



TENNESSEE DEPARTMENT OF TRANSPORTATION

Design-Build

Book 2 Contract

Gallatin Pike (SR-6) Safety Project

Gallatin Pike: (Walton to Wiley) and (Liberty to Northside)

Davidson County, Tennessee

Project Identification Number (PIN): **125526.09 (Walton to Wiley)** and **132524.00 (Liberty to Northside)**

State Project Number: **19025-1233-94 and 19025-3233-94 (Walton to Wiley)** and **19S006-F1-006 and 19S006-F3-006 (Liberty to Northside)**

Federal Project Number: **HSIP-6(145) (Walton to Wiley)** and **HSIP-6(155) (Liberty to Northside)**

Contract# **DB2504**

June 2026

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DESIGN-BUILD CONTRACT

This Design-Build Contract is entered into by and between the State of Tennessee (the “State”), acting by and through the Department of Transportation (the “Department”) and [Enter name of Design-Builder] (the “Design-Builder”), (collectively, the “Parties”) as of the Effective Date of the Contract.

RECITALS

WHEREAS, the Department requires the improvements for the project known as the Gallatin Pike (SR-6) Safety Design-Build Project (the “Project”) more particularly described in **Book 3 (Project Specific Information)**. The Project will be funded with federal dollars, thereby requiring that the Design-Builder adheres to all pertinent state, federal, and local requirements; and

WHEREAS, the Parties intend for the Contract to be a lump-sum Contract, obligating the Design-Builder to perform all work necessary to complete the Project by the deadlines specified herein, for the Contract Amount, in accordance with the Contract Documents and subject only to certain specified limited exceptions (the “Work”). To allow the Department to budget for the Project and to reduce the risk of cost overruns, the Contract includes restrictions affecting the Design-Builder’s ability to make claims for an increase to the Contract Amount or an extension of the Completion Deadlines. The Department may require additional related work within the general vicinity of the Project, which, if required, shall be included in the Project and added to the Contract by Change Order; and

WHEREAS, the Department requires a Design-Builder competent to perform all Work necessary to complete the Project in accordance with the terms and conditions of the Contract and able to do so within the Contract Time allocated herein. If the Design-Builder fails to complete the Project within the time limitations set forth in the Contract, then the Department will suffer substantial losses and damages. The Contract therefore provides that a deduction shall be made from monies due the Design-Builder, not as a penalty, but as Liquidated Damages, as stated in **Book 3 (Project Specific Information)**, if such completion is delayed; and

WHEREAS, Design-Builder asserts that it is competent and prepared to perform all Work necessary to complete the Project in accordance with the terms and conditions of the Contract, and that it is able to do so within the Contract Time allotted herein; and

WHEREAS, the Department is authorized under Section 54-1-119 of the Tennessee Code Annotated to enter into this Contract.

NOW, THEREFORE, in consideration of the mutual promises contained herein, and for other good and valuable consideration, the Department and the Design-Builder agree as follows.

AGREEMENT

1 GENERAL CONTRACT PROVISIONS, DEFINED TERMS, AND GENERAL SCOPE OF WORK

1.1 Incorporation of Recitals

The foregoing recitals incorporated herein and made a part hereof for all purposes as if fully set forth constitute additional promises or representations and warranties of the Parties.

1.2 Contract Documents

The Contract Documents, made a part hereof for all purposes as if fully set forth, are intended to reflect the complete understanding of the Parties concerning their respective rights and responsibilities under the Contract.

1.3 Effective Date

The Contract shall become effective on the date on which each Party has signed this Contract and all approvals have been obtained (the "Effective Date").

1.4 The Contract

The Contract, which includes this **Book 2 (Design-Build Contract)** and all other Contract Documents, forms the entire agreement between the Parties.

1.5 Defined Terms and Acronyms

Defined terms and acronyms utilized in this **Book 2 (Design-Build Contract)**, **Book 3 (Project Specific Information)**, and in the other Contract Documents are either set forth in the Department's *Design-Build Standard Guidance*, or defined in the text accompanying the term.

1.6 Applicable Version of Law or Standard

All Work shall be performed pursuant to the applicable law and in accordance with the standards in effect at the time of the RFP issuance, including addenda, unless otherwise specified in the Contract or by amendment.

1.7 Minimum Contract Requirements

1.7.1 Department Supplied

Among the Contract, the Department has mandated certain Contract requirements from which the Design-Builder may not deviate in the scope of the work, except as instructed by the Department. The Department has also established certain minimum Contract requirements that set a minimum standard of performance or quality that the Design-Builder must meet or exceed in performance of the Contract.

1.7.2 Design-Builder Supplied

The Design-Builder has established certain minimum Contract requirements located in Exhibit A (Design-Builder's Technical Proposal), consisting of those provisions of its Proposal that meet or exceed minimum

Contract requirements established by the Department and upon which the Department has relied in awarding the Contract to the Design-Builder.

Any non-standard Department specification or provision shall be considered the Design-Builder-supplied Contract provisions and shall require Department Review and Approval, which will obligate the Design-Builder within this Contract.

1.7.3 Management Plans

Pursuant to the *Design-Build Standard Guidance* and Section 2 of **Book 3 (Project Specific Information)**, the Design-Builder shall submit a Project Management Plan (PMP).

1.8 Right-of-Way/Utility Coordination Services

Right-of-Way (ROW) acquisition and utility coordination services are expected under this Contract. **Book 3 (Project Specific Information)** provides additional information on ROW and utility coordination services needed to complete the Project.

1.9 Design Services

The design services required under the Contract shall include, at a minimum, each of the following:

- Performance of all design services, including, but not limited, to all services and Work detailed in **Book 3 (Project Specific Information)**; and
- Performance of all other engineering design services required under the Contract and/or otherwise necessary to complete the Work in accordance with all Contract requirements.

All Design Documents and Design Reviews shall be provided by the Design-Builder and performed in accordance with the Design Review schedule established in the Critical Path Method (CPM) Schedule, and in accordance with all Contract requirements.

All design services to be performed under the Contract are appurtenant to construction services being provided by the Design-Builder.

1.9.1 License Requirements; Standard of Care

Whether the Design-Builder is a design professional, has a design professional as a member or on staff, or will otherwise provide an outside source to perform the services of a design professional, all design services (whether constituting the practice of architecture, the practice of engineering, the practice of surveying, or the practice of other design services) referred to in this Contract shall be provided by duly licensed and competent design professionals employed or otherwise retained by the Design-Builder.

The design professionals currently designated to provide such design services are listed in Subsection 3.4. All design services shall be performed by a design professional of the appropriate professional discipline in accordance with the degree of skill and care ordinarily used by competent practitioners of the same professional discipline under similar circumstances, taking into consideration the contemporary state of the practice and the project conditions.

1.9.2 Design Documents

The Design-Builder shall generate and provide to the Department all Design Documents. The Design-Builder shall make a comprehensive design check and Design Review at the following five (5) stages of design development, stated in more detail within *Design-Build Standard Guidance*:

- Definitive design;
- Interim design;
- Readiness-for-Construction Plans, Readiness-for-Construction Specifications, and quantity estimates;
- Working Plans; and
- As-Built Plans.

1.9.2.1 READINESS-FOR-CONSTRUCTION PLANS AND SPECIFICATIONS

Upon completion of the Definitive Design Reviews, Working Plan Design Reviews, Interim Design Reviews (if any), and Readiness-for-Construction Design Reviews, as specified in the *Design-Build Standard Guidance*, the Design-Builder shall finalize the Readiness-for Construction Plans and Specifications. In performing these services, the Design-Builder shall meet the following requirements:

- Readiness-for-Construction Plans and Specifications shall comply with all applicable Laws and all Contract requirements.
- Readiness-for-Construction Plans and Specifications shall be a complete, fully coordinated, integrated package, without any significant modifications or further clarifications required.
- The Design-Builder shall file all documents required for the approval of Authorities having jurisdiction over the Project, shall obtain all necessary permits not obtained by the Department, and shall pay for all associated fees, including application, filing, plan review, and appeal fees.
- The Design-Builder shall provide the Department with written certification and all Design Documents required for the Readiness-for-Construction certification, in accordance with *Design-Build Standard Guidance*.
- The Design-Builder shall submit to the Department all documentation and Design Quality Records required under the *Design-Build Standard Guidance*.
- The Design-Builder shall submit to the Department As-Built Plans and the Design-Builder Specifications, compiled and organized in accordance with all Contract requirements that incorporate all changes in the design and construction of the Project.
- The Design-Builder shall prepare and deliver to the Department all As-Built Plans, the Design-Builder Specifications, and other Design Documents, information, and data required under the Contract to be provided to the Department.

1.9.2.2 VALUE ENGINEERING COST PROPOSALS

During development of the Design Documents, the Design-Builder and the Department may collaborate on identifying, evaluating, and implementing value engineering cost proposal (VECP) options in accordance with the *Design-Build Standard Guidance*. The Design-Builder's development of the Design Documents and completion of the Readiness-for-Construction Plans and Specifications shall not preclude further identification and implementation by the Design-Builder and the Department of additional cost reduction

options during construction. VECs adopted by the Department will be implemented through Change Orders pursuant to the *Design-Build Standard Guidance*.

1.10 Construction Services

The construction services required under the Contract shall include, at a minimum, each of the following:

- Performance of all construction services, including, but not limited to, all services and Work detailed in **Book 3 (Project Specific Information)**;
- Protection of environmental resources, including plant and animal life and associated habitats; and
- Performance of all other construction services required under the Contract and/or otherwise necessary to complete the work in accordance with all Contract requirements.

The Design-Builder shall provide all necessary work to furnish to the Department complete, fully functional road improvements specified in the *Design-Build Standard Guidance*, capable of being fully utilized for the purposes described in the Contract and constructed in compliance with all Contract requirements. The Design-Builder shall perform the construction services as follows:

- The Design-Builder shall supervise and administer all construction activities in accordance with Contract requirements.
- In the event of the existence of any dispute between the Parties under the Contract, the Design-Builder shall continue to perform in accordance with the Contract terms and seek resolution in accordance with the *Design-Build Standard Guidance*.
- The construction Work shall be of good quality, free from faults and defects, and in conformance with all Contract requirements. At its own expense, the Design-Builder shall correct construction Work that does not conform to these requirements.
- The Design-Builder shall utilize new materials and equipment in the work, unless otherwise specified in the Contract.
- The Design-Builder shall pay all taxes, fees, and costs associated with the acquisition of tools, equipment, materials, and the performance of the Work, in accordance with the *Design-Build Standard Guidance*.
- The Design-Builder shall keep the work location and its vicinity free from accumulation of waste materials and rubbish caused by the Design-Builder's operations.
- The Design-Builder shall deliver to the Department all notices regarding completion of the Work pursuant to *Design-Build Standard Guidance*, including notifying the Department when the Work or an agreed upon portion thereof has been completed.
- The Design-Builder shall maintain, on the work location, a copy of all approved Management Plans, environmental permits, approved design documents, project records, the entire Contract, and any other document required in accordance with the *Design-Build Standard Guidance*.
- As the Project constitutes "Highway construction" utilizing Federal funds, the Design-Builder shall comply with any federal requirements and appropriate Department Special Provisions as provided by the *Design-Build Standard Guidance* and **Book 3 (Project Specific Information)**, respectively.
- Consistent with the *Design-Build Standard Guidance*, the Design-Builder shall be fully responsible for initiating, maintaining, and supervising safety precautions and programs in connection with the

work, including, but not limited to, taking reasonable precautions to ensure the safety of, and prevention of damage, injury, or loss to:

- Employees of the Department present on or in the vicinity of a work location, employees of the Design-Builder and other persons performing Work on or in the vicinity of a work location, and other persons, including the traveling public, who may be affected;
 - Materials and equipment to be incorporated into the Project;
 - Portions of the Project under construction or completed; and
 - Other property within or adjacent to a work location.
- The Design-Builder shall be liable for damage to or loss of property at work locations and on private property affected by the Design-Builder's activities, pursuant to the *Design-Build Standard Guidance*. This subparagraph shall in no way affect the applicability or coverage of the bonds and insurance required under Section 7 of this Contract.

1.11 Quality Management Services

Quality Management services shall include performance, at a minimum, of all activities and obligations, including preparation of all documentation, described in the *Design-Build Standard Guidance*, and as otherwise necessary to ensure that the Work is performed in accordance with all Contract requirements.

1.12 Project Management Services

Project management services shall be integrated with the design services and construction services described herein and in **Book 3 (Project Specific Information)** and shall include, at a minimum, the following:

- Project Controls (including Risk Management, Scheduling, Design and Construction Quality Management, Reporting and Document Management).
- Design and construction management;
- Contract management;
- Safety management; and
- Traffic management.

2 GENERAL STANDARDS FOR PERFORMANCE OF THE WORK

2.1 Good Faith

The Design-Builder shall provide and perform all design services, Quality Management, project management, and construction services in good faith and as expeditiously as is consistent with the applicable standards of skill and care ordinarily exercised by members of the profession under similar conditions and circumstances and of the orderly prosecution of the Work.

2.2 Performance Standards

Where specific performance standards for any aspect of the Work have been established in the Department Special Provisions as stated in Appendix B, or as pursuant to **Book 3 (Project Specific Information)**, the Work shall be performed so as to meet or exceed such standards.

2.3 Critical Path Method (CPM) Schedule

The CPM Schedule establishes the schedule and deadlines for Contract performance, with which the Design-Builder must comply. The CPM Schedule, as it may be modified during the course of the Project pursuant to the *Design-Build Standard Guidance* and **Book 3 (Project Specific Information)** shall anticipate and accommodate such periods of time as may be required for the Department's review of Design Documents, and for approval by Authorities having jurisdiction over the Project of any required submissions, including but not limited to, applications for permits and environmental impact evaluations. Since time is of the essence in the Design-Builder's successful completion of its assignment, the Design-Builder agrees to begin Work on each work location immediately after receiving authorization from the Department to proceed with its Work efforts.

2.4 Review and Comment, or Acceptance

The Department's consideration, Review and Comment, or Acceptance of any matters, or the Department's authorization of any action, will not be deemed or construed as relieving the Design-Builder of its sole responsibility for, and its complete and exclusive control over, the means, methods, sequences, and techniques for performance of the Work in accordance with the terms of the Contract.

2.5 Extra Work to be Provided by the Design-Builder

The Design-Builder shall perform Extra Work in accordance with the *Design-Build Standard Guidance*.

3 RELATIONSHIP AND ROLES OF THE PARTIES

3.1 Independent Entity

The Design-Builder is an independent entity and not an officer, employee, or agent of the Department.

