THE EAST END CROSSING

(LOUISVILLE-SOUTHERN INDIANA OHIO RIVER BRIDGES PROJECT)

PUBLIC-PRIVATE AGREEMENT

BOOK 2
TECHNICAL PROVISIONS

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1 GENERAL SCOPE OF WORK

Developer shall provide all necessary services to design and construct all permanent and temporary portions of the East End Crossing. The design and construction of all Work shall conform to the Project Standards. Developer shall also perform the O&M Work. All Work performed or furnished under the PPA Documents shall comply with the requirements of the PPA Documents and Good Industry Practice. All plans shall be stamped by a Registered Professional Engineer.

1.1 Project Limits

This project is divided into three main sections. The Kentucky Approach (Section 4) extends along KY 841 from Sta. 0+99.72 to Sta. 187+51.86 (back). Section 5 is the Ohio River Bridge Main Spans, which begins at KY 841 Sta. 187+40.00 (ahead) and ends at Sta. 212+74.51 ("Kentucky Approach"). The Indiana Approach (Section 6) extends along SR 265 from Sta. 212+74.51 to Sta. 428+63.00 ("Indiana Approach"). These limits and stationing are general in nature and are only intended to provide the design intent as indicated in the Reference Information Documents (RID). See Section 9 for more detailed limits of the work. References within the Technical Provisions to Sections 4, 5, and 6 that are not underlined refer to the East End Crossing Sections ("Section") described above and are not to be construed as PPA Document cross-references.

Developer scope of work for the East End Crossing does not include the proposed Salem Road design and construction; including the proposed bridge over SR 265 depicted in the RID RD-6.11 through RD-6.24 (see INDOT Construction Contract IR-34937). Section 1.2.2 describes coordination requirements related to this work.

1.1.1 Reference Information Documents

The Reference Information Documents (RID) are provided to convey certain information about the East End Crossing Reference Design. See Section 1.4 of the PPA regarding purpose and use of the RID.

1.1.2 Project Datum

All existing elevations and dimensions used in the Reference Design are provided for information only. Developer shall verify all existing elevations, dimensions, and horizontal and vertical alignments in the field. This shall include but is not limited to elevations at interfaces of existing and proposed pavement, drainage features, structures and grading limits.

Coordinates for horizontal control were obtained by global positioning system (GPS) methods and adjusted to the national NAD83/FBN system. Coordinates shown are project datum of ground coordinates and are in U.S. survey feet. See Attachment 09-1 for detailed information on the project coordinate systems and vertical control.

English units shall be used in this East End Crossing.

1.2 East End Crossing Requirements

1.2.1 Coordination

Developer shall coordinate all design and construction, including that of any of its Contractors, with other designers, contractors, the Utility Owners, governmental agencies, IFA personnel, Department personnel, KYTC personnel, and other operating personnel concerning site access, the establishment and use of temporary facilities, work schedules, and other elements of the specified Work that require interface with others.

1.2.2 Coordination with Other Work

INDOT will have four separate projects active within the Project Limits that are not part of the East End Crossing project. Developer shall be responsible for coordinating its activities with this construction work. Delays arising from coordination issues shall not be considered a Relief Event. These projects are:

1. A design/build contract for the construction of the proposed Salem Road, including the proposed bridge over SR 265 depicted in the RID RD-6.11 through RD-6.24 (INDOT Construction Contract IR-34937). Contract was awarded July 31, 2012.
2. Contract for the demolition and removal of structures and clearing of trees within the Indiana portion of the Project Limits (INDOT Construction Contract IR-35205). Department anticipates advertising this contract on or about September 12, 2012.
3. Contract for the demolition and removal of structures and clearing of trees within the Kentucky portion of the Project Limits INDOT Construction Contract IR-35204). Department anticipates advertising this contract on or about September 12, 2012.
4. Contract for installation of ITS traffic management system along I-65, I-64 and I-265 (INDOT Construction Contract T-30451), plans included in RID TR-6.08. Contract was awarded February 17, 2012.

1.2.3 Safety and Security

Refer to <u>Section 6.5.5</u> for Safety Plan requirements. The Safety Plan shall be a component part of the Project Management Plan.

1.2.4 Environmental

The East End Crossing is bound by agreements with and commitments to Governmental Entities and local communities for the Project that are documented by the 2012 Record of Decision (ROD), 2003 Final Environmental Impact Statement (FEIS), and 2012 Supplemental Final Environmental Impact Statement (SFEIS), which are included in the RID. IFA has incorporated into these Technical Provisions the unique project commitments that Developer shall perform. Developer shall obtain clarification regarding any perceived conflicts or ambiguity between the agreements and commitments found in the Environmental Approvals and those identified elsewhere in the PPA Documents before proceeding with Design Work or Construction Work.

1.3 Construction Requirements

1.3.1 General Requirements

The Department's Standard Specifications shall govern all Construction Work unless otherwise modified by these Technical Provisions. Where two or more standards or guidelines conflict, the more stringent shall govern.

Construction of East End Crossing elements in Kentucky shall be furnished and installed using Kentucky Standard Specifications for Road and Bridge Construction and Kentucky Department of Highways Standard Drawings unless stipulated otherwise in the Technical Provisions.

Developer may submit proposed Deviations to these Technical Provisions to the IFA if Developer has determined that the Deviation will be beneficial. Proposed Deviations shall be submitted in accordance with and governed by Sections 5.2.4 and 6.1.2.7 of the PPA.

1.4 Quality Control Requirements

Refer to Sections 2, 3, and 4 for quality control and quality assurance requirements.

1.5 Project Management

1.5.1 Key Personnel

Developer shall provide Key Personnel in accordance with Section 7.4 of the PPA. Refer to Section 7.4.3 of the PPA for information regarding time-commitment requirements for Key Personnel and IFA rights regarding Key Personnel and Section 1.5.3.2 for location requirements.

1.5.2 Project Administration

1.5.2.1 Project Schedule

Developer shall provide a Project Schedule in accordance with Section 108 of the Standard Specifications and Recurring Special Provision 108-C-215 as supplemented by this Section 1.5.2.1. The Project Schedule shall be used by the Parties for planning and monitoring the progress of the Work, as well as serving to determine the amount due to Developer for a Milestone Payment in accordance with Section 10.1 of the PPA.

1.5.2.1.1 Project Baseline Schedule

The Project Baseline Schedule and the Preliminary Project Baseline Schedule shall conform to the "Baseline CPM Schedule" in Recurring Special Provision 108-C-215. Developer shall submit the Project Baseline Schedule no later than 90 Days following NTP1 for approval by the IFA in its sole discretion. IFA will review the Project Baseline Schedule in accordance with Recurring Special Provision 108-C-215. Developer shall use Oracle Primavera P6, release 6.2 or higher. Upgrades during Construction shall be mutually agreed to by the IFA and Developer.

Each activity on the Project Baseline Schedule shall be assigned a cost by Developer for the purposes of calculating and tracking earned value. The cost loading of the schedule will be reviewed by IFA as described in preceding paragraph.

1.5.2.1.2 <u>Project Status Schedule</u>

Developer shall submit to IFA Project Status Schedule updates to reflect the current status of the Project including recovery schedules, schedule revisions due to Relief Event determinations, and approved Change Orders.

The Project Status Schedule shall conform to the "Monthly Update CPM Schedule" in Recurring Special Provision 108-C-215. The Project Status Schedule shall be submitted to IFA in accordance with Recurring Special Provision 108-C-215 for approval. If the Project Status Schedule is not submitted by the required date the IFA may withhold or adjust Milestone Payments.

1.5.2.1.3 <u>Progress Report</u>

Each month, beginning with the first full month after NTP1, Developer shall submit to IFA the Progress Report for review and comment ("Progress Report"). Developer shall submit the Progress Report on or before the close of business seven Days following each month's end. An electronic and printed copy of the entire Progress Report shall be submitted to IFA.

The Progress Report shall contain a narrative which shall include the following information:

1. Describe progress for each Project Section and the East End Crossing as a whole, including all phases of Work. Identify start date and completion dates on major areas of Work. Group the information based on the WBS.
2. Summarize QA/QC findings.
3. List any Change Orders that were identified or executed during the period. Include their status.
4. Identify any pending or resolved Claims during the period.
5. Identify schedule activities planned for the upcoming period.
6. Identify problems and issues that arose during the month and issues that remain to be resolved.
7. Summarize resolution of problems/issues raised in previous progress reports or resolved during the period.
8. Identify Critical Path issues and proposed resolution.
9. Provide a report on the Milestone Schedule Deadlines showing the schedule dates for the immediate prior month and current month. A narrative is required to explain why the dates have changed for variances greater than 30 days.
10. Provide monthly expenditure projection curves for the total East End Crossing.
11. Provide monthly earned value report for all activities and a total earned value for the East End Crossing.
12. Identify requested and/or required IFA actions for the next month.

13. Provide digital progress photographs that accurately depict project progress as outlined in the Progress Report narrative.

If requested by IFA, Developer shall make all corrections to the monthly Progress Report and resubmit. If Developer does not agree with IFA's comments, Developer shall provide written notice of disagreement within seven days from the receipt of the comments.

1.5.2.1.4 <u>As-Built Schedule</u>

Developer shall submit an "as-built schedule" in conformance with the "Final CPM Schedule" in Recurring Special Provision 108-C-215. The "as-built schedule" shall be submitted to IFA in accordance with Recurring Special Provision 108-C-215 for approval.

1.5.2.2 Revisions

If it becomes necessary to add, combine, eliminate, or modify Milestone Payment or schedule Activities to reflect modifications to the Work, such changes shall be made through a Change Order that has been issued by IFA, and therefore reflected in the Project Schedule. Revisions to the Project Schedule and consequent realignment of funds between payment activities may be requested by Developer in accordance with, and subject to, <u>Section 15</u> of the PPA.

1.5.2.3 Time Impact Analysis

As part of a Relief Request as set forth in <u>Section 15.1.2</u> of the PPA Developer shall submit to IFA a written time impact analysis illustrating the influence of each claimed Relief Event. Each time impact analysis shall include a fragmentary network demonstrating how Developer proposes to incorporate the change, delay, or Developer request into the current Project Status Schedule.

The time impact analysis shall demonstrate the time impact to each and every affected schedule Activity in the most recent Project Status Schedule at the time of the occurrence.

The time impact analysis submittal shall include the details of the change, including added, changed or deleted data for schedule Activities and logic. If the current Project Status Schedule is revised subsequent to submittal of a time impact analysis but prior to its approval, Developer shall promptly indicate in writing to IFA the need for any modification to its time impact analysis.

Developer shall submit one printed Gantt chart including all schedule Activities affected by the time impact analysis, grouped and sorted by WBS and compared to the current Project Baseline Schedule. In addition, Developer shall provide one electronic backup of the Project Schedule with the time impact analysis and a comprehensive narrative for each Relief Request. Developer shall incorporate the results of the Relief Event Determination from IFA into the Project Status Schedule for the next Progress Report.

1.5.2.4 Recovery Schedule

If the Work is delayed on any Controlling Work Item for a period which exceeds the greater of either thirty days in the aggregate or that number of days in the aggregate equal to five percent of the days remaining until Substantial Completion, the next Project Status Schedule shall include a recovery schedule demonstrating the proposed plan to regain lost Project Schedule progress and to achieve Substantial Completion by the specified date.

1.5.2.5 Project Management Plan

Developer shall provide to IFA a Project Management Plan (PMP) in accordance with the schedule and approval requirements provided in Attachment 01-1. Developer's project management effort shall be defined by and follow the Project Management Plan (PMP), which is a collection of several management plan elements describing discrete Elements of the Work. IFA shall have approval rights over the Project Management Plan and each component part of the Project Management Plan, unless expressly stated otherwise in these Technical Provisions. The Project Management Plan is an umbrella document that describes Developer's managerial approach, strategy, and quality procedures to design and build the Project and achieve all requirements of the PPA Documents.

The structure, submittal time frames and IFA review and, as applicable, approval rights regarding each component part of the Project Management Plan are specified in Attachment 01-1. Table 1-1 provides a general outline of the PMP.

Table 1-1 Project Management Plan Outline

PMP Chapter	Chapter Title
1	Project Administration
2	Quality Management Plan
2A	Design QA/QC Plan
2B	Construction QA/QC Plan
3	Environmental Management
4	Public Involvement Plan
5	Safety Plan
6	Communications Plan
7	Operations and Maintenance Plan

A listing of documents to be included in the Project Management Plan is contained in Attachment 01-1 and related requirements for the component parts appear throughout these Technical Provisions.

Propose updates to the PMP and, as applicable, affected components in the event of the following:

- The occurrence of any changes to Key Personnel, Quality Plan, Safety Plan, Project Schedule, project administration policies and procedures
- The occurrence of other changes necessitating revision to the PMP
- As otherwise directed by IFA

Provide the revised PMP to IFA for approval no later than 14 days after the occurrence of the change or direction triggering the need for the revisions to the PMP.

IFA will audit and monitor the activities described in the PMP to assess Developer performance. All commitments and requirements contained in the PMP shall be verifiable.

1.5.2.6 Document Management

In the provision of a document management system, Developer shall:

1. Use data systems, standards and procedures compatible with those employed by IFA and implement any new operating practices required as a result of IFA's amendments to any such systems, standards, and procedures.
2. Provide a secure location for any interface as may be provided by IFA, such that only authorized users have access and that it is protected from loss theft, damage, unauthorized or malicious use.
3. Employ appropriate standards and procedures, and train Developer personnel to operate any IFA data management system which IFA may require in connection with the East End Crossing.
4. Developer shall train IFA personnel to operate any Developer data management system approved by IFA for Developer use in connection with the East End Crossing.
5. Provide a mechanism for the electronic transfer of meta-data along with the associated portable document format (PDF) images for uploading into an Electronic Document Management System (EDMS).
6. Provide IFA with procedures and software for accessing all project-related documents as a component of Developer's obligations under Article 23 of the PPA.

All project-related documents shall be searchable and legible.

In the Project Management Plan, Developer shall describe:

1. Methods by which all project-related documents will be uniquely coded and retrievable in a user-friendly format.
2. The routing, filing, control, and retrieval methods for all documents.
3. Methods to facilitate sharing of data, including procedures and software for accessing all project-related documents.
4. All documents and data elements that will support records. These data elements shall include, as a minimum: document class, document type/subtype, document name, form number, IFA records series item number, IFA agency item number, IFA records series title, IFA retention period, turnover media, turnover frequency, submission type, special requirements, and remarks.

To allow for disaster recovery, Developer shall back-up and store all project-related documents in a secure off-Site area.

1.5.3 Project Office

Developer shall establish a "Project Office" in Indiana within 90 days after NTP1 and within 5 miles of any point of the East End Crossing. The purpose of the office is to consolidate and co-locate Developer's key management, design, construction, quality, and compliance functions and IFA's management, oversight, and compliance staff in order to facilitate the teamwork, communications, and interaction called for by the PPA Documents and necessary to ensure a successful project. The Project Office shall remain open and fully functional as specified herein until 90 days after Final Acceptance.

IFA's section of the Project Office shall conform to the requirements of this Section 1.5.3 and the Type C field office described in Standard Specifications Section 628. Where discrepancies arise between the two documents, the larger, higher-quality, or newer technology shall be provided. Unless otherwise approved by IFA, four times the amount of "Field Office Equipment and Supplies" detailed for a Type C field office in Section 628.02(b) of the Standard Specifications shall be provided. Except as otherwise provided in Section 1.5.3.3.3. One computer system with internet access shall be provided per desk. Developer shall propose reductions in these requirements for some features (e.g., four refrigerators are not needed).

1.5.3.1 Interim Project Office

Until the final office is established, Developer shall establish an interim office within 30 days after NTP1 in order to facilitate early communications and interaction between the staffs of Developer and IFA. The interim office is not required to be proximate to the East End Crossing. The amount of office space, including the accommodation of IFA staff, in the interim office will be as mutually agreed to by Developer and IFA during the initial office coordination.

1.5.3.2 Developer Personnel and Functions to be Located at the Project Office

At a minimum, the principal location of Developer's key managers and Key Personnel listed in (1) and (2) below is expected to be in the Project Office, along with support staff relative to their functions.

1. The following key managers shall be assigned to the Project Office on a full-time basis for the duration of the project:

    a) Project Manager

    b) Deputy Project Manager(s)

    c) Quality Manager

    d) Environmental Compliance Manager

    e) Safety Manager

2. The following key managers and Key Personnel shall be assigned primarily to the Project Office, acknowledging that some time will be spent in the field or design offices during the performance of their responsibilities:

    a) Lead Engineer

    b) Construction Manager

    c) DQAM

    d) Construction Quality Manager

    e) CQCM

    f) Public Information Coordinator

g) Utility Manager

h) Erosion and Sediment Control Manager

i) Project Controls Manager

j) Lead Scheduler

Although considered beneficial by IFA, it is left to the discretion of Developer as to whether design activities of the East End Crossing are located at the Project Office. If all or a portion of the design is not accomplished at the Project Office, it is expected that the key design discipline leads shall spend a significant amount of their time in the Project Office.

It is required that all Design Reviews, Developer's design discipline (subject area) meetings including design, all meetings called for by the PPA Documents, and all coordination and other activities requiring IFA's consultation be held in the Project Office.

1.5.3.3 Office Facility

1.5.3.3.1 <u>Developer's Responsibilities</u>

1. Developer shall be responsible for the all-inclusive management, insurance, and costs of all capital, lease agreements, janitorial services and the maintenance of electrical; heating, ventilation, and air-conditioning (HVAC); plumbing; telephone systems; fax machines; copiers; computer systems; and equipment, including any maintenance contracts, costs of supplies (paper for printers/copier/fax machines, ink cartridges, etc.), utilities, consumables (paper towels, pens, pencils, tape, etc.), and incidentals described elsewhere in this special provision to permit the efficient and uninterrupted operation of the Project Office. All facilities and build-outs/fitouts shall be constructed and maintained in accordance with federal, state and local building codes.

2. Developer shall provide security of the Project Office, including protection of the building or space within a building against theft, 24 hours per day and shall take responsibility for loss of property of IFA or personal property of employees of IFA housed therein, due to fire, theft, or related causes, except that Developer is not responsible for non-job-related personal property. Protection shall include a continually monitored security and alarm system.

3. In addition to the responsibility to maintain all internal office spaces and equipment, Developer shall be responsible for (either directly or through a building manager, depending on facility arrangements) the maintenance of the immediate grounds and landscaping and the removal of snow and ice, including the supply and application of deicing or ice-melting agents, from parking areas and walks in a timely manner to ensure safe passage to and from the Project Office.

1.5.3.3.2 <u>IFA's Space Requirements</u>

It is important that the space occupied by IFA be integral with that of Developer to facilitate teamwork and continuous interaction. However, IFA space shall be sufficiently separated within the overall Project Office space to allow internal IFA functions and interaction to take place apart from Developer's operations.

1.5.3.3.3 Management and Design Oversight

Developer shall provide the following space within the Project Office for the Department's design oversight and program management personnel:

1. 5 offices at a minimum of 120 square feet each with lockable doors
2. 10 work cubicles at a minimum of 64 square feet each
3. 1 work rooms of 200 square feet
4. 1 file storage room of 300 square feet
5. 1 secured computer network room of 144 square feet
6. Lockable storage space of 100 square feet
7. Color printers, copiers, facsimile machines, plotters, etc., and associated paper supplies.
8. Kitchen facility

The requirements appearing in Section 1.5.3 for four times the amount of "Field Office Equipment and Supplies" is revised with respect to the following list of equipment to require only the corresponding quantities identified:

- 5 field office desktop computer systems
- 5 field office laptop computer systems
- 8 additional of:
  - 22 inch wide screen digital flat panel monitor
  - USB enhanced multimedia keyboard
  - USB 2-button scroll mouse

After design activities are substantially complete a smaller project office may be provided, consistent with the requirements of a Department Type C field office, with the exception that a computer shall be provided for each desk. This smaller office shall not be a trailer and will serve as IFA's management office on the project.

1.5.3.3.4 Common Space and Equipment

Developer shall provide the following shared common space and equipment, adequate and appropriate for the efficient operations of the entire Project Office, for joint use by both the Developer and IFA personnel:

1. Varied-size conference room space to hold all reviews and meetings (one small conference room in space allocated for IFA is desirable)
2. Kitchen facility
3. Reception area
4. Male and female bathrooms
5. Printers, copiers, facsimile machines, plotters, etc., and associated paper supplies (Developer may elect to locate some of this equipment in IFA's allocated spaces).

1.5.3.3.5 Facility Specifications

Developer shall provide an adequate Project Office, to include the following:

1. Access and security lighting in the immediate areas of and exterior to the office, including but not limited to parking areas, walkways, hallways, and entrances.
2. Appropriate male and female restroom facilities with cold and hot water.
3. An HVAC system for adequate heating and air conditioning throughout the general working areas, office spaces, and conference rooms, thermostatically controlled to ensure even office temperature distribution.
4. Appropriate furnished and installed office furnishings (new or refurbished and in good condition) for IFA-identified spaces, including desks, chairs, bookshelves, file cabinets, etc.
5. Telephone systems with independent service for up to 15 Department personnel. IFA shall be responsible for payment of monthly telephone bills for IFA's service.
6. Adequate parking facilities for the Project Office (immediately adjacent to or as close as possible), including dedicated spaces for 40 people. The parking facility shall consist of a hard pavement with clearly identified parking spaces.

1.5.3.3.6 Replacement

In case of fire, theft or breakdown, all furnishings and equipment involved shall be repaired or replaced by Developer within 48 hours of the incident. If the Project Office facility is destroyed or rendered unusable for any reason, Developer shall coordinate with IFA with the intent of replacing (temporarily and permanently) the facility, furnishing, equipment, and functions as soon as practical

1.5.3.4 Field Offices

A minimum of two Type C field offices shall be provided within one mile of the project Site by Developer in accordance with the Standard Specifications. One field office shall be provided in Kentucky and one field office shall be provided in Indiana. Developer shall provide in each field office an additional office field system per the Standard Specifications and as specified below:

- Bloodborne Pathogen Kit 2
- Broom and Dust Pan 2
- Calculators 0
- Carbon Monoxide Detector 2
- Chairs 30
- Cleaning Supplies Yes
- Drafting Stools 0
- Drafting Tables 0
- Drinking Water Yes
- File Cabinet Drawers 48
- Fire Extinguishers 4
- First-Aid Kit 3
- Folding Office Tables 8

• Microwave Oven	2
• Office Desks & Office Chairs	15
• Paper Shredder	2
• Pencil Sharpener	3
• Refrigerator/Freezer	1 (26 cubic feet minimum combined)
• Shelving (lft)	100
• Six-hook Coat Rack	2
• Smoke Detector	6
• Telephones Lines	16
• Telephones	16
• Toilet Facilities	Yes
• Voice Mail	16
• Waste Paper Baskets	20

Developer shall provide satisfactory space and parking to accommodate the on-Site field oversight personnel of IFA provided in the same quantity and manner as provided to Developer's office staff, and consistent with the operations of a field office. Space requirements shall be coordinated with IFA at the field office coordination meeting. All costs of the field offices shall be borne by Developer.

1.5.3.5 Office and Field Office Coordination Meeting

Within two weeks after issuance of NTP1, Developer shall schedule a meeting with IFA to coordinate plans for both the interim and permanent offices and the construction field office(s), including the integration, accommodation, and incorporation of IFA's requirements.

1.5.3.6 Field Laboratory

Developer shall provide a Type C field laboratory in Indiana and in Kentucky. The field laboratory shall be as specified in Department Standard Specifications 628.02(f). In addition to the provisions of Section 628.02(f) Developer shall provide hot and cold running water (potable). Developer does not need to include telephone lines or telephones in the field laboratory.

1.6 Water Transportation for the Engineer

Developer shall provide water transportation for the Engineer. Water transportation shall consist of providing a boat and safety equipment at the Site, along with adequate parking and docking facilities until the Engineer can access both sides of the Ohio River across the East End Bridge. The boat shall be for the exclusive use of, and operated by, the Engineer.

The boat shall not be less than 18-feet in length with at least a 72-inch beam, equipped with an outboard motor of at least 70 horsepower, and shall be capable of accommodating at least 6 adult passengers, including the operator. In addition, the Engineer shall at all times retain the right to travel on, or be present on, any of the floating plant or equipment of Developer-Related Entities.

The boat shall be in good condition and meet the approval of the Engineer. The boat and safety equipment shall at all times meet all applicable boating regulations of the United States Coast Guard.

The boat shall be equipped with 2 fuel tanks, complete remote control, a spotlight and an adequate whistle or horn. The motor shall be equipped with electric and hand starters, an alternator or generator, and slip clutch propeller protection. These requirements are in addition to all Coast Guard or State requirements. The Developer shall service, gas, oil and maintain the boat during the Construction Work until the Engineer can access both sides of the Ohio River across the East End Bridge, unless otherwise directed by the Engineer.

1.7 Harrods Creek Emergency Response Training and Staffing

IFA will provide for emergency response training for the Harrods Creek Fire Protection District for the Tunnel construction period. The training is described in detail in RID TN-4.03. Harrods Creek Fire Protection District will provide a dedicated 5-man emergency response team, per the OSHA Underground Construction Regulation 1926.800, during Tunnel construction. This provision will not relieve Developer of any OSHA requirements for providing its own emergency response personnel.

1.8 Responsibility for Utility Service Costs

1.8.1 Developer Responsibility

Developer shall be responsible for all costs of utility services during D&C Work, including costs for power, communications, and water service necessary for the Design and Construction of the East End Crossing.

1.8.2 IFA Responsibility

IFA will pay for all costs of utility services during the D&C Work and prior to the Operating Period for facilities placed in permanent service and necessary for the normal operation of the facility. See Section 22.1.4 for cost of utility services during the Operating Period.

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2 QUALITY MANAGEMENT PLAN

2.1 General Requirements

Developer shall submit a "Quality Management Plan", updated as necessary, to IFA as a component part of the PMP.

The Quality Management Plan shall address the topics and shall meet the specified requirements contained in Sections 3 and 4 in the order listed herein as applicable.

The Quality Management Plan shall establish a quality system team, which shall be distinct and separate from the design and construction production organization. The Quality Management Plan shall address both Design Work and Construction Work quality control. The quality system team shall report directly to Developer's Quality Manager. The Quality Management Plan shall describe the quality system to be implemented at all levels of Developer's organization, to include consultants, Contractors, suppliers, and vendors at all tiers.

2.1.1 Quality Management Plan Submittal

Developer shall submit a comprehensive Quality Management Plan as part of the PMP within the time frame specified in Attachment 01-1.

2.1.2 Quality Management Plan Reviews and Updates

Developer shall conduct management reviews of its quality system as specified herein.

As work progresses, Developer shall update the Quality Management Plan to reflect current conditions. Developer and, as applicable, IFA may identify the need for revisions to the Quality Management Plan. Developer shall submit any revisions or updates to the Quality Management Plan to IFA for approval within 30 days of the identification of the need for a revision.

In addition, Developer shall submit updates to its Quality Management Plan in accordance with the PMP requirements. Developer shall submit to IFA a conformed copy of the updated Quality Management Plan with revisions highlighted.

2.1.3 Environmental Compliance and Mitigation Plan

As part of the PMP, Developer shall establish appropriate controls in its management, design, construction/installation, and documentation procedures to ensure that requirements of the ROD, FSEIS, other Environmental Approvals, and Environmental Laws are met and documented, and coordinated with the East End Crossing environmental commitments. The Environmental Compliance and Mitigation Plan (ECMP) shall be completed and submitted to IFA in accordance with the provisions of Section 1.5.2.5 and Section 7 and shall include the following:

1. Describe how Developer shall achieve full compliance with the East End Crossing commitments, considerations, conditions of Environmental Approvals, Environmental Laws, and IFA review and approval requirements for Design Work and Construction Work.

2. Describe how and where Developer proposes to further avoid and minimize impacts to woodlands, 4(f) resources, parklands, historical properties, Threatened or Endangered Species, wetlands, and waters of the United States.

3. Describe Developer's process, structure, organization location, and methods proposed for documentation, communication, and QA/QC with respect to environmental compliance.

4. Describe Developer's plan to take corrective actions to keep the East End Crossing in compliance with Environmental Approvals, Environmental Laws and East End Crossing commitments at all times.

2.1.4 Organizational Requirements

Developer shall designate a Quality Manager who shall be classified as one of the Key Personnel and who shall be responsible for overseeing the overall quality program and the preparation, implementation, and update of the Quality Management Plan for Developer, including management, design, and construction. The Quality Manager shall have the overall responsibility for the development and management of Developer's Quality Management Plan and is responsible for the overall quality assurance/quality control (QA/QC) program of Developer, including the quality and management for design and construction.

The Quality Manager shall not report to Developer's Project Manager, but shall be directly responsible to and report to a joint venture board, senior management, or similar level of Developer's organization not directly responsible for Design Work or Construction Work.

Developer's Quality Manager shall be present and available for consultation with IFA throughout the duration of the East End Crossing. The Quality Manager shall attend the weekly progress meetings as a minimum and such other meetings as IFA may request, including individual meetings between the Quality Manager and IFA staff.

The Quality Manager shall be the primary point of contact to IFA for all issues relating to Developer's Quality Management Plan, including preparation, review, implementation, and updates. The Quality Manager, irrespective of other responsibilities, shall have defined authority and responsibility for the following:

1. Ensuring that a quality system is established, implemented, and maintained;

2. Reporting on the performance of the quality system to Developer's management for review and as a basis for improvement of the quality system; and

3. Direct supervision of the DQM and Construction Quality Manager and their respective staffs.

2.2 Quality System Requirements

2.2.1 Management Responsibility

2.2.1.1 Quality Policy

Developer's executive management shall define and document its policy for quality, including objectives for quality and its commitment to quality. In the context of this Section 2.2.1, "executive management" shall mean those persons to whom Developer's Project Manager reports and who have overall responsibility for Developer's performance.

Developer shall have a published statement, signed by the responsible executive(s), of its commitment to quality and the organization's quality objectives. It shall explain the commitment in terms of the services provided to IFA, and the responsibilities assumed by Developer to discharge its contracted accountabilities relative to IFA's overall responsibility for ensuring quality in the constructed facility. The statement shall be made known to and understood by all staff and be included in the Quality Management Plan.

2.2.1.2 Quality Organization

Developer's Quality Organization shall meet the following:

1. Responsibility and Authority:

   a. Executive management shall have the responsibility and authority to plan and determine the overall direction of Developer and its relationship to the quality efforts. Executive management shall ensure the quality policy is documented and understood by all employees and management by formal and informal indoctrination and shall further ensure the implementation of the quality policy by everyone in the organization.

   b. The quality system shall be an integral part of the overall management system, and as such, shall be supported and implemented from the top down. On a public-private partnership project, most employees are involved in managing, performing, or verifying work that affects quality. Quality shall not be the sole domain of the design checkers, QC inspectors, or QC personnel. All workers, including design and construction production personnel, including those of Contractors, shall be aware of the quality system requirements that govern their respective work.

   c. A description of the organizational arrangements, such as a chart, shall be available and kept current. All key roles and persons, and lines of communication and authority between Developer and IFA and their representative(s), and with other organizations involved, shall be identified.

   d. The responsibility, authority, and interrelation of personnel who manage, perform, and verify work affecting quality shall be defined and documented, particularly for personnel who need the organizational freedom and authority to do the following:

      1) Initiate action to prevent the occurrence of any nonconformities relating to the product, process, and quality system.

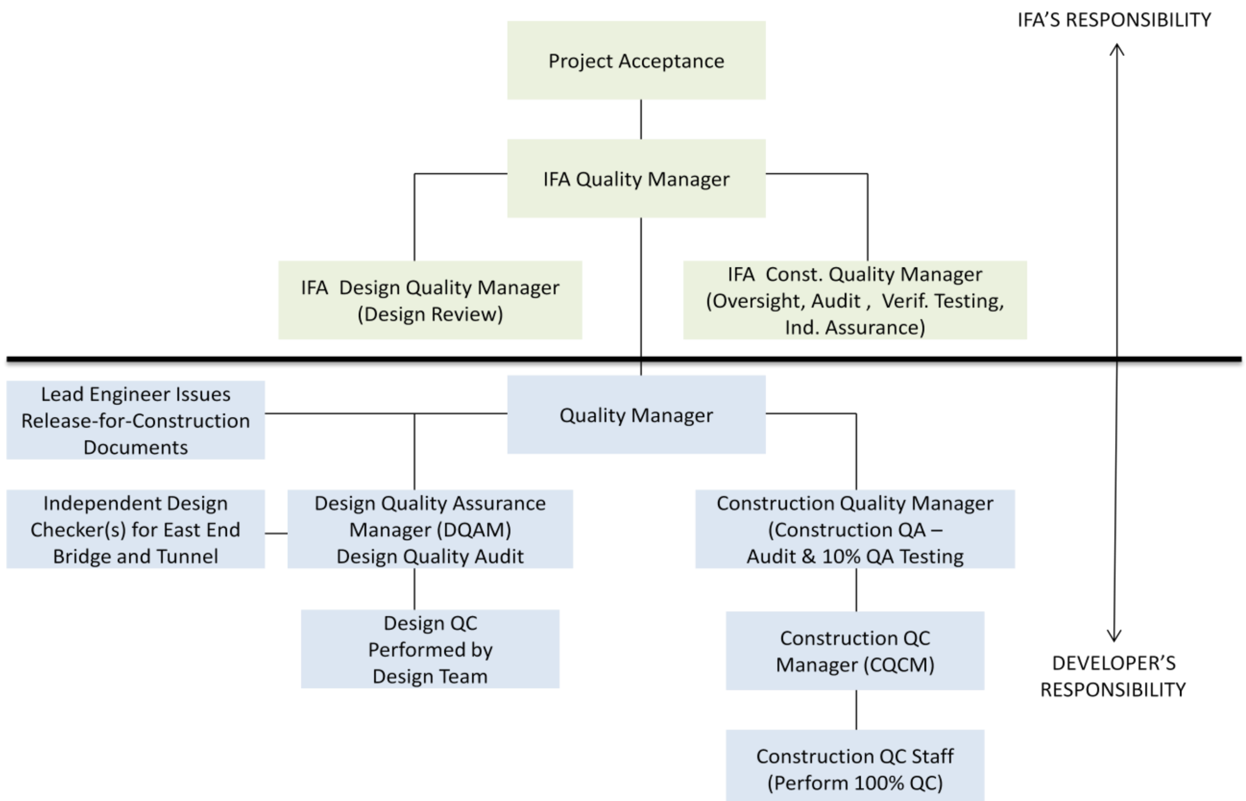
      2) Identify and record any problems relating to the product, process, and quality system.

      3) Initiate, recommend, or provide solutions through designated channels. It shall be everyone's responsibility to report any and all quality and safety problems.

      4) Confirm, in a timely manner, the implementation of solutions. The verification shall also investigate if the solution to the identified problem created another quality problem.

5) Control any further processing, delivery, or installation of nonconforming product until the deficiency or unsatisfactory condition has been corrected. Controls shall be established, including stopping work if necessary, once a significant quality problem is identified, until the cause of the problem can be identified and the required corrective action can be implemented.

Figure 2-1 Project Quality Control and Quality Assurance Organization



2. Resources:

   a. Developer shall identify resource requirements and provide sufficient resources, including the assignment of trained personnel, for management, performance of work and verification activities, including internal quality audits.

   b. Developer shall have a system for ensuring that projects are adequately staffed and that resources are provided adequate training to perform such activities as Design Reviews, verification activities, receiving, in-process and final inspections, and internal quality audits.

   c. The Quality Management Plan shall identify the source of staffing, including management, professional, technical, and labor, and shall deal with the integration of resources into the specific requirements of the PPA Documents.

   d. Other resources shall also be addressed, such as computers, craft tools, equipment, and facilities.

2.2.1.3 Management Review

Developer's executive management shall review the quality system at defined intervals sufficient to ensure its continuing suitability and effectiveness in satisfying the requirements of this standard and Developer's stated quality policy and objectives. Management reviews shall be held, at least, at three-month intervals. Records of such reviews shall be maintained. Minutes shall be taken of the review meetings, and these minutes shall be maintained as quality records. Copies of minutes shall be provided to IFA within 30 days.

2.2.2 Quality System

2.2.2.1 General

Developer shall establish, document, and maintain a quality system as a means of ensuring that products conform to the requirements of the PPA Documents. The Quality Management Plan shall include, or make reference to, the quality system procedures and outline the structure of the documentation used in the quality system. The Quality Management Plan shall include procedures and methods that will define how the Developer will collaborate with IFA through IFA’s requirement verification database application.

The Quality Management Plan shall cover temporary and permanent components.

The Quality Management Plan shall either contain or reference the procedures and documentation structure outline critical to quality.

The Quality Management Plan shall also establish or reference the procedures that make up the quality system. Should the plan only reference the procedures, it shall also detail the levels of the documented system, its contents, and the interrelationship of the document types.

There shall be a roadmap within the Quality Management Plan that is lined up to the applicable element that describes the quality system. This roadmap may be a cross-reference, narrative, chart, index, or some similar method.

The plan shall detail the roles, responsibilities, and authority of Developer, each Developer-Related Entity, Designer, Lead Engineer, Quality Manager, DQM, Construction Quality Manager, CQCM, and other team members having a significant quality role.

The Quality Management Plan shall define the policies, goals, and objectives of the organization and organizational interfaces.

2.2.2.2 Quality System Procedures

1. Developer shall prepare documented procedures consistent with the requirements of this Section 2 and Developer’s stated quality policy.
2. Developer shall document standard work methods in procedures and enforce the implementation of these best practices. However, it is inevitable that situations will arise that require a departure from the norm. These conditions shall be anticipated in the procedures and shall allow for control of these activities.

3. The plan shall define the liaison and interface between the quality organization and the design and construction arms of Developer.

4. The quality procedures shall, as a primary objective, be written with the intent of gaining employee understanding of the system.

5. It is Developer's responsibility to describe to IFA the rationale for the procedures selected and, if the procedures do not address every provision of this Section 2, to explain why the standard is not applicable in their particular situation.

6. The following list of procedures (items a through u) shall serve as the starting point for defining Developer's quality management system:

   a. Procedure for the preparation, control, and distribution of the Quality Management Plan;

   b. Scope;

   c. Key Personnel;

   d. Organizational/technical interfaces;

   e. Design input requirements;

   f. Design output requirements (deliverables);

   g. Design Reviews;

   h. IFA and Department participation;

   i. Levels of responsibility and authority;

   j. Procedure to control, verify, and validate the design;

   k. Procedure for document issue, approval, and revision;

   l. Procedure for the identification of, and where required by PPA Documents, the traceability of, deliverable items, such as Design Documents, Construction Documents, and Record Drawings;

   m. Procedure for the verification and control of computer programs used in design;

   n. Procedures for inspecting, testing, and calibrating equipment;

   o. Procedures for handling Nonconforming Work;

   p. Procedures for environmental compliance;

   q. Procedures for corrective/preventive actions;

   r. Procedures for handling storing, packaging, tracking and delivering PPA deliverables;

   s. Training processes;

   t. Procedures for internal quality audits; and

u. Procedure for management review.

7. Developer shall identify and include its standard procedures, as applicable to the East End Crossing, and shall develop project-specific procedures for all elements of the East End Crossing that are important to quality for the East End Crossing but are not addressed adequately by its standard procedures. Both types of procedures shall be included in the Quality Management Plan.

8. The implementation of the quality system shall be demonstrated by internal quality audit reports, the trending of nonconformances, records of root-cause analysis, records of corrective and preventive actions, and records of IFA complaint handling.

9. For the purposes of Section 2, the range and detail of the procedures that form part of the quality system depend on the complexity of the Work, the methods used, and the skills and training needed by personnel involved in carrying out the activity. The procedures shall accurately reflect the Work that is to be accomplished and shall benefit the organization and project.

10. Documented procedures may make reference to specifications that define how an activity is performed. Procedures shall describe the process steps of what needs to be done and work instructions shall prescribe how it is to be done.

2.2.2.3 Quality Planning

There shall be evidence of quality planning that ensures specific requirements of the PPA Documents have been identified and incorporated into the documented quality system. IFA’s requirements represent the minimum requirements.

Developer shall define and document how the requirements in the PPA Documents for quality will be met. Quality planning shall be consistent with all other requirements of a Developer's quality system and shall be documented in a format to suit Developer's methods of operation. Developer shall give consideration to the following activities, as appropriate, in meeting the specified requirements for the East End Crossing:

1. Preparing the Quality Management Plan.

2. If Developer already has a quality management system, blending the unique East End Crossing requirements into the quality management system:

3. State the project objectives to be obtained;

4. Identify responsibilities, authorities, interfaces, both internal and external;

5. Identify specific procedures, methods, and instructions to be used (standard and project-specific;

6. Identify inspections, tests, audits, and surveillances to be used;

7. Control modifications and change; and

8. Incorporate into the standard documents.

9. Identifying and acquiring any controls; processes; equipment, including inspection and test equipment; fixtures; resources; and skills that may be needed to achieve the required quality.

10. Ensuring the compatibility of the design, the production process, installation, servicing, inspection and test procedures, and the applicable documentation. Developer shall have significant interface obligations and shall describe in its Quality Management Plan how these obligations shall be met.

11. Updating, as necessary, of quality control, inspection, and testing techniques, including the development of new instrumentation.

12. Identifying suitable verification at appropriate stages.

13. Clarifying standards of acceptability for all features and requirements, including those that contain a subjective element.

14. Identifying and preparing quality records. Quality records comprise such documents as audit inspection reports, approved designs, specifications, plans, calculations, purchase orders, Design Review records, vendor evaluation reports, and cumulative progress and audit reports.

2.2.3 Design Control

2.2.3.1 General

Developer shall establish and maintain documented procedures to control and verify the design of the product in order to ensure that the specified requirements are met.

Design control shall be applied to computer programs, design tables, and other products that provide analytical results that are used to develop or check designs.

The plan shall detail the roles of the following:

1. Designer;
2. Lead Engineer;
3. Environmental Compliance Manager;
4. DQAM; and
5. Responsible Engineer(s).

2.2.3.2 Design and Development Planning

Developer shall prepare and submit to IFA a Design QA/QC Plan for each design and development activity, as a component part of the PMP. The Design QA/QC Plan shall describe or reference these activities and define responsibility for their implementation. The design and development activities shall be assigned to qualified personnel who are equipped with adequate resources. The Design QA/QC Plan shall be updated as the design evolves. The Design QA/QC Plan shall be included in the overall Quality Management Plan.

The Design QA/QC Plan shall define the technical interfaces among the different groups that provide input to the design process or receive output. The necessary information shall be documented, transmitted, and regularly reviewed. If not defined in these procedures, a separate description shall be required.

2.2.3.3 Design Input

Design-input requirements relating to the product, including applicable statutory and regulatory requirements, shall be identified, documented, and their selection reviewed by Developer for adequacy. Incomplete, ambiguous, or conflicting requirements shall be resolved with those responsible for imposing these requirements.

The essence of this sub-element is that Developer determines what information is needed and the available sources for information, reviews all pertinent available data, ensures that there is sufficient information to carry out its assignment, and resolves with IFA and other appropriate authorities any actual or apparent conflicts or inconsistencies in the information so gathered. The information, sources, and decisions taken shall be documented and treated as a quality record.

2.2.3.4 Design Output

Developer shall document design output and express output in terms that can be verified and against design-input requirements and validated.

The control of these design outputs is an integral part of Developer's document control process, which encompasses a portion of the Design QA/QC Plan.

Output documentation shall be reviewed for compliance with design requirements.

2.2.3.5 Design Review

At appropriate stages of design, documented reviews of the design results shall be planned and conducted. Participants at each Design Review shall include representatives of all functions concerned with the design stage being reviewed, as well as other specialist personnel, as required. Records of such reviews shall be maintained.

Any computer software used to perform alternative calculations or verify clearances through the use of scale models or computer-aided design and drafting (CADD) techniques shall be validated before the use of the application, with validation documented in accordance with Section 2.2.15. In addition, at each submittal to IFA for review, Developer shall provide hand calculations that validate any calculations performed by computer software.

2.2.3.6 Design Verification

Design verification is the process of ensuring that specified requirements have been met.

The Design QA/QC Plan shall include procedures for verifying and documenting that the design output meets the design input requirements. Verification shall include independent checks, tests, and reviews.

Verification shall be performed under the direction of the DQAM.

Designs provided by subconsultants shall be independently verified and documented under the direction of the DQAM prior to their approval and incorporation into the work of others.

2.2.3.7 Design Validation

Developer shall perform design validation to ensure that the East End Crossing conforms to defined user needs and requirements. The Design QA/QC Plan shall identify appropriate validation procedures.

2.2.3.8 Design Changes

After a design is complete and the Work is ready to be executed, or is being executed, or is complete, all subsequent design changes and modifications shall be identified, documented, reviewed, and approved by authorized personnel before their implementation.

Developer shall establish and include in the Design QA/QC Plan procedures on how design changes are initiated, reviewed, approved, implemented, and recorded in order to maintain configuration control, and shall include the identification of persons authorized to approve design changes. Changes may originate from IFA's request, an internal and external design organization, and Site or field personnel. Design changes may result in a modification of a Governmental Approval, which modifications would be subject to Section 4.3 of the PPA.

Any proposed changes shall be reviewed and approved by the Responsible Engineer who produced the original Work. The degree and nature of control on design changes shall be at least equivalent to that under which the original Work was accomplished. An administrative system shall be in place to ensure that approved changes are documented and provided to holders of the original material in a timely manner. Also, there shall be a documented process that ensures that superseded information is removed from use when the updated document or record is received.

A master list of currently effective Design Documents shall be maintained to reflect design changes and approved modifications and shall be communicated to the construction Site in a timely manner. A listing of the design changes shall be communicated to the construction Site on a timely basis, consistent with the progress of construction activities. Under no circumstances shall work be performed without current knowledge of the approved design changes to be incorporated into the work product.

2.2.4 Document and Data Control

2.2.4.1 General

Developer shall establish and maintain documented procedures to control all documents and data that relate to the requirements of this Section 2 and Section 1.5.2.6, including, to the extent applicable, documents of external origin such as Project Standards and Department plans.

This shall include, but is not limited to, Design Documents, Construction Documents, contracts, plans, specifications, Governmental Approvals, master drawing lists or equivalent documents, critical procedures and work instructions, quality system manuals, East End Crossing quality plans, and data like computer data bases and computer files.

2.2.4.2 Document and Data Approval and Issue

Developer shall be responsible to see that the documents and data are reviewed and approved for adequacy by authorized personnel prior to issuance. A master list or equivalent document control procedure identifying the current revision status of documents shall be established and be readily available to preclude the use of invalid or obsolete documents.

Developer shall be responsible for establishing, documenting, maintaining, and implementing a procedure that clearly defines the process for document review, the resolution of comments, and approval authority.

No Construction Work activities shall be performed using unreleased, unauthorized, or outdated Design Documents.

This control shall ensure that the following occurs:

1. The pertinent issues of appropriate documents are available at all locations where operations essential to the effective functioning of the quality system are performed; and
2. Invalid or obsolete documents are promptly removed from all points of issue or use, or are otherwise ensured against unintended use.

2.2.4.3 Document and Data Changes

Developer shall identify and include in the Quality Management Plan the process for the initiation, review, and approval of all document changes prior to issuance of those changes.

Changes to documents and data shall be reviewed and approved by the same functions/organizations that performed the original review and approval, unless specifically designated otherwise in the Quality Management Plan. If this is not possible, then the designated approval authority shall have adequate background and experience upon which to base the decision. The designated functions/organizations shall have access to pertinent background information upon which to base their review and approval.

2.2.4.4 Design and Record Drawings Format and Organization

With the approval of IFA, Developer may use electronic plans in the field. If electronic plans are used in the field, Developer shall provide a sufficient number of handheld computer devices, with the appropriate software, for IFA’s use. The handheld computer devices supplied to IFA shall be new and of the same make and model as are used by Developer.

2.2.5 Procurement and Purchasing

2.2.5.1 General

Developer shall establish and maintain documented procedures to ensure that purchased services and products conform to requirements of the PPA Documents.

Developer shall be responsible for establishing, documenting, and maintaining procedures for the evaluation and selection of Suppliers, vendors, and Contractors.

2.2.5.2 Evaluation of Contractors, Suppliers, and Vendors

Developer shall do the following:

1. Evaluate and select Contractors on the basis of their ability to meet subcontract requirements, including the quality system and any specific QC requirements.
2. Control the evaluation and selection of Suppliers, vendors, and Contractors. Specific procedures, rather than just a statement of policy in the Quality Management Plan, shall be used.
3. Describe the evaluation and selection process for Suppliers, vendors, and Contractors of all tiers and describe the priority of quality in the evaluation and selection criteria in the Quality Management Plan.
4. Define the type and extent of control exercised by Developer over Contractors.
5. Establish and maintain quality records of acceptable Contractors. Records shall be maintained to document the selection, control exercised over, performance, delivery, quality, etc., of all consultants, Contractors, vendors, and Suppliers.

The methods Developer elects to use to control the delivery of the contracted service or product may include but are not limited to the following:

1. Design Reviews;
2. Shop inspection;
3. Receiving inspection; and
4. Witnessed inspection hold points: the procedures shall detail how Contractors, including consultants, shall be presented to IFA for approval.

Procurement and purchasing documents shall contain data clearly describing the service or product ordered, including, where applicable, the following:

1. The type, class, grade, or other precise identification;
2. The title or other positive identification, and applicable issues of specifications, plans, process requirements, inspection instructions, and other relevant technical data, including requirements for the approval or qualification of product, procedures, process equipment, and personnel; and
3. The title, number, and issue of the quality system standard to be applied.

Developer shall review and approve procurement/purchasing documents for the adequacy of the specified requirements prior to release.

The documented procedures shall identify how and by whom procurement and purchasing documents are reviewed, how comments are resolved, and who in the organization has the authorization for final approval of the document.

2.2.5.3 Verification of Purchased Service or Product

1. Developer verification at Contractor's premises shall include the following:

    a. Where Developer proposes to verify a purchased product or service at the Contractor's premises, Developer shall specify verification arrangements and the method of product release in the procurement/purchasing documents.

2. Department verification of subcontracted product or service includes the following:

    a. Where specified in the PPA Documents, Developer or IFA's representative shall be afforded the right to verify, at the Contractor's premises and Developer's premises, that a subcontracted product or service conforms to specified requirements. Such verification shall not be used by Developer as evidence of effective control of quality by the Contractor.

    b. The Contractors shall be responsible for fulfilling all of the specified procurement requirements regardless if IFA, Developer, or an agent performed any tests or inspections.

2.2.6 Control of Department-Supplied Items

Developer shall establish and maintain documented procedures for the control of verification, storage, and maintenance of Department-supplied items provided for incorporation into the East End Crossing or for related activities. When such items are encountered, documented procedures shall exist that detail the receipt/approval, storage, and maintenance (preservation) of these items.

When items are considered inadequate for the task required, documented procedures shall detail the process used to report such deficiencies to IFA.

2.2.7 Product Identification and Traceability

Developer shall establish and maintain documented procedures for identifying the product by suitable means from receipt and during all stages of production, delivery, and installation.

Developer shall establish and maintain documented procedures whereby items of work for which records are to be kept shall be identifiable.

Developer shall include document title, unique number, IFA's name, Developer's name, the preparer's name, and the date and revision number on all East End Crossing Submittals.

The filing and retrieval of operating manuals, certificates of compliance and, as applicable, analysis, heat numbers, inspection status, and nonconforming product shall be traceable to the items. Records shall be kept that identify the installed location of the equipment.

Developer shall establish and maintain documented procedures for the unique identification and recording of individual product or batches.

2.2.8 Process Control

Developer shall plan and control the Work and when necessary shall prepare a documented process plan defining how work is to be carried out. Documentation may be in the form of a narrative, flow chart, or control points.

Developer shall identify and plan the production, installation, and servicing processes that directly affect quality and shall ensure that these processes are carried out under controlled conditions.

2.2.9 Inspection and Testing

2.2.9.1 General

Developer shall establish and maintain documented procedures for inspection and testing activities in order to verify that the specified requirements for the East End Crossing are met. The required inspection and testing, and the records to be established, shall be detailed in the Quality Management Plan or documented procedures.

This section shall address inspection, testing methodology, methods of control, documentation, approval, and the distribution of results.

Developer shall establish, document, and maintain procedures for inspection and testing activities.

QC inspection and testing shall be performed in accordance with written procedures developed by Developer, or the proper issue of test procedures issued by industry, government, and, as applicable, code bodies available to test personnel.

Quality check points and hold points (Work that shall be inspected and approved by the assigned QC inspector before Work can proceed) shall be clearly established and identified on the East End Crossing execution schedule or other suitable means. QC inspection procedures, logistics, and the reporting of results shall be clearly defined, developed, and implemented.

2.2.9.2 Incoming Product Inspection and Testing

Developer shall ensure that the incoming product is not used or processed (except in the circumstances described in Section 2.2.9.2) until it has been inspected or otherwise verified as conforming to specified requirements. Verification of the specified requirements shall be in accordance with the Quality Management Plan and documented procedures.

The Quality Management Plan shall include incoming product inspection that shall include, but not be limited to, the following:

1. Documentation review;
2. Physical inspection of materials and equipment;
3. Identify items per the purchase order and shipping list, tag number, or marking;
4. Verification of quantity and size;

5. Dimensional checks, when applicable;
6. Verification of protective coatings, if applicable; and
7. Examination of item(s) for condition and shipping damage.

2.2.9.3 In-Process Inspection and Testing

Developer shall do the following:

1. Inspect and test the product as required by the Quality Management Plan and documented procedures; and
2. Hold product until the required inspection and tests have been completed or the necessary reports have been received and verified.

2.2.9.4 Final Inspection and Testing

Developer shall jointly conduct all final inspection and testing with IFA in accordance with the requirements of the PPA Documents and the Quality Management Plan and documented procedures to complete the evidence of conformance of the finished East End Crossing to the specified requirements.

Developer shall have documented procedures to ensure that the final observation and testing, where applicable, have been completed.

Records of final inspections and tests are required to verify that compliance with the specified requirements has been achieved.

The Quality Management Plan and documented procedures for final inspection and testing shall require that all specified inspection and tests, including those specified either upon the receipt of product or in-process, have been carried out, and that the results meet the specified requirements.

2.2.9.5 Inspection and Test Records

Developer shall establish and maintain records that provide evidence that the product has been inspected and, as applicable, tested. These records shall show clearly where the inspection or test was performed, what WBS work element the record relates to, whether the product has passed or failed the inspections and, as applicable, tests according to defined approval criteria. Soils testing records shall include horizontal and vertical location data. Where the product fails to pass any inspection and, as applicable, test, the procedures for the control of nonconforming product shall apply.

Inspection and test records for inspections and tests performed by Developer, IFA, and, as applicable, a third party or collected by the Developer shall be submitted to IFA within 10 days of the inspection or test being performed. The record of the inspection or test shall be in an electronic format acceptable to IFA. A product that fails inspection becomes a nonconforming product. Also, the records shall identify the responsible inspection authority.

2.2.10 Control of Inspection, Measuring, and Test Equipment

2.2.10.1 General

Developer shall establish and maintain documented procedures to control, calibrate, and maintain inspection, measuring, and test equipment – including test software – used by Developer to demonstrate the conformance of product to the specified requirements. Inspection, measuring, and test equipment shall be used in a manner that ensures that the measurement uncertainty is known and is consistent with the required measurement capability.

Developer shall employ an independent QC engineering firm which shall establish, document, and maintain procedures for the control of inspection, measuring, and test equipment. It shall be Developer's responsibility, through the Quality Manager, to assess the Contractor to ensure the required procedures exist and are implemented.

Developer and the independent QC engineering firm shall be responsible for ensuring applicable requirements of Section 2 are addressed, including the following:

1. Definition of the responsibility and authority for the inspection, measuring, and test equipment;
2. Procedures for selecting measurements, determining the accuracy and precision required, and obtaining equipment that meets those requirements;
3. Disposition of nonconforming equipment;
4. Procedures for the identification, maintenance, and storage of measuring equipment;
5. Record keeping;
6. Calibration frequency;
7. Calibration status, including indicators;
8. Disposition of items checked with equipment found to be out of calibration; and
9. Traceability of primary and secondary calibration standards.

2.2.10.2 Control Procedure

Developer, through the independent QC engineering firm, shall do the following:

1. Determine the measurements to be made and the accuracy required and select the appropriate inspection, measuring, and test equipment that is capable of the necessary accuracy and precision.
2. Identify all inspection, measuring, and test equipment that can affect product quality, and calibrate and adjust them at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to internationally or nationally recognized standards. Where no such standards exist, document the basis used for calibration.

3. Develop a master calibration listing indicating the inspection and test equipment that is used. The log shall include, as a minimum, the identification number, item description, and the required frequency of calibration and accuracy requirements.
4. Define the process employed for the calibration of inspection, measuring, and test equipment, including the details of equipment type, the unique identification, the location, the frequency of checks, the check method, approval criteria, and the action to be taken when results are unsatisfactory.
5. Identify inspection, measuring, and test equipment with a suitable indicator or approved identification record to show the calibration status.
6. Maintain calibration records for inspection, measuring, and test equipment.
7. Assess and document the validity of previous inspection and test results when inspection, measuring, or test equipment is found to be out of calibration.
8. Ensure that the environmental conditions are suitable for the calibrations, inspections, measurements, and tests being carried out.
9. Ensure that the handling, preservation, and storage of inspection, measuring, and test equipment is such that the equipment's accuracy and fitness for use is maintained.
10. Safeguard inspection, measuring, and test facilities, including both test hardware and test software, from adjustments that would invalidate the calibration setting.

2.2.11 Inspection and Test Status

The inspection and test status of products shall be identified by a suitable means that indicates the conformance or nonconformance of a product regarding the inspection and test performed. The identification of inspection and test status shall be maintained, as defined in the Quality Management Plan and, as applicable, documented procedures, throughout the production, installation, and servicing of the product to ensure that only product that has passed the required inspections and tests is dispatched, used, or installed.

2.2.12 Control of Nonconforming Product

2.2.12.1 General

Developer shall establish and maintain documented procedures to ensure that products that do not conform to specified requirements are prevented from use (unintended or otherwise) or installation. This control shall provide for identification, documentation, evaluation, segregation (when practical), the disposition of nonconforming product, and for notification to the functions concerned.

2.2.12.2 Review and Disposition of Nonconforming Product

Developer shall define the responsibility for review and authority for the disposition of nonconforming product.

A nonconformance shall be defined as any condition in equipment, materials, or processes that do not comply with required plans, specifications, codes, standards, documentation, records, procedures, or requirements of the PPA Documents that cause the acceptability of equipment, materials, or processes to be unacceptable or indeterminate.

Nonconforming Work shall be reviewed in accordance with documented procedures. It may be:

1. Reworked to meet the specified requirements; or,
2. Rejected.

The procedures shall also address the disposition of nonconforming items and the steps necessary to verify that the nonconformances have been adequately addressed and that the item then can be characterized as conforming.

Developer shall keep and maintain records of nonconforming findings. Also, each nonconformance record shall contain all deliberations; retesting; and resolution activities, findings, and decisions.

Repaired and, as applicable, reworked product shall be re-inspected in accordance with the Quality Management Plan and, as applicable, documented procedures. Developer's obligations and IFA's rights with respect to Nonconforming Work shall be governed by the PPA.

2.2.13 Corrective and Preventive Action

2.2.13.1 General

Developer shall establish and maintain documented procedures for implementing corrective and preventive action.

This Section 2 encompasses aspects for dealing with Nonconforming Work. The first is implementation and effectiveness of previously implemented corrective actions.

The second is preventive action which plays a major role in this requirement. Most procedures addressing corrective action need to include preventive action. The investigation of Nonconforming Work needs to look into three possible causes: the product, the process, and the quality system.

Developer shall implement and record any changes to the documented procedures resulting from corrective and preventive action.

2.2.13.2 Corrective Action

Developer shall maintain and document a procedure for dealing with Nonconforming Work and, as applicable, complaints, to ensure that the cause has been determined and investigated, and that the appropriate corrective action, if any, shall be taken.

Follow-up action shall investigate to see if the corrective action resolved the identified problem, and also to ensure the corrective action did not have an undesirable effect on another element of the quality system.

2.2.13.3 Preventive Action

Developer shall establish, document, and maintain procedures for implementing preventive actions to eliminate the causes of potential nonconformities in order to prevent their occurrence.

Preventive actions shall be appropriate to the effects of the potential problems. The results of preventive actions shall be documented and reviewed for their effectiveness.

2.2.14 Handling, Storage, Packaging, Preservation, and Delivery

2.2.14.1 General

Developer shall establish and maintain documented procedures for the handling, storage, packaging, preservation, and delivery of product.

The procedures developed shall apply to all parties involved on the East End Crossing, beginning with Developer drafting the Construction Documents, all the way through to the personnel responsible for the start-up and turnover of the facility to IFA at the completion of construction, and for those elements within the O&M Limits at the turnover of the facility at the completion of the Term at handback. The specific application of the requirements is determined by the function performed: Developer, Contractors, Suppliers, manufacturer, distributor, vendor, warehousing, equipment operators, and installer.

Procedures shall be developed and implemented for designating which items require special handling, storage, or maintenance. The development of the HSPPD procedures and work instructions are affected by the other elements of Section 2, and therefore shall be reviewed for applicability and requirement inclusion.

2.2.14.2 Handling

Developer shall provide methods of handling products that prevent damage or deterioration.

Special handling clothing and precautions shall be identified for all hazardous materials, with assurances that only qualified and trained personnel handle the material. The handling procedures shall include instructions to follow for decontamination and the notification of authorities and responsible parties in the event of an accident.

2.2.14.3 Storage

Developer shall use designated storage areas or stock rooms to prevent damage or the deterioration of product, pending use or delivery. Appropriate methods for authorizing receipt to and dispatch from such areas shall be stipulated.

To detect deterioration, the condition of product in stock shall be assessed at appropriate intervals.

Items requiring protection shall be identified and protected as necessary to prevent loss, damage deterioration, or the loss of identification.

Special storage requirements shall be clearly defined for materials and equipment that are received on the East End Crossing; this includes plans, records, and operating manuals.

Materials shall be segregated to prevent cross contamination or environmental contamination.

Material with limited shelf life shall be identified and procedures developed and implemented to identify the means of ensuring the usage of material prior to its expiration date. The procedures shall also identify the disposal of materials that may be toxic, hazardous, or might otherwise have an adverse effect on the environment or on unsuspecting humans.

2.2.14.4 Packaging

Developer shall control packing, packaging, and marking processes (including materials used) to the extent necessary to ensure conformance to the PPA Documents.

Engineering or procurement documents shall specify applicable packaging requirements to ensure no damage, contamination, or deterioration occurs in the course of packaging and transporting the material and equipment. Procedures/work instructions shall clearly define all special packing and packaging and marking process requirements, including export crating, moisture barrier, regulatory requirements, climate control, identification, and all requirements of the PPA Documents.

The labeling of hazardous materials, special handling instructions, and the notification of authorities and Developer shall be clearly and plainly identified on the packaging.

2.2.14.5 Preservation

Developer shall apply appropriate methods for the preservation and segregation of product when the product is under Developer's control.

Procedures shall include special unpacking instructions, the controlled conditions necessary to prevent or deter the deterioration of material or equipment and prevention of corrosion and, as applicable, contamination, and required servicing.

2.2.14.6 Delivery

Developer shall arrange for the protection of the quality of product after final inspection and testing. This protection shall be extended to include delivery to destination where the final inspection and testing is not on-Site.

When the delivery of equipment and, as applicable, materials to the jobsite is the responsibility of Developer, it shall develop procedures or reference appropriate standards to protect the items during delivery.

2.2.15 Control of Quality Records

Developer shall establish and maintain documented procedures for the identification, collection, indexing, access, filing, storage, maintenance, and disposition of quality records.

Quality records shall be maintained to demonstrate conformance to requirements of the PPA Documents and the effective operation of the quality system. Pertinent quality records from the Contractor shall be an element of these data.

Records shall be kept of documents that serve as evidence that requisite quality is achieved in Work on the East End Crossing. Records shall be adequately identified, filed, and stored. Retention periods and the storage medium of such records shall be established in accordance with the requirements of the PPA Documents.

All quality records shall be legible and shall be stored and retained in such a way that they are readily retrievable in facilities that provide a suitable environment to prevent damage or deterioration and to prevent loss. Quality records shall be made available for inspection, duplication, audit, and evaluation by IFA in accordance with the requirements of the PPA Documents.

Management shall identify the records necessary to provide objective evidence of review; of the PPA Documents; procedure compliance; Design Review, when applicable; training; and the completion and approval of inspection and testing – or to provide the traceability of equipment or items to documentation.

A list of project-required records shall be developed, retained, and, as applicable, turned over to IFA prior to completing the Work.

2.2.16 Internal Quality Audits

Developer shall establish and maintain documented procedures for planning and implementing internal quality audits to verify whether quality activities and related results comply with planned arrangements and to determine the effectiveness of the quality system.

Internal quality audits shall be conducted in accordance with sound auditing principles. The frequency of the audits shall be appropriate to the importance and complexity of the East End Crossing or corporate operation, but shall at least be on a quarterly basis. Audits shall be initiated early enough in the life of the East End Crossing to ensure effective quality control during all phases. The audits shall include project management as well as technical work activities.

Internal quality audits shall be carried out by personnel independent of those having direct responsibility for the activity being audited.

The internal quality audit program shall provide verification that the quality system is operating and being implemented as planned. Audits shall be conducted on a planned and scheduled basis, consistent with the importance of the activities being performed.

The results of the audits shall be recorded and brought to the attention of the personnel having responsibility in the area audited. The management personnel responsible for the area shall take timely corrective action on deficiencies found during the audit.

Follow-up audit activities shall verify and record the implementation and effectiveness of the corrective action taken.

The results of internal quality audits shall be reviewed in management review meetings. In accomplishing management review, the results of internal audits and their attendant corrective action status shall be reviewed for adequacy and effectiveness.

Auditor qualifications shall be established and documented by Developer. Staff assigned auditing tasks shall be qualified accordingly, with qualification records maintained as quality records. Auditing need not be a full-time assignment, but staff assigned auditing tasks shall have no direct responsibilities for the function or work they audit.

Audits shall be carefully planned and executed to avoid or minimize disruption of the audited activity. Results shall be provided promptly to personnel responsible for the audited activity and their management. Corrective action shall be developed to identify the root causes and to institute measures to prevent the types of deficiencies identified in the audit. Corrective actions shall be monitored through a review of documents, surveillance, or follow-up audits. These actions shall be conducted in a timely manner to determine the effectiveness of corrective action that is implemented. Records of corrective actions shall be kept together with the respective audit records.

Records of internal audits shall be maintained by Developer.

2.2.17 Training

Developer shall establish and maintain documented procedures for identifying training needs and provide for the training of all personnel performing activities affecting quality. Personnel performing specific assigned tasks shall be qualified on the basis of appropriate education, training, and, as applicable, experience, as required. Appropriate records of training shall be maintained.

Developer shall establish documented procedures and records to ensure that the skills and professional judgment of their personnel are developed appropriately for their intended roles, through training and, as applicable, the recorded accumulation of experience, with systematic reviews of their competence at determined levels, and before any deployment of new roles.

Training shall focus on improving competency and skill for those performing activities that materially impact quality.

All qualification and training records are quality records and shall be maintained accordingly.

East End Crossing personnel shall be trained in all the special East End Crossing procedures applicable to their work.

Craft journeymen with special skills need not be trained, but their competency shall be verified and a record maintained of the verification.

2.2.18 Servicing

Where servicing of an installed product or equipment is a specified requirement, Developer shall establish and maintain documented procedures for performing, verifying, and reporting that the servicing meets the specified requirements.

The requirement of this Section 2.2.18 is applicable only where it is specified in the PPA Documents.

Should such a requirement exist, Developer shall document procedures that detail the methodologies to be used while performing the service, how compliance to these operations and IFA's requirements are verified, and the agreed-upon method of reporting compliance of service operations to the requirements of the PPA Documents.

2.2.19 Statistical Techniques

2.2.19.1 Identification of Need

Developer shall identify the need for statistical techniques required for establishing, controlling, and verifying process capability and product characteristics.

Developer shall review its operations for activities that may benefit from the use of statistical techniques as a means of establishing a level of control, the maintenance of an existing level of performance, and the verification of performance. The needs assessment could include determining an activity impact on cost, time management/utilization, and the quality of deliverables. It could also identify areas where the application of statistics would provide an indication of variation, activities efficiencies, and deviation control.

2.2.19.2 Procedures

Developer shall establish and maintain documented procedures to implement and control the application of the statistical techniques identified in Section 2.2.19.1.

Should the need for statistical programs be established, Developer shall document procedures detailing the methods to be applied.

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3 DESIGN QUALITY ASSURANCE, QUALITY CONTROL, AND OVERSIGHT

3.1 Designer Responsibilities

The Design Work shall be performed in accordance with the requirements of Section 5.2.1 of the PPA.

It shall be Developer’s sole responsibility to provide Design Documents, Plans and Construction Documents in order to develop a finished product in accordance with the PPA Documents and Developer’s Design Quality Assurance/Quality Control (QA/QC) Plan, hereinafter “Design QA/QC Plan”. The Design QA/QC Plan is a component part of the PMP. Developer shall verify pertinent dimensions in the field prior to the review of Design Documents, Plans, and Construction Documents. A review of Developer’s Design Documents, Plans, and Construction Documents shall not relieve Developer of the responsibility for the satisfactory completion of the Work.

Design Documents, Plans, and Construction Documents shall be subject to IFA’s Design Review before beginning construction work covered by the Plans, and shall not be thereafter amended or altered without the prior approval of Developer’s Designer and subsequent Design Review by IFA.

Developer shall perform the following:

1. Manage the Design Work and Design Work QA/QC.
2. Coordinate with and obtain necessary Governmental Approvals (excluding IFA-Provided Approvals) from, but not limited to, authorities having jurisdiction for temporary road diversions and detours, shutdowns, utility relocations, temporary sidewalk closures, and pedestrian/bicycle detours.
3. Ensure that the Designer properly checks the Design Documents for the East End Crossing and that the Design QA Manager (DQAM) certifies QC procedures in accordance with the PPA Documents and Design QA/QC Plan.

The procedures for the checking of the Design Documents of permanent components also apply to the Design Documents of major temporary components and construction sequences that affect the permanent components of the East End Crossing.

3.2 Developer’s Design Organization and Obligations

3.2.1 Designer

Developer shall appoint a suitably qualified and experienced Designer, which may be a consultant or an in-house design team, to undertake the design of the permanent components and the major temporary components of the East End Crossing. Developer shall require the Designer to maintain all necessary representation throughout the duration of the PPA to ensure Developer can meet all its obligations under the PPA.

3.2.2 Location of Developer's Designer

The Designer may perform production Design Work in the East End Crossing vicinity or elsewhere. However, the Key Personnel shall be assigned primarily to the Project Office.

3.2.3 Completeness of Design

The Design Work shall be considered complete upon Final Acceptance, following the submittal and review of the Record Drawings, in accordance with the PPA Documents and project requirements.

3.2.4 Lead Engineer

Developer shall designate and assign a Lead Engineer to manage all Work performed by Developer's Designer ("Lead Engineer"). The Lead Engineer shall be located in the East End Crossing vicinity as required for the Design Work, and shall be present as required thereafter to manage Design Work support during construction, design changes, and the completion of Record Drawings.

The Lead Engineer and staff working under the direct supervision of the Lead Engineer shall conduct an assessment and evaluation of Design Work such that the Lead Engineer can certify to Developer and to IFA that the Design Documents satisfy the requirements of the PPA Documents, including, and without limitation to, the following requirements:

1. Accuracy;
2. Adequacy;
3. Conformance to Good Industry Practice;
4. Compliance with Project Standards; applicable Laws, including codes, and standards; and Governmental Approvals;
5. Cost-effectiveness;
6. Quality; and
7. Function as specified or implied in the PPA Documents.
8. The Lead Engineer shall include such written certification for all Work being subjected to a Design Review.
9. The Lead Engineer's activities shall include, as a minimum, an assessment and evaluation of the following:
   a) Design reports;
   b) Analytical approach;
   c) Details of Design Documents for conformity to requirements of PPA Documents;
   d) Construction Documents and Plans for conformity to requirements of PPA Documents;
   e) Effect of major temporary components on permanent components;

f) Field design changes;

g) Design approval for materials and procedures; and

h) Record Drawings for conformity with Final Design Documents, requirements of PPA Documents and Governmental Approvals, and the Design QA/QC Plan.

3.2.5 Responsible Engineer

Developer shall designate and assign a Responsible Engineer for each Developer-designated Design Unit ("Responsible Engineer"). The Responsible Engineer will be the engineer of record in accordance with applicable state laws and regulations. The Responsible Engineer(s) shall sign and seal Design reports, Plans, and Project Specifications for the assigned Design Unit(s). Responsible Engineers shall be Registered Professional Engineers.

Responsible Engineers shall be located in the Project Office as necessary to coordinate the Work on assigned Design Units. Responsible Engineers shall be present in the East End Crossing area for, and shall attend all Design Reviews for, assigned Design Unit(s).

3.2.6 Design Quality Assurance Manager

Developer shall assign a "Design Quality Assurance Manager (DQAM)", as one of the Key Personnel specified. The DQAM shall report to the Quality Manager and shall be independent from the production of the Design Documents.

The DQAM shall be responsible for providing QA direction in accordance with the Design QA/QC Plan for all Design Work performed by Developer. The DQAM shall be in the Project Office as required throughout the design process and shall be present as required thereafter to manage design QA related to design support during Construction Work, design changes, and the completion of Record Drawings.

Developer's DQAM shall assess and evaluate Developer's design QA and QC activities in order to certify to Developer and to IFA that the Design QA and QC activities comply with the Design QA/QC Plan and requirements of the PPA Documents.

Developer shall ensure that the DQAM carries out all duties expressed and implied in the PPA Documents.

1. The DQAM shall have QA responsibilities related to the following:

   a) Design of permanent and major temporary components;

   b) Changes in design of permanent components; and

   c) Record Drawings.

2. The DQAM shall also perform the following activities:

   a) Identify and report nonconformance with PPA Documents;

   b) Track, monitor, and report on the status of outstanding design-related nonconformance reports;

   c) Supply monthly Progress Reports; and

d) Submit specified certificates (permanent components and major temporary components).

3.2.7 Check by the Designer

The requirement that Developer engage and use a DQAM shall not relieve Developer from carrying out all the Design QC checks and reviews that are consistent with Good Industry Practice and that a professional and prudent designer would normally carry out on the type of Work that is actually being designed.

3.3 Design Units

Developer shall package all design, drawings, and other related documents for the Work into separate Design Units. Within 30 days of NTP1, Developer shall submit a written report to IFA identifying each Design Unit. The IFA will review and comment on the Design Units proposed by Developer. Each Design Unit shall consist of similar and coherent significant parts of the project that can be checked and reviewed as a self-contained package with due consideration for accommodating interfaces with other project components.

The written report shall include the following:

1. Design Unit description, including the scope of the Design Work within each Design Unit, including limits and interface points;
2. Planned review stages and dates, including specific information to be reviewed, review dates (measured from NTP1 date) specified in the PPA Documents, and percent complete represented by each review;
3. Responsible Engineer; and
4. Locations where Design Work will be performed.

Developer shall submit any revisions to the information provided in response to the requirements in this Section 3.3 in writing to IFA concurrent with the monthly Progress Report.

3.4 Relationship of Early Construction Starts to Design Development and Review

It is the intent of IFA to allow Construction Work to begin on a Design Unit prior to IFA approval of Final Design. Construction Work on any Design Unit, or component thereof, may begin at any time after the applicable Released-for-Construction (RFC) Design Review. Construction may progress in increments determined by Developer prior to Final Design, at Developer’s risk, provided each increment of construction is covered by Plans and Construction Documents that have been reviewed by IFA and meet the requirements for Released-for-Construction.

3.5 Schedule for Design Checks, Design Reviews, and Submission of Checked Design

Developer is responsible for scheduling and conducting design checks and Design Reviews to meet the design and construction needs of the Project Schedule. It is recognized and anticipated that the Design Review process and the frequency, duration, and intensity of Design

Reviews may vary with the complexity of the individual Design Units and the associated construction activities. The duration of typical Design Reviews shall be 15 days, unless otherwise agreed to by IFA during the design workshop (Section 3.1.2.1 of the PPA). Actual durations of Design Reviews shall be verified during the course of the East End Crossing Work. The Design Review durations specified in the PPA Documents may be modified by mutual agreement of the Parties. Developer shall give a written notice of scheduled Design Reviews to IFA at least one week prior to any review.

Developer shall include the agreed-upon Design Review Plan and Schedule for all Design Units, including their components, design safety assessment, and elements, as part of the Project Schedule. The Design Review Plan and Schedule shall be reviewed jointly by both IFA and Developer at a minimum monthly.

Except for Record Drawings, Design Documents that are to be reviewed during Design Reviews shall be submitted with sufficient copies, as defined in the Design Review Plan and Schedule, to accommodate all participants in the Design Review, and shall be assembled for review in the Project Office.

Developer shall only conduct Design Reviews on Design Documents that have been checked. No Design Documents shall be submitted for Design Review prior to approval of the Design QA/QC Plan. Design Documents shall be complete for each Design Unit, but may be combined for multiple Design Units at any one time upon IFA's written concurrence. A portion of a Design Unit may be reviewed where that portion has been identified for RFC. Developer shall include a review of each Design Unit for consultation and written comment in accordance with the Project Baseline Schedule.

For each Design Unit designated by Developer, Developer shall include design checks and Design Reviews as indicated in Table 3-1, and such additional reviews as may arise as indicated in Section 3.12.2.4. Developer shall allow the time for IFA's participation and input to any design check conducted by Developer's DQAM. Developer shall incorporate this schedule into Developer's Project Schedule and report progress and updates in the monthly Progress Reports. Developer shall keep IFA up to date on the exact timing of reviews and RFC Design Reviews through the weekly progress meetings.

3.6 Revisions to Design

Developer shall treat any changes to design initiated by Developer and already checked by the Designer and certified by the DQAM as an entirely new design. Such circumstances shall not form the basis of a Relief Event or otherwise entitle Developer to additional compensation or a time extension.

3.7 IFA Design Review Plan and Schedule

As a component of the Design QA/QC Plan Developer shall prepare and submit a written Design Review Plan and Schedule within 45 days of NTP1, for review and comment by IFA ("Design Review Plan and Schedule"). The Design Review Plan and Schedule shall address design stages, plan completeness, and the QA/QC process, for each Design Unit. The Design Review Plan and Schedule shall describe the level of design that the Designer shall accomplish for each of the planned stages of design development and provide a description and checklist for each Design Unit that clearly identifies the Design Documents that will be reviewed. The design schedule shall include review times for each design check and IFA Design Review, including the review dates and durations for IFA, unless noted otherwise in the Technical Provisions or otherwise agreed to by IFA at the design workshop.

3.8 Stages of Design Development

Developer shall provide for a design check and Design Review for each Design Unit at each Developer defined stage of design development specified herein, as proposed by Developer, and agreed to in the design workshop. The following are the six stages of design development:

1. Stage 1 Design;
2. Stage 2 Design (optional unless noted otherwise);
3. Released-for-Construction;
4. Final Design;
5. Working drawings; and
6. Record Drawings.

Developer’s design check and IFA’s Design Review at each stage of design development shall, as applicable:

a. Verify that the Design Documents and Construction Documents comply with the requirements of the PPA Documents;
b. Allow components of Design Units to be Released-for-Construction; or,
c. In the case of reviews of working drawings, allow construction to continue.

Design Reviews and design checks shall be completed for each Design Unit (and for each component or element within a Design Unit), at each stage of design development. Developer shall schedule the Design Review and Submittals to be consistent with the Project Baseline Schedule and timeframes for IFA action on those Submittals.

The East End Bridge and Tunnel shall have Stage 1, Stage 2 and Final Design Design Reviews as specified above. Design Units that are smaller and less complicated need only have Stage 1 review prior to RFC review.

3.9 Design Reviews

Except as mutually agreed upon by Developer and IFA, all Design Reviews shall be conducted in the Project Office. IFA will provide Stage 1, Stage 2 where applicable, RFC, and Final Design Design Reviews. Each of the Design Reviews (for each stage of design development) will consist of three phases.

- **Phase 1** shall consist of informal, brief presentations (sometimes known as over-the-shoulder reviews) during the development of design at the review office by the Responsible Engineer of the Design Unit being reviewed and the other Developer staff. The presentations shall include an explanation of what component(s) are being reviewed, highlighting any critical points or other information that may be of particular interest to the review participants.

- **Phase 2** shall be a period of more detailed review by the review participants. For minor items with little complexity, and although it is expected that most Phase 2 reviews will take place in the Project Office, Phase 2 shall, as necessary, provide for review participants to take the review package to their own offices for further examination, particularly for complex and, sensitive features. During this period, reviewers are encouraged to contact or meet with the Responsible Engineer to gain further understanding of the design intent of discuss the reviewers issues. The length of Phase 2 shall be consistent with the durations agreed to at the design workshop or as subsequently agreed to in writing. IFA's Phase 2 written comments, if any, shall be provided to Developer through a design requirement verification report and within the periods specified in the PPA or as agreed to during the Design Workshop. All IFA design requirement verification observations shall be viewable to the Developer's staff through the IFA's requirement verification database application. Developer's design staff shall be required to respond to all IFA observations related to design non-conformances or Design Requirements not being realized through the IFA's requirement verification database application.
- Phase 3 shall consist of review participants meeting face to face with the Responsible Engineer and other members of Developer's staff to present and resolve comments from review participants. All IFA detected issues shall be appropriately resolved within the IFA's requirement verification database application. Phase 3 face to face comment resolution meetings may be waived as mutually agreed between Developer and IFA but any waiver of this meeting by IFA does not release Developer from appropriately resolving the IFA detected issues within IFA's requirement verification database application.

3.9.1 Stage 1 Design Review

The Design Review of Stage 1 Design shall be the first Design Review after award and is intended to verify that the design concepts proposed by Developer meet the requirements of the PPA Documents. The Stage 1 Design Review shall verify the following:

1. That the design concepts governing future East End Crossing design development are consistent with the requirements of the PPA Documents;
2. That the design concepts are substantiated and justified by adequate Site investigation and analysis;
3. Final Project ROW requirements;
4. That the Project Standards applicable to the proposed design concepts are identified and appropriate;
5. The proposed design concepts are constructible; and
6. That the design meets East End Crossing quality requirements and required procedures in the Design QA/QC Plan.

If the Stage 1 Design is revised subsequent to the Stage 1 Design Review, Developer shall recheck and recertify the design as an additional Stage 1 Design Review. Unless the revisions resulted from an IFA Change, such revisions shall not form the basis of a Relief Event or otherwise entitle Developer to additional compensation or a time extension.

3.9.2 Stage 2 Design Review

Stage 2 Design Review shall be performed at the discretion of Developer except for the East End Bridge and Tunnel, which shall have Stage 2 Design Reviews. Design Units that are smaller and less complicated need only have Stage 1 review prior to RFC review. Developer shall schedule Stage 2 reviews when the Design Work is sufficiently advanced from Stage 1 and in advance of RFC or Final Design to provide the opportunity to verify that the design is advancing per the requirements of the PPA documents, considering the type of design element.

Developer and IFA shall use the Stage 2 Design Review(s) to verify that the concepts and parameters established and represented by Stage 1 Design are being followed and that requirements of the PPA Documents continue to be met. Developer shall specifically highlight, check, and bring to the attention of IFA in writing any changes to information presented at Stage 1 Design. Developer shall submit the Stage 2 Design for review and comment by IFA.

3.9.3 Released-for-Construction Design Review

Developer and IFA shall use the Design Review(s) of Released-for-Construction (RFC) Design to verify that the concepts and parameters established and represented by Stage 1 Design, or Stage 2 Design as applicable, are being followed and that requirements of the PPA Documents continue to be met. Developer shall specifically highlight, check, and bring to the attention of IFA in writing any changes to information presented at Stage 1 Design. Developer shall submit the RFC design to IFA for discretionary approval. RFC Design Review may be conducted at any level of design of the Design Units, suitable to proceed to construction.

Developer shall not construct any permanent components or major temporary components until the design checks, Design Reviews, and DQAM's certifications have been completed for the relevant Design Unit, or component thereof, and until any issues raised in IFA's review and Discretionary Approval on the Design have been resolved to IFA's satisfaction. Additionally, Developer shall not commence any construction until any design-related Nonconformance Reports have been addressed and resolved to IFA's satisfaction.

After completion of all such requirements, Developer's Lead Engineer shall stamp, sign and date the Design Documents as "released for construction," certifying that all requirements of the PPA Documents have been satisfied. Subsequent revisions to RFC documents shall clearly indicate revisions and include a complete history of revisions since first issuance in the title block and shall follow the same Released-for-Construction Design Review process described in this Section 3.

3.9.4 Final Design Review

Developer shall schedule and conduct a Final Design Review when the Design Documents and Construction Documents for a Design Unit are 100 percent complete. Developer shall specifically highlight, check, and bring to the attention of IFA in writing any changes to information presented at previous Design Reviews. Developer shall present the Final Design for review and comment by IFA.

3.10 Working Drawings

Construction Documents include working drawings which include, but may not be limited to, the supplemental design products listed below:

1. Construction details;
2. Erection plans;
3. Fabrication plans;
4. Field design change plans;
5. Stress sheets;
6. Shop plans;
7. Lift plans;
8. Bending diagrams for reinforcing steel;
9. Falsework plans;
10. Materials samples; and
11. Similar data required for the successful completion of the Work.

Developer shall check, review, and certify working drawings prior to their being issued for construction.

The IFA will review and comment on the working drawings within 14 days.

3.11 Record Drawings

Developer shall submit the Record Drawings for each Design Unit in accordance with the requirements of the PPA Documents.

Refer to Section 3.12.2.2 for additional requirements relating to Record Drawings and information.

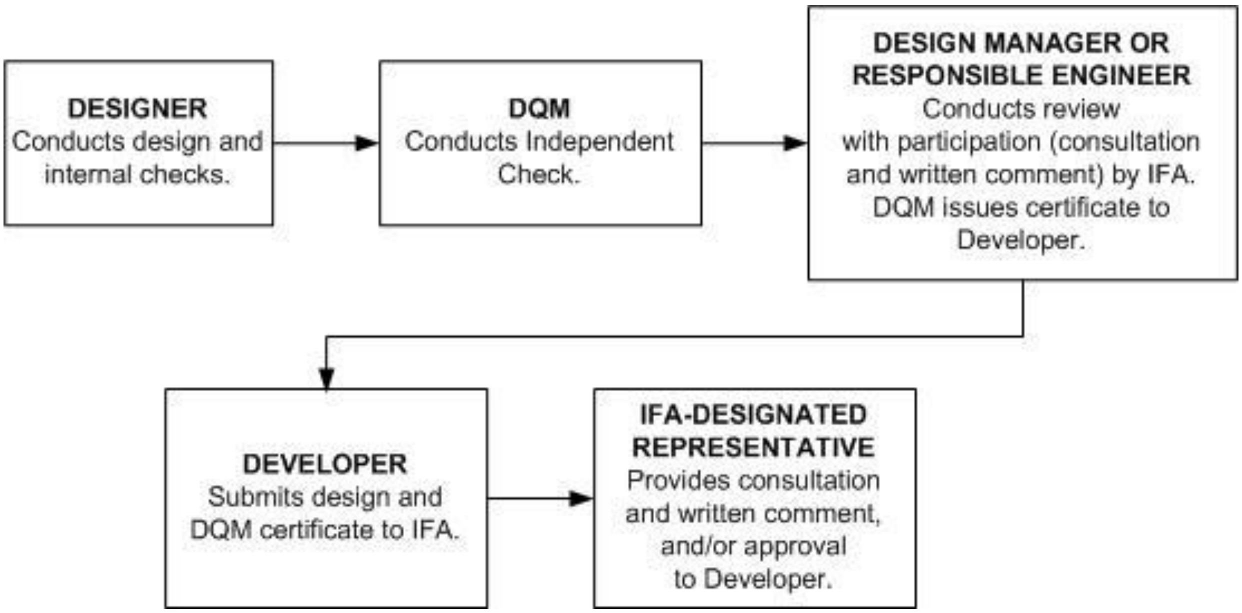
3.12 Design Checks, Certifications, and Design Reviews

Developer shall ensure that the Designer's organization checks all Design Documents, including drawings, Plans, specifications, calculations, and reports, produced by Developer's organization. The DQAM shall certify that these documents have been checked in accordance with the requirements of the PPA Documents and Developer's Design QA/QC Plan. The DQAM's written certification shall provide the certification specified in Section 3.12.3.

Developer and IFA shall follow the process shown in Figure 3-1 for design checks conducted by Developer's DQAM and IFA Design Reviews. This applies to all design checks and Design Reviews except Record Drawing reviews.

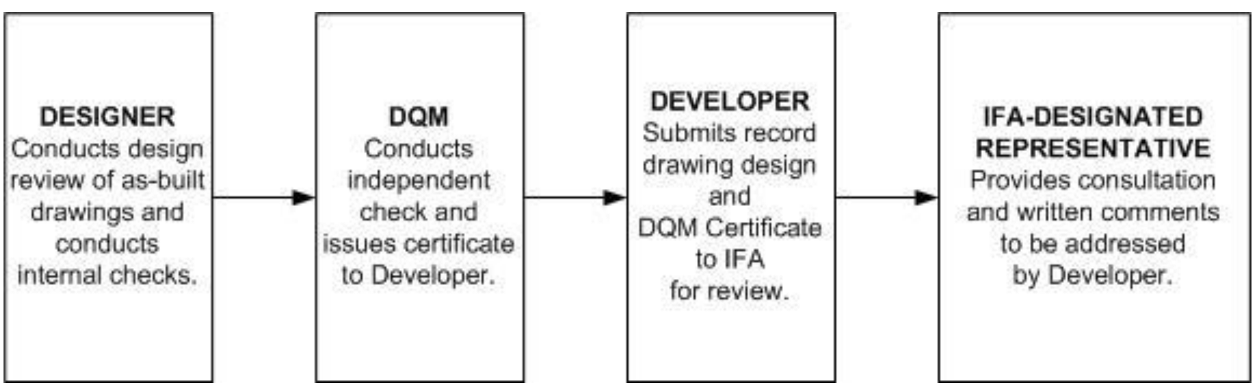
Responses to and the disposition of Nonconformance Reports shall be provided by Developer in a timely manner. IFA may also issue design Nonconformance Reports shall be addressed and resolved in accordance with Section 3.1 of the PPA prior to releasing the design(s) for construction. IFA will close a Nonconformance Report only if the issue has been resolved or addressed to IFA's satisfaction, in accordance with the requirements of the PPA Documents.

Figure 3-1 Design Check/Review Flow Chart (Developer's DQAM Conducts Design Check)



Developer and IFA shall follow the process shown in Figure 3-2 for Record Drawings being submitted for Department Design Review.

Figure 3-2 Design Review Flow Chart for Record Drawings



Developer shall conduct and complete the design checks, certifications, and reviews for each Design Unit by the entity specified in the column entitled "Design Check and Certification to Developer" appearing in Table 3-1. IFA will provide review and approval on the design prior to Developer releasing designs for construction.

Developer shall conduct its design check or submit its design for Design Review in accordance with Table 3-1 supported by a written certification issued by the DQAM, at the stages of design development shown in Table 3-1 for each Design Unit in accordance with the Design Review Plan and Schedule and the Project Baseline Schedule.

Table 3-1 Design Checks, Certifications, and Design Reviews for Permanent and Temporary Components

Stage of Design Development	Design Check and Certification to Developer	Design Review
Stage 1 Design	Designer and DQAM	IFA and Designer
Stage 2 Design Review(s)	Designer and DQAM	IFA and Designer
Released-for-Construction Design	Designer and DQAM	IFA and Designer
Final Design	Designer and DQAM	IFA and Designer
Working Drawings and Related Documents	Designer and DQAM	IFA and Designer
Record Drawings	Designer and DQAM	IFA
Major Temporary Components	Designer and DQAM	IFA and Designer
Temporary Components	Designer and Checker	Not Applicable

3.12.1 Developer's Independent Design Checks

Developer shall carry out independent design checks of East End Bridge and the Tunnel, major temporary structures for the East End Bridge and Tunnel, and the effects of temporary structures on the permanent components by senior engineers who are not involved in the production of the design being reviewed and who have either equal to or more qualifications and experience, for the design being checked, than the Responsible Engineer.

Independent design checks shall be identified in the Design QA/QC Plan and shall comprise design assessment and analytical checks as specified in Sections 3.12.1.1 and 3.12.1.2.

3.12.1.1 Design Assessment

Design assessment shall be the review of general compliance with the requirements of the PPA Documents, taking into consideration the proposed method of construction, and shall cover the following areas:

1. Loads;
2. Applicable Laws and Project Standards;
3. Methods of analysis;
4. Computer software and its validation;
5. Interface requirements;
6. Maintenance requirements;
7. Materials and material properties;
8. Durability requirements;

9. Fatigue performance;
10. Hydrology;
11. Design flows; and
12. Requirements and conditions of Governmental Approvals and environmental commitments.

3.12.1.2 Analytical Check

The independent design check shall include an independent analytical check using separate calculations – and without reference to the Designer's calculations – to establish the structural adequacy and integrity of critical structural members. This shall include, but is not limited to, the following:

1. The structural geometry and modeling;
2. Material properties;
3. Member properties;
4. Loading intensities; and
5. Structural boundary conditions.

3.12.2 Design Reviews

Developer's time and cost impacts of revisions arising from IFA's participation in Design Reviews or caused by Developer's noncompliance with the PPA Documents requirements shall be borne by Developer and shall not form the basis of a Relief Event.

3.12.2.1 Design Checks Conducted by Developer's DQAM

Developer shall notify and invite IFA to participate in all design checks conducted by the DQAM.

For design checks conducted by the DQAM (refer to Table 3-1), the DQAM shall provide a design check report for each Design Unit at the conclusion of each design check. The design check reports shall identify any actions arising from the review. The report shall note items requiring corrective action on a design Nonconformance Report. The DQAM shall send the design Nonconformance Report to the Designer and a copy to IFA.

Developer shall conduct design checks in the Project Office. The Responsible Engineer and any specialists with significant input to the design or Design Review shall be present. Developer shall make available to IFA all drawings, copies of calculations, reports, or other items pertinent to the design check in accordance with the Design Review Plan and Schedule.

3.12.2.2 Record Drawing Review

Record Drawings shall incorporate complete information that reflects that the Work as constructed meets the requirements of the PPA Documents.

As a condition of Final Acceptance, Developer shall submit Record Drawings, complete for each Design Unit, to IFA for review and comment.

Developer shall make all corrections noted in the review of Record Drawings and resubmit the corrected Record Drawings to IFA for review and approval.

The approval of Record Drawings by IFA is a condition of Final Acceptance and will not occur until the Record Drawings are submitted, reviewed, and corrected to IFA's satisfaction.

3.12.2.3 Design Review of Major Temporary Components

The DQAM shall conduct a design check of major temporary components that represent complex structures and that potentially can affect the safety, quality, and durability of the permanent components. The review shall include the effect of the major temporary components on the permanent components. Developer shall invite IFA to participate in the review.

3.12.2.4 Additional Reviews

IFA may conduct additional over-the shoulder reviews as considered necessary to ensure a continued and uniform consistency in the quality and effective incorporation of revisions to designs. Developer may also conduct reviews necessary to facilitate the early release of designs for construction.

3.12.3 Released for Construction

Developer may start the construction of any element of the permanent components only after occurrence of all of the following:

1. The Designer has conducted its design QC checks throughout the design process in compliance with the Design QA/QC Plan and certifies, in writing, that the Design Document is complete to the appropriate level or stage of review, checked, and ready to be Released-for-Construction.
2. The DQAM has signed the title sheet for the drawings, certifying to the following (the title sheet can be formatted to include the items of certification):
    a. Design checks have been completed;
    b. Design Work conforms to requirements of the PPA Documents;
    c. Any Deviations or design exceptions have been approved, in writing, by IFA;
    d. Design QC activities are following Developer's Design QA/QC Plan; and
    e. All outstanding issues or comments from Design Reviews have been resolved to IFA's satisfaction.
3. The Responsible Engineer has signed all drawings prepared under their direction. For those drawings and documents included in the Submittal that are prepared by a manufacturer or Supplier or other persons not under the direct supervision of the Responsible Engineer, the Responsible Engineer shall affix a stamp that indicates the design shown on the sheet or Design Document conforms to the overall design and requirements of the PPA Documents.
4. The DQAM has signed the title sheet to the drawings certifying to the items contained in Section 3.2.4. The title sheet can be formatted to include the items of certification.

5. Developer has verified in writing the following:
   a. Design has undergone constructability review and is constructible as represented;
   b. Design Documents, Construction Documents, and related documents for the portion of the East End Crossing to be constructed are complete and checked;
   c. The design and drawings for maintenance of traffic (MOT) and temporary erosion control and environmental measures applicable to the Work are complete; and
   d. Adequate stakes, lines, and monuments necessary to control the Work have been established on the Site.
   e. Developer has addressed the IFA-provided written comments regarding the Design Documents and applicable MOT plans, temporary erosion control measures, and environmental requirements to the IFA's satisfaction.
6. Developer's Lead Engineer stamps the Design Documents as "released for construction".

See Section 3.1.8 of the PPA for additional information regarding the affect of IFA's consultation and written comments.

Any design Nonconformance Reports issued by the DQAM or IFA shall be addressed and resolved by Developer, to the satisfaction of IFA prior to any design being Released-for-Construction.

3.12.4 Detected Nonconformances and Comment Resolution

IFA comments and detected Nonconforming Work from Design Reviews will be recorded and transmitted to Developer. Developer shall record its proposed disposition and response to each detected Nonconformance and comment and meet with IFA to resolve outstanding detected Nonconformances, comments, and dispositions. Final disposition and resolution shall be documented by Developer within an IFA-provided database application.

All Design Reviews shall include a comment and Nonconformance Report resolution process where unresolved comments and Nonconformance Reports are discussed and a written action plan and schedule for the resolution of unresolved comments are presented in accordance with Section 3.1 of the PPA. The DQAM shall lead the process.

3.13 Design Exceptions

All design Deviations or design exceptions from Project Standards shall be submitted to IFA for review and approval in accordance with the IDM. All requests for Deviations and exceptions shall be submitted with a justification report detailing the reasons to retain a nonstandard or substandard feature or for providing an improvement that does not bring the feature up to standard. Requests for design Deviations and exceptions shall be submitted not later than the Stage 1 Design Review and approved by IFA, in writing, before the affected Design Units will be Released-for-Construction.

3.14 Design Changes Prior to Construction

Design changes may occur prior to commencement of Construction Work and may be initiated by Developer or IFA.

For all design changes requiring calculations, the Designer and the DQAM shall conduct a documented check of all calculations. All design changes requiring the alteration of Design Documents Released-for-Construction shall undergo all review procedures included for original Design Documents in Developer's Design QA/QC Plan and Section 3.12.

3.15 Design Support During Construction

The Lead Engineer and Construction Quality Manager shall verify, during Construction Work, that the conditions actually encountered are consistent with the design and related Design Documents and Construction Documents. The Designer shall prepare necessary adjustments in the Design Documents and Construction Documents and Developer shall obtain IFA consultation and written comment. The Designer and DQAM shall check any such changes in accordance with the Design QA/QC Plan. The DQAM shall certify the change, in writing, as meeting the requirements of the PPA Documents. Developer shall incorporate the adjustments in the Record Drawings. Developer shall retain copies of the DQAM's written certifications and submit the certifications to IFA.

3.16 Design Workshop

Developer shall arrange a design workshop to familiarize the Designer's personnel and IFA review personnel with the design concepts, issues, status, and review procedures. The intent of the workshop is to make the subsequent Design Reviews more effective and efficient for all parties. IFA and Developer shall jointly develop the agenda of the workshop and how it is be organized (e.g., by Design Unit and engineering discipline). The design workshop shall take place before Design Work commences. The design workshop shall take place no later than 30 days after NTP1.

The agenda shall include developing an agreement regarding time provided in the schedule for Design Reviews. The duration of Design Reviews, particularly the duration of Phase 2, may vary depending on items such as the stage of the design development, the size of the review package, the complexity of the subject for review, potential environmental implications, public safety concerns, and the need for third-party review. The agenda shall include a discussion of the necessary Environmental Approvals, permitting processes, review times, and strategy for the mitigation of potential delays.

Developer shall consider these issues and specified review times when preparing its proposed Project Baseline Schedule, as well as when discussing durations at this workshop.

All agreements, schedules, and understandings reached during the design workshop shall be documented, in writing, by Developer and approved by Developer's Project Manager and IFA.

3.17 Quantity Estimates

To facilitate determining QC sampling and testing requirements, Developer shall provide a detailed schedule of pay items in a format acceptable to IFA, complete with item codes prior to any construction activity.

3.18 Design Documentation

3.18.1 Progress Tracking

Developer shall include engineering and design progress and changes in its Project Status Schedule, including Work on any design change.

3.18.2 Design Quality Records

The DQAM shall prepare and submit monthly monitoring reports to IFA of all design issues and review comments resulting from the scheduled and additional checks and reviews, including over-the-shoulder reviews.

Developer shall also maintain an auditable record of all Design QA/QC Plan procedures, reviews, and checks. Developer shall perform verification sampling of quality assurance's documentation to determine if all procedures included in the Design QA/QC Plan have been followed.

Developer shall submit reports of checks and reviews within seven days of the completion of the review.

Developer shall develop, implement, and maintain a log of design Nonconformance Reports and notices indicating the dates issued, reasons, their status, or their resolution and the date of resolution.

Developer shall prepare and maintain daily records of design activities using forms acceptable to IFA.

3.18.3 Design QA Manager Reports

3.18.3.1 Monthly Report to IFA

The DQAM shall submit a monthly Progress Report directly to IFA in accordance with this Section 3.18.3.1 and Section 1.5.2.1.3 that includes the following:

1. Summary of reviews conducted;
2. Nonconforming Work and current status and disposition, based on design nonconformance log; and
3. Submission(s) from Developer and status.

3.19 Design Documents and Construction Documents

The PPA Documents establish the minimum standards of quality and define requirements that the Design Work and Construction Work shall satisfy.

During the design process, Developer shall develop Construction Documents and Design Documents based on the PPA Documents that are applicable to the specific materials, products, equipment, procedures, and methods that Developer intends to use.

During Design Reviews, the Design Documents and Construction Documents will be evaluated by IFA to determine if they meet the PPA requirements.

3.19.1 Plans

The Work shall be performed in accordance with the details as shown on the Design Documents prepared by the Designer and those Construction Documents prepared by Developer. It shall be solely Developer's responsibility to provide Construction Documents of such a nature as to develop a finished product in accordance with Design Documents and requirements of the PPA Documents. Developer shall verify pertinent dimensions in the field prior to conducting a Design Review. Participation in the review of Developer's Design Documents and Construction Documents by IFA shall not relieve Developer of the responsibility for the satisfactory completion of the Work.

Construction Documents shall be reviewed and approved, in writing, by the Designer before beginning the Construction Work and shall not thereafter be amended or altered without prior written approval of the Designer and IFA's review and written comment.

All Released-for-Construction Design, Final Design, and Record Drawings shall be signed and stamped/sealed by the appropriate Responsible Engineer and shall include, on the title sheet for the plans, the certification signatures of the Lead Engineer and the DQAM (the title sheet can be formatted to cite the appropriate certification requirements of Sections 3.2.4 and 3.12.3).

3.19.2 Design and Record Drawings Format and Organization

Developer shall prepare project CADD Drafting Standards for IFA review and comment within 120 days of NTP1.

All Plans shall include relevant reference files and information, including but not limited to proposed Project ROW, property lines for adjacent properties, limit of disturbance, environmental features, etc., to facilitate the full and complete review of the Plan, as well as support other project efforts, including coordination with third parties, Governmental Entities, and public outreach.

Electronic submittals of Plans, for any purpose, shall be in PDF format of a sufficient resolution and clarity to allow full-size printing, with accurate scale, that is indistinguishable in quality from a traditional mylar print. Developer is advised that scanning to PDF format using a standard multi-function copier will generally not meet this requirement.

Design revisions to Released-for-Construction Plans shall be indicated using redline format, with modifications shown in red and noted with a revision number near the revision and in the revision block.

Relevant .DGN files shall be submitted with each Plan set for review as agreed upon by the Parties or as requested by IFA.

Plans shall be formatted and organized such that a single, indexed, and well-organized set of Released-for-Construction Plans shall be available in electronic PDF format to IFA at all times. This conformed plan set shall include plan revisions made during Construction Work and Record Drawings.

3.19.3 CADD Standards

CADD formatting for Design Documents and Record Drawings shall conform to Developers CADD Drafting Standards.

3.19.4 Special Provisions

Developer shall prepare Special Provisions based on the requirements of the PPA Documents. Developer may perform the following activities:

1. Use Department's Standard Specifications and Recurring Special Provisions as supplemented by the PPA Documents; and
2. Prepare Special Provisions to the Standard Specifications.

Special Provisions, including Special Provisions to the Standard Specifications and Recurring Special Provisions, shall be submitted to IFA and reviewed by Developer and IFA during the applicable Design Reviews to verify that the Special Provisions provide a level of quality that meets or exceeds the requirements of the PPA Documents and that the Special Provisions are suitable and appropriate to control the Work. Developer shall be responsible for demonstrating that the Special Provisions meet or exceed the standard of quality required by the PPA Documents.

The Special Provisions shall define the type and frequency of QC sampling and testing to be conducted for the Work covered by a Special Provision. Use the Department's "*Manual for Frequency of Sampling and Testing and Basis for Use of Materials*" as specified in Section 4.

4 CONSTRUCTION QUALITY ASSURANCE, QUALITY CONTROL, AND OVERSIGHT

4.1 Developer Construction Responsibilities

Construction Work shall be performed in accordance with the requirements of the PPA Documents, Good Industry Practice, Governmental Approvals, Laws, Final Design Documents, Construction Documents, and the approved PMP and components thereof.

Developer shall submit a Construction QA/QC Plan for the Construction Work as a component of the PMP. Developer, through the Construction QA/QC Plan, shall have the primary responsibility for the quality of the Work, including all Work and products of Contractors, fabricators, Suppliers, and vendors, both on- and off-Site. The IFA, in its Oversight role, through Quality Assurance (QA), will conduct verification Oversight inspections, audits, sampling, and testing.

The Construction QA/QC Plan shall be capable of ensuring that procurement, shipping, handling, fabrication, installation, cleaning, inspection, construction, testing, storage, examination, repair, maintenance, and required modifications of all materials, equipment, and elements of the Work shall comply with the requirements of the PPA Documents, and that all materials incorporated in the Work and all equipment and all elements of the Work shall perform satisfactorily for the purpose intended.

4.1.1 Construction Quality Control Inspection

All construction processes, procedures, and workmanship shall be inspected by Developer's construction quality control inspectors. The construction quality control inspections and material sampling shall include the requirements, observations, measurements, and documentation specified in the Department's current Office of Materials Management (OMM) Manual for Frequency of Sampling and Testing and Basis for Use of Materials (Frequency Guide), and included in Developer's Construction QA/QC Plan. Inspection observations, measurements, results, non-conformances, and corrective actions shall be documented on Department standard forms or on Developer forms accepted by IFA. Inspection observation and documentation shall include a description of construction activity and location arranged by the Department's Standard Specification section.

Construction QC inspection and documentation shall be performed in compliance with those documents and standards included in the Project Standards that are published, issued, or maintained by the Department.

4.2 Inspection and Testing of Materials

4.2.1 General

All materials are subject to inspection, sampling, and testing at any time before Final Acceptance.

References in the PPA Documents to Department test methods or test designations of the American Association of State Highway and Transportation Officials (AASHTO), the American

Society for Testing and Materials (ASTM), or any other recognized national organization shall mean the latest revision of that test method or specification for the Work in effect on the Setting Date.

Materials shall be sampled and tested by the construction QC testers and samplers. Copies of all test results shall be furnished to Developer's Project Manager, the Construction Quality Manager, and the Lead Engineer. When a test is done for Developer as process control, ensuring that its process and materials source is producing an acceptable product, test results are not furnished to the above-stated individuals, but are internal Developer documents.

IFA's Authorized Representative may observe any sampling testing performed by the QC testers and samplers. If IFA's Authorized Representative observes a deviation from the specified sampling or testing procedures, IFA's Authorized Representative will verbally describe the observed deviation to Developer's Quality Manager, followed by a written Nonconformance Report addressing the deviation to Developer's Quality Manager and Project Manager within 24 hours.

4.2.2 Construction Quality Control Testing and Sampling

The QC sampling and testing shall be recorded on Department standard forms or on similar forms acceptable to IFA and may be used in IFA's approval decision. Construction QC testers and samplers shall be certified to the level appropriate for the Work being sampled/tested. Developer shall maintain a list of construction QC testers and samplers that indicate what test certifications each person currently holds. Testers and samplers shall be certified prior to performing any work on the East End Crossing.

The construction QC testers and samplers shall test and sample only those materials for which they are certified to sample and test. The reports of each test shall be recorded on the form prescribed for that test. All tests that do not pass specified requirements shall be added to a log of failed tests. This log of failed tests shall be used to ensure that the Work is reconciled by a passing test, as required by the specifications.

Developer shall utilize a software system sufficient to meet the documentation, material testing, and field Site inspection requirements of the Quality Plan. Developer shall submit the proposed software system to IFA for review and comment 120 days prior to commencement of Construction.

4.3 Quality Assurance Oversight

4.3.1 IFA Quality Oversight

IFA Quality Oversight will be performed by the "IFA Quality Manager".

The IFA Quality Manager and their staff will periodically audit Developer QA/QC activities, including conducting independent verification sampling and testing. The audits, test results and subsequent feedback to Developer are intended to assess the adequacy of Developer's QA/QC, including the frequency of testing.

IFA will provide the Developer access to the requirement verification database application to review and respond to observations made during IFA Quality Oversight activities. Developer is required to utilize the IFA's requirement verification database application to record all material test quality records, and to respond to IFA generated observations. Developer is given the option of either directly entering all QA/QC observations and material test results into the IFA requirement verification database application or providing IFA with data collected during QA/QC efforts in an electronic format compatible for batch upload into IFA's requirement verification database application. IFA generated observations will be identified either as conforming or nonconforming to related requirements of the PPA Documents. IFA observations will be presented to Developer through IFA Quality Oversight Verification Reports. Developer shall be required to respond to all detected instances of Nonconforming Work using IFA's database application. A construction Nonconformance Report will be closed by IFA upon the verification of a resolution of the issue acceptable to IFA in accordance with the requirements of the PPA Documents.

Developer's Project Manager shall provide information to IFA's Quality Manager regarding verification that activities are completed as per Developer's Project Schedule. Documentation related to Claims shall contain sufficient information to satisfy an audit.

Verification sampling and testing will be performed by IFA on samples that are taken independently of the QC samples.

4.3.2 Independent Assurance

IFA will provide, periodically, independent assurance to evaluate Developer's qualified sampling and testing personnel and testing equipment. The independent assurance program will evaluate the sampling and testing procedures, and testing equipment used by Developer's construction quality control staff, IFA's quality staff, and the independent referee laboratory.

4.3.3 Quality Check Points

Developer shall establish quality control checkpoints (QCPs) at stages of the construction progress to ensure Work is performed in accordance with Developer's Construction QA/QC Plan and within the terms and conditions of the East End Crossing. As Work is accomplished, Developer's Quality Manager and Lead Engineer shall meet with the IFA to review documentation and procedures for QA/QC, including but not limited to material certifications, daily inspection records, material testing results, survey results, permits, and material placement records. Developer's Quality Manager shall coordinate group members to ensure that QCPs are accomplished in a timely manner so that Developer is not delayed. When an identified QCP is accomplished and when notified by the Quality Manager, IFA will respond within four working hours to verify whether Work has been completed for the checkpoint. Notification to IFA that a QCP has been reached while Work is still being performed or not allowing adequate time to complete the QCP review and opportunity for adjustments (e.g., concrete trucks are queuing while reinforcement is still being placed and QCP is being reviewed for a specified unit) will result in the issuance of a Nonconformance Report.

At a minimum, Developer shall establish QCPs at the following stages of construction:

1. Environmental:

    a. After the establishment of erosion and sediment control measures for defined earth disturbance area (EDA) and Wellhead Protection Area (WHPA);

b. At the end of each month to review weekly and post-storm inspections; and

c. After installation of required protection measures in the Wellhead Protection Area.

2. Embankments:

a. After the completion of drainage and Utility Adjustments and prior to backfill;

b. After clearing, grubbing, and excavation to check subgrade;

c. Per specifications for lift requirements at 5 foot intervals of embankment construction;

d. After the completion of mechanically stabilized earth (MSE) wall panel placement; and

e. At the completion of embankment placement to establish the settlement monitoring baseline.

3. Structures:

a. At the completion of placement for bridge deck reinforcement and prior to the placement of concrete;

b. At the completion of placement for abutment wall reinforcement and prior to the placement of concrete;

c. After the completion of pile-driving at each structure support, including pile-driving results and records;

d. At the completion of placement for footing reinforcement steel and prior to the placement of concrete;

e. At the completion of excavation for drilled shaft foundations and prior to concrete placement;

f. After setting rails for screed machine and prior to placing concrete overlays;

g. After the completion of the first component to receive specified aesthetic wall treatment/form liner and prior to proceeding with the construction of subsequent components; and

h. After the completion of every 500 feet of noise wall posts and panels.

4. Utilities:

a. After the installation of direct-burial duct banks and prior to backfill operations; and

b. For concrete-encased duct banks, after the installation of conduits and prior to the placement of concrete.

c. For all utility lines intended to transport pressurized materials and lines intended to carry liquids, after the installation and prior to the completion of pressure testing.

5. Paving and sidewalks:

6. Before the placement of each course above subgrade on permanent roadway components;

   a. Before the placement of each lift of asphalt or Portland cement concrete; and

   b. Prior to the placement of concrete for sidewalks.

4.4 Independent Referee Laboratory

IFA will retain, subject to the Party's payment obligations set forth in this Section 4.4, the services of an independent Department approved laboratory on an on-call basis to act as a referee laboratory for the resolution of disputes regarding sampling and testing results reported by IFA's verification samplers and testers and Developer's construction QC testers and samplers. The referee laboratory will not be the Department's Office of Materials Management laboratory. The services of the referee laboratory may be requested by IFA or by Developer. The sampling and testing results determined by the referee laboratory shall be final and binding for both Parties and not subject to the Disputes Resolution Procedures. The Party who's sampling and testing results are not confirmed and supported by the referee laboratory, such as the unsuccessful Party, shall be responsible for payment for the referee services. If IFA is the unsuccessful Party, it will make payment directly to the referee laboratory. If Developer is the unsuccessful Party, the cost of the referee laboratory services will be invoiced directly to Developer and IFA will make payment to the referee laboratory on behalf of Developer.

The independent referee laboratory will not be associated with the East End Crossing in any capacity or be affiliated with any Party, the Department, or with any Developer-Related Entities. The independent referee laboratory shall not be a department, agency, or office of any project participant.

4.5 Material Testing Process

Developer's construction quality control staff shall inspect, sample, test, and accept or reject materials in accordance with the approved Construction QA/QC Plan and consistent with the Department's Frequency Manual. Refer to Standard Specifications Section 106 regarding the approval of materials. All results shall be submitted to IFA for review and statistical comparison with verification sampling and testing. Materials determined by Developer to be noncompliant shall be rejected. Discrepancies of allowable tolerances between the IFA's verification testing and the Engineer may be forwarded to the independent referee laboratory for determination at the request of Developer. Materials that are mutually agreed upon as noncompliant, or are determined by the independent referee laboratory to be not in compliance with the Specifications, shall be assigned a Nonconformance Report and tracked separately until satisfactorily disposed of.

All failing test data shall be included in the comparing QC and verification test data, unless material is rejected by Developer based on the failing test data. In such instances, the test data representing the rejected lots of material can be excluded from comparison.

4.6 Competence

If a concern arises as to the competence of any certified individual, IFA's concern shall be documented, in writing, to Developer's Project Manager and the Lead Engineer. The concern shall be investigated as deemed necessary by the Lead Engineer. If this investigation substantiates the concern, corrective action or decertification shall be implemented in accordance with procedures established by IFA.

4.7 Developer Quality Control

Developer shall provide process control measures adequate to produce a constructed product of acceptable quality that conforms to the requirements of the PPA Documents. Developer shall perform process control sampling, testing, and inspection during all phases of the Work at a rate sufficient to ensure that the Work conforms to the requirements of the PPA Documents.

Developer shall provide personnel and equipment capable of providing a product that conforms to specified requirements and shall provide personnel and equipment capable of confirming and documenting performance. The continual production of Nonconforming Work shall not be allowed.

Deficient materials and products shall be brought into compliance with the PPA Documents or replaced. Refer to the requirements of the PPA Documents for the resolution of unacceptable materials. The method of reconciliation shall be noted in the log of failed tests.

4.8 Developer's Construction Quality Control Organization

The Construction QA/QC Plan shall provide information regarding Developer's construction QA/QC organization.

4.8.1 Construction Quality Manager

Developer shall assign an on-Site "Construction Quality Manager". This individual shall be considered one of Developer's Key Personnel and is responsible for Construction Quality Assurance. Developer shall also assign an on-site Construction Quality Control Manager (CQCM) who shall also be considered one of Developer's Key Personnel and is responsible for construction inspection and quality control sampling and testing activities ("Construction Quality Control Manager (CQCM)").

Developer's Construction Quality Manager shall be responsible for the overall management and supervision of Developer's construction quality programs. Developer's Construction Quality Manager shall report directly to Developer's Quality Manager.

Developer's Construction Quality Manager, or its designees, shall be delegated the authority to make needed improvements to the quality of Work, including the suspension of the Work, if required.

Developer's CQCM shall be responsible for coordinating the schedules of Developer's construction QC inspectors and construction QC testers and samplers with Developer's construction activities so as not to delay Developer's operations due to construction QC inspection, sampling, and testing activities.

4.8.2 Staffing Levels

The actual size of the field/Site staff shall reflect the complexity, needs, shifts, and composition of QC activities, consistent with Work in progress.

Developer's Construction QA/QC Plan shall identify administrative and clerical support for the maintenance and management of records and documents pertinent to QC activities.

The QC staffing schedule shall be updated, as necessary, throughout the Term of the PPA to reflect an accurate forecasting of QC staffing requirements.

4.8.3 Laboratories

Laboratory QC testing shall be conducted by testing laboratories, retained by Developer under subcontract, that comply with the requirements for Department certification for applicable tests. Laboratories shall be accredited by the AASHTO Material Reference Laboratory (AMRL), the Concrete Cement Reference Laboratory (CCRL), the National Precast Concrete Association (NPCA) for precasters, or the Prestressed Concrete Institute (PCI), as appropriate, for the Work to be constructed.

Department certification shall be obtained for all AASHTO and ASTM test methods to be performed by the testing laboratory. Certification shall also be obtained for AASHTO and ASTM test methods that are modified or referenced by Department test methods.

Satellites (field laboratories) of these laboratories may be used where appropriate for the tests being conducted. The equipment in the satellite laboratories shall be certified at the start of Work and annually thereafter. Certification shall be performed by an independent AASHTO-accredited laboratory or AMRL inspector.

The laboratory shall have written policies and procedures to ensure portable and satellite laboratories performing testing activities on the project are capable of providing testing services in compliance with applicable test methods. The policies and procedures shall address the inspection and calibration of testing equipment, as well as a correlation testing program between the accredited laboratory and portable or satellite facilities.

IFA reserves the right to check testing equipment for compliance with specified standards and to check testing procedures and techniques.

IFA also reserves the right to access the testing facilities of the testing laboratories – with no additional cost to IFA – to witness the testing and verify compliance of the testing procedures, testing techniques, and test results.

IFA's rights to check equipment, procedures, and techniques and to access testing facilities will also apply to Utility Companies when Developer is performing Work on their facilities.

4.9 Developer Scheduling and Notice to IFA

Developer shall notify IFA, in writing, by noon on Friday of each week of planned Construction Work activities, including fabrication, for the following two weeks to allow IFA to schedule its resources. Developer shall also discuss this information at the weekly coordination meeting in order to allow timely coordination of inspection activities. For activities, such as fabrication, occurring out of the immediate East End Crossing area, or beyond 100 miles of the East End Crossing, Developer shall give IFA at least 21 days of notice of planned Work.

4.10 Documentation

Developer shall collect, preserve and submit to IFA each of the following types of data in a computer-generated form concurrently during Developer's performance of the Work, all of which shall be in a format acceptable to IFA:

1. Daily inspection reports;
2. Record Drawings;
3. Secure databases, such as spreadsheets, standard database software, and computation books;
4. Materials approval records;
5. Photographs; and
6. Field change sheets.

Daily manpower and equipment reports for Developer and each Contractor for Construction Work activities shall be prepared and maintained by Developer using the standard Department forms or other forms with a format acceptable to IFA.

A daily log for Construction Work activities shall be maintained by Developer's Project Manager or their designee(s) in which all significant occurrences on the East End Crossing shall be recorded daily in a narrative form, including unusual weather, asserted occurrences, events, and conditions causing or threatening to cause any significant delay or disruption or interference with the progress of any of the Work, significant injuries to person or property, and a listing of each activity depicted on the current monthly plan update that is being actively prosecuted. Also, in the East End Crossing area, traffic accidents and lane Closures in effect at the time of the accident shall be noted.

For Utility-related activities, such data shall be maintained separately for each Utility facility.

For Hazardous Materials Management, such data shall be maintained separately for each site.

Records shall document all QC operations, inspections, activities, and tests performed, including the Work of Contractors. Developer may use the forms provided by IFA or its own forms providing equivalent information. Such records shall include any delays encountered and Work noted that does not conform to the requirements of the PPA Documents or design together with the corrective actions taken regarding such Work.

Developer shall complete and submit appropriate documentation at the following times and frequencies:

1. Monthly.

2. Weekly – Developer shall maintain and submit records that include factual evidence that required activities or tests have been performed, including the following:

3. Type, number, and results of QC and control activities, including reviews, inspections, tests, audits, monitoring of Work performance, and materials analysis;

4. Closely related data, such as the qualifications of personnel, procedures, and equipment used;

5. The identity of Developer's QC inspector or data recorder, the type of test or observation employed, the results and the acceptability of the Work, and action taken in connection with any deficiencies noted;

6. Nature of Nonconforming Work and causes for rejection;

7. Proposed corrective action;

8. Corrective actions taken; and

9. Results of corrective actions.

4.11 Material Certifications

Within 30 days of NTP2 and to the extent information is known, Developer shall provide to IFA the sources of supply and item material types that will be used in the Work. For materials not initially identified or changes to the initial source provided, the source of supply shall be provided sufficiently in advance of their use. Fabricated structural steel, other metal fabricated structural members and prestressed/precast structural members, can have long lead times for fabrication. The fabricator for these items shall be presented to IFA as soon as it is known. Copies of documentation for all sources of supply shall be provided as soon as they are known, but shall be provided to IFA no less than 30 days prior to delivery to the East End Crossing.

Developer shall use the Department's list of qualified manufactures, producers, and fabricators for the specified materials, unless otherwise approved by the IFA at its good faith discretion.

When Developer purchases materials from suppliers shown on the Department's approved materials or source list, Developer shall be provided a materials certification, or a certificate of delivery, certificate of analysis, or certificate of compliance, as required, from the supplier that covers the materials and the source. If Developer wishes to purchase materials from a supplier not shown on the list of qualified manufacturers Developer shall submit a request to the IFA for its sole discretionary approval.

Documentary evidence that materials and equipment conform to the procurement requirements shall be available at the jobsite no less than 24 hours prior to installation or the use of such materials and equipment. This documentary evidence shall be retained at the jobsite and shall be sufficient to identify that the specific requirements, such as Construction Documents, Project Standards, and applicable Laws, are fulfilled by the purchased materials and equipment. The substitution of specified materials shall not occur without prior approval by Developer's Lead Engineer. Failure to acquire prior substitution approval shall result in the assignment of a Nonconformance Report. Additionally, a copy of all documentary evidence that materials and equipment conform to the procurement requirements shall be provided to IFA, or its representative, at the same time Developer receives such documentary evidence. The effectiveness of the QC by Developer's own forces and Contractors shall be assessed by Developer's Construction Quality Manager at intervals consistent with the importance, complexity, and quantity of the product or services. IFA reserves the right to audit and review these documents at any time.

Prior to Final Acceptance of the East End Crossing, Developer shall submit a certificate of compliance signed by Developer's Project Manager, Lead Engineer and Construction Quality Manager indicating that all materials incorporated in the East End Crossing conform to the requirements of the PPA Documents.

4.12 Construction Quality Control for Final Acceptance

IFA shall determine when Developer achieves Final Acceptance pursuant to Section 5.8.4 of the PPA. Developer shall complete all Work and provide all documents, certifications, and other information in accordance with the requirements of the PPA Documents.

5 AESTHETICS AND LANDSCAPE ARCHITECTURE

5.1 General

Developer shall design and construct landscape architecture and plantings associated with the East End Crossing in accordance with this Section 5 and the PPA Documents.

The East End Crossing requires particular attention to the aesthetic and landscape architectural design elements of the highway corridor. The East End Crossing corridor traverses through a variety of existing land use types that include the following: residential, open landscape, historic districts, and riparian buffer/stream and floodplain valleys. The East End Crossing corridor also includes discrete access nodes/community gateways. The East End Crossing may adjoin roads or streets that have landscape guidelines or developed landscape concepts. Developer shall complement and blend the interface of the East End Crossing with these adjacent conditions.

5.1.1 Landscaping and Aesthetic Work Allowance

An allowance has been established for a portion of the requirements specified in this Section 5, refer also to Section 5.10 of the PPA ("Landscaping Work Allowance"), related to portions of the landscaping and aesthetic Work in the Kentucky Approach. The Landscaping Work Allowance shall include the landscape and aesthetic treatments for the Kentucky Approach that exceed Project Standards. The Landscaping Work Allowance shall be used for elements of Developer's design for the Kentucky Approach such as:

- Structural staining/coatings
- Structural textures
- Plantings
- Lawn
- Decorative fencing/lighting
- Decorative lighting (in excess of standard fixtures)
- Decorative pedestrian railings (in excess of standard railings)
- Architectural cladding
- Wall form liners or surface treatments

The following items are considered standard landscaping or aesthetic treatments and are not included in the Landscaping Work Allowance but shall be a part of Developer's Work for the entire East End Crossing, including the Kentucky Approach, as specified in the applicable Technical Provisions:

- Earthwork, topsoil, seeding, sodding, erosion control
- Standard lighting fixtures
- Standard traffic and pedestrian railings
- Standard bridge painting and surface sealing
- Aesthetic elements of the East End Bridge specified in Section 15
- Landscape and aesthetic elements of the Indiana Approach

- Reforestation as specified in Section 7.5.2

5.2 Standards and References

Perform the Aesthetic and Landscape Architecture Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 5, Governmental Approvals, and applicable Laws.

5.3 Aesthetic and Landscape Concept Development

As a starting point, Indiana Department of Transportation (Department) and Kentucky Transportation Cabinet (KYTC) have developed aesthetic design guidelines with considerable input from local residents, community groups, local officials, and other groups regarding the East End Crossing aesthetic preferences to be incorporated into the final design of the East End Crossing. Developer shall use these aesthetic guidelines to develop an Aesthetics and Enhancement Implementation Plan which shall be submitted with the Stage 1 Design.

5.3.1 Aesthetics and Enhancement Implementation Plan

Employ context sensitive solutions (CSS) for all aesthetics and landscape work. Prepare and submit an Aesthetics and Enhancement Implementation Plan using the context-sensitive design guidelines as described in RID Document LA-4.01 through LA-4.05 Sect 4 Aesthetic 2007 Guidelines. The aesthetic treatment for the Indiana East End Approach shall complement the project setting in Indiana. The Aesthetics and Enhancement Implementation Plan will be reviewed and approved by IFA.

Aesthetic and landscape elements of the Aesthetics and Enhancement Implementation Plan shall include the following:

- Bridges (including but not limited to pier details, parapet details, texture, and color of fence, concrete sealers for parapet/superstructure/piers/abutments, and painted steel surfaces)
- Streetscape enhancements (including plantings and furnishings)
- Bicycle and pedestrian facilities
- Contour grading
- Retaining structures (texture, color, architectural details)
- Slope protection
- Vegetation
- Historic Preservation Plan areas
- Street lighting
- Traffic signal mast arms
- Project ROW and stormwater facility fencing and screening
- Architectural concrete textures
- Architectural surface finishes

The Aesthetics and Enhancement Implementation Plan shall include adjacent natural and manmade features, conceptual design elements, limits of construction phasing, and clear labels or a legend to identify these elements. The plan shall be formatted as a roll plan at a minimum scale of 1 inch = 200 feet, one for the Indiana Approach and one for the Kentucky Approach. The plan shall include contiguous geographic warranty areas as specified in Section 5.7.

5.3.1.1 Allowance Work

As part of the Aesthetics and Enhancement Implementation Plan Developer shall include a separate section detailing the aesthetic elements of the plan related to the Landscaping Work Allowance. This portion of the plan shall clearly delineate those elements of the plan subject to the allowance, their use, and estimated cost. The IFA will review and approve, in its sole discretion, this portion of the Aesthetics and Enhancement Implementation Plan. Developer shall include a tracking mechanism for all of the items in the Aesthetics and Enhancement Implementation Plan that are subject to the Landscaping Work Allowance.

5.4 Design Requirements

5.4.1 Landscape Architect Requirements

Developer shall have an experienced landscape architectural design team to address, in a collaborative, multidisciplinary approach, the functional and aesthetic needs of the East End Crossing. The landscape architectural team shall be led by an Indiana-registered landscape architect with more than 10 years of landscape architectural design experience related to highway corridor design and construction. The lead landscape architect shall have a working knowledge and experience with the implementation process of context-sensitive designs/solutions, be familiar with the native vegetation of the Midwestern and Great Lakes regions, and be familiar with Storm Water Management (SWM)/bioretention planting.

5.4.2 East End Crossing Landscape Plans

Developer shall prepare landscape plans for the aesthetics and landscape enhancements, based on the Aesthetics and Enhancement Implementation Plan. The landscape plans shall be developed to reflect the use of native plants and to revegetate disturbed areas within the East End Crossing to the fullest extent possible. Large masses or groupings of trees and shrubs shall be used whenever possible to create naturalistic plantings that have continuity and provide for genetic diversity and seasonal interest to the fullest extent possible. Developer shall coordinate the landscape plans with all other elements of work performed under the East End Crossing, including but not limited to final grading, turf establishment, SWM Best Management Practice (BMP) locations, highway clear zones and sight distances, storm drain and SWM BMP outfalls and cross-culvert outfalls, utilities, signing/lighting, Tunnel portals, and the location of earth reinforcement.

Developer shall provide temporary measures to stabilize soils in rough graded areas in accordance with applicable Project Standards. If Developer determines the existence of a conflict from one or more of these elements, Developer shall be responsible for modifying the landscape plans while retaining the intent of the design. Areas used for SWM BMPs shall not be used for landscape plantings. Landscape plantings required as part of the SWM plans shall be coordinated with the landscape plans to ensure that a unified planting theme is created for the East End Crossing corridor. Developer shall furnish all seed mixes according to the Department Standard Specifications.

5.4.3 Landscape

The approved plant species, minimum acceptable sizes, and maximum spacing are listed in Table 5-1. The list of approved plant species is intended as a guide for Developer. Developer shall have the opportunity to suggest a plant species mix to reflect a specific condition if necessary. Requests for substitution of other plant species shall be submitted in writing for approval by IFA. Developer shall not plant non-native, invasive species.

5.4.3.1 Landscape Maintenance

Developer shall design the landscape and groundplane treatments to facilitate and minimize future maintenance. Plant materials selected shall be drought tolerant, native species that have a proven track record of success in the region. All plant placements shall be based on IFA's and KYTC's requirements in the respective states.

Developer shall match the planting densities by plant type (tree, shrub, groundcover, etc.) to the IFA-approved Aesthetics and Enhancement Implementation Plan for all plantings. Developer shall provide native seeding for any East End Crossing areas disturbed and not designated for planting with the exception of rock embankments and rock cut slopes.

