy and stability of girders for each step of bridge assembly

iii. Calculations to verify adequate capacity of contractor-fabricated rigging such as lift beams, welded lugs, spreader beams, beam clamps, etc. Submit manufacturers' certification or catalog cuts for pre-engineered devices

iv. Geometrical information that will be used to monitor the structure during erection to ensure that the final geometry of the structure is as indicated on the plans

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

C. COORDINATION ITEMS

i. Review / approval by other agencies as required (e.g., us coast guard, us army corps of engineers, etc.)

ii. Construction activities that occur concurrently with steel erection, such as setting forms or concrete deck pours

7.0 TRANSPORTATION

7.1 RESPONSIBILITY: The contractor is responsible for coordinating delivery from the fabricator to the jobsite and for providing adequate site access.

7.2 SHIPPING PLAN: The contractor is responsible for preparing a shipping plan indicating support, lateral bracing, and tie-down points for primary members during transportation to the jobsite.

7.3 HANDLING: Ship primary members upright, unless otherwise approved by the owner. Load, support, and unload primary members in a manner that will not damage, excessively stress, or permanently deform the steel and not cause repeated stress reversals.

8.0 LIFTING AND ASSEMBLY

8.1 GENERAL: Lift, position, and assemble all members in accordance with the approved erection procedures. The proposed crane location(s) and member delivery location(s) may require modification in the field to suit changing jobsite conditions. However, cranes and material must be located such that the lift is safe and within the crane manufacturer's rated capacity for all required positions.

8.2 LIFTING DEVICES: Install lifting devices, including welded lugs and bolted assemblies using existing bolt holes (splices, cross frame connection plates, etc.), and use owner approved details.

8.3 ERECTION STABILITY: Girders shall be stabilized with falsework, temporary bracing, and/or holding cranes until a sufficient number of adjacent girders are erected with cross frames connected to provide the necessary lateral stability and to make the structure self-supporting.

8.4 FALSEWORK AND TEMPORARY SUPPORTS: Falsework and temporary supports shall be detailed to ensure that the temporary elevation of supported steel accommodates the deflections expected to occur as the structure is completed.

8.5 PINS: Pins are normally used to align holes for bolted field connections. Field reaming to facilitate fitup will only be allowed with the owner's prior approval. Any abnormal distortion of the member or of the holes during the alignment process shall be immediately reported to the owner.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

8.6 CONNECTIONS: For splice connections of primary members, fill at least 50 percent of the holes prior to crane release. The 50 percent may be either erection bolts in a snug tight condition or full-size erection pins, but at least half (25 percent of all holes) shall be bolts, and sufficient pins shall be used near outside corners of splice plates and at member ends near splice plate edges to ensure alignment. Uniformly distribute the filled holes.

The 50 percent requirement may be waived if a reduced percentage is calculated as sufficient and shown on the approved erection procedure. Permanent bolts may be used as erection bolts, provided they are installed in accordance with the specifications.

Primary member splice connections that are made up on the ground (prior to erection) shall be 100 percent complete, in the no-load condition, prior to any lifting operation.

8.7 ABNORMALITIES: Any abnormal member deformation or brace deflection after crane release or temporary support removal shall be immediately reported to the owner for swift resolution. Further work affecting the area, except for restoring support or adding bracing, shall be stopped until the deformation/deflection is resolved.

9.0 REPAIR

9.1 DOCUMENTATION: The contractor is responsible for documenting damage due to handling, removal of erection aids, aligning members and other actions, uncorrected misfits at connections, and misalignments exceeding tolerances in erected members. As-received damage attributable to transport or fabrication shall also be documented.

9.2 IMPLEMENTATION: The contractor shall propose a method of repair and basis for acceptance for the owner's review.

9.3 REPAIR PROCEDURES: Submit repair procedures for damaged or misaligned steel in the form of sketches and/or written procedures as applicable. Information must provide sufficient detail for the owner to adequately review the repair application. After repairs are complete, the contractor shall provide as-built detailed drawings, NDT results, and procedures/materials used to the owner for inclusion in the project file.

9.4 WELDS: Field or shop welds that are unacceptable must be repaired in accordance with d1.5. Responsibility for the cost of the repair and subsequent inspection shall be based on the cause.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

SPECIAL NOTE FOR DISK BEARINGS

1.0 DESCRIPTION AND SCOPE OF WORK

1.1 SCOPE: This work shall consist of furnishing Multi-Rotational, High Load Disc Bearings and installing disc bearing assemblies at the locations shown on the plans and in accordance with these specifications and the *AASHTO LRFD Bridge Design and Construction Specifications.* Bearing assemblies shall include bearing device, distribution plates, distribution pads, and connection hardware as shown in the plans.

1.2 DESCRIPTION: Disc bearings shall consist of a polyether urethane structural element (disc) confined by upper and lower steel bearing plates. The bearing shall be equipped with an uplift shear resisting mechanism and uplift guide bars capable of resisting the loads shown in the plans. Bearings shall adequately provide for the thermal expansion and contraction, extreme events, rotation, camber changes, and creep and shrinkage of structural members, where applicable.

2.0 EXPERIENCE REQUIREMENTS AND SUBMITTALS

2.1 QUALIFIED SUPPLIERS

The D.S. Brown Company

300 East Cherry Street

North Baltimore, Ohio 45872

R. J. Watson, Inc.

11035 Walden Ave

Alden, NY 14004

The contractor should note that he/she is not limited to sourcing the disc bearings from the above suppliers. Alternate suppliers shall submit to the Engineer documented previous projects, which at a minimum, meet the qualification requirements of Section 2.2. The Engineer shall determine if the submitted documentation is satisfactory for qualification.

2.2 QUALIFICATION REQUIREMENTS: Disc bearings and the bearing supplier shall be subject to the qualification requirements for acceptance listed below.

A. Disc bearings shall be designed and constructed in accordance with *AASHTO LRFD Bridge Design Specifications 6th Edition, Section 14, and AASHTO LRFD Bridge Construction Specifications 3rd Edition, Section 18.*

B. The supplier shall show previous history in the design and fabrication of disc bearings. Documentation showing a minimum of five years experience and bridge installations shall be provided to the Engineer.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

C. Sliding bearings shall be stiff in shear, i.e. negligible shear displacements shall occur within the vertical load support element.

2.3 SHOP DRAWINGS: The contractor shall submit shop drawings to the Engineer for approval, and shall have received said approval prior to the construction of the beam seats and fabrication of disc bearings. These drawings shall include, but not be limited to, the following information.

A. Plan and elevation of each disc bearing size

B. Complete details and sections showing all materials (with ASTM or other designations) incorporated in the disc bearings.

C. Vertical and horizontal load capacities and movement ratings.

D. All bearing connection details.

E. Design calculations verifying compliance with AASHTO standards.

The shop drawings and design calculations shall be sealed by a professional Engineer employed by the bearing supplier with at least five years of documented history of disc bearing design experience.

2.4 CERTIFICATE OF COMPLIANCE: In addition to records of test results, the contractor's disc bearing supplier shall submit Certificates of Compliance for the disc bearings indicating the materials, fabrication, testing, and installation are as specified herein.

3.0 DISC BEARING FUNCTION AND CONSTRUCTION

3.1 FUNCTION

A. Bearing capacity shall satisfy the capacities as designated by the contract documents.

3.2 CONSTRUCTION

A. Bearings delivered to the bridge site shall be stored under cover on a platform above the ground surface. Bearings shall be protected at all times from damage. When placed, bearings shall be dry, clean, and free from dirt, oil, grease, or other foreign substances.

B. Bearing devices shall not be disassembled unless otherwise permitted by the Engineer or manufacturer.

C. Bearings shall be installed in accordance with the alignment plan and installation scheme as shown in the contract plans. Upon final installation of the bearings, the Engineer shall inspect the bearing components to assure that they are level and parallel to within ± 0.03125in/ft. Any deviations in excess of the allowed tolerances shall be corrected.

D. Bearing assemblies shall be handled and installed in accordance with the manufacturer's instructions as approved by the design Engineer.

E. Caution shall be taken to ensure that the steel temperature directly adjacent to the polyether urethane rotational element does not exceed 225°F. The polyether urethane disc must not be exposed to direct flame or sparks.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

4.0 TESTING, MATERIALS, AND EQUIPMENT

4.1 TESTING:

A. Production bearing sampling and testing shall be performed in accordance with *AASHTO LRFD Bridge Construction Specifications, Sections 18.3.4 and 18.1.5.*

B. The Long-Term Deterioration Test per *AASHTO LRFD Bridge Construction Specifications, Section 18.1.5.2.7* shall be satisfied by pre-qualification unless otherwise specified in the contract plans.

C. Each bearing shall be visually examined both during and after testing. Any resultant defects, which include, but are not limited to, bond failure, physical destruction or cold flow of PTFE to the point of debonding, shall be cause for rejection. Defects such as permanently extruded or severely deformed elastomer or cracked steel shall also be cause for rejection.

4.2.1 MATERIALS AND EQUIPMENT:

A. All materials shall be new and unused, with no reclaimed material incorporated in the finished bearing.

B. The physical properties of the polyether urethane elements shall conform to *AASHTO LRFD Bridge Construction Specifications, Table 18.3.2.8-1*.

C. All steel plates except stainless steel components of the bearing shall conform to the requirements of the type of steel designated on the contract plans; either ASTM A36, A588 or A572

D. Stainless steel shall conform to the requirements of ASTM A240 – Type 304. Higher grades of stainless are permissible. Stainless steel in contact with PTFE shall be polished to a No. 8 bright mirror finish. The minimum thickness of stainless steel sheet shall be 12 gage.

E. Polytetrafluoroethylene (PTFE) sheet shall be manufactured from pure virgin (not reprocessed) PTFE resin. PTFE sheet shall meet the applicable material requirements of *AASHTO LRFD Bridge Construction Specifications, Section 18.8.2*. Alternative low coefficient of friction materials shall be considered for use on both the guide bars and horizontal sliding surface. Materials used on the horizontal sliding surfaces shall be more durable than PTFE with a coefficient of friction similar to PTFE.

5.0 FABRICATION

5.1 FABRICATION DETAILS

A. Elastomeric rotational element shall be molded as a single piece, separate layers are not allowed.

B. The contractor shall provide the Engineer with written notification prior to the start of bearing fabrication. This notification shall include all of the information required by

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

Section 2. The bearing fabricator shall be certified by the American Institute of Steel Construction (AISC) for Simple Steel Bridges Category.

C. All steel surfaces exposed to the atmosphere, except stainless steel surfaces ~~and metal surfaces to be welded~~, shall be hot dip galvanized per ASTM A123 or painted to match the girders using a paint system from the KYTC List of Approved Materials. Prior to coating, the exposed steel surfaces shall be cleaned in accordance with the recommendations of the coating's manufacturer.

D. Stainless steel sheet shall be attached to its steel substrate with a continuous seal weld.

E. All welding shall conform to, and all welders shall be qualified in accordance with, the requirements of the American Welding Society (AWS).

F. Except as noted, all bearing fabrication tolerances shall be in accordance with *AASHTO LRFD Bridge Construction Specifications, Table 18.1.4.2-1*.

G. Each bearing shall be stamped with the manufacturer's name, bearing type or model number, bearing number and the installed location. The stamp shall be on a surface visible after installation.

H. After assembly, including sole plates, load plates, and masonry plates as applicable, bearing components shall be held together with steel strapping or other means to prevent disassembly until the time of installation, unless otherwise permitted by the Engineer.