3.2 Department Representative and Contact Information

The Department's representative for this Project is:

	Jonathan Vogel, P.E.
	Region 3 - Alternative Delivery Representative
Address:	Tennessee Department of Transportation
	6601 Centennial Blvd., Building A
	Nashville, TN 37209
E-mail:	jonathan.vogel@tn.gov
Telephone Number:	615-308-0678

3.3 Design-Builder Representative

The Design-Builder's representative for this Project is:

	<u>[Enter Design Builder's Project Manager Name]</u>
	Design-Builder's Project Manager
Address:	<u>[Enter Design-Builder Name]</u>
	<u>[Enter address line 2, Physical Address]</u>
	<u>[Enter City, State, and Zip Code]</u>
E-mail:	<u>[Enter e-mail address]</u>
Telephone Number:	<u>[XXX-XXX-XXXX]</u>

3.4 Key Personnel and Design Professionals

The Design-Builder's Key Personnel, including its Design Professionals, shall perform the functions established under the Contract for the duration of the Contract and are listed below.

3.4.1 Key Personnel

Design-Builder's Project Management Personnel (Level "1" Personnel) shall consist of the following:

Design-Builder Project Manager:	<u></u>
Design Manager:	<u></u>
Construction Manager:	<u></u>

3.5 Substitution of Key Personnel and/or Design-Professionals

The Parties agree that each Key Personnel, Design Professional, and applicable Subcontractor is unique, and that the Department has relied upon their qualifications in selecting the Design-Builder to perform the Contract. Therefore, the Design-Builder shall not replace any Key Personnel or Design Professional during the term of the Contract. Notwithstanding the foregoing, in those limited circumstances in which the Department elects to consider substitutions, the process shall be governed by the provisions of the *Design-Build Standard Guidance*.

In the event the Department approves a substitution request, the Department retains the right to strictly enforce this Section 3.5 in the event of future requests for substitution. No individual substitution approval or pattern of substitution approvals shall constitute a waiver of this requirement. Should the Department, in its sole discretion, elect to authorize a substitution, such authorization shall not relieve the Design-Builder of its sole responsibility under the Contract to complete all Work and deliver the Project in accordance with all Contract requirements.

4 DATE OF COMMENCEMENT AND COMPLETION OF SERVICES

4.1 Time for Performance

The Contract shall take effect on the Effective Date and shall be performed by the Parties according to its terms, unless earlier terminated, until Final Acceptance by the Department in accordance with the *Design-Build Standard Guidance*.

4.2 Commencement of Services

The Design-Builder is authorized to commence the Work within the Contract for post-award submittals pursuant to the *Design-Build Standard Guidance*. The Design-Builder shall not perform any services beyond post-award submittal until the issuance of first Notice to Proceed (NTP) and for each subsequent phase requiring a Review and Approval NTP.

4.3 Completion Dates

The Design-Builder shall complete all Work to be done under the Contract, except for punch list and plant/vegetation establishment, by [Enter #] Calendar Days after the Effective Date (the "Contract Completion Date").

5 COMPENSATION

5.1 Contract Amount

The Department agrees to compensate the Design-Builder for all Work performed under the Contract for a fixed price of \$[Enter Contract Amount] (the "Contract Amount"). The Contract Amount includes the entire cost of completing the Project in accordance with all Contract requirements as contemplated by the Parties under the Contract, and further includes all contingencies and the Design-Builder's overhead and profit.

5.2 Progress Payments

The Department shall make progress payments to the Design-Builder in accordance with the *Design-Build Standard Guidance*. Progress payments shall be based upon the Design-Builder's Schedule of Items, which shall include the cost of all Work. The Department's payment of progress payments shall not be deemed by either Party to constitute Acceptance or Approval of any Pay Item covered by such payment, or a waiver of a claim or demand for repair of any defects therein.

5.3 Adjustments to the Contract Amount

The Contract Amount shall only be adjusted through issuance of properly authorized Change Orders.

5.4 Payments for Extra Work

The Department will make payments for Extra Work in accordance with the provisions of the *Design-Build Standard Guidance*.

5.5 Deductions from Monies Due

The Department may deduct from monies due or to become due the Design-Builder, as follows:

- Amounts representing price adjustments authorized under the provisions specified in this **Book 2 (Design-Build Contract)** or in **Book 3 (Project Specific Information)**;
- Amounts representing recoupment of damages, including, but not limited to, Liquidated Damages as stated in **Book 3 (Project Specific Information)**;
- Amounts assessed by Authorities (e.g., fines and penalties) for which the Design-Builder is responsible under the terms of the Contract or by law;
- Amounts the Department is compelled by court order or other legal mandate to withhold and/or tender to Authorities or third parties; and

- Any other amounts authorized under the Contract or by law to be deducted.

6 CHANGES IN THE WORK

Changed Work and Extra Work shall be authorized by the Department only under the circumstances set forth in, and pursuant to the terms of, this **Book 2 (Design-Build Contract)** and the *Design-Build Standard Guidance*. The Design-Builder shall not begin performance of any Changed Work or Extra Work until the Department has issued a properly authorized Change Order, and the Design-Builder shall perform all such Work strictly in accordance with the terms of the Change Order.

7 INSURANCE AND BONDING REQUIREMENTS

7.1 Insurance Requirements

During the term of the Contract, the Design-Builder shall maintain in full force, at its own expense and from insurers holding a current certificate of authority to transact the business of insurance in the State of Tennessee, all of the insurance coverages required under the *Design-Build Standard Guidance* and this Section 7.1.

- **Commercial General Liability:** The Design-Builder agrees to maintain commercial general liability insurance to be no less than \$1,000,000 per occurrence, \$2,000,000 general aggregate limit, and \$2,000,000 completed operations aggregate.
- **Professional Liability:** The Design-Builder, being an independent contractor, agrees to maintain professional liability (errors and omissions) insurance in such an amount (\$1,000,000 minimum) and form as are agreeable to the Department.
- **Railroad Protective Insurance:** Not Required.
- **Automobile Liability Insurance:** The Design-Builder agrees to maintain automotive liability insurance to be a combined single limit per policy period of not less than \$1,000,000 per accident or shall be scheduled under the excess or umbrella liability policies. Subcontractors' policies shall have a combined single limit of no less than \$1,000,000 per accident.
- **Worker's Compensation:** The Design-Builder agrees to maintain and shall require all Subcontractors (of all tiers) to obtain and maintain a policy or policies of insurance providing workers' compensation statutory benefits and employer's liability in conformance with the laws of the State.
- **Umbrella or Excess Liability Insurance:** The Design-Builder agrees to maintain an umbrella or excess liability insurance to provide total per occurrence and aggregate limits of not less than \$2,000,000 (including limits provided in any primary policy), that will provide bodily injury, personal injury and property damage liability coverage at least as broad as the primary coverages set forth above, including commercial general liability in excess of the amounts set forth herein.

7.2 Bonding Requirements

During the term of the Contract, the Design-Builder shall maintain in full force, at its own expense and from Sureties licensed to do business in Tennessee and listed on the United States Department of the Treasury Financial Management Service list of approved bonding companies (Circular 570), Performance and Payment Bonds in the full Contract Amount. The Parties understand and agree that the obligation of the Design-Builder's Surety for the faithful performance of the Contract shall include not only all construction, but also the performance of all design services under the Contract.

7.3 Indemnification

The Design-Builder shall, at all times, observe and comply with all applicable federal, state and local laws, ordinances and regulations and shall indemnify and hold harmless the State and all of its officers, agents and servants against any claim of liability or assessment of fines or penalties arising from or based upon the Design-Builder's and/or its employees' or agents' violations of any such law ordinance or regulation.

The Design-Builder shall hold harmless and indemnify the Department for all claims and damages which result from the failure of the Design-Builder to perform its engineering and design duties in conformance with the reasonable standard of care within the State. Said indemnification shall include, but not be limited to, costs for the redesign of plans and the preparations of new specifications as well as the costs for repairs to the construction Work itself.

The Design-Builder shall be responsible for any and all injury or damage to persons or to property arising from the prosecution of the Work and due to any act, omission, neglect or misconduct in its manner or method of prosecuting the Work or due to its non-execution of the Work or due to defective Work or materials. The Design-Builder shall indemnify and hold harmless the State, the Department, and all of its officers, agents, and employees from all suits, actions or claims of any character arising from the Design Builder's acts or omissions in the prosecution of the Work, use of unacceptable materials in constructing the Work, infringement of patent, trademark or copyright, or claims for Workers' Compensation.

If any such suit, action or claim is filed, the Department may retain from the monies due to the Design-Builder under this Contract a sum deemed sufficient by the Department to protect the Department from loss therefrom. Upon resolution of the suit, action or claim, any remaining retained funds will be released.

These requirements of indemnification shall be a continuing obligation of the Design-Builder and shall survive the termination of the Contract regardless of cause.

8 OWNERSHIP AND USE OF WORK PRODUCT OF THE DESIGN

All Work Product of the Design-Builder arising from performance of the Contract shall be the exclusive property of the Department, as more particularly provided for under the *Design-Build Standard Guidance*.

Plans, specifications, and any maps prepared or obtained under the terms of this Contract shall be delivered to and become the property of the Department pursuant to the *Design-Build Standard Guidance*. Basic design notes and sketches, charts, computations, all original drawings, and other data prepared or obtained under this Contract shall be made available, upon request, to the Department without restriction or limitation of their use.

9 PROJECT RECORDS

9.1 Financial and Other Project Records

The Design-Builder shall maintain complete Project Records as described in the *Design-Build Standard Guidance*, in the manner required under the terms of the Contract. The Design-Builder shall keep full and detailed accounts and exercise such controls as may be necessary for proper financial management of the Project. The accounting and control systems shall be satisfactory to the Department.

9.2 Record Retention Period

The Design-Builder shall retain and preserve all Project Records in accordance with the process described in the *Design-Build Standard Guidance* and for a period of 5 years after final payment, or for such longer period as may be required by law (the “Record Retention Period”).

9.3 Access to Records

The Department, the Department’s representatives, and FHWA (if applicable) shall be afforded reasonable and regular access to the Project Records for the duration of the Contract and the Record Retention Period. This requirement to make Project Records available to the Department shall be a continuing obligation of the Design-Builder and shall survive the termination of the Contract regardless of cause.

9.4 Subcontract Record Retention Requirements

The Design-Builder shall require each Subcontractor to retain its Project Records for the Record Retention Period, and to provide equivalent access to Project Records to the Department, the Department’s representatives, and FHWA (if applicable). The Design-Builder shall require each Subcontractor to include in lower-tier subcontracts the same Project Record retention and access requirements.

9.5 Location

The Design-Builder shall maintain all Project Records at the locations required under the terms of the Contract for the duration of the Contract. Subsequent to Contract completion, the Project Records shall be maintained for the Record Retention Period with suitable security, protection against damage and casualty loss, and access to the Department and FHWA (if applicable).

10 TERMINATION OR SUSPENSION

10.1 Termination for Convenience and No Fault; Payment

The Contract may be terminated for convenience by the Department in accordance with Department Standard Specifications, as amended. In such case, the Department will make payment in accordance with the *Design-Build Standard Guidance*. However, the amount to be paid to the Design-Builder shall in no event exceed the Contract Amount.

10.2 Termination for Cause; Amounts Payable

The Contract may be terminated by the Department for default in accordance with Department Standard Specifications, as amended, and the *Design-Build Standard Guidance*. In addition to the acts listed in the above documents the following shall also be considered defaults for which the Contract may be terminated:

- The Design-Builder or its Design Professionals no longer hold the licenses or certificates required to perform the Work or any portion thereof;
- The Design-Builder so fails to perform any agreed-upon portion of the Work or Contract item or applicable standard of care as to materially affect the Design-Builder’s performance under the Contract in accordance with its terms, and such breach, default, or failure is not cured within the requirements of the *Design-Build Standard Guidance*; or
- The Design-Builder made knowing or reckless misrepresentations, concealed facts, or failed to disclose information in Design-Builder’s Proposal. Such shall constitute fraudulent inducements and

shall entitle the Department to recover reliance damages, in addition to any other available remedies to which it may show itself entitled.

In case of termination for cause, the Department will make payment consistent with the payment provisions included in the *Design-Build Standard Guidance* and at the Department's option, including payment for materials left on hand, in accordance with Department Standard Specifications, as amended.

10.3 Contract Notice of Contract Termination

The Department may terminate the Contract, in whole or in part, immediately upon notice to the Design-Builder, or at such later date as the Department may establish in such notice, in accordance with Department Standard Specifications, as amended.

10.4 Quality of the Work

In the event of the Department's termination of the Contract, regardless of reason, the Design-Builder shall remain responsible for the quality of the Work performed through the date of termination.

10.5 Litigation

In the event of litigation instigated by the Design-Builder in accordance with the Contract or by the Department for breach of contract or fraudulent inducement, the Department may pursue both recoupment and set-off in addition to its other available remedies.

11 ENUMERATION OF CONTRACT

The Contract includes the following:

- 1. BOOK 2 (DESIGN-BUILD CONTRACT);**
- 2. BOOK 3 (PROJECT SPECIFIC INFORMATION);**
- 3. DESIGN-BUILD STANDARD GUIDANCE AND ADDENDUM;**
- 4. THE DEPARTMENT STANDARD SPECIFICATIONS;**
- 5. THE DEPARTMENT SUPPLEMENTAL SPECIFICATIONS;**
- 6. THE DEPARTMENT DESIGN GUIDELINES AND ADDENDUM;**
- 7. THE DEPARTMENT CONSTRUCTION CIRCULAR LETTERS;**
- 8. THE DEPARTMENT STANDARD DRAWINGS;**
- 9. THE DEPARTMENT MATERIAL AND TEST STANDARD OPERATING PROCEDURES;**
- 10. EXHIBIT A (TECHNICAL PROPOSAL);**
- 11. CHANGE ORDERS;**
- 12. FORCE ACCOUNT WORK ORDERS;**
- 13. WRITTEN ORDERS AND AUTHORIZATIONS ISSUED BY THE DEPARTMENT;**
- 14. ALL OTHER PROGRAMMATIC PLANS OR ANY OTHER DOCUMENTS; IN ANY FORM, REQUIRED TO BE SUBMITTED TO THE DEPARTMENT PURSUANT TO THE TERMS OF APPLICABLE CONTRACT.**
- 15. ALL MATERIAL INCLUDED BY REFERENCE IN ANY OF THE ABOVE DOCUMENTS.**

12 ORDER OF PRECEDENCE

All Contract Documents are intended to be complementary. Conflicts, if any, will be resolved utilizing the following descending order of precedence.

- 1. BOOK 3 (PROJECT SPECIFIC INFORMATION) AND ADDENDA;**
- 2. BOOK 2 (DESIGN-BUILD CONTRACT), including the Special Provisions listed in Appendix B;**
- 3. THE DEPARTMENT SUPPLEMENTAL SPECIFICATIONS;**
- 4. THE DEPARTMENT STANDARD SPECIFICATIONS;**
- 5. THE DEPARTMENT DESIGN GUIDELINES AND ADDENDUM;**
- 6. THE DEPARTMENT STANDARD DRAWINGS;**
- 7. DESIGN-BUILD STANDARD GUIDANCE;**
- 8. THE DEPARTMENT CONSTRUCTION CIRCULAR LETTERS;**
- 9. ALL OTHER PROGRAMMATIC PLANS OR ANY OTHER CONTRACT DOCUMENTS;**
- 10. ALL MATERIAL INCLUDED BY REFERENCE IN ANY OF THE ABOVE DOCUMENTS.**

13 DESIGN-BUILDER CERTIFICATIONS AND DISCLOSURES

13.1 Nondiscrimination

The Design-Builder shall follow the nondiscrimination provisions as provided in this **Book 2 (Design-Build Contract)**.