5.4.3.2 Historic Preservation Plan (HPP) Areas

Special attention shall be given to viewsheds that are significantly affected within the areas identified in the HPP's. Developer shall focus on the development and implementation of creative strategies for mitigating those impacts. This may include landscaping of public rights-of-way.

5.4.4 Groundplane Treatments

All landscape areas, including interchanges and along the East End Crossing mainline, shall include groundplane treatments to address permanent erosion control and aesthetics. Developer shall design groundplane treatments to support the Aesthetics and Enhancement Implementation Plan with and without plant material and to employ contour grading, slope rounding, and other design/construction methods to help emphasize the concept of the corridor. Developer shall demonstrate that the drainage design, especially for surface channels and detention basins/water quality basins, are integrated into the design of the aesthetics for the groundplane.

5.4.5 Hardscape Treatments

Developer shall use hardscape treatments of colored and stamped paving where medians or islands are too small for plant material, where plant material would interfere with sight distances, or where maintenance access/safety is necessary. If along a local street, such paving shall match the city or community standards/requirements.

Developer may propose alternative treatments, such as rock/cobble-scapes, among others. However, the approval of alternative treatments is at IFA's good faith discretion.

5.4.6 Sound Barrier/Retaining Wall/Safety Wall Areas

Developer shall include areas for plantings adjacent to the noise barriers, which includes the side facing the roadway corridor. In the Indiana Approach a 10-foot clear zone (turf grass only) for maintenance access shall be provided on the residential side. For areas adjacent to the noise barriers on the resident side that exceed 10 feet in width to the Project ROW, Developer shall provide landscape treatment for the portion that exceeds 10 feet. Deciduous, ornamental, and evergreen trees shall not be planted closer than 15 feet to the sound barrier/retaining wall face. In the Kentucky Approach no landscaping is required on the owner side of the barriers or walls.

5.4.6.1 Stormwater Management Areas

All stormwater treatment facilities shall be coordinated with the landscape to create a seamless aesthetic design and be compatible with the existing landscape of the adjacent land uses and surroundings. Plant selections at SWM areas shall be appropriate for each facility type and shall meet IFA's requirements.

Planting at SWM facilities shall provide maximum environmental value (water quality, wildlife, biodiversity) while providing low-maintenance, native landscapes within curvilinear-shaped SWM facilities. To create a highway corridor that maximizes Indiana's and Kentucky's native beauty, fall color shall be maximized in the choice of native trees and shrubs, and the winter structure shall be maximized in the choice of native grasses and forbs.

5.4.7 Design Coordination

The aesthetics and landscape design units shall coordinate with other design disciplines on the location of proposed underground facilities, such as utilities and drainage lines, so that the landscape installation does not damage underground utility facilities.

5.5 Construction Requirements

5.5.1 Landscape Requirements

Developer shall install plantings and other landscape materials using IFA's Project Standards. All plantings shall be installed in a timely manner in relation to the other Work to minimize unsightly bare earth. Plant material delivered to the Site shall be planted within 48 hours of delivery.

Developer shall provide a method and schedule for watering all plantings, including existing vegetation in the East End Crossing corridor that is to remain during construction for approval by IFA.

5.5.1.1 Topsoil

Developer shall place topsoil, either salvaged and stockpiled from on-site or imported, to a 6-inch depth in all planting areas. Developer may elect to ask IFA for permission to use existing topsoil if the soils tests prove the existing soils to be a sufficient growing medium (assuming minor amendments are needed). Soil testing shall be in accordance with the Department specifications. Existing topsoil may only be used for topsoil with the written approval of IFA.

5.5.1.2 Soil Preparation

The soils in all areas to be landscaped shall be prepared prior to beginning plantings in accordance with the Department's specifications. Developer shall perform a minimum of 20 soil tests scattered equally through the East End Crossing landscape areas, including native seed areas. All imported soil sources shall be tested prior to delivery on-site. Soil tests shall determine what amendments are necessary for the successful establishment of the plantings. Developer shall be responsible for submitting a memorandum with the resulting soil tests, a map showing sample locations, and the proposed approach to the amendment placement (including type and amounts) to IFA for approval before beginning soil preparation, planting, or seeding.

5.5.1.3 Herbicide

All areas to receive planting, other than native seeded areas, shall be treated with a pre-emergent herbicide prior to planting. Pre-emergent herbicide treatments used shall not be detrimental to the intended replacement plantings. The application of herbicide shall follow the Department's standards, Recurring Special Provisions 624-M-024, and the manufacturer's recommendations. In addition, the application of the pre-emergent herbicide shall be in compliance with the Noxious Weed Control Plan.

Developer shall treat any perennial weed species with a post-emergent non-selective herbicide not less than two weeks prior to beginning soil preparation activities. Perennial weed treatment shall be as per the Department's standards and in accordance with the approved Noxious Weed Control Plan.

5.5.1.4 Mulching

All landscape areas, other than seeded areas, shall be mulched to reduce erosion, lessen weed germination and growth, and inhibit water loss from the soil. Mulch shall be broken corncobs, wood chips, chopped bark, size No. 5 gravel, or crushed stone, in accordance with the Department's standards.

Wood chip mulch shall be placed per the Department's standards in all plant basins. Mulch shall not contain anything that would inhibit growth of the replacement plantings. Mulch shall be capable of matting together to resist scattering by the wind. Developer may shred or grind any on-site woody plant material for use as mulch, as long as the species present do not produce growth-inhibiting substances that might jeopardize the new plantings. The stockpiling of mulch shall be carefully planned to prevent combustion from generated heat.

5.5.2 Landscape Maintenance

Developer shall maintain all landscaping until Final Landscape Acceptance, including the following activities:

1. *Watering:* All proposed tree, shrub, and other plantings and existing vegetation in the East End Crossing area that is to remain shall be kept sufficiently watered so that plants are provided water during all phases of the East End Crossing.
2. *Weed Control:* Maintain the planting and lawn areas within the East End Crossing area free of weeds.
3. *Pruning:* Prune damaged branches on trees and shrubs in conformance with International Society of Arboriculture standards to prevent further injury or disease.

Avoid root pruning, but if root pruning cannot be avoided, conform to International Society of Arboriculture standards.

4. *Insect and Pest Control:* Monitor plant materials for any insect or pest problems. Spray or dust with appropriate insecticides and fungicides as necessary to maintain plants in a healthy and vigorous condition.
5. *Erosion Control:* Replace mulch as needed. Repair eroded areas if needed. Complete repairs within one week of notification, or per SWM requirements, whichever is most restrictive.
6. *Plant Replacement:* Replace damaged or dead plant materials within one week of notification.

5.6 Submittals

5.6.1 Nutrient Management Plan Report

Developer shall comply with the Indiana Natural Resources Conservation Service (NRCS) Nutrient Management Code 590.

Before performing turf establishment and sodding, Developer shall sample and test soils for texture, pH, organic matter, phosphorus, and potassium needs in accordance with Project Standards and requirements of the Office of Geotechnical Services.

Developer shall use the soil test results and obtain the services of an Indiana-certified nutrient management planner to develop a Nutrient Management Plan for nitrogen, phosphorus, potassium, organic matter, sulphur, and limestone input levels for planting areas. The Nutrient Management Plan shall be submitted to the IFA with the RFC plans for review and comment. A directory of certified nutrient management planners may be found by contacting Indiana's NRCS Nutrient Management Specialist, at (317) 290-3200.

5.6.2 Soil Reports

Developer shall submit all soil testing reports to IFA for review and comment. Soil testing shall be performed for texture, particle size gradation, pH, and organic content. The soil report shall be completed and submitted in advance of the Nutrient Management Plan and coordinated with its requirements.

5.6.3 Noxious Weed Control

Developer shall perform the control of noxious weed species within the ROW, easements, and limits of disturbance until Final Acceptance. Control of noxious weeds shall apply in each State as required by that State's applicable seed laws. Developer shall prepare and submit a Noxious Weed Control Plan to IFA for review and comment prior to the commencement of eradication or removal work. If chemical controls are proposed they shall be applied by a certified pesticide applicator.

5.7 Establishment Period

Developer shall provide a two-year establishment period and maintain all landscape plantings for two years after the IFA's initial approval of plantings and landscape Work for those areas outside of the O&M Limits. IFA shall provide its initial approval for plantings and landscape work only after all plant materials within a geographic warranty area approved by IFA have been planted, are true to species and minimum size and are in a healthy and thriving condition. In addition, each plant pit or bed shall be properly filled, mulched, pruned, and staked. Developer shall define geographic establishment areas and submit to IFA for approval with the Aesthetics and Enhancement Implementation Plan. No more than 10 geographic establishment areas shall be designated. The geographic establishment areas shall be contiguous and well defined by landmarks such as bridges, cross roads, etc. SWM facilities and riparian plantings shall be included in the areas proposed for initial approval. The replacement of any areas damaged after initial approval by IFA and prior to Final Acceptance shall be performed by Developer.

During this two-year establishment period, Developer shall replace any plant materials that are not in a healthy and thriving condition, reflective of the species and in accordance with the Department's Standard Specifications.

5.7.1 Final Landscape Acceptance

At the end of the two-year establishment period, Developer shall request that IFA perform the final inspection of the landscape areas outside of the O&M Limits. A minimum of three weeks advance notice is required. Developer shall submit a "Plant and Turf Establishment Certification Package" that consists of field photographs, completed turf inspection checklists and completed planting checklists, and the East End Crossing landscape plans and details.

The plant and turf establishment certification process shall be completed and approved as a condition of Final Landscape Acceptance.

5.7.1.1 Plant and Turf Establishment Inspections

Developer shall inspect plants at the end of the two-year warranty for species, size, quantity, health, and location. Plants that measure smaller than the installed size shall be considered dead and be replaced. Plant and turf establishment inspections shall be conducted in accordance with the Department's standards.

The following planting and turf shall be inspected and documented:

1. All plantings shall be in a thriving condition.
2. All groundcover areas shall have a 95 percent cover of the specified groundcover with no bare areas greater than 144 square inches.
3. Ponds and wetlands: (Refer to Section 7 and Section 8).
4. SWM facilities: Vegetation survival rate of 50 percent shall be verified at submerged benches if provided.
5. Infiltration Trenches: Turf establishment with 95 percent coverage of Department permanent seed mix inspected in conveyances, filter strips, and other features draining to the trench that are within the Project ROW and within the limits of disturbance. Off-site areas shall be visually observed and the location of off-site eroded or bare areas included in the report and photographed.
6. Infiltration Basins: Plant, turf, or native meadow establishment inspected at basin bottom and side slopes. Establish turf with 95 percent coverage on all conveyances draining to the facility within the Project ROW and within the limits of disturbance. Off-site areas shall be visually observed and the location of off-site eroded or bare areas included in the report and photographed.

7. Filtering Systems: Establishment of turf with 95 percent coverage on weir, bottom, and sides of facility, and all conveyances draining to the facility. At bioretention facilities, verify a plant survival rate of at least 90 percent. The mulch bed shall be inspected and replenished to constructed depth and condition.
8. Open Channel Systems: For dry swales, inspect the establishment of turf with 95 percent coverage on weir, bottom, side slopes, and conveyances draining to the facility. For wet swales, inspect the establishment of turf with 95 percent coverage on weirs, sides, and all conveyances draining to the facility. Inspect planting at the bottom of the facility for a 50 percent survival rate.

Table 5-1 Approved Plant List

Botanical Name	Common Name	Minimum Size	Maximum Spacing
Deciduous Trees			
Acer negundo	Box elder	2 in Cal. B&B/CG	30 ft OC
Acer pensylvanicum	Striped maple	2 in Cal. B&B/CG	20 ft OC
Acer rubrum	Red maple	2 ½ ft Cal. B&B/CG	25 ft OC
Acer saccharinum	Silver maple	2 ft Cal. B&B/CG	30 ft OC
Acer saccharum	Sugar maple	2 ½ in Cal. B&B/CG	30 ft OC
Aesculus flava	Sweet buckeye	2 in Cal. B&B/CG	40 ft OC
Aesculus glabra	Ohio buckeye	2 in Cal. B&B/CG	30 ft OC
Amelanchier arborea	Serviceberry	8 ft Ht. B&B/CG	15 ft OC
Amelanchier canadensis	Shadbush	2 ½ in Cal. B&B/CG	15 ft OC
Aralia spinosa	Devil's walkingstick	8 ft Ht. B&B/CG	15 ft OC
Asiminia triloba	Pawpaw	5 ft Ht. B&B/CG	15 ft OC
Betula lenta	Cherry birch	2 in Cal. B&B/CG	30 ft OC
Betula nigra	River birch	6 ft Ht. B&B/CG	30 ft OC
Carpinus caroliniana	American hornbeam	2 in Cal. B&B/CG	20 ft OC
Carya cordiformis	Swamp hickory	2 in Cal. B&B/CG	40 ft OC
Carya glabra	Pignut hickory	2 in Cal. B&B/CG	30 ft OC
Carya ovata	Shagbark hickory	2 in Cal. B&B/CG	40 ft OC
Celtis occidentalis	Hackberry	2 in Cal. B&B/CG	30 ft OC
Cercis canadensis	Redbud	2 ½ in Cal. B&B/CG	15 ft OC
Chionanthus virginicus	Fringe tree	2 in Cal. B&B/CG	5 ft OC
Cornus alternifolia	Alternate-leaf dogwood	2 in Cal. B&B/CG	20 ft OC
Cornus florida	Flowering dogwood	2 in Cal. B&B/CG	25 ft OC
Crateagus viridis	Hawthorn	2 ½ in Cal. B&B/CG	20 ft OC
Diospyros virginiana	Persimmon	5 ft Ht. B&B/CG	20 ft OC
Fagus grandifolia	American beech	2 ½ in Cal. B&B/CG	25 ft OC
Gymnocladus dioicus	Kentucky coffeetree	2 ½ in Cal. B&B/CG	35 ft OC
Ilex opaca	American holly	5 ft Ht. B&B/CG	15 ft OC
Juglans nigra	Black walnut	2 in Cal. B&B/CG	40 ft OC

Botanical Name	Common Name	Minimum Size	Maximum Spacing
Liquidambar styraciflua	Sweetgum	2 in Cal. B&B/CG	25 ft OC
Liriodendron tulipifera	Tulip tree	2 ½ in Cal. B&B/CG	25 ft OC
Magnolia acuminata	Cucumber tree	2 ½ in Cal. B&B/CG	40 ft OC
Magnolia tripetala	Umbrella tree	6 ft Ht. B&B/CG	20 ft OC
Magnolia virginiana	Sweetbay magnolia	6 ft Ht. B&B/CG	15 ft OC
Malus	Flowering crabapple	2 in Cal. B&B/CG	20 ft OC
Nyssa sylvatica	Black gum	2 in Cal. B&B/CG	25 ft OC
Oxydendrum arboreum	Sourwood	2 in Cal. B&B/CG	20 ft OC
Platanus occidentalis	Sycamore	2 ½ in Cal. B&B/CG	40 ft OC
Populus deltoides	Cottonwood	2 in Cal. B&B/CG	40 ft OC
Prunus americana	Wild plum	2 ½ in Cal. B&B/CG	15 ft OC
Prunus serotina	Black cherry	6 ft Ht. B&B/CG	35 ft OC
Prunus virginiana	Chokeberry	2 in Cal. B&B/CG	20 ft OC
Quercus alba	White oak	2 in Cal. B&B/CG	25 ft OC
Quercus bicolor	Swamp white oak	2 in Cal. B&B/CG	20 ft OC
Quercus coccinea	Scarlet oak	2 in Cal. B&B/CG	25 ft OC
Quercus imbricaria	Shingle oak	2 in Cal. B&B/CG	40 ft OC
Quercus macrocarpa	Bur Oak	2 in Cal. B&B/CG	40 ft OC
Quercus muehlenbergii	Chestnut oak	2 in Cal. B&B/CG	25 ft OC
Quercus palustris	Pin oak	2 in Cal. B&B/CG	40 ft OC
Quercus phellos	Willow oak	2 in Cal. B&B/CG	30 ft OC
Quercus rubra	Red oak	2 in Cal. B&B/CG	30 ft OC
Quercus stellata	Post oak	2 in Cal. B&B/CG	30 ft OC
Quercus virginiana	Live oak	2 1/2 in Cal. B&B/CG	40 ft OC
Robinia pseudoacacia	Black locust	2 in Cal. B&B/CG	30 ft OC
Sassafras albidum	Sassafras	6 ft Ht. B&B/CG	30 ft OC
Tilia americana	American linden	2 in Cal. B&B/CG	25 ft OC
Evergreen Trees			
Juniperus virginiana	Red cedar	6 ft Ht. B&B/CG	15 ft OC
Juniperus virginiana 'Emerald Sentinel'	Emerald sentinel red cedar	6 ft Ht. B&B/CG	15 ft OC
Picea abies	Norway Spruce	5 ft Ht. CG	20 ft OC
Picea rubens	Red spruce	6 ft Ht. B&B/CG	20 ft OC
Pinus echinata	Shortleaf pine	5 ft Ht. B&B/CG	35 ft OC
Pinus pungens	Hickory pine	6 ft Ht. B&B/CG	30 ft OC
Pinus resinosa	Red Pine	5 ft Ht. B&B/CG	40 ft OC
Pinus rigida	Pitch pine	5 ft Ht. B&B/CG	30 ft OC
Pinus strobus	White pine	5 ft Ht. B&B/CG	25 ft OC

Botanical Name	Common Name	Minimum Size	Maximum Spacing
Pinus taeda	Loblolly pine	5 ft Ht. B&B/CG	25 ft OC
Pinus virginiana	Virginia pine	5 ft Ht. B&B	20 ft OC
Taxodium distichum	Common bald cypress	6 ft Ht. B&B/CG	25 ft OC
Thuja occidentalis	Eastern arborvitae	5 ft Ht. B&B/CG	20 ft OC
Tsuga canadensis	Canadian hemlock	6 ft Ht. B&B	25 ft OC
Shrubs			
Aronia melanocarpa	Black chokeberry	3 ft Ht. CG	5 ft OC
Asimina tribola	Pawpaw	5 ft Ht. B&B/CG	15 ft OC
Callicarpa americana	American beautybush	3 ft Ht. CG	4 ft OC
Castanea pumila	Chinquapin	2 ft Ht. CG	5 ft OC
Ceanothus americanus	New Jersey tea	2 ft Ht. CG	3 ft OC
Cephalanthus occidentalis	Buttonbush	2 ft Ht. CG	3 ft OC
Clethra alnifolia	Sweet pepperbush	2 ft Ht. CG	4 ft OC
Comptonia peregrina	Sweet fern	2 ft Ht. CG	3 ft OC
Cornus alternifolia	Alternate leaf dogwood	3 ft Ht. CG	5 ft OC
Cornus amonmum	Silky dogwood	3 ft Ht. CG	5 ft OC
Cornus racemosa	Gray dogwood	3 ft Ht. CG	5 ft OC
Corylus americana	American hazelnut	3 ft Ht. CG	6 ft OC
Euonymus americanus	Strawberry bush	2 ft Ht. CG	3 ft OC
Hamamelis virginiana	Common witchhazel	6 ft Ht. CG	15 ft OC
Hydrangea arborescens	Wild hydrangea	2 ft Ht. CG	4 ft OC
Hydrangea quercifolia	Oakleaf hydrangea	2 ft Ht. CG	5 ft OC
Hypericum prolificum	Shrubby St. John’s wort	2 ft Ht. CG	3 ft OC
Ilex verticillata	Winterberry holly	3 ft Ht. CG	5 ft OC
Itea virginica	Sweetspire	3 ft Ht. CG	3 ft OC
Kalmia latifolia	Mountain laurel	2 ft Ht. CG	3 ft OC
Lindera benzoin	Spicebush	2 ft Ht. CG	6 ft OC
Lonicera reticulata	Grape honeysuckle	2 ft Ht. CG	4 ft OC
Morella cerifera	Southern bayberry	2 ft Ht. CG	5 ft OC
Myrica pensylvanica	Northern bayberry	2 ft Ht. CG	6 ft OC
Physocarpus opulifolius	Ninebark	3 ft Ht. CG	5 ft OC
Rhododendron calendulaceum	Flame azalea	2 ft Ht. CG	5 ft OC
Rhododendron catawbiense	Mountain rosebay	2 ft Ht. CG	5 ft OC
Rhododendron maximum	Rosebay rhododendron	2 ft Ht. CG	5 ft OC
Rhododendron prinophyllum	Wooly azalea	2 ft Ht. CG	6 ft OC
Rhus aromatica	Fragrant sumac	2 ft Ht. CG	4 ft OC
Rhus aromatica 'Gro-Low'	Gro-Low fragrant sumac	1 Gal. CG	5 ft OC

Botanical Name	Common Name	Minimum Size	Maximum Spacing
Rhus glabra	Smooth sumac	2 ft Ht. CG	6 ft OC
Rhus typhina	Staghorn sumac	2 ft Ht. CG	10 ft OC
Ribes rotundifolium	Round leaf currant	3 ft Ht. CG	5 ft OC
Robinia hispida	Standing sweet pea	1 Gal. CG	4 ft OC
Sambucus canadensis	Elderberry	2 ft Ht. CG	5 ft OC
Staphylea trifolia	American bladdernut	2 ft Ht. CG	5 ft OC
Symphoricarpos orbiculatus	Coralberry	2 ft Ht. CG	4 ft OC
Vaccinium stamineum	Deerberry	2 ft Ht. CG	3 ft OC
Viburnum acerfolium	Mapleleaf viburnum	3 ft Ht. CG	5 ft OC
Viburnum dentatum	Arrowwood viburnum	3 ft Ht. CG	5 ft OC
Viburnum lentago	Nannyberry	3 ft Ht. CG	6 ft OC
Viburnum prunifolium	Blackhaw viburnum	3 ft Ht. CG	6 ft OC
Viburnum trilobum	American cranberry bush	3 ft Ht. CG	6 ft OC
Perennials			
Aquilegia canadensis	Columbine	1 Gal. CG	12 in OC
Asclepias incarnata	Marsh milkweed	1 Gal. CG	24 in OC
Asclepias tuberosa	Butterfly weed	1 Gal. CG	18 in OC
Aster laevis	Smooth aster	1 Gal. CG	18 in OC
Aster novae-angliae	New England aster	1 Gal. CG	18 in OC
Aster shortii	Short's aster	1 Gal. CG	18 in OC
Baptisia australis	Blue false indigo	1 Gal. CG	24 in OC
Chelone glabra	Turtlehead	1 Gal. CG	18 in OC
Coreopsis tripteris	Tall coreopsis	1 Gal. CG	18 in OC
Delphinium tricorne	Woodland larkspur	1 Gal. CG	18 in OC
Echinacea purpurea	Purple coneflower	1 Gal. CG	18 in OC
Eupatorium maculatum	Spotted Joe-Pye weed	1 Gal. CG	24 in OC
Eupatorium purpureum	Sweet Joe-Pye weed	1 Gal. CG	24 in OC
Filipendula rubra	Queen of the prairie	1 Gal. CG	18 in OC
Geranium maculatum	Wild geranium	1 Gal. CG	18 in OC
Helenium autumnale	Autumn sneezeweed	1 Gal. CG	18 in OC
Heliopsis helianthoides	False sunflower	1 Gal. CG	24 in OC
Heuchera americana	Alumroot	1 Gal. CG	18 in OC
Hibiscus moscheutos	Swamp rose mallow	1 Gal. CG	24 in OC
Iris cristata	Crested iris	1 Gal. CG	18 in OC
Iris virginica shrevei	Blue flag iris	1 Gal. CG	18 in OC
Lespedeza violacea	Violet lespedeza	1 Gal. CG	18 in OC
Liatris spicata	Dense blazing star	1 Gal. CG	24 in OC

Botanical Name	Common Name	Minimum Size	Maximum Spacing
Lobelia cardinalis	Cardinal flower	1 Gal. CG	24 in OC
Lobelia siphilitica	Great blue lobelia	1 Gal. CG	18 in OC
Mertensia virginica	Virginia bluebells	1 Gal. CG	18 in OC
Monarda fistulosa	Bergamot	1 Gal. CG	18 in OC
Phlox divaricata	Blue phlox	1 Gal. CG	12 in OC
Phlox paniculata	Summer phlox	1 Gal. CG	12 in OC
Polemonium reptans	Jacob's ladder	1 Gal. CG	12 in OC
Ratibida pinnata	Yellow coneflower	1 Gal. CG	18 in OC
Rudbeckia hirta	Black-eyed Susan	1 Gal. CG	24 in OC
Rudbeckia laciniata	Green-headed coneflower	1 Gal. CG	18 in OC
Rudbeckia subtomentosa	Sweet black-eyed Susan	1 Gal. CG	24 in OC
Sedum ternatum	Wild stonecrop	1 Gal. CG	12 in OC
Silene regia	Royal catchfly	1 Gal. CG	18 in OC
Silene virginica	Fire pink	1 Gal. CG	18 in OC
Solidago caesia	Blue-stemmed goldenrod	1 Gal. CG	18 in OC
Solidago nemoralis	Grey goldenrod	1 Gal. CG	18 in OC
Solidago rigida	Stiff goldenrod	1 Gal. CG	18 in OC
Solidago rugosa	Wrinkle-leaf goldenrod	1 Gal. CG	18 in OC
Stylophorum diphyllum	Celandine poppy	1 Gal. CG	12 in OC
Vernonia gigantea	Ironweed	1 Gal. CG	24 in OC
Veronicastrum virginicum	Culver’s root	1 Gal. CG	24 in OC
Grasses			
Andropogon geradii	Big bluestem	1 Qt. CG	24 in OC
Bouteloua curtipendula	Side oats gramma	1 Qt. CG	18 in OC
Carex stricta	Tussock sedge	1 Qt. CG	24 in OC
Chasmanthium latifolium	Northern sea oats	1 Qt. CG	24 in OC
Hystrix patula	Bottlebrush grass	1 Qt. CG	18 in OC
Koeleria pyramidata	June grass	1 Qt. CG	18 in OC
Panicum virgatum	Switch grass	1 Qt. CG	24 in OC
Schizachyrium scoparium	Little bluestem	1 Qt. CG	18 in OC
Sorghastrum nutans	Indian grass	1 Qt. CG	24 in OC
Sporobolus heterolepis	Prarie dropseed	1 Qt. CG	18 in OC
Groundcovers			
Asarum canadense	Wild ginger	1 Qt. CG	18 in OC
Carex muskingumensis	Palm sedge	1 Qt. CG	18 in OC
Carex pensylvanica	Common oak sedge	1 Qt. CG	18 in OC
Iris cristata	Dwarf crested iris	1 Qt. CG	12 in OC

Botanical Name	Common Name	Minimum Size	Maximum Spacing
Phlox subulata	Common phlox	1 Qt. CG	12 in OC
Vines			
Aristolochia tomentosa	Woolly Dutchman's pipe	1 Qt. CG	5 ft OC
Bignonia capreolata	Crossvine	1 Qt. CG	25 ft OC
Campsis radicans	Trumpet creeper	1 Qt. CG	25 ft OC
Clematis virginiana	Virgin's bower	1 Qt. CG	15 ft OC
Parthenocissus quinquefolia	Virginia creeper	1 Qt. CG	20 ft OC

6 PUBLIC INVOLVEMENT

6.1 General

This Technical Provision outlines the requirements for the Public Involvement Plan (PIP) program and defines the roles and responsibilities for this effort.

The PIP program includes activities of the IFA, Bi-State Management Team (BSMT), and Developer, including the following:

- PIP
- Community involvement and meetings
- Communications with the public
- Public notices
- Media relations
- PIP portions of the Transportation Management Plan

In support of IFA, Developer shall provide assistance with regard to community participation and interaction during the development of the design and construction of the East End Crossing.

6.2 Standards and References

Perform the public involvement Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 6; Governmental Approvals; and applicable Laws.

6.3 Requirements

The community involvement and participation element is intended to advance previous dialogue with residents, landowners, community groups, local officials, Area Advisory Teams (AAT), and other like groups. This effort shall include Developer supporting IFA in meetings with individual land owners, local officials, and community groups and public meetings to keep the public informed regarding design and construction activities.

The Public Involvement Plan shall detail how Developer proposes to engage communities, neighborhood organizations, and historic preservation groups in the design and construction of the East End Crossing. Developer shall consult with these groups regarding aesthetic, landscaping, and context sensitive design elements to be incorporated in the project. Developer's PIP shall include a "Community Outreach Plan" which will ensure local participation in the Context Sensitive Solutions (CSS) process.

Developer shall make a good-faith effort to support IFA in addressing any concerns the public may have and to consider all reasonable suggestions from the public. Documentation shall be in the form of meeting minutes and correspondence, including emails. Developer shall direct all requests it receives to IFA and shall assist in preparing responses. All design or construction modifications are subject to written approval by IFA.

6.4 IFA Public Involvement Responsibilities

IFA and Developer have shared responsibility for the PIP program.

Except for the items expressly referenced in this Section 6 as being the responsibility of IFA, Developer shall have primary responsibility for performing the public information activities, as well as in the PPA Documents.

IFA's responsibilities as lead will include the following activities:

- Designate an IFA PIP program manager to function as a single point of contact for Developer regarding PIP activities.
- Maintain quality assurance of any approved communication efforts by Developer.
- Liaise with and monitor Developer's performance for compliance with the PIP program requirements of the PPA Documents.
- Function as the official spokesperson for the East End Crossing, except as described below.
- Coordinate media activities, such as interviews, including those with Developer staff; press releases; and media events.

6.5 Developer Public Involvement Responsibilities and Requirements

6.5.1 Public Involvement Plan

Developer shall submit to IFA its Public Involvement Plan, which is a component part of the PMP, which addresses all public involvement tasks defined in this Section 6 and in the PPA Documents. See Attachment 01-1 for submission schedule and review requirements. Developer shall provide a Public Information Coordinator to lead all Developer public information tasks.

6.5.2 Developer's Response to Inquiries and Comments

- Questions or comments from residents, businesses, or other members of the public shall be referred to IFA's PIP Manager within four hours. Developer shall take the necessary steps to facilitate such contact.
- If Developer receives a complaint regarding its conduct of work on the East End Crossing, Developer shall notify IFA's PIP Manager within four hours. Developer shall provide the necessary information, staff support, and representation to assist in resolving the issue.
- On occasions specified by IFA, Developer shall commit its Project Manager to serve as a spokesperson for the East End Crossing for technical and safety issues with certain designated audiences.
- Reference contacts to the Kentucky or Indiana ombudsman.

6.5.3 Public Notifications

- Developer shall facilitate IFA's notification of the public and affected businesses and residents. As directed by IFA, this shall include direct contact with affected parties for updates on upcoming events.

- Developer shall provide the specific notifications listed in Table 6-1 to IFA and PIP program manager.
- Utility shut-off/diversion announcements shall be coordinated in advance with IFA. Developer shall prepare a written notice to the affected parties.

Table 6-1 Notifications

Notice	Requirement
Lane Closure	Depending on the duration of the Closure, written notices shall be posted in advance of planned Closures at the start and end of the East End Crossing and at intermediate intersections/junctions with United States (U.S.), state, or county highways and roads.
Critical Utility Shut-off/Diversion	Written notice at least 48 hours, or as agreed to in Utility Agreement, in advance of shut-off and, as applicable, diversions. Copy of notice to IFA PIP program manager.
Business/Commercial Utility Shutdown	Written notification of Utility shutdown or diversion for businesses and commercial property at least 48 hours, or as agreed to in Utility Agreement, in advance of shut-down. Copy of notice to IFA PIP program manager. Notice shall be coordinated in advance with IFA.
Residential Utility Shutdown	Written notification of Utility shutdown or diversion for residential property 48 hours, or as agreed to in Utility Agreement, in advance of shut-down. Copy of notice to IFA PIP program manager. Notice shall be coordinated in advance with IFA.
Weekly Construction Updates	Construction updates shall be provided weekly and shall identify all planned traffic shifts, lane Closures, and Utility shut-downs and activities. Updates shall cover at a minimum the prior week and project out the next 6 weeks.
Emergency Unforeseen Utility Disruptions, Hazardous Conditions, Traffic Emergencies, Security, and Loss of Access	See Section 6.5.5.
Road and Driveway Closures	Written notice and personal contact in advance of closure, as specified in Maintenance of Traffic (MOT), Haul Routes, and Access During Construction Technical Provisions. Copy of notice to IFA PIP program manager.

6.5.4 Public Contact Records

Developer shall maintain a consistent system for documenting all Developer and IFA contact with business owners, residents, the media, and property owners. Unless otherwise directed, Developer shall direct all requests for comment to the IFA PIP Manager. Developer shall provide IFA's PIP Manager with an electronic copy of all public contact records. The file shall be received by the 1st of each month and shall include all contacts made prior to the 25th of the previous month.

6.5.5 Emergency, Unforeseen Utility Disruptions, Hazardous Conditions, Traffic Emergencies, Security, and Loss-of-Access Notifications

Developer shall develop a Safety Plan, which is a component part of the PMP, for all Work with input from law enforcement or fire suppression agencies. See Attachment 01-1 for submission schedule and review requirements. Department practices are described in the *INDOT Employee Safety Manual*. The Safety Plan shall, at a minimum address these key features:

- OSHA Safety measures and procedures
- Incident Management Plan to include emergency response measures to construction sites
- Construction site security
- Traffic control safety measures and procedures
- Review schedule for Temporary Traffic Control Plans to confirm adherence to safety procedures

The plan at a minimum shall require Developer to provide immediate response to emergencies by trained personnel from an incident response team within 60 minutes of receiving notification from IFA, law enforcement or fire suppression agencies, Utility Owners, and, as applicable, affected businesses and, as applicable, residents. Immediately following the initiation of actions necessary for the security of people and property, Developer shall coordinate with IFA the explanation of all emergency or unforeseen disruptions. IFA will serve as the spokesperson with affected parties and media for all emergencies and, as applicable, unforeseen disruptions. At a minimum, Developer shall provide IFA with details on the following:

- Cause of disruption (i.e., whether it is construction related or not).
- Actions being taken to alleviate the issue.
- Responsible party for the actions.
- Anticipated duration of the disruption.

Developer shall establish and manage an emergency response telephone tree. All appropriate emergency response agencies shall be included on this telephone tree for immediate response in the event of an emergency. The telephone tree shall be divided into areas of expertise so that the proper people are called for specific emergency situations.

Developer shall notify IFA one month before starting Construction Work in any area of the East End Crossing.

6.5.6 East End Crossing Identification Signage

Developer shall install project identification signs 30 days after NTP2 to be placed at the start and end of the East End Crossing, at intersections/junctions with U.S. and state highways, at the Project Office (if along the East End Crossing alignment), and at all field offices. The project identification signs shall identify the IFA and IFA by their official logos and show the name of the East End Crossing, the East End Crossing hotline number, the East End Crossing website address, and the East End Crossing logo. A sample of the East End Crossing Identification Board shall be submitted to IFA for review and comment 30 days prior to installation. Signs and lettering shall be sized appropriately for the speed limit in the area, using Manual on Uniform Traffic Control Devices size guidelines.

6.5.7 Public Forums

At the specific request of IFA, Developer shall participate in IFA-organized public forums.

6.5.8 Construction Progress Photographs

Developer shall provide to IFA high-resolution construction progress photographs in electronic format at least monthly or at any time that a new significant activity commences. Monthly submissions shall include, at a minimum, 10 (ten) new progress photos. In addition, Developer shall facilitate requests and make arrangements for IFA to take additional photos on an as-requested basis. Distinct from progress documentation photos, the purpose of photos identified in this Section 6 is to facilitate public information via East End Crossing website(s), newsletters, and other such materials.

6.6 Other Developer Activities

Developer is encouraged to provide additional, cost-effective services to enhance the overall PIP program. Additional services shall adhere to the standards indicated in the PIP and be a supplement to the services outlined in this Section 6. Any such enhancements may be implemented at any time during the project, subject to IFA's review and approval. Any enhancements would be at Developer's sole cost, unless directed by the IFA pursuant to Article 16 of the PPA.

6.7 Media Relations

Media relations will be handled by IFA. Developer shall assist by providing timely information to IFA regarding construction activities for use in media events.

Developer shall not interface with the media without the expressed consent of IFA, except as specifically directed by IFA. Developer shall immediately notify IFA of any situations, including emergencies, which may involve the media.

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7 ENVIRONMENTAL

7.1 General

Developer shall design and construct the East End Crossing in accordance with the requirements of the PPA Documents, including this Section 7; and Project Standards; Environmental Laws; and all Governmental Approvals.

Further discussion of the environmental impacts of the East End Crossing is provided in the following documentation which are included in the RID:

- Louisville-Southern Indiana Ohio River Bridges Project 2003 Final Environmental Impact Statement (FEIS)
- Louisville-Southern Indiana Ohio River Bridges Project 2012 Supplemental Final Environmental Impact Statement (SFEIS)
- Louisville-Southern Indiana Ohio River Bridges Project Revised ROD signed July 20, 2012
- Section 106 First Amended MOA among the Federal Highway Administration (FHWA), the Advisory Council on Historic Preservation, the Indiana State Historic Preservation Officer, and the Kentucky State Historic Preservation Officer regarding the Louisville-Southern Indiana Ohio River Bridges Project in Clark County, Indiana, and Jefferson County, Kentucky, March 23, 2012

See Attachment 07-1 for a listing and status of IFA-Provided Approvals, IFA-Initiated Approvals and Major Environmental Approvals as well as identification of Major Environmental Approval Deadlines.

7.2 IFA's Environmental Roles and Responsibilities

The Department and the Kentucky Transportation Cabinet (KYTC) have conducted extensive coordination with the public and various state and federal environmental and regulatory agencies. The coordination was conducted throughout the development of the 2003 FEIS, the 2003 Section 106 MOA, the 2012 SFEIS, the revised ROD approved June 20, 2012, the 2012 Section 106 First Amended MOA, and the 2003 BA and amendment thereto in 2012. The requirements of this Section 7 include the commitments arising out of those processes that IFA will delegate to Developer to complete.

7.3 Developer's Responsibilities

Developer shall obtain all necessary Governmental Approvals other than IFA-Provided Approvals, comply with all conditions and requirements of all Governmental Approvals, and achieve and maintain the environmental requirements and commitments through the development and implementation of an Environmental Management System (EMS) that shall meet the requirements of ISO 14001 and shall include all environmental performance requirements in this Section 7. The Developer shall provide an Environmental Compliance and Mitigation Plan while partnering with IFA. The Environmental Compliance and Mitigation Plan shall include all environmental commitments and required mitigation listed in this Section 7.

Developer shall be responsible for compliance with the requirements in both the design and construction of the East End Crossing. Developer shall prepare a checklist that documents all impacts and anticipated impacts to resources that were identified in the PPA Documents, SFEIS/ROD and any Governmental Approval. The checklist shall be submitted with the ECMP for IFA review and comment. Developer shall submit the updated checklist to IFA for review and concurrence within one week after the end of each quarter. The checklist is to stipulate those requirements that are to be reviewed by the Department for concurrence and those requirements that are expected to be reviewed for concurrence in the subsequent quarter,

Developer shall designate an on-staff Environmental Compliance Manager (ECM) to be responsible for the implementation of all the environmental design and construction commitments and conditions of Environmental Approvals required for the East End Crossing. The ECM shall have a minimum of 10 years of experience, with demonstrated expertise with construction management; permitting compliance; and overall environmental compliance on large-scale, complex transportation projects with environmentally sensitive areas.

The ECM shall report directly to Developer’s Project Manager and shall be the primary liaison to IFA for environmental issues. The ECM shall be a full-time, on-Site member of Developer’s staff. The ECM shall have the authority to stop or redirect Construction Work as needed to maintain environmental compliance.

Developer shall develop and implement an Environmental Compliance and Mitigation Training Program at a minimum for supervisory personnel, including those of Contractors that will enter within the Project Limits and Project ROW boundaries to perform Construction Work. The training shall provide supervisory personnel with an understanding of the necessary environmental compliance requirements and any environmentally sensitive areas for the East End Crossing.

The training shall cover the following elements:

- Erosion control measures – sequencing, implementation and maintenance
- Maintaining approved limits of disturbance
- Tree and shrub protection
- Avoidance and minimization of impact to wetland areas, streams, or other water bodies
- Wildlife habitat protection
- Seasonal work restrictions – trees and waterways
- Pumping and dewatering operations
- Accidental discovery of archaeological material or human remains
- Impacts and consequences for departure from approved operating procedures
- Hazardous materials
- No work zones
- Historic properties

The Environmental Compliance and Mitigation Training Program is a component part of the PMP. Developer shall finalize the Environmental Compliance and Mitigation Training Program prior to starting any work tasks associated with construction activities within the Project Limits and Project ROW boundaries. Developer shall not allow any supervisory personnel to enter the Project ROW and construction limits without completing the required training. Developer shall provide annual updates to this training program for supervisory personnel to IFA.

7.4 Governmental Approvals and Modifications

East End Crossing impacts to streams, wetlands, and other water bodies are summarized in the Environmental Approvals. Developer shall be responsible for obtaining all Governmental Approvals necessary to complete the Work other than the IFA-Provided Approvals. IFA is responsible for obtaining the IFA-Provided Approvals identified in Attachment 07-1. Developer shall not be responsible for preparing and obtaining the IFA-Provided Approvals, but shall provide conditional information requested by the permitting agencies, based on the Final Design. IFA-Provided Approvals are based on the Reference Design. In addition, IFA has started the process of obtaining certain other Governmental Approvals; applications submitted by IFA for IFA-Initiated Approvals are included in the RID. Developer is responsible for completing applications for and obtaining IFA-Initiated Approvals. Attachment 07-1 also sets forth Major Environmental Deadlines for each of the Major Environmental Approvals. See Sections 4.3 through 4.5 of the PPA for specific requirements, obligations and information regarding Governmental Approvals and Environmental Approvals, including any modifications to Governmental Approvals; IFA-Provided Approvals; IFA-Initiated Approvals; Major Environmental Approvals; and Major Environmental Approval Deadlines.

7.4.1 Government Approval Submittals

Developer shall submit to IFA for review and comment prior to submission to the permitting agency, drafts of all applications for Governmental Approvals for which Developer is responsible.

7.4.2 Governmental Approval Modifications

See Section 4.3 of the PPA for Developer's obligations with respect to modifications, renewals, and extensions of Governmental Approvals.

7.5 Environmental Requirements

7.5.1 Natural Resources

7.5.1.1 Groundwater and Wellhead Protection Area

Developer shall include the Standard Specifications for temporary and permanent erosion control measures in its Design Documents. Developer shall also include protection measures for that portion of the East End Crossing within the Louisville Water Company (LWC) "Wellhead Protection Area (WHPA)". The limits of the WHPA are shown in RID UT-4.02 and UT-4.14. These measures include the following:

1. Work within the WHPA shall be limited to that described in the Technical Provisions for the East End Crossing, unless otherwise approved by the Engineer in writing.

2. No concrete plants shall be placed nor shall equipment and materials be stored within the WHPA.

3. Equipment required for construction of the bridge piers may be located within the WHPA, provided a berm is constructed around the equipment and a liner placed within the bermed area to protect against any accidental release. Developer shall submit berm and liner design to IFA for review and comment as part of the ECMP.

4. Upon completion of individual bridge pier construction, equipment shall be moved from the WHPA at the earliest opportunity, and berms and liners removed and any materials contained within the bermed area transported to an approved disposal site, outside the WHPA. Developer shall propose a disposal site(s) to the IFA 45 days prior to disposal operations for its approval.
5. Louisville Water Company collector wells are located near the project as shown in RID UT-4.06. Developer shall not use bentonite within 500 feet of the collector wells and shall not use polymer fluids within 1,000 feet.
6. Developer shall coordinate design and construction details and special notes with the LWC and KDW.
7. The Developer shall install 2 “Entering Wellfield Protection Area" signs at the limits of the WHPA along KY 841. The limits of the WHPA are shown in RID UT-4.02 and UT-4.14.

The following provisions shall apply to storm runoff and potential spills from the East End Bridge, bridges, and roadway within the WHPA for the Final Design.

1. There shall be no direct roadway runoff to the WHPA. Runoff shall be collected and floating materials shall be separated before the stormwater is discharged into Harrods Creek.
2. Developer shall ensure the drainage system can contain a 26,000 gallon spill. A manual control shall be provided at a point within the system to stop the spill from entering Harrods Creek or the WHPA.
3. Roadway drainage shall be conveyed in either a water-tight storm sewer or lined ditch. Ditch lining shall be impermeable and shall extend a minimum 1-foot beyond the top of bank of the ditch.

7.5.1.2 Surface Water

Developer shall include measures to control and minimize erosion and water quality impacts from construction activities related to the East End Crossing. Developer shall include best management practices (BMPs), standard erosion and sediment control measures, and other measures included in the Department Standard Specifications and Recurring Special Provisions.

7.5.1.3 Aquatic Biota

Developer shall comply with the following stipulations:

1. All construction equipment used in the Ohio River and tributaries shall be free of zebra mussel adults and veligers. Any construction equipment that has been used in waters that could have been infested with zebra mussels (within the last two weeks) shall be appropriately disinfected and inspected for zebra mussel adults and veligers prior to use in the Ohio River and tributaries. A special note shall be included in the final and Released-for-Construction Construction Documents providing information on the appearance and characteristics of zebra mussels and any other special steps that may be appropriate for the particular phased approach to the final East End Crossing.

2. The bottom/invert of all culverts and pipes that carry streams shall be sumped, 2 foot maximum, to allow streambed material to accumulate and provide a natural streambed for aquatic organisms.

3. For the Indiana Approach below ordinary high water mark channel work outside of cofferdams shall not be performed during the fish-spawning season between April 1 and June 30. Channel work inside cofferdams during this time frame shall be performed from streambanks in shallow waters or barges in deeper waters.

7.5.1.4 Wetlands and Waters of the United States

The East End Crossing includes permanent and temporary impacts to wetlands, wetland areas, and waterways. The impacted wetland areas are summarized in the East End Crossing Environmental Approvals. IFA will provide waterway and wetland mitigation for the impacts described in the IFA-Provided Approvals. Developer shall be responsible for constructing the on-site restoration for the temporary impacts to Wetland E, Streams 7 and 8, and the permanent impact to Wetland B as shown in Attachment 2 of the Indiana 401 and 404 permits. After finalizing design and obtaining any needed modifications or amendments to Governmental Approvals, but prior to performing construction for the East End Crossing, Developer shall be responsible for the installation and continued maintenance of temporary protective fencing and prohibitive signing adjacent to wetland areas. The temporary protective fencing shall be installed along the limits of the disturbance adjacent to wetland areas. All Developer and Contractor personnel shall be made aware of all designated protection areas.

7.5.1.5 Impacts to Wetlands and Waterways

The Department has obtained IFA-Provided Approvals that minimize or prevent disturbance or damage to existing waterways and wetland areas. Developer shall further avoid and minimize impacts to wetlands and streams in the development of the Design Documents and during Construction Work. The following stipulations shall be adhered to:

1. Developer shall not impact any wetland area or waterway, whether it is permanent or temporary, unless that impact is addressed and approved as an authorized action by the appropriate federal and, as applicable, state regulatory agency in a Governmental Approval or permit modification.

2. IFA shall be immediately notified of inadvertent impacts to wetlands or waterways for which activities are not permitted. Areas shall be immediately restored to the full satisfaction of IFA and the appropriate environmental regulatory agencies. The cost of restoration and, as applicable, mitigation of any inadvertent impacted areas shall be the sole responsibility of Developer.

7.5.1.6 Best Management Practices for Work in Wetlands, Waterways, and 100-Year Floodplains

Developer shall follow the Best Management Practices (BMPs) listed below for stream protection in place during East End Crossing construction. The Department's Standard Specifications and the Department's Special Provisions shall govern construction activities to control erosion and subsequent water pollution.

BMPs shall be used to prevent non-point source pollution, to control stormwater runoff, and to minimize sediment damage to water quality and aquatic habitats. Those BMPs to be implemented include the following:

1. Developer shall not stockpile or store excess fill, construction material, equipment, or debris in wetlands, waterways, wetland buffers, or any 100-year floodplains unless authorized by the East End Crossing Governmental Approvals. Developer shall not place materials in a location or manner that adversely impacts surface or subsurface water flow into or out of wetlands, waterways, or any 100-year floodplains.

2. Developer shall not use excavated material as backfill if it contains waste metal products, unsightly debris, and toxic material or any other deleterious substance unless authorized by the East End Crossing Governmental Approvals. If additional backfill is required, Developer shall use clean materials that are free of waste metal products, debris, toxic material, asphalt, or any other deleterious substance.

3. Developer shall not operate equipment in a manner that will damage wetlands, waterways or any 100-year floodplains unless authorized by the East End Crossing Governmental Approvals.

4. Developer shall repair and maintain any serviceable structure or fill so there is no permanent loss of wetlands, waterways, the 100-year floodplains, or permanent modification to any 100-year floodplains in excess of that allowed under permit unless authorized by the East End Crossing Governmental Approvals.

5. Developer shall limit the physical disturbance of waterways and riparian vegetation to only that which is necessary and authorized by the East End Crossing Governmental Approvals. Notes and details shall be included in the plans to further minimize the removal of trees and understory vegetation that fall within the required Project ROW but outside the actual limits of construction. Hollow trees, trees with sloughing bark, and other large trees that are dead or alive and occur within the Project Limits shall be avoided to the maximum practical extent and delineated by special notes in the Plans.

6. Developer shall permanently revegetate all bare and disturbed areas with a mixture of native grasses, sedges, wildflowers, and native shrub and hardwood tree species within the same construction season that construction in the disturbed area is completed. Any varieties of tall fescue or other non-native plants (e.g., crown-vetch) shall not be used.

7. Developer shall seed and protect all disturbed slopes that are 3:1 or steeper with biodegradable heavy-duty erosion control blankets in accordance with Standard Specifications and all East End Crossing Governmental Approvals.

8. Staging, refueling, and cleanup areas shall not be allowed within a minimum distance of 200 feet from streams, wetlands, and other waterbodies in accordance with requirements of East End Crossing Governmental Approvals. Equipment cleaning/staging areas shall be located such that runoff from these areas shall not directly enter streams, wetlands, and other waterbodies. Equipment cleaning/staging areas shall be located such that effluent shall be filtered through vegetated areas and proper sediment control structures located between the staging area and receiving water bodies, thereby minimizing the potential impacts such as sedimentation and pollution.

9. The size, shape, and stability of natural stream channels unavoidably impacted by construction shall be used as the basis for designing replacement channels. Work in the

low-water channel of existing streams shall be minimized to the maximum practicable extent by limiting construction to the placement of required drainage structures or structure components such as piers, pilings, footings, cofferdams, the shaping of spill slopes around bridge abutments, and the placement of riprap. Newly created stream channels shall be stabilized with vegetation prior to water being diverted from the original stream channel (or diversion measure).

10. Fording of streams shall not be allowed unless authorized by the East End Crossing Governmental Approvals. Temporary bridges or other structures shall be used in accordance with East End Crossing Governmental Approvals. Unless otherwise approved in writing by the Engineer, and upon the receipt of any required East End Crossing Governmental Approvals, mechanical equipment shall not be operated in streams or in wetlands. Only No. 2 stone shall be permitted to be placed in streams during Construction Work. Any temporary river accesses built in conjunction with this East End Crossing shall be completely removed upon the completion of Construction Work.

11. Developer shall prevent downstream siltation during cofferdam dewatering. Pollutants such as fuels, lubricants, bitumen, raw sewage, and other harmful materials shall not be discharged into or near rivers, streams, and impoundments, or into natural or manmade channels leading thereto. Washwater or waste from concrete mixing operations shall not be allowed to enter any streams, wetlands, or other waterbodies. The use of artificial bank stabilization such as riprap shall be limited unless otherwise required by Final Design details. A minimum average 6-inch graded stone, shall be extended below normal low-water level to provide habitat for aquatic organisms in the voids.

12. If piers are placed within the floodplain as required by structural design, impacts to drainage within the floodplain and the LWC hard rock tunnel along Transylvania Beach Road shall be minimized.

7.5.1.7 Temporary Impacts to Streams, Wetlands, and Floodplains

The East End Crossing will have temporary stream impacts during Construction Work. Temporary impacts are defined as waterways that are temporarily altered during construction but are restored to preconstruction conditions after Construction Work is completed. Additional stream stabilization measures may be required to ensure the stability of the restored section. Developer shall limit temporary stream impacts to those impacts authorized by the East End Crossing Governmental Approvals.

The restoration of temporarily impacted streams to preconstruction vegetation, topography, and hydrology shall be performed by Developer.

The streams with temporary impacts in Indiana include the following:

- Tributaries to Lancassange Creek
- Lentzier Creek
- Tributaries to Lentzier Creek

The streams with temporary impacts in Kentucky include the following:

- Ohio River
- Tributaries to the Ohio River

- Harrods Creek
- Tributaries to Harrods Creek

The specific location of the anticipated temporary stream impacts are provided in the tables in the Section 401 and Section 404 IFA-Provided Approvals submitted by IFA. Earthen materials shall not be constructed for temporary stream diversions, stream crossings, or cofferdams due to the potential for washout during storm events. All temporary fill material shall be of a nonerosive nature.

7.5.1.8 Temporary Impacts - Stream, Wetland, and Floodplain Restoration Efforts

Some restoration plans will already be dictated by waterway IFA-Provided Approvals. Developer shall be responsible for final design and construction of all stream and wetland restoration required by the East End Crossing Governmental Approvals and Technical Provisions. The following elements shall be incorporated into restoration for additional work proposed by Developer.

1. Removal of all construction and temporary fill material.
2. Use of timber mats or similar materials when working within wetland areas to prevent soil compaction.
3. Deconsolidation and, as applicable, scarification of compacted soils.
4. Replacement of topsoil and, as applicable, organic matter lost to erosion and sediment control measures.
5. Reestablishment of grades to preconstruction conditions.
6. Removal of temporary stream crossings.
7. Restoration of streambanks with woody vegetation.
8. Avoid disturbance to riparian vegetation, particularly within 50 feet of streambanks unless impacts were included in East End Crossing Governmental Approvals.
9. Replant any area within 50 feet of a streambank that was disturbed temporarily and that was vegetated preconstruction with native vegetation similar to preconstruction species composition, with the exception of underground utility corridors.

Monitoring by IFA to ensure the successful restoration of temporary impacts will continue in accordance with requirements and conditions of East End Crossing Governmental Approvals. Additional remediation efforts shall be implemented by Developer if it is determined necessary, following the completion of the monitoring period as presented in the East End Crossing Governmental Approvals. Developer shall be responsible to mitigate for the lost resource if remediation does not prove successful one year after the remediation efforts were implemented.

For any stormwater management pond constructed in the vicinity of a stream, the pond shall be located a sufficient distance from the stream to maintain a 15-foot-wide cleared area beyond the toe of any berms surrounding the pond, plus an additional 30-foot-wide, or larger, vegetated buffer along the stream.

Developer shall place Do Not Mow or Spray signs every 150 feet along the Project ROW for areas of stream and wetland restoration. These signs shall be maintained until Final Acceptance.

7.5.1.9 Avoidance and Minimization

Developer shall focus its efforts to continue to minimize impacts to wetlands, waterways, floodplains, parks, and forest in all areas of the East End Crossing. Developer shall focus its efforts to maximize reductions in the quantities of riprap and other bank stabilization materials placed in stream channels. Engineering designs shall continue to emphasize the avoidance and minimization of impacts as the feasibility and effectiveness of using measures such as retaining walls, steeper fill slopes, increased headwall heights, reduced roadway sections, and any other feasible minimization efforts are evaluated. Developer shall acquire necessary amendments to Environmental Approvals if additional wetland and stream impacts cannot be avoided beyond what is included in the East End Crossing Environmental Approvals. IFA will provide waterway and wetland mitigation for the impacts described in the IFA-Provided Approvals. Developer shall be responsible for any additional mitigation requirements associated with additional impacts to streams, wetlands, and other waterbodies in accordance with Sections 4.3 through 4.5 of the PPA.

Developer shall park, service and maintain equipment in designated areas as approved by IFA. These areas shall be located away from all existing streams, streambeds, sinkholes, other environmentally sensitive areas, and their immediate watersheds.

Prior to construction, parking and turning areas for heavy equipment outside the construction limits but within the right-of-way shall be identified and located to minimize soil erosion, tree clearing, and impacts to other identified resources.

7.5.2 Reforestation

7.5.2.1 Forest Impact Avoidance and Minimization

Developer shall use Good Industry Practice to minimize the cutting or clearing of trees. IFA will clear trees within the Reference Design construction limits. Developer impacts to forests (riparian and upland forested habitat) outside of the Reference Design construction limits and within the Project ROW, due to Developer's Final Design, shall not exceed:

1. Riparian forest - see Section 7.4
2. Upland forest - 25 acres in Indiana and 34 acres in Kentucky

7.5.2.2 Forest Mitigation

For mitigation of stream and wetland impacts, see Section 7.5.1.4.

Developer shall revegetate all disturbed areas within the Project ROW.

Developer shall prepare an Indiana Reforestation Mitigation Plan and submit to IFA during Stage 1 Design Review for approval. The plan shall include mitigation as follows:

1. Developer shall prepare and submit an Indiana Reforestation Mitigation Plan that includes a minimum 1:1 reforestation/preservation ratio for all impacts to upland forests

in Indiana, including all impacts caused by the separate INDOT clearing and demolition project in Indiana referenced in Section 1. Developer's Reforestation Mitigation Plan shall consider as partial mitigation that IFA will reforest or preserve 50 acres for upland forest mitigation off Site, outside of the Project Limits. If required to achieve the 1:1 reforestation/preservation ratio, Developer's Reforestation Mitigation Plan may include reforestation/preservation of excess parcels outside the Project ROW as shown in RID EV-6.03.

2. Developer shall mitigate for tree clearing removal in Kentucky by replanting trees beyond the grading limits within the Project ROW as available to provide a visual screen and buffer for abutting properties. Additionally, trees other vegetation shall be included in areas associated with any noise barriers.

3. Developer shall perform forest mitigation in accordance with the approved Reforestation Mitigation Plan. Forest mitigation shall include tree species that produce sloughing bark and snags. Species to consider include white oak (*Quercus alba*), northern red oak (*Quercus rubra*), white ash (*Fraxinus americana*), shagbark hickory (*Carya ovata*), slippery elm (*Ulmus rubra*), black locust (*Robinia pseudoacacia*), American elm (*Ulmus americana*), shellbark hickory (*Carya laciniosa*), eastern cottonwood (*Populus deltoides*), and sycamore (*Platanus occidentalis*). Tree spacing shall be in accordance with Project Standards.

4. IFA will provide for all of the riparian forest mitigation described in the IFA Provided Approvals unless specified elsewhere in this Section 7.

5. Developer shall prepare and include calculations in the Reforestation Mitigation Plan of additional forest impacts and mitigation based on the Final Design as described in Section 7.5.2.1.

7.5.3 Terrestrial Wildlife

7.5.3.1 Terrestrial Wildlife Avoidance and Minimization

Developer shall place "Do Not Disturb" signs at intervals of 250 feet at the construction zone boundaries for those portions of the East End Crossing. These signs shall be placed beyond the construction limits to protect re-vegetation areas and areas of existing vegetation. Trees that occur within the Project ROW, but outside of the construction limits, shall be identified during the design phase and delineated by fencing or other measures to minimize impacts.

Developer shall place "Do Not Mow or Spray" signs every 150 feet along the Project ROW for areas of woody re-vegetation, wetlands, and the preservation of existing woody vegetation in Indiana in accordance with the Department Standard Specifications and in selected areas in Kentucky where mitigation plantings are required.

Developer shall incorporate invasive-free mulches, topsoil and seed mixtures, and eradication strategies to eliminate known invasive species into the East End Crossing.

Developer shall consult with the Bridgepointe Neighborhood Association and consider its recommendations in developing a landscape component for any wall placed along the border of the neighborhood.

The Final Design shall include wildlife crossings at the areas defined as “Bridge Structures 6 & 7” and “Bridge Structures 9 & 10”. The two specified crossings shall be bridged as shown in the RIDs, unless Developer can design and construct an animal crossing in the same location that is acceptable to United States Fish and Wildlife Service (USFWS).

Developer shall maintain connectivity between the specified wildlife communities to the extent feasible and provide structures with adequate underpass space to allow safe passage of large wildlife under the roadway. The crossing shall include a one-foot minimum natural substrate covered bottom. Minimum clear opening, if located in a floodplain, shall be set at an elevation that will result in no more than two foot thickness of natural sediment. The design shall take into account any filling that may occur due to sediment deposition on the floodplain. There shall be no exposed riprap in the bottom of the wildlife passages, the bottom of the culvert or on the approaches to the passage that would make the passage inaccessible by deer.

Developer shall submit wildlife crossing details to IFA for review and written comment with Stage 1 Design Documents.

Culverts shall provide natural bottom substrates and a smooth bed transition from upstream to downstream allowing for reptile and amphibian crossing as well as fish movement. The Developer shall provide protection for wildlife by installing wildlife and small animal exclusion fencing in appropriate areas along the highway.

If riprap is determined necessary on the floodplain floor under any bridges, the riprap shall be buried with material that is accepted by the IFA in its good faith discretion and easily traversable by wildlife. In addition, the use of slope protection under bridges shall be minimized to retain as much of the natural terrain as possible for wildlife movement and to minimize the disturbance of earthwork in the vicinity of streams. If riprap is needed for energy dissipation at either end of a stream culvert or to protect a buried utility, riprap and stream substrate material shall be placed together to establish a stream invert elevation that will not impede fish passage during low flows.

7.5.4 Endangered, Threatened, and Rare Species

7.5.4.1 Endangered, Threatened, and Rare Species Time-of-Year Restrictions

Developer shall only perform tree clearing from August 16 through March 31.

Developer shall not cut any trees suitable for Indiana bat roosting (greater than 5 inches in diameter at breast height, living or dead, with loose hanging bark) from April 1 through August 15.

7.5.4.2 Endangered, Threatened, and Rare Species Avoidance and Minimization

The amended BA approved by the USFWS on February 18, 2012, includes mitigation measures for the Indiana bat, gray bat, and federally listed mussels. The following mitigation measures shall be implemented for the East End Crossing:

Developer shall minimize construction limits.

Developer shall not perform construction work at night at stream crossings, with the exception of pouring concrete for bridge decks. This provision does not apply to bridge construction over the Ohio River.

Developer shall design and construct all culverts and pipes such that the bottom (invert) is at a 2-foot lower elevation than the stream bottom/bed, and the design of the culvert/pipe is such that it will allow natural stream bed material to accumulate throughout the length of the culvert. The specific depth of the culverts and pipes shall be included in the East End Crossing Governmental Approvals.

Developer shall avoid impacting trees greater than or equal to 3 inches in diameter at breast height, except those in the direct construction limits.

Developer shall contact IFA at least two weeks prior to the start of construction. IFA will contact the USFWS at least one week prior to the start of construction for the proposed East End Crossing.

In Kentucky, Developer shall revegetate disturbed areas at stream crossings with tree species that produce sloughing bark and snags and follow the general guidelines of USFWS, Interstate Mining Compact Commission, and Office of Surface Mining (2009). Species shall include a minimum of six different tree species. Species selection shall be determined by site-specific characteristics (soil moisture, sun exposure, etc.) and seedling availability. A stocking success rate of not less than 300 stems per acre shall be required. A minimum of four species identified as exfoliating bark species shall be planted and equal at least 40 percent of the minimum stems per acre. Tree species shall be planted at approximately equal rates. Exfoliating bark species (suitable for planting in the East End Crossing area) are sugar maple (*Acer saccharum*), bitternut hickory (*Carya cordiformis*), pignut hickory (*Carya glabra*), shellbark hickory (*Carya laciniosa*), shagbark hickory (*Carya ovata*), mockernut hickory (*Carya tomentosa*), eastern cottonwood (*Populus deltoides*), white oak (*Quercus alba*), shingle oak (*Quercus imbricaria*), northern red oak (*Quercus rubra*), post oak (*Quercus stellata*), black oak (*Quercus velutina*), sassafras (*Sassafras albidum*), and slippery elm (*Ulmus rubra*). An herbaceous ground cover of native species shall be established.

Developer shall conduct the pouring of concrete for piers and, as applicable, bridge decks such that spills into the stream do not occur. In the unforeseen event that spillage does occur, Developer shall notify IFA, who will initiate coordination with the USFWS office and the Engineer shall halt the activity immediately and not resume until appropriate remedial actions have been implemented.

7.5.4.3 Bat Reporting and Handling

Discovery of any dead bat located within the construction limits, right-of-way, staging areas, or mitigation areas of the project, regardless of species, shall be immediately reported to USFWS Bloomington Field Office, BFO, at (812) 334-4261, or USFWS, Frankfort Field Office, FFO, at (502) 695-0468 and subsequently transported, frozen or on ice, to BFO or FFO.

No attempt shall be made to handle any live bat, regardless of its condition. Report bats that appear to be sick or injured to BFO or FFO.

The BFO or FFO will make a species determination of any dead or moribund bats. If an Indiana bat is identified, BFO or FFO will contact the appropriate service or law enforcement office as required.

7.5.4.4 Eagle Reporting and Handling

Discovery of any dead bald or golden eagle located within the construction limits, right-of-way, staging areas, or mitigation areas of the project, shall be immediately reported to USFWS Bloomington Field Office, BFO, at (812) 334-4261, or USFWS, Frankfort Field Office, FFO, at (502) 695-0468, and subsequently transported, frozen or on ice, to BFO or FFO.

Any sick or injured bald or golden eagle located within the construction limits, right-of-way, rest stops, or mitigation areas of the project shall be immediately reported to BFO and an Indiana Conservation Officer, to the FFO and a Kentucky Conservation Office or the appropriate State Police if outside of normal business hours or on weekends.

If possible, attempts shall be made to remove an injured eagle from harm’s way, until a trained person arrives to safely capture and transport the bird. Sick and injured eagles shall be transported to a veterinarian or a rehabilitation center that has a valid Federal permit to treat and rehabilitate eagles.

7.6 Cultural Resources

The First Amended Memorandum of Agreement (MOA) will provide mitigation for adverse effects of the project on historic and archaeological resources. In addition, the Historic Preservation Plans (HPP) for the Country Estates of River Road Historic District/River Road Corridor, Township of Utica Historic Lime Industry and the Ohio River Camps Multiple Property Group provide a context to inform the implementation of specific mitigation measures. Developer shall be responsible for the following mitigation measures for the project:

1. Design the section of roadway adjacent to the Lentz Cemetery to minimize noise impacts and complement the refinement with landscaping within the public ROW whenever appropriate.
2. Designate “No Work Zones” within NRHP boundaries on Construction Documents and in contract documents. The no work zone for a historic property shall consist of an area where damaging activities including storage yards, waste disposal, borrow pits, and staging areas will not be permitted. Mapping of the NRHP boundaries for the properties listed below will be provided to Developer. The “No Work Zones” do not apply to project right-of-way.
    a. Utica Lime Kilns
    b. Country Estates of River Road Historic District/River Road Corridor
    c. Allison-Barrickman House
    d. Rosewell
    e. Belleview
3. Design and construct roadway lighting and navigational lighting to minimize the dispersion of light beyond the ROW for the following locations:

a. Country Estates of River Road Historic District/River Road Corridor

b. Belleview

c. Rosewell

4. Pile driving and blasting shall not be conducted between the hours of 6:00 a.m. and noon on Sunday. Any modification to this restriction shall be approved prior to initiation of construction activities.

5. Design and construct roadway signage for the following locations:

   a. INAAP Igloo Storage Historic District - Historical Marker with agreement from River Ridge Commerce Center

   b. Utica Pike - Interpretive Marker along the roadway describing the impact of the lime kiln industry on the region

6. Design and implement measures and materials that minimize adverse noise effects on the following historic properties including innovative quiet pavements, which also provide durability and safe driving conditions, quiet bridge decks and expansion joints, berms, noise barriers, and landscaping:

   a. Lentz Cemetery

   b. Country Estates of River Road Historic District / River Road Corridor

   c. Allison-Barrickman House

   d. Rosewell

   e. Belleview

7. Design the Ohio River Bridge and embankment taking into account the cultural landscape. Context sensitive landscaping and other visual treatments shall be considered on or adjacent to the NRHP boundary, with owner consent and maintenance on the properties including:

   a. Belleview

8. If, during the implementation of the project, any previously unidentified archaeological site is discovered or a previously identified historic property is affected in an unanticipated manner, work within 50 feet around the area shall cease and reasonable measures shall be implemented to avoid harm. The Bi-State Management Team (BSMT) is responsible to ensure that the FHWA, IN SHPO, KY SHPO, Native American Tribes and other parties deemed appropriate by FHWA are consulted within 48 hours of the discovery, an on-site evaluation is conducted and a Treatment Plan(s) is developed, as needed. If the find is determined not to be eligible for the NRHP, ground-disturbing work may continue. If any archaeological resources are identified during construction monitoring, the find is to be treated in accordance with this stipulation.

7.7 Noise Barrier and Noise Attenuation

Barriers for the neighborhoods listed below are likely; however, as part of the Final Design process, more detailed barrier analyses and design shall be performed utilizing the more detailed design information that will be available at that time. Developer shall be responsible for implementing the requirements of the Department and KYTC noise policy in order to make final determinations on whether noise walls shall be constructed in these areas. Developer shall be responsible for design and construction of all required noise walls. Potentially reasonable and feasible noise barriers shall be coordinated with the affected communities for their input to determine if there is local support for proposed barriers. Those communities whose input will be sought include, but are not necessarily limited to, the following:

- Green Spring Subdivision
- Wolf Creek Subdivision
- Wolf Pen Woods Subdivision
- Old Tay Bridge, Cottage Rake, and Boulder Creek Subdivision
- Preliminary studies have indicated that noise abatement is anticipated at the following locations on the Kentucky Approach:

N1	30+70.00 to 82+62.30 LT KY 841
N2	51+18.00 to 80+00.00 RT KY 841

The structural design of noise barriers shall conform to Section 14.

7.8 Blasting Operations and Construction Vibration

Developer shall control vibrations due to blasting or other Construction Work to avoid damage to structures or other property, including fragile or extremely fragile historic structures. Developer shall prepare a Blasting Plan and a Vibration Monitoring Plan prior to beginning any construction activity that requires blasting or will result in groundborne vibration (e.g., pile driving, vibratory compaction) within a minimum of 500 feet of a structure or other property. These plans shall be implemented during appropriate construction activities.

1. Developer shall make its own determination about the allowable peak particle velocity (PPV) threshold values for fragile and extremely fragile structures; however, the PPV threshold for fragile and extremely fragile structures shall not exceed the following:

    a. Fragile Structure = 0.20 inches per second

    b. Extremely Fragile Structure = 0.12 inches per second

2. Developer shall have a historic professional evaluate the condition of all structures prior to the occurrence of any blasting. Structures on all historic properties shall be considered fragile. The blasting Contractor, in consultation with a historic professional, shall make a determination if a structure is extremely fragile.

3. Developer shall make its own determinations as to the existing conditions of potentially affected structures or other property prior to blasting or other construction operations that may induce vibrations.

The plans shall include provisions for pre-construction and post-construction surveys conforming to industry standards, construction monitoring, and other measures to minimize harm to historic properties.

Developer shall develop individual Blasting and Vibration Monitoring Plans for the following historic Indiana and Kentucky structures and other properties:

1. The Indiana structures and other properties include the following:
   a. INAAP Igloo Storage Historic District
   b. Lentz Cemetery
   c. Lime Kilns within the Utica Lime Industry Multiple Property Listing

      Prior to any work within 1,000 feet of the lime kilns, a report shall be prepared by IFA detailing the condition of the kilns prior to Construction Work. The report will serve as the baseline to measure construction related damage.
2. The Kentucky structures and other properties include the following:
   a. Country Estates of River Road Historic District/River Road Corridor
   b. Drumanard Property, including the Strater House
   c. Allison-Barrickman House
   d. Rosewell Property
   e. Belleview
   f. River Camps

The blasting and vibration plans shall include the following:

1. Blasting program that prevents ground vibration in excess of 2.0 inches per second PPV at any structure, in excess of 0.5 inches per second PPV at any residential structure, in excess of 0.2 inches per second PPV at any fragile structure, and in excess of 0.12 inches per second PPV at any extremely fragile historical structure.
2. Minimum of one small-test charge that is below the threshold level for that location for each new drill-and-blast site prior to production blasting to establish local groundborne vibration propagation characteristics.
3. Seismometers or other devices placed in selected locations around a drill-and-blast site to monitor vibration levels to use in refining the blasting program and document compliance with the limits specified herein.
4. Adjustments in the charge per delay will be considered for any change in condition encountered during construction and as a result of monitored vibration levels.
5. Condition surveys for structures within a minimum of 500 feet of a drill-and-blast site, prior to the initiation of blasting and after the completion of the blasting work.
6. The blasting program shall be designed and performed by qualified Contractors.

Developer’s historic professional will make the determination whether damage has occurred to historic structures or other property as a result of East End Crossing activities. The Developer shall provide a written report based on its historic professional’s recommendations, indicating the specific structures and properties that have been damaged due to construction activities and detailing the extent of the damage to each structure.

Developer shall be responsible for the repair of any damage to structures or other property caused by Construction Work. Any repairs to historic structures shall be coordinated in advance with the respective State Historic Preservation Officer ("SHPO") to ensure repairs are carried out in accordance with the Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* (Secretary's Standards).

Developer shall obtain written consent from owners of privately owned property prior to accessing the property to perform surveys, vibration monitoring, repairs or other related activities.

7.9 Hazardous Materials

Developer shall apply the following provisions to the spillage or release of Hazardous Materials during the construction of the East End Crossing.

The following provisions shall apply to the spillage or release of Hazardous Materials during the construction or operation of the Indiana portion of the East End Crossing:

1. Construction Work: Hazardous Material releases, oil spills, fish/animal kills, and radiological incidents shall be reported to the Indiana Department of Environmental Management (IDEM) Office of Emergency Response (OER), at (888) 233-7745. This shall occur as soon as action has been taken to either contain/control the extent of the release, or protect persons, animals, or fish from harm or further harm. Appropriate response actions for spills occurring on East End Crossing sites, in order, are as follows:

    a. Identify the spilled material from a safe distance.

    b. Contain the spilled material or block/restrict its flow using absorbent booms/pillows, dirt, sand or by other available means.

    c. Cordon off the area of the spill.

    d. Deny entry to the cordoned off area to all but response personnel.

    e. Contact OER/IDEM, then Operations Support.

Operations: INDOT *Hazardous Material Accidents/Incidents Policy*, February 1992 (revised July 1998 or most recent version)

The following provision shall apply to the spillage or release of Hazardous Materials during the construction or operation of the Kentucky portion of the East End Crossing:

1. Construction Work: Developer to prepare a Spill Prevention Plan, which is a component part of the PMP, in accordance with Section 7.9.1 and KYTC Standard Specification 108.03, and present it at the Preconstruction Conference, for its proposed operations and receive approval prior to the initiation of Construction Work.

2. Developer shall minimize, to the extent possible, the area that shall be disturbed to construct bridge piers and footings and other elements of bridge substructure located

below the surface. The bridge piers shall be located at least 40 feet away, at its closest point, from the LWC riverbank filtration (RBF) tunnel in the horizontal direction.

3. Any voids between the pier and surrounding ground shall be sealed by using bentonite clay or other approved materials as soon as possible after the completion of work on the pier; however, bentonite is prohibited for use adjacent to any pier shaft that is within 400 feet of a collector well.

4. The design and construction of bridge piers within the Ohio River shall include the use of cofferdams or other construction techniques that limit streambed disturbance and re-suspension of streambed sediments. Material removed from the cofferdams shall be disposed of at approved sites outside the Ohio River and its floodplain.

7.9.1 Hazardous Materials Management Plan

Developer shall prepare a Hazardous Materials Management Plan, which is a component part of the PMP, and submit it to IFA in accordance with Attachment 01-1, and to LWC and KDW at least two weeks prior to the initiation of Construction Work for review and comment. The Hazardous Materials Management Plan shall include the following contents at a minimum:

- Responsible Personnel
- Spill Reporting
- Project and Site Information
- Potential Spill Sources
- Spill Prevention and Response Training
- Spill containment
- Spill Prevention
- Spill Response
- Project Site Map
- Spill Report Form(s)

7.10 Sustainability Management Plan

The East End Crossing shall be delivered and maintained in a manner that reflects the following sustainability elements the project is safe and secure, provides long term security, improves cross river accessibility and mobility, optimizes life-cycle costs, provides economic opportunity, protects and conserves environmental resources, and provides for proactive engagement with the public.

The Developer shall submit a Sustainability Management Plan to the IFA for review and comment. The Sustainability Management Plan shall be a component part of the PMP. The Sustainability Management Plan shall demonstrate how the Developer plans on addressing the sustainability goals and objectives of the East End Crossing during both performance of the Construction Work and the Operating Period.

The Sustainability Management Plan shall address the following sustainability goals and objectives:

- Safety
  - Maintain a safe environment for the public and workers.

- Optimize life-cycle costs
  - Use durable materials.
  - Use recyclable materials.
  - Minimize waste.
  - Consider the impact of ice and snow control materials.

- Provide economic opportunity
  - Achieve diverse workforce goals.
  - Create DBE, small business opportunities and subcontracting.
  - Consider the source of materials based on sustainability principals.

- Protects and conserve environmental resources
  - Use of recycled, recyclable, and waste materials.
  - Use of green infrastructure stormwater management design principles.
  - Protect, conserve and enhance all environmentally sensitive areas.
  - Minimize and eliminate waste.
  - Optimize energy efficiency in construction and operations.

- Improve cross river accessibility and mobility
  - Consider access and amenities along multi-use pathways.
  - Provide and enhance level of service.

- Proactive engagement with the public
  - Communicate the goals and achievements of the sustainability plan with the public.
  - Include sustainability goals, efforts and activities in the Public Involvement Plan.

The Sustainability Management Plan shall include:

- Measurable standards and performance measures to demonstrate that the Developer is meeting the sustainability goals and objectives;
- Means to remedy deviations from the goals and objectives;
- An organizational structure which sets out the roles and responsibilities of Developer's team members as they relate to sustainability;
- A monthly and quarterly reporting and tracking mechanism during construction and operations respectively; and,
- An accepted methodology for evaluation of the performance of the Sustainability Management Plan such as INVEST ("Infrastructure Voluntary Evaluation Sustainability Tool"), Greenroads, or GreenLITES.

The Sustainability Management Plan shall distinguish between the requirements for the Construction Work and the Operating Period. Developer shall update the Sustainability Management Plan every five (5) years during the Operating Period to enable application of new Best Management Practice and which update shall be completed in accordance with the requirements set forth in this Section 7. The revised Sustainability Management Plan and all subsequent updates shall address all operations and maintenance activities including Rehabilitation Work.

7.11 Construction Noise

Disturbance to local residents due to Construction Work operations shall be in accordance with Section 7.6, Federal Permit for Eagle Take to Protect an Interest in a Particular Locality, FHWA *Construction and Noise Handbook (FHWA-HEP-06-02),* and state and local laws and ordinances.

7.12 Environmentally Restricted and No Work Zones

In addition to the requirements of the PPA and Section 7, Developer shall be subject to the access and Construction Work restrictions described below. See RID EV-0.10 for a graphical depiction of the restricted and no work zones.

The work restrictions are based upon the assumption that all permits have been received. Therefore wetlands or streams outside the Reference Design construction limits are considered to be restricted areas; and wetlands or streams within the Reference Design construction limits are considered to be accessible for construction activities in accordance with the restrictions provided in the PPA Documents.

Kentucky

- Drumanard Historic District
  The Drumanard Historic District is on the National Register of Historic Places. A commitment has been made to tunnel under this property to limit adverse impacts to this property. Above ground Work shall be limited to restrictions set forth in Section 16.1.4.1.

- Bald Eagle Nest
  There is a bald eagle nest located approximate 600 feet right of KY 841 Station 172+50. Work activities within ½ mile of the nest are subject to a Federal Fish and Wildlife Permit. The permit places limits on Construction Work to avoid, minimize and mitigate any disturbance of the eagles.

  - Restrictions from November 1 to June 30
    - Blasting and pile driving within ½ mile shall be avoided
    - Timber shall not be removed within 660 feet
  - Restrictions at any time
    - Timber shall not be removed within 330 feet

8 DRAINAGE

8.1 Standards and References

Design and construct the drainage Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 8, Governmental Approvals, and applicable Laws.

8.2 Design Requirements

Developer shall design and construct surface drainage conveyance that ensures effective drainage as it relates to the design requirements. The surface drainage conveyances include but are not limited to storm sewer systems, inlets, culverts, roadside ditches, open channels, water quantity and quality, outlet protection, and energy dissipators. All drainage design and erosion control plans, as indicated herein, shall be submitted to IFA for Design Review. Developer shall coordinate with IFA regarding all Governmental Approval submittals. The mainline drainage design shall meet freeway design standards.

The Final Design Documents and Construction Work shall meet the design requirements of Table 8–1 and Table 8–2 for the appropriate sections of the East End Crossing. These tables are only a summary of the design criteria and are not a comprehensive list of all design requirements. Developer shall verify all design requirements, which includes the criteria listed in Tables 8–1 and 8–2 and Project Standards. Developer shall submit to IFA the drainage design criteria for the East End Crossing for approval with Stage 1 reviews.

Table 8-1 Design Summary for Indiana Approach

Design Criteria		Design Summary	Reference
Hydrologic Parameters	IDNR Coordinated Curves (If available)	Use for stream flow, culverts, and bridges. IDNR Letter of Discharge for all structures that require a Construction in a Floodway Permit	IDM Chapter 29 NOAA Atlas IDNR
	Rational Method	Use for storm sewers, inlets, roadside ditches, and culverts and if tributary area is: < 100 acres in urban setting < 200 acres in rural setting	
	NCRS (TR-20) Method/Program	Use for stream flow, culverts, and detention basins. (Tributary area > 200 acres and < 640 acres.)	
	Refer to IDM Figure 39-6A for discharge selection criteria above		
	Time of Concentration	NRCS (TR-55) Maximum sheet flow = 100 feet Min Tc = 5 minutes	
	Rainfall Data	Obtain from NOAA atlases. Use single gauge.	
	Hydrographs - HUFF	Use Evansville HUFF Distribution	

Design Criteria		Design Summary	Reference
	Distribution (IDM Figure 29-6A)	1st Quartile (6 hours or less) 2nd Quartile (6.1 hours to 12 hours) 3rd Quartile (12.1 hours to 24 hours) 4th Quartile (greater than 24 hrs)	
	Runoff Coefficients	IDM Table 29-7B, 8A, 8B	
	NRCS Curve Numbers	IDM Table 29-10C, 10D, 10E	
Roadside Ditches (Open Channels)	Design Storm	10-year	IDM Figure 29-5A IDM Chapter 30 IDM Chapter 45 IDM Chapter 52
	Design Procedures	Manning's equation	
	Max. Allowable Velocity	Refer to IDM Figure 30-3A.	
	Freeboard	6-12 inches or 2 velocity heads (which ever criteria is greater)	
	Channel Slope Lining	10-year design storm < 1% = seeded channel 1%≤G<3% = sod lined channel ≥3% = paved channel 3%≤G≤10% = riprap lined channel 3%≤G≤15% = soil erosion matting All lining shall be confirmed using the lining selection methodology described in IDM 30-6.03.	
	Ditch Min. Radius	3 times bottom width from centerline of ditch/channel	
	Min. Longitudinal Grad.	0.3% minimum (0.5% desirable)	
	Side Slopes	2:1 max. for riprap lined channels 3:1 max outside of clear zone (30' off the EOP). 6:1 within clear zone (IDM Fig. 45-3A). Verify clear zone criteria with Roadway Specifications. Shall meet clear-zone requirements	
	Shape	Refer to typical cross-sections – 4-ft min. flat bottom.	
	Depth	Refer to underdrain criteria (IDM and Section 9) and Median Drain Outlet Criteria to determine depth limits. Freeboard requirements also govern.	
Culverts	Design Storm	100-year backwater analysis	IDM Figure 29-5A Chapter 31 Chapter 34 Chapter 49
	Allowable Velocities - Freeways, Ramps, Multi-Lane Non Freeways	50-year	
	Allowable Velocities - Two Lane Facilities	50-year for AADT ≥ 3000 25-year for 3000 ≥ AADT≥1000 10-year for AADT<1000	
	Allowable Vel. - Driveways	10-year	
	Culvert Type Priority	Refer to IDM 31-3.05 (01)	
	Culvert Interior/Roughness	Two designs for each culvert using	

Design Criteria		Design Summary	Reference
		n = 0.012 and n = 0.024	
	Min. Size (Diameter)	36 in- Mainline or public road approach (≥3 lanes) 15 in - Public road approach (2 lanes) and drives	
	Alignment	- 45-degree skew maximum	
	Min. Cover (Top of Pipe to Bottom of Pavement)	1' for circular pipes 1.5' for deformed pipes 3-sided structures and boxes - cover to be examined per str. (1' min.)	
	Backwater and Surcharge	Refer to IDM 31-3.04(01)	
	Freeboard	If design storm = Q100 - 2' minimum difference between edge of pavement and headwater. If design storm < Q100 - headwater not to exceed edge of pavement.	
	Minimum Velocity	3 ft/s (Refer to IDM 31-3.04[04])	
	Maximum Velocity and Outlet Protection	V < 6.5 ft/s - Revetment Riprap 6.5 ft/s ≤ V<10 ft/s - Class 1 Riprap 10 ft/s ≤ V<13 ft/s - Class 2 Riprap V≥13 ft/s - Use Energy Dissipator	
	Energy Dissipators	Refer to IDM Chapter 34	
	Tailwater	Refer to IDM 31-5.04(03)	
	End Treatments Sumping	Refer to IDM 31-3.06(02) Refer to IDM 31-3.04(07) and IDM Figure 31-3B(1)	
Spread Criteria	Freeways: Multi-Lane Non-Freeways: Two-Lane Facilities: Bridge Non-Freeway: (V≥ 50 mph) Bridge Non-Freeway: (V< 50 mph) Ramps (V≥ 50 mph): Ramps (V< 50 mph):	Design: 50-yr (Edge of travel lane) Design: 10-yr (Across 1/2 travel lane) Design: 10-yr (4 ft of travel lane) Design: 10-yr (Edge of travel lane) Design: 10-yr (3 ft of travel lane) Design: 10-yr (Edge of travel lane) Design: 10-yr (3 ft of travel lane)	IDM Figure 36-7A
Catch Basins/Inlets	Design	Match design and check storm events for storm sewers.	IDM Chapter 36
	Casting Types Drainage Structure Types	Refer to IDM Figure 36-2A and INDOT Standard Specifications	
	Max. Manhole Spacing	400 ft	
	Inlet Location	Refer to list located in IDM 36-9.03. Place structure prior to radius return on all curbs draining toward intersections and before flat spot in super rollover.	

Design Criteria		Design Summary	Reference
	Inlet Spacing	Dependent on Roadway Spread Criteria (Refer to IDM 36-7 and 36-10.)	
	Inlet at Low Point of Major Sag	50-yr rainfall and runby flow for design Construct Flanking Inlets (IDM 36-12.03)	
Storm Sewer Networks	Design Storm - Freeways	50-yr gravity flow and 50-year HGL	
	Design Storm - Non-Freeways and Ramps	10-yr gravity flow and 50-year HGL (50-yr for major sag point)	
	Minimum Size	12-in diameter	IDM Chap. 28-6.04
	Minimum Slope	Slope to ensure 2.5 ft/s or per IDM Figure 36-12E	IDM Chapter 29 IDM Figure 29-5A
	Invert Elevations	Match pipe crowns or at least 80% of the diff. in pipe sizes, if possible.	IDM Chapter 36 IDM Fig 36-12E
	Min. Cover (Top of Pipe to Bottom of Pavement)	INDOT Standard Drawings	IDM Chapter 36
	Design Velocities	2.5 ft/s min. (flowing full) 6.5 ft/s max. (flowing full)	
Bridges	Bridge Waterway Opening Allowable Backwater	100-year	IDM Chapter 32 IDM Chapter 33 IDM Chapter 38
	Bridge Waterway Opening Allowable Velocity	100-year	
	Bridge Hydraulics	Refer to Chapter 32.	
	Bridge Deck Drainage	Refer to Chapter 33.	
	Scour Countermeasures	Refer to Chapter 38.	
Pipe Material/Type	Type 1	Culvert under roadway	IDM Chap. 28 INDOT Standard Specs. 715.02
	Type 2	Storm pipe	
	Type 3	Culvert under drive or field entrance	
	Type 4	Underdrain or drain tile	
	Type 5	Broken-back pipe or other pipe installation requiring coupled pipes	
Storage Facilities (Water Quantity): Refer to Section 8.2.3 for further detailed information regarding this Design Criteria and IDM Chapter 35.			IDM Chapter 25 FEIS, SFEIS

Table 8-2 Design Summary for Kentucky Approach

Design Criteria		Design Summary	Reference
Hydrologic Parameters	Rational Method	Use for storm sewers, inlets, roadside ditches, and culverts and if tributary area is: < 200 acres	KDM DR-401-11 KDM-DR403-1 KDM-DR404
	Regional Method	> 200 acres Rainfall data and intensities shall be determined from KDM-DR404.	
	NCRS (TR-20) Method/Program	Use for stream flow, culverts, and detention basins.	
	Refer to IDM Figure 39-6A for Discharge Selection Criteria above		
	Time of Concentration	NRCS (TR-55) Maximum sheet flow =300 feet Min Tc = 8 minutes	
	Rainfall Data	Obtain from NOAA atlases (except for regional method). Use longitude and latitude from geometric project center.	
	Hydrographs - NCRS Unit Hydrograph (KDM DR-405)	NCRS Type II 24-hour Distribution (DR Table 405-1)	
	Runoff Coefficients	KYM DR Table 403-1	
	NRCS Curve Numbers	KYM DR Table-405 & 405-3	
Roadside Ditches (Open Channels)	Design Storm	10-year	KYM DR-202-13 DR Table 402-1 KYM DR-502 KYM DR-504 KYM DR-505
	Check Storm	100-year	
	Freeboard	1 foot between 10-year water surface elevation and shoulder elevation	
	Channel Slope Lining	10-year design storm Refer to KYM DR-504 and DR-505 for channel lining hydraulic procedures and lining materials.	
	Ditch Min. Radius	Avoid sharp bends and check for erosion.	
	Min. Longitudinal Grad.	0.5%	
	Side Slopes	Shall meet clear-zone requirements	
	Shape	Refer to Typical Cross-Sections. 2' min. flat bottom	
	Depth	Refer to Underdrain Criteria (Section 9) and Median Drain Outlet Criteria to determine depth limits. Freeboard requirements also govern.	

Design Criteria		Design Summary	Reference
Culverts	Design Storm	10-year for ADT<400 25-year for 400<ADT<2000 25-year for 2000<ADT 50-year for interstate	DR Table 402-1 KDM DR-500s KDM DR-600s KDM DR-705 KDM DR-1000 HD 800 IDM 31
	Check Storm	100-year for ADT<400 100-year for 400<ADT<2000 100-year for 2000<ADT 100-year for interstate	
	Culvert Type Priority	Refer to KDM DR-603-3 and DR-604	
	Culvert Roughness	n = 0.012 (KDM DR-705)	
	Min. Size (Diameter)	15 in to 54 in - Depends on road classification and cover depth (Refer to KDM DR Table 610-1)	
	Alignment	Match existing watercourse if possible. Meet DR-500s, DR-608.2, and DR-608-4.	
	Min. Cover (Top of Structure to Sub-grade) Min. Cover/Desirable Cover	0.5 ft/1.0 in for entrance pipe 1.0 ft/2.0 ft for culverts 1.0 ft/2.0 ft for reinforced conc. box Cast in place concrete box culvert dictated by structural design. (KDM DR 610-5) Refer to KDM DR Table 610-2. If the cover height for a culvert pipe is less than one pipe diameter (or equivalent diameter), flowable fill is required as backfill material up to an elevation of 1' above the top of the pipe.	
	Freeboard	1 foot from design storm headwater to lowest adjacent shoulder elevation	
	Allowable Velocity and Outlet Protection	Velocity calculated to determine erosion control protection and energy dissipators (KDM DR-1000) Developer required to use KDM DR-1000 when it becomes available.	
	Energy Dissipators	Refer to KDM DR-1000	
	Tailwater	Refer to KDM DR-605-5	
	End Treatments	Refer to KDM DR-606 and DR-607	
	Safety Treatments	Refer to KDM DR 606-5 and 608-3	
	Sumping	Refer to IDM 31-3.04(07) and IDM Figure 31-3B(1)	
Spread Criteria	Spread Encroachment Into Driving Lane: Interstate or Parkway: Non Interstate or Parkway:	 0 feet 3 feet	KDM Table 402-1 KDM Table 707-1

Design Criteria		Design Summary	Reference
	ADT > 1500 (V> 45 mph)		KDM DR-707
	Non Interstate or Parkway: ADT > 1500 (V≤ 45 mph)	6 feet	
	Non Interstate or Parkway: ADT < 1500 All Speeds	6 feet	
	10-year design storm and inlet spacing shall be base on 4 in/hr rainfall intensity (Refer to KDM DR Table 402-1 and DR Table 707-1)		
Catch Basins/Inlets	Design	Match design and check storm events for storm sewers	KDM Table 402-1 KDM DR-702 KDM DR-703 KDM DR-704 KDM DR-707
	Casting Types Drainage Structure Types	Refer to KDM DR-702 and DR-703 KYTC Standard Specifications	
	Max. Manhole Spacing	Pipe Size 12 in-24 in - Max. Space 300 ft Pipe Size 27 in-36 in - Max. Space 400 ft Pipe Size 42 in-54 in - Max. Space 500 ft Pipe Size ≥60 in - Max. Space 1000 ft	
	Inlet Location	Refer to list located in KDM DR-702-3	
	Inlet Spacing	Dependent on Roadway Spread Criteria (Refer to KDM DR-704)	
	Inlet At Low Point of Major Sag	Construct Flanking Inlets 25-year design storm (50-year check storm for interstate) - Refer to KDM DR Table 402-1, DR-704-9, and DR-707-2	
Storm Sewer Networks	Design Storm	10-year gravity flow	KDM Table 402-1 KDM DR-610-5 KDM DR-705 KDM DR-706 KDM DR-707
	Design Storm at Sag Point	25-year gravity flow and 50-year HGL check for interstates	
	Check Storm	100-year storm HGL to ensure off-Site impact is acceptable	
	Minimum Size	12 in not under traffic (<25 ft length) 15 in not under traffic (>25 ft length) 15 in-18 in under traffic (Refer to KDM DR 707-5)	
	Minimum Slope	Slope to ensure 2.0 ft/s	
	Min. Cover Under Pavement	1 foot (Top of pipe to bottom of pavement sub-grade). If the cover height for a Storm Sewer Pipe is less than one pipe diameter (or equivalent diameter), flowable fill is required as backfill material up to an elevation of 1' above the top of the pipe.	
	Min. Cover Not Under Pavement	1 foot (Top of pipe to ground)	
	Pipe Interior/Roughness	n=0.012	

Design Criteria		Design Summary	Reference
Bridges	Design Storm	10-year for ADT<400 25-year for 400<ADT<2000 50-year for 2000<ADT 100-year for Interstate	KDM DR-800s KDM DR-702-7 KDM DR-1102
	Check Storm	100-year for ADT<400 100-year for 400<ADT<2000 100-year for 2000<ADT 500-year for interstate	
	Bridge Hydraulics	Refer to KDM DR-800's	
	Bridge Deck Drainage	Refer to KDM DR-702-7 and Storm Sewer Network Criteria.	
	Scour Countermeasures	Design Storm = 100-year Check Storm = 500-year Refer to KDM DR-804.	
Pipe Material/Type	Type 1	Culvert under roadway	IDM Chap. 28 INDOT Stand. Spec. 715.02 KDM DR-602
	Type 2	Storm pipe	
	Type 3	Culvert under drive or field entrance	
	Type 4	Underdrain or drain tile	
	Type 5	Broken-back pipe or other pipe installation requiring coupled pipes	
Storage Facilities (Water Quantity): Refer to Section 26 for further detailed information regarding this design criteria and KDM DR-900s.			KDM DR-900s FEIS, SFEIS,

Developer shall submit signed and stamped Plans and drainage reports for all surface drainage conveyances and drainage structures for Design Review. The calculations and exhibits necessary for IFA review shall follow the submittal guidelines outlined in the IDM.

Presented below is a list of additional design elements and requirements that shall be incorporated into the final Design Documents and Construction Documents:

1. Department Hydraulics may, at its discretion, require submittals of HY-8 computations for review of culverts or other small structures of less than 36 inches in diameter or equivalent size.

2. All drainage structures and apparatuses shall be designed to accommodate all drainage design elements (surface drainage conveyances, water quantity, and water quality) for future widening of the mainline roadway. The mainline (SR 265 and KY 841) will eventually be built out to a six-lane interstate section with full shoulders and 12 foot travel lanes under a separate contract.

3. All culverts located along existing streams and waterways shall be in a sump condition, such that the bottom invert is a maximum of 2 feet lower than the stream bottom/bed. The design of the drainage structure/culvert shall allow natural stream bed material to accumulate throughout the length of the culvert. Sumping requirements shall follow the IDM, including all culverts and required drainage structures in Kentucky.

4. Storm sewer median drain outlets shall be a minimum of 1.00 foot above the ditch flowline elevation.

5. All culverts and storm sewer outlets shall include outlet protection or energy dissipators to be installed during construction. The design criteria for outlet protection and energy dissipators shall follow the IDM and KDM as they pertain to the individual states.

6. All roadside ditches and channels shall have proper channel lining installed to ensure stable and erosion-free ditches and channels. The types of lining include grass/seeded, sod, paved channel, rip-rap, or erosion matting. When performing work in Indiana, Developer shall select the type of channel lining, first based on the slope of the ditch/channel as presented in Table 8-1 and the IDM. Once a lining selection has been made, Developer shall verify the lining stability following the procedures and calculations presented in the IDM. When performing work in Kentucky, Developer shall select the channel lining based on the methodology described in the KDM.

7. For additional requirements for bridge deck drainage for the East End Bridge refer to Section 15.5.19.

8.2.1 Structure Table

Table 8-3 lists anticipated waterways, with crossing culverts and wet bridges. The list is not intended to show all culverts or small structures that will be required to satisfy all of the drainage criteria and concerns as it relates to the East End Crossing and the design standards. If any Governmental Approvals need to be revised due to re-design, Developer shall work through the permitting agencies to acquire the needed Governmental Approvals, in coordination with IFA. Developer shall submit signed and stamped plans and drainage reports for all drainage structures and culverts for Design Review.

Table 8-3 Drainage Structure Table

Structure Type	Stationing	Alignment	Road Classification	Design Runoff, cfs	Description
Bridge	137+47.70 - 149+37.99 (SB) 137+47.70 - 149+77.99 (NB)	KY 841	Freeway	25,190	Bridge Structure No. 1 – Harrods Creek Bridge
Culvert	153+64.55	KY 841	Freeway	99	Middleton Run
Bridge	167+82.86 - 187+51.86 (SB) 167+82.86 - 187+51.86 (SB)	KY 841	Freeway	812,000	Bridge Structure No. 4 – East End Bridge Kentucky Approach Spans
Culvert	225+09.50	A	Freeway	100	Str. No. 1
Bridge	255+22.60-260+14.04 (RT) 255+17.83-260+18.56 (LT)	A	Freeway	1360	Bridge Structures No. 6 & 7 – Lentzier Ck. Tributary
Culvert	267+90	A	Freeway	86	Str. 101, Sect. B
Culvert	18+50	LS-I	Non-Freeway (2-Lane Collector)	44	Str. 103, Sect. B

Structure Type	Stationing	Alignment	Road Classification	Design Runoff, cfs	Description
Culvert	64+95	SWR	Ramps - Freeway	85	Str. 105, Sect. B
Culvert	283+87	A	Freeway	122	Str. 106, Sect. B
Culvert	33+00	LS-I	Non-Freeway (2-Lane Collector)	29	Str. 108, Sect. B
Bridge	295+79.00 - 302+50.00 (RT) 295+79.00 - 302+50.01 (LT)	A	Freeway	650	Bridge Structures No. 9 & 10 – Unnamed Tributary to Lentzier Ck.
Culvert	314+80	A	Freeway	30	Str. 219
Bridge	321+39.19 - 327+72.23 (LT) 321+77.93 - 328+13.90 (RT)	A/LA-EB A/LA-WB	Freeway	2600	Bridge Structures No. 11 & 12 – Lentzier Ck. and Brookhollow Way
Bridge	4+68.21 - 8+67.66	LS-5	Non-Freeway (2-Lane Local St.)	2600	Bridge Structure No. 13 – Brookhollow Way over Lentzier Ck.
Culvert	374+95	A	Freeway	105	Str. 101, Sect. E
Culvert	361+92	A	Freeway	131	Str. 102, Sect. E
Culvert	37+64	LS-4	Non-Freeway (Multi-Lane Arterial)	30	Str. 104, Sect. E
Culvert	32+22	LS-3	Non-Freeway (Multi-Lane Collector)	124	Str. 106, Sect. E
Culvert	35+50	LS-3	Non-Freeway (Multi-Lane Collector)	48	Str. 107, Sect. E
Culvert	708+81	IR-7	Ramps - Freeway	64	Str. 109, Sect. E
Culvert	203+00	IR-2	Ramps - Freeway	35	Str. 112, Sect. E
Culvert	601+02	IR-6	Ramps - Freeway	86	Str. 116, Sect. E
Culvert	1114+50	IR-11	Ramps - Freeway	145	Str. 120, Sect. E
Culvert	617+03	IR-6	Ramps - Freeway	46	Str. 123, Sect. E

8.2.2 Water Quantity (Detention) Requirements

Developer shall be responsible for ensuring that post-construction stormwater discharge does not cause downstream flooding or property damage. The Developer shall follow the most stringent requirement from the Project Standards or local code for each location.

8.2.3 Water Quality

Developer shall be responsible for ensuring that runoff from the East End Bridge and Kentucky Approaches be collected and routed in accordance with Section 7.

8.3 Erosion Control

8.3.1 Erosion Control Plans

Developer shall be responsible for developing Erosion Control Plans (ECPs) for all earth-disturbing activities and the restoration of areas used for temporary impacts. The ECPs shall be developed in conjunction with final Design Documents and Construction Documents. The ECPs shall be created to satisfy all design requirements presented in the IDM Chapter 37 (Temporary Erosion and Sediment Control), KDM Chapter 1000 (Erosion Control), and Department Standard Specifications and Standards Drawings. The ECPs shall also be created to fulfill all IDEM Rule 5 permit, within Indiana, and Kentucky Division of Water (KDOW) Storm Water Pollution Prevention (SWPP) Plan permit, within Kentucky, requirements. The ECPs shall incorporate any pertinent information from Sections 5 and 7. The ECPs will be accepted by IFA, and the IDEM Rule 5 permit and KDOW SWPP permit shall be obtained prior to any earth-disturbing activities. ECPs shall be amended if any revisions to the ECPs take place during construction. The amended ECPs shall be resubmitted to the appropriate authorities and IFA as described in the above mentioned design standards, specifications, and Governmental Approvals.

8.3.2 Erosion Control Supervisor

Developer shall designate one or more employees as an “Erosion Control Supervisor”. The Erosion Control Supervisor shall be a Certified Professional in Erosion and Sediment Control. For additional requirements, refer to the Department Standard Specifications and Recurring Special Provisions 108-C-192.

8.4 Construction Requirements

8.4.1 Storm Pipe

Developer shall specify storm pipe materials according to the Project Standards or approved equals. If Developer chooses to select a pipe material not specified per the Project Standards, then Developer shall submit a design and construction alternative to IFA for review and its good faith approval with the RFC Design and Construction Documents stating the pipe material, its application, and at what location that pipe material will be constructed. Only after IFA has approved the pipe material can Developer consider it an approved equal.

All existing drainage structures that will no longer be used shall either be removed and disposed of off-Site and the trenches backfilled with structure backfill or shall remain in place and be filled with flowable backfill. All existing drainage structures that are to remain in use within the Project ROW limits shall be examined and cleaned.

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9 ROADWAY

9.1 Standards and References

Design and construct the roadway Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 9; Governmental Approvals; and applicable Laws.

9.2 Project Description

The East End Crossing begins in Jefferson County, Kentucky, and ends in Utica Township, Clark County, Indiana. The East End Crossing includes the Kentucky Approach, the Ohio River Bridge, and the Indiana Approach.

9.2.1 Adjustments to the Reference Design

Adjustments to the horizontal and vertical alignments shown on the Reference Design in the RID are allowed, provided the adjustments are consistent with the PPA Documents, Laws, Governmental Approvals, and meet the following requirements:

1. Developer may suggest adjustments that result in design exceptions and the Department's design exception process; however, the Department reserves the right to reject, in its sole discretion, any proposed change that requires a Level One Design Exception or does not otherwise conform to the requirements of the PPA Documents. All adjustments to the East End Crossing shall conform to applicable Laws and Governmental Approvals.

2. IFA reserves the right to reject any proposed adjustment to the Reference Design that require additional 2:1 slopes, additional roadside barrier, or the elimination of the clear zone.

3. The Reference Design horizontal alignments shall not be changed on SR 265 – At Salem Road from Sta. 276+00.00 to Sta. 280+00.00

4. Developer shall not change the location of the East End Crossing termini or the begin/end construction limits along KY 841, SR 265, Port Road, or SR 62.

5. Developer shall not change the horizontal alignment or the profile grade and elevation at the location of the project termini or at the begin/end construction limits along KY 841, SR 265, Port Road or SR 62.

6. Developer shall not revise the SR 265 profile grade and elevation under Salem Road from Sta. 276+00.00 to Sta. 280+00.00. Developer shall ensure that the vertical clearance requirements for SR 265 under Salem Road are met with the final design.

7. The design requirements listed for each roadway shall not be changed unless written approval is received from IFA.

8. Developer shall not eliminate any traffic movements outlined in the Design Requirements.

9. Developer shall not implement any adjustments that cause the proposed level of service (LOS) to fall below the minimum LOS specified in the Design Requirements.

10. Developer shall ensure that the low edge of the proposed KY 841 and SR 265 pavement and shoulder is a minimum of 18 inches above the Ohio River 500-year flood level, which is the design flood level of the Ohio River (El. 457.0 feet using NAVD88).

11. Developer shall determine the final guardrail length-of-need and complete all guardrail calculations based on the requirements of the governing regulations.

12. Bridge substructure elements, superstructure elements and retaining walls shall conform to the sight distance criteria contained in the governing regulations.

13. All superelevation transitions shall be designed according to the American Association of State Highway and Transportation Officials (AASHTO) Geometric Design of Highways and Streets. The emax used in the superelevation calculations shall be 8 percent, AASHTO Method 5, unless specified differently in this Section 9.

14. U-turn median openings shall be placed along the mainline at the following locations:

    a. KY 841 - North of the Tunnel at the location of the Emergency Access Road tie-in point with the mainline.

    b. KY 841 – South of the Tunnel at Sta. 72+00.

    c. SR 265 - At Sta. 220+00.00 "A." This U-turn median opening shall be 30 feet wide.

15. Applicable sign structures and roadway and bridge barrier ends shall be protected.

16. Developer shall design and build a commercial driveway on each side of Sellersburg Road at approximate Sta. 29+50.00. The driveways shall not require any additional right-of-way.

17. Permanent cross-overs north and south of the Tunnel shall be constructed along the mainline for a 45 mph design speed. Locations shall be presented by the Developer to IFA during Design Review for review and comment. Movable barrier meeting the test level required for mainline shall be provided at the cross-overs.

9.3 Design Requirements

See Attachment 09-1 for information on coordinate systems for the Kentucky Approach, East End Main Spans, and the Indiana Approach.

Developer shall not place any garages or other facilities that are necessary for the operation and maintenance of the roadway within the East End Crossing limited access ROW.

IFA will acquire a 22.4 acre excess parcel associated with Parcel 25 in Indiana that will be available for development by Developer for its maintenance facility. Use of all or a portion of this parcel by Developer will be subject to the following conditions for the portion used by Developer:

1. Developer shall be responsible for all site development costs including any associated Environmental Approvals or Governmental Approvals.

2. Developer shall be responsible for all utilities and services associated with the maintenance facility.

3. Developer shall be responsible for any site cleanup, including any hazardous or contaminated materials, required at the end of the Operating Period to prepare the parcel for disposal and sale by IFA.

4. Developer shall remove any dilapidated site improvements at the end of the Operating Period as directed by IFA. Any serviceable site improvements that remain at the end of the Operating Period as agreed by Developer and IFA shall become the property of IFA.

9.3.1 Kentucky Approach

The Kentucky Approach begins in Jefferson County, Kentucky, on existing KY 841 just north of the I-71/I-265 interchange. The project continues northwest along the existing KY 841 corridor to U.S. 42. KY 841 then proceeds north on new alignment to the Ohio River. Developer shall design and construct the following:

1. Overlay and provide the necessary widening on the existing southbound KY 841 lanes from Sta. 0+99.72 to Sta. 11+33.46.

2. From 11+33.46 to the US 42 Interchange, construct a new six-lane divided freeway featuring a concrete median barrier.

3. A four-lane divided freeway (KY 841) on a new alignment from US 42 to 187+51.86. Proposed KY 841 features a concrete median barrier and a variable median width.

4. Reconstruction of the existing southbound KY 841 Ramp to I-71.

5. KY 841 shall be constructed through a Tunnel as described in <u>Section 16</u>. The KY 841 median shall be transitioned on each Tunnel approach to accommodate the Tunnel.

6. A Tunnel Access Road of sufficient width to accommodate maintenance and emergency vehicles safely passing each other shall be built from Shadow Wood Lane to provide permanent maintenance access to the Tunnel control facility.

7. An Emergency Access Road of sufficient width to accommodate maintenance and emergency vehicles safely passing each other shall be built from River Road to allow access to KY 841 between Harrods Creek and the Ohio River.

8. A partial interchange at KY 841/U.S. 42 shall be constructed to allow access from northbound KY 841 to U.S. 42 and from U.S. 42 to southbound KY 841. The existing signalized intersection at KY841/U.S. 42 is not to be reconstructed. Developer shall mitigate any impacts to existing signal equipment (including loops) required to complete the Work. This mitigation shall be coordinate with IFA and KYTC.

9. Approximately 1,150 feet of Wolf Pen Branch Road shall be reconstructed to accommodate the proposed bridge with adequate clearance over KY 841.

10. The following intersections shall be reconfigured:

    a. Wolf Pen Branch Road/Springdale Road

    b. Wolf Pen Branch Road/Olde Creek Way

11. A new intersection shall be constructed for the River Road/Emergency Access Road.
12. River Road shall receive an overlay, and proposed guardrail shall be installed on the north and west side.
13. The east end of Shadow Wood Drive and the portion of Shadow Wood Lane that connects to Shadow Wood Drive shall be removed back to the property lines of the remaining homes.
14. A shared-use path that starts at River Road and travels along the west side of KY 841 then over the Ohio River shall be constructed. The portion of the path from River Road to the East End Bridge shall be constructed in accordance with the Louisville Loop Design Guide RID RD-0.11.

Table 9-1 Project Limits for the Kentucky Approach

Description	Approximate Station Limits (from the Reference Information Documents)
Mainline	
KY 841 SB Overlay	Sta. 0+99.72 to Sta. 11+33.46
KY 841	Sta. 11+33.46 to Sta. 187+51.86
Ramps	
KY 841 SB Ramp to I-71	Sta. 10+00.00 to Sta. 24+42.19
KY 841 NB to U.S. 42 “Ramp A”	Sta. 25+79.96 to Sta. 48+40.00
U.S. 42 to KY 841 SB “Ramp B”	Sta. 12+23.23 to Sta. 42+80.00
Paving Exceptions	
Bridge No. 1 - KY 841 NB Bridge over Harrods Creek/River Road	Sta. 137+47.50 to Sta. 149+78.00
Bridge No. 1 - KY 841 SB Bridge over Harrods Creek/River Road	Sta. 137+47.70 to Sta. 149+38.00
Bridge No. 2 - KY 841 NB Ramp to U.S. 42 over KY 841	Sta. 36+00.00 to Sta. 44+40.00 “Ramp A”
Bridge No. 3 - Wolf Pen Branch Road over KY 841	Sta. 48+73.62 to Sta. 51+06.96
Bridge No. 4 - KY 841 NB Ohio River Bridge Approach	Sta. 167+82.86 to Sta. 187+51.86
Bridge No. 4 - KY 841 SB Ohio River Bridge Approach	Sta. 167+82.86 to Sta. 187+51.86
Local Roads	
Springdale Road	Sta. 10+10.04 to Sta. 13+50.00
Wolf Pen Branch Road	Sta. 43+50.00 to Sta. 55+00.00
Olde Creek Way Connector	Sta. 8+50.00 to Sta. 9+90.00
River Road	Sta. 48+14.28 to Sta. 54+93.19
Emergency Access Road	Sta. 39+16.82 to Sta. 49+50.25
Tunnel Access Road	Sta. 17+81.22 to Sta. 19+98.71
Shared Use Path	Sta. 46+72.62 to Sta. 67+84.65

9.3.2 Indiana Approach

The Indiana Approach consists of new freeway, designated SR 265, which begins at the Ohio River in Utica Township, Clark County, Indiana, and continues west on new alignment past Salem Road, Brookhollow Way, Port Road, SR 62, and Utica Sellersburg Road. SR 265 utilizes the existing alignment west of SR 62 before ending just east of the bridges over existing Jeffersonville-Charleston Road. Developer shall design and construct the following:

1. A four-lane divided freeway (SR 265) on a new alignment from the Ohio River to SR 62. From SR 62 to the west end of the project, the proposed SR 265 will be reconstructed as a four lane freeway on the existing alignment. The total project length along the proposed SR 265 is approximately 3.837 miles. The proposed SR 265 features a four-lane section with a depressed median. Auxiliary lanes are required at the SR 62 interchange.
2. One new and one reconfigured interchange shall be included as part of this project:
    a. A proposed SR 265 interchange shall provide full access to and from Salem Road, with a single-lane entrance and exit ramp in each direction.
    b. A complex interchange shall be constructed at proposed SR 265/SR 62 and Port Road. The existing SR 265 interchange at SR 62 and Port Road shall be reconfigured to make SR 265 the primary mainline route. SR 62 shall be reconstructed with variable width depressed median. Proposed interchange ramps shall be built to accommodate every movement to and from proposed SR 265, SR 62, and Port Road. All SR 265 traffic shall have the option to exit onto either direction of SR 62 or Port Road.
        1) The Developer shall provide uninterrupted traffic movements, meaning no stop or yield conditions, from Port Road to eastbound or westbound SR 265. All SR 62 traffic shall be able to access either direction of SR 265 or Port Road through this complex interchange.
        2) Every movement within the proposed interchange at SR265 / SR 62 and Port Road shall accommodate a truck with a 140-foot trailer along the horizontal and vertical alignments. It is not required that the over sized vehicle or overhang remain within its travel lane however, design considerations shall also include placement of signs, lights, and other permanent features. The only movements exempted from this requirement are the SR 62 to WB SR 265 entrance ramp, WB 265 exit ramp to Port Road, and the EB 265 exit ramp to SR 62.
3. The existing at-grade railroad crossing on SR 62 south of proposed SR 265 shall be reconstructed. Developer shall coordinate this reconstruction with the Railroad.
4. The reconstruction of several local roads shall be a part of this project:
    a. Port Road shall be reconstructed to tie into the SR 265/SR 62 interchange.
    b. Brookhollow Way shall be realigned starting at Boulder Court and travel to the west on a new bridge over Lentzier Creek and under SR 265 before connecting with the north side of the Brookview Drive loop. The east side of the Brookview Drive loop shall be removed and the cul-de-sac on the east corner of Brookview Drive shall be

reconstructed. Brookhollow Way shall remain operable to at least one lane of traffic throughout construction.

c. The cul-de-sac on Springbrook Drive shall be removed, but the west portion of Brookhollow Way from Springbrook Drive to the west shall remain in place.

d. As part of the Brookhollow Way realignment, the intersection at Coyote Court shall be reconfigured, shortening Coyote Court, which leads to the cul-de-sac.

e. The portions of Wood Creek Way and Boulder Court that are located inside the ROW shall be removed.

f. Boulder View Way (Field Drive) shall be removed within the SR 265 ROW.

g. New Chapel Road shall be removed through the proposed SR 265/SR 62 and Port Road interchange.

h. Utica Sellersburg Road shall be reconstructed as a two-lane road with a new bridge over SR 265.

5. A shared-use path shall be constructed on the south side of the proposed SR 265 from the Ohio River to Salem Road. The shared-use path shall be constructed on the south side of the eastbound SR 265 entrance ramp and shall tie in to the shared use path graded along northbound Salem Road as part of Contract IR 34937. The paving for the segment of the path along northbound Salem Road will be constructed as a part of the East End Crossing.

Table 9-2 Project Limits for the Indiana Approach

Description	Approximate Station Limits (from the Reference Information Documents)
Mainline	
SR 265	Sta. 212+74.51 to Sta. 428+63.00 “A”
Ramps	
WB SR 265 Exit to Salem Road	Sta. 80+00.00 to Sta. 92+77.26 “NER”
Salem Road Entrance to EB SR 265	Sta. 100+22.17 to Sta. 110+98.19 “SER”
EB SR 265 Exit to Salem Road	Sta. 58+41.06 to Sta. 69+16.29 “SWR”
Salem Road Entrance to WB SR 265	Sta. 100+22.08 to Sta. 110+42.00 “NWR”
SB SR 62 to WB SR 265	Sta. 100+92.30 to Sta. 118+25.00 “IR-1”
NB SR 62 to WB SR 265	Sta. 201+77.68 to Sta. 204+96.73 “IR-2”
EB SR 265 to NB SR 62	Sta. 308+05.64 to Sta. 327+22.03 “IR-3”
EB SR 265 to SB SR 62	Sta. 1200+93.34 to Sta. 1203+87.74 “IR-3S”
WB SR 265 to SR 62	Sta. 404+50.59 to Sta. 421+43.27 “IR-4”
NB Port Road to WB SR 265	Sta. 501+88.52 to Sta. 512+09.15 “IR-5” (Loop)
NB Port Road to SR 62	Sta. 600+00.00 to Sta. 618+15.08 “IR-6”
WB SR 265 to SB Port Road	Sta. 703+67.58 to Sta. 709+94.07 “IR-7” (Loop)
EB SR 265 to SB Port Road	Sta. 808+50.00 to Sta. 826+10.29 “IR-8”
SR 62 to EB SR 265	Sta. 902+89.16 to Sta. 935+89.17 “IR-9”
SR 62 to SB Port Road	Sta. 1004+58.25 to Sta. 1010+10.01 “IR-10”

Description	Approximate Station Limits (from the Reference Information Documents)
NB Port Road to EB SR 265	Sta. 1110+58.88 to Sta. 1120+93.13 “IR-11”
Paving Exception	
Bridge No. 7 - WB SR 265 over Utica Charleston Road and Lentzier Creek Tributary Des #0900249	Sta. 255+22.60 to Sta. 260+14.04 “A”
Bridge No. 6 - EB SR 265 over Utica Charleston Road and Lentzier Creek Tributary Des #0900248	Sta. 255+17.83 to Sta. 260+18.56 “A”
Bridge No. 10 - WB SR 265 over a Tributary of Lentzier Creek and a field drive Des #0900252	Sta. 295+79.00 to Sta. 302+50.00 “A”
Bridge No. 9 - EB SR 265 over a Tributary of Lentzier Creek and a field drive Des #0900253	Sta. 295+79.00 to Sta. 302+50.00 “A”
Bridge No. 12 - EB SR 265 over Brookhollow Way Bridge Des #0900251	Sta. 321+39.19 to Sta. 327+72.23 “LA-EB”
Bridge No. 11 - WB SR 265 over Brookhollow Way Bridge Des #0900250	Sta. 321+77.93 to Sta. 328+13.90 “LA-WB”
Bridge No. 13 - Brookhollow Way over Lentzier Des # TBD	Sta. 4+68.21 to Sta. 8+67.66 “LS-5”
Bridge No.14 - Utica Sellersburg Road over SR 265 Des # 0900237	Sta. 20+67.62 to Sta. 23+79.26 “LS-2”
Bridge No. 15 - Ramp “IR-1” over RR Des #0900239	Sta. 113+15.81 to Sta. 115+66.76 “IR-1”
Bridge No. 16 - WB SR 265 over RR Des#0900242	Sta. 404+63.32 to Sta. 406+80.38 “LA-WB”
Bridge No. 17 - EB SR 265 over RR Des #0900241	Sta. 405+09.12 to Sta. 407+62.97 “LA-EB”
Bridge No. 18 - Ramp “IR-3” over RR Des #0900240	Sta. 313+55.99 to Sta. 316+05.00 “IR-3”
Bridge No. 19 - WB SR 265 over SR 62 Des #0900243	Sta. 392+47.02 to Sta. 395+07.68 “LA-WB”
Bridge No. 20 - EB SR 265 over SR 62 Des #0900244	Sta. 392+86.10 to Sta. 395+45.79 “LA-EB”
Bridge No. 21 - WB SR 265 over Port Road Des #0900246	Sta. 375+26.25 to Sta. 376+66.75 “LA-WB”
Bridge No. 22 - EB SR 265 over Port Road Des #0900245	Sta. 375+62.64 to Sta. 377+03.14 “LA-EB”
Bridge No. 23 - Ramp “IR-9” over Port Road Des #0900247	Sta. 917+15.88 to Sta. 918+49.00 “IR-9”
Bridge No. 24 - Ramp “IR-8 over Ramp “IR-9” Des #1005117	Sta. 812+15.66 to Sta. 813+94.96 “IR-8”
At-Grade RR Crossing – SR 62	Sta. 21+13.91 to Sta. 21+63.91 “LS-4”
Local Roads	

Description	Approximate Station Limits (from the Reference Information Documents)
Brookhollow Way	Sta. 0+50.00 to Sta. 15+19.31 “LS-5”
Wood Creek Way	Remove inside the ROW limits
Boulder View Way	Remove inside the ROW limits
Port Road	Sta. 15+00.00 to Sta. 43+21.51 “LS-3”
SR 62	Sta. 11+80.47 to Sta. 47+00.00 “LS-4”
Utica Sellersburg Road	Sta. 14+50.00 to Sta. 29+60.00 “LS-2”
Shared-Use Path	Sta. 212+74.51 to Sta. 260+20.00 “B-1”

9.3.3 General Design Standards

1. Clear Zones – IDM required clear zones shall be provided everywhere unless IFA approves the use of roadside barrier at specific locations.

2. Side Slopes – Outside of clear zones, Developer shall use 3:1 side slopes at all locations where Project ROW allows. If the 3:1 slopes cannot be met within the Project ROW and requirements of the Technical Provisions, Developer shall request written approval from IFA to utilize steeper slopes in all locations except where slopes steeper than 3:1 are shown in the Reference Design plans. Upon receiving written IFA approval, Developer may use steeper slopes. The maximum allowable slope is 2:1, but Developer shall attempt to use 2.5:1 slopes prior to using 2:1 slopes. If 2:1 slopes are used within the Indiana Approach, Developer shall prepare a Department Level Two Design Exception to document these locations. Slopes steeper than 3:1 shall be evaluated for stability. Developer shall seed and protect all disturbed slopes that are steeper than 3:1 with biodegradable heavy-duty erosion control blankets in accordance with the Department’s Standard Specifications.

3. Stormwater Runoff – All stormwater runoff within the Project Limits shall be collected in either roadside ditches or enclosed storm sewer.

4. Roadside Ditches – All roadside ditches shall be a minimum of 2 feet deep. Ditches in the Kentucky Approach shall be a minimum of 2 feet wide and ditches in the Indiana Approach shall be 4 feet wide.

5. Rock Cut Sections – Developer shall determine the limits of the rock cut sections based on Developer submitted geotechnical reports. Ditches in rock-cut sections shall be designed to ensure that adequate capacity is provided and that the side slopes will stay within Project ROW limits.

6. Barrier Offset – The barrier offset for the outside shoulders on the Kentucky Approach shall be 0 feet from the effective usable (paved) shoulder to the face of the guardrail or roadside barrier. The barrier offset for the Indiana Approach shall be 2 feet from the effective usable (paved) shoulder to the face of guardrail or barrier.

7. Graded Shoulder Behind Guardrail – For locations where guardrail is required, 2 feet of embankment shall extend 3 feet beyond the face of the guardrail to the hinge point of the front slope. If the 2:1 side slopes cannot be met inside the Project ROW, Developer may request written permission from IFA to reduce the embankment behind the guardrail to 0 feet in areas where doing so shall avoid additional Project ROW impacts.

8. Underdrain – Developer shall install underdrains in all locations of new pavement. Underdrains shall also be installed in rock cut sections.

9. Ramp Axis of Rotation – The interchange ramp axis of rotation shall be located on the ramp alignment, regardless of what side of the ramp the alignment is on.

10. Turning Roadway Design – All loop ramps shall be designed using turning roadway design criteria to determine the lane and shoulder widths, minimum radius, and superelevation.

11. Single Lane Ramps in Kentucky Approach – The typical section for single-lane ramps in the Kentucky Approach shall be a 15-foot travel lane with a 4-foot inside paved shoulder and an 8-foot outside paved shoulder. The clear zone slope shall be 6:1.

12. Single Lane Ramps in Indiana Approach – The typical section for single-lane ramps in the Indiana Approach shall be a 16-foot travel lane with a 4-foot inside paved shoulder and an 8-foot outside paved shoulder. The additional usable shoulder width shall be 1-foot additional width on both sides. The clear zone slope shall be 6:1.

13. Two Lane Ramps – The typical section for dual-lane ramps shall be two 12-foot travel lanes with a 4-foot inside paved shoulder. The outside paved shoulder width shall be 8 feet within the Kentucky Approach and 10 feet within the Indiana Approach. The additional usable shoulder width shall be 1 foot additional width on both sides. The clear zone slope shall be 6:1.

14. Crest Vertical Curves on Ramps – All vertical curves on ramps shall be designed with desirable K values for the given design speed, unless specified otherwise.

15. Ramp Grades – Maximum grade of all ramps shall be 5% for the Indiana Approach and 4% for the Kentucky Approach.

16. Longitudinal Grades on Vertical Curves - Developer shall ensure that the lengths of the bottoms of sag vertical curves or the top of crest vertical curves provide adequate longitudinal grade to provide positive drainage.

17. Sag Vertical Curves - Developer shall not place the low point of a sag vertical curve within the limits of any SR 265/KY 841 bridge or within Tunnel limits.

18. Salem Road Interchange - Developer shall tie the SR 265 interchange ramps into Salem Road, which will be built in Contract IR 34937, Des. No. 0900254. Contract IR 34937 will leave a gap in the shoulders where the proposed ramps were planned to tie into Salem Road. If Developer changes the location of the proposed Salem Road ramps, then Developer shall fully construct the Salem Road shoulders in the gaps using the pavement design in Contract IR 34937.

19. Cable Barrier System - A cable barrier system (CBS) shall be installed in the SR 265 median throughout the entire length of the Indiana Approach. Median slope of 6:1 maximum required where CBS is used.

9.3.4 Specific Design Standards

Table 9-3 KY 841 Design Data

Jurisdictional System	KYTC
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Rural Interstate
Rural/Urban	Rural
Access Control	Full
Design Vehicle	WB-65
Terrain	Rolling
Median Type	Concrete Median Barrier
Traffic Data	
Current Year A.A.D.T. (2010)	South of US 42: 9,300 NB/9,300 SB North of US 42: New Segment
Construction Year A.A.D.T. (2017)	South of US 42: Not Available North of US 42: 21,300 NB/21,300 SB
Design Year A.A.D.T. (2030)	South of US 42: 35,400 NB/35,400 SB North of US 42: 26,000 NB/26,000 SB
Design Hourly Volume (D.H.V.) (2030)	5,600
Directional Distribution (NB/SB)	50/50
Percent Trucks (A.A.D.T.)	South of US 42: 10% North of US 42: 12%
Percent Trucks (D.H.V.)	South of US 42: 10% North of US 42: 12%
Proposed Design Speed	70
Proposed Posted Speed	55
KY 841 Special Features	
KY 841 shall be designed to interstate standards, but shall be designated as a state route.	
The typical section from Sta. 0+99.72 to Sta. 11+33.46 shall have a depressed median with a variable slope. No work shall be done on the northbound lanes in this section while the southbound travel lanes and shoulder shall receive an overlay and shall be widened to the inside to transition from the existing section to the proposed section. The proposed section shall have two (2) 12-foot lanes with an outside paved shoulder 10 feet wide and with an additional 2-foot usable shoulder, and an inside paved shoulder 4 feet wide and with an additional 2 ft usable shoulder.	
The typical section from the beginning of the East End Crossing at Sta. 11+33.46 to the U.S. 42 ramps shall include a 12-foot inside paved shoulder, three (3) 12-foot lanes and a 12-foot outside shoulder (10-foot paved) in each direction. This section shall have standard median barrier. The inside shoulders shall slope towards the median at 4 percent. The travel lanes and outside shoulders shall slope to the outside. The northbound lanes shall be tapered from the existing section to the proposed section.	

The typical section from the U.S. 42 ramps to the south end of the Tunnel shall be widened so that the concrete median barrier rail matches the tunnel cross section. The northbound median paved shoulder shall transition from 12 feet wide to 4 feet wide between the U.S. 42 ramp gores and the south tunnel portal. The southbound median paved shoulder shall transition from 12 feet wide at the U.S. 42 ramp gores to 14 feet wide immediately south of the south tunnel portal, providing a 14-foot uniform width inside shoulder for a minimum length of 500 feet south of the south portal. Two (2) 12-foot lanes shall be built in each direction. The northbound and southbound outside paved shoulders shall be 12 feet. The Developer shall excavate and grade an additional width to allow for eventual completion by others of a pavement section including three (3) 12-foot lanes plus a 4-foot inside paved shoulder and 8-foot outside paved shoulder in each direction. Developer shall ensure that the KY 841 cross section at each Tunnel portal matches the cross section inside the Tunnel.
The typical section through the Tunnel shall include a 4-foot inside paved shoulder, two (2) 12-foot lanes and a 12-foot outside paved shoulder. All lanes shall slope towards the outside unless in a superelevated section. The grade point shall be located within the median shoulder 2 feet from the toe of the inside median barrier. The minimum vertical clearance shall be 17 feet with a minimum distance to any mechanical equipment or lighting of 17 feet 6 inches.
The typical section from the north end of the Tunnel to the bridges over Harrods Creek shall be built with a 4 foot median paved shoulder and two (2) 12-foot lanes in each direction. The inside paved shoulder shall transition to 12 feet wide south of the bridges over Harrods Creek. All lanes shall slope towards the outside unless in a superelevated section. The Developer shall excavate and grade an additional width, to allow for future widening by others of the pavement section to include three (3) 12-foot lanes and a 4-foot inside paved shoulder and 8-foot outside paved shoulder in each direction.
The typical section from Harrods Creek to the East End Bridge shall include a 12-foot inside paved shoulder, two (2) 12-foot lanes and a 12-foot outside paved shoulder in each direction. All lanes shall slope towards the outside. Developer shall excavate and grade an additional width to allow for eventual completion by others of a pavement section including three (3) 12-foot lanes plus a 4-foot inside paved shoulder and 8-foot outside paved shoulder in each direction.
All roadway, shoulder, and median tapers shall be according to the standard KYTC taper rates unless specified otherwise.
For all sections with guardrail, the paved shoulders shall extend to the face of the guardrail, and the graded shoulder shall extend 3 feet beyond the face of the guardrail.
The clear zone width on tangents shall be 30 feet with 6:1 clear zone slopes. Where rock wall faces are required within the clear zone due to ROW constraints, barrier rail shall be placed at the edge of outside shoulder and the rock face shall be a minimum of 24 feet from the outside edge of the outside travel lane. If the rock is supported by retaining wall, a barrier rail shall be constructed in front of the retaining wall, and the rail constructed 12 feet from the outside edge of the outside travel lane.
All KY 841 superelevation transitions shall be calculated for three (3) lanes in each direction and any additional auxiliary lanes. The point of rotation shall be about the profile grade line.
The profile grade line location shall take into account the future section with three (3) 12 foot travel lanes.
The additional usable shoulder width shall be 2 feet except in locations where the barrier offset is required. The usable shoulder does not include any grading required for the third lane.
All crest and sag vertical curves shall be designed to desirable standards for 70 mph.
The minimum profile grade shall be 0.50 percent. The maximum profile grade shall be 4.00 percent.