6.0 MEASUREMENT

The final quantity of Dis~~c~~k Expansion Bearings will be the actual number of individual bearings acceptably furnished and placed during the project. The Department will not measure bearings replaced due to damage or rejection.

7.0 PAYMENT

The Department will pay for the Disk~~e~~ Expansion Bearings at the contract unit price bid for each. The Department will not pay for bearings replaced due to damage or rejection. Payment is full compensation for furnishing all materials and equipment necessary to install, operate, move, repair, and maintain or replace the disc bearings. All prescribed work shall be done in a workmanlike and acceptable manner including all labor and incidentals necessary for completion. The Department will make payment for the completed and accepted quantities under the following:

Pay Item	Pay Unit
Disk~~e~~ Expansion Bearing	Each

Formatted: Font: Not Bold

Formatted: Font: Not Bold

Field Code Changed

SPECIAL NOTE FOR LEAD CORE ELASTOMERIC SEISMIC ISOLATION BEARINGS (TYPES A & B)

Trigg County
US 68/KY80 Bridge over Lake Barkley

This Special Note applies to the six Lead-Core Elastomeric (LCE) Seismic Isolation Bearings for Span 8 as indicated on the Contract Plans. Bearings will be procured by the Department under separate contract and furnished to the Contractor for installation. The Contractor shall assume all responsibility for the furnished material once the Department-furnished materials are turned over to the Contractor as per section 106.07 of the standard specifications.

This Special Note supplements information provided in the standard specifications. Where a conflict exists between this Special Note and the standard specifications, the provisions herein shall govern.

1.0 DESCRIPTION. This work consists of pickup, handling, storing, delivering and installing six Lead-Core Elastomeric Seismic Isolation Bearing assemblies ("bearing assemblies"), procured by the Department and furnished to the Contractor, for installation at the locations shown on the Contract Plans in accordance with: this special note; KYTC Standard Specifications for Road and Bridge Construction, 2012 Edition (KYTC); AASHTO *LRFD Bridge Design Specifications*, 6th Edition, 2012 *(*AASHTO *LRFD Design*); AASHTO *LRFD Bridge Construction Specifications*, 2010 (AASHTO *LRFD Construction*); and AASHTO *Guide Specifications for Seismic Isolation Design*, 3rd Edition (Guide Specifications). The work also includes the fabrication, delivery and installation of the masonry plate and shear studs, including surface preparation of the grout pocket and all grouting required to properly install the masonry plate, shear studs and bearing.

For purposes of this Note "bearing assembly" is defined as the top load plate, top and bottom LCE mounting plates, lead-core isolator and sub-base plate. The bearing assembly is also denoted "replaceable bearing" in the Plans.

Design, fabrication and testing of the bearings will be completed by the Department under separate contract, and the procured bearings, approved shop drawings, and relevant test results will be provided by the Department to the Contractor.

The LCE Seismic Isolation Bearing as shown in the Plans consists of a lead-core elastomeric energy absorbing device (isolator) bonded to top and bottom mounting plates. All items below the tie girder sole plate, including top load plate, isolator, mounting plates, sub-base plate, masonry plate, shear studs and grout plinth/pocket shall be considered part of the LCE isolation bearing system.

1.1 Pre-Approved Supplier. The following manufacturer will provide all six arch main span (Span 8) LCE bearings and required test results to the Department as part of a separate contract:

Seismic Energy Products
518 Progress Way
Athens, TX 75751
Ph. (903) 675-8571

1.2 Quality Assurance / Quality Control. Fabrication of the isolation bearings will be performed under a separate procurement contract in accordance with the applicable provisions of the AASHTO *LRFD Bridge Design Specifications*, the AASHTO *LRFD Bridge Construction Specifications* and the AASHTO Guide *Specifications for Seismic Isolation Design*. Inspection and testing was the responsibility of the Fabricator Quality Control (FQC) staff.

1.4 Shop Drawings Furnished by the Department. The Department will provide to the Contractor approved shop drawings that were prepared by the LCE Supplier under separate contract. These shop drawings include:

a. Detailed drawings of the individual isolation bearings and overall seismic bearing assemblies.

b. A description of material properties and conformance specifications for the isolation bearings including the isolators, tap bolts, top load plates, and sub-base plates.

1.5 Shop Drawings to be provided by the Contractor

a. Prior to fabrication, submit for review and obtain approval from the Engineer of shop drawings for the masonry plates and shear studs.
b. Prior to fabrication, submit for review and obtain approval from the Engineer of the installation plan; casting the grout pockets and plinths, and installing the bearing assemblies.

2.0 MATERIALS (for Contractor reference)

2.1 LCE Seismic Isolation Bearing. Isolator with mounting plates shall meet the following material requirements:

a. Internal steel reinforcing plates shall, as a minimum, conform to ASTM A1011 Grade 40.

b. LCE mounting plates provided by the bearing manufacturer shall, as a minimum, conform to ASTM A572, Grade 50.

c. The purity of lead shall be established from a sample of lead used in the isolators and shall demonstrate a minimum of 99% purity.

c. The elastomer shall be Grade 3 Natural Rubber.

e. Results showing performance within the stated parameters shall be provided for each elastomer formulation used in the isolators. Tests performed within the previous 12 months are acceptable for the following tests:

– Compression Set (ASTM D395) at 70°C for 22 hours:
Maximum permissible set = 40%.

– Bond Strength (ASTM D429, Method B):

Minimum bond strength = 40lb/in, 100% rubber tear.

– Heat Resistance (ASTM D573) at 70°C for 7 days:
  Maximum permissible change in tensile strength = -25%
  Maximum permissible change in ultimate elongation = -25%
  Maximum permissible change in durometer hardness = +10%

– Ozone Resistance (ASTM D 1149)

Representative strips of material shall be prepared in accordance with ASTM D518, Method A. The tests shall be performed at a concentration of 50±5 parts per hundred million, at 20% strain after conditioning at 38°C±1 for 100 hours. No cracks shall be visible using 7X magnification.

f. Results from tests performed on each batch of elastomer used in the isolators shall demonstrate compliance with the following requirements:

– Tensile Strength (ASTM D412):
  Minimum permissible tensile strength = 2500 psi

– Elongation at break (ASTM D412):
  Minimum permissible elongation at break = 500%

– Shear Modulus at 50% Shear Strain (ASTM D4014):
  Maximum permissible variation from design value=±10%

2.2 Masonry Plates, Sub-Base Plates, Top Load Plates, Shear Studs. Masonry plates, sub-base plates, and top load plates shall conform to M270 Grade 50W steel. Material for shear studs shall conform to ASTM A108.

2.3 Grout for Shear Stud Pocket. Shear stud pocket shall be prepared as indicated on the plans and filled by the Contractor with a non-shrink grout from the Department's List of Approved Materials and conforming to KYTC Section 601.

3.0 DESIGN AND PERFORMANCE REQUIREMENTS (for Contractor reference)

3.1 Seismic Acceleration & Response Spectra

Seismic isolation bearing analyses have been performed in accordance with the Guide Specification using the following criteria:

– Seismic Design Category: D
– Site Specific Design Response Spectrum: See Table 3.1a
  Note that the design response spectrums presented below are for the 1,000 year return event.

Table 3.1a: Design Response Spectrum

Main Span West Pier 7			Main Span East Pier 8		
Station Range			Station Range		
	Horizontal	Vertical		Horizontal	Vertical
T_m (sec)	S_a(g)	S_a(g)	T_m (sec)	S_a(g)	S_a(g)
0.001	0.363	0.242	0.001	0.539	0.359
0.110	1.328	0.886	0.110	1.689	1.126
0.191	1.328	0.886	0.114	1.689	1.126
0.470	1.328	0.886	0.232	1.689	1.126
0.500	0.890	0.593	0.350	1.689	1.126
0.600	0.519	0.346	0.400	0.847	0.565
0.700	0.295	0.197	0.500	0.414	0.276
0.800	0.258	0.172	0.600	0.344	0.230
0.900	0.230	0.153	0.700	0.295	0.197
1.000	0.207	0.138	0.800	0.258	0.172
1.100	0.188	0.125	0.900	0.230	0.153
1.200	0.172	0.115	1.000	0.207	0.138
1.300	0.159	0.106	1.100	0.188	0.125
1.400	0.148	0.098	1.200	0.172	0.115
1.600	0.129	0.086	1.300	0.159	0.106
1.700	0.122	0.081	1.500	0.138	0.092
1.900	0.109	0.073	1.600	0.129	0.086
2.100	0.098	0.066	1.800	0.115	0.077
2.300	0.090	0.060	2.000	0.103	0.069
2.500	0.083	0.055	2.200	0.094	0.063
2.700	0.077	0.051	2.400	0.086	0.057
2.900	0.071	0.048	2.600	0.079	0.053
3.100	0.067	0.044	2.800	0.074	0.049
3.300	0.063	0.042	3.000	0.069	0.046
3.500	0.059	0.039	3.200	0.065	0.043
3.700	0.056	0.037	3.400	0.061	0.041
3.900	0.053	0.035	3.600	0.057	0.038
4.100	0.050	0.034	3.800	0.054	0.036
4.300	0.048	0.032	4.000	0.052	0.034
4.500	0.046	0.031	4.200	0.049	0.033
4.700	0.044	0.029	4.400	0.047	0.031
4.900	0.042	0.028	4.600	0.045	0.030

5.100	0.041	0.027	4.800	0.043	0.029
5.300	0.039	0.026	5.000	0.041	0.028
5.500	0.038	0.025	5.200	0.040	0.026
5.700	0.036	0.024	5.400	0.038	0.026
5.900	0.035	0.023	5.600	0.037	0.025
6.100	0.034	0.023	5.800	0.036	0.024
6.300	0.033	0.022	6.000	0.034	0.023
6.500	0.032	0.021	6.200	0.033	0.022
6.700	0.031	0.021	6.400	0.032	0.022
6.900	0.030	0.020	6.600	0.031	0.021
7.100	0.029	0.019	6.800	0.030	0.020
7.300	0.028	0.019	7.000	0.030	0.020
7.500	0.028	0.018	7.200	0.029	0.019
7.700	0.027	0.018	7.400	0.028	0.019
7.900	0.026	0.017	7.600	0.027	0.018
8.100	0.026	0.017	7.800	0.026	0.018
8.300	0.025	0.017	8.000	0.026	0.017
8.500	0.024	0.016	8.200	0.025	0.017
8.700	0.024	0.016	8.400	0.025	0.016
8.900	0.023	0.015	8.600	0.024	0.016
9.100	0.023	0.015	8.800	0.023	0.016
9.300	0.022	0.015	9.000	0.023	0.015
9.500	0.022	0.015	9.200	0.022	0.015
9.700	0.021	0.014	9.400	0.022	0.015
9.900	0.021	0.014	9.600	0.022	0.014
10.000	0.021	0.014	9.800	0.021	0.014
			10.000	0.021	0.014

3.2 Loads.

a. Bearing shall be designed to resist, at a minimum, the following unfactored reactions as provided in Table 3.2a.