13.2 Reserved

13.3 Illegal Immigrants

The Design-Builder shall attest to the Illegal Immigrant provisions as provided in Form AT in Appendix C. The Contract includes a completed/executed Form AT in Appendix C.

13.4 Certification Regarding Debarment, Suspension, and Other Responsibility Matters – Primary Covered Transactions

The Design-Builder shall follow the debarment, suspension, and other responsibility matters provisions as provided in this **Book 2 (Design-Build Contract)**.

13.5 Certification for Grants, Loans, and Cooperative Agreements

The Contract includes a completed/executed Form LC in Appendix C.

The Design-Builder agrees that if any funds other than federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any federal agency, a member of Congress, an officer or employee of Congress, or an employee of a member of Congress in connection with this Contract, the Design-Builder shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.

13.6 Reserved

14 MISCELLANEOUS PROVISIONS

14.1 Employment of Department Workers

The Design-Builder shall not engage, on a full, part-time, or other basis during the period of this Contract, any professional or technical personnel who are or have been at any time during the period of the Contract in the employ of the Department, except regularly retired employees, without the written consent of the Department.

14.2 Covenant Against Contingent Fees

The Design-Builder warrants that it has not employed or retained any company or person other than a bona fide employee working solely for the Design-Builder to solicit or secure this Contract, and that it has not paid or agreed to pay any company or person, other than a bona fide employee working solely for the Design-Builder, any fee, commission, percentage, brokerage fee, gifts, or any other consideration, contingent upon or resulting from the award or making of this Contract. For breach or violation of this warranty, the Department shall have the right to deduct from the Contract Amount or consideration, or otherwise recover, the full amount of such fee, commission, percentage, brokerage fee, gifts, or contingent fee.

14.3 Energy Policy and Conservation Act

Under this Contract, the Design-Builder shall give due consideration to and, as applicable, comply with the standards, orders, and requirements relating to energy efficiency contained in the Department energy conservation plans issued in compliance with the Energy Policy and Conservation Act (P.L. 94-165).

14.4 Additional Employment Regulations

The Design-Builder shall comply with the Vocational Rehabilitation Act of 1973 as approved by Congress on September 26, 1973, herein incorporated by reference, which prohibits employment discrimination against physically handicapped persons. Further, the Design-Builder shall comply with Section 2012 of the Vietnam Era Veterans Readjustment Act of 1974 which requires the Design-Builder to take affirmative action to employ and advance in employment qualified veterans of the Vietnam Era.

14.5 Copyrighting

The Design-Builder shall be prohibited from copyrighting any papers, reports, forms, or other material which is a part of any Work under this Contract without written approval from the Department. Publication rights to any documents produced are reserved by the Department.

14.6 Governing Law; Jurisdiction; Venue

The Design-Builder is assumed to be familiar with and observe and comply with those federal, state, and local laws, ordinances, and regulations in any manner affecting the conduct of the Work and those instructions and prohibitive orders issued by the Department and federal government regarding fortifications, military, and naval establishments and other areas. The Design-Builder shall observe and comply with those laws, ordinances, regulations, instructions, and orders in effect as of the date of this Contract.

This Contract shall be governed by and construed in accordance with the laws of the State. The Design-Builder agrees that it will be subject to the exclusive jurisdiction of the courts of the State in actions that may arise under this Contract. The Design-Builder acknowledges and agrees that any rights or claims against the Department or its employees hereunder, and any remedies arising there from, shall be subject to and limited to those rights and remedies, if any, available under TCA § 9-8-101 through 9-8-407.

14.7 Contract Interpretation

Notwithstanding anything in the Contract to the contrary, no field explanations or interpretations provided by the Department at any meetings, and no comments by the Department on Design Documents or Construction Documents, shall be deemed, construed or interpreted to (a) amend, supersede or alter the terms, requirements, limitations or meaning of any Contract Document or (b) release or relieve the Design-Builder from full responsibility for the design of the Project in accordance with the Contract. However, written interpretive engineering decisions from the designated Department contact person(s) pursuant to the Contract may be relied upon to provide information and interpretations of ambiguous or uncertain requirements set forth in the Contract.

14.8 Notices

Notices to be given hereunder shall be given in writing by personal delivery, facsimile, emailing or mailing the same, postage prepaid, to the Design-Builder or the Department at the addresses or numbers set forth in Sections 3.2 and 3.3, or as either Party may hereafter indicate pursuant to this Section. Any notice delivered by facsimile and email shall be deemed to be received when confirmation of successful transmission is generated by the transmitting machine. Any notice so mailed, personally delivered, facsimile or email transmission shall be the sole responsibility of the Design-Builder to track and confirm receipt by the Department and shall be confirmed by telephone notice to the Department for the Project. Any notice shall be effective as to the Design-Builder upon delivery into the possession of one of the Design-Builder's designated management personnel, and as to the Department, upon delivery to the Department. Regular, day-to-day communications may be transmitted through one of the methods set forth above, in person, by email, or by other similar electronic transmission.

14.9 Disclosure of Tax Identification Number

The Design-Builder shall provide its federal tax identification number to the Department. The tax identification number provided pursuant to this authority will be used for the administration of state, federal, and local tax law.

14.10 Severability

The Parties agree that if any term or provision of the Contract is declared by a court of competent jurisdiction to be illegal or otherwise invalid, the validity of the remaining terms and provisions shall not be affected, and the rights and obligations of the Parties shall be construed and enforced as if the Contract did not contain the particular term or provision held to be invalid.

14.11 No Waiver

The failure of the Department to enforce any provision of the Contract shall not constitute a waiver by the Department of that provision or any other provision of the Contract.

14.12 Media Contacts; Confidentiality

Unless otherwise specifically authorized in writing, the Design-Builder shall provide no news release, press release, or any other statement to a member of the news media regarding this Project without the Department's prior written authorization. The Design-Builder shall require this clause within all Subcontractor agreements.

14.13 Organizational Conflicts of Interest

The Design-Builder shall identify all relevant facts relating to past, present, or planned interest(s) of the Design-Builder's (including the Major Participants, proposed Design-Builder members, and their respective chief executives, directors, and Key Personnel) which may result, or could be viewed as, an organizational conflict of interest in connection with this Project.

The Design-Builder shall disclose:

1. Any current contractual relationships with the Department (including identification of the Department contract number and project manager);
2. Present or planned contractual or employment relationships with any current Department employee;
3. Any current relationships between or among the Design-Builder, the Major Participants, Key Personnel, and/or Design Professionals of the Design-Builder on other Department projects (including identification of the Department contract number and project manager); and
4. Any other circumstances that might be considered to create a financial interest in the Contract by any current Department employee if the Design-Builder is awarded the Contract.

The Design-Builder must also disclose any current contractual relationships where the Design-Builder is a joint venture. The foregoing is provided by way of example and shall not constitute a limitation on the disclosure obligations.

For any fact, relationship, or circumstance disclosed in this Section 14.13, the Design-Builder must identify steps that have been or will be taken to avoid, neutralize, or mitigate any organizational conflicts of interest.

All Organizational Conflicts of Interest shall be addressed on Form COI in Appendix C.

14.14 The Department's Insurance

The State is self-insured, and such insurance shall cover the Department's operations and activities under the Contract.

14.15 Joint Ventures and Partnerships

If the Design-Builder is a joint venture or a partnership, each joint venture member or partner is executing this Contract on behalf of both itself and the Design-Builder, and each joint venture member or partner and Design-Builder shall be jointly and severally liable under this Contract.

14.16 Merger Clause

The Contract constitutes the entire Contract between the Parties on the subject matter addressed herein. The terms of this Contract cannot be waived or amended, in any manner whatsoever, except by written instrument signed by the Parties and containing all required State approvals. Any waiver, if made, shall be effective only in the specific instance and for the specific purpose given. There are no understandings, agreements, or representations, oral or written, regarding this Contract except as contained or incorporated by reference herein.

THIS CONTRACT is executed in three (3) original copies, of which one is to be delivered to the Design-Builder, and the remainder to the Department.

The Design-Builder's authorized representative, by his/her signature below, hereby acknowledges that he/she has read this Contract, understands it, and can affirm that the Design-Builder agrees to be bound by its terms and conditions. This Contract may be executed in several counterparts, each of which shall be an original, and all of which shall constitute but one and the same instrument.

IN WITNESS WHEREOF, the Parties have executed this Contract, which shall be effective as of the Effective Date.

Design-Builder Name: _____

Company Officer Signature

Printed Name and Title

Date

**State of Tennessee
Department of Transportation**

This Contract is accepted on _____ and is effective on _____

Will Reid, P.E., Commissioner

Leslie South, General Counsel
Approved as to Form and Legality

APPENDIX A

RESERVED

APPENDIX B

SPECIAL PROVISIONS

The following table incorporates the Special Provisions by reference for bidding and Project design and construction purposes. These Special Provisions may be obtained from the Department's website at:

<https://www.tn.gov/tdot/tdot-construction-division/transportation-construction-division-resources/construction-special-provisions.html>

Except for the Special Provisions included after the table, the date of the Department's last RFP addendum shall establish the "revision date" for each of the following Special Provisions.

Title	Special Provision #
Unbalanced Bids	102B
Employing and Contracting with Illegal Immigrants	102I
TDOT Standard Specifications for Road and Bridge Construction	102LC
Prohibition of Certain Telecommunication and Video Surveillance Services or Equipment	106B
Environmental Permits	107FP
Lane Closures and Project Completion Liquidated Damages	108B
Payment Adjustment for Fuel	109A
Price Adjustment for Bituminous Material	109B
Settlement Plate Monitoring Devices	203S
Mass Concrete	604MC
Retaining Walls	624
Highway Signs, Luminaires, and Traffic Signals	700SIG
Speed Feedback Sign Assembly	712SFS
Contrast Pavement Markings	716CPM
ITS Specifications	725
Temporary Traffic Control (Signalization)	730A
NDOT Special Provisions	730N

Title	Special Provision #
Equal Employment Opportunity	1230
Debarment, Suspension, etc.	1275
Labor (State Projects Only)	1280
Non-Discrimination in Employment	1290
State Wage Rates	AA-ST RATES

STATE

OF

TENNESSEE

September 16, 2025
County: Davidson
Contract No. DB2504

SPECIAL PROVISION

REGARDING

LANE CLOSURE AND PROJECT COMPLETION LIQUIDATED DAMAGES

All temporary lane closures for the Project must be approved in advance by the Department and local agency (as applicable). Requests for temporary lane closure approvals must be sent at least seven (7) calendar days in advance of the closure date.

Lane closures shall only be allowed between 9:00 AM and 3:00 PM daily and 8:00 PM and 5:00 AM nightly. For each hour, or portion thereof, in which a lane is closed to traffic outside of these allowances, the Design-Builder will be charged **\$1,000.00** per hour (or portion thereof) per lane, not as penalty, but as liquidated damage.

No lane closures will be allowed during Holidays or Holiday weekends in accordance with Section 101.03 of the TDOT Standard Specifications, as directed by the Department.

All lane closures and operations must be coordinated with other construction contracts in the area and additionally meet the requirements of Section 10.4.4 of Book 3.

The Project shall be completed in its entirety, except for the plant establishment and punch list (defined as a listing of instructions for correction of unsatisfactory work, in whole or in part, after an inspection by the Department prior to final acceptance and clean-up not requiring lane closures), on or before the **Contract Completion Date**. For each calendar day after the Contract Completion Date, that all Work specified in the Project is not complete, a sum of **\$1,000.00** per day shall be deducted from monies due the Design-Builder, not as a penalty, but as liquidated damages. The liquidated damage deductions specified in Subsection 108.09 of the Standard Specifications, as amended, for failure to complete the Project on or before the Contract Completion Date, shall not apply to this Project.

Where provisions of this Special Provision conflict with Subsection 108.09 of the Standard Specifications, as amended, this Special Provision prevails.



730N

TENNESSEE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS

Nashville Department of Transportation & Multimodal Infrastructure (NDOT)

Rev. January 2025

Accepted by: _____

Date: _____

**TENNESSEE DEPARTMENT OF TRANSPORTATION
STANDARD SPECIFICATIONS FOR
ROAD AND BRIDGE CONSTRUCTION
January 1, 2021 (Excerpt)**

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SECTION 730N—TRAFFIC SIGNALS

These specifications, Section 730N, are intended as a supplement to Section 730 of the Tennessee Department of Transportation (TDOT) Standard Specifications for Road and Bridge Construction (March 1, 2006, or latest edition). This supplement is applicable to all traffic signal installations within Nashville and Davidson County, Tennessee. The purpose of this supplement is to provide adequate and acceptable technical specifications for the construction procedures and quality of materials that would be in the best interest of safety, convenience, and prosperity of the public. Deviation from these specifications shall be at the discretion of the Nashville Department of Transportation & Multimodal Infrastructure (NDOT). All selected equipment must also be on NDOT's approved Qualified Product List (QPL) unless written approval is provided by NDOT project manager.

730.01—Description of Work.

The work to be performed consists of furnishing and installing all required materials and equipment to complete in-place traffic signal systems and/or modifying existing systems, as shown on approved design Plans, Standard Details, or Special Provisions, and as set forth in these specifications. Unless otherwise indicated on the Plans or specified in the Special Provisions, all materials shall be new.

Where existing systems are to be modified, the existing material shall be incorporated into the revised system, salvaged, or abandoned as specified or as directed by the Engineer.

All incidental parts that are not shown on the Plans or specified herein, and that are necessary to complete the traffic signal or other electrical systems or required for modifying existing systems, shall be furnished and installed as though such parts were shown on the Plans or specified herein. Costs of such incidentals shall be included in the bid price for other items. All systems shall be complete and in operation to the satisfaction of the Engineer at the time of completion of the work. Materials used in any installations must be approved by way of a materials list submission from the Contractor to NDOT.

GENERAL REQUIREMENTS

730.02—Regulations and Code.

All equipment provided must conform to the National Electrical Manufacturers Association (NEMA) Standards Publication, Traffic Control Systems, latest revision, or the Radio Manufacturers Association guidance, whichever is applicable. In addition to the requirements of these specifications, the Plans, and the Special Provisions, all material and work shall conform to the requirements of the National Electric Code (NEC), ASTM International (ASTM), American National Standards Institute (ANSI), Institute of Traffic Engineers (ITE), and International Municipal Signal Association (IMSA); the Manual on Uniform Traffic Control Devices (MUTCD); and applicable local ordinances. Wherever reference is made to the NEC, or the standards mentioned above, consider the reference to mean the code or standard that is in effect on the date of advertisement of the bids or of authorization for force account.