Table 9-4 SR 265 Design Data

Jurisdictional System	INDOT
Project Design Criteria	4R New Construction (Freeway)
Design Functional Classification	Principal Arterial
Rural/Urban	Rural
Access Control	Full
Design Vehicle	WB-65
Terrain	East of SR 62 – Rolling; West of SR 62 - Level
Median Type	Depressed Median
Traffic Data	
Current Year A.A.D.T. (2010)	West of SR 62 – 12,700 EB/12,700 WB
Construction Year A.A.D.T. (2017)	East of Salem Road – 21,300 EB/21,300 WB Salem Road to SR 62 – 16,000 EB/16,000 WB
Design Year A.A.D.T. (2030)	East of Salem Road – 26,000 EB/26,000 WB Salem Road to SR 62 - 19,500 EB/19,500 WB West of SR 62 – 29,700 EB/29,700 WB
Design Hourly Volume (D.H.V.) (2030)	East of Salem Road – 3,600 EB/3,300 WB Salem Road to SR 62 – 3,400 EB/2,800 WB West of SR 62 – 3,600 EB/3,700 WB
Directional Distribution (EB/WB)	50/50
Percent Trucks (A.A.D.T.)	East of Salem Road – 12% Salem Road to SR 62 – 15% West of SR 62 – 16%
Percent Trucks (D.H.V.)	East of Salem Road – 7% EB/8% WB Salem Road to SR 62 – 8% EB/11% WB West of SR 62 – 10% EB/13% WB
Proposed Design Speed	70
Proposed Posted Speed	55
SR 265 Special Features	
SR 265 shall be designed to interstate standards, but shall be designated as a state route.	
The typical section shall consist of two (2) 12-foot lanes in each direction with a 12-foot outside paved shoulder and a 4-foot inside paved shoulder. The usable shoulders shall be 1 additional width on both sides.	
The profile grade line and axis of rotation shall be located between the two lanes.	
The depressed median slope shall be a maximum of 4:1 with guardrail and 6:1 in all other locations.	
The clear zone width on tangents shall be 30 feet with 6:1 clear zone slopes.	
The median width shall be tapered from the Ohio River Bridge to a minimum of 54.5 feet.	
All crest and sag vertical curves shall be designed to desirable standards for 70 mph.	
The minimum profile grade shall be 0.30 percent.	
The paved shoulders shall consist of full-depth pavement that matches the travel lane pavement design.	
All vertical clearance, superelevation and other applicable design calculations shall assume that a future third lane will be built on the inside of the median along SR 265. The future typical section includes an additional 12-foot lane and a 14-foot paved shoulder in each direction with concrete median barrier.	

Table 9-5 SB KY 841 Ramp to I-71 Design Data

Jurisdictional System	KYTC
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Rural
Access Control	Full
Design Vehicle	WB-65
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	3,960
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	10,400
Design Hourly Volume (D.H.V.) (2030)	1,100
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	2%
Percent Trucks (D.H.V.)	2%
Proposed Design Speed	45
Proposed Posted Speed	45
SB KY 841 to I-71 Ramp Special Features	
For all sections with guardrail, the paved shoulders shall extend to the face of the guardrail, and the graded shoulder shall extend 3 feet beyond the face of the guardrail.	

Table 9-6 KY 841 NB to U.S. 42 Ramp “A” Design Data

Jurisdictional System	KYTC
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Rural
Access Control	Full
Design Vehicle	WB-65
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	8,828
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	9,400
Design Hourly Volume (D.H.V.) (2030)	1,000
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	7%
Percent Trucks (D.H.V.)	7%
Proposed Design Speed	50
Proposed Posted Speed	50

Ramp "A" Special Features
The ramp design shall accommodate a future third lane on KY 841. See the KY 841 special features for more details.
The crest vertical curve shall have a minimum K value of 84 (50 mph).
The minimum profile grade shall be 0.50 percent.
The allowable barrier offset for Ramp A shall be 0 feet.

Table 9-7 U.S. 42 to KY 841 SB Ramp "B" Design Data

Jurisdictional System	KYTC
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Rural
Access Control	Full
Design Vehicle	WB-65
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	8,828
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	9,400
Design Hourly Volume (D.H.V.) (2030)	1,000
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	6%
Percent Trucks (D.H.V.)	6%
Proposed Design Speed	50
Proposed Posted Speed	50
Ramp "B" Special Features	
The ramp design shall accommodate a future third lane on KY 841. See the KY 841 special features for more details.	
The crest vertical curve shall have a minimum K value of 84 (50 mph).	
The minimum profile grade shall be 0.50 percent.	
The allowable barrier offset for Ramp B shall be 0 feet.	

Table 9-8 WB SR 265 Exit to Salem Road Ramp "NER" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Rolling
Median Type	N/A

Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	8,000
Design Hourly Volume (D.H.V.) (2030)	600
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	2%
Percent Trucks (D.H.V.)	2%
Proposed Design Speed	45
Proposed Posted Speed	45
Ramp "NER" Special Features	
None Specified	

Table 9-9 Salem Road Entrance to EB SR 265 Ramp "SER" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	6,600
Design Year A.A.D.T. (2030)	8,000
Design Hourly Volume (D.H.V.) (2030)	700
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	3%
Percent Trucks (D.H.V.)	1%
Proposed Design Speed	45
Proposed Posted Speed	45
Ramp "SER" Special Features	
None Specified	

Table 9-10 EB SR 265 Exit to Salem Road Ramp "SWR" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	1,200
Design Year A.A.D.T. (2030)	1,500
Design Hourly Volume (D.H.V.) (2030)	200
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	13%
Percent Trucks (D.H.V.)	9%
Proposed Design Speed	45
Proposed Posted Speed	45
Ramp "SWR" Special Features	
None Specified	

Table 9-11 Salem Road Entrance to WB SR 265 Ramp "NWR" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	1,500
Design Hourly Volume (D.H.V.) (2030)	200
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	11%
Percent Trucks (D.H.V.)	9%
Proposed Design Speed	45
Proposed Posted Speed	45
Ramp "NWR" Special Features	
None Specified	

Table 9-12 SB SR 62 to WB SR 265 Ramp "IR-1" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	11,000
Design Year A.A.D.T. (2030)	13,400
Design Hourly Volume (D.H.V.) (2030)	1,425
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	10%
Percent Trucks (D.H.V.)	8%
Proposed Design Speed	30-50
Proposed Posted Speed	N/A
Ramp "IR-1" Special Features	
None Specified	

Table 9-13 NB SR 62 to WB SR 265 Ramp "IR-2" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	3,500
Design Hourly Volume (D.H.V.) (2030)	225
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	10%
Percent Trucks (D.H.V.)	8%
Proposed Design Speed	25
Proposed Posted Speed	25
Ramp "IR-2" Special Features	
None Specified	

Table 9-14 EB SR 265 to NB SR 62 Ramp "IR-3" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	8,100
Design Year A.A.D.T. (2030)	9,900
Design Hourly Volume (D.H.V.) (2030)	875
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	10%
Percent Trucks (D.H.V.)	8%
Proposed Design Speed	25-50
Proposed Posted Speed	N/A
Ramp "IR-3" Special Features	
None Specified	

Table 9-15 EB SR 265 to SB SR 62 Ramp "IR-3S" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	2,900
Design Year A.A.D.T. (2030)	3,500
Design Hourly Volume (D.H.V.) (2030)	325
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	9%
Percent Trucks (D.H.V.)	7%
Proposed Design Speed	25
Proposed Posted Speed	25
Ramp "IR-3S" Special Features	
None Specified	

Table 9-16 WB SR 265 to SR 62 Ramp "IR-4" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	3,400
Design Year A.A.D.T. (2030)	4,100
Design Hourly Volume (D.H.V.) (2030)	850
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	5%
Percent Trucks (D.H.V.)	3%
Proposed Design Speed	30-50
Proposed Posted Speed	N/A
Ramp "IR-4" Special Features	
The minimum profile grade in curbed sections is 0.50 percent.	

Table 9-17 NB Port Road to WB SR 265 Ramp "IR-5" (Loop) Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	Not Available
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	1,800
Design Hourly Volume (D.H.V.) (2030)	325
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	45%
Percent Trucks (D.H.V.)	31%
Proposed Design Speed	30 (Loop)
Proposed Posted Speed	N/A
Ramp "IR-5" Special Features	
None Specified	

Table 9-18 NB Port Road to SR 62 Ramp "IR-6" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	4,500
Design Year A.A.D.T. (2030)	5,500
Design Hourly Volume (D.H.V.) (2030)	1,025
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	5%
Percent Trucks (D.H.V.)	3%
Proposed Design Speed	30-45
Proposed Posted Speed	N/A
Ramp "IR-6" Special Features	
The minimum profile grade in curbed sections is 0.50 percent.	

Table 9-19 WB SR 265 to SB Port Road Ramp "IR-7" (Loop) Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	900
Design Hourly Volume (D.H.V.) (2030)	75
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	10%
Percent Trucks (D.H.V.)	12%
Proposed Design Speed	30 (Loop)
Proposed Posted Speed	N/A
Ramp "IR-7" Special Features	
None Specified	

Table 9-20 EB SR 265 to SB Port Road Ramp "IR-8" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	2,700
Design Hourly Volume (D.H.V.) (2030)	300
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	27%
Percent Trucks (D.H.V.)	28%
Proposed Design Speed	40-50
Proposed Posted Speed	N/A
Ramp "IR-8" Special Features	
The minimum profile grade in curbed sections is 0.50 percent.	
The crest vertical curve shall have a minimum K value of 84.	

Table 9-21 SR 62 to EB SR 265 Ramp "IR-9" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	4,500
Design Year A.A.D.T. (2030)	5,900
Design Hourly Volume (D.H.V.) (2030)	1,175
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	3%
Percent Trucks (D.H.V.)	3%
Proposed Design Speed	30-50
Proposed Posted Speed	N/A
Ramp "IR-9" Special Features	
The minimum profile grade in curbed sections shall be 0.50 percent. The crest vertical curve shall have a minimum K value of 84 (50 mph).	

Table 9-22 SR 62 to SB Port Road Ramp "IR-10" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	500
Design Hourly Volume (D.H.V.) (2030)	125
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	4%
Percent Trucks (D.H.V.)	4%
Proposed Design Speed	30
Proposed Posted Speed	30
Ramp "IR-10" Special Features	
The crest vertical curve shall have a minimum K value of 23. If configuration is changed, then the desirable K value for a crest vertical curve shall be met).	

Table 9-23 NB Port Road to EB SR 265 Ramp "IR-11" Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Freeway)
Design Functional Classification	Interchange Ramp
Rural/Urban	Urban (Suburban)
Access Control	Full
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	New Segment
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	900
Design Hourly Volume (D.H.V.) (2030)	175
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	8%
Percent Trucks (D.H.V.)	6%
Proposed Design Speed	45
Proposed Posted Speed	45
Ramp "IR-11" Special Features	
None Specified	

Table 9-24 Springdale Road Design Data

Jurisdictional System	Jefferson County
Project Design Criteria	New Construction 3R (Non-Freeway)
Design Functional Classification	Local
Rural/Urban	Rural
Access Control	None
Design Vehicle	SU
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	3,760
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	4,970
Design Hourly Volume (D.H.V.) (2030)	545
Directional Distribution	50/50
Percent Trucks (A.A.D.T.)	N/A
Percent Trucks (D.H.V.)	N/A
Proposed Design Speed	35
Proposed Posted Speed	35
Springdale Road Special Features	
The typical section shall include a 10-foot travel lane with a 3-foot usable shoulder in each direction. The normal cross slope shall be 2 percent with the centerline, crown, and grade point in the center of the road. The usable shoulders shall be 8 percent with 6:1 desirable slopes.	
The minimum profile grade shall be 0.50 percent. The maximum profile grade shall be 5.00 percent.	

Table 9-25 Wolf Pen Branch Road Design Data

Jurisdictional System	Jefferson County
Project Design Criteria	New Construction 3R (Non-Freeway)
Design Functional Classification	Local
Rural/Urban	Rural
Access Control	None
Design Vehicle	SU
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	4,700
Construction Year A.A.D.T. (2017)	Not Available
Design Year A.A.D.T. (2030)	6,200
Design Hourly Volume (D.H.V.) (2030)	640
Directional Distribution	50/50
Percent Trucks (A.A.D.T.)	3%
Percent Trucks (D.H.V.)	3%
Proposed Design Speed	35
Proposed Posted Speed	35

Wolf Pen Branch Road Special Features
The typical section shall include a 10-foot travel lane with a 3-foot paved shoulder in each direction. The normal cross slope shall be 2 percent with the centerline, crown, and grade point in the center of the road. The left side from Springdale Road to Olde Creek Way shall have 6-inch curb and gutter on the outside of the 3-foot shoulder with a 6-foot sidewalk sloping back towards the road at 2 percent. The usable shoulders shall be 8 percent with 4:1 desirable slopes. The side slopes shall be 4:1 desirable, unless ROW constraints require the use of steeper slopes. The maximum slopes allowed shall be 2:1.
The minimum profile grade shall be 0.50 percent. The maximum profile grade shall be 5.00 percent. Minimum stopping sight distance shall meet 45 mph for overpass.

Table 9-26 Olde Creek Way Connector Design Data

Jurisdictional System	Jefferson County
Project Design Criteria	Intersection with Local Road
Design Functional Classification	Local
Rural/Urban	Rural
Access Control	None
Design Vehicle	SU
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	N/A
Construction Year A.A.D.T. (2017)	N/A
Design Year A.A.D.T. (2030)	N/A
Design Hourly Volume (D.H.V.) (2030)	N/A
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	N/A
Percent Trucks (D.H.V.)	N/A
Proposed Design Speed	35
Proposed Posted Speed	35
Olde Creek Way Connector Special Features	
The typical section shall include a 10-foot travel lane and no shoulder in each direction. Each side shall have standard 6-inch curb header with a 2 percent slope back towards the road for a distance of 7.42 feet. The normal cross slope shall be 2 percent with the centerline, crown, and grade point in the center of the road. The side slopes shall be 4:1, unless ROW constraints require the use of steeper slopes. The maximum slopes allowed shall be 2:1.	
The minimum profile grade shall be 0.50 percent. The maximum profile grade shall be 5.00 percent.	

Table 9-27 River Road Design Data

Jurisdictional System	Jefferson County
Project Design Criteria	Overlay Existing Pavement
Design Functional Classification	Local
Rural/Urban	Rural
Access Control	Full
Design Vehicle	SU
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	5,600
Construction Year A.A.D.T. (2017)	N/A
Design Year A.A.D.T. (2030)	12,700
Design Hourly Volume (D.H.V.) (2030)	N/A
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	16%
Percent Trucks (D.H.V.)	16%
Proposed Design Speed	35
Proposed Posted Speed	35
River Road Special Features	
A 1¼-inch overlay shall be placed over the existing pavement which consists of one (1) 10-foot travel lane in each direction. In areas where guardrail is required, the proposed guardrail shall be placed so the face of the rail is 2 feet from the edge of travel lane.	
At the beginning and end of construction, the overlay shall be tapered in to match the existing pavement at a transition rate of 1:120.	

Table 9-28 Emergency Access Road Design Data

Jurisdictional System	KYTC
Project Design Criteria	New Construction (Non-Freeway)
Design Functional Classification	Local
Rural/Urban	Rural
Access Control	Full
Design Vehicle	BUS-40
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	N/A
Construction Year A.A.D.T. (2017)	N/A
Design Year A.A.D.T. (2030)	N/A
Design Hourly Volume (D.H.V.) (2030)	N/A
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	N/A
Percent Trucks (D.H.V.)	N/A
Proposed Design Speed	25
Proposed Posted Speed	25

Emergency Access Road Special Features
The maximum profile grade shall be 5.00 percent.
The typical section of the Emergency Access Road includes a single 16-foot lane with a 2-foot full depth paved shoulder on each side. Guardrail shall be installed on the right side of the alignment. The shoulder shall be paved to the face of the guardrail and a 3-foot graded shoulder shall be constructed from the face of the guardrail to the hinge point of the slope. A V-ditch on the left side shall have a 4:1 front slope for 4 feet.

Table 9-29 Tunnel Access Road Design Data

Jurisdictional System	KYTC
Project Design Criteria	New Construction-Access Road
Design Functional Classification	Local
Rural/Urban	Rural
Access Control	Full
Design Vehicle	BUS-40
Terrain	Rolling
Median Type	N/A
Traffic Data	
Minimum Level of Service	N/A
Current Year A.A.D.T. (2010)	N/A
Construction Year A.A.D.T. (2017)	N/A
Design Year A.A.D.T. (2030)	N/A
Design Hourly Volume (D.H.V.) (2030)	N/A
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	N/A
Percent Trucks (D.H.V.)	N/A
Proposed Design Speed	N/A
Proposed Posted Speed	N/A
Tunnel Access Road Special Features	
The maximum profile grade shall be 14.00 percent.	
The typical section of the Tunnel Access Road includes a single 16-foot lane with a 1-foot aggregate shoulder on each side. Each side shall have 2:1 cut or fill slopes.	

Table 9-30 Brookhollow Way (Line “LS-5”) Design Data

Jurisdictional System	INDOT
Project Design Criteria	3R (Non-Freeway)
Design Functional Classification	Local Street
Rural/Urban	Urban (Suburban/Built-Up)
Access Control	None
Design Vehicle	SU
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	1,100
Construction Year A.A.D.T. (2017)	N/A

Design Year A.A.D.T. (2030)	1,500
Design Hourly Volume (D.H.V.) (2030)	150
Directional Distribution	50/50
Percent Trucks (A.A.D.T.)	1%
Percent Trucks (D.H.V.)	1%
Proposed Design Speed	20
Proposed Posted Speed	20
Brookhollow Way Special Features	
Brookhollow Way shall be realigned to fit between the proposed SR 265 bridge piers. The realignment shall start just west of Boulder Court and Brookhollow Way shall be relocated to tie into Brookview Drive. The existing Brookhollow Way shall be removed within the limits of the realignment. A bridge on Brookhollow Way shall be built over Lentzier Creek and under SR 265.	
The typical section on the east side of the bridge shall include a 12-foot travel lane in each direction. The right side does not have a shoulder while the left paved shoulder shall be 0 feet wide until a 150-foot transition from 0 feet to 4 feet just before the bridge. Each side shall have concrete curb and gutter and shall have a 5-foot graded bench behind the curb with a 12:1 slope (may use a maximum 8:1 slope if ROW constraints force the use of steeper slopes). The normal cross slope of the travel lanes and the paved shoulders shall be 2 percent with the centerline, crown and grade point in the center of the road. The clear zone width on tangents shall be 10 feet wide with 6:1 clear zone slopes. The side slopes shall be 3:1 unless ROW constraints require the use of steeper slopes. The maximum slopes allowed shall be 2:1.	
The typical section on the west side of the bridge shall include a 12-foot travel lane and a 4-foot paved shoulder in each direction. The normal cross slope of the travel lanes and the paved shoulders shall be 2 percent with the centerline, crown, and grade point in the center of the road. The clear zone width on tangents shall be 10 feet wide with 6:1 slopes within the clear zone. The side slopes shall be 3:1 with a 4-foot bottom ditch. If ROW constraints require the use of steeper slopes, the maximum slopes allowed shall be 2:1.	
The minimum profile grade shall be 0.50 percent. The maximum profile grade shall be 8.00 percent.	

Table 9-31 Port Road (Line “LS-3”) Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Non-Freeway)
Design Functional Classification	Collector
Rural/Urban	Urban (Suburban)
Access Control	Full/Partial
Design Vehicle	WB-65
Terrain	Level
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	N/A
Construction Year A.A.D.T. (2017)	N/A
Design Year A.A.D.T. (2030)	8,200
Design Hourly Volume (D.H.V.) (2030)	1,150
Directional Distribution	50/50

Percent Trucks (A.A.D.T.)	43%
Percent Trucks (D.H.V.)	33%
Proposed Design Speed	30
Proposed Posted Speed	30
Port Road Special Features	
The typical section shall include a 12-foot travel lane, an 8-foot outside paved shoulder and a 1-foot additional width usable shoulder in each direction. The clear zone width on tangents shall be 15 feet with 6:1 clear zone slopes. The side slopes shall be a maximum of 3:1 and any required ditches shall be 4 feet wide. The crown and the profile grade line shall be placed in the center of the road. The normal cross slope of the travel lanes is 2 percent. The horizontal alignment shall be designed using low speed urban criteria.	
In locations where median concrete barrier is required, 6-inch concrete curb and gutter shall be placed on the outside of the paved shoulder, and the proposed grading from the back of the curb to the barrier shall slope back towards the curb at a rate of 20:1.	
Auxiliary lanes shall be developed to tie Port Road into the SR 265/SR 62 interchange. The minimum auxiliary lane width along SR 62 is 12 feet, and the minimum auxiliary lane paved shoulder width is 8 feet.	
Port Road traffic shall have direct access to both directions of SR 265 and SR 62 through interchange ramps.	
The minimum profile grade shall be 0.00 percent in uncurbed sections and 0.50 percent in curbed sections. The maximum profile grade shall be 5.00 percent.	

Table 9-32 SR 62 (Line “LS-4”) Design Data

Jurisdictional System	INDOT
Project Design Criteria	New Construction (Non-Freeway)
Design Functional Classification	Arterial
Rural/Urban	Urban (Suburban)
Access Control	Full/Partial
Design Vehicle	WB-65
Terrain	Level
Median Type	Raised Median
Traffic Data	
Current Year A.A.D.T. (2010)	10,300 NB/10,300 SB
Construction Year A.A.D.T. (2017)	N/A
Design Year A.A.D.T. (2030)	South of SR 265 – 15,500 NB/15,500 SB North of SR 265 – 20,400 NB/20,400 SB
Design Hourly Volume (D.H.V.) (2030)	South of SR 265 – 1,775 NB/1,575 SB North of SR 265 – 2,075 NB/2,350 SB
Directional Distribution (NB/SB)	50/50
Percent Trucks (A.A.D.T.)	South of SR 265 – 5% NB/4% SB North of SR 265 – 8% NB/7% SB
Percent Trucks (D.H.V.)	South of SR 265 – 2% NB/4% SB North of SR 265 – 5% NB/6% SB
Proposed Design Speed	45
Proposed Posted Speed	45

SR 62 Special Features
The typical section shall include 12-foot travel lanes, a 10-foot outside paved shoulder with a 1-foot additional width usable shoulder, and 6-inch concrete curb and gutter on the left edge of the inside travel lane in each direction. The clear zone width on tangents shall be 20 feet with 6:1 clear zone slopes. The side slopes shall be a maximum of 3:1, and any required ditches shall be 4 feet wide. The inside travel lane shall slope towards the median at 2 percent. The crown and the profile grade line for each direction shall be placed along the outside edge of the inside lane. The raised island median shall be a minimum of 16 feet wide and shall be constructed from the beginning of construction to the end of construction. In the curb and gutter sections, the median shall be crowned at the SR 62 centerline, shall be sloped down towards the roadway at 2 percent, and shall be sodded. The maximum median slope shall be 6:1 and shall be used only in areas of incidental construction where curb and gutter is not constructed along the median edge of the inside lane.
The incidental construction shall include a 73-foot taper on the south end and a 330-foot taper on the north end, where the road shall transition to match the existing pavement and shoulders.
If the SR 62 interchange is constructed as a Diverging Diamond Interchange (DDI), the reverse curves associated with the DDI shall be constructed as 14-foot lanes through the DDI crossovers from approximate Sta. 22+00 to Sta. 28+00 and from Sta. 32+00 to Sta. 39+00. The lanes shall be widened at the appropriate locations from 12 feet to 14 feet to provide for the turning movements of the design vehicle. The crossovers shall be designed using low speed urban criteria for a crown section.
The minimum profile grade shall be 0.30 percent. The maximum profile grade shall be 5.00 percent.
The minimum auxiliary lane width along SR 62 is 12 feet, and the minimum auxiliary lane paved shoulder width is 4 feet.
SR 62 shall have an at-grade railroad crossing from Sta. 21+13.91 to Sta. 21+63.91. Developer shall design the proposed interchange geometry and traffic control to avoid conflicts with the railroad.

Table 9-33 Utica Sellersburg Road (Line “LS-2”) Design Data

Jurisdictional System	INDOT
Project Design Criteria	Reconstruction (Non-Freeway)
Design Functional Classification	Collector
Rural/Urban	Urban (Suburban)
Access Control	None
Design Vehicle	WB-65
Terrain	Rolling
Median Type	N/A
Traffic Data	
Current Year A.A.D.T. (2010)	South of Surry Road: 1,450 North of Sundancer: 2,200
Construction Year A.A.D.T. (2017)	N/A
Design Year A.A.D.T. (2030)	South of Surry Road: 3,500 North of Sundancer: 5,000
Design Hourly Volume (D.H.V.) (2030)	N/A
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	7%
Percent Trucks (D.H.V.)	7%
Proposed Design Speed	35
Proposed Posted Speed	35
Utica Sellersburg Road Special Features	
The typical section shall include an 11-foot travel lane, an 8-foot paved shoulder, and a 1-foot additional width usable shoulder in each direction. The normal cross slope of the travel lanes and the paved shoulders shall be 2 percent with the centerline, crown, and profile grade in the center of the road. The clear zone width shall be 12 feet wide with 6:1 clear zone slopes. The side slopes shall be 3:1, and any required ditches shall have a 4-foot bottom.	
The incidental construction shall include a 170-foot taper on the south end and a 70-foot taper on the north end where the road shall transition to match the existing pavement and shoulders.	
Crest vertical curves shall be designed for a K value of 44 (designed for 35 mph).	
The minimum profile grade shall be 0.00 percent. The maximum profile grade shall be 5.00 percent.	
Two commercial driveways shall be added off of Utica Sellersburg Road. One drive shall be located on each side of the road at approximate Sta. 29+50. The drives shall be constructed entirely within the ROW. Temporary ROW will not be available.	

Table 9-34 Shared Use Path (Line "B-1") Design Data

Jurisdictional System	Jefferson County, KYTC – Kentucky Approach; INDOT – Indiana Approach
Project Design Criteria	N/A
Design Functional Classification	Local
Rural/Urban	Rural
Access Control	None
Design Vehicle	N/A
Terrain	Rolling
Median Type	N/A
Traffic Data	
Minimum Level of Service	N/A
Current Year A.A.D.T. (2010)	N/A
Construction Year A.A.D.T. (2017)	N/A
Design Year A.A.D.T. (2030)	N/A
Design Hourly Volume (D.H.V.) (2030)	N/A
Directional Distribution	N/A
Percent Trucks (A.A.D.T.)	N/A
Percent Trucks (D.H.V.)	N/A
Proposed Design Speed	25
Proposed Posted Speed	25
Shared Use Path Special Features	
The paved width of the path in Kentucky and Indiana shall be 13 feet except for the reduced width for the path across the East End Bridge.	
The path within the Kentucky Approach shall be separated from KY 841 by a 42-inch concrete barrier at all times when the path is either within the KY 841 clear zone limits or adjacent to the shoulder. Minimum clearances shall be in accordance with IDM 51-7.05(02).	
The path within the Indiana Approach shall be separated from SR 265 mainline and ramp traffic by a 42-inch concrete barrier wall and from Salem Road traffic by guardrail and a chain-link fence.	
The maximum profile grade shall be 5.00 percent.	

9.4 Design Exceptions

The only design exceptions currently allowed on the East End Crossing are listed below.

Level One Design Exception

1. Superelevation Transition (Attachment 09-2) – A Level One Design Exception, as defined in the Project Standards, is in the process of being approved by IFA for the superelevation transition that ties into the existing transition at the west end of the SR 265 project limits. The overall superelevation transition length meets the design standards, but the distribution of the transition on/off the curve does not. IDM Figure 43-3F states that the superelevation transition for two lanes at 70 mph shall have 20 percent of the transition on the curve and 80 percent on the tangent. The Reference Information Documents show 100 percent of the eastbound SR 265 superelevation transition on the tangent.

2. Shoulder Width (Attachment 09-3) – A Level One Design Exception is in the process of being approved by the Department for the eastbound SR 265 outside shoulder width between the SR 62 Entrance Ramp (IR-1) and the existing bridge over the CSX Railroad. The design exception is necessary to transition from the required shoulder width to the existing bridge shoulder width at the end of the project.

Level Two Design Exception

1. Side Slopes – Developer shall prepare a Level Two Design Exception, as defined in the Project Standards, which documents the locations where 2:1 side slopes are utilized.
2. Minimum Level of Service (LOS) – There are several locations on the mainline and ramps within the DDI where the proposed LOS is less than the required minimum LOS. These locations have been approved for the DDI design shown in the RID. If Developer revises the complex interchange at SR 265/SR 62 and Port Road, then the minimum LOS for each movement shall be met.
3. Intersection Sight Distance (ISD) (Attachment 09-4) – The left-turn movements at the Salem Road Ramps do not meet intersection sight distance requirements, and a Level Two Design Exception is required. The ISD design exceptions at Salem Road are in the process of being approved by the Department.

9.5 Deliverables

9.5.1 Released For Construction Documents

Developer shall produce Design Documents and Construction Documents in a format that facilitates Design Review by IFA.

9.5.2 Design Calculations

Design calculations for all proposed and temporary alignments shall include the following:

- Horizontal sight distance (mainline, ramps, and secondary roads)
- Vertical sight distance
- Intersection sight distance
- Intersection geometrics (including vehicle turning movements)
- Superelevation calculations
- Level one checklists (for Indiana Approach)
- Executive summaries (for Kentucky Approach)
- Clear zone calculations and curve adjustments
- Guardrail length of need
- Earthwork calculations
- Pavement quantities
- Traffic barrier, end treatments, and impact attenuators

10 PAVEMENT

10.1 General

This Section 10 covers the design and construction of pavement. Developer shall provide long-lasting pavement that meets required functionality, durability, and safety requirements. Developer shall conduct all work necessary to meet the requirements associated with this Section 10 and the PPA Documents.

10.2 Administrative Requirements

10.2.1 Certification

All field and laboratory testing conducted by Developer shall be conducted in an accredited laboratory and performed by certified personnel who are qualified to perform Department and KYTC test methods.

10.2.2 Coordination

IFA's Authorized Representative will assist in the coordination and resolution of roadway pavement issues with affected interests and regulatory agencies. Developer shall document the resolutions of issues, including meeting minutes and memoranda for the record.

10.3 Design Requirements

10.3.1 Developer Specified Pavement Designs

For pavement sections within the O&M Limits Developer shall design, maintain and rehabilitate roadway pavements within the O&M Limits using Good Industry Practices and in accordance with a nationally accepted pavement design procedure. The Department's standard design procedures and terminology are included in Chapter 52 of the Indiana Design Manual. Pavement in the tolling zone shall be HMA pavement. The tolling zone pavement section shall be 200-feet long centered on the tolling gantry. Pavement outside the tolling zone may be PCCP.

For purposes of this Section 10.3, the word "lanes" shall mean all travel lanes, auxiliary lanes, passing lanes, deceleration lanes, and any other pavement on which traffic may normally travel. The word "shoulders" shall mean inside and outside shoulders and gore areas. Ramps shall be considered to start at the theoretical back of gore.

Pavement structural layers for all new roadways within the O&M Section shall be designed with no reduction of, or restrictions to allowable legal load limits. Materials for roadway pavement surfaces may be hot-mixed asphalt (HMA) or portland cement concrete (PCC). All travel lanes and shoulders shall have the same structural section. The pavement design shall provide for positive drainage of subgrade and subbase materials from under the pavement. At Substantial Completion and at the Expiry Date, the Developer shall provide a consistent pavement type throughout each roadway element. Each roadway element shall be defined as a discreet segment, such an entire ramp, a section of roadway between two pavement termini, or other logical limits.

During the operating period, designs for all pavement rehabilitation activities shall be prepared and submitted for IFA review and comment.

10.3.2 Pavement Design Reports

Developer shall prepare and submit Pavement Design Reports for review and comment by IFA for Design Review with the Stage 1 Design Documents. Pavement Design Reports shall be signed and sealed by a Registered Professional Engineer.

Pavement Design Reports shall include, at a minimum, the following:

- All design inputs, including design method, design life, analysis parameters, performance criteria, traffic load spectra, climate, pavement structural cross section, subgrade and subbase drainage, materials characteristics and input parameters including soil subgrade.
- Discussion of the input parameters, rationale and assumptions used.
- Site plan showing the limits of the roadway element covered by the design report.
- Typical cross section drawings for the recommended pavement design strategy.

Prior to handback, Developer shall provide calculations and condition distress surveys that address both pavement functional and structural requirements.

10.3.3 Quiet Pavement Requirements

The final pavement surface for all travel lanes, shall be designed to reduce tire-pavement noise using one of the following methods:

- HMA Pavements: Surface Course shall be 165 lb/sq. yd. HMA-9.5 mm with PG 76-22 Asphalt, or approved equal.
- PCC Pavements: Next Generation Concrete Surface (NGCS) texturing method using revised IGGA Guide Specifications for NGCS Construction on Newly Constructed Roadways, or another proven concrete surface texture method that will reliably produce less than 103 decibels over 90% of the surface area.

Rehabilitations during the Term shall use the pavement surface courses as described above to provide quiet pavement surface.

Developer shall test and report pavement noise levels using On Board Sound Intensity (OBSI) - AASHTO TP76-11 test method for both HMA and PCC pavements. Initial testing shall be done no sooner than 60 days before the roadway is open to traffic. After Substantial Completion, Developer shall conduct and report OBSI tests every 3 years during the Term. In addition, OBSI testing and reporting shall be performed within 30 days after a pavement rehabilitation that includes surface courses.

10.3.4 IFA Specified Pavement Designs

Outside of the O&M Limits the minimum pavement design requirements are specified below.

In Indiana:

All pavement outside of the O&M Limits:

- PCCP pavement shall be:
  - Travel lanes: 10-inch PCCP with, with 14-foot widened slab driving lanes, with 1.25-inch dowel bars at 12” c-c spacing, 15-foot’ joint spacing
  - Inside and outside shoulders (except as provided below for SR-62, Utica-Sellersburg Road, or Port Road): 10-inch PCCP, 15-foot joint spacing. Tied to travel lanes using #5 bars @ 30-inch spacing
  - 9-inch Subbase for PCCP consisting of 3-inch coarse aggregate No.8 and 6” Compacted aggregate, size No. 53
  - Subgrade treatment: 1B for soil and 1C for rock per Project Standards
  - Construct underdrains in accordance with Project Standards
  - Use silicone joint sealer for transverse joints

- HMA pavement shall be:
  - 165 Ib/sy QC-QA-HMA 3,70, surface, 9.5 mm, on
  - 275 Ib/sy QC-QA-HMA 3,70, intermediate, 19.0 mm, on
  - 330 Ib/sy QC-QA-HMA 3,64, base, 19.0 mm, on
  - 250 Ib/sy QC-QA-HMA 5,76, intermediate, O.G., 19.0 mm, on
  - 330 Ib/sy QC-QA-HMA 3,64 base, 19.0 mm, on
  - Subgrade treatment: 1B for soil and 1C for rock per Project Standards
  - Construct underdrains in accordance with IDM

- If PCCP mainline pavement is constructed for SR-62, Utica-Sellersburg Road, or Port Road, the shoulders shall be HMA in accordance with Figure 52-13G of the IDM. HMA for shoulders shall be:
  - 165 lb/sy HMA Surface, Type A, on
  - 495 lb/sy HMA Base, Type A

- If HMA mainline pavement is constructed for SR-62, Utica-Sellersburg Road, or Port Road, the shoulders shall be HMA in accordance with Figure 52-13B of the IDM. HMA shoulders shall be:
  - 165 lb/sy HMA Surface, Type A, on
  - 495 lb/sy HMA Base, Type A

- Brookhollow Way, LS 5 shall be:
  - 165 Ib/sy HMA surface, Type B, on
  - 385 Ib/ sy HMA Intermediate, Type B, on
  - 6-inch compacted aggregate, #53 stone, on
  - Subgrade treatment 1B (Soil) 1C (Rock)

In Kentucky:

- For Ride Quality, Category A defined in 410.03.02 of the KYTC Standard Specifications shall be used for both PCC and HMA pavement.

- 2 ft rock roadbed shall be constructed of material excavated from within the project limits.

- PCCP Pavement section shall be constructed through the tunnel and extend 200 ft outside of each portal.

- KY 841 ramps travel lanes, shoulders, and I-71 Ramps:
  - PCCP pavement shall be:
  - Travel lanes: 12-inch PCCP with 1.5-inch dowel bars @ 20-inch centers, 15-foot joint spacing
  - Inside and outside shoulders: 12-inch PCCP, 15-foot' joint spacing. Tied to travel lanes using #5 bars @ 20-inch spacing
  - 4-inch crushed stone base
  - Subgrade treatment: 2-foot rock roadbed
  - Silicone seal for transverse joints

- HMA pavement sections for KY 841 and ramp travel lanes:

Items Number	Description	Travel lanes Thickness
342	CL 4 Asph. Surf. 0.38A PG 76-22	1 ¼ in.
219	CL4 Asph. Base 1.0D PG 76-22	3¼ in.
217	CL4 Asph. Base 1.0D PG 64-22	8 in. (4 in. + 4 in.)
18	Drainage blanket-TY II Asphalt	4 in.
2702	Sand for blotter	5.0 Ib/sq. yd.
358	Asphalt curing seal	1.6 Ib/sq. yd.
1	DGA Base	4 in. (Variable)
	2-foot rock roadbed	

- HMA pavement sections for KY 841 and ramp shoulders:

Items Number	Description	Travel lanes Thickness
339	CL3 Asph. Surf. 0.38D PG 64-22	1¼ in.
214	CL3 Asph. Base 1.0D PG 64-22	11 ¼ in. (4 in. +4 in.+3 ¼ in.)
18	Drainage blanket-TY II asphalt	4 in.
2702	Sand for blotter	5.0 Ib/sq. yd.
358	Asphalt curing seal	1.6 Ib/sq. yd.
1	DGA Base	4 in. (Variable)
	2-foot rock roadbed	
Asphalt seal required from outside edge of paved shoulders to a point two feet down the ditch or fill slope. Two applications of the following: 103 Asphalt seal coat 2.4 lb/sq yd 100 Asphalt seal aggregate 20 lb/sq yd, D (Size No. 8 or 9M)		

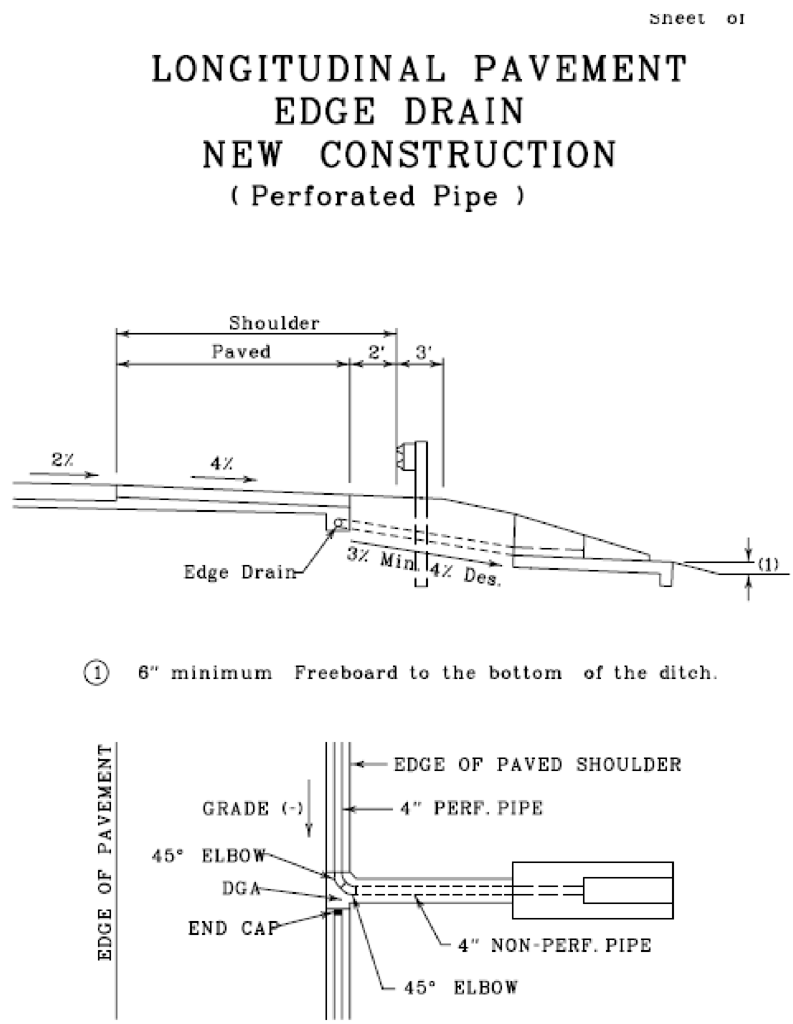
- Longitudinal pavement edge drains (for asphalt alternate only)

Items Number	Description	Dimension
1000	Perforated Pipe	4 in. Linear Foot (1)

1001	Perforated Pipe	6 in. Linear Foot
1010	Non-Perforated Pipe	4 in. Linear Foot (2)
1011	Non-Perforated Pipe	6 in. Linear Foot (2)
1740	Cored Hole Drainage Box Con	4 in. Each
---	Perf. Pipe Headwall TY #	4 in. Each
78	Crushed Aggregate Size No. 2	Ton (estimated at one ton per Outlet)

Notes:
(1) Fabric Geotextile Type IV and Crushed Aggregate Size No. 57 are incidental to Perforated Pipe – 4 inch.
(2) Discharge all longitudinal pipe drainage systems for the pavement drainage blanket to a Headwall, Median Box Inlet, or a Ditch Box Inlet.
Place Outlets in a fill section whenever possible. Do not let outlet spacing exceed 500 feet except grades 1% or less, in which case the outlet spacing is every 250 feet. Place an outlet at all sags. The Designer will locate these on the plans or in the proposal.
Plan Notes No.: 444 (A), 555 (A), 447
Special Note For: (9Y) Material Transfer Vehicle (3-12-08)

Figure 10-1 Edge Drain



- Wolf Pen Branch Road Travel lanes and shoulders:

* **Maximum Asphalt Design**		CBR-->	4
Flexible Pavement		6.50 in. asphalt pavement	
One or Two Directions:	2	0.00 in. drainage blanket	
Design Number of Years:	20	4.00 in. aggregate base	
Construction Year:	0	0.230 miles (length of East End Crossing)	

- HMA pavement overlay section for River Road travel lanes and shoulders
  - 1.25 in. asphalt pavement overlay

10.3.5 Temporary Pavement

Developer shall design, construct, and maintain all temporary pavements within the Project Limits in compliance with the requirements of the PPA Documents and the following performance requirements:

- Provide documentation describing the assumptions used to design the temporary pavement, at a minimum the documentation shall include design life and anticipated traffic loading for each temporary pavement location within the East End Crossing.
- Provide a durable, maintainable pavement system that meets the following requirements during its service life:
  - Minimum friction number of 37
  - IRI of less than 120 inches/mile
  - Free of potholes or rutting exceeding 0.25 inches
  - Provide adequate cross slope to drain water quickly from pavement surface

Developer shall analyze and prepare separate temporary pavement designs, as applicable, for the following:

- Mainline pavements
- Ramp pavements
- Local road pavements

If the IFA believes, in its sole discretion, that these requirements are not being met, the IFA will direct Developer to conduct pavement testing to measure the pavement properties. Both the testing and corrective actions shall be considered part of Developer's Work.

10.3.6 Shoulder Corrugations

All permanent pavements in Indiana shall have shoulder corrugations in accordance with the Project Standards. Shoulder corrugations are not required in Kentucky.

11 TRAFFIC

11.1 General

Developer shall be responsible for analysis and design activities required to determine advisory speeds; the design and construction of signage, lighting, traffic signals, and pavement markings; and the traffic analysis of roadway, intersection, and highway-rail crossing operations for both interim and permanent conditions to verify proposed designs meet or exceed minimum LOS requirements specified in the Project Standards and this Section 11.

Signing shall consist of:

- Interchange guide signing for both the SR 265 and KY 841 mainline
- Guide signs for cross streets approaching the mainline freeway (within the Indiana Approach: SR 62, Port Road, and Salem Road; within the Kentucky Approach: U.S. 42, Wolf Pen Branch Road, and River Road)
- Supplemental signs along mainline
- Toll signing
- Regulatory and warning signs
- Local roads within the Project Limits

All signs shall be coordinated with Intelligent Transportation Systems (ITS) devices and Electronic Toll Collection (ETC) equipment. Signing shall also be installed along the shared use path. Signing outside the Project Limits shall also be required. These locations include the approaches to the I-71 and KY 841 interchange and the approaches to the I-65 and SR 265 interchange.

Continuous freeway lighting shall be required from south of the KY 841 and U.S. 42 interchange beginning at Sta. 10+00, throughout the Tunnel, and across the Ohio River Bridge ending at Sta. 220+00. Full interchange lighting shall be required for the SR 265, SR 62, and Port Road interchange. Partial interchange decision point lighting shall be provided at the SR 265 and Salem Road interchange. Partial interchange lighting shall consist of luminaires located in the areas where entrance and exit ramps connect with the through traffic lanes of a freeway (i.e., lighting between the entry gore and the end of the acceleration ramp or exit gore and the beginning of the deceleration ramp). Developer shall be responsible for the design and construction of sign structures and light poles, including foundations, conduit systems, circuitry, power supplies, lighting cabinets, and coordination with the power companies (Clark County REMC and Louisville Gas and Electric Company) to obtain power feed for traffic signals and lighting devices.

Pavement markings and raised reflective pavement markers shall be provided along the mainline freeway, ramps, and cross streets in accordance with the IDM and IMUTCD in Indiana and the KDM in Kentucky.

Developer shall provide a railroad interconnection between the railroad signals that cross SR 62 and the traffic signals for the SR 265 / SR 62 / Port Rd interchange, including a conduit system, circuitry, detection devices, and associated signal equipment.

Developer shall provide fully functioning traffic signals at the following intersection as required at interchange based on Reference Design:

- SR 265 / SR62 / Port Rd interchange, including foundations, traffic signal poles, signal heads, conduit system, circuitry, detection devices as acceptable to the Department district traffic engineer, associated signal equipment, and intersection lighting and signing. The Work shall include coordinating Utility connections with the proper Utility Owner and coordinating the signal cable connections with local jurisdictions.

11.2 Standards and References

Design and construct the traffic Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 11; Governmental Approvals; and applicable Laws.

11.3 Engineer Supervision and Qualifications

The design of the activities described in this Technical Provision shall be supervised and submitted by a Registered Professional Engineer certified as a Professional Traffic Operations Engineer with a minimum of 10 years of experience on projects of a similar complexity.

Electrical and lighting design shall be supervised and submitted by a Registered Professional Engineer, with a minimum of 10 years of experience on projects of a similar complexity.

11.4 Advisory Speeds

Developer shall prepare and submit to IFA for IFA's approval prior to Final Acceptance, a report that documents all mainline advisory speeds and advisory ramps speeds. The report shall include an investigation of the horizontal geometrics based on the American Association of State Highway and Transportation Officials (AASHTO) roadway design guidelines. The investigation shall define the critical stopping sight distance for each ramp, and acceleration and deceleration distances. These above values shall be field-verified to determine if the actual conditions provide the critical distances required. The pavement conditions of each ramp shall also be noted. Photographs for each ramp shall be taken and included in the report. Developer shall evaluate each ramp with an approved electronic accelerometer or ball-bank indicator. All electronic accelerometer measurements shall follow the manufacturer's instructions. The field testing using an electronic accelerometer shall not exceed the posted regulatory mainline speed limit and shall be stopped if g-force measurements exceed 0.40 g-ft/s^2. The recommended average g-force for determining advisory speeds is 0.28 g-ft/s^2 and shall be posted in 5-mile-per-hour increments. The field testing using a ball-bank indicator shall be in accordance with Section 2C.08 of the MUTCD.

11.5 Signing

11.5.1 Design and Construction Requirements

All signs and supports within the Project Limits shall be new unless stipulated otherwise herein. Developer shall not be required to provide sign lighting.

11.5.1.1 Design Signing Roll Plans

Developer shall prepare and provide a design signing roll plan for IFA approval prior to preparing signing Plans. The design signing roll plan shall include proposed sign locations and messages for all guide signs, toll signing, typical regulatory and warning sign applications, proposed locations for relocating existing signs located outside of the Project Limits, and proposed locations for new structures. Developer shall relocate existing overhead or cantilever sign structures as required for proper sign installation. The design signing roll plan shall display signing for all mainlines, ramps, and interchanges, as well as for the arterial streets, frontage roads, and any other signing affected by the project. Developer shall also provide for the replacement or removal of any signage outside the Project Limits that are no longer appropriate or pertinent. The design signing roll plan shall include the location of all proposed and existing dynamic message signs, as specified in Section 19 and shown in the RID.

The design signing roll plan shall include locations of all proposed electronic toll equipment. Developer shall provide signing for roadways where existing access has been modified. The signing modifications due to the access modifications shall be shown on the design signing roll plan. The plan shall also denote which agency is responsible for ownership and maintenance of each sign and structure (e.g., the Department, KYTC, TRIMARC, or local jurisdiction). The plan features shall include but are not limited to the existing and proposed roadway alignments, Project ROW, utilities, baseline of construction (including stationing), and existing topography at the tie-in points of the roadway limits of Work. The proposed pavement markings shall also be shown on the design signing roll plan.

Developer shall develop a regional signing plan for IFA approval that includes existing and proposed signing modifications to the following locations:

- Northbound I-65 approach to SR 265/SR 62 (Exit 6A)
- Southbound I-65 approach to SR 265/SR 62 (Exit 6A)
- Eastbound SR 265 at I-65 (Exit 7)
- Eastbound SR 265 approach to SR 62/Port Rd/10th St. (Exit 10)
- Northbound I-71 approach to KY 841(Exit 9B)
- Southbound I-71 approach to KY 841(Exit 9B)
- Northbound KY 841 approach to I-71 (Exit 35)

The regional signing plan shall be submitted along with the design signing roll plan. If any existing panel sign requires alteration of the message, the panel sign shall be replaced in accordance with Section 11.5.1. If any existing panel sign on an existing overhead sign structure is replaced, the Developer shall replace all other existing panel signs on the structure. If the overall square footage of panel signs on an existing overhead sign structure is increased, the Developer shall evaluate the existing sign structure to determine if it is meets the structural capacity requirements for the new sign(s) in accordance with Section 14. In the case that an existing sign structure is not sufficient to support the new panel signs, the Developer shall replace the entire sign structure, including the foundations.

11.5.1.2 Signing Plan Requirements

Developer shall prepare signing Plans at a scale equal to the roadway Plans. Signing Plans shall show the proposed message; the MUTCD sign designation (if applicable); the size and location of all route marker assemblies; and guide, warning, toll, and regulatory signing. Signing Plans shall also show the location, messages, and sizes of all existing signs. All existing signs to be removed or relocated shall also be shown. Signing Plans shall include the location and type of delineation devices (including pavement markings). Developer shall also include milepost signs in accordance with the applicable MUTCD along mainline utilizing the D10-1a, D10-2a, and D10-3a signs. For every whole mile, Developer shall use the D10-5 sign. Reference markers in Indiana shall match those currently on the system. Station 212+50 is near the state line. The approximate Mile Post for Sta. 212+50 is noted below:

Route	MP	
EB SR 265	12.8	MP decrease to West
NB KY 841	39.0	MP decrease to South

All exits shall be numbered using reference location sign exit numbering, which means the existing numbers relate to the mile reference of the mile marker, at that location. When more than one exit occurs within the same mile, the first exit shall be identified with the number and letter “A,” the second exit “B,” and so forth. The owner of each sign/structure shall be clearly noted on the plan sheets. All proposed guide signs shall be detailed on a detail sheet. All ground-mounted sign supports (steel and wood) shall be detailed on this sheet. The tables on this sheet shall include the sign number, plan sheet number where the sign is located, the sign size, the post size to be used, whether the supports are breakaway or non-breakaway, the support lengths, the lateral clearance code, and the support spacing from the left edge of the sign. The overhead structures and the cantilever structures sheets shall also be included in the Plan set.

11.5.1.3 Design of Sign Locations

Developer shall design, fabricate, and install all the overhead and ground-mounted signs shown on the signing Plans within 100 feet of the location shown or as otherwise directed by the Department. For signing along the mainline freeway, all guide signs; dynamic message signs; supplemental guide signs; and any overhead structures, including toll gantries, shall be installed in accordance with Section 2 of the MUTCD. Signs, including regulatory and warning signs along the ramps and cross streets, shall be installed in accordance with Section 2 of the MUTCD. Developer shall provide to IFA, for review and comment with signing Plan submissions, documentation that there is sufficient sight distance provided to allow for appropriate perception-response time for all signs along the ramps and cross streets. The interchange signing shall include, at a minimum, the 1 mile, ½ mile, and exit direction guide signs, and the exit gore sign, as well as all additional toll-related signing. Developer shall provide street name signs at overpasses along the mainline freeway. Developer shall design all details of the sign panels, as well as ground-mounted and overhead supports. Developer shall coordinate the proposed sign locations with all proposed landscaping, utility, hydraulic, lighting, ITS equipment, toll equipment, and all other roadside features, to ensure proper clearances, lighting levels, and adequate sight distance.

11.5.1.4 Sign Design and Construction Requirements

The messages, fonts, font sizes, arrows, shields, colors, borders, and type of supports for the overhead and ground-mounted signs shall be designed and constructed according to the MUTCD and following interstate interchange classifications. The Clearview font shall be used for all positive contrast guide signs. Positive contrast guide signs are signs that use white text/copy on a dark-colored background (e.g., green, blue, black, brown, etc.) The SR 265 and SR 62 interchange shall be classified “Major-Category b” as defined in MUTCD Section 2E.32. The SR 265 and Salem Road interchange shall be classified “Intermediate” as defined in MUTCD Section 2E.32. The KY 841 and U.S. 42 interchange shall be classified as “Major-

Category b” as defined in FHWA MUTCD Section 2E.32. The text size for the mainline freeway shall be in accordance with Section 2 of the applicable MUTCD.

Regulatory/warning signs and route marker assemblies, all signs along the mainline freeway, and associated ramps shall be “freeway” size. All signs designed and installed along all other roadways shall be “standard” size. The sizes of the signs shall adhere to the latest edition of the FHWA Standard Highway Signs Book, KYTC Traffic Operations Manual, and, as applicable, the Indiana Standard Sign Book.

All guide signs along northbound KY 841, approaching the U.S. 42 interchange, shall include the “Last Exit Before Toll” message below the sign, in black legend, on fluorescent yellow background. All guide signs along eastbound SR 265, approaching the Salem Road interchange, shall include the “Last Exit Before Toll” message below the sign, in black legend, on fluorescent yellow background.

Guide signs along eastbound SR 265 shall indicate that the bridge over the Ohio River is a toll bridge. Guide signs along northbound KY 841 shall indicate that the bridge over the Ohio River is a toll bridge.

Guide signs indicating exit-only movements entering or exiting freeways or expressways shall have the action message (i.e., “Exit Only,” etc.) in black legend, on fluorescent yellow background. A fluorescent yellow background shall be used for all yellow traffic signs. When a sign contains more than one background color, the signs shall have two separate borders corresponding to each background color where the background colors meet. If the background colors use the same border color, then only one border is necessary where the background colors meet.

All proprietary logos and welcome signs will be provided by the Department. Developer shall identify the logos required during the design process. Those logos will be provided by the Department to place onto signs and, as applicable, supports furnished and installed by Developer. “Welcome to Indiana” and “Welcome to Kentucky” signs shall be installed. Developer shall submit a letter to the Department requesting all logos and the required sizes between the Stage 1 and Released-for-Construction submissions.

All signs greater than 4 feet x 8 feet shall be manufactured using extruded aluminum sign material. All signs that are installed under this East End Crossing shall conform to ASTM D4956-4 Type IX sheeting. This includes both the sheeting for the text and the sign backgrounds.

11.5.1.5 Sign Supports

In accordance with MUTCD, all mainline and freeway interchange guide signs and toll rate signs shall be installed on overhead box truss or cantilever sign supports. For each sign support location, Developer shall draw the sign panel(s) and the sign supports on the corresponding completed cross section. The proper vertical and horizontal clearances, sign sizes and offsets, number of lanes, and lane widths shall be labeled on the cross sections. Developer shall check cross sections and profiles at all sign locations and make adjustments as necessary to provide adequate sight distances and proper placement of the guide signs. If a non-standard overhead sign support is proposed, Developer shall submit calculations to properly size the sign supports for IFA approval with signing Plan submissions.

Ground mounted signs shall be installed in accordance with the Department standard drawings and other design guidance.

At the SR 265/SR 62 interchange, signs or sign structures may be allowed on the bridge overpass structures.

No signs shall be banded to utility poles, street lighting poles, or overhead or cantilever sign structure uprights.

If signs are to be installed on the East End Bridge, Developer shall consider the size and location of the proposed signs during the structural design of the bridge.

The mainline freeway and State marked route signing shall be installed at the end of the project and prior to opening the road to traffic.

Traffic barriers shall be provided for protecting all non-breakaway supports within the clear zone for sign structures within the East End Crossing and for new sign structures outside the Project Limits. Non-breakaway signs shall be placed outside the clear zone wherever possible.

For the proposed shared use path, Developer shall provide signing along the trail and along the cross streets. The trail signing shall provide for the orderly and predictable movement of both pedestrian and bicycle traffic. Also, the signing shall provide proper guidance and warnings as are needed to ensure the safe and informed operations of both the pedestrian and vehicular traffic along both the trail and roadway.

See Sections 13.3.2.12, 13.3.2.13, and 14.7 for structural design requirements.

11.5.2 Submittals

Developer shall submit the following items prior to the Released-for-Construction review.

- Design signing roll plan.
- Plans required in this Section 11
- For all existing sign structures, written justification to add, delete, or modify signs on existing structures.

11.5.3 Signing Database

Developer shall be responsible for inventorying all publicly owned signs installed on Project ROW and all other State-owned signs installed under this East End Crossing. The inventory shall include sign size, support type, the GPS and mile post location, the pictures of the sign (front and back), and retroreflectometer readings for each sign. Developer shall be responsible for inputting the field-inventoried information into a Microsoft Access database approved by IFA. Developer shall provide a database manual with descriptions of the database fields. Separate sign databases shall be developed for the Department and KYTC. Developer shall submit the completed database to the Department and KYTC prior to Final Acceptance. Developer shall be responsible for updating this database in O&M Limits defined in the PPA.

Developer shall be responsible for providing all signing plan sheets in PDF format, along with all Plans and approved shop drawings in PDF format, to IFA.

11.5.4 Regulatory Signing

Developer shall be responsible for providing an engineering study to IFA for review and comment, prior to Final Acceptance, that documents all regulatory signing (e.g., speed limits, truck restrictions, etc.) installed under this project as part of Release-for-Construction Plans.

11.5.5 Sign Lighting

External sign lighting and related appurtenances, such as a sign walkway, will not be required for an overhead-sign, cantilever, or box-truss structure. However, conduit shall be installed in the foundations. A structure handhole shall be placed toward the base of the sign support. A grounding system shall be included.

11.6 Traffic Signals

11.6.1 Performance Requirements

Based on the Reference Design diverging diamond interchange, traffic signals shall be constructed at two (2) intersections within the project area. The approximate locations of the traffic signals are identified in the Reference Design within the diverging diamond interchange. Developer shall perform analysis to determine the appropriate traffic control at all intersections within the interchange. This includes submitting a signal warrant analysis to IFA for approval prior to preparation and submission of signal Plans. The cost of constructing signals, temporary or permanent, required as a result of Developer requested interchange revisions shall be the responsibility of Developer. The existing signal at U.S. 42 and KY 841 is not within the Project Limits and is not to be altered as part of the East End Crossing.

Using the criteria specified within Sections 11.9 and 11.6.2:

- All traffic signals shall be designed to provide for the efficient movement of traffic (vehicular and pedestrian) in both the year of operation (2017) and the design year (2030).
- Developer shall develop signal timing plans that optimize traffic flows and provide signal coordination with adjacent intersections, railroads, and arterial roads.

11.6.2 Design and Construction Requirements

11.6.2.1 Traffic Signal Design

Developer shall prepare a preliminary design in the form of traffic signal plan sheets for IFA approval during Stage 1 submissions that includes all existing signal equipment and interconnect and displays all proposed signal equipment and interconnect within the East End Crossing. The plan sheets shall also display all existing and proposed crosswalks within the project. Any required temporary maintenance of traffic signal plan, along with the associated phasing of signal construction, shall also be presented at this time.

11.6.2.2 Traffic Signal Plan Requirements

Developer shall prepare traffic signal Plans to address any new traffic signals or modifications that are required. All traffic signal Plans shall be drawn in accordance with the IDM, applicable

CADD standard requirements, the MUTCD, and the Indiana MUTCD. Traffic signal Plans shall be provided to IFA for Design Review in accordance with Section 3.

Existing traffic signal operation and detection shall be maintained during all phases of the roadway construction and all stages of MOT.

The design and construction of all permanent traffic signals shall use mast arms unless otherwise approved by IFA.

Lighting shall be provided on all signal poles wherever feasible and shall be coordinated with adjacent existing and, as applicable, proposed roadway.

11.6.2.3 Interconnect Plans

Developer shall prepare traffic signal interconnect Plans and include with traffic signal Plans submissions, as required. Interconnect plans shall be drawn at a scale of 1 inch = 50 feet. Developer shall obtain all existing interconnect information. Interconnect plans shall include controller cabinet locations, conduits, handholes, sampling stations, a wiring diagram, cables, construction details, and an equipment list that is in accordance with Developer's design and computer-aided design drawing (CADD) requirements.

The proposed traffic signal interconnect cables shall not use any conduit runs that contain toll system cables.

Developer shall also provide a railroad interconnection between the railroad signals that cross SR 62 and the traffic signals at the SR 62 and SR 265 interchange, including a conduit system, circuitry, detection devices, associated signal equipment, and signal timing parameters. As part of this work, Developer shall submit a railroad warning time study to determine the minimum time necessary to activate the traffic signals and clear the railroad crossing. This study shall be submitted as part of the traffic signal design package.

Developer shall be responsible for utility pole removals required when relocating existing interconnect. All interconnect shall be relocated prior to roadway construction to ensure that interconnect can be maintained throughout construction. Developer shall be responsible for the relocation of any existing fiber-optic cable impacted by construction. Splices shall not be permitted along interconnect runs. Developer shall be responsible for obtaining all Governmental Approvals and third party agreements required for placing interconnect on utility poles and shall be responsible for all associated costs.

11.6.2.4 Utility Requirements

Developer shall be responsible for locating and marking all underground Utilities prior to any signal installation work. Note that Department utility conduits for lighting are not included in "call before you dig" database systems. Developer shall be responsible for all work, materials, and costs associated with obtaining power and maintaining power throughout construction for all traffic signals, including coordination with the power company and obtaining power supply for all traffic signals and other electrical work required for the East End Crossing. Developer shall be responsible for completing all electrical-service application materials necessary for obtaining service from the appropriate power company. All materials shall be submitted to the power company and copied to IFA. Developer shall use 200A Metered Service Pedestals at all traffic signal locations, unless otherwise specified in the Technical Provisions. Developer shall be solely responsible for all Work and costs associated with obtaining communication cable and maintaining communication cable throughout construction for all signals. Metered Service Pedestals shall only be used to service traffic signal equipment and related intersection lighting unless otherwise accepted by IFA. Developer shall complete all paperwork, coordinate with the Utility Owner, pay the cost associated with the service installation and schedule all utility connections.

11.6.2.5 Sight Distance Requirements

Developer shall ensure all traffic signal heads for temporary and permanent conditions can be seen by all approaching traffic at the required sight distance, at all times during and after Construction Work.

Developer shall prepare and present sightline plans for all traffic approaches to IFA for review and written comment with traffic signal Plan submissions.

Developer shall also prepare and submit to IFA for review and written comment, with traffic signal Plan submissions, sightline profiles for all overhead signs, bridges, and hazard identification beacons that are on traffic signal approaches.

Developer shall prepare and present to IFA for review and written comment, with traffic signal Plan submissions, separate sightline plans and profiles for each MOT phase that has different sightlines approaching a traffic signal. If sightlines do not meet the MUTCD requirements, Developer shall provide a recommendation for meeting the requirements to IFA.

11.6.2.6 Materials

All traffic signal equipment shall be new and designed and constructed in accordance with the Project Standards.

11.6.3 Temporary Traffic Signals

Developer shall provide temporary traffic signals as required by the maintenance of traffic Plans. Developer shall perform all studies as necessary for the placement of Temporary Traffic signals and present all information to IFA for review and written comment.

11.6.4 Traffic Control Device Verification – Signals

Developer shall schedule meetings with IFA to verify traffic control device work as follows:

- At the completion of all cabling and wiring and prior to electrical utility service connection.
- Prior to traffic control device activation.

11.7 Lighting

11.7.1 Design and Construction Requirements

Developer shall design and install lighting within the Project Limits. Existing highway illumination is to be maintained. For existing lighting, the maximum outage time for luminaires shall be 24 hours. All flexible conduit is required to be galvanized steel, polyvinyl jacketed, and watertight.

11.7.1.1 Design Criteria

Developer shall prepare and present lighting calculations for IFA approval with lighting Plan submissions. Developer shall design and install lighting structures such that they are consistent with the aesthetic guidelines in Section 5. The specific criteria for the Kentucky Approach, Indiana Approach, and Ohio River Bridge sections are as follows.

11.7.1.1.1 Kentucky Approach Lighting

For Sta.10+00 to Sta.160+00, full cut-off optics shall be used for all the new lighting fixtures to avoid lighting spillover on the residential areas close to the roadway. High Mast lighting structures shall not be installed on the Kentucky approach. The mounting height of the fixtures shall range from 40 feet to 50 feet. The recommended mounting height is 40 feet. Power supply for lighting shall be installed in separate conduits and on independently metered circuits.

11.7.1.1.2 East End Bridge Lighting

The East End Bridge shall include roadway lighting that meets the criteria included in publication ANSI/IESNA RP-8-00 *American National Standard Practice for Roadway Lighting*. Power supply for lighting shall be installed in separate conduits and on independently metered circuits.

11.7.1.1.3 Indiana Approach Lighting

High mast lighting is allowed on the Indiana Approach. However, Developer shall coordinate the heights with U.S. Federal Aviation Administration (FAA), comply with FAA requirements, and apply for permits if necessary. The mounting height for high mast towers at the interchanges shall be between 80 feet to 200 feet. The mounting height of the conventional fixtures shall range from 40 feet to 50 feet. The recommended mounting height for conventional fixtures is 40 feet. Power supply for lighting shall be installed in separate conduits and on independently metered circuits.

11.7.1.1.4 Existing Roadway Lighting

In locations where the project will impact existing roadway lighting, the existing structures shall be replaced by Developer. Lighting shall incorporate the same luminaire and pole type as existing to maintain consistency. Developer shall design and construct the lighting system consistent with the operational and engineering requirements of the Utility Owner, Department and KYTC as applicable. For locations where luminaires are attached to a utility pole, Developer (as a part of the utility relocation effort) shall contact the local Utility Owner to coordinate the relocation of the light fixture. Developer is responsible for coordinating and entering into agreements with the Utility Owner and paying for any and all related costs. Developer shall remove existing light poles that are no longer required due to construction of the East End Crossing. The equipment shall be the property of Developer upon removal. Developer shall notify IFA of the lighting being removed at least two weeks in advance of scheduled equipment removal.

11.7.1.1.5 Underpass Lighting

Developer shall provide underpass lighting to maintain roadway lighting continuity. The underpass lighting shall be in accordance with the criteria from AASHTO's "*An Informational Guide for Roadway Lighting*."

11.7.1.1.6 <u>Intersection Lighting</u>

Developer shall combine intersection lighting with the traffic signal Plans whenever possible. All intersection lighting shall be prepared using the guidelines from the Department, KYTC, and ANSI/IESNA RP-8-00, Annex D, for the design of intersection lighting.

11.7.1.1.7 <u>Reserved</u>

11.7.1.1.8 <u>Sign Lighting</u>

All existing sign lighting within the Project Limits shall be maintained throughout performance of Construction Work.

11.7.2 Submittals

A lighting roll plan shall be presented concurrently with the design signing roll plan and ITS roll plans, for review and comment by IFA. The lighting roll plans shall include proposed locations for all lights and photometric calculations supporting the light locations. Developer shall provide spacing computations showing the average maintained illuminance. The calculations shall include uniformity ratios and point-by-point computations. Developer shall apply the light loss factor of 0.78 when computing photometrics.

11.7.3 Performance Requirements

All proposed lighting equipment shall be located such that it can be readily maintained. Lighting placed on traffic signal equipment shall be serviced from a metered service pedestal. Each luminaire mounted on a signal structure shall be equipped with a photocell. Developer shall provide voltage drop calculations for all circuits. The voltage drop for each circuit shall not exceed 10percent for new circuits. A minimum of two branch circuits shall be used for each continuous succession of lighting structures. All lighting circuits shall have balanced lighting loads. Two conductor duct cables shall be used for all lighting circuits. Only the conductors that serve the lighting structures shall enter the foundation of the lighting structures. All other conductors shall remain unspliced and bypass the foundation. Developer shall furnish and install single conductor cables in conduit under all roadway surfaces. Single conductor cables shall be used any place cables are to be installed in conduit. Developer shall provide electrical manholes and connector kits to splice the conductors. No in-ground splices of electrical cables shall be permitted for any reason. No electrical manholes shall be placed in drainage ditches. Developer shall abandon existing conductors between poles that are to be removed. Any existing lighting structure that is impacted by the construction of this project shall be disconnected and reconnected to its original power supply by Developer as part of this project unless it is being removed. All abandoned cables shall be made safe. All light poles that are not protected by traffic barrier and are in the clear zone, as defined in the AASHTO Roadside Design Guide, shall be installed on a breakaway transformer base complying with the Project Standards. Light poles shall not be installed in front of traffic barrier. Residential shielding shall be provided with all lighting within 75 feet of a residential structure, where necessary to achieve the 0.01 fc illuminance requirement. All electrical designs shall be coordinated with the electrical system required for the ITS and ETC equipment. The lighting system shall use cabinets and conduits separate from the ETC and ITS equipment.

11.7.3.1 Plan Sheet Requirements

Developer shall prepare and present lighting Plans with a scale appropriate for the project, generally 1 inch = 50 feet. The Plans shall include all the necessary elements as specified in the Chapter 14 of the IDM.

11.7.3.2 Temporary Lighting

Developer shall maintain all existing and temporary lighting within the Project Limits throughout Construction Work. If required to maintain the existing lighting levels in the Site area, Developer shall install and maintain temporary lighting (luminaires attached to wood poles). Temporary overhead electrical service is acceptable for non-breakaway poles. Developer shall remove temporary lighting when no longer needed. Developer shall be responsible for the power costs of any and all temporary lighting that may be required, and it is Developer's responsibility to schedule, coordinate, and pay for all utility connections.

11.7.3.3 Electrical Service for Lighting

Developer shall be solely responsible for all Work, materials, and costs (including coordination with the power company) required to obtain power supply for all lighting and Work required for this project. Developer shall be responsible for all electrical service application materials necessary for obtaining service from the appropriate power companies. All materials shall be submitted to the power company and copied to IFA. Developer shall contact all Utility Owners to fulfill requirements to determine the location of all existing and proposed utilities, obtain power company requirements for service, and obtain power company approval for feed location(s). It is Developer's responsibility to complete all paperwork, coordinate with the Utility Owner, pay all costs associated with the service installation and schedule all utility connections so as to not adversely affect the Project Schedule. For utility services during the D&C Work see Section 1.8. For utility services during the Operating Period see Section 22.1.4.

Lighting systems owned by different jurisdictions shall have separate power sources derived from the Utility Owner. Exceptions shall require written approval and the agreement of all jurisdictions involved and shall require separate circuits.

11.7.3.4 Aesthetic Requirements

Developer shall provide lighting structures and luminaires that conform to the aesthetic guidelines provided in Section 5.3.

11.7.4 Traffic Control Device Verification – Lighting

Developer shall schedule meetings with IFA and KYTC to verify traffic control device work as follows:

- At the completion of all cabling and wiring and prior to electrical utility service connection.
- Prior to traffic control device activation.

11.8 Pavement Markings

Pavement markings and delineation shall include the design and installation on interstate routes, state highways, ramps, streets, bridges, Tunnels, and underpasses.

11.8.1 Design and Construction Requirements

Pavement marking materials shall be installed in accordance with the Department Standard Specifications.

For all temporary and final pavement marking lane lines including parallel, acceleration/deceleration lanes for ramps, and intersection auxiliary lanes, the appropriate pavement marking type. The spacing and width of the pavement marking may change from one side of the bridge to the other, as the pavement marking widths specified by the Department and KYTC are different.

Crosswalks shall be provided across roads at all signalized intersections within the Project Limits.

Developer shall provide all grade crossing pavement markings. The Department Standard Drawings provide additional details for the location of railroad-crossing markings.

Developer shall install reflective pavement markers (RPMs) on SR 265, KY 841 and adjacent ramps. Reflective pavement markers shall not be installed on bridge decks. Spacing, colors, and arrangement of reflective pavement markers shall conform to the Project Standards for permanently installed pavement markers. Snow-plowable raised pavement markers shall be new and conform to the Project Standards. Raised pavement markers shall be used only to supplement pavement markings, not as a substitute.

In Kentucky, gore markings at interchanges with tapered ramps shall be striped in conformance with Standard Drawing TPM-130. Gore markings at interchanges with parallel ramps shall be striped in conformance with Standard Drawing TPM-135. Other types of interchanges or those with unusual geometry shall be striped using similar principles to those shown in the Standard Drawings (TPM-130 and TPM-135) and the MUTCD.

Developer shall provide delineators on the outside-shoulder of a freeway and on one side of each interchange ramp in accordance with the Project Standards. The delineator color shall match the color of the edge line. Delineators shall be provided along the outside of each curve on an interchange ramp. Developer shall provide double or vertically-elongated delineators installed at 100-foot intervals along each acceleration or deceleration lane.

Delineators shall be used to mark all median crossovers on divided highways. The delineator shall be located to mark the far side of the opening for each direction of traffic. When post-mounted delineators are installed, flexible delineator posts shall be used instead of metal posts.

Barrier-wall delineators shall be used on all sections of roadway with concrete barrier wall in the median.

All proposed pavement markings shall be shown in the signing Plans and included in the signing Plan submissions for IFA approval. The Plans shall show the color, size, location, and material type for markings within the Project Limits. The final pavement marking Plans shall be indicated on the signing Plan with the same scale as the signing Plan. The lanes shall be dimensioned based on the typical sections for the project. Dimensions shall be included for each change in the roadway typical.

11.9 Traffic Operational Analyses – Procedures and Application

Traffic operations analysis shall be required for all freeways, ramp, weave, merge, diverge, and intersections within the Project Limits for 2017 and 2030 projected traffic volumes. A design change to the interchange configuration at SR 265 / SR 62 / Port Road may be proposed. Any modifications to the Reference Design shall require additional analysis to verify that levels of service (LOS) are better than or equal to the Reference Design. The LOS for the Indiana Approach Reference Design is shown in Table 11-1.

11.9.1 Approved Analysis Techniques and Software

11.9.1.1 Highway Capacity Manual and Software

The Highway Capacity Manual and Software (latest version) shall be used to analyze all freeway mainlines, ramp junctions (merge and diverge locations), and weaving sections. Developer shall provide IFA with a summary of results on a line diagram of the proposed roadway configurations, including both the LOS and the volume-to-capacity (V/C) ratio, as appropriate. Developer shall also provide IFA with a report and all calculation files on a CD to support the summary of results for review and comment with the Design Review submissions.

11.9.1.2 Synchro and SimTraffic

For corridors with multiple intersections, Developer shall use Synchro and SimTraffic (latest version) to analyze corridor operations. Developer’s timing plans shall consider corridor-wide cycle lengths and appropriate offsets. Developer shall provide IFA with a report and all calculation files on a CD to support the summary of results for review and comment with the Design Review submissions.

11.9.1.3 CORSIM

For freeway and arterial operations, Developer may elect to use CORSIM (latest version) to analyze operations. This shall be in addition to the Highway Capacity Manual and Software and Synchro/SimTraffic requirements listed in Sections 11.9.1.1 and 11.9.1.2. Results will be considered by IFA in conjunction with the reports in Sections 11.9.1.1 and 11.9.1.2 when assessing Deviations proposed by Developer.

11.9.1.4 VISSIM

For railroad interconnection and traffic signal operations, Developer may elect to use VISSIM (latest version) to analyze operations. This shall be in addition to the Highway Capacity Manual and Software, Synchro/SimTraffic and CORSIM requirements listed above. Results will be considered by IFA in conjunction reports in Sections 11.9.1.1 and 11.9.1.2 when assessing Deviations proposed by Developer.

11.9.1.5 Operational Assessment

It shall be Developer's responsibility to perform traffic analyses for the interim conditions and the proposed final design using the tools and techniques listed above, as appropriate.

Developer shall use the modified selected alternative 2030 design volumes (RID TR-0.01) to develop and test the Final Design. Developer shall provide LOS equal or better than what is listed in Table 11-1. If a movement or roadway is not listed, the Developer shall provide the minimum LOS required in the Project Standards. Calculations shall be provided to IFA with an HCS analysis of the Final Design in accordance with Sections 11.9.1.1 and 11.9.1.2. Where an interpretation of the traffic analyses is required (e.g., if a change results in some improvements and some decreases in operations), IFA's approval will be in its sole discretion.

See Section 9.3.2 for additional requirements for traffic movements through the SR 265 and SR 62/Port Road interchange.

Table 11-1 Specific LOS Requirements

Facility	Location	2030 Build LOS	
		A.M.	P.M.
SR-265 EB	West of SR-62 off-ramp	B	E
SR-265 EB	SR-62 off-ramp	B	C
SR-265 EB	West of Port Road off-ramp	A	C
SR-265 EB	Port Road off-ramp	A	C
SR-265 EB	West of Port Road/SR-62 on-ramp	A	C
SR-265 EB	Port Road/SR-62 on-ramp	B	D
SR-265 EB	East of Port Road/SR-62 on-ramp	A	D
SR-265 WB	East of SR-62 off-ramp	C	B
SR-265 WB	SR-62 off-ramp	C	B
SR-265 WB	East of Port Road on-ramp	B	A
SR-265 WB	Port Road on-ramp	A	A
SR-265 WB	East of Port Road off-ramp	B	A
SR-265 WB	Port Road off-ramp	A	A
SR-265 WB	East of SR-62 on-ramp	C	B
SR-265 WB	SR-62 on-ramp	D	C
SR-265 WB	West of SR-62 on-ramp	E	C
SR 62	Within Project Limits	C	C

Developer shall also analyze all ramps such that the queues do not back from the ramp terminus to the mainline freeway. Developer shall provide IFA with calculations for Design Review showing the sight distance will be adequate for vehicles exiting the mainline freeway at highway speeds to see the back of the queue and decelerate to a stop condition.

In addition to the above, Developer shall also be responsible for reviewing the anticipated 2030 operational and proposed design speed for each segment of roadway and shall provide IFA with the operational and design speed differentials between adjacent lanes (i.e., mainline versus merging ramp) in tabular form, for Design Review.

It shall be Developer's responsibility to make sure that Final Design Documents for the East End Crossing accommodate the 2030 design volumes and the 2017 traffic volumes. Developer shall test the proposed interchange operations and the mainline operations.

11.9.2 Preparation and Submittal of Traffic Control Device Request

For the following improvements, Developer shall submit an official action to IFA for IFA's discretionary approval, copied to the Highway Management Deputy Commissioner in the Department with accompanying traffic operational analysis reports/documentation and signal warrant analyses:

- New traffic signals, intersection control beacons, or hazard identification beacons.
- The removal of existing traffic signals, intersection control beacons, or hazard identification beacons.
- The functional change of any existing traffic signal, such as adding or changing signal phases.
- Any type of signal pre-emption or priority.
- Any existing traffic signal modification, such as relocating poles, strobes, optically programmed heads, light emitting diodes (LED) heads, back plates, adding or shifting signal heads, the addition of accessible pedestrian signals and countdown pedestrian signals, etc.
- Additional signal detection or changes to existing detection.
- Signal detector repair/replacement as part of a reconstruction or resurfacing effort.
- All highway lighting or major change to an existing lighting system.
- All new overhead or cantilevered sign structures or modifications to existing sign structures.
- All revisions to the legend of major guide signs.
- Signing additions or changes within the Project Limits.
- Signing and pavement markings for new facilities and modifications to existing facilities.

All traffic signal equipment shall satisfy the criteria set forth in the Project Standards. For Indiana locations, the signal equipment choice shall be made by the Department District Traffic Engineer. All requests shall be submitted to IFA for Design Review prior to Developer proceeding with the design, installation, or modification of any traffic control device.

12 MAINTENANCE OF TRAFFIC (MOT), HAUL ROUTES, AND ACCESS DURING CONSTRUCTION

12.1 General

Maintenance of traffic (MOT) for the East End Crossing shall be implemented in accordance with the requirements of this Section 12, including performance requirements, Project Standards, maintenance during construction, and required reviews; Governmental Approvals; applicable Laws; and the PPA Documents.

MOT shall be performed in a manner that minimizes both construction duration and impact to the traveling public. This section defines specific requirements, restrictions, and allowable closure durations for both travel lanes and ramps. Due to the complex nature of the East End Crossing and the associated MOT issues and concerns, Developer shall submit a Transportation Management Plan (TMP) that includes a Traffic Operations Plan (TOP), a Temporary Traffic Control Plan (TTCP), and a traffic management section for the Public Involvement Plan (PIP), before initiation of construction.

12.2 Standards and References

Design and construct the Maintenance of Traffic (MOT), haul routes, and access during construction Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 12; Governmental Approvals; and applicable Laws.

12.3 Performance Requirements

12.3.1 Project-Wide Transportation Management Plan

Developer shall provide a TMP in accordance with the requirements in the IDM. The TMP shall evaluate alternatives and develop a TTCP, including MOT Plans, contract provisions, standard drawings, and standard specifications, as well as TOP and PIP section. IFA will provide Developer with a list of IFA representatives for the East End Crossing traffic management team to be included in Developer's TMP.

12.3.2 Additional Developer Requirements for TMP Development

In addition to the requirements in the IDM, the TMP shall include the following information:

1. A cover page/title sheet sealed by a Registered Professional Engineer.
2. A Temporary Traffic Control Plan (TTCP) including:
   a. MOT Plans, with a traffic and mobility analysis performed for each phase of construction. Refer to Section 11.9 for analysis requirements. The MOT Plans shall detail phases and durations and shall identify all long-term lane closures and lane restrictions anticipated for the project.
   b. Descriptions of the design methods to be used for temporary roadways.
   c. Detour routes required during Construction Work. Developer shall obtain approval from local agencies for all proposed detour routes and shall obtain, pay for, and

comply with requirements of all necessary Governmental Approvals and agreements required for the detour routes.

d. Special Provisions that include a switching procedure between each controlled MOT phase change. The switching procedure shall consist of the methods, actions, and signing necessary to complete the switch and the number and duties of traffic personnel assigned to perform the switch.

e. Special Provisions that describe a process for transitioning from temporary signage and temporary pavement marking to permanent signing and permanent pavement marking.

f. Special Provisions that specify Developer coordination work with the construction and maintenance projects of Governmental Entities that are adjacent to or near the East End Crossing Project ROW. The Special Provisions shall include a coordination clause listing other adjacent or nearby construction projects. At this time, these projects include the following:

   1) Louisville Water Company construction on their B.E. Payne Plant Property, to clean their Sludge Lagoon #3. Construction is anticipated to begin mid-2012 and is anticipated to be completed by mid-2014.

   2) Louisville Water Company construction of a 12” sewer along Transylvania Beach Road across the Project Limits. Construction is anticipated to start May 1, 2012 and be completed by the end of 2012.

   3) The Louisville Water Company construction of a 36” transmission water main will be adjacent to the KY 841 right of way (outside the Project Limits) for approximately 2,000 feet beginning near Station 42+25 and will continue south to Westport Road. The project is expected to bid in August 2012.

   4) City of Jeffersonville construction of a 24-inch force main from Lentzier Creek to River Ridge along existing and proposed Salem Road. Construction is anticipated to begin late 2012 and anticipated to be completed by the fall of 2013.

   5) The Department’s construction of Salem Road and the Salem Road Bridge over SR 265 (Contract IR-34937). Construction is anticipated to begin mid-2012 and is anticipated to be complete by mid-2013.

g. Special Provisions that require Developer to maintain existing access to all properties within the East End Crossing Project Limits for the duration of the Construction Work, except as provided elsewhere in the PPA Documents. Appropriate information about access modifications shall be made available to the property owners as required in the PIP.

3. A Traffic Operations Plan (TOP) including:

   a. Developer identification of a “Maintenance of Traffic (MOT) Manager” to coordinate all construction traffic impacts with IFA’s PIP Manager and TMP team, as well as Developer’s “Certified Worksite Traffic Supervisor (CWTS)” who is responsible to monitor daily MOT activities. The TOP shall also include descriptions of contact methods and response times of the CWTS to address any conditions needing attention during all hours.

b. Coordination with the Emergency Plan. Items to coordinate shall include identifying staging areas where equipment or vehicles needed for incident clearance response can be stored and have reasonable and safe access to the construction zone. Developer shall have the necessary equipment on-Site to repair temporary barrier or to set up temporary traffic control until the barrier can be repaired.

c. Procedures to identify and incorporate the needs of transit operators, Utility Owners, and business owners in the East End Crossing corridor, including Utility Owner access and business access signing.

d. Identification of measurable limits for the repair and replacement of traffic control devices, including pavement markings, as called out in the Department Standard Specifications.

e. A process to indentify, design, and receive approval for the designs of any necessary temporary traffic signals.

f. A process to determine the need for revised traffic signal timings, and if revisions are required, detail the procedures for the development, approval, implementation, testing, and maintenance of all affected signals.

g. A work zone access management map and a construction haul route map for each construction phase.

h. Methods and frequency of inspection and maintenance of all traffic control throughout the Project Limits.

i. Provisions to provide continuous access to established truck routes and any hazardous material (hazmat) routes. Procedures are to be identified that can modify the MOT Plans as needed to adapt to current project circumstances.

4. The TMP shall be developed in coordination with, and include procedures to communicate all MOT phase installations and changes with emergency service providers, school transportation officials and all affected local public agencies.

5. The TMP shall be developed in coordination with and be consistent with the PIP, and include procedures to communicate TMP information to the PIP Manager for communication of all MOT work to the public prior to implementation of any MOT phase or phase change.

12.3.3 Approved Analysis Techniques and Software for the TMP

The criteria used to determine the impact of proposed work zones shall be queue length and minimum delay times. Along with the techniques and software listed in Section 11, Developer may utilize Quewz-98 or similar programs to model the expected queue lengths and delay times that will be generated.

12.3.4 Maintenance of Traffic Analysis

Using no-build traffic data, or if not available, use existing traffic counts supplemented by additional traffic counts by the Developer as required, and analysis techniques described in Section 12.3.3, Developer shall test all MOT phases proposed on the East End Crossing to ensure that there are no operational or safety issues created by the TMP. The traffic alternative analysis shall be submitted to IFA with the MOT Plans and be subject to the same review requirements. The traffic analysis shall be summarized in report format, and all supporting documentation shall also be submitted to IFA.

The following thresholds for freeways and arterials shall be used by Developer in the evaluation of the work zone mobility impacts:

1. Freeways and Ramps

   Developer shall evaluate the operation of two-lane portions of the freeway and ramps as two-lane, two-way arterial roadways.

2. Signalized Intersections

   If the existing LOS on each approach is between A and C, then the LOS during MOT operations on each approach shall not be reduced below a D with a control delay of 45 seconds. If the 45-second control delay is exceeded, alternative strategies shall be reviewed and proposed. If the existing LOS on each approach is D or worse, then the control delay during MOT operations on each approach shall not increase more than 30 percent. If the 30 percent threshold is exceeded, alternative strategies shall be reviewed and proposed.

3. Unsignalized Intersections

   If the existing LOS on each approach is between A and C, then the LOS during MOT operations on each approach shall not be reduced below a D with a control delay of 30 seconds. If the 30-second control delay is exceeded, alternative strategies shall be reviewed and proposed. If the existing LOS on each approach is D or worse, then the control delay during MOT operations on each approach shall not increase more than 30 percent. If the 30 percent threshold is exceeded, alternative strategies shall be considered.

4. Local or Arterial Roadway Segment

   If flagging operations are performed on a local arterial roadway segment, a maximum delay of up to 10 minutes for any vehicle is acceptable. A delay of greater than 10 minutes for any vehicle is unacceptable, and alternative strategies shall be reviewed and proposed. In addition, maximum queue lengths as described in the IDM shall not be exceeded. Otherwise, at signalized intersections, an LOS on each approach shall be maintained at or above an LOS D with a control delay of 45 seconds.

IFA recognizes that specific work activities and time periods may make it infeasible to comply with the threshold levels listed in Section 12.3.4. Under these circumstances, Developer shall submit a request for Deviation to IFA for approval in accordance with Section 5.2.4 of the PPA. All Deviations from the threshold levels shall be submitted as early in the design process as possible. The request for Deviations from the threshold levels shall include the following:

1. East End Crossing Location and Description:

   a. East End Crossing location and work required

   b. Existing condition

   c. Purpose for the threshold exception request, along with how long and what hours the lane closures will be in effect

   d. Recommendations to minimize impacts

2. MOT Alternatives – All potential options for MOT with descriptions and discussions of each, including the following:

   a. Advantages/disadvantages

   b. Estimated time frame

   c. User and construction cost

   d. Potential economic impact to communities and businesses

   e. Ability to gain public buy-in and awareness of the impacts and means to mitigate those impacts

3. Traffic Analysis

   a. Queue/delay analysis

   b. Percent diversion that is reasonable to expect for the East End Crossing location and conditions

   c. Queues with expected percentage of traffic diverting

4. Detour Calculations

   a. If a detour is proposed, provide detour route description, detour map(s), and user cost created to travel the extra distance.

   b. Provide capacity, volume, and queue length calculations for the critical node along the detour route.

   c. Suggest improvements to the detour route to improve traffic flow on the route with the detour traffic.

5. Summary and Recommendations

   a. List alternatives in order of preference and explain why the alternative is or is not preferred.

   b. Summarize alternatives in table format, including important comparison items such as maximum queue lengths, the number and width of open lanes, the length, dates and duration of construction period, incremental construction cost associated with each option, etc.

Developer shall be responsible for monitoring queues and delays during MOT operations. If the thresholds listed in Section 12.3.4 are being exceeded, then it shall be Developer's responsibility to modify the MOT Plans to mitigate the queues and keep delays below the threshold levels. All proposed changes to the MOT Plans shall be submitted to IFA for review and comment.

12.4 Design and Construction Requirements

12.4.1 Design Criteria

The information listed below shall be incorporated into the conceptual MOT Plans and the TMP.

1. Design Speed

    a. The design speed and posted speed on state highways shall be the existing posted speed limit on approaches to the work zone, with a maximum 10-mile-per-hour speed reduction within the work zone; The posted speed can be reduced an additional 10 miles per hour in the work zone using flashing worksite speed limit assemblies as shown in the Department Standard Drawings 801-TCDV-10 and 801-TCDV-11 and “When Workers Are Present” signing.

    b. The design speed on non-state highway facilities shall be the existing posted speed limit on approaches to the work zone, with a maximum 10-mile-per-hour reduction of posted speed within the work zone. The posted speed can be reduced an additional 10 miles per hour in the work zone using flashing worksite speed limit assemblies as shown in the Department Standard Drawings 801-TCDV-09 and 801-TCDV-10 and “When Workers Are Present” signing.

2. Lane Widths

    a. The minimum MOT lane width shall be 11 feet on state and county routes.

    b. The minimum MOT lane width shall be 10 feet on subdivision local roadways.

3. Uncurbed Edge of Pavement Widths

    a. Any existing, temporary, or proposed edges of pavement shall be a minimum of 2 feet away from the edge of a travel lane.

4. Separation

    a. A minimum clearance of 2 feet between barrier and edge of travel lane is required.

    b. Temporary concrete barrier and approved end treatments shall be used to protect the motoring public from the work area within the Project Limits when work or equipment, including personal vehicles and trucks used for loading and unloading, are within an 8-foot offset of the travel lane. Portable concrete barrier or temporary guardrail shall be provided if the entire clear zone is not traversable or if hazards exist within the clear zone.

    c. Portable concrete barrier on bridge decks shall be installed per the Department Standard Drawings.

    d. On state highways, tubular delineators shall be used between opposite bounds to separate two-way traffic when opposing traffic is maintained on the same roadbed, in accordance the Department Standard Drawings.

5. Crash Compliance

    a. All work zone traffic control devices shall be compliant with National Cooperative Highway Research Program (NCRP) 350 requirements.

6. Signing/Lane Shifts/Closures

   a. All MOT procedures shall be in accordance with the MUTCD.

7. Pavement Edge Drop-offs

   a. Drop-off conditions 3 inches or less shall be protected by barrels or delineators spaced every 40 feet or a distance in feet equivalent to two times the speed limit in Miles Per Hour, whichever is less.

   b. Drop-offs greater than 3 inches shall be wedged with Dense Graded Aggregate or other suitable materials on a 3:1 or flatter slope, in conjunction with barrels spaced every 40 feet or a distance in feet equivalent to two times the speed limit in Miles Per Hour, whichever is less.

   c. If a positive separation of 8 feet or greater can be achieved between traffic and the drop-off, no wedging will be required but barrels will be required. Temporary drop-offs during working hours in which construction operations are taking place shall be kept to a minimum.

   d. Drop-offs greater than 3 inches, resulting from excavations directly adjacent to traffic (with no positive separation), shall be limited to 500 feet in length. The intent of this requirement is to keep the temporary wedging operation in close proximity to the work to promote safety for motorists.

8. Channelizing Devices

   a. Channelizing devices approved for use on the East End Crossing are detailed in the Project Standards. Developer shall refer to Recurring Special Provision 107-C-208 regarding the utilization of drums or other channelizing devices for traffic control.

   b. Temporary channelizing device spacing shall be a maximum of 40 feet center-to-center in tapers or a distance in feet equivalent to the speed limit in Miles Per Hour, whichever is less, and 80 feet center-to-center in tangent sections or a distance in feet equivalent to two times the speed limit in Miles Per Hour, whichever is less, of freeways and ramps (including mainline curves). On local roadways, device spacing shall be a maximum of 20 feet center-to-center in tapers, 40 feet center-to center in tangent sections, and 6 feet center-to-center in radii.

   c. Developer shall provide, erect, and maintain channelizing devices, signs, barriers, and other traffic control devices used for MOT in acceptable condition, in accordance with the Project Standards.

9. Flashing Arrows and Variable Message Boards

   a. Developer shall be responsible for supplying all flashing arrows and variable message boards necessary to maintain traffic for the East End Crossing. Upon completion of the East End Crossing, the flashing arrows and variable message boards shall remain the property of Developer.

10. Drainage shall be maintained at all times during all phases of Construction Work.

11. Traffic signals, either temporary or permanent, shall remain operational from beginning of implementation to end of implementation.

12.4.2 Traffic through the Construction Zone

Developer shall provide a CWTS on-site whose responsibility is to supervise and continuously monitor the installation and maintenance of all traffic control devices, under the supervision of the MOT Manager. Developer shall authorize the CWTS to direct traffic changes to ensure safe and continuous traffic flow and to direct traffic operations after a traffic incident has occurred. The CWTS shall inspect all traffic control devices at a minimum of once daily and shall provide for the repair or replacement of defective devices. The CWTS shall submit a weekly written report of the daily traffic control device inspections to IFA for review and comment. The report shall include comments on all MOT setups, including but not limited to temporary signals, maximum queue lengths/delays, work zone modifications, MOT phase changes, incidents, repairs and replacements made and suggested improvements.

The CWTS shall be available at all times and be on-site within a half hour of notification throughout the duration of the Construction Work. The minimum qualifications of the CWTS shall include certification as a certified worksite traffic supervisor by the American Traffic Safety Services Association (ATSSA), or an approved equal certifying organization.

Access to all businesses and residences shall be maintained at all times.

Developer shall design, place, and maintain all approved construction detour routes required during Construction Work and shall obtain all necessary Governmental Approvals for detours from the appropriate Governmental Entities.

Developer shall be responsible for all needed construction and haul roads required for the delivery of fill, asphalt, concrete, bridge girders, and all other materials required for the East End Crossing and shall obtain, pay for and comply with the conditions of all necessary Governmental Approvals from the appropriate Governmental Entities for temporary roadways, including Construction Work and, as applicable, haul routes.

Developer shall arrange and hold an initial MOT meeting with IFA and all affected Governmental Entities at least four weeks prior to initial installation of traffic control devices for any MOT phase and shall hold a MOT phase switch meeting with IFA and all affected Governmental Entities at least two weeks before any MOT phase switch.

Developer shall design all geometric aspects of temporary roadways for the accepted work zone design speed.

Developer shall coordinate the operation of portable changeable message signs with IFA.

Developer shall not use local streets through residential neighborhoods for access to the Site without approval of the local jurisdiction. Appropriate MOT and flagging procedures shall be followed during all Construction Work, including mobilization and demobilization activities. Deliveries and hauling to and from the construction Site shall be confined to the Project ROW and performed via designated haul routes along the East End Crossing alignment.

12.4.3 Construction Access and Haul Routes

Developer will be allowed to utilize local streets through residential neighborhoods for the following activities after obtaining any required approvals from the local jurisdiction:

- Local roadway improvements
- Utility Adjustments
- Construction Work and implementation of roadway detours

Developer shall develop an access and mobility plan depicting haul routes and access point's 90-days after NTP1 and submit to IFA for approval in its good faith discretion. The access and mobility plan shall depict how deliveries and hauling to and from the East End Crossing shall be performed via haul routes as permitted by IFA and the entity owning the haul route. Movement of materials from one location to another within the Project ROW shall be confined to the Project ROW (except over the proposed Tunnel locations on the Drumanard Property) and performed via haul routes, as permitted by IFA and the entity owning the haul route.

Table 12–1 describes the privately owned roads in the vicinity of the East End Crossing.

Table 12-1 Private Roads

Road	Description
Kentucky	
Hoskins Beach Road	Intersects River Road, south of Harrods Creek
Marina Drive	Intersects US 42, north of KY 841
Transylvania Beach Road	Parallel to Ohio River
Mayfair Avenue*	Intersects River Road, north of proposed KY 841
Concourse Road	Mayfair turns into Concourse
Indiana	
Patrol Road	Along boundary of old Ammo Depot
Salem Road	Between New Chapel Road and 3rd Street
*A section of Mayfair Avenue may be public.	

Construction vehicles used by Developer shall comply with any and all load restrictions and vehicle delineation requirements when used on roads open to the public.

Construction equipment shall always be stored in locations that do not pose a safety risk to the traveling public. Construction equipment shall be stored either behind barriers or outside of the clear zone. Construction equipment shall be stored outside of sidewalks and bike lanes/paths that are open to traffic.

Construction traffic will be allowed to cross roadways that intersect with the mainline alignment as long as the crossing is maintained within the Project ROW. With IFA approval, proper flagging procedures and, as applicable, temporary traffic signals can be used to facilitate construction traffic crossing local roadways. At-grade roadway crossings shall not be allowed during the times identified in Table 12-2 unless prior written approval is granted by IFA.

Table 12-2 Construction Traffic Roadway Crossing Restrictions

Roadway	Day of the Week	Prohibited Crossing Times
Wolf Pen Branch Road	Monday - Friday	5:00 a.m. - 9:00 a.m. 3:00 p.m. - 9:00 p.m.

Roadway	Day of the Week	Prohibited Crossing Times
U.S. 42	All	Cross at the signalized intersections or at locations as approved by the Engineer except Monday-Friday 5:00 a.m. - 9:00 a.m. 3:00 p.m. - 9:00 p.m.
River Road	Monday - Friday	5:00 a.m. - 9:00 a.m. 3:00 p.m. - 9:00 p.m.
Brookhollow Way	Monday - Friday	5:00 a.m. - 9:00 a.m. 3:00 p.m. - 9:00 p.m.
Utica Sellersburg Road	Monday - Friday	7:00 a.m. - 9:00 a.m. 3:00 p.m. - 7:00 p.m.

12.4.4 Detour Routes

Developer shall maintain detour routes in a condition that is reasonably smooth and free from holes, ruts, ridges, bumps, dust, and standing water. Once the detour is removed and traffic is returned to its normal pattern, the detour route shall be restored to a condition that is equivalent or better than the condition which existed before its use for this purpose. All required pavement markings shall meet IMUTCD standards and local requirements.

12.4.5 Improvements to Existing Roadway Network

Developer shall videotape haul routes before construction operations. Developer shall maintain these routes in a condition that is reasonably smooth and free from holes, ruts, ridges, bumps, dust, and standing water. Once the haul route is removed and traffic returned to its normal pattern, or construction operations are completed, the route shall be restored to a condition that is equivalent or better than the condition which existed before its use for this purpose. Developer shall include in the MOT Plans a schedule for restoring any damaged route to its preconstruction condition. All required pavement markings shall meet IMUTCD standards and applicable Laws and requirements.

12.4.6 Maintenance-of-Traffic Manager

Developer shall identify an MOT Manager to perform the following:

- Coordinate MOT activities with IFA
- Implement traffic management strategies
- Provide an MOT report to IFA with each change in traffic phasing, including expected queue lengths/delays, a summary of expected operations, and MOT durations
- Be continuously available during construction until Final Acceptance of the East End Crossing and the elimination of all temporary traffic control
- Supervise the activities of the CWTS.

12.4.7 Restrictions

Developer shall refer to the Department’s Recurring Special Provision 108-C-585 regarding working restrictions during holiday periods, except as modified herewith. Developer will be permitted to work during holiday periods, if desired, in accordance with road lane closure restrictions as listed in Table 12-3; however, Developer shall be required to suspend work associated with deliveries and off-site hauling operations during holiday periods. Developer shall suspend deliveries and offsite hauling operations one day in advance to one day after the Kentucky Derby and associated activities at Churchill Downs and the 2014 PGA Championship at Valhalla Golf Club. Developer shall coordinate with KYTC regarding all restriction dates.

Construction operations using shoulder closures will be allowed (except holidays), provided any resulting temporary drop-off conditions and signing requirements shall be addressed in the TMP.

Roadways within a blast zone may be closed during off-peak traffic hours for a maximum of 20 minutes at a time during blasting operations to execute the blast and perform any cleanup necessary to reopen the road for traffic for both directions of travel. Failure to open the roadway shall be subject to Noncompliance points in accordance with Exhibit 12, Attachment 1 of the PPA. Following any incident where the debris cannot be cleared within the 20-minute requirement, Developer shall present to the Project Manager for approval the proposed methods for controlling the blast and cleanup such that the 20-minute limit can be met before the next blast. After a blast requiring closure and cleanup, the through traffic delayed by the closure shall be allowed to clear before the next closure.

12.4.8 Freeway/Ramp/Roadway Closures and Restrictions

Table 12-3 summarizes the allowable closures and restrictions for the roadways in the East End Crossing area.

Table 12-3 Permitted Roadway Closure and Restricted Access Provisions

Facility	Allowable Closures/Restrictions	Notes
KY 841	Maintain one lane in each direction from I-71 to U.S. 42.	
U.S. 42	No lane restrictions allowed.	
Wolf Pen Branch Road	Maintain one lane of traffic in each direction (two-way, one-lane traffic at a minimum with a temporary signal at the bridge replacement location).	Wolf Pen Branch Road shall be open to unrestricted traffic within six months of beginning of construction on Wolf Pen Branch Road Bridge.
Olde Creek Way		Coordinate access with affected property owners and homeowners association.
Shadow Wood Lane	Close from Shadow Wood Ct. to Shadow Wood Drive.	
River Road	No lane restrictions allowed.	Intermittent 20-minute off-peak closures allowed for overhead bridge work.
Hoskins Beach Road	Close within Project ROW.	
Transylvania Avenue	Maintain one lane of traffic in each direction.	Intermittent 20-minute off-peak closures allowed for overhead bridge work.

Facility	Allowable Closures/Restrictions	Notes
Transylvania Beach Road/Upper River Road	Maintain one lane of traffic in each direction.	Intermittent 20-minute off-peak closures allowed for overhead bridge work.
Utica Charlestown Road	Maintain one lane of traffic in each direction at all times.	Intermittent 20-minute off-peak closures allowed for overhead bridge work.
Salem Road	Maintain one lane of traffic in each direction at all times.	Developer shall also coordinate Work with contractor building this road and bridge.
Wood Creek Way	Close within Project ROW.	
Brookhollow Way	Maintain one lane of traffic in each direction.	Intermittent 20-minute off-peak closures allowed for overhead bridge work. Brookview Drive access shall be provided at all times.
Springbrook Drive	Close within Project ROW.	
Utica Sellersburg Road	Close during construction of overpass	Utica Sellersburg Road shall be open to unrestricted traffic within six months of beginning of construction on the Utica Sellersburg Road Bridge.
Port Road/New Chapel Road	Maintain one lane of traffic in each direction.	Maintain access to SR 62 via a temporary signal.
SR 265	Maintain one lane of traffic in each direction.	Maintain continuity with Port Road/New Chapel Road.
Railroad Crossing	Maintain Railroad traffic at all times.	Coordinate with MG Railroad Co. to provide flagging services.
SR 265/SR 62/Port Rd Interchange Ramps	Maintain one lane access.	Use of temporary signal acceptable.
EB SR 265 to SR 62	Maintain one lane access.	Use of temporary signal acceptable.
SR 62	Maintain one lane of traffic in each direction	

Additional restrictions to reduce to a single lane on local roads shall be included in the TMP. Traffic may be restricted to a single lane with the use of the appropriate signs and flagmen on all other local roadways within the Project Limits, and for the local roads in the table above as approved in the TMP, during the working hours of 9:00 a.m. to 3:00 p.m., Monday through Friday, and during daylight hours on Saturday and Sunday. Requirements as called out in Section 12.3.4 shall apply to flagging operations.

12.4.9 Notification and Coordination

The MOT Manager shall notify IFA at least 14 days before the start of any construction activities that would affect traffic operations, including but not limited to the placement or relocation of work zone signs.

Throughout the duration of the Construction Work, the MOT Manager shall notify IFA and the others listed in the TMP and this Section 12 in writing of all traffic restrictions and upcoming MOT changes. Developer shall ensure the written notification is submitted in accordance with Table 12-3. This notification shall be received by IFA before the physical setup of any applicable signs or message boards.

Information shall include but is not limited to all construction activities that impact or interfere with traffic and shall list the specific location, type of work, road status, date and time of restriction, duration of restriction, number of lanes maintained, detour routes if applicable, and any other information requested by IFA. A summary of the notification time and requirements for closures and restrictions is provided in Table 12-4.

Table 12-4 Road and Lane Restriction Notification Requirements

Item	Duration of Closure	Notification Time Frame
Ramp and Road Closures	>+2 weeks	14 business days before closure
	>12 hours and < 2 weeks	7 business days before closure
	<12 hours	2 business days before closure
Lane Closure/Restrictions	>=2 weeks	7 business days before closure
	<2 weeks	2 business days before closure

Any unforeseen conditions not specified in the MOT Plans or TTCPs requiring traffic restrictions shall also be reported to IFA using the above table.

A pre-MOT meeting between IFA and Developer shall be held (minimum of 10 Business Days) before beginning Construction Work or executing any change of MOT staging. This meeting shall include IFA and any Developer subconsultants involved with temporary traffic control.

Developer shall prepare a point of contact list that identifies current contact information for Key Personnel to include but not be limited to the following agencies affected by the East End Crossing: local fire/police departments, local school districts, mass transit agencies, state or community colleges, and 911 dispatch centers.

12.5 Deliverables

Developer shall for prepare and maintain a TMP in accordance with the IDM and as specified in these Technical Provisions. The initial draft is due upon submission of the Stage 1 Design Documents and it shall be updated on an as needed basis through Final Acceptance. The final TMP shall be submitted to the IFA for approval 90 days before anticipated commencement of Construction Work.

12.5.1 Release-For-Construction Documents

The TTCP consists of the East End Crossing-specific MOT Plans, MOT Special Provisions, standard drawings, and standard specifications and the requirements in Section 12.3.2. These documents define how Developer is to phase construction and detail all the required elements of the physical work zone. The TTCP for this East End Crossing includes queuing/delay analysis. Upon completion of queuing/delay analysis, MOT Plans and MOT Special Provisions shall be developed and included with the Released-for-Construction Design Documents. The MOT Plans shall include all major traffic shifts, lane closures, use of temporary roadways, temporary traffic signal, and access modifications to businesses and residences. The anticipated duration of each phase shall also be noted on the plan.

The MOT Plans shall contain the following components for each phase of construction:

1. Plans at an appropriate scale to facilitate IFA review, showing the following:
   a. The work area
   b. Begin/end tapers
   c. Work in vicinity of entrance ramps
   d. Temporary pavements and, as applicable, structures
   e. Locations of signs (existing, proposed, covered, and modified)
   f. Roadway plan sheets showing all in-place traffic control devices that need to be retained, relocated, or removed an all temporary traffic control devices that need to be installed, retained, relocated, or removed for each phase of construction
   g. Provisions for using temporary guardrail, temporary concrete barrier wall, or attenuators to protect the traveling public and to provide security of the East End Crossing site
   h. Location of signs (existing, proposed, covered, and modified)
   i. Type and location of all pavement markings (temporary and permanent) to be installed, removed, or renewed for each phase and location of the final pavement markings
   j. Plan insert sheets, including ingress/egress locations for Developer-Related Entities
   k. Plan notes
   l. References to applicable Project Standards
2. Plans at an appropriate scale, showing the following:
   a. Detailed detour Plans, incorporating detour routes and alternatives specified in Section 12.4.4
   b. Portable changeable message signs and advance notification signing locations
   c. Temporary signal Plans for each phase of construction that involves a change to the signal. Temporary signal Plans shall include signal timing and phasing

d. Typical sections showing lane widths, pavement markings, channelizing devices, temporary concrete barrier (TCB), limiting stations, work area, drop-offs, etc.

e. Sign details for proposed signs and overlays/modifications of existing signs

f. Haul routes

g. Plan showing any detour routes or closures within or adjacent to historic sites and districts

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13 GEOTECHNICAL

13.1 General

Geotechnical data reports, which contain the preliminary geotechnical data obtained by IFA for this Work, are included as Reference Information Documents. Data reports generated from the preliminary studies conducted for IFA are provided to Developer for evaluation of the subsurface conditions along the alignment and for the various design elements.

Developer may use existing boring data and test results contained in the Reference Information Documents to satisfy the geotechnical requirements as appropriate.

The Developer shall form its own interpretation of the existing geotechnical data and satisfy itself as to the suitability and sufficiency of the geotechnical data, and the form and nature of the subsurface conditions that may affect its detailed design, construction methods, and equipment.

Developer shall conduct sufficient research and additional investigation as necessary to verify and, as applicable, supplement the available information such that it is sufficient, reliable, and accurate to design and construct the Work.

As required, Developer shall conduct supplemental subsurface explorations, testing, and analyses for all geotechnical components of the East End Crossing in accordance with all applicable criteria and Project Standards cited herein and in accordance with this Technical Provision. Relief events related to subsurface conditions are defined in PPA Exhibit 1. Geotechnical reporting shall be conducted in accordance with Chapter 18 of the IDM. Geotechnical investigation and design shall be conducted in accordance with the Project Standards. Developer shall conduct geotechnical Work and reporting in accordance with Chapter 18 of the IDM, with the exception that the Office of Geotechnical Services will not prepare the geotechnical evaluation report summary, as described in IDM 18-1.05. Developer shall be solely responsible for conducting additional required geotechnical investigations and preparing all geotechnical reports and recommendations.

A geotechnical baseline report (GBR) has been prepared only for the Tunnel section of the East End Crossing (see Attachment 16-1). The GBR defines the geotechnical conditions and risks, and together with the Technical Provisions and PPA, establishes the responsibilities of Developer related to the use of the geotechnical information for the purposes of designing and constructing the Tunnel. Developer shall refer to the GBR and Section 16 for all geotechnical information related to the Tunnel. The Tunnel in this regard shall include only the excavated area of the Tunnel between and including the portals on either end.

13.2 Standards and References

Design and construct the geotechnical Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 13; Governmental Approvals; and applicable Laws.

13.3 Design Requirements

13.3.1 Geotechnical Subsurface Exploration

13.3.1.1 Preliminary Subsurface Data

A GBR is provided only for the Tunnel segment of the East End Crossing. Unless noted otherwise, this Section 13 applies only to the non-Tunnel portion of the East End Crossing.

Preliminary subsurface investigations have been completed to provide site characterization for the non-Tunnel portion of the East End Crossing. They are included with the RID and are titled as follows:

- Stantec Consulting Services, Inc., Report of Geotechnical Investigation, East End Kentucky Approach Structure, Ohio River Bridges Project, Section 4, Item No. 5-731.00, Jefferson County, Kentucky, S-128-2011, January 10, 2012. (RID Index name GE-4.10 Section 4 - Kentucky Approach Structure to ORB Approved Geotechnical Report.pdf)
- CTL Engineering, Inc., Geotechnical Investigation – Data Report, Des. No. 0201297, New Expressway on SR265, Clark County, Indiana, January 3, 2012. (RID Index name GE-6.01 Section 6 Geotech)
- K.S. Ware and Associates, L.L.C., Report of Geotechnical Exploration, Roadway Report, Wolf Pen Branch Road, LSIORBP – Section 4 – KY 841, Louisville, Jefferson County, Kentucky, August 14, 2009. (RID Index name GE-4.02 Section 4 Geotech 2009)
- K.S. Ware and Associates, L.L.C., Report of Geotechnical Exploration, Bridge Structure Report, New Wolf Pen Branch Road Bridge and Temporary Diversion Bridge, LSIORBP – Section 4 – KY 841, Louisville, Jefferson County, Kentucky, July 23, 2009. (RID Index name GE-4.01 Str 3 Wolf Pen Branch Geotech)
- Fuller, Mossbarger, Scott, & May Engineers, Inc., Report of Geotechnical Exploration, Ohio River Bridges Project, East End Approach – Section 4, Roadway Portion, Item No. 5-118.11, Jefferson County, Kentucky, June 10, 2008. (RID Index name GE-4.03 Section 4 Geotech 2008)
- PB Americas, Inc. and FMSM Engineers, Inc., Geotechnical Engineering Report, Section 5 – East End Bridge over Ohio River, Ohio River Bridges Project, Item No. 5-118.00, Jefferson County, Kentucky, May 12, 2008. (RID Index name GE-5.01 Section 5 Geotech)

The preliminary subsurface investigations consist of standard penetration test (SPT) borings with rock coring, seismic refraction testing, electrical resistivity testing, in-situ testing, laboratory testing, and groundwater monitoring wells.

13.3.1.2 Developer's Subsurface Exploration

Should Developer determine that additional geotechnical data is necessary to complete the Work, a subsurface exploration and testing program shall be implemented. The supplemental investigation shall include all field and laboratory testing necessary to establish the geotechnical conditions and to perform all geotechnical and foundation design and analyses.

The program, herein designated as Developer's subsurface exploration program, shall be developed and implemented to supplement the data provided by IFA and to obtain the data as required to meet Project Standards and Developer's design approach and construction methods. Developer's subsurface exploration program, including the location, number, depth, type of boreholes, field-testing and sampling, and laboratory testing shall conform to the Project Standards. The details of Developer's subsurface exploration program to be used for Design Work shall be submitted to IFA for review and comment. The rationale for the development of the exploration programs, data interpretation, and parameter selection, together with descriptions of the methods of analyses, shall be clearly presented. IFA review and comment on the geotechnical planning reports will indicate only that it conforms to the minimum requirements of the Project Standards. Developer shall maintain full responsibility to ensure that the subsurface exploration program is sufficient to design and construct the Work.

In addition to the techniques described in the AASHTO *Manual on Subsurface Investigations*, Developer's geotechnical engineer may include the Ko blade, Prebored Pressuremeter (ASTM D-4719), Electronic and Piezocone Testing (ASTM D-5778), Mechanical Cone Penetrometer (ASTM D-3441), and Dilatometer Test Probes (ASTM D-6635) in the subsurface investigations to aid in the development of in-situ soil parameters for the design of the East End Crossing. Ko testing shall be in accordance with the manufacturers' recommended procedures and shall be submitted to IFA as part of the subsurface exploration program.

IFA will review and comment on Developer's subsurface exploration program prior to its implementation. Developer shall perform its subsurface exploration program to establish all geotechnical parameters and subsurface conditions required for Design Work and Construction Work. In areas of erratic subsurface conditions and where stratification indicates possible deep stability or settlement problems, borings shall extend into rock, and into a hard or dense soil stratum, and, as applicable, additional test holes shall be constructed.

Developer shall provide the results of the studies in the geotechnical planning reports to IFA.

The minimum requirements for layout and the depth of exploration points for structures shall be in accordance with AASHTO Load and Resistance Factor Design (LRFD) Specifications, Section 10, Table 10.4.2-1, which is incorporated in Table 13-1 for reference only. The requirements specified in AASHTO LRFD Table 10.4.2-1 shall be regarded as minimum. In accordance with the AASHTO Manual on Subsurface Investigations, Developer shall conduct additional investigations if the geologic conditions warrant. The Department geotechnical manual shall hold precedence in areas where it stipulates greater and, as applicable, additional requirements.

Table 13-1 Minimum Requirements for Exploration Points and Depth of Exploration for Structures

Application	Minimum Number of Exploration Points and Location of Exploration Points	Minimum Depth of Exploration
Retaining Walls	A minimum of one exploration point for each retaining wall. For retaining walls more than 100 feet in length, exploration points spaced every 100 to 200 feet with locations alternating from in front of the wall to behind the wall. For anchored walls, additional exploration points in the anchorage zone spaced at	Investigate to a depth below bottom of wall at least to a depth where stress increase due to estimated foundation load is less than 10 percent of the existing effective overburden stress at that depth and between one and two times the wall height. Exploration depth shall be great enough to fully penetrate soft highly compressible soils, e.g., peat,

Application	Minimum Number of Exploration Points and Location of Exploration Points	Minimum Depth of Exploration
	100 to 200 feet. For soil-nailed walls, additional exploration points at a distance of 1.0 to 1.5 times the height of the wall behind the wall spaced at 100 to 200 feet.	organic silt, or soft fine-grained soils, into competent material of suitable bearing capacity, e.g., stiff to hard cohesive soil, compact dense cohesionless soil, or bedrock.
Wing Walls	A minimum of one (1) boring shall be performed for each wing wall. For wing walls in excess of 75 feet in length, refer to Retaining Walls, above.	Same as retaining walls.
Noise Walls/ Concrete Walls	A minimum of one (1) boring shall be performed for each noise and concrete wall. For noise and concrete walls in excess of 75 feet in length, see Retaining Walls, above.	Same as retaining walls.
Shallow Foundations	For substructure, e.g., piers or abutments, widths less than or equal to 100 feet, a minimum of one exploration point per substructure. For substructure widths greater than 100 feet, a minimum of two exploration points per substructure. Additional exploration points shall be provided if erratic subsurface conditions are encountered.	Depth of exploration shall be: Great enough to fully penetrate unsuitable foundation soils, e.g., peat, organic silt, or soft fine-grained soils, into competent material of suitable bearing resistance, e.g., stiff to hard cohesive soil or compact to dense cohesionless soil or bedrock. At least to a depth where stress increase due to estimated foundation load is less than 10 percent of the existing effective overburden stress at that depth. If bedrock is encountered before the depth required by the second criterion above is achieved, exploration depth shall be great enough to penetrate a minimum of 10 feet into the bedrock, but rock exploration shall be sufficient to characterize compressibility of infill material of near-horizontal to horizontal discontinuities. Note that for highly variable bedrock conditions, or in areas where very large boulders are likely, more than 10 feet of rock core may be required to verify that adequate quality bedrock is present.
Deep Foundations	For substructure, e.g., bridge piers or abutments, widths less than or equal to 100 feet, a minimum of one exploration point per substructure.	In soil, depth of exploration shall extend below the anticipated pile or shaft tip elevation a minimum of 20 feet, or a minimum of two times the maximum pile

Application	Minimum Number of Exploration Points and Location of Exploration Points	Minimum Depth of Exploration
	For substructure widths greater than 100 feet, a minimum of two exploration points per substructure. Additional exploration points shall be provided if erratic subsurface conditions are encountered, especially for the case of shafts socketed into bedrock.	group dimension, whichever is deeper. All borings shall extend through unsuitable strata such as unconsolidated fill, peat, highly organic materials, soft fine-grained soils, and loose coarse-grained soils to reach hard or dense materials. For piles bearing on rock, a minimum of 10 feet of rock core shall be obtained at each exploration point location to verify that the boring has not terminated on a boulder. For shafts supported on or extending into rock, a minimum of 10 feet of rock core, or a length of rock core equal to at least three times the shaft diameter for isolated shafts or two times the maximum shaft group dimension, whichever is greater, shall be extended below the anticipated shaft tip elevation to determine the physical characteristics of rock within the zone of foundation influence. Note that for highly variable bedrock conditions, or in areas where very large boulders are likely, more than 10 feet of rock core may be required to verify that adequate quality bedrock is present.
Roadway Subgrade and Pavement Design	The spacing between borings along the roadway alignment shall not exceed 200 to 500 feet. The selected spacing and location shall depend on the geologic complexity and subsurface variability.	Where minor cuts are anticipated, 10 feet below proposed subgrade elevation minimum, or 10-foot minimum from existing ground surface where minor fills are anticipated.
Roadway Embankments	The spacing between borings along the roadway alignment shall not exceed 300 feet. The selected spacing and location shall depend on the geologic complexity and subsurface variability.	Extend borings a minimum depth equal to twice the embankment height, or to a depth where stress increase due to estimated embankment load is less than 10 percent of the existing effective overburden stress at that depth, unless a hard stratum is encountered above this depth. Where soft strata are encountered that may present stability or settlement concerns, the borings shall extend to hard material. Embankments over soft ground shall include deeper and, as applicable, additional borings to

Application	Minimum Number of Exploration Points and Location of Exploration Points	Minimum Depth of Exploration
		determine the limits of soft deposits.
Roadway Cuts	The spacing shall be the same as for roadway embankments or as needed based on the geologic complexity. A minimum of one boring shall be performed for each cut slope. At critical locations and where high cuts, provide a minimum of three borings in the transverse direction to model the existing geological conditions for stability analyses.	Borings shall extend a minimum of 10 feet below the anticipated depth of the cut at the ditch line. Boring depths shall be increased in locations where base stability is a concern due to the presence of soft soils, or in locations where the base of the cut is below groundwater level to determine the depth of the underlying pervious strata. For deeper cuts, additional soil borings may be needed to develop a lateral profile.
Culverts 36-inch-Diameter or Greater or Where Problematic Soils Exist	A minimum of one boring at each culvert. Additional borings shall be provided for long culverts or in areas of erratic subsurface conditions.	Borings shall extend a minimum of 15 feet below the bottom of the culvert or until 5 feet of firm, competent material is encountered, whichever is deeper.
High-Mast Highway Signs, High Mast Lighting	Per AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals. As a minimum, one boring shall be made at each defined location.	Borings shall extend a minimum of 40 feet into suitable soil or 10 feet into competent bedrock. Borings may be extended deeper for structures where high torsional loads are expected. Other criteria are the same as for deep foundations.
Note: Any foundation boring used shall be within 25 feet of the substructure unit to be applicable.		

Among the requirements for the subsurface investigation and laboratory testing to be performed for the East End Crossing are the following:

1. Supervision and Inspection – All geophysical investigations shall be planned and performed under the direct supervision of a geophysicist with a minimum of 10 years' experience. All boring and in-situ testing inspection shall be performed by field inspectors who have passed the NHI Subsurface Investigation Qualification Course (#132079) and (a) are a degreed engineer or geologist or (b) have a minimum of two (2) years of field experience in the inspection and reporting of field sampling and testing of similar size and content. All field investigations and laboratory testing shall be performed under the direct supervision of a Registered Professional Engineer, with a minimum of five (5) years of experience in the performance and supervision of geotechnical engineering projects.

2. Location and Ground Surface Elevation – Developer shall determine the coordinate location, station, and offset from the mainline and ground surface elevation for each boring and other test probes and show the information on the individual boring logs.

3. Soil classification shall be performed in accordance with the AASHTO classification system.

4. Final boring and rock core logs shall be prepared and presented using gINT software as supplied by Bentley Systems Inc. IFA will provide the electronic template for the latest version of gINT.

5. The soils and rock samples obtained by Developer for the supplemental subsurface investigation are the property of IFA. Developer shall deliver all samples to a location to be coordinated with IFA.

6. Boreholes shall be covered with bags of sand or metal plates and topped with orange cones for 24 hours until obtaining the 24-hour water reading. After the reading is taken, abandoned borehole shall be sealed with bentonite pellets or grout from the bottom of the hole to the ground surface. Unless otherwise directed by IFA, soils that cave in during the 24-hour waiting period do not need to be removed. Spoils shall be evenly distributed to the surrounding area.

13.3.1.3 Laboratory Testing

After collecting soil and rock samples, laboratory tests shall be performed to quantify material properties and verify design assumptions. Sufficient testing shall be performed so that Developer is satisfied that the test results are representative of in-situ conditions. All standard soil and rock sample laboratory testing shall be performed in accordance with the appropriate AASHTO Test Designation. All laboratory testing shall be performed by laboratories with AASHTO Materials Reference Laboratory certification for each specific test performed.

13.3.1.4 Geotechnical Planning Reports

Developer shall prepare geotechnical planning reports for individual East End Crossing elements or groups of project elements based upon the D&C Work priority and, as applicable, sequence of construction and submit to IFA for IFA approval. These geotechnical planning reports shall be submitted a maximum of 60 days after NTP1. The geotechnical planning reports shall include a detailed method statement describing the general philosophy and methods of investigation, preliminary design and analysis, and the selection of the anticipated means of construction for the included project elements. The method statement shall indicate how material and design details are chosen to match selected construction methods and construction details and the soil, rock, and groundwater environment for the site.

For each geotechnical planning report, Developer shall include the following technical information, as a minimum:

1. Description of geology and various ground types to be encountered along the alignment.

2. A description of the geotechnical information that was collected and analyzed in developing Developer’s geotechnical planning report.

3. Assessment of the engineering properties of all soil types, including the expected average and range of soil strengths and deformation properties and the preliminary design parameters for all soil and rock types.

4. A narrative describing the interpretation of the pertinent geotechnical data used as a basis for preliminary selection, design, and installation of the proposed foundation elements.

5. A description of the planned supplemental subsurface investigation.

6. Define the investigation, engineering, and design approach that will be followed in order to develop the most technically and environmentally acceptable and durable foundations, cut-and-fill slopes, retaining structures, pavements, stormwater management facilities, and geotechnical designs for the elements included in the geotechnical planning report.

13.3.2 Geotechnical Design

13.3.2.1 Design of Bridge Foundations

The criteria set forth herein shall pertain to the geotechnical and foundation design and shall conform to AASHTO LRFD Bridge Design Specifications.

A deep foundation shall be used where a shallow foundation cannot be designed to carry the applied loads or displacements. Deep foundations shall also be used where scour, erosion, or unacceptable settlement might occur.

Refer to Sections 14 and 15 for design scour depths, scour analyses requirements, material requirements, and the structural design requirements of foundation elements.

13.3.2.2 Shallow Foundations

Shallow foundations shall include spread footings for isolated columns, combined footings for supporting the load from more than one structural unit, strip footings, and mats or raft foundations beneath an entire structure area.

Shallow foundations may be used where there is a suitable bearing stratum near the surface and where there are no highly compressible layers or soils susceptible to collapse or expansion below. Shallow foundations shall not be placed in the reinforced portion of mechanically stabilized earth (MSE) abutments. Foundation design shall accommodate potentially detrimental substances in soil or groundwater, including but not limited to chlorides and sulfates.

The effects of adjacent foundations, variable groundwater conditions, and surcharge loads shall be accommodated when evaluating foundation settlements and bearing capacity.

13.3.2.2.1 Bearing Capacity

Shallow foundations shall be analyzed for bearing capacity to confirm that the underlying soil can resist the footing loads without bearing capacity failure.

13.3.2.2.2 Settlement

Analyses shall be conducted to estimate the total and differential soil settlement induced by the foundation loads. Immediate settlements for granular soils and immediate, primary, and secondary consolidation settlements for cohesive soils shall be accommodated. Shallow foundations shall be designed to keep estimated settlements within the serviceability limits of the structure.

13.3.2.2.3 External Stability

Shallow foundations shall be analyzed and constructed for external stability. External stability analyses shall include analysis of overturning, sliding, eccentricity, and global failures. Shallow foundations shall be designed such that the resultant load falls within the middle third of the foundation.

13.3.2.3 Deep Foundations

Deep foundations may include steel driven piles, steel drilled piles, or drilled shafts. Timber piles, precast prestressed concrete piles, auger cast in place, rammed aggregate piers, screw piles, or existing foundations shall not be considered for use on the East End Crossing. When designing deep foundations, design and construction shall include accommodations to minimize the level of construction noise and the radius of influence from construction vibrations.

Drilled shafts shall be designed and constructed in accordance with INDOT Geotechnical Design Manual Chapter 408, as supplemented by AASHTO LRFD. The LRFD design code does not specify minimum drilled shaft spacing. As specified in LRFD, the Designer shall account for interaction effects between adjacent drilled shafts spaced closer than 4.0 diameters. This shall include both design and construction effects. INDOT Design Manual Chapter 408 further stipulates that minimum spacing for driven piles founded in shale have a minimum spacing of 6.0 diameters. Piles shall be designed to account for all static and cyclic loads, including load reversals, and shall include an appropriate reduction factor to the ultimate capacity of the pile or pile group to account for load reversal.

13.3.2.3.1 Axial Capacity

Deep foundations shall be analyzed for axial capacity. The axial capacity shall be verified by field tests, which may include static, statnamic, and dynamic load tests, as appropriate for the foundation type and soil conditions.

13.3.2.3.2 Group Spacing and Performance

The design of deep foundations shall consider material properties of the penetrated strata, type of foundation, and group effects due to the spacing of foundation elements.

13.3.2.3.3 Settlement

The design of deep foundations shall accommodate the total and differential settlement caused by the structure loads. The settlement of individual deep foundation elements and of pile groups shall be estimated. The foundation shall be designed and constructed to keep the settlement within the serviceability limits of the structure.

13.3.2.3.4 Downdrag (Negative Skin Friction)

The design of deep foundations shall accommodate the effect of negative skin friction from existing ongoing ground settlement, construction dewatering, variable groundwater conditions, the placement of fill or embankments, or pile installation. Downdrag loads shall be determined by accounting for the load transfer distribution along the deep foundation element as well as the group layout.

To reduce downdrag forces, corrugated metal sleeves or bituminous coatings may be used. Friction-reducing rings welded on steel pipe piles to reduce downdrag shall not be used.

13.3.2.3.5 Lateral Load Capacity

Deep foundations shall be designed to adequately resist the lateral loads transferred to them from the structure without exceeding the allowable deformation of the structure or overstressing the foundation elements. Refer to Section 14 for allowable lateral deformations. The lateral load resistance of the individual and group of deep foundation elements shall be analyzed and included in the design. The analysis shall accommodate non-linear soil pressure-displacement relationships, soil/structure interaction, group action, groundwater, and cyclic and static and dynamic load conditions. The deep foundation performance evaluation shall include the determination of vertical and horizontal movements, rotation, axial load, shear, and bending moment for the foundation elements and the bending stresses in the batter piles due to the weight of settling soils. Equivalent points of fixity shall be determined using the equivalent stiffness method accounting for the soil-structure p-y stiffness and the equivalent fixed end method.

13.3.2.4 Design of Retaining Walls and Retaining Wall Foundations in Fill

Refer to Section 14 for design criteria of retaining walls. MSE retaining walls shall have a minimum design life of 75 years or 100 years if part of a bridge abutment.

13.3.2.4.1 Vertical Loads

The loads used in the design of permanent Work shall be in accordance with the requirements of the relevant Project Standards, except where herein modified or augmented.