Table 3.2a: Unfactored Dead and Live Load Reactions (per bearing)

Location	Bearing Type	Dead Load Vertical (kips)	Live Load Vertical (kips)	Dead Load Longitudinal (kips)	Live Load Longitudinal (kips)	Braking Force (kips)	Live Load Rotation (rad)
Pier 7	A	2743	609	76	17	17	0.003
Pier 7	B	301	357	54	11	17	0.003
Pier 8	A	2743	609	77	17	17	0.003

Pier 8	B	301	357	54	11	17	0.003

b. Bearing shall be designed to resist, at minimum, the service lateral loads as provided in Table 3.2b. Additionally, the bearing shall be designed such that the deflection does not exceed the values provided in Table 3.2b for the specified load case.

Table 3.2b: Wind Service Lateral Reactions (per bearing)

Location	**Bearing Type**	**Wind (0.3WS*) (kips)**	**Max. deflection due to Wind (0.3WS) (inches)**	**Wind (1.0WS**) (kips)**	**Max. deflection due to Wind (1.0WS) (inches)**	**Wind on Live (1.0WL*) (kips)**	**Max. deflection due to Wind on Live (1.0WL) (in)**
Pier 7	A	24	0.46	81	1.54	14	0.3
Pier 7	B	24	0.46	82	1.54	14	0.3
Pier 8	A	24	0.46	81	1.53	14	0.3
Pier 8	B	24	0.46	79	1.49	14	0.3

* Based on a Keff (elastic value) of 103 (k/in). Stiffness must remain elastic for Service Load condition with 0.3Ws.
** Based on a Keff value of 53 (k/in).

c. Bearings shall be designed to resist, at minimum, the strength lateral loads and displacements as provided in Table 3.2c. Additionally, the bearing shall be designed such that the deflection does not exceed the values provided in Table 3.2c for the specified load case.

Table 3.2c: Maximum Strength Wind Loads (per bearing)

Location	**Bearing Type**	**Wind (1.4WS*) (kips)**	**Max. deflection due to Wind (1.4WS) (inches)**
Pier 7	A	114	2.15
Pier 7	B	114	2.15
Pier 8	A	114	2.15
Pier 8	B	111	2.09

* Based on a Keff value of 53 (k/in)

d. Bearing shall be designed to resist, at minimum, the temperature lateral loads and displacements as provided in Table 3.2d. Additionally, the bearing shall be

designed such that the deflection does not exceed the values provided in Table 3.2d for the specified load case.

Table 3.2d: Thermal Movement and Demands (per bearing)

Location	Bearing Type	Temperature Rise (inches)	Max. Force Temperature Rise* (Kips)	Temperature Fall (inches)	Max. Force Temperature Fall** (Kips)
Pier 7	A	1.48	79	2.21	89
Pier 7	B	1.48	79	2.21	89
Pier 8	A	1.48	79	2.21	89
Pier 8	B	1.48	79	2.21	89

* Based on a Keff value of 54(k/in)
** Based on a Keff value of 40(k/in)

e. Bearings shall be designed to resist the minimum total design displacement provided in Table 3.2e. The minimum Keff of the bearing at this total design displacement shall be as specified in the table. The bearing shall be designed to resist a force, at minimum, equal to the total design displacement of the bearing multiplied by the actual bearing Keff value at that displacement.

Additionally, in accordance with Section 12.3 of the Guide Specification, the bearing shall be designed such that it is stable under 1.2 times the dead load shown in Table 3.2a at a horizontal offset equal to 1.5 times the total design displacement.

Table 3.2e: Minimum Seismic Stiffness and Displacement Requirements (per Bearing) (EQ)

Location	Bearing Type	Total Lateral Design Displacement (in)
Pier 7	A	1.55
Pier 7	B	1.56
Pier 8	A	2.37
Pier 8	B	2.64

4.0 FABRICATION

(Underlined provisions apply to the work of this contract. Other sections are provided for Contractor reference)

4.1 General. Fabrication shall be in accordance with this Special Note and AASHTO *LRFD Construction*.

4.2 Welding. All welding shall conform to and all welders shall be qualified in accordance with the requirements of the current AASHTO/AWS D1.5M/D1.5 *Bridge Welding Code*.

4.3 LCE Isolator with Mounting Plates. Mounting plates shall be vulcanized bonded to the isolation bearing and mechanically connected to the internal lead core. Exposed steel surfaces shall be protected from rust by one coat of organic zinc-rich primer. All exposed steel surfaces shall receive a final field coat to be applied by the Contractor in accordance with the plans and specifications. Galvanizing will not be permitted. The surfaces to be painted or metalized shall be shown in the shop drawings.

Areas to be field welded shall not be coated. However, Contractor is responsible for ensuring that all surfaces to be field welded are properly prepared at no additional cost to the Department. This may include abrasive cleaning and/or grinding rusted, primed or painted surfaces as directed by the Engineer and spot priming after welding but prior to applying the final paint coat.

4.4 Masonry, Sub-Base, Top Load Plates and Shear Stud Coats shall be cleaned and painted by the Contractor per the Contract Plans General Notes.

4.5 Other Coatings. Connection bolts and washers shall be mechanically galvanized as described in AASHTO M 154.

5.0 SAMPLING, TESTING & INSPECTION

(Underlined provisions apply to the work of this contract. Other sections are provided for Contractor reference)

5.1 Testing and Inspection for Fabricator Quality Control. Fabrication quality control is part of an earlier contract. The Contractor shall provide material certificates for all items not furnished by the Department.

5.2 Fabrication Tolerances. The tolerances on isolator dimensions prior to testing shall be as follows:

External Plan Dimensions	± ¼ inch
Overall height	± ¼ inch
Variation between top and bottom surface	≤ 0.005 radian
Variation of sides from theoretical	± ¼ inch
Flatness of external plates	± 1/16 in. per 36 in.

Each isolator shall be marked with the isolator serial number specified by the manufacturer.

5.3 Prototype Tests. Isolation system suppliers shall submit characterization test results by means of the evaluation findings of the Highway Innovative Technology Evaluation Center and shall also submit prototype test results in accordance with Section 13.2 and 13.3 of the AASHTO *Guide Specifications*.

Prototype tests shall be performed on the isolators fabricated for the subject project. Testing of similarly sized or reduced scale specimens is not allowed. As per section 13.2 of the AASHTO *Guide Specifications*, prototype tests shall be performed on a minimum of two isolators of each type shown in this specification. However, if tests of any isolator fail

to meet the requirements of the AASHTO *Guide Specifications*; then all isolators of that type shall be tested and any isolators that fail to meet the requirements shall be rejected. Fabrication of the remaining bearings shall not be continued until prototype test results are approved by the Engineer.

5.4 Quality Control Tests. Each isolator shall be tested and evaluated in accordance with the requirements of the AASHTO *Guide Specifications*, Section 15.2. Any bearing that fails to satisfy the requirements shall be rejected.

6.0 IDENTIFICATION, STORAGE & HANDLING. The Contractor will pickup the bearings within 180 days of contract award. Pickup will be from the Department of Highways Maintenance Facility for Calloway County, which is adjacent to the Murray Section Construction Office.

This Facility is located at:

200 Industrial Road
Murray, KY 42071

Every bearing shall have the project identification number, lot number and individual bearing number indelibly marked with ink on a side that will be visible after erection. Bearing assemblies shall be handled by their bottom surfaces only, and shall not be lifted by their tops, sides and/or shipping bands. Completed bearings shall be individually banded in the upright position. When in storage the bearings shall be kept banded, wrapped and secured in a clean, dry and upright position. Maintain the packaging and provide adequate protection to prevent damage from impact as well as from dust and moisture contamination during shipping and storage. The bearings shall be stored with the top and bottom LCE mounting plates, the top load plate, the sub-base plate and the isolator all assembled together. The bearings shall be stored in an indoor storage facility.
At no time prior to completion of the project may any bearing be disassembled without authorization from the Bearing Supplier.

7.0 INSTALLATION

7.1 Preparing Concrete Bearing Areas. The sides and bottom of the grout pocket shall be cleaned of laitance and loose and foreign material prior to setting masonry plates. The Contractor shall mark the location of the masonry plates in the pockets (by plan station and offset.) Masonry plates on each pier shall be set by template to the indicated elevation and alignment and positively secured to the top of the pier prior to grout placement.

7.2 Substructure Survey. After preparing concrete surface and setting masonry plates, the Contractor shall perform a horizontal and vertical control survey of the center and corner of each plate. The Engineer will inspect the bearing components to ensure that they are level and parallel to within ± 0.005 radians. Any deviations in excess of the allowed tolerances shall be corrected.

7.3 Grouting Stud Pocket. Prior to grouting, contact surfaces of pocket shall be coated with concrete bonding agent. Grout shall be place into pocket under pressure until the voids are completely filled and grout exits the vent holes on the top of the masonry plate and overflows the perimeter of the masonry plate. Strike off excess grout and provide a clean bearing surface for the installation of the bearing components. Completely remove

all overflow grout located above the top-of-bearing elevation. Properly collect and dispose of all overflow grout in an environmentally safe manner.

7.4 Seismic Bearing Assemblies. Care shall be taken during storage and installation of the isolators to prevent damage to the isolator or coating materials on the steel.

The bearing assemblies shall be installed level in exact position (true roadway station and offset, or as adjusted by the Engineer due to substructure location out of tolerance), and the bottom LCE mounting plate shall have full and even bearing upon the sub-base plates. Bearing sub-base plates shall have full and even bearing upon and shall be field welded to the masonry plates. Any superstructure gradients are accommodated by tapered sole plates which are part of the arch tie girders or end floor beams. The top load plate shall be in full contact with the sole plates and shall be field welded to the sole plates. The top LCE mounting plate shall have full and even contact with the top load plates. Connections shall be adjusted as necessary, under the direction of the Engineer, to obtain full contact. All grout holes in the masonry plates shall be covered by the sub-base plate after field welding the plates together.

Contractor shall take care to minimize heat build-up in bearing. Temperature in nearest bearing load plate shall be kept below 200°F. Multiple weld passes may be required.

Contractor shall provide a complete record of the location of each installed isolator, by serial number, to both the Engineer and the manufacturer.

There shall be no obstructions, including bolt extensions, which prevent the isolators from deforming horizontally in any direction. The area around each isolator shall be cleaned of all debris and construction material at the completion of the contract.

7.5 Arch Erection. The seismic bearings shall be installed as outlined in arch erection and camber given in the General Note "Arch Erection and Camber" in the Contract Drawings and Special Note for Steel Erection – Arch Span.

If, at the completion of construction, the seismic bearing assemblies are not vertical at 60^{O}F, the Contractor shall remove the bearing sub-assembly to masonry plate weld and re-center the bearings. Permanent horizontal deflection of the bearings shall be no more than 1/8" measured at the bottom of the bearing sub-assembly top plate.

Approximate jacking force during erection and concurrent stiffness as provided in Table 7.1:

Table 7.1:

Erection Temperature (°F)	Required Jacking Movement (in)	Required Jacking Load (kips)	Effective Stiffness (kip/in)
0	3.6	648	180
60	1	180	180
120	1.6	288	180

8.0 MEASUREMENT.

This work will not be measured.

9.0 PAYMENT.

No separate payment will be made for the work described in this section. The Department will pay for the masonry plate and shear studs as part of the bid item “Structural Steel-Arch Span.” Grout and surface preparation for the shear stud pockets and bearing plinths are incidental to the bid item for “Concrete - Class A.” All remaining materials and labor associated with preparing concrete surfaces; installing and grouting shear studs; and delivering and installing the seismic isolation bearing assemblies shall be considered incidental to other pay items.