730.03—Submittal Data Requirements.

Within 30 calendar days after the issuance of a work order, the Contractor shall submit to NDOT the manufacturer's **specification documentation** and technical data that fully describe the types of signal equipment the Contractor proposes to use. Descriptive literature shall include the manufacturer, models, etc. and be adequate to determine if the equipment or material meets the requirements of the Plans and these specifications. These sets of submittal data shall include a list of the materials proposed along with descriptive information for, but not limited to, the following items:

- Controller.

- Conflict Monitors and Malfunction Management Unit.
- Cabinet and Exhaust Fan.
- Detectors — Inductive, Video, Radar, etc.
- Signal Heads including Lamp and Light-Emitting Diode (LED).
- Lens Information and Mounting Hardware.
- Loop Wire and Loop Sealant.
- Shielded Detector Cable.
- Signal Cable.
- Communication Cable.
- Cable for Span Wire, Guys, Attachment Hardware, etc.
- Pull Boxes.
- Conduit, Related Fittings, Condulets, and Attachment Hardware.
- Communication Equipment.

The submittal sets shall also include detailed-scale drawings of any non-standard or special equipment and of any proposed deviations from the Plans. If requested to do so, the Contractor shall submit for approval sample articles of any materials proposed for use. NDOT will not be liable for any materials purchased, labor performed, or delay to the work prior to such approval.

Six prints of "Design" or "Shop" drawings indicating the proposed dimensions and material specifications for each of the supports and mast arms involved shall be submitted by the Contractor to NDOT for approval purposes within 30 calendar days after the work order is issued. These drawings, stamped and sealed by an engineer registered in the State of Tennessee, will be reviewed by NDOT at the earliest possible date, and two prints will be returned to the Contractor marked as "Approved for Fabrication" or "Returned for Revisions as Noted." For prints returned for revisions, appropriate action shall be taken by the Contractor to ensure that the earliest possible correction of these items can be achieved so as not to delay the installation.

730.04—Mill Test Reports and Certifications.

A Mill Test Report or Certification of Conformance to the Specifications for Materials and Design shall be required for all materials incorporated into the work. The following shall be supplied by the Contractor prior to acceptance of the structures:

1. A Mill Test Report for **major** structural items only, as noted in Chart 1, which shall include both physical and chemical descriptions of the material as supplied to the fabricator. When physical properties are altered during the fabrication, the Mill Test Report covering chemical composition shall be supplemented by a certified test report indicating the physical properties of this material after fabrication.
2. Certification of Conformance to the Specifications for all remaining materials not covered by a Mill Test Report as noted in Chart 1.
3. Certification that all welding was performed by operators qualified as follows: steel welders qualified by American Welding Society (AWS) and aluminum welders qualified by American Society of Mechanical Engineers (ASME).
4. Certification of Conformance to the Specifications for the design of all components not completely dimensioned and detailed on the "Standard" drawing.

CHART 1

Component Materials	Mill Test Report	Certification
Tubes for arms and poles	X	
Base castings	X	
Anchor bolts	X	
Pole tops, miscellaneous fittings and hardware		X
Fabricated or cast-type arm connections		X
Galvanizing		X

730.05—Working Drawings.

The Contractor shall provide within the controller cabinet and to NDOT an electrical schematic diagram of the cabinet system wiring and one set of As-Built/Red-Line drawings depicting any field modifications. Manufacturer's instructions for installation, maintenance, and operation of all equipment and components shall also be submitted to NDOT and placed within the controller cabinet. All materials placed in the cabinet shall be mounted in the cabinet inside a plastic envelope.

730.06—Warranty.

The traffic signal system(s) installed under these specifications, including all equipment, parts, and appurtenances in connection therewith, shall be warrantied to NDOT by the Contractor against defective workmanship and materials for a period of not less than one year following the date the signal system is made operational, except in no case shall this warranty expire prior to one year after the final acceptance of the project. Upon completion of the project, warranties on equipment and materials that are offered by the manufacturers as normal trade practice and have not expired shall be turned over by the Contractor to NDOT. At this time, the Contractor should request a written Letter of Acceptance from NDOT for the installation.

730.07—Training.

If requested, the Contractor shall provide to NDOT a training session for the controller and associated cabinet equipment to be supplied by the project. The Contractor shall be notified in advance if training will be required. The training session will last for a minimum of two calendar days unless NDOT determines a lesser time is adequate. The training shall be of a level to train the user in the complete operation and programming features of all controllers. The Contractor shall provide this training at a facility agreed upon by NDOT. The Contractor shall provide the training prior to the acceptance of the project. After the required training, the Contractor shall certify to the Engineer that training has been completed.

This training requirement shall not apply if a training program meeting these criteria has been accomplished by the vendor and/or manufacturer of the equipment being bid within 18 months previous to the date of the invitation to bid but shall apply if the bidder is proposing new, upgraded, or modified equipment not covered in such previous training program.

MATERIALS AND INSTALLATION

730.08—Excavating and Backfilling.

The excavations required for the installation of conduit, foundations, and other equipment shall be performed in such a manner as to cause the least possible damage to streets, sidewalks, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical equipment and foundations. Excavating activities shall not be performed until immediately before installation of conduit

and other equipment. The material from the excavation shall be placed in a position where the least disruption and obstruction to vehicular and pedestrian traffic and the least interference with the surface drainage will occur. Trenches shall be graded level with suitable backfill prior to laying the conduit in the trench.

The excavations shall be backfilled and compacted to at least the density of the surrounding material. All surplus excavation material shall be removed and disposed of by the Contractor outside of the highway right-of-way, in accordance with these specifications or as directed by the Engineer.

Excavations, after backfilling, shall be kept well filled and maintained in a smooth and well-drained condition until permanent repairs can be made.

At the end of each day's work, and at all other times when construction operations are suspended, all equipment and other obstructions shall be removed from that portion of the roadway used by public traffic and parked a minimum of 30 feet (ft) from the edge of pavement unless otherwise protected by guardrail, bridge rail, or barriers installed for other purposes. Any sidewalks damaged during construction shall be traversable by pedestrians at the end of each day's work. Repair to these sidewalks shall be in accordance with NDOT's specifications.

Excavation in the street or highway shall be performed in such a manner that not more than one traffic lane shall be restricted in either direction at any time. Traffic shall not be obstructed during hours of peak flow unless approved otherwise by the Engineer or NDOT's Permits Office. Construction signage shall be incorporated in accordance with the provisions of the MUTCD.

730.09—Removing and Replacing Improvements.

Improvements, such as sidewalks, curbs, gutters, Portland cement concrete and asphalt concrete pavement, bituminous surfacing, base material, and any other improvements removed, broken, or damaged by the Contractor, shall be replaced or reconstructed with the same kind of materials. All replacement shall be in accordance with NDOT standards and specifications.

The outline of all areas to be removed in Portland cement concrete sidewalks and in all pavements shall be cut to a minimum depth of 2 inches with an abrasive-type saw prior to removing the sidewalk and pavement material. Cuts for the remainder of the required depth may be by any method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as specified above.

All work shall be done in accordance with these specifications, or any local ordinance that may apply, whichever is of a higher standard. The cost of this removal and replacement is to be included in the bid price for other contract items.

730.10—Foundations.

Foundations for posts, standards, and cabinets shall be Class A, Portland cement concrete. All foundations shall include a spare conduit, of a size specified on the Plans, stubbed out parallel to the road.

Foundations for posts, standards, and pedestals shall be poured after the post, standard, pedestal, or anchor bolts or reinforcing steel is in proper position. The exposed portions shall be formed to present a neat appearance. The bottom of concrete foundations shall rest on firm, undisturbed ground. Each foundation shall include one extra 2-inch conduit.

Forms shall be true to line and grade. Tops of footings for posts and standards, except special foundations, shall be finished to curb or sidewalk grade or as ordered by the Engineer. Forms shall be rigid and securely braced in place. Conduit ends and anchor bolts shall be placed by means of a template until the concrete sets. Both forms and ground that will be in contact with the concrete shall be thoroughly moistened before placing concrete. Forms shall not be removed until the concrete has cured for at least 12 hours and hardened sufficiently to allow firm removal without causing damage to the concrete.

Ordinary surface finish shall be applied to exposed surfaces of concrete. Wherever the edge of a concrete foundation or sidewalk section is within 18 inches of any existing concrete improvement, the sidewalk section shall be extended to meet said existing improvement. Any sidewalk construction or repair shall be in accordance with NDOT standards.

Where obstructions prevent construction of planned foundations, the Contractor shall construct a foundation satisfactory to the Engineer.

730.11—Anchor Bolts.

Anchor bolts meeting the requirements of ASTM F 1554, grade 55 or other high-strength steel anchor bolts having a minimum yield strength of 55,000 pounds per square inch (psi) and a minimum ultimate strength of 90,000 psi, each fitted with one regular hex nut and one heavy-duty square nut, shall be furnished with anchor-base type poles. All nuts and not less than 10 inches of the threaded ends of anchor bolts shall be hot-dip galvanized in accordance with ASTM F 153. The anchor bolts shall be capable of resisting at yield strength stress the bending moment of the shaft.. No exposed anchor bolts shall be allowed when work is not in progress. Exposed anchor bolts could pose a hazard to pedestrians.

Plumbing of standards, posts, and pedestals shall be accomplished by adjusting the nuts before the foundation is finished to final grade. Shims or similar devices for plumbing or raking will not be permitted. After plumbing or raking has been completed, anchor bolts shall be cut off ¼ inch above the top nut and the exposed surface painted with rust-protective paint.

Anchor bolts and nuts required for relocating existing standards and posts shall be furnished by the Contractor. Anchor bolts for signal poles shall meet NDOT's minimum diameter standards.

730.12—Pull Boxes, Type B Traffic.

Pull boxes shall have a minimum dimension of 32¼ inches x 19¼ inches x 18 inches and be constructed and installed as shown on the Plans and standard drawings or as directed by the Engineer. Additional pull boxes may be required where conduit runs are more than 150 ft long. Pull boxes shall be installed wherever practicable out of the line of traffic. Covers shall be level with the pavement, the curb or sidewalk grade, or the surrounding ground as required. Each pull box shall include one extra 2-inch conduit.

Electrical conductors shall be placed within pull boxes in such a manner as to be clear of the frame and cover.

The bottom of the pull box shall rest firmly on a bed of crushed stone with a minimum depth of 12 inches below the bottom, and extending 6 inches beyond the outside edge of the pull box, unless otherwise specified by the Engineer.

The frame shall have a minimum weight of 42 pounds (lbs). The cover shall be of the "Extra Heavy" type with a minimum weight of 54 lbs.

1. All pull boxes shall meet Tier 22 requirements.

- A. If other than concrete, pull boxes shall be composed of reinforced plastic or epoxy mortar.
- B. Shall be designed and tested to a temperature of -50 degrees Fahrenheit (°F).
- C. Shall meet the requirements of ASTM D 543, ASTM D 570, ASTM D 790, and ASTM D 635.
- D. Shall be based on a vertical design/test load of - 22,500 lbs/33,750 lbs.
- E. Loadings shall comply with ANSI 77 2002 and shall meet Tier 22 test provisions for both the cover and sidewall.
- F. The word "TRAFFIC" or the words "TRAFFIC SIGNALS" shall be inscribed on top of the covers.

730.13—Fiber Optic Pull Boxes.

Fiber optic pull boxes must be properly grounded according to NEC, Electronic Industries Alliance (EIA)/Telecommunications Industry Association (TIA), and Bellcor (Telcordia) standards. All splice points shall contain sufficient slack (50-ft minimum) to allow for future addition of communication devices, cable and splice repairs, or additional runs of "drop" cable. Sizes for fiber optic pull boxes shall be determined based on the number of cables in the system. Pull boxes shall be required on each side of a street or railroad crossing.

Type A Pull Box with Cover. The pull box shall meet the following requirements:

- 1. Minimum dimensions: 36-inch x 26-inch x 32-inch exterior pull box and cover shall be precast composite polymer concrete product. Pull boxes with a polymer cover but other material for the box will **not** be accepted.
- 2. Pull boxes and covers shall be single-stack, open-bottom assemblies configured as shown on the Plans.
- 3. Vertical design/test load: -22,500 lbs/33,750 lbs. Loadings shall comply with ANSI 77 2002 and shall meet Tier 22 test provisions for both the cover and sidewall.
- 4. Pull boxes shall meet current NEC requirements for handhole enclosures.
- 5. Pull box covers shall be labeled (NDOT ITS COMMUNICATIONS) with 3-inch letters.
- 6. Installation shall be as per guidelines of the TDOT Standard Specifications for Road and Bridge Construction, latest version. Pull boxes and covers shall be installed per the design details.
- 7. Pull boxes will be measured in units of each and paid for at the contract price per each after the complete installation. The price bid shall include furnishing and installing the pull box and cover including excavation, gravel, restoration, and miscellaneous materials necessary for a complete and accepted installation. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Type B Pull Box with Cover. The pull box shall meet the following requirements:

- 1. Minimum dimensions: 49-inch-wide x 32-inch-long x 36-inch-diameter exterior.
- 2. Pull boxes and covers shall be precast composite polymer concrete product. Pull boxes with a polymer cover but other material for the box will **not** be accepted. Note this is a different pull box than shown in TDOT standard drawings.
- 3. Pull boxes and covers shall be single-stack, open-bottom assemblies configured as shown on the plans.
- 4. Vertical design/test load: -22,500 lbs/33,750 lbs. Loadings shall comply with ANSI 77 2002 and shall meet Tier 22 test provisions for both the cover and sidewall.
- 5. Pull boxes shall meet current NEC requirements for handhole enclosures.
- 6. Pull box covers shall be labeled (NDOT ITS COMMUNICATIONS) with 3-inch letters.
- 7. Each pull box shall come equipped with four cable racks and 12 rack hooks. The cable racks shall be a minimum of 24 inches and the rack hooks shall be a minimum of 7 inches in length. The cable racks and rack hooks shall be hot-dipped galvanized steel.

8. Installation shall be per guidelines of the TDOT Standard Specifications for Road and Bridge Construction, latest version. Pull boxes and covers shall be installed per the design details.
9. Cable racks and rack hooks shall be installed in accordance with the manufacturer's recommendations.
10. Ducts shall enter the side of the pull box using a terminator and shall extend into the box no more than 4 inches and no less than 2 inches.
11. Pull boxes shall be measured in units of each and paid for at the contract price per each after the complete installation. The price bid shall include furnishing and installing the pull box and cover including excavation, gravel, restoration, cable rack rails and hooks, terminator rings, and miscellaneous materials necessary for a complete and accepted installation. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Terminator Ring. The terminator ring shall meet the following requirements:

1. Shall accommodate the number of ducts penetrating into the side of the pull box.
2. Shall mount securely to the side of the box. The terminator shall be a minimum of 1 inch thick and allow adequate spacing of the ducts.
3. Shall be manufactured from a composite material that will not deteriorate in any type of weather conditions.
4. Shall be installed in accordance with the manufacturer's recommendations.
5. Shall be included in the measurement and payment of the Type A pull boxes, Type B pull boxes, and manhole and will not be measured separately for payment.