13.3.2.4.2 Lateral Earth Pressure

The design of the retaining structures shall be based on the maximum lateral pressures that will develop behind the structures.

Loads due to soils or backfill shall be derived using the maximum values of the saturated densities. Only where it can be clearly demonstrated that the fill is well drained, and will remain well drained in the future, shall any reduction in the degree of saturation may be allowed. The submerged densities shall be used for soil unless the location is above the standing water table.

Hydrostatic pressure induced by the groundwater table, when present, shall be included in the lateral pressures. Additional hydrostatic pressures and variations in groundwater conditions due to drainage, flooding, and rapid drawdown conditions shall be accommodated in the design of retaining structures.

13.3.2.4.3 Shallow Foundations

Shallow foundations for retaining walls shall be designed to maintain wall settlements (total and differential) within the service limits of the structure. For MSE walls, shallow foundations shall be designed to maintain wall settlements (total and differential) within the applicable tolerances specified in FHWA *Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes.*

13.3.2.4.4 External and Internal Stability

The external and internal stability shall be in accordance with the requirements of the relevant Project Standards.

13.3.2.4.5 Deep Foundations

Deep foundations for retaining walls shall be designed in accordance with Section 13.3.2.3.

13.3.2.5 Design of Top-Down Retaining Walls (Walls in Cut)

Top-down retaining walls shall include steel sheet-piling, tangent or secant pile systems, soldier pile and lagging, soil nails, slurry walls, and ground anchored wall systems. Refer to Section 5.3 for aesthetic surface finishing requirements.

For requirements related to loading, stability, and drainage, refer to Section 13.3.2.4.

Where soil nail, tie-backs, or ground anchors are required for the resistance of lateral loads, the elements shall be designed in accordance with either FHWA *Geotechnical Engineering Circular No. 7: Soil Nail Walls* or *Geotechnical Engineering Circular No. 4: Ground Anchors and Anchored Systems.*

13.3.2.6 Design of Fill Embankments

13.3.2.6.1 Slope Stability

The analyses, design, and construction of soil and rock embankment side slopes shall accommodate the effects of deterioration and loss of soil resistance due to local climatic and construction conditions, and the natural tendencies of the geologic materials of which they are constructed. All slopes shall be designed to minimize erosion by rainfall and runoff. Adequate drainage and erosion control provisions shall be incorporated in the design and construction of the embankments. Embankments in excess of 40 feet in height shall include a bench at least 15 feet in width and shall be graded to drain. Subsurface drainage shall be provided for all fill slopes greater than 15 feet in height that do not have graded drainage at the top of the slope. Subsurface drainage may also be required on all other slopes depending upon the analysis of the slope design.

Slope stability analyses shall be conducted using a computer program accepted in the Project Standards. Each embankment configuration and slope shall be analyzed for potential circular and wedge type failures. The evaluation of global slope stability shall accommodate potential seepage forces, water infiltration, surficial water runoff, and any weak deposits and seams that are adversely impacted by water flow. The global stability analyses shall account for the use of buttressing, placement of select material, or improvements to the foundation material of the embankment, especially at the toe of slope near ponds, wetlands, streams, and other locations of poor materials. A minimum safety factor of 1.25 shall be provided under static loads for permanent embankment slopes for both global stability and surficial (shallow) stability analyses. In addition to global and surficial stability analyses, Developer shall provide stability analyses for the rapid drawdown condition with a minimum factor of safety of 1.1 for all slopes where rapid drawdown conditions may occur.

Developer shall coordinate landscape features to account for landscaping, revegetation, and, as applicable, reforestation operations to address potential adverse impacts and reductions in the factor of safety for fill embankment slopes for the as-built condition. At these locations, Developer's geotechnical engineer shall perform site-specific global stability studies for the landscaping condition, which may require preemptive measures such as localized areas of reinforcement and, as applicable, localized areas with buttressing at the toe of slope to maintain the required factors of safety.

13.3.2.6.2 Settlement

Analyses shall be conducted to estimate the soil settlement induced by the embankment loads. Immediate settlement in granular soils and both immediate and consolidation settlements in cohesive soils shall be accommodated. Embankments shall be designed to keep estimated total long-term settlements limited to 2 inches during a period of 50 years after the completion of the pavement construction. For soft-ground situations, refer to Section 13.3.2.7.

13.3.2.7 Design of On-Site Soil Improvement

The use of soil improvement techniques to increase soil strength and reduce compressibility in order to increase the safety factors for external and internal stability and reduce settlements to the allowable range will be allowed in the design. Developer shall demonstrate the suitability of the proposed method(s) for local conditions.

All soil improvement systems shall be designed using current practices and procedures. The performance of all ground improvement techniques shall be verified with a preproduction field testing program. The testing program shall be developed to demonstrate that the proposed methods and design will provide sufficient ground improvement to satisfy the specified performance requirements.

13.3.2.8 Alternative Embankment Materials

Alternative embankment materials for reducing load and settlement shall be considered for use on the East End Crossing. Developer shall demonstrate that any alternative materials used are designed in accordance with current practices and procedures, and comply with all environmental compliance requirements set forth in the PPA Documents, Governmental Approvals, and applicable Environmental Laws.

13.3.2.9 Design of Reinforced Steepened Slopes

Where reinforced steepened slopes are approved by IFA for reducing impacts to wetlands and, as applicable, other natural resources, the design procedures and performance requirements shall conform to the requirements of FHWA *Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes*. As discussed in the aforementioned requirements, no specific AASHTO LRFD guidance on performance criteria is presently available for reinforced soil slope (RSS) structures. Therefore, the design procedures and performance requirements for RSS shall be as presented in the previous allowable stress design version of FHWA *Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes*. This shall include adequate drainage provisions, slope protection, and erosion control provisions.

13.3.2.10 Design of Permanent Cut Slopes

Geotechnical analyses of soil cut slopes shall be performed to assess soil slope stability along new and existing roadway cuts. Potential circular and wedge type failure modes shall be analyzed for each soil cut and each slope and orientation. A geotechnical analysis of cut slopes shall be performed using an appropriate slope stability computer program. Permanent soil cut slopes shall be no steeper than 2:1, with a minimum factor of safety of 1.5. Cut slopes in rippable rock shall be no steeper than 1.5:1 and shall be serrated when between 1.5:1 and 2:1. Cut slopes in rippable rock flatter than 2:1 shall not be serrated. Cut slopes in rock requiring blasting for excavation shall be no steeper than 0.25:1. Cut slopes in rock requiring blasting for excavation that are steeper than 1:1 shall be presplit, with lifts no greater than 20 feet. At soil/rock interfaces or changes in slope ratio, benches with a minimum 5-foot width are required. Cut slopes in excess of 40 feet in height shall include a bench at least 15 feet in width at approximately half the rock-face height. The placement of a toe bench to contain rock fall material shall be included where appropriate.

13.3.2.11 Design of Ground-Mounted Noise Barrier and Concrete Wall Foundations

Foundations for ground-mounted noise barriers and concrete walls may be shallow or deep as appropriate for the soil conditions. Refer to Section 13.3.2.3 for the design requirements of deep foundations. Refer to Section 13.3.2.2 for the design requirements of shallow foundations.

13.3.2.12 Design of Foundations for Traffic, Intelligent Transportation System, and Electronic Toll Collection Structures

Refer to Section 13.3.2.3 and AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals* for design requirements for deep foundations for sign structures, light poles, and all other ancillary intelligent transportation system (ITS) and electronic toll collection (ETC) components, including but not limited to cameras, cabinets, and traffic poles. Refer to Section 13.3.2.2 for the design requirements for shallow foundations.

13.3.2.13 Design of Foundations for Toll Gantries

Drilled shafts shall be constructed as foundations for the toll gantries. Refer to Section 13.3.2.3 for the design requirements of drilled shaft foundations. Coordinate with the Tolling Systems Integrator for vibration limits for ETC components on the toll gantries.

13.3.2.14 Design of Subgrade for Pavements

The top of subgrade shall be identified by Developer on the pavement details. Any material placed above the top of subgrade shall be considered part of the pavement structure. Any material placed below or other Work below top of subgrade shall be considered a subgrade improvement. Developer shall specify the design subgrade strength, planned subgrade improvements, and as-needed subgrade improvements in the interim pavement report. The same design subgrade strength value shall be used throughout the entire area of each roadway element. In the case that a subgrade improvement is used throughout a significant portion of a roadway element, it shall be shown in the pavement details. When the native soils are not capable of providing the minimum design strength, a subgrade improvement strategy shall be included in the pavement design to reach the minimum strength requirement at the top of subgrade.

Developer may propose to use a design Mr or k value greater than the minimum requirement specified in Section 10. A design subgrade strength value used in the pavement design that is greater than the minimum required shall be supported by Developer with historical performance results and design documentation in the interim pavement report. The maximum allowable design values for subgrade strengths at the top of subgrade are specified in Section 10 regardless of the subgrade improvement. This documentation shall be submitted with the Stage 1 Design Review submission.

Subgrade improvements and testing shall be conducted in accordance with Department Standard Specification Section 207. Proof-rolling records and field notes shall be required to confirm the minimum subgrade strength was achieved and shall be included in the final pavement report. In the case that the top of subgrade does not pass test rolling, Developer shall improve the failed area to a point that it meets or exceeds the test rolling requirements. Additional test rolling of the failed area shall be performed after improvement to verify the test rolling requirements have been met. Documentation shall be in accordance with Project Standards and a copy provided to IFA for review and comment.

13.3.3 Interim Design Memoranda

Developer shall prepare an interim design memorandum for each individual East End Crossing element or group of East End Crossing elements that is consistent with the geotechnical planning reports. Interim Design Memoranda shall be prepared and provided to IFA for approval with the Stage 1 Design Review submission. Each interim design memorandum shall be submitted in accordance with the Project Standards and shall include the following, at a minimum:

- Description of the East End Crossing elements included in the memorandum
- Locations of borings, rock coring, geophysical testing, and other in-situ testing
- Field testing procedures
- Final typed boring logs updated with laboratory testing results
- Electronic copy of the gINT data of subsurface investigation data
- Results of any in-situ testing and geophysical testing
- A description of subsurface conditions, including groundwater, and subsurface profiles
- Results of laboratory tests
- Values assigned to soil parameters for design
- Descriptions of pertinent geotechnical analyses and designs
- Conclusions and recommendations for the specific East End Crossing elements
- Construction considerations such as blasting and vibration monitoring
- Instrumentation and monitoring requirements.

13.4 Construction

Developer shall be responsible for any and all damage (including but not limited to settlement and vibrations) to property, structures, or utilities, both inside and outside of the Project ROW, caused by the Work on the East End Crossing, and shall appropriately mitigate for these damages, and repair any damage caused by, arising out of, or related to Developer’s Work.

13.4.1 Temporary Support of Excavation

Temporary support of excavation shall be designed in accordance with all applicable Occupational Safety and Health Administration (OSHA) standards and AASHTO requirements. Detailed design of all components shall be completed by Developer.

13.4.2 Utilities

Developer shall identify all new and existing Utilities crossing embankments, evaluate settlement impacts on these lines, and evaluate the impacts of abandoned lines on settlements.

Developer shall design new and relocated Utilities to accommodate the anticipated settlements, to verify Utilities operate effectively during and after Construction Work, and to satisfy the requirements of the Utility Owner. Developer shall also be responsible for costs associated with relocating or strengthening utilities, as necessary.

New Utilities shall not be placed within nor shall existing Utilities remain within the pavement section of the highway. Abandoned Utilities shall not be allowed within the pavement section of the highway and shall be removed prior to placement of the pavement section. Utilities of any size that fall within 3 feet below the pavement section (below subbase) shall be removed. Other Utilities shall be removed or abandoned as indicated in Table 13-2.

Table 13-2 Removal of Abandoned Utilities

Depth	Utility Diameter	Method of Abandonment
0 ft to 3 ft	All	Remove
3 ft to 15 ft	< 8 in	Plug ends
3 ft to 15 ft	>= 8 in	Fill with flowable fill
15 ft or more	< 24 in	Plug ends
15 ft or more	>= 24 in	Fill with flowable fill

13.4.3 Blasting Requirements

In addition to the requirements of the Project Standards, 90 days prior to blasting operations, Developer shall submit a Blasting Plan(s) to the IFA, for review and comment, and the Indiana or Kentucky state fire marshal, as applicable. The state fire marshal is empowered to regulate the character and strength of explosives used, and the manner of their use and storage. The handling and storage of explosives shall be in accordance with Federal Regulation 18 U.S.C., Chapter 40, sections 841 to 848.

The location of magazines for the storage of explosives and for the separate storage of detonators shall be included in the Blasting Plan(s). Explosives shall be kept under lock, with the key only to be kept in the hands of a licensed blaster. In no case shall caps or other detonators be stored or transported with dynamite or other explosives. Developer shall make a weekly audit of blasting material, and it shall be reconciled with blasting materials actually used at the Site. Developer shall notify the IFA immediately of any missing blasting material.

Blasts shall be carefully confined and adequately covered to prevent injury to persons and to protect adjacent structures, utilities, and property against damage. Disturbance to local residents due to blasting operations shall be in accordance with Section 7.6, Federal Permit for

Eagle Take to Protect an Interest in a Particular Locality, and state and local laws and ordinances. Before initiating each blast, ample warning shall be given to allow all persons to reach positions of safety. Developer shall complete, maintain, and submit permanent blast reports to IFA for review and comment weekly during blasting, including logs of each blast. Logs shall be available for review and verification by IFA and, as applicable, authorized personnel at all times. Complete reports after each series of blasts shall include the following information:

- Scale drawings showing the location of each hole, geometry of open face, height of face, and delay pattern.
- Total charge for each blast, total charge of each delay, and approximate volume of rock removed.
- Type of primer and of explosives used for each delay, type of primary location of primers, and manufacturer's specifications for explosives used.
- Pattern design, including burden, spacing, total length of each blast hole, length of subdrilling, and stemming.
- Complete description of rock face before and after test, including amount of overburden, quality of rock noted in face before test, amount of back break in face, condition of excavation floor after each test, and mount of displacement of and sizing of broken rock. All descriptive data shall be accompanied by photographs.
- All monitoring locations for each test, including the plan coordinate of each monitoring station and distance from blast.
- The monitoring record from each blast.
- Date, time, and limits of blast by station.
- Amount of explosives used by weight and number of cartridges.
- Name of qualified blasting foreman in charge of Work.
- Weather conditions, including wind direction and velocity.

All blasting shall be monitored by Developer to control vibrations in the vicinity of roadways, structures, and utilities. Refer to Section 7.8 and Section 13.5.1 for blasting controls and monitoring requirements.

13.4.4 Construction of Bridge and Retaining Wall Foundations

Ground consolidation, existing structure settlements, and disturbance to local residents due to the installation of deep foundations shall be maintained within limits required by applicable Laws.

13.4.4.1 Shallow Foundations

After excavation, Developer's geotechnical engineer shall verify that the exposed subgrade is suitable for the calculated toe-pressures exerted by the proposed abutment or fill-type retaining wall.

13.4.4.2 Deep Foundation Testing and Monitoring

Field testing shall be performed for deep foundations to evaluate foundation capacity and integrity, to verify design assumptions, to determine foundation installation characteristics, to evaluate the pile-driving system performance, and to establish foundation depths. The deep foundation testing and monitoring shall include all necessary quality control testing, including test piles or shafts, dynamic testing, static load testing, statnamic testing, and non-destructive integrity testing as appropriate for the foundation type.

At least 30 working days prior to driving piles, Developer shall submit to IFA for review and comment the results of wave equation analysis of piles (WEAP) on the hammer-pile-soil systems proposed for the East End Crossing. The WEAP analysis shall be performed for all hammers proposed for use and for each East End Crossing element with driven pile foundations.

A pile driving analyzer (PDA) shall be used to determine if each hammer is delivering the energy required by the WEAP analysis. Each hammer used to drive test piles and production piles shall deliver a minimum of 45 percent of the rated hammer energy. Foundation testing and monitoring shall be performed on both the testing and production deep foundations, and shall be located so that they will address all conditions of foundation type, capacity, and soil conditions encountered. All PDA equipment, testing, recording, and reporting shall be performed in accordance with ASTM D-4945 Standard Test Method for High Strain Dynamic Testing of Piles. The PDA Operator shall be a Registered Professional Engineer and shall have achieved advanced level certification within the last three years through “Dynamic Measurement and Analyses Proficiency Test” conducted by Pile Dynamics, Inc., and the Pile Driving Contractors Association. The Case Pile Wave Analysis Program (CAPWAP) shall be utilized to determine the as-built pile capacity from the PDA data. As a minimum, the first pile driven for each substructure unit shall be a PDA test pile.

At least 30 days before constructing deep foundations, Developer shall prepare and submit to IFA a detailed description of the proposed deep foundation testing and monitoring programs for review and comment. The description shall include detailed specifications and plans presenting the foundation type, test type, purpose, number, location, and procedures for each test, and the recording and reporting procedures. The testing and monitoring of deep foundations shall be in accordance with the applicable American Society for Testing and Materials (ASTM) and AASHTO specifications.

Static load tests performed on piles or drilled shafts shall be in accordance with the ASTM D-1143 or AASHTO. Developer may also submit to IFA for its review the use of either the Osterberg Load Cell or the Statnamic Testing arrangement. Load tests shall be performed at locations representative of the different subsurface conditions, foundation types, foundation capacities, and foundation depths. At least 30 working days prior to driving load-test piles, Developer shall submit to IFA, for review and comment, the proposed configuration for pile load tests, including the structural calculations for the reaction beam, piles, and connections; calibration results for the loading jack, load cell, and gauges before the tests; and other pertinent details.

All foundation field-testing results shall be compared with the design capacity and proposed resistance factors. Where field-testing results reflect a lower-than-required resistance factor, Developer shall prepare a Remedial Action Plan to be submitted with Released-for-Construction Design Documents for Design Review.

13.4.4.3 Drilled Shaft Inspection and Integrity Testing

Developer shall assign one full-time inspector for each drilled shaft installation rig in use for bridges, retaining walls, and other critical structures. Developer shall also assign inspectors for at least 15 percent of drilled shaft installation for all other structures utilizing drilled shaft foundations. At least 30 working days prior to drilled shaft installation, Developer shall submit the qualifications for each proposed drilled shaft inspector who meets the following minimum requirements to IFA for approval:

- At least one year of drilled shaft installation experience working under the supervision of a Registered Professional Engineer specializing in foundations and geotechnical engineering; or
- At least two months of inspection experience and attendance at the FHWA-NHI Drilled Shaft Foundation Inspection Course (#132070).

Integrity testing consisting of ASTM D-6760 Crosshole Sonic Logging (CSL) or ASTM D-5882 Low Strain Pulse Echo Methods shall be performed on 100 percent of bridge foundations.

Based upon the installation and testing data, Developer's geotechnical engineer shall validate that the drilled shafts were adequately constructed. If not adequately constructed, Developer's Responsible Engineer shall recommend an appropriate resolution for review and approval by IFA.

13.4.4.4 Pile Driving Records

Developer shall create and maintain a written record of pile driving. For the entire length of each pile, Developer shall record blows and estimated delivered energy (hydraulic hammers) or stroke (diesel hammers) for each foot of penetration. Developer shall record the start and stop times to the nearest minute and record any stoppages in field pile driving.

Prior to beginning the placement of reinforcing steel around the piles, and, as applicable, prior to beginning any backfilling around the piles, Developer shall present to IFA for its review and comment the complete driving records, including tolerance measurements for all piles in each pile group and the PDA and CAPWAP results.

13.4.4.5 Developer's Pile Inspector and Geotechnical Engineer

Developer shall assign one inspector for each pile driving rig in use. At least 30 days prior to pile driving, Developer shall submit to IFA for approval qualifications for each pile driving inspector who meets the following minimum requirements:

- At least one year of pile driving inspection experience while working under the supervision of a Registered Professional Engineer specializing in foundations and geotechnical engineering; or
- At least two months of pile driving inspection experience and successful completion of FHWA-NHI Driven Pile Foundation Inspection course (#132069).

The geotechnical engineer shall either be on-site during the driving of the first pile at each support (monitored with PDA) and until sufficient data is gathered to establish appropriate driving criteria for each support, or be in direct telephone contact with the PDA operator and the inspector observing the pile driving. The geotechnical engineer shall be notified immediately if any unusual or otherwise unanticipated pile driving conditions are encountered, including if the piles are driven out of the tolerances specified in the Project Standards.

Based upon the installation and testing data, Developer's geotechnical engineer shall validate that the piles were adequately driven. If not adequately driven, Developer's Responsible Engineer shall recommend an appropriate resolution for review and approval by IFA.

13.4.5 Mechanically Stabilized Earth Retaining Wall Construction

MSE retaining walls shall be designed and constructed in accordance with Recurring Special Provision 731 – Mechanically Stabilized Earth Retaining Walls.

13.4.6 Fill Embankment Construction

Fill embankments shall be constructed in accordance with the Department Standard Specifications in Indiana and the Kentucky Standard Specifications in Kentucky. General use of shales in Kentucky shall be subject to the provisions of KYTC Construction Standard 206, Embankment. Additionally, the New Albany Shale is known to contain abundant amounts of pyrite, and will produce an acidic runoff when it is in direct contact with air and water. Use of this material in Kentucky is subject to the requirements of KYTC Geotechnical Branch Publication GT-609-5.

Developer shall submit the source and material properties of all fills proposed for use, including the results of gradation tests and plasticity tests. All laboratory tests shall be performed in accordance with the appropriate ASTM/AASHTO test methods. The bearing capacity of the embankment subgrade shall be validated by Developer's geotechnical engineer prior to initiating construction. Sheet flow across the slope face shall not be permitted during construction or for the permanent condition until vegetation is established on the face of the slopes.

13.4.6.1 Settlement of Embankments

Prior to proceeding with subsequent construction activities, Developer shall compile and submit to IFA for review and comment all settlement data, including analyses demonstrating that settlements have dissipated to the extent required by subsequently constructed facilities.

13.4.6.2 Embankment Construction near Existing Structures

Where embankments or walls are to be constructed in the vicinity of existing structures, Developer shall develop and implement a program for performing preconstruction surveys and monitoring the movement of structures that shall include the following:

- Estimate the settlement influence zone from embankment and construction loads that includes settlements in excess of 0.50 inch
- Site reconnaissance to determine the sensitivities of adjacent structures to settlement
- Identification of site-specific facilities that may be adversely affected by settlement
- Procedures to mitigate and to compensate property owners affected by settlement/movement resulting from construction activities.

13.4.7 Construction of Top-Down Walls (Cut Walls)

Top-down walls (cut walls) shall be designed and constructed in accordance with Department Standard Specification 734 – Permanent Earth Retention System for Cut-Wall Application.

13.4.8 Culvert Construction

Refer to and Section 8 and Section 13.4.2 with the exception that culverts may be constructed and remain within the pavement section of the highway.

13.4.9 Construction of Noise and Concrete Wall Foundations

Refer to Section 13.4.4.

13.4.10 Construction of Foundations for Sign Structures

Refer to Section 13.4.4.

13.4.11 Construction of Pavement Subgrades

Developer shall be responsible for construction of a suitable and stable subgrade on which to place the pavement section. The top of subgrade shall be proof-rolled prior to placing the base course in the pavement section(s). Any movement in the top of subgrade during test-rolling shall be an indication of unstable subgrade or the presence of unsuitable material. Unstable or unsuitable areas shall be treated as recommended in the final geotechnical report. After treatment, the area shall again be test-rolled. Any area still showing movement shall receive additional corrective treatment.

13.4.12 Excavation in Shale

Developer shall construct a moisture barrier over the shale in the roadway cuts leading up to the Tunnel. The finished grade surface of the shale shall be exposed to the ambient air for no more than 8 hours prior to constructing the moisture barrier. Final shale surface excavation and preparation shall not be conducted when rain is reasonably anticipated within the work shift. The contractor shall leave a sufficient amount of material in place above the final shale surface such that excavation to the final surface produces a fresh cut that has not been degraded due to exposure to moisture. Developer shall not allow water to run on to the exposed shale surface that is to receive the moisture barrier. The visible surface of the moisture barrier shall meet the aesthetic requirements of Section 5.

For temporary cuts in non-durable shale exposed for greater than 8-hours, Developer shall evaluate the performance of the slope assuming degraded shale material properties. The performance evaluation shall include both short term performance during construction and long term performance after construction is complete. Exposure shall be defined as both open air exposure and any new exposure to moisture that did not exist prior to construction.

13.5 Submittals

13.5.1 Geotechnical Instrumentation for Construction

Developer shall prepare and submit monitoring plans to either monitor facilities that may be affected by construction activities or to monitor the field performance of specific construction elements in accordance with the following criteria and requirements:

- The extent of the monitoring program will depend on the size and type of the facilities.

- The type and distribution of instrumentation shall demonstrate an understanding of the need, purpose, and advantages of using each proposed instrument.
- The plans shall include consideration of environmental effects such as temperature, rain, sun, wind, corrosion, and electromagnetic wave interference.
- Responsibilities for the instrumentation plans, procurement, installation, recording, maintenance, and protection shall be Developer's.
- The instrumentation plans shall provide construction-related control information and accommodate the collection of long-term performance data.
- Test installations may be performed to demonstrate the compliance and acceptability of instrumentation in relation to the requirements of the PPA Documents.
- If instruments fail or are damaged, they shall be replaced at no cost to IFA, and Developer's geotechnical engineer may require that all Work cease in the area to be monitored by the instruments.
- Monitoring shall be initiated well in advance of construction to establish baseline readings.
- The results of vibration measurements shall be used to develop attenuation curves for predicting vibrations at varying distances from the source.

13.5.1.1 Monitoring of Structures for Effects of Construction Activities

Developer shall prepare a Vibration Monitoring Plan, where appropriate, to monitor existing structures or other property, temporary construction support structures, and in-progress construction of permanent structures or other property for effects of construction activities, such as excavation by blasting, pile driving, and nearby construction equipment traffic. The Vibration Monitoring Plan shall be submitted to the IFA for review and comment 60 days prior to beginning construction activities. Monitoring may include vibrations, ground accelerations, tilt or rotation, and vertical and lateral movement during and after construction. Developer shall prepare a report detailing the proposed program of instrumentation and monitoring, establishing threshold values of monitored parameters, and describing the response plans that will be implemented when threshold parameters are exceeded. After IFA's review and comment on the instrumentation report, threshold values, and response plan, Developer shall provide, install, and monitor the instrumentation during and after construction and interpret the data.

Construction instrumentation monitoring reports shall be submitted to IFA prior to opening the instrumented Work for subsequent construction. Corrective actions shall be taken where the instrumentation data so warrant.

The Vibration Monitoring Plan shall provide that potentially affected structures or other property are protected against damage due to the construction of the Work. Limiting values of movement (horizontal and vertical), vibration, and acceleration for each facility within the zone of influence of the Work shall be established by Developer. The limiting values for historic properties and structures or other property are established in Section 7.8. Records of structures or other property, where available, shall be examined during the design stage and, where no records exist; assessments shall be made and clearly documented. These assessments shall be subject to verification at the commencement of the construction phase prior to the adjacent construction activity.

In addition to the Vibration Monitoring Plan, Developer shall conduct preconstruction and post-construction surveys for existing structures or other property, temporary construction support structures, and new permanent structures or other new property, within 500 feet of the

Developer's construction activities that may cause ground vibrations, including blasting, pile driving, and moving construction equipment. The preconstruction and post-construction surveys shall include a detailed photographic log (photographs with descriptions) of the exterior of all structures surveyed.

13.5.1.2 Instrumentation for Monitoring Field Performance of Construction Elements

Developer shall include in the Vibration Monitoring Plan, where appropriate, monitoring of the field performance of specific construction elements such as settlement, lateral earth movement, the rotation of structural elements, and changes in groundwater. The instrumentation and monitoring program shall include appropriate types and quantities of monitoring instruments capable of measuring horizontal and vertical movements, tilt/rotation of structural elements, soil pore pressures, and vibrations, as applicable.

Instrumentation that may be used in monitoring programs to control and assist design and construction include but are not limited to the following:

- Piezometers and observation wells
- Inclinometers
- Survey stations on structures and at ground-level locations
- Tiltmeters
- Deep and shallow settlement points and extensometers
- Strain and load-measuring devices
- Seismographs

Developer shall not release monitored elements for subsequent construction until completed monitoring reports have been submitted and approved by IFA.

13.5.2 Final Geotechnical Reports

Developer shall prepare final geotechnical reports for individual East End Crossing elements or groups of East End Crossing elements, consistent with the geotechnical planning reports and the interim design memoranda. The reports shall be submitted to IFA for approval prior to releasing constructed elements for subsequent Work. The final geotechnical reports shall include the following, at a minimum:

- The corresponding geotechnical planning report
- The corresponding interim design memorandum
- The locations and results of borings, rock coring, geophysical testing, and other in-situ testing
- A detailed description of geological and subsurface conditions for each East End Crossing element (including a description of site stratigraphy)
- Field investigation procedures
- A description of groundwater conditions
- Results of laboratory tests
- Values assigned to all applicable soil parameters for design
- All pertinent data and complete discussions of all geotechnical analyses and design

- All relevant design calculations and computer program results, checked and initialed by a Registered Professional Engineer
- Conclusions and recommendations for foundation types for structures, embankments, cut slopes, retaining walls, ground improvement, requirements for backfill materials
- Groundwater problems encountered, means of dewatering, and, as applicable, other solutions
- Designs for support of excavation
- Results of instrumentation and monitoring and post-construction monitoring summaries
- Potential settlement problems
- Potential stability problems and analysis results
- Seismic Zone Information

For each of the following East End Crossing elements, Developer shall submit the corresponding listed items with the final geotechnical reports, as a minimum.

1. Foundations

   a. Individual pile and pile group design calculations, including maximum factored axial and lateral capacity for the pile type, size, and length to achieve the required capacities (including any effects of liquefaction and downdrag)
   b. Estimated pile and pile group settlement
   c. Shallow foundations calculations, including maximum factored bearing resistance, estimated differential and total settlements, and rotations
   d. Calculations of embankment settlement (magnitude and time rate) and downdrag forces on the piles, depths to zero or negligible settlement, and the proposed means to mitigate the downdrag

2. Retaining Walls

   a. Wall design calculations, including the results of the global and internal stability analyses and analyses of total, differential, and secondary settlements
   b. Calculations for analyses of sliding, overturning, eccentricity, and bearing pressure for live and seismic loadings

3. Embankments

   a. The results of the slope stability analyses, including external loading from live and seismic loading, the recommended side slopes of all embankments
   b. The results of settlement analyses, including predictions of the magnitude and duration of primary, secondary, and post-construction settlements
   c. The results of the liquefaction analyses and the proposed methods of mitigation for any location deemed necessary to protect the integrity of bridges and adjacent walls
   d. The proposed method(s) of protecting and abandoning utilities
   e. Details of staged construction design, if recommended

4. Cut Slopes

   a. The results of the slope stability analyses, including external loading from live and seismic loading
   b. The recommended side-slopes of all cuts

5. Instrumentation

   a. All items included in <u>Section 13.5.1</u>.

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14 STRUCTURES

14.1 Standards and References

Design and construct the structures Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 14; Governmental Approvals; and applicable Laws.

14.2 Kentucky General Requirements

Developer shall perform the structures work in Kentucky in accordance with the provisions contained in this section.

The structures, including all wall types, shall be designed and constructed with sensitivity to aesthetic commitments, historic cultural landscapes, and the historic context. The design shall include aesthetic treatments to surfaces, structures, and appurtenances that complement the historical contexts of historic properties and in keeping with the historic preservation plans for those areas. Refer to Section 5.3 for additional requirements. The aesthetics of the structures and walls shall be consistent with the aesthetic concepts proposed for the entire Kentucky Approach and the East End Bridge.

All proposed structure types for waterway crossings shall satisfy minimum freeboard and waterway opening requirements. Preliminary hydraulic and scour analysis report(s) are included in the RID. Developer shall perform the final hydraulic and scour analysis consistent with the final design.

All structures shall be designed using load and resistance factor design (LRFD) methods. All structures shall be designed for HL-93 loading in accordance with the *AASHTO Load and Resistance Factor Design, LRFD, Bridge Design Specifications, 6th Edition* plus 25 percent live load. The weight of all falsework and stay-in-place forms shall be accounted for in the design. Seismic design of the structure shall be based on the soil profile type.

Microcomposite (MMFX 2) steel reinforcement bars meeting the mechanical properties of ASTM A1035 steel bars and ASTM A615 Grade 75 are permitted subject to the Project Standards.

For bridges where it is practical to remove and replace the deck in phased construction while maintaining traffic on the structure use 15 pound per square foot for future-wearing surface. For bridges where it is not practical to remove and replace the deck in phased construction while maintaining traffic, the bridge shall be designed such that a full depth overlay that will fully carry all deck loads can be added to the structure without additional design effort or retrofitting the basic structure. A note shall be placed in the General Notes describing the loads used in the design, the amount of existing concrete to be removed and the reinforcement needed in the new deck.

Bridge foundations shall conform to the provisions of Section 13 in addition to the applicable requirements listed in the other sections of the Technical Provisions.

All substructures shall be reinforced concrete.

Hollow piers shall have all internal forms removed. The bottom of voids for hollow piers shall not extend below the ground line or below normal pool.

Abutments located within mechanically stabilized earth (MSE) walls shall be supported by deep foundations.

Railway crash walls shall be designed and constructed in accordance with the strictest requirements of the railroad, Department specifications, AASHTO LRFD, and American Railway Engineering and Maintenance-of-Way Association (AREMA) specifications.

Single-lane ramps shall have a minimum of three beams. For bridges constructed under part-width construction, each phase of traffic shall be supported by a minimum of three girder lines.

All joints shall be sealed from bridge deck surface drainage. Open-type joints that accept bridge deck surface drainage, such as finger joints, shall include drainage troughs to collect runoff and protect superstructure and substructure components.

Developer shall not propose any new structures that include fracture-critical members.

Prestressed, post-tensioned, concrete I-beams shall have a minimum web thickness of 8 inches.

Elastomeric bearings shall be designed based on a selected durometer of 50 to 60. Field welding of a beam or girder to the bearing load plate shall not be allowed.

Bituminous-type wearing surfaces shall not be used for permanent bridge deck construction.

Bridge deck expansion joints shall be located at substructures only.

Approach slabs shall be constructed for all bridges on the East End Crossing.

Lightweight concrete shall not be used for cast-in-place concrete decks or overlays.

Mass concrete shall be considered for any concrete pour with a plan section where its minimum dimension measured in any direction is 6 feet or greater. Developer shall prepare and provide IFA with a Mass Concrete Thermal Control Plan for review and comment, 30 days before commencing concrete placement work, that details the following elements to cope with the generation of heat of hydration and attendant volume change to minimize cracking:

1. Analysis of the anticipated thermal developments in the mass concrete for all expected project temperature ranges using the proposed mix design, casting procedures, and materials.

2. Description of the measures and procedures intended for use in maintaining a maximum temperature of less than 160 degrees Fahrenheit and maintaining a temperature differential of 35 degrees Fahrenheit or less between the interior and exterior portions of the designated mass concrete elements during curing. The 35-degree-Fahrenheit temperature differential does not apply to drilled shaft foundations below grade.

Developer shall submit both the mass concrete mix design and the proposed plan to monitor and control the temperature differential concurrently to the Construction QC Manager for approval before concrete placement.

Developer shall provide temperature monitoring devices to record temperature development between the interior and exterior portions of the elements. Details of this shall be included in the Mass Concrete Thermal Control Plan.

The Mass Concrete Thermal Control Plan shall also include details on reading the monitoring devices and recording the readings at not greater than six-hour intervals, beginning when casting is complete and continuing until the maximum temperature differential is reached and begins dropping. If monitoring indicates that the 35-degree Fahrenheit temperature differential has been exceeded, Developer shall take immediate action to retard further growth in the temperature differential and make the necessary revisions to the accepted plan to maintain the 35 degree Fahrenheit or less temperature differential on any remaining placements. Developer shall obtain the Engineer's approval of all revisions to the approved plan prior to implementation.

Existing structures not utilized in Developer's Final Design shall be removed in accordance with the Project Standards.

Quiet bridge decks in accordance with Section 7.6 shall be constructed using transverse tining as follows:

1. A width of 0.10 inches (±0.02 inches and a depth of 0.10 inches maximum are recommended. Narrower, deeper grooves are better than wider, shallower grooves, within the limits indicated, for minimizing noise.
2. Random spacing of either 0.5 inch or 1-inch average tine spacing is recommended. The 0.5 inch random tine spacing shall have the following tine pattern (in inches):
    a. 0.40/0.55/0.63/0.43/0.40/0.51/0.59/0.63/0.43/0.40/0.83/0.51/0.40. The 1-inch random tine spacing shall have the following tine pattern (in inches): 0.94/1.06/0.91/1.22/0.83/1.34.

14.2.1 Load Rating

Developer shall provide a load rating for all newly constructed bridges in the Kentucky Approach according to the latest AASHTO *Manual for Bridge Evaluation, 2nd Edition, 2011* using Load and Resistance Factor Rating (LRFR) method. Developer shall provide a rating manual for any bridge type that is not compatible with AASHTO Virtis software. The rating manual shall include a Microsoft Excel compatible spreadsheet in electronic format to load rate the bridge for future permit vehicles (e.g., overweight or superload vehicles). Such vehicles may range up to 600,000 pounds, have as many as 25 axles with two to eight tires per axle, and have a width of 20 feet and a length of 200 feet. Each bridge load rating submission shall include the computer files in electronic format. The ratings shall be based on the final Record Drawings of the structures. Developer shall submit the load rating calculations and NBIS forms to the IFA for review and comment with the Record Drawings.

14.3 Kentucky Specific Descriptions and Requirements

14.3.1 Bridge Structure No. 1

KY 841 over Harrods Creek and River Road Sta 143+42.75 Line “841”

The clear roadway for the KY 841 northbound and southbound structures shall each be 48 feet, consisting of two 12-foot lanes with 12-foot outside and inside shoulders.

The minimum low-structure elevation shall be the Q100 elevation (for Harrods Creek) plus the minimum required freeboard of 2 feet. Developer shall provide a minimum 56-foot horizontal navigation clearance normal to flow at all times including during construction.

A minimum vertical clearance of 14 foot 6 inches over River Road to the low structure elevation shall be provided.

Piers and abutments shall be spaced in order to accommodate a future shared use path along River Road and the north abutment of Structure No.1 as shown in RID RD-4.02. The future shared use path will be by others and is not the shared use path Line “B-1” to be constructed by Developer as defined in Section 9.3.1 and Table 9-34.

14.3.2 Bridge Structure No. 2

Ramp A over KY 841 Sta 40+20.00 Line “Ramp A”

The clear zone shall utilize the defined requirement in Section 9.

The clear roadway for the structure shall be 27 feet, consisting of one 15-foot lane with an 8-foot outside shoulder and a 4-foot inside shoulder.

A minimum vertical clearance of 17 feet over KY 841 to the low structure elevation shall be provided.

14.3.3 Bridge Structure No. 3

Wolf Pen Branch Rd. over KY 841 Sta 49+90.29 Line “Wolf Pen Branch Rd”

The clear zone shall utilize the defined requirement in Section 9.

The clear roadway for the structure shall be 26 feet, consisting of two 10-foot lanes with a 3-foot inside shoulder and a 3-foot outside shoulder. The structure shall also include a 6-foot exterior sidewalk on the north side of the structure.

Barriers and sidewalks shall not be considered part of the cross section for the calculation of structural capacity.

A minimum vertical clearance of 17 feet over KY 841 to the low structure elevation shall be provided.

Per the Kentucky Design Manual, a partial cage detail similar to a pedestrian cage shall be used.

14.3.4 Bridge Structure No. 4 (East End Bridge Kentucky Approach Spans)

KY 841 over Transylvania Beach Road, East End Bridge Kentucky Approach Spans, Sta 177+67.36 Line "841"

The clear zone shall utilize the defined requirement in Section 9.

The clear roadway for the northbound structure shall be 48 feet, consisting of two 12-foot lanes with a 12-foot inside shoulder and a 12-foot outside shoulder.

The clear roadway for the southbound structure shall be 48 feet, consisting of two 12-foot lanes and 12-foot outside and 12-foot inside shoulders. The southbound structure shall also include an 11-foot 0-inch-wide clear walkway on the downstream side of the bridge. The walkway shall be designed to accommodate bicycles.

A minimum vertical clearance of 14 feet 6 inches over Transylvania Beach Road to the low structure elevation shall be provided.

The minimum low structure elevation shall be the Q100 elevation plus the minimum required freeboard of 2 feet. Ohio River 100 year floodplain shall be bridged by KY 841.

Refer to Section 15.5.19 for deck drainage requirements.

The aesthetics of the East End Bridge Kentucky Approach Spans shall be consistent with the East End Bridge Main Spans. Refer to Section 15.4.1 for aesthetic requirements.

Seismic design shall comply with the requirements of Section 15.

Durability, design life, service life shall comply with the requirements of Section 15.

The East End Bridge Kentucky Approach Spans shall be load rated in accordance with the requirements of Section 15.4.11.

Refer to Section 15.4.14 for utility service requirements.

14.4 Indiana General Requirements

Developer shall perform the structures work in Indiana in accordance with the provisions contained in this section.

All proposed structure types for waterway crossings shall satisfy minimum freeboard and waterway opening requirements. Preliminary hydraulic and scour analysis report(s) are included in the RID. Developer shall perform the final hydraulic and scour analysis consistent with the final design. Refer to Section 8 for hydraulic and drainage requirements.

Bridge foundations shall conform to the provisions of Section 13 in addition to the requirements listed in the other sections of the project.

All structures shall be designed for HL-93 loading, in accordance with the AASHTO *Load and Resistance Factor Design, LRFD, Bridge Design Specifications, 6th Edition*, and any subsequent interim specifications, unless specified otherwise. Structures shall be designed for actual dead loads and shall include an additional design load for a future-wearing surface at 35 pounds per square foot. The weight of all falsework and stay-in-place forms shall be accounted for in the design. Seismic design of the structure shall be based on the soil profile type. The construction loading shall be accounted for in accordance with Design Memorandum 10-18 and the applicable IDM sections.

Microcomposite (MMFX 2) steel reinforcement bars meeting the mechanical properties of ASTM A1035 steel bars and ASTM A615 Grade 75 are permitted subject to the Project Standards.

The bridges shall be composite and shall also be continuous over interior supports. Integral or semi-integral end bents shall be used wherever eligible, per the IDM.

Concrete bridge railing shall be used on all bridge structures and shall be TL-5 for all mainline SR 265 and SR 62 structures and TL-4 for all other structures.

Foundations and structures shall be designed and constructed to meet the following performance criteria:

1. Post-construction settlement of bridge piers and abutments: Less than 1-inch total settlement and less than 0.5 inch differential between adjacent piers or abutments.
2. Lateral deflection at top of foundations for non-seismic loading: As required for serviceability of Developer's design, but not to exceed 1 inch.

Bridge decks shall be 8-inch-thick minimum Class C concrete with epoxy-coated reinforcing steel.

Surface seal shall be applied to top of decks, top of approach slabs, all exposed surfaces of concrete railings and railing transitions, and all exposed surfaces of the substructures. Surface seal shall be applied to deck copings and exterior concrete beams in accordance with Design Memorandum 09-25 and the applicable IDM sections. The superstructure shall be sealed prior to opening the structure to traffic.

Steel bridges shall use painted or weathering steel. If weathering steel is used, details shall be provided to minimize staining of MSE walls, abutments, and, as applicable, piers.

Full-width reinforced concrete bridge approach slabs shall be constructed. Approach slabs shall be detailed such that they shall not be allowed to be poured concurrently with the bridge deck.

All bridges shall have a minimum of four beam lines.

Developer shall design drainage features to eliminate or minimize the need for bridge deck drains. Wherever possible, bridge drainage shall be directed to riprap drainage turnouts located beyond an approach concrete bridge railing transition and outside of any MSE wall backfill. Open bridge deck drains shall be no closer than 10 feet from the face of a substructure element.

The structure shall be constructed in phases to accommodate the MOT Plans and the maintenance-of-traffic requirements described herein.

Railway crash walls shall be designed and constructed in accordance with the strictest requirements of the railroad, the Department specifications, AASTHO LRFD, and AREMA specifications.

If Developer revises the preliminary grade, it shall meet all design criteria.

The design shall consider and be constructed to account for future build-out of a 12 foot third through lane, widened in the median in both directions of SR 265. Developer shall provide vertical clearance for the currently constructed structures that shall provide required clearance after future widening. The clear roadway width and vertical clearances provided below are for the current build-out. Vertical clearance requirements shall provide for a future inside lane on both eastbound and westbound SR 265.

Superstructure designs shall not include side-by-side box beams.

Existing structures not utilized in Developer's Final Design shall be removed in accordance with the Project Standards.

New structures on SR 265 shall be designed to include a strength-limit-state factor of 1.05 as described in IDM Chapter 403-1.02.

14.4.1 Load Rating

Developer shall provide a load rating for all structures in the Indiana Approach according to the latest AASHTO Manual for Bridge Evaluation, 2nd Edition, 2011 and in accordance with the requirements of Section 15.4.11. The ratings shall be based on the final Record Drawings of the structures. Developer shall submit the load rating calculations and NBIS forms to the IFA for review and comment with the Record Drawings.

Developer shall be responsible for analyzing all permit loads during the Operating Period for structures within the O&M Limits that are the Developer's maintenance responsibility, including existing structures to be rehabilitated.

14.5 Indiana Bridge Specific Descriptions and Requirements

14.5.1 Bridge Structures No. 6 & 7

File Structure No. 265-10-9600 (SR 265 EB over Utica Charlestown Rd. & Lentzier Creek Tributary - Sta 257+68.25 Line "A")
File Structure No. 265-10-9601 (SR 265 WB over Utica Charlestown Rd. & Lentzier Creek Tributary - Sta 257+68.34 Line "A")

The clear roadway for each structure shall be 55 feet 4 inches, consisting of two 12-foot lanes, a 12-foot ramp lane with a 13-foot 8-inch outside shoulder and a 5-foot 8-inch inside shoulder.

The eastbound structure shall include a 13-foot outside shared-use path on the south side which shall be separated from the road by a TL-5 barrier.

A minimum future vertical clearance of 14 feet 6 inches over Utica-Charlestown Road to the low future structure elevation shall be provided.

The minimum future low structure elevation shall be the Q100 elevation, plus minimum required freeboard of 2 feet over Lentzier Creek Tributary.

Lentzier Creek Tributary 100 year floodplain shall be bridged by SR 265.

14.5.2 Bridge Structures No. 9 & 10

File Structure No. TBD (SR 265 EB over Unnamed Tributary to Lentzier Creek - Sta 299+14.50 Line "A")
File Structure No. TBD (SR 265 WB over Unnamed Tributary to Lentzier Creek - Sta 299+14.50 Line "A")

The clear roadway for the eastbound structure shall vary from 43 feet 4 inches to 56 feet 8 inches, consisting of two 12-foot lanes, a varying-width ramp lane, a 13-foot 8-inch outside shoulder, and a 5-foot 8-inch inside shoulder.

The clear roadway for the westbound structure shall vary from 55 feet 4 inches to 43 feet 4 inches, consisting of two 12-foot lanes, a varying width ramp lane, a 13-foot 8-inch outside shoulder, and a 5-foot 8-inch inside shoulder.

The minimum future low structure elevation shall be the Q100 elevation plus minimum required freeboard of 2 feet over the Unnamed Tributary to Lentzier Creek.

Unnamed Tributary to Lentzier Creek 100 year floodplain shall be bridged by SR 265.

14.5.3 Bridge Structures No. 11 & 12

File Structure No. TBD (SR 265 EB over Lentzier Creek and Brookhollow Way - Sta 324+83.25 Line "A")

File Structure No. TBD (SR 265 WB over Lentzier Creek and Brookhollow Way - Sta 324+83.25 Line "A")

The clear roadway for each structure shall be 42 feet 4 inches, consisting of two 12-foot lanes with a 13-foot 8-inch outside shoulder and a 5-foot 8-inch inside shoulder.

A minimum vertical clearance of 14 feet 6 inches over Brookhollow Way Bridge to the low future structure elevation shall be provided.

The minimum low structure elevation shall be the Q100 elevation, plus the minimum required freeboard of 2 feet.

Pile sleeves shall be provided for future widening, for the full width of the area between structures 11 & 12, spaced at the same distance as the final design of Structure 11 & 12.

14.5.4 Bridge Structure No. 13

File Structure No. TBD (Brookhollow Way over Lentzier Creek - Sta 6+66 Line "LS-5")

The clear roadway for the structure shall be 35 feet 4 inches, consisting of two 12-foot lanes with 5-foot 8-inch shoulders.

The minimum low structure elevation shall be the Q100 elevation, plus the minimum required freeboard of 2 feet over Lentzier Creek.

Lentzier Creek 100 year floodplain shall be bridged by Brookhollow Way.

14.5.5 Bridge Structure No. 14

<u>File Structure No. 265-10-9595 (Utica Sellersburg Road over SR 265 - Sta 22+23.50 Line “LS-2”)</u>

The clear zone shall be 30 feet from the edge of travelled way of SR 265.

The clear roadway for the structure shall be 39 feet 4 inches, consisting of two 11-foot lanes with 8-foot 8-inch shoulders.

A minimum vertical clearance of 16 feet 6 inches over SR 265 to the low structure elevations shall be provided.

14.5.6 Bridge Structure No. 15

<u>File Structure No. 265-9-2616 DRW Ramp IR-1 (SR 265 WB over CSX Railroad - Sta 114+41.29 Line “IR-1”)</u>

1. The existing 16-foot travel lane shall be replaced with two 12-foot lanes. The entire structure shall be widened for a clear roadway width of 41 feet 4 inches, consisting of two 12-foot travel lanes with an 11-foot 8-inch right shoulder and 5-foot 8-inch left shoulder.

2. The structure shall be designed for HS-20 loading in accordance with *AASHTO Standard Specifications for Highway Bridges, 17th Edition*, and shall be designed for actual dead loads.

3. The bridge superstructure and substructure shall be rehabilitated with the following minimum improvements:

   a. If required by the roadway geometric design, the profile grade shall be raised for the superelevation transition and to provide adequate vertical clearance. The minimum proposed vertical clearance shall match the existing clearance of 23 feet 4 inches and be in accordance with governing railroad requirements.

   b. Both approaches and bridge rail transitions shall be removed. The existing bridge superstructure shall be removed. End bents shall be removed down to the pilings.

   c. Substructure units shall be widened to accommodate the widened superstructure.

   d. In order to widen the existing substructures, deflection of pier extensions shall be used as necessary to accommodate required horizontal clearance to the existing railroad tracks, per governing railroad clearance requirements.

   e. Reinforcing shall be drilled and grouted into the existing pier crash walls, and the existing crash walls shall be modified, as necessary, per governing railroad crash wall height requirements.

   f. All cracks between the top of the slope wall and the concrete berm shall be epoxy injected.

   g. Exposed reinforcing steel shall be cleaned and epoxy coated at spalls that will otherwise not be treated as part of the rehabilitation as directed by the Engineer.

h. The end bent diaphragms and bridge deck shall be constructed to match the semi-integral detail provided in the IDM Figure 409-3.

i. Additional beams and widened bridge deck shall be installed.

j. New full-width reinforced concrete bridge approaches and barrier rail transitions shall be placed.

k. TL-4 bridge railings shall be replaced at both copings.

l. Existing guardrail and guardrail transitions shall be replaced at the completion of construction.

m. Existing pavement relief joint and sleeper slabs shall be replaced.

n. Existing light standards found on the bridge according to Section 11 shall be replaced.

o. Bridge deck drainage design shall be performed, and drains shall be added as needed. Drainage shall not be discharged within railroad ROW. All existing piping and inlets shall be cleaned to ensure proper drainage. All misaligned pipes and inlets shall be corrected.

p. Six feet of existing berm gutter shall be replaced. Existing inlets shall be capped and new drainage added.

q. Developer shall obtain, and pay all costs associated with, all necessary permits and approvals required by the railroad for Work on or near the railroad ROW. Developer shall comply and pay for the costs of compliance with all conditions of agreements, permits and approvals. Developer shall be responsible for all railroad coordination and requirements. Refer to Section 18 for additional requirements.

14.5.7 Bridge Structure No. 16

File Structure No. 265-9-2616 (WB SR 265 over C&O and CMC Railroad - Sta 405+71.85 Line "LA-WB")

1. The existing north shoulder shall be widened 3 feet. The clear roadway width for the bridge shall be 43 feet 8 inches, consisting of two 12-foot travel lanes with a 13-foot 8-inch right shoulder and a 6-foot left shoulder.

2. The structure shall be designed for HS-20 loading in accordance with the *AASHTO Standard Specifications for Highway Bridges, 17th Edition*, and shall be designed for actual dead loads.

3. The bridge superstructure and substructure shall be rehabilitated with the following minimum improvements:

    a. Both approaches and bridge rail transitions shall be removed. The existing bridge deck expansion joints and 5 feet of the bridge deck (measured along a line parallel with the beams) at both ends shall be removed. Existing reinforcing shall be cleaned and straightened. Bridge deck barrier railing shall be removed. Mud walls shall be removed down to the bridge seats.

b. One-quarter inch of the bridge deck shall be milled, and hydro-demolition shall be used to remove unsound portions of the existing deck, as directed by the Engineer.

c. Substructure units shall be widened to accommodate the widened superstructure.

d. In order to widen the existing substructures, deflection of pier extensions shall be used as necessary to accommodate required horizontal clearance to the existing railroad tracks per governing railroad clearance requirements.

e. Reinforcing shall be drilled and grouted into the existing pier crashwalls and the existing crashwalls shall be modified as necessary per governing railroad crashwall height requirements.

f. All cracks between the top of the slope wall and the concrete berm shall be epoxy injected.

g. Exposed reinforcing steel shall be cleaned and epoxy coated at spalls that will otherwise not be treated as part of the rehabilitation, specifically on the interior diaphragms at the piers as directed by the Engineer.

h. End bent diaphragm and bridge deck shall be constructed to match the semi-integral detail shown in the IDM Figure 409-3.

i. Additional beams and widened bridge deck shall be installed.

j. The removed portion of the bridge deck shall be replaced.

k. A latex modified PCC overlay shall be constructed on the entire superstructure. The overlay shall be a thickness so the proposed grade and cross-slope results in a constant overlay thickness.

l. New full-width reinforced concrete bridge approaches and barrier rail transitions shall be placed.

m. TL-5 bridge railings shall be replaced at both copings. Developer shall field drill holes and anchor reinforcing steel in the deck as required for the required minimum reinforcing spacing.

n. Existing guardrail and guardrail transitions shall be reconnected on the south side and replaced on the north side at the completion of construction.

o. Existing pavement relief joint and sleeper slabs shall be replaced.

p. Existing light standards found on the bridge according to Section 11 shall be replaced.

q. Bridge deck drainage design shall be performed and drains shall be added as needed. Drainage shall not be discharged within railroad ROW. All existing piping and inlets shall be cleaned to ensure proper drainage. All misaligned pipes and inlets shall be corrected.

r. The existing 36-inch drainage structure on the east slopewall shall be protected during widening.

s. Developer shall obtain, and pay all costs associated with, all necessary permits and approvals required by the railroad for Work on or near the railroad ROW. Developer shall comply and pay for the costs of compliance with all conditions of agreements, permits and approvals. Developer shall be responsible for all railroad coordination and requirements. Refer to Section 18 for additional requirements.

14.5.8 Bridge Structure No. 17

File Structure No. 265-9-2616 CDE (EB SR 265 over C&O and CMC Railroad - Sta 406+35.96 Line "LA-EB")

The existing south shoulder shall be widened by 1 foot. The existing north shoulder shall be widened by 12 feet 8 ½ inches. The clear roadway width for the bridge shall be 43 feet 4 inches, consisting of two 12-foot travel lanes with a 13-foot 8-inch left shoulder and a 5-foot 8-inch right shoulder.

The structure shall be designed for HS-20 loading in accordance with *AASHTO Standard Specifications for Highway Bridges, 17th Edition*, and shall be designed for actual dead loads.

The bridge superstructure and substructure shall be rehabilitated with the following minimum improvements.

1. Both approaches and bridge rail transitions shall be removed. The existing bridge deck expansion joints and 5 feet of the bridge deck (measured along a line parallel with the beams) at both ends shall be removed. Existing reinforcing shall be cleaned and straightened. Bridge deck barrier railing shall be removed. Mud walls shall be removed down to the bridge seats.

   a. One-quarter inch of the bridge deck shall be milled, and hydro-demolition shall be used to remove unsound portions of the existing deck as directed by the Engineer.

   b. Substructure units shall be widened to accommodate the widened superstructure.

   c. In order to widen the existing substructures, deflection of pier extensions shall be used as necessary to accommodate required horizontal clearance to the existing railroad tracks, per governing railroad clearance requirements.

   d. Reinforcing shall be drilled and grouted into the existing pier crashwalls, and the existing crashwalls shall be modified as necessary, per governing railroad crashwall height requirements.

   e. All cracks between the top of the slope wall and the concrete berm shall be epoxy injected.

   f. Exposed reinforcing steel shall be cleaned and epoxy coated at spalls that will otherwise not be treated as part of the rehabilitation, specifically on the interior diaphragms at the piers as directed by the Engineer.

   g. End bent diaphragm and bridge deck shall be constructed to match the semi-integral detail shown in the IDM Figure 409-3.

   h. Additional beams and widened bridge deck shall be installed.

   i. The removed portion of the bridge deck shall be replaced.

j. A latex modified Portland cement concrete (PCC) overlay shall be constructed on the entire superstructure. The overlay shall be a thickness so the proposed grade and cross-slope results in a constant overlay thickness.

k. New full-width reinforced concrete bridge approaches and barrier rail transitions shall be placed.

l. TL-5 bridge railings shall be replaced at both copings. Developer shall field drill holes and anchor reinforcing steel in the deck, as required, for the required minimum reinforcing spacing, in accordance with standard drawings.

m. Existing guardrail and guardrail transitions shall be replaced at the completion of construction.

n. Existing pavement relief joint and sleeper slabs shall be replaced.

o. Existing light standards found on the bridge, according to Section 11 shall be replaced. An additional light underneath bridge shall be added.

p. Bridge deck drainage design shall be performed, and drains shall be added as needed. Drainage shall not be discharged within railroad ROW. All existing piping and inlets shall be cleaned to ensure proper drainage. All misaligned pipes and inlets shall be corrected.

q. The existing 36-inch drainage structure on the east slopewall shall be protected during widening.

r. Developer shall obtain, and pay all costs associated with, all necessary permits and approvals required by the railroad for Work on or near the railroad ROW. Developer shall comply and pay for the costs of compliance with all conditions of agreements, permits and approvals. Developer shall be responsible for all railroad coordination and requirements. Refer to Section 18 for additional requirements.

14.5.9 Bridge Structure No. 18

File Structure No. TBD (SR 265 Exit Ramp IR-3 over CSX & Port of Indiana Railroad - Sta 314+80.50 Line "IR-3")

The clear roadway for the structure shall be 31 feet 4 inches, consisting of one 16-foot lane with a 9-foot 8-inch outside shoulder and a 5-foot 8-inch inside shoulder.

A minimum vertical clearance of 23 feet shall be provided over the railroad to the proposed low structure elevation. The structure shall accommodate a future rail line 30 feet east of, parallel to, and at the same elevation as the rail line that crosses SR 62.

Developer shall obtain, and pay all costs associated with, all necessary permits and approvals required by the railroad or for Work on or near the railroad ROW. Developer shall comply and pay for the costs of compliance with all conditions of agreements, permits and approvals. Developer shall be responsible for all railroad coordination and requirements. Refer to Section 18 for additional requirements.

14.5.10 Bridge Structure No. 19

File Structure No. 265-9-7405 (WB 265 over SR 62 - Sta 393+77.35 Line "LA-WB")

1. The existing north shoulder will be widened 1 foot. The clear roadway width for the bridge shall be 53 feet 8 inches, consisting of two 12-foot travel lanes and a 12-foot auxiliary lane with an 11-foot 8-inch right shoulder and a 5-foot 8-inch left shoulder.

2. The structure shall be designed for HS-20 loading in accordance with the *AASHTO Standard Specifications for Highway Bridges, 17th Edition*, and shall be designed for actual dead loads.

3. The bridge superstructure and substructure shall be rehabilitated with the following minimum improvements:

   a. Both approaches and bridge rail transitions shall be removed. The existing bridge deck expansion joints and 5 feet of the bridge deck (measured along a line parallel with the beams) at both ends shall be removed. Existing reinforcing shall be cleaned and straightened. Bridge deck barrier railing shall be removed. Mud walls shall be removed down to the bridge seats.

   b. One-quarter inch of the bridge deck shall be milled, and hydro-demolition shall be used to remove unsound portions of the existing deck, as directed by the Engineer.

   c. Substructure units shall be widened to accommodate the widened superstructure.

   d. Reinforcing shall be drilled and grouted into the existing pier crashwalls, and the existing crashwalls shall be modified as necessary.

   e. All cracks between the top of the slope wall and the concrete berm shall be epoxy injected.

   f. Exposed reinforcing steel shall be cleaned and epoxy coated at spalls that will otherwise not be treated as part of the rehabilitation, specifically on the interior diaphragms at the piers, as directed by the Engineer.

   g. End bent diaphragm and bridge deck shall be constructed to match the semi-integral detail shown in the IDM Figure 409-3.

   h. Additional beams and widened bridge deck shall be installed.

   i. The removed portion of the bridge deck shall be replaced.

   j. A latex modified PCC overlay shall be constructed on the entire superstructure. The overlay shall be a thickness so the proposed grade and cross-slope results in a constant overlay thickness.

   k. New full-width reinforced concrete bridge approaches and barrier rail transitions shall be placed.

   l. TL-5 bridge railings shall be replaced at both copings. Developer shall field drill holes and anchor reinforcing steel in the deck, as required, for the required minimum reinforcing spacing.

   m. Existing guardrail and guardrail transitions shall be reconnected on the south side and replaced on the north side at the completion of construction.

n. Existing pavement relief joint and sleeper slabs shall be replaced.

o. Existing light standards found on the bridge, according to Section 11 shall be replaced.

p. Bridge deck drainage design shall be performed, and drains shall be added as needed. All existing piping and inlets shall be cleaned to ensure proper drainage. All misaligned pipes and inlets shall be corrected.

14.5.11 Bridge Structure No. 20

File Structure No. 265-9-7405 CDE (EB 265 over SR 62 - Sta 394+15.95 Line “LA-EB”)

The existing south shoulder shall be widened 7 feet. The existing north shoulder shall be widened 12 feet 8½ inches. The clear roadway width for the bridge shall be 55 feet 4 inches, consisting of three 12-foot travel lanes with a 13-foot 8-inch right shoulder and a 5-foot 8-inch left shoulder.

The structure shall be designed for HS-20 loading in accordance with *AASHTO Standard Specifications for Highway Bridges, 17th Edition*, and shall be designed for actual dead loads.

The bridge superstructure and substructure shall be rehabilitated with the following minimum improvements:

1. Both approaches and bridge rail transitions shall be removed. The existing bridge deck expansion joints and 5 feet of the bridge deck (measured along a line parallel with the beams) at both ends shall be removed. Existing reinforcing shall be cleaned and straightened. Bridge deck barrier railing shall be removed. Mud walls shall be removed down to the bridge seats.

2. One-quarter inch of the bridge deck shall be milled, and hydro-demolition shall be used to remove unsound portions of the existing deck, as directed by the Engineer.

3. Substructure units shall be widened to accommodate the widened superstructure.

4. Reinforcing shall be drilled and grouted into the existing pier crashwalls, and the existing crashwalls shall be modified as necessary.

5. All cracks between the top of the slope wall and the concrete berm shall be epoxy injected.

6. Exposed reinforcing steel shall be cleaned and epoxy coated at spalls that will otherwise not be treated as part of the rehabilitation, specifically on the interior diaphragms at the piers, as directed by the Engineer.

7. End bent diaphragm and bridge deck shall be constructed to match the semi-integral detail shown in the IDM Figure 409-3.

8. Additional beams and widened bridge deck shall be installed.

9. The removed portion of the bridge deck shall be replaced.

10. A latex modified PCC overlay shall be constructed on the entire superstructure. The overlay shall be a thickness so the proposed grade and cross-slope results in a constant overlay thickness.

11. New full-width reinforced concrete bridge approaches and barrier rail transitions shall be placed.
12. TL-5 bridge railings shall be replaced at both copings. Developer shall field drill holes and anchor reinforcing steel in the deck, as required, for the required minimum reinforcing spacing.
13. Existing guardrail and guardrail transitions shall be replaced at the completion of construction.
14. Existing pavement relief joint and sleeper slabs shall be replaced.
15. Existing light standards found on the bridge, according to Section 11 shall be replaced. An additional light underneath the bridge shall be added.
16. Bridge deck drainage design shall be performed, and drains shall be added as needed. All existing piping and inlets shall be cleaned to ensure proper drainage. All misaligned pipes and inlets shall be corrected.

14.5.12 Bridge Structures No. 21 & 22

File Structure No. TBD (SR 265 WB over Port Road - Sta 375+96.50 Line "LA-WB")
File Structure No. TBD (SR 265 EB over Port Road - Sta 376+32.89 Line "LA-EB")

The clear zone shall utilize the defined requirement in Section 9.

The clear roadway for the westbound structure shall be 53 feet 4 inches, consisting of two 12-foot lanes, one 12-foot auxiliary lane, an 11-foot 8-inch outside shoulder, and a 5-foot 8-inch inside shoulder.

The clear roadway for the eastbound structure shall be 43 feet 4 inches, consisting of two 12-foot lanes with a 13-foot 8-inch outside shoulder and a 5-foot 8-inch inside shoulder.

A minimum future vertical clearance of 16 feet 6 inches over Port Road to the low future median widened structure elevation shall be provided.

14.5.13 Bridge Structure No. 23

File Structure No. 265-10-9599 (SR 265 Ramp IR-9 over Port Road - Sta 917+83.75 Line "IR-9")

The clear zone shall utilize what the defined requirement in Section 9.

The clear roadway for the structure shall be 41 feet 4 inches, consisting of two 12-foot lanes with an 11-foot 8-inch outside shoulder and a 5-foot 8-inch inside shoulder.

A minimum future vertical clearance of 16 feet 6 inches over Port Road to the low future median widened structure elevation shall be provided.

14.5.14 Bridge Structure No. 24

File Structure No. 265-10-9557 (SR 265 Ramp IR-8 over IR-9 - Sta 813+03.95 Line "IR-8")

The clear zone shall utilize what is defined in Section 9.

The clear roadway for the structure shall be 31 feet 4 inches, consisting of a 16-foot lane with a 5-foot 8-inch inside shoulder and a 9-foot 8-inch outside shoulder.

A minimum vertical clearance of 16 feet 6 inches over Ramp IR-9 to the low future median widened structure elevation shall be provided.

14.6 Wall General Description and Requirements

All walls shall be designed in accordance with all applicable Project Standards. Settlement and deflection tolerances shall be in accordance with AASHTO specifications.

Retaining wall types shall not include modular block, bin walls, gabion walls, or prefabricated modular walls unless stipulated otherwise herein. Extensible ground reinforcement shall not be used. Wall types shall be included in Design Review submittals submitted to IFA for its review and comment. Modular block walls will be allowed if they are less than 10 feet tall, are reinforced, and are not in a flood plain.

Proposed MSE walls shall be in accordance with the Recurring Special Provision 731-R. Other retaining wall types proposed for the East End Crossing shall be in accordance with the construction tolerances defined in the MSE retaining wall Recurring Special Provision. Material specifications for wall types other than MSE walls shall be in accordance with the Project Standards and applicable minimum service life of 75 years, or 100 years if part of a bridge abutment. Timber elements shall not be used to resist permanent loads.

Where exposed heights of retaining walls present grade differences of greater than 2 feet, appropriate fall hazard protection in the form of fence consistent with Developer's Aesthetics and Enhancement Implementation Plan shall be installed on retaining wall structures and shall be placed in conjunction with concrete walls described in Section 14.6.1.

14.6.1 Wall Structures Specific for Kentucky

Retaining wall limits from the Reference Design are shown below and are for reference only. Actual wall limits and locations shall be as required based on Developer's Final Design.

R1	89+63.00 to 103+82.00 RT KY841
R3	92+84.30 to 94+70.00 LT KY841
R4	22+50.00 to 26+32.30 RT Ramp B
R5	18+50.00 to 26+32.30 RT Ramp B
R6	96+25.00 to 106+00.00 LT KY841
R13	149+49.60 to 150+32.20 RT KY841
R14	149+77.00 to 151+30.40 RT KY841
R15	149+67.40 to 150+49.30 LT KY841
R16	149+36.10 to 153+79.60 LT KY841
R17	152+77.00 to 154+74.50 RT KY841
R18	154+95.00 to 157+28.20 RT KY841

R20	156+48.00 to 161+82.00 LT KY841
R21	150+86.50 to 152+22.40 LT KY841
R22	152+42.90 to 153+26.00 LT KY841
R23	154+38.00 to 157+15.00 RT KY841

Concrete safety walls shall be constructed within the Project ROW between the limits shown below. Concrete safety walls shall be a minimum 8 feet in height from finished ground level and have aesthetic treatments in accordance with Section 5. Structural design requirements for concrete walls shall be in accordance with Section 14.6.3.

S1	82+62.30 to 83+52.60 LT KY 841
S2	80+00.00 to 81+14.40 RT KY 841
S3	82+26.80 to 106+86.00 RT KY 841
S4	125+20.00 to 134+00.00 LT KY 841

Additional concrete safety walls shall be constructed within the ROW between the limits shown below. Concrete safety walls shall be a minimum 8 feet in height from finished ground level and have aesthetic treatments in accordance with Section 5. Clear zone requirements shall be followed. Structural design requirements for concrete safety walls shall be in accordance with Section 14.6.3.

47+30.00 to 48+63.00 LT Wolf Pen Branch Rd
48+18.90 to 48+81.00 RT Wolf Pen Branch Rd
50+95.00 to 52+24.00 LT Wolf Pen Branch Rd
51+15.00 to 52+50.00 RT Wolf Pen Branch Rd
10+19.80 to 11+27.70 LT Springdale Rd

14.6.2 Wall Structures Specific for Indiana

Retaining wall limits from the Reference Design are shown below and are for reference only. Actual wall limits and locations shall be as required based on Developer’s Final Design.

317+42.44 "A" to 321+39.19 LT "LA-EB"
320+41.20 to 321+77.93 RT "LA-WB"
8+82.71 to 13+75.40 LT "LS-5"
12+36.54 to 14+68.73 RT "LS-5"
Bridge Str No 21
Bridge Str No 22
Bridge Str No 23
Bridge Str No 24

14.6.3 Noise Wall Structures

Developer shall design and construct noise wall systems where required by Department or KYTC noise policy (depending on location) to protect residences adjacent to the East End Crossing alignment. Noise barriers shall be considered roadside hazards and may be located adjacent to the roadway shoulders, the top of cut slopes, on top of or immediately behind retaining walls, and on bridges.

The provisions of Indiana Special Provision 620-R-483 and AASHTO *Guide Specifications for Structural Design of Sound Barriers*, whichever provides the more strict criteria, shall be utilized for the design.

Wind velocity of 90 miles per hour shall be utilized.

Noise wall structure designs shall be prepared and provided to IFA for Design Review with Release-for-Construction Design Documents. All designs shall be accepted by IFA prior to construction.

14.6.4 Anti-Graffiti Coating

Anti-graffiti coating shall be placed upon all the exposed surfaces of proposed walls, from the finished ground surface at the base of the wall to a height of 10 feet above the finished ground surface.

The anti-graffiti coating shall be a sacrificial wax based emulsion type coating.

Prior to application, Developer shall inspect all surfaces to be treated and correct all flaws in the substrate that would ultimately affect the performance or appearance of the anti-graffiti coating.

Surface preparation, method of application, application techniques, coating thickness time of application, rate of application, temperature requirements for application and curing time for the anti-graffiti coating shall be in accordance with the written requirements of the manufacturer.

Developer shall allow substrate to fully cure and newly coated surface to fully cure before application. Application shall be performed by an experienced applicator in accordance with the manufacturer1s recommendations. The number of coats and coverage rates shall at no time be less than the manufacturers written requirements.

Developer shall protect plants and vegetation from over-spray and adjoining surfaces that are not to have the anti-graffiti coating applied. Developer shall protect the public in an area used by the public. Developer shall comply with all federal, state, and local environmental restrictions.

Developer shall apply surface seal prior to applying the anti-graffiti coating.

14.7 Traffic Structures

The minimum design life for the traffic structures covered herein shall be 50 years. Refer to Section 13 for foundation design for traffic structures and Section 11.5.1.5 for design and construction requirements.

14.7.1 Sign Structures

All sign structures in Indiana shall be designed and detailed in accordance with Department Box Truss & Cantilever Structure Detail Drawings, (Attachment 14-1), Standard Specifications and AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition*.

All sign structures in Kentucky shall be designed and detailed in accordance with KYTC Standard Details, Standard Specifications and AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition*.

For Dynamic Message Signs and other special sign types, Developer shall apply sign data (material, weight and dimensions, etc.) from sign manufacturers approved by the Department to perform sign structure calculations, and shall submit calculations to IFA for approval. Written comments to the calculations will be returned to Developer for revisions if needed. Once comments to calculations have been satisfactorily resolved, Developer shall develop the standard sheets for the sign supports.

In addition, for Dynamic Message Signs and other special sign types, Developer shall apply 50-year recurrence interval for wind speed and other adjustment factors in accordance with AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, 5th Edition* (Sign 3, 5, 6) and use additional DMS sign structure standards as required by IFA and KYTC and those required by OSHA with respect to safety and security access regulations.

Any modifications to existing sign supports, including the replacement of sign panels, shall be submitted to IFA for Design Review. Developer shall evaluate the existing sign supports for structural adequacy.

Where new sign panels are proposed by Developer on existing structures, Developer shall prepare and provide calculations demonstrating that the existing structure can accommodate the proposed sign panels to IFA for approval. If an existing sign structure cannot accommodate the proposed sign panels, Developer shall provide a new sign structure. The finish shall match the finish of the existing structures on those roadways. Bridge mounted sign structures shall be treated in the same manner.

14.7.2 Toll Gantry Structures

Toll gantry structures shall be designed and constructed to accommodate the loads from Tolling Equipment and all other appurtenances. The gantry structures shall be designed and configured to allow maintenance access to all signing, lighting, and Tolling Equipment without requiring lane closures on the on the roadway below. Gantry structures shall be similar in appearance to other sign structures required on the project. The design and detailing of toll gantry structures shall be coordinated by Developer with the Tolling Systems Integrator.

15 EAST END BRIDGE MAIN SPANS STRUCTURE

15.1 General

15.2 Standards and References

Design and construct the East End Bridge Main Spans structure Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 15; Governmental Approvals; and applicable Laws.

15.3 Definitions

See Exhibit 1 of the PPA for the definition of East End Bridge, East End Bridge Main Spans, and East End Bridge Kentucky Approach Spans. For the requirements of the East End Bridge Kentucky Approach Spans, refer to Section 14.3.4, unless expressly included in this Section 15 under the term East End Bridge.

15.4 Structure Description and Requirements

The structure type, arrangement, and architectural renderings depicted in the Reference Information Documents (MS-5.01, MS-5.02, MS-5.06, and MS-5.07) show the context-sensitive architectural treatment during the bridge type selection process.

An approach slab shall be provided at the Indiana abutment. The bridge shall carry IN-265/KY-841 traffic with two 12-foot 0-inch-wide lanes of traffic in each direction and a minimum 12-foot 0-inch-wide shoulder on each side of each direction roadway. The bridge shall also carry an 11-foot 0-inch-wide clear walkway on the downstream side of the bridge. The walkway shall be designed to accommodate bicycles.

- The East End Bridge shall have a minimum design life of 100 years, starting at the substantial completion date.
- The bridge, when opened, shall be striped for two lanes of traffic in each direction, with wide shoulders, as shown in the Reference Information Documents, but shall be designed to carry six lanes of traffic by restriping, resulting in reduced-width shoulders.

15.4.1 Aesthetic Requirements

The East End Bridge shall be designed and constructed with sensitivity to aesthetic commitments, historic cultural landscapes, and the historic context and shall be consistent with the Bridge Type Selection Process. The design shall include aesthetic treatments to surfaces, structures, and appurtenances that complement the historical contexts of historic properties and are in keeping with the Historic Preservation Plans for those areas.

In an earlier project phase, a Bridge Type Selection Process was conducted to evaluate potential bridge types for this setting. The structure types considered in that process are depicted in the RID MS-5.06. The Reference Design (RID MS-5.01, MS-5.02 and MS-5.07) is based on the Bridge Type Selection Process Alternative A-5 (later designated Alternative R-3). Developer shall work with IFA, advisory groups and the public in development of aesthetic elements in the Final Design, as per the requirements appearing in Section 5 of these Technical Provisions.

In keeping with the Bridge Type Selection Process, the East End Bridge Main Spans shall be one of five (5) bridge types designated Alternative A-1, A-2, A-3, A-4 or A-5 (depicted in RID MS-5.06 p. 6-12), or a sixth bridge type, which is an H-tower cable-stayed bridge and generally described as follows:

- H-towers shall have vertical pylons
- Pylons shall be visually external to the bridge superstructure
- Towers shall meet all other physical requirements given in the Technical Provisions
- Stay cables shall be connected to the bridge superstructure outside of the roadway parapets.

The following are the essential aesthetic design guidelines that the East End Bridge Main Spans bridge type shall follow:

1. The new bridge is of symbolic importance to the community. The structure should be a memorable and visually outstanding bridge with which the local residents can identify.
2. The new bridge should be as visually transparent and unobtrusive in order to fit within the context of the river and shorelines. The new bridge should complement its surroundings and not dominate the site.
3. The pedestrian walkway should be user friendly, maximize the feeling of safety and separation from traffic lanes, and encourage pedestrian and bicycle usage as much as possible. The pedestrian walkway should be attractive, and the location should allow for uninterrupted vistas of the river and the surrounding environment.
4. The design should enhance the important views and vistas. The view of the underside of the bridge is very important because not many areas along the river are open to the public but the river can be used for recreational purposes. One of the most important views will be on the river looking at the bridge from a distance. The view from the approach roadways is important and shall be considered, as well as the view from the surrounding neighborhoods.
5. The new bridge should create an architectural legacy through attention to detail. The main structural elements should be well proportioned, and the details (barriers, superstructure elements, lighting, signing, etc.) should be open-looking and not visually imposing.
6. Bridge lighting should be subtle and non-intrusive to neighborhoods.
7. The color of the bridge and all its components should blend in with the sky and the landscape. Features of the local historic landscape should be considered as inspiration for architectural themes in terms of color or texture (Utica Quarry, Limestone bluffs and outcropping, Louisville Water Tower, and covered bridges).
8. The bridge should be complementary to the native vegetation, landforms and materials in the area.

The aesthetics of the East End Bridge Kentucky Approach Spans shall be consistent with the East End Bridge Main Spans. In addition to the aesthetic requirements, the East End Bridge Main Spans shall meet all other requirements specified in this Section 15.

15.4.2 Navigation Channel Clearances

The sailing line of the navigation channel shall be as defined by the U.S. Army Corps of Engineers navigation Chart No. 88. The following navigation channel clearance shall be maintained:

- Minimum Vertical Clearance = 71 feet above the normal pool.
- Minimum Horizontal Clearance = 900 feet normal to and centered on the sailing line of the river channel.
- Minimum Horizontal Clearance During Construction = 600 feet normal to and centered on the sailing line of the river channel. (The sailing line of the channel is at a skew to the longitudinal centerline of the bridge and shall be maintained within the 900-foot navigation channel that is established from the design.)

15.4.3 Roadway Clearance

The minimum vertical clearance over Upper River Road shall be 18 feet 0 inches.

15.4.4 Horizontal and Vertical Alignment

The horizontal alignment of the bridge shall be designed to fit within the Project ROW, with a minimum clearance of 40 feet of clearance from the face of the bridge to the nearest Project ROW line.

The vertical alignment of the bridge shall have a minimum 0.50 percent grade and a maximum 3.0 percent grade. The roadway cross slope shall be 2.0 percent.

15.4.5 Unit and Dimensions

All dimensions shall be measured horizontally and vertically at 60° Fahrenheit, unless otherwise noted.

15.4.6 Datum

Elevations shall be based on the North American Vertical Datum of 1988 (NAVD88). The plans presented in the RID (MS-5.01 and MS-5.02) are based upon the project coordinates.

15.4.7 Water Levels

Table 15-1 Ohio River Elevations (Near River Mile Point 595)

Condition	ORD Elevation	NAVD88 Elevation
Normal Pool	420.0	418.8
Ordinary High Water	423.2	422.0
2% Flow Line (50-year)	450.1	448.9
100-Year Flood	452.9	451.7
Note: ORD – Ohio River Datum		

15.4.8 Bridge Barriers and Railings

All bridge railings shall be structurally and geometrically capable of surviving the crash test for Test Level 5 (TL-5), as defined by Chapter 13 of the American Association of State Highway and Transportation Officials (AASHTO) *Load and Resistance Factor Design (LRFD) Bridge Design Specifications*.

The roadway barrier between the roadway and walkway shall be structurally and geometrically capable of surviving the crash test for TL-5. The modification shall be designed to satisfy TL-5 requirements.

The walkway shall be Americans with Disabilities Act (ADA) compliant and have pedestrian railings with a minimum height of 42 inches, and it shall be designed for pedestrians and bicycles.

15.4.9 Temporary Structures

Developer shall provide all temporary structures necessary to perform the Work.

15.4.10 Checking of Structural Design

Developer shall engage an independent checking team, consisting of professional engineers experienced in the design of cable-stayed structures, to perform independent design checks of the East End Bridge Main Spans. No independent check of the approach bridge or other project structures is required. The independent checking team shall be from a different firm than the Designer.

The checking team shall be responsible for the following:

- Conducting design checks to ensure that the design of structure meets performance expectations outlined in these Technical Provisions and that such design is carried out according to Good Industry Practice.
- Undertaking supplementary analyses to independently verify and confirm the design methodologies and assumptions used.
- Identifying deficiencies in the design and analyses, and notifying Developer and IFA of unresolved deficiencies.

The independent design check requirement shall be separate from and in addition to Developer's required quality assurance procedures.

15.4.11 Bridge Load Rating

Developer shall load rate the East End Bridge according to the latest *AASHTO Manual for Bridge Evaluation, 2nd Edition, 2011* and the Department *Bridge Inspection Manual, Part 3: Load Rating*. The ratings shall be based on the final Record Drawings of the bridge and be prepared and submitted in accordance with the Project Standards. Complete and detailed as-built structural models shall be provided to IFA with the Record Drawings.

The load rating models shall be developed by a Registered Professional Engineer experienced in developing load rating models and shall be checked by a Registered Professional Engineer.

The model shall be capable of distributing loads based on the geometry and stiffness of the structural elements. Nonstructural elements, such as barrier rail, shall not be modeled as load-carrying elements. In performing the load rating, the distribution of loads shall be the same as that used in the design of the structure.

Standard AASHTO vehicles and Indiana Legal Loads (Indiana Title 9, Article 20) shall be used in the models to generate load-rating results for superstructure elements of the bridges that carry live loads.

The overall rating shall be the lowest rating of any individual component, segment, or type. The final rating and each component rating shall be accompanied by the location of the rating, limit state, and impact factor.

Each separate bridge component, segment, or element constructed shall be rated and reported to IFA. At a minimum, ratings shall be computed for moment and shear at the 1/10th points of each bridge span. The Bridge Load Rating Report shall also include the load rating analysis computer model electronic files as an attachment (see Part 3, Chapter 9 of the Department Bridge Inspection Manual.

Developer shall submit a Bridge Load Rating Report for the East End Bridge, in accordance with the requirements of this Section 15.4.11, to IFA with the Record Drawings for Design Review and approval. This report shall include the methods and software, if applicable, used to load rate the bridge, such as influence lines or surfaces.

15.4.12 Security

Developer shall assess accident and terrorist vulnerabilities and incorporate mitigation measures in the design of the East End Ohio River Bridge in accordance with Section 24.1.

Developer shall comply with the *AASHTO Bridge Security Guidelines, 1st Edition*. Localized spall and breach damage shall be accounted for when designing bridge components for blast forces (refer to guidelines from the U.S. Department of Defence for spall and breach damage estimated for non-column structural components). The blast load analysis of the structure shall consider inertial effects, and dynamic analysis shall be used for the design of any structural member subjected to blast loads.

15.4.13 Signing

Refer to Section 11 for signing requirements. All sign structures shall be designed in accordance with Project Standards.

15.4.14 Utilities

In addition to any utility services required in this Section 15, Developer shall design and install six (6) 4-inch vacant conduits for future utility use on the East End Bridge. The conduits shall extend from the south abutment in Kentucky to the north abutment in Indiana and shall be terminated in handholes outside of the structure or pavement. Developer shall provide a dead load allowance for future utilities within the vacant ducts. Position of the ducts shall comply with the aesthetic requirements set forth in Section 15.4.1.

Ducts may be embedded in the structural elements if appropriate. Exposed conduit on bridge structures shall be bullet resistive. If exposed, Developer shall use PVC coated galvanized rigid steel.

15.5 Design Criteria

15.5.1 Design for Durability

Developer shall design the East End Bridge to meet the required service life either by selecting materials with reduced corrosion potential, by selecting materials and details that resist degradation, or by other means that Developer demonstrates will meet the required service life. The IFA will review any proposed means for its good faith discretion.

The service life of the East End Bridge shall be 100 years, except as otherwise indicated in Table 15-2 for replaceable components.

Table 15-2 Minimum Service Life for Components

Non-Replaceable Components	Minimum Service Life (Years)
Towers, piles, pile caps, piers, pier caps, deck, and superstructure	100
Replaceable Components	**Minimum Service Life (Years)**
Stay cables	60
Bridge bearings	50
Expansion joints	30
Bridge and walkway barrier	60
Separate bridge deck wearing surface	30
Drainage system	75
Access (boxes, towers and piers): Internal access ladders, platforms, etc. (galvanized and painted)	60
Stay-cable dampers	40
Dehumidification system [a]	30
Painting – superstructure external for orthotropic box, composite box	20
Access: electrical and mechanical parts	30
Other proposed components	As agreed to during final design
[a] If required by Corrosion Protection Plan.	

The requirements specified herein are intended as minimum requirements. Developer shall provide a Corrosion Protection Plan that details the selection of materials, design details, and all other provisions necessary for achieving the specified service life ("Corrosion Protection Plan"). The Corrosion Protection Plan shall be submitted for Design Review with the Stage 1 Design Documents.

All structural steel shall be painted, with the exception of piling and maintenance appurtenances. Maintenance appurtenances shall be hot-dip galvanized, per ASTM A 123.

The Corrosion Protection Plan shall, at a minimum, include the following:

- Include a conceptual approach to achieving the required 100-year service life for non-replaceable elements.
- Identify a conceptual approach to achieving the required service life in Table 15-2 for replaceable elements.
- Identify each structure component with the corresponding environmental exposure conditions for each component (e.g., buried, submerged, exposed to atmosphere, exposed to corrosive chemicals).
- Identify relevant degradation and protective mechanisms for each structure component. Quantify degradation processes and resistances to these processes with respect to time. Models shall use a probabilistic approach to evaluate the time-related changes in performance that occur, depending on the component, environmental conditions, and any proposed protective measures. Models shall be listed in the plan.
- Adjust the expected service life of each structural component (refer to Table 15-2), based on the proposed material, exposure condition, relevant degradation mechanism, and any proposed protective measures, taking into account the proposed inspection/maintenance schedule. List any corrosion allowances and thresholds used. Include the level of reliability or probability of the predicted service life of each element, as well as the expected interval of replacement or renewal of the protective measures within the service life duration (e.g., thickness of coats, number of times to recoat paint that protects steel members).
- Detail construction methods to ensure the highest quality products are achieved (e.g., ensure uniform compaction of the concrete, adequate concrete cover, proper curing for the element, etc.).

Additional specific requirements for the Corrosion Protection Plan shall include the following:

1. List of the manufacturers of all proposed coatings, inhibitors, sealers, and membranes.
2. Schedule for corrosion inspection of the structural components.
3. Proposed maintenance schedule for items/materials that could be affected by corrosion.
4. Direct electrical current and sacrificial materials (catholic protection) shall not be used to mitigate for expected corrosion effects.
5. Discussion of any Deviations, including engineering support, for how such Deviations will achieve performance requirements.

15.5.2 Towers

The towers shall not exceed 300 feet in height above the normal pool elevation. This shall not include attachments such as railings or lights.

15.5.3 Footings

The main tower footings shall be designed within the elevations in Table 15-3.

Table 15-3 Footing Elevation Criteria

Element	Minimum Elevation	Maximum Elevation
Top of Footing [a]	424.0	n/a
Top of Footing[b]	n/a	406.8

[a] If the top of footing is designed to be near normal pool surface.
[b] If the top of footing is designed to be below the normal pool surface.

15.5.4 Overlay

The roadway area and the walkway shall be protected by minimum 2-inch latex modified concrete (LMC) overlay or wearing course.

15.5.5 Expansion Joints

All expansion joints shall be sealed. All open-type expansion joints shall be detailed to collect all drainage and convey it off of the structure. Expansion joints within the walkway shall have a top plate for pedestrian and bicycle use. Mid-span expansion joints shall not be allowed.

15.5.6 Bearings

Bearings shall be designed and detailed to be replaceable by jacking the superstructure off the permanent bearings. The design shall allow adequate space for constructability. The superstructure shall be designed to accommodate jacking without future modification. The longitudinal and transverse analysis of the superstructure shall consider the redistribution of reactions and forces when jacks are engaged to replace the bearings. The Plans shall indicate the intended position of the jacks. Bearing replacement shall be considered with a single lane closure for live load.

15.5.7 Stay Cables

Wedge-type anchorage shall be used for stay cables. Cable anchor heads shall be sized to accommodate a minimum of 5 percent additional number of strands for future needs. No saddle at the towers shall be included in the final design.

15.5.8 Cable Corrosion Protection

The strands of each stay cable shall be greased or waxed and individually sheathed by polyethylene (PE). Developer shall specify the material properties necessary to achieve the required service life. The bundle of strands shall be placed in a PE pipe. The space between the PE pipe and the strand bundle shall not be filled with grout. Developer shall specify a means of protection for the cable anchorages at deck level to protect from corrosion. Developer shall include these requirements and any additional requirements in the Corrosion Protection Plan.

15.5.9 Cable Replacement

The bridge shall be designed so that stay cables can be replaced one at a time while maintaining two lanes of traffic in each direction. The active lane shall be away from the cable. Fatigue stress consideration need not be applied for this condition. A cable replacement plan shall be included in the Maintenance Plan.

15.5.10 Cable Loss

The bridge shall be designed so that the accidental loss of a single cable or a group of cables, where they are in close proximity and have the potential to fail as a group, shall not result in failure of the bridge. Six lanes of live load shall be placed in accordance with AASHTO requirements.

15.5.11 Barge Impact

All towers and anchor piers, plus the transition pier (Pier 1 of the Reference Information Documents), shall be designed for barge impact in accordance with AASHTO LRFD Section 3.14 *Pier Protection*, such as fenders, dolphins, berms, island, or other sacrificial devices, shall not be allowed. The vessel data for traffic density and velocity shall be from the McAlpine Lock and Dam which is included in RID MS-5.03.

Developer shall submit a Barge Impact Analysis Report to the IFA for Design Review prior to commencing with the Stage 2 Design that shall include the following ("Barge Impact Analysis Report"):

- An introduction
- Analysis procedures
- Analysis results
- Calculations
- Historical hydrograph data at bridge location

15.5.12 Deflection Limits

The maximum allowable rotation at the center of main span due to one side of the one roadway being fully loaded with design live load, while the other side is unloaded with live load, shall be 2 percent, or 1.146^{o}. One roadway fully loaded is defined as placing three lanes of live load in one direction, distributed as defined by AASHTO.

15.5.13 Acceptable Acceleration for Human Comfort

The walkway vertical vibration induced by one passing truck shall be computed. The maximum allowable vertical acceleration shall be less than $1.64\ f^{0.5}\ ft/s^2$, where f = bridge frequency in Hz. This is derived from Eurocode EC 2.2 for pedestrian comfort criteria as a function of the fundamental natural frequency.

15.5.14 Bridge Lighting and Illumination

15.5.14.1 General

All aesthetic, roadway, and walkway lighting shall be designed and constructed to minimize the dispersion of light beyond the Project ROW and include state-of-the-art techniques and systems, such as full cutoff optics or other similar systems, to the extent that is required to ensure safe roadway lighting designs, and navigation required by the U.S. Coast Guard (USCG) and the Federal Aviation Administration (FAA).

15.5.14.2 Reserved

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15.5.14.3 Aesthetic Lighting

Aesthetic lighting of the cables, towers, and underside of the box girder shall be provided consistent with the context-sensitive design process. Lighting shall be sufficient to highlight the cables and superstructure while minimizing the lighting pollution to the rural surroundings.

15.5.14.4 Obstruction Lighting

Obstruction lighting shall be provided on the towers in compliance with the FAA Aeronautical Information Manual.

15.5.14.5 Navigation Lights

The centerline (sailing line) and edges of the navigation channel, which is 900 feet normal to and centered on the sailing line of the river channel, shall be marked using navigation lights that shall be mounted on the superstructure, on both upstream and downstream sides, in compliance with the Code of Federal Regulations (CFR) 33 Chapter I, Subchapter C – Aids to Navigation.

15.5.15 Electrical Grounding

Electrical grounding and lightning protection shall be provided in accordance with NFPA 70 National Electrical Code and NFPA 780 *Standard for the Installation of Lightning Protection Systems*. All connections and components of the system shall be accessible for inspection and maintenance. For the cable-stayed bridge structure, lightning protection of concrete pylons and stay cables shall consist of the following:

- Installation of collector lines from each stay-cable anchorage to a transition line. Installation of a collector line from the reinforcement near the top of the pylon to the transition line. Collector lines shall be made of copper and have a cross section of at least 0.08 inches; and,

- Installation of a transition line, in direct contact with the reinforcement cage, from the pylon tip down to the foundation. The transition line shall have a cross section of at least 0.3 square inches and may consist of specifically designated reinforcing steel bars properly welded together to assure adequate electrical conductivity. The transition line shall be connected to the foundation earth which typically consists of a horizontal closed loop of reinforcing steel bars (min 0.3 inches cross section) placed low in the foundation, inside the concrete. The concrete deck does not need any specific protection in general. In case electrically isolated bearings are used, they need to be electrically connected to earth with cables (min. cross section of 0.08 square inches or copper bar with a minimum diameter of ¼ inches). Composite structures are suggested to be protected similarly to concrete structures.

The lightning protection system shall include protection for all access ladders, maintenance walkways, and platforms in order to protect maintenance workers.

The electrical systems shall be grounded separately.

15.5.16 Channel Closing

Channel restrictions shall be in compliance with the USCG Section 9 permit requirements.

15.5.17 Maintenance and Inspection Access

Permanent ladders and platforms shall be provided for access to cable anchorage inside the tower and the box girders, all interior spaces inside the tower and the box girders, navigation lights, aviation obstruction warning light, and aesthetic lights.

Developer shall provide an access system for the maintenance and inspection of all superstructure areas under the deck. The access system shall be capable of reaching all superstructure areas under the deck that will require inspection and maintenance. The access system shall be capable of being used by all maintenance and inspection staff. Any permanent portions of the access system shall be consistent with the aesthetic requirements. If inspection access to the underside of the superstructure box girders and the drainage pipes is from an inspection snooper truck on top of the deck (either roadway or walkway) the walkway shall be designed to support the inspection snooper truck.

Tower and box girder interior spaces shall be designed to be accessed from deck level. Box girder access points shall not be spaced more than 300 feet.

All access doors and hatches shall be secured by weatherproof locks.

Lighting shall be provided in all interior spaces inside the tower and the box girder, providing a minimum of 5 foot-candles in all locations. Electrical duplex power outlets, 120-volt alternating current, shall be provided at every access hatch and a minimum of every 100 feet thereafter.

Tower and box girder interior spaces shall be ventilated in accordance with Developer’s Corrosion Protection Plan and Occupational Safety and Health Administration (OSHA) standards.

For future maintenance and repair operations, Developer shall provide any necessary appurtenances to provide for the easy movement of heavy equipment and materials, such as cable anchorages. Developer shall specify how such movement will be accommodated in the Maintenance Plan.

15.5.18 Rigging Anchor

Anchors for the attachment of rigging equipment at tower top shall be installed to allow inspection of the stay cables and the tower outside surface. At least one anchor shall be provided for each tower face. Anchors shall comply with OSHA standards for construction (29 CFR 1926).

15.5.19 Drainage

Stormwater within the roadways, median, and walkway shall be collected in a closed drainage system and carried to the Kentucky Approach. The drainage system shall be designed for a 100-year, 1-hour storm event. Refer to Sections 7 and 8 for drainage storage and treatment requirements.

No drainage pipes shall be located within any box girders. The drainage pipes along both edges of the superstructure shall be hidden from view from the shore. The design shall be such that drainage pipes can be inspected and replaced as necessary.

15.5.20 Permanent Retaining Walls

For permanent retaining wall requirements, refer to Section 14.

15.6 Design and Analysis Method

15.6.1 Importance Factor

The operational importance factor shall be 1.05 for the strength limit state, 1.0 for all other limit states, and 1.0 for the redundancy factor.

15.6.2 Structural Steel

Steel beams shall be designed to act compositely with the concrete deck.

15.6.3 Overlay

The overlay shall not be considered for the calculation of section properties for composite action.

15.6.4 Foundations

Foundation design shall be in accordance with Section 13. Steel casing of the drilled shafts shall not be considered as a part of any structural member. However, the steel casing may be considered to provide confinement and stiffness. The thickness of the casing to be considered for confinement and stiffness shall be reduced from the actual thickness to account for corrosion loss.

15.6.5 Hydraulic Modeling and Scour Analysis

Developer shall perform all hydrology/hydraulic analyses and design for the East End Bridge Main Spans and any portion of the East End Bridge Kentucky Approach Spans as is necessary to provide a complete analysis. The hydraulic analyses shall include a 2D analysis of the proposed bridge configuration to predict hydraulic impacts on the existing Ohio River flow regime. The 2D analysis shall be completed with a Surface Water Modeling System (SMS) interface using the Finite Element Surface Water Modeling System (FESWMS) solution algorithm. The 2D hydraulic modeling shall include an analysis of the dry weather (normal pool) condition, 10-year (10 percent probability), 50-year (2 percent probability), 100-year (1 percent probability), and 500-year (0.2 percent probability) storms. The total potential increase to the 100-year flood elevation of the Project on the Ohio River shall not exceed 0.15 feet at any location. Developer is advised that there are backwater effects from the proposed Downtown Bridge project not under this PPA. Developer is required to coordinate its design with the Downtown Crossing design-build team and reflect those backwater effects in the analysis.

This hydrology/hydraulic analysis shall include all modeling, analysis, and design to ensure that all foundations and water course banks are designed to resist 100-year scour. Scour analysis shall be performed for a 500-year flood event to ensure structural stability. The scour analysis shall be performed in accordance with the methodology outlined in the Federal Highway Administration (FHWA) *Hydraulic Engineering Circular (HEC) No. 18* to develop predictions of long-term, contraction, and local scour at piers and abutments.

Developer shall provide velocity vectors from the 2D model to the Seamen's Church Institute for the purposes of navigation simulation. Velocity vectors shall be provided for the normal pool, 50-year, and 100-year storm events at each node in a grid layout.

Developer shall provide a Hydraulic Report to IFA for review and comment prior to commencing with Stage 2 Design that includes the full hydraulic analysis and scour depth calculations. The IDM presents a Design Procedures Checklist as Fig. 32-7A which shall be included in and identified in the Hydraulic Report.

The Hydraulic Report shall be prepared by a Registered Professional Engineer and shall be signed and sealed by the Responsible Engineer as per IDM requirements.

15.6.5.1 Navigation Simulation

Developer shall comply with the U.S. Coast Guard Section 9 permit. The U.S. Coast Guard will determine if any proposed changes to the pier locations by Developer from those provided by IFA as part of the submittal of applications for IFA-Initiated Approvals require a reanalysis of the navigation simulation. Developer shall be responsible for performing any required re-analysis. See Sections 4.3 through 4.5 of the PPA for additional information on Governmental Approvals.

15.6.6 Creep and Shrinkage

The CEB-FIP Model Code for Concrete Structures, 1990, for "*Time Dependent Behavior of Concrete Creep and Shrinkage*" shall be used to compute the effects of creep and shrinkage on the deck and tower.

15.6.7 Non-Linear Effects

The non-linear effects due to large deformations shall be considered for cable replacement and cable loss cases. Non-linear effects shall be considered in both the global and local analysis of the structural bridge system.

The forces and deformations shall consider the following and shall be included in the design documentation:

- The p-delta effect of the towers under axial load and bending
- The p-delta effect (geometric non-linearity) of girders under axial load and bending
- The variation of load intensity with loaded length when load superposition is no longer valid
- The non-linear effect of live load that includes the moment due to dead load thrust acting on the live load displacement
- Material nonlinearity

15.6.8 Aerodynamic Evaluation

Developer shall carry out a wind study and generate site-specific wind climate data obtained from the correlation of wind load data available from the Louisville International Airport and

Bowman Field. Developer shall be responsible for assessing and verifying the return period and wind loads to be used for construction stage analysis.

Developer shall perform full aeroelastic model testing of the East End Bridge Main Spans in its final configuration and throughout all critical stages of construction. Static aerodynamic coefficients (lift, drag, and moment), aeroelastic flutter coefficients, and vortex-induced aerodynamic motions shall be obtained from wind tunnel tests using a detailed sectional model of the bridge, using an appropriate scale. Static aerodynamic coefficients shall be determined for a +/-10 degree angle of attack. Dynamic response shall be determined for a +/-5 degree angle of attack.

Developer shall prepare a Wind Engineering Study Report, divided into two Submittals specified below, with the results of the wind study and full aeroelastic model testing of the bridge to determine wind design forces based on wind tunnel test findings. Critical construction stages shall be determined by Developer. The Wind Engineering Study Report shall contain the following two Submittals, at a minimum:

1. Wind Study Report
   a. Introduction.
   b. Wind climate and site analysis, including introduction, data sources, methodology, results, conclusions, and recommendations.
   c. Section model test information, including objectives and criteria, model description, wind tunnel test procedures, aerodynamic stability results, and static force and moment coefficients.
   d. Results to wind buffeting, including background information, mean and background fluctuation wind loads, inertial loads due to wind-induced bridge motions, and simplified wind load distributions for structural design.
2. Wind Engineering Report
   a. Description of the aeroelastic model and its design
   b. Description of the wind tunnel simulation
   c. Description of the wind tunnel test and instrumentation
   d. Aerodynamic stability from wind tunnel test results
   e. Response to turbulent winds from wind tunnel test results
   f. Response comparisons between the stability and buffeting analysis and the test results
   g. Comparison of simultaneous peak moments at the base of the tower
   h. Stay-cable wind, rain vibration, and pedestrian comfort analysis
   i. Cable damping evaluation
   j. Conclusions and recommendations

The Wind Study Report shall be submitted to the IFA for review and comment with Stage 2 Design Review and the Wind Engineering Report shall be submitted to the IFA for review and comment with Released-for-Construction Design Review documents. The two Submittals shall be assembled into the Wind Engineering Study Report and submitted with Record Drawings.

Wind buffeting analysis shall be performed by Developer in accordance with AASHTO *LRFD Bridge Design Specifications* and ASCE/SEI 7-10. Both static and dynamic wind effects shall be considered, utilizing computer models of the bridge that incorporate the results of wind tunnel tests of sectional models of the deck. Wind tunnel tests shall include smooth and turbulent flow, and 0.5 percent to 1.5 percent damping.

Developer shall provide a cable dampening system if required for stability.

15.6.8.1 Wind Events

The wind analysis and design shall consider both a high-probability serviceability event and a lower-probability aerodynamic stability event. The wind analysis and design shall consider both the completed bridge and critical construction stages.

The serviceability wind event shall have a probability consistent with a mean return period of 100 years as defined in ASCE/SEI 7-10, but the resulting mean-hourly wind speed shall not be less than the mean hourly wind speed of a 100 year return period from wind climate data. During all phases of construction, a mean hourly wind speed of not less than wind climate data shall be applied.

Vertical deck accelerations shall not exceed 0.05g for winds up to 30 mph and 0.10g for winds between 30 mph and 45 mph (where g denotes acceleration due to gravity). The completed bridge shall show no signs of flutter instability up to a 10,000 year return wind event and during all phases of construction for the 20-year wind event. If the bridge shows any sign of aerodynamic instability during the serviceability wind event or does not meet deck acceleration limits, the cross-section or other bridge design features shall be revised and all wind tunnel tests repeated. All revisions are subject to the IFA's review and comment. During construction, temporary remedial measures to counteract any distress shall be implemented as required without obstructing the minimum horizontal clearance and the vertical clearance.

15.6.9 Tensile Stress in Concrete Deck

For segmental cable-stayed box deck section alternates, follow the requirements of AASHTO LRFD Section 5.9.4 applicable to "segmentally constructed bridge". For alternates with a steel edge girder with transverse floor beam system, deck longitudinal stress (as well as deck stress in the direction of main load path) shall meet the requirements of AASHTO LRFD Section 5.9.4.

15.7 Loads

The bridge shall be designed in accordance with the more stringent specifications of the IDM or AASHTO LRFD requirements and load combinations, unless otherwise noted.

15.7.1 Dead Loads

The unit weight of concrete shall be 150 pounds per cubic foot, except as noted:

- Concrete deck and tower – 155 pounds per cubic foot
- Post tensioned concrete – 155 pounds per cubic foot

15.7.2 Utilities

No additional utilities other than those required for roadway lighting, aesthetic lighting, navigation lighting, tower and box girder internal lighting, and air beacons are anticipated for the bridge.

15.7.3 Live Load

The bridge shall be designed for HL-93 loading

Pedestrian live load shall be 75 pounds per square foot applied to the walkway/bike path, in accordance with LRFD 3.6.1.6. The pedestrian live load shall be applied in combination with vehicular live load, in accordance with LRFD Sections 3.6.1.1.2 and C3.6.1.1.2.

The walkway shall be checked for (1) H-20 truck load, which represents a fire engine or other emergency vehicle, and (2) an inspection snooper truck weighing 80 kips. The H-20 and snooper truck loads shall not be combined with pedestrian live load, but shall be combined with vehicular live load in accordance with LRFD Section 3.6.1.1.2.

15.7.4 Construction Live Load

Developer shall apply all anticipated construction live loads.

15.7.5 Vehicular Dynamic Allowance

Vehicular dynamic allowance shall be considered in the design as required by AASHTO Reference LRFD Section 3.6.2 for HL-93 live load and Section 3.8 of the AASHTO Standard Specifications for HS-25 live load.

The loaded length L, to be used for calculating the dynamic allowance, shall be determined from influence lines and shall be the sum of the individual lengths that shall be loaded so as to produce the maximum stress in the members being considered.

Stay-cable design (including anchorages) shall include live load dynamic allowance in accordance with the *Recommendations for Stay-Cable Design, Testing, and Installation* by Post-Tensioning Institute.

Live-load dynamic allowance shall be considered for the design of the towers and piers above the top of footing level. Live-load dynamic allowance shall not be considered for the design of footings, pile caps, drilled shafts, and bearings.

Expansion joints and their supports shall be designed for 100 percent dynamic allowance.

15.7.6 Fatigue

Fatigue loading shall be in accordance with AASHTO LRFD Specifications 3.6.1.4 and in accordance with *Recommendations for Stay-Cable Design, Testing, and Installation* by Post-Tensioning Institute. The 2030 ADTT of 6,760 vehicles per day (13 percent trucks) shall be used.

15.7.7 Stay-Cable and Component Fatigue

Developer shall follow the *Recommendations for Stay-Cable Design, Testing, and Installation*, written by Post-Tensioning Institute.

15.7.8 Wind Loads

The wind analysis shall determine the 100-year mean-hourly speed at deck level and corresponding 10-minute mean value which shall be used as the design wind speed. The design flutter speed shall be determined for a 10,000-year 10-minute mean speed. For the design wind speed in the construction phase, the mean-hourly and 10-minute mean value return period shall be 20 years and the design flutter speed shall have a 1,000-year return 10-minute speed.

15.7.8.1 Static Wind Load

Static wind pressure and drag coefficients shall be provided by wind tunnel test result.

A buffeting analysis shall be performed based on the data measured from the wind tunnel tests. The buffeting analysis shall generate equivalent static loads to the structure. Wind loads shall be applied to the structure to determine the maximum stress effect.

15.7.8.2 Dynamic Wind Load

Sectional and aeroelastic wind tunnel tests shall verify the aerodynamic stability of the complete bridge and the construction stages. The tests shall measure cable axial forces of selected cables and the bending moments of the towers. The cables and towers shall be checked for the measured dynamic forces.

15.7.9 Thermal Loads

Temperature range shall be computed based on AASHTO LRFD Procedure B. Use a median temperature of 60° Fahrenheit.

The structure shall be designed to accommodate a temperature differential of 14.4° Fahrenheit between the stay cables and deck and a temperature variation of +10° Fahrenheit or -10° Fahrenheit over the thickness of the tower legs.

15.7.10 Earthquake Effects

A site-specific response spectrum shall be developed for the seismic analysis. Only 50 percent of the total scour shall be assumed when designing for seismic condition. See Table 15-4 for additional criteria.

Table 15-4 Seismic Design Criteria

Seismic Hazard Level	Return Period	Events	Performance Criteria
Safety Evaluation Earthquake (SEE)	2,500 yrs.	4% in 100 yrs. Probability of Exceedance.	No collapse, repairable damage, limited access for emergency traffic within 48 hours, full service within month(s).
Functional Evaluation Earthquake (FEE)	500 yrs.	20% in 100 yrs. Probability of Exceedance.	No collapse, no damage to primary structural elements, minimal damage to other components, full access to normal traffic available immediately (allow for inspection).

15.7.11 Barge Impact Loads

Barge impact loads shall be calculated in accordance with AASHTO LRFD Section 3.14. (These requirements have been adopted from Method II of the AASHTO *Guide Specification and Commentary for Vessel Collision Design of Highway Bridges*.) The importance classification shall be considered “critical.”

The bridge capacity of resisting the barge impact shall be computed at half of the maximum scour depth.

15.7.12 Creep and Shrinkage

The design shall be based on a mean annual relative humidity of 70 percent.

S = 0.25 for normal hardening cement shall be used in the CEB-FIP formula.

15.7.13 Ice Loads

The effects of ice shall be considered in the design of all structural elements, including the cables in accordance with AASHTO LRFD.

15.7.14 Load Factors and Combinations

Load factors and load combinations shown in the AASHTO LRFD Tables 3.4.1-1 and 3.4.1-2 shall be used, except for the following:

- Vehicular live loads shall be factored by an additional factor of 1.1.

Load factors and load combinations for the design of the stay cables shall be in accordance with the *Recommendations for Stay-Cable Design, Testing, and Installation* by Post-Tensioning Institute. This shall include the cable replacement and cable loss load combinations.

To account for the 100-year design life requirement and long-span characteristics, redundancy, and importance classification requirements, the following load factors shall be modified. Apart from highway loading, no modifications are proposed to be made to other loads or load combination factors to accommodate extended design life. Wind loads based on climate analysis shall cover the design life.

15.7.14.1 Seismic Loading

The East End Bridge Main Spans and East End Bridge Kentucky Approach Spans are categorized as a critical structure. The return periods are consistent with other bridges with a 100-year design life.

The crossing shall be analyzed for two earthquake hazard design levels as specified in Section 15.7.10. A site-specific soil response analysis shall be carried out by Developer. For the East End Bridge Main Spans, the effects of spatial variation on the seismic ground motions shall also be considered.

Article 6 of AASHTO *Guide Specifications for Seismic Isolation Design* shall be modified so that R shall be taken as 1.0 for elements protected by seismic isolation.

15.7.15 Maintenance Areas

Loading for maintenance areas shall comply with International Building Code Group U at a minimum, except where the Operations and Maintenance Plan requires maintenance equipment or materials to be used. Handrails shall comply with International Building Code Factory – Industrial Handrail, occupant load of more than 50 people. Fixed ladders shall comply with OSHA Standard 1910.

15.8 Materials

All products used on the East End Crossing shall meet the applicable Project Standards and shall be selected from the Department Approved Materials List, where applicable. The use of products that are not on the Department Approved Materials List requires written approval from IFA, in accordance with the Quality Management Plan. Acceptance shall be subject to Developer demonstrating sufficient experience with the proposed product and acceptable performance for the proposed product under conditions and applications similar to those existing for the East End Crossing.

Lightweight concrete shall not be permitted.

15.8.1 Prestressing Steel (for other than Stay Cables)

Prestressing strands shall be low-relaxation 0.6-inch-diameter seven-wire strands conforming to ASTM A416-90a, Grade 270.

Prestressing bars shall be of 150 ksi grade all-thread-bars manufactured in compliance with ASTM A-722-98 and AASHTO M275 specifications.

15.8.2 Post-Tensioning Ducts

If internal post-tensioning is required corrugated plastic duct shall be used for all internal post-tensioning tendons and shall be made of high-density virgin polyethylene material (HDPE) conforming to the requirements of D3350, cell classifications 33443C to 345544C. HDPE materials used shall not react with concrete, shall not enhance the corrosion of reinforcing and high-strength prestressing steel, and shall be free of water-soluble chlorides.

The duct system components and accessories shall meet the requirements of International Federation of Structural Concrete (FIB) Technical Report, Bulletin 7, Chapter 4, Articles 4.1 through 4.1.8, titled "*Corrugated Plastic Duct for Internal Bonded Post-Tensioning*."

15.8.3 Stay Cables

Strands shall be low-relaxation seven-wire weldless strands conforming to ASTM A416-90a, Grade 270. Strands shall be waxed or greased and individually sheathed by PE.

15.8.4 Stay-Cable Polyethylene Pipe

Single heavy duty co-extruded colored polyethylene (HDPE) pipe conforming to the requirements of ASTM F714 shall be used to protect the stay cables. The required length for each cable shall be obtained by continuous extrusion or by a fusion welding of standard-length sections of pipe. The ratio of the outside diameter to the minimum wall thickness shall conform to Post-Tensioning Institute recommendations for stay-cables. A spiral fillet shall be welded to the pipe surface to reduce rain/wind induced vibration.

15.8.5 Reinforcing Steel

Microcomposite (MMFX 2) steel reinforcement bars meeting the mechanical properties of ASTM A1035 steel bars and ASTM A615 Grade 75 are permitted for the East End Bridge subject to the Project Standards.

15.9 Construction Requirements

15.9.1 Concrete Cover

The minimum clear concrete cover for main reinforcing bars shall be in accordance with the Project Standards, with the following modifications:

- 2-inch concrete cover from top of concrete deck slab (overlay excluded) to top of the reinforcement bars.
- 1.5-inch concrete cover on interior surfaces other than the deck slab.
- 2-inch concrete cover for uncoated reinforcement bars on exterior surface other than the deck slab.
- 3-inch concrete cover on the exterior surfaces in the towers, tower footings, and piers in water for unprotected reinforcement bars.
- 2-inch concrete cover for piers on land.
- Cover to ties and stirrups may be 0.5 inches less than the values specified above for main bars but shall not be less than 1 inch.

The cover requirements listed above are minimums and may be increased if required to satisfy service life requirements.

15.9.2 Erection Procedures

Developer shall develop Construction Documents, including construction specifications and erection procedures for all segments of the East End Bridge Main Spans that include complete detailed erection sequence drawings; erection stresses in permanent and temporary members; bent and falsework reactions determined for each construction stage; and moments, shears, axial loads, and other forces, computed and tabulated for the towers and the superstructure at a sufficient number of points to demonstrate that the load demand shall not exceed the capacity and allowable stresses for erection and service conditions.

Developer shall include step-by-step erection procedures with complete details of fabrication, erection, and stressing operations. Details of contemplated elevations, cable lengths, adjustments, and shims required shall be shown for each erection stage.

The geometry control specification shall be developed by Developer.

Developer shall submit an Erection Procedure Report to the IFA for review and comment with Released-for-Construction Design Documents. The Erection Procedures Report shall include details of camber, stay-cable forces at each stage, anticipated stage deflections, and the rotations of all bridges to be constructed. The method of monitoring shall also be included within the report.

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16 TUNNEL

16.1 General

This section applies to all tunnels and underground structures constructed using conventional excavation methods (drill and blast, roadheader, and/or other mechanical excavators, rippers, etc.) and cannot disturb the property above, as shown on the Plans. Alternative proposed methods require the approval of IFA.

The Work for this section is for the Drumanard Tunnel, hereinafter "Tunnel", which is defined as the twin tunnels that run beneath U.S. 42 and the Drumanard Estate and as described in detail below. The ground condition baseline values are described in the Geotechnical Baseline Report in Attachment 16-1.

The Tunnel shall provide for:

- The safe and efficient movement of traffic;
- An LOS reliability consistent with high-quality modern road tunnels servicing heavily trafficked urban areas;
- Full integration and compatibility with the East End Crossing and the traffic management and control systems in Section 19;
- The support and preservation of existing infrastructure, including roads, railways, and buildings;
- Continuous control of internal and external air quality to meet the requirements of the Technical Provisions;
- The appropriate collection, treatment, and disposal of all drainage, wash waters, fire water, and intercepted waters;
- Rapid and effective response to incidents in all areas of the roadway;
- Emergency egress from all areas of the vehicular tunnels;
- Mechanical ventilation and smoke control systems capable of fully functional continuous operation for the range of fire events as prescribed in Section 17; and
- Provide an elevated egress walkway with railing along the inside edge of each tunnel bore, connected by emergency egress cross passages between the tunnel bores.

The Design and Construction (D&C) of the Tunnel and underground structures shall:

- Minimize whole-of-service-life costs; and
- Include detailed risk assessments of all aspects of the proposed design, construction, operation, repair, and maintenance processes for the Tunnel and underground structures.

Developer shall perform the D&C activities in general accordance with the Project Standards or equivalent international guideline and/or standards approved by the IFA in its sole discretion, except:

- Where the requirements of this Section 16 specify a different standard or LOS, the requirements of this Section 16 will prevail.

16.1.1 Structures and Excavations

- Developer shall establish all design parameters, load cases, and load combinations as required by all applicable Laws, Project Standards, and guidelines and be detailed to deal with all conditions throughout their required service life of 75 years of this Section 16 and as necessary for the design and construction of structures' service life. Normal, unusual, and extreme conditions of loading shall be considered in the determination of the design loads.
- The structural capacity shall be checked using the LRFD (Load and Resistance Factor Design) method, in accordance with the guidelines outlined in the FHWA *Technical Manual for Design and Construction of Road Tunnels – Civil Elements; Publication # FHWA=NHI-10-034, December 2009*. Load cases shall be developed for the most critical combinations.
- Permanent rock support systems, where required, shall be provided with suitable corrosion protection.
- All structural Tunnel components shall be designed or provided with appropriate fire protection. Concrete, any final shotcrete, and steel structural elements shall have a minimum four-hour fire resistance rating in accordance with the time/temperature curve in American National Standards Institute (ANSI)/Underwriters Laboratories, Inc. (UL), 1709 for a baseline 300 MW design fire (due to the permitting of fuel tankers in the Tunnel). The structures baseline 300 MW design fire may be reduced to a lesser event as long as the Developer can provide detailed engineering justification for a lesser event through mitigating measures (such as fire suppression systems, drainage, ventilation systems, or other NFPA approval means) and the approval of the local fire department and other jurisdictional agencies. A fire rating of fireproofing materials shall be determined in accordance with the applicable Technical Documents. Only inorganic fireproofing materials will be acceptable. All fireproofing materials and systems shall conform to appropriate specifications of American Society for Testing and Materials (ASTM). Fire rating performance tests shall be in accordance with NFPA 502 or other applicable Technical references, which will be approved by IFA.

16.1.2 Design and Service Life

The primary elements of the Tunnel are required to be designed and constructed for a service life of 75 years, with no Tunnel outages required for structural rehabilitations during the 75-year life. Elements not specifically required to be designed to a 75-year service life shall be designed to applicable and appropriate codes, guidelines, and Project Standards.

The following elements shall be designed and constructed to a 75-year service life:

- Tunnel lining system, including reinforced concrete lining, shotcrete, annular grout (if any), and impermeable waterproofing liner
- Cross passages, including reinforced concrete lining, shotcrete, annular grout (if any), and impermeable waterproofing liner
- All components of portal structures
- All components of tunnel equipment building(s)
- Tunnel drainage and stormwater conveyance systems

Assessment of 75-Year Service Life includes but not limited to:

- **Loading –** The Tunnel lining system, cross passages, tunnel equipment building(s), and portal structures shall be designed for all prescribed time-dependent loading and deformations. The 75-year service life shall be deemed to have been met by demonstrating compliance with the long-term time-dependent loading specified in the FHWA *Technical Manual for Design and Construction of Road Tunnels – Civil Elements; Publication # FHWA=NHI-10-034, December 2009*. As there is no AASHTO reference specifically for Tunnel LFRD design, the following specification is required for this project: AASHTO *LRFD Bridge Design Specifications 6th Edition*.
- **Sulfate Attack** – The cement for any grout and reinforced concrete or shotcrete lining shall be designed to resist the effects of sulfate attack. Accredited tests, which have been approved by IFA, shall be performed on grout and lining concrete mixes. The 75-year service life shall be deemed to have been met by demonstrating, through testing, that the mixes are resistant to sulfate attack derived from the highest values of sulfate concentrations for the groundwater in contact or potentially in contact with the Tunnel lining or grout over a 75-year period.
- **Corrosion from Chloride Penetration** – The Tunnel lining system shall be designed to be resistant to corrosion from chloride penetration. The 75-year service life shall be deemed to have been met by demonstrating that the time taken to reach the corrosion threshold at the reinforcing steel, based on chloride diffusion rates for the concrete and chloride levels present in the groundwater in contact or potentially in contact with the Tunnel lining or annular grout, exceeds 75 years. Tests to derive chloride diffusion rates used to demonstrate compliance with the 75-year service life shall be in accordance with test methods approved by IFA.

16.1.3 Condition Surveys

Preconstruction and post-construction condition surveys shall be undertaken by Developer of all buildings and infrastructure as specified in Sections 7.8 and 16.1.3, including any active recorded drinking water wells within 400 feet of the Tunnel Construction Work. This work shall be coordinated with condition survey work specified in Sections 13.4.6.2 and 13.5.1.1. Independent consultants, qualified in this work, will carry out the condition surveys. Developer shall review and accept the results of these surveys. These surveys will be used to determine the impact, if any, of the performance of the Work on the surveyed buildings and infrastructure.

16.1.4 Environmental Protection

Refer to Section 7 and Sections 4.3 through 4.5 of the PPA for environmental requirements.

16.1.4.1 Environmental Requirements

The Drumanard Estate, as identified on the Reference Design, shall be protected with fencing paid for and installed by Developer. Trespassing or disturbance, except as required for monitoring and instrumentation, within these areas by personnel of Developer-Related Entities is not permitted.

On-site burning shall not be allowed.

If fueling facilities are required on site, there shall be only one such fuel facility located at the south portal. The fuel tanks shall be stored above ground on a concrete pad and shall comply with the requirements of the Project Standards, Governmental Approvals, applicable Laws and the PPA Documents.

16.1.4.2 Blasting

All blasting shall be undertaken in compliance with KRS 351.330 and *"Special Notes for Blasting and Vibration"* (Jefferson County NH-2653(018) Item 5-731.00 in its original or amended form), Sections 7.6 and 13.4.3. In addition, both above and underground excavations shall use controlled blasting techniques to minimize overbreak and damage to the rock beyond the designed boundary of the excavation. Controlled blasting shall employ such techniques as, but not necessarily limited to, the following:

- Presplitting
- Smooth blasting
- Cushion blasting (trimming)
- Line drilling

Developer shall establish standard blast warning code report. The code report shall be included in the Blasting Plan.

Where road closures of highway and roads are required during or immediately after blasting (controlled activities) in the vicinity of the work area, coordinate with IFA to observe the closure requirement and complete all controlled activities within the allotted closure period without delay.

Notice of blasting shall be placed in local newspapers. Developer shall develop and submit a protocol for informing immediately affected residents, IFA, KYTC, and the City of Louisville of the blasting schedule. This protocol shall be included in the Blasting Plan.

Monitoring of all ground vibrations and deformation shall be undertaken during all blasting, with special emphasis on the historic, sensitive, and very sensitive structures.

16.1.5 Disposal of Excavated Material

Developer shall provide temporary and permanent storage or stockpiles. Any runoff from the stockpile shall be directed to a Developer-supplied water treatment facility prior to discharge into any water course. The water treatment facility design shall be prepared and submitted to IFA for Design Review, for review and comment, 30 days before excavation within 500 feet of the Tunnel.

The designated storage or stockpiles shall be in compliance with the Environmental Compliance and Mitigation Plan.

16.1.6 Reserved

16.1.7 Tunnel Alignment Constraints

The alignment of the Tunnel shall satisfy the following requirements:

- The south portal of the Tunnel shall be located east of Highway 42 and north of existing Highway 841 indicated on the Reference Design.
- The north portal of the Tunnel shall be located west of the west property line of Drumanard Estate at the location indicated on the Reference Design.

- The Tunnel shall have a constant pillar width of 40 feet measured from the inside face of initial tunnel liner to inside face of initial tunnel liner between the two tunnel bores, as depicted in Section 1/3 on Sheet 3 in the tunnel Reference Design plans in RID TN-4.01.
- The GBR is based on the horizontal and vertical alignment of the Tunnel as shown in the Reference Design, with Tunnel construction (A-Line) within the GBR Envelope, as defined in the PPA and as indicated in Figure 11 in the GBR. If the Developer shifts the alignment of the Tunnel such that construction (A-Line) extend beyond the GBR Envelope in any direction, then the GBR shall not apply at that location, and the Developer assumes all geotechnical risks with respect to construction of the Tunnel at that location. Excavation for and construction of any initial ground support (B-Line) that extends outside of the GBR Envelope shall not be considered a deviation from the GBR Envelope.
- The horizontal and vertical alignment of the Tunnel shall interface seamlessly with all other project components.

If Developer varies the alignment of the Tunnel such that it deviates from the GBR Envelope as defined herein Developer shall bear all associated risk and benefits, including without limitation, all geological risks and benefits.

16.1.8 Tunnel Work Plan

Developer shall provide a Tunnel Work Plan to IFA for its review and approval, within 90 days after NTP1. The Tunnel Work Plan shall identify the means and methods to be used to excavate and provide initial support of the excavation by reach, including working drawings.

Developer’s Tunnel Work Plan shall include a detailed description, data, or calculation of the proposed facilities, equipment to be used, and method of construction, including but not limited to the following:

- Proposed A-Line, defined as a dimensional line, inside of which rock projections are not permitted.
- Proposed B-Line is defined as the Developer’s planned limit of excavation. Excavation or removal of rock outside of these limits is considered overbreak. The Developer’s construction means and methods shall control the amount of overbreak within the limits defined in GBR Section 4.2.4.
- Sequence of excavation and support installation, including number, location, direction, and timing of all Tunnel headings, including details of size, length, and support system design for tunnels.
- Tunnel ventilation, lighting, communications, and draining systems, including layout details, specifications for all components, and data for mechanical systems.
- Methods of controlling line and grade and survey protocols.
- Detailed list and description of all equipment to be used for Tunnel excavation and installation of support.

16.2 Tunnel Lining Design

16.2.1 General Considerations

The Tunnel lining shall be made of concrete and reinforced as necessary to control cracking during construction and after installation.

The Tunnel lining shall be capable of adequately supporting all loads including those imparted on the lining from long-term effects (e.g.: rock swelling). Alternatively, the Tunnel supporting system with features such as compressible grout or other means to mitigate the load imparted on the lining from long-term effects is acceptable individually or in combination with the earlier approach.

The Tunnel lining system is required to incorporate a waterproofing layer above the roadway so that seepage through the lining is prevented from developing.

Permanent rock support systems shall be provided with suitable corrosion protection to meet the requirements of Section 16.1.2.

16.2.1.1 Tunnel Wall Finishes

Developer shall provide a reflective finish on the walls of the Tunnel. The tunnel wall finish shall provide a smooth, hard finish that provides a high degree of light reflectance. Finish materials shall be glazed porcelain ceramic tile or porcelain enamel on steel panel or equivalent. The tunnel wall finish above the reflective finish shall be paint or other approved materials.

The reflective wall finish shall have an abrasive resistant surface enabling it to withstand cleaning by professional wash equipment and in particular the cleaning action of brushes typically used.

Developer shall provide IFA documentation for review and comment with the Stage 1 Design Submittal showing that the proposed wall finish materials have a documented history in similar tunnel applications. The reflective finish shall have a documented history in similar tunnel applications of providing a surface that is light-reflective, durable, and of a white to off-white color supplying a light reflective surface. Finishes applied directly to concrete surfaces, such as epoxy finishes and paints, are not acceptable for the reflective wall finish.

Installers of the tunnel wall finishes shall demonstrate successful experience on projects of similar scope and scale and who also have been authorized by the lining manufacturer to apply the linings.

16.2.1.2 Tunnel Lining Design

The tunnel concrete lining shall meet the NFPA 502 requirement that the tunnel lining structure shall be capable of withstanding the Rijkswaterstaat time/temperature curve. Developer may propose other time/temperature curve for approval by IFA.

16.2.2 Tunnel Lining Load Conditions

Loads to be considered in the design of the concrete lining shall include but not be limited to the following:

- Self-weight of the lining
- Self-weight of all finishes and fit-out
- Rock loading of a loosened slab of thickness not less than 10 feet up to the full width of the Tunnel and shear deformations along bedding planes and joints in Reach 1 (from the southeast portal at Station 50+30 to Station 55+00) and Reach 2 (Station 55+00 to Station 61+00) and load of not less than 30 feet up to the full width of the Tunnel or

maximum overburden (whichever is applicable) in Reach 3 (Station 61+00 to the northwest portal at Station 69+85)

- Grouting pressure
- External groundwater pressures
- Loads resulting from stress changes caused by Tunnel excavation
- Time-dependent rock deformation loading if any on the lining
- Uneven pressure distribution due to the presence of karst features on one side of the Tunnel
- Existing Surcharge loads (from building and other infrastructure)

Developer is responsible for designing the final liner for swell loading based on Developers analysis of the swell test data in provided in the GDR.

16.2.3 Load Combinations

Loads and load effects in Section 16.2.2 shall be considered in appropriate combinations, which include load and strength reduction factors, and take into account the stages and sequences of construction and operation and ground/structure interaction.

16.2.4 Numerical Modeling

The Tunnel lining system shall be modeled using an appropriate FEM (Finite Element Method) and/or FDM (Finite Difference Method) numerical software acceptable by IFA. Closed-form solutions are not acceptable. The design shall account for the loads and loading conditions identified in Sections 16.2.2 and 16.2.3.

Considerations during analysis and design shall also include but not be limited to:

- The accessibility of the rock to water (or high relative humidity) during construction and throughout the lifetime of the structure and the influence of bedding planes on water access
- The variability of the amount and rate of time-dependent deformation along the length of the Tunnel and other structures
- The effect of stress on rock swelling pressure (strain and/or stress)
- The state of stress in the rock mass after excavation, which affects the swelling pressure
- Anisotropic swelling
- Anisotropic deformability of the rock mass
- Non-uniform loading

The modeling shall include appropriate number of analyses for the varying geologic and tunnelling conditions, including for both the deepest and shallowest Tunnel sections.

The following parameters, at a minimum, shall be incorporated in the analyses:

- Appropriate rock mass and bedding plane strength and deformability values
- Appropriate in-situ stresses
- Residual rock mass strength parameters when appropriate
- Plastic shear strain in rock
- Horizontal rock swelling is equal to or less than the vertical rock swelling

In cases where direct measurements of the parameter(s) required for the analysis are not available, conduct the analysis using a range of values that would reasonably "bracket" the expected value and assess the results of the analysis conservatively by choosing the analysis that leads to the highest stresses or largest deformation.

16.2.5 Tunnel Excavation and Support – General

Developer shall design the Tunnel lining in accordance with the Project Standards.

Where temporary support is required to facilitate construction of the excavation, sufficient support shall be provided to maintain the stability and safety of the underground Construction Work appropriate to the temporary condition.