SPECIAL NOTE FOR VISCOUS DAMPERS

1.0 DESCRIPTION AND SCOPE OF WORK

1.1 DESCRIPTION: Furnish and install completed fluid viscous damping devices, including mounting pins, girder connection plates, anchor plates, and mounting brackets at the locations shown on the plans in accordance with these specifications and the *AASHTO LRFD Bridge Design and Construction Specifications.*

A. WORK IN THIS SECTION: Principal items include:

i. Preparation of shop drawings, test reports, designing, fabrication, testing, handling and shipping to the site.

ii. Extent of fabrication of Fluid Viscous Damping Devices (FVD) work of this section is indicated by the requirements of this section.

iii. Production Dampers: Provide FVDs, referred to herein as "Production Dampers" in accordance with the specifications.

2.0 EXPERIENCE REQUIREMENTS AND SUBMITTALS

2.1 QUALIFIED SUPPLIERS

Taylor Devices, Inc.
90 Taylor Drive
North Tonawanda, NY 14120-0748
Contact: Paul Tuttobene (585) 624-7259

ITT Enidine, Inc.
7 Center Drive
Orchard Park, NY 14127
Contact: Ben Eder (585) 313-9740

The contractor should note that he/she is not limited to sourcing the FVDs from the above suppliers. Alternate suppliers shall submit to the Owner documented previous projects, which at a minimum meet the qualification requirements of Section 2.2. The Owner shall determine if the submitted documentation is satisfactory for qualification.

2.2 QUALIFICATION REQUIREMENTS: FVDs and the FVD supplier shall be subject to the qualification requirements for acceptance listed below.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

A. Documentation of independent product testing by Departments of Transportation, other government agencies, or internationally-recognized facilities/organizations as approved by the engineer of record.

~~A.~~

B. A published test report showing the dynamic characteristics of a design similar to the proposed FVDs. This report shall include force-displacement and force-velocity plots and shall be used to demonstrate the independence of the proposed FVDs to temperature, frequency and cyclic degradation.

C. A list of five or more projects where FVDs have been installed in a structure for seismic protection. For each project, the FVDs shall have provided a minimum of one year satisfactory service.

2.3 SUBMITTALS

A. GENERAL: All submittals shall be made as directed by the engineer of record.

B. SHOP DRAWINGS: Shop drawings shall be submitted to the Engineer with the Steel Girder Shop Drawings. Submit Shop Drawings for:

i. Each and every FVD type indicating dimensions and weights.

ii. Mounting pins.

iii. Mounting brackets.

iv. Anchor plates.

v. Girder connection plates.

C. PRODUCT DATA

i. FVD: Product Data shall include, but shall not be limited to manufacturer's standard product specifications, a list of production history for seismic dampers, and installation instructions.

ii. Paint: Submit manufacturer's literature and data.

D. CERTIFICATIONS: Submit the following documents, written and signed by the Quality Assurance Manager of the vendor.

i. A Certificate of Conformance (C of C) stating that all testing equipment has been checked for accuracy by appropriate standards for the purpose of this specification and that all mill test reports for all steel to be used are on file at the vendor facility.

Formatted: Indent: Left: 0.75", No bullets or numbering

Formatted: Font: Not Bold

Formatted: Font: Not Bold

E. INSPECTION AND TEST REPORTS: Submit the following test reports, written and signed by testing agency approved by the Engineer.

i. Production FVD Test Reports: Submit test data for each production FVD within fourteen (14) calendar days after the completion of testing of the subject FVD.

ii. Final FVD Test Report: Submit the Final FVD Report, as described in this Section, within twenty-eight (28) calendar days after the completion of all production FVD testing.

F. PROPOSED TEST PROCEDURES: Submit annotated and drafted illustrations of all proposed test apparatus and procedures for tests required by this Section. Such illustrations shall be submitted and approved by the engineer of record and/or architect prior to the commencement of any testing.

G. WARRANTIES AND GUARANTEES: A written warranty of not less than 35 years shall be provided with the cost proposal along with certification that a maintenance plan does not have to be purchased to activate the warranty. The manufacturer of the FVD's specified herein shall have manufactured FVD's of more than 150 kips output for a minimum of 10 years at the same manufacturing site proposed to manufacture the FVD's for this project.

3.0 VISCOUS DAMPER FUNCTION AND CONSTRUCTION

3.1 FUNCTION

A. FUNCTION: The FVD's shall provide an output force in either tension or compression that is directly proportional to the relative velocity between the two ends of the dampers. The damper output force varies only with velocity, and does not change with damper stroke position or orientation angle. The function of the dampers is to absorb earthquake energy, thereby reducing or eliminating damage to the structure when an earthquake occurs.

B. FLUID MEDIUM: The unit shall use inert silicone fluid as the operating fluid medium which shall comply with U.S. Federal Standard VV-D-1078.

C. FLUID EXPANSION COMPENSATION: The unit shall contain provisions to allow for thermal expansion and contraction of the fluid medium to prevent excessive buildup of internal high pressure or vacuum pressure.

D. SERVICING PROVISIONS: The dampers shall be maintenance and service free over a period of at least 35 years and preferably over the expected life of the structure. This means that no inspection, or fluid level verification, or refilling or replacement of fluid or any other parts shall be needed on any basis whatsoever. The dampers shall be designed and constructed so that installation, removal, or replacement, if necessary, shall be a simple process not requiring any special tools or methods.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

E. ADJUSTMENT: The unit shall be designed to provide for a length adjustment of plus or minus 0.25 inch, or an additional plus or minus 0.25 inch of stroke length shall be provided.

F. DIMENSIONS: The overall dimensions of the unit shall be held to a minimum consistent with the requirements of this specification, and in no case shall they exceed the dimensions specified in the plans.

3.2 CONSTRUCTION

A. GENERAL: The FVD unit shall be of corrosion protected construction with stainless steel piston rod internally mounted.

B. DESIGN LOADS

i. Axial Design Load: The maximum axial design loads are as follows:

At End Bents 1 & 2 = ~~600~~ 250 kips (tension or compression)

FVD shall be capable of providing the maximum design load with the rod fully extended, retracted, or at any intermediate point.

ii. Lateral Design Loads: The unit shall be designed to withstand a lateral acceleration of 1 g in any direction in any position of rod extension/retraction.

iii. Fluid Pressure: The unit shall be designed to withstand the following internal pressure:

(1) Proof: 200 percent of maximum operating pressure.

(2) Burst: 300 percent of maximum operating pressure, ~~but not less than 20,000 psi.~~

iv. Factors of Safety: Limit and ultimate loads shall include the effects of load factors included herein. Minimum factors of safety for the unit shall be 2.0 limit and 2.5 ultimate. The unit shall be such that no yielding will result from the application of limit loads and no failure will result from application of ultimate loads. ~~Limit and ultimate loads shall include the effects of load factors included herein.~~

Formatted: Font: Not Bold

Formatted: Font: Not Bold

3.3 PERFORMANCE

A. DAMPING COEFFICIENT

The units shall operate meeting the Damping Constitutive Law: $F = C * V^{\alpha}$

Where,
F = Damper Resistive Force (kips)
C = Damping Coefficient (kips*sec / inch)
V = Velocity (inch / sec)
α = Velocity exponent (dimensionless)

Damper characteristics shall be as follows:

At End Bents 1 & 2 C = ~~115~~ 65 kip-s/in with α = 0.~~57~~

Damping shall be present in both directions of travel and meet the performance shown in Figure 1. The normal operating force developed by the unit over the design range of velocity shall always fall within the envelopes as shown in Figure 1.

B. DUTY CYCLES: The unit shall be designed to the amplitude, frequency and time requirements of the following ~~wind~~ service load and seismic load~~ing~~ duty cycles.

i. ~~Wind~~ Service Load Duty Cycle: 0 to 0.~~25~~ 20 in. amplitude at 1 cps for ~~300~~600,000 cycles per year.

ii. Seismic Load~~ing~~ Duty Cycle: 1 inch mean amplitude (2 inches peak amplitude) at ~~0.75~~2.35 cps for 5 cycles (average) per year.

C. MAXIMUM/MINIMUM OPERATING TEMPERATURES: The unit shall be capable of operating at the energy levels, time and the environmental conditions specified herein, without degradation of performance or life as a result of maximum/minimum operating temperature.

D. LEAKAGE: The use of fluid seals that require fluid weepage for lubrication are prohibited. Under non-operating conditions, static seals shall not leak externally. When subjected to proof pressure for three (3) minutes, the unit shall show no visible evidence of external leakage.

E. STROKE: The unit shall be capable of meeting the performance requirements of 3.3 A and C, when cycled about any point within the full stroke of the unit. The full stroke shall be:

At End Bents 1 & 2 = +/- ~~12~~ 10 inches

Formatted: Font: Not Bold

Formatted: Font: Not Bold

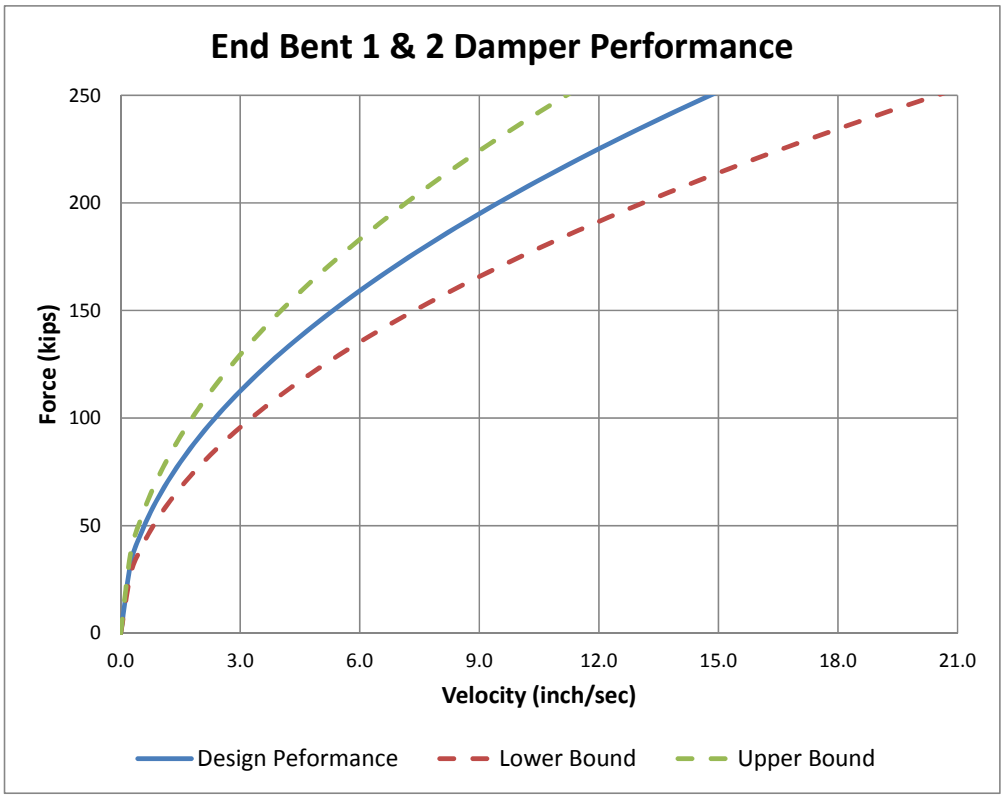


FIGURE 1 – END BENTS 1 & 2 FORCE - VELOCITY DAMPER OUTPUT ENVELOPE

Comment [DR1]: Damper Performance Curve has been updated since 90% Plans.