Payment. The contract unit price shall be full compensation for all work specified in this section. Payment shall be made under:

Item No.	Description	Unit
730.03.23	Install Pull Box (Fiber Optic – Type A)	Each
730.03.24	Install Pull Box (Fiber Optic – Type B)	Each

Pull boxes shall be paid per each as follows:

Stored materials shall be paid per TDOT Standard Specifications.

Final payment shall be made after complete installation and testing.

730.14—Transformer Base.

The transformer base shall be fabricated from steel plate and sheet and designed to harmonize with the shaft. Each transformer base shall be provided with, at a minimum, a 7½- x 9-inch handhole with cover secured with stainless-steel fastening screws; four galvanized steel-bearing plates to fasten the base to the anchor bolts; four galvanized steel bolts, nuts, and washers to fasten base and standard; and a 0.5-inch, 13 UNC grounding nut welded to the inside of the base opposite the handhole opening. The strength of the transformer base shall be comparable with that of the shaft. When a transformer base is required, no handhole shall be required in the shaft.

730.15—Conduit.

Furnishing and installing plastic and steel conduit shall be in accordance with these specifications and in close conformity with the lines shown on the plans or as established by the Engineer.

Threads shall be clean cut, straight, and true, and of sufficient length to permit proper coupling; long-running threads will not be permitted on any part of the work. Threads shall be protected in transit and during installation, and conduit shall be provided with proper supports and protection during construction to prevent injuries. All ends of pipe installed for future connections shall be properly threaded, reamed, and capped to

prevent water and foreign matter from entering the conduit system. Sections shall be made up with red lead, so that ends of conduit will butt together. Threaded ends shall be provided with approved conduit bushings. Conduits for fiber optic cable shall be clear of obstructions. Water-based lubricants shall be used to reduce the potential for outer sheath corrosion.

Signal conduit shall be 2 inches in diameter, and detector conduit 1 inch in diameter, unless otherwise indicated. Conduit for service connections shall be 1 inch in diameter. Conduit shall be 2 inches in diameter for street lights and for communication cable. Conduits smaller than 1 inch in diameter shall not be used unless otherwise specified, except grounding conductors at service points shall be enclosed in ½-inch-diameter conduit. The Contractor may, at its own expense, use large size conduit, in which case it shall be for the entire length of the run with no reducing couplings permitted. There shall be one extra 2-inch conduit provided in each foundation and pull box.

Materials. Types of conduits and fittings used shall be as follows:

1. Steel Conduit.
 - A. Rigid conduit and fittings shall be heavy-wall, hot-dipped galvanized steel conforming to Federal Specification WW-C-581-d(3) and ANSI-C 80.1. The conduit shall be galvanized inside and out and shall meet the requirements of ASTM A 53. Each length shall bear the label of Underwriters Laboratories, Inc. (UL).
 - B. Flexible conduit shall be galvanized, flexible steel meeting Federal Specification WW-C-581-d(3), ANSI C-80.1, and UL Standard No. 6 with a minimum of 40-mil-thick polyvinyl chloride (PVC) coating conforming to ASTM D 746.
 - C. Fiber optic conduits shall be in accordance with ASTM F 2160.
2. Plastic Conduit. Plastic conduit shall be high-impact PVC, Schedule 80.

Installation. All bends shall be in strict compliance with the NEC.

Conduits shall be laid to a depth of 6 inches below subgrade but not less than 24 inches below pavement grade except when approved by the Engineer; conduit may be laid at a depth of not less than 24 inches below the top of the curb when placed in the back of the curb. Conduit runs for detectors shall be parallel to existing or proposed curbs and not more than 18 inches behind the curb face unless other specified. Steel conduit or Schedule 80 PVC conduit shall be placed under existing pavements by approved jacking or drilling methods. Pavements shall not be disturbed without the approval of the Engineer. Where trenching is allowed in a traffic-bearing area, PVC conduit (Schedule 80) encased in concrete shall be used.

All conduits shall have a Teflon™ pull line installed for future use and a No. 14 solid American Wire Gauge (AWG) locating wire installed and terminated in the controller cabinet on one eight position isolated ground bar labeled Locating Buss. Locating wire shall be capped off and identified in all handholes and pull boxes.

After installation of the conduit is completed, all conduits installed under this contract shall be tested with a mandrel having a diameter ¼ inch smaller than the conduit and a length of 2 inches. All conduits that will not allow passage of the mandrel shall be repaired to the satisfaction of the Engineer; if repairs cannot be made, the conduit shall be removed and replaced at no additional cost to NDOT. After the mandrel test, all conduits shall be scoured with a stiff wire brush slightly larger in diameter than the conduit. The Contractor shall clear all conduits in the presence of the Engineer or the Engineer's representative.

Conduits terminating in anchor base standards and pedestals shall extend approximately 2 inches above the foundation and shall be sloped toward the handhole opening. Conduits shall enter pull boxes from the bottom

and shall terminate not less than 4 inches nor more than 6 inches above the bottom of the box and near the box walls to leave the major portion of the box clear.

Existing underground conduit to be incorporated into a new system shall be cleaned by blowing with compressed air, or by other means approved by the Engineer.

730.16—Fiber Optic Conduit.

General Requirements

All continuous flexible conduit products and structure-mounted multi-cell conduit shall meet the requirements specified herein. All continuous flexible conduit and structure-mounted multi-cell conduit shall have been manufactured and labeled no earlier than in the sixth calendar month preceding NDOT's award date of the contract.

Continuous Flexible Conduit (Conduit Duct Bank)

1. Continuous flexible conduit shall be manufactured from virgin high-density polyethylene (HDPE) resin compound with a minimum cell classification of PE 345434C for PE 3408 materials in accordance with ASTM D 3350.
 - A. Physical and Mechanical Properties and Test Methods
 - (1) Tensile strength at yield – minimum of 3,000 psi in accordance with ASTM D 638.
 - (2) Density – minimum of 0.941 grams per cubic centimeter in accordance with ASTM D 4883/1505.
2. Conduit shall be extruded from colored material for uniform full-thickness coloring.
3. All continuous flexible conduit shall be labeled with durable identification providing the name of the manufacturer, conduit size (inner diameter trade size and wall thickness/rating), manufacturer/date codes, the NDOT legend, and sequential foot marking. Labeling shall occur a maximum of every 2 feet.
4. Conduit to be used in bends and sweeps shall have a minimum burn through time of 30 minutes when tested in accordance with Generic Requirement GR-356-CORE, Issue 1, October 1995.
5. The conduit manufacturer shall have a documented Quality Control/Assurance System.
6. All conduit used on this project shall conform to the color scheme and use described below:
 - A. Conduit Bank Type 3
 - (1) Orange (Trunk Fiber).
 - (2) Blue (Drop Fiber).
 - (3) White (Spare).
 - B. 2-inch Electrical Conduit
 - (1) Gray (Electrical Wire).
7. 1¼-inch conduit shall conform to ASTM D 3035 and meet the following requirements:
 - A. Smoothwall Standard Dimension Ratio (SDR) 11.
 - B. Nominal outer diameter: 1.660 inches.
 - C. Minimum inner diameter: 1.313 inches.
 - D. Minimum wall thickness: 0.151 inch.

Whenever 1¼-inch conduit is used, three 1¼-inch conduits shall be bored.

8. 2-inch conduit shall conform to ASTM D 3035 and meet the following requirements:
 - A. Smoothwall SDR 11.
 - B. Nominal outer diameter: 2.375 inches.
 - C. Minimum inner diameter: 1.885 inches.
 - D. Minimum wall thickness: 0.216 inch.

9. Coupling

- A. Every effort should be made to minimize coupling. Couplings are permitted only with the Engineer's prior approval.
- B. Couplings shall be airtight and watertight. All couplings shall be installed in accordance with the conduit and the coupling manufacturer recommendations. Only couplings of the type specified below and approved by the conduit manufacturer are permitted.
- C. Couplings shall be accomplished only by hydraulic press-on or electro-fusion coupling methods:
 - (1) Use hydraulic press-on couplings of seamless, tool-grade, tubular aluminum with sealing ring barbs and center stop.
 - (2) Use hydraulic compression duct coupling tools and follow all manufacturer installation procedures, fully inserting both conduit sections to the coupling center stop.
 - (3) Use pre-fabricated electro-fusion couplings that are field-installed using the coupling manufacturer's recommended automatic self-monitoring fusing machine and installation procedures.
 - (4) Do not use any other coupling methods.

Conduit Detection Wire. Conduit detection wire shall be No. 10 AWG stranded copper orange-insulated THHN-THWN conductor.

Pull Tape. The pull tape for cable installation shall meet the following requirements:

- 1. 1,250-lb tensile strength.
- 2. Flat, not round, construction.
- 3. Printed sequential foot markings.
- 4. Pre-lubricated for reduced pulling tension at start of cable pull.
- 5. Low susceptibility to absorption of moisture; moisture resistant.

Duct Plugs. Duct plugs shall meet the following requirements:

- 1. Duct plugs intended for underground telecommunications infrastructure shall be installed on conduits.
- 2. Duct plugs shall be sized to fit the conduits and cables with which they are used.
- 3. Duct plugs shall provide watertight and airtight gasketed seals by use of mechanical expansion of the duct plug body and gasket. No sealants or caulks shall be used.
- 4. All metallic components of duct plugs shall be stainless steel.
- 5. Blank duct plugs shall be used to seal spare conduits and shall have inner rings to which pull tape can be tied.
- 6. Cable duct plugs shall be used to seal conduits that contain a cable. The plug shall be sized to fit the conduit and cable with which it is used and shall be a split plug with a bushing assembly for sealing around the cable by mechanical compression.

Installation Requirements. All material installed shall follow the guidelines below and in the following sections:

- 1. Blank duct plugs shall be used to seal the ends of all conduit immediately upon conduit placement. This includes, but is not limited to, intermediate/incomplete sections of conduit prior to conduit splicing or termination in pull boxes and empty conduits in pull boxes prior to cable installation.
- 2. Conduit shall be installed in a straight-line, horizontal path between pull boxes except where shown otherwise in the Plans.

Continuous Flexible Conduit (Conduit Duct Bank)

1. Conduit duct banks shall be installed by configuring individual continuous flexible conduits into a continuous duct bank from termination point to termination point as shown in the Standard Details and other Contract Documents.
2. Continuous flexible conduit installation in earth shall be trenched, horizontal directional bored or drilled, or plowed at the Contractor's discretion, unless otherwise noted on the Plans, at a minimum depth of 30 inches from the top of the conduit.
3. All continuous flexible conduit located under the paved roadway as shown on the plan sheets shall meet the following requirements: the conduit shall be placed at a minimum depth of 30 inches; backfill shall meet NDOT standards for a paved roadway; and all areas shall be completely restored daily according to the time frames set in the approved Traffic Control Plan.
4. All conduit underneath railroad tracks shall be horizontal directional bored or drilled at a minimum of 10 ft below the railroad bed. It is the Contractor's responsibility to determine any additional requirements of the railroad owner and to meet those requirements in addition to those included in the Plans and these specifications. Any required steel casings or other materials needed to meet the railroad authority requirements shall be included in the cost of the conduit.
5. All conduit to be installed under streams shall be horizontal directional bored or drilled. No open trenching through an area deemed to be a current or wet weather stream shall be allowed. All conduit bored under streams shall be a minimum depth of 5 ft below the stream bed.
6. Bore logs shall be required for each bore location.
7. The Contractor shall submit a proposed bore log format to the Engineer for review and approval.
8. If a drainage or utility conflict arises, the Contractor shall submit a plan for resolving the conflict to the Engineer for review and approval.
9. Every effort should be made to minimize the use of couplings. Couplings are permitted only with the Engineer's prior approval.
10. Conduit shall be placed in the straightest orientation possible, reducing bends, twists, rises, and waves. Conduits shall be held in place during backfilling when necessary to keep straight and at the proper depth. Where field conditions require the trench to change direction and bends are necessary, the bends shall be formed in the trench, should be smooth and even, and shall not have less than a 4-ft radius (as measured to the inside surface of the conduit).
11. Every conduit should be tested after it is installed and before cable or pull tape is installed. Testing shall be performed on all conduit types in these specifications, including but not limited to each cell of multi-cell conduits and each conduit in duct banks. All testing shall be performed using the procedures and mandrel size recommended by the conduit manufacturer. Testing shall be performed in the presence of the Engineer. Payment for all testing shall be included in the cost of the conduit.

Rigid Galvanized Steel Conduit

1. Exposed conduit runs shall be 2-inch rigid galvanized steel unless otherwise required by the Plans.
2. All conduit runs on structures and poles shall be properly terminated into the respective device, or a duct seal shall be installed so as to seal the conduit from moisture, insects, rodents, and other foreign material. The costs of the galvanized steel conduit and all associated fittings shall be included in the cost of other items.
3. Bushings shall be installed in conduit at all exposed conduit terminations for protection of the conductors.

Conduit Detection Wire

1. One conduit detection wire shall be installed within all conduits. Conduit detection wire is required with all conduits installed by any installation method, including trenching, directional boring, or plowing.

2. Only one conduit detection wire is required per installed conduit segment regardless of the number of conduits installed in that segment.
3. Conduit detection wire shall be installed inside the conduit.
4. Conduit detection wire is not required for structure-mounted conduit, except where underground segments of structure-mounted conduit are greater than 20 ft in length.
5. Conduit detection wire is not required for conduit segments between pull boxes and pole/sign structure foundations, except where conduit segments are greater than 20 ft in length.
6. The conduit detection wire shall be continuous and unspliced between pull boxes and shall enter the pull boxes at the same location as the conduit with which it is installed, entering under the lower edge of the pull box.
7. In each pull box or vault, 4 ft of conduit detection wire shall be coiled and secured.
8. Testing
 - A. A continuity or tone test shall be performed after installation to confirm that a continuous run of conduit detection wire was installed between pull boxes or vaults.
 - B. A test plan shall be prepared for supplying equipment, conducting the test, and documenting the results. The test plan shall be submitted to NDOT at least 15 working calendar days prior to the desired testing date. Testing shall not begin until the Engineer has approved the test plan, and all tests shall be conducted in the presence of the Engineer.

Pull Tape

1. Install pull tape into each empty conduit and empty cell within a multi-cell conduit.
2. Install the pull tape after conduit testing has been completed.
3. Install and secure 5 ft of slacked pull tape in each empty conduit or cell at each pull box.
4. Secure the pull tape by tying it to the blank duct plug for the conduit in which it is installed.