All Tunnel and underground works that contain road pavements, walkways, egress passages, and plant and equipment rooms shall have permanent and durable structural linings, consisting of permanent cast in-situ concrete.

Rockbolts shall not be used as a permanent support in lieu of a structural lining.

The initial shotcrete liner may be used for all or some portion of the final support, if Developer can technically demonstrate that the liner meets the required durability, leakage, and structural requirements of the final liner.

In addition to the rock and other loads on the final lining, with regard to hydrostatic loading:

- The final liner above the invert shall be designed for the full ambient hydrostatic loading condition (defined as the groundwater level being at the ground surface).
- The final invert shall be designed and constructed to provide for dissipation of hydrostatic pressures through a subdrain layer and shall be designed for a minimum of 10 percent of the ambient hydrostatic loading condition.

Tunnel excavation and initial support installation shall:

- Ensure less than 1 inch of ground surface settlement at any location above or within 350 feet of the twin tunnel centerline;
- Be performed with controlled blasting or machine excavation to ensure any blast or construction machinery-induced ground vibrations, air overpressures, and noise measured at the prescribed nearby structures is below the limits specified in Section 7.8;
- Be monitored by seismographs, ground surface surveys, underground surveys, extensometers, and other appropriate methods at a frequency and areal coverage to adequately verify the safety and integrity of the underground works; and
- Be jointly monitored and geotechnically mapped by Developer's Designer on a round-by-round basis during excavation and initial support installation, and this information shall be made available to IFA's Authorized Representative within one day of occurrence.

16.2.6 Waterproofing of Tunnel Structures

Developer shall provide:

- A waterproof membrane and geotextile drainage layer in accordance with the "Federal Highway Administration, Technical Manual for Design and Construction of Road Tunnels – Civil Elements, Report No. FHWA – NHI-10-034, 2009," "NFPA 502, Standards for

Road Tunnels, Bridges, and Other Limited Access Highways," or equivalent international guideline and/or standard acceptable to IFA, or a sprayed waterproof membrane and drainage layer, installed in accordance with the manufacturer's specifications. The waterproof membrane type shall have an extensive history of use and proven reputation by the manufacturer for satisfactory performance in tunnels with similar groundwater conditions. Developer shall submit the waterproof membrane for Design Review, which will be subject to IFA's good faith approval;

- A waterproof membrane is required around the entire structure except the floor where a subdrainage system shall be provided to relieve hydrostatic pressure and drain all water seeping in from the ground below the invert;
- A waterproof membrane and geotextile that is self-extinguishing at ambient Tunnel environment conditions;
- Waterstops that are welded to the waterproof membrane compatible with the type of waterproof membrane used;
- Evidence obtained from the manufacturer that no components of the membrane will leach out and deleteriously affect the durability of any of the following:
  - the waterproofing membrane;
  - the geotextile drainage/protective layer; and
  - Other plastic materials or PVC materials, such as waterstops.

16.2.7 Cross-Passages

Cross-passages connecting the northbound and the southbound tunnel bores shall be designed and spaced as per NFPA 502 requirements. In comparison with the main excavation, the cross-passages are relatively small excavations. However, the main excavation will require additional ground support in preparation for the increased span after the excavation of the cross-passages. Cross passages shall be ADA compliant.

16.3 Tunnel Excavation and Construction

16.3.1 Personnel

Developer shall employ a supervisor of tunnelling construction to supervise the tunnelling Construction Work. This individual is to have a minimum of 15 years of experience in New Austrian Tunneling Method, also referred to as Sequential Excavation Method, construction and show experience on at least 3 prior similar projects. Developer shall submit the Tunnel Supervisor's credentials to IFA for review and approval within 30 days of NTP2.

Developer shall employ a lead underground geologist or geotechnical engineer, hereinafter "underground geologist" to fulfill duties associated with the tunnelling Construction Work described in this Section 16. The lead underground geologist shall possess a minimum of two years of previous similar tunnel experience as well as experience in the application of rock mass classification systems for underground rock support on civil engineering projects. Developer shall submit the underground geologist's credentials to the IFA for review and approval a minimum of 60 days prior to the start of excavation.

16.3.2 Tunnel Excavation Method

The Tunnel shall be excavated by means of a drill and blast or a mechanical-type excavation technique such as roadheader or a combination thereof.

The Tunnel will be excavated in near horizontally bedded sedimentary rock formations that are prone to overbreak. Developer shall select an excavation method, equipment, and procedure to minimize overbreak. Controlled blasting or cutting procedures and the timely installation of ground support are essential to reducing the overbreak and maintaining a stable excavation.

The excavation shall be conducted using heading(s) and bench, probably with multiple headings as appropriate to minimize the exposure of unsupported area at any one time before advancing to the next round. Regardless of the timing of support, limiting the unsupported span width and advance length will be vital to limiting overbreak, limiting rock falls, and maintaining Tunnel stability.

The overbreak quantity can be measured as the average cross-section area of the area bounded by the designed excavation perimeter and actual excavated perimeter.

Good Industry Practice, controlled blasting, pre-support, and prompt installation of initial support is essential to reduce the amount of overbreak.

No Tunnel heading or bench shall be left unsupported between shifts, during an off-shift or holiday or any other non-working day.

The Tunnel face shall be supported if required to ensure excavation stability.

As a minimum, the excavation of the first 45 feet of the Tunnel inside the southeast portal and the last 45 feet of the Tunnel adjacent to the break through at the northwest portal will require arch pre-support such as spiling, pipe canopy, or other equal pre-support system installed ahead of the excavation to form a stable roof.

16.3.3 Initial Ground Support

The initial ground support shall be selected and designed to meet the following requirements:

- Can be integrated into the excavation cycle and can be installed before or immediately after the excavation.
- Provide sufficient flexibility to accommodate field changes initiated by the changing rock mass conditions observed in the probeholes or the heading.
- Compatible with the planned excavation sequence, such as multiple heading and bench.

In “Reach 3”, as defined in the GBR, where ever the ground arch does not exist or is only partially formed because of the combination of low ground cover and fractured/solutioning limestone above the Tunnel, sufficient support shall be provided to form a stable opening. This condition is mostly expected to be seen in Reach 3.

The initial ground support shall be designed to stabilize unstable rock blocks. Such blocks are typically bounded by ubiquitous bedding partings and other subhorizontal discontinuity surfaces and, upon intersecting near-vertical adversely oriented discontinuities, will be prone to fallout in one of the following forms:

- Slab fallout that occurs during blasting or scaling, caused by the tendency of rocks to break back to the sub-horizontal discontinuities.
- Progressive failure by gradual loosening and the fallout of small blocks of rock. This failure mode is more likely to occur in the Waldron Shale than the other two formations, especially if initial support is not installed immediately after the Tunnel is excavated.

- Block failure in the sidewalls if the Waldron Shale is left unprotected and allowed to crumble, disintegrate, or swell and undermine the Louisville Limestone above.

A combination of rockbolts, shotcrete, and structural arch (lattice girders) shall be used in various combinations, arrangement, and spacing to temporarily support the excavation in “Reach 1”, “Reach 2” and “Reach 3” as defined in the GBR.

The initial/temporary ground support may be supplemented by spiles and/or grouting that will provide early support before excavation.

The underground geologist shall classify the rock mass exposed in the excavation in a correct and timely manner and direct the proper and timely installation of the initial ground support.

16.3.4 Probehole Drilling

Provide probe drilling equipment suitable for drilling holes for probing and grouting the rock ahead of the advancing Tunnel headings.

Minimum drilling requirements:

- From South Portal to Station 61+00: minimum two probeholes at approximately 10 and 2 o’clock positions, plus or minus one hour, and inclined 10 degrees. Locations, angles, spacing, and distances of probeholes are for the Developer to characterize geotechnical, groundwater, and void conditions and execute the excavation in a safe and prudent manner.
- From Station 61+00 to North Portal: minimum four probeholes approximately 9, 11, 1, and 3 o’clock positions and inclined 10 degrees. Locations, angles, spacing, and distances of probeholes are for the Developer to characterize geotechnical, groundwater, and void conditions and execute the excavation in a safe and prudent manner.
- Drill additional probeholes if one or several probeholes intercept geologic features such as karst features, faults, fractured zone, or groundwater that may affect the stability of the excavation and require grouting in order to determine the extent of the feature.
- A minimum of 20 feet of rock plug shall be left to investigate cavities and water for excavation look-ahead, planning, and execution of Developer’s work.
- It should be noted that actual number of probeholes will be dependent on Developer’s work plan and number of headings proposed.

Select the outward angle of the probeholes in accordance with the dimensions of the heading used in excavation to cover the entire perimeter of the planned Tunnel excavation.

Provide grouting equipment, packers, appurtenances, and supplies to perform grouting through the probeholes as needed for the Developer’s proposed excavation and initial support plan.

Provide and install packers at the collar of probeholes immediately after encountering groundwater to prevent the outflow of groundwater.

Do not advance any heading of either tunnel bore without maintaining a minimum of one tunnel width probed ahead of the Tunnel at all times.

The underground geologist shall direct, observe, and log the probehole drilling.

Inform IFA of the probehole drilling schedule at least 48 hours ahead of each occurrence and allow IFA access to the heading to observe probehole drilling.

Logs of probehole shall be managed in the same manner as instrumentation data and uploaded to the secured website within 16 hours of the completion of the drilling of each hole.

Provide contact grouting equipment and staging to enable grouting through any position around the final lining.

16.3.5 Contingency Plans

Developer shall prepare contingency plans and submit to IFA for review and comment 30 days prior to the start of the Tunnel excavation.

Developer shall prepare contingency plans for the scenario of encountering the following features in the probeholes:

- Groundwater
- Karst features
- Fractured zones
- Faults

Developer shall prepare contingency plans for the scenario of encountering the following features in the excavation whether or not these are encountered in the probehole:

- Groundwater
- Karst features
- Fractured zones
- Faults

Developer shall prepare contingency plans for encountering the following during excavation:

- Settlement at the ground surface above the Tunnel in excess of 0.5 inches.
- Continuing movement of the Multiple Point Borehole Extensometer (MPBX) without load change, or total movement of MPBX in excess of 0.5 inches.
- Overbreak in excess of 18 inches outside the planned perimeter of excavation.
- Collapse of tunnel section.

The contingency plans shall include the method of excavation and mitigation, revised ground support design (if any), and revised Tunnel liner design (if any).

16.3.6 Protection of Waldron Shale

The Waldron Shale is susceptible to disintegration when left to dry and swelling when allowed to come into contact with water.

Protect the surface of Waldron Shale exposed at the final excavation perimeter with a flash coat (1-inch minimum) of shotcrete within 8 hours of exposure.

Protect the surface of Waldron Shale at intermediate excavation surfaces with a flash coat of shotcrete within 8 hours of exposure, as required to maintain stability at interim stages of excavation.

16.3.7 Groundwater Inflow

Minimize groundwater inflow into the Tunnel by grouting after encountering flow as required for Developer's operations to maintain stability of opening.

Where groundwater flow occurs along solutioning channels across the Tunnel, re-route the water using channels or other conveyance structures installed outside the Tunnel A-Line perimeter to maintain the natural water system.

16.3.8 Tunnel Geologic Mapping

Map the geology of the rock exposed in the excavation before the exposed area is covered by ground support.

Geologic mapping shall be supplemented using photogrammetric methods.

Use geologic mapping to assist in the selection of the initial ground support.

Geologic maps prepared during excavation, including photogrammetric maps, and assignment of ground support shall be managed in the same manner as instrumentation data, except that the maps may be uploaded up to 72 hours after the mapped area is exposed in the excavation.

16.3.9 Excavation Profiling

Developer shall provide for an excavation profiling system to measure the amount of overbreak over Developer's planned B-Line using an approved system such as Dibits, Leica, Ambert, Atlas Copco, or equal.

Developer shall provide for copies of records every 200 feet of advance and a complete summary report within three days after the completion of the reach.

16.4 Tunnel Drainage

Developer shall provide a drainage system for the Tunnel that complies with the PPA Documents, applicable Laws, and Environmental Approvals.

At a minimum, the Tunnel drainage system shall provide:

- The height and shape of walls surrounding the Tunnel entrances, the elevation of access road surfaces, and any entrances shall be designed such that the entry of water is prevented. In addition, the invert elevation at the north portal shall be above the 500-year flood level, which is the design flood level of the Ohio River (El. 457.0 feet using NAVD88).
- Capacity to maintain all Tunnel traffic lanes, utilizing the future three lane configuration, flood-free in both directions for stormwater runoff from portal areas for the design 50-year storm event.
- Accommodation of the credible combination of stormwater, incident, groundwater, maintenance, fire fighting, and other water ingress events, including but not limited to the following:
  - stormwater runoff from portal areas;
  - stormwater carried into the Tunnel by vehicles;

  - wastewater effluent from washdown activities;
  - subsurface groundwater seepage;
  - accidental spillage of liquids from damaged tankers and other vehicles and the washdown of such products; and
  - fire system operations.

- The subsurface drainage system below the invert shall be designed and constructed to lower uplift pressure at the base of the invert slab to a minimum of 10 percent from ambient (ground surface) hydrostatic conditions (maximum of 90 percent reduction). The hydrostatic pressure at the base of the pavement shall be zero.
- Any temporary drainage systems behind the initial Tunnel support shall be grouted or removed prior to placement of the final liner.
- Collection of runoff at portals and in the vehicular tunnels via drop inlets at maximum 200-foot intervals, with longitudinal pipework to sumps, and cleanout connections, as necessary. The grate and covers are to be positioned such that they do not protrude into the roadway. Each pit is to be fitted with a trash rack to prevent gross pollutants finding their way into the sumps;
- All system elements are to be flame-proof and explosion-resistant;
- All facilities necessary to identify, isolate, treat, and dispose of collected drainage water and contaminated water to the requirements of the relevant Governmental Entities and the Environmental Approvals;
- A drainage collection system that separates clean water from contaminated water. Clean water is to be discharged into the stormwater system and contaminated water is to be treated prior to disposal or disposed of at a licensed facility. For the purpose of Tunnel drainage, water quality is categorized as follows:

  - “groundwater” – water that seeps into the Tunnel from the groundwater table;
  - “contaminated” – water that may contain contaminants, such as water used to clean the Tunnel; water from fire-fighting sources, such as deluge systems and hydrants; and spilled liquids from accidental spills; and
  - “clean” – runoff water from rainfall events draining into the Tunnel portals or brought into the Tunnel on vehicles that is not contaminated.

- A separate dedicated drainage system for groundwater seepage, (including, as necessary, pipework, sumps, pumps, and treatment facilities), unless an assessment is carried out by Developer, to demonstrate that contaminated groundwater will not be drawn into the Tunnel;
- As needed, clean water sumps that are suitably lined and sealed and vented to the atmosphere and that discharge to holding tanks. Duty and standby pumps shall be easily retrievable by vertical slide rails or block and tackle equipment and without closing more than one traffic lane;
- As needed, wastewater sumps that are suitably lined and sealed and vented to the atmosphere and that discharge to holding tanks. Duty and standby pumps (if required) shall be easily retrievable by vertical slide rails or block and tackle equipment, without closing more than one traffic lane;
- Continuous monitoring, control, and recording of the drainage system’s operations as part of an integrated control system within the tunnel equipment building(s);
- Sumps, holding tank, and pump capacities to be compatible with the maximum inflow rate. Appropriate pump system redundancy shall be provided;

- Pumps and associated control gear designed to operate automatically, although manual override will be required for testing and maintenance;
- For all sumps to include forced ventilation provided by duty and standby extraction fans. A gas detection system shall also be provided to automatically trigger an inert gas foam extinguisher if hydrocarbons are detected. The monitoring of pump operation and gas detection shall be provided at the tunnel equipment building(s); and
- For sumps and equipment to be designed for easy cleaning and maintenance. In particular, adequate space shall be provided in all sumps to allow cleaning and maintenance of pipes, pumps, and all associated equipment.

16.5 Groundwater Control

16.5.1 Water Table and Groundwater Control Requirements

Developer shall ensure that any water table drawdown and subsequent effect on the groundwater regime caused during the D&C activities of the East End Crossing works has no adverse impact on property, adjacent infrastructure, the East End Crossing works, or the environment with respect to:

- Construction risk and safety, including the protection of excavated surfaces, in particular when in shale from exposure to the tunnel environment during construction;
- Groundwater drawdown effects, including settlement, contamination migration, and impacts on available water for groundwater dependent ecosystems and existing groundwater users;
- Durability requirements and maintenance consequences from water inflows;
- Treatment and discharge requirements of any water inflows; and
- Whole-of-life service costs for the treatment and pumping of water inflows.
- All tunnels, cross passages, and associated underground structures may be designed and constructed as undrained or drained during construction, while for the final conditions during operations, above the invert, the liners shall be designed as undrained and the floors shall be designed as drained assuming a residual hydrostatic load of 10 percent of the ambient hydrostatic (uplift) pressure:
- Lowering of groundwater levels using permanent dewatering systems by pumping is not permitted.
- Developer shall install groundwater monitoring wells above the Tunnel, at a minimum spacing of 200’ along the length of the Tunnel, prior to any subsurface excavation activities, and shall monitor groundwater levels weekly during Tunnel construction activities and for a period of 12 months following completion of the Tunnel liner. Developer’s D&C means and methods shall consider potential impacts on ground water levels and shall ensure that none of the activities associated with the Tunnel construction will affect groundwater sources that support vegetation above the Tunnel. If ground water levels drop more than 6 feet as a result of Developers’ construction activities as demonstrated by the monitoring well recordings, Developer shall provide temporary irrigation to support the vegetation for a period of 12 months following completion of the Tunnel liner. The installation and operation of any temporary irrigation equipment shall be at Developer’s expense.

16.5.2 Groundwater Seepage

Developer shall ensure that visible Tunnel linings and retaining structures are not visibly wet. Visible weep holes in Tunnel linings and retaining structures are not permitted.

Developer shall ensure that any groundwater seepage into the completed Tunnel and associated project works is not visible. No water shall be permitted to drip or flow onto or over road pavements, walkways, egress passages, or plant and equipment rooms.

Appropriate treatments shall be employed during construction to minimize groundwater seepage into the Construction Work so as to achieve the requirements of Section 16.5.1, and all other requirements of the PPA Documents. Permanent treatments shall be employed as required to ensure that any water present on internal surfaces does not affect the safety, durability, or function of the Tunnel.

To prevent groundwater seepage entering onto the Tunnel roadway, a waterproofing membrane system shall be implemented that is impermeable to any groundwater seepage going through the Tunnel roof and walls. Prior to placement of final liner and subdrain system (so as not to contaminate the subdrain), every effort shall be made to cut-off seepage emanating from around the Tunnel roof and walls initial support system by grouting of weep holes, wick drains, formation drains or other sources of water (prior to placement of waterproofing system and final liner. Where such measures are ineffective, groundwater seepage shall be directed by a drainage collection system (wick drains, formation drains, etc. to toe drains) to the subsurface tunnel drainage system without directing it onto the roadway.

- Without limiting the above groundwater control and waterproofing requirements, water ingress during the design life of the Tunnel of 75 years shall not exceed the following:
  - A target gross seepage rate of 2 gallons/minute per 1000 feet along station or less over the full length of both tunnels for the combined inflow from groundwater into both the internal and external drainage systems of the Tunnel;
  - A target average seepage rate of 25 gallons/day or less over any 10-foot length along stations in either tunnel;
  - Groundwater seepage upward through the pavement and floors shall be zero gallons per minute everywhere; and
  - There shall be no discernible flow or drips of water through the Tunnel lining anywhere above the paved surface and walkways.

Notwithstanding the target seepage rates above, Developer shall provide suitable groundwater pumping, treatment, and disposal capacity to accommodate the actual flows.

- The specified degree of water tightness above shall be achieved prior to the completion of the D&C activities, as a condition precedent to the achievement of Final Acceptance.
- Developer shall ensure that there are no adverse effects of groundwater seepage or groundwater chemistry on the overall Tunnel structural integrity or the Tunnel drainage system, including either the potential for the precipitation of salts, biological clogging, or other compounds to reduce the effectiveness of the drainage system or the dissolution of liner systems and the surrounding ground and subgrade, over the design life of the Tunnel.

16.6 Tunnel Survey

Perform as-built surveys of the Tunnel and underground structures at intervals not exceeding 10 feet along stations. Survey points at each 10-foot maximum interval shall be spaced at not more than 3 feet along the circumference. As-built surveys shall be performed, at a minimum, at the following intervals:

- After excavation and before initial shotcrete
- After initial shotcrete and before smoothing layer
- After smoothing layer and before waterproofing
- After final lining

As-built surveys shall be performed at the same station at each interval so that as-built thicknesses of each component can be accurately measured and documented.

All instrument locations shall be surveyed at the time of installation and at the time of each underground instrument reading.

Developer shall confirm, with a Kentucky Land Surveyor, the final position of the Tunnel with respect to the legal limits of the easement. The survey report shall be prepared and submitted to IFA for review and comment before Final Acceptance.

Reasonable access shall be provided to IFA to independently audit the Tunnel survey.

16.7 Ventilation Equipment

For the purpose of Tunnel ventilation equipment design and operation, the Tunnel shall be classified as potentially gassy in accordance with U.S. Department of Labor OSHA Part 1926. Provide ventilation systems with reversible fans to meet the requirements specified herein.

Provide equipment to monitor continuously and that has the capability of giving audible and visual warnings of any hazardous gas concentration above the threshold limit values as required by the applicable Laws.

Provide equipment to monitor continuously and that has the capability of giving audible and visual warnings regarding oxygen levels, except that warning devices shall be activated when levels fall to the threshold limit value as required by the applicable Laws.

Provide equipment to continuously monitor dust levels.

Routinely maintain monitoring devices in accordance with manufacturers' recommendations to ensure they are in good working order at all times.

Provide air filtration equipment as needed on ventilation equipment.

Fabricate ventilation ducting from non-flammable material.

16.8 Portal

16.8.1 Access, Restriction, and Coordination

Portal excavation shall be confined to the Project ROW

Comply with restrictions on blasting set forth in Section 16.1.4.2, above.

Limit construction activities to within designated areas as indicated in the Reference Design.

Comply with “No Access Limits” as indicated on Reference Design.

Other construction activities may be underway in the area outside and adjacent to both portals; coordinate portal excavation and construction with these other activities.

Access to the north portal currently does not exist and shall be provided by Developer.

16.8.2 Design

Portal excavations shall be designed with permanent rock support at all locations.

Portal excavations shall comply with all applicable requirements of the PPA Documents, including the Project Standards.

Portal area drainage shall be designed in conjunction with Tunnel drainage and stormwater conveyance to provide a seamless system.

16.8.3 Excavation and Support

The portal excavations are located nearby to residential areas, busy highways, and sensitive and registered historic estates and structures. The drill-and-blast techniques will be required for a significant portion of the rock-volume excavation. Ripping or other machine excavation techniques may be possible for a portion of the excavation. Blasting-assisted ripping could also be considered.

Portals will be excavated through rock formations of different strength. Select the excavation method, equipment, and procedure to minimize the potential for the overcutting or overexcavation of the soft rock formations.

Rockbolt installation, weephole drilling, and shotcrete application shall be performed in each lift before the excavation of the next lift.

Some form of temporary rock support will be required in the portal faces at the location of the Tunnel to maintain stability and integrity until such time as Tunnel excavation starts.

16.8.4 Protection of Waldron Shale

The Waldron Shale exposed in the portal excavation is prone to disintegration when dried and swelling when allowed to come into contact with water.

Developer shall make every effort to not conduct excavation in the Waldron Shale, in the portal area where the shale may be exposed to rain, when it is raining or when rain is forecasted for a time period shorter than Developers ability to protect the exposed shale.

Protect the Waldron Shale exposed in the excavation within eight hours with a flash coat of shotcrete and protect from water or moisture until the final, permanent support has been installed. Protect the shale in the portal face prior to start of tunnel excavation at the north portal.

16.9 Instrumentation

16.9.1 General

Instrumentation shall be installed and monitored until Final Acceptance by Developer, as required, to:

- Monitor movements of the ground surface, existing structures, and buildings affected by the Work to ensure their protection, structural integrity, and safety and to confirm design assumptions and ground response to excavation and support.
- Monitor each tunnel and response of adjacent rock at locations and frequencies in accordance with the minimum requirements of this Section 16.9 and Section 17.5 during construction, fit-out, and commissioning.
- Monitor groundwater levels.
- Developer shall submit the proposed instrumentation in this Section 16.9 to the IFA for review and comment 30 days prior to commencement of Tunnel Construction Work.

16.9.2 Instrument Type

Surface monitoring point: A surface monitoring point is a marker fixed to a surface and used for the measurement of vertical and horizontal movements of that surface. Above ground, a surface monitoring point shall be permanent pins on structures or grouted rods in soil or in rock. Underground, surface monitoring points may also be prism-type targets or hooks. Survey equipment (theodolite, level, electronic distance measuring device, tape extensometer) will be capable of measuring vertical and horizontal movements of a monitoring point of ± 0.05 inches.

Multiple-Point Borehole Extensometer (MPBX): A multiple-point borehole extensometer is a device installed in boreholes for monitoring the changing distance between more than two points along the axis of the borehole. The MPBX sensing element shall be of the vibrating wire type and shall be capable of determining the relative position of each anchor to the surface installation with a repeatability of ± 0.005 inches.

Groundwater Piezometer: A groundwater piezometer is a device that is sealed within the ground so that it responds only to groundwater pressures around the monitoring tip. Piezometers shall be of the vibrating wire type and shall be capable of measuring the head of water at the piezometer tip to a repeatability of ± 0.1 foot.

16.9.3 Minimum Instrumentation Requirements

16.9.3.1 General Requirements

Developer shall, at all times, coordinate with and assist the IFA by prioritizing the timely installation of instrumentation and reporting of data.

Developer shall establish a secured website where all monitoring data will be uploaded and provide the IFA with access to the site. All monitoring data shall be uploaded to the site within 16 hours of collection.

Developer shall halt work at any time when instrumentation data suggests continued movement with no increase in loading or accelerating movement and examine ground conditions and implement the required remedial work in accordance with IFA-accepted contingency plans, per Section 16.3.5.

Where possible, a remote, automated monitoring and logging system is preferable to other systems that require access to the instrumentation location.

16.9.3.2 Surface Monitoring Points

Developer shall install points on masonry or buildings that may be influenced by the Work prior to commencing any excavation. Buildings will include but not be limited to all buildings within an angle of draw of 2 horizontal to 1 vertical from the nearest point at the invert of the nearest tunnel.

Developer shall install a series of points at 20-foot maximum spacing along the crest of both portal cuts.

At Highway 42, Developer shall install a series of points at 20-foot maximum spacing for 300 feet, centered over the project centerline, along both ditch lines and the centerline.

Developer shall install a series of points at 20-foot maximum spacing for a minimum of 300 feet along the west property line of the Drumanard Estate, centered over the project centerline.

16.9.3.3 Excavation Monitoring

Excavation monitoring shall include, at a minimum, the instrumentation described in this section. The Designer shall propose all additional instruments, monitoring points, and surveying deemed as necessary to ensure the adequate excavation and support monitoring and verification of design assumptions.

Developer shall install a permanent array of a minimum of one MPBX in horizontal or near-horizontal holes drilled at each vertical or near-vertical rock cut at the north and south portal cut faces at approximately the mid-height and 10 feet above the crown of the Tunnel that shall have, as a minimum, monitoring positions (anchors) at 60 feet, 30 feet, 15 feet, and 7 feet from the portal excavation face. Electrical leads shall be in watertight conduits leading to a lockable watertight box located about 4 feet above final excavation level and be accessible during the duration of construction.

Developer shall install instrumented Tunnel section.

Developer shall install four piezometers around the north portal and four piezometers around the south portal at locations and depths agreed to by the IFA.

16.9.3.4 Instrumented Tunnel Section

For excavation support monitoring (prior to placement of the final liner), Developer shall install underground surface monitoring points in four-point MPBX arrays installed at the crown and at a maximum spacing of 250 feet from the South Portal to Station 61+00 in each tunnel, at each of the first two cross passage locations to be encountered, and at three additional locations, as directed by the IFA. These MPBX arrays installed from within the tunnel are not required once convergence has subsided and reached a steady level as determined by the Developer’s Engineer and are not required to be maintained during installation of waterproofing or after completion of the final liner unless directed otherwise by the Developer’s Engineer.

From Station 61+00 to the North Portal, install MPBX arrays from vertical holes drilled from the surface at the tunnel centerline to a depth of 5 feet above the crown of the Tunnel at a maximum spacing of 250 feet in each tunnel.

Installation requirements for MPBX installed underground:

- Each array of MPBXs installed underground shall have, as a minimum, monitoring positions (anchors) at 60, 30, 15, and 7 feet, radially from the inside surface of the Tunnel lining, adjusted as required to accommodate the top of rock. Installation shall be completed and the initial readings taken before the tunnel face advances more than 30 feet beyond the array. Install one surface monitoring point at each MPBX. Monitoring shall continue through Final Acceptance and shall be handed off to the IFA.
- Electrical leads for MPBXs shall be in watertight conduits, adequately fixed to the tunnel crown and extending down to about 4 feet above tunnel invert to a lockable watertight box located at an accessible location.

Installation requirements of MPBX installed at the surface above the tunnel centerline:

- Each permanent array of MPBXs installed at the surface shall have, as a minimum, monitoring positions (anchors) at 5, 10, 20, and 30 feet below the ground surface, adjusted as required such that the deepest anchor is located no less than 5 feet above the crown of the Tunnel. The installation of all arrays shall be completed and the initial readings taken before the tunnel face reaches Station 61+00. This array of MPBXs shall be capable of being monitored remotely from the surface during final lining and outfitting the Tunnel. Install one surface monitoring point at each MPBX, and survey the point in conjunction with the routine surface settlement survey conducted above the Tunnel. Monitoring shall continue through Final Acceptance, and the arrays shall be decommissioned (remove the borehole grouted) after the final reading.
- Electrical leads for MPBXs shall be in watertight conduits and terminated at a lockable watertight box located at the collar of each hole.

Developer shall add additional instrumented Tunnel section if the initial readings indicate movements larger than those indicated by the numerical analysis and in locations where fractured zones or large karst features are encountered.

16.9.3.5 Tunnel Piezometers

Tunnel piezometric levels shall be measured at three locations along the alignment of the Tunnel, at approximate stations 52+00, 55+00 and 68+00. Each location shall consist of five piezometers. Final locations shall be agreed upon by the IFA prior to installation.

Piezometer holes shall be cased with a corrosion-resistant casing with a minimum 4-inch inside diameter. The annular gap between the rock and the casing shall be grouted and sealed to prevent groundwater migration between the different rock formations.

The piezometer shall be embedded in concrete at the surface with adequate detailing to prevent problems of ground movement due to soil moisture changes or frost heave. A watertight, lockable cap shall be provided.

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17 TUNNEL MECHANICAL AND ELECTRICAL SYSTEMS

17.1 General Requirements

This Section 17 identifies the technical requirements of mechanical, electrical, and supervisory systems for the Tunnel and Tunnel ancillary facilities. All elements of these Tunnel systems shall be designed, furnished, and installed in accordance with the requirements the PPA Documents, Governmental Approvals; and applicable Laws.

Developer shall be responsible for all analyses, reports, designs, drawings, detailing, clearances, tolerances, specifications, testing, and commissioning of the electrical systems and the procurement, fabrication, and installation of components to provide fully functional electrical systems that meet the Tunnel requirements of the PPA Documents.

17.1.1 Scope of Work

The Work specified in this Section 17 consists of designing, furnishing, installing, testing, and commissioning all specified and necessary mechanical/electrical systems and components for the Tunnel and Tunnel ancillary facilities. The Work also includes connections and communication equipment required to permit monitoring and supervision of all tunnel mechanical and electrical equipment, included the following.

- Fire detection and suppression
- Tunnel ventilation system
- Emission monitoring system
- Power supply and distribution system
- Tunnel lighting
- Drainage and water treatment
- Fire- and life-safety systems (radio communications)
- Supervisory Control and Data Acquisition (SCADA)
- Intrusion detection and access control
- Tunnel traffic surveillance and ITS
- Tunnel signage, signals, and control
- Tunnel communications and control

17.1.2 Concept of Operations

The Tunnel includes ITS devices for monitoring and controlling traffic and mechanical and electrical equipment controlled through a SCADA system. The ITS devices in the Tunnel are described in this Section 17 and in Section 19.

All the devices in the Tunnel will be under continuous monitoring and control. Monitoring and control will be performed at TRIMARC when staffed and at the KYTC TOC in Frankfort during the hours when TRIMARC is not staffed. In addition, SCADA control shall be enabled via operator SCADA workstations at the KYTC District Office and in a control room at the south tunnel equipment building(s) at the Tunnel.

Developer shall accommodate communications between TRIMARC and the Tunnel ITS and SCADA controllers on the fiber network installed as part of this project. Refer to Section 19 for additional communication system details. A redundant data path shall be developed to connect the East End Crossing with TRIMARC; the redundant data path can include Developer-installed fiber or commercial service provided through a secure data path. Fault detection and automatic failover shall be included in the network design.

Developer shall deliver all ITS device data, video and control included in the East End Crossing to the existing control facilities at TRIMARC, KYTC TOC, and Department TMC. Full operability shall be provided for the East End Project through manufacturer operation management software, temporary video monitors, databases, servers, and networks sufficient to complete full system testing. ITS system control center integration shall be completed by the respective control centers following satisfactory completion of all system testing.

Developer shall provide six complete tunnel operator workstations: two at TRIMARC, two at KYTC TOC, one at the KYTC district office, and one at tunnel equipment building(s). Each workstation shall include an ITS workstation; a SCADA workstation; and interfaces for the AM/FM Commercial Radio rebroadcast system, Tunnel telephone system, voice break-in system, and public address system. The SCADA system shall include an administrative procedure to manage control of devices and permit transfer of control as required to support operations at any of the indicated locations. Facilities to enable communication with emergency responders on site and at the tunnel equipment building shall also be provided at both TRIMARC and KYTC TOC.

17.2 Design Requirements

Developer shall perform engineering analyses and classify all subsurface configurations as road tunnel, in accordance with NFPA 502, and apply other applicable Project Standards. In all cases, Developer shall design and provide the necessary mechanical, electrical, and supervisory features to provide an appropriate environment during all emergency and non-emergency operating modes.

Developer shall prepare and submit a “Tunnel Emergency Response Plan” (ERP) that meets all the requirements of an ERP as described in NFPA 502. The ERP shall be developed in conjunction with KYTC, TRIMARC, City and State Police, the Kentucky State fire marshal, the Harrods Creek Fire Protection District, METROSAFE, towing services, and other agencies to ensure coordination of response to incidents in the Tunnel. Developer shall provide an outline and proposed plan for the preparation of the ERP to IFA for review and comment within 100 days following NTP 1, including schedules of draft document submittals, coordination meetings, and agency reviews. The ERP shall be approved by involved agencies prior to opening the Tunnel for service. Fire- and life-safety systems shall be discussed and coordinated with IFA and, as applicable, KYTC. The electrical systems design requires full coordination with other design disciplines and the relevant Governmental Entities.

Systems shall be designed to provide redundant, fault-tolerant management and control of tunnel devices. Data paths, network devices, power supply and distribution, and servers shall include means to assure high system availability. Full functionality of communication systems, and tunnel monitoring and control of tunnel devices shall be provided at TRIMARC and KYTC TOC in order to satisfy NFPA 502 requirements for an alternate operations control center.

17.2.1 Technical Documents

Developer shall determine which Project Standards (or portions of) will be applied to the design of all mechanical systems covered in this Section 17 and shall submit a list of these codes and standards to IFA prior to the submission of Stage 1 Design Documents for approval. The most current Project Standards, as of the Setting Date, including those referred to below are intended to establish basic standards and include:

- Air Movement and Control Association International, Inc.
  - AMCA 210, Laboratory Methods Of Testing Fans for Aerodynamic Performance Rating
  - AMCA 250, Laboratory Methods of Testing Jet Tunnel Fans for Performance
  - AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data
  - AMCA 500-D, Laboratory Methods of Testing Dampers for Rating
  - AMCA 500-L, Laboratory Methods of Testing Louvers for Rating
- National Fire Protection Association
  - NFPA 10, Standard for Portable Fire Extinguishers
  - NFPA 13, Standard for the Installation of Sprinkler Systems
  - NFPA 14, Standard for the Installation of Standpipe and Hose Systems
  - NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection
  - NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems
  - NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
  - NFPA 70, National Electric Code
  - NFPA 70E Electrical Safety in the Workplace
  - NFPA 72 National Fire Alarm Code
  - NFPA 80, Standard for Fire Doors and Other Opening Protectives
  - NFPA 101, Life Safety Code®
  - NFPA 502, Standard for Road Tunnels, Bridges, and Other Limited Access Highways
  - NFPA 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers
  - 2011 ASHRAE Handbook, Chapter 15 “Enclosed Vehicular Facilities”
- Illumination Engineers Society of North America
  - RP 8 Standard Practice for Roadway Lighting
  - RP 22 Standard Practice for Tunnel Lighting
- Institute of Electrical and Electronic Engineers (IEEE)
  - IEEE 399 Recommended Practice for Power System
  - IEEE 141 Recommended Practice for Electrical Power Distribution
  - IEEE 142 Recommended Practice for Grounding
  - IEEE 446 Recommended Practice for Emergency and Standby Power
  - IEEE 493 Recommended Practice for Reliable Power System

- American National Standards Institute
  - ANSI C2 National Electric Safety Code (NESC)

17.2.2 Mechanical and Electrical Systems Design

The requirements of this section shall apply to the Tunnel and Tunnel ancillary facilities, including Tunnel ramps, pump stations, utility rooms, cross passageways, and emergency egresses.

All mechanical and electrical systems and equipment shall be suitable for the intended application and within the manufacturer's warranted ratings. Operating environments with adverse conditions shall be taken into account (e.g., high temperatures, adverse winds, gasses, soot and smoke, explosives, and highly corrosive atmospheres).

17.2.2.1 Fire Protection for Tunnel

Developer shall meet the following general requirements for fire protection systems:

- Fire protection and suppression features shall include standpipe systems, fire hose cabinets, portable fire extinguishers, fire hose valve stations, and smoke/heat alarm systems. The fire extinguishers and fire hose valve stations shall be protected from physical and heat damage.
- A standpipe system shall be provided for the Tunnel. Standpipe system(s) shall be designed, installed, inspected, and maintained as a Class 1 system(s) in accordance with NFPA 14 and NFPA 502, Chapter 10.
- The following fire protection system requirements shall apply:
  - The standpipe system shall be arranged and designed such that it will fill the applicable standpipe section with water in accordance with the time limits specified in NFPA 502. The standpipe system shall be designed to provide fire protection for all reasonable event scenarios. Developer shall demonstrate to the IFA how the standpipe can be isolated, cross-connected, and provide protection under different event scenarios. The remainder of the requirements listed in NFPA 14 and NFPA 502 for dry standpipe systems shall be applied as necessary. All fire suppression system components except steel piping shall be UL listed. Steel piping components shall meet the requirements of ASTM A53.
  - Tunnel fire detection shall be provided in accordance with the requirements of NFPA 502, Chapter 7 and NFPA 72. Fire alarm pathways shall be independent of other systems, parallel, redundant, and routed for incident survivability, and shall comply with UL 864 "*Control Units and Accessories for Fire Alarm Systems*".
  - Portable fire extinguishers and cabinets for the Tunnel shall be provided in accordance with NFPA 502, Chapter 7. Cabinets shall be provided with tamper switches connected to the fire detection and security systems.
- Fire hydrants and fire hydrant water supply shall be provided to meet the requirements of this section and meet the requirements of the Governmental Entities.

- If Developer proposes an optional fire suppression system in the form of sprinklers or misting system. Developer shall submit a proposal for IFA approval that defines the following:

  - Demonstration that the proposed system will perform as required including supporting analyses and certified test results.
  - Type of fire suppression system proposed.
  - Component specifications.
  - Proposed performance criteria covering containment and control of fire magnitude, zoning, water supply requirements and component sizing.
  - Proposed water supply.
  - Description and catalog cut sheets covering of proposed piping, valves, control panels and other hardware.
  - Description of suppression system control concept and sequence of operation, automatic control valves shall be capable of remote activation and reset.
  - List of successful tunnel installations where similar suppression systems have been used.
  - Expected reduction in fire heat release rate and supporting documentation
  - Freeze protection strategy.
  - Security intrusion alarm notification shall be provided to a 24-hour remote monitoring and control location that shall identify the location and type of enclosure breached for immediate response or maintenance.
  -

17.2.2.2 Tunnel Ventilation System

Developer shall design a Tunnel ventilation system that:

- Maintains carbon monoxide (CO) and oxides of nitrogen (NO_x) concentrations below the maximum acceptable levels during all non-emergency traffic conditions, including congested, stopped, and normal flowing. During these traffic conditions, the Tunnel ventilation system shall maintain the CO level below 50 parts per million the nitrogen dioxide (NO_2) level below 3 parts per million, and the nitrogen oxide (NO) level below 25 parts per million.
- Provides a tenable environment for motorists evacuating the Tunnel during an emergency. The environmental parameters (air temperature, CO level, visibility, radiation heat flux, air velocities, and noise levels) described in NFPA 502 Annex A shall be considered and shall not be exceeded.
- Assists fire rescue and fire-extinguishing operations.
- Removes and controls smoke and heated gases that result from fire emergencies within the Tunnel to assist in the evacuation and rescue of motorists in the Tunnel to meet NFPA 502 requirements.
- Is based on a design fire size as determined by an assessment of the expected type of vehicles utilizing the Tunnel, but shall not be less than 300MW (based on tanker truck in the Tunnel, as noted in NFPA 502, Annex A). IFA will consider the use of a fire suppression system a means of reducing the fire magnitude.
- Provides redundant Tunnel ventilation fans per NFPA 502, Chapter 11.6.
- Appropriately provides protection of the Tunnel structural elements and non-structural elements.

The following requirements shall apply to the ventilation equipment and the ventilation system.

- The Tunnel ventilation system shall include all fans, motors, cooling systems, dampers, equipment condition monitoring devices, and associated appurtenances necessary for the complete installation, operation, and maintenance of the ventilation system. All Tunnel ventilation equipment and systems shall be factory and field tested for compliance with NFPA 502 and AMCA 210, 250, 301, 500-D and other applicable standards.
- Jet fans shall be reversible and equipped with sound attenuators that reduce jet fan noise to 85 dBa at a location 5 feet above the roadway and 30 feet from the outlet of the fan.
- Jet fans shall be rated in accordance with the latest edition of AMCA Standard 250, "Laboratory Methods of Testing Jet Tunnel Fans for Performance," as applicable.
- The sound power level ratings of all fans shall comply with the latest revision AMCA Standard 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data."
- Fans that are directly exposed to the Tunnel environment or the Tunnel exhaust shall be designed to meet the NFPA 502 Chapter 11.6 temperature requirements. A representative jet fan shall be tested at the elevated temperature in Chapter 10.6 of NFPA 502 to verify fan design prior to the installation of jet fans in Tunnel.
- All fan power curves shall not exceed 100 percent of the motor rating at any point for design condition air density. The brake horsepower for reverse flow shall not exceed the brake horsepower for forward flow.

17.2.2.3 Tunnel Ventilation Control System

The capability to monitor and operate the Tunnel ventilation system fans, motors, and dampers shall be provided at the nearest ventilation control structure and remotely at the Traffic Management Center, through the SCADA system. Tunnel ventilation systems shall be parallel, redundant, and routed for incident survivability, and shall comply with UL 864 "*Control Units and Accessories for Fire Alarm Systems*".

Developer shall provide a fully functional automatic Tunnel ventilation control system with operating modes as necessary to maintain the aforementioned Tunnel environment under congested, stopped, and normal flowing traffic, and a semi-automatic control system for any possible fire emergency event in the Tunnel. Tunnel ventilation system operating modes shall be determined by computational fluid dynamics (CFD) modeling of anticipated environmental conditions within the Tunnel. The design fire size heat release and smoke generation rates established in NFPA 502 shall be used as input parameters to the CFD modeling at any location within the Tunnel. The modeling shall also determine airflows at typical outside ambient air temperatures and wind flows such that each tunnel ventilation system operating control mode can be field-tested and commissioned using airflow testing in the tunnels using outside ambient air. Longitudinal smoke/airflow tests are required for the verification of all emergency operating mode configurations.

The Tunnel shall be equipped with monitoring equipment/sensors to monitor and control the Tunnel atmosphere/environment for CO, NO_x, and visibility. The monitoring and control systems shall be integrated such that the Tunnel ventilation system response is activated based on the threshold levels established by Developer.

17.2.2.4 Cross Passageways and Emergency Egress Pressurization

Tunnel cross passageways and, as applicable, emergency egress shall be pressurized in accordance with the requirements of NFPA 101, Section 7.2.3.9. The force required to open egress doorways shall not exceed that specified in NFPA 502, Chapter 7.15.5.5.

17.2.2.5 Emission Monitoring System

The Developer shall conduct all Work necessary to complete the Carbon Monoxide (CO) monitoring system for the Tunnel. Elements of Work shall include, but are not limited to, the following:

1. Furnish and install carbon monoxide monitoring system (COMS) including pumps, filters, switches, flowmeters, CO detection cells, readout control modules, and calibration equipment.
2. Furnish and install all necessary mechanical and electrical services and all required interconnections.

This Section 17.2.2.5 is written with the assumption that CO is the limiting gas, however if another gas is found by Developers design to be the limiting gas, then that gas shall be monitored in addition to CO. Any additional monitoring will adhere to the design requirements of this Section.

17.2.2.5.1 Standards

The emissions monitoring system for the Tunnel shall follow the National Electrical Manufacturers Association (NEMA), *Standard 250 Enclosures for Industrial Controls and Systems* and Project Standards as applicable.

Developer shall propose any additional standards deemed necessary at the time of bid. Any additional standards shall be in English and the system of units shall be English. Any translations from a different language shall be certified by a Registered Professional Engineer.

17.2.2.5.2 Performance Requirements - General

The requirements and criteria specified within this Section are applicable to the CO detection systems and other work included within this Section 17.2.2.5.

1. The COMS shall be able to measure CO levels between 0-250 ppm.
2. Each CO sensor shall be located at the monitoring point.
3. Sensor readings shall be communicated via the SCADA system. A 20 mA signal shall take the CO sensor reading to the SCADA for reporting through the tunnel monitoring and control system.
4. CO alarms shall automatically activate the Tunnel Ventilation System (TVS) and provide alarm notification through the tunnel monitoring and control system.

17.2.2.5.3 Coordination Meetings

The Developer is required to hold various types of coordination meetings for design, construction, fire-life safety and other issues as necessary through the design and construction of the East End Crossing. These meetings will include IFA, the local building department, KYTC, the Department, and state and federal agencies as necessary. Developer shall prepare the agenda, meeting minutes and exhibits necessary for each meeting.

17.2.2.5.4 Design Coordination

Developer's design of the COMS requires coordination with other design disciplines and agencies as necessary. Developer shall fully coordinate with all disciplines and agencies as necessary such that the CO detection system will function as intended. The COMS system shall be connected to appropriate power in addition to SCADA connectivity.

17.2.2.5.5 Environmental Design Conditions

All COMS equipment exposed to the roadway environment shall be designed to meet the conditions in this Section 17.2.2.5. The COMS equipment and systems shall be designed, furnished, and installed /constructed with particular details and features necessary for suitable operation in the intended environment. The tunnel and other spaces therein such as the pump stations, egresses/exits, etc, contain environments with adverse conditions such as high humidity, high temperatures, potentially explosive atmospheres, and corrosive atmospheres. The equipment shall be selected, purchased and installed with the full disclosure of the intended environments.

The road tunnel environment is harsh, consisting of vehicular emissions and fumes. Consequently, all roadway systems shall be protected from corrosion for their design life.

17.2.2.5.6 Calculations

Perform necessary calculations and submit final checked and Registered Professional Engineer sealed calculations to IFA as part of the Design Review submittal.

17.2.2.5.7 Personnel Requirements

The engineer of record for the COMS design shall have continuous and progressive experience in the design and construction of COMS of a level commensurate with the proposed facilities and have at least one major tunnel/highway-rated project with an understanding of all systems that support life safety.

17.2.2.5.8 Design Requirements

Developer shall design the CO system to meet the following requirements:

1. The COMS shall use the electrochemical sensors.
2. The COMS shall be maintained from the egress corridor and not from the roadway level.
3. The COMS shall use remote sensors with replaceable heads.
4. The monitor housing and its components shall be corrosion resistant.

5. Each sensor shall be provided with local display to indicate the concentration of CO in the air sample being analyzed in ppm.

6. Sensor range shall be 0 to 250 parts of CO per million parts of air, full scale. Accuracy shall be plus or minus two percent of full scale.

7. Detection cell shall be such that no humidifier is required.

8. Calibration shall be accomplished by removing the CO detection head and replacing with a calibrated one. The detection head shall be calibrated in the maintenance workshop for future use.

9. A quantity of sample heads equal to 110 percent of those installed is to be provided to the Project for uninterrupted operation of the COMS during calibration.

10. Detection cell design shall provide that the cell is unaffected by atmospheric pressure changes, and is not sensitive to nominal variations in sample flow rate.

11. Detection cell is to be sensitive to CO. Sensor life is to average not less than 18 months before need for replacement.

12. Electrical connections external to sensor housing shall be quick disconnect type located on the exterior of sensor housing.

13. If dual units are selected, then each unit shall be electrically separate and independent of the other, and the electrical shutdown of one unit shall in no way affect the operation of the others. Each unit shall have a separate power supply and switch for the detection unit.

14. All wiring for external connections shall be readily accessible at terminal strips.

15. Maximum zero and span drift for 24 hours of operation shall not exceed plus or minus two percent of full scale. Zero and span drift shall be less than 10 percent per year.

16. The monitor system shall be equipped with automatic temperature compensation and maintain specified accuracy in ambient temperatures from 15 degrees Fahrenheit to 104 degrees Fahrenheit and in relative humidity from 5 to 99 percent. Test reports confirming that operational units have remained within specifications for 24 hours during the full range of temperature and humidity testing shall be provided.

17. The monitor system shall be capable of withstanding a concentration of up to 5,000 parts of CO per million parts of air without being damaged.

18. Filtration shall be provided to prevent particulates from entering the sensor.

19. For an electrochemical sensor, the interfering gases that may affect the analysis shall be eliminated by utilizing a charcoal filter. A test report shall be provided which demonstrates that interfering gases do not affect the CO analysis.

20. Repeatability shall be plus/minus one percent of full scale or better, for 10 analyses in 30 minutes.

21. The system shall only require periodic calibration maintenance and checking of sensor unit function at 90 day intervals. Periodic sensor checking or actual adjustment of the

sensor units shall be capable of being accomplished by one person at the sensor unit location.

22. Control Room Display: A separate three digit LED or backlit LCD display readout shall be provided for the purpose of displaying the value of each sensor. The value displayed shall be a direct reading of concentration of CO value in parts per million (ppm). The output signal to the SCADA system shall be a linear signal of four milliampere (zero parts CO per million parts of air) to 20 milliampere (250 parts CO per million parts of air). The SCADA system will store CO readings and make recorded data available upon request.

17.2.2.5.9 <u>System Configuration</u>

The COMS design shall consist of remote CO sensors that report readings locally and send readings to the tunnel control center via the SCADA system. Readings shall be recorded and maintained for one year.

17.2.2.5.10 <u>Carbon Monoxide Monitoring System</u>

The COMS shall be designed and programmed by Developer to configure and operate the TVS, including the fans and dampers, in line with the operating scenarios developed by Developer.

Developer shall design and construct the COMS such that the CO detectors can be monitored remotely at both the tunnel operation center and from any redundant remote operations control location, via the tunnel SCADA system.

17.2.2.5.11 <u>Construction Requirements</u>

The COMS shall be procured, installed and constructed in a complete manner and shall include all of the components necessary to provide a complete and operable system. The COMS includes, but is not limited to, pumps, filters, switches, CO detection cells, readout control modules, calibration equipment and other components systems as necessary. The COMS manufacturer shall have a minimum of 10 years continuous and current experience in the manufacture of COMS.

17.2.2.5.12 <u>Construction Work Plan Requirements</u>

Coordination working drawings showing the location of CO monitoring locations with respect to the roadway and other roadway level systems such as emergency exits, CCTV, lighting, etc., shall be provided by Developer.

17.2.2.5.13 <u>Carbon Monoxide System Commissioning</u>

Developer shall prepare a commissioning plan memo that consists of individual equipment performance and quality assurance tests, as well as a complete installation testing plan that confirms that the systems functions and operates as intended. The commissioning plan memo shall be submitted as part of the Final Design for IFA review and comment. Equipment installed by or under direction of Developer, which is found to be defective in material or workmanship, shall be repaired or replaced.

17.2.2.5.14 Field Tests

Operation Tests: Each CO monitoring location shall be field tested under operating conditions to determine that all parts of the system function properly. All defects shall be corrected and necessary adjustments made to satisfy the requirements specified in the Developers ready for construction plans. Developer shall submit three certified copies of results obtained from field tests to the Engineer, indicating the total response time for each system.

Before final acceptance and after testing Developer shall show by in-service demonstration that the equipment and all associated accessories are in good operating condition and properly performing their intended function.

17.2.2.5.15 Carbon Monoxide System Training

Developer shall provide training in the use of the COMS to the Department, KYTC, or other nominated representative after installation but prior to East End Crossing Final Acceptance. The training shall be estimated based on an attendance of ten staff and/or representatives. Training shall include:

How to operate the COMS including but not limited to meaning of readings and alarms that may be received.

1. How to maintain the COMS including but not limited to sensor calibration and the replacement of parts.
2. Shall instruct the trainee in 1 the use of the Operations and Maintenance (O&M) Manual.
3. A test shall be administered to assess the trainees understanding of the subject. The test shall be approved by the Department and have a pass/fail criteria.

17.2.2.5.16 Design Submittals

All submittals shall be in accordance with the Design QA/QC Plan.

Developer shall submit the following:

1. Manufacturer's catalog cuts and brochures. These shall be referenced to the specific Specifications section and location where the items are to be used.
2. Nameplates: Nameplates shall be furnished on all sensors and readout control housings designating unit number. Nameplates shall be of a black laminated plastic material with block letters engraved to the center white core. The nameplates and lettering shall be of suitable size and shall be fastened using self tapping, corrosion-resistant screws.

17.2.2.5.17 Plans

Developer shall prepare COMS plan sheets in accordance with the Department instructions. The Developer shall submit Stage 1 Design Review plans for the COMS. The plans shall include, but are not limited to, the following items:

1. CO instrument locations.
2. Proposed access to the CO detection locations shall be provided.

3. Connection to SCADA shall be shown.

All final design documents shall include the stamp of a Registered Professional Engineer. In addition, after installation, as-built drawings shall be prepared showing, as a minimum, the information found on the original plans. Record Drawings shall be prepared in accordance with the PPA Documents.

17.2.2.5.18 Shop Drawing Submittal

The Developer shall submit shop drawings to IFA for the COMS for review and comment. The following information shall be included in the shop drawings:

1. Submit for review detailed shop drawings, flow diagrams, wiring diagrams, elementary diagrams and equipment supports indicating supports and appurtenances required for proper installation.
2. Submittals shall include catalogs, operating and maintenance manuals, capacity, materials, finishes, and accessories and installations instructions. Shop drawings shall be completely dimensioned and shall indicate the intended installation method.
3. Catalog cuts and brochures shall be referenced to the specific Specifications section and location where the items are to be used.
4. Submit operating and maintenance manuals in accordance with the PPA Documents.
5. Submit manufacturer’s warranty information in accordance with the PPA Documents.
6. Submit list of manufacturer’s recommended spare parts.
7. A sample nameplate shall be submitted prior to manufacture for review.

17.2.2.5.19 RFC Plan Sheet Revisions During Construction

Whenever new plan sheets are required as part of a contract revision, the information in the title blocks of these sheets shall be identical to the title blocks of the contract they are for. Every revision will be assigned a number. The assigned number shall be located both at the location of the change on the sheet and in the revision block of the plan sheet along with an explanation of the change.

17.2.2.5.20 Commissioning Submittals

Prior to Final Acceptance submit operational test reports to IFA for review and comment containing:

1. Verification that operational units have remained within specifications for 24 hours during the full range of temperature and humidity.
2. Interfering gases do not affect the CO analysis.
3. Verification that data received at the control room is accurate.

17.2.2.6 General Electrical

Developer shall design a complete Tunnel electrical system and coordinate the design with Tunnel architectural, structural, civil, and mechanical designs.

1. The architectural, mechanical, and electrical designs shall be integrated to provide adequate space to install and maintain all electrical equipment. No electrical equipment subject to failure shall be installed in any location that would require excavation or Tunnel modification to replace such equipment.
2. Working clearances around electrical equipment shall, at a minimum, meet the requirements of the National Electrical Code, National Electrical Safety Code, and Kentucky Building code.
3. Remediate the negative effects of harmonic currents.
4. The electrical design shall incorporate energy-saving practices.
5. The design shall provide for complete and operational primary and secondary voltage distribution sources that shall serve the electrical and control requirements of the Tunnel and ancillary facility systems. In addition, the sources shall consist of all necessary and required components to form a complete and operational electrical distribution system that provides safety, reliability, and durability.
6. The primary and secondary distribution sources shall each be sized to meet the total electrical system design demand for the Tunnel and ancillary facilities. The design demand load shall include the as-built electrical system demand plus 20 percent additional capacity. Where required to meet the demand, more than two sources at more than two locations shall be permitted.
7. The maximum voltage drop on both feeders and branch circuit's loads to the farthest load shall be designed not to exceed the limits specified by regulatory requirements, and in any event, the voltage at each load shall not be less than its minimum rated voltage.
8. All electrical systems shall be designed for conditions suitable for operation in an environment where adverse conditions (high temperature, adverse winds, gasses, soot and smoke, explosives, and highly corrosive atmospheres) are anticipated.
9. Developer shall coordinate with Tunnel design and provide any easements or special conditions required by the Utility for the installation.
10. Developer shall coordinate with the Utility Owner for all available electrical rebate programs.

17.2.2.6.1 <u>Conduit</u>

Design Criteria: Exposed PVC conduit is prohibited from being used between the portals of the Tunnel. All transitions from PVC conduit to rigid metallic conduit shall be made a minimum of 12 inches inside concrete walls, floors, ceilings, and other interfaces with Tunnel interior spaces.

17.2.2.6.1.1 <u>Construction and Material Requirements:</u>

1. Conduits mounted on Tunnel ceiling:

All conduit attachments for roadway ceiling-mounted conduit shall be made to the embedded channel in the ceiling. No penetration of any kind will be permitted into the Tunnel structure beams.

Exposed conduit runs shall be neatly installed parallel or at right angles to the walls. Use straps, clamps, or hangers of an approved type made of stainless steel or galvanized malleable iron. Space the attachments as specified. When specified, paint all exposed rigid steel conduit surfaces to match the color of adjacent material. Submit calculations stamped by a Registered Professional Engineer with the Design Review packages to verify that the conduit supports and embedded strut are capable of supporting the conduit loads.

2. Conduits installed in other locations than Tunnel ceiling:

Any wall-mounted conduits shall be installed at approved and designated locations, as shown on Plans.

Developer shall be responsible for the proper location and alignment of all sleeves for electrical work before and during concrete placement.

Seal sleeves for electrical conduit and cables passing through heated to unheated areas, making them air-tight and fire-resistant in a manner similar to that specified for watertight sleeves. Where sleeves containing a single conduit penetrate fire-rated walls, floors, partitions, or slabs, fill and seal conduit to the sleeve with 1-part intumescent caulk or putty sealant, creating a fire stop equal to or exceeding the fire rating of the construction material being penetrated. Fire sealant shall prevent the spread of flame, smoke, air, and water through the sleeve and shall be rated for a three-hour test per ASTM E814 and UL 1479. Fire sealant shall be installed in accordance with the manufacturer’s written instructions.

Where sleeves containing multiple conduits or multiple cables penetrate fire-rated walls, floors, partitions, or slabs, fill and seal spaces between the conduits or cables and the sleeve with 2-part intumescent foam sealant, creating a fire stop equal to or exceeding the fire rating or construction material being penetrated. Fire sealant shall prevent the spread of flame, smoke, air, and water through the sleeve and shall be rated for a three-hour test per ASTM E814 and UL 1479. Fire sealant shall be installed in accordance with the manufacturer’s written instructions.

17.2.2.6.2 Vaults and Handholes

Design Criteria: Developer shall furnish and install precast electrical vaults and handholes at locations shown on the Plans. Structure design calculations, materials, and shop drawings, approved by a Registered Professional Engineer, shall be submitted for review and comment with the appropriate Design Review packages.

Precast electrical vaults and handholes shall be manufactured in accordance with ASTM C858, “*Underground Precast Concrete Utility Structures*,” and conform to the structural design requirements of ACI 318-05 for reinforced concrete capable of withstanding earth pressure, traffic lifting, and other appropriate loadings recommended in ASCTM C857, “*Minimum Structural Design Loading for Underground Precast Concrete Structures*.”

Four (4) lifting inserts shall be provided in the lid and located to balance the weight of the lid. All metal lifting devices cast into the internal or external surfaces shall be hot-dipped galvanized or made from stainless steel.

All vaults and handholes shall have the manufacturer's name and date of manufacture permanently marked on the inside vault wall surface.

All electrical vaults shall have a drain sump installed in the vault and a fixed ladder.

Construction and Material Requirements:

1. Bedding and foundation support

   Adequate foundation preparation shall be obtained per Project Standards. The final elevation for the bedding and foundation support for the electrical vaults and handholes shall be in accordance with the Tunnel drainage structure Project Standards. Developer shall be responsible for the assembly of all precast vault sections according to the manufacturer's requirements.

   The frame and hatch covers of electrical vaults and handholes shall not be grouted to final grade until the final elevation of the pavement has been established and until permission thereafter is given by the Engineer to grout the frame and cover or hatch cover in place.

2. Conduit Entrances

   All conduit entrances to proposed electrical vaults and handholes shall be at designed knockout locations, and Developer shall maintain a minimum of 1 foot 6 inches from the centerline of conduit to the inside wall. An Electrical Safety Observer shall be present for all work within energized electrical vaults.

3. Sealing Electrical Vaults

   Developer shall grout and caulk all spaces around conduit entrances and the concrete floor to provide a watertight seal. Cement grout shall be applied to ensure all other openings and voids through the walls or top or bottom slabs are properly filled.

4. Grounding

   Developer shall install the ground bus and ground rods for precast electrical vaults and handholes in accordance with Project Standards. Ground rods shall be installed at each corner of the structure. A 2/0 AWG CU bare conductor shall be installed as the ground bus and connected to each ground rod.

5. Identification

   Developer shall provide identification labels for each electric vault and handhole for future maintenance.

17.2.2.6.3 Tunnel Cabling

Design Criteria: Developer shall be responsible for furnishing and installing power cables, fiber-optic cables, signaling cables, and control cables and associated connectors inside the Tunnel.

Construction and Material Requirements:

All Tunnel cables and wires used in the Tunnel shall be rated as follows:

- Toxicity index less than 2.0 when tested to NES (Naval Engineering Specification) 713
- Low smoke with UL ST1 listing
- Zero halogen meeting MIL-C-24643
- Low acid gas meeting MIL-C-24643

Cables used in the electrical rooms and Tunnel shall not contain any PVC. All cables shall be rated for wet environments.

17.2.2.6.4 Panelboards

Design Criteria: Developer shall furnish, install, and test panelboards, including circuit breakers, accessories, and cabinets, completed as specified in this Section 17.

Panelboards shall be in conformance with the Project Standards including the most current version, as of the Setting Date, of the latest NEMA Standards and federal specifications listed below.

National Fire Protection Association (NFPA)

70	National Electrical Code (NEC)

Underwriters Laboratories, Inc. (UL):

67	Panelboards
489	Branch Circuit and Service Circuit Breakers

National Electrical Manufacturer's Association (NEMA):

PB1	Panelboards
AB1	Molded Case Circuit Breakers

Federal Specifications (FS):

W-P-115B	Panel, Power Distribution
W-C-375B	Molded Case Circuit Breakers

In case of conflict between provisions of applicable Laws, and these Technical Provisions, the more stringent requirements will apply.

Construction and Material Requirements:

Copies of all receipt inspections, installation data, and field tests shall be submitted to the Engineer for review and comment a maximum of 30 days after installation.

The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years.

Certified copies of production test reports demonstrating compliance with the standards listed in this Section 17.2.2.6.4 shall be supplied to the Engineer a maximum of 30 days after installation.

Panelboards

Furnish factory-assembled dead-front-type panelboards.

Furnish panelboards complete with branch circuit breakers and a main circuit breaker or main lugs per tunnel requirements.

Furnish all three-phase, three-wire panelboards with full-capacity separate ground bus. Provide a separately insulated neutral bus and a separate ground bus for panelboards connected to a three-phase, four-wire service or a single phase, three-wire service.

Furnish panelboards with the voltage, frequency, and current ratings conforming to NEMA Standard PB1, Federal Specification W-P-115B, UL 67, NEC, OESC.

Furnish the panelboard main, neutral, and ground busses with a minimum 98 percent conductivity rectangular copper bars provided with bolted-type lugs.

Provide drilled busses to fit either “A,” “B,” or “C” Phase connectors so that connectors are interchangeable and installed in a distributed phase sequence.

Provide tin-plated busses, connectors, and terminals, to a minimum plated thickness of 0.005-inches.

Provide terminal lugs, which are prevented from turning per NEMA standard PB1. Lugs are to be compatible with the conductor material and size.

Provide main bus-bracing for each panelboard adequate for interrupt ratings of 22 kA symmetrical short circuit minimum at 208Y/120 volts or 250 volts and 42 kA symmetrical short circuit minimum at 480Y/277 volts or 480 volts.

Provide typed panelboard directory cards with the following information:

- Panelboard name designation
- Panelboard voltage rating
- Panelboard ampere rating
- Panelboard short-circuit rating
- Panelboard pole/circuit numbers and branch circuit description as wired in the field.
- Indicate 2-pole and 3-pole branch circuit breakers.
- Label spare circuit breakers “spare.”

Circuit Breakers

Furnish bolt-on-type fully rated branch and main circuit breakers. Furnish frame sizes, trip settings, and the number of poles as indicated. Breakers with a short-circuit requirement higher than 10 kA symmetrical shall be current limiting. Provide circuit breakers marked with ampere trip rating that can be read at a distance of 2 feet from the panel. Provide breakers meeting the requirements of Fed. Spec. W-C-375B and NEMA AB1.

Furnish all breakers with quick-make, quick-break toggle mechanisms; thermal-magnetic, inverse time-limit overload; and instantaneous short-circuit protection on all poles, unless otherwise indicated. Provide an indication of automatic tripping by the breaker handle assuming a distinctive position from the manual ON and OFF position. Furnish breaker handles that are trip-free on overloads.

Single pole breakers with handle ties or nails in lieu of multipole breakers are not acceptable.

Furnish handle lock device on breakers as indicated to prevent the manual opening of the selected breakers.

Furnish padlocking devices on breakers as indicated to prevent the opening of indicated breakers.

Voltage and interrupting rating of the main breaker in a panelboard is to be greater than the voltage and short-circuit rating of the panelboard main busses, as indicated. Furnish breakers to operate at the frequency as required.

Furnish ground fault interrupter circuit breakers for circuits as required.

Furnish single pole breakers with full module size. Two pole breakers in a single pole's module are not acceptable.

Cabinets

Provide NEMA-1 surface-mounted cabinets without knockouts, unless otherwise required.

Unless otherwise specified, provide panelboard cabinets of code-gauge galvanized, sheet steel and equip with gutters of an ample size for the risers and outgoing circuits. Cabinets are not to exceed 78 inches (1,980 millimeters) in height.

Provide hinged door option for all panelboards. Each door of the cabinet shall be hung on semi- or fully concealed hinges with a combination catch and lock.

On cabinets 48 inches (1,200 millimeter) high and over, provide a 3-point catch assembly latching at the top, bottom, and middle.

Provide all panelboard locks, keyed alike.

Provide cabinets drilled only for the exact conduit entrances and mounting bolts.

17.2.2.6.5 Switchgear

Design Criteria: Developer shall furnish, install, and test utilization voltage switchgear for operation on 480-Volt, three-phase, and four-wire systems as required by the Tunnel design. The switchgear shall be self-supporting, completely metal-enclosed, dead-front type, and equipped with low-voltage power circuit breakers and molded case circuit breakers. Switchgear shall be arranged as part of a unitized line-up with transformers or bussed to a separate transformer as required.

Switchgear shall be completely factory-assembled, factory-tested, metal-enclosed structures equipped with fixed-type low-voltage power circuit breakers. Each individual section shall be separated from others by steel barriers, but shall be electrically interconnected and physically joined to form a single self-supporting, free-standing assembly complete with all required components for satisfactory operation.

Switchgear shall be designed for indoor application, the acceptance of two (2) incoming sources (termination of two feeders per phase), and the subsequent distribution of electrical power to various loads as required.

Switchgear shall be in conformance with the Project Standards including the most current standards and codes listed below as of the Setting Date.

American National Standards Institute (ANSI)

C2	National Electrical Safety Code
C12.1	Electricity Metering
C37.1	Definition, Specification and Analysis of Manual, Automatic, and Supervisory Station Control and Data Acquisition
C37.13	IEEE Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures
C37.16	Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors
C37.17	American National Standard for Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers
C37.20	IEEE Standard for Switchgear Assemblies Including Metal-Enclosed Bus
C37.20.1	Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear
C37.50	Test Procurements for Low-Voltage AC Power Circuit Breakers Used in Enclosures
C37.90.1	Surge Withstand Capacity (SWC) Tests for Protective Relays and Relay Systems
C39.1	Requirements for Electric Analog Indicating Instruments
C57.13	Requirements for Instrument Transformers
Z55-1	Gray Finishes for Industrial Apparatus and Equipment

National Electrical Manufacturers Association (NEMA):

AB-1	Molded Case Circuit Breakers
PB-2	Deadfront Distribution Switchboards
PB 2.1	Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less
PB 2.2	Application Guide for Ground Fault Protective Devices for Equipment
SG-3	Low-Voltage Power Circuit Breakers
SG-5	Power Switchgear Assemblies

National Fire Protection Association (NFPA):

70	National Electrical Code

Underwriter's Laboratories Inc. (UL) Publication:

489	Molded-Case Circuit-Breakers, Molded-Case Switches and Circuit-Breaker Enclosures
891	Dead Front Switchboards
1053	Ground Fault Sensing and Relaying Equipment
1558	Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

Construction and Material Requirements:

Copies of all receipt inspections, installation data, and field tests shall be submitted to the Engineer for review and comment a maximum of 30 days after installation.

Developer shall provide switchgears with the following components:

- Enclosures
- Circuit Breakers
- Switches
- Meters
- Ground Sensors
- Relays
- Surge Arresters
- Microprocessor Metering Unit (MMU)
- Terminations
- Interlocks

All materials of switchgears shall be new, of current manufacture, high grade, and shall not have been in prior service. Switchgear shall be able to accept bulk power from an external source and distribute it to multiple loads. A complete material list of manufacturer, equipment type, ratings, catalog numbers, current transformer ratios, accuracy class, potential transformer ratings, interrupting ratings, and all pertinent technical support equipment shall be provided to the Engineer for review and comment 30 days after installation.

Spare Parts Data: As soon as practicable after the approval of materials and equipment, furnish spare parts data for each different item of equipment listed. The data shall include a complete list of parts and supplies, with current unit prices and sources of supply.

Certificates of Conformance or Compliance:

Circuit Breakers: Certified Laboratory Test Reports: Three (3) weeks prior to shipment, submit, in triplicate, certified copies of reports of all tests required in referenced publications for the switchgear, including reports that include results of design, production, and conformance test performed according to ANSI C37.20.

Operating and Maintenance Manuals: Shall be furnished for each switchboard and switchboard component including, but not limited to circuit breakers, metering, relaying, etc., three (3) weeks prior to shipment.

Installation

Installation and grounding shall comply with ANSI C2, National Electrical Code (NEC), and to the requirements specified in this Section 17.2.2.6.5.

Meters and Instrument Transformers: Per ANSI C12.1.

Install conduits and raceways in accordance with manufacturer’s recommendations, KYTC *Standard Specifications for Road and Bridge Construction* section 716.03.02 Conduit Installation.

All live components shall be contained in a grounded metal enclosure approximately 92 inches high and 72 inches deep maximum, fabricated from minimum 11-gauge modular designed steel frame with removable plates. Individual vertical sections 22 inches wide, maximum, shall be constructed of bolted steel frames. Each breaker compartment shall be isolated completely from other breaker compartments by means of grounded metal barriers. Barriers shall isolate the breaker compartment from the bus bar system. Hinged rear covers, which can be bolted closed, shall be provided for each cable compartment. A front hinged door shall be provided for each breaker and metering compartment. Provide a rear cable and terminal compartment for cable installation and termination. A lockable rear hinged door shall be provided for access to the cable and termination compartment for installation, testing, and termination facilitation. The cable bending space shall meet the requirements of the NEC.

Factory Tests

Submit design tests or certified copies of test reports for identical units, performed for each type and rating of circuit breaker as assembled in its complete switchboard unit, including bus compartment.

Circuit Breaker Tests: Shall be performed in accordance with the requirements of ANSI C37.50.

Switchboard Assembly Tests: Shall be performed in accordance with the requirements of ANSI C37.20.

Developer shall provide all personnel and equipment required to perform the tests. Developer shall provide four certified copies of the complete test reports to the Engineer within 30 days of completion for review and comment. At least 30 days prior to the commencement of each test, submit the types, styles, or catalog numbers of all required testing equipment to the Engineer for review and comment. Include a written certification stating when the testing equipment was last calibrated by a testing agency approved by the Engineer. The calibration date shall be within 180 days of the date when the tests are to be performed.

Field Tests

Acceptance Checks, Settings, and Tests: Perform in accordance with the manufacturer's recommendations and the latest IEEE and NETA standards. Perform work in a careful and safe manner so as not to endanger personnel or equipment. Perform tests in such a way as to obtain information about the performance of the breakers, meters, wiring, and instrument transformers together as a unit, as well as separately.

17.2.2.7 Electrical Power Source

Developer shall design the electrical systems to provide power at a suitable voltage for all required loads. The design shall provide electrical power under all conditions to each load defined by Developer and as required by the applicable Technical Documents. Standby power sources with automatic failover shall be identified and developed to ensure the continuity of power in the event that the preferred power source becomes unavailable. Developer shall provide sources of power, in accordance with the requirements of NFPA 502, to all life-safety and/or emergency loads throughout the Tunnel and at all times. The preferred sources shall be a retail energy provider.

Developer shall provide, at a minimum, a primary electric utility service entrance for the Tunnel consisting of a single underground 15 kV feed from LG&E's Harrods's Creek substation and an on-site engine generator system for a 100% redundant secondary emergency power source.

Developer shall coordinate with LG&E to provide a "dedicated" 15 KV circuit breaker and circuit to serve the Tunnel from LG&E's Harrods's Creek Substation. The circuit breaker shall only feed the line for the Tunnel. No other customers shall be served from either the breaker or dedicated line. The dedicated line shall be run underground in a concrete encased duct bank from the Harrods's Creek Substation to the Tunnel. The duct bank shall contain two spare ducts for the purposes of replacing the line in the event of a cable/termination failure.

17.2.2.7.1 Normal Power

The electrical system voltages, layout, loads, and emergency generation requirements shall be based on the Tunnel design.

Developer shall study the electrical system to determine infrastructure, life safety, security, and overall capacity requirements and shall design the power supplies to meet long-range development plans.

Power System Studies

Developer shall provide the following power system studies listed below for the electrical system to the Engineer for Design Review:

- Short circuit calculations
- Coordination studies for setting protective devices
- Generator loading analysis
- Arc flash hazard analysis

The short circuit and coordination studies shall include calculations used for determining the trip settings, fuse ratings, and medium-voltage switchgear relays included within the limits of the this Section 17.2.2.7.

Developer shall also employ the services of a testing firm, subject to the review and comment of the Engineer, in accordance with the provisions of this Section 17.2.2.7, with the specified demonstrated capability for calibrating, setting protective devices, and testing of devices as specified herein. The testing firm qualifications shall be submitted to the Engineer prior to executing a sub-contract. Device calibration and settings are to be based on the results of the above coordination study.

Developer shall provide a report summarizing the coordination study, including one-line of system, relay, and breaker setting tabulation, coordination curves, relay curves, circuit breaker curves, protective device coordination, and short-circuit calculation, including maximum fault levels at the switchgear busses.

Developer shall provide an arc flash hazard analysis verifying that the equipment provided does not exceed a hazard/risk category 2 arc rating and personal protective equipment (PPE) requirement.

Changes and additions of equipment characteristics, based on the actual equipment supplied, may be suggested by the results of the short-circuit and protective device coordination studies and arc flash hazard analysis study. Submit any such changes and additions as a part of the study as specified in this Section 17.2.2.7.1. Field settings of devices, adjustments, and minor modifications to equipment that are required to accomplish conformance with the approved short circuit and protective device coordination studies shall be carried out by Developer.

The design of the power system shall be in conformance with the Project Standards including the most current version, as of the Setting Date, of the standards and codes listed below:

Institute of Electrical and Electronic Engineers (IEEE):

242	Protection & Coordination of Industrial and Commercial Power Systems

American National Standards Institute (ANSI):

C37.010	Application Guide for AC High-Voltage Circuit Breakers Rated on Symmetrical Current Basis

National Fire Protection Association (NFPA)

70	National Electrical Code
70E	Standard for Electrical Safety in the Workplace

Electrical Design Data

Utility Coordination: Developer shall coordinate with the local power Utility for new services or service expansions as required. Once the power design is reviewed by the Engineer as specified above, Developer shall coordinate with the local power Utility for metering requirements and point of service entrance connections. Developer shall coordinate with the local power Utility for all available electrical rebate programs.

17.2.2.7.2 Uninterruptible Power Source (UPS)

Design Criteria: Developer shall design and provide UPSs for Tunnel equipment. The UPS shall automatically maintain AC power within specified tolerances to the critical load as identified by the IFA, without interruption, during failure or deterioration of the normal power source. The UPS shall provide backups of all Tunnel emergency illumination, fire- and life-safety systems, SCADA, and communications backbone equipment to keep the Tunnel operable. Developer shall design and furnish all materials and equipment to be fully compatible with electrical, environmental, and space conditions at the site. It shall include all equipment to properly interface the AC power source to the intended load and be designed for unattended operation.

Standards

The UPS and all associated equipment and components shall be manufactured in accordance with the Project Standards including the current version, as of the Setting Date, of the following applicable standards:

- CSA 22.2, No. 107.1
- ANSI C62.41
- National Electrical Code (NFPA 70)
- NEMA PE-1
- OSHA
- UL Standard 1778

- NFPA 111

Construction and Material Requirements:

The UPS module shall consist of a rectifier/charger and three-phase inverter with associated transformers, static transfer switch, bypass synchronizing circuitry, protective devices, and accessories as specified. The specified system shall also include a battery disconnect breaker and battery system.

The UPS shall have built-in protection against: surges, sags, and over current from the AC source, overvoltage and voltage surges from output terminals of paralleled sources, and load switching and circuit breaker operation in the distribution system.

The UPS shall be protected against sudden changes in output load and short circuits at the output terminals. The UPS shall have built-in protection against permanent damage to itself and the connected load for all predictable types of malfunctions. Fast-acting current limiting devices shall be used to protect against cascading failure of solid-state devices.

Internal UPS malfunctions shall cause the module to trip off-line with minimum damage to the module and provide maximum information to maintenance personnel regarding the reason for tripping off line. The load shall be automatically transferred to the bypass line uninterrupted for an internal UPS malfunction. The status of protective devices shall be indicated on the front of the unit.

All materials of the UPS shall be new, of current manufacture, high grade, and shall not have been in prior service except as required during factory testing. All active electronic devices shall be solid-state. All power semi-conductors shall be sealed. Control logic and fuses shall be physically isolated from power train components to ensure operator safety and protection from heat. All electronic components shall be accessible from the front without removing sub-assemblies for service access.

Wiring

Wiring practices, materials, and coding shall be in accordance with the requirements of the National Electrical Code, OSHA, and applicable Laws and Project Standards. All bolted connections of busbars, lugs, and cables shall be in accordance with requirements of the National Electric Code and Project Standards. All electrical power connections shall be torqued to the required value and marked with a visual indicator.

Provisions shall be made in the cabinets to permit the installation of input, output, and external control cabling, using raceway or conduit. Provisions shall be made for top and bottom access to input, output, bypass, and DC connections. In conformance with NEC, connection cabinets shall provide for adequate wire bend radius. All copper busbars for customer power connections shall be tin plated for connection integrity.

Construction and Mounting

The UPS shall be in NEMA Type 1 enclosures, designed for floor mounting. The UPS shall be structurally adequate and have provisions for hoisting, jacking, and forklift handling.

The UPS shall be NEMA Type 1 compliant with front doors open, to enable safe change of air filters, without the need for shutdown.

Cooling

Adequate ventilation shall be provided to ensure that all components are operated well within temperature ratings. The cabinet blowers shall be redundant so that a single blower failure will not cause temperatures to increase beyond acceptable limits.

Temperature sensors shall be provided to monitor UPS internal temperature. Upon the detection of temperatures in excess of the manufacturer's recommendations, the sensors shall cause visual alarms to be sounded on the UPS control panel.

A separate room ambient temperature sensor shall be provided to give an alarm if the temperature of the inlet air to the UPS is above the specified limits.

Air filters shall be located at the point of air inlet and be changeable. No service clearance or ventilation shall be required in the rear of the system.

Factory Tests

Developer shall provide factory test reports of the UPS equipment to the Engineer for review and comment prior to installation.

Field Tests

Perform inspections by factory-trained field service personnel during the UPS startup. Perform control/logic checks and adjust to meet the manufacturer's specifications with energized control power.

Spare Parts Stock

Spare parts shall be stocked by local field service personnel with backup available from a national parts center and the manufacturing location. A national parts center customer support parts coordinator shall be on call 24 hours a day, 7 days a week, 365 days a year through Final Acceptance for immediate parts availability.

Maintenance Contracts

The manufacturer shall provide to the IFA a factory maintenance contract with duration of two years, starting at completion of UPS commissioning. The contract shall include free service and parts for the two year maintenance contract period.

17.2.2.7.3 Generator

Design Criteria: Developer shall furnish, install, and test a prime duty generating unit complete with all required accessories, generator control panel, auxiliary equipment, and associated Work required for complete and fully operable systems. One or more diesel or natural gas fired generators shall be provided with total installed capacity adequate to permit traffic operations through the Tunnel. The generator(s) shall be indoor or outdoor type. Controls shall be provided for automatic start and load transfer upon loss of commercial power. Load banks shall be provided to test the generator(s) at full operating capacity.

The generator shall be in conformance with the Project Standards including the most current version, as of the Setting Date, of the standards and codes listed below:

American National Standards Institute (ANSI) Publications:

C2	National Electrical Safety Code
C37.1	Definition, Specification and Analysis of Manual, Automatic, and Supervisory Station Control and Data Acquisition
C50.10	General Requirements for Synchronous Machines
C50.13	Cylindrical Rotors, Synchronous Generators
B16.3	Malleable Iron Threaded Fittings, Class 150 and 300
B16.5	Steel Pipe Flanges and Fittings
B16.9	Factory Made Wrought Steel Butt Welding Fittings
B16.11	Forged Steel Fittings, Socket Welding and Threaded

National Electrical Manufacturers Association (NEMA) Publications:

AB1	Molded Case Circuit Breakers
MG1	Motors and Generators

Institute of Electrical and Electronic Engineers (IEEE) Publication:

115	Test Procedure for Synchronous Machines

National Fire Protection Association (NFPA) Publications:

30	Flammable and Combustible Liquids Code
37	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
70	National Electrical Code (NEC)
110	Standard for Emergency and Standby Generators

American Society for Testing and Materials (ASTM) Publication:

A53	Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A181	Forgings, Carbon Steel, for General Purpose Piping

Underwriter's Laboratories Inc. (UL) Publication:

489	Circuit Breakers, Molded Case, and Circuit Breaker Enclosures

Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry Publication:

SP83	Carbon Steel Pipe Unions Socket Welding and Threaded

Diesel Engine Manufacturers Association (DEMA) Publications:

Standard Practices for Stationary Diesel and Gas Engines

Federal Specifications (FS) Publication:

W C 375B	Circuit Breaker, Molded Case; Branch Circuit and Service

Construction and Material Requirements:

Developer shall furnish new materials of high quality that will give long life and reliable operation. Equipment shall not have been in prior service except as required by factory tests. Workmanship shall be of highest quality in every detail.

Developer shall construct each engine rigid, neat in appearance, and to allow easy access to various parts for maintenance purposes. Frame shall be heavy construction. Enclose all parts to prevent throwing or dripping oil. Flywheel shall be solid type, arranged to facilitate barring over the engine if not located in the generator.

Regulatory Requirements

Certified copies of production test reports shall be supplied demonstrating compliance with these standards when requested by the Engineer.

- Generator(s) being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. Equipment shall be stored in a secure, bonded, and heated warehouse.
- The manufacturer shall certify that the equipment will be in production for at least five years from the date of delivery and shall also certify that the equipment will be supported and spare parts will be available by the manufacturer for another 15 years.

Operations and Maintenance Manuals:

Developer shall furnish operation and maintenance manuals and other relevant manuals for each piece of equipment, unless otherwise specified herein. Information contained shall include all as-built information. The number of copies shall be as stated in each applicable section of these Technical Provisions. Each complete manual for equipment specified shall be provided bound in hardback binders or an approved equivalent.

Factory Testing

Developer shall perform factory tests and inspections on the engine and generator prior to shipment. Developer shall provide certified copies of all manufacturer's test data and results to the Engineer prior to shipment. Test procedures shall conform to ASME, IEEE, and ANSI Standards, and to DEMA Standard Practices Section on testing, as appropriate and applicable. Equipment necessary for tests shall be provided by the manufacturer performing the tests, and all measuring and indicating devices shall be certified correct or correction data furnished for the device(s). Tests shall indicate satisfactory operation and attainment of specified performance. If satisfactory, equipment tested will be given a qualified approval. Following the installation of all permanent equipment within the tunnel equipment building(s), perform further tests to ensure satisfactory operation. Developer shall not ship equipment without the approval of the shop test reports.

Field Testing

Developer shall perform all field tests and trial operations and conduct all field inspections (except final field inspection). Provide all labor, equipment, and incidentals required for the tests. The IFA representative will witness all field tests and trial operations and will conduct final field inspections. The IFA shall be given ample notice of the dates and times scheduled for tests, trial operations, and inspections that require the presence of the Engineer. Developer shall rectify all deficiencies and retest all work affected by such deficiencies at no additional cost.

17.2.2.7.4 Batteries

Design Criteria: Developer shall furnish, install, and test stationary batteries. Batteries for UPS shall have sufficient capacities to maintain the UPS system output at full rated load for the time specified for each UPS based on Tunnel requirements. Separate battery chargers shall not be required for these batteries. Battery chargers will be supplied as part of the UPS system.

Standards

The Batteries and all associated equipment and components shall be manufactured in accordance with the Project Standards including the current edition, as of the Setting Date, of the following applicable standards:

American National Standards Institute (ANSI):

C2	National Electrical Safety Code

Underwriters Laboratories, Inc. (UL):

1012	Power Units Other Than Class 2

Institute of Electrical and Electronics Engineers, Inc. (IEEE):

446	Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications
1184	Guide for the Selection and Sizing of Batteries for Uninterruptible Power Systems
1187	IEEE Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications
1188	IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
C37.90.1	Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems Associated with Electric Power Apparatus

National Electrical Manufacturers Association (NEMA):

1B1	Definitions for Lead Acid Industrial Storage Batteries
1B4	Determination of Ampere-hour and Watt-hour Capacity of Lead Acid Industrial Storage Batteries for Stationary Service
1B5	Life Testing of Lead Acid Industrial Storage Batteries for Station Service
1B7	Testing Flame Arrestor Vents Used on Lead Acid Industrial Storage Batteries for Stationary Service
1B8	Lead Acid Industrial Storage Batteries for Stationary Service

National Fire Protection Association (NFPA):

70	National Electrical Code (NEC)

Occupational Safety & Health Administration (OSHA)

STD 1-8.2	Medical Services and First Aid

Construction and Material Requirements:

The battery shall be a sealed, valve-regulated design type. The battery shall be a minimum maintenance type, with no gas emission during normal operation.

The battery shall be covered by a 10-year life expectancy certification when operated in float service.

Electrolytes shall be of the absorbed type.

Alloy shall be calcium or antimony to ensure maximum life with low or no gassing over its service life. Cadmium shall not be acceptable.

Both positive and negative plates shall be of the flat pasted plate design to ensure highly reliable electrical performance throughout the life of the battery. Positive plates shall be at least 0.1 inch thick and equipped with fibrous retention mats to inhibit the loss of active material as a result of repeated cycling. The plates in the cells, when the cells are in a horizontal mode, shall be in a vertical mode to prevent undue stress on the plates and allow for electrolytes to be evenly distributed in the cell.

The cell terminal shall be designed such that the cell-to-cell and cell-to-terminal resistance shall not be more than 50 milliohms. Copper cored posts shall be provided. One-minute rating to 1.75 volts per cell shall be 2.6 times the one-hour rating, and one-hour rating shall be 4.5 times the eight-hour-capacity rating minimum.

The cell container and cover shall be polypropylene with a minimum limiting oxygen index of 28.

Each cell shall have a self-sealing safety valve that operates at low pressure range of three to seven psi. Vent shall be designed using flash arrestor.

The cell jar and cover shall be joined by heat sealing to ensure positive seal.

Intercell connectors shall be lead-plated copper.

Connection bolts and washers shall be stainless steel Type 316.

Positive and negative plates shall be separated by glass mat.

Circuit breakers rated for the proper DC voltage and final discharge ampacity for the UPS system. These circuit breakers shall be placed at the input and output of the storage battery. Furnished circuit breakers shall be selected with proper interrupting rating and coordinated with the battery discharge currents.

Battery rack design shall meet the seismic criteria in accordance with Division IA of AASHTO with acceleration coefficient, A = 0.06 and a Seismic Performance Category, SPC = A. The site coefficient, in accordance with Division IA of AASHTO, is 1.0.

The battery performance test procedure shall be approved by the engineer prior to the shipment of batteries from the factory.

Developer shall perform factory tests and field tests with manufacturer's recommendations and applicable UL, NEMA, and IEEE standards. Upon the completion of all approval checks, settings, and tests, Developer shall show, by demonstration in service, that all circuits and devices are in good operating condition and can properly perform their intended function.

Any battery jar that fails the performance test shall be replaced with a new jar. That jar shall be tested individually per section 7.5 of IEEE 1188 prior to installation into the battery string.

17.2.2.8 Electrical Power Distribution

Developer shall provide a distribution system such that a single event within the utility system cannot affect both the preferred and standby power sources. All loads shall have preferred and backup power sources available to them by automatic means, and transfer between these sources shall be automatic. All automatic switching will take place on the utilization voltage system.

The power distribution system shall be based on a selective system with both a preferred and standby power source made available to all distribution substations serving the Tunnel and ancillary facilities' systems. The distribution system shall carry both preferred and standby power sources to points within the Project Limits by means of an open-primary loop configuration. A protection scheme shall be provided to prevent a fault on any primary feed or switchgear from disabling any other equipment, and in addition:

1. Developer shall be responsible for incorporating the design intent of all electrical systems that have been addressed herein and shall employ commonly accepted voltages used in the United States.
2. All switchgear assemblies and components shall be designed in accordance with IEEE, ANSI, and NEMA, and shall have the required short circuit and impulse withstand capability to operate safely.
3. All primary and secondary switchgear, motor controllers, and control devices shall be designed to accommodate the required SCADA functions of remote monitoring and control, and annunciation of system conditions.
4. Electrical interlocks shall be provided as necessary to fulfill all operational conditions, and mechanical interlocks shall be provided for personnel safety during all operational and maintenance conditions.
5. The interrupt rating of breakers shall be determined based on Developer's calculated fault currents so as to interrupt safely.
6. Jet fans, starters, and disconnect switches for the jet fans and stairwell pressurization fans shall be monitored to annunciate an open switch condition. In addition, all source feeders arranged to provide redundant sources of supply to jet fan ventilation zones or sets thereof shall be physically and electrically separated from each other from source to load.

17.2.2.8.1 <u>Transformers</u>

Design Criteria: Developer shall furnish, install, and test transformers; shall furnish, install, and test dry-type distribution transformers as specified herein; and shall furnish and install general-purpose transformers, 600 volts and below.

The transformers shall be supplied with accessories, enclosure type, finish and color described, and shall be designed for storage and service conditions, including ambient, overload, and unusual operating conditions, as specified.

Design, construction, and testing shall be in strict accordance with the latest revision of industry standards and shall include, as a minimum, the applicable requirements of those listed below. Where standards or specifications contain different minimum requirements, the more stringent shall apply. Where Project Standards conflict with this Section 17.2.2.8 this Section 17.2.2.8 shall take precedence.

Standards

The transformers and all associated equipment and components shall be manufactured in accordance with the Project Standards including the most current version, as of the Setting Date, of the following applicable standards:

American National Standards Institute (ANSI) Publications:

C2	National Electrical Safety Code
C57.12.01	General Requirements for Dry-type Distribution and Power Transformers Including Those With Solid Cast and/or Resin-Encapsulated Windings
C57.12.70	Terminal Markings and Connections for Distribution and Power Transformers
C57.12.80	Terminology for Power and Distribution Transformers
C57.12.91	Test Code for Dry-type Distribution and Power Transformers
C57.94	Recommended Practices for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers
C57.96	Guide for Loading Dry-Type Transformers
Z55.1	Gray Finishes for Industrial Apparatus and Equipment

National Electrical Manufacturers Association (NEMA):

ST20	Dry-Type Transformers for General Applications
TP-1	Guide for Determining Energy Efficiency of Distribution Transformers
TP-2	Standard Test Method for Measuring the Energy Consumption of Distribution Transformers

National Fire Protection Association (NFPA):

70	National Electrical Code (NEC)
101	National Life Safety Code

Underwriter's Laboratory Inc. (UL) Publications:

1561	Dry-Type General Purpose and Power Transformers
1562	Transformers, Distribution, Dry-Type, over 600 Volts

Institute of Electrical and Electronics Engineers (IEEE) Publications:

P745	Guide to Conducting a Transient Voltage Analysis for a Dry-Type Transformer Coil

International Electrical Testing Association Inc.:

Section 16T.7.2.1	Transformers, Dry Type

Construction and Material Requirements:

General Requirements:

Flux Density: Sufficiently below saturation to allow a minimum of 10 percent over-voltage excitation.

Noise Level: Not exceeding limits set by cited standards or applicable Laws.

Finishes: Thoroughly cleaned, degreased, coated with hot phosphate chemical bath, corrosion-inhibiting primer or undercoat, and overall finish coat of manufacturer's standard electrical gray pigmented paint, as approved.

Transformer Efficiency: Ratings as shown.

Low Voltage Transformer KVA	Single Phase Efficiency %	Three Phase Efficiency %
15	97.7	97.0
25	98.0	--
30	--	97.5
37.5	98.2	
45	--	97.7
50	98.3	--
75	98.5	98
112.5	--	98.2
150	--	98.3
225	--	98.5
300	--	98.6
500	--	98.7
750	--	98.8

General Purpose Transformers

All applicable IEEE Std. C57.12.01 and UL requirements and NEMA TR 1, TP 1 requirements, as applicable. Indoor dry type, primary and secondary copper windings, self-cooled, with class H insulation at 40 degree C ambient temperature, but with winding rise limited to 150 degrees C.

Transformer coils: Vacuum impregnated with non-hygroscopic, thermosetting varnish, final wrap of electric insulating material designed to prevent injury to the magnet wire. Transformers having coils with magnet wire visible will not be acceptable.

The core and coil: Completely isolated from the enclosure by means of vibration absorbing mounts with no metal-to-metal contact between the core and coil and the enclosure. On units 500 KVA and smaller, the vibration isolating system shall be designed to provide continual support of the core and coil unit to the enclosure. Sound isolating systems requiring the removal of all tie-down facilities will not be acceptable.

All ventilating openings: Louvered type, expanded metal coverings will not be accepted. The base of the transformers shall be constructed of 12-gauge steel minimum with stamped openings for ventilation.

Provide lifting eyes or provisions on transformer enclosures, holes in the enclosures requiring the use of spreader bars will not be acceptable.

Core and coils: Visibly grounded to the frame of the transformer cubicle by means of a flexible grounding strap of adequate size.

Ratings

Voltage:	Primary, 480 unless otherwise indicated. Secondary, single phase, 240/120; or three phase, 208Y/120 as indicated.
KVA	Rating: Single or three-phase as indicated, 60 hz.
Class:	AA
Rise Rating:	15 kva and above, 150 degrees C.
Enclosure:	Totally enclosed; non-ventilating through 15 kva, 3-phase and 25 kva, single-phase; non-ventilated or ventilated drip-proof at higher kva ratings.
Mounting:	45 kva and below, wall mounting type unless otherwise indicated; above 45 kva, floor or platform mounting type.
Taps:	Single phase, less than 15 kva, two 5 percent taps below rated voltage; 15 kva and above, six 2-1/2 percent increment taps on primary, two above and four below rated voltage. Three phase, below 30 kva, four 2-1/2 percent increment taps on primary, two above and two below rated voltage on primary; 30 kva and above, two above and four below rated voltage.
Busses:	Tinned copper.

General-Purpose Transformers (600 Volts and Below, Below 15kVA)

Standards: Shall conform to NEMA ST20. All characteristics, definitions, terminology, voltage designations, and tests shall be in accordance with ANSI C57.12.01.

Application: Suitable for indoor application and step down of the incoming 480 Volt to 208Y/120 Volt or 120/240 Volt utilization level.

Listing: Shall be UL listed.

Type: Two winding, low voltage, dry-type.

Cooling: Self-cooled.

Core and Coil Assembly: Coils shall be of the continuous wound construction. Cores shall be constructed of high-grade, non-aging, grain-oriented silicon steel with high magnetic permeability and low hysteresis and eddy current losses. Magnetic flux densities shall be kept well below the saturation point. The core and coil assembly shall be completely encapsulated in a proportional mixture of resin and aggregate to provide a moisture-proof, shock-resistant seal.

Insulation System:

KVA Rating	Insulation
2 and below	150°C, based on 80°C rise by resistance
3 through 15	185°C, based on 115°C rise by resistance

Enclosure: Shall be constructed of heavy gauge sheet-steel, totally enclosed, non-ventilated.

Spare Parts Data: As soon as practicable after the approval of materials and equipment, furnish to the Engineer spare parts data for each different item listed. The data shall include a complete list of parts and supplies, with current unit prices and sources of supply. The foregoing shall not relieve Developer of any responsibilities under the warranty.

Test procedures, detailing tests to be conducted, description of how tests will be performed, and what the expected results shall be, shall be submitted to the Engineer for Design Review with Released-for-Construction Design Documents.

Developer shall install conduits and raceways in accordance with the manufacturer's recommendations, and KYTC *Standard Specifications for Road and Bridge Construction* section 716.03.01 Wiring and section 716.03.02 Conduit Installation.

Developer shall make power cable and control wire connections in accordance with the manufacturer's recommendations, and KYTC *Standard Specifications for Road and Bridge Construction* section 716.03.01 Wiring.

Provide delivery, storage, and handling of materials, equipment, and spare parts as specified herein.

Testing

Tests as called for in this Section 17.2.2.8 shall be conducted in strict accordance with applicable ANSI standards. Certified test reports covering shop testing shall be provided by the manufacturer to the Engineer no later than one week after shipment. IFA reserves the right to witness tests in accordance with Section 3.4.1 of the PPA.

Factory Tests

Quality control of factory testing of the Tunnel equipment will be performed in accordance with the requirements of the Construction QA/QC Plan.

Routine Tests: Routine tests shall be made on each transformer in accordance with the requirements of ANSI standards for dry type transformers. These shall include the following:

- Ratio test
- Full load coil test
- Excitation current test
- Polarity test
- Applied voltage test
- Partial discharge (as complete transformer)
- No-load core loss
- Phase relation
- Impedance voltage
- Resistance measurement
- Induced over-potential test

Special Tests: Special tests shall be made in accordance with the requirements of ANSI standards for dry type transformers. These shall include the following:

- Temperature rise test (will accept test of similar design in lieu of new test unit)
    - Sound level test,
    - Impulse test ANSI (will accept copy of prior test of similar design, KVA, and voltage[s]).
    - Short circuit test (may accept test of similar design in lieu of new unit test).

- Radio influence voltage
- Insulation power factor
- Insulation resistance

Field Tests

Quality control of field testing and commissioning of the Tunnel equipment will be performed in accordance with the requirements of the PPA Documents.

The following field tests shall be performed on each transformer after installation, prior to energizing following National Electrical Testing Association outline:

- Visual and Mechanical Inspection
  - Inspect for physical damage, mechanical and electrical conditions.
  - Compare equipment nameplate information with latest single line diagram and report discrepancies.
  - Verify proper auxiliary device operation such as fan and indicators in accordance with manufacturer's recommendations.
  - Check tightness of accessible bolted electrical joints.
  - Perform specific inspections and mechanical tests as recommended by manufacturer.
  - Make a close examination for shipping brackets or fixtures that may not have been removed during original installation. Ensure resilient mounts are free.
  - Make a close examination for the collection of dirt or other forms of material that may have collected in the windings during manufacture/shipping. Any foreign material that may interfere with cooling or reduce clearances to ground shall be removed using manufacturer's recommended methods.

- Electrical Tests
  - Insulation-resistance tests shall be performed winding-to-winding and winding-to-ground.
  - A dielectric absorption test shall be made winding-to-winding and from each winding-to-ground for ten (10) minutes. The polarization index shall be computed.
  - Insulation power factor tests shall be made from winding-to-winding and from each winding-to-ground.
  - A turns ratio test shall be performed between windings.
  - Over potential test shall be made on all high and low voltage winding-to-ground.
  - Winding resistance tests shall be made for each winding at nominal tap position.
  - Measure secondary voltage phase to phase and phase to ground after final energizing and prior to loading.
  - Phase rotation test.

- Test Values
  - Insulation resistance and absorption test voltage to be used shall be in accordance with NETA recommendations.
  - The absorption test polarization index shall be above 2.0 unless an extremely high value is obtained at the end of one (1) minute that when doubled will not yield a meaningful value with the available test equipment.
  - Power factor test values in excess of three percent (3 percent) shall be investigated.

- Winding resistance test results shall compare within one percent (1 percent) of adjacent windings.

Turns ratio test results shall not deviate more than one-half of one percent (0.5 percent) from the calculated ratio.

17.2.2.8.2 Automatic Transfer Switch

Design Criteria: Developer shall furnish, install, and test automatic transfer switch (ATS) for main switchgear 1.

Developer shall design, construct, and test ATS in strict accordance with the latest revision of industry standards and shall include, as a minimum, the applicable requirements of those listed below. Where standards or specifications contain different minimum requirements, the more stringent shall apply. Where Project Standards conflict with this Section 17.2.2.8 this Section 17.2.2.8 shall take precedence.

Standards

The ATS and all associated equipment and components shall be manufactured in accordance with the Project Standards including the most current version, as of the Setting Date, of the following applicable standards:

American National Standards Institute (ANSI) Publications:

C2	National Electrical Safety Code
C37.90.1	Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems
446	Emergency and Standby Power Systems for Industrial and Commercial Applications

National Electrical Manufacturers Association (NEMA) Publications:

ICS 1	General Standards for Industrial Control and Systems
ICS 2	Standards for Industrial Control Devices, Controllers and Assemblies
ICS 6	Enclosures for Industrial Controls and Systems

National Fire Protection Association (NFPA) Publications:

20	Centrifugal Fire Pumps
70	National Electrical Code (NEC)
110	Standard for Emergency and Standby Power Systems

Underwriters Laboratories, Inc. (UL) Publications:

1008	Automatic Transfer Switches

Construction and Material Requirements:

The automatic transfer and bypass isolation switch (ATS/BIS) shall consist of the following components:

- Mechanically held transfer switch
- Bypass isolation switch

- Control module

The ATS/BIS components shall be furnished in a single enclosure, completely factory assembled, interconnected and tested as one unit. The bypass isolation switch shall be provided to permit manual bypass and isolation of the automatic transfer switch for the purpose of maintenance and testing of the ATS.

Ratings

- Switch Ratings (Volts): 480.
- Switch Ratings (Amperes): As required by codes.
- Number of Switched Poles: 4

Withstand Rating: Shall be rated to withstand the available RMS symmetrical short circuit at the ATS terminals with the type of overcurrent protection, as outlined in UL-1008. The ATS shall be rated to withstand the available RMS symmetrical short circuit current for 30 cycles.

Type of Load:

Load shall be 3 phase, 100 percent non-linear with a total harmonic distortion factor of 10%.

Main and Neutral Contacts:

Main and neutral contacts shall be fully rated for supplying 3 phase, 100 percent non-linear load with a total harmonic distortion factor of 10 percent, at the switch ampere and voltage rating as required by codes and standards.

Neutral Conductor Provisions

ATS shall be provided with 4-pole switched neutral non-overlapping fully rated contacts. For ATS design utilizing overlapping neutral contacts, neutrals of the normal and standby power sources shall be connected together only during the transfer and retransfer operation and remain connected together until power source contacts close on the source to which transfer or retransfer is being made. The overlapping neutral transfer contacts shall not overlap for time duration greater than 100 milliseconds.

Transfer Switch Construction

The transfer switch unit shall be electrically operated and mechanically held. The electrical operator shall be a single solenoid mechanism or motor, with 85 to 110 percent line voltage capability, momentarily energized to minimize power consumption and heat generation. The switch shall be positively locked and unaffected by voltage variations or momentary outages so that contact pressure is maintained at a constant value and temperature rise at the contacts is minimized for maximum reliability and operating life. The switch shall be mechanically interlocked to ensure only one of two possible positions normal or standby.

All main contacts shall be break before make type. All main and neutral contacts shall have a silver composition. Switches shall have segmented, blow-on construction for high withstand current capability and protected by separate arcing contacts. ATSs utilizing components or parts which have not been intended for continuous duty, repetitive switching, or transfer between two active power sources are not acceptable.

Bypass Isolation Switch Construction

A two-way bypass-isolation switch shall provide manual bypass of the load to either source and permit isolation of the automatic transfer switch from all source and load power conductors.

Power interconnections shall be made with suitably sized silver plated copper bus bars, braced to withstand magnetic and thermal forces created at the withstand rating specified for the associated ATS. The only field installed power connections required shall be at the "line" and "load" terminals.

Separate bypass and isolation handles shall be utilized to provide clear operational distinction between the two functions. The bypass handle shall provide three operating modes:

- Bypass to Normal
- Automatic
- Bypass to Standby

The operating speed of the bypass contacts shall be the same as that of the associated automatic transfer switch and shall be independent of the speed at which the manual bypass handle is operated. In the "Automatic" mode, bypass contacts shall be fully open so that they will not be subjected to fault currents.

The isolation handle shall provide, but not be limited to the following operating modes:

- Closed
- Open

The "Closed" position shall indicate that the ATS is closed in one of the two operating positions. The "Open" mode shall completely isolate the automatic transfer switch from all source and load power conductors. When in the "Open" mode, it shall be possible to completely withdraw the automatic transfer switch for inspection or maintenance without removal of power conductors or the use of any tools.

When the isolation switch is in the "Open" mode, the bypass switch shall function as a manual transfer switch allowing transfer and retransfer of the load between the two available sources without the feedback of load-regenerated voltage to the transfer switch. This transfer/retransfer operation shall comply with Paragraph 42.7 of UL 1008.

Control Module Construction

The control module shall direct the operation of the transfer switch. The module's sensing and logic shall be controlled by a built-in microprocessor or by hard wired control relays. The control module shall be connected to the transfer switch by an interconnecting wiring harness.

The control module shall be completely enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on printed circuit boards. Interfacing relays shall be industrial control grade plug-in type with dust covers. All relays shall be identical to minimize the number of unique parts.

The control panel shall meet or exceed the voltage surge withstand capability in accordance with IEEE 472 (ANSI C37.90a) and the impulse withstand voltage test in accordance with the proposed NEMA ICS 1-109.

Operation

Three-phase control modules shall be provided.

The voltage of each phase of the normal source shall be monitored, with pick-up adjustable from 85 to 100 percent and dropout adjustable from 75 to 98 percent of pick-up setting, both in increments of one percent. Repetitive accuracy of settings shall be plus or minus two percent or better over an operating temperature range of minus 20 degrees Centigrade to plus 70 degrees Centigrade, factory set to pick-up at 90 percent and dropout at 85 percent.

Single phase voltage sensing of the standby source shall be provided, with a pickup adjustable from 85 to 100 percent (and dropout fixed at 84 to 86 percent of pickup), and frequency sensing with pickup adjustable from 90 to 100 percent (and dropout fixed at 87 to 89 percent of pickup). Both pickup settings shall be fully-field adjustable in one percent increments. Repetitive accuracy of settings shall be plus or minus two percent or better over an operating temperature range of minus 20 degrees Centigrade to plus 70 degrees Centigrade, factory set to pick up at 90 percent voltage and 95 percent frequency.

The control module or hard wired control relays shall include four time delays that are fully field adjustable in increments of at least 13 steps over the entire range as follows:

- Time delay to override momentary normal source outages to delay all transfer switch and engine starting signals. Adjustable from 0 to 6 seconds. Factory set at 3 second.
- Transfer to standby time delay. Adjustable from 0 to 5 minutes. Factory set at 0 minutes unless indicated otherwise on applicable codes.
- Retransfer to normal time delay. Time delay shall be automatically bypassed if standby source fails and normal source is acceptable. Adjustable from 0 to 30 minutes. Factory set at 30 minutes.
- Unloaded running time delay for standby engine generator cool down. Adjustable from 0 to 60 minutes. Factory set at 5 minutes.

Where required, a set of DPDT gold-flashed contacts rated 10 amperes, 32 volts dc shall be provided for a low-voltage engine start signal when the normal source fails. The start signal shall prevent dry cranking of the generator by requiring the generator to reach proper output, and to run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred. Also provide a "commit/no commit to transfer" selector switch to select whether the load should be transferred to the standby generator if the normal source restores before the generator is ready to accept the load.

A momentary-type test switch shall be provided to simulate a normal source failure. Also terminals for a remote contact which opens to signal the ATS to transfer to standby and terminals for remote contacts which open to inhibit transfer to standby and/or retransfer to normal, wired to terminal strip, shall be provided. For automatic transfer, provide two interposing relays to allow the SCADA system to energize/de-energize the automatic transfer switch exercise circuit via four (4) wire momentary signal (stop and start). Relays shall be 120 VAC and of a construction for this application. Relay shall have 3 form ‘C’ contacts (3PDT) that have a minimum rating of 10 AMPS. Control points shall be wired out to a terminal strip.

Output terminals or contacts to signal the actual availability of the normal and standby sources (3 each), wired to terminal strip, shall be provided.

As applicable, a visual position indicator shall be provided to indicate bypass isolation switch position.

As applicable, terminals or contacts to indicate the position of bypass switch (4 for each position) and wired to terminal strip shall be provided. Three of these contacts shall be for use by the SCADA system to indicate bypass position: Bypassed to standby supply, bypassed to normal supply and normal position. These points shall be clearly labeled at terminal strip.

A "green" signal light to indicate when the automatic transfer switch is connected to the normal source and a "red" signal light to indicate when the automatic transfer switch is connected to the standby source shall be provided.

One contact which closes upon transfer of ATS to standby position shall be connected to a terminal strip labeled as "STANDBY MODE". This contact shall be rated ten amperes, 120 volts, 60 Hertz ac.

Three normally open and three normally closed auxiliary contacts when ATS is connected to normal source, and three normally open and three normally closed auxiliary contacts when ATS is connected to standby source shall be provided. The auxiliary contacts shall be rated 10 amperes, 120 volts, 60 Hertz ac and wired to a terminal strip.

Two of these contacts shall be for use by the SCADA system to indicate ATS position: ATS in Normal Position, ATS in Standby Position. These points shall be clearly labeled at terminal strip.

One contact rated at 10 amps shall be provided for use by the SCADA system to indicate "Loss of Normal Power" and wired to a terminal strip. This point shall be clearly labeled at terminal strip.

Enclosure

ATS/BIS shall be housed in a free standing, NEMA 1 sheet metal enclosure constructed in accordance with UL-1008. Gauge of the metal shall be not less than No. 11. Enclosure shall be equipped with at least two specified size and type of grounding lugs as required by codes.

Enclosure shall be constructed for convenient removal and replacement of contacts, coils, springs and control devices from the front without the disconnection of external power conductors or the removal or disassembly of major components.

Enclosure shall be equipped with specified size and type of lugs/terminals for incoming and outgoing power and control wiring with top or bottom feed as required by codes. All wiring shall be accessible from the front.

Spare Parts Data: As soon as practicable after approval of materials and equipment, furnish to the Engineer spare parts data for each different item listed. The data shall include a complete list of parts and supplies, with current unit prices and source of supply. The foregoing shall not relieve Developer of any responsibilities under the warranty.

Test Procedures, detailing tests to be conducted, description of how tests will be performed, and what the expected results shall be, shall be submitted to IFA for review and comment with the Released-for-Construction Design Documents.

Developer shall install conduits and raceways in accordance with manufacturer's recommendations, section 804, Grounding, section 805, Electrical Conduit and Fittings, section 810, Electrical Cable, Wire, and Connectors, section 820, General Electrical.

Developer shall make power cable and control wire connections in accordance with manufacturer's recommendations.

Provide delivery, storage, and handling of materials, equipment and spare parts as specified in this Section 17.2.2.8.

Testing

Tests as called for in this Technical Provision shall be made in strict accordance with applicable ANSI standards. Certified test reports covering shop testing shall be provided by the manufacturer to the Engineer no later than one week after shipment. The IFA reserves the right to witness tests in accordance with Section 3.4.1 of the PPA.

Factory:

The complete ATS/BIS or ATS assembly shall be subjected to production and conformance tests in accordance with the latest applicable standards of NEMA, ANSI and UL.

All production units shall be subjected to the following factory tests:

- Tests to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance with the specification requirements.
- A dielectric strength test per NEMA ICS 1-109.21.
- Continuity tests.

Developer shall provide all material, equipment and personnel required for all tests and shall submit all test procedures, schedules, and results to the Engineer for review and comment.

Field:

Quality Control of field testing and commissioning of the Tunnel equipment shall be performed in accordance with the requirements of the Construction QA/QC Plan.

Acceptance checks and tests shall be performed in accordance with manufacturer's recommendations, UL-1008, and NETA ATS-1995 Test shall include, but not be limited to, the following:

- Compare actual connections with wiring diagrams. If differences are found, determine if error is in diagram or in actual wiring and correct as necessary.
- Inspect all devices, equipment, etc., for damage or maladjustment caused by shipment or installation.

Perform insulation resistance test at 1,000 volts dc on all power and control wiring. Minimum insulation resistance shall be 1,000,000 ohms.

Follow-Up Verification:

Upon completion of all approval checks, settings and tests, Developer shall show by demonstration in service that all circuits and devices are in good operating condition and properly perform their intended function. Test shall be such that each item will perform its function not less than three times. As an exception to requirements that may be stated elsewhere in the Technical Provisions, the Engineer shall be given ten (10) Days advance notice of the dates and times for all checks and tests. The Engineer reserves the right to witness all tests. Certified copies of all test results shall be provided to the Engineer.

17.2.2.9 Grounding and Bonding/Lightning and Surge Protection

Developer shall provide all materials and components required for complete grounding and bonding systems for all systems and equipment protection, static dissipation, and personnel safety. All grounding systems shall be designed in accordance with NFPA 70 and IEEE 142.

Developer shall provide surge protection connected between phase and ground, to limit the voltage to ground impressed upon the electrical equipment due to lightning surges and switching surges. Types, locations and when to apply surge protection to the electrical system/equipment shall be designed in accordance with IEEE 142 and NESC C2.

Standards

The grounding and bonding/lightning and surge protection and all associated equipment and components shall be manufactured in accordance with the Project Standards including the most current version, as of the Setting Date, of the following applicable standards:

American Society for Testing and Materials (ASTM):

B187 Standard for Copper, Bus Bar, Rod and Shapes

National Fire Protection Association (NFPA):

70	National Electrical Code (NEC)
780	Standard for the Installation of Lightning Protection Systems

Underwriters Laboratories, Inc. (UL):

467	Grounding and Bonding Equipment

National Electrical Manufacturer's Association (NEMA):

GR-1	Grounding Rod Electrodes

American National Standards Institute (ANSI):

C2	National Electrical Safety Code
Z244-1	American Standard for Personnel Protection.

Institute of Electrical and Electronic Engineers, Inc. (IEEE):

80	Guide for Safety in AC Substation Grounding
81	Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

National Electrical Testing Association, Inc. (NETA):

Standard for Acceptance Testing Specifications

Construction and Material Requirements:

Grounding Conductors

- **Type:** Insulated or bare as shown
- **Material:** As specified in 26 05 19 Low- Voltage Electrical Power Conductors and Cables
- **Size:** As required by the NEC and applicable codes

Ground Bus

- Material: Copper
- **Size:** 1/4 inch by 2 inch, length as required by the NEC and applicable codes.
- **Mounting:** As required by the NEC and applicable codes.
- **Connections:** Drilled to receive bolted ground cable connections to equipment and for attachment of an external grounding conductor(s).

Terminal Lugs

Type:

- NEMA 2 hole, copper compression type for all conductors #4/0 AWG and smaller.
- NEMA 2 hole, long barrel, copper, double compression type for all conductors 250 kcmil and larger.
- Provide multiple lugs where more than one conductor is terminated in the same device.

Construction:

Lugs shall be tin plated to minimize corrosion.

Ground Rods

- **Type:** Copper clad steel with U.L. label
- **Material:** 1035 steel with minimum .010 thick copper plating
- **Size:** ¾" diameter x 10 ft length

Exothermic Connections

- **Type:** Connections shall be suitable for exposure to the elements or direct burial in earth or concrete without degradation over the lifetime of the grounding system.

Material:

- Molds shall be made from graphite material capable of withstanding high temperatures and providing an average life of not less than fifty separate exothermic welds or refractory ceramic or other material suitable for a single connection.
- Starting material (where used) shall consist of aluminum and copper and iron oxides. It shall not contain phosphorous, magnesium or any caustic, toxic or explosive substances.
- Weld metal used for grounding connections shall contain copper oxide, aluminum and not less than 3% tin as the wetting agent.

- Weld metal packages shall be identified as to the part number, size and type of metals to be connected, such as copper to copper or copper to steel, cast iron, etc.; or shall be marked for their intended use – such as cathodic connections.
- Neutral conductors, cable shields, metallic cable sheaths and armor, metallic conduits, cable trays, cable terminations, junction boxes, poles, surge arresters, fencing enclosing electrical equipment, and other non-current carrying metallic parts of electrical equipment shall be grounded. The installation shall conform to the requirements of ANSI C2, NEC, and to the requirements specified herein.
- Install grounding conductors for switchboards and switchgear so they will not be exposed to physical damage. Install connections firm and tight. Arrange conductors and connectors so there will be no strain on connections.
- Install loop type, low impedance, grounding system interconnecting all main and distribution switchboards components so at least two grounding connections are provided for each major item of electrical equipment. Severing of any single grounding conductor in this system may not remove grounding protection on any major item.
- Perform exothermic welding with properly sized molds for the ground cables used.
- Connections to structural members are to be made by exothermic welding process or by bolted connector. Connections to equipment or ground bus are to use bolted connectors.
- Where conduits are not effectively grounded by firm contact with a grounded enclosure, provide grounding bushings on at least one end of conduit run.
- Connect grounding conductors from equipment in area to the area ground bus. Connect ground bus to grounding system. Mount ground bus on 600V pedestal insulators.
- Provide continuous bonding of each circuit as per NEC.

Resistance Values:

- Non-current carrying metallic parts of electrical equipment shall have a maximum resistance to solid "earth" (ground) not exceeding five (5) ohms.
- Ground Connections:
- Below Grade: Weld buried and concealed ground connections exothermically in strict accordance with manufacturer's recommendations as described in the instructions accompanying the product. Run grounding conductors associated with direct burial cables in common trenches, or, if indicated, beside cables.
- Above Grade: Use terminal lug(s) to connect grounding conductor to equipment enclosure. Use approved ground connector(s) to connect grounding conductor to piping, fencing and conduit systems.

Splices:

- Grounding conductors shall not be spliced.
- Raceways: Where raceways are used to contain and protect grounding conductors, install in accordance with Section 26 05 33-Raceways and Boxes for Electrical Systems. Where bare grounding conductors are contained within protective metallic raceways, bond ends of raceways to conductors.
- Equipment Grounding:
- Shall be provided for personnel safety and continuous operation of equipment at ground potential.
- Equipment grounding shall be provided by means of a green-colored insulated (600-Volt insulation) conductor, separate from the electrical system neutral conductor, and

installed within or as part of the feeder and branch circuit raceway system. Equipment grounding conductor shall be provided with:

- All feeder circuits
- Branch circuits

Equipment grounding conductors shall be sized as required by the NEC.

Ground each piece of electrical equipment by means of a grounding conductor installed in raceway feeding that piece of equipment with copper wire sized in accordance with NEC.

Connect transformer cases and neutrals to grounding system. Connect neutral ground connection at transformer terminal. Provide two separate, independent, diagonally opposite, connections for power transformers so removal of one connection will not impair continuity of other.

Connect two separate ground connections from ground grid to ground bus of switchgear assemblies, and all transformer equipment. Ensure that each connection for an item of equipment is from a different section of ground grid.

Connect lightning arresters to ground system by suitable conductors. Where lightning arresters are furnished with electrical equipment and grounding connections are not inherently provided, ensure that suitable separate grounding conductor connects lightning arresters with system ground.

Ground Grid:

Developer shall make all connections to the ground grid interconnecting conductors and to enclosures of electrical equipment, metal fences, structures and ground buses using stranded bare copper cable, size as required by codes.

Where two dissimilar metals come in contact, an antioxidant compound shall be applied to prevent corrosion.

Bonding

General: For personnel safety, metallic objects and/or equipment in the vicinity of electrical equipment shall be bonded to a ground bus or grounding conductor using #6 AWG insulated conductor minimum. The bonding shall be provided to eliminate any possibility of difference in "potential" that could develop between the metallic object(s) and the ground potential.

Metallic objects to be bonded to a ground bus or grounding conductor are:

- All electrical equipment enclosures
- Ductwork
- Metallic piping
- Metallic ladders or stairs
- Raceway, pull boxes, and cable trays
- Door frames near electrical equipment
- Other metallic objects as required by codes

Surge Suppression

Design surge arresters and transient voltage surge suppressors (TVSS) with primary or secondary electrical service equipment.

Provide surge arresters in the primary side of all medium-voltage transformers, and in 5-kV and 15-kV loop switches. Fused transformer primary switches (5 kV and 15 kV) do not require a separate surge arrester as long as surge arresters are provided in the medium-voltage transformer.

A single TVSS device shall be installed on the load side of a building's main service disconnect, typically at the service entrance switchboard or main distribution panel. If required, surge arrestors installed on sub-panels shall be coordinated with primary surge arrestors.

Surge arresters and TVSS devices shall be metal oxide varistor (MOV) type. Include replacement of existing surge arresters and TVSS devices in the Project if they are not MOV type.

TVSS devices shall be connected through a multi-pole circuit breaker.

Test Equipment

Test equipment used by Developer is to be inspected and calibrated.

Perform calibration and setting checks with calibrated test instruments of at least twice that of the accuracy of the equipment, device, relay or meter under test. Dated calibration labels shall be visible on test equipment. Calibrations over 6 months old are not acceptable on field test instruments. Inspect test instruments for proper operation prior to proceeding with the tests. Record serial and model numbers of the instruments used on the test forms.

Field Tests and Inspections

Testing and checkout work shall be conducted in a safe manner. Provide the following special safety precautions wherever they would result in a safer workplace and as required by campus and the IFA's requirements:

- Locking and tagging procedures
- Barricades
- De-energizing and/or isolation of equipment prior to testing
- Review of procedures with the Engineer
- Erection of warning signs
- Stationing of guards and watchmen
- Maintenance of voice communications
- Personnel orientation
- Coordination and staging

Tests shall:

- Provide initial equipment/system approval.
- Provide recorded data for future routine maintenance and troubleshooting.

- Provide assurance that each cable is installed satisfactorily and can be expected to perform, and continue to perform, its function with reasonable reliability throughout the life of the grounding system.
- At any stage of Construction Work and when observed, any item determined to be damaged, or faulty, is to be reported to the IFA. Corrective action by Developer requires prior approval, retesting, and inspection.
- Check and tighten terminals and connection points, and review and collect manufacturer's drawings and instructions for delivery to the Engineer. Make routine checks and tests as the job progresses to ensure that cables and devices are properly installed.

Testing and checkout work is to be performed with fully qualified personnel skilled in the particular tests being conducted. Personnel are to have at least five years of experience with tests of same type and size as specified. Personnel qualifications shall be included in the Construction QA/QC Plan specified in Section 4 and shall be subject to the same review and approval requirements.

Developer shall provide supervision, labor, materials, tools, test instruments and all other equipment or services and expenses required to test and operationally check work and components for all portions of the Work. See individual sections of the Technical Provisions for detailed test requirements.

Developer shall pay for all tests specified including expenses incident to retests occasioned by defects and failures of equipment to meet the requirements of the PPA Documents, at no additional cost to the IFA. Unless otherwise specified, Developer will supply the electric current necessary for tests.

Developer shall replace items found defective (defined as failing to meet specified requirements) at no additional cost to the IFA.

Do not void equipment warranties or guarantees by testing and checkout work. Checks and tests shall be supplemental to and compatible with the manufacturer's installation instructions. Where deviations are apparent, obtain the manufacturer's approved review of procedure prior to testing. Where any repairs, modifications, adjustments, tests or checks are to be made, Developer shall contact the Engineer to determine if the work should be performed by or with the manufacturer's representative.

All checks and tests specified for proper operating and safety of equipment and personnel are to be performed concurrent with progression of the Work, prior to Final Acceptance.

Check Out and Testing

Developer shall provide checkout and testing of the entire grounding system in accordance with the following:

- Measure ground grid resistance with earth test megohmeter and install additional ground rods and conductors until resistance to interconnected ground system is 5 ohms or less. Measure ground resistance in dry conditions and not less than 48 hours after rainfall.
- Ground resistance measurements of each ground rod shall be taken, before any wire is connected, and test results recorded.

Ground-resistance measurements shall be made from all grounded non-current carrying metallic parts of electrical equipment (enclosures) to the ground electrode, and measured results recorded. Values obtained shall not exceed those specified previously.

Recorded results shall be tabulated to form a test report which shall be submitted to the Engineer for review and comment within 30 days of the completion of the test. The test report shall include, but not be limited to, the following:

- Identification of each component tested.
- Location of each component tested.
- Time of each test.
- Resistance values.
- Soil condition and resistivity at the time the test (for ground rod measurements) was performed.
- The test report shall be submitted to the Engineer for review and comment.

Test Methods:

Perform “fall-of-potential” type test per IEEE Standard No.81 on the main grounding electrode or system.

Perform the “two-point” type test per IEEE Standard No.81, to determine the ground resistance between the main grounding system and non-current carrying metallic parts of electrical equipment (enclosures), system neutral and/or derived neutral points.

Inspections: Inspect ground system for compliance with grounding requirements.

17.2.2.10 Electrical Load Classification

The electrical power system shall be arranged to serve four distinct classifications of loads: normal, essential, standby, and emergency. The sources for these loads shall have full capacity to supply the full connected load demand without need for load shedding or selective load pick-up.

Normal

Normal loads shall be all loads that are not defined as essential, standby, or emergency.

Essential

Essential loads shall be those loads classified as such by codes or regulations. They are required to be supplied by two separate and distinct sources of power. Essential loads may be supplied by the standby or emergency systems provided that they are designed and installed to meet the requirements of those systems.

Standby

Standby loads shall be those loads that are deemed, by Developer, to offer enhanced operations, safety and protection through their continued availability during a total loss of commercial utility electrical supply. Standby loads shall be primarily served by the essential electrical supply and backed-up by an alternate source during a total loss of the respective preferred supply. The sources for standby loads shall be permanently installed, and shall be arranged for temporary continued operations during planned or unplanned downtime.

Emergency

Emergency loads shall be those loads legally required and classified as emergency to meet the requirements of the PPA Documents. All emergency loads shall be reviewed by the IFA and, as applicable, KYTC. Emergency loads are supplied by an emergency system meeting the requirements of NFPA 70, NESC C2, IEEE 446 and NFPA 502.

Emergency loads shall be connected to the distribution system such that emergency loads are automatically connected to the emergency source upon loss of primary source(s) or shall be continuously supplied by the emergency source. Only emergency loads shall be connected to the emergency system, and the essential or standby sources shall not be permitted as the emergency source for any emergency loads. In addition, the emergency source shall be permanently installed and continuously monitored for derangement or inability to serve the emergency loads.

17.2.2.11 Illumination

Developer shall provide fully functional lighting systems for the Tunnel and support facilities which meet the visibility requirements for day and night conditions, for interiors of enclosed facilities and occupied buildings, and for safety and security. All lighting systems shall be complete, operational, and designed in accordance with ANSI/IES RP-8 and RP-22.

Developer shall install monitoring equipment that is connected to TRIMARC through the SCADA system and will report the status of the lighting (On or Off), state of lighting (if lighting levels change in response to ambient lighting conditions), and provide controls to manually select the state (set the lighting level to higher or lower intensities).

The following performance requirements shall apply:

1. The lighting system design shall be based on equipment and materials suitable for the operating environment and be comprised of components providing for ease of maintenance and repair. In addition, the lighting system shall be designed to prevent sudden and complete darkness at any time in the Tunnel and all ancillary facilities.
2. All components of the lighting system shall be designed with consideration of serviceability and prevention of vapors, dust and water jet spray from entering the lighting fixtures, luminaires and electrical systems. All fixtures shall exhibit the ability to withstand high pressures resulting from roadway washing machines. All luminaires within the Tunnel shall be UL listed accordingly.
3. The lighting systems shall not create spurious radio frequency emissions in excess of Federal Communications Commission (FCC) limits in any licensed frequency band.
4. Flicker effect shall be avoided by Developer in the lighting design.
5. The Tunnel lighting shall be glare free, uniform, and organized in a logical manner, and shall serve as a visual guide to lead the roadway user’s eye along the road ahead. The Tunnel luminance criteria shall be developed in zones according to the requirements of ANSI/IES RP-22. The reduction of luminance level in the threshold zone shall not be less than one safe-stopping sight distance, and overall the combined length of the threshold and transition zones shall follow ANSI/IES RP-22.

6. Lighting shall be configured such that consistent luminance uniformity ratios are maintained between exterior and interior surfaces. These uniformity ratios shall be maintained during varying ambient light conditions and switching steps in threshold and transition zones shall be utilized to accommodate this variability by automatic means. The system shall prohibit response to sudden short duration light level changes.

7. The switching steps shall be controlled by appropriate photo controls that monitor outdoor light at the threshold of the Tunnel. Switching from full daytime levels to night time levels shall be moderately stepped to avoid abrupt changes in illumination.

8. Prism lighting (or colored lighting) shall be used in selected areas to add color as needed to fully convey aesthetic treatment.

Luminaires shall permit specific directional light control and shall be coordinated with the lighting control system to allow switching on and off of specific lamps within the luminaire.

Appropriate luminance values shall be provided for all spaces, and emergency lighting shall be provided throughout as required by regulatory agencies. All exits, cross passageways, and egress stairwells shall be highly illuminated and clearly identified by dedicated emergency exit lighting. The emergency lighting system shall provide maintained illumination throughout all means of egress in accordance with NFPA 502.

17.2.2.11.1 Control

Developer shall provide a Tunnel lighting control system and all equipment and materials required to make the system complete and workable as specified herein. The lighting control system shall control and monitor the lighting installed within the Tunnel and interface with a Supervisory Control and Data Acquisition (SCADA) system.