3.4 LIFE

A. LIFE: The unit shall be designed to guarantee a minimum reuse of one maximum capable seismic event before requiring refurbishment.

3.5 ENVIRONMENTAL CONDITIONS

A. AMBIENT OPERATING TEMPERATURE: When installed, the unit shall be capable of operating in an ambient air temperature from 0°F to +120°F.

B. ATMOSPHERIC PRESSURE: The unit shall operate at essentially sea level pressure (760 ±50mm mercury).

C. HUMIDITY: The unit shall be designed to withstand relative humidity up to 100 percent, including condensation due to temperature change.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

D. SUBMERSION: The unit shall be designed to withstand submersion and be equipped with wipers and/or bellows to protect seals from silt damage.

E. OTHER ATMOSPHERIC ELEMENTS: The unit shall be designed to withstand any of the probable combinations of the following atmospheric elements: rain, snow, sleet, hail, ice, fog, smoke, wind, ozone, sunshine, sand and dust, and salt atmosphere.

3.6 DELIVERY, HANDLING, AND STORAGE

A. DELIVERY: Deliver production FVD's to the job site in protective packaging for freight and handling purposes.

B. HANDLING: Handle FVD's and components carefully to prevent damage, breaking, denting or scoring. Do not deliver damaged FVD's or components; replace with new.

C. STORAGE: Store FVD's in a clean place. Protect from dirt, fumes, construction debris and physical damage.

3.7 INSTALLATION

A. INSTALLATION: FVD's shall be installed in accordance with the manufacturer's instructions as approved by the Engineer. FVD's shall not be installed until the bridge deck has been fully cast.

4.0 TESTING, MATERIALS, AND EQUIPMENT

4.1 TESTING OF VISCOUS DAMPING DEVICE UNITS

A. PRODUCTION UNIT TESTING:

i. Purpose: Production unit testing shall be conducted in order to verify the following:

(1) The general quality and manufacturing consistency of each of the production units.

(2) The general consistency of all production units in terms of their performance characteristics to meet the requirements of the contract documents.

ii. Acceptance Criteria:

(1) No visible leakage or signs of physical deterioration or degradation in performance shall be observed during and after the series of tests. There shall be no signs of yielding or permanent deformation, or re-torqueing of parts.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

(2) The force-velocity results from the tests both in tension and in compression, adjusted for expected variations due to temperature and number of stroke cycles shall fall entirely within the upper and lower bound curves (Figure ~~s~~ 1 ~~& 2~~) as used for the final design of the damped structure.

iii. Sequence of Testing:

(1) Quality Assurance Tests: Production units shall be subjected to and pass the following sequence of quality assurance tests:

a. Proof Load Test: An internal pressure shall be applied to each FVD that shall be equivalent to 150% of the maximum damper load (each production unit). This pressure shall be maintained for 180 seconds.

b. High Level Proof Load Test: One out of every fifty production units, or a minimum of two (2) units, shall have an internal pressure ~~of 20,000 psi~~equivalent to ~~applied~~ 300% of the maximum damper load (300% maximum operating pressure). This pressure shall be maintained for 180 seconds.

c. Life Cycle Test: One out of every fifty production units, or a minimum of two (2) units, shall be cycled through its full end to end displacement for a total of 60 cycles. The cyclic velocity is expected to be much slower than the design maximum velocity and shall depend on the capacity of the approved testing apparatus.

(2) Performance Verification Tests:

a. Production unit testing shall be conducted on all units in order to verify the performance consistency of each production unit. These tests shall be performed in the tension and compression directions and shall verify the force velocity characteristics of the damper. Tests are to be performed at 100% of DBE velocity as determined from dynamic analysis of the structure for 3 cycles. The test results shall fall entirely within the upper and lower bound curves (+/- 15%). The force, displacement and time measurements shall be accurately obtained and recorded. Force-velocity plots shall be constructed from this data.

b. For time/cost savings, testing in the compression direction only may be proposed, provided the damper manufacturer can substantiate the balanced nature of fluid orificing in each direction. The use of valves and/or reservoirs or accumulators are not considered a balanced method and will require testing in both directions.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

4.2 STANDARDS: Conform to the applicable provisions of the current editions of the following standards, except as indicated otherwise on the drawings or the specifications:

A. Title 24, Part 2, CCR, 1989 Amendments

B. ASTM E4 - Load Verification of Testing Machines

C. ASTM A36 - Specification for Structural Steel

D. ASTM A325 - Specification for High Strength Steel Bolts

E. ASTM A570 - Specification for Structural Sheet Steel

F. AWS D1.1 - Structural Welding Code of the American Welding Society

G. AMS-W-6858 - Welding, Resistance: Spot and Seam

H. AWS- C3.4, C3.5, C3.6 - Brazing of Steels, Copper, Copper Alloys, Nickel Alloys, Aluminum and Aluminum Alloys

I. AWS- C1.4, C1.4M - Welding, Spot, Hardenable

J. NAV SEA S9074-AQ-GIB-010/248 – Welding and Brazing Procedure and Performance Qualifications

K. AMS-STD-2175 - Classification and Inspection of Casting

L. ANSI/ISO/ASQ 9001 (ISO 9001) - Quality Management Systems-Requirements

M. SAE AS/EN 9100 Quality Management System

N. ISO 14001 – Environmental Management Systems

O. AISC "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings", by the American Institute of Steel Construction

P. AISC "Code of Standard Practice for Steel Buildings and Bridges"

Q. SSPC "Steel Structures Painting Council"

R. MIL-HDBK-5 "Specifications for Metallic Materials"

NOTE: Proposed alternate standards shall be submitted to the architect/engineer for review and approval.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

4.3 FVD MATERIALS AND PARTS

A. Except as specified herein, the materials, parts and processes used in the design and manufacture of the unit shall conform to specifications and standards selected in the order of precedence established by MIL-STD-970. All materials and processes used shall be identified in vendor drawings by specifications or standards.

B. MATERIALS: All materials used in the manufacture of the unit shall be subject to approval by the engineer of record.

i. Materials: Materials shall have allowable stress values taken from MIL-HDBK-5. Unless suitably protected against electrolytic corrosion, dissimilar materials as defined in MIL-STD-889 shall not be used in contact with each other. Dissimilar metal joints shall not be permitted without a non-metallic separator or gasket of at least .06 inch thickness. The use of aluminum, aluminum alloys, magnesium, magnesium alloys, beryllium and beryllium alloys is prohibited. The use of non-stainless steel internally exposed to internal pockets of air or gas (as could occur in an internal reservoir, and plumbing to the reservoir) is allowable provided components are suitably protected from corrosion by means of appropriate surface treatments.

ii. Fungus Resistant Materials: Only non-nutrient materials shall be used in the unit.

iii. Castings: All castings shall be prohibited for pressure vessel parts or any other parts subjected to tensile or bending stresses, except for parts such as covers, handles, etc. whose failure would not affect the structural integrity or performance characteristics of the unit. Such casting may be Class 2B, subject to the approval of the engineer of record.

C. PARTS

i. FVD's shall be constructed of maintenance-free designs only. External ~~R~~reservoirs, external plumbing, and/or fluid level indicators such as sight windows or pressure indicators that may leak are strictly prohibited.

ii. Age Sensitive Parts: All non-metallic packing, seals, wipers, bellows, or gaskets shall be of non-age sensitive materials.

iii. Piston rods and any part that slides relative to a seal shall be manufactured from stainless steel only. Plating may be applied over the stainless steel if required by the type of fluid seal selected.

iv. Operating fluid used in the dampers shall be non-toxic, non-flammable, and cosmetically inert silicone per U.S. Federal Standard VV-D-1078. Petro-chemical fluids shall not be used.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

v. The components of the damper that are pressure vessels are to be of non-tie rod type construction, without externally supported heads or end caps. Welded construction or castings of any type are not permitted for pressure vessel construction.

vi. Pressure vessels and seals shall be rated for ~~20,000 psi minimum burst pressure~~a minimum burst pressure of 300% maximum operating pressure. A randomly selected production unit shall be tested to this pressure, with no loss of fluid or parts failure of any type permitted.

vii. Parts List Approval: The vendor shall submit the equipment parts list for review and approval by the engineer of record. Approval will be based on an evaluation of the following documentation as applicable to each part.

(1) Vendor part number and nomenclature

(2) Military or other applicable specifications

(3) Source name and part number

(4) Testing and inspection requirements

5.0 FABRICATION AND QUALITY CONTROL

5.1 FABRICATION

A. PROCESS

i. Protective Treatment: Materials subject to deterioration when exposed to environmental conditions likely to occur during service usage, shall be protected against such deterioration in a manner that will in no way prevent compliance with the requirements of this specification. The use of any protective coating that will crack, chip or scale with age or extremes of climate and environmental conditions shall not be used. Corrosion control shall be used as a guide for minimizing corrosion damage to the assembly.

ii. Fusion Welding: Fusion welding shall be in accordance with approved standards. Weld design shall be based on the function and strength of the assemblies. Fillet welds on plate above 0.125 inches thickness will not be used on primary structure without specific approval by the engineer of record. Weld quality shall be specified on vendor drawings with proper acceptance standards and inspection methods.

iii. Resistance Welding: Resistance welding shall be in accordance with MIL-W-6858 and MIL-W-45223, as applicable.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

iv. Welder Certification: Certification tests for welders shall be in accordance with AWS D1.1.

v. Brazing: The brazing of steels, copper, copper alloys and nickel alloys shall conform to MIL-B-7883.

vi. Soldering: Soldering shall be in accordance with approved standards. Whenever insulation material is subject to heating during soldering, the material shall be undamaged and parts fastened thereto shall not be loosened. No mechanical assembly shall depend on soft-solder for mechanical strength.

vii. Finish: The exterior finish of the unit, including the color and finish type required shall be recommended by the vendor and submitted to the engineer of record for approval.

B. WORKMANSHIP: All parts shall be free of burrs and sharp edges and any damage, defect or foreign material which might detract from the intended operation, function or appearance of the unit.

5.2 SAFETY

A. SAFETY: The design of the unit shall be such that all possible sources of danger to personnel or equipment during assembly, disassembly, testing, operation and maintenance are minimized. Where required, precautionary measures shall be prominently and clearly indicated on the equipment.

5.3 MAINTAINABILITY

A. MAINTAINABILITY: The unit shall be constructed to be maintenance free. The use of external reservoirs, external plumbing, and/or fluid level indicators shall not be permitted. Each FVD shall be designed and constructed such that installation, removal and replacement, if necessary, shall be a simple process not requiring any special tools or methods. The use of fluid seals that require fluid weepage for lubrication are prohibited.

5.4 INTERCHANGEABILITY

A. INTERCHANGEABILITY: All parts having the same manufacturer's part number shall be functionally and physically interchangeable. The vendor shall assign new part numbers when change numbers cause any of the following conditions:

i. Performance or durability is affected to such an extent that superseded items must be discarded for reasons of safety or malfunctioning.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

ii. Parts, subassemblies of complete units are changed to such an extent that the superseded and superseding items are not interchangeable.

iii. Superseded parts are limited to use in specific articles or models of articles and the superseding parts are not so limited to use.
When interchangeable repairable assemblies contain a non-interchangeable part, the part number re-identification of the non-interchangeable part, of the next assembly and all the progressive higher assemblies shall be changed up to and including the assembly where the interchangeability is re-established.