Duct Plugs

1. Install blank duct plugs in each empty conduit that enters a pull box, ground-mounted cabinet, pole foundation, hub, or building entrance.
2. Install cable duct plugs in each conduit containing fiber optic, cat5 or 6 cable, or Radar Detection System (RDS) communications cable that enters a pull box, ground-mounted cabinet, hub, or building entrance.
3. Do not install cable duct plugs on conduits containing power service conductors.

Spare Conduits in Foundations

1. A minimum of one 2-inch spare conduit shall be installed in all pole foundations, and a minimum of two 2-inch conduits shall be installed in the base of all ground-mounted cabinets.
2. Spare conduits shall be sealed with blank duct plugs.

Measurement. All conduit material shall be measured based on the guidelines in the following sections. All conduit types shall be measured in linear feet per type to the nearest foot. All conduit types shall be measured along the conduit as follows:

1. Measurements will be made from center of pull box to center of pull box.
2. No additional measurement will be made for vertical conduit inside the pull box or structure.
3. No additional measurement will be made for conduit between a pull box and the nearby pole or structure.

Continuous Flexible Conduit (Conduit Duct Bank)

1. Unless otherwise specified in the Plans, all costs for trenching, installation, backfilling of trench, plowing, directional boring, restoration, materials including pull tape, duct plugs, fittings, conduit

- detection wire, testing, bore logs, and other accessories and hardware necessary for installation of the conduit system shall be included in the overall cost of the conduit or conduit duct bank.
2. Continuous flexible conduit installation in the earth or the shoulder shall be trenched, horizontal directional bored or drilled, or plowed at the Contractor's discretion, unless otherwise noted on the Plans.
 3. All conduit to be installed under streams shall be horizontal directional bored or drilled. No open trenching through an area deemed to be a current or wet weather stream shall be allowed.
 4. Continuous flexible conduit (conduit duct bank) shall be measured by linear foot for each type of conduit bank after installation and shall include the type and number of conduit indicated below:
 - A. Conduit Bank: Three 1¼-inch continuous flexible conduits.
 - B. 2-inch Conduit: One 2-inch continuous flexible conduit or PVC Schedule 40 conduit.
 - C. 2-inch Conduit with Bank: One 2-inch continuous flexible conduit installed in the same trench as the related conduit bank type as specified on the plan sheet.
 - D. Conduit Bank Bored: Three 1¼-inch continuous flexible conduits.
 - E. 2-inch Conduit Bored: One 2-inch continuous flexible conduit.

(Note: Separate encasement for borings is not required unless necessary for proper installation due to poor soil conditions. If encasement is needed in those situations, the cost of the encasement shall be included in the cost of the conduit.)

Rigid Galvanized Steel Conduit. Rigid galvanized steel conduit and related materials, including but not limited to couplings, mounting straps, bonding to ground, etc., that are installed on sign structures, on poles, or between the pull boxes and equipment cabinets are included in the cost of other items and will not be measured separately.

Conduit Detection Wire. Conduit detection wire is included in the cost of the conduit and will not be measured separately.

Pull Tape. Pull tape is included in the cost of the conduit and will not be measured separately.

Duct Plugs. Duct plugs are included in the cost of the conduit and will not be measured separately.

Payment. The contract unit price shall be full compensation for all work specified in this section. Payment shall be made according to standard TDOT item numbers.

All conduit shall be paid per linear foot, as applicable, as follows:

1. Stored materials shall be paid per TDOT Standard Specifications.
2. Final payment shall be made after complete installation and testing.

730.17—Fiber Optic Infrastructure.

All fiber optic infrastructure shall be installed per the Plans or where directed by the Engineer.

1. Furnish fiber optic infrastructure materials that meet applicable industry standards including but not limited to:
 - A. EIA/TIA.
 - B. Rural Utilities Service (RUS).
 - C. Institute of Electrical and Electronics Engineers (IEEE).
 - D. Insulated Cable Engineers Association (ICEA).
 - E. Telcordia.
 - F. ASTM.
 - G. UL.

- H. NEC.
- I. National Electrical Safety Code (NESC).
- 2. Upon request of the Engineer, provide certification from an independent testing laboratory that certifies that the cable conforms to industry standards.
- 3. Furnish fiber optic infrastructure materials recommended by the manufacturer for outside plant use and the intended application.
- 4. Furnish all optical fiber, fiber optic cable, fiber optic drop cable, optical termination and connection materials, and all ancillary and incidental materials that are single-mode and/or compatible. All materials shall meet the following requirements:
 - A. Materials shall be listed with and conform to RUS 7 Code of Federal Regulations (CFR) 1755.900, 1755.901, 1755.902, and associated fiber optic test procedures (FOTPs); ANSI/ICEA S-87-640; EIA/TIA-568-B.3, 598B, 758, and Fiber Optic Connector Intermateability Standards (FOCISs); and Telcordia GR-20 core requirements.
 - B. Manufacturer is currently International Organization for Standardization (ISO) 9001 certified. This requirement applies to assemblers of manufactured components, such as patch cords and termination cabinet interconnection cables.
 - C. All cables and termination infrastructure shall be assembled from Corning SMF-28e and OFS All Wave or approved equivalent single-mode optical fiber.
 - D. All fibers and buffer tubes shall follow TIA/EIA-598 (Optical Fiber Cable Color Coding) identification using colors. Do not use printed legends.
 - E. All cables shall have been manufactured and labeled no earlier than in the third calendar month preceding NDOT's letting date of the contract.
- 5. Maintain and calibrate fiber optic installation and testing tools in accordance with the tool manufacturer's recommendations. Provide tool manufacturer certified calibration documentation upon Engineer's request. Installation and testing tools include but are not limited to:
 - A. Fusion splicers.
 - B. Cable pulling strain dynamometers and breakaway links.
 - C. Cable air jetting/blowing systems.
 - D. Optical time domain reflectometers (OTDRs).
 - E. Optical attenuation testers (light sources and power meters).
- 6. Fiber optic installation and testing tools shall be operated only by Contractor personnel who have been trained and certified by the tool manufacturer. Installation and testing tools requiring certified operators include but are not limited to:
 - A. Fusion splicers.
 - B. Cable air jetting/blowing systems.
 - C. OTDRs.
 - D. Optical attenuation testers (light sources and power meters).

Fiber Optic Cable.

- 1. Provide 144-count fiber optic cable that meets the following requirements:
 - A. All-dielectric outside plant loose tube cable with central strength/anti-buckling member.
 - B. Dry water blocking materials and construction.
 - C. Reverse oscillating "SZ" stranded buffer tube construction.
 - D. High tensile strength yarn.
 - E. Medium-density polyethylene outer jacket.
 - F. 144 fiber cable with 12 active buffer tubes and 12 individual stranded fibers per buffer tube.
 - G. Cable construction design that allows no more than 12 buffer tube positions.
 - H. Maximum diameter of 0.62 inch.
 - I. Maximum weight of 0.108 pounds per foot.

2. Provide 12-count fiber optic cable that meets the following requirements:
 - A. All-dielectric outside plant loose tube cable with central strength/anti-buckling member.
 - B. Dry water blocking materials and construction.
 - C. Reverse oscillating “SZ” stranded buffer tube construction.
 - D. High tensile strength yarn.
 - E. Medium-density polyethylene outer jacket.
 - F. 12 fiber cable with 1 active buffer tube and 12 individual stranded fibers
 - G. Cable construction design that allows no more than 5 buffer tube positions.
 - H. Maximum diameter of 0.4 inch.
 - I. Maximum weight of 0.042 pounds per foot.
3. Provide Corning ALTOS All-Dielectric, Pirelli FlexLink, OFS MiDia, or approved equivalent cables.
4. Designate this cable as a trunk cable.
5. Ensure that the cable can withstand a maximum pulling tension of 600 pound-force (lbf) during installation and 200 lbf installed long term (at rest).
6. Provide cable with shipping, storage, and operating temperature range of -22°F to +158°F.
7. Provide cable with an installation temperature range of -22°F to +158°F.
8. Provide cable with outer jacket marking using the following template:
 Manufacturer’s Name – “Optical Cable” – Month/Year of Manufacture – Telephone Handset Symbol – “NDOT ” – “144F SM”.
9. Include in the outer jacket marking the cable sequential length in accordance with the following:
 - A. In English units every 2 feet.
 - B. Within -0/+1% of the actual length of the cable.
 - C. In contrasting color to the cable jacket.
 - D. Marking font height no less than 0.10 inch.
 - E. On any single length of cable on a reel, the sequential length markings do not run through “00000.”
10. Ensure that fiber optic cable, with the required fiber count, conforms to RUS CFR 1755.900. Provide cable with all fibers that are usable and with a surface sufficiently free of imperfections and inclusions to meet optical, mechanical, and environmental requirements. Distinguish each fiber and buffer tube from others by means of color coding that meets EIA/TIA-598 (Optical Fiber Cable Color Coding).

Fiber Optic Cable Indoor/Outdoor.

1. Provide fiber optic plenum-rated cable that meets the following requirements:
 - A. All-dielectric inside plant loose tube central core cable.
 - B. High tensile strength yarn surrounding the central tube core.
 - C. Dry water blocking materials and construction.
 - D. 144 fiber cable with 12 active buffer tubes and 12 individual stranded fibers per buffer tube.
2. Provide Corning FREEDM Loose Tube All-Dielectric, Pirelli CentraLink, or approved equivalent cables.
3. Designate this cable as building entry.
4. Ensure that the cable can withstand a maximum pulling tension of 300 lbf during installation.
5. Provide cable with shipping, storage, and operating temperature range of -22°F to +158°F and an installation temperature range of 14°F to 140°F.
6. Provide cable with outer jacket marking using the following template:
 Manufacturer’s Name – “Optical Cable” – Month/Year of Manufacture – Telephone Handset Symbol – “NDOT” – “144F SM.”
7. Include in the outer jacket marking the cable sequential length in accordance with the following:

- A. In English units every 2 feet.
- B. Within $-0/+1\%$ of the actual length of the cable.
- C. In contrasting color to the cable jacket.
- D. Marking font height no less than 0.10 inch.
- E. On any single length of cable on a reel, the sequential length markings do not run through "00000."

Fiber Optic Drop Cable.

- 1. Provide fiber optic drop cable that meets the following requirements:
 - A. All-dielectric outside plant loose tube central core cable.
 - B. High tensile strength yarn surrounding the central tube core.
 - C. Dry water blocking materials and construction.
 - D. 12 individual stranded fibers contained within the central tube core.
- 2. Provide Corning FREEDM Loose Tube All-Dielectric, Pirelli CentraLink, or approved equivalent cables.
- 3. Designate this cable as drop cable.
- 4. Ensure that the cable can withstand a maximum pulling tension of 300 lbf during installation.
- 5. Provide cable with shipping, storage, and operating temperature range of -22°F to $+158^{\circ}\text{F}$ and an installation temperature range of 14°F to 140°F .
- 6. Provide cable with outer jacket marking using the following template:
Manufacturer's Name – "Optical Cable" – Month/Year of Manufacture – Telephone Handset
Symbol – "NDOT" – "12F SM."
- 7. Include in the outer jacket marking the cable sequential length in accordance with the following:
 - A. In English units every 2 feet.
 - B. Within $-0/+1\%$ of the actual length of the cable.
 - C. In contrasting color to the cable jacket.
 - D. Marking font height no less than 0.10 inch.
 - E. On any single length of cable on a reel, the sequential length markings do not run through "00000."

Plenum Rated Non-Metallic Corrugated Raceway.

- 1. Provide plenum-rated non-metallic corrugated raceway inside buildings when cable is not in rigid conduit.
- 2. Install to conform with NEC Articles 770 and 800.
- 3. Provide raceway that meets UL Standards 910 and 2024.
- 4. Provide 2-inch-diameter raceway.

Fiber Optic Fusion Splice.

- 1. Provide fusion splices for splicing of all fibers on the project. Do not provide any other type of fiber splicing.
- 2. Perform fusion splicing with a fully automatic portable fusion splicer that provides consistent low loss (maximum 0.10 decibel [dB]) splices. Splicer shall provide three-axis fiber core alignment using light injection and loss measurement techniques. The fusing process shall be automatically controlled. The splicer shall provide splice loss measurements on an integral display, as well as a magnified image of the fiber alignment. The Contractor shall retain ownership of the fusion splicer.

Fiber Optic Connectors.

1. Provide fiber optic angled physical contact (APC) connectors compliant with these specifications for all fiber optic infrastructure including, but not limited to, fiber optic termination cabinets, fiber optic drop panels, and fiber optic patch cords.
2. Provide only lucent connector (LC) compatible APC connectors for all fiber optic infrastructure. Provide only factory-installed APC connectors of a type other than LC when required by the network switches. Do not use field-installed connectors. Do not use adapter couplers to change connector types.
3. Use ceramic ferrule connectors factory-installed with a thermal-set heat-cured epoxy and machine polished mating face. Install connectors as per manufacturer application and recommendations, including proper termination to the outer tubing (900-micron tubing, 0.12-inch fan out tubing, etc.) required for the application.
4. Use APC connectors rated for an operating temperature of -40°F to +185°F.
5. Provide connectors that have an installed insertion loss of less than or equal to 55 dB.
6. Use duplex APC connectors for all male LC connectors. Provide latching cover for two male connectors being used in a duplex configuration. Female couplers may be duplex but shall allow simplex mating connectors.
7. Label each fiber position on panels and termination cabinets containing duplex couplers with the port/position ID as shown in the Plans.
8. Provide dust caps for all exposed male connectors and female couplers at all times until permanent connector installation.

Fiber Optic Termination Cabinet.

1. Provide fiber optic termination cabinets at field junctions as shown in the Plans for termination of 144-fiber outside plant (OSP) cable.
2. Use termination cabinets that are fully compatible with all components of the fiber optic infrastructure as specified, including, but not limited to, fiber optic cable, fiber optic fusion splices, and fiber optic connectors.
3. Use wall-mount termination cabinets.
4. Provide all mounting hardware and supports to mount the termination cabinets in the locations shown in the Plans.
5. Use fiber optic termination cabinets providing 144 fiber connectors and capable of storing 144 fusion splices in splice trays.
6. Use termination cabinets that integrate the splice trays and connector modules into one compartment within one cabinet, or that house the splice trays and connector modules in separate compartments integrated into one cabinet. The closed connector housing (CCH) splice cassette is loaded with factory-terminated pigtails. Available with single-fiber splicing configurations, the cassette includes the appropriate number and type of heat-shrinks and protective tubing depending on fiber count and cable type.
7. Maximum dimensions of a complete termination cabinet shall be 16.53 centimeters (cm) high by 14.38 cm wide by 4.6 cm deep.
8. Use fiber optic termination cabinets with fully enclosed metallic construction and with a protective hinged front cover for the connector ports.
9. Provide cable access on all sides of the enclosed area behind the connector port panel.
10. Provide sufficient splice trays for storing 144 fusion splices in 12- or 24-splice increments.
11. Provide termination cabinets with fiber optic connector modules in a 12-fiber configuration of 6 rows of 1 duplex connector coupler.
12. Connector modules shall mount vertically in the termination cabinet front panel.
13. Connector modules shall:

- A. Include clearly legible and permanent labeling of each of the 12-fiber connector couplers.
- B. Be labeled and identified as shown in the Plans.
- 14. Provide factory-assembled 12 fiber termination interconnect cables (pigtail cables) to be fusion spliced to the outside plant cable and connected to the rear of the connector modules. Termination interconnect cables shall be all-dielectric, single-jacketed cable with high tensile strength yarn surrounding 12 individual 900-micron fibers following EIA/TIA-598B color identification with factory-installed connectors.
- 15. The splice shelf shall house and protect fusion splices of fibers to optical fiber pigtails with 6 ft of pigtail slack on each fiber. The housing shall protect the required quantity of connectors and splices on each pigtail and slack for fiber optic patch cords. The fiber pigtail slack shall be neatly coiled and secured in a manner that does not allow the minimum operational bending radius of the pigtail to be exceeded.
- 16. The approved type of optical connectors on the end of each pigtail shall screw into a sleeve securely mounted to a patch panel within the housing. The maximum optical loss across the connection shall not exceed 0.4 dB.
- 17. Provide all incidental and ancillary materials including but not limited to grommets, cable strain relief and routing hardware, splice protectors/heat shrinks, blank connector panels, and labeling materials.