The Tunnel lighting controller shall be designed, manufactured and tested to the latest ANSI, IEC, IEEE, and NEMA standards as listed in this Section 17. The Tunnel lighting controller and associated equipment shall be UL listed.

Developer shall provide a complete and operable Tunnel lighting control system as specified herein. The major components of the system shall include a cabinet with a PLC, RIO, OIT, and multiple remotely mounted luminance sensors sufficient to monitor areas of varied illumination, especially at transitions near the portals.

The Tunnel lighting control system shall incorporate a communication network. This network shall interface with the SCADA system described herein.

The Tunnel lighting controller assembly shall have hardwired connections to the SCADA.

The Tunnel lighting controller shall be furnished with the manufacturer's “off the shelf” standard programming software that is used to create the specific functional program software for the controller. The software shall be designed to simplify the creation and editing of the functional controller program without requiring the end user to have knowledge of high level programming languages or formatting. Software shall include a complete CD package, programming manuals, and licenses.

The Tunnel lighting controller operating software shall be the manufacturer's “off the shelf” standard software to support the full functioning of the controller as an automated control system with all mathematical operators, logical operators, data storage registers, and memory allocation. The controller operating software shall fully support the required controller capabilities as required by the specifications. Software shall include a complete CD package, programming manuals, and licenses.

The operator interface terminal shall be furnished with a completely installed and tested version of a commercially available, “off the shelf” interface software package. Software shall include a complete CD package, programming manuals, and licenses.

17.2.2.11.1.1 Lighting Panels

Design Criteria

Provide remotely controlled lighting panels such that lighting control panelboards contain both standard and remotely operable circuit breakers. Provide control electronics for switching circuit breakers and monitoring the status of the system from a remote location as well as at the panelboard.

Material Requirements

The lighting panel system shall consist of microprocessor-based control electronics and remotely operated circuit breakers. Control electronics and breakers shall be mounted to a UL67 listed lighting panelboard interior. The panel enclosure shall be UL50 listed.

The circuit breakers shall provide overcurrent protection, and have an AIR rating that meets or exceeds the fault current of the system to which the panelboard is being applied.

FCC Emissions: All assemblies are to be in compliance with FCC emissions Standards specified in Part 15, Subpart J for Class A applications

Electronic panelboard components shall meet or exceed levels as follows:

- ESD Immunity IEC 1000, Level 4
- RF Susceptibility IEC 1000, Level 3
- Electrical Fast Transient Susceptibility IEC 1000, Level 3
- Electrical Surge Susceptibility – power line IEC 1000, Level 4
- Electrical Surge Susceptibility – interconnection lines IEC 1000, Level 3.

The panels shall provide status feedback by monitoring branch circuit breaker status based on actual system voltage at load side terminals. Breaker status shall be monitored by the lighting control system.

The panels shall accept remote commands from the lighting control system.

Panels shall be installed with barriers to separate Class 2 wiring from power conductors.

All remotely operated branch circuit breakers shall provide overload and short circuit protection suitable for the location in the electrical system.

17.2.2.11.1.2 Lighting Control Electronics

Master Panelboards

Master panels shall contain both a power supply module and controller. Master panels shall provide power and control for operating and monitoring remotely operated branch circuit breakers connected to control busses located in master and slave panelboards. One power supply module and controller shall support a maximum of eight (8) control busses.

Master panels shall labeled to indicate the panel designation, automation level network address, and the designations and addresses of all associated slave panels.

A power supply module shall be furnished to provide control power for the operation of the remotely operated circuit breakers, controller, bus system and low voltage inputs. Power module(s) shall connect directly to the panel interior and receive line voltage from the panel bus. Power module(s) shall be internally self-protected and operate within a range of –15% to +10% of its nominal line voltage rating.

The controller shall operate whenever voltage is within the power supply operating range. In the event of incoming power outage, the controller shall automatically halt execution in a safe manner. Upon return of power, the controller shall automatically reboot and return to normal system operation.

The controller shall include:

- A keypad and LCD front panel for local setup. Front panel setup shall permit local input setup without requiring separate PC-based software or hand held loader devices.
- USB 2.0 communications interface to permit local connection to personal computer without having to remove panel trim. In the event that the panel does not natively support the USB 2.0 interface, the manufacturer shall supply a converter all necessary hardware and software to allow communication with a laptop computer with a USB 2.0 port.
- Non-volatile memory to retain all setup and configurations.
- An auxiliary control power source for powering external control devices as indicated on the contract drawings.
- Capability for accepting downloadable firmware so that the latest production features may be added in the future without replacing the module.
- Each panel controller shall have no less than sixteen (16) physical inputs that can be connected to eight (8) external devices as shown on the drawings. These inputs shall be capable of being Configurable for Normally Open, Normally Closed, 2-wire maintained toggle, 2-wire momentary toggle, 2-wire momentary On, 2-wire momentary Off, or 3-wire momentary operation.
- Each panel controller shall be capable of operating in a pass-through mode for Modbus connected devices, such as meters, whereby the information is automatically ported to the Modbus TCP/IP port without separate gateway devices.
- Each panel controller shall support Ethernet communications using Modbus TCP/IP or BACnet/IP protocols.
- Each input connected to the controller shall be capable of controlling any branch circuit connected to any other controller.
- Means for setting initial Ethernet parameters via a local operator interface without having to employ special software or configuration tools.

- Panel summary showing the master and all slave panels connected to the controller.
- Controller summary showing controller diagnostic information.
- For a consistent user interface provide remote front panel mimic screens for setting up controller parameters, input types, zones, and operating schedules. Mimic screens shall also allow direct breaker control and zone overrides.
- Sub-net wiring connections shall allow connection of wiring to a terminal that can be removed from the panel without interrupting the communications to other panels.

17.2.2.11.1.3 <u>Configuration Software</u>

Configuration software shall be designed specifically for the lighting control system and supported by the manufacturer. Software shall support system configuration, printing of configuration records, and monitoring and control functions in a Windows environment.

For basic setup and control, the software shall serve as a configuration and diagnostic utility. Basic features shall include support for configuring inputs, zones, circuit breaker actions, and time schedules. Software shall be able to monitor the status of the system and provide visual indication of input status, circuit breaker status, and operational parameters. Software shall be able to establish connections to the system through a controller front port, USB 2.0 port, and Ethernet port. Support for remote system dial-up shall be incorporated into the software package.

Construction Requirements

Developer shall provide any custom hardware or communication devices necessary to make the system perform as specified above.

Developer shall provide PC user interface custom screens.

17.2.2.11.2 <u>Sensors</u>

The Tunnel lighting shall be controlled by luminance sensors at each end of the Tunnel with a minimum of five (5) controller output levels for each that can be configured through the operator interface terminal.

17.2.2.11.3 <u>Interface</u>

Developer shall provide an operator interface terminal shall be provided for the lighting control system. The interface shall be a text display keypad mounted on the contactor cabinet. The interface shall display the parameters to be controlled. Configurations and local lighting control selections shall be accomplished through the interface. The interface shall operate in running, test, or setup modes.

Changes shall only be allowed with a password. All configured values and programs for the interface and lighting controller shall be saved on battery-backed or non-volatile memory. The system shall provide means for a level lockout for emergency power resumption.

17.2.2.11.4 <u>Luminaires</u>

Tunnel lighting may use high pressure sodium vapor luminaires or other equivalent high-output fixtures. All fixtures shall meet the requirements of IES-RP-22 and IP-65.

Developer’s lighting design shall minimize the need for lane closures for lamp replacement and other lighting maintenance activities.

17.2.2.12 Tunnel Drainage Systems

Developer shall coordinate and establish responsibility, protocol and executable procedures as necessary to meet the remote monitoring and control requirements herein for all active drainage systems.

Tunnel Drainage Systems

The Tunnel drainage system design shall incorporate the following:

1. The Tunnel drainage system shall be designed in accordance with the requirements of NFPA 502. Pipe and fittings for tunnels and adjacent spaces shall be suitable for a tunnel environment and meet the NFPA 502, NFPA 820 and International Plumbing Code (IPC) requirements.

2. Corrosion control measures shall be provided for buried pipes in accordance with the National Association of Corrosion Engineers (NACE) corrosion control standards.

3. Where drainage cannot be directed to a gravity system, drainage shall be directed to pump stations located at the low points of the Tunnel or Tunnel approaches.

4. Pump station hazardous spaces shall be classified per NFPA 70. Pump station equipment shall be suitable for the applicable space hazardous classification (e.g., equipment located in wet wells or spaces that potentially will have explosive levels of hydrocarbons shall be explosion proof). Systems, equipment and components installed in wet wells shall be designed to fully exclude moisture, abrasive material, corrosive gases, and all other matter that may contribute to wear.

5. The pump station access hatches or panels shall not be located in travel lanes of the roadway. Access hatches or panels may be located in the shoulder lane and shall be designed to handle anticipated traffic loadings.

6. All pump stations shall be monitored and have override control connected to the Tunnel SCADA system for remote control. Wet well atmospheric monitoring systems, ventilation, station telemetry systems and other elements for a complete and operable pumping system shall be provided. In addition, all pump stations shall provide means for settling of sediment and skimming of floating materials; shall have an automatic pump operating control system, water level detection and control, and alarm signals to annunciate locally and at a “remote” control location in the event of water level being too low or too high. The pump bay shall have submersible, non-clogging, non-overloading, centrifugal type pumps that provide adequate redundant capacity to pump 100% of Developer’s calculated design flow with a failure of one pump. The automatic pump control system shall provide for equal operating time for each pump and prevent pumps from overheating. The water level detection system installed in the wet well shall be intrinsically safe, mercury free and suitable for the wet well environment. The piping system shall be designed to provide scour velocities with a single pump running and shall be designed to handle the flow from all pumps running at the same time.

7. A wet well ventilation system, designed in accordance with NFPA 820, suitable for a moisture and corrosive environment shall be provided that is capable of providing a

minimum of 12 air changes per hour. This system shall be provided with controls that will operate the ventilation system automatically based on time of day and concentration levels of hydrocarbon vapor and manually locally.

8. A hydrocarbon based vapor detection system shall be provided that provides an alarm in the event petroleum vapors are present in the drainage system, shall start fresh air supply upon high hydrocarbon levels, and shall shut down all pumps should hydrocarbon levels exceed a safe value. The alarm shall annunciate locally and be connected to the Tunnel SCADA system for remote annunciation to a “remote” control location.

17.2.2.13 Fire and Life Safety Systems

Developer shall design and specify all required materials, components, software, and programming necessary to provide fully functional fire and life safety systems for safe and efficient operation and to support maintenance and emergency response activities. This shall include, but are not limited to; amplitude modulation (AM)/frequency modulation (FM) rebroadcast system, two-way emergency response radio system, personnel telephone system and fire detection and alarm system. The two-way radio and personnel communication systems shall be provided throughout the Tunnel, ancillary facilities, Tunnel cross passageways and emergency egresses. All systems shall be central-controlled from tunnel operator workstations in TRIMARC and KYTC TOC.

17.2.2.13.1 Commercial Radio Rebroadcast

Design Criteria: The Developer shall install a commercial radio rebroadcast system through the Tunnel capable of rebroadcasting all commercial radio stations that can be received at the Tunnel portals. The radio rebroadcast system shall include override capabilities, permitting a tunnel operator to override all commercial frequencies with the rebroadcast of highway advisory radio (HAR) messages, WIZARD warnings, pre-recorded emergency messages, and/or ad hoc messages. Rebroadcast capability shall be provided for WIZARD warnings over the CB radio band at signal strength in conformance with FCC regulations inside the Tunnel.

Developer shall design and install the rebroadcast system to permit interruption and override of all rebroadcasted commercial radio signals to convey instructions to motorists for traffic and emergency response instructions. All override programming shall originate from the tunnel operator workstations.

No degradation of the two-way FM radio system shall be permitted by the rebroadcast system.

Construction and Material Requirements: Refer to Two-Way FM Radio for installation and material details on local repeater station and antennas. Redundancy shall be provided to preclude the loss of signal due to physical damage or equipment failure to a single antenna. The local equipment of the rebroadcast system shall be controlled and monitored from a designated console at the tunnel operator workstations and shall be designed to communicate with all participating agencies via their approved communications protocols. Developer shall design all rebroadcast equipment in conformance with FCC rules and regulations Section 90.242, and fully test and integrate the system into the tunnel operator workstations.

17.2.2.13.2 Two-Way FM Radio

Design Criteria: Developer shall design and install a two-way FM radio communications system to include frequencies and channels for police department, fire rescue, local emergency services, highway patrol unit, maintenance unit, KYTC, and the National Government Interoperability frequencies, etc. as deemed necessary by the IFA. Actual frequencies are to be determined in coordination with first responder operating on the 150, 450 and 800 MHz bands. Developer shall provide repeaters and infrastructure to support rebroadcast of up to 25 frequency pairs within the first responder frequency bands. All Tunnel areas shall have coverage by this system to generate, receive, and re-transmit radio signals for continuous two-way radio communication between authorized vehicles or hand-held terminals in the Tunnel and their respective central dispatchers.

Construction and Material Requirements: Local radio amplifier equipment for AM/FM rebroadcast and two-way FM radio shall be installed at the cross-over passage in the middle of the Tunnel. Two types of antennas shall be provided at maximum distance of 90 feet, center-fed from their local amplifiers. Two types of antennas will be suspended by stand-off insulators fastened to the Tunnel liner with clearance from the traffic and other Tunnel equipment. The lower antennas shall be leaky coaxial cable covering AM and FM broadcast bands, and the upper antennas shall be a solid copper or steel-coated copper wire for two-way emergency response bands and emergency override communications. The upper antennas will survive a fire longer than will leaky coaxial cable and can provide radio communications in times of critical emergency.

All local rebroadcast and two-way radio equipment shall be controlled from the tunnel operator workstations.

Redundancy shall be provided to preclude the loss of signal due to physical damage or equipment failure to a signal antenna. Developer shall design all rebroadcast equipment in conformance with FCC rules and regulations Section 90.242.

17.2.2.13.3 Telephone System

Developer shall provide a multifunctional private automatic branch exchange (PABX), of the most current technology available as of the Setting Date, system for normal and emergency voice communications. The PABX central equipment, including the server and an interface to the local Public Switched Telephone Network (PSTN) carriers, and the station administration panel, shall be located in the south tunnel equipment building(s). The telephone systems shall permit tunnel operator control of calls. The telephone system will provide standard PABX features, including call waiting, call transfer, call pick up, six-way conference calling and speaker-phone operation. Diagnostic software will create audible alarms in case of system malfunction, and peg counts, occupancy and other system statistics will be monitored, maintained and recorded hourly.

The proposed telephone system shall have the followings components:

- The dedicated telephone network equipment in the tunnel equipment building(s).
- Emergency call boxes in the Tunnel
- Interconnect to radio rebroadcast VBI (Voice Break-In) in the Tunnel
- Public address system

Dedicated/Direct Telephone Network: The dedicated network is a group of direct telephone lines providing point-to-point non-dialed voice communications. These lines guarantee direct communication with emergency service providers through specific terminals with automatic dialing. The locations for the direct telephone network shall be determined during final design, in conjunction with the development of the ERP.

Emergency Call Boxes: Call boxes are provided at 200 foot intervals along the maintenance walkways in the Tunnel for the safety and convenience of motorists. When activated, voices of motorists and operators will be coded and carried over the Ethernet IP network between each call box and the handset at the tunnel operator workstations. Lifting a callbox phone will immediately ring operators.

The emergency call box is an integral part of the complete project telephone system. The call boxes used for this application function the same way as traditional call boxes, except for their use of the communications transport medium. Copper pairs from the call boxes connect to gateways which digitalize the voice streams and convert them to TCP/IP packets for transport to the PABX via the fiber backbone. Tunnel operators will answer the call and can verbally coordinate emergency services.

Operators are also able to monitor the functionality of the call boxes remotely. Central control software shall be installed on a designated server to quickly recognize potential problems anywhere within the call box system. Abnormal situations detected by the designated server will be promptly displayed and printed for emergency action. This assures timely repair or replacement of a problem call box.

Public Address: Public Address speakers will broadcast audible messages in the Tunnel in times of emergencies. Speakers will be individually addressable by operators for maximum flexibility. The principal functions of this subsystem are group paging, intercom, and loudspeaker public address.

Audio amplifiers, speakers and volume levels for messages shall be designed per manufacturer’s requirements to match speaker power to local conditions to reach the optimal sound pressure level for all covered areas throughout the Tunnel. Developer shall prepare and submit a system design analysis and recommendation to provide a clearly audible messaging capability throughout the Tunnel, cross passages, and tunnel equipment building(s). Capability shall be provided for selective messaging by zone.

17.2.2.13.4 Fire Detection and Alarm System

Design Criteria: Developer shall design, install and test a fire detection and alarm system in the Tunnel. Developer shall coordinate fire detection and alarm requirements in accordance with NFPA 70, NFPA 72, NESC C2, NFPA 101, NFPA 502, and State fire codes.

Fire detection for Tunnel shall be automatic. The system shall include intelligent type fire alarm control panels and associated peripherals. All fire alarm control panels in the Tunnel shall be monitored by the SCADA system for alarms and system emergency. In addition, the following shall apply:

1. Fire detection and alarm systems shall be designed based on 24/7 monitored operations.
2. Fire detection systems shall be designed to apply two separate forms of detection, identify or locate a fire, and shall include a manual pull station system. No glass shall be used in manual fire alarm pull stations.

3. The fire detection and alarm system shall be point-addressable, with analog alarm initiating devices where applicable. All initiating devices shall report to the fire alarm control panels.

Construction and Material Requirements: The fire detection and alarm system shall include all required materials, components, software, and programming necessary to provide a fully functional system for fire detection and annunciation in the Tunnel fully controlled from the tunnel operator workstations.

The design shall incorporate the installation of required pull stations, detectors, indicators, switches, and other devices as necessary to meet requirements. Perform visual and audible device layout calculations to determine placement of devices. The design shall incorporate the installation of all code required fire alarm peripheral devices, with the location and spacing of each type of device as required by NFPA and other applicable codes and standards. Fire detection and alarm systems shall meet ADA requirements.

The system shall provide tamper switches for each post indicator valve (PIV) and for each outside screw and yoke control and sectionalizing valve associated with the standpipe system, potential sprinkler system and water supply system located throughout the Tunnel. Separate initiating zones shall be provided for the supervisory valves' switches. Provide separate addressable fire alarm monitor modules for each supervisory valves' tamper switch and area flow switch in the sprinkler system.

Connect addressable fire alarm monitor modules for each switch to the control panels in accordance with manufacturer's requirements, which shall be further monitored by the SCADA equipment installed in cross-over passages in the Tunnel. The SCADA will report system status to the SCADA workstations via the dedicated optic fiber backbone. Fire Alarm pathways shall be independent of other systems and shall comply with UL 864 "*Control Units and Accessories for Fire Alarm Systems*".

Fire alarm circuits shall be installed in their own dedicated conduit, separated from any open conductors of power, lighting, or Class 1 circuits, and shall not be placed in conduit, junction boxes, or raceways containing such conductors. Specify all fire alarm junction box covers shall be painted red and shall have "Fire Alarm System" stenciled on the cover.

17.2.2.14 Supervisory Control and Data Acquisition (SCADA) System

Developer shall provide a fully functional SCADA system to continuously monitor and control the Tunnel and ancillary equipment, including but not limited to; electrical and ventilation equipment, carbon monoxide and hydrocarbon monitoring systems, fire protection systems, drainage system, lighting system, and emergency response radio systems. In addition, the SCADA system shall provide the hardware and software for operator interfaces, data archival and retrieval, and integration with all other necessary systems, including the ITS. The system shall operate continuously under all operating conditions and at all times.

A fail-safe network topology is required. The design shall meet the requirements of NFPA 70, NFPA 72, and NESC C2. In addition, the following shall apply:

1. The system shall be designed to accommodate an increase in monitoring and control points, and all equipment except the actual monitoring devices shall be redundant.

2. The system shall send required signals to the SCADA servers for processing while providing full functionality under all operating conditions, including allowance for modifications and repair. In addition, SCADA equipment in non-environmentally controlled areas shall be designed to operate without the need for active cooling or heating support, or shall be housed in enclosures that have redundant environmental control powered from emergency supplies.

3. The design shall eliminate vulnerability to a single point failure, adequately handle all anticipated transaction volumes, and accept future hardware and software growth.

4. Data processing shall be redundant. Dual servers and disk arrays are required and shall be programmed for automatic failover and recovery.

5. Fire Life Safety components and pathways shall be parallel, redundant, and routed for incident survivability, and shall comply with UL 864 “Control Units and Accessories For Fire Alarm Systems”.

Developer shall be responsible for the planning, design and installation of a Remote Control Unit (RCU) based Supervisory Control and Data Acquisition (SCADA) system, an Operator Interface Terminal (OIT), Remote Input / Output (RIO) assemblies, control cabinets, and associated work herein specified or otherwise required for a complete and fully operable control and monitoring system for the Tunnel.

The working drawings shall indicate the dimensions, weight, and full mounting details of all components. Developer’s Design Documents shall include termination and inter-connection diagrams between the components specified.

Developer shall be responsible to provide all software in accordance with this specification.

The major SCADA system components shall include redundant RCUs, redundant power supplies, redundant Uninterruptible Power Supplies (UPS), redundant communication networks, operator interface terminal, and Remote Input/Output (RIO) assemblies. In addition, Developer shall provide the instrumentation to monitor the SCADA enclosure temperatures, room temperatures, area carbon monoxide sensors, smoke detectors, and building door magnetic intrusion switches. All instrumentation shall be industrial grade suitable for the application.

The SCADA system shall incorporate the remote I/O network including all points listed below. This network will allow communication connections with all RIO chassis and the OIT.

Each RIO shall consist of a chassis rack mounted on a back panel with the number of modules as necessary for the I/Os to monitor points listed below.

There shall be at least 20% spare I/O capacity above the quantities shown on the Contract Design Documents for each type of points. All spare I/O points shall be wired to field termination blocks. In addition, provide one (1) unused spare and wired I/O card of each type.

The RCU shall be furnished with the manufacturer's “off the shelf” standard RCU programming software that is used to create the specific functional program software for the RCU. The software shall be designed to simplify the creation and editing of the functional RCU program without requiring the end user to have knowledge of high level programming languages or formatting. Software shall include a complete CD package, programming manuals, and licenses.

Software

The RCU operating software shall be the manufacturer's “off the shelf” standard software to support the full functioning of the RCU as an automated control system with all mathematical operators, logical operators, data storage registers, and memory allocation. The RCU operating software shall fully support the required RCU capabilities as required by these specifications and be in accordance with the manufacturer's standard system. Software shall include a complete CD package, programming manuals, and licenses.

The manufacturer's standard RCU programming software shall be fully installed and tested. The software shall be capable of creating functional programs for all current RCU models of the same class of family offered by the manufacturer.

The OIT shall be furnished with a completely installed and tested version of a commercially available, “off the shelf” interface software package. Software shall include a complete CD package, programming manuals, and licenses.

The software shall include at least the following packages:

- Ladder logic program creation and editing software
- RCU operating software and application software
- Video display creation and editing software
- Video display operating software and application software

Program Creation and Editing Software

The RCU system shall be furnished with the manufacturer's standard software that is used to create the specific functional program software. The software shall be designed to simplify the creation and editing of the functional RCU program without requiring the preparer's knowledge of special non ladder type programming languages or formatting.

The manufacturer's standard software shall support functional program creation and editing using all of the following input types. The manufacturer's standard software shall allow functional programs that are prepared, or are partially completed, using one input type, to be completed or edited using any of the two input types.

- Traditional Ladder Logic input using a graphic presentation
- Logic flow-diagram input using a graphic presentation.

The manufacturer's standard software shall provide for graphical off-line simulation or testing of the functional program. The simulation shall indicate all logical inputs, values, and results by graphically indicating all device conditions and values (e.g. - inputs, outputs, registers, timers, counters, logic statements, etc.). The graphical simulation shall be available in both ladder-logic format and logic flow-diagram format. The graphical simulation shall allow manual assignment of device conditions (e.g. - true, false, numerical values, etc.) to simplify testing and troubleshooting.

The software shall include provisions to simplify debugging and to identify errors in the functional program. The debugging capability shall be designed to detail the specific errors, to recommend corrective action, and to provide "help" instructions to search, identify, and implement corrections.

The manufacturer's standard software shall allow the actual conditions of the functional program to be graphically monitored on-line as it is executed by the RCU. On-line monitoring shall be available at both ladder-logic format and logic-flow-diagram format.

The RCU system and the manufacturer's standard program creation and editing software shall allow the functional program to be edited both "on-line" and "off-line."

The software shall require confirmation of password prior to allowing either on-line editing or downloading a functional program to the RCU. Passwords shall be tied to levels of control / indication.

The software shall enable full text remarks to be included within both the ladder-logic format and logic-flow-diagram format. The remarks shall clearly identify the assignment and function of the functional program, instruction set groups, single instruction sets, subroutines, and individual devices.

The system shall also include supporting software that will provide automatic monthly logging.

The RCU programming software shall operate on Microsoft Windows operating system.

RCU Operating Software

The RCU unit shall be furnished with a complete and fully tested version of the RCU operating software. The RCU operating software shall be the manufacturer's standard software to support the full functioning of the processor as an automated controller system with all mathematical operators, logical operators, data storage registers, and memory allocation. The RCU operating software shall fully support the required RCU processor capabilities as required by this specification and in accordance with the manufacturer's standard system including but not limited to items such as the following:

- Register quantity
- Data memory capacity
- Instruction set capacity
- Instruction set execution cycle speed

The software shall be fully compatible with all other software packages described in this specification.

The software shall incorporate self-test and self-check functions to verify system operability. At power-up, the system shall verify which cards are connected to the system. The self-test and self-check functions shall be performed during each execution scan and shall include but not be limited to the following:

- Check all system memories
- Check all I/O
- Check data register integrity
- Test logic processes
- Test network processors
- Check communications processors

SCADA System RCU Functional Program Software

The functional program software shall be developed with complete integral annotation to simplify understanding by others who will review, maintain, update, and perhaps modify the operating system in the future. Annotation shall clearly indicate the function and logic of devices, operators, rungs, groups of rungs, and subroutines. Annotation shall specifically indicate the purpose and logic of operations that may be reset or adjusted in the future (e.g. - timers, counters, comparators, etc.).

17.2.2.14.1 Points

Electrical and ventilation equipment

Provide SCADA monitoring of electrical and ventilation equipment status and alarms.

Carbon monoxide (CO) and hydrocarbon monitoring systems

Provide SCADA monitoring of carbon monoxide and hydrocarbon monitoring systems status and alarms.

Fire protection systems

Provide SCADA monitoring of fire protection systems status and alarms.

Drainage system

Provide SCADA monitoring of drainage systems status and alarms.

Lighting system

Provide SCADA monitoring of lighting systems status and alarms.

Emergency response radio systems

Provide SCADA monitoring of emergency response radio systems status and alarms.

17.2.2.14.2 PLC

The PLC shall read the inputs, perform all system logic, conduct on line diagnostics, and control the outputs. Diagnostics shall include memory checks, scan time monitoring and I/O bus monitoring. If a fault is detected within the PLC, the processor shall stop and transfer control to the alternate PLC. The redundant PLC shall be configured as hot standby. If a fault is detected on the remote I/O network, the PLC shall hold outputs in their last commanded state within the PLC memory, prior to the fault.

The PLC shall be a self contained unit, and shall provide ladder rung program execution and support remote or local programming. The PLC shall provide I/O scanning and inter processor and peripheral communication functions.

The PLC shall give visual indication by illuminating an indicator when no fault is detected and turn off and/or turn-on a second indicator when a fault is detected.

The PLC shall be based on a 32 or 64 bit microprocessor.

The PLC shall have the capability to communicate with at least 4 separate RIO and OIT.

A minimum of 64K words of internal, solid state RAM memory shall be provided for storage of the control program. The full memory of the PLC shall be usable for program or data storage. The memory shall be expandable with the addition of RAM memory sub modules.

Program back up shall be on non volatile EEPROM memory cartridges.

Memory shall be capable of retaining all stored program data through a continuous power outage for up to four months under worst-case conditions.

Program functions shall include contacts, coils, timers, counters, math functions (add, subtract, multiply, divide), shift registers, bit, and word operations.

The PLC shall include an integral real time clock which can be accessed from the control program. The clock shall include functions for time of day (year, month, day, hour, minute, seconds), alarm, and operation hours' counter. The PLC and clock shall be designed to accommodate timing through at least the year 2,099 AD.

The PLC shall be capable of floating point math calculations including, but not limited to, integer to floating point conversion, floating point to integer conversion, add, subtract, multiply, divide, square root, compare and all other commonly available functions.

The PLC shall permit changing ladder program or data values while running.

17.2.2.14.3 <u>Remote I/O</u>

The RIO shall consist of a single chassis mounted on a back panel with the number of modules required for the I/O required.

RIOs shall be located as required to monitor the facility.

All RIO's shall have same size, type, and capacity modules.

All hardware of the RIO shall operate at an ambient temperature of 32 to 140 degrees F.

The RIO hardware shall function continuously in the relative humidity range of 5 percent to 95 percent with no condensation.

The RIO shall withstand vibration and impact shock tests as per IEC 60068 2 6 and IEC 60068 2 27.

The equipment shall be design to the site seismic condition as follow: Division IA of AASHTO with acceleration coefficient, A = 0.06 and a Seismic Performance Category, SPC = A. The site coefficient, in accordance with Division IA of AASHTO, is 1.0.

Modules shall be plugged into a chassis that are designed to restrict improper module insertion and allows for installation in only one direction. The design shall prohibit upside down insertion and backward insertion, as well as safeguard against the insertion of a module into the wrong slot. The chassis shall be mounted on a back panel.

All system and signal power to the processor and support modules shall be distributed on a single motherboard or backplane. The modules shall not be interconnected using wiring or plug terminated jumpers.

All modules shall include an LED that is visible from the front (insertion side) and that will illuminate if, and only if, the module is properly and completed inserted with power from the backplane.

The I/O chassis and its respective modules shall be compatible with any RCU manufactured by the supplier.

All I/O modules shall be firmly attached to the I/O chassis.

The chassis design shall allow replacement of any input or output module without disturbing field wiring.

Equipment tag number nameplates shall be provided for each RIO chassis.

Front Each RIO (inside cover) shall include, but not be limited to, the following controls and indications.

- I/O rack fault
- On/Off status of individual input or output points for each I/O module
- RIO adapter active
- RIO adapter fault

During normal operation, a malfunction in any RIO chassis shall affect the operation of only that chassis and not the operation of the RCU or any other chassis.

Any RIO chassis shall be field selectable to shut down the PLC upon failure of that chassis.

Upon remote channel shutdown, the RCU shall see all inputs on the malfunctioning chassis as they were when the shutdown occurred and all outputs shall de energize in that chassis.

Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 1500 VRMS.

Discrete output modules shall be provided with self contained fuses for overload and short circuit protection of the module. These cards shall also be capable of having fused swing arms for each point so as not to disturb the card and/or wiring while changing a blown fuse.

All I/O modules shall be color coded and titled with a distinctive label.

All input modules shall have a specified filter time constant to limit the effects of voltage transients.

All digital input modules shall be isolated 120 volts AC.

All digital output modules shall be isolated contacts with normally open contacts. Each output shall have a separate common and shall be electrically isolated from module logic circuitry. Each output shall conduct a maximum load of 2.0 A continuously at 500 VA for ac loads.

Analog input modules shall have isolated differential channels with a minimum of 12 bit resolution. Analog inputs shall be 4-20 mA.

The processor module shall interface the RIO to the RCU processors across the Modbus Network. The transmission rate of communication shall operate at minimum 50K baud on the Network.

The power supply for RIOs shall meet the requirements as the RCU power supply.

17.2.2.14.4 Operator Interface Terminal (OIT)

Developer shall furnish and install one complete OIT assembly for the SCADA system. The OIT shall provide local control and monitoring capability for the SCADA system.

The OIT shall be furnished complete with video display creation software.

The OIT shall have a flat-panel design, high resolution pixel graphics, touch screen and color display. The screen size shall be at least 19".

The OIT shall have alarm capabilities to record, display data and audible alarm. The OIT shall have controlled operator access, by assigning security classifications to application screens.

The OIT shall be mounted on the SCADA control cabinet door in the electrical equipment room.

The OIT shall be rated NEMA 12.

The OIT shall be capable of continuous operation without any degradation throughout any combination of the following conditions.

- 32 to 140 degrees F (continuous operation at either limit)
- 5 to 95 percent relative humidity (non-condensing with continuous operation either limit)
- Non-blowing dust and dirt

Video Display Creation and Editing Software

OIT shall be furnished with a completely installed and tested version of a commercially available "off the shelf" video display creation and editing software.

The software shall allow creation and editing of a customized video display. The software shall include full color capability. The software shall allow development and previewing of the screens.

The software shall create custom video presentations that interface the RCU functional program to the OIT functions. The video presentations shall be capable of indicating actual device conditions and shall enable local operator input and control as developed in the RCU functional program.

The software shall allow multiple video screens for each functional program to facilitate information clarity for specific environments. All graphic views shall be current real time status of equipment. Each view will convey different levels of information and will allow different levels of operator input and control as described in this specification.

The software shall provide the ability to design high level graphics either by using its own drawing editor or by importing graphic display files from other drawing packages such as AutoCAD, Microstation, Canvas, CorelDRAW, Photoshop, etc. The software shall have the ability to animate graphic displays including, but not limited to, position, rotation, size, color, and visibility.

The software shall include a library of standard, full color, detailed graphical presentations of typical industrial items (e.g. - fans, dampers, motors, valves, pumps, conveyors, pipe-lines, air duct, etc.). The software shall also allow importing graphic symbols stored on CD in standard graphics formats (bmp, tif, gif, pcx, etc.). The software shall allow graphic symbols to be "dragged and dropped" into the graphic display.

The software shall have minimum 24 bit color and have visual basic scripting and procedure to supplement product capability. The software shall include complete text capability to identify all system components, device conditions, and control status.

17.2.2.14.5 Operator SCADA Workstation

The SCADA workstations shall provide a graphical user interface and text-based status capability of all SCADA-controlled devices in the tunnel. The operator SCADA workstations shall be capable of monitoring, querying, managing, and controlling the SCADA devices. Workstations shall interface to printers in control rooms to permit printing reports. The configuration and requirements for the operator SCADA workstations shall be developed in conjunction with the requirements of TRIMARC and the Department.

17.2.2.15 Intrusion Detection and Access Control

Developer shall provide a fully functional intrusion detection/access control system to continuously monitor and control all people movements within monitored buildings and to monitor intrusion to equipment enclosures serving Tunnel and ancillary facilities. Methods and devices for detection shall be selected to suit the environment in which they are installed. Devices shall include, but not be limited to: door contacts, motion detectors, tamper switches, cameras, card readers, intercommunication devices, and other devices appropriate for the type of coverage required. As a minimum, the intrusion detection/access control system shall be provided to:

1. All areas to which the entry by unauthorized persons could cause disruption to or delay Developer’s operations, particularly operation of the Tunnel and facility/buildings
2. All cross passage doors
3. All exterior doors at the tunnel equipment building(s)
4. All areas to which the entry by unauthorized persons could result in the personal injury to those persons or others
5. Provide a high probability of detection and annunciate system status, alarm, and diagnose information at the tunnel operator workstations, or other “remote” control location as defined by IFA. As a minimum, alarm annunciation shall provide location, address of device, nature of the alarm, time and date, and alarm priority.
6. Have a minimum 25% spare capacity of detection points and indication outputs.
7. Be integrated with the CCTV system to visually detect intruders upon alarm notification.

Developer shall design and install motion detectors throughout secure areas as defined by the IFA. Point and volume motion detectors and tamper switches shall be placed to detect unauthorized entry or access to equipment. All security data will be available to operators at the tunnel operator workstations. Alarms and video from the proposed Tunnel will be visible at security panels and on operator workstations, which will initiate an in-depth inquiry and emergency response if necessary.

17.2.2.16 Intelligent Transportation System Operations

Developer shall be responsible for the planning, design and installation of safe and functional Intelligent Transportation System (ITS) for the proposed Tunnel. The dedicated ITS subsystem will provide traffic surveillance inside and at the two portals of the Tunnel, display lane usage information to drivers, and monitor and detect vehicle accidents or wrong movements. As a minimum, the Developer shall write the Tunnel Operations and Maintenance Manual and train KYTC and Department personnel on the Tunnel ITS system.

The functionality of the Tunnel ITS shall be such that command and control of appropriate field devices is shared with relevant Governmental Entities (Department, KYTC, etc). Developer shall provide a complete and fully operational Tunnel ITS composed of vehicle detection, camera monitoring, lane control signs, and a traveler information systems.

17.2.2.16.1 Vehicle Detection in the Tunnel

Traffic Detectors

Design Criteria: Developer shall be responsible for the design and installation of the microloop detectors in all travel lanes in the Tunnel to provide vehicle volumes, classifications, speeds, and occupancies by lane in accordance with Project Standards. The microloop detectors shall be designed and installed into the pavement structure at the approximate middle of the Tunnel. Developer shall coordinate the design and installation of microloop detectors with the tunnel design.

Material Requirements:

Developer shall be responsible for furnishing, insuring, and transporting all materials associated with the microloop detector assembly and the controller cabinets.

All materials shall be furnished in accordance with the material requirements as stipulated under Project Standards, including but not limited to probe sensors, lead-in cables, conduits, pullboxes, home-run cables and splice enclosure kits, traffic monitoring controllers, controller cabinets, and all communication interfaces between the controllers to the lane probes and to the TMC.

Construction Requirements:

Developer shall be responsible for the design, furnishing and installation of the microloop detectors into the tunnel pavement.

The microloop detectors shall be inserted into 3-inch conduit placed below the pavement surface at a depth as specified by the manufacturer. Microloop probes shall be placed and interconnected in a series to obtain required lane coverage and to remove magnetic-induced noises inside tunnel. All lead-in cables shall be spliced into the home-run cables in splice enclosures in pullboxes, which shall be sealed and insulated from water damages in accordance with manufacturer's specifications. The traffic monitoring controller shall be configured to communicate with field probes to detect vehicle volumes along with length classifications, speeds, and occupancies by lane in user-defined intervals (typically 2 minutes to 15 minutes) with accuracy levels in accordance with manufacturer's specifications. For any time interval the maximum error rate shall not exceed ±10% compared with ground truth vehicle data. All interface cables and communication ports shall be connected and configured to complete the communications and control from center to field cabinet and from field cabinet to lane probes.

At a minimum, the detector shall provide the following four (4) vehicle classes on Table 4-A-1, FHWA *Traffic Monitoring Guide*:

Vehicle Class	Recommended Length
Passenger vehicles (PV):	<13 ft
Single unit trucks (SU):	13 ft - 35 ft
Combination trucks (CU):	35 ft - 61 ft
Multi-trailer trucks (MU):	61 ft - 120 ft

The microloop detectors shall also be configured to detect and report stopped or dysfunctional vehicles on travel lanes inside the Tunnel. Application-specific software shall also be provided to enable traffic data reporting and Incident detection in the TMC.

Developer shall provide power and communications connections to the control cabinet to which the microloop detectors report to transmit traffic data to the TMC for traffic management and Incident detection.

Developer shall test and integrate tunnel microloop detectors into TMC operations for Tunnel traffic monitoring, incident detection, and emergency responses.

Wrong-Way Detection

Design Criteria: Developer shall be responsible for the design and installation of the dedicated wrong-way detectors on the highways approaching the Tunnel from each direction to monitor approaching wrong-way vehicles and to prevent severe wreckage accidents. The detectors shall be able to differentiate vehicle movement directions and to detect the presence of wrong-way vehicles approaching the Tunnel. The locations shall be dependent of roadway geometry and shall be identified and approved by the relevant Governmental Entities. Two optional locations are on the westbound KY 841/I-265 after I-71 Interchange and eastbound SR 265 after the Salem Road Interchange.

The wrong-way detection shall be real-time on 24/7, and shall trigger alarms in TMC system for verification using the CCTV cameras at the approach. Once it is confirmed, the TMC will initiate emergency response procedures by dispatching patrol unit to the site, as well as trigger audible alarms and strobe lights mounted on the LUS structures to the Tunnel to alert the driver entering from the wrong direction and other vehicles.

Material Requirements: Developer shall be responsible for furnishing, insuring, and transporting all materials associated with the wrong-way detector assembly, audible alarms, strobe lights and controller cabinets.

The wrong-way detectors shall be dedicated wrong-way sensors placed in arrays with a directional logic to accurately sense the wrong-way vehicles.

Due to the high accuracy and reliability requirements in real-time tunnel operations, microwave radar, Doppler radar, acoustic or inductive loops are not recommended (Refer to the manufacturers' manuals for field limitations).

Construction Requirements: Developer shall design and install dedicated wrong-way detectors at the two approaches to the Tunnel with a clear line-of-sight to provide full coverage of all travel lanes. The detectors shall be placed based on manufacturer's requirements to activate a series of directional zones to confirm vehicles are traveling in the right directions. The detectors shall be able to operate at all weather conditions on 24/7 to detect any vehicles approaching from wrong direction.

Developer shall provide power and communications between the wrong-way detector, field control cabinets, audible alarms and strobe lights mounted on the nearest LUS structures, including installations of all conduits, cabling, power supplies and converters, wiring harnesses, circuit breakers, fiber patch panels and jump cables, and other materials, to provide a fully functional wrong-way detection system.

Developer shall coordinate the design of wrong-way sensor assembly and customized software package with the Tunnel structure design. The customized software shall be installed at TMC to automatically control and switch the polarity of all field sensors for directional detection and reporting. This control software shall be reviewed and preapproved for operability and compatibility with the TMC.

Developer shall rigorously test the Tunnel wrong-way detection system under all weather and operational conditions, including all hardware and customized application software. Such testing shall follow the emergency response procedures specified by the relevant Governmental Entities, fire and police departments and the TMC, etc.

17.2.2.16.2 Reference Markers

Developer shall be responsible for the design and installation of reference markers in the Tunnel along both directions of KY 841/I-265 to provide continuous mile post markings per MUTCD requirements. To provide a consistent highway referencing system, the reference markers inside the Tunnel shall comply with provisions specified under Section 19.5.5.

17.2.2.16.3 Closed Circuit Television (CCTV) Cameras

Developer shall provide a fully functional closed-circuit television system for traffic surveillance and confirmation of fire detection in accordance with NFPA 502. The cameras shall provide continuous overlapping coverage of the entire Tunnel with the ability to remotely monitor real-time traffic conditions. Full overlapping coverage of all Tunnel areas (travel lanes, shoulders, maintenance areas, and cross-over passages, etc.) and all Tunnel equipment (fire detection, ITS, ventilation, illumination, etc.) shall be maintained at all times. Camera placement in the Tunnel will depend on horizontal and vertical curvatures of the Tunnel structure and to a minimum, six cameras shall be installed to cover the two approaches, the cross-over areas and travel lanes inside the Tunnel. Cameras in the Tunnel shall have pan-tilt-zoom capabilities.

Video stream output shall be transmitted to tunnel operator workstations and displayed on the video walls. The Tunnel video control software shall automatically select the four cameras nearest to an activated fire alarm site (two cameras upstream of the alarm site and two cameras downstream) for display on a dedicated monitor at the active tunnel operator workstation. The same feed shall be sent to a dedicated video recorder that shall automatically start recording upon actuation of the fire alarm. In addition to the provisions specified under Section 19.5.5, the following shall apply:

- Dedicated Tunnel video display shall be provided at the tunnel operator workstations. The video display shall be fully functional and include, but not limited to screens, supporting hardware, cabling, IP encoder bank, video patch panels, and all necessary accessories to provide an integrated Tunnel video display system. The tunnel operator shall be able to control all displays and provide selection and switching of multiple sources for display.
- The design shall follow the standards of the existing TRIMARC video acquisition system to provide up to four simultaneous video signals on display and for recording.
- All components of the CCTV cameras shall be designed with consideration to serviceability and prevention of vapor, dust, temperature and water jet sprays.

17.2.2.16.4 Dynamic Message Signs (DMS)

The two proposed DMS on westbound of KY 841/I-265 at Sta. 50+00 and eastbound at Sta. 135+00 approaching the Tunnel from both directions will be acquired for display of Tunnel related traffic messages and emergency response instructions in times of incidents/accidents. Those proposed DMS further upstream of the Tunnel shall also be used to post Tunnel events and diversion instructions to roadway drivers when necessary. Developer shall design the DMS control software to allow coordination of traffic operations and message displays on the two adjacent DMS for both open road and Tunnel users.

Refer to provisions specified under Section 19.5.5 for DMS requirements.

17.2.2.16.5 Lane Control Signal (LCS)

Developer shall provide a comprehensive subsystem of LCSs for the Tunnel to display lane use control signals in both directions of travel to support contra-flow traffic operations and to effectively shift traffic away from lanes with safety concerns. LCSs shall be mounted above travel lanes at Tunnel approaches (within 1,100 feet of the Tunnel portals), Tunnel portals and every 500 feet in the Tunnel. Developer shall field verify exact LCS locations at two Tunnel approaches based on the roadway alignments and line-of-sight per MUTCD standards on LCS.

LCS control software shall be designed with a comprehensive sequential logic corresponding to incident identification, closure, and recovery by using a series of LCSs from upstream to downstream.

The installation of the LCS shall be coordinated with the Tunnel structure design to provide adequate load support to the LCS overhead equipment and provide adequate clearance to adjacent Tunnel equipment (e.g., illumination, ventilation and other ITS equipment).

Developer shall be responsible for the design and installation of supporting structures for LCS, as required by OSHA, Department, and TRIMARC standards (RID IT-0.08). Developer shall be responsible for field tests by running the LCS software to control the LCS in sequence, per NTCIP standards and TRIMARC standards, to ensure the safe operations of the Tunnel.

17.2.2.16.6 Highway Advisory Radio (HAR) and WIZARD Radios Rebroadcast

The proposed HAR station located east of the Tunnel and the proposed WIZARD station west of the Tunnel before the east-end bridge shall be acquired to broadcast Tunnel related traffic messages and emergency response instructions when necessary. The central software of HAR and WIZARD shall be designed to allow coordination of message broadcast for both open road and Tunnel users.

The broadcast signals from HAR and WIZARD will be received by the normal automobile radios throughout the Tunnel by using the proposed Tunnel AM/FM rebroadcast devices. The radio rebroadcast system will allow Tunnel motorists to continue the reception of HAR and WIZARD bands the same as open road motorists. Refer to section on AM/FM rebroadcast for material and construction details.

17.2.2.17 Signs, Signal, and Traffic control

Developer shall design, install and test dedicated traffic signs and signals to provide three functions. In case of a Tunnel emergency, the portal traffic signals outside each entrance portal shall control public access to the Tunnel. These may be activated from the signal cabinet or from the tunnel operator workstations. During normal operations they will rest in green.

Traffic signals shall also provide safe access to the vehicle crossovers at both ends of the Tunnel for tow trucks, wreckers, and other emergency and maintenance vehicles, stopping Tunnel traffic briefly while exiting the facilities.

Finally, traffic signals shall be triggered by the Fire Department to provide safe access for fire vehicles entering the Tunnel lanes.

All traffic signal heads will be 3-aspect 12” diameter LED types, with locations approved by the IFA in accordance with MUTCD and NFPA 502 requirements.

17.2.3 Tunnel Communications and Control

Developer shall adhere to the requirements of the fiber-optic network, described in Section 19 and shall extend this network into and through the Tunnel facility. The network shall additionally support all communications requirements between the Tunnel systems (SCADA monitored systems, fire and life safety and ITS) and TRIMARC.

System Control: The tunnel operator workstations will be primary point of control for the Tunnel systems. Dedicated Tunnel workstations shall be provided for each system operators’ console to allow operators to display any screen graphic or video image on the video wall display. Depending upon permissions set by the system administrator, each workstation will have access to Tunnel data and applications, providing a unified operator interface. In case of facility failure, operators shall be automatically notified to prepare and coordinate incident response and maintenance personnel activities.

17.3 Computerized Maintenance Management System

Developer shall provide, configure and implement a CMMS to support the maintenance of all tunnel equipment. The CMMS shall interface with the SCADA system to collect operating performance of SCADA-controlled equipment, including runtime, alarms, faults, and failures. The CMMS shall permit scheduling maintenance activities, track performance of service and repairs, track spare parts, tools, equipment, and consumables, issue maintenance work orders, and provide performance information such as mean time between failure for all devices and pieces of equipment. The CMMS shall include network connectivity and CMMS workstations at KYTC District Office, KYTC TOC, TRIMARC, and the south Tunnel Equipment Building control room. This CMMS is separate from the system provided by IFA for the operations and maintenance of the East End Crossing within the O&M Limits.

17.4 Tunnel Equipment Building(s)

Developer shall provide tunnel equipment building(s) as necessary to contain the systems specified in the Technical Provisions. Buildings shall conform to applicable building codes and standards and shall include a fire suppression system that meets the requirements of NFPA 72 UL - 864 and NFPA 502. Proposed codes and standards to be followed in the design of the portal buildings shall be submitted to IFA for approval with the Stage 1 Design submittal. The tunnel equipment building(s) shall be consistent with the East End Crossing aesthetic requirements. The tunnel equipment building(s) shall generally conform to the layout depicted in RID TE-4.06, and shall include a control room and restroom facilities on the ground floor of the south tunnel equipment building. The control room shall provide an operator console with one operator workstation conforming to Section 17.1.2 and shall include building and tunnel fire alarm control panels. Developer shall submit recommended locations and housing for emergency generators with the Stage 1 Design submittal.

17.5 Commissioning and Warranties

17.5.1 Record Drawing

The Record Drawings shall be organized and indexed to facilitate easy retrieval of information and shall be certified by Developer to reflect the actual condition of East End Crossing Tunnel at Final Acceptance.

17.5.2 Operation and Maintenance Training

Developer shall provide operation and maintenance training a minimum of 90 days prior to Substantial Completion. Developer shall provide a Tunnel O&M Training Syllabus 30 days prior to beginning training for review and comment by IFA. The training shall be conducted by the manufacturer's technical service personnel or factory authorized representatives for all of the systems installed in the Tunnel. Developer shall provide a minimum of 40 hours of training for each Tunnel sub-system.

Developer shall include in the training; operation instructions, theory of operation, circuit description, preventive maintenance procedures, troubleshooting and repair of all equipment specified herein. Developer shall include with the training all material and manuals required for each participant.

17.5.3 Manuals

Developer shall provide the draft Tunnel Operations & Maintenance Manual to the IFA for review and approval 120 days prior to Substantial Completion. Developer shall provide 5 printed and bound copies and 1 electronic copy in native editable format of the final Tunnel Operations & Maintenance Manual after IFA approval. The Tunnel Operations & Maintenance Manual shall include catalog cuts, final as-built shop drawings, hardware and software instruction manuals, final Tunnel lighting controller configuration stored on CD-R, equipment maintenance, and recommended spare parts. Final Acceptance of the Tunnel system will not be provided until Tunnel Operations & Maintenance Manual has been approved.

17.5.4 Warranty

A standard manufacturer's warranty shall be furnished for each major item which is furnished and installed or otherwise provided to the IFA. The effective date for the beginning of the warranty shall be the date of Final Acceptance and shall be for a minimum of two (2) years, or as the manufacturer's standard warranty, whichever is longer, following Final Acceptance. The warranty documentation shall be provided to IFA and a copy shall be included in the Tunnel Operations & Maintenance Manual.

Developer shall be responsible for all costs associated with vendor or manufacturer warranty service until Final Acceptance, or Final Acceptance of that portion of the contract where the equipment is installed. Any extension of the warranty period required to meet the warranty period noted above, shall be the responsibility of Developer.

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18 UTILITY AND RAILROAD

This Technical Provision provides information on the Developer's responsibilities as they relate to existing and, as applicable, new utilities or utility services; the manner in which utilities are to be protected, relocated, upgraded, constructed, or incorporated into the construction; and who shall be responsible for the Work. Developer shall be responsible for providing for construction and connection of new utility services as applicable for signs, lighting, signals, tunnel operations, and other new utility services required for the East End Crossing.

Potential Utility conflicts associated with the Reference Design have been identified and brought to the attention of Utility Owners. The Developer is responsible for identifying and resolving all Utility conflicts resulting from the East End Crossing design and construction. Existing Utility Information, as is known, is shown in the Utility Impact Matrix (RID UT-0.01). See Section 5.5.10 of the PPA for additional information regarding Developer's use of Utility Information and Reference Information Documents.

The Adjustment of a Utility may be necessary to accommodate the East End Crossing for either one or both of the following reasons: (a) a physical conflict between the Utility and the East End Crossing, including its construction, operation, maintenance, or use; and, as applicable, (b) an incompatibility between the East End Crossing as designed and the Utility based on the requirements of the applicable Adjustment Standards and applicable Laws. The limits of adjustment of existing Utilities shall extend as far as is necessary to accommodate or permit construction of the East End Crossing, whether inside or outside of the Project ROW. The Developer shall ensure that utility replacements are capable of providing service at least equal to that offered by the Utilities existing as of the Proposal Due Date, unless the Utility Owner has specified a lesser replacement. Betterments or other Utility Enhancements are not included in the Work unless otherwise specified (refer to Section 5.5.6 of the PPA).

The Developer shall abide by and fulfill the requirements related to Utilities and Utility Adjustments as described in this Section 18, and any other utility-related obligations of Developer set forth in the PPA Documents and shall follow the Department's 105 IAC 13 *Utility Relocation Guidance* and relevant regulations in Section 26.

18.1 General

18.1.1 Utility Owners

There are several Indiana and Kentucky Utility Owners that have been identified within the proposed Project ROW. A list of all known Utility Owners, along with contact information is provided in the RID UT-0.03.

18.1.2 Utility Adjustment Types

Three Utility Adjustment types have been identified on the East End Crossing:

- Type 1 Utility Adjustments – The Utility Owner performs design and construction of the Utility Adjustment and is reimbursed by IFA. These Utility Adjustments and schedules are identified in Attachment 18-1. A Developer Utility Agreement is not required for these Adjustments. Final Design Documents prepared by the Developer for the East End

Crossing shall accommodate Utility Adjustments performed as Type 1 Utility Adjustments.

- Type 2 Utility Adjustments – IFA has entered into an IFA Utility Agreement with the Utility Owner that sets forth the allocation of responsibilities with respect to any necessary Utility Adjustments. The Utility Owner has also performed preliminary Utility Adjustment work plans. The preliminary Utility Adjustment work plan provides the Utility Owner's understanding of the required Utility Adjustment work based on the Reference Design and includes an estimated cost and schedule. The IFA Utility Agreements and preliminary Utility Adjustment work plans are included in the Reference Information Documents. Developer shall enter into a Developer Utility Agreement and perform final Utility Adjustment design itself or through a consultant, as specified by the Utility Owner in the Utility Agreements. Developer shall perform the Utility Adjustment work using a Contractor acceptable to the Utility Owner. Lists of acceptable consultants and contractors, in addition to applicable Utility Adjustment design standards and construction specification for each respective Utility Owner are included in the IFA Utility Agreement.

  IFA will reimburse the Utility Owner for preliminary design costs, and Developer shall be responsible for the cost of final design and Utility Adjustment construction work. IFA will acquire all Replacement Utility Property Interests or other easements identified on the ROW Maps as being interests that IFA will acquire. If Developer Final Design requires additional easements or other property interests, Developer shall reimburse the Utility Owner for all effort, time, and cost associated with the acquisition of the easement or the other property interest. The Developer Utility Agreement shall include specifics of the Type 2 Utility Adjustments, including design and construction requirements, Utility Adjustment Plan review and construction inspection, details of Developer's obligations to reimburse utility Owner for costs associated with any additional easements or other property interests, and any Betterments or Enhancements. For Betterments, the Developer shall seek reimbursement from the Utility Owner in accordance with Section 5.5 of the PPA.

- Type 3 Utility Adjustments – The IFA has received from the Utility Owner a preliminary Utility Adjustment design, an estimated schedule and an estimated cost for each Type 3 Utility Adjustment. These items and an IFA Utility Agreement that addresses allocation of responsibilities with respect to any necessary Utility Adjustments are included with the Reference Information Documents. The preliminary design provides the Utility Owner's understanding of the required Utility Adjustment work based on the Reference Design. IFA will reimburse the Utility Owner for the design work associated with these preliminary efforts. The Developer shall coordinate the final design with the Utility Owner and negotiate a Developer Utility Agreement. The Utility Owner will perform the final Utility Adjustment design and Utility Adjustment work in accordance with a Developer Utility Agreement negotiated by Developer. Developer shall reimburse the Utility Owner for its costs associated with the final Utility Adjustment design and construction work. IFA will acquire all Replacement Utility Property Interests or other easements or other property interests identified on the ROW Maps as being interests that IFA will acquire. If Developer's Final Design requires additional easements or other property interests, Developer shall reimburse the Utility Owner for all effort, time, and cost associated with the acquisition of the easement or other property interest. The Developer Utility Agreement shall include specifics of the Type 3 Utility Adjustments, including design and construction requirements, Utility Adjustment plan review and construction inspection, details of Developer's obligations to reimburse Utility Owner for costs associated with any additional easements, and any Betterments or Enhancements. For Betterments, the Developer shall seek reimbursement from the Utility in accordance with Section 5.5 of the PPA.

See Attachment 18-1 for a breakdown of Utility Owners and Utility Adjustment types.

18.1.3 Utility Design and Construction Constraints

All Utility Adjustments along the East End Crossing, whether designed and, as applicable, constructed by the Developer or the Utility Owner, that are to be newly installed, adjusted, or upgraded as a result of the Work, shall be placed in accordance with the Utility Owner standard specifications, and the applicable Adjustment Standards of the Kentucky Transportation Cabinet (KYTC) or IFA utility regulations and policies, including the INDOT Utility Accommodation Policy and the terms and conditions of the encroachment permit for the respective State. See Section 5.5 of the PPA for additional provisions governing Utility Adjustment Work.

For each Adjustment or installation, the Developer, in coordination with the Utility Owner, shall be responsible for verifying that the adjusted Utility, as designed and constructed, is compatible with and interfaces properly with the East End Crossing Final Design.

18.1.4 Standard of Care Applicable to Utility Work

The Developer shall contact Before You Dig (BUD), at 1-800-752-6007 (in Kentucky), or Indiana811, at 1-800-382-5544 (in Indiana), prior to commencing any Construction Work and shall be responsible for requesting mark-outs for Utilities whose owners are not members of the locate systems. The Developer shall also coordinate with the Department, as the Department will mark Department-owned lighting and signal utilities. The Developer shall carry out its Work carefully and skilfully and shall support and secure Utilities so as to avoid damage and keep them satisfactorily maintained and functional. The Developer shall not move or remove any Utility without the Utility Owner's written consent, unless otherwise directed by IFA. At the completion of the Construction Work, the condition of all utilities shall be safe and permanent, as before.

If any Utilities are damaged by Developer's Work, the Developer shall notify the affected Utility Owner. The Utility Owner may cause the damage to be repaired at the Developer's expense. All repairs by Developer shall be performed in accordance with Good Industry Practice.

The Developer shall include provisions for its obligations with respect to Utilities in its Quality Management Plan.

18.1.5 Utility Agreements and Permits

Except as otherwise provided in Section 18.1.2, the Developer shall be responsible for preparing a Developer Utility Agreement with each of the Utility Owners. The Developer shall submit the Developer Utility Agreement and Utility Adjustment plans to IFA for transmittal to INDOT or KYTC, as applicable, for issuance of a Utility permit. The permitting agency will review the Developer Utility Agreement and Utility Adjustment Plans for completeness and compliance with encroachment policies and provide a response within ten (10) business days. The response could require changes to the Utility Adjustment Plan to comply with encroachment polices.

Utility Adjustments on county or city roads may need a permit from the jurisdictional municipality. The Developer is responsible to obtain, or ensure the Utility has obtained, the required permits before the adjustment construction begins.

Any water or sewer Utility Adjustments may also require permits from the Kentucky Division of Water (KDOW), if located in Kentucky; or from the Indiana Department of Environmental Management (IDEM), if located in Indiana. If the Developer is responsible for the Adjustment of a water or sewer Utility, the Developer shall obtain the required Governmental Approvals.

18.1.6 Additional ROW and Easements

IFA will secure utility easements identified on the ROW Maps as being interests that IFA will acquire. The Developer will be responsible for additional utility easement that will be needed through Developer coordination of final Utility Adjustment Plans.

If final design by the Developer requires additional utility easements to be acquired; the Developer shall follow the procedures outlined in Section 5.4 of the PPA and Section 21. The Developer shall be responsible for coordinating with the Utility Owner to use the standard easement document format and language associated with the Utility Owner's procedures. All costs, time and coordination of effort associated with additional ROW or easements shall be the responsibility of the Developer.

18.1.7 Instructions and Authorizations

The Developer shall be responsible for obtaining authorization from the Utility Owner for any design or construction the Developer performs on behalf of the Utility Owner and for verifying that instructions and authorizations are consistent and compatible with the Developer's Final Design.

18.1.8 Utility Owner's Right to Inspect

The Utility Owner has the right to inspect the Work that is to be performed by the Developer on the Utility Owner's facilities in Type 2 adjustments. The notification requirements are included in the IFA Utility Agreements.

18.1.9 Utility Enhancements

Some Utility Owners may request Betterments and other Utility Enhancements to their service facilities as a result of the required Adjustments of their facilities. Any such Utility Enhancements shall be governed by and comply with Sections 5.5.6 and 5.5.8 of the PPA.

The Developer shall keep IFA informed as to the status of requests for and negotiations with Utility Owners concerning Utility Enhancements.

18.1.10 Abandoned Utilities

Unless specifically noted otherwise in the PPA Documents or Utility Agreements, or directed otherwise in writing by IFA, the Developer shall be required to remove abandoned Utilities within the Project ROW. All such abandoned utilities shall be capped, filled, or otherwise properly abandoned in accordance with the PPA Documents and applicable Laws.

18.1.11 Protection of Utility Facilities

The Developer shall prepare a reasonable “Protection Plan” for all Utility facilities to be left in place and protected. The Protection Plan shall be submitted to IFA with the Stage 1 design for review and comment. The Developer shall also obtain written approval of the Protection Plan from each Utility Owner that has a Utility that will be impacted by the Work of the specific facility to be protected.

18.2 Utility Coordination Requirements

The Developer shall provide information, as required, and maintain close coordination with IFA and the Utility Owners to ensure timely completion of Utility Adjustments.

Regardless of previous notification by IFA or KYTC, the Developer shall coordinate with all Utility Owners within the Project ROW, as needed, to identify potential conflicts, verify locations, enter into Developer Utility Agreements, and conduct other activities needed to cause and schedule Utility Adjustments, sufficiently in advance of commencement of Work to allow the Utility Owners to relocate or protect their facility. No Work shall be done that injures or damages such Utility until satisfactory arrangements have been completed with the Utility Owner.

The Developer shall notify IFA at least five Business Days in advance of each meeting with a Utility Owner’s representative, and shall allow IFA or its representative the opportunity to participate in the meeting. The Developer shall also provide to IFA, or its representative, copies of all correspondence between the Developer and any Utility Owner within seven days after receipt or sending, as applicable.

The Developer shall let IFA, or its representative, know if any Utility Owner fails to cooperate, refer to Section 5.5.7 of the PPA.

The Developer shall allow for the time required to accomplish the tasks and activities necessary to design and adjust utility facilities in the Project Baseline Schedule and Project Status Schedule. The schedule shall be consistent with any times specified in (a) the IFA Utility Agreement, (b) the Developer Utility Agreements, or (c) through coordination with the Utility Owner.

If work by one or more Utility Owners is contingent on work by the Developer or another Utility Owner, the Developer shall keep all parties informed of the status and estimated completion date for the advance work in order to give each Utility Owner as much notice as possible to schedule crews and material for its Adjustment work.

18.2.1 Developer’s Coordination Requirements

The following requirements identified by IFA are important to the Utility Owners. The Developer shall perform the following activities as part of the Utility Adjustment Work:

1. Keep Utility Owners well informed of construction schedules and notify Utility Owners at least 48 hours in advance of any Work in the vicinity of the Utility Owners’ facilities. This coordination shall occur whether the Developer is protecting the facility in place or the Utility Owner is to protect their facility.

2. Keep Utility Owners well informed of changes to the Utility Adjustment Plans that affect their Utility facilities.

3. Ensure Utility Owners are involved in making the decisions that affect their own Utilities so that they can provide uninterrupted service to their customers or minimize the interruption of services.

4. Give the Utility Owners 48-hour notice of potential impacts to service, or as agreed to in the IFA Utility Agreement and Developer Utility Agreement.

5. Cooperate with the Utility Owners to solve Adjustment and, as applicable, installation issues to the extent that such Adjustments and, as applicable, installations are part of the Utility Adjustment Work, as otherwise set forth in the PPA Documents, and without causing IFA to incur any unnecessary expense to the East End Crossing or causing the Utility Owners to incur unnecessary expense.

6. Act diligently in continuing the positive relationship that the Department and KYTC have developed with the Utility Owners.

7. Coordinate with those Utility Owners that perform their own work by scheduling adequate time to accomplish their work, as per the Utility Agreement.

8. Review each Utility and consider its effect on the East End Crossing.

9. Develop procedures for addressing Utility conflicts discovered during design development and, as applicable, Construction Work.

10. As part of the Utility Agreement, develop, negotiate, and provide a schedule in coordination with the Utility Owners for the design and construction of all Adjustments.

11. Identify critical activities and sequences as they affect the Utility Owners and plan to effectively mitigate impacts.

12. Designate a Utility Manager, experienced in Utility coordination, to be the principal contact for all Utility-related East End Crossing activities.

13. Through its Utility Manager, coordinate, cooperate, and work with those Utility Owner representatives on the Utility contact list (initially, the list set forth in RID UT-0.03, to be updated as new or substitute contacts are identified).

14. Monitor the progress of Utility Owner work and provide notice to IFA in accordance with Section 5.5.7 of the PPA.

15. Developer shall be responsible for mitigating impacts to LWC Lagoon No. 4 due to East End Bridge Construction. Developer is required to coordinate with the LWC and perform Design and Construction Work to mitigate the project's impacts to the lagoon. LWC has provided two acceptable options, Options 1 and 2, in the "BE Payne Water Treatment Plant Lagoon No. 4 Bridge Impact Study" provided in RID UT-4.25. Developer shall be responsible for all costs associated with either Option 1 or 2, including loss of lagoon area associated with Option 2, or any other mitigation required by Developer's Final Design, as approved by LWC.

16. The Developer shall coordinate plan design with LG&E to avoid relocating the transmission poles on Springdale Road from left of station 38+23 to left of station 73+57 where possible. The transmission poles cannot be placed on the residential side of

Springdale Road. The preliminary work plan assumes the poles can remain. LG&E has designed the relocation of transmission poles from left of station 78+65 across Wolf Pen Branch Road to left of station 93+50.

17. The Developer shall coordinate with the City of Jeffersonville Wastewater Department and limit the amount of construction excavation on SR 62 to avoid a conflict with the existing 14-inch sanitary sewer force main until it can be abandoned, in December 2013. Horizontal and vertical locations of the force main are provided in the RID.
18. The Developer is advised of the proposed 24-inch force main sewer work in the area of Salem Road and will be required to coordinate with City of Jeffersonville Wastewater Department to coordinate construction schedules and avoid a conflict with the East End Crossing. The pump station located in proximity to Wood Creek Way will be relocated as part of this force main project. See RID Document UT-0.02 for additional information.
19. The Developer is required to coordinate with Watson Rural Water Co. to ensure their 20" water main is relocated with minimal disruption to its customers.
20. Developer is advised of the proposed Wolf Pen 36-inch water main project along the south right of way line of KY 841 along Springdale Road, outside of the Project Limits. The Louisville Water Company's project will tie into the existing 36-inch water main crossing KY 841 at approximately station 42+25.and proceed south from left of station 42+25 to left of station 18+00, then south to Westport Road. The LWC expects to bid the project in August 2012. A copy of the LWC Wolf Pen 36-inch plans is available in the RID.

18.2.2 Coordination of Design Reviews

The Developer shall invite affected Utility Owners to participate in relevant Developer and IFA Design Reviews. The affected Utility Owners can provide feedback on the Work, potential conflicts, resolutions, and Adjustments.

18.2.3 Meetings and Coordination

Within 30 Business Days of NTP1, the Developer shall schedule meetings with each Utility Owner potentially impacted by the East End Crossing, the Developer, and IFA. These meetings are for the purpose of reviewing all items related to the Utility Work, including all items that affect the Project Baseline Schedule, such as the time required procuring construction material, and the period of time Utility service may be curtailed. These meetings shall also be used to review IFA Utility Agreements and initiate Developer Utility Agreements.

The Developer shall, with IFA, schedule at least monthly joint Utility meetings with the Utility Owners to discuss East End Crossing progress, issues, and planned work for all phases of Utility Adjustment Work, including design and construction. These meetings shall include the Key Personnel of Developer and IFA personnel that are responsible for Utilities. The Developer and IFA will jointly develop the agenda for these meetings. The Developer shall be responsible for providing meeting facilities unless otherwise agreed upon. The Developer shall keep minutes of the coordination meetings and distribute copies of the minutes to participants, including representatives of the Utility Owners, even if not present, who have facilities in the area, to be reviewed within five working days after the meeting date.

18.3 Utility Design Requirements

The design of the Utility Adjustment Work and protections-in-place for the East End Crossing delegated to the Developer shall be in accordance with the PPA Documents. The Developer shall obtain the clarification of any unresolved ambiguity prior to proceeding with design or construction.

18.3.1 Responsibility for Design of Utility Work

After Developer has advanced the East End Crossing design sufficiently to clearly define Utility impacts, the Utility Adjustment Plans for affected Utilities shall be prepared. The allocation of responsibility for the design of each Utility Adjustment is described in the IFA Utility Agreements included in the RIDs

Where the Utility Owner is preparing Utility Adjustment Plans (Type 3 Adjustment), Developer shall review and approve the Utility Adjustment Plans for consistency with the East End Crossing Final Design and prepare and negotiate a Developer Utility Agreement in accordance with the requirements of the PPA Documents, and shall obtain IFA’s review and comment. IFA will provide written comments within 14 Business Days.

Where Developer is responsible for the design of the Utility Adjustment Plans (Type 2 Adjustment) Developer shall ensure the adjustment design is compatible with and interfaces properly with the East End Crossing. The Utility Owner will be provided time to review and approve the Utility Adjustment Plans for consistency with company standards and specifications. The Utility will reply in accordance with the IFA Utility Agreement.

Either way, Developer is responsible for the cost.

18.3.2 Identification of Utilities

Developer shall be responsible for confirming the exact location, type, and all other relevant information about each Utility in the East End Crossing area. If Developer discovers Utilities not previously identified that may be affected by the East End Crossing, Developer shall take the lead in identifying the affected Utility Owner, notifying the Utility Owner, entering into a Developer Utility Agreement, and making arrangements for Utility Adjustment Work to proceed.

18.3.3 Changes to Utility Adjustment Design

Developer shall be required to obtain written acceptance from IFA and the Utility Owner for any proposed changes to the Utility Adjustment designs after the Utility Adjustment Plans are approved and incorporated into the Developer Utility Agreement.

18.3.4 Additional Design Requirements

1. There are specific restrictions for placement of bridge piers near the LWC Riverbank Filtration (RBF), Collector Wells and Tunnel. Developer shall comply with the design restrictions set forth in the LWC report (Jordan, Jones & Goulding Technical Report, dated June 2, 2009); such as:

    a. No construction of foundations, including temporary construction Work, shall be located within 40 feet horizontally from either edge of the tunnel.

See the technical report, As-Built Plans for the River Bank Filtration Tunnel and location of the collector wells are also provided within the RIDs.

2. Developer shall design around the LG&E / KU transmission poles on Springdale Road to avoid relocating the poles from left of station 38+23 to left of station 73+57 where possible. Transmission poles cannot be placed on the residential side of Springdale Road.

3. Developer shall avoid a design conflict with the Watson Rural Water Company 1-million-gallon water tank and 300,000-gallon standpipe near SR 265 and SR 62. The Developer is required to coordinate with Watson Rural Water Co. to ensure the 20-inch water main serving the tank is relocated with minimal disruption to its customers.

4. Developer shall avoid a design conflict with the LWC's 24-inch sludge pipeline near Station 172.

5. Developer shall comply with the Metropolitan Sewer District (MSD) specifications when designing MSD sewers. MSD design specifications include:

   a. Sanitary sewer design shall be in accordance with Ten States' Standards.

      1) http://lrc.ky.gov/kar/TITLE401.HTM

   b. Design of sanitary sewers shall adhere to Louisville MSD Design Manual where applicable.

      1) Including drafting standards

      2) http://www.msdlouky.org/insidemsd/standard-drawings.htm

   c. Louisville MSD Standard Drawings shall be used where applicable.

      1) http://www.msdlouky.org/insidemsd/standard-drawings.htm

   d. Materials used shall adhere to Louisville MSD Standard Specifications, or be listed on Louisville MSD's pre-approved materials list.

      1) http://www.msdlouky.org/insidemsd/sources/index.htm

   e. All sanitary sewer design shall be approved by Louisville MSD and the Kentucky Division of Water.

   f. Floodplain Permit shall be obtained from Louisville MSD and the Kentucky Division of Water for construction in the floodplain.

   g. Any existing sewers that require relocation are the sole responsibility of the Developer. All sewer relocation will be approved by Louisville MSD, as well as the Kentucky Division of Water prior to construction. The Developer shall coordinate all work performed to Louisville MSD facilities with MSD staff.

   h. Developer shall acquire all necessary sanitary sewer and drainage easements. Any easement acquired for sanitary sewers shall be dedicated as a "Sanitary Sewer and Drainage Easement." Developer shall use Louisville MSD forms and verbiage in sanitary sewer and drainage easement language. Developer shall submit easement plat(s) and associated documentation to MSD for review prior to beginning acquisition. Developer shall provide copies of all acquired sanitary sewer and drainage easements, including the deed book and page number under which the easement(s) were recorded.

18.4 Utility Construction Requirements

Construction may ensue following the review and approval of the Utility Adjustment Plans by the Utility Owner or the Developer, as applicable; the review and written comment by IFA; and the satisfaction of any applicable additional conditions to the commencement of construction specified in the PPA Documents, including Section 5.6.2 of the PPA.

Any subsequent revisions to the Utility Adjustment Plans shall require the review and written comment by the affected Utility Owner and IFA.

18.4.1 Construction Requirements

1. Developer shall be required to follow restrictions as set forth in the *Construction Mitigation Report for 60-inch Water Main* (UT-4.21) and in other sections of the PPA Documents, such as:

   a. Limit the PPV measured in the vicinity of the 60-inch water main to 0.2 inches per second;

   b. Conduct a test blast monitored by a seismograph. Test blasting shall commence with a charge weight per delay and distance to the pipe as shown in Figure 4 of the report. Subsequent test blasts may be made if the seismograph readings indicate that further blasting can be safely conducted.

   c. Continuously monitor blasting by a seismograph to ensure the recorded PPV components do not exceed the 0.2 in./sec limit

   d. Provide record seismograph readings to LWC after each blasting operations. Conduct blasting operations using a drilling pattern and blasting procedure that will keep the resulting vibration at the lowest possible level.

   e. Notify LWC immediately in the event that the PPV of any one component direction exceeds the 0.2 in./ sec limit. LWC engineer will review the results and determine if additional protection shall be provided

   f. No blasting or pile driving shall be conducted closer than 30 feet to the 60-inch water main

   g. A consulting firm that specialized in underground blasting shall develop a blasting plan, conduct the seismograph survey, and provide calculations showing anticipated ground vibration and loads on the pipeline. A Registered Professional Engineer shall certify the results. The blasting plan and results of analysis shall be reviewed by an independent consultant selected by LWC and LWC may elect to inspect the pipeline for damage before, or after blasting.

   h. The consultant who conducts the seismograph survey shall have verifiable expertise and experience, and shall provide at least three of his/her past blasting projects to LWC prior to the commencement of the work.

i. If seismograph readings in excess of the limit stated in the report are recorded, LWC may elect to expose the pipeline to inspect for damage. All costs associated with such exposure, and any subsequent repair necessitated by the blasting, shall be borne by Developer. LWC may require a bond posted for excavation, examination and possible repair of the LWC pipeline if damaged.

See the report for a complete list of blasting requirements.

2. There are specific restrictions for construction near the LWC Riverbank Filtration Collector Wells and Tunnel. The Developer shall comply with the construction restrictions set forth in the RID UT-4.22 *LWC Tunnel Report* (Jordan, Jones & Goulding Technical Report, dated June 2, 2009), such as:

   a. No drilling fluids shall be used for construction for any pier shaft within 400 to 500 feet for bentonite and 1,000 feet for polymer fluids (both distances are in the horizontal direction from the end of the downriver lateral in Collector Well No. 3).

3. Developer shall comply with all environmental/ erosion and sediment control and best management practices during construction utilizing materials / supplies acceptable for use within a wellhead protection area to insure against contamination of the water supply. Dewatering conducted in this area could adversely impact the supply of water to the plant and plans for dewatering shall be reviewed and accepted by Louisville Water prior to implementation. As-Built Plans for the River Bank Filtration Tunnel and location of the collector wells are provided within the RIDs.

4. The Developer is required to follow the National Electric Safety Code when working in the vicinity of electric facilities.

5. The Developer shall monitor blasting and limit if necessary to avoid damage to the LG&E Transmission pole support structures along Springdale Road.

6. The Developer is required to comply with the Metropolitan Sewer District (MSD) construction specifications when constructing MSD sewers. MSD construction specifications include:

   a. Developer shall be responsible for fines and / or penalties from Governmental Entities associated with the construction of projects.

   b. Developer is responsible for damages to existing Louisville MSD facilities throughout construction.

   c. Sanitary sewer construction shall be in accordance with Ten States' Standards.

      1) http://lrc.ky.gov/kar/TITLE401.HTM

   d. Construction of sanitary sewers shall adhere to Louisville MSD Standard Specifications.

      1) Including testing of sanitary sewers

      2) http://www.msdlouky.org/insidemsd/standard-drawings.htm

   e. Materials used shall adhere to Louisville MSD Standard Specifications, or be listed on Louisville MSD's pre-approved materials list.

1) http://www.msdlouky.org/insidemsd/sources/index.htm

f. All manholes shall be watertight and shall include chimney seals. The chimney seal shall be constructed by certified personnel.

1) All manholes shall be tested to ensure they are watertight

g. Louisville MSD inspector shall inspect all construction, and be notified a minimum of two weeks prior to construction activity.

h. All sanitary sewer construction shall be approved by Louisville MSD and the Kentucky Division of Water.

i. Floodplain Permit shall be obtained by Developer from Louisville MSD and the Kentucky Division of Water for construction in the floodplain.

j. The Developer shall not cover or bury any existing sewer access points, including but not limited to: manholes, catch basins, air release valves, etc.

k. Sanitary sewer overflows or the potential of sanitary sewage escaping its designated collection line(s) shall be reported immediately to Louisville MSD 24-Hour Customer Relations Line at 502-587-0603 for appropriate response by Louisville MSD. This includes damage caused by the Developer or discovery of damage and/or blockage of sanitary sewer lines during investigation or normal work.

Damages to Louisville MSD assets not resulting in sewer overflows or the potential of overflows shall be reported to Louisville MSD.

18.4.2 Restricted and No Work Zones

Kentucky

- Louisville Water Company - 60" Water Main
  See Section 18.4.1.

- Louisville Gas and Electric - Electrical Transmission Lines
  A 69 kV electrical transmission line runs parallel and along the south side of KY 841 from Station 18+00 Left to 108+00 Left. The electrical transmission line is outside of the Project ROW, in a dedicated easement. Construction near the transmission line is subject to restrictions to maintain safe distance from the wires including OSHA, state and local laws. Refer to "Power Line Safety Handout" and "Mobile Crane Power Line Clearance Worksheet" in the RID for additional information.

- Louisville Water Company (LWC) Sludge Lagoon
  See Section 18.4.1.

- Louisville Water Company River Bank Infiltration Tunnel
  The proposed alignment for KY 841 crosses the River Bank Infiltration Tunnel. This tunnel provides drinking water to the Louisville metropolitan area. Bridge foundations shall be a minimum of 40-feet horizontally from the tunnel.

- Louisville Water Company Wellhead Protection Area

The proposed alignment for KY 841 crosses the wellhead protection area. The use of bentonite and polymer drilling fluids are restricted in the WHPA.

Indiana

- Boulder Creek Sanitary Sewer Pump Station
  The Boulder Creek sanitary sewer pump station is located approximate 125' left of Station 320+00 "A", at the west end of Wood Creek Way. The pumping station is located within the Project ROW, but outside the Reference Design construction limits. The City of Jeffersonville Wastewater Department has plans to construct a new force main system (RID UT-6.01). The force main construction is expected to be completed by the end of December 2013. Once the new force main system is in place and active, this pump station may be removed. While this pump station is still in operation, no Work shall occur near this site which could negatively impact its operations. Developer requirements will be included in the Utility Agreements.

18.4.3 Record Drawings

For Utility Adjustment Work constructed by the Developer, the Developer shall provide three sets of as-built Utility Plans; two provided to IFA for the permitting agency, INDOT or KYTC, and one for the Utility Owner. The as-built Utility Plans shall comply with as-built requirements stipulated in the state Utility regulations and shall be part of the East End Crossing Record Drawings.

For Utility Adjustment Work constructed by the Utility Owner, the Utility Owner will be required, in the Developer Utility Agreement, to provide three sets of Record Drawings to the Developer. The Developer shall provide two sets to IFA for the permitting agency, INDOT or KYTC. The as-built Utility Plans shall comply with the as-built requirements stipulated in the state Utility regulations and shall be part of the East End Crossing Record Drawings.

18.5 Other Utility Requirements

18.5.1 Developer-Caused Changes to Utility Owner Work

If the Utility Owner maintains responsibility for the design and, as applicable, construction of the Utility Adjustment and the Developer revises the plans affecting the cost or schedule after the Developer Utility Agreement has been executed, the Developer shall be responsible for the additional cost and, as applicable, any schedule delays related to the change.

18.5.2 Quality Control

The Developer shall provide quality control for all of the Utility Adjustment Work performed by the Developer in accordance with the Quality Management Plan.

18.5.3 Construction Record

The Developer shall maintain a record of the Utility Adjustment Work and utility design and construction activities of all Utility facilities that have been performed by the Developer and that have been designed and Released for Construction after issuance of NTP2. Individual files shall include a record of the following information:

1. Utility Adjustment Plans that have been reviewed by the Utility Owner and received review and written comment by IFA.
2. Notification of construction dates.
3. A record of meetings with the Utility Owner.
4. A signature of the Utility Owner's representative on the Utility Adjustment Plans.
5. A record of the Utility Owner's representation at design and construction meetings.
6. Any revisions to the Utility Adjustment Plans.
7. Dates of construction completed.
8. All other as-built requirements stipulated in the applicable Adjustment Standards.
9. Utility Agreements.
10. Two sets of the Record Drawings, as it pertains to Utility facilities, shall be provided to IFA.

18.5.4 Utility Damage Reports

The Developer shall be responsible for developing a "Utility Damage Report" form to use in the event a Utility is damaged. The form shall include sufficient information, such as the location; date; time; Utility Owner; Utility locate details; the name of the Construction Manager and witnesses; a description of the damage; and the signatures of the developer superintendent, Utility Owner, and locate service. The form shall be submitted to IFA for review and comment prior to the start of Construction Work.

The Developer shall immediately report any damage to Utility facilities to the Utility Owner and IFA, and fully cooperate with the Utility to ensure the facility's safe and timely return to operation. The Developer shall complete and submit the Utility Damage Report form to IFA within two days of the damage.

18.5.5 Utility Adjustment Master Plan

IFA has provided Utility Information regarding the existing Utility facilities within the Reference Design that is included in the RIDs. The information is based on Utility Owners' record plans; field locations; and, in some instances, vertical elevation. Also provided are preliminary Utility Adjustment plans for each utility, based on the Reference Design. Within 30 days after the issuance of the NTP1, the Developer shall submit an initial Utility Adjustment Master Plan to IFA for its records showing all known existing utilities and proposed Utility Adjustments. The Utility Adjustment Master Plan shall be a living document throughout the life of the East End Crossing; the Developer shall update it and submit it to IFA monthly to reflect all changed information then known to the Developer, and also shall distribute copies for discussion at scheduled Utility meetings. Updates shall be submitted to the IFA for review and comment.

18.6 Railroad Coordination

18.6.1 General Requirements

This section defines the criteria required for the East End Crossing to accommodate and, as applicable, design and construct facilities and structures for rail line(s) crossing the Project ROW. The Developer is responsible for all coordination with all owning and operating railroads that may be impacted by the Work, preparing and negotiating any agreement for construction and maintenance, designing and constructing facilities as described in this Section 18.6 and complying with and paying all costs associated with the Work specified herein, including all costs related to the Railroad Agreements.

18.6.2 Railroad Design Standards

The Developer shall prepare the geometric design of the railroad facilities and, as applicable, roadway elements affecting railroad facilities following current Standard Industry Practices, such as FHWA *Railroad-Highway Grade Crossing Handbook*, AREMA, and MUTCD, and incorporating the usual and customary design standards and operating requirements of the owning and operating railroad(s) that has, or is expected to have, an agreement with IFA. However, wherever a conflict arises between any details in the design, the criteria as detailed by the railroad shall be governing parameters.

The Developer's Final Design shall minimize service interruptions to existing rail lines.

Construction details and specifications shall conform to the Department standard specifications and the rules, regulations, and requirements of the owning and operating railroads, including those related to safety, fall protection, and protective equipment. A draft copy of the Special Provision for the Protection of Railway Interest is included in the RID UT-6.10. The Developer shall coordinate with the railroad to finalize the special provisions and comply with the finalized special provisions at no additional cost to IFA.

18.6.3 Coordinating Design

The Developer shall coordinate the East End Crossing design with the owning and operating railroad(s). This coordination will include meetings, Plan submissions, and addressing pertinent commentary provided by the railroad. The Developer is expected to fully consult the railroad(s) in such a manner as necessary to ensure compliance with all standards and a viable Final Design. The railroad has final approval rights for the design.

CSXT and the Ports of Indiana own tracks that run under SR 265. Ports of Indiana owns the at-grade crossing on SR 62 (with lease to MG Rail). The Developer can contact Amanda DeCesare, CSXT at (859) 426-6924, Rodney Gross, Ports of Indiana at (812) 288-2327 and Roger Wilson, MG Rail at (812) 218-1336 (Note: the contact names are as of the issuance of the RFP).

18.6.4 Design Costs

During negotiation and design coordination, the Developer shall secure an estimate of all anticipated costs from CSXT. The costs shall be reviewed by the Developer and IFA and determined as compliant with federal and state standards and will be the basis of the Railroad

Agreement. The Developer shall submit the estimate to IFA for review and comment. The IFA will provide comment within ten (10) Business Days.

Developer shall be responsible for the cost of design of the MG Rail crossing at SR 62.

18.6.5 Records

The Developer shall maintain a record of all negotiation, coordination, and construction efforts in relation to the railroad involvement. These records shall be provided in copy to IFA as completed. Specific documents required are as follows: correspondence, meeting minutes, negotiations, Force Account Estimates from the railroad for their work, design comments, agreements, inspection records, invoices, and change orders.

18.7 Project Work Affecting Railroad Operations

Where the East End Crossing crosses or affects a railroad ROW, operations, or facilities, the Developer shall coordinate the Work with the owning and operating railroads, and the Department Capital Program Management's Railroads Team, as appropriate.

18.7.1 Schedule

The Developer shall be responsible for obtaining all required approvals, permits, petitions, and agreements required for any railroad-related work. All costs, fees, and work associated with these matters shall be the responsibility of the Developer. The Developer shall be responsible for including and incorporating all railroad-related items into the project schedule. No time extensions will be granted to the Developer for the railroad related Work.

Developer shall enter into other agreements with, and obtain any permits from; Governmental Entities or others that are necessary to perform the Work described herein or that otherwise apply to Work hereunder, except for those items expressly described in this Section 18.7 as being the responsibility of IFA.

18.7.2 Agreement for Construction and Maintenance

Whenever an agreement for construction and maintenance within railroad ROW between the owning and operating railroad and IFA is required, the Developer shall prepare the draft Railroad Agreement and all the documentation required to obtain the Railroad Agreement, including (a) any Railroad Agreement documents on behalf of IFA, and (b) the Plans and Construction Documents. Developer shall revise the documentation as necessary to finalize and obtain the Railroad Agreement.

The Developer shall submit the draft Railroad Agreement to IFA for review, as required by IFA. The Developer shall coordinate with IFA the required Railroad Agreement format and submittal procedure. After all comments have been incorporated or satisfactorily resolved by the Developer, railroad, and IFA, the Developer shall sign the Railroad Agreement, submit it to the Railroad for signature, and then provide the final Railroad Agreement to the IFA for execution.

The Developer shall comply with all requirements contained in the Railroad Agreement, which compliance is included as part of the Work. Developer shall pay, as part of the Work, for the railroad's expenses relating to Work hereunder that the Railroad Agreement states are payable by IFA, within the time specified in the Railroad Agreement, including all costs associated with railroad flaggers. Draft Railroad Agreement(s) are included in RID UT-6.03 and UT-6.07. Railroad Special Provisions are included in RID UT-6.10. Developer shall consult with the railroad owners for clarification and confirmation of the validity of the standards represented in these provisions.

18.7.3 Operation Safety

The Developer shall arrange with the owning and operating railroad for railroad flagging as required. These flagging costs shall be included in the Railroad Agreement and all flagging costs, including those in excess of the estimate provided in the Railroad Agreement, are included in the Work. The Developer shall comply with the owning and operating railroad's requirements for contractor safety training prior to performing Construction Work or other activities on the owning and operating railroad's property.

18.7.4 Railroad Right-of-Entry Agreement

In order to enter the operating railroad's right of way to perform the Work, the Developer shall have secured its right of entry from the railroad and shall coordinate the arrangements of the necessary agreements directly with the operating railroad.

18.7.5 The Developer Right-of-Entry Agreement

The Developer shall cooperate and coordinate with all owning and operating railroads for access by the owning and operating railroad and, as applicable, their agents to the railroad right of way as necessary for rail maintenance and operations activities. The Developer shall also secure Right-of-Entry permission for all IFA personnel as well.

18.7.6 Insurance Requirements

Developer shall procure and maintain any insurance coverage as may be required by any owning and operating railroad as a condition of the owning and operating railroad's consent for entry into railroad facilities or property. Developer shall comply with all insurance requirements set forth in the unique special provisions Railroad Agreement(s), rights of entry, or other agreements or approvals required for performing Work on or near the ROW of any owning and operating railroad.

All insurance policies shall be in a form acceptable to the owning and operating railroad. The original Railroad Protective Liability Insurance Policy shall be submitted to the railroad with the railroad as the name insured. Copies of all other insurance policies shall be submitted to the owning railroad, operating railroad, IFA and be approved by the railroad prior to any entry by the Developer upon railroad property.

18.8 Railroad Construction Requirements

The Developer shall comply with all construction requirements and specifications set forth by the owning and operating railroad, including those requirements set forth in the Railroad Agreements.

The Developer shall be responsible for scheduling the Work to be completed by the owning and operating Railroad or its contractor, as well as the Work to be completed by the railroad's own forces. The Developer shall be responsible for all costs associated with the Railroad Force Account Work.

Developer shall be responsible for construction of the MG Rail crossing at SR 62.

18.8.1 Cost of Right of Way

The Developer shall be responsible for the cost of obtaining all necessary ROW as required for the Work, including any railroad related Work.

18.8.2 Cost of Reimbursements

The Developer shall be responsible for all reimbursement of costs to CSXT, and is responsible for reimbursing all costs that CSXT or MG Rail incur in adjusting their facilities or operations, as applicable, to accommodate the Work.

18.8.3 Design Criteria in Railroad Right of Way

1. The design of any facilities shall conform to the requirements of the owning and operating railroad specifications and the provisions set forth by the Railroad Agreement.
2. All railroad tracks and other railroad property shall be protected from damage during the Work.
3. All bridges over rail facilities shall conform to a minimum vertical clearance over rail facilities of 23 feet, 0 inches, or other clearance as approved in the Railroad Agreement.
4. All horizontal clearances shall conform to the operating railroad specifications, and crash walls shall be used as required by the operating railroad specifications.
5. All substructure elements within 25 feet of the centerline of tracks shall be designed with a crash wall per AREMA requirements.

18.8.4 Monitoring Construction Management Costs

The Developer shall monitor the costs associated with the construction of the project as it relates to railroad coordination. The Developer shall provide minimally monthly reports to IFA on the usage of a railroad flagman. The Developer is responsible for all flagging costs.

18.8.5 Petition for altering the at-grade crossing at SR 62 and SR 265

The Developer on behalf of the IFA, shall ensure the submittal through the INDOT Rail Office the necessary petition and supporting documentation to allow for issuance of the ruling required to alter the existing at-grade crossing of SR 62 at the SR 265 interchange near Jeffersonville, Indiana. The Petition shall be filed to the provisions of Indiana Code 1971, 8-6-1-7. Once approved, the IFA will provide the resulting documentation to the Developer for their records. A sample petition is included in RID UT-6.08. The Developer shall ensure the Petition is filed and the Petition approval process is complete prior to work on the at-grade crossing.

19 INTELLIGENT TRANSPORTATION SYSTEM

19.1 General

The East End Crossing shall include an Intelligent Transportation System (ITS) as described in this Section 19 and as depicted in the Reference Design presented in the RID. The purpose of the ITS is to improve traveller safety, improve traffic efficiency by minimizing congestion, mitigate the impact of Incidents, and minimize traffic-related environmental impacts.

Developer shall provide an ITS based on the requirements provided in this Section 19, in accordance with the architecture and standards of the Department or KYTC in their respective jurisdictions. The elements of the ITS will include vehicle detection for traffic management, motion detection for facility security, roadway weather information systems (RWISs) to report bridge conditions, virtual weigh stations to enforce commercial vehicle weight restrictions, roadway reference markers, closed-circuit television (CCTVs) cameras for Incident verification and monitoring, dynamic message signs (DMSs), lane control signals (LCSs), a highway advisory radio (HAR) along KY 841, and a WIZARD CB Radio unit to disseminate information to the travelling public.

The ITS shall also include all fiber-optic, leased telephone, and wireless communications; electrical power; and supporting infrastructure to provide a complete, fully operational ITS that is ready to be integrated and controlled by the Department Traffic Management Center (TMC) for those devices located in Indiana and by TRIMARC Traffic Operations Center, for those devices located in Kentucky, hereinafter individually (as the context requires) and collectively "TMC".

All components of the system designed and installed in Indiana as part of the East End Crossing shall be controlled and operated by the Department TMC. All components of the system designed and installed in Kentucky as part of the East End Crossing shall be controlled by TRIMARC.

19.2 Standards and References

Design and construct the ITS Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 19; Governmental Approvals; and applicable Laws.

19.3 Performance Requirements

Developer shall design, and construct the ITS to meet the requirements of the PPA Documents. The design and construction of the ITS material shall be consistent with Department ITS requirements to ensure compatibility for system integration of those devices located in Indiana and consistent with KYTC-TRIMARC standards to ensure compatibility for the system integration of those devices located in Kentucky, including all devices installed on the East End Bridge, up to, but not including, the Indiana Approach to the East End Bridge. The system shall meet the state and federal architecture requirements, to provide seamless interaction between the existing ITS and throughout the Project Limits.

System design and construction shall maintain the operation of the existing ITS within the Project Limits throughout the duration of the East End Crossing Construction Work unless otherwise noted in these requirements. Refer to RID documents IT-4.01 and IT-6.01 for location of existing ITS equipment.

The ITS shall provide accommodation for routine system maintenance with no impact to normal traffic operations. The ITS shall provide adequate features for the safety of maintenance personnel, including widened access shoulders, level maintenance platforms, and safety guide railings or traffic barriers if within clear zones. Refer to Section 9 to coordinate with roadway design standards for any ITS equipment or support within the clear zones.

19.4 Design and Construction Criteria

19.4.1 Definitive Design of Operations

Developer shall develop and submit to the IFA for review and comment a “Definitive Design of Operations” (DDO) document to update the ITS design and provide the system’s concept of operations within 90 days after issuance of NTP1. The DDO shall provide an analysis of the design and technology alternatives considered to meet the ITS requirements outlined here. The DDO shall include a high-level system design and recommended integration, validation, operation, and maintenance plan. It shall describe the method of deployment of each element of the system through each phase of system construction and system integration, testing and start-up. It shall note each element’s compatibility with ITS elements throughout the Department TMC region for devices placed in Indiana, especially as is applicable to shared communications networks and Department TMC control systems. It shall also note each element’s compatibility with ITS elements throughout the TRIMARC region for devices placed in Kentucky, especially as is applicable to shared communications networks and TRIMARC control systems.

The DDO shall be provided for review, and all comments consistent with the East End Crossing requirements shall be satisfactorily addressed prior to further design.

19.4.2 Existing Management Systems

The ITS designed and installed under the East End Crossing shall be consistent with the requirements of Department TMC and compatible, as required, with the Indianapolis Control Center and the Gary Control Center, as well as with the TRIMARC Management System and the National Transportation Communications for ITS Protocol (NTCIP).

19.4.3 Power Requirements

Developer shall coordinate with utility providers to deliver metered alternating current (AC) power to all ITS and communications equipment installed or modified under the East End Crossing. Developer shall be responsible for all work, materials, and costs required to obtain and maintain power, including application and coordination with the utility provider.

19.4.4 Location of Intelligent Transportation System Equipment

Developer shall submit to Department and KYTC for review and approval the quantity and location of the ITS elements, subject to the requirements of the PPA Documents, including the Project Standards. Developer shall provide a preliminary and final ITS layout, including communication network diagrams, ITS location plan sheets, and dimensioned layout sheets illustrating horizontal and vertical plan locations, ITS elements, support structures, and construction materials. The preliminary ITS layout shall be submitted with the Stage 1 Design

Documents and the Final ITS layout shall be submitted with RFC Design Documents in accordance with the provisions of Section 3.

The placement of the roadside equipment shall comply with the Project Standards. Clearances between sign elements shall be coordinated with the non-ITS Traffic elements and shall comply with the Project Standards.

The location of ITS equipment shall accommodate safe access for Routine Maintenance activities.

19.4.5 Intelligent Transportation System Operations

Regardless of the State of construction, all ITS elements that may have potential to be in the public view shall be under the control of the Department TMC (for Indiana devices) and KYTC TRIMARC (for Kentucky devices). Developer shall not activate any display, broadcast, or other message without prior coordination with the TMC.

19.4.6 Intelligent Transportation System Work Elements

1. Detectors

   Developer shall design, furnish and install vehicle detectors into the proposed highways (e.g., SR-265 and KY-841), interchanges, and the entrances/exits of the East End Bridge and Tunnel to detect any changes in traffic flow for traffic management and Incident detection. The detectors shall be microloop type unless conditions (e.g., on East End Bridge Main Spans and the Tunnel) restrict proper installation or compromise detector performance. Microwave radar detectors shall be used for all locations where microloop detectors are not appropriate.

   The detectors shall be spaced a maximum 0.25 to 0.30 miles between nodes to provide complete coverage on all travel lanes at the detection station. The detectors shall provide vehicle volumes, speeds, user-defined classes, and occupancies by lane in user-defined intervals (typically 2 minutes to 15 minutes). All traffic data shall be transmitted continuously to the Department TMC or TRIMARC, as required. Detectors in Indiana shall connect to an AFP (provided by Developer) in the Department field cabinet for communications back to the TMC, where the detector field data will be integrated into the existing vehicle detection system for traffic monitoring and management. Detectors in Kentucky do not explicitly require the use of an AFP or other terminal server in the field cabinet. Developer shall provide all necessary intermediate communications devices required to provide the field data to TRIMARC.

2. Intrusion Detection/Access Control

   Developer shall design, furnish and install motion detectors in the maintenance access areas on the East End Bridge. Proposed locations shall be coordinated and approved by IFA.

3. Roadway Weather Information System

   Currently, TRIMARC has one Road Weather Information System (RWIS) in Louisville, at the Kennedy interchange. Developer shall provide one additional roadway weather station on the Kentucky Approach of the East End Bridge to provide weather condition monitoring at the bridge structure. The proposed location shall be coordinated with IFA and KYTC.

Developer shall design, furnish, install, and test the new roadway weather station to provide a complete and operational RWIS for the East End Crossing area.

4. Virtual Weigh Station

Virtual Weigh Stations (VWS) automatically weigh and measure vehicles on travel lanes without stopping the traffic, provide real-time vehicle records for enforcement, which enables commercial traffic surveillance, commercial vehicle data collection and data analysis over a computer network. A Virtual Weigh Station provides in-line monitoring of commercial vehicles traveling on state highways at normal speeds, classifies vehicle types based on weight and axle spacings, performs weight compliance analysis based on stipulated regulations, determines overload violations if any, and produces commercial vehicle records for transmission to the traffic center or police enforcement via network connections.

The Department has been implementing virtual weigh-in-motion technologies to supplement the existing weigh stations under the Commercial Vehicle Information Systems and Networks Program (CVISNP) for overload screening and law enforcement prior to entering the East End Bridge and Tunnel.

Under the framework of the states' guidelines, the Developer shall design, furnish, install, and test virtual weigh stations for non-intrusive and automated data collection, East End Bridge and Indiana port-of-entry enforcement screening, and overweight violations detection. The virtual weigh stations shall be installed for each direction of travel close to the East End Bridge Indiana approach. The exact locations shall be identified and coordinated with the current CVISNP program, weigh-in-motion station system, and Automatic Vehicle Identification (AVI) using electronic preclearance transponders (PrePass etc.).

The VWS system shall be modular in design for ease of service and upgradeability. The system shall include Weigh in Motion (WIM) sensors, remote processor controllers with network interfaces, an image capture system and Automatic Vehicle Identification (AVI) system. VWIM controllers shall connect to AFP (provided by Developer) in the Department field cabinet for communications back to the TMC.

The Developer shall furnish documentation which demonstrates to the satisfaction of IFA that all equipment proposed for use in the Virtual Weigh Station is of standard manufacture registered to an ISO 9001 Quality Control Program; that the manufacturer has had VWS equipment available for purchase for not less than ten (10) years, and that the manufacturer's VWM equipment has a proven acceptable performance history while in use under roadway conditions similar to the field deployments under this project.

5. Reference Markers

The reference markers shall be installed along all approaches of the proposed highways, refer to Section 11.5 for provision details.

6. CCTV Cameras

Developer shall design, furnish, install, and test CCTV cameras, field equipment and control center equipment that are necessary to integrate the East End Crossing video coverage and detection functions into the existing video coverage and control system. CCTV spacing shall not exceed one mile and the placement of the CCTVs shall provide 100% video coverage inside the Tunnel and of the roadways, interchanges, intersections, and critical traffic operations. All visual indicators from ITS devices, including but not limited to DMS messages, LCS status display and HAR flashing beacon operation (along KY 841), shall be clearly viewable through a CCTV camera for video confirmation of system status at the control centers.

7. Dynamic Message Signs (DMSs)

   Developer shall design, furnish, install, and test DMSs to provide traffic information on critical roadways and the East End Bridge, and the Indiana and Kentucky Approaches for the East End Crossing. The overhead DMSs are desired to be located at the following critical approaching and departure locations, to a minimum:

   a. Kentucky Approach:

      1) I-71 Northbound at I-71/ KY 841 Interchange

      2) KY 841 Southbound between the Tunnel and the I-71/ KY 841 interchange (for Tunnel management)

      3) KY 841 Northbound between the tunnel and the I-71/ KY 841 interchange

      4) KY 841 Southbound and Northbound (two DMSs) between the East End Bridge and the Tunnel (one for Tunnel management)

      5) I-265 Northbound between Westport Road and I-71

      6) Two DMSs (arterial type) on KY 22, one on eastbound KY 22 west of I-265 and one on westbound KY 22 east of I-265

   b. Indiana Approach:

      1) SR-265 Eastbound west of SR-265/SR-62 interchange

      2) SR-265 Eastbound and Westbound (two DMSs) between the East End Bridge and the Salem Road Interchange

   Developer shall also coordinate with the TMC and TRIMARC for the integration of the existing DMSs in operation on interstate highways near the Project Limits, including SR-265, KY 841 and I-71, to provide a seamless DMS subsystem to communicate to travelers the potential traffic impacts and congestions within the East End Crossing area. Integrating the new and existing DMSs will maximize the opportunities to decrease delays in times of construction activities and incidents.

8. Lane Control Signals (LCSs)

   Developer shall provide a comprehensive subsystem of LCSs for the Tunnel to display lane use control signals in both directions of travel to support contra-flow traffic operations and to effectively shift traffic away from lanes with safety concerns. LCSs shall be mounted above travel lanes at Tunnel approaches (within 1,100 feet of the tunnel portals), Tunnel portals and in the Tunnel. LCSs shall be mounted every 500 feet to alert travelers about lane open, lane prohibition, or impending lane closures in accordance with MUTCD 2009 Edition Chapter 4M. The final mounting height of the signal enclosures shall have the minimum clearance as required by the PPA documents and pertinent MUTCD standards to allow the operation of signals for both directions with flexibility to incorporate for future lane expansions.

9. Highway Advisory Radio (HAR) along KY 841

   Currently, TRIMARC has multiple HAR stations, in operation at AM 1610, to broadcast traffic alerts in Louisville. Developer shall provide one additional HAR station along KY 841 east of the proposed East End Bridge to provide East End Crossing traffic information to travelers on interstate highways toward the new bridge at both the Indiana and Kentucky approaches.

   Developer shall design, furnish, install, and test the new HAR station to provide complete radio coverage of the entire East End Crossing area. Three HAR flashers shall be included as shown on the RIDs in addition to existing HAR flashers on I-71, SR-265, KY841, etc. Final locations shall be verified by field surveys and approved by the States to provide adequate broadcast coverage to roadway drivers and to provide clear visibility to the HAR flashers.

   The coverage area is defined by a distance to the East End Crossing boundary equal to a minimum of two minutes of travel time on each interstate highway approach. It is anticipated that the coverage area shall be beyond the physical limits of the East End Crossing to alert roadway drivers of traffic congestion and delays from any direction, on all interstate highways using the East End Bridge and Tunnel.

   The Work shall include all necessary coordination and application for licensing with the Federal Communications Commission (FCC) regarding highway radio licensing and frequency. This work requires synchronized broadcast from proposed and existing HAR stations using a signal synchronized to Global Positioning System (GPS) timing, depending on the nature of the message and coordination of KYTC. Developer shall work out the details of HAR design, synchronization, and broadcast guidelines with TRIMARC due to the extensiveness of the coverage area.

10. WIZARD System (CB Radio device)

    Currently, TRIMARC has one WIZARD (CB radio device) at the traffic operations center at Louisville and one portable WIZARD for work zone alert and information radio alert. The existing WIZARD units provide heavy trucks entering the hospital district of the Louisville and Kennedy Interchange with traffic delay and hazard warnings. Developer shall provide an additional WIZARD at the proposed East End Bridge to provide traffic warnings to commercial truckers traveling on interstate highways toward the new bridge at both the Indiana and Kentucky approaches.

    Developer shall design, furnish, install, and test the new WIZARD.

19.4.7 IFA-Furnished Materials

None.

19.4.8 Communication System

In accordance with the current state architectures, Developer shall design, furnish and construct communications conduit and a backbone fiber-optic communications network for the ITS. The fiber-optic network shall support the data and video communications requirements of all ITS assets, installed and existing, in the East End Crossing area. Developer shall design and construct the system with redundant routing capabilities. Redundant routing shall be such that all field devices are provided a minimum of two separate and unique logical network paths and that a break, failure or other interruption occurring at any point of one of those paths at any time shall not cause a loss of communication between the field device and the control centers. The system shall automatically discover the most efficient path of transmission and route communications through that path.

The ITS system communications network shall include communication hub buildings and cabinets to support the network. Communications shall be provided between each element of the ITS to the Department TMC in Indianapolis, the Gary Control Center, TRIMARC in Louisville and the KYTC TOC in Frankfort.

Coordinate with INDOT Contract T-30451 to provide fiber optic connection to the Indiana ITS network at the SR 265 / SR 62 Interchange communications shelter. Communications with Department TMC and Gary Control Center are provided through this connection.

Deliver all system video and data to the TRIMARC Control Center via a leased-line communication service as the primary communications path and via a secondary path through the Department fiber. The Developer shall design and furnish the leased-line service for connection near the eastern hub to the TRIMARC facility. The Developer shall coordinate the design with Department for use of existing fiber from West of Charlestown-Jeffersonville Pike / I-265 to complete the backbone communications routing. The Developer shall be responsible for all design, furnishing and installation of all fiber optic cabling and infrastructure, including splicing and interconnection to existing facilities.

Developer shall coordinate with the Toll System Integrator and provide conduit, pull boxes, and other communications infrastructure separate from the ITS system infrastructure, from the electronic toll collection gantry location, along the right-of-way, to the nearest public roadway with suitable existing telecommunication utilities. Toll system communications shall not pass through ITS System infrastructure. See also Section 20 for coordination requirements.

Capacity shall be provided for expansion of the communication system at a minimum level of 100 percent expansion. Design considerations for capacity shall include cabinet dimensions, communication shelf slots, network bandwidth capacity, conduit capacity, backbone fiber availability, and electrical circuit capacity.

The fiber-optic backbone shall be installed along each mainline segment of the East End Crossing. All ITS data shall be aggregated at one or more field communication hubs.

19.5 Design Criteria

19.5.1 Traffic Detectors

19.5.1.1 Not Used

19.5.1.2 Microloops

Except as otherwise provided herein, magnetic microloop vehicle detectors shall be installed under pavement. Developer shall provide handholes and cross-roadway conduit at detector locations to provide convenient access to the microloops for maintenance.

Two detectors shall be provided at each location for a speed trap configuration. Magnetic microloops shall be installed under pavement along SR-265, two microloops detectors at each location (node) for a speed trap configuration. Developer shall provide handholes and cross-roadway conduit at detector locations to provide convenient access to the microloops for maintenance.

The microloops detectors shall also be installed on all entrances and exits to the East End Bridge and the Tunnel to provide traffic detection and monitoring.

19.5.1.2.1 Design Criteria

The microloop detectors shall be designed and installed in and protected by conduits, in accordance with Project Standards. To provide traffic flow monitoring of the East End Bridge and Tunnel, the detectors shall be placed at critical approaches as shown on the RID plans. Developer shall coordinate the design and installation of microloop detectors with the pavement design.

In addition, the microloops detectors shall be installed to provide wrong-way detection to the East End Bridge and the Tunnel.

Refer to Section 17.2.2.16.1 for wrong-way detection functional requirements. The wrong-way detection controller shall connect to an AFP (provided by Developer) in the Department field cabinet for communications back to The TMC. The central software of wrong-way detection shall be stand-alone, compatible with, and able to be integrated into the existing central management systems in the future by field adjusting parameters to meet the accuracy levels by various state centers. This is to minimize possible disturbances on regular system operations caused by false alarms from the wrong-way detectors.

19.5.1.2.2 Material Requirements

Developer shall be responsible for furnishing, insuring, and transporting all materials associated with the microloop detector assembly and the controller cabinets.

All materials shall be furnished in accordance with the material requirements as stipulated under Project Standards, including but not limited to probe sensors, lead-in cables, conduits, pullboxes, home-run cables and splice enclosure kits, traffic monitoring controllers, controller cabinets, and all communication interfaces between the controllers to the lane probes and to the center.

19.5.1.2.3 <u>Construction Requirements</u>

Developer shall be responsible for the design, furnishing and installation of the microloop detectors into the pavement structure on the proposed highways identified in the RID.

The microloop detectors shall be inserted into 3-inch conduit placed below the pavement surface at a depth as specified by the manufacturer. For multiple lanes, multiple microloop probes shall be placed and interconnected in a series to obtain required lane coverage and to remove magnetic-induced noises. All lead-in cables shall be spliced into the home-run cables in splice enclosures in pullboxes along the roadside, which shall be sealed and insulated from water damages in accordance with manufacturer's specifications. The traffic monitoring controller shall be configured to communicate with field probes to detect vehicle volumes along with user-defined classifications, speeds, and occupancies by lane in user-defined intervals (typically 2 minutes to 15 minutes) with accuracy levels in accordance with manufacturer's specifications. For any time interval the maximum error rate shall not exceed ±10% compared with ground truth vehicle data. All interface cables and communication ports shall be connected and configured to complete the communications and control from center to field cabinet and from field cabinet to lane probes.

At a minimum, the detector shall provide the following four (4) vehicle classes on Table 4-A-1, FHWA *Traffic Monitoring Guide:*

Vehicle Class	Recommended Length
Passenger vehicles (PV):	<13 ft
Single unit trucks (SU):	13 ft - 35 ft
Combination trucks (CU):	35 ft - 61 ft
Multi-trailer trucks (MU):	61 ft - 120 ft

The microloop detectors shall also be configured to detect and report stopped or dysfunctional vehicles in the direction of travel. Application-specific software shall also be provided to enable traffic data reporting and Incident detection in the TMC.

Developer shall provide power and communications connections to the control cabinet to which the microloop detectors report to transmit traffic data to the TMC for traffic management and Incident detection.

Developer shall test the microloop detectors. Developer shall coordinate with the State agencies for data sharing and information dissemination by using the cameras, detectors, and DMSs installed at the approaches to the East End Bridge and Tunnel.

19.5.1.3 Microwave

Microwave radar detectors shall be used where conditions are not appropriate for the installation of microloop detectors. Refer to the ITS Standards and Specifications (TRIMARC) in RID IT-0.08 for Side-Fire Radar Detector Station requirements within the KYTC jurisdiction.

19.5.1.3.1 <u>Design Criteria</u>

The microwave radar detectors shall be designed, furnished and installed side-fired on equipment poles or structures (e.g., overhead sign supports) in accordance with Department TMC or TRIMARC standards. The detectors and equipment cabinets shall be roadside-mounted and continuous along roadways, with a maximum spacing of 0.3 miles.

The microwave ranging radar detectors shall be installed on all newly constructed roadways and interchanges to provide traffic monitoring and travel-time detection. For highway installations, the detectors shall provide the following traffic data measurements with the accuracy stipulated by Department TMC and KYTC TRIMARC standards:

- Vehicle volumes by lane
- Travel speeds by lane
- Vehicular occupancy by lane

A field controller shall be provided to process the field data collected from the detector and transmit to the Department TMC. Developer shall be responsible to install and align each detector with adequate setback distance in accordance with the manufacturer's requirements to provide radar coverage over the entire detection zones. In any case that a detector's location is within the clear zone as stipulated under <u>Section 9.3</u>, safety guide railings or traffic barriers shall be provided for protecting ITS devices and their supports as required by state and Occupational Safety and Health Administration (OSHA) standards.

19.5.1.3.2 <u>Material Requirements</u>

Developer shall be responsible for furnishing, insuring, and transporting all materials associated with the microwave radar detector assembly and the controller cabinets.

All materials shall be furnished in accordance with the material requirements as stipulated under Project Standards.

19.5.1.3.3 <u>Construction Requirements</u>

Developer shall be responsible for the design and installation of the microwave radar detectors, with coverage distributions coordinated and approved by IFA.

The microwave radar detectors shall be aligned and aimed to the target roadway, with clear coverage of traffic without the interference of any other microwave devices. The setback distance and mounting height shall be site-surveyed and approved in accordance with the manufacturer's requirements to allow maximum detection coverage over all lanes.

Developer shall provide power and communications connections to the control cabinet connecting to microwave radar detectors. The composite power and data cable shall meet the manufacturer's specifications on communications protocol requirements and shall be continuous without splices between the cabinet and the detector assembly. Cable ends shall be kept sealed at all times during installation using an approved end cap until connectors are installed. Tapes shall not be used to cap the cable end at any time.

19.5.2 Intrusion Detection/Access Control

19.5.2.1 Design Criteria

The motion detectors shall be designed and installed in all East End Bridge maintenance areas, Tunnel cross passage doors, and tunnel equipment building(s) to provide detection throughout secure areas, as defined by the ATVA. Once a movement is detected and confirmed when an incoming or reflected signal exceeds a preset threshold based on the types of sensor used (can be dual-technology type to reduce the false alarms), an alarm will be activated and transmitted to the TMC to alert the operator or the central security control program to initiate an in-depth inquiry and respond to any unauthorized entry.

19.5.2.2 Material Requirements

Developer shall be responsible for furnishing, insuring, and transporting all materials associated with the motion detector assembly and the controller cabinets.

All materials shall be furnished in accordance with the material requirements as stipulated under TMC standards.

19.5.2.3 Construction Requirements

Developer shall be responsible for the design, furnishing and installation of the motion detectors on the East End Bridge.

Developer shall provide power and communications connections to the control cabinet to which the motion detectors report to transmit alarm signals to the traffic center when an alarm is triggered.

Developer shall test and integrate the motion detectors to the TMC. Developer shall provide software for defining threshold values to minimize false alarms, for alarm acquisition and inquiry, video monitoring and investigation, etc., to guarantee the safety of the security areas on the East End Bridge.

19.5.3 Roadway Weather Information System

19.5.3.1 Design Criteria

The Road Weather Information System (RWIS) shall provide both air and surface weather data, including the following:

- Atmospheric data: temperature, precipitation, visibility, humidity, solar radiation, remote camera imaging and wind data.
- Surface/subsurface data: pavement temperature, subsurface temperature, surface condition, amount of deicing chemical on roadway, and freezing point.

Refer to the RWIS Equipment Reference document in RID IT-0.09 for Roadway Weather Information System requirements within the KYTC jurisdiction.

Developer shall be fully responsible for the site survey, design, fabrication, and installation of the RWIS and control cabinets. Developer shall be responsible for the design and installation of maintenance platforms, and safety guide railings or traffic barriers if within clear zones, as required by OSHA, and TRIMARC standards. Refer to Section 9 for traffic protection requirements for any ITS equipment or support within the clear zones.

Developer shall be responsible for testing the proposed RWIS to the central traffic management control and emergency weather control per existing TRIMARC standards.

19.5.3.2 Material Requirements

Developer shall be responsible for furnishing, insuring, transporting, and storing (for the interim) all materials associated with RWIS and control cabinets. Materials include but are not limited to sensors for pavement surface conditions, subsurface temperature probes, atmospheric sensors, wind speed and direction detectors, precipitation and visibility sensors, and video imaging for precipitation and moisture.

All materials shall be furnished in accordance with the material requirements as stipulated under Department and TRIMARC standards.

19.5.3.3 Construction Requirements

Developer shall be responsible for the installation of the RWIS and control cabinets in accordance with state Project Standards.

Developer shall provide power and communications connections to the RWIS and control cabinets in accordance with requirements of the RWIS manufacturer to provide a complete RWIS system.

Developer shall test the RWIS at TRIMARC. Manufacturer software shall be configured for data monitoring and detecting alarms/warnings from pavement and subsurface probes of the proposed RWIS using approved thresholds.

19.5.4 Reserved

19.5.5 Virtual Weigh Station – Indiana Approach

VWIM Station location is shown in the Reference Design plans. Developer shall determine final station position based on final roadway geometry and in accordance with manufacturer installation recommendations.

19.5.5.1 VWIM Physical Station Requirements

The Designer shall coordinate with the Department to determine exact location of the VWIM or station within the Project Limits. VWIM station shall be positioned in the eastbound and westbound lanes. It shall be the Designer's responsibility to ensure selected locations are in accordance with the following:

Horizontal Alignment:

The horizontal curvature of the roadway for 200 feet in advance of and 100 feet beyond VWIM system sensors shall have a radius not less than 5,700 feet measured along the centerline of the roadway.

Longitudinal Alignment (Profile):

The longitudinal gradient of the road surface for 200 feet in advance of and 100 feet beyond of VWIM sensors shall not exceed 2%.

Cross Slope:

The cross slope of the road surface for 200 feet in advance of and 100 feet beyond VWIM sensors shall not exceed 3%. However, up to 4% will be tolerated but an attempt shall be made to keep gradients greater than 2% towards the left most travel lanes.

Lane Width:

VWIM stations shall not be placed at locations where lane width is less than 11.5 feet or greater than 14 feet.

19.5.5.2 VWIM 450-foot PCCP Requirements

Developer shall provide a 450-foot section of PCCP to allow reliable VWIM system performance within tolerances outlined in ASTM E 1318-09. This pavement section shall be divided into three sections as follows:

1. **Approach Section**. The length of the PCCP approach section shall be 180 feet. Pavement shall transition from the planned pavement prior to this section to 15-inch PCCP in each lane prior in this section. This section shall consist of ten 15-inch PCCP pavement panels with 18 foot D-1 contraction joint spacing in each travel lane.

2. **15 inch Reinforced Sensor Section.** The 15-inch reinforced sensor section is for in-road sensors. Length of this section shall be 90 feet consisting of five 15-inch PCCP panels with 18 foot D1 contraction joint spacing in each lane. Sensors shall be installed in the center 3 panels in each lane, where possible, leaving one unused reinforced panel before and after sensors for future use. This pavement section shall follow the approach section.

3. **Exit Section.** The length of the PCCP exit section shall be 180 feet. Pavement shall transition from 15-inch PCCP pavement panels with 18 foot D-1 contraction joint spacing back to the planned pavement beyond this pavement section. This section shall consist of ten 15 in PCCP pavement panels with 18 foot D-1 contraction joint spacing in each travel lane.

The construction requirements shall be in accordance with applicable Department Standards. Pavement smoothness shall be in accordance with the current edition ASTM specification E 1318 for Type III WIM Stations as of the Setting Date.

19.5.5.3 Pavement Smoothness Testing and PCCP Profiling

Prior to installing sensors in the 450-foot section of PCCP, Developer shall perform pavement smoothness testing of the 450-foot section of PCCP to ensure a 6 inch diameter circular plate

0.125 inches thick cannot be passed beneath a 16 foot long straightedge when the straightedge is positioned in the following manner:

> Starting at the beginning of the 450-foot section of PCCP and in the center of each travel lane, place the straightedge along each respective lane edge with the upstream end (the first end a vehicle traveling in the lane would cross) at intervals of fifteen. Then pivot the straightedge about this end, and sweep the opposite (downstream) end nearest the sensors between the lane edges while checking clearance beneath the straightedge with the circular plate. Move downstream 7.5 feet and to the other side of the travel lane and repeat the process from this edge at 15 foot intervals. Apply this procedure to the end of the 450-foot section of PCCP. Switch to the other side of the roadway and repeat this process for the other direction. Additional information concerning this process may be found in section 6.1.5 of ASTM E 1318-09.

Locations failing pavement smoothness testing shall be profiled in accordance with applicable Department Standard Specifications.

19.5.5.4 VWIM Electronic Equipment

19.5.5.4.1 *VWIM System Controller*

VWIM system controllers used at all locations shall provide data in accordance with ASTM E 1318-09 for WIM Systems.

VWIM system controller provided shall at minimum include, provide, or be in accordance with the following:

1. OPERATIONAL REQUIREMENTS:

   a. Each system controller provided shall be compatible with the existing Linux based network.

   b. Each VWIM system controller provided shall provide the following data items in accordance with ASTM 1318-09:

      i. Individual Wheel Weight (right and left wheel)
      ii. Individual Axle Load
      iii. Axle-Group Load
      iv. Gross-Vehicle Weight
      v. Speed
      vi. Center-to-Center Spacing Between Axles
      vii. Vehicle Class (via axle arrangements)
      viii. Site Identification Code
      ix. Lane and Direction of Travel
      x. Date and Time of Passage
      xi. Sequential Vehicle Record Number
      xii. Wheelbase (front-most to rear-most axle)
      xiii. Equivalent Single-Axle Loads (ESALs)
      xiv. Violation code

c. In addition to the previous list of data items, each VWIM system controller provided shall also:

   i. Provide errors for vehicles that the system could not properly detect.
   ii. Provide warnings when a possible error in a vehicle record exists.
   iii. Insert sequence numbers for vehicle records
   iv. Perform WIM operation.
   v. Weigh all vehicles traveling over WIM scales.
   vi. Classify all vehicles traveling on all instrumented lanes of the highway.
   vii. Perform weight compliance analysis on vehicles in accordance with Department or agency regulations.
   viii. Perform sorter operation in accordance with decisions based on weight compliance analysis, other violations (speeding, improper maneuver, sudden speed change, etc.).
   ix. Capture images for all vehicles.
   x. Filter out all non-interesting images and format for Web server.
   xi. Perform data collection, data storage, file management and report generation functions for collected vehicle information.

d. Each VWIM system electronics shall include capability of viewing vehicle records, vehicle images, and sensor diagnostics via a direct computer connection as well as via an IP telecommunications link. Up to five users shall be able to access vehicle record and vehicle images in the system simultaneously. Each vehicle record displayed shall at minimum contain the following information:

   i. A thumbnail image of the vehicle
   ii. The vehicle record number
   iii. Date and time
   iv. The vehicle class
   v. Speed
   vi. Length of the vehicle
   vii. Gross Vehicle Weight
   viii. Individual axle and wheel weights
   ix. Axle spacing
   x. A color indicator for whether the vehicle is compliant (green) or in violation (red)
   xi. If the vehicle is in violation or if an error in measurement has occurred. In the event an error in measurement has occurred, then a message indicating the violation or error shall be displayed.

e. While connected to the VWIM system, the user shall be able to select any vehicle record in the listing and open a detailed display which shows all data recorded for that vehicle, including all the data above plus individual wheel weights, maximum allowed weights for each axle or show any weight violations in red, all violations, and the full size image in the vehicle record.

f. VWIM system controllers shall automatically power up and resume data collection when powered up.

g. Each VWIM system controller provided shall be capable of displaying to a single user connected to the VWIM system via a network connection a list of vehicle records.

h. The VWIM system shall have the capability to show vehicle record history stored in the electronics by date range. All data shall be available including the vehicle image.

i. Each VWIM system controller provided shall support the option of displaying the vehicle record data over the internet to authorized viewers using a web browser. The web browser display shall include all the information above and in addition have the following capabilities:

   i. The user shall be able to select to display all trucks or only violation vehicles
   ii. The user shall be able to search the vehicle record database using vehicle record numbers or date and time to select vehicle records

j. Each VWIM system controller provided shall support the option of displaying vehicle record data from multiple VWIM systems over the internet to authorized viewers using a web browser. Each VWIM system shall be user selectable from the web browser.

k. Each VWIM system controller provided shall include capability for downloading data via both a remote network connection as well as via a laptop computer directly connected to the Controller while on site. All necessary wiring and harnesses required to accomplish these tasks shall be included with each system controller provided.

l. Each VWIM system controller provided shall be able to be interfaced in the future to an optional industry standard License Plate Reader (LPR) system. The VWIM system shall include the capability of linking images produced by a LPR system to the record of the appropriate vehicle.

m. Each VWIM system controller provided shall be able to be interfaced in the future to an industry standard Automatic Vehicle Identification (AVI) system using Dedicated Short Range Communication (DSRC) transponders.

n. All material, equipment, and wiring necessary for setup and operation of the system in accordance with these specifications, including all wiring and cabling necessary to connect sensors in each travel lane as well as to interconnect modules and components of the system, shall be included with each VWIM system controller provided

o. All required software necessary for setup and operation of the system shall be provided to the Department with each VWIM system controller provided

p. When viewing a detailed image, user shall be able to enter weights per axle from a static scale or portable wheel weigher and print a ticket. These weights will be saved with the vehicle record and can be shown in a report.

q. The VWIM system settings shall have the ability to easily choose and modify the criteria in which vehicles will be highlighted as violators. The system will have the capability to set a unique set of criteria for each class of vehicle. This feature will be password protected.

2. PHYSICAL REQUIREMENTS:

Each VWIM system controller provided shall be fully encased in a rigid, protective housing. Front and rear panels of “rack type” recorders may be used to satisfy the requirements of this specification.

a. The housing shall effectively prevent foreign objects, including dust, dirt, rain, snow, vermin and insects, from gaining access to the interior of the recorder.

b. This housing shall provide protection to the electronics contained therein from physical damage during periods of transport.

c. This housing shall provide maintenance technician’s easy access to internal components for testing, maintenance, and repairs performed in the field.

d. The electronics shall be modular in design to facilitate easy maintenance, trouble shooting, and in-field servicing. All sensor interface modules shall be field replaceable and slot mounted in a system electronics sub chassis.

3. VWIM SYSTEM CONTROLLER POWER SOURCE:

a. Each VWIM system controller provided shall operate from 120 VAC 60 Hz.

b. At locations where the Controller is powered only by 120 VAC, Developer shall provide one rack mount Uninterruptible Power Supply (UPS) per each VWIM system controller provided. Each UPS shall be powered by 120 VAC 60 Hz. Each UPS provided shall be SNMP card capable with one SNMP card installed. It shall be capable of providing 3 hours of independent operation.

4. SENSOR INPUTS:

a. Each VWIM system controller provided shall at minimum be equipped with sufficient sensor interface cards and connectors to allow input of four axle sensors and two loop detectors in each lane. Please note, this stipulation does not preclude the requirement for three loop detectors in each lane.

b. All sensor modules shall feature self-testing and built-in fault diagnosis.

c. All sensor modules shall be field replaceable and slot mounted in a system electronics sub-chassis.

5. COMMUNICATION AND INTERFACES:

Each VWIM system controller provided shall include the following communication and interface ports with necessary harnesses to complete the connections:

a. USB interface

b. Ethernet interface

c. Remote administration

d. One RJ-45 network or RS-232 serial interface dedicated to external interface (on site laptop direct connection)

e. One RS-232 serial interface dedicated for remote administration via modem dial-in

f. Four Quartz (PCCP locations) sensor inputs per each travel lane

g. Interface to a minimum of two Loop Detectors per each travel lane

6. PLANNING DATA FORMAT:

   The planning data output from the VWIM electronics provided by Developer shall include all of the data elements listed in Section 1.2(B)1 above and be in a format compatible with Midwestern Software Solutions database currently in use by the Department's Planning Division; otherwise, Developer shall work with Midwestern Software Solutions and the VWIM equipment manufacturer to develop and provide a data formatting module which will read data output from the VWIM electronic equipment then format it for input into the Department's existing Midwestern Software Solutions database. The output data shall include all data elements, errors, and warnings listed in Sections 1.b and 1.c above.

7. ENFORCEMENT DATA FORMAT (Optional):

   The enforcement data output from the VWIM electronics provided by Developer shall include all of the data elements listed in section 1 above in a real time streaming format and be compatible with Department central server. The output data from the format module shall include all data elements, errors, and warnings listed in Sections 1.b and 1.c above. In addition to the output data, vehicle image data shall be included.

8. DATA STORAGE:

   Each VWIM system controller provided shall be provided with the maximum of storage available for the model and shall at minimum be capable of storing up to 6 million vehicle records without images or up to 40,000 vehicle records with one image per vehicle. Data storage shall be non-volatile to prevent data loss during power outages.

DATA TRANSFER:

Stored data shall at minimum be transmittable:

a. via a high speed internet connection to multiple remote computers without interrupting the file currently being recorded
b. via a modem dial-in connection
c. via both automatic and manual polling features
d. both individually and in batch mode
e. via direct connect to a laptop computer on-site

9. SELF DIAGNOSIS AND AUTOMATED MALFUNCTION WARNING:

   Each VWIM system controller provided shall have self-diagnostic capabilities. These capabilities shall be usable locally by technicians during on-site inspections and shall be visible in any lighting condition. Self-diagnostics shall include, but not be limited to:

   a. Loop detector on/off indication
   b. Invalid measurement flag in the data file to alert the analyst of errors associated with any vehicle being recorded

10. OPERATING SYSTEM:

    Each VWIM system controller provided shall include all necessary software with operating system. Developer shall provide one original copy of the VWIM system controller provided operating system, including installation disks and manuals for each VWIM electronics provided by this specification.

11. MANUALS AND DOCUMENTATION

    a. Developer shall provide documentation showing the step by step process of performing sensor diagnostics remotely via an IP telecommunications link.
    b. Developer shall provide documentation showing the step by step process of system calibration. This shall include programming and setup instructions for entering initial calibration factors.
    c. One copy of each of the following manuals shall be provided with each VWIM system controller provided:

        i. Operating or user's manual
        ii. Software manual
        iii. Service or technical manual
        iv. Operating System Manual

19.5.5.4.2 *Field Controller*

One field controller (shall be required per each VWIM cabinet provided (see Section 502-6.04(05) of the IDM).

19.5.5.4.3 *Ethernet Field Switch*

One ethernet field switch shall be required per cabinet (see Section 502-6.04(06) of the IDM).