5.5 CHANGE CONTROL

A. CHANGE CONTROL: After initial design completion and approval or initial hardware delivery, whichever occurs first, any change or substitution of material, dimensions, processes or other characteristics must be approved by the engineer of record prior to incorporation. The vendor shall exercise the same configuration control over his suppliers.

5.6 IDENTIFICATION MARKING

A. IDENTIFICATION MARKING: Units shall be marked for identification in accordance with MIL-STD-130.

5.7 SERIAL NUMBER ASSIGNMENT

A. SERIAL NUMBER ASSIGNMENT: Sequential serial numbers shall be assigned to all units in accordance with architect/engineer of record's requirements. The individual number shall be assigned according to the vendors standard practice unless otherwise specified in the purchase order or contract.

5.8 QUALITY CONTROL PROVISIONS

A. PRODUCT QUALITY CONTROL: To ensure effective control over product quality, the vendor shall, establish and maintain a manufacturing/processing control system including written process specifications and procedures to insure that manufacturing, processing, inspection and testing are accomplished in accordance with the following:

i. Quality Management System Requirements ISO 9001 and AS/EN 9100.

The seller shall provide and maintain a system that complies with U.S. requirements of the current revision of ISO 9001and AS/EN 9100 for quality assurance in design, manufacture, test, and repair of dampers. Certification to ISO 9001 or AS/EN 9100 by an individual or firm located outside the United States of America is prohibited.

Formatted: Font: Not Bold

Formatted: Font: Not Bold

B. MANUFACTURING PROCESS CONTROL: In addition to compliance with both of the quality assurance systems listed above, the vendor must maintain a system for manufacturing process control of this project which includes as a minimum the following:

i. Raw Material Traceability.

ii. Inspection instructions.

iii. In process and final detail component inspection instruction with actual dimensions.

C. CALIBRATION SYSTEM REQUIREMENTS: All devices used to measure, gage, test, inspect or otherwise examine items to determine compliance with specification and/or contractual requirements shall be calibrated in compliance with the applicable section of the current revision of both ISO 9001 and AS/EN 9100 standards, to a calibrated measurement standard which has known valid relationships traceable to the U.S. National Institute of Standards and Technology (NIST).

6.0 MEASUREMENT

The final quantity of FVDs will be the actual number of individual dampers, including mounting pins, girder connection plates, anchor plates, and mounting brackets, acceptably furnished and installed during the project. The Department will not measure dampers replaced due to damage or rejection.

7.0 PAYMENT

The Department will pay for the Viscous Dampers at the contract unit price bid for each. The Department will not pay for dampers replaced due to damage or rejection. Payment is full compensation for furnishing all materials and equipment necessary to install, operate, move, repair, and maintain or replace the dampers. All prescribed work shall be done in a workmanlike and acceptable manner including all labor and incidentals necessary for completion. The Department will make payment for the completed and accepted quantities under the following:

Pay Item	Pay Unit
Seismic Dampers~~ – End Bents –~~	Each

Formatted: Font: Not Bold

Formatted: Font: Not Bold

SPECIAL NOTE FOR FINGER EXPANSION JOINT

1.0 DESCRIPTION

This work includes the fabrication, furnishing and installation of a tooth expansion joint with a fabric reinforced drainage trough for highway bridge joints. Materials and workmanship shall be in accordance with the KYTC Standard Specifications; AASHTO/AWS D1.5M/D1.5 "Bridge Welding Code"; AWS D1.1/D1.1M "Structural Welding Code – Steel"; AASHTO "LRFD Bridge Design Specifications", 6th Edition (AASHTO LRFD Design); AASHTO "LRFD Bridge Construction Specifications," 3rd Edition, 2010 (AASHTO LRFD Construction); the Contract Documents; and this Special Provision.

2.0 MATERIALS

Materials shall conform to the following:

A. Structural Steel: Steel plate, bars and shapes shall conform to AASHTO M270 (ASTM A709), Grade 50. (Sidewalk and (railing) cover-plates shall conform to AASHTO M270, Grade 50). No aluminum components or hardware shall be used. Galvanize steel components in accordance with ASTM A123.

B. Welded Studs: Welded studs for anchorage purposes shall conform to ASTM A108.

C. Anchors Bolts: Anchor bolts, nuts and washers shall be in accordance with ASTM F1554, Grade 55, ASTM A563 Grade DH and ASTM F436, respectively, and shall be hot-dipped galvanized.

D. Neoprene Trough: Fabric reinforced drainage trough shall be polychloroprene (Neoprene) of the thickness specified in the plans. Trough shall be reinforced with one or two plies of tightly woven polyester or nylon fabric and shall be supplied and installed in one continuous length. The inside surface of the trough shall be smooth to promote self-removal of foreign material during normal joint operation. The shape of the trough shall be designed to minimize stress concentrations at compression strips.

Neoprene/fabric composite material shall comply with the following:

PHYSICAL PROPERTY	ASTM TEST	VALUE
~~Density~~		~~75 psf minimum~~
Hardness (Type A Durometer)	D2240	50 to 75 points
Tensile Strength, both directions	~~D378~~D412	~~8~~2000 lbs/in. minimum
Elongation @ ultimate tensile	D412	~~35~~250% maximum

PHYSICAL PROPERTY	ASTM TEST	VALUE
strength		
Tear (Die C)	ASTM ~~S~~D624	120 lbs/in. minimum
Low Temperature Brittleness (22 hrs. @ -20^{0}F, then wrapped around a 3 inch mandrel)	ASTM D2137	No cracks
Ozone Resistance (20% Strain) 100 pphm in air (100 hrs. @ 100^{0}F)	D1149	No cracks

3.0 FABRICATION

~~Tooth plates for each assembly shall be cut from a single plate by burning in such a way that, after the plate is cut and the toothed plates placed in the same relative position as before burning, no part of the cut shall be wider than 5/16 in.~~ Anchor holes, vent holes and tapers shall be machined into the plate. Upon completion, the machined plate shall be galvanized per ASTM A123.

The joint segments shall be manufactured and delivered in pairs of independent elements with parallel gaps between teeth. Both halves (~~abutment~~ end bent and superstructure~~, or each side of adjacent units~~) of finger expansion joints shall be fully assembled in the shop to ensure that full joint closure can be attained without binding of fingers. After joint segments have been fully assembled to nominal joint dimensions and approved, they shall be match marked and scored (the upper surface of the finger plates shall be permanently scored to provide two or more parallel lines in both directions) to aid in proper field installation.

4.0 SAMPLING, TESTING & INSPECTION

An independent laboratory, to ensure compliance with these provisions, shall test each lot of composite neoprene/fabric sheeting. Two certified copies of the qualification test data indicating that the tested materials comply with these provisions shall be submitted to the Engineer and KYTC. The sample from each lot shall be one 6-inch piece, 2-foot long.

5.0 IDENTIFICATION, SHIPPING & HANDLING

Expansion joint openings shall be preset prior to shipment and assembled with temporary shipping angles at maximum 5'-0" centers. Fabricator shall show details of all shipping and erection temporary attachments on the shop drawings.

6.0 INSTALLATION

Installation of the expansion dam shall be to the lines and grades shown on the plans and in accordance with Contract Documents and shop drawings. Expansion joint system shall be shipped to job site preassembled ~~for units either side of crown~~.

Align the finger plate or sliding plate joint assemblies in position and check the expansion opening. The expansion opening must be adjusted for temperature prior to bolting, welding or placing concrete on each side of the joint.

Test fit the finger plates or sliding plates with all the armoring and anchorages in place. Install the finger joint centered over the expansion gap, for both fingerplates and sliding plates. Verify that the joint is in plane and sloped per the roadway. Make sure the fingers do not rub during the full range of temperature movement.

The Engineer will confirm the procedure, opening and alignment prior to concrete placement. After confirmation, ~~remove the finger plates or sliding plates before concreting. C~~ cast and cure the expansion joint blockout per KYTC specifications. Place concrete under the expansion dams, vibrate until the concrete is forced through air holes, and strike off excess concrete. After the concrete has cured, clean air holes and fill with an approved sealer.

Install the fabric trough and the finger or sliding plates according to the Contract Documents and shop drawings. Do not splice the drain trough, unless indicated. If splices are indicated, use splices vulcanized by the manufacturer. Do not use longitudinal splices.

7.0 SUBMITTALS

Submit shop drawings, for each location, type and model of expansion device used. Shop drawings shall include, but not be limited to, the following:

A. Complete details of all components and sections showing all materials used in the expansion joints.

B. A listing of all applicable KYTC, ASTM and AASHTO specifications.

C. Name and address of the manufacturer, and location of the fabrication plant.

D. Name and telephone number of the manufacturer's representative who will be responsible for coordination of production, inspection, sampling and testing.

E. Welding procedures used in the expansion joint assembly manufacture clearly described and detailed.

F. Table of longitudinal offsets for installation at varying temperatures. Use 60°F as the mean temperature.

Joint shop drawings and neoprene trough shop drawings shall be coordinated to ensure that joints and troughs will fit when field assembled. Fabrication shall not commence until the approved shop drawings are in the hands of the Inspector and fabricator and the Engineer has authorized fabrication.

8.0 MEASUREMENT

Quantity for Finger Expansion Joint will be measured per linear foot from the inside face of the north vehicular barrier to inside face of ~~exterior traffic barriers~~ the pedestrian railing curb. The unit price for Finger Expansion Joint will be full compensation for furnishing, fabricating, installing structural steel tooth plates, roadway joint seals, drainage troughs, catch basins, downspouts, sidewalk plate, barrier cover plates and all material, labor, equipment, tools and incidentals necessary to complete the work as specified in the Contract Documents.

9.0 PAYMENT

Code	Pay Item	Pay Unit
23859EC	FINGER EXPANSION JOINT	LF

SPECIAL NOTE FOR INSTALL - DUCT BANK

Trigg County
US 68/KY80 Bridge over Lake Barkley

1.0 DESCRIPTION AND SCOPE OF WORK

1.1 Perform all work in accordance with the Kentucky Transportation Cabinet, Department of Highways 2012 *Standard Specifications for Road and Bridge Construction* and applicable Supplemental Specifications, the Standard Drawings, and this Note. Section references are to the *Standard Specifications* unless noted otherwise.

1.2 This work shall apply to the Approach Spans and Arch Span and include the furnishing (except where noted otherwise) and installation of duct banks, pull boxes, hanger supports, utility platforms and ground pull box vaults along or in the vicinity of the bridge, in accordance with the plans, specifications and this special note. At a minimum this includes:

1.2.1 Installing two 4-in. diameter XHW fiberglass conduits (furnished by Contractor) and two 1 ½-in. diameter inner ducts (furnished by AT&T) in each 4" conduit, ~~Installing two 4-in. diameter XHW fiberglass conduits (furnished by Contractor) with inner ducts (furnished by AT&T),~~ collectively known as "AT&T Duct Bank."

1.2.2 Installing four 4-in. diameter XHW fiberglass conduits (furnished by Contractor), collectively known as "PRECC Duct Bank."

1.2.3 Furnishing and installing fiberglass plates, wind support cable bracing, threaded rod hanger system, all connectors and other related fittings, as detailed in the Plans, or as otherwise required for installation of AT&T Duct Bank and PRECC Duct Bank.