Fiber Optic Closure.

- 1. Provide fiber optic closures (splice closures) designed for outside plant use for splicing cables.
- 2. Use fiber optic splice closures that are impact- and corrosion-resistant and waterproof when immersed in 10 ft of water.
- 3. Use fiber optic splice closures that are fully compatible with all components of the fiber optic infrastructure as specified, including but not limited to, fiber optic trunk cable, fiber optic drop cable, and fiber optic fusion splices.
- 4. Use a cylindrical dome-type splice closure with cable entry at one end only and a sealed single-molded piece dome body of high-density polyethylene or equivalent non-metallic material.
 - A. The cable entry end shall be manufactured of a similar material as the dome body and shall seal the closure with flexible thermoplastic rubber or polymer gasket seals.
 - B. The cable entry end shall include cable entrance ports that shall seal the cable and port opening with flexible thermoplastic rubber or polymer gasket seals with mechanical compression.
 - C. Closures shall be re-enterable and resealable without the need for specialized tools or equipment, or the use of any additional parts.
 - D. No heat shrink or caulk/encapsulate materials shall be used for sealing the assembled closure or terminated cables.
- 5. Provide splice closures with maximum outer dimensions of 9 inches in diameter and 23 inches in length unless otherwise approved by the Engineer.
 - A. Splice closures shall provide cable entrance ports for at least five fiber optic cables.
 - B. At least two cable entrance ports shall accommodate cables of at least 0.60-inch outer diameter.
 - C. The closure shall allow for the storage and express of at least six unopened buffer tubes.
- 6. Provide a splice closure with a cable entry end with pre-template cable ports and a split-plate design permitting installation of the closure in mid-span cable segments.
- 7. The splice closure size shown in the Plans specifies the minimum number of fusion splices to be accommodated by the closure. With the splice closure, provide all materials to accommodate the number of splices specified by the closure size, including splice tray, storage, and organizing materials.

Fiber Optic Drop Panel.

1. Provide fiber optic drop panels designed for outside plant use for terminating drop cables in equipment cabinets.
2. Use fiber optic drop panels that include the fiber optic drop cable as an integral component.
3. Use fiber optic drop panels that are fully compatible with all components of the fiber optic infrastructure as specified, including, but not limited to, fiber optic trunk cable, fiber optic closures, fiber optic fusion splices, and fiber optic connectors.
4. Use fiber optic drop panels that are factory-manufactured assemblies of fiber optic drop cable with factory-installed fiber connectors and integral ruggedized fiber connector enclosures.
5. Use drop panels with 12 fiber (two duplex LC) connectors.
6. Use ruggedized fiber connector enclosures of thermally stable rigid plastic housings fully potted with a thermally stable epoxy filling that encapsulates the drop cable fan out, fibers, and connector bodies.
7. Use permanent labels on the enclosure with contrasting color to identify each connector body by its associated fiber number.
8. Arrange fiber connectors in rows of one duplex connector coupler. All fiber connectors shall be arranged on one of the long (vertical) faces of the enclosure.
9. Provide a unique serial number permanently attached on the enclosure body of each drop panel.
10. Provide an outer non-metallic cable strain-relief boot where the drop cable enters the fiber connector enclosure and that secures the cable to the enclosure; the strain-relief boot shall fully encircle the cable for a minimum of 2 inches from the enclosure's outer surface.
11. Use fiber connector enclosures on the drop panel that are no more than 2 inches wide and deep (the maximum dimension of the enclosure plus fiber connector body) and no more than 11 inches long.
12. Provide a 0.125-inch-thick aluminum mounting plate that secures to the fiber connector enclosure. The mounting plate shall have at least four mounting holes near the plate's corners that permit horizontal or vertical mounting flush to a panel, and are spaced appropriately for vertical mounting to an EIA equipment rack rail using two of the mounting holes.
13. Test all completed and assembled fiber optic drop panels at the point of manufacture and provide two copies of the manufacturer test documentation. Test each connected fiber in the drop panel to demonstrate compliance with all requirements for cables and connectors as detailed in these specifications. Include in the test documentation the location station number where the drop panel is to be installed, the serial number of the drop panel, the drop cable sequential length markings at each end of the drop cable, and the total drop cable distance.

Cable Labels.

1. Provide cable labels that meet the following requirements:
 - A. Self-coiling wrap-around type.
 - B. PVC or equivalent plastic material with ultraviolet (UV) and fungus inhibitors.
 - C. Base materials and graphics/printing inks/materials designed for underground outside plant use including solvent resistance, abrasion resistance, and water absorption.
 - D. Minimum size of 2.5 inches wide by 2.5 inches long.
 - E. Minimum thickness of 0.010 inch.
 - F. Orange label body with pre-printed text in bold black block-style font with minimum text height of 0.375 inch.
2. Pre-print the following text legibly on labels used for all fiber optic trunk cables (FO Cables):

NDOT
OPTICAL CABLE
3. Pre-print the following text legibly on labels used for all fiber optic drop cables (FO Drop Cables):

NDOT
OPTICAL DROP CABLE

4. On all cable labels, print the text specified above twice on the label with the text of the second image inverted. The end result shall be text that “reads correctly” when the label is coiled onto a cable.

Fiber Optic Patch Cords.

1. Fiber optic patch cords provided shall consist of a length of fiber optic cable terminated on both ends.
2. All patch cords shall be factory pre-connected assemblies adhering to all applicable cable and fiber specifications stated in these specifications.
3. Patch cords shall be of the appropriate length for the necessary connections, maintaining minimum bend radius, and with no residual strain at the connector or anywhere on the patch cord itself beyond self-support. Patch cords shall not have excess length beyond what is necessary for equipment connection and routing.
4. All patch cords shall be duplex zip-cord fiber cable with simplex LC connectors, except as otherwise allowed in the section concerning fiber optic fusion splices.
 - A. The two connectors of each end of the patch cord shall be differentiated by different colors.
 - B. Sufficient flexibility shall be provided at each end to disconnect one connector without disturbing the other, or to allow swapping of the two connectors within the same duplex coupler without disturbing the remainder of the patch cord.
 - C. Strain relief and reinforcement shall be provided at the point where the duplex cable separates for the individual simplex connectors.
5. Fiber cable shall be 0.08-inch jacketed cable with high tensile strength yarn protecting the inner fiber manufactured into a duplex zip-cord configuration. All inside plant patch cords shall meet NEC jacketing requirements.
6. Connector strain relief boots shall be fixed to the outer jacket and strength yarn.
7. Yellow outer jackets shall be used for single-mode fiber.
8. No splices of any type are allowed within a patch cord assembly.

Fiber Optic Attenuator Patch Cords.

1. Fiber optic attenuator patch cords provided shall meet all requirements of the section concerning fiber optic patch cords.
2. Each fiber in the attenuator patch cord shall contain a passive optical attenuator with the following performance characteristics:
 - A. Dual-wavelength capability (1,310 and 1,550 nanometers [nm]).
 - B. Fixed attenuation value of 6dB $\pm$ 15%.
 - C. Minimum optical return loss of 40 dB.
 - D. Operating temperature range no less than -30 to +65 C.

Project Submittal Program Requirements.

1. General Requirements. The Contractor shall provide project submittals for all fiber optic infrastructure as required in the section pertaining to fiber optic termination cabinets, including scheduling requirements. The project submittals for fiber optic infrastructure shall include, but are not limited to, the additional specific requirements in this subsection.
2. Fiber Optic Installation and Testing Tools
 - A. Provide project submittals including manufacturer-recommended operations, maintenance, and calibration procedures for the following equipment:
 - (1) Fusion splicers.
 - (2) Cable pulling strain dynamometers and breakaway links.
 - (3) Cable air jetting/blowing systems.
 - (4) OTDRs.

- (5) Optical attenuation testers (light sources and power meters).
- B. Submit documentation and proof of manufacturer-recommended operator training and certification for the following equipment:
 - (1) Fusion splicers.
 - (2) Cable air jetting/blowing systems.
 - (3) OTDRs.
 - (4) Optical attenuation testers (light sources and power meters).

Installation Requirements. Install all fiber optic infrastructure according to the manufacturer's recommended procedures and specifications.

Cable Shipping and Delivery.

- 1. Package the cable for shipment on reels. Each package shall contain only one continuous length of cable. Construct the packaging so as to prevent damage to the cable during shipping and handling.
- 2. Seal both ends of the cable to prevent the ingress of moisture.
- 3. Include with each reel an attached weatherproof reel tag identifying the reel and cable that can be used by the manufacturer to trace the manufacturing history of the cable and the fiber. Include with each cable a cable data sheet containing the following information:
 - A. Manufacturer name.
 - B. Cable part number.
 - C. Factory order number.
 - D. Cable length.
 - E. Factory-measured attenuation of each fiber.
- 4. Cover the cable with a protective and thermal wrap.
 - A. Securely fasten the outer end of the cable to the reel head so as to prevent the cable from becoming loose in transit.
 - B. Project the inner end of the cable a minimum of 6.5 ft into a slot in the side of the reel or into a housing on the inner slot of the drum, in such a manner to make it available for testing.
 - C. Plainly mark each reel to indicate the direction in which it is to be rolled to prevent loosening of the cable on the reel.

Arrival On Site. The cable and reel shall be physically inspected by the Contractor on delivery and 100% of the fiber shall be tested with an OTDR for attenuation to confirm that the cable meets requirements. Test results shall be recorded and dated. Attenuation deviations from the shipping records greater than 5% shall be brought to the attention of NDOT in writing. The cable shall not be installed until completion of this test sequence and receipt of written approval by NDOT. If the OTDR test results are unsatisfactory, the reel of fiber optic cable shall be considered unacceptable and all records corresponding to that reel of cable shall be marked accordingly. The unsatisfactory reel of cable shall be replaced with a new reel of cable at the Contractor's expense. The new reel of cable shall then be tested to demonstrate acceptability. Copies of the test results shall be submitted to NDOT for approval.

Cable Handling and Installation.

- 1. Do not exceed the maximum recommended pulling tension during installation as specified by the cable manufacturer.
- 2. Continuously monitor pulling tensions with calibrated measuring devices, such as a strain dynamometer.
- 3. Protect all pulled installations with calibrated breakaway links.

4. Do not violate the minimum recommended bend radius during installation as specified by the cable manufacturer. Unless the manufacturer's recommendations are more stringent, use the following guidelines for minimum bend radius:
 - A. 15 X Cable Diameter Short Term – During Installation.
 - B. 10 X Cable Diameter Long Term – Installed.
5. Before cable installation, carefully inspect the cable reels and reel stands for imperfections or faults such as nails that might cause damage to the cable as it is unreeled.
6. Take all necessary precautions to protect reeled cable from vandals or other sources of possible damage while unattended. Any damage to reeled cable or the reel itself shall necessitate replacement of the entire cable section at the Contractor's expense.
7. Whenever unreeled cable is placed on the pavement or surface above a pull box, provide means of preventing vehicular or pedestrian traffic through the area in accordance with the approved Maintenance of Traffic provisions.
8. Keep the cable continuous throughout the pull. Cable breaks and reel end splices are permitted only as shown in the Plans.
9. Where a cable ends in an underground fiber optic closure, secure and store all unused fibers and buffer tubes in splice trays in preparation for future reel end splicing and continuation.

Cable Storage.

1. Properly store all cable to minimize susceptibility to damage.
 - A. Maintain proper bend radius, both short and long term, during cable storage.
 - B. Storage coils shall be neat in even length coils, with no cross over or tangling.
 - C. Storage coils of different cables shall be kept completely separate except when the cables terminate in the same splice closure.
 - D. Storage coils shall be secured to cable racking hardware with tie wraps, Velcro straps, or non-metallic cable straps with locking/buckling mechanism.
 - E. Do not use adhesive or self-adhering tapes, metal wires and straps, or rope/cord.
2. Unless otherwise noted on the Plans, the following are the requirements for cable storage for underground applications:
 - A. Trunk cable in Type A pull box – 25 ft.
 - B. Trunk cable in Type B pull box – 200 ft.
 - C. Drop cable in Type A pull box – 10 ft.
 - D. Drop cable in Type B pull box terminated in a splice closure – 10 ft.
 - E. Communications hub or Control Center (interior) – Do not store slack cable inside the communications hub building or Control Center.

Fiber Optic Fusion Splice.

1. Perform fusion splicing of all fiber optic splices as shown in the Plans.
2. Perform fusion splicing only in enclosed spaces such as splice trailers or tents specifically intended for this operation
3. Completed fusion splices shall have no more than 0.10-dB optical loss as measured in accordance with the section pertaining to fiber optic patch cords.
4. Adequately protect all fusion splices in splice trays in a splice closure or termination cabinet. Provide the splice with strain relief and protection of the stripped fiber splice in a manner recommended by the fiber and the splice tray manufacturers.
5. Use fusion splice protectors of a heat shrink tubing that protects the splice and extends over the fiber coating. Splice protectors shall be compatible with and as recommended by the fiber and the splice tray manufacturers.
6. No bare fiber may be exposed.

Fiber Optic Termination Cabinet.

1. Install only one outside plant cable per termination cabinet, including within the separate splice tray storage compartment if so equipped. Install the connector modules for fibers 1 through 144 as shown in the Plans. Equip any remaining unused connector module slots with blank panels.
2. Install all fibers, buffer tubes, and cables following minimum internal and external bend radius, proper management, routing, fastening and protection, and with no residual strain on any connector, fiber, buffer tube, or cable.
3. Install one cable buffer tube to one termination cabinet interconnect cable, matching fiber to fiber. Keep all fibers of the outside plant cable buffer tube and its corresponding termination interconnect cable complete within the same splice tray.
4. Label the front and rear of the termination cabinets with the trunk cable segment ID of the cable terminated within; use permanent clearly legible labels with a minimum of a 0.5-inch text height.
5. Label each end of termination cabinet interconnect cables to identify the 12 trunk cable fibers/buffer tube connected; use permanent overlapping cable labels with clearly legible text.