19.5.5.4.4 *VWIM Imaging System*

The purpose of the VWIM imaging system is to provide images of vehicles passing over the sensors so they can be linked to the data record. These images shall be able to be viewed in real time or stored for future use. Each VWIM imaging system consist of and shall be constructed in accordance with the following:

1. Camera, Lens, and Weatherproof Enclosure

    Developer shall provide two CCD or CMOS color and low light monochrome (black and white) progressive scan side fire cameras and lens with a minimum resolution of 1.3 megapixels.

    a. Each camera provided shall be capable of full color images during daytime operation, and monochrome (black and white) near-infrared images during nighttime and low light operation.

b. Each camera provided shall be powered via power over ethernet and have a night minimum scene illumination needed (without IR illumination) of 0.01 Lux (F1.2) without excessive gain.

c. Each camera provided shall be capable of capturing a resolution of 1300 X 1000 pixels at a minimum of 15 frames per second (fps) using a CCD or CMOS sensor.

d. Lenses shall be high quality glass

e. Each lens provided shall have a variable zoom range which includes view angles of 15 to 30 degrees. Depth of field for view angles of 15 to 30 degrees shall at minimum include 25 to 55 feet measured from the camera focal plane.

f. Each camera provided shall be capable of Image transfer via HTTP, FTP, or RTP. Image transfer shall be via a standard RJ 45 connector and CAT 5 cable.

g. Each camera provided shall provide optimum performance using 850 nm wavelength Illuminators.

h. Developer shall ensure each camera provided is fully compatible with the VWIM system electronics.

i. The imaging system shall be capable of storing and providing images to the VWIM computer for attachment to a detailed vehicle record for passing commercial vehicles, which shall be a function of the VWIM system, while images of non-commercial vehicles are discarded.

j. Each camera provided shall be enclosed in a stainless steel weatherproof housing and have a lens cleaning system consisting of a wiper and washer tank to allow the camera window on the housing to be cleaned remotely. The cleaning system shall be able to be operated remotely over IP based communication lines.

k. Image outputs shall terminate inside the cabinet via CAT 5 cable and standard RJ 45 connectors.

l. The VWIM software shall have the capability to take camera snapshots and operate the enclosure wiper from its diagnostics screens.

2. Poles and Pole Foundations

Developer shall provide two, (one on each side of the roadway), Type IV 12 inch by 24 foot cable span sign poles with foundations in accordance with applicable Department Standard Specifications. Each pole shall be capped on the top to prevent moisture from entering the pole and shall have one removable weatherproof cover near the base so technicians can access wiring inside the pole.

a. Developer shall provide pole mounting brackets for the weatherproof camera housing and illuminators. In addition, Developer shall provide all necessary harnesses/cables, power supplies, and required hardware to install the cameras and illuminators.

3. IR Illuminator Systems

Developer shall provide a minimum three IR illuminators for each camera to enable the camera to be used during night time hours. IR Illumination shall be near invisible to passing motorists so as not to hinder motorist’s night vision.

a. Night time illumination shall be sufficient to allow 3 inch black letters on a white background during the hours of darkness to be clearly legible at a distance of 49 feet. In addition, vehicles shall be clearly in focus and able to be identified by their physical features during the hours of darkness in all travel lanes.

b. Each IR Illuminator provided shall operate on an 850 nm wavelength.

c. Each IR Illuminator provided shall have a maximum beam pattern angle no greater than 30 degrees.

4. Construction Requirements

The following are Construction requirements for the imaging system:

a. Developer shall install the side image cameras alongside the roadway on the mainline in a position to obtain the best possible images, detailing their cab and side. Developer shall ensure pole placement is in compliance with clear zone requirements.

b. Cameras shall be mounted 16 feet ± above highway grade on the pole.

c. The camera shall be situated so that it is aimed at the center of the leading loop in the travel lane nearest the camera at a 30 to 35 degree angle.

d. Final placement of the side image cameras and poles shall be as shown on the Design Documents.

The center illuminator on each side of the highway shall be directed across the center of the leading edge of the leading loop detector in the right hand travel lane. Both illuminators to either side of the center illuminator shall be adjusted so approximately half of their illumination overlaps half of the illumination from the center illuminator.

19.5.5.5 VWIM System Common Station Components and Structures

VWIM Station Components. See IDM Figure 502-6G for a typical 4 lane divided highway VWIM overview. VWIM stations shall contain the following components:

1. Controller Cabinet and Foundation. ITS Cabinet and foundations shall be used at VWIM stations. Cabinets and foundations shall be in accordance with Section 502-6.03(03) of the IDM and in accordance with applicable Department Standard Specifications.

2. Ground Rods and Systems. VWIM ground rods and systems shall be in accordance with applicable Department Standard Specifications.

3. ITS Handholes, Rings and Covers. ITS Handholes shall be used at VWIM stations with class III reinforced concrete pipe in accordance with applicable Department Standard Specifications. Only lid and ring assemblies with bolted lids rated for traffic use may be used.

4. Traffic Signal Detector Housings. Traffic signal detector housings shall be in accordance with applicable Department Standard Specifications.

5. Galvanized Steel and PVC Conduits. Galvanized steel and PVC conduits at VWIM stations shall be in accordance with applicable Department Standard Specifications.

6. Utility Service Point. VWIM utility service points shall be in accordance with applicable Department Standards.

7. ITS Communications Network Connection. VWIM stations shall be connected to the existing ITS communications network in accordance with applicable Department Standards.

19.5.5.6 VWIM Roadway Sensor Array

VWIM Roadway Sensor Array. Sensors currently in use at VWIM station by the Department fall under three categories:

1. ***Presence Detection***. The only presence detection sensor currently in use for traffic monitoring systems is the loop detector. Traffic monitoring loop detectors shall be 6 feet round loop detectors and in accordance with Department Standards.

2. ***Axle Detection***. The Department currently utilizes two types of axle sensors at VWIM station, namely quartz and piezo. Quartz sensors shall be used at locations with PCCP and piezo sensors shall be used at locations with bituminous pavements. VWIM stations shall have dual axle sensors installed providing separate weights for right and left wheels. Axle sensors shall be installed per manufacturer's recommended procedures.

3. ***Temperature Sensor***. One temperature sensor is required for each controller in use and shall be in accordance with Department Standards. Temperature sensors shall be installed per the VWIM controller manufacturer's recommended procedures.

VWIM sensor arrays shall consist of one 6-foot round loop detector, followed by two 6-foot axle sensors (right and left wheel paths), followed by one 6-foot round loop detector, followed by two 6-foot axle sensors (right and left wheel paths), followed by one 6-foot round loop detector in each travel lane. Sensor placement shall be such that saw slots are no closer than 2 feet to transverse pavement joints. Moving in the direction of travel (downstream), sensors shall be offset from the left most lane to the right approximately 6.75 feet in a downstream direction.

Roadway loop wire shall be 14 AWG gauge IMSA 51-3 wire with polyvinyl chloride or polyethylene outer jacket of 0.136 inch diameter. Only non-duct loop wire may be used for traffic monitoring loop detectors. IMSA 51-7 loop wire with polyvinyl chloride or polyethylene outer jacket of 0.250 inch diameter may be used if the wire is separated from the outer duct prior to installation.

All saw slots other than the loop detector body and where the lead-in joins with the loop detector body shall be at right angles to the roadway. Lead-in saw slot intersections shall only be allowed on shoulder and median pavement.

Loop detector lead in cable shall be in accordance with applicable Department Standard Specifications.

4 inch pieces of foam backer rod shall be inserted at 2 foot +/- intervals on the loop detector and lead-in saw slots after the roadway loop wire has been installed prior to sealing.

19.5.5.6.1 Quartz Sensor Testing

Developer shall meter all new quartz sensors prior to and following installation. Equipment needed to perform the testing is an LCR (inductance, capacitance, and resistance) meter which also measures dissipation and an oscilloscope/scope meter.

1. PRE-INSTALLATION TEST READINGS - The following testing shall be performed on Quartz axle sensors prior to installation into the roadway to ensure the sensor is reliable:

   a. **Capacitance:** Measure the capacitance of the sensor with the attached lead in cable. This shall be within 20% ± of the reading recorded on the sensor's data sheet included with the sensor. The meter shall typically be set on a 20nF range. The measurement shall be taken with the red lead on the center electrode of the cable and the black lead connected to the outer braid.

   b. **Dissipation Factor:** With the capacitance set on the scale indicated above, switch the meter over to dissipation factor. The reading shall be less than 0.04 and shall be 20% ± of the reading recorded on the sensor's data sheet included with the sensor.

   c. **Resistance:** Measure the resistance across the sensor. The meter shall be set on the 20M ohms setting. The meter shall read in excess of 20M ohms, which is typically displayed with a "1" on most LCR meters. This test may be performed using a standard multimeter which will display actual measured resistance.

2. POST-INSTALLATION TEST READINGS – The following testing shall be performed on Quartz axle sensors after installation into the roadway to ensure the sensor WAS not damaged during installation and is functional per the manufacturer's specifications:

   a. Once the sensor is installed and the grout has cured, repeat the Pre-Installation Testing per the instructions above.

   b. The contractor shall hook up an oscilloscope to the sensor and view wave forms as vehicles pass over the sensors to ensure the signal is clear and without noise. The sensor output voltage shall consistently measure a minimum of 90 mV for smaller vehicles to be accepted.

3. QUARTZ SENSOR TESTING AND MATERIAL RECORD – Developer shall record quartz test readings with sensor and material information. The record shall at minimum include the following information for each quartz sensor installed:

   a. Quartz Sensor Serial Number
   b. Quartz Sensor length
   c. Quartz lead-in length from the factory
   d. Readings from pre-installation testing
   e. Readings from post-installation testing
   f. Lane description or number
   g. The quartz sensor number as shown on the plans.

h. The quartz Sensor grout type and expiration date

i. The lot number of the grout

j. The outside temperature when the quartz was installed

k. Installation date

l. Installer's name and company

If multiple cans of grout are used to encapsulate one quartz sensor, then the grout type, lot number, and the expiration date for each can of grout used shall be recorded.

4. QUARTZ SENSOR ACCEPTANCE CRITERIA – For a quartz sensor to be accepted, test readings as described in section 1 and 2 above shall fall within the following ranges:

Capacitance	4 to 15 nF
Resistance	Greater than 900 KΩ
Dissipation	Less than 0.05

Average Signal Level for 2 axle passenger vehicles shall be a minimum of 90 mV.

Sensors testing and producing other readings and/or failing to be in compliance with this Section shall be considered as failing and shall be replaced at no additional cost to the Department.

19.5.5.6.2 Piezo Sensor Testing

Developer shall meter all new piezo sensors prior to and following installation. Equipment needed to perform the testing is an LCR (inductance, capacitance, and resistance) meter which also measures dissipation and an oscilloscope/scope meter.

1. PRE-INSTALLATION TEST READINGS - The following testing shall be performed on piezo axle sensors prior to installation into the roadway to ensure the sensor is reliable:

   a. Capacitance: Measure the capacitance of the sensor with the attached lead in cable. This shall be within 20% ± of the reading recorded on the sensor's data sheet included with the sensor. The meter shall typically be set on a 20nF range. The measurement shall be taken with the red lead on the center electrode of the cable and the black lead connected to the outer braid.

   b. Dissipation Factor: With the capacitance set on the scale indicated above, switch the meter over to dissipation factor. The reading shall be less than 0.04 and shall be 20% ± of the reading recorded on the sensor's data sheet included with the sensor.

   c. Resistance: Measure the resistance across the sensor. The meter shall be set on the 20M ohms setting. The meter shall read in excess of 20M ohms, which is typically displayed with a "1" on most LCR meters. This test may be performed using a standard multimeter which will display actual measured resistance.

2. POST-INSTALLATION TEST READINGS – The following testing shall be performed on piezo axle sensors after installation into the roadway to ensure the sensor was not damaged during installation and is functional per the manufacturer's specifications:

a. Once the sensor is installed and the grout has cured, repeat the pre-installation testing per the instructions above.

b. The contractor shall hook up an oscilloscope to the sensor and view wave forms as vehicles pass over the sensors to ensure the signal is clear and without noise. The sensor output voltage shall consistently measure a minimum of 90 mV for smaller vehicles to be accepted.

3. PIEZO SENSOR TESTING AND MATERIAL RECORD – Developer shall record piezo test readings with sensor and material information. The record shall at minimum include the following information for each piezo sensor installed:

a. Piezo sensor serial number

b. Piezo Sensor length

c. Piezo lead-in length from the factory

d. Readings from pre-installation testing

e. Readings from post-installation testing

f. Lane description or number

g. The piezo sensor number as shown on the plans.

h. The piezo Sensor grout type and expiration date

i. The lot number of the grout

j. The outside temperature when the piezo was installed

k. Installation date

l. Installer's name and company

If multiple cans of grout are used to encapsulate one piezo sensor, then the grout type, lot number, and the expiration date for each can of grout used shall be recorded.

4. PIEZO SENSOR ACCEPTANCE CRITERIA – For a piezo sensor to be accepted, test readings as described in section 1 and 2 above shall fall within the following ranges:

Capacitance	4 to 15 nF
Resistance	Greater than 900 KΩ
Dissipation	Less than 0.05

Average Signal Level for 2 axle passenger vehicles shall be a minimum of 90 mV

Sensors testing and producing other readings and/or failing to be in compliance with this Section shall be considered as failing and shall be replaced at no additional cost to the Department.

19.5.5.7 VWIM Station Calibration & Accuracy Requirements

Calibration

Upon completion of all work at the VWIM station, Developer shall perform scale calibration for each travel lane. Developer shall calibrate each lane using a five-axle tractor-trailer with air ride suspension loaded with a non shifting load at near legal gross weight limit with a minimum weight of 75,000 pounds.

Prior to the start of calibration, Developer shall have the truck weighed at a certified scale to obtain individual single axle (i.e. steering axle, etc.) and grouped axle (i.e. tandem, tri-axle, etc.) weights for every axle/group of axles on the vehicle, as well as the overall vehicle gross weight. These weights shall be provided to the person performing the calibration so the actual weight of the vehicle is known prior to the start of calibration.

The truck shall make a minimum of 15 passes over each lane to ensure that each lane is properly calibrated.

Upon completion of the calibration procedure, the contractor shall submit a summary of the calibration process to the Engineer showing the weight of the truck from the certified scales and the weight the system indicated each time the truck crossed over the scales. This summary shall at minimum include the pre-calibration weights for each axle with total gross weight and individual axle with total gross weights for the last ten passes of the truck for each lane. Developer shall include all variable factors related to calibration of the system which were programmed into the VWIM electronics for each lane on this summary. Electronic copy of the site parameters and VWIM Electronics configuration files shall be provided to the Engineer.

Accuracy Requirements

Utilizing quartz sensors in each lane, the system shall meet the following accuracy criteria:

	Mean Error	Standard Deviation
Steering axles	+/- 2%	8%
Single axles	+/- 2%	8%
Tandem axles	+/- 2%	7%
Gross vehicle weight	+/- 1.5%	5%
Axle spacing	+/- 2 in.	3 in.
Vehicle length	+/- 12 in.	18 in.
Speed	+/- 1 mph	2 mph

Utilizing Class I piezos in each lane, the system shall meet the following accuracy criteria:

	Mean Error	Standard Deviation
Steering axles	+/- 3%	10%
Single axles	+/- 3%	10%
Tandem axles	+/- 3%	10%
Gross vehicle weight	+/- 2%	8%
Axle spacing	+/- 2 in.	3 in.
Vehicle length	+/- 12 in.	18 in.
Speed	+/- 1 mph	2 mph

The above accuracy specifications are to be based on a minimum sample of 10 vehicle passes, loaded to a minimum of 93% of the legal allowable weight limit. Vehicle passes which traverse the scale with more than a 10% speed variation shall not be considered. The accuracy will be based on a one standard deviation confidence level. This assumes that the errors are normally distributed, and subsequently, 68% of all samples fall within the above quoted limits.

In addition to previously described accuracy criteria, each VWIM system covered by this specification shall comply with the requirements of ASTM E1318-09 for Type III WIM systems. In the event the station does not operate within tolerances defined by the above accuracy criteria and does not satisfy requirements of ASTM E1318-09 for Type III WIM systems. The Department will not accept any work at the VWIM station until Developer has taken necessary corrective action to bring the station into compliance.

19.5.5.8 ITS Technology Deployment Division Final Acceptance Check

After Developer has notified the Engineer that all work at the VWIM station has been completed, utilities have been connected, and the site has been calibrated, then the Department's ITS Technology Deployment Division shall schedule technicians to perform a thorough site inspection/operation test within ten working days. Noted discrepancies, if any, will be reported to the Engineer and Developer shall correct these discrepancies before the site is accepted. It shall be Developer's responsibility to notify both the Engineer when all work is completed to have the final acceptance check performed.

Prior to acceptance of the station, a minimum of two weeks data shall be collected, processed, and evaluated by the Department. Acceptance of the station shall not take place until it has been determined that data accuracy is in accordance with above stated accuracy criteria.

19.5.5.9 Warranty

Developer shall arrange for vendors to warranty their equipment for not less than five years after the date of final acceptance of all work in the Contract. Specified warranty periods shall apply to all in-road sensors and equipment installed in or at each VWIM station.

Warranties shall include, but not be limited to, defects in material, poor workmanship, and/or malfunction of any in-road sensor and/or equipment provided by this special provision. Any in-road sensor, splice or lead-in cable that fails to meet specifications and/or develops a problem during the construction and/or warranty period shall be repaired or replaced as required within fourteen days of notification by the Department. All warranty costs outside shall be covered under the warranty including parts, travel, labor, maintenance of traffic, and mileage. Any equipment that fails during the warranty period likewise shall be replaced or repaired within fourteen days of notification by the Department.

The warranty shall include damage to the electronics in the cabinet caused by lightning.

19.5.6 Reference Markers

Developer shall furnish and install reference markers on designated highways and interchanges per MUTCD (refer to Chapter 2) and State ITS architecture and signage standards (refer to Section 11.5).

19.5.7 Closed-Circuit Television Cameras

19.5.7.1 Design Criteria

CCTVs shall be designed to mount on camera poles/towers in open-space areas. Special connections shall be provided to mount CCTVs on bridge structure, and locations shall be approved by IFA and KYTC as part of the Design Review process. All cameras shall be located within the Project ROW and shall be designed and constructed in accordance with the pertinent Department standards and existing TRIMARC standards. Refer to the ITS Standards and Specifications (TRIMARC) document in RID IT-0.08 for CCTV Pole, lowering device, CCTV Assembly, CCTV Field Controller, CCTV Control Cable and CCTV Keyboard Controller requirements within the KYTC jurisdiction.

Developer shall be responsible for CCTV assembly and camera composite cable. Developer shall be responsible to provide an ARIES Field Processors (AFPs) for video encoding, decoding, and pan-tilt-zoom (PTZ) control between the field and TMC or a Treehaven CCTV Field Controller, or approved equal, for video encoding, decoding, and pan-tilt-zoom (PTZ) control between the field and TRIMARC. Camera poles shall be used in KYTC jurisdiction and camera towers shall be used in INDOT jurisdiction. Poles and towers shall be designed in compliance with the Department and KYTC standards on pole sizes, foundations, concrete paving, and lightning protection, and shall be located in areas where access to equipment shall not require traffic control. Otherwise, the pole shall be protected by safety guide railings or traffic barriers (refer to Section 9). All pole mounted ITS devices shall use a camera lowering system, as detailed in Department and KYTC standards, to ease future maintenance. Each pole pole/tower shall have a foundation and a concrete work pad for maintenance.

Developer shall be fully responsible for site survey, design, structural calculations, fabrication, installation of the CCTV camera assembly, AFPs or CCTV field boxes, camera pole/tower, lowering device assembly, pole foundation and other Incidentals including fence and gate, tower grounding and lightning protection. Camera locations shall be coordinated with the roadway design and shall be submitted to IFA and KYTC for Design Review and approval in order to provide optimal coverage. Developer shall be responsible for all testing of CCTV to the control centers cameras per Department and KYTC standards to provide a fully functional CCTV subsystem.

19.5.7.2 CCTV Assembly

CCTV assembly shall have the following components:

1. One (1) camera dome with PTZ.
2. One (1) camera lowering system as necessary.
3. CCTV composite cable.

19.5.7.2.1 INDOT Camera Dome with Pan Tilt Zoom

19.5.7.2.1.1 Material Requirements

Camera dome with PTZ shall be manufactured by: Honeywell – RVSHDXGNWACW-8 series

The contact information is as follows:

Mr. Perry Wolfe
P.T. Wolfe Associates Inc.
2017 Garey Rd. NE
Junction City, OH 43748
Telephone: 740-987-2550
Fax: 740-987-2477
Mobile Phone: 740-503-2148

Developer is responsible for maintaining current contact information after the publish Setting Date.

19.5.7.2.1.2 Construction Requirements

All installation services shall comply with all warranty provisions and warranty contract maintenance services and Department electrical codes. All wiring entry to the camera dome shall use watertight fittings. All wiring entry and exits shall be made at the side or underneath components; no exposed top entry or exits are permitted.

19.5.7.2.2 Camera Lowering System

19.5.7.2.2.1 Material Requirements

Camera lowering system shall be provided by one of the following manufacturers or department approved equivalent:

1. [MG]2 Inc.
2. Camera Lowering Systems, Inc.

The camera lowering system shall be capable of lowering the camera to the ground without contacting the pole/tower structure. To the minimum, the lowering system shall consist of the following components:

1. Coaxial contact unit
2. Self-aligning divided support arm
3. Adapter for attachment to tower
4. CCTV control cable junction box at the top of the tower
5. Lowering tool
    a. The camera-lowering device shall withstand wind forces of 100 miles per hour with a 30 percent gust factor using a 1.65 safety factor. The lowering device shall effectively operate within a temperature range of –40 to 191 degrees Fahrenheit.

The interface and locking components shall be made of stainless steel and or aluminum. All external components of the lowering device shall be made of corrosion-resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coatings to withstand exposure to a corrosive environment. A weephole with screen shall be included on the underside of the weight box.

All electrical and video coaxial connections between the fixed and lowerable portion of the contact block shall be protected from exposure to the weather by a waterproof seal to prevent degradation of the electrical contacts. The electrical connections between the fixed and movable lowering device components shall be designed to conduct 56,000 bps RS422/485 or RS-232 data and one (1) volt peak-to-peak video signals as well as the power requirements for operation of dome environmental controls.

1. **Coax contact unit.** The suspension contact unit shall have a load capacity 200 pounds with a 4 to 1 safety factor. There shall be a locking mechanism between the fixed and movable components of the lowering device. The movable assembly shall have a minimum of two latches. This latching mechanism shall securely hold the device and its mounted equipment. The latching mechanism shall operate by alternately raising and lowering the assembly using the winch and lowering cable. When latched, all weight shall be removed from the lowering cable. The fixed unit shall have a heavy-duty cast tracking guide and means to allow latching in the same position each time. The contact unit housing shall be weatherproof, with a gasket provided to seal the interior from dust and moisture.

    a. The prefabricated components of the lift unit support system shall be designed to preclude the lifting cable from contacting the power or video cabling. Developer shall supply a means of separating the power and video cabling from the lowering cable if required by the Design Documents or Engineer. The only cable permitted to move during lowering or raising shall be the stainless steel lowering cable. All other cables shall remain stable and secure during lowering and raising operations.

    b. The coax connector block consists of DIN Housing containing thermoplastic insulation bodies that hold the individual contacts. Guide pins and guide bushings shall prevent misconnections and provide accurate mating without relying on the contact pins to provide alignment. There shall be a minimum of 12 -.06-in. contacts and 1-75 Ohm contact. The max current rating for each pin shall be at least 13 amps. The signal and power wires shall be crimped using an industry standard 8-point crimp tool. The video cable shall be 75 ohm coax not to exceed a length of 1,000 feet. The cable loss with the connectors shall not exceed 0.8 decibels per 100 feet at 5 megahertz. The camera cable shall be made up with the coax connector block in the factory and sealed with electrical insulating. The entire coax connector block shall be sealed from external dust and moisture when in the mated condition by means of a gasket.

2. **Divided support arm.** The divided support arm and receiver brackets shall be designed to self-align the contact unit during installation and ensure the contact unit cannot twist under high wind conditions.

3. **Lowering tool.** The camera-lowering device shall be operated by use of a permanent mount lowering tool. The lowering tool shall be provided with an adapter for operating the lowering device by a portable drill using a clutch mechanism. The clutch mechanism, but not the portable drill, shall be provided for each site. The lowering tool shall be equipped with a positive locking mechanism to secure the cable reel during raising and lowering operations. The lowering tool shall be made of durable and corrosion-resistant materials, powder coated, galvanized, or otherwise protected from the environment by industry-accepted coating to withstand exposure to a corrosive environment. Lowering tool shall be installed in the stainless steel, or aluminum enclosure, rated 3R, mounted to the tower.

4. **Pulleys.** All pulleys for the camera lowering tool shall have sealed, self-lubricated bearings, oil tight bronze bearing, or sintered bronze bushings. The lowering cable shall be a minimum 1/8-inch-diameter stainless steel aircraft cable with a minimum breaking strength of 1,740 pounds with (7) strands of 19 gauge wire each.

19.5.7.2.2.2 Construction Requirements

1. **Installation.** Installation of the camera lowering system shall be coordinated with the Engineer to determine actual mounting height and azimuth. Typically, the camera lowering system azimuth will be perpendicular to the mainline lanes.
2. **Manufacturer Testing.** Prior to the delivery of the camera lowering system, the manufacturer will test for the following:
   a. Electrical continuity
   b. Direct connectivity to ground for an open circuit of 120 volts

The results of these tests will be supplied to IFA with each camera lowering system upon delivery.

1. **Certification.** Developer shall provide a 916.02(b) Type C certification from the vendor verifying the CCTV control cable was properly installed and tested before delivery to Developer.
2. **Warranty.** Developer shall provide a manufacturer's warranty against defects in material and workmanship for a period of five years after Final Acceptance of each complete installation. Developer shall include labor for removal and reinstallation of a failed unit. Warranty shall include complete connector assembly replacement for contacts failing due to water ingress and corrosion damage.

19.5.7.2.3 Composite Cable

19.5.7.2.3.1 Material Requirements

CCTV composite cable shall be provided by manufacturers including Treehaven Technologies or Department approved equivalent. CCTV composite cable shall conform to specifications of UL/NEC/CEC CATV or CM with Flame Resistance of Underwriters Laboratories (UL) 1581 Vertical Tray.

1. CCTV control cables shall be a composite cable consisting of one RG59 coax video cable and an appropriate number and size of copper conductors to meet the needs of the camera. Developer shall coordinate with the camera manufacturer to ensure proper connectivity.

19.5.7.2.3.2 Construction Requirements

Developer shall coordinate the cable installation as required to suit field conditions and as approved by the Engineer. Cables shall be a suitable length to allow installation between equipment without exceeding the minimum bend radius as specified by the manufacturer. Connectors shall be installed as necessary, and shall match the connector interface requirements for the equipment being connected. Adapters are not acceptable.

19.5.7.3 ARIES Field Processor

19.5.7.3.1 Description

The AFP is an interfacing device installed in the cabinet to perform as a terminal server. It provides software-based digital video encoding/decoding for video transmission from field CCTV camera to the applicable TMC and transfer PTZ control commands from TMC to camera site. In addition, AFP has options to provide interface between TMC network and all field devices such as DMS, Virtual Weigh-in-Motion Station, HAR (including audio .wav files playback), and field processing of vehicle detectors such as microwave and microloop).

19.5.7.3.2 Material Requirements

The AFP products have been chosen as main component in TMC. Refer to the IFA-approved materials list for material details.

The contact information is as follows:

Mr. Richard Anderson
Iron Mountain Systems, Inc.
31540 Pio Pico Road
Temecula, CA 92592
Telephone: (951) 491-0153
Fax: (951) 491-0193
Email: randerson@imsmail.org

19.5.7.3.3 Construction Requirements

Developer shall install all AFPs in the cabinets and connect them to the network. Developer shall provide environmental testing results, bench testing results, and field test results per NTCIP and Department standards.

19.5.7.4 Camera Tower, Foundations, and Concrete Paving

19.5.7.4.1 Description

This Work shall consist of designing, furnishing, and erecting self-supporting camera towers, including the tower foundations and the concrete tower pad, for the type and height specified herein. All Work shall be accomplished in accordance with the PPA Documents including the Technical Provisions, Section 711 Steel Structures of the Department Standard Specifications and the corresponding Supplemental Specifications, and any other applicable sections of the Department Standard Specifications, including Sections 701 Driven Piling, Section 702 Structural Concrete, and Section 703 Reinforcement Bars. The tower shall be supplied complete with all parts, fittings, and foundations; completely erected; lighted (as required); painted (as required); and ready for use by IFA. Developer shall comply with all applicable Laws for this type of structure.

The towers will be used to support CCTV and microwave detectors for expressway surveillance along the Project ROW. The towers are located along the interstate. Camera towers shall be designed in accordance with the design data detailed below. Developer shall provide IFA with structural designs and engineering Design Documents for the camera towers, including the tower foundations for Design Review. The design of the foundations shall be in accordance with Section 13.3.2.12 and the Project Standards. Basic tower components shall include the following:

- Concrete base, piers, and foundation
- Stone base
- Structural members
- Conduit(s), cables, cable supports, and winch drive enclosures per design schedules
- Transmission line ladder and hangers
- Lightning rod and grounding cable
- Grounding system
- Safety climb devices – horizontal members, welded climbing loops, ladder, or bolt-type climb pegs for climbing and stainless steel cable type safety climb system
- Trolley with removable traveler
- Tower-mounted camera cabinets as required by the East End Crossing

The design shall comply with ANSI/EIA/TIA 222-G specifications.

The tower shall have a straight face design, such that the face width is uniform from the base to the top of the tower. The size of the steel rods shall be the only difference between successive tower sections. For communication towers, the 60-foot section closest to the ground shall be tapered, with a maximum distance at the base of the tower of 8 feet between vertical tower support members. The sections of communication towers higher than 60 feet above grade shall be straight face design.

19.5.7.4.2 Design Data

The design criteria for camera towers shall conform to the EIA Bulletin ANSI/EIA/TIA-222-G or the latest edition.

Each tower shall be designed per American National Standards Institute/Electronic Industries Alliance/Telecommunications Industry Association (ANSI/EIA/TIA) -222-G structure class 2 and exposure class C. The ANSI/EIA/TIA-222-G topographic feature shall be designed per the most conservative topographic feature on the East End Crossing. The topographic feature for the towers shall be based on the latitude and longitude of each tower. The total load specified shall be applied to the structure in the direction that will cause the maximum stress in the various members.

The dead weight of the structure and all materials attached thereto shall be considered in the design.

The tower and footings shall be designed and constructed to maintain tower twist or sway limits as specified in EIA Bulletin ANSI/EIA/TIA-222-G or the latest edition. The twist and sway limits shall conform to a 90-mile-per-hour wind with no ice load. Developer shall verify with the manufacturer that specifications for selected antennas do not conflict with the tower deflection specification.

The tower shall support beacon(s), sidelights, and lighting equipment in accordance with the Federal Aviation Administration (FAA) requirements for each site.

An integral climbing device shall be furnished for the full length of the tower. The device steps shall be evenly spaced no further than 18 inches apart. This device shall be compatible with the safety climbing equipment described herein. The climbing device shall be part of the tower, not an external structure attached to the tower. The climbing device shall include a stainless steel cable climb safety device for the full length of the tower. The climb safety device shall use stainless steel mounting hardware. A solid climbing ladder may be considered as an alternate bid if an integral device is not available from the tower vendor. All applicable federal and Indiana OSHA regulations for climbing devices shall be complied with.

Towers shall be designed to incorporate an integral cable support system, enabling the use of snap-in hangers such as Andrew type 206706 snap-in cable support hanger.

19.5.7.4.3 Plans and Marking

Complete Plans and assembly drawings shall be supplied showing all of the necessary details to permit proper installation.

Plans are to include the tower base and anchors, concrete tower foundation, cubic yards of concrete, concrete finishing techniques, tower section details, torque stabilizer details, hardware, and electrical wiring data.

All steel, except hardware, shall be marked with stencilled markings on metal tags wired to the members. The markings shall have a height of not less than 5/8 of an inch. The markings shall correspond with the markings on the manufacturer’s erection diagrams (assembly drawings).

19.5.7.4.4 Materials Requirements

Solid steel rod members shall be used for tower construction to reduce drag coefficients, minimize wind and ice loading and high-corrosion resistance properties. In-factory welded construction shall be used as practical for easy in-field installation. Solid steel rod members shall be factory-painted as required or treated for corrosion protection in the factory.

All towers shall be labeled with a unique identification tag. The tag shall identify the manufacturer. In addition to the tower requirements above, the following items are required for specific tower locations, as referenced below. Developer shall provide a written certification that the manufacturer has designed the self-supporting tower and foundations in accordance with EIA/TIA standards and this Section 19. A Registered Professional Engineer shall stamp the tower and foundation designs. Design Documents shall be submitted in accordance with Section 3. Structural steel, cast steel, and steel forgings and bolts shall conform to specifications listed in *"Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings,"* issued by the American Institute of Steel Construction (AISC), latest edition. Bolts and locking devices furnished shall be of high-strength steel and shall conform to the AISC specifications.

Steel tubes and/or pipe shall not be acceptable as construction material for this tower. Tower design shall include the following basic criteria:

1. Self-supporting lattice tower structure with triangular base. Camera towers shall have straight vertical legs to the top.
2. Solid steel rod members (i.e., no hollow components that can trap water).

3. Tower codes per current EIA/TIA standards.
4. Camera Tower Loading:
    a. Two (2) cameras (maximum of one (1) camera per tower face).
    b. Two (2) cameras with lowering systems (maximum of one (1) per tower face). Camera lowering arms shall be designed at 70 feet from the base of the tower, with a maximum total equipment dead load of 600 pounds per camera.
    c. Two (2) 4-foot parabolic antennas (designed such that, regardless of tower height, the tower will be able to support the antennas mounted 2 feet from the top of a 120-foot tower to accommodate future expansion of towers less than 120 feet in height).
    d. Two (2) 30-inch by 30-inch by 48-inch tower-mounted camera cabinets mounted 5 feet above the base of the tower (conduit and 0.5-inch antenna cabling as necessary).

For friction-type connections, all high-strength bolts shall be installed in accordance with American Institute of Steel Construction (AISC) publication "*Specifications for Structural Joints Using ASTM A325 or A490 Bolts*," latest edition. All bolts shall require a nut locking device.

Solid steel members shall be used for tower construction to provide high-corrosion-resistance properties. In-factory welded construction shall be used for easy in-field installation. Solid steel members shall be factory primed and painted as required or treated for corrosion protection in the factory. All cotter pins used in the East End Crossing shall be made of a high-quality stainless steel to ensure long life. No substitutes shall be accepted.

Levelling of the tower at the base shall be done using only a steel plate of a suitable area and thickness.

All towers shall be labelled with a unique identification tag. The tag shall identify the manufacturer and shall include the tower identification address used in the Design Documents.

19.5.7.4.5 Manufacture and Workmanship

All manufacturing and workmanship shall be in accordance with commonly accepted standards of the structural steel fabricating industry.

All welding procedures shall be in accordance with the requirements of the appropriate AISC or AISI specifications.

19.5.7.4.5.1 Galvanizing Process

All steel material shall be galvanized after fabrication as described in the Electronics Institute Alliance (EIA) Bulletin ANSI/EIA/TIA-222-G or the latest edition as of the Setting Date.

19.5.7.4.5.2 Reserved

19.5.7.4.5.3 Safety Climb System

A 3/8-inch, minimum, safety climb stainless steel cable system shall be installed on the tower, which meets EIA/TIA-222-G and OSHA-approved safety climb system standards, latest edition. A "trolley" attachment device or safety sleeve (a device that safely attaches to the safety cable with an emergency brake) with all necessary hardware and safety devices shall be furnished by Developer. The system shall include a removable traveler as well as all end-sleeves, connections, and standoffs (if Developer's proposed system is compatible with the Rohn Safety Climb). The climb safety system shall extend above the top of the tower, a minimum of 3 feet, to allow for continuous attachment of the climber while inspecting or performing maintenance on the top beacon light assembly.

If a rail system is used in lieu of a cable system, there shall not be a significant void or gap between sections of the rail to allow the trolley to fall out of the rail track or be hung up at the gaps or voids.

19.5.7.4.5.4 Foundation and Anchors

The pad and stem foundation alternate as shown in the plans is preferred and shall be used wherever possible on the East End Crossing as directed by the Engineer. Foundations and anchors shall be designed, taking into consideration the actual soil pressure from the soil analysis report for this specific site. The design shall take into account the resultant of all dead- and live-load reactions. Foundations and anchors shall be designed for the maximum combined dead and live loading expected.

In uplift, it shall be assumed that the base of the standard foundations or anchors with an undercut or toe engages the frustum of an inverted pyramid or cone of earth whose sides form an angle of 30 degrees with the vertical. Earth shall be considered to weigh 100 pounds per cubic foot (unless the soil analysis report dictates otherwise) and concrete 150 pounds per cubic foot. Weights of other materials shall be considered at the established values. The weight of all materials used to resist the uplift shall be calculated, and 50 percent of the actual value is added in order to provide a minimum safety factor of 2.

Foundation plans shall ordinarily show standard foundations and anchors as defined in this section. Where some modifications of the Project Standards are necessary because soil conditions are not normal, the manufacturer shall furnish a foundation design and Plan based on the actual soil conditions.

The concrete strength shall be in accordance with ASTM C94 and ACI 318 (latest edition) and shall test 4,000 pounds per square inch minimum in 28 days. Reinforcing steel shall be of intermediate grade 60 and in accordance with ASTM-A-615. All exposed concrete surfaces not formed shall be chamfered. Concrete tests shall be in accordance with ACI 301. Test two (2) cylinders at the age of seven days and two (2) cylinders at the age of 28 days. Reserve one (1) cylinder for 56 days if the 28-day test does not meet the requirements. Three copies of the concrete test results, in report form, shall be supplied to the IFA.

Erection of the tower may begin fourteen (14) days after the concrete has been poured, provided the concrete test results are acceptable.

The tower base shall be carefully formed and poured so that the portion above grade level will present a neat and finished appearance. At least 6 inches of the base shall be above the final grade level. This base shall contain adequate reinforcement steel, neatly spaced, to provide adequate strength within the dictates of good engineering practices.

19.5.7.4.6 Construction Requirements

Prior to installation, Developer shall verify with the Engineer the exact location, coordinates, and orientation of the CCTV camera before the placing of the foundations. The top of foundation for each tower shall be placed at the elevation indicated on the Plans. The tower orientation typically will permit mounting of the camera lowering system perpendicular to the mainline travel lanes such that it does not conflict with the microwave detector installation.

Grounding connections shall be made as soon as the first section is installed.

19.5.7.4.6.1 Concrete Paving

Developer shall pave the interior of the fenced area with 6 inches of non-reinforced Portland cement concrete (PCC). The cost of this PCC pavement shall be incidental to the tower construction and shall be included in the cost of the tower.

19.5.7.4.6.2 Site Preparation

Developer shall provide a staked layout of the tower base and anchors, for the review and approval by the IFA 3 days prior to construction.

Developer shall be responsible for field adjustments of the tower location, including foundation and anchors. Any alteration to the locations on the Plans shall be submitted to the IFA for review and approval. Developer shall document changes on the Plans and submit revisions to the IFA.

Care shall be taken by Developer to preserve the lawn area around the tower construction area to the extent possible to minimize lawn restoration. Developer shall restore the grounds to their original condition. Upon completion and before the final inspection, all debris from the construction shall be removed and the site left in a neat and presentable manner.

19.5.7.4.6.3 Drilled Shaft Submittals

If drilled shaft foundations are selected by Developer, Developer shall submit an installation plan for Design Review by the IFA with RFC Design Documents. This plan shall provide the following information, as a minimum:

1. Proposed concrete mix designs.
2. Name and experience record of drilled shaft superintendent in responsible charge of drilled shaft operations.
3. List and size of proposed equipment including cranes, drill rigs, augers, bailing buckets, digging buckets, final cleaning equipment, slurry tanks, descending equipment, slurry pumps, method and equipment to perform exploration (if required), tremies or concrete pumps, casings, etc.
4. Details of sequence of construction operations and sequence of shaft construction in bents or shaft groups.
5. Details of shaft excavation methods.
6. Details of slurry type and usage, including proposed methods to mix, circulate and descend slurry when slurry is required.

7. Details of proposed methods to clean shaft after initial excavation.
8. Details of reinforcement placement including support and method to center in shaft.
9. Details of concrete placement including proposed operational procedures for concrete tremie or pump, including initial placement, raising during placement, and overfilling of the shaft concrete, and ability of the concrete supplier to provide a continuous pour for the anticipated volumes.
10. Details of casing installation and removal (when removal is required).

The Engineer will evaluate the drilled shaft installation plan for conformance with the PPA Documents, after which the Engineer will notify Developer of any additional information required and/or changes that may be needed. Any part of the plan that is unacceptable will be rejected and Developer shall submit changes for re-evaluation.

All earthwork preparation, grading, dewatering, and temporary casings necessary for installation of the communication and/or camera towers shall be considered incidental to this work. When the installation is completed, all disturbed portions of the construction area shall be cleaned and any excess excavation or other materials shall be disposed of in a timely manner. All final cleanup shall also be considered incidental to this Work.

19.5.7.5 Tower Site Access

Developer shall provide driveway access to sites in excess of 15 feet from the edge of shoulder. This access shall be in accordance with a modified Class II driveway, with 12 inches of #53 stone, and appropriate pipe and end sections per the IDM.

19.5.7.6 Fence and Gate for Tower Sites

19.5.7.6.1 Description

This work shall consist of installing a barbed wire fence around the field tower sites and a gate for access into the fenced area.

19.5.7.6.2 Material and Construction Requirements

Fencing surrounding the field tower, including the barbed wire and gate shall be installed as shown on the Plans in accordance with Section 603 of the Department Standard Specifications. The fence height and gate shall be sized as shown on the Plans. Gates shall be supplied with a gate latch capable of being padlocked when in the closed position. One (1) padlock shall be provided per gate. Padlocks are to be as described elsewhere in these Technical Provisions. The fence, barbed wire, and gate shall be grounded according to the Plans and these Technical Provisions. Gates shall be positively grounded to the grounding system.

19.5.7.7 Grounding Assembly

19.5.7.7.1 Description

This work shall consist of furnishing, assembling, and installing a grounding system as shown on the Plans and in accordance with these Technical Provisions and Motorola Standards and Guidelines for Communications Sites 2000 (R-56). Developer shall use a Registered

Professional Engineer experienced in ground system design to design the grounding assembly and ensure that it is compatible with the site's ground system. Proof of such shall be submitted with the Final Design Documents in the form of a design drawing sealed by a Registered Professional Engineer. The ground system of each site shall achieve a resistance to earth of 4 Ohms or less (verified by three-point/fall-of-potential testing). An instrument designed specifically to measure the resistance of a point to each ground shall be used, and the instructions provided with the instrument shall be followed for proper measurement method. All measurements shall be recorded along with the location of each ground rod and submitted to the IFA.

19.5.7.7.2 <u>Material Requirements</u>

The grounding assembly includes all items and incidentals necessary to successfully ground the tower sites, the surrounding chain-link fence, communication shelter, ITS equipment cabinets, generators, and panel boards as shown on the Plans.

Ground rods shall be copper-clad steel or solid copper as approved by IFA. The rods shall have a minimum length of 10 feet and minimum diameter of 5/8 of an inch, or greater, as otherwise required by National Fire Protection Act (NFPA) 70, Article 250-52. The actual diameter (greater than minimum diameter), length (greater than minimum length), and number of rods required may vary with site dimensions and/or as determined by an engineering study based on the soil resistivity profile and soil pH of the site. Electrolytic ground rods maybe used, if required by soil conditions, with the approval of the IFA. Refer to "*Soil Resistivity Measurements*" NFPA 70, Article 250-52, and NFPA 780, Section 3-13, for more information. The method of bonding grounding conductors to ground rods shall be compatible with the types of metals being bonded.

19.5.7.7.2.1 <u>General</u>

Ground rods shall be buried to a minimum depth of 30 inches below finished grade, where possible, or buried below the freeze line, whichever depth is greater. Where practical, ground rods shall be buried below permanent moisture level (NFPA 70, Article 250-52). Ground rods that cannot be driven straight down due to contact with rock formations may be driven at an oblique angle of not greater than 45 degrees from the vertical, or may be buried horizontally and perpendicular to the building, in a trench at least 30 inches deep (Refer to NFPA 70, Article 250-52 and NFPA 780, Section 3-13.1.5 for more information.).

Ground rods shall not be installed more than 20 feet apart (or twice the length of the rod) and not less than 6 feet apart (per NFPA 70, Article 250-56).

The method of bonding grounding conductors to ground rods shall be compatible with the types of metals being bonded. Ground rods shall be free of paint or other nonconductive coatings (NFPA 70, Article 250-52 and NFPA 780, Section 3-13.1).

All grounding conductors outside of the communication shelters shall be bare tinned solid #2/ AWG copper wire or as shown on the Plans and shall meet the size requirements of NFPA 70, Article 250-66. Solid wire is required below grade to prolong longevity. For areas highly prone to lightning and/or areas with highly acidic soil, larger conductors shall be used, per Motorola R-56. Solid straps or bars may be used as long as the cross-sectional area equals or exceeds that of the specified grounding conductor.

19.5.7.7.2.2 Reserved

19.5.7.7.2.3 Tower Grounding

A ground ring containing at least three equally spaced ground rods shall encircle the tower. The ground rod spacing shall not exceed 20 feet for 10-foot ground rods. The tower ground ring shall have a minimum diameter of 18 feet.

Self-supporting towers exceeding 5 feet in base width shall have at least four ground rods (ANSI T1.313-1997 and ANSI/EIA/TIA-222f). The ground rod spacing shall not exceed 20 feet for 10-foot ground rods. The tower ground ring shall have a minimum diameter of 23 feet.

Each leg of the towers shall be bonded to the tower ground ring using grounding conductors of #2 AWG minimum, bare tinned solid copper conductor. The vertical wire from the tower leg to the ring shall be insulated from earth contact for the first 12 inches or more by passing it through a polyvinyl chloride (PVC) pipe. This is to reduce the step voltage in the immediate vicinity of the tower.

In addition, a top-mounted lightning rod, extending above the topmost appurtenance, connected to a full tower length "down conductor" grounding cable shall be installed to provide a non-destructive path to ground for lightning contact with the tower structure. The down conductor shall consist of a #2 stranded copper cable attached and exothermically bonded to the uppermost tip of one tower leg, extending downward in a continuous run, exothermically bonded to the lower end of the same leg, then exothermically bonded to the grounding ring at the tower base. The down conductor shall be securely fastened, using two wraps of stainless steel Wraplock, to the tower leg on which it is installed to prevent movement. The lightning rod shall be bonded to this down conductor. The tower ground bus bars shall be bonded to the "down conductor."

19.5.7.7.3 Construction Requirements

All tower grounding work shall be coordinated with the tower erection, fence construction, and other electrical work associated with energizing the panel board within the communication shelter. All electrical components installed on the tower shall be electrically connected to the grounding system, including but not limited to the PTZ mechanisms, cameras, and cable shielding. All construction and testing work shall conform to National Electrical Code (NEC) requirements, as well as these Technical Provisions. Developer shall provide the IFA with all test data and results.

The pH (hydrogen ion concentration) of the soil where a grounding electrode system is to be installed shall be tested before the system is installed. Acidic soils (pH below 7) can have a destructive effect on copper and other metals. In strongly acidic soils (pH of 5 or below), an electrolytic ground rod system shall be installed to maintain the life expectancy of the system. The electrolytic ground rod system shall be by Harger or an equivalent.

The following requirements apply when installing grounding conductors:

1. Grounding conductors shall be run as short, straight, and smoothly as possible, with the fewest possible number of bends and curves (refer to NFPA 70, Articles 800-40, 810-21, and 820-40).

2. A minimum bending radius of 8 inches shall be maintained, applicable to grounding conductors of all sizes (per NFPA 780, Section 3-9.5 and ANSI T1.313-1997). A diagonal run is preferable to a bend even though it does not follow the contour or run parallel to the supporting structure. All bends, curves, and connections shall be toward the ground location, rod, or ground bar (grounded end) of the conductor.

Grounding conductors attached to the tower, communication shelter, and above-ground structures, especially copper straps, are exposed to movement by wind and other physical forces that can lead to damage or breakage over time. The following requirements shall apply when installing grounding conductors on these structures:

1. The grounding conductor or its enclosure shall be securely fastened to the surface on which it is carried.
2. Grounding conductors shall be attached using the method recommended by the equipment manufacturer.
3. The fasteners shall not be subject to breakage and shall be of the same material as the conductor or of a material equally resistant to corrosion as that of the conductor.
4. Approved bonding techniques shall be observed for the connection of dissimilar metals.
5. Grounding conductors shall be securely fastened at intervals not exceeding 3 feet (refer to NFPA 70, Articles 250-64(b), 810-21(c), and NFPA 780, Section 3-10).

All earthwork preparation and grading necessary for installation of the tower grounding system will be considered incidental to this Work. When the installation is completed, all disturbed portions of the construction area will be cleaned, and any excess excavation or other materials shall be disposed of in a timely manner. All final cleanup will also be considered incidental to this Work.

19.5.7.8 Lightning Protection

19.5.7.8.1 Description

Lightning protection shall include all devices necessary to provide safety for the equipment, cabinets, and service personnel by preventing damage caused by lightning. All poles and towers that are connected to an external power source (i.e., non-solar) and that exceed 15 feet in height shall be equipped with appropriate lightning protection. All ground wires shall be tinned copper.

Developer shall design a lightning protection system for each tower site and submit Plans in the form of a design drawing for approval by the Engineer. The design shall be stamped by a Registered Professional Engineer.

The system shall be an effective, aesthetically acceptable streamer-delaying lightning protection system designed to the standards of UL96 and UL96A. The system shall be designed in such a manner that it affords protection to the structure upon which it is installed in the event a direct lightning strike to the structure does occur. The system shall require no external power and shall require no extraordinary maintenance.

The following sections of the Standard Specifications contain requirements that relate to this section:

- Underwriters Laboratories, Inc., Lightning Protection Components, UL 96 and UL 96A
- NFPA, Standard for the Installation of Lightning Protection Systems, NFPA 780
- Motorola R-56, Motorola Standards and Guidelines for Communications Sites 2000, Chapter 6, External Grounding.

Where conflicts exist between the above-referenced documents and this document, the more stringent requirement shall prevail.

19.5.7.8.2 ***Material Requirements***

Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include but are not limited to Alltec Corporation, in Canton, North Carolina; or Lightning Masters Corporation, in Clearwater, Florida; or East Coast Lightning Equipment, Inc., in Winsted, Connecticut.

The lightning protection system shall be the standard product of a manufacturer regularly engaged in the production of lightning protection equipment and shall be the manufacturer's latest approved design. The manufacturer shall have a proven track record of successful lightning protection system performance. The equipment shall be UL listed and properly UL labeled.

The manufacturer or its authorized representative shall provide product and technical support.

All equipment shall be new and of a design and construction to suit the application where it is used in accordance with accepted industry standards and UL and NFPA requirements.

All lightning protection materials and components shall comply in weight, size, and composition with UL96 and NFPA780 lightning protection material requirements for the structure being protected. Components shall be constructed of material as specified by UL96 and UL96A for a system employing copper components, unless otherwise directed by IFA or as necessary to prevent dissimilar metals from coming into contact. Class II materials shall be used on throughout the system.

19.5.7.8.3 ***Construction Requirements***

Installation shall be accomplished by an experienced installation company that is listed with UL for lightning protection installation.

If installed on a metallic or an otherwise electrically conductive structure, the system shall be electrically bonded to the structure upon which it is installed through its mounting clamps and brackets, with additional bonding jumpers to grounded objects and to the structure, as required.

Developer shall coordinate its work in such a manner as to not interfere with the normal operation of the structure upon which the installation is performed. Developer shall ensure a sound bond to the grounding system.

19.5.8 Signs

19.5.8.1 Dynamic Message Signs

The DMS shall meet the ITS standards as stipulated by KYTC (refer to Refer to the ITS Standards and Specifications (TRIMARC) in RID IT-0.08 for Variable Message Sign requirements) for the signs located on the Kentucky Approach and by Department (refer to *Traffic Management Strategic Deployment Plan, Final Report, Indiana Department of Transportation, 2008*) for the signs located on the Indiana Approach. All overhead DMSs shall be mounted perpendicular to and centered over the travel lanes for the best line of sight. Developer shall design the DMS installations to meet the pertinent state standards, MUTCD standards, and TRIMARC standards on DMS controller and communications, maintenance with safe access, and operation on 24/7 schedules.

The overhead DMSs are LED (light emitting diode) displayed, full-matrix signs capable of displaying three lines of up to 21 characters each, with support structures and foundations in accordance with the AASHTO standards and pertinent State standards for DMSs.

The sign display shall have a minimum width of 127 pixels and a minimum height of 27 pixels.

Developer shall be fully responsible for site survey, design, structural calculations, fabrication, the installation of the DMSs, and sign structure and supporting foundations. Developer shall be responsible for the design, furnishing and installation of maintenance platforms, guide railings, or traffic barriers if within clear zones, as required by OSHA, Department TMC, and TRIMARC standards (refer to Section 9). Developer shall be responsible for all testing of DMSs, per NTCIP standards and existing TRIMARC standards, to provide a fully functional DMS subsystem.

Developer shall furnish and install a permanent DMS mounted on a new or existing structure at locations as shown on the Plans. This work will be done in accordance with Project Standards, except as modified herein. The sign messages shall be initiated by the advanced traffic management system (ATMS) software, or by a portable field control computer at the sign site for local diagnostics. Commands from the ATMS software shall be transmitted over Department communications infrastructure or a standard cellular connection using a wireless modem and service. All DMS equipment shall be housed within the sign housing; no external cabinets will be used. The DMS shall be NTCIP compliant as currently defined by the NTCIP *Object Definitions for Dynamic Message Signs Publication 1203* (including subsequent revisions).

19.5.8.1.1 Description

This work shall consist of furnishing and installing a permanent DMS, complete with all components as shown on the Plans and as described herein.

The DMS shall be a full matrix LED sign with a walk-in enclosure housing using all modular, controller, electrical, and communication equipment. The DMS shall include the following basic components:

1. DMS
2. Walk-in enclosure
3. DMS controller, firmware, and software
4. Electrical end-equipment
5. Mounting hardware

6. Overhead DMS Box Truss, per Department Standard Drawings

19.5.8.1.2 General Requirements

1. Furnish, install, and test all equipment and components necessary to provide full and complete ITS functionality in all respects, without additional expense to IFA.
2. Furnish one controller as an integral part of each DMS. The controller is to be mounted inside the DMS and connected to the AFP (provided by Developer) for communications back to the TMC.
3. Demonstrate that the DMS functions and meets the requirements in these specifications.
4. Provide all equipment required for testing of the DMS and DMS components included as part of the Work as an appurtenance to the electronic equipment included within the East End Crossing at no additional expense to IFA.

19.5.8.1.3 National Transportation Communication for ITS Protocol Standards

19.5.8.1.3.1 NTCIP Definitions

NTCIP	Definition Terms under the Scope of this Section 19
DMS	A DMS includes the sign display, controller, housing, and other associated field equipment. NTCIP standards (defined in two distinct sub-requirements, as below): • If the access of the object is read-write, a management system shall be able to set the object to any valid value as defined by the syntax and description fields (except that the value of “other” need not be supported when such a value is defined) and the indicated functionality shall be provided. • The value indicated by the object (e.g., in response to a “get”), regardless of the access, shall reflect the current condition per the rules specified in the object’s description.
Management System	A computer system used to control a DMS. This includes any laptop software used for field control as well as the central control software.
NTCIP Component	A DMS or a management system
NTCIP System	A management system, plus the various DMSs controlled by the management system

19.5.8.1.4 Dynamic Message Sign Manufacturing and Design Standards

DMS manufacturers shall comply with the Project Standards including the most current version, as of the Setting Date, of the following standards:

1. High-voltage wiring: High-voltage components and circuits (120 volts alternating current) shall be wired and color-coded per the NEC.
2. Environmental: The display and all display components shall conform to NEMA TS-2 Section 2 Environmental Standards.

3. Shock/Vibration: The display and all display components shall conform to NEMA TS-2 Section 2 shock/vibration tests.

4. NTCIP: Refer to NTCIP Section.

5. NEMA TS 4 Hardware Standards for DMS with NTCIP Requirements.

19.5.8.1.5 Material Requirements

All electrical equipment shall operate within the range of environmental conditions specified herein and come with warranties. The warranties shall receive the approval of IFA prior to the use of the respective equipment.

19.5.8.1.5.1 Weight and Dimensions

The maximum static weight of the DMS, including all internal and external components and mounting devices and members shall not exceed 4,500 pounds. In addition to the static weight, a live load of 600 pounds for maintenance personnel and equipment is to be accounted for in the structural analysis. The approximate outside dimension of the DMS enclosure shall not exceed 28 feet wide by 9 feet 10 inches high by 4 feet 1 inch deep.

19.5.8.1.5.2 Display Characteristics

The DMS shall consist of interchangeable LED modules arranged to provide a full matrix display. The full matrix display shall provide three character lines each 20 characters long, separated vertically by three blank pixel rows. Horizontal spacing between characters shall be a minimum of one pixel column. Each display module shall consist of one or more pixel matrices. Each pixel matrix shall form characters that are 18 inches in height.

The sign display shall have a minimum width of 127 pixels and a minimum height of 27 pixels.

The width of the borders on the display shall be equal and not less than 12 inches. Legibility of displays shall include daylight hours with direct sunlight on the face and behind the DMS.

Minimum clear visibility and legibility distance for the sign shall be 900 feet at an eye height of 3.5 feet within a 10^{o} cone of vision about the optical axis under all weather conditions, except heavy rain, fog, or snow.

The display shall not perceivably brighten due to stray headlights shining on the photocells at night.

19.5.8.1.5.3 Basic Dynamic Message Sign Functions

A character set shall be provided and shall consist of at least the following:

- All 26 capital letters of the alphabet
- All digits 0 through 9
- Arrows pointing to the eight primary compass points
- Punctuation marks ($□ + - = . , ‘ & / \ ( ) * ! ; : “ ” % # ? < > @ ~ ^ [ ] |)
- Sequential arrow
- Standard font (7x5 pixels per character)
- Double stroke font (7x7 pixels per character)

- Condensed font (7x4 pixels per character)
- Expanded font (7x6 pixels per character)
- Two additional user-defined fonts for a total of six fonts (standard, double stroke, condensed, expanded, two user defined)

Each sign shall be able to display static, multiframe, or flashing messages.

Static Message: The chosen message shall be displayed constantly on the sign face until the sign controller is instructed to do otherwise.

Multiframe Message: The chosen message shall display up to four different frames alternately at durations separately controllable in 0.1-second increments from 0.1 seconds to 25.5 seconds.

Flashing Message: A flashing capability shall be possible by blanking the LEDs. The parameters controlling the flashing rate shall be operator-selectable from 0.1 seconds to 9.9 seconds, in increments of 0.1 seconds.

19.5.8.1.5.4 <u>Display Modules</u>

The sign display shall be created by interconnecting several individual and interchangeable display modules. Each display module shall be capable of displaying a minimum of one 18-inch character, but not more than three 18-inch characters. The replacement of a complete display module shall be possible from the interior of the sign enclosure without the use of any special tools. Display modules shall be identical and interchangeable in all signs provided for the East End Crossing. Interconnection of modules shall be through connectors only. Each pixel shall have its optic axis oriented perpendicular to the sign face. Pixels shall be attached to the display module with a secure fastening system.

19.5.8.1.5.5 <u>Pixels</u>

Pixel columns and rows shall be perpendicular. The horizontal and vertical spacing (the pitch) of the pixels on center shall be identical on each display module and between all display modules in the DMS.

Each pixel shall contain either one or two strings of LEDs. Pixels containing only one string shall have a minimum of six LEDs and be designed such that the failure of one LED shall not affect the operation of the rest of that string or any other string. Pixels containing two strings shall contain a minimum of three LEDs per string and be designed such that the failure of an LED in one string shall not affect the operation of any other string or pixel.

Each pixel shall have a total brightness of 40 candelas per pixel at 20 milliampere as the sum from all LEDs in each individual pixel. The total on-axis (0 degrees horizontal, 0 degrees vertical) luminance intensity of the sign will be a minimum of 8,000 candela per square meter. All pixels shall have equal color and on-axis intensity. The method used to provide the brightness, equal color, and intensity shall be included in the shop drawing submittals and approved by the Engineer. Pixel brightness shall be tested and documented by a third-party lab. This documentation shall be submitted to the Engineer for approval prior to shipping the sign.

Each pixel shall have a device attached to the printed circuit board (PCB) to hold and protect the LEDs. These devices shall do the following:

1. Hold the LEDs to within 0.5 degrees of being perpendicular to the display modules.

2. Prevent the LEDs from being crushed or bent during handling.
3. The LEDs shall be protected such that there is no contact with them when the display module is handled or dropped.
4. Protect the LEDs from damage when the display module is laid on the front surface (the side the LED lamps are located).
5. Be easily removable from the display module PCB without any specialized tools.
6. Not put any stress on the LEDs due to differentials of expansion and contraction between the device and the LEDs over the temperature range herein specified.
7. Not become loose or fall off during handling or due to vibration.
8. Not block airflow over the leads of the LEDs.
9. Not block the light output of the LEDs at the required viewing angle.
10. Be black in color to maximize contrast.

19.5.8.1.5.6 LEDs

The LEDs shall be amber in color and manufactured by Avago Technologies, Nicha Corporation, Sander, Agilent, or Toshiba Corporation, and be of the same make and model and all traceable to the manufacturer. LEDs will have a 30-degree viewing angle. LEDs shall have a typical luminous intensity of 4.2 to 7.2 candelas per individual discrete LED when driven at 20 milliamperes. The light emitted by the LED display shall be an amber color, with a peak wavelength centered at approximately 590 nanometers $\pm$2 nanometers. LEDs in an individual sign will be from no more than two consecutive “bins” for either color or light intensity levels. The DMS manufacturer will perform the color/intensity sorting of individual LEDs, and they will be distributed consistently from pixel to pixel. The luminous intensity of the highest- and lowest-appearing pixels will be measured, and the intensity ratio (L_1/L_2 where $L_1 > L_2$) between the two shall be less than 3:1. LEDs shall have no less than 50 percent of the normalized intensity at their respective 30º viewing angle.

Each LED shall be individually soldered to the boards. Each LED shall be mechanically inserted onto the appropriate LED matrix module and wave-soldered. A conformal coating shall then be applied to both sides of each PCB to provide moisture and mildew resistance. LEDs that are surface mounted or through-hole with standoffs will not be allowed.

LEDs shall be nominally rated for 100,000 hours of operation under field conditions, which shall include operating temperatures between 29.2 degrees Fahrenheit and 165.2 degrees Fahrenheit.

The brightness of each LED shall be measured in accordance with the International Lighting Commission (CIE) Test Method A, as described with the CIE 127-2007, Technical Report: Measurement of LEDs. The LED brightness and color bins that are used in each pixel shall be provided to the Engineer for approval.

Certification shall be provided with the shop drawing submittals from the LED manufacturer that demonstrates the LEDs were tested and binned in accordance with CIE Test Method A. This certification shall be provided to the Engineer prior to site delivery.

19.5.8.1.5.7 Optical Performance

Operating contrast values between 6 and 25 shall be demonstrated for each lighting condition given the following definitions:

Luminance =	The luminous intensity of the 35 pixels The area of the block containing the 35 pixels including the background
Daytime Contrast =	(Luminance On - Luminance Off)/Luminance Off

Where the ambient light is simulated by a solar source simulator placed 10 degrees off the horizontal axis in front of the sign when measured on-axis to the center of the sign face giving a luminance of 40,000 lux on the sign face.

19.5.8.1.5.8 Electronics

All DMS electronics shall be solid state technology and, with the exception of the PCBs, shall be commercially available, easily accessible, replaceable, and removable using conventional electronic repair methods. Moving parts shall be minimized where practical. All electronic and electrical components used in the LED display or DMS controller or other digital control devices shall be UL or Electronic Testing Laboratories (ETL) listed. This includes but is not limited to power supplies, wiring, and wiring accessories. Copies of UL or ETL product cards shall be provided to the Engineer prior to site delivery to document the listings. All data and low power connections will be accomplished via positive locking devices.

All workmanship shall comply with ANSI/IPC A-610D Class 2 titled, “Acceptability of Electronic Assemblies,” and ANSI/IPC-7711/21B titled, “Rework Modification and Repair Electronic Assemblies.”

All PCBs, except for the LED motherboard, power supply PCBs, and controller PCBs, shall be completely conformal coated with 0.010-inch-minimum-thickness silicone resin. The LED motherboard shall be completely conformal coated, except at the pixels on the front of the PCBs, with 0.010-inch-minimum-thickness silicone resin. The material used for the PCB coating shall meet the military specification MIL-I-46058C Type SR.

The LED pixels shall be directly driven using pulse width modulation (PWM) of the drive current to control the display intensity. This LED driver circuitry shall vary the current pulse width to achieve the proper display intensity levels for all ambient light conditions. The drive current pulse shall be modulated at a frequency high enough to provide flicker-free operation and a minimum of 200 brightness levels. The power supplies shall be designed such that one supply may fail and the sign display will still be supplied with sufficient power to run 100 percent of the pixels at 100 percent duty at 60ºC. The power distribution system shall connect each display module to all power supplies and shall minimize voltage drop over the face of the sign. Multiplexing drive circuits shall not be used. The LED display manufacturer shall supply the schematic of the display to document the LED drive mode used.

The current provided at maximum brightness shall be easily adjustable between 15 milliampere and 30 milliampere in 1 percent increments. This adjustment will be altered occasionally over the life of the sign to offset the dimming of the LEDs as they age. LED brightness shall be controlled or adjusted in three ways: locally using the sign controller, remotely from the ATMS using the sign controller's serial communications port, and automatically via a closed-loop ambient light monitoring circuit. Once the LED brightness is set or adjusted, intensity shall not fluctuate or flicker due to sudden ambient light level changes caused by weather (i.e., moving cloud cover) or vehicle headlights. It is not necessary that maximum brightness be remotely controlled. Upon installation, Developer shall set the maximum brightness current to 20 milliampere.

The sign controller shall continuously measure all LED module power supply voltages. The sign controller shall provide these voltage readings to the ATMS or remote laptop when polled.

19.5.8.1.5.9 Maintenance

All DMS equipment components, modular assemblies, and other materials located in the DMS housing shall be removable, transportable, and capable of being installed by a single technician accessing the sign from inside the walk-in enclosure.

19.5.8.1.5.10 Miscellaneous Requirements

The presence of ambient magnetic or electromagnetic fields, including those created by any components of the DMS subsystem, shall not interfere with the performance of the signs.

The rated life of all components (except LEDs, fans, filters, and equipment not normally furnished with the DMS) shall be a minimum of 20 years under 24-hour-a-day operation.

Equipment and accessories shall be, essentially, the standard cataloged products and of the latest design of manufacturers regularly engaged in production of such equipment and accessories for at least five (5) years.

Differential expansion of the sign enclosure, sign face, and the display panel shall not cause damage to any of the components.

19.5.8.1.5.11 Walk-In Enclosure

The DMS walk-in enclosure (housing) shall be furnished and installed in the East End Crossing and be designed integral to the DMS. The DMS housing, including its front-face panels, shall be a NEMA type 3R, as described in the latest edition of the NEMA Standards Publication 250. The bottom of the sign shall be horizontal, and all sides shall be vertical. The top shall slope to the rear to completely drain rainwater from the roof. Sign housings shall be constructed of aluminum alloy 3003-HI4 or 5052-H32, and shall not be less than 0.125 inches thick. Seams shall be continuously welded. Framing structural shapes shall be constructed of aluminum alloy 6061-T6 or 6063-T52. Non-corrosive materials shall be used where possible and corrosion protection shall be provided between dissimilar metals. Sign housings shall be cleaned and de-oxidized after welding.

To allow for the vacuum effect of the passage of large trucks, the sign face shall be designed for and shall withstand a negative (outward) pressure of 50 percent of the design inward wind pressure. Gasket material, where needed, shall be impervious to moisture, smog, and salt spray. If neoprene is used, the mating surface shall be covered with a silicon lubricant to prevent sticking to the mating metal surface.

The walk-in enclosure shall be designed such that the top of the display face (the surface that faces approaching traffic) is tilted 3 degrees toward traffic. The top plane of the housing shall be sloped 0.5 degrees toward the back of the housing. The rear plane of the housing shall remain vertical, and the interior walkway surface shall remain level (horizontal).

The manufacturer's name, month, and year of manufacture shall appear on the inside of the DMS housing. No logos or names of manufacturers shall appear on the outside of the housing.

19.5.8.1.5.12 Painting

The front of the sign enclosure will be coated with a semigloss black polyvinylidene fluoride (PVDF) protective coating. This coating will be designed to have a minimum of 10-year color retention and chalk resistance. All finish coatings shall be resistant to chipping, impacts, weather, scuffs, corrosion, and bacteria for a minimum of 10 years. All other surfaces shall be left their natural finish or unfinished aluminum.

19.5.8.1.5.13 Environmental

The sign shall be constructed to present a clean, neat appearance, and the equipment located therein shall be protected from moisture, dust, dirt, and corrosion. Sign enclosures shall contain small weep holes for draining moisture that accumulates in the signs from condensation. Weep holes shall be designed to prevent the entrance of insects and shall have snap-in drain filter plug inserts. The filter plug inserts shall be replaceable.

19.5.8.1.5.14 Sign Attachment Members

The sign shall be attached to the sign structure with I-beams or Z-bar extrusions. The number of I-beams or Z-bars needed and the method of attaching the I-beams or Z-bars to the sign housing and sign structure shall be as required to conform to the Project Standards. The housing shall be designed to accommodate mounting on the rear vertical plane. All structural hardware and mounting bracket hardware will be stainless steel or galvanized high-strength steel and appropriately sized for the application. Mounting brackets will be attached to the DMS using direct-tension indicators to verify that mounting hardware is tightened with the proper amount of force. The attachment method shall be certified by a Registered Professional Engineer. The DMS shall be furnished with all required hardware for attachment to the sign structure. Alternative mounting methods will be considered, and Developer shall submit final mounting plans to the IFA for Design Review.

Lifting eyes or the equivalent shall be provided for moving and mounting signs. The DMS housing shall be designed such that the DMS can be shipped and temporarily stored without damage or undue stresses prior to installation on the overhead support structure.

19.5.8.1.5.15 Maintenance and Repair

Design and construct the walk-in housing so that all maintenance and repair is performed from within the DMS housing, with the exception of structural members and components thereof. The minimum clear distance from the interior rear wall of the DMS housing to the closest display components shall be 2 feet. This free space shall be maintained across the entire interior of the sign housing. Structural members shall be designed and positioned so as to not be an obstruction to free movement of maintenance technicians throughout the interior of the housing.

Include in the housing an internal incandescent lighting system of at least six fixtures to provide maintenance personnel with a minimum of 35 foot-candles of light measured at the floor, evenly distributed, provided by ceiling or top of wall mounted incandescent or compact fluorescent lights utilizing a cold-weather ballast within each sign housing. Locate two 3-circuit control switches inside the DMS housing for the lighting system, within easy reach from outside the DMS housing through the entryway. The sign housing and display panel shall be designed to be sufficiently “light tight,” such that during night-time maintenance activities, no internal lighting shall be visible or distracting to motorists.

The DMS housing shall include a minimum of three 15 Amp, 120 volts alternating current duplex electrical outlets, with ground fault circuit interrupters, for use by maintenance personnel. The duplex outlets are to be mounted on the back wall of the DMS, distributed evenly within the housing. All power runs inside the housing shall be protected in intermediate metallic conduits attached to the inside of the sign case.

19.5.8.1.5.16 Interior Walkway

The interior of the walk-in enclosure shall be designed to provide a minimum clear width of 2 feet and a minimum clear height of 6 feet through the length of the walkway to allow maintenance personnel free movement and working space. The interior walkway of the DMS will be non-slip and able to support a minimum of a 500-pound load per linear foot and will be constructed of multiple removable panels. The walkway’s top surface shall be free of obstructions that would present a tripping hazard to maintenance personnel.

19.5.8.1.5.17 Personnel Access

The DMS housing shall have two vertically hinged doors, one on each end of the sign. The DMS housing doors shall be rain-tight/dust-tight. Doorway openings shall be a minimum of 6.5 feet in height and a minimum of 2 feet in width. The doors shall use a Corbin Lock Number 2 and shall be furnished with a minimum of one number 2 key. The DMS doors shall open to the exterior of the DMS and have a stop to retain the door in its fully open position while workers are inside the sign.

The latching/locking mechanism shall include two handles: one on the interior of the housing such that a person with no key and no tools cannot become entrapped inside the housing and another on the exterior of the housing with a key lock.

19.5.8.1.5.18 Cable Access

Provide a cable entrance for AC power as described herein. Conduit shall enter the rear exterior wall (facing away from traffic) of the sign case through a 90-degree bend in the conduit. The attachment point between the conduit and sign case shall be sealed on both sides of the sign case with a neoprene gasket or other approved material such that no moisture, condensation, or light can penetrate the seal.

Attach two junction boxes to the interior wall of the sign case: one to receive the AC power and one the communications cables. The junction box for the communications cable shall be 6 inches by 6 inches by 2 inches and labelled on the outside “COMM.” The junction box for the power cable shall be labelled on the outside “AC POWER.” All entries and exits from the junction boxes will be made via conduit. Approximately 2 feet of cable slack shall be coiled in the junction boxes. Conduits leading from the junction boxes to the lighting panel and the AFP shall also be provided.

19.5.8.1.5.19 Sign Display Cover

The sign display cover is attached to the front of each sign case and is a weatherproof assembly that presents an unobstructed view of the sign display.

The DMS shop drawings submitted by Developer shall demonstrate the technique employed to minimize glare, reduce solar heat gain on the LEDs, and increase sign contrast in all ambient lighting conditions.

Compose the sign display cover of a series of clear-formed segments that, when placed side by side, form a complete face. Each display cover segment shall be of a size and weight that can easily be handled by maintenance personnel for replacement or cleaning. The sign display covers and display modules shall be constructed to allow all service operations from inside the sign case. The cover shall not be damaged by sign vibration or the positive and negative pressures resulting from changes in atmospheric conditions or the passing of large trucks.

This includes cleaning the outside of the window by tipping the modules and sign face inward. The removal of any combination of windows shall not alter the structural integrity of the sign case.

The clear lens panels shall be made of polycarbonate. Polycarbonate shall contain an ultraviolet (UV) light inhibitor, which protects the LED display matrix from the effects of UV light exposure and prevents premature aging of the polycarbonate itself. Polycarbonate sheets shall have the following characteristics:

- Tensile Strength, Ultimate: 9,000 pounds per square inch
- Tensile Strength, Yield: 9,300 pounds per square inch
- Tensile Strain at Break: 125 percent
- Tensile Modulus: 330,000 pounds per square inch
- Flexural Modulus: 330,000 pounds per square inch
- Impact Strength, Izod (1/8 inch, notched): 17 foot-pounds per inch of notch
- Rockwell Hardness: M75, R118
- Heat Deflection Temperature Under Load: 264 pounds per square inch at 270°F and 66 PSI at 288°F
- Coefficient of Thermal Expansion: 3.9X10-5 in/in/F
- Specific Heat: 0.30 British thermal unit per pound per degree Fahrenheit
- Initial Light Transmittance: 85 percent minimum
- Change in Light Transmittance, 5 years exposure in a southern latitude: less than 5 percent
- Change in Yellowness Index, 5 years exposure in southern latitude: less than 5 percent

The display cover and all associated parts, such as fasteners, shall be captive so that they cannot fall to the roadway. The windows shall be dust-proof and shall not leak when sprayed with water from any angle by a garden hose at a pressure equivalent to rain in a 90-mile-per-hour wind. The window frame(s) shall have a continuous closed-cell neoprene gasket around the entire perimeter. Horizontal portions of the gasket shall be supported by a channel. The gasket shall be at least 1 inch wide and 0.375 inches thick. The mating surface of the gasket shall be treated with silicone lubricant so that it does not stick. The sign face display cover shall be designed to minimize bowing.

19.5.8.1.5.20 Heaters and Fans

Signs shall contain thermostatically controlled fans and electric heating elements to prevent condensation on the inside of the display windows. A humidistat and thermostat shall also be included to activate the fans and electric heaters at user-selectable settings to control temperature and humidity for the display window and sign case. The defogging system shall be capable of substantially removing condensation from a completely fogged window within five minutes.

Vented thermostatically controlled fans shall be used to circulate the air inside the enclosures for cooling. Cooling fans shall turn on when the internal DMS air temperature reaches 30ºC. Fans shall keep the back side of the display modules below 60ºC when the outdoor temperature is 40ºC, the face of the sign is in full sun, and 50 percent of the pixels are illuminated, drawing 20 milliamperes of current. The ventilation system shall achieve this performance despite the failure of any single fan. The fans shall be installed so as to either "blow" air into or out of the sign case. Air inlets shall have louvers to keep out rain, rustproof screens to keep out insects, and replaceable 2-inch air filters to keep out dust. The filters shall be available from multiple manufacturers and shall be located to facilitate replacement. Exhaust vents shall be screened and have movable louvers that are closed when the fans are not running.

The LED modules and electric equipment shall be protected by a fail-safe, back-up fan control system in the event of an electronic fan control failure or shutdown of the DMS controller.

Heaters shall operate from a 240-volt, 60-hertz, single-phase AC power. Fans shall operate from 120-volt, 60-hertz, single-phase AC power.

19.5.8.1.5.21 Fire Extinguisher

Furnish and install a 5-pound standard BC powder fire extinguisher by the rear door. The fire extinguisher shall have squeeze grip operation. The fire extinguisher shall be supplied complete with a wall bracket and shall be mounted on the internal wall of the sign enclosure within easy reach of the door opening.

The fire extinguisher shall include positive on/off operation, pull-pin safety locks, a waterproof stainless steel gauge, and an anodized aluminum valve.

19.5.8.1.5.22 Interference

The dimming circuit and DMS power system shall have electrical devices installed to minimize radio frequency interference (RFI) noise generated by the DMS both on the power line and radiated by sign circuitry.

19.5.8.1.5.23 DMS Controller, Firmware, and Software

Furnish, test, and install a DMS controller, firmware, and software compatible with the communications protocol provided by the Engineer, at each DMS site shown on the Plans. Furnish, test, and install the auxiliary equipment and wiring required to complete the system testing. The DMS shall be capable of receiving communications from the server located at one of Department's TMCs and displaying messages by illuminating the LEDs to form legible words and graphics. Provide all equipment and materials needed to interconnect and interface the controller to the sign, including cables and connectors. Provide controller software that is consistent with the operational requirements and communications protocols.

DMS controllers shall have the following features:

1. **Communications Ports.** The DMS controller shall be able to receive instructions from and provide information to the ATMS network. There will be ports available for both local and remote operation of the DMS.

a. The DMS sign controller shall contain a minimum of one (1) 10/100Base-T Ethernet communication port. This port shall be available for optional use for communicating from the ATMS to the DMS sign controller when an Ethernet network is available. The Ethernet port shall have a standard RJ45 connector.

b. The DMS sign controller shall contain a minimum of two (2) NTCIP-compatible RS-232 communications ports. These ports shall support multiple communication interfaces, including but not limited to, direct null-modem (for local laptop control), dial-up and leased-line modems, radio systems, cellular modems, and fiber-optic modems. The RS232 ports shall all have standard DB9M connectors.

2. **Microprocessor.** The DMS controller shall be a solid state microprocessor.

3. **Internal Clock.** The controller shall have an internal clock that will satisfy the following minimum requirements:

a. The internal clock shall obtain its timing reference either from a crystal or from the 60-hertz frequency of the power input line. For internal clocks obtaining its timing reference from the 60-hertz power line frequency, the timing reference shall be crystal controlled in the absence of AC power. In either case, the clock shall be accurate to within 15 seconds per month.

b. The internal clock shall have both permanent and changeable memory. The permanent memory shall be in the form of plug-in programmable read-only memory (PROM) integrated circuits. It shall contain the software for performing the required timing functions. The changeable memory shall be in the form of random access memory (RAM) integrated circuits with a lithium battery back-up that retains the data in memory for a minimum of one (1) year following a power failure.

c. The changeable memory shall contain the current time in the form of year, month, day of month, hour of day, minute of hour, and second of minute.

d. The correct time shall be entered into changeable memory as a function of the year, month, day of month, hour of day, minute of hour, and second of minute. Hours of the day shall be entered in 24-hour (military) format.

e. The internal clock shall automatically compensate for leap years. The dates and times on which daylight-savings-time changes take place shall be user-programmable. The programming for daylight-savings-time changes shall be accomplished in such a manner that reprogramming each year is not necessary. Once set, the internal clock shall automatically adjust the hour of the day for daylight-savings-time changes.

4. **Stored Messages.** The DMS controller shall be capable of storing a minimum of 100 messages in non-volatile memory, each message consisting of up to three (3) phrases and each phrase consisting of up to three (3) full lines of text.

5. **Default Message.** The DMS controller shall be designed to blank out the sign in the event of a power failure.

6. **Message Speed.** The LED display shall update instantaneously with no shifting, scrolling, or other visual disturbance apparent to the motorist.

7. **Controller Failures and Loss of Power.** In the event of a controller failure, any displayed message shall be blanked out. The controller's operating system shall reside in non-volatile memory and shall reinitialize automatically at power-up and run without operator intervention. In the event of power outage, the clock shall re-start with the correct time (e.g., GPS or crystal clock) on the restoration of power.

    a. During the period of time that the controller is attempting to automatically recover from a controller failure, and until such time that the initialization process is complete, no messages shall be displayed on the sign.

8. **Pixel Failures.** The controller shall determine how many pixels are not turning on, how many pixels are not turning off, and the number of modules that have failed. This information shall be reported to the DMS controller.

9. **LED Temperature Monitor.** The sign controller shall monitor the temperature of the LED circuit board and shall reduce light output (DC forward current) when the temperature exceeds unacceptable thresholds. At least three (3) temperature levels, set via the system interface, shall be supported, which will result in increasingly lower output to the LEDs. The sign controller shall perform an automatic sign shutdown when the temperature exceeds an absolute threshold. The sign controller shall use an analog to digital converter to capture the current LED temperature. Current temperature shall be reportable to the ATMS or portable computer via the sign controller interface. The temperature sensors shall be equally spaced to cover each end and the middle of the sign.

    a. The DMS controller shall continuously measure all LED module power supply voltages and be able to report those voltages both locally and remotely to the ATMS.

10. Physical

    a. The DMS controller and all of its associated equipment, cables, connectors, and materials shall be designed, constructed, and positioned so that all maintenance and repair is performed from inside the walk-in enclosure.

    b. All DMS controller equipment, components, modular assemblies, and other materials located in the walk-in enclosure shall be removable, transportable, and installable by a single technician.

    c. Provide space inside the walk-in enclosure for the installation of the AFP and junction boxes. The area provided for the installation of this auxiliary equipment shall clearly be shown in Developer's submittal of the DMS shop drawings. Conduits shall be provided between the DMS controller and equipment racks to the AFP and cabinet interface panel as necessary for a neat and orderly installation of cables and connectors.

    d. The DMS equipment, components, and housing shall be designed and constructed for ease of maintenance. A single technician shall be able to remove and replace any modular assembly under adverse conditions in under 15 minutes. All electronic subassemblies shall be accessible and easily replaced by using plug-in or connector-based subassemblies. Any required configuration jumpers shall be clearly marked.

    e. DMS controller circuit breakers, fuses, switches, and indicators shall be readily visible inside the walk-in enclosure.

f. All assemblies and panels shall allow air circulation through the top and bottom, unless specifically called out otherwise. Assemblies shall be fabricated of 0.0625-inch-minimum- thickness aluminum or stainless steel sheet. The metal surface shall be treated with clear chromate.

11. **Software.** The application software shall be supplied for local operation of the DMS controller, and it shall be NTCIP compliant. Provide a licensing agreement that facilitates unlimited use within IFA or authorized maintenance contracts. Provide software with the following minimum capabilities:

a. Verify, set, and change the time on the internal clock.

b. Verify, enter, change, and delete dates and times for daylight savings time changes.

c. View, enter new, edit existing, and delete entries in the event schedule.

d. Verify, enter, modify, and delete password protection codes.

e. Diagnostic routines capable of testing full sign operation. Display tests shall include but not be limited to the following:

1) All pixels on

2) All pixels off

3) All pixels on and off alternately

4) Sequence through each column

5) Sequence through each row

6) Sequence through the entire character set

f. Display immediate messages on the DMS entered through the portable field control computer's keyboard.

g. Mimic both diagnostic and operator-generated messages sent to the DMS display on the portable field control computer's display in pixel matrix format identical to that of the sign being controlled.

h. Operator selection of dimming levels.

19.5.8.1.5.24 Exerciser

The manufacturer shall supply two compiled, latest versions of the FHWA, NTCIP exerciser with the manufacturers MIB. One copy shall be sent to Troy Boyd, Department ITS Technology Deployment Division Director, and one to Rick Anderson, of Iron Mountain Systems.

19.5.8.1.5.25 Dimming System

The DMS controller shall incorporate a means of changing the lighting level provided by the LEDs automatically in response to ambient lighting conditions at each sign location as detected by the photocell system, and remotely in response to commands received from the software. A light sensing system shall be used to detect lighting conditions between ranges of 2 to 20,000 lux. Provide photoelectric cells integral to the DMS. These devices shall direct the DMS controller to modify the intensity of the light produced by the pixel elements. Locate the photoelectric cells such that they are easily accessible for maintenance. Seal photoelectric cells using twist-lock-type receptacles or other approved receptacles suitable for this application. Three (3) replaceable photocells shall be located on the DMS enclosure and positioned to sense the ambient light on three axes of the DMS in such a manner to provide the information necessary to allow the controller to adjust the light levels of the DMS to maintain optimum visibility at sunrise, sunset, and other abnormal lighting conditions.

Provide all wiring and equipment necessary for the operation and interconnection of the photocell system and the light level output control circuit. Incorporate the light level output control circuit in the DMS controller. The circuit shall consist of solid state or other approved methods for control of the photoelectric system. The system shall provide a minimum of eight settings that are both locally and remotely settable.

19.5.8.1.5.26 Electrical End-Equipment

Developer shall establish electric service accounts in the Department's name, as appropriate. Each DMS sign shall have a lighting panel mounted within the sign case.

Each circuit shall be over-current protected. Each circuit breaker shall be UL or ETL, or an approved equal, switching duty type. The service personnel lighting and convenience receptacle outlets shall be provided with ground fault interrupters.

Power supplies shall operate from 120- or 240-volts-alternating-current power. The LED displays shall be operated at low internal DC voltage not exceeding 24 volts direct current. Power supplies shall be solid state electronic switching regulated output. The display shall be powered with two or more supplies wired in a redundant parallel configuration such that the supplies provide equal amounts of current to the display. When a power supply fails, the remaining supplies shall be capable of providing sufficient power to the sign display (20 milliampere to every LED on the line when the air around the power supply is at 60ºC) and electronics.

Power supplies shall operate from -30ºC to +60ºC. Power supplies shall be short-circuit protected by DC power off and shall reset automatically after 5 seconds of AC power off. Power supplies shall also be protected by a minimum overload allowance of 105 percent and have an efficiency rating of at least 75 percent. The power supply shall be UL or ETL listed. Power supplies may be mounted either above or below the interior walkway of the housing. Units mounted above shall not encroach on the 2-foot-wide, 6-foot-high clear space above the walkway. Units placed beneath the walkway shall be mounted above the bottom surface of the housing with a chair bracket to provide protection against water damage.

All signs shall be unaffected by surges or transient voltages normally experienced on commercial and industrial power lines. Signs will be protected from surges and transient voltages by the incorporation of metal-oxide varistor (MOV) devices at the AC line circuit input utilization of a multisection L-C filter ahead of the sign electronics power supply. Protection against abnormally low and high voltages will be provided by an electronic voltage detection circuit controlling the AC input power with a suitably selected contact relay.

An AC line monitor shall be provided to monitor the AC signal entering the sign. If three consecutive positive pulses are not detected, the AC line monitor will relay a signal to the DMS controller indicating power has failed. The DMS controller will then send a signal to the drivers to blank the sign or display the default message.

All signs shall be equipped with lightning protection, including electrical service and telephone service, as appropriate. Protection from lightning shall include gas discharge devices followed by zener diodes for data entry connections to the sign. Proper grounding of the sign housing shall be the responsibility of Developer

19.5.8.1.5.27 Mounting Hardware

Mounting hardware shall be supplied with the DMS. The mounting hardware shall include those devices shown on the Plans and all other appurtenant hardware, connectors, bolts, structural stiffening members, etc., necessary to attach the DMS to the structural supports.

19.5.8.1.6 Construction Requirements

19.5.8.1.6.1 Installation

Upon delivery to a storage location or to the site of installation, place the DMS in a manufacturer-approved manner, including supports that keep the sign off the ground and in a stable position. Supply all mounting bracket and required hardware for the permanent mounting of the DMS. Supply bolts if the lifting eyebolts are removed from the DMS after installation, to plug and seal the holes to prevent water from entering the DMS housing. If the lifting bolts are to be removed, provide compatible lifting bolts to Department for possible future use.

19.5.8.1.6.2 DMS Testing and Acceptance Requirements

Conduct such tests as necessary to ensure each DMS meets the requirements and specifications. The Engineer or Department Representative reserves the right to witness and verify, or to appoint a representative to witness, all product testing during manufacture of the DMS. If the FAT is performed at a location more than 100 miles from the project site, the Developer shall reimburse travel costs for up to four Engineer or Department Representatives.

1. Factory acceptance testing (FAT):

    a. The FAT shall be performed at the DMS vendor’s manufacturing facility. FAT is required prior to shipping of any DMS. FAT tests include but are not limited to the following:

        1) Passage of the NEMA 250 Water Spray Test with no visible signs of water leakage through any of the sign housing seams.

        2) Proof of the 48 hours of continuous operation of the FAT DMS at each of two test conditions: 25 degrees Fahrenheit (first test) and 125 degrees Fahrenheit (second test).

        3) Post-FAT, the Engineer will audit and approve all burn-in test logs for each DMS prior to that DMS shipping from the factory.

        4) The physical verification through inspection by the Engineer or IFA Representative that the DMS meets the special provision and the approved submittal and shop drawings.

2. Post-Delivery Testing and Operation

    Prior to delivery of the DMS, the site shall have all lightning and surge suppression and grounding and bonding performed and accepted. Upon the delivery of each DMS to the location designated by IFA in the RID and as shown on the Plans, provide permanent power for demonstration of the DMS' functions in accordance with the requirements and specifications and for proof that the DMS has not been damaged during shipment. Maintain the DMS power feed from the day of delivery to Final Acceptance, thereby protecting the interior electronics within the DMS from environmental degradation.

a. Post-Delivery Test Plan: Develop and submit to the IFA for review and comment a DMS Post-Delivery Test Plan with RFC Design Documents. The test plan shall demonstrate the complete functionality and integrity of the DMS after shipment and post-delivery. The plan will describe test procedures, detail the features being tested, and the detail the expected values that demonstrate DMS compliance.

b. Testing Schedule: All DMSs will be tested in accordance with the Post-Delivery Test Plan. Schedule and conduct the post-delivery tests at a time approved by the Engineer.

3. Reporting Requirements

a. Submit vendor and third-party reports verifying testing procedures, testing dates, and testing results to the IFA. The report will document the comparison of test results to the specifications detailed herein. The report will clearly identify any failure to conform to the specifications.

b. Failure to conform to testing procedures will be considered a defect of the equipment, and will thereby be subject to rejection by the Engineer or IFA Representative. Rejected equipment may be offered again for a retest. The retest shall fully comply with the test procedure, and the DMS is retested by the vendor or third party. Evidence of conformance of the test shall be submitted to the Engineer and/or IFA Representative.

c. Failure of any DMS to conform to the Design Documents, Construction Documents, or the PPA Documents will be considered a Defect, and the DMS is thereby subject to rejection by the Engineer or IFA. Rejected equipment may be offered again for a retest, provided that all nonconformances have been corrected and retested by the vendor and evidence thereof has been submitted to the Engineer or IFA.

d. Final FAT and product test reports showing complete compliance with specifications shall be submitted for review and comment by the Engineer before Developer releases the DMS for shipment.

4. Conduct final inspection and acceptance of the DMS after:

a. Approval of the product testing report

b. Approval of the FAT report

c. Delivery of the DMS to a site designated by IFA

d. Proof and verification of the DMS continuous operation post-delivery

e. Approval of the reports documenting the results of the post-delivery test

19.5.8.1.6.3 Warranty

The DMS device and all ancillary equipment shall be covered under full manufacture warranty for parts for two (2) years after approval. The mounting of a radio antenna and/or pole to the DMS shall not void this warranty. The manufacturer shall submit warranty information on company letterhead to IFA with the authorizing company representative's signature. Warranty information will include shipping and replacement part procedures that allow IFA to obtain a warranty replacement of defective parts in a timely manner. Standard warranties will be issued in IFA's name.

1. Supply a DMS factory-trained technician to observe and oversee the DMS and ACP installation process for each sign. The technician is to verify that the installation practices follow the DMS vendor's standard operating procedure and that DMS vendor's warranty was not in any way voided or limited during the installation.
2. Once accepted by IFA and upon Developer's request, the DMS warranty will begin.
3. Warrant that:
   a. All work furnished pursuant to the contract documents will conform to all professional engineering principles generally accepted as standards of the industry in the state.
   b. The DMS will be free of defects.
   c. Materials and equipment furnished under the PPA Documents will be of good quality and, when installed, will be new.
   d. The work will meet all of the requirements of the PPA Documents.
   e. The Design Documents and Construction Documents for the DMS devices and ancillary equipment selected and prepared for use during Construction Work are appropriate for their intended use.
4. Document all installation activities, including the quantity, brand, model/part numbers, and test results of all materials used. Provide an installer-signed list of the materials installed with the required documentation.

19.5.8.1.7 DMS Box Truss Structure

Overhead DMS shall be installed on DMS box trusses, per the Department Standard Drawings.

19.5.8.2 Lane Control Signals

19.5.8.2.1 Design Criteria

For effective lane control in the Tunnel, to inform drivers of downstream lane usage conditions, one-line LCSs shall be mounted above each lane to display a minimum of three states to drivers – off, green downward arrow, and red x – per MUTCD standards. The LCS shall be subject to manual intervention or override by an operator if the LCS fails to respond to the remote communications commands. The manual control, when activated, will override any automatic control commands. LCSs shall also send current statuses to the traffic center when polled.

Each LCS shall be capable of displaying an 18-inch by 18-inch green downward arrow and red x. The full graphical display of the LCS shall be positioned in the line-of-sight of the roadway segment so it is clearly visible and legible from in-vehicle view under clear daylight and night-time conditions. The graphical display shall also be seen when the sun is in the background of the LCS from in-vehicle view to avoid sun-glare issues. The design and operation of LCSs shall comply with the pertinent state guidelines, MUTCD standards, and TRIMARC standards regarding DMS/LCS controller and communications, maintenance with safe access, and operation on 24/7 schedules.

Developer shall be fully responsible for the site survey, design, fabrication, and installations of the LCSs. Developer shall be responsible for the design, structural calculations, and installation of supporting structures for LCS, as required by OSHA, Department, and TRIMARC standards. Developer shall be responsible for field tests by running the LCS software to control the LCS in sequence, per NTCIP standards and TRIMARC standards.

19.5.8.2.2 Material Requirements

Developer shall be responsible for furnishing, insuring, transporting, and storing (for the interim) the following materials:

LCS enclosures (with adequate National Electrical Manufacturers Association rating), display modules, LCS (PLC) controllers, terminal servers and switches, interface cabling and connectors, power supplies, junction boxes, power disconnects, mounting hardware, and controller cabinets. All materials shall be furnished in accordance with the material requirements as stipulated under Department and TRIMARC standards.

19.5.8.2.3 Construction Requirements

Developer shall be responsible for the installation of LCS assemblies on the Tunnel structures, LCS controllers, and cabinets in accordance with Project Standards.

Developer shall provide power connections to the LCS controller cabinets and LCS assembly as stipulated by the power requirements of the sign manufacturer, which includes installations of all conduits, cabling, power supplies and converters, wiring harnesses, circuit breakers, and other incidental materials, to provide a complete powered LCS. Developer shall provide communications connections to allow data transmission from the traffic center to the LCS assembly. Developer shall furnish and install all conduits, cabling, connectors, terminal servers and switches, cable management devices, and other incidental materials to make required data connections. The LCS controller shall include not only the individual sign control but also a comprehensive sequence control logic corresponding to incident identification, closure, and recovery by using a series of LCSs from upstream to downstream, to guarantee the safe operations of the Tunnel. The controller shall also be able to verify the device status, and any failure to respond to central command shall activate manual control override to complete and lane control logic.

The control software shall be designed to refuse any prohibited combination of signal indications to any traffic at any point in the controlled lanes in accordance with MUTCD 2009 Edition Chapter 4M and pertinent State standards.

19.5.8.3 Portable Dynamic Message Signs

Portable DMS trailers shall also be provided to facilitate traffic management in work zones during the construction and inform travelers to be prepared for construction activities. The numbers and locations of portable DMS trailers shall be determined by construction staging plans in accordance with the requirements of Section 12.

19.5.9 Highway Advisory Radio

19.5.9.1 Design Criteria

The HAR station along KY 841 shall be compatible with the existing HAR stations, and the HAR flashers shall be compatible with the existing HAR flashers to provide visual consistency. Refer to the ITS Standards and Specifications (TRIMARC) in RID IT-0.08 for Highway Advisory Radio (HAR) Sign and Highway Advisory Radio (HAR) Transmitter requirements.

Developer shall be fully responsible for the site survey, design, fabrication, furnishing, and installation of the HAR station and flashers, supporting structures and foundations, and controller cabinets. Developer shall be responsible for the design, furnishing, and installation of maintenance platforms, and guide railings or traffic barriers if within clear zones, as required by OSHA, Department TMC, and KYTC standards (refer to Section 9).Developer shall be responsible for testing of the proposed HAR stations and flashers (including synchronization work) per Department and KYTC standards.

19.5.9.2 Material Requirements

Developer shall be responsible for furnishing, insuring, transporting, and storing (for the interim) all materials associated with the HAR station and HAR flashers. Materials include but are not limited to transmitter antenna, transmitter unit, recorder/player unit, remote processing unit, digital communications controller, power supply unit, communications interface modem and terminal server/switch, flasher beacon assembly, and beacon controller.

All materials shall be furnished in accordance with the material requirements as stipulated under Department and KYTC standards.

19.5.9.3 Construction Requirements

Developer shall be responsible for field surveys (RF survey of the transmitter and line-of-sight survey of the HAR flasher), the installation of HAR station and flasher assemblies, transmitter, and beacon controllers, controller cabinets, associated hardware and foundation supports in accordance with state standards.

Developer shall provide power connections to the transmitter and beacon controllers as stipulated by the power requirements of the HAR manufacturer, which includes installations of all conduits, cabling, power supplies and converters, solar panels if any and its assemblies, wiring harnesses, circuit breakers, and other incidental materials, to provide a complete powered HAR system.

Developer shall provide communications connections to allow broadcast traffic information to the coverage area from TRIMARC. Developer shall furnish and install all conduits, cabling, connectors, terminal servers and switches, cable management devices, and other incidental materials to make required radio broadcasts.

Developer shall test the new HAR stations with the manufacturer software and existing stations to ensure a completely operational and sychronized HAR system to provide radio broadcast during the construction of the East End Crossing to alert alternate traffic routes to travelers on interstate highways.

19.5.10 WIZARD System

19.5.10.1 Design Criteria

Developer shall be fully responsible for the site survey, design, fabrication, and installation of the WIZARD assembly and controller cabinet at the proposed East End Bridge. The WIZARD shall be a CB transmitter to record traffic-related messages and automatically broadcast the recorded messages during an idle period on the selected CB channel (usually Channel 19). The WIZARD shall be designed and tested per KYTC standards. Developer is not responsible for integration of the WIZARD system at TRIMARC. Refer to the ITS Standards and Specifications (TRIMARC) in RID IT-0.08 for Work Zone Alert and Information Radio (WIZARD) requirements.

Developer shall install the WIZARD assembly and controller cabinet in areas where access to equipment shall not require traffic control during maintenance.

19.5.10.2 Material Requirements

Developer shall be responsible for furnishing, insuring, transporting, and storing (for the interim) all materials associated with the WIZARD assembly and controller cabinet. All materials shall be furnished in accordance with the material requirements as stipulated under Department and KYTC standards.

19.5.10.3 Construction Requirements

Developer shall be responsible for the installation of the WIZARD assembly and controller cabinet in accordance with Department and KYTC standards.

Developer shall provide all power connections to the WIZARD assembly and controller cabinet as stipulated by the power requirements.

19.5.11 Intelligent Transportation Systems Field Cabinets

Developer shall furnish and install ITS controller cabinets per the Department Standard Specifications and Standard Drawings or the ITS Standards and Specifications (TRIMARC). Developer shall design and install an appropriate foundation for the ITS controller cabinet in accordance with the applicable Department foundation design standard. Each cabinet foundation shall have a concrete footpad surrounding the foundation and shall be a minimum with of three feet.

19.5.11.1 Design Criteria

Each ITS equipment cabinet shall meet the required NEMA rating and shall be fabricated with approved material in accordance with pertinent Department and TRIMARC standards.

Developer shall be responsible for the design and installation of work pads for maintenance and repairs, and guide railings or traffic barriers if within clear zones, as required by OSHA, Department TMC, and TRIMARC standards (refer to Section 9).

Concrete work pads shall be furnished and installed at each cabinet site to provide a level and dry maintenance platform for maintenance and repair activities. This work shall also include excavation, gravel base, backfilling, and soil grading to support the concrete work pad at the cabinet site.

ITS equipment cabinets shall be designed for access by a single agency, unless joint access is explicitly agreed to by all involved stakeholders.

19.5.11.2 Material Requirements

Developer shall be responsible for furnishing, insuring, transporting, and storing (for the interim) all materials associated with the ITS equipment cabinet, including power supply unit, equipment racks, circuit breakers, interface cables, and conduit entries, etc.

All materials shall be furnished in accordance with the material requirements as stipulated under Department and TRIMARC standards.

19.5.11.3 Construction Requirements

Developer shall be responsible for the design and installation of ITS equipment cabinets, concrete bases (for ground-mounted only), and concrete work pads.

The concrete work pads shall be level. Developer shall install conduit entries for fiber-optic communication drop cables from ITS backbone handholes and power conductors from power suppliers. All cables shall be labeled accurately to allow for future identification. Conduit stubs shall be provided and the number shall be configured for future power and communications usage in accordance with Department and TRIMARC standards and requirements of the PPA Documents.

19.5.12 ITS Communications System

19.5.12.1 General Design Criteria

Developer shall design and construct a backbone communication system with fiber- optic cables installed along the mainline sections of the East End Crossing area. Lateral drop cabling may be used to reach ITS elements installed along approach roadways that are not considered mainline to the East End Crossing, as well as for drops off the backbone to the ITS cabinets for connection to ITS elements. General design criteria elements are as follows:

1. Provide an internet protocol (IP)-based system with a fully redundant architecture, allowing automatic failover of data flow to a secondary path or segment in the case of a primary equipment failure or fiber break. The ITS communication system backbone shall be rated for a 10-gigabit transfer rate, minimum. ITS field switches shall be rated for a 1-gigabit uplink transfer rate, minimum. Downlink ports at the field switches shall be 10/100BaseT.

2. Provide core Ethernet switches to support backbone data traffic. Provide core Ethernet routers to connect the local ITS backbone data network to the TRIMARC facility via a Developer provided leased Telco DS3 service interface and upgrade existing TRIMARC leased lines and interconnects to METROSAFE and to the KYTC TOC in Frankfort, KY to accommodate the increased video and data traffic, also via Telco DS3 interfaces. If

the existing services between TRIMARC, METROSAFE and the KYTC TOC are unable to handle the increased traffic, Developer shall provided leased Telco DS3 services with increased capacity as required.

3. Where required, Developer shall provide a field processor to act as terminal server, video encoder, and/or to perform data field processing.

4. Integrate existing and new ITS elements within the East End Crossing area to the new fiber-optic communication system. The maximum number of elements assigned to a network path shall not exceed one-third of the path's throughput capacity. Developer shall be responsible for providing any modifications to the existing communication networks required to integrate the existing ITS elements. Developer shall be responsible for modifying existing ITS elements in the East End Crossing area that may be required to provide compatibility with the new communications network.

    a. Developer shall integrate existing KYTC I-71 southbound DMS (at milemarker 8.5) to the Project communication system.

5. Developer shall determine the quantity of fibers required for the backbone communication system. Developer shall provide all calculations required to support the design determination. Include capacity for 100 percent system expansion. Developer shall provide 100 percent spare fibers that shall be continuous along any section of the East End Crossing. Developer shall determine the light loss budget analysis for all fiber-optic links.

6. The fiber optic network topology shall not include daisy chain as an option. All sites shall be home run to a core switch.

19.5.12.2 General Material Requirements

All fiber optics used in the East End Crossing shall be single-mode fiber. The general material elements are as follows:

1. Provide fiber-optic cables and fiber-optic cable splices as required to connect each ITS equipment cabinet and ITS elements to the backbone communication system.

2. ITS field Ethernet switches shall support a minimum of twenty-four (24) 10/100 Ethernet ports. Provide two 10/100/1000/SFP-gigabit ports. Additionally, the switches shall support the following:

    a. SFP support: SX, LX, XD, ZX, CWDM, 100FX, and T1

    b. Resilient Stacking: up to 8 units/192 ports per stack

    c. Stacking ports: 2 built-in HiStack ports per switch

    d. Total stacking capacity: 320 gigabits per second

    e. Individual switch packet throughput: 6.6 megapulses per second

    f. Individual switch capacity: 48.8 gigabits per second

    g. Concurrent VLANs: 256

    h. Jumbo frame support on gigabit ports

   i. Maximum MAC addresses: 8,000

3. An ITS core router shall be a chassis base system with three medium module slots capable of accepting 8-port T1 and 1-port DS-3 modules and four small modules slots capable of accepting 1- or 2-port T1 modules, 128-megabit compact flash, 1-gigabit DDR RAM. Software, fan tray, and dual AC Non-PoE power supplies, as well as North American (10A/110-120V) power cord included. Provide 1-port Clear Channel DS3 Medium Interface Module for Core Router.

   a. Two (2) switch fabric modules with 256-gigabits-per-second switch fabric capacity; 1.3-gigahertz central processing unit; 1-gigabit memory, minimum; and compact flash slot.

   b. Two (2) Ethernet interface modules with eight (8) ports of Autosensing 10Base-T/100Base-TX/1000Base-T, twenty-four (24) ports for SFP style GBIC Card, and two (2) 10-gigabit XFP style GBIC cards. Module shall be vendor's most current model with exact port counts listed above.

   c. Two (2) 48-port Autosensing 10Base-T/100Base-TX/1000Base-T Ethernet interface modules.

   d. One (1) software kit shall include the base software necessary for operation of the switch. Latest version available from the manufacturer.

4. The ITS core switch will be located in a conditioned shelter or building. The ITS core switch consists of the following:

   a. One (1) chassis with at least 6 slots

   b. Two (2) 100-240 VAC 1140W/1462W power Supplies with appropriate power cord

   c. Two (2) switch fabric modules with 256 Gbps switch fabric capacity, 1.3 GHz CPU, 1 GB memory and compact flash slot

   d. Two (2) ethernet interface modules with eight (8) ports of autosensing 10Base-T/100Base-TX/1000Base-T, twenty-four (24) ports for SFP style GBIC card and two (2) 10Gigabit XFP style GBIC cards. Module shall be vendors' most current model with exact port counts listed above. Two (2) 48 port autosensing 10Base-T/100Base-TX/1000Base-T ethernet interface modules

   e. One (1) software kit, includes base software necessary for operation of the switch. Latest version available from the manufacturer

All materials shall be furnished in accordance with the material requirements as stipulated under Department and TRIMARC standards.

19.5.12.3 General Construction Requirements

All equipment and components shall be installed in accordance with the manufacturer's recommended procedures. All fiber-optic terminations shall be labeled with an approved naming convention.

19.5.12.4 General Testing Requirements

Developer shall conduct installation testing as part of the design and construction process, and component/subsystem testing during construction, to ensure that the devices perform per the manufacturer's specifications. Vendor-unique software or hardware used to verify proper operation of a component or used to troubleshoot a component may be used by Developer. Developer shall provide this vendor-unique software or hardware to IFA as part of the test equipment package.

Developer shall also furnish IFA with any special or unique test equipment that is required to maintain and/or test the system after Final Acceptance. The test equipment shall be identified in the associated Design Review submittal.

All spare equipment shall meet the requirements set forth in the applicable sections of this Section 19. At the option of the Engineer, certain items of support equipment shall be tested by being installed in place of a similar item of equipment in a field or central location that has already passed acceptance testing. Testing shall be witnessed by the Engineer or an IFA Representative.

Tests shall be scheduled to allow a representative from the Engineer’s office to witness the test. The Engineer shall be notified a minimum of 72 hours prior to the commencement of each test. All test plans and the test procedures for the component and/or subsystem being tested shall be approved by the Engineer before any testing is conducted. Additionally, Developer shall provide the Engineer 72 hours notification of an anticipated disruption of any services. Concealed work (including underground) shall be tested by Developer and witnessed by the Engineer prior to covering.

Instruments used by Developer shall be regularly and accurately calibrated and maintained in good working condition. Test reports shall include copies of documentation (calibration reports or tags) demonstrating calibration within one year of the start of testing. Developer shall provide all test instruments.

19.5.12.5 Vaults and Handholes

19.5.12.5.1 Description

Developer shall provide handholes and vaults to support the cable and conduit installation of the East End Crossing.

Provide a vault at each planned fiber-optic cable splice location. Space ITS vaults at no more than 2,500-foot intervals. Handholes may be proposed at interim locations to facilitate cable installation or relocations, with locations to be determined based on construction staging requirements.

Provide a communications handhole within 6 feet of each ITS location to facilitate the installation of cabling to the cabinet.

19.5.12.5.2 Material Requirements

All handholes and vaults shall be in conformance with the Project Standards.

19.5.12.5.3 Construction Requirements

Handhole and vault covers shall be horizontally stamped as “TRAFFIC MANAGEMENT SYSTEM” across the center of the lid.

All conduit between handholes shall be complete and continuous. All connections between sections of conduit shall be made to be watertight and shall be tested with compressed air prior to installing cables. Grouting fill surrounding conduit entries at the handholes shall be made watertight.

Handholes shall be precast with the top of the handhole sloped to match the final grade.

19.5.12.6 Fiber-Optic Cable

19.5.12.6.1 Description

Under these items, Developer shall furnish and install loose-tube, single-mode, fiber-optic cable of the number of fibers specified as shown in the Plans and as directed by the Engineer.

19.5.12.6.2 Material Requirements

The single-mode, fiber-optic cable shall incorporate a loose, buffer-tube design. The cable shall be qualified to the requirements of RUS 7 CFR 1755.900 (PE-90) for armored cable (as required by this specification), and shall be new, unused, and of current design and manufacture.

19.5.12.7 Fiber-Optic Drop Cable

19.5.12.7.1 Description

The fiber-optic drop cable is used for installing fiber-optic cable into ITS control cabinets and relay shelters. This ITS drop cable is used for connectivity between a primary fiber trunk, or feeder cable, and various field devices such as CCTV cameras at field locations as shown on the Plans.

19.5.12.7.2 Material Requirements

The fiber-optic ITS drop cable shall include a factory pre-terminated, factory pre-tested connector module with pigtails that splice into the primary fiber trunk. This connector module mounts into the ITS field cabinet enclosure or on a standard 19-inch rack rail. The fiber-optic ITS drop cable shall have the following specifications:

1. Single mode
2. Fiber count: 6 fiber
3. Connector #1: SC (factory pre-terminated)
4. Connector #2: Pigtail length of 150’
5. Mounting plate for cabinet rack
6. Insertion Loss: 0.2 decibel typical

7. Return Loss: > −40 decibel SPC
8. Tensile Strength: 50 pounds (220 Newtons) <0.20 decibel change
9. Temperature Cycling: 40 degrees Fahrenheit (−40 degrees Celsius) + 158 degrees Fahrenheit (70 degrees Celsius), 40 cycles < 0.20 decibel change
10. Ferrule material – Ceramic
11. Housing material – Acrylic, UL94V0

19.5.12.7.3 Construction Requirements

Construction requirements are as follows:

1. Coordinate layout and installation of fiber optic drop cable with other installations. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer or IFA in their good faith discretion.
2. The cables shall use dispersion unshifted fibers. The fibers shall comply with ITU G.652.D. The optical and physical characteristics of the uncabled fibers shall include the following:
    a. Core Diameter: 8.3 µm (nominal)
    b. Numerical Aperture: 0.14
    c. Zero Dispersion Wavelength: 1300−1322 nm
    d. Zero Dispersion Slope: 0.092 ps/(nm^2*km) (maximum)
    e. Cladding Diameter: 125.0 ± 0.7µm
    f. Core-Clad Concentricity: 0.05µm maximum
    g. Cladding Non-Circularity: 1 percent maximum
    h. Coating Diameter: 245 ± 10 µm
    i. Coating-Cladding Concentricity: 12 µm maximum
    j. Mode Field Diameter: 9.2µm±0.4µm at 1310nm
    k. Mode Field Diameter: 10.4µm±0.5µm at 1550nm
    l. Dispersion: 18.0 ps/(nm*km) maximum at 1550nm
3. The number of fibers in each cable shall be as specified on the plans.
4. The core construction shall consist of individual buffer tubes, each containing 12 fibers. These buffer tubes shall be stranded around a dielectric central strength member using a reverse oscillation process.
5. The maximum attenuation of any cabled fiber shall not exceed 0.4 decibels per kilometer at 1,310 nanometers and shall not exceed 0.3 decibels per kilometer at 1550 nanometers.

6. The cable shall be capable of withstanding a minimum-bending radius of 20 times its outer diameter during installation and 10 times its outer diameter during operation without changing the characteristics of the optical fibers.

7. The cable shall meet all of specified requirements under the following conditions:

    a. Shipping/storage temperature: −58 degrees Fahrenheit to +158 degrees Fahrenheit (−50 degrees Celsius to +70 degrees Celsius)

    b. Installation temperature: −22 degrees Fahrenheit to +158 degrees Fahrenheit (−30 degrees Celsius to +70 degrees Celsius)

    c. Operating temperature: −40 degrees Fahrenheit to +158 degrees Fahrenheit (−40 degrees Celsius to +70 degrees Celsius)

    d. Relative humidity from 0 percent to 95 percent, non-condensing

19.5.12.7.3.1 Armor

A steel armor, plastic coated on both sides, is required for direct buried cable installed under the provisions of this Technical Provision. An armor is optional for duct and aerial cable. The plastic-coated steel armor shall be applied longitudinally directly over the core wrap or the intermediate jacket and have a minimum overlap of 3.0 millimeters.

The uncoated steel tape shall be electrolytic chrome coated steel (ECCS) with a thickness of 0.155 ± 0.015 millimeters.

The reduction in thickness of the armoring material due to the corrugating or application process shall be kept to a minimum and shall not exceed 10 percent at any spot.

The armor of each length of cable shall be electrically continuous with no more than one joint or splice allowed per kilometer of cable. This requirement does not apply to a joint or splice made in the raw material by the raw material manufacturer.

The breaking strength of any section of an armor tape, containing a factory splice joint, shall not be less than 80 percent of the breaking strength of an adjacent section of the armor of equal length without a joint.

19.5.12.7.4 Experience Requirements

Personnel involved in the installation, splicing, and testing of the fiber-optic cables shall meet the following requirements:

1. Possess a minimum of three (3) years experience in the installation of fiber-optic cables, including fusion splicing, terminating, and testing single-mode fibers.

2. Demonstration of the installation two systems where fiber-optic cables are outdoors in conduit and where the systems have been in continuous satisfactory operation for at least two years. Developer shall submit as proof photographs or other supporting documents and the names, addresses, and telephone numbers of the operating personnel who can be contacted regarding the satisfactorily installed fiber-optic systems.

Developer shall arrange for the Engineer to witness, at the Engineers discretion, one satisfactorily installed fiber-optic cable system (which may be one of the two in the preceding paragraph) for each installer to provide proof of competency.

Installers shall be familiar with the cable manufacturer's recommended procedures for installing the cable. This shall include knowledge of splicing procedures for the fusion splicer being used on the East End Crossing and knowledge of all hardware such as breakout (furcation) kits and splice closures. Developer shall include documented procedures in the Construction QA/QC Plan to be used by construction inspectors.

Personnel involved in testing shall have been trained, by the manufacturer of the fiber-optic cable test equipment to be used, in fiber-optic cable testing procedures. Proof of this training shall be submitted to the Engineer as part of the Construction QA/QC Plan. In addition, Developer shall submit documentation of the testing procedures for approval by the Engineer.

19.5.12.8 Cable Installation in Conduit

Developer shall provide a cable-pulling plan, identifying where the cable will enter the underground system and the direction of pull. This plan will address locations where the cable is pulled out of a handhole/vault, coiled in a figure eight, and pulled back into the handhole. The plan shall address the physical protection of the cable during installation and during periods of downtime. The cable-pulling plan shall be provided to the Engineer for review and comment a minimum of 10 working days prior to the start of installation. The Engineer shall have 7 days to provide comment and installation shall not commence until all comments are satisfactorily addressed. The Engineer's review shall be for the operation on the freeway and does not include an endorsement of the proposed procedures. Developer is responsible for the technical adequacy of the proposed procedures.

During cable-pulling operations, Developer shall ensure that the minimum bending of the cable is maintained during the unreeling and pulling operations. Entry guide chutes shall be used to guide the cable into the handhole/vault conduit ports. Lubricating compound shall be used to minimize friction. Corner rollers (wheels), if used, shall not have radii less than the minimum installation-bending radius of the cable. A series array of smaller wheels can be used for accomplishing the bend if the cable manufacturers specifically approve the array.

The pulling tension shall be continuously measured and shall not be allowed to exceed the maximum tension specified by the manufacturer of the cable. Fuse links and breaks can be used to ensure that the cable tensile strength is not exceeded. The pulling system shall have an audible alarm that sounds whenever a preselected tension level is reached. Tension levels shall be recorded continuously and shall be given to the Engineer upon request.

The number of handholes/vaults and their locations shall be as shown on the Plans.

The cable shall be pulled into the conduit as a single component, absorbing the pulling force in all tension elements. The central strength member and Aramid yarn shall be attached directly to the pulling eye during cable pulling. "Basket grip" or "Chinese-finger type" attachments, which only attach to the cable's outer jacket, shall not be permitted. A breakaway swivel, rated at 95 percent of the cable manufacturer's approved maximum tensile loading, shall be used on all pulls. When simultaneously pulling fiber-optic cable with other cables, separate grooved rollers shall be used for each cable.

19.5.12.9 Not Used

19.5.13 Operation and Maintenance Documentation

After the fiber-optic cable plant has been installed, Developer shall submit to IFA ten (10) complete sets of operation and maintenance documentation. The documentation shall, as a minimum, include the following:

1. Complete and accurate as-built diagrams showing the entire fiber-optic cable plant, including the locations of all splices
2. Final copies of all approved test procedures
3. Complete performance data of the cable plant showing the losses at each splice location and each terminal connector
4. Complete parts list, including names of vendors

19.5.14 Testing Requirements

Developer shall include detailed test procedures in the Construction QA/QC Plan prior to any tests being conducted. All fibers shall be tested bi-directionally at both 1,310 nanometers and 1,550 nanometers with both an optical time-domain reflectometer (OTDR) and a power meter and optical source. For testing, intermediate breakout fibers may be concatenated and tested end to end. Developer shall resolve any discrepancies between the measured results and this Section 19 to the satisfaction of the Engineer.

Developer shall provide the date, time, and location of any tests required by this Section 19 to the Engineer at least five days before performing the test. Upon completion of the cable installation, splicing, and termination, Developer shall test all fibers for optical continuity loss, events above 0.1 decibels, and total attenuation of the cable. The test procedure shall be as follows:

1. A certified technician utilizing an OTDR and optical source/power meter shall conduct the installation test. The technician is directed to conduct the test using the standard operating procedures defined by the manufacturer of the test equipment. All fibers installed shall be tested in both directions.

2. The method of connectivity between the OTDR and the cable shall be a factory patch cord of a length equal to the "dead zone" of the OTDR. Optionally, the technician can use a factory "fiber box" of 328 feet (100 meters) minimum with no splices within the box.

At the completion of the test, Developer shall provide two copies of documentation of the test results to the Engineer. The test documentation shall be submitted as both a bound copy and a CDROM and shall include the following:

1. Cable and Fiber Identification:
    a. Cable ID

b. Cable location – beginning and end point

c. Fiber ID, including tube and fiber color

d. Operator name

e. Date and time

f. Set-up parameters

g. Wavelength

h. Pulse width (OTDR)

i. Refractory index (OTDR)

j. Range (OTDR)

k. Scale (OTDR)

l. Set-up option chosen to pass OTDR “dead zone”

2. Test results:

   a. OTDR test

3. Total fiber trace

4. Splice loss/gain

5. Events > 0.10 decibels

6. Measured length (cable marking)

7. Total length (OTDR)

   a. Optical source/power meter

   b. Total attenuation

   c. Attenuation (dB/km)

8. File format for the OTDR Test Results: The file format for the OTDR test results shall be Bellcore/Telcordia-compliant according to GR-196-CORE Issue 2, OTDR Data Standard:

   a. GR 196, Revision 1.0

   b. GR 196, Revision 1.1

   c. GR 196, Revision 2.0 (SR-4731)

9. These results shall be provided in tabular form. The following shall be the criteria for the approval of the cable:

   a. The test results shall show that the decibels per kilometer loss does not exceed +3 percent of the factory test or 1 percent of the cable's published production loss. However, no event shall exceed 0.10 decibels. If any event is detected above 0.10 decibels, Developer shall replace or repair the fiber including that event point.

b. The total loss of the cable (decibel), less events, shall not exceed the manufacturer's production specifications as follows: 0.5 decibels per kilometer at both 1,310 and 1,550 nanometers.

c. If the total loss exceeds these specifications, Developer shall replace or repair that cable run at Developer's expense, both labor and materials. Elevated attenuation due to exceeding the pulling tension during installation shall require the replacement of the cable run at Developer's expense, including labor and materials.

d. Label the destination of each trunk cable onto the cable in each handhole, vault, or cable termination panel.

19.5.15 Splicing Requirements

Splices shall be made at locations shown on the Plans. Any other splices shall be permitted only with the approval of the Engineer.

All optical fibers shall be spliced as indicated on the Plans. If no information is provided, mainline splices will concatenate the fibers from the two cable segments, that is, the colors of the buffer tubes and fibers shall be the same across the splice. For splices that breakout the individual fibers, the fibers shall be spliced in accordance with the Plans.

19.5.16 Slack Storage of Fiber-Optic Cables

As part of these items, slack fiber shall be supplied as necessary to allow splicing the fiber-optic cables in a controlled environment, such as a splicing van or tent. The following slack shall be provided:

1. ITS Cabinet: 5 feet
2. ATMS Handhole: 20 feet
3. ATMS Vault: 100 feet
4. Shelter, Relay: 100 feet

19.5.17 Fiber-Optic Cable Slack Estimates

After splicing has been completed, the slack fiber shall be stored underground in ATMS vaults.

19.5.18 Cable Tagging

Fiber-optic cable shall be tagged inside handholes with yellow tape containing the text "CAUTION - FIBER OPTIC CABLE." In addition, permanent tags, as approved by the Engineer, shall be attached to all cable in a handhole or other break-out environment. These tags shall be stainless steel, nominally 0.75 inches by 1.72 inches, and permanently embossed. These tags shall be attached with stainless steel straps and shall identify the cable number, the number of fibers, and the specific fiber count. Tags and straps shall be Panduit or approved equal.

19.5.18.1 Fiber-Optic Splice

19.5.18.1.1 <u>Description</u>

Developer will splice optical fibers from different cable sheaths and protect them with a splice enclosure at the locations shown on the Plans. Fiber splicing consists of in-line fusion splices for all fibers described in the cable plan at the particular location.

Two basic types of splices are identified. In a drop cable splice, the buffer tubes in the mainline cable are dressed out, and those fibers identified on the Plans are accessed and spliced to drop cables. A mainline splice involves the splicing of all fibers in the cable sheath to a second, continuing cable.

19.5.18.1.2 <u>Material Requirements</u>

19.5.18.1.2.1 <u>Splice Enclosures</u>

Splice enclosures shall be designed for use under the most severe conditions, such as moisture, vibration, impact, cable stress, and flex temperature extremes, as demonstrated by successfully passing the factory test procedures and minimum specifications listed below:

19.5.18.1.3 <u>Physical Requirements:</u>

The enclosures shall provide ingress for up to four cables in a butt configuration. The closure shall prevent the intrusion of water without the use of encapsulates. For combined mainline and drop cable splices, a single-splice enclosure shall be used.

The enclosure shall be capable of accommodating splice organizer trays that accept mechanical or fusion splices. The splice enclosure shall have provisions for storing fiber splices in an orderly manner, mountings for splice organizer assemblies, and space for excess or un-spliced fiber. Splice organizers shall be re-enterable. The splice case shall be UL rated.

Enclosure re-entry and subsequent reassembly shall not require specialized tools or equipment. Furthermore, these operations shall not require the use of additional parts.

The splice enclosure shall have provisions for controlling the bend radius of individual fibers to a minimum of 1.5 inches (38 millimeters).

For splices in armored cables, the splice closure shall provide a method of bonding the armor from all sheaths entering the closure. It shall also provide a means of grounding the armor and closure at the splice location.

19.5.18.2 Factory Testing

19.5.18.2.1 <u>Compression Test</u>

The closure shall not deform more than 10 percent in its largest cross-sectional dimension when subjected to a uniformly distributed load of 1,335 Newtons at temperatures of 0 and 100 degrees Fahrenheit (–18 and 38 degrees Celsius). The test shall be performed after stabilizing at the required temperature for a minimum of two hours. It shall consist of placing an assembled enclosure between two flat parallel surfaces, with the longest enclosure dimension parallel to the surfaces. The weight shall be placed on the upper surface for a minimum of 15 minutes. The measurement shall then be taken with weight in place.

19.5.18.2.2 Impact Test

The assembled enclosure shall be capable of withstanding an impact of 28 N-M at temperatures of 0 and 100 degrees Fahrenheit (–18 and 38 degrees Celsius). The test shall be performed after stabilizing the enclosure at the required temperature for a minimum of two hours. The test fixture shall consist of 20-pound (9 kilogram) cylindrical steel impacting head with a 2-inch (50-millimeter) spherical radius at the point where it contacts the enclosure. It shall be dropped from a height of 12 inches (305 millimeters). The enclosure shall not exhibit any cracks or fractures to the housing that would preclude it from passing the water immersion test. There shall be no permanent deformation to the original diameter or characteristic vertical dimension by more than 5 percent.

19.5.18.2.3 Cable Gripping and Sealing Testing

The cable gripping and sealing hardware shall not cause an increase in fiber attenuation in excess of 0.05 decibels per fiber at 1,550 nanometers when attached to the cables and the enclosure assembly. The test shall consist of measurements from six fibers, one from each buffer tube or channel, or randomly selected in the case of a single fiber bundle. The measurements shall be taken from the test fibers before and after assembly to determine the effects of the cable gripping and sealing hardware on the optical transmission of the fibers.

19.5.18.2.4 Vibration Test

The splice organizers shall securely hold the fiber splices and store the excess fiber. The fiber splice organizers and splice-retaining hardware shall be tested per EIA Standard FOTP-II, Test Condition 1. The individual fibers shall not show an increase in attenuation in excess of 0.1 decibels per fiber.

19.5.18.2.5 Water Immersion Test

The enclosure shall be capable of preventing a 10-foot (3-meter) water head from intruding into the splice compartment for a period of seven days. Testing of the splice enclosure is to be accomplished by the placing of the enclosure into a pressure vessel and filling the vessel with tap water to cover the enclosure. Apply continuous pressure to the vessel to maintain a hydrostatic head equivalent 10 feet (3 meters) on the closure and cable. This process shall be continued for 30 days. Remove the enclosure and open to check for the presence of water. Any intrusion of water in the compartment containing the splices constitutes a failure.

19.5.18.3 Certification

It is the responsibility of Developer to ensure that either the manufacturer or an independent testing laboratory has performed all of the above tests, and that the appropriate documentation has been submitted to IFA. Manufacturer certification is required for the model(s) of enclosure supplied. It is not necessary to subject each supplied closure to the actual tests described herein.

19.5.18.4 Construction Requirements

The enclosure shall be installed according to the manufacturer's recommended guidelines. For mainline splices, the cables shall be fusion spliced. Forty-five days prior to start of the fiber-optic cabling installation, Developer shall submit the proposed locations of the mainline splice points for review and comment by IFA.

Developer shall prepare the cables and fibers in accordance with the enclosure and cable manufacturers' installation practices. A copy of these practices shall be provided to the Engineer for review and comment 21 days prior to splicing operations.

Using a fusion splicer, Developer shall optimize the alignment of the fibers and fuse them together. Developer shall recoat the fused fibers and install mechanical protection over them.

Upon completing all splicing operations for a cable span, Developer shall measure the mean bi-directional loss at each splice using an OTDR. This loss shall not exceed 0.1 decibel.

Developer shall measure the end-to-end attenuation of each fiber, from connector to connector, using an optical power meter and source. This loss shall be measured from both directions and shall not exceed 0.5 decibel per installed kilometer of single-mode cable. Measurements shall be made at both 1,300 and 1,550 nanometers for single-mode cable.

The cable installation shall satisfy the requirements of both the NEC (NFPA-70-2008) and the National Electric Safety Code (IEEE C2-2007). The standards require that the armor be bonded and grounded any time that the armor is interrupted or exposed by opening the sheath. These documents also provide minimum separations from foreign utilities.

For splices in armored cables, Developer shall ground the splice closure using a #6 AWG conductor or equivalent.

As directed by the good faith discretion of the Engineer, Developer, at no additional cost to IFA, shall replace any cable splice not satisfying the Project Standards, PPA Documents, including this Section 19.

Developer shall secure the splice enclosure to the side of the splice facility using cable support brackets. All cables shall be properly dressed and secured to rails or racks within the ATMS vault. No cables or enclosures will be permitted to lie on the floor of the splice facility. Cables that are spliced inside a building will be secured to the equipment racks or walls as appropriate and indicated on the Plans.

19.5.19 Fiber-Optic Patch Cables

19.5.19.1 Description

This section describes furnishing fiber-optic patch cables for making fiber- optic network device connections with SC and LC connectors as shown on the Plans. This includes patch panel connections, network card connections, and other equipment.

19.5.19.2 Material Requirements

All conductors shall be have the following specifications:

19.5.19.2.1 Multimode Patch Cord

1. Attenuation:
   a. 850 nanometers: 3.0 decibels per kilometer
   b. 1,310 nanometers: 1.0 decibels per kilometer
2. Bandwidth:
   a. LED: 1500/500 megahertz per kilometer OFL at 850/1,310 nanometers
   b. 2000/500 megahertz per kilometer RML at 850/1,310 nanometers
3. Diameters Core: 50 µm
4. Cladding: 125 µm
5. Buffer: 900 µm
6. Fiber Type: Laser-optimized multimode
7. Jacket: PVC
8. Operating Temperature: −40 to +185 degrees Fahrenheit (−40 to +85 degrees Celsius)

19.5.19.2.2 Single Mode Patch Cord

1. Bend radius: Meets ANSI/TIA/EIA-568B.3 standard
2. Cladding: 125 µm
3. Core: 9 µm
4. Crush resistance: 750 Newtons per centimeter
5. Ferrule: Ceramic
6. Housing: Composite
7. Insertion Loss: 0.2 decibels typical
8. Operating Temperature: − 4 to +158 degrees Fahrenheit (-20 to +70 degrees Celsius)
9. Return Loss: ≥55 typical
10. Tensile Strength: 240 Newtons (54 pounds per 24.5 kilograms)
11. Wavelength: 1,310 nanometers, 1,550 nanometers
12. Maximum attenuation: 0.4 decibels, typical 0.2 decibels

19.5.19.2.3 Construction Requirements

Coordinate the layout and installation of fiber patch cables with other installations. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer.