1.2.4 Furnishing and installing pull boxes with padlocks along the bridge at the locations shown in the Plans for both AT&T Duct Bank and PRECC Duct Bank.

1.2.5 Designing, furnishing materials and installing grated utility platforms at all pull box locations.

1.2.6 Installing two ground pull box vaults (furnished by PRECC), one at each end of the bridge. The approximate size of the vaults will be 8' x 4' x 4' deep. The vaults shall be located at the top of the slope behind the guardrail and installed flush with the final grade. The four PRECC 4-in. diameter XHW fiberglass conduits shall terminate at either end within the boxes.

1.2.7 Installing two ground pull box vaults (furnished by AT&T), one at each end of the bridge. The vaults shall be located at the top of the slope behind the guardrail and installed flush with the final grade. The two AT&T 4-in. diameter XHW fiberglass conduits shall terminate at either end within the

boxes.

2.0 GENERAL

Pull box dimensions shall be in accordance with the Plans and *Standard Specifications* and must satisfy requirements of the National Electrical Safety Code (NESC.) Pull boxes shall have locking mechanisms and weather-resistant padlocks. Padlocks shall be keyed differently for AT&T Duct Bank and PRECC Duct Bank and shall include a minimum of four identical keys for each.

The number and diameter of ducts for each Duct Bank shall comply with the Plans and Section 1.0 of this Note. Duct material shall be in accordance with Section 4.0 of this Note.

Grated utility platforms shall conform to the Plans and the material specifications in Sect. 4.0 of this Note.

Utility support channels shall conform to the Plans and be spaced no greater than 16'-6" along the bridge.

Installation of fiber optic cables and electric lines will be by others.

3.0 DESIGN

3.1 The Contractor shall design the grated utility platforms and their components, including hatches, ladders, railings and all connections. All design documents shall be prepared and stamped by a Professional Engineer licensed in the Commonwealth of Kentucky. Design calculations and shop drawings shall be submitted to the Engineer for review and approval. The shop drawings shall include all member sizes, connection details and materials specifications.

The Contractor shall receive Engineer's approval prior to purchasing any materials or equipment for the platform system.

3.2 Shop drawings for the duct bank and hanger systems and the pull boxes shall be submitted to the Engineer for review and approval. The shop drawings shall include all member sizes, connection details and materials specifications.

4.0 MATERIALS

4.1 All materials shall comply with the Plans, *Standard Specifications* and this Special Note. Where material or component properties are not adequately identified or described, they shall comply with AASHTO *LRFD Bridge Construction Specifications*, 3rd Ed., 2012 Interims.

4.2 Utility Conduit. 4-in. diameter conduit shall comply with NEMA TC 14-2002 and 2011 NEC Article 355. Fire resistance and water tightness of the conduit shall meet or exceed UL 2515A. The inner surface shall be smooth. Wall thickness shall be ¼" and conduit shall be capable of spanning 16'-6" with a cable load of 14 pounds per lineal foot with a maximum deflection of 5/8".

4.3 Structural Steel. Structural steel for grated utility platforms, ladders, hatches and handrails shall meet the physical requirements of ASTM A709, Grade 50. Members shall be painted in compliance with the *Standard Specifications* to match the steel bridge girders. All hardware and fasteners for access hatches shall be stainless steel, Type 316.

4.4 Threaded Rod. 3/4" threaded hanger rods shall be ASTM A709, Grade 36, and hot-dipped galvanized in accordance with AASHTO M232 after fabrication.

4.5 Bolts, Nuts & Washers. Except where connected to stainless steel cable bracing or platform access hatches, the bolts, nuts and washers shall be in accordance with ASTM F1554 Grade 36, ASTM A563 Grade A, and ASTM F436, respectively, and shall be hot-dipped galvanized.

4.6 Wind Support Cable Bracing. 1/8" cable bracing shall be stainless steel aircraft cable (7 x 19) complying with ASTM A492, Type 304. Bolts, nuts, washers and other hardware in contact with cable shall be Type 316 stainless steel complying with ASTM A276, unless shown otherwise in the Plans.

5.0 INSTALLATION

Installation of duct banks, duct bank support system, utility platforms and pull boxes shall comply with the Contract Plans, Standard Specifications, this Special Note and the approved calculations and shop drawings. Installation of ground pull box vaults shall be coordinated with the utility companies. Fabrication and installation shall not commence until all relevant calculations and shop drawings have been submitted and have been reviewed and accepted by the Engineer.

Guidelines for Installing Expansion Joints

Install expansion joints between securely mounted items such as pull boxes or other conduit terminations as follows, unless noted otherwise on the plans:

- For conduit length less than 50 ft., no expansion joint is required.
- For conduit length between 50 ft. and 200 ft., install one expansion joint mid-way.
- For conduit length over 200 ft., install one expansion joint every 200 ft. with the first expansion joint no more than 100 ft. from the end termination.
- If more than one expansion joint is installed within a conduit length (i.e., greater than 200 ft.), split anchor rings shall be installed around the hanger that is closest to mid-way between each expansion joint. The hangers that have split anchor rings shall be braced.

6.0 MEASUREMENT

This work will be measured on a linear feet of duct bank basis between back face of the end bents. The work to terminate the duct banks at the ground pull box vaults will not be measured.

7.0 PAYMENT

Payment at the contract unit price shall include the cost of all labor, supervision, material (except that furnished by the utility companies) and equipment to complete the work in accordance with the Plans and Specifications.

The cost of installing inner duct (to be furnished by AT&T) into the AT&T duct bank shall be included in the cost of this item.

The cost of furnishing and installing the duct bank support assemblies including bracing cable and connection hardware, and utility platforms, including pull boxes, access hatches and ladders shall be included in the cost of this item.

The cost of all labor, material and equipment to terminate the duct banks at the ground pull box vaults (to be furnished by the utility companies) shall be included in the cost of this item.. Apportion the work equitably between the AT&T Duct Bank and PRECC Duct Bank pay items on a lineal per foot basis.

Payment will be made under:

BID ITEM CODE		
24617EC	INSTALL –DUCT BANK(AT&T)	LF
24617EC	INSTALL –DUCT BANK (PRECC)	LF

The Department will consider payment as full compensation for all work required by this note.

SPECIAL NOTE FOR HELPER BOAT

1.0 SCOPE OF WORK. Bidders are advised that there is commercial barge traffic on this portion of Lake Barkley throughout the year.

The work described in this special note is to provide a helper boat with pilot to assist commercial tows upon request by commercial barge pilots transiting under the bridge.

Requests for a helper boat will be at the discretion of the commercial barge pilot transiting the bridge on the navigable waterway.

2.0 EQUIPMENT. The equivalent utility of an 1800 horsepower (1800 HP) tow boat shall be provided. When not servicing requests from transiting Commercial Barge Pilots, the helper boat may be used by the Contractor for other construction activities, but shall be made available to assist tows when requested without delay to the needs of commercial navigation.

During the phases of work listed in Section 5.0 herein, the helper boat will be moored or docked on-site or within one mile of the project site at all times except when in use as a helper boat or assisting construction activities.

3.0 PERSONNEL. The pilot of the helper boat shall have and maintain a Transportation Worker Identification Card (TWIC) and the Merchant Mariner Credential (MMC) for the Pilot of a Towing Vessel appropriate for the class and size of tow boat being operated as a helper boat. One or more relief pilots with the same credentials as listed above shall also be retained by the Contractor such that 24 hours a day, during instances when a helper boat is an active requirement, a qualified and licensed pilot is always available to operate the helper boat.

4.0 REQUIREMENTS. The United States Coast Guard (USCG or Coast Guard) regulates all work on or in navigable waters. Comply with all permit conditions and Coast Guard regulations.

Provide regular advance notifications in writing to the Engineer of upcoming work activities on the lake for forwarding to the USCG and the United States Army Corps of Engineers (USACE) for the agencies' issuance as Notices to Mariners.

Three months prior to the first instance of work requiring a helper boat to be active, the Contractor shall submit to the Engineer for approval the Chain of Communication by which the Commercial Industry will contact the Contractor's Helper Boat Pilot for requesting assistance in transiting the bridge site.

Two months prior to the first instance of work requiring a helper boat, the Contractor shall participate in a meeting with the Department, the USCG, and representatives of the commercial towing industry for the purpose of advance coordination and safety preparation.

5.0 INSTANCES REQUIRING HELPER BOAT. (Note: All references to pier and span identifiers for both the existing Henry R. Lawrence Memorial Bridge and the Proposed new bridge conform to the Contract Drawings.)

The existing navigation channel span of the Lawrence Bridge is designated as Existing Span No. 2 (Span No. 2 is the eastern-most arch span over the "Existing Sailing Line" designated in the plan, and also referenced as the "Right Descending Span.")

Provide a helper boat upon request of the Pilot of any Commercial Towing Vessel transiting the site when any work activity results in reduction to the horizontal navigation channel defined by the clearances for Existing Span No. 2 projection parallel to the sailing line.

Construction of Proposed Pier 8 foundation shafts, footing and pier are example activities anticipated to encroach into the navigation channel and result in reduction to the horizontal navigation clearance in Existing Span No. 2. Other construction and/or demolition operations which encroach into the navigation channel defined by Existing Span No. 2 will also require the Contractor provide a helper boat, upon request of a Pilot.

Do not rely on Existing Span No. 3 to be an alternate span for Commercial Towing Vessel transiting the site.

6.0 DEMOBILIZATION OF HELPER BOAT. Submit to the Engineer a request in writing to discontinue the Helper Boat service certifying that there will be no subsequent Contractor operations or instances requiring a helper boat. Do not demobilize the Helper Boat until authorized in writing by the Engineer.

7.0 RECOVERY OF DAMAGES. In the event that any damages to the Department, to the public, or to commercial towing interests result from the Contractor's failure to provide a helper boat when requested during the instances requiring a helper boat as described above, such damages will be the responsibility of the Contractor. The Department will seek recovery from the Contractor of any and all damages resulting from failure to provide a helper boat in accordance with this special note.

8.0 MEASUREMENT.

When Helper Boat is included in the Bid Proposal as a separate bid item, the Department will measure all work performed as part of providing a Helper Boat as a lump sum.

~~All work described in this Special Note is incidental to other pay items and therefore does not require measurement.~~

9.0 PAYMENT.

The Department will pay for the quantities at the contract unit price as follows.

When Helper Boat is included in the Bid Proposal as a separate bid item, the Department will make partial payments for Helper Boat in 4 equal or approximately equal payments.

1) 25 percent after the Helper Boat has assisted ten (10) Commercial Tows at the request of the Commercial Tow Pilots transiting the bridge, or with Payment 2, whichever comes first.
2) 25 percent when all proposed concrete bridge pier construction is complete.
3) 25 percent when the proposed bridge is substantially complete and has been opened to traffic.

4) 25 percent after removal of the existing Lawrence Memorial Bridge Channel Piers and Spans and after the Helper Boat has been authorized in writing by the Engineer to be demobilized.

The Department will consider payment as full compensation for all work required under this section. Payment will be made under:

~~The work required in this Special Note will not be paid separately by the Department. It is considered incidental to the cost of other work items.~~

~~The Department will consider payment under other work items as full compensation for all work required in this note. Payment will be made under:~~

BID ITEM CODE		
~~Not Applicable~~	~~Not Applicable~~	~~N/A~~
24620EC	HELPER BOAT	LS

SPECIAL NOTE FOR WEB CAMERA CONST MONITORING SYSTEM

1.0 GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes an integrated, professional-grade, high resolution digital webcam system designed specifically for the construction industry as a turnkey package including camera(s) and related hardware, mounting equipment, software, wireless cellular data transmission service, website hosting, image hosting and storage, online interface for the system and technical support.