19.5.19.3 Fiber-Optic Patch Panel Assembly

19.5.19.3.1 Description

This section describes furnishing fiber-optic patch panels for making fiber- optic terminations at the cable demarcation point sites. The fiber patch panel assembly consists of the following:

1. One (1) fiber closet connector housing
2. Eight (8) fiber panels

19.5.19.3.2 Material Requirements

The fiber patch panels shall have the following specifications:

1. Rack mountable for 19-inch rack 4U in size
2. Housing accepts up to 12 SC simplex or SC duplex connector panels
3. connector panels shall be single-mode in 12 fiber configuration
4. Meets requirements of ANSI/TIA/EIA-568A and 606
5. SC adapters have ceramic sleeves

19.5.19.3.3 Construction Requirements

Coordinate the layout and installation of fiber patch panels with other installations. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer. The splice shall be a fusion splice as specified in the Technical Provisions and shall not exceed 0.1 decibels. Developer shall measure the mean bi-directional loss at each splice using an OTDR and provide the results to the Engineer.

19.5.19.4 Fiber Gigabit Interface Card Modules

19.5.19.4.1 Description

The Fiber Gigabit Interface Card (GBIC) module inserts into the ITS switches to allow for a fiber connection.

19.5.19.4.2 Material Requirements

The Fiber GBIC module shall be compatible with the ITS field, field relay, and core switches.

The Fiber GBIC module shall provide performance as follows:

1. Operating temperature of 32 degrees to degrees 140 degrees Fahrenheit
2. Connector type of LC
3. Medium Time Between Failure (MTBF) of 807,000 hours
4. Distance Range:

a. Short up to 500 meters for 50 µm multimode fiber

b. Medium up to 10 kilometers for 9 µm single-mode fiber

c. Long up to 40 kilometers for 9 µm single-mode fiber

d. Extended up to 70 kilometers for 9 µm single-mode fiber

5. Optical Budget:

   a. Short 7 decibels

   b. Medium 10.5 decibels

   c. Long 17 decibels

   d. Extended 20 decibels

6. Transmit/Receive wavelength:

   a. Short 850 nanometers

   b. Medium 1,310 nanometers

   c. Long 1,470-1,610 nanometers

   d. Extended 1,550 nanometers

19.5.19.4.3 <u>Construction Requirements</u>

Fiber GBIC cards shall be installed at each site that is to be connected to fiber as shown on the Plans.

19.5.19.5 Intelligent Transportation System Field Ethernet Switch, Managed

19.5.19.5.1 <u>Description</u>

The ITS field Ethernet managed switch is used to connect communications equipment and the AFP at camera sites, as well as provide relay communications to the ATMS network.

19.5.19.5.2 <u>Material Requirements</u>

Provide materials conforming to the following specifications: Avaya 4526-T

19.5.19.5.3 <u>Construction Requirements</u>

Developer shall install the ITS field relay Ethernet switch as shown in the Plans in accordance with the manufacturer's instructions. Installation shall include all cables, mounting hardware, power supplies and associated equipment required to mount and interface the spur low-speed communications subsystem. Document all installation activities, including the quantity, brand, model/part numbers, test results of all materials used. Provide an installer-signed list of the materials installed with the required documentation.

19.5.19.6 Intelligent Transportation System Core Ethernet Switch, Managed

19.5.19.6.1 Description

The ITS core ethernet switch is used to connect the fiber backbone of the ITS field equipment to the CDP sites. This switch will be located in a conditioned shelter or building. The ITS core switch consists of the following:

1. One (1) chassis with at least 6 slots
2. Two (2) 100-240 VAC 1140W/1462W power supplies with appropriate power cord
3. Two (2) switch fabric modules with 256 Gbps switch fabric capacity, 1.3 GHz CPU, 1 GB memory and compact flash slot
4. Two (2) ethernet interface modules with eight (8) ports of autosensing 10Base-T/100Base-TX/1000Base-T, twenty-four (24) ports for SFP style GBIC card and two (2) 10Gigabit XFP style GBIC cards. Module shall be vendors' most current model with exact port counts listed above. Two (2) 48 port autosensing 10Base-T/100Base-TX/1000Base-T ethernet interface modules
5. One (1) software kit, includes base software necessary for operation of the switch. Latest version available from the manufacturer

Functional requirements:

1. Meet 99.999 percent error free operation; multiple protocol data communication over fiber optic and copper transmission mediums.
2. Perform to stated specifications over a temperature range of 32° to 104° F and a humidity of 85 percent relative noncondensing.
3. Shall operate on 120 volt (plus or minus 10 percent) 60 Hz commercial power.
4. 19 inch Rack Mountable.

19.5.19.6.2 Material Requirements

Provide materials conforming to the following specifications:

1. Switch architecture: 720Gbps gross throughput
2. Switch Fabric performance: up to 512Gbps in an Active/Active configuration
3. Frame forwarding rate: up to 380Mpps
4. Frame length: 64 to 1518 Bytes (802.1Q Untagged), 64 to 1522 bytes (802.1Q Tagged)
5. Jumbo Frame support: up to 9,000 Bytes (802.1Q Tagged)
6. Multi-Link Trunks: up to 128 Groups, with 8 Links per Group
7. VLANs: up to 4,000 Port/ Protocol/802.1Q-based
8. Multiple Spanning Tree Groups: up to 32
9. MAC Address: up to 64k
10. IP Interfaces: 1,972
11. Dynamic ARP Entries: up to 32k
12. VRRP Interfaces: up to 255
13. IP Forwarding Table: 250k
14. ECMP Routes: up to 5k

15. RIP Instances: up to 64
16. RIP Interfaces: up to 200
17. RIP Routes: up to 10k
18. OSPF Instances: up to 64
19. OSPF Adjacencies: up to 80
20. OSPF Routes: up to 50k
21. BGP Peers: up to 250
22. BGP Routes: up to 250k
23. SPB C-VLANs: up to 1,500
24. SPB IS-IS Adjacencies: up to 50
25. SPB IP Routes for L3 VSN: up to 25k
26. SPB IP Routes for IP VPN-Lite/SPB: up to 250k
27. VRF-Lite Instances: up to 255
28. MPLS LDP LSPs: up to 16k
29. MPLS Tunnels: up to 2,500
30. PIM Active Interfaces: up to 200
31. PIM Neighbors: 80/up to 200 for all VRFs
32. IP Multicast Streams: up to 4k

19.5.19.6.3 Construction Requirements

The ITS core switch shall be installed in accordance with the manufacturer's instructions and per the plans. All materials shall be installed in a neat and professional manner. All installation services will comply with all warranty provisions and warranty contract maintenance services in accordance with these specifications. Installation shall include all cables, mounting hardware, power supplies and associated equipment.

Document all installation activities, including the quantity, brand, model/part numbers, test results of all materials used. Provide installer signed list of the materials installed with the required documentation.

19.5.19.7 Padlocks

19.5.19.7.1 Description

This work shall consist of furnishing and installing padlocks for all cabinets, fence gates, box truss ladder gates, and enclosures specified in these Technical Provisions.

19.5.19.7.2 Material Requirements

The padlock shall be classified as a high-security padlock with hardened shackle, laminated body, and 4-pin cylinder (minimum), and shall come complete with a weather cover to protect the lock body and cylinder from sand, dirt, water and ice. A wafer cylinder shall not be used. Keys shall be provided to IFA with each padlock supplied. All padlocks shall be keyed alike and identical to the keys currently in use by IFA. The main body width of the padlock shall not exceed 3 inches and shall have a shackle length of 2.25 inches to 3.75 inches and a shackle diameter of 0.3125 inches.

19.5.19.7.3 Construction Requirements

For padlock information, contact the ITS Field Engineer, Indiana Department of Transportation, at 8620 East 21st Street, Indianapolis, Indiana 46219, (317) 899-8606.

19.5.20 Intelligent Transportation System Electrical Power

19.5.20.1 Power Service Drop

19.5.20.1.1 Description

Work under this item shall include furnishing and installing all equipment necessary to provide a complete service point power entry. Electrical service, where required, shall be provided by the appropriate Utility Owner. A 100 Amp, 240/120 volts alternating current, 1-phase, 3-wire service shall be provided at power service drop locations. The service point locations shall be coordinated with the appropriate Utility Company. Work under this item includes overhead and underground service power drops for 120/240 volt. Developer shall pay for all costs required by the utility for service installation.

After coordination with the power company's representative, Developer shall submit a connection request form to the Department. The Department shall forward this form to the power company, and the Department shall be responsible for paying bills after service is connected. The service drops shall be in accordance with these Technical Provisions and with Standard Specification Section 807.15.

19.5.20.1.2 Material Requirements

The service drops shall be sized and equipped as shown on the Plans. Meter sockets shall be installed in accordance with the requirements of the utility. Grounding shall be in accordance with Standard Specification Section 807.12 and shall be part of the service installation.

The outdoor rated disconnect switch shall be a NEMA 3R enclosure with multi-position (4 or 6) circuit breaker panel with 100 amp main circuit breaker, 3 pole, 600 volts. The enclosure shall be lockable with a padlock. Padlocks are to be in accordance with the padlock Technical Provisions and are for paid separately.

Supplemental Disconnect – In the event that the service point and cabinet are separated by mainline roadway lanes, collector/distributor lanes, ramp lanes or a distance greater than 500' (as measured along the electrical wire from the service point to the cabinet), an additional 3R rated electrical disconnect shall be installed within 25 feet of the ITS controller cabinet/DMS as a safety disconnect device.

19.5.20.1.3 Construction Requirements

All electrical work associated with the service power drop installations shall be in accordance with the Design Documents, Construction Documents, Project Standards, and the manufacturer's written instructions.

As identified in the Plans or per the Engineer request, where the proposed service point is more than 500 feet from the ATMS remote site, a second disconnect shall be provided at the ATMS site.

19.5.20.2 Wires and Cables

19.5.20.2.1 Description

This section shall consist of furnishing and installing wires and cables, and making all connections as shown on the Plans. This Section 19 includes wires and cables and associated splices, connectors, and terminations for wiring systems rated 600 volts and less. The following sections of the Standard Specifications relate specifically to this section: Section 807, Highway Illumination, Section 920.01(c), Wire and Cable.

Deliver wire and cable according to NEMA WC-26.

19.5.20.2.2 Material Requirements

Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include but are not limited to the following:

1. Wires and Cables Vendors
    a. American Insulated Wire Corp., Leviton Manufacturing Co.
    b. Brand-Rex Cable Systems, Brintec Corp.
    c. Carol Cable Company, Inc.
    d. Senator Wire & Cable Co.
    e. Southwire Co.
2. Connectors for Wires and Cables Vendors
    a. Teledyne Penn-Union
    b. ILSCO
    c. Thomas & Betts Corp.
    d. Electrical Products Division, 3M Co.
    e. O-Z/Gedney Unit, General Signal
3. All conductors shall have insulation rated at 600 volts alternating current, with conductor temperatures not to exceed 194 degrees Fahrenheit (90 degrees Celsius) in dry locations and 167 degrees Fahrenheit (75 degrees Celsius) in wet locations.
4. Service Entrance: Type XHHW, copper conductor, in raceway
5. Branch Circuits: Type XHHW, copper conductor, in conduit at ATMS equipment cabinets/enclosures.
6. Connectors and Splices: UL-listed factory fabricated wiring connectors of size, ampacity rating, material, and type and class for application and for service indicated. Select to comply with the East End Crossing's installation requirements.

19.5.20.2.3 Construction Requirements

1. Coordinate layout and installation of cable with other installations. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer.

2. All components and installation shall comply with NFPA 70, NEC. Provide products specified in this section that are listed and labeled as defined in the NEC, Article 100.

3. Install wires and cables as indicated, according to the manufacturer's written instructions and the National Electrical Contractors Association Standard of Installation.

4. Pull conductors into raceway simultaneously where more than one is being installed in same raceway.

   a. Use pulling compound or lubricant where necessary; compound used shall not deteriorate conductor or insulation.
   b. Use pulling means; including fish tape, cable, rope, and basket weave wire/cable grips that will not damage cables or raceway.

5. Minimize conductor splices where possible.

   a. All splices and connections shall comply with the Standard Specifications, Section 807.
   b. Install splices and covers that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

6. Use splice and tap connectors that are compatible with conductor material.

7. Examine conduits to receive wires and cables for compliance with installation tolerances and other conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

8. Testing: Upon installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

9. Procedures: Perform each visual and mechanical inspection and electrical test stated in InterNational Electrical Testing Association Standard ATS, Section 7.3.1. Certify compliance with test parameters.

10. Correct malfunctioning products at site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

19.5.20.3 Vaults and Handholes

19.5.20.3.1 <u>Design Criteria</u>

Developer shall provide handholes and vaults to support the cable and conduit installation of the East End Crossing.

Provide a power handhole within 6 feet of each ITS location to facilitate the installation of cabling to the cabinet.

19.5.20.3.2 <u>Material Requirements</u>

All handholes and vaults shall be in conformance with the Project Standards for construction.

19.5.20.3.3 Construction Requirements

Handhole and vault covers shall be stamped as “TRAFFIC MANAGEMENT POWER” horizontally, across the center of the lid.

All conduits between handholes and/or vaults shall be complete and continuous. All connections between sections of conduit shall be made to be watertight and shall be tested with compressed air prior to installing cables. Grouting fill surrounding conduit entries at the handholes shall be made watertight.

Handholes shall be precast with the top of the handhole sloped to match the final grade. Vaults shall be installed such that the top is level and grading surrounding the vault shall be made level. Developer shall provide retaining walls as necessary to support the grading requirement.

19.5.21 Intelligent Transportation System Conduit

19.5.21.1 Design Criteria

Developer shall provide a minimum of one (1) 2-inch HDPE Schedule 80 conduit for electrical power and three (3) 1 ¼-inch conduits of different colors (blue, orange, and green) for fiber communications along all mainline sections of the East End Crossing. These quantities shall also be installed on both sides of the East End Bridge and Tunnel. Provide additional conduit where required to meet the needs of the East End Crossing. Conduit installed for the East End Crossing shall support 100 percent expansion of the ITS. To support system expansion, maximum conduit fill for all new conduits shall not exceed 0.5 of the fill percentage recommended by Table 1, Chapter 9, of the NEC.

Conduit trenches shall be in accordance with the Project Standards. Wherever possible, conduit shall be installed in common trenches.

Bored conduit shall be installed perpendicular to roadway or other paved crossings.

All conduit shall be locatable, either by installing a tonable pull tape, armoured fiber optic cable, copper wire within the conduit wall, etc.

19.5.21.2 Material Requirements

Conduit materials shall be in accordance with the Project Standards.

19.5.21.3 Construction Requirements

Developer shall be responsible to repair any pavement or concrete that is damaged by boring operations. Developer shall install trenched, bored, or structurally mounted conduit in accordance with the Project Standards.

During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground plastic line marker, located directly above line at 6 inches to 8 inches below finished grade. Where multiple lines are installed in a common trench or concrete envelope, do not exceed an overall width of 16 inches; install a single line marker.

19.6 Integration and Testing Requirements

Developer shall conduct installation testing during construction to ensure that the devices perform per the manufacturer's specifications. Developer shall provide to the IFA for review and comment Construction Documents including test plans and test results. Test plans shall be provided 30 days prior to installation and test results within 30 days after installation. Vendor-unique software or hardware used to verify proper operation of the ITS or used to troubleshoot the ITS may be used by Developer. Developer shall provide this vendor unique software or hardware to IFA with the Construction Documents.

Developer shall also furnish IFA with any special or unique test equipment that is required to maintain and/or test the system within 30 days of installation. The test equipment shall be identified in the Construction Document submittal in this Section 19.6. All spare equipment shall meet the requirements set forth in the applicable sections of the Technical Provisions.

Tests shall be scheduled to allow a representative from the Engineer’s office to witness the test. The Engineer shall be notified a minimum of 72 hours prior to the commencement of each test.

Additionally, Developer shall provide the Engineer 72 hours of notification for the anticipated disruption of any services. Concealed work (including underground) shall be tested by Developer and witnessed by the Engineer prior to covering.

Instruments used by Developer shall be regularly and accurately calibrated and maintained in good working condition. Test reports shall include copies of documentation (calibration reports or tags) demonstrating calibration within six (6) months of the start of testing. Developer shall provide all test instruments.

Developer shall test the installation of each component/subsystem to ensure the component/subsystem is properly installed and is operational. The component/subsystem test procedure may be vendor-supplied acceptance test procedures. Developer shall use the component test plan to verify the component has been correctly installed and is operational.

Each subsystem and communication path shall be operated without any failures for a period of no less than 30 calendar days prior to Final Acceptance. Any failures during the 30-calendar-day period shall be repaired by Developer and restart the 30-calendar-day period for the system. Developer shall be responsible for configuring the equipment. IFA will provide the configuration parameters required to interface with existing systems. These parameters include but are not limited to multilink trunks, split multilink trunking groups, inter switch trunk links, virtual local area network creation and associated IP addressing, open shortest path first routing protocol, protocol independent multicast routing protocol, and internet group management protocol snooping. IFA will provision the network equipment with the unique system network parameters. At the good faith discretion of the Engineer, preinstallation testing may be repeated as part of the Final Acceptance by IFA. Final Acceptance by IFA will occur when testing concludes and all components and subsystems perform as an integrated system.

As part of the Construction QA/QC Plan, Developer shall develop and submit for review and comment test plans and test procedures for each component and each subsystem. As a minimum, the test plans shall define Developer’s planned approach, the desired results of each test, and steps for resolving out-of-spec conditions. As a minimum, the test procedures shall specify the step-by-step process for connecting to test equipment, reading the test equipment, and recording the results. Further, the test procedures shall contain forms to be used in recording results during actual testing. Test plans and test procedures shall be submitted no later than 120 days from the approval of Release-for-Construction Design Documents. Testing may not commence without the Engineer's approval of the test plans and procedures.

Developer shall accurately record and report the methods of testing, times, and dates of the test; the calibration dates of test equipment; witnesses to the test; and the results of the test. When systems are tested in segments, a separate and complete report is required for each segment. The Engineer shall have a minimum of five days to review the test report. Final Acceptance shall not occur until a satisfactory review of the test report has been completed and all other requirements of the PPA Documents have been satisfied.

19.7 Maintenance During Construction

Developer shall maintain the new ITS through Final Acceptance. Developer shall maintain any existing ITS that is modified under this Section 19 through Final Acceptance.

19.7.1 ITS Operations and Maintenance

Developer shall develop and submit an "ITS Operations and Maintenance Plan" for review and comment with the RFC Design Documents. Developer shall develop the ITS Operations and Maintenance Plan with involvement of the Department, TRIMARC, and KYTC, and shall integrate the plan with the States' current ITS operations and maintenance strategies to facilitate maintenance and operation of all ITS deployments by Department and KYTC upon the final system integration and acceptance.

Developer shall submit an ITS "Concept of Operations Report for IFA review and comment with the RFC Design Documents.

The Concept of Operations Report shall provide system architecture and equipment standardization guidelines. To minimum, it shall cover the following areas:

- Inventory of existing and proposed ITS components.
- Delivery of ITS Architecture Database and Documentation for the East End Crossing using the most updated version of Turbo Architecture software.
- Assessment of conformity to National and Regional ITS Architecture.
- Standardized communications protocols intra- and inter-agencies along with system diagrams (including elements and data flows) for integration of existing and proposed ITS systems in the Department TMC and TRIMARC.
- Interoperability of ITS devices and equipment provided in this contract with existing hardware, software, operator workstations, video displays and controllers, network devices, data storage devices and software, and other legacy devices and equipment in use at the Department TMC, TRIMARC and the KYTC TOC.
- Strategy for fault and alarm handling, operator interface requirements.
- Maintenance requirements, tools and equipment.
- Estimated annual ITS O&M cost including equipment, material and staff labor.

Developer shall develop and maintain an ITS inventory asset database and submit to the Engineer for review and approval during Construction Work. Development of this database is to be completed and all comments resolved prior to Final Acceptance.

- An inventory of all ITS system components including all field deployments and spare parts in storage shall be developed and maintained under the ITS Operations and Maintenance Plan. The ITS inventory asset database shall automate documentation, tracking, monitoring and evaluation of all ITS assets.
- The ITS inventory shall provide a centralized set of complete as-built's, field change drawings and manufacturers' cut sheets for all ITS equipment. It shall also include cost records for each ITS elements, such as equipment purchase cost, lead time, replacement cycle, warranty period, preventive maintenance schedules, etc.
- The ITS inventory provides basis for monitoring the amount of resources consumed by future maintenance activities, scheduling and prioritizing field preventive and corrective activities, and tracking field repairs and replacements by contractors. It also provides essential input for States' decisions on budgets and staffing levels to support the ITS system.

Develop and submit ITS procurement guidelines to the Engineer for review and approval during Construction Work. Development of these guidelines is to be completed and all comments resolved prior to Final Acceptance.

- The ITS O&M plan shall provide system procurement criteria for ITS equipment, firmware, and software requirements. It shall include a list of Standard Specifications, tools and test equipment for ITS O&M activities.
- Developer shall also provide a list of preapproved materials and products for future consistency and compatibility of ITS equipment.
- This will ensure the interpretability and interchangeability of system parts in the TMC.

Develop and submit ITS staffing requirements for the Engineer review and approval during Construction Work. Development of these requirements is to be completed and all comments resolved prior to Final Acceptance.

- The ITS Operations and Maintenance Plan shall include a staffing plan that provides for sufficient, qualified and experienced staff for operating and maintaining the ITS system.
- The staff levels shall be based on the ITS system as recorded in the ITS inventory asset database and scheduling needs. The staffing requirements shall include qualifications, classifications and quantities, as well as the staffing resources currently available in the TMC.

Developer shall prepare and submit Operation Manuals and Maintenance Manuals for all equipment and devices supplied and installed in the project. Developer shall prepare and submit a detailed outline of the Operations and Maintenance Manual for approval. Operations and Maintenance Manuals shall include, at a minimum the following:

- ITS Operation Manuals for each ITS component distributed in the field and in the either of the TMC facilities.
- Preventive (periodical) maintenance schedules and corrective (troubleshooting) procedures for all field and TMC devices. The procedures for maintenance shall be identified and priority guidelines shall be established.

Developer shall refer to existing ITS O&M manuals in use by the TMC to avoid any conflict with existing guidelines.

- The ITS Operations and Maintenance Plan shall include an ITS training program for Department TMC, TRIMARC, and KYTC staff. The ITS training program shall identify, document and assess the training needs to provide continuously trained and well-qualified staff for ITS system operation and maintenance. Developer shall identify training needs for all personnel at different responsibilities levels.

20 ELECTRONIC TOLL COLLECTION

20.1 Project Description

The Louisville-Southern Indiana Ohio River Bridges Project will include the tolling of all cross-river traffic on both the Downtown and East End Crossing bridges. Tolling shall begin once the toll system is operable, and the East End Crossing is open to traffic. Tolling shall be maintained throughout the total completion of Construction Work on the East End Crossing, which shall include the time between Substantial Completion and Final Acceptance. Developer shall coordinate with a Tolling System Integrator, whose procurement will occur at a later date, to provide the fully functioning toll system. The toll system shall accommodate the tolling of all river crossing traffic on the East End Bridge through all stages of traffic control and travel lane configurations and be initially installed to fully function without relocation of the tolling facilities. Developer shall provide the Tolling Infrastructure described in this Section 20.

The Tolling Systems Integrator shall design, develop, integrate, deliver, install and test the entire tolling and violation enforcement system, which would include all equipment installed at the roadside, software, the toll data center (TDC) servers and the entire back office which would be comprised of the electronic toll collection (ETC) system account management, customer service center functions and the violation processing system. The TDC shall be at a location determined by the Tolling Systems Integrator in cooperation with the IFA. Developer shall install conduits and fiber optic cables for the Intelligent Transportation System (ITS) facilities as described in Section 19. The Tolling Systems Integrator may utilize these fiber optic cables or install additional cables in the conduits provided and installed by Developer through the requirements of Section 19. Developer shall install specific conduits as necessary for the tolling system as specified in Section 20.7.5 and in coordination with the Toll Systems Integrator.

This Section 20 covers the furnishing and installing of Tolling Infrastructure. Some components of the ETC system infrastructure such as the fiber optic backbone, conduits and power distribution shall be provided by Developer for the ITS to provide a fully interoperable tolling system and ITS that will be integrated with the existing TMCs.

20.2 Standards and References

The design and construction of the Tolling Infrastructure Work in support of the Toll Collection System (TCS), in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 20; Governmental Approvals; and applicable Laws.

20.3 General Requirements

Developer shall be responsible for the design and installation of all infrastructure that is necessary to support the TCS including civil work and utilities to enable the Tolling Systems Integrator to install and integrate the TCS roadside equipment, subsystems, and back office components (“Tolling Infrastructure”). Tolling Infrastructure describes all elements of the TCS whether installed by Developer or Toll System Integrator. Developers Tolling Infrastructure Work shall include the following, as well as all other Work described in this Section 20:

- Design, furnish and install tolling gantries to cover both directions of traffic in the location identified in the RID IT-4.01 and IT-6.01. This would include tolling gantries for two (2) tolling zones, one northbound and one southbound at one location on the Kentucky Approach;

- Design, furnish and install the concrete foundation slab and control cabinets that shall be located near each of the tolling gantries;
- Design, furnish and install conduits under the roadway and between the two (2) tolling zones in order for the Tolling Systems Integrator to connect their equipment between the two gantries at each site;
- Design, furnish and install fiber optic stub points/junction boxes at each of the two (2) tolling zone sites, at each location where TCS equipment shall be installed by the Tolling Systems Integrator;
- Provide commercial power to each of the control cabinets, other TCS equipment; and,
- Provide HMA pavement in the tolling zone.

Table 20-1 is intended to provide a tabular summary of the responsibilities of the Toll System Integrator and Developer.

Table 20-1 Toll Responsibility Matrix

	TSI				DEVELOPER		
ELEMENT	PROVIDE ENG. DATA	DESIGN	FURNISH	INSTALL	DESIGN	FURNISH	INSTALL
Toll Rate Sign	X				X	X	X
Gantry	X				X	X	X
Mounting Fixtures, Brackets, Hangers, Mounting Channels, Mounting Hardware, Tethering Mechanisms, Support Tubes, Mounting Trays, U-Bolts	X	X	X	X			
Gantry Electronic Components	X	X	X	X			
In-pavement Equipment or Sensors	X	X	X				X
Tolling System Power Requirements	X	X	X	X			
Conduit					X	X	X
Power & Communication to Cabinet from Source					X	X	X
Power & Communication to Gantry / Pole from Cabinet	X	X	X	X			
Cabinet & Equipment Rack #1 (Power and Comm. from Source)	X				X	X	X
Other Cabinets & Equipment Racks (Power and Comm from Racks to Equipment)	X	X	X	X			
All Cabinet Foundations	X				X	X	X

Developer is responsible for coordination with the Tolling Systems Integrator during the design and construction phases of the East End Crossing to ensure that tolling gantries, the cabinet/concrete slab and all conduit, and commercial power runs are in the proper locations and terminations are made according to the Tolling Systems Integrator's requirements. Coordination with the Tolling Systems Integrator shall be in accordance with Section 20.6 of this Technical Provision. Coordination of Tolling Infrastructure Turnover shall comply with Sections 20.6 and 20.7 of this Technical Provision and Sections 5.8.1.4 and 5.8.1.6 of the PPA.

The Tolling Systems Integrator's work affecting the Tolling Infrastructure will include:

- Install and integrate the TCS roadside Tolling Equipment and subsystems including the lane controller, communications equipment, and any other devices that are required to support the roadside tolling system;
- Install all Tolling Equipment on the tolling gantries;
- Install and integrate the TCS back office components;
- Install fiber optic cabling between tolling gantries and control cabinets;

- Install the fiber optic trunkline and distribution system to serve TCS equipment;
- Install redundant fiber optic path; and,
- Provide all operations and maintenance of the Tolling Equipment during the Operating Period.

Developer shall not disrupt the Tolling Infrastructure and any associated sub-systems and facilities during construction or the Operating Period once the TCS is established and functional. This includes the following:

- Electrical service;
- Vehicle enforcement and CCTV surveillance cameras;
- Toll equipment;
- Vehicle detector loops;
- Conduit infrastructure;
- Signage;
- Lightning protection;
- Grounding;
- Any other items (systems, subsystems, or facilities) within the vicinity of the tolling zone sites or any other interruption by Developer of the complete and accurate toll facility functionality.

Developer shall be responsible for Tolling Infrastructure Turnover work. Turnover shall include providing proper notice to the Tolling System Integrator in accordance with Section 5.8.3.2 of the PPA. The turnover work shall include any coordination including meetings with the Tolling System Integrator and completing punch list items identified by the IFA or Tolling System Integrator.

Any Developer-caused disruptions shall be restored to full functionality by Developer within 24 hours. Failure to conform to this Performance Requirement and cure period shall result in the assessment of Noncompliance Points in accordance with Attachment 12-1 of the PPA.

The tolling gantries and the other TCS roadside equipment locations have been identified and are shown in the Reference Design in the RID. All indicated signs and locations shall be as designed by the Tolling Systems Integrator or as directed by IFA. If Developer proposes locations different than those shown in the RID, Developer shall coordinate with and obtain approval from IFA during Design Review.

20.4 Documentation

Developer shall provide Design Documents and Construction Documents, which will be subject to the review and comment by IFA, at a minimum in the following areas:

- Tolling gantries, which includes the actual gantries, the foundations, the mounting design, the wind loading analysis, etc.;
- The concrete slab and cabinet that will be used by the Tolling Systems Integrator to locate their lane controller, communications equipment, and any other devices that are required to support the roadside tolling system;
- Commercial power, including the calculations and documentation supporting all facets of the power system design and distribution;

- Communications, including measuring and documenting the quality of all communications components, including but not limited to, the optical link parameters and the ground measurements at all installation locations; and
- Record Drawing Schematics, including the provision of line-diagrams of the completed power and conduits for the communication systems to the port level, including all components and connections.

20.5 Warranty

Developer shall provide the manufacturers warranties covering defects in workmanship, assembly, fabrication and materials to IFA for a minimum of two (2) years from the date of the Final Acceptance for all equipment and materials furnished as part of East End Crossing. If the manufacturer's warranties for the components are for a longer period, those longer period warranties shall apply.

20.6 Coordination

Developer shall coordinate closely with IFA and the Tolling Systems Integrator during the toll systems design process as it relates to the tolling gantry requirements and where they should be located. Developer shall closely coordinate the design and location of the roadside cabinet and the foundation that will hold the cabinet with the Tolling Systems Integrator. Developer and Tolling Systems Integrator shall coordinate the Tolling Infrastructure Work in accordance on a schedule in accordance with Sections 5.8.1.4 and 5.8.3.2 of the PPA. Developer shall also coordinate closely with IFA and the Tolling Systems Integrator during the design, installation, distribution, and testing of the commercial power as well as the fiber optic communications system.

20.6.1 Tolling Infrastructure Turnover

Developer shall provide the IFA notice of Substantial Completion to afford the Tolling Systems Integrator sufficient time to plan, mobilize, and test the Toll Collection System in accordance with Section 5.8.1.4 of the PPA. Tolling Infrastructure Turnover shall occur when Developer has completed all of the Tolling Infrastructure Work in Sections 19 and 20 and the Tolling Systems Integrator takes possession of the Tolling Infrastructure. The Tolling Infrastructure Turnover Date shall be no later than 120 days prior to the date of expected Substantial Completion. All testing of Tolling Infrastructure in accordance with Section 19 shall be satisfactorily completed prior to the Tolling Infrastructure Turnover Date. Developer shall complete all punch list items related to the Tolling Infrastructure prior to the Tolling Infrastructure Turnover Date.

After the Tolling Infrastructure Turnover Date Developer shall provide full access to the Tolling Infrastructure within the Project Limits. Developer shall be responsible for coordinating its Construction Work with the Tolling Systems Integrator.

20.7 Tolling Infrastructure Requirements

20.7.1 Maintenance Access

Developer shall design and provide a safe area for maintenance technicians to park, access, and service roadside Tolling Infrastructure throughout both the period of Construction Work and

Operating Period. The site plan for the Tolling Infrastructure shall identify how maintenance vehicles will access each area in which Tolling Infrastructure is located.

The maintenance access areas shall allow for safe ingress and egress, parking, and staging of at least two (2) maintenance vehicles or portable lifts.

The area shall be stabilized and physically protected by roadside barrier.

In case of absence of an area to locate roadside maintenance access pull-off areas, full lane/shoulder closures at each of the tolling zone sites shall be required for any overhead or roadside equipment maintenance at the gantry.

20.7.2 Toll Equipment Gantries

Developer shall be responsible for the design, engineering, fabrication, and erection of the toll equipment gantries, horizontal support structural members, horizontal supports, toll equipment arms, and all associated structural hardware for all tolling sites defined herein in accordance with Section 14.

Developer shall also furnish and install power to each tolling gantry and at the locations that other TCS equipment shall be installed by the Tolling Systems Integrator. Developer shall also design and install conduits to be run to each tolling zone gantry, including installing conduit under the roadway in order to link tolling gantries that are installed across the roadway.

As described previously in this document, all power requirements shall be coordinated closely with the Tolling Systems Integrator.

At the toll gantries the Developer shall install all control cabinets required by the Tolling Systems Integrator. Developer shall install all foundations necessary for the control cabinets in accordance with Section 19 and Project Standards. Each toll gantry will include 2 or 3 control cabinets for servers and equipment, power feed and communication equipment.

20.7.3 Grounding, lightning, and surge protection

The Tolling Equipment shall be protected from damage caused by lightning strikes, transient voltage surges, and induced current. Developer shall design, install and test all grounding, lightning protection, and transient voltage surge suppression subsystems in accordance with Underwriters Lab (UL) 96A specifications.

All Tolling Equipment, subsystems, devices and ancillary components with electrical interconnects shall be protected from voltage surges caused by lightning, transient voltage surges, and external electromagnetic fields at the time of installation of each device, as specified in the Project Standards.

20.7.4 Electrical Service

Developer shall make arrangements and pay all costs for the design, procurement, installation and relocation of power service to support the TCS equipment, subsystems, and infrastructure. Electrical facilities owned by the KYTC and IFA may be shared. Power feeds and connections to existing electrical services shall be clearly shown on Developer Plans. Transfer ownership of any new service points to IFA shall occur at Final Acceptance.

20.7.5 Communications Infrastructure

The Tolling Systems Integrator shall design, furnish and install the fiber optic trunkline and distribution system to serve TCS equipment, which shall be located within the Project Limits.

The Tolling Systems Integrator shall provide separate redundant fiber optic path for communications shall be supplied from any communications hub building, traffic data center or TMC to the TCS roadway equipment, components.

Developer shall meet the following minimum requirements for conduits and pull boxes along the entire length of the East End Crossing:

- Fiber optic conduit shall include four (4) 1¼" color-coded SDR 11 HDPE conduits with pull boxes spaced at approximately 1,500 feet. Conduits shall be white, black, orange and blue in color.
- Power conduit shall include one 3" SDR 40 PVC conduit with pull boxes spaced at 500 feet. Conduits shall be gray in color.
- Provide locking pull boxes for all No. 9 pull boxes, bury or provide locking No. 7 pull boxes. All pull boxes shall be individually GPS located following installation and marked on as-built plans, a copy to be furnished for storage in the local TCS controller cabinet(s).

Developer shall coordinate the shutdown, start-up and testing of the communications system with the Tolling Systems Integrator, IFA staff and/or their designated representatives.

The Tolling Systems Integrator shall calculate and meet bandwidth requirements for transmitting data between the roadside lane equipment and subsystems and the TDC based on the final agreed configuration. Developer shall furnish and install communications equipment conduit and related devices in conjunction with arranging an agreement with a public or private communications service company to establish a reliable and secure communication link supporting the calculated bandwidth.

21 ROW ACQUISITION

21.1 Project ROW

IFA shall acquire and provide the Project Right of Way. Acquisition of Additional Properties and Project Specific Locations shall be governed by and subject to Section 5.4 of the PPA. All agreements, easements, rights of entry and other instruments under which IFA has received or will receive title, rights of entry or rights of access on and to lands owned by Public entities are set forth in the RIDs.

Should Developer require Additional Properties it shall comply with the requirements of Section 5.4 of the PPA. In addition to complying with the requirements of the PPA, Developer shall:

1. Obtain a concurring opinion from IFA as to the necessity for said Additional Properties.
2. Be responsible for performing all of the necessary environmental studies, reports and public involvement activities to comply with the National Environmental Policy Act (NEPA) requirements. The content and format of these studies and reports shall comply with the applicable requirements of the state in which the ROW is to be acquired.
3. Be responsible for coordinating with all adverse impacts to Utility Owners caused by Developer's proposed Additional Properties. In addition, Developer shall be responsible for acquiring any Replacement Utility Property Interests and Adjusting the impacted Utility.
4. Bear all costs associated with this work.

Any Additional Properties acquired shall comply with all the Department ROW policy manuals, in addition to any other applicable Law, Governmental Approval.

21.2 Monument and Fence Construction

Developer shall design and construct Project ROW fence, survey monumentation assemblies, reference monuments, and any other items associated with monuments in accordance with Project Standards.

21.3 ROW Acquisition Status

See Attachment 21-1 for the current ROW Acquisition Status.

Developer will be updated regularly on the status of the acquisition and relocation of the parcels.

Title reservations, conditions, easements or encumbrances of record or not of record, on any parcel in the Project Right of Way/Project Right of Entry are described in Attachment 21-1.

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22 OPERATIONS AND MAINTENANCE

22.1 General

Developer shall be responsible for developing and providing the resources, equipment, materials, and services required to operate and maintain the infrastructure within the O&M Limits in accordance with the requirements of the PPA Documents throughout the Operating Period. Developer shall provide sufficient levels of properly trained personnel, on-site and off-site facilities, storage areas, garages, fleet vehicles, computer hardware and software, tools, and other items as required to operate and maintain safe, reliable roadways and facilities, with the main objectives to maximize public safety, reliability, and roadway availability. To this end, Developer shall coordinate, plan, and perform the O&M Work required by the PPA Documents including this Section 22 in a manner that shall provide safe conditions for the maintenance staff and the motorists using the facilities while minimizing traffic disruptions. The Availability Payments to Developer will be subject to adjustment depending upon Developer's level of performance, as set forth in Section 10.2 and Exhibit 10 of the PPA.

22.1.1 General Operations and Maintenance Obligations

Developer shall be responsible for all O&M Work-related tasks and activities, including but not limited to the following:

1. Maintain the East End Crossing and Related Transportation Facilities within the O&M Limits in a manner appropriate for a facility of the character of the East End Crossing and in compliance with the requirements of the PPA Documents.

2. Minimize delay and inconvenience to Users and, to the extent Developer is able to control, users of Related Transportation Facilities.

3. Identify and correct all Defects and damages to the East End Crossing from Incidents

4. Monitor and observe weather and weather forecasts to proactively deploy resources to minimize delays and safety hazards due to heavy rains, snow, ice or other severe weather events.

5. Remove debris, including litter, graffiti, animals, and abandoned vehicles or equipment from the Project ROW.

6. Minimize the risk of damage, disturbance to or destruction of third party property during the performance of maintenance activities.

7. Coordinate with and enable the Department and, as applicable, KYTC and others with statutory duties or functions in relation to the East End Crossing or Related Transportation Facilities to perform such duties and functions.

8. Perform systematic East End Crossing inspections, periodic maintenance, and routine maintenance in accordance with the provisions of Developer's Maintenance Plan and Developer's Safety Plan.

9. Providing an Operations and Maintenance Plan (OMP) that identifies all of the functions, procedures, and manuals necessary to operate and maintain the East End Crossing in accordance with the requirements of this Section 22.

Developer is responsible for providing all resources necessary for the performance of the O&M Work and as required to comply with the PPA Documents, the Operations and Maintenance Plan, and the Maintenance Plan. The Developer shall be responsible for complying with the requirements of the Sustainability Management Plan.

The O&M Limits comprise an operating facility that shall be available 24 hours per day, seven days per week, 365 days per year. Developer shall provide staff for these hours of operation. Developer is not responsible to provide staffing for the TMC or the Toll Collection System.

Developer's procedures for the O&M Work shall be developed in accordance with these requirements and shall include the necessary provisions and requirements for compliance with the PPA Documents.

22.1.2 Standards and References

Design, construct, maintain, and operate the O&M Work in accordance with the applicable requirements of the PPA Documents, including Project Standards and this Section 22; Governmental Approvals; and applicable Laws. Deviations in performance, operation, and maintenance standards are subject to Section 6.1.2 of the PPA.

22.1.3 Developer's Obligation to Remedy and Repair

For Category 1 Defects, Developer shall take necessary action such that any hazard to Users is mitigated within the period specified in the column entitled "Category 1 Hazard Mitigation" in the Performance and Measurement Table, in Attachment 22-1, and shall permanently remedy the Defect within the period specified in the column entitled "Category 1 Permanent Remedy" in the Performance and Measurement Table. Permanent Remedy shall be performed within the cure period allowed, weather conditions permitting. Hazard Mitigation shall be performed within the cure period provided and shall continue until a Permanent Remedy is completed.

For Category 2 Defects, Developer shall undertake the permanent repair within the period specified in the column entitled "Category 2 Permanent Repair" in the Performance and Measurement Table, in Attachment 22-1.

Developer shall use the results of the inspections described in its Maintenance Plan and other relevant information to determine, on an annual basis, the Residual Life of each Element of the East End Crossing within the O&M Limits. From this, Developer shall determine the scope of the Rehabilitation Work Schedule. Rehabilitation Work shall be performed at the point in time necessary to establish a Useful Life for each Element that will avoid deterioration of any Element to the extent that such deterioration would result in the failure to comply with a Performance Requirement.

22.1.4 Operations and Maintenance Limits

The "O&M Limits" are generally defined as all areas and facilities within the Project ROW between the limits of construction, as described in Table 9-1 and Table 9-2, of SR 265/KY 841 beginning at the northerly abutment of the proposed Harrods Creek/River Road Bridge (approximately Sta. 149+77.99 northbound and Sta. 149+37.99 southbound of the RID), excluding any elements connected to the Harrods Creek/River Road Bridge such as approach slabs or wing walls, and continuing north to the northerly limits of the Kentucky Approach, continuing further north to include all of East End Bridge Main Spans to the Kentucky/Indiana state line, continuing further north and west to include all of the Indiana Approach to the limits of construction of SR 265 including the Salem Road Interchange and the SR 62/Port Road Interchange. The O&M Limits include the entire shared-use path from River Road across the East End Bridge to Salem Road, the entire emergency access road from River Road to KY 841, the drainage outfall to Harrods Creek carrying stormwater from the East End Bridge, and all interchange ramps to the edge of pavement of the intersecting roadway, or their point of beginning or ending. Developer's O&M Work does not include the following facilities:

- ITS system
- Toll Collection System
- Cross roads and cross road bridges over the highway, including lighting and traffic signals

See O&M Responsibility Figures in RID OM-0.01 and OM-0.02.

The O&M Work includes the operations and maintenance of all items within the O&M Limits, unless noted otherwise in this Section 22. The O&M Work includes maintenance of the landscaped elements of the East End Crossing within the Project ROW that is within the O&M Limits. Developer shall not place any garages or other facilities that are necessary for the operation and maintenance of the roadway within the limited access ROW. See Section 9.3 for available IFA owned parcel.

Developer is responsible for Incident response within the O&M Limits.

Developer is not responsible for utility costs associated with roadway lighting, aesthetic lighting, East End Bridge security system, Toll Collection System, or ITS system power, or other utility services required for the normal operation of the East End Crossing, during the Operating Period. Developer is responsible for all utility costs associated with Developer's operations such as maintenance facilities, office facilities, or other similar facilities under Developer's control during the Operating Period.

22.1.5 Operations and Maintenance Plan

Developer shall develop an Operations and Maintenance Plan (OMP) as a component of the PMP which shall meet the requirements set forth in this Section 22.1.5. The OMP shall be updated annually or more frequently, as necessary, to indicate changes to operating protocols, agreements, and interactions with other entities and to indicate the revised operating requirements for equipment and systems that have been revised, upgraded, and, as applicable, replaced.

The OMP shall identify the operating protocols, agreements, and interactions with other entities such as the Louisville-Southern Indiana Bridges Authority (and other agencies, such as adjacent roadway authorities, police, fire, etc.).

The operating procedures and protocols shall include all traffic control, Incident response, and other procedures as necessary to operate the facility. The OMP shall include the requirements for work zone safety, vehicular accident tracking, weather-related Incidents/Closures, security-related Closures, Hazardous Material Management, and roadway traffic Closure/shutdown procedures.

The OMP shall include detailed procedures and protocols for the operation of the systems as necessary to maintain a safe environment on the roadway and bridge to meet the Performance Requirements identified within PPA Documents, including all of the Technical Provisions. The operating protocols and procedures for the various bridge and roadway systems that are required include the following: mechanical systems, electrical systems, and other systems provided by Developer that support the operation of the bridge and roadway. The OMP shall include any ancillary facility operating procedures and protocols as necessary for the reliable, safe operation of the bridge and roadway systems equipment included therein. For the East End Bridge, the OMP shall cover the 100-year service life, for the remainder of the O&M Limits the OMP shall cover the Operating Period.

The OMP shall comply with all requirements of the PPA Documents, including the following:

1. Includes the staff organization chart for the Operations and Maintenance Plan including a description of the staffing plan, including all positions, work locations, and work hours required to operate the East End Crossing facilities;
2. Description of the staff qualifications for each staff position;
3. A contact list of the various entities and agencies that operations staff will require coordination with, including their contact information (contact person, address, telephone numbers, website address);
4. Identifies the major documents that are the basis of the Operations and Maintenance Plan;
5. Describes Developer's self-monitoring processes, including a list of the procedures to be used to monitor compliance with minimum performance criteria;
6. Describes the Operations Report system;
7. Describes the Maintenance Work Report system;
8. Describes the process for calculating and preparing the invoice for Quarterly Payments in accordance with Article 10 of the PPA;
9. Describes the method of tracking and reporting Defects, Noncompliance Events, Noncompliance Points, and Unavailability Events accumulated throughout the Operating Period;
10. Includes a list of all Noncompliance Events, Noncompliance Points, Defects and Unavailability Events accumulated during the Operating Period that are equivalent to those specified within the PPA Documents, including this Section 22, if those elements of the Final Design are not included in the provisions of this Section 22;
11. Includes a list of the methods of monitoring and verifying O&M Contractor compliance with all O&M procedures, including those specified in the approved PMP, the approved OMP, the approved MP, and Good Industry Practice;
12. Copies of all operations forms, checklists, fault detection logs, etc.;
13. Describes Developer's plan for Hazardous Materials Management and response;
14. Describes Developer's general approach and assumptions for Routine Maintenance;

15. Describes Developer's approach and assumptions for the Rehabilitation Work items and equipment replacement, including life cycles;
16. Includes preliminary Planned Maintenance schedule and Rehabilitation Work Schedule;
17. Maintenance dispatching procedures;
18. Communications procedures;
19. Winter maintenance procedures;
20. Includes a list of vehicles, tools, Incident response, and major equipment furnished by Developer to support the O&M Work;
21. Includes a list of real estate, facilities, computers, software, and other major assets/items to support the OMP;
22. Includes a description and schedule of the inspections;
23. Include copies of drawings that indicate the types of O&M Work to be provided and the physical limits or boundaries of each type;
24. Description and form of the quarterly Operations Report;
25. Description and form of the Annual Budget (if required by Lender);
26. Procedures for completing Emergency-related repair work in accordance with Section 9.3 of the PPA;
27. Responsibilities and procedures for cooperation with public law enforcement and emergency response agencies in accordance with Section 6.11.1 of the PPA; and,
28. Responsibilities and procedures for security and incident response in accordance with the Technical Provisions and Section 6.11.2 of the PPA.

Developer shall submit the proposed format and proposed media of the quarterly Operations Report with the OMP submittal.

22.1.6 Meetings

Developer shall have monthly meetings with the appropriate Department representatives to discuss the O&M Work. The items to be discussed shall include the following: future lane Closures; the maintenance activities of the previous month, Planned Maintenance for the next month, Incidents/accidents; a calculation showing the adjustments to the Availability Payment; and an assessment of Noncompliance Points, Unavailability Events, and any other pertinent information related to the O&M Work. Developer shall also participate in quarterly traffic incident management team meetings. IFA may request a meeting at any time to discuss O&M Work-related issues, Incidents, etc.

22.1.7 Safety

Developer shall conduct the O&M Work in accordance with all applicable Laws including those pertaining to safety and Safety Standards. Developer shall perform all O&M Work with the goal to maximize the safety of the public and Developer's employees. Some hazards include high-voltage electrical equipment, confined spaces, traffic, exposure to Hazardous Materials, and other conditions not specifically identified herein. Developer shall develop an O&M Safety Plan that includes staff training, safety procedures, and protocols to address the hazardous conditions associated with Developer's O&M Work ("O&M Safety Plan"). The provisions of Section 7.9 shall apply during the Operating Period. The O&M Safety Plan shall be an integral part of the Operations and Maintenance Plan and shall be incorporated into the Project Safety Plan and shall be reviewed and approved in accordance with the Safety Plan. Developer shall remove and replace any personnel or O&M Contractors who are jeopardizing safety, disregarding safety rules and procedures, or acting in a negligent or irresponsible manner.

22.1.8 Quality Management Requirements

Developer shall prepare an O&M Quality Plan as a component of the PMP, which shall be submitted in accordance with Attachment 01-1 ("O&M Quality Plan"). Developer's O&M Quality Plan shall fully comply with the requirements of the PPA Documents and shall include O&M Contractor log forms, procedures, and other means as necessary to create a system that assembles the necessary information and data. Developer's O&M Quality Plan shall include a system to monitor the performance of the O&M Work and a quality assurance system. The primary function of the O&M quality management system is to monitor the performance of Developer's O&M Work. The O&M quality management system shall provide the means to evaluate Developer's level of performance with respect to the minimum operations Performance Requirements.

The O&M Quality Plan shall also assemble the maintenance information and data necessary and compare it to the Planned Maintenance schedule and Rehabilitation Work Schedule and, ultimately, document the maintenance Noncompliance Points imposed on Developer. The O&M Quality Plan shall identify the means for monitoring and evaluating all aspects of the performance indicators specified in this Section 22. All of the supporting data and calculations used in the O&M Quality Plan shall be submitted to IFA in the quarterly Operations Report and the PPA Documents. Developer's Final Design, equipment selections, and construction quality will impact the requirements and performance of the O&M Quality Plan; therefore, Developer shall consider these requirements during the design development phase.

As part of the O&M Quality Plan Developer shall also develop a detailed quality assurance system that is consistent with its Quality Management Plan for the East End Crossing. The quality assurance system shall be developed for validating the information, accuracy, and results of the O&M Quality Plan. The quality assurance system shall include procedures to validate the data, times, dates, O&M Contractor logs, other information, and calculations that are the basis of the Availability Payment and Noncompliance Points. Developer shall include in the quarterly Operations Report as section that identifies the results of the O&M quality management and quality assurance system.

Developer's staff for the O&M Work shall receive training to understand the importance of the O&M quality management system. Developer shall not alter any operations logs, maintenance logs, procedures, inspection forms, or any other information that is used to monitor the performance indicators. .

22.1.9 Reporting and Books and Records

Developer shall, in accordance with Section 22.2.2 and Section 11.2 of the PPA, deliver quarterly Operations Report to IFA for its records, all in accordance with the PPA Documents and quality management system. Because the Availability Payment is related to the level of

Developer's O&M Work, IFA will perform audits of the O&M Work using sources such as logs, activities, and the recordkeeping efforts of Developer to ensure compliance. Developer shall submit the proposed format and proposed media of the quarterly Operations Report with the OMP submittal. The Operations Report shall include a high-level summary of Noncompliance Events, Unavailability Events and Noncompliance Point assessments. The report shall also include, in an organized and readable format, all of the supporting information and detailed data necessary to confirm the occurrence of any Noncompliance Events, Unavailability Events and any Defects or other occurrences that result in Noncompliance Point assessments. See Article 23 of the PPA for additional requirements regarding Developer Books and Records and IFA audits.

22.1.10 IFA Audits

IFA will perform periodic audits of Developer's O&M Work to verify that the Operations and Maintenance Plan meets the requirements specified within this Technical Provision. Developer shall provide IFA access to all personnel files, records, logs, data, databases, and any other information related to the Operations and Maintenance Plan, such that IFA can verify that all of the requirements of this section are performed appropriately. Developer shall maintain accurate, updated files that are accessible for this purpose. See Section 23.2 of the PPA for additional IFA audit rights.

22.2 Operations Requirements

22.2.1 Introduction

Developer shall be responsible for operating safe, reliable roadways and facilities within the O&M Limits, with the main objectives to maximize safety, reliability, and roadway availability. Developer shall be responsible for operating the roadway, ancillary facilities, and ancillary facility systems/equipment within the O&M Limits. All of the Performance Requirements set out a minimum standard; however, Developer shall, at all times, demonstrate the standard of care of a reasonable contractor in like circumstances and Good Industry Practice.

Developer shall provide and maintain a sufficient number of properly trained operations staff to perform the operating duties specified herein and the activities identified in the OMP and MP. Operations personnel shall be available 24 hours per day, every day of the year, to respond to urgent issues and Incidents, as defined within the OMP. Developer shall provide all of the equipment, personnel, resources, training, and facilities required to meet these requirements. Developer's operations staff shall be trained to assist and coordinate with IFA and, as applicable, KYTC, the emergency response agencies, and the other agencies as required.

Developer shall report any project Defect, Closure, or unscheduled Permitted Closure to IFA.

Developer shall coordinate with IFA and KYTC and provide operations training of a maximum of twenty five Department and KYTC personnel upon Substantial Completion and again prior to the Termination Date so that the Department and KYTC personnel have a complete understanding of the facility and the method of operating all aspects of the O&M Limits.

22.2.2 Operations Report

The quarterly Operations Report shall identify all of the Defects, Incidents, accidents, Incident response times, operations logs, service requests, severe weather Incidents, and security

Incidents that occur over the preceding quarter. The reports shall include a system for referencing each activity/event and the time and date of commencement and date of resolution.

Quarterly Operations Report shall include, at a minimum, the following data and information:

1. Summary of the status of all segments for the month identifying all Closures, Permitted Closures, and Unavailability Events as defined by the PPA.
2. Summary of Closures, Permitted Closures, compliance hours, and Planned Maintenance hours for the coming month. This report shall include details describing the location, duration, and reason of each.
3. Non-Conformance Reports: For each material Defect in the Project Elements, the report shall identify the location, the nature and cause of the material Defect and the steps that will be, or have been, taken to address the material Defect.
4. O&M Contractor event log data, including all operator actions and event details for traffic and systems events, Incidents, security Incidents, weather Incidents, and the details of Developer's Incident response, including response time data, response records, etc.
5. Developer's Incident response logs, including a time-based report of all actions and activities performed by Developer.
6. Quality assurance review of the O&M Contractor actions and lessons learned where appropriate.
7. Summary of staff and hours worked for the month.
8. Summary of Closures, Permitted Closures, and Planned Maintenance hours for the coming month. This report shall include details describing the location, duration, and reason of each.
9. Maintenance Work Report.
10. Any additional information required pursuant to Section 11.1.2.3 of the PPA.

22.2.3 Roadway Closure Criteria

There shall be periods where the roadways within the O&M Limits may be closed by Developer due to Planned Maintenance, unplanned maintenance repairs/activities, vehicular Incidents, weather, or other circumstances that require either complete or partial Closure of the roadway. These Closures shall comply with IFA Interstate Highways Lane Closure Policy (March 2010), as may be modified from time to time. This route shall be designated as an "Executive Approval" route.

Developer shall close the facility within the O&M Limits to the general public should circumstances either compromise the safety of the East End Crossing users or as is necessary to protect the facility's assets. Regardless of the circumstances, Developer shall coordinate with the IFA, Louisville Metro and Clark County, the Department, KYTC, and other agencies that may be impacted by Closures of the segment. Developer shall maintain a log of the segment Closure periods. Developer shall identify the Closure periods of within the Operations Report. The report shall include the time log of the events, the cause of the nonconformance, and the measures taken to achieve conformance.

Any lane Closures or reductions in width will be subject to a Quarterly Unavailability Adjustment as specified in Exhibit 10 of the PPA. For any Closure during the Operating Period Developer shall prepare a Transportation Management Plan.

22.2.4 ITS Operations and Maintenance

The Department and KYTC will provide all operations and maintenance for the ITS assets.

22.3 Performance Requirements

In the Maintenance Plan (MP), Developer shall set forth annually, for IFA approval, a Performance and Measurement Table which shall, except where indicated below, be consistent with Performance and Measurement Table in Attachment 22-1.

The first such submittal of the Performance and Measurement Table shall be submitted in accordance with the schedule specified in Attachment 01-1. The Performance and Measurement Table shall set forth the following information:

Heading in Attachment 22-1 - Performance and Measurement Table	Contents of Developer's submitted Performance and Measurement Table
Element	As Attachment 22-1
Element Category	As Attachment 22-1
Performance Requirements	As Attachment 22-1
Response to Defects	As Attachment 22-1
Inspection and measurement method	Subject to proposed amendment by Developer as part of annual submittal of MP
Measurement record	Subject to proposed amendment by Developer as part of annual submittal of MP
Target	As Attachment 22-1

In its annual submittals of the Performance and Measurement Table, Developer shall propose for IFA's approval such amendments to the inspection and measurement methods and measurement records as are necessary to cause these to comply with Good Industry Practice and the Technical Provisions.

To acknowledge Developer's ability to utilize design innovation, Developer's Final Design and equipment provided shall be used as the basis for Developer to amend the Performance and Measurement Table. Developer's Performance and Measurement Table shall include the equipment manufacturer's recommended maintenance tasks at the manufacturer's recommended intervals, where applicable.

Within these Technical Provisions, reference to the Performance and Measurement Table means the latest approved version of the Performance and Measurement Table as included within Developer's MP. Failure to meet a Performance Requirement, whether through failure to meet the Target for any relevant measurement record, or for any other reason, shall be deemed to be a Defect. Whenever a Defect is identified, either by Developer's inspections, by IFA or any third party, Developer shall act to remedy and repair the Defect as described in Section 22.5 and Attachment 22-1.

22.3.1.1 Roadway Surface Debris

Developer shall comply with the requirements of Attachment 22-1. Debris is defined as any object that is not normally intended to be on the roadway, which creates hazardous conditions for motorists, pedestrians, or other persons. Examples include but are not limited to pieces of wood; light fixtures; pipe; hardware; tires; tire debris; vehicle parts; hubcaps; boxes; crates; tools; ladders; animals; metal or any other materials; excessive water; or other objects that may cause motorists to brake, evade, or otherwise impact normal driving.

22.3.1.2 Roadway Condition – Rigid Pavement & Flexible Pavement

Refer to the IDM for definitions of the terms used within Attachment 22-1. The pavement shall provide the minimum Performance Requirements for any pavement as specified in Attachment 22-1.

Roadway smoothness shall be measured for the entire continuous roadway surface within the O&M Limits but the data from 50 feet prior to and 50 feet after any bridge approach shall be excluded from the Performance Requirements.

22.3.1.3 Stormwater Drainage System Condition

The stormwater drainage system is defined as the bridge drainage system, side cross drains, roadside median ditches, outfall ditches, inlets, underdrains, and other piping to drainage collection areas. This shall also include the hazardous spill storage system in Section 7.5.1.1. Developer shall comply with the Performance Requirements of Attachment 22-1.

22.3.1.4 Structures

Structures installed by Developer within the roadway and facilities O&M Limits includes bridges, retaining walls, sound walls, sign structures, drainage structures, sign structures, and lighting structures. The structures shall meet Performance Requirements in Attachment 22-1.

22.3.1.5 Pavement Marking

Developer shall be responsible for the installation, retracing, and reinstatement of pavement markings, including all pavement markings required by the MUTCD at the time of the work. All pavement marking lines shall be straight and true. Any tracking or splatter shall be corrected within five days after detection or after notice has been given. Performance Requirements shall be as specified in Attachment 22-1.

Developer shall be responsible for selecting the materials, material sources, types, properties, and all requirements for the materials that are used for the pavement markings. Pavement markings shall comply with the Project Standards.

22.3.1.6 Fixed Signs

Fixed signs are defined as any signs permanently installed by Developer within the roadway and facilities O&M Limits. Performance Requirements shall be as specified in Attachment 22-1. At a minimum all sign panels and overlays shall be replaced every 18 years.

22.3.1.7 Highway Lighting

The lighting system within the roadway and facilities O&M Limits shall meet the Performance Requirements of Attachment 22-1.

22.3.1.8 Security and Electrical Power System

The security and electrical power system for the East End Bridge shall be as specified in Section 24.1. The minimum Performance Requirement of the security systems is as specified in Attachment 22-1. Should the ATVA require a response time different from that specified in the Performance and Measurement Table Developer shall be responsible to amend the table in its submission.

22.3.1.9 Bridge Secondary/Back-up Electric Power System

Should the ATVA requirements in Section 24.1 require electrically powered security systems, the minimum Performance Requirement for the bridge secondary/back-up electric power supply system shall comply with the requirements of Attachment 22-1.

22.3.1.10 Closed-Circuit Television System

Should the ATVA requirements require a closed-circuit television (CCTV) system for the roadways or the East End Bridge, the minimum Performance Requirement of the CCTV system is as specified in Attachment 22-1.

22.3.1.11 Incident Detection and Response Compliance

When Developer is made aware of an Incident within the O&M Limits by IFA, Department, KYTC or when Developer becomes aware of an Incident through it’s own forces Developer shall respond to Incidents and provide assistance to the police and other regulatory emergency service providers and appropriate Governmental Entities to protect the safety of motorists and highway users, including response on short notice for Incidents such as accidents, highway spills, and other miscellaneous Incidents, and to remove and dispose of debris from the highway lanes and shoulders.

When Developer is made aware of an Incident within the O&M Limits, Developer shall be responsible for proceeding to the Incident site to secure the site and, as applicable, provide assistance as required. Developer shall take all action required to keep the travelling public, adjacent landowner, and Developer staff safe.

Developer shall respond to all traffic or roadway-related Incidents within the O&M Limits within the time period specified in Attachment 22-1, Table 22-1. The time period shall commence when Developer is made aware of an Incident. The time period commences at the time when Developer is made aware of the occurrence of the Incident and stops when Developer has initiated the appropriate response steps for the Incident, as detailed by the Incident response procedures. These steps include all required notifications, traffic, and facility control systems activations and the arrival on the scene of the Incident of appropriate equipment and personnel from Developer's field response team. Developer shall log and record the sequence of all actions taken in response to the Incident.

Noncompliance with this Incident detection and response policy will constitute a Category 1 Defect (Hazard Mitigation). An Unavailability Event shall be applied to this event for the duration of the Incident, which is defined as the time at which the Incident occurs to the time at which the roadway is cleared and restored to normal operating conditions.

22.3.1.12 Winter Maintenance

22.3.1.12.1 General

This Performance Requirement covers the obligations for winter maintenance and establishes the level of service for snow and ice control for the East End Crossing. Winter maintenance operations are provided to maintain a consistent level of service across Indiana and Kentucky in the O&M Limits.

All conditions that are considered to be causing a hazard are considered a Category 1 Defect (Hazard Mitigation) and shall be addressed immediately by Developer upon detection or upon being made informed of the condition(s). Developer shall be responsible to use available resources to assess weather conditions and make decisions and direct actions that maintain the roadway in as safe as possible a condition during winter events. Developer shall use the full complement of available resources to keep the roadway as safe as possible throughout the winter and to reach the prescribed level of service as soon as possible after winter events have abated or ceased.

Developer shall have available staff and equipment in a state of readiness one month prior to and one month after the median date for the first and last snowfall of 0.5 inches or more based upon past meteorological data and monitoring weather patterns. However, Developer shall be prepared to maintain the roadway at all times and under all weather conditions to the best of its ability and to prevent and to address any adverse conditions, regardless of the time of the year, using all available resources.

Developer shall monitor long-term forecasts to aid in deciding when equipment should be readied for unusually early and late storms, including those outside of the normal snowfall period.

22.3.1.12.2 Snow and Ice Control Plan

Developer shall develop, write, and carry out a "Snow and Ice Control Plan (SICP)". The SICP shall contain detailed operational procedures for performing the Snow and Ice Control work outlined herein. The SICP shall comply with all applicable Law, codes, and regulations governing the operation of snow removal equipment on public highways, best highway management practices, the Department's *Total Storm Management Manual*, and the requirements specified in this Section 22.3.1.12.

The SICP shall address the following:

- Advance preparation procedures

- Call-out procedures
- Response protocol
- Operational requirements
- Training
- Recordkeeping/Reporting
- Environmental management
- Anti-icing and de-icing chemical storage
- Equipment

Developer shall annually update and submit the SICP to IFA for its review and approval in its good faith discretion prior to July 30 each year, and shall incorporate any changes in strategy, equipment levels, etc., designed to rectify faults identified by Developer, and IFA in Developer's snow and ice removal operations during the preceding winter season.

22.3.1.12.3 Bare Pavement Event

Developer shall ensure that during the winter season the roadway is kept clear and safe. The Performance Requirement used to determine clear and safe is bare pavement. Bare pavement is defined as a condition under which the entire driving surface has been cleared of loose snow and ice. The driving surface may have isolated patches of ice, snow, or slush that, when treated with chemicals or abrasives or a combination of these, may be negotiated safely by the average driver at a reduced speed.

Developer shall measure the percent of times bare pavement is achieved within the Target time after a storm as defined in Attachment 22-1. As a measure of Developer's performance in achieving this objective, Developer shall report bare pavement performance.

The storm event beginning date and time is the date and time that snow and, as applicable, freezing rain falling is first observed. The storm ending is the date and time that snow and, as applicable, freezing rain is observed to have stopped.

Bare pavement is considered lost on a roadway when snow or ice is covering the road surface and winter operations (plowing and, as applicable, spreading) are required. Record this date and time as the bare pavement lost date and time. If winter maintenance equipment is called in advance of the roadway being covered (with ice and, as applicable, snow) and operations are then required, bare pavement is considered lost when the first unit arrives at the area to be serviced. Record the date and time the unit arrived at the area as the date and time bare pavement was lost.

Bare pavement is considered regained when more than 95 percent of the portion of the roadway affected by the storm is bare.

There are three storm types: snow (S), freezing rain (FR), which includes hail, and both (B).

Drifting is not considered a storm, and therefore is not recorded as such. When drifting delays the time to regain bare pavement, this shall be noted as part of the data collection. Each storm shall be recorded as it happens, even if bare pavement is not regained before the start of the next storm. If precipitation begins again within three hours of the previous storm ending, it shall be considered to be the same storm.

The “bare pavement regained time” is “N/A” if the next storm begins within the performance target time. For this event, the bare pavement regained time is recorded as the start time of the next event. This event shall not be used in determining performance.

Time shall be recorded using the 24-hour clock and rounded to the nearest half hour for the local time zone.

22.3.1.12.4 Reporting Requirements

The winter patrol diary (supplied by Developer) shall be completed, dated, and signed daily during the winter season and submitted to IFA within 24 hours upon request. A sufficient quantity of hardbound diaries shall be maintained for documenting the requirements. Developer shall document daily information in the diary, which, at a minimum, includes the following:

- Weather condition
- Date
- Printed name and signature
- Work completed during the day and equipment and material used ({to include, but not limited to, salt, slurry, agricultural by-product, brine, mag chloride)
- When patrols are completed, areas patrolled, deficiencies noted
- Discussions with the public (name the individual)
- Discussions with IFA or KYTC (name the individual)
- Equipment that cannot be operated at full capacity and why
- Calls from the police services and action taken
- Accident information
- Page number (e.g., page 1 of 2)

Developer shall complete the winter operations record or a report of a similar nature that shall record the following information for each winter vehicle:

- Date and time each winter vehicle is called for work
- Time operator arrived at the yard
- Time the winter vehicle is left at the yard
- Quantity of salt/liquid used
- Lane miles serviced
- Rate of application
- Total hours worked
- Unit number
- Page number (e.g., page 1 of 2)
- Comments
- Time drivers dismissed or relieved

Each daily entry shall be signed by the operator of the winter vehicle at the start of performing winter operations and at the end, when relieved. A printed name is also required to clearly identify the operator’s name.

Developer shall collect bare pavement data and report its achievement of meeting the performance target on an annual basis. Data shall be in electronic format and shall be provided to IFA by June 1 of each year.

The information collected and recorded for each storm event is as follows:

- Date and time event started
- Date and time event ended
- Date and time bare pavement was lost
- Date and time bare pavement was regained
- Type of event
- Bare pavement regained time is N/A (if applicable)
- Comments

22.3.1.12.5 Performance Requirements

Developer shall ensure that the work performed under this Section 22.3.1.12 meets or exceeds the Performance Requirements specified in Attachment 22-1.

22.3.1.13 Overweight Load Permits

Developer shall be responsible for analyzing overweight load permit applications from the Indiana Department of Revenue, Motor Carrier Services Division (MCSD). In 2010 approximately 15,000 single trip overweight vehicle permits with weight between 80,000 and 199,999 pounds and 210 permits with weight over 200,000 pounds were processed by MCSD on the I-64 crossing of the Ohio River. All oversize permitted vehicles shall be allowed across the East End Bridge subject to the restriction of the MCSD. Refer to the Indiana Department of Revenue *Oversize/Overweight Vehicle Permitting Handbook* for a description of permit types.

Notification of an overweight load permit application will come from and response shall be returned to MCSD. Developer shall have one (1) business day to analyze and respond to the overweight load permit request. Permit analysis shall be performed according to the AASHTO Manual for Bridge Evaluation.

22.3.1.14 Roadway Reopening Time Policy Compliance

For an Incident (breakdown, minor accident (no injuries), non-Hazardous Material spill, or debris in one travel lane) within the O&M Limits that requires Developer’s action to reopen the roadway, Developer shall be required to reopen the segments within 25 minutes which shall commence after the incident is cleared by law enforcement, applicable recovery efforts by others are completed and, as applicable any cleanup by Developer is completed.

Conditions shown to be outside the control of Developer and circumstances requiring additional specialized equipment that will need to be mobilized shall be exempted from the 25 minute requirement. Such conditions shall be documented via Developer reporting to the Department or KYTC operated TMC and verified using CCTV records. Developer is not responsible for vehicle towing or recovery.

Failure to open the roadway within the required restoration time shall be considered a Category 1 Defect (Hazard Mitigation). Cure period begins after the incident is cleared and as applicable recovery efforts by others are completed If the restoration period is exceeded, an Unavailability Event shall be applied to this Defect for the duration of the Incident, which is defined as the time at which the Incident occurs to the time at which the Incident is cleared by law enforcement, and as applicable after recover efforts by others are completed, and the segment is restored to normal operating conditions. Developer shall be subject to Noncompliance Points for this Unavailability Event in accordance with Attachment 22-1.

Closure of the roadway within the O&M Limits by law enforcement agencies with jurisdiction shall not constitute an Unavailability Event.

22.4 Maintenance Requirements

Developer shall be responsible for performing maintenance and maintaining safe, reliable assets within the O&M Limits, with the main objectives to maximize safety, reliability, and roadway availability. Developer shall be responsible for maintenance of the assets within the O&M Limits.

Developer shall provide and maintain properly trained maintenance personnel of sufficient quantities to perform the maintenance activities identified in the Maintenance Manual. Developer shall also provide sufficient maintenance staff on-site for 24 hours per day, seven days per week, every day of the year. Maintenance personnel shall be available to respond to urgent maintenance issues as necessary to support the operational requirements of the segments.

Developer shall coordinate all lane Closures and maintenance activities with IFA and KYTC a minimum of two weeks in advance for planned activities. These Closures shall comply with the *Department Interstate Highways Lane Closure Policy* (March 2010). Developer shall coordinate with the Department and KYTC prior to closing any travel lanes for unplanned lane Closures when the circumstances arise.

Developer shall provide maintenance training of the Department and KYTC personnel upon Substantial Completion and again prior to the Termination Date, such that the Department and KYTC personnel have a complete understanding of the maintenance program, plans, tasks, reports, and activities for the maintenance scope of the East End Crossing.

22.4.1 Maintenance Plan

Developer shall draft and submit a Maintenance Plan (MP) to IFA for review and comment in accordance with the schedule specified in Attachment 01-1. The MP shall conform to the maintenance-related aspects of the Operations and Maintenance Plan (OMP) requirements included in this Section 22. Developer shall prepare a MP that is consistent with the general maintenance obligations described in Section 22.1 and defines the process and procedures for the maintenance of the East End Crossing for the Term of the PPA. The MP shall include:

- Performance requirements, measurement procedures, and threshold values, at which maintenance is required for each physical Element of the East End Crossing in accordance with this Section 22, including impacts to Related Transportation Facilities.
- Inspection procedures and frequencies, and subsequent maintenance to address noted deficiencies of the physical Elements shall also be included, in accordance with the requirements of Section 22.5.
- Response times to mitigate hazards, permanently remedy, and permanently repair Defects, which shall, at a minimum, be in accordance with the Performance and Measurement Table. Developer shall differentiate response times for Defects that require prompt attention due to immediate or imminent damage or deterioration,

excluding those items which have no impact on any parties other than Developer, and response times for other Defects.

The MP shall be updated at least annually or more frequently, as necessary, to indicate the maintenance requirements for the equipment and systems as they are revised, upgraded, rehabilitated, and, as applicable, replaced. For the East End Bridge, the MP shall cover the full 100-year service life. For the remainder of the O&M Limits the MP shall cover the Operating Period.

The MP shall be a complete document that includes a brief description of the assets within the O&M Limits. In addition to the items listed above, the MP shall include the following minimum requirements:

1. Overview description of all assets within the O&M Limits, including facilities, systems, and equipment to be maintained by Developer.
2. A logical system breakdown of the assets within the O&M Limits, including facilities equipment and systems and the levels of maintenance to be provided by Developer's staff.
3. Description of the staffing plan and related workshop, maintenance garages, major equipment, vehicles, storage facilities, etc., as necessary to support the maintenance program.
4. List of the East End Crossing's major systems and equipment manufacturers/ vendors, including their contact information (contact person, address, telephone numbers, website address).
5. List of O&M Contractors used to perform any maintenance activities and the identification of the services expected to be provided.
6. A list of preventive maintenance procedures.
7. Planned Maintenance schedule indicating the tasks and the required frequency.
8. A list of unplanned but anticipated maintenance activities.
9. Diagnostic procedures for equipment and systems.
10. Detailed preventive maintenance procedures.
11. Detailed reactive maintenance procedures.
12. Spare parts inventory procedures.
13. A list of spare parts inventory (on-site and off-site).
14. Repair procedures for repairs that are anticipated.
15. Systems and equipment manufacturer's operations and maintenance manuals.
16. Software manuals.
17. Wiring diagrams, schematic drawings, logic block diagrams, etc.
18. Assembly and disassembly drawings clearly identifying the components.

19. Copies of all inspection forms, checklists, etc.

20. Lane Closure plans.

21. Summary listing of all maintenance tasks categorized by system/discipline and the related maintenance classifications and Noncompliance Points.

Standard service manuals for commercially available equipment and products shall be acceptable only if the equipment provided is standard off-the-shelf equipment without any custom features or functions. Custom equipment and systems shall have custom operations and maintenance manuals that include detailed information that addresses the custom features of the equipment provided and shall include drawings. The non-applicable portions of standard manuals shall be neatly encircled and cross-hatched to clearly indicate that these sections are not applicable.

22.4.1.1 Maintenance Plans and Schedules

Developer shall update the MP including preparing maintenance plans and schedules in accordance with the requirements of this section. Developer shall prepare Planned Maintenance, Routine Maintenance, and Rehabilitation Work Schedules on an annual and monthly basis. The annual Planned Maintenance schedules shall be submitted to IFA for review and approval at least 90 days prior to the commencement of the year scheduled. Monthly Planned Maintenance and Routine Maintenance schedules, except for the first month of the year scheduled, shall be submitted to IFA for review and approval at least 30 days prior to the commencement of the month scheduled. The annual and monthly Planned Maintenance schedules shall describe, for each segment, all of the scheduled maintenance tasks or activities, and the dates, times, and durations of each, and the total quantity of Planned Maintenance hours and Routine Maintenance lane hours. Permitted Closures for Planned Maintenance shall not exceed 120 calendar days per calendar year.

During each year of the Operating Period, Developer shall incorporate into the MP all Planned Maintenance, Routine Maintenance and Rehabilitation Work. The MP shall be submitted to IFA for review and approval at least 90 days prior to the commencement of the planned calendar year. The MP shall describe, for each segment, all of the Rehabilitation Work activities planned, and the dates and expected durations of each, as well as the total quantity of Planned Maintenance hours, Routine Maintenance lane hours, compliance lane hours, and Rehabilitation Work hours. The MP shall address both the next calendar year and the next five calendar years. The one-year MP shall be a moving plan submitted every quarter and shall be updated to identify the Rehabilitation Work completed, the major maintenance work remaining, as well as any changes to the plan. A five-year plan shall be submitted annually and shall indicate the Rehabilitation Work activities planned over the next five calendar years. A Rehabilitation Work Schedule which shall conform to the requirements of Section 6.8 of the PPA shall be included in the MP.

22.4.1.2 Unplanned Maintenance and Repairs

If Developer is required to perform unplanned maintenance and repairs to the roadway, bridge, equipment, and ancillary facilities, the works shall meet the minimum operational requirements specified in this Section 22.

Developer shall maintain a time log indicating the time at which the equipment has a fault that requires attention, maintenance, or repair. The time log shall identify the time when the response was initiated and the time at which the equipment was put back into service. Developer shall prepare quarterly reports that indicate all instances of unplanned maintenance. The reports shall include a summary of unplanned maintenance or repair activities and clearly indicate the instances in which the repairs or maintenance were performed to return the equipment to service within the specified time criteria, as well as the instances in which the maintenance or repairs were performed and the equipment was returned to service beyond the specified time criteria.

22.4.1.3 Maintenance Work Report

The "Maintenance Work Report" shall identify all of the Planned Maintenance and Rehabilitation Work for the period, the actual Work performed for the period, and confirmation that the all Work performed was in compliance with the maintenance procedures. The Maintenance Work Report shall be submitted quarterly and shall be broken down for each month of the quarter.

Maintenance Work Report shall include the following data and information, at a minimum:

1. Summary of the Planned Maintenance and Rehabilitation Work for each month of the quarter.
2. Summary of the Planned Maintenance and Rehabilitation Work performed and completed for the month.
3. Summary of the Planned Maintenance and Rehabilitation Work that was not completed for the month. This report shall include reasons for the incompletion of the Planned Maintenance and a summary of deferred days for each deferred item.
4. Summary of the maintenance activities performed for the month beyond the Planned Maintenance and Rehabilitation Work.
5. Detailed results of all Planned Maintenance and Rehabilitation Work and other maintenance work that was performed during the month.
6. Summary of Closures, Permitted Closures, and Planned Maintenance and Rehabilitation Work hours for the coming month. This report shall include details describing the location, duration, and reason of each.
7. Detailed results of all inspections, assessments, and testing activities, including the procedures, forms, etc.
8. Equipment Out-of-Service Report. This report shall list all traffic control and traffic surveillance, mechanical, and electrical equipment that was not functional at some time during the month and include data such as durations, reasons, and cross-references to any events or Incidents that may be related to the out-of-service equipment.
9. Quality assurance review of all maintenance personnel actions, lessons learned, etc.
10. Summary of staff and hours worked for the month.
11. A listing of all assets in the operation and maintenance program, including individual equipment and assets, with a summary of all of the maintenance activities performed during the month and the complete history of maintenance for the asset as reported by the CMMS.

22.4.1.4 Computerized Maintenance Management System

Developer shall use the Department's Computerized Maintenance Management System (CMMS) database for all maintenance activities. The Department will provide the CMMS software at no cost to the Developer. The Developer shall be responsible for creating the asset database based on Final Design. The CMMS database shall include all of the assets to be maintained and that includes a description of the item/equipment, location, tag number, equipment nameplate data (model number, serial number, size, etc.).

The CMMS database shall include the preventive maintenance activities required, those performed, dates, and repair history. The database shall include the day and time that equipment is taken out of service and the day and time that it is returned to service and shall include detailed information regarding the type of repairs or failures and identification of the maintenance work performed. The CMMS software shall have a minimum of the following functional capabilities: scheduling, database of equipment, database of preventive maintenance tasks, descriptions and work codes, work order generation, technician identification, spare parts inventory, purchasing requisitions, and repair history.

The Department shall provide training for Developer personnel on the CMMS, such that Developer personnel have a complete understanding of the program, the program's capabilities and functions, and how Developer shall apply the program to the East End Crossing.

22.4.1.4.1 ***Mandatory Spares***

Developer shall determine the spares required to maximize the potential to receive the Maximum Availability Payment. Developer shall determine mandatory spares due to their custom nature and associated long-lead time.

22.4.1.5 Rehabilitation of Elements

Elements are to be rehabilitated when any of the following conditions are evident:

1. Targets for individual Elements fall below 75% average compliance with the relevant Targets for each Element.

2. Individual Elements are in fair condition, but suggesting need for early replacement, rehabilitation or repair of individual Element and/or maintenance or operation improvement action to meet Performance Requirement.

3. The "reliability" is less than 99.9% for any safety critical Element. Such an Element is one that, should it fail, the safe operation of the Project would be in jeopardy or an immediate or imminent safety hazard would result.

4. The "reliability" is less than 90% Element other than a safety critical Element.

5. The Element ceases to function, or dies (as in the case of certain landscaping).

6. The frequency of repair is higher than that recommended in the manufacturer's preventive maintenance schedule.

For the avoidance of doubt "reliability" is calculated as the in-service time over a prescribed time period. For example, if an Element is out of service for 20 days of 365 days, its "reliability" is 94.5% (i.e. (365 – 20)/365 x 100%). The reliability measurement is made over a moving 365 days.

22.4.1.6 Structure Monitoring

As part of the MP, Developer shall develop a structural monitoring program to ensure the structural health and performance of the East End Bridge Main Spans. The development of this program shall be coordinated with the Designer to ensure actionable data. The structural monitoring program shall employ the current off-the-shelf hardware and software components for structural monitoring and shall be calibrated with the original design and structural models. The data collected shall be analyzed on an annual basis to demonstrate that the structure is behaving as designed. Developer shall at a minimum provide instrumentation to gather the data listed in Table 22-1. The monitoring system shall have the same design life as the East End Bridge and all hardware and software shall be upgraded to current standards every ten years. Data shall be collected by the Developer remotely via a secure system and shall provide an alarm function should critical setpoints be exceeded. All analysis shall be made available to IFA upon request. All data collection systems and database shall be redundant and backed up daily. Developer shall provide an off-site secure data center to archive all captured data. Prior to installation Developer shall perform a full scale network test. A summary of the actual structural performance and any related maintenance tasks shall be included in the annual condition inspection report.

Table 22-1 Monitoring Instrumentation

Structural Element/Data	Instrumentation
Main piers/towers	
Inclination	Biaxial tilt meter
Temperature	Thermal transducers at selected locations at center of section near bottom of pier above highest water level , near deck level and at top of tower
Accelerations and frequencies	Permanent triaxial servo-type accelerometer/ vibration meters at the top of towers. Temporary triaxial servo-type accelerometer/ vibration meters at three points up the towers from deck level upwards
Settlement/movement	Fixed survey points; 3 locations at each main tower (base, deck, and top), and 2 at each pier location (ground and top).
Cable System	
Vibrations	Temporary triaixal servo-type accelerometers/ vibration meters at 3 cable locations for each cable group (2 year period)
Strain	Dynamic strain gauges at cable anchorage to measure initial and service period peak tension for each cable group

Structural Element/Data	Instrumentation
Superstructure	
Accelerations and frequencies	Permanent triaxial servo-type accelerometers/ vibration meters at midspan of main span
Temperature measurement	Thermal transducers at selected locations for top of surfacing, top of concrete/deck and girder
Deflection	
Bearings	
Longitudinal and angular movements	Transducers at 4 bearing locations
Climatic Conditions	
Cable-stay bridge deck	Air temperature transducer, hygrometer, anenometer, wind vane at midspan of each bridge

22.5 Inspections

Developer shall cause trained and competent personnel to plan and implement a program of inspections of the East End Crossing which:

- Verifies the continuing safety of the Project for Users.
- Prioritizes Defects requiring immediate and urgent attention because they are likely to create a danger or serious inconvenience to Users (Category 1 Defects).
- Identifies Category 2 Defects to be included for repair either within Developer's annually recurring highway maintenance and repair program or as Rehabilitation Work.
- Is responsive to reports or complaints received from Customer Groups.
- Takes account of Incidents and Emergencies affecting the Project.
- Monitors the effects of extreme weather conditions.
- Collates data to monitor performance of the Project and to establish priorities for future maintenance operations and Rehabilitation Work.

Developer shall ensure that personnel performing inspections of road pavements and structures are certified as inspectors and/or raters, or otherwise appropriately qualified to perform the Inspections in accordance with the Technical Provisions and the Project Standards.

22.5.1 Inspection Frequencies

Developer shall establish inspection procedures and carry out inspections so that:

- All Category 1 Defects are identified and repaired such that the hazard to Users is mitigated within the period given in the column entitled "Category 1 Hazard Mitigation" in the Performance and Measurement Table.
- All Category 1 Defects are identified and permanently remedied within the period given in the column entitled "Category 1 Permanent Remedy" in the Performance and Measurement Table.
- All Category 2 Defects excluding those items which have no impact on any parties other than Developer are identified and permanently repaired within the period given in the

column entitled "Category 2 Permanent Repair" in the Performance and Measurement Table.

The periods stated in the Performance and Measurement Table under each of the above headings shall be deemed to start upon the date Developer first obtained knowledge of, or first reasonably should have known of, the Defect. For this purpose Developer shall be deemed to first obtain knowledge of the failure not later than the date of delivery of the initial notice to Developer. Developer shall investigate reports and complaints on the condition of the Project received from all sources. Developer shall record these as O&M Records together with details of all relevant inspections and actions taken in respect of Defects, including temporary protective measures and repairs.

22.5.2 Inspection Standards

In performing inspections to identify Category 1 and Category 2 Defects, Developer shall, for any Element defined in the column entitled "Element" on the Performance and Measurement Table, conform at a minimum to the inspection standards set forth for that Element in the column entitled "Inspection and Measurement Method" on the Performance and Measurement Table.

22.5.3 General Inspections

Developer shall perform General Inspections in accordance with the MP so that the repairs of all Defects are included in planned programs of work.

O&M Records in respect of General Inspections shall include details of the manner of inspection (e.g. center lane closure or shoulder), the weather conditions and any other unusual features of the inspection.

General Inspections shall be performed such that Category 2 Defects are identified and repaired within the period shown in the Performance and Measurement Table or, if the Defect is not specified in the Performance and Measurement Table, within six months of the Defect occurring; provided that Defects which require special equipment to identify or are listed under the heading of Specialist Inspections in Section 22.5.4 may have different identification periods.

22.5.4 Specialist Inspections

Developer shall undertake Specialist Inspections for Elements listed in Table 22-2 and shall include the inspection results as O&M Records.

Table 22-2 Specialist Inspections

Element	Frequency
Roadway	Annual survey of pavement condition for the entire Facility, including main lanes, ramps, and frontage roads, undertaken using automated condition survey equipment to measure all necessary criteria including: ruts, skid resistance and ride quality according to the inspection and measurement methods set forth in

Element	Frequency
	the Performance and Measurement Table.
Bridges	Inspections and load rating calculations at the frequency specified in the Technical Provisions. In addition, NBIS inspections as per FHWA regulations and at the frequency specified in FHWA regulations.
Electrical supplies to lighting, signs, traffic signals and communications equipment	Inspections as required by FHWA or electrical regulations.

22.5.5 Performance Inspections

Developer shall undertake detailed inspections of randomly selected Performance Sections for audit purposes (the "Performance Inspections") annually. Developer shall submit proposed Performance Sections to IFA for approval 90 prior to anticipated Substantial Completion. On each occasion that a Performance Inspection is undertaken, it shall include at least five percent of the total available Performance Sections. Developer shall assess the condition of each Element of the Project, as set forth in the column entitled “Element” on the Performance and Measurement Table using the inspection and measurement method set forth in the column entitled “Inspection and Measurement Method”. Developer’s Performance Inspections shall include physical inspection of those Elements that are safely accessible without traffic control. Where the measurement method would require specialist equipment or would require traffic lane closures to implement, Developer shall assess the condition of the relevant Element by reference to the current O&M Records held in Developer’s database.

Developer shall create a new O&M Record for each Element physically inspected in accordance with the column entitled “Measurement Record” on the Performance and Measurement Table. Developer's Performance Inspections shall be undertaken to a schedule agreed with the IFA on Performance Sections randomly selected by the IFA. The IFA shall be given the opportunity by seven days notice, to accompany Developer when it undertakes the physical inspections associated with the Performance Inspection.

22.6 Reports and Records

In general, O&M Records shall be drafted or maintained by Developer, or, if applicable, it’s Contractors. The O&M Records and records shall adhere to the approved quality management system and shall, at a minimum, meet the following minimum requirements.

22.6.1 Reports During Operating Period

22.6.1.1 Quarterly Operations Report

Within the first 20 days of each quarter from the Substantial Completion Date, and continuing each quarter until the Termination Date, Developer shall deliver to IFA an Operations Report containing the information specified in this Section 22. Developer shall provide all other reports required by the PPA Documents to be submitted during the Operating Period.

22.6.1.2 Maintenance Work Report

The Maintenance Work Report shall comply with the requirements of Section 22.4.1.3.

22.6.1.3 Rehabilitation Work Report

Developer shall comply with the requirements of Section 6.7.2 of the PPA.

22.6.1.4 Rehabilitation Work Schedule

Developer shall comply with the requirements of Section 6.8.1 of the PPA.

22.6.2 Handback Plan

At least six years prior to the end of the Term, Developer shall deliver to IFA Developer's Handback Plan.

22.7 Copies

Developer shall issue one electronic copy and three hard copies of each report to IFA.

22.7.1 Design

All documents related to design work and construction records required by the Technical Provisions shall be catalogued and indexed in both paper and searchable electronic formats for use by Developer in planning and executing the maintenance Work.

22.7.2 Operations and Maintenance

Developer shall maintain the following:

- The O&M Records, as well as any other records required under the public-private agreement (PPA) and as required in this Section 22.
- Complete records of Incidents that affect the operation and maintenance of the O&M Limits.
- Complete records of all inspections, executed test and assessments, as well as results of all tests, assessments, and the results of those inspections.
- Details of all of the Rehabilitation Work executed.
- All data in relation to all original tests, graphics, and other records in relation to measurement equipment, certifications, and calibration records.
- Complete series of quarterly reports.
- Monthly records in relation to lane Closures on the O&M Limits.

22.7.3 Handback

The Handback Plan as required per Section 23.

The Handback Evaluation Testing and Inspection Procedures as required per Section 23.

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23 HANDBACK

23.1 General

Developer shall prepare a plan ("Handback Plan") that contains the methodologies and activities that will be undertaken or employed to ensure that the Handback Requirements in the PPA are achieved at the end of the Term of the Agreement. Developer shall submit the Handback Plan, including a Residual Life Methodology plan, to IFA for review and approval at least 60 months before the anticipated expiration of the Term or earlier termination of the Agreement.

Developer shall perform all inspections and work necessary to meet or exceed the Residual Life requirements contained in Table 23-1 by the time of Handback of the Project to IFA.

Developer shall perform all Residual Life Inspections as and when required by the PPA Documents. Not later than 90 days before delivery of the O&M Limits within the East End Crossing to IFA, Developer shall perform a Final Inspection that covers all physical Elements within the Project, whether or not Rehabilitation Work has been performed for a particular Element.

Within 30 days following performance of the Final Inspection, Developer shall submit to IFA, for review and approval, the findings of the inspection, Residual Life test results, and Residual Life calculations.

At the point of Handback, Developer shall certify that all physical Elements of the Project comply with the Residual Life requirements defined in the PPA.

For any Element of the Project for which a required final Residual Life is not specified in the following Table 23-1, the Element shall have a required final Residual Life equal to the documented serviceable life of the Element or five years, whichever is less.

23.2 Residual Life Methodology

Developer shall prepare and submit to IFA for approval a Residual Life Methodology, 60 months before the scheduled Handback. The inspection requirements and Residual Life Methodology requirements identified in the Table 23-1 are minimum requirements. This submittal shall contain the evaluation and calculation criteria to be adopted for the calculation of the Residual Life at Handback of all Elements of the Project. The scope of any Residual Life testing shall be included, together with a list of all independent Residual Life testing organizations, proposed by Developer. These organizations shall be submitted to IFA's for approval in its sole discretion, have third party quality certification, and be financially independent of Developer and not be an Affiliate.

IFA's approval of the Residual Life Methodology, including the scope and schedule of inspections, shall be required before commencement of Residual Life Inspections.

23.3 Residual Life Inspections

Inspections and testing shall be performed with appropriate coverage such that the results are representative of the whole O&M Limits within the East End Crossing as described in the Table 23-1.

IFA shall be given the opportunity to witness any of the inspections and/or tests and shall be provided with a minimum of ten Business Days notice prior to the performance of any such tests. Developer shall deliver to IFA, within ten days after it is created, the output data arising from any testing and any interpretation thereof made by the testers.

In the event that Developer fails to undertake inspections within the relevant time periods described below, IFA shall be entitled to undertake or arrange the relevant inspections itself, following 30 days written notice to Developer.

1. First Inspection
   Between 57 and 60 months before the end of the Term, Developer shall perform a Residual Life Inspection (the 'First Inspection'), including all Elements set forth in the Table 23-1.

   Within 30 days following performance of the First Inspection, Developer shall submit to IFA the findings of the inspection, including Residual Life test results, the report of the independent testing organization(s), Developer's Residual Life calculations and Developer's calculation of Residual Life at Handback for all Elements.

2. Second Inspection
   Between 15 and 18 months before the end of the Term, Developer shall perform a second Residual Life Inspection (the 'Second Inspection') including all Elements set forth in the Table 23-1.

   The Second Inspection shall be performed for all Elements of the O&M Limits within the East End Crossing within the O&M Limits whether or not Developer has undertaken Rehabilitation Work for a particular Element in the period since the First Inspection.

   Within 30 days following the performance of the Second Inspection, Developer shall submit to IFA the findings of the inspection, including Residual Life test results, the report of the independent testing organization(s), Developer's Residual Life calculations and Developer's calculation of Residual Life at Handback for all Elements of the O&M Limits within the East End Crossing.

3. Final Inspection
   Not later than 90 days before the end of the Term, Developer shall perform a final Residual Life Inspection (the 'Final Inspection') including all Elements of the O&M Limits within the East End Crossing within the O&M Limits, whether or not Developer has undertaken Rehabilitation Work for a particular Element in the period since the First Inspection and Second Inspection.

   Within 30 days following performance of the Final Inspection, Developer shall submit to IFA for review and approval the findings of the inspection, including Residual Life test results, the report of the independent testing organization(s), Developer's Residual Life calculations and Developer's calculation of Residual Life at Handback for all Elements of the Project.

23.4 Rehabilitation Work Schedule at Handback

The Rehabilitation Work Schedule for each of the five years before Handback shall include, in addition to any other requirements specified in the PPA Documents:

1. Developer's calculation of Residual Life for each Element calculated in accordance with the Residual Life Methodology and taking into account the results of the inspections set forth above.

2. The estimated cost of the Rehabilitation Work for each Element at the end of its Residual Life.

23.5 Residual Life and Useful Life Requirements

1. Where a Residual Life at Handback is specified in Table 23-1, the Residual Life at Handback shall be equal to or greater than the period set forth.

2. Where a Useful Life is specified in Table 23-1 in place of a Residual Life at Handback, the Useful Life created at the time of its last reconstruction, rehabilitation, restoration, renewal or replacement before the end of the Term shall be equal to or greater than the period set forth in the column entitled "Useful Life", and the Rehabilitation Work Schedule shall estimate the cost of the next Rehabilitation Work (after the end of the Term) on the assumption that such Rehabilitation Work will be performed in order to create a new Useful Life of the same duration.

3. For the pavement:

   a. Pavement Surface Condition – The pavement surface, including lanes and shoulders, shall be free of any evidence of structural weakness, pitting, potholes, ravelling, segregation, scaling, delamination, localized roughness and all other deficiencies. All cracks and joints shall be sealed with a sealant acceptable to the Department. The pavement surface shall be free and clear of dirt, sand and other debris.

   b. Structural Requirements – At the time the Department assumes responsibility of the roadway, the structural capacity of each and every lane of the roadway shall be such that a rehabilitation design for 10 years of traffic loading starting as of the date the Department assumes responsibility for the roadway will require no more than a 2-inch asphalt concrete overlay or equivalent treatment for the pavement type. The 10 year traffic loading will be determined based on traffic estimates at the time, but in no case will it exceed 10 million equivalent single axle loads for any lane of any section of roadway.

      Pavement strength testing to determine the structural capacity and the rehabilitation needed for the requirement above will be completed by an independent consultant retained and paid for by the Department and acceptable to both the Department and the Contractor. The Contractor shall be responsible for providing all traffic accommodation to allow pavement strength testing or other testing (either destructive or non-destructive), as required.

Table 23-1 Roadway and Bridges Asset Handback Criteria

Element Category		Residual Life at Handback (Yrs)	Useful Life (Yrs)	Inspection Requirements	Residual Life Methodology (RLM) Requirement
	Element Description				
1) ROADWAY					
	Pavement	-	10	Pavement inspections shall be undertaken by an independent consultant jointly approved by IFA and the Developer. Inspections shall provide a continuous or near-continuous record of Residual Life in each lane. Where the inspection method does not provide a continuous record of Residual Life, the number of valid measurements in each Performance Section shall be sufficient to give a statistically valid result. Inspections shall be repeatable to an agreed level of accuracy and inspection contracts shall include an agreed proportion of inspections to verify accuracy. Inspections shall include automated condition distress survey, ride quality, skid resistance, rutting and faulting.	RLM shall be capable of calculation of Residual Life for each 0.1 mile Performance Section. For a nominal 10 year Residual Life at Handback, 90% of Performance Sections shall have a Residual Life exceeding 10 years, and no Performance Section shall have a calculated Residual Life of less than 5 years.)
	Curbs and gutters	-	10	Inspections of all curbs and gutters shall be undertaken by personnel having adequate training on modes of failure, risk assessment and observational skills.	RLM shall draw on historical asset maintenance records, inspection and test histories for each Element.

<table>
<tr><th colspan="2">Element Category</th><th rowspan="2">Residual Life at Handback (Yrs)</th><th rowspan="2">Useful Life (Yrs)</th><th rowspan="2">Inspection Requirements</th><th rowspan="2">Residual Life Methodology (RLM) Requirement</th></tr>
<tr><th></th><th>Element Description</th></tr>
<tr><td colspan="6">2) NEW STRUCTURES – OTHER THAN EAST END BRIDGE</td></tr>
<tr><td rowspan="15"></td><td>Reinforced concrete</td><td>40</td><td>-</td><td rowspan="15">Inspections of structures shall be undertaken by independent testing organizations.

Inspections shall follow the latest inspection guidelines (as they apply at the relevant date that the testing is undertaken) recognized by IFA.
A close examination shall be made of all parts of each structure.

Non-destructive tests shall be undertaken appropriate to the type of structure. These shall include the measurement of structural deflection under calibrated load, the identification and measurement of de-lamination in bridge decks, the measurement of chloride and carbonation profiles from surface to reinforcement and/or tendon level, and the in-situ strength testing of concrete Elements.

Testing of steel structures shall include the depth of corrosion and/or the measurement of remaining structural thickness for hidden and exposed parts.

All lengths of weld shall be tested for cracking at key areas of structural steelwork (residual life first inspection only).</td><td rowspan="15">RLM shall:

Draw on historical asset maintenance records, inspection and test histories for each structure.

Take account of IFA and FHWA records of other structures on the network with similar characteristics.

Include an assessment of load carrying capacity based on the original structural design calculations, the as built drawings and results of load deflection tests where appropriate.

Take account of any trends in asset deterioration to determine the rate of deterioration and to predict the future condition of individual Elements and the entire structure.</td></tr>
<tr><td>Pre-stressed concrete</td><td>40</td><td>-</td></tr>
<tr><td>Structural steelwork</td><td>40</td><td>-</td></tr>
<tr><td>Weathering steel</td><td>40</td><td>-</td></tr>
<tr><td>Corrugated steel</td><td>40</td><td>-</td></tr>
<tr><td>Corrosion Protection for structural steelwork</td><td>-</td><td>10</td></tr>
<tr><td>Deck wearing surface</td><td>-</td><td>10</td></tr>
<tr><td>Deck joints</td><td>-</td><td>5</td></tr>
<tr><td>Bearings</td><td>-</td><td>30</td></tr>
<tr><td>Barrier railings</td><td>40</td><td>-</td></tr>
<tr><td>Sign/signal gantries (structural Elements)</td><td>15</td><td>-</td></tr>
<tr><td>Retaining Walls</td><td>40</td><td>-</td></tr>
<tr><td>Sound Barriers</td><td>40</td><td>-</td></tr>
<tr><td>Traffic signal poles</td><td>-</td><td>10</td></tr>
<tr><td>High mast lighting poles</td><td>15</td><td>-</td></tr>
</table>

<table>
<tr><th colspan="2">Element Category</th><th rowspan="2">Residual Life at Handback (Yrs)</th><th rowspan="2">Useful Life (Yrs)</th><th rowspan="2">Inspection Requirements</th><th rowspan="2">Residual Life Methodology (RLM) Requirement</th></tr>
<tr><th></th><th>Element Description</th></tr>
<tr><td colspan="6">3) REHABILITATED/MODIFIED STRUCTURES – OTHER THAN EAST END BRIDGE</td></tr>
<tr><td></td><td>Reinforced concrete</td><td>15</td><td>-</td><td rowspan="10">Inspections of structures shall be undertaken by independent testing organizations.

Inspections shall follow the latest inspection guidelines (as they apply at the relevant date that the testing is undertaken) recognized by IFA.
A close examination shall be made of all parts of each structure.

Non-destructive tests shall be undertaken appropriate to the type of structure. These shall include the measurement of structural deflection under calibrated load, the identification and measurement of de-lamination in bridge decks, the measurement of chloride and carbonation profiles from surface to reinforcement and/or tendon level, and the in-situ strength testing of concrete Elements.

Testing of steel structures shall include the depth of corrosion and/or the measurement of remaining structural thickness for hidden and exposed parts.

All lengths of weld shall be tested for cracking at key areas of structural steelwork (residual life first inspection only).</td><td rowspan="10">RLM shall:

Draw on historical asset maintenance records, inspection and test histories for each structure.

Take account of IFA and FHWA records of other structures on the network with similar characteristics.

Include an assessment of load carrying capacity based on the original structural design calculations, the as built drawings and results of load deflection tests where appropriate.

Take account of any trends in asset deterioration to determine the rate of deterioration and to predict the future condition of individual Elements and the entire structure.</td></tr>
<tr><td></td><td>Pre-stressed concrete</td><td>15</td><td>-</td></tr>
<tr><td></td><td>Structural steelwork</td><td>15</td><td>-</td></tr>
<tr><td></td><td>Weathering steel</td><td>15</td><td>-</td></tr>
<tr><td></td><td>Corrugated steel</td><td>15</td><td>-</td></tr>
<tr><td></td><td>Corrosion Protection for structural steelwork</td><td>-</td><td>10</td></tr>
<tr><td></td><td>Deck wearing surface</td><td>-</td><td>10</td></tr>
<tr><td></td><td>Deck joints</td><td>-</td><td>5</td></tr>
<tr><td></td><td>Bearings</td><td>-</td><td>15</td></tr>
<tr><td></td><td>Barrier railings</td><td>15</td><td>-</td></tr>
</table>

<table>
<tr><th colspan="2">Element Category</th><th rowspan="2">Residual Life at Handback (Yrs)</th><th rowspan="2">Useful Life (Yrs)</th><th rowspan="2">Inspection Requirements</th><th rowspan="2">Residual Life Methodology (RLM) Requirement</th></tr>
<tr><th></th><th>Element Description</th></tr>
<tr><td colspan="6">3) STRUCTURES – EAST END BRIDGE</td></tr>
<tr><td rowspan="14"></td><td>Reinforced concrete</td><td>65</td><td>-</td><td rowspan="14">Inspections of the East End Bridge shall be undertaken by independent testing organizations.

Inspections shall follow the latest inspection guidelines (as they apply at the relevant date that the testing is undertaken) recognized by IFA.
A close examination shall be made of all parts of each structure.

Non-destructive tests shall be undertaken appropriate to the type of structure. These shall include the measurement of structural deflection under calibrated load, the identification and measurement of de-lamination in bridge decks, the measurement of chloride and carbonation profiles from surface to reinforcement and/or tendon level, and the in-situ strength testing of concrete Elements.

Testing of steel structures shall include the depth of corrosion and/or the measurement of remaining structural thickness for hidden and exposed parts.

All lengths of weld shall be tested for cracking at key areas of structural steelwork (residual life first inspection only).</td><td rowspan="14">RLM shall:

Draw on historical asset maintenance records, inspection and test histories for each structure.

Take account of IFA and FHWA records of other structures on the network with similar characteristics.

Include an assessment of load carrying capacity based on the original structural design calculations, the as built drawings and results of load deflection tests where appropriate.

Take account of any trends in asset deterioration to determine the rate of deterioration and to predict the future condition of individual Elements and the entire structure.</td></tr>
<tr><td>Pre-stressed/post-tensioned concrete</td><td>65</td><td>-</td></tr>
<tr><td>Structural steelwork</td><td>65</td><td>-</td></tr>
<tr><td>Stay-cables</td><td>25</td><td>-</td></tr>
<tr><td>Vibration dampeners</td><td>5</td><td>-</td></tr>
<tr><td>Corrosion protection for structural steelwork</td><td>-</td><td>10</td></tr>
<tr><td>Deck wearing surface</td><td>-</td><td>15</td></tr>
<tr><td>Deck joints</td><td>-</td><td>10</td></tr>
<tr><td>Bearings</td><td>15</td><td>-</td></tr>
<tr><td>Deck drainage</td><td>40</td><td>-</td></tr>
<tr><td>Maintenance access walkways & appurtenances</td><td>25</td><td>-</td></tr>
<tr><td>Aesthetic lighting</td><td>-</td><td>10</td></tr>
<tr><td>Object and channel lighting</td><td>-</td><td>25</td></tr>
<tr><td>Barrier railings</td><td>25</td><td>-</td></tr>
</table>

Element Category		Residual Life at Handback (Yrs)	Useful Life (Yrs)	Inspection Requirements	Residual Life Methodology (RLM) Requirement
	Element Description				
4) DRAINAGE					
	Underground storm sewer systems	50	-	Inspection of storm sewer systems shall include closed circuit TV inspection of all buried pipe work. Groundwater level monitoring at selected locations will be required to provide assurance through the RLM of a 10 year Residual Life for groundwater interceptor drains.	RLM shall draw on historical asset maintenance records, inspection and test histories for each Element of the drainage system. Developer shall include a methodology to determine the Residual Life of filter drains designed to intercept groundwater.
	Culverts	50	-		
	Ditches	-	10		
	Inlets	25	-		
	Outfalls	-	10		
5) TRAFFIC AND SAFETY					
	Guardrail	-	10	Inspections of all traffic and safety items shall be undertaken by personnel having adequate training on modes of failure, risk assessment and observational skills.	RLM shall draw on historical asset maintenance records, inspection and test histories for each traffic and safety Element.
	Concrete barrier	-	20		
	Attenuators	-	20		
	Overhead signs	-	5		
	Roadside traffic signs	-	5		
	Traffic signal housings & mountings	-	8		
	Pavement markings	-	3		
	Delineators	-	5		
6) ELECTRICAL					
	Luminaires	-	5	Inspections of all electrical items shall be undertaken by personnel having adequate training on modes of failure, risk assessment and observational skills.	RLM shall draw on historical asset maintenance records, inspection and test histories for each electrical Element.

Element Category		Residual Life at Handback (Yrs)	Useful Life (Yrs)	Inspection Requirements	Residual Life Methodology (RLM) Requirement
	Element Description				
7) ANCILLARY					
	Earthwork slopes	50	-	For embankment and cut slopes a risk based inspection procedure shall be adopted following Good Industry Practice. Deformation monitoring will be required to provide assurance through the RLM of a 50-year Residual Life.	RLM shall draw on historical asset maintenance records, inspection and test histories for each ancillary Element.
	Lighting poles	-	10	Inspections of all traffic and safety items shall be undertaken by personnel having adequate training on modes of failure, risk assessment and observational skills.	
	Fences	-	10		
	Manhole covers, gratings, frames and boxes	50	-		

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24 EAST END BRIDGE AND TUNNEL SECURITY

24.1 Accident and Terrorist Vulnerability Assessment Requirements

24.1.1 General

Developer shall assess accident and terrorist vulnerabilities and incorporate mitigation measures to deter, deny or detect threats in the design of the East End Bridge and Tunnel. Developer shall comply with the requirements of this Section 24 for all accident and terrorist vulnerability assessment ("ATVA") activities performed by Developer and any ATVA information provided by the states of Indiana or Kentucky.

Developer shall produce an ATVA Report that documents all analyses, reports and other ATVA related assessment documentation for review and comment by IFA. The ATVA Report shall be subject to the security requirements of this Section 24 and shall be submitted with the Stage 1 Design Documents.

24.1.2 Definition

ATVA: All studies, analyses, reports, and other documentation related to assessing the accident and terrorist vulnerability of the East End Bridge and Tunnel. The intent of ATVA is to determine if any of the key structural elements of the bridge and Tunnel shall be modified in order to increase the overall resistance to each of the following, at a minimum, and to minimize the potential for a global bridge collapse in the event one of the following occurs:

- An attack on the bridge or Tunnel
- An accident on the bridge or Tunnel that could result in vehicular collision with a key structural element, fire, or other detrimental occurrence

24.1.3 References and Coordination

The *Sector-Specific Plan for Transportation Systems,* developed as part of the *National Infrastructure Protection Plan*, shall provide a framework for developing the ATVA Report. Louisville Metro Fire, the police, emergency management, and emergency medical services shall be consulted to get input into response needs for the East End Crossing.

The ATVA Report shall also consider the U.S. Department of Homeland *Security Characteristics and Common Vulnerabilities Infrastructure Category: Highway Bridges*, which describes potential threats, highway bridge characteristics, common vulnerabilities, standards and regulations, consequences of events, and general vulnerabilities, and the U.S. Department of Homeland Security *Protective Measures Infrastructure Category: Highway Bridges*, which describes potential threats, available protective measures, and the implementation of protective measures. These documents are "for official use only" publications.

The Kentucky Department of Homeland Security is currently working on assessments to other transportation infrastructure using the Automated Critical Asset Management System (ACAMS). Structures within the East End Crossing may be added to the list for future assessments. The Kentucky Intelligence Fusion Center is working with the U.S. Department of Homeland Security on a state-wide threat assessment document. This will be a classified document; however, once the report is available, IFA may be provided with a "for official use only" document. Developer shall also coordinate with the Indiana Intelligence Fusion Center.

24.1.4 Scope

Developer shall perform an ATVA prior to the commencement of the Stage 1 design to reduce the likelihood of a potential terrorist attack or accidents and to reduce the potential for a bridge or Tunnel collapse in the event of an attack or accident on the bridge or Tunnel. The preliminary bridge and Tunnel design shall be analyzed to determine its vulnerability to attack or accidents. Blast load analysis shall be considered during the assessment. Anticipated damage levels and repair costs shall be developed along with the vulnerability assessment and will be used in the risk assessment workshop.

The evaluation shall include the following areas of concern:

- Structural vulnerability of the main bridge towers and piers at the water level.
- Structural vulnerability of the main bridge towers at the deck level
- Structural vulnerability of the stay cable system.
- Structural vulnerability of the deck system.
- Structural vulnerability of any other key structural component.
- Access restriction to critical components.
- Access restriction to the construction site.

Developer shall conduct a terrorist risk analysis workshop with representatives from the Indiana Department of Transportation (Department), Kentucky Transportation Cabinet (KYTC), Federal Highway Administration (FHWA), first responders, and Developer’s design team. Developer shall develop a risk matrix with the key structural elements and appoint a risk number for different intentional or accidental threat types.

The ATVA shall evaluate the most probable threats, and those with the greatest impact, that could occur and affect the bridge.

Developer shall be responsible to incorporate mitigation measures into the construction that deter, deny and detect attacks and accidents that may occur at the bridge and Tunnel. At the option of IFA Developer will incorporate mitigation strategies which defend, strengthen or harden the East End Bridge against accidents or attacks as an IFA Change.

Developer will update the risk matrix with the selected mitigation strategies to determine the remaining and most significant risks to the structure.

24.1.5 Security Protocol

ATVA Handling

IFA intends to seek official Sensitive Security Information (SSI) designation under 49 CFR 1520 for the final ATVA Report. From initiation of the development of the ATVA, Developer shall mark and treat the ATVA documents as SSI in accordance with 49 CFR 1520. Once the ATVA Report has been officially designated as SSI by the Transportation Security Administration, Developer shall be required to comply with the requirements under 49 CFR 1520. The following are the minimum requirements for handling ATVA and SSI information:

- Electronic presentations (e.g., PowerPoint) shall be marked with the SSI header on all pages and the SSI footer on the first and last pages of the presentation.

- Spreadsheets shall be marked with the SSI header on every page and the SSI footer on every page or at the end of the document.
- Video and audio shall be marked with the SSI header and footer on the protective cover when able, and the header and footer shall be shown and, as applicable, read at the beginning and end of the program.
- CDs and DVDs shall be encrypted or password-protected, and the header and footer shall be affixed to the CD or DVD.
- Portable drives, including flash or thumb drives, shall not themselves be marked, but the drive itself shall be encrypted or all documents stored shall be password-protected.
- When leaving the computer or desk, the ATVA participant shall lock up all ATVA information and lock or turn off the computer.
- ATVA participants shall not take ATVA or SSI home.
- Discussing ATVA or SSI over cellular telephones shall be done carefully to prevent eavesdropping. Land lines in non-public locations are more secure than cellular telephones.
- Email shall not contain ATVA or SSI in the body of the email. ATVA or SSI shall be emailed in a password-protected attachment. Passwords shall be sent separately with no subject line or shared either in person or via telephone.
- Passwords for ATVA or SSI documents shall contain at least eight characters, shall have at least one upper-case and one lower-case letter, shall contain at least one number, and shall not be a word in the dictionary.
- Faxing of ATVA or SSI shall be done by first verifying the fax number and that the intended recipient will be available to retrieve the SSI faxed.
- ATVA or SSI shall be mailed by U.S. First Class mail or other traceable delivery service using an opaque envelope or wrapping, and the outside wrapping shall not be marked as ATVA or SSI.
- Interoffice mail shall be sent using an unmarked, opaque, sealed envelope so that the ATVA or SSI cannot be read through the envelope.
- ATVA or SSI stored on network folders shall either require a password to open or the network shall limit access to the folder to only ATVA participants.
- Destroying ATVA or SSI shall be done using a cross-cut shredder that produces particles that are 1.5 inches by 0.75 inches or smaller.

Developer shall do the following:

- Establish appropriate points of contact for Developer, IFA, and KYTC.
- Limit reproductions and account for electronic and paper documents.
- Release secure information only to those who have a need to know, as determined by IFA.
- Identify appropriate storage methods.
- Control transmitting and shipping information.
- Dispose of documents as necessary to control security information.

Developer shall provide an ATVA information protocol that addresses how Developer shall meet the requirements listed above such that the process of developing assessments and subsequent work of the East End Crossing shall meet the SSI requirements of 49 CFR 1520. Developer shall not disclose or release any ATVA information without express written authorization from IFA.

Developer shall promptly report to IFA any security violation, including loss, theft, misuse, misplacement, or unauthorized disclosure of ATVA information, whether or not the ATVA participants or any other official, employee, consultant, or Contractor to Developer is personally involved.

24.2 Requirements

24.2.1 Security Professional Qualifications

Developer shall engage a qualified security professional who meets the following requirements:

- The security professional(s) responsible for the development of strategies to mitigate the identified security risks shall have a minimum of 10 years of relevant experience in successfully completing threat, vulnerability, and risk assessments for government (city, state, or federal) structures that have public accessibility. The resume shall include, at minimum, one structure that is a bridge.
- Provide a scope of services associated with identifying mitigating strategies to threats and the subsequent design of those strategies, Developer is to utilize the services of a Physical Security Professional (PSP) and Certified Protection Professional (CPP) who are accredited through ASIS International.
- The Blast Specialist shall have experience completing blast evaluations and the design of blast protection systems on at least three structures. Experience on a building can be used to meet these requirements, but, at a minimum, the specialist’s experience shall include one bridge structure.

As proof of experience, Developer shall submit to IFA for review and comment 30 days after NTP1 resumes of the security professional(s) that clearly identifies his or her relevant experience for the function he or she shall perform. The resumes shall list the following information for each project being submitted for consideration as experience: (1) project name; (2) project description; (3) location of project; (4) date of PPA completion; (5) IFA's representative to contact, including telephone number, email address, and mailing address; (6) Contractor or Contractor's representative to contact, including telephone number, email address, and mailing address; and (7) the engineer's representative to contact, including telephone number, email address, and mailing address.

24.2.2 Security Systems Testing

The testing protocols and certification process shall require the completion of at least one pertinent safety and security simulation of the bridge and Tunnel facilities. Fire or explosives on the bridges are potential scenarios for testing the management and response systems and resources. These tests shall be planned and coordinated with the local responders. The plan shall include the types and locations of tests and the level of East End Crossing completion required for the optimum test. Each test shall have a written testing plan fully coordinated with the local responders and local disaster officials.

24.2.3 Operations and Maintenance Phase

The implementation of the safety and security protocols shall require training and drills with all pertinent participating stakeholders (first responders, emergency management teams, transportation management teams, etc.). Developer shall plan for and provide simulations to be organized and scheduled in conjunction with state emergency management officials. Much of this planning will be accomplished by the local responding agencies; however, IFA will participate in the planning efforts and will coordinate during the opening and initial operations of the facilities. Local agencies will collaborate on the development of the Safety Plan to understand the specific vulnerabilities and their various responsibilities for responding.

24.2.4 Monitoring

Because threats and risks change over time, Developer shall regularly update the ATVA for the East End Bridge throughout the operational term. Developer shall coordinate the annual updates with appropriate agencies.

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25 DELIVERABLES

Developer shall submit the deliverables listed in Table 25-1. The table describes the deliverables specified in the Technical Provisions, but is not intended to be inclusive of all deliverables required in the Standard Specifications, Project Standards or other references and guidelines. See the referenced sections for detailed submittal requirements. Unless otherwise indicated, all deliverables shall be submitted in both electronic format and hard-copy format. Acceptable electronic formats include current versions of Microsoft Word, Microsoft Excel, or Adobe Acrobat (PDF) files, unless otherwise indicated. Drawings shall be submitted electronically in the current versions of the original MicroStation format and in PDF format.

Timeframe for the review types are specified in Section 3.1.2 of the PPA unless noted otherwise.

Table 25-1 Deliverables

Deliverable	Submittal Schedule	Reference Section
Project Baseline Schedule	90 days after NTP1	1.5.2.1.1
Project Status Schedule	Monthly (7th of the month)	1.5.2.1.2
Progress Report	Monthly	1.5.2.1.3
Final CPM Schedule	30 days after Final Acceptance	1.5.2.1.4
Project Management Plan	See Attachment 01-1	1.5.2.2
Quality Plan	See Attachment 01-1	2.1
Design QA/QC Plan	See Attachment 01-1	2.2.3.2
Design Unit Report	Within 30 days of NTP1	3.3
Design Review Plan and Schedule	See Attachment 01-1	3.7
CADD Drafting Standards	See Attachment 01-1	3.19.2
Construction QA/QC Plan	See Attachment 01-1	3
Transportation Management Plan	See Attachment 01-1	12.1
Environmental Compliance and Mitigation Plan	Within 30 days of NTP1	2.1.3
Public Involvement Plan	Within 30 working days of NTP1	6.1
Community Outreach Plan	See Attachment 01-1	
Safety Plan	Within 90 days of NTP1	6.5.5
Incident Management Plan		6.5.5
Emergency Plan	Within 60 days of NTP1	6.5.5
Hazardous Materials Management Plan	Two weeks prior to the initiation of construction work	7.9.1
Spill Prevention Plan	See Attachment 01-1	7.9
Sustainability Management Plan	See Attachment 01-1	7.10

Deliverable	**Submittal Schedule**	**Reference Section**
Operations and Maintenance Plan	See Attachment 01-1	22.1.5
O&M Safety Plan	See Attachment 01-1	22.1.7
O&M Quality Plan	See Attachment 01-1	22.1.8
Stage 1 Design	By Developer	3.9.1
Stage 2 Design (as-needed)	By Developer	3.9.3
Released-for-Construction (RFC) Design	By Developer	3.9.2
Final Design	By Developer	3.9.4
Record Drawings	Prior to Final Acceptance	3.11
Aesthetics and Enhancement Implementation Plan	With Stage 1 Design	5.3.1
Noxious Weed Control Plan	Prior to the commencement of eradication or removal work	5.6.3
Nutrient Management Plan	With RFC Documents	5.6.1
Reforestation Mitigation Plan	With Stage 1 Design	7.5.2.2
Pavement Design Report	With Stage 1 Design	10.3.2
Traffic Operations Plan (TOP)	With TMP	12.3.2
Temporary Traffic Control Plan (TTCP)	With TMP	12.3.2
Access and Mobility Plan	90 days after NTP1	12.4.3
Blasting Plan	90 days prior to blasting	13.4.4
Vibration Monitoring Plan	60 days prior to construction work	13.5.1.1
Mass Concrete Thermal Control Plan	30 days prior to concrete pour	14.2
Corrosion Protection Plan	Concurrent with Stage 1 design	15.5.1
Barge Impact Analysis Report	Prior to commencing Stage 2 design	15.5.11
Hydraulic Report	Prior to commencing Stage 2 design	15.6.5
Wind Study Report	Prior to submittal of the Wind Engineering Report	15.6.8
Wind Engineering Report	Prior to RFC documents	15.6.8
Erection Procedure Report	With RFC documents	15.9.2
Bridge Load Rating Report	With Record Drawings	15.4.11
As-Built Models	With Record Drawings	15.4.11
Tunnel Work Plan	90 days after NTP1	16.1.8
Tunnel Emergency Response Plan	100 days after NTP1	17.2

Deliverable	Submittal Schedule	Reference Section
Tunnel Operations & Maintenance Manual	120 days prior to Substantial Completion	17.3.3
Tunnel O&M Training Syllabus	120 days prior to Substantial Completion or 30 days prior to training	17.3.2
Protection Plan	Concurrent with Stage 1 design	18.1.11
Utility Adjustment Master Plan	30 days after NTP1	18.5.5
Definitive Design of Operations Document	90 days after NTP1	19.4.1
Post-Delivery Test Plan	With RFC plans	19.5.7.1.6.2
Installation Practices for Outdoor Fiber-Optic Cable Systems Manual	30 day prior to starting installation of the fiber-optic cable plant	19.5.11.9.2
ITS Operations and Maintenance Plan	With RFC plans	19.7.1
Concept of Operations Report	With RFC plans	19.7.1
Maintenance Plan	Nine months prior to opening the O&M segments to the general public	22.4.1
Snow and Ice Control Plan	Prior to July 30 each year	22.2.7.4
Handback Plan	60 months (six years) prior to the Termination Date of the Operating Period	23.1
ATVA Report	Concurrent with Stage 1 Design Documents	24.1.1

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26 STANDARDS AND REFERENCES

Developer shall design and construct the Work in accordance with the relevant requirements of the Project Standards listed in Table 26-1. In some instances, only specific sections of the referenced standard apply, as specified in these Technical Provisions. Section 1.2.3.6 of the PPA provides requirements regarding irreconcilable conflicts, ambiguities or inconsistencies among the Project Standards.

Developer shall use the most current version of each listed standard or reference as of the Setting Date unless expressly stated otherwise in the PPA Documents.

Any standards, manuals and guidelines that are not included within the definition of Project Standards shall be approved prior to use by Developer. Any manuals or documents other than those reflected herein or in the PPA Documents require IFA's prior approval before use in the Work. Obtain advance prior written approval from IFA for any Deviation from the Project Standards, in addition to complying with any other requirements regarding requested Deviations set forth in the PPA Documents.

The design of all Work on the Kentucky Approach, with the exception of the East End Bridge Kentucky Approach Spans, shall conform to the current applicable KYTC standards listed in Table 26-1. The design of all Work on the Indiana Approach and East End Bridge shall conform to current Department standards listed in Table 26-1. The construction of all Work on the East End Crossing shall conform to current Department standards listed in Table 26-1.

Developer shall be responsible to communicate with the applicable Utility Owner to determine the applicable Adjustment Standards for any Adjustment Work.

Table 26-1 Standards and References

Author/Agency	Title
INDOT	Standard Specifications
INDOT	Recurring Special Provisions
INDOT	INDOT Standard Drawings and Recurring Plan Details
INDOT	Design Manual (IDM) including Design Memoranda and Geotechnical Memoranda
INDOT	Approved Materials List
INDOT	Indiana Manual on Uniform Traffic Control Devices (IMUTCD)
INDOT	Traffic Management Strategic Deployment Plan
INDOT	Work Zone Safety Mobility Policy-October 2007
INDOT	Professional Services Contract Administration Manual
INDOT	Sign Design Guide
INDOT	Construction Memorandums
INDOT	Geotechnical Manual
INDOT	Public Involvement Manual
INDOT	Total Storm Management Manual

Author/Agency	Title
INDOT	Utility Accommodation Policy
KYTC	Highway Design Manual (KHDM)
KYTC	Aesthetic Design Guidelines for the Kentucky East End Approach
KYTC	Drainage Manual (KDM)
KYTC	Standard Specifications and Standard Drawings
KYTC	Standard Drawings Manual
KYTC	Highway Design Guidance Manual (HDGM)
KYTC	Special Provisions Technical Advisories
KYTC	Design Manual
KYTC	Professional Services Guidance Manual
KYTC	Traffic Operations Guidance Manual
KYTC	Geotechnical Guidance Manual
KYTC	Traffic Operations Manual
KYTC	Standard Drawings Sepia List
KYTC	Utility and Rail Manual
KYTC	Permits Manual
KYTC	Special Geologic Considerations, GT-609-5 for Acid-Producing Shales
KYTC & KY Environ. and Public Protection Cabinet	Best Management Practices (BMPs) for Controlling Erosion, Sediment, and Pollutant Runoff from Construction Sites – Planning and Technical Specifications Manual
AASHTO	T88, T194 and T289
AASHTO	A Guide for Transportation Landscape and Environmental Design
AASHTO	Guide for the Planning, Design, and Operation of Pedestrian Facilities
AASHTO	Guide for the Development of Bicycle Facilities
AASHTO	A Guide for Achieving Flexibility in Highway Design
AASHTO	A Policy on Geometric Design of Highways and Streets
AASHTO	Roadside Design Guide, 4th Edition
AASHTO	Highway Safety Design and Operations Guide
AASHTO	Roadway Lighting Design Guide
AASHTO	Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, 5th Edition
AASHTO	An Informational Guide for Roadway Lighting
AASHTO	Standard Specifications for Transportation Materials and Methods of Sampling and Testing
AASHTO	Guide Specifications for Structural Design of Sound Barriers
AASHTO	LRFD Bridge Design Specifications, 6th Edition

Author/Agency	Title
AASHTO	Standard Specifications for Highway Bridges, 17th Edition (for checking HS25 load only)
AASHTO	Guide Manual for Condition Evaluation and Load and Resistance Factor (LRFD) Highway Bridges, 2nd Edition with 2011 interim revisions
AASHTO	Guide Design Specifications for Bridge Temporary Works, 1995 with 2008 interim revisions
AASHTO	Geometric Design of Highways and Streets, 6th Edition
AASHTO	Bridge Security Guidelines, 1st Edition
AASHTO/AWS	D1.5M/D1.5:2008 Bridge Welding Code, 2010, 6th Edition with 2011 Interims
FHWA	Flexibility in Highway Design
FHWA	Code of Federal Regulations, Title 23 (Highways), Chapter 1, Part 752 Landscape and Roadside Development
FHWA	FHWA Railroad-Highway Grade Crossing Handbook
FHWA	Manual on Uniform Traffic Control Devices (MUTCD)
FHWA	Standard Highway Signs Book
FHWA	Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes, Volume I & II
FHWA	Alternative Intersection/Interchanges: Informational Report (AIIR) FHWA – HRT-09-060
FHWA	Roadway Lighting Handbook
FHWA	Geotechnical Engineering Circular No. 7: Soil Nail Walls
FHWA	Geotechnical Engineering Circular No. 4: Ground Anchors and Anchored Systems
FHWA	FHWA-NHI-05-046, Earth Retaining Structures
FHWA	FHWA-HI-99-007, Rock Slopes
FHWA	FHWA-NHI-01-023, Shallow Foundations
FHWA	FHWA/NHI 10-016-IF-99-025 Drilled Shafts: Construction Procedures and LRFD Design Methods Manual
FHWA	Technical Manual for Design and Construction of Road Tunnels – Civil Elements, Report No. FHWA – NHI-10-034
FHWA	Program Guide Utility Relocation and Accommodation
ADA	Americans with Disabilities Act Accessibility Guidelines
ANSI A300 (Part 1)	Tree Care Operations – Tree, Shrub and Other Woody Plant Maintenance – Standard Practices
ANSI A300 (Part 2)	Tree Care Operations – Tree, Shrub and Other Woody Plant Maintenance – Standard Practices – Part 2 – Fertilization
ANSI A300 (Part 3)	Tree Care Operations – Tree, Shrub and Other Woody Plant – Standard Practices – Part 3 – Tree Support Systems

Author/Agency	Title
ANSI Z60.1	American Standard for Nursery Stock
ANSI Z133.1	Safety Requirements for Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and for Cutting Brush
ANSI/IESNA RP-8-00	American National Standard Practice for Roadway Lighting
ASTM	Annual Books of Standards
Hortus Third	A Concise Dictionary of Plants Cultivated in the United States and Canada (L. H. Bailey Hortorium, 1976)
IDEM	Indiana Storm Water Quality Manual
IDNR	Indiana Drainage Handbook
IDNR	Guidelines for the Hydrologic-Hydraulic Assessment of Floodplains in Indiana
IEEE	National Electric Safety Code
IES	Roadway Lighting Handbook, RP-8, Addendum: “Designing the Lighting System – Using Roadway Lighting”
IES	DG-5-94, Recommended Lighting for Walkways and Class 1 Bikeways
IES	RP-19-01, Roadway Sign Lighting
IES	RP-22-96, American National Standard for Tunnel Lighting
IES	RP-8-00, American National Standards for Roadway Lighting
IGGA	Guide Specification - Next Generation Concrete Surface (NGCS) Construction on Newly Constructed Roadways
ITE	Manual of Transportation Engineering Studies
ITE	Traffic Engineering Handbook
ITE	Preemption of Traffic Signals Near Railroad Crossings: An ITE Recommended Practice
MSD	Design Manual
JEDEC	Joint Electronic Device Engineering Council
MoDOT	Missouri’s Experience with a Diverging Diamond Interchange
NCHRP	NCHRP Report 480, A Guide to Best Practices for Achieving Context Sensitive Solutions
NCHRP	Report 350. Recommended Procedures for the Safety Performance Evaluation of Highway Features
NEMA	National Electrical Manufacturer Association
NFPA	National Electric Code
NFPA	National Electric Safety Code
NFPA	502-Standard for Road Tunnels, Bridges and Other Limited Access Highways
PTI	Recommendations for Stay-Cable Design, Testing, and Installation
TRB	Highway Capacity Manual

Author/Agency	Title
TRB	NCHRP Report 529, Guideline and Recommended Standard for Geofoam Application in Highway Embankments
	Bellcore Technical Advisories and technical requirements