B. Related Sections:
1. Division 1 Section "Photographic Documentation" for periodic construction photographs.
2. Division 1 Section "Closeout Procedures" for submitting digital photographs as Project Record Documents at Project closeout.

1.03 DEFINITIONS

A. CCD: Charge-coupled device.

B. System Vendor: Provider of camera system hardware and software and host maintaining off-site server, data storage devices, and troubleshooting software and equipment. Contractor shall maintain an active contract for System Service for duration of Contract Time unless other term is agreed upon in writing by the Owner. Cost for System Service shall be included in the Contract Sum.

C. System Service: Host services provided by System Vendor including image acquisition, transfer, backup, periodic upgrades to the system, viewing access via a maintained interface on the Internet and on-line storage of images for duration of the Service Contract.

1.04 SUBMITTALS

A. Shop Drawings:
1. Key Plan: Submit key plan of Project site with notation of vantage points marked for location and direction of each camera. Indicate camera mounting heights relative to ground or bridge deck elevation.

B. Quality Assurance Submittals:

1. Manufacturer’s Instructions: Follow manufacturer’s installation and testing instructions.

C. Closeout Submittals:

1. Digital Images: Submit digital still images exactly as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.
    a. Date and Time: Include date and time in filename for each image.
    b. Format: Submit a sortable/identifiable archive of all digital still images on an external hard drive or DVD format.
2. Time-Lapse "Movie": Compile select digital still images into a time-lapse movie of the construction period. Optimize images included and run-time length of movie to suit Owner's requirements.

1.05 QUALITY ASSURANCE

A. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1. Factory assemble camera system from components bearing UL Classification Marking indicating that materials have been produced under UL's Classification and Follow-Up Service.

B. Comply with NECA 1, "Standard Practices for Good Workmanship in Electrical Construction."

C. Comply with NFPA 70, "National Electrical Code."

D. Manufacturer Qualifications: Company specializing in manufacturing Products specified in this Section with minimum five years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels.

B. Store materials to comply with manufacturer's directions to prevent deterioration from moisture, heat, cold, direct sunlight, or other causes.

1.07 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient

temperatures of minus 10 to plus 120 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph. NEMA 250, Type 3R enclosures.

1.08 COORDINATION

A. Coordinate installation of cameras so that system is fully operational prior to commencement of construction operations.

B. Coordinate layout and installation of cameras to avoid interference from trees or other obstructions and to prevent sunlight and light from fixtures entering directly into the camera lens.

C. Coordinate layout and installation of cameras to avoid interference with construction operations.

1.09 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of cameras and equipment related to camera operation that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, the following:

1. Failure of system to meet performance requirements.
2. Faulty operation of hardware and software.
3. Defects in other components of the work.

B. Warranty Period: Lifetime product warranty required

1.10 USAGE RIGHTS

A. Obtain and transfer copyright usage rights to Owner for unlimited reproduction of photographs and archives generated by the system.

B. Contractor shall understand that photographs and archives generated by the camera system become the mutual property of the Owner and System Vendor and cannot be used for advertisement or publicity reasons without the expressed written consent of the Owner and System Vendor.

1.11 MAINTENANCE

A. Maintenance Service: Provide service and maintenance of camera system for entire Construction period.

1. Examine monthly; clean and adjust equipment.
2. Provide remote emergency repair service by System Vendor 24 hours a day, seven days a week to ensure uninterrupted camera service. Provide personnel on-site to assist System Vendor as needed during working

hours. Provide replacement parts and components due to system failure, damage, or theft within two business days.

3. Maintenance service shall not be assigned or transferred to another agent or subcontractor without prior written consent of Owner.

4. Require system vendor to proactively monitor the system by means of service and maintenance contract. If no connection is made within a span of time not to exceed 24 hours during regular business days, require system vendor to notify Contractor and commence troubleshooting.

   a. Provide necessary staff during troubleshooting to verify power availability, to remove and replace system, and to verify functioning phone lines or internet access for dialup and Ethernet based systems.

2.0 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. OxBlue, Inc., 888-849-2583, http://www.OxBlue.com/.
2. EarthCam, Inc., 800-327-8422, http://www.EarthCam.net

B. Substitutions: As approved by the Owner.

2.02 SYSTEM REQUIREMENTS

A. The indoor/outdoor camera system shall consist of a tamper and impact resistant, discreet, fixed pole or wall-mount enclosure with integrated fixed camera, lens and controller.

B The cameras shall have the ability to take a high-resolution **8.0 Megapixel** digital still images of the construction site at a set time interval, every 15 minutes, and upload the still images over a wireless cellular modem to a secure, password-protected website.

2.03 EQUIPMENT

A. Camera: Integrated high definition camera and lens assembly consisting of a charge coupled device (CCD) camera with a remotely controlled focal length lens mounted as a permanent module with the following features:

1. Digital Still Image Resolution: Minimum sensor size of **8.0 megapixels**, and at an image resolution of not less than 3264 x 2448 pixels.
2. Memory: Unlimited remote storage provided by the system vendor.
3. Lens: ~~6.3 - 63 mm (38-380mm equivalent in 35mm photography), system~~ System capable of ~~ten times (10x)~~ optical ~~zoom. Include a wide angle conversion lens with a 0.66x factor.~~zoom and production of wide angle images to provide sufficient coverage and detail of the construction

site as required by the Owner. ~~Provide capability to remotely control focal length lens to change resolution, focus and zoom.~~

4. Focus Mode: iESP auto, Spot AF, Selective AF target, Manual.
5. Metering Mode: Digital iESP multi-pattern auto TTL, Spot metering, Center Weighted metering.
6. Data Connection: Provide one of the following:
    a. In areas with cellular coverage, operate cameras via built-in cellular data connection provided and maintained by the system vendor.
    b. In areas without cellular coverage, operate cameras via an RJ-45 Ethernet data connection over broadband or satellite internet access provided and maintained by the Contractor.
7. Electrical Operation: 120 VAC at maximum 83 Watts.

B. Quantity of Cameras: Six (6)

C. Camera Enclosure: Construct tamper and impact resistant housing of extruded aluminum, die cast aluminum, and sheet aluminum body with factory-applied powder coated finish.

1. Construct with forward opening, front hinged lid, allowing easy access to camera mounting sled.
2. Provide rear link-lock latch, manufactured from stainless steel, suitable for use with pad lock.
3. Equip with heater, blower and thermostat.

2.04 INTERFACE AND ONLINE ACCESS

A. Remote Access: Contractor's System Vendor shall provide an online interface system to allow viewing of all high-definition digital still images captured and stored during construction, from any location with internet access and with password protection.

1. Maintain images on the System Vendor's website for reference available at all times during construction and for not less than 90 days after Final Completion.

B. Online Interface:

1. The online interface system shall be accessible by an unlimited number of human users.
2. System shall display Project name and Owner Logo.
3. The system shall display online time-lapse videos and allow for videos to be downloaded by users.
4. Navigation: Provide calendar based navigation system for selecting specific images.
5. Zoom: Provide pan and zoom capability for zooming into high definition images.
6. User Screen Viewing Options:

a. Dynamic Calendar: Provide screen showing calendar in which each day displays an image for that day.
b. Project Dashboard: Provide screen allowing user to view multiple sites at one time.
c. Quad View: Provide screen showing four windows, allowing user to view last four days, weeks, or months on one screen.
d. Split Screen: Provide screen showing two discrete images side by side, from same camera or from two different cameras.
e. Overlay Mode: Provide screen showing two discrete images overlaid, allowing user to determine differences between the two.
f. Full-Screen: Provide screen maximizing view of images on users monitor.

7. Email: Provide capability to email photos with comments from within the system.
8. Slideshow: Provide capability to browse through images, moving forward and backward in time by individual image and by day.

3.0 EXECUTION

3.01 PREPARATION

A. Unpack camera system components and save packing materials (box and foam) for future shipment of camera system including associated appurtenances and mounting equipment to Owner or Manufacturer as required.

3.02 INSTALLATION

A. General:
1. Install camera system in accordance with manufacturer's printed instructions, State and Municipality codes and requirements and approved submittals. The Owner shall have final approval of all camera locations.
2. Install units plumb and at proper angle to provide maximum field of view of on-site operations.
3. Securely and rigidly anchor products in place.
4. Connect cameras to power.

B. Location – Cameras shall be located to provide coverage of full project site.
1. One (1) camera shall be located near the western project limit to capture roadway construction.
2. One (1) camera shall be located near the west bank of Lake Barkley to capture roadway and bridge construction.
3. Two (2) cameras shall be located on the existing bridge to capture new bridge construction.
4. One (1) camera shall be located near the east bank of Lake Barkley to capture roadway and bridge construction.

5. One (1) camera shall be located near the eastern project limit to capture roadway construction.
6. The Owner shall have final approval of all camera locations.

C. Relocate camera as directed by Owner during construction progress.
1. Each camera may be relocated up to two (2) times prior to Final Completion.
2. Camera positions may include attachment to existing construction, new construction and temporary facilities.

D. Position camera so that field of view of approximately 77 degrees covers intended area of site.
1. Install camera at elevation that will provide uncompromised visual coverage.
2. Install camera so that position of sun or man made light sources will not come into direct contact with field of view of camera at any time during construction.

3.03 FIELD QUALITY CONTROL

A. Preinstallation Testing: Test camera on site at ground level prior to mounting unit in its intended elevated position.
1. Contact System Vendor not less than 24 hours in advance of installation for testing.
2. Connect unit.
3. After 30 minutes contact System Vendor and require System Vendor to remotely confirm camera is operating properly.
4. Install cameras in approved locations.

3.04 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean camera system components, including camera-housing windows, lenses, and monitor screens.

3.05 INSTRUCTION

A. Engage a factory-authorized service representative by phone to instruct Contractors personnel in procedures to adjust and maintain camera equipment.
1. Instruct personnel on procedures and schedules for troubleshooting and maintaining equipment.
2. Explain methods of determining optimum alignment and adjustment of components.

3.06 OPERATION, TERMINATION, AND REMOVAL

A. Maintenance: Maintain camera equipment in good operating condition on a 24-hour basis until removal.

B. Termination and Removal: Remove camera system after Final Completion of the project and with approval from Owner. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with camera system. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Camera system including associated appurtenances and mounting equipment are property of Owner.

3.07 METHOD OF MEASUREMENT

A. When WEB CAMERA CONST MONITORING SYSTEM is included in the Bid Proposal as a separate bid item, the Department will measure the work performed as part of providing WEB CAMERA CONST MONITORING SYSTEM as a lump sum.

3.08 PAYMENT

A. The Department will pay for the quantities at the contract unit price. When WEB CAMERA CONST MONITORING SYSTEM is included in the Bid Proposal as a separate bid item the Department will make partial payments for WEB CAMERA CONST MONITORING SYSTEM in two (2) equal or approximately equal payments.

1. 50 percent after the system is installed and fully operational.
2. 50 percent after all Closeout Submittals have been submitted and accepted by the Department.

B. The Department will consider payment as full compensation for all work required under this section.

1. Payment will be made under:

Bid Item Code		
23912EC	WEB CAMERA CONST MONITORING SYSTEM	LS

END OF SECTION