Fiber Optic Closure.

1. Install fiber optic splice closures where and of the size shown in the Plans. Install splice closures in the center ± 3 ft of the entire length of stored cable coils or install at the end of cables that terminate in the pull box.
2. Store FO closures and cable coils on the pull box cable rack hooks. Keep all closures and cable coils off the bottom of the pull box. Secure closures and/or cable coils as needed to hold them in place.

Fiber Optic Drop Panel.

1. Prior to factory manufacture of fiber optic drop panels, verify the final installed location of all portions of each drop cable route from the splice closure to the equipment cabinet (including, but not limited to, the cabinet location, all conduit and pull boxes, and the splice closure location) to determine the required length of drop cable, including all splice closure and storage coils, to be factory manufactured with each drop panel. Do not use the Plans quantity for determining the drop cable length to be factory manufactured.
2. Using the drop panel mounting plate, install drop panels on the side panel or equipment cabinets. Mount the fiber optic drop panel with the connectors horizontal or facing downward and route the drop cable up or down as necessary. Route and secure the drop cable such that it is fully strain-relieved, does not violate the manufacturer's recommended bending radius, and does not interfere with the operation of or access to any cabinet equipment or electrical components.
3. Place one copy of the manufacturer test documentation in the equipment cabinet, where the drop panel is installed, and submit the other copy to the Engineer.

Cable Labels.

1. Install cable labels on all trunk and drop fiber optic cables. Clean the installed cable of all dirt and grease before applying any label.
2. Label all cables in or at every location where the cable is exposed outside of a conduit, innerduct, or pole, using the cable IDs for trunk cables or the device number for drop cables. As a minimum, install cable labels in the following locations:
 - A. Within 12 inches of every cable entry to a pull box, equipment cabinet, communications hub, or the transportation management center (TMC).
 - B. Within 12 inches of the exterior entry point of every fiber optic splice closure, termination cabinet, and drop panel.

- C. Every 30 feet for the entire length of cable in any storage coil in pull boxes.

Fiber Optic Patch Cords.

- 1. Install duplex fiber optic patch cords to connect all electronic equipment with the fiber optic infrastructure. Follow port assignments as shown in the Plans.
- 2. Install duplex fiber optic patch cords to connect all active optical paths between fiber optic termination cabinets in communications hubs as shown in the Plans.
- 3. Neatly route and dress all patch cords to the connected devices and within cable management facilities.

Fiber Optic Attenuator Patch Cords. Provide fiber optic attenuator patch cords in accordance with the section pertaining to fiber optic drop panels.

Project Testing.

- 1. General Requirements
 - A. The Contractor shall conduct a project testing program for all fiber optic infrastructure as required in the section pertaining to plenum-rated non-metallic corrugated raceways. The project testing program for fiber optic infrastructure shall include but is not limited to the additional specific requirements in this subsection.
 - B. All test results shall confirm physical and performance compliance with these specifications including, but not limited to, optical fibers and fusion splices. No event in any given fiber may exceed 0.3 dB. Any event measured above 0.3 dB per splice and 0.75 dB per connector pair shall be replaced or repaired at the event point.
 - C. In addition to the notification requirements of the section pertaining to plenum-rated non-metallic corrugated raceways, the tentative date, time, and location of fiber optic infrastructure testing shall be provided to NDOT no less than 7 calendar days in advance of the test. Provide confirmed date, time, and location of fiber optic infrastructure testing no less than 48 hours before conducting the test.
 - D. Test result documentation shall be provided in electronic format (one copy) and printed format (three copies). Electronic formats shall be readable in Microsoft Excel or other approved application. Printed copies shall be bound and organized by cable segment.
 - E. All test results shall be provided in English units of measure of length.
 - F. All test result documentation shall be submitted to the Engineer within 14 calendar days of completion of the tests. The Engineer will review test documentation pertaining to fiber optic termination cabinets.
- 2. Pre-Installation Test
 - A. A pre-installation test (PIT) shall be performed on all FO cable prior to any cable removal from the shipping reels. A PIT shall be performed on each cable reel delivered to the job site.
 - B. The PIT for FO cable shall include but is not limited to:
 - (1) A visual inspection of each cable and reel.
 - (2) An OTDR Test and documentation as required for the standalone acceptance test (SAT) as described below, for three randomly selected fibers from each buffer tube.
 - (3) An Optical Attenuation Test is not required. If the Contractor decides to perform one for its own protection, said test should be documented and documentation provided to the Engineer.
- 3. Standalone Acceptance Test
 - A. An SAT shall be performed on all fiber optic infrastructure on this project after field installation is complete including, but not limited to, all splicing and terminations.
 - B. An SAT for each fiber in each cable shall include OTDR Tests and Optical Attenuation Tests.

- C. All fibers in all FO cables and FO drop cables shall be tested from termination point to termination point, including:
 - (1) Fibers from FO termination cabinet to FO termination cabinet.
 - (2) Fibers from FO termination cabinet to FO drop panel.
 - (3) Fibers from FO drop panel to FO drop panel.
 - (4) Fibers from FO termination cabinet to the end of the cable run in the last FO closure.
- D. All test results shall confirm compliance with these specifications including but not limited to optical fibers and fusion splices. No event in any given fiber may exceed 0.10 dB. Any event measured above 0.10 dB shall be replaced or repaired at the event point.
- E. Test documentation shall include but is not limited to:
 - (1) Cable & Fiber Identification
 - a. Cable & Fiber ID and Location – Physical location (device ID and station number of FO termination cabinet, FO drop panel, or cable end FO closure), fiber number, and trunk or drop cable ID for both the beginning and end points.
 - b. Operator Name.
 - c. Engineer's Representative.
 - d. Date & Time.
 - (2) Setup and Test Condition Parameters
 - a. Wavelength.
 - b. Pulse Width (OTDR).
 - c. Refractory Index (OTDR).
 - d. Range (OTDR).
 - e. Scale (OTDR).
 - f. Ambient Temperature.
 - (3) Results of OTDR Test (each direction and averaged)
 - a. Total Fiber Trace (miles).
 - b. Splice Loss/Gain (dB).
 - c. Events > 0.05 dB.
 - d. Measured Length (cable marking).
 - e. Total Length (OTDR measurement).
 - (4) Test Results for Attenuation Test (each direction and averaged)
 - a. Measured Cable Length (cable marking).
 - b. Total Length (OTDR measurement from OTDR Test).
 - c. Number of Splices (determined from as-builts).
 - d. Total Link Attenuation.
- F. OTDR Test
 - (1) Conduct the OTDR Test using the standard operating procedure and recommended materials as defined by the manufacturer of the test equipment.
 - (2) Use a factory patch cord ("launch cable") of a length equal to the "dead zone" of the OTDR to connect the OTDR and the fiber under test.
 - (3) Conduct bi-directional OTDR Tests for each fiber. Calculate bi-directional averages.
 - (4) Conduct all tests at 1,310 and 1,550 nm for single-mode cable.
- G. Optical Attenuation Test
 - (1) Conduct the Optical Attenuation Test using the standard operating procedure and recommended materials as defined by the manufacturer of the test equipment.
 - (2) Conduct bi-directional Optical Attenuation Tests for each fiber. Calculate bi-directional averages.
 - (3) Conduct all tests at 1,310 and 1,550 nm for single-mode cable.

Measurement.

Fiber Optic Cable (12F).

Fiber Optic Cable (12F) shall be measured in units of linear feet and paid for at the contract price per linear foot. The price bid shall include the length in feet of actual cable installed as measured from the cable sequential length markings, cable labels, patch cords, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. No measurement for payment shall be made for cable storage amounts in excess of that required in these specifications or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Fiber Optic Cable Indoor/Outdoor (144F).

Fiber Optic Cable Indoor/Outdoor (144F) shall be measured in units of linear feet and paid for at the contract price per linear foot. The price bid shall include the length in feet of actual cable installed as measured from the cable sequential length markings, cable labels, patch cords, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. No measurement for payment shall be made for cable storage amounts in excess of that required in these specifications or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Fiber Optic Drop Cable (12F).

Fiber Optic Drop Cable (12F) shall be measured in units of linear feet and paid for at the contract price per linear foot. The price shall include the length in feet of actual cable installed as measured from the cable sequential length markings, fiber optic connectors, cable labels, patch cords, manufacture with the fiber optic drop panel, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. No measurement for payment shall be made for cable storage amounts in excess of that required in these specifications or the Plans. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Fiber Optic Closure.

Fiber Optic Closure (FO Closure) shall be measured in units of each and paid for at the contract price per each. The price bid shall include cable labels, patch cords, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Plenum-Rated Non-Metallic Corrugated Raceway.

Non-Metallic Corrugated Raceway shall be measured in units of linear feet and paid for at the contract price per linear foot. The price shall include the length in feet of actual raceway installed as measured by the cable sequential length markings in the raceway, hangers, tape, and any ancillary and incidental materials necessary to complete the work.

Fiber Optic Connectors.

Fiber Optic Connectors are included in the quantities of other pay items and will not be measured separately for payment.

Fiber Optic Splice, Fusion.

Fiber Optic Splice, Fusion (FO Splice, Fusion) shall be measured in units of each and paid for at the contract price per each. The price bid shall include but is not limited to all ancillary and incidental materials, testing,

documentation, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Fiber Optic Termination Cabinet.

Fiber Optic Termination Cabinet (FO Termination Cabinet) shall be measured in units of each and paid for at the contract price per each. The price bid shall include but is not limited to fiber optic connectors, cable labels, patch cords, splice tray, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Fiber Optic Drop Panel (FO Drop Panel, 12F)

Fiber Optic Drop Panel (FO Drop Panel, 12F) shall be measured in units of each and paid for at the contract price per each. The price bid shall include but is not limited to fiber optic connectors, cable labels, patch cords, manufacture with the fiber optic drop cable, mounting hardware, ancillary and incidental materials, testing, documentation, and all labor and equipment necessary to complete the work. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

Cable Labels.

Cable Labels are included in the quantities of other pay items and will not be measured separately for payment.

Fiber Optic Patch Cords.

Fiber Optic Patch Cords are included in the quantities of other pay items and will not be measured separately for payment.

Fiber Optic Attenuator Patch Cords.

Fiber Optic Attenuator Patch Cords are included in the quantities of other pay items and will not be measured separately for payment.

Payment.

The contract unit price shall be full compensation for all work specified in this section. Payment shall be made according to standard TDOT item numbers.

Fiber optic infrastructure, except as specified below, shall be paid per linear foot or per each, as applicable, as follows:

- 25% of the contract unit price upon delivery and completion of PIT.
- Additional 35% of the contract unit price for complete installation of cables.
- Additional 30% of the contract unit price for completion of standalone testing and documentation of all fibers in linear feet and in each splice or termination/connection location, and submission of and acceptance of all test documentation.
- Final 10% of the contract unit price upon Final System Acceptance.

Fiber optic splices, fusion, shall be paid per each as follows:

- 60% of the contract unit price upon completion of the splice.
- Additional 30% of the contract unit price for completion of standalone testing and documentation of all fibers in linear feet and in each splice or termination/connection location, and submission of and acceptance of all test documentation.
- Final 10% of the contract unit price upon Final System Acceptance.

730.18—Conductors.

Traffic control conductors shall be rated at 600 volts. All conductors, except loop conductors and cables run along messengers, shall be run in conduit except where run inside poles. Where telephone circuits are introduced into controller foundations, the telephone conductors shall be encased in flexible metal conduit, and shall also conform to regulations of the Code. Fiber optic cable shall be encased in Schedule 80 PVC conduit.

Conductors for traffic loops shall be continuous No. 14 AWG (0.003224 square inch) stranded wire to the detector terminals or splice with shielded detector cable within a pull box or pole base.

Detector cable shall be 2 conductor twisted pair shielded No. 14 AWG (0.003224 square inch) stranded meeting IMSA Specification No. 19-2.

730.19—Cable.

All signal cable shall conform to applicable IMSA Specification No. 19 or 20. Stranded cable color-coded No. AWG 14 (0.003224 square inch) shall be used for all signal and accessory circuits. All circuit runs shall retain the same color identification throughout their entire length. Communications cable shall be shielded 12 pair No. 19 solid AWG meeting IMSA Specification 20-2 unless otherwise specified by the Engineer. All communication conductors shall retain the same color code throughout their entire length.

730.20—Wiring.

1. All wiring shall be terminated to screw terminals by means of lugs.
2. All splices shall be made with solderless connectors and shall be insulated with weatherproof tape applied to a thickness equal to the original insulation.
3. Cables shall be attached to messenger by means of non-corrosive lashing rods or stainless-steel wire lashings. Stainless-steel lashing wire shall not be allowed on traffic signal spans.
4. All wiring within enclosed cabinets shall be neatly formed and harnessed and shall have sufficient length for access servicing.
5. Splicing of 120-volt signal cable shall not be allowed in conduit, pull boxes, or other non-accessible locations. Splicing of any signal-related cable shall be pre-approved by NDOT.

730.21—Service Connection.

Service connection details, metering, etc. shall be coordinated with the local utility as directed by the Engineer and shall conform to NDOT's requirements. The Contractor shall be responsible for obtaining the necessary service for each installation. A remote disconnect shall be installed with a 50-amp, 2-pole switch in weatherproof housing.

730.22—Sealant.

All sealant material shall be on the qualified products list maintained by NDOT's Material and Test Division for sealing saw cuts. It shall resist the upward movement of loop and lead-in and shall exhibit stable dielectric characteristics, including a low permittivity and high dielectric strength. It shall bond to the roadway paving material, preventing entry of moisture, and shall remain flexible without melting for all anticipated temperature and weather conditions.

730.23—Strand Cable.

Span cable for suspending signal heads between pole supports shall be 7-strand, Class A, copper-covered steel wire or greater, extra high-strength (12,500-lb minimum breaking strength) grade meeting the requirements of ASTM A 475, with a minimum breaking strength as noted in the Plans. An acceptable

alternate is 7-strand steel wire with a Class A zinc coating meeting the requirements of ASTM A 475, with a minimum breaking strength as indicated in the Plans.

Strand cable for messenger wire use (other than span wire above) and for pole guy cable shall be of the diameter(s) indicated in the Plans and shall meet the requirements of ASTM A 475 for zinc-coated steel wire strand, 7-strand Siemens-Martin Grade with Class A zinc coating or greater, and high-strength (6,500-lb breaking strength) grade..

A Figure 8 cable combining the messenger cable and conductor cable in an insulated jacket is an acceptable alternative to conductor cable lashed to a messenger cable.

730.24—Bonding and Grounding.

Metallic cable sheaths, conduit, transformer bases, anchor bolts, and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system, and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire or copper strap of not less than the same cross-sectional area as No. 6 AWG (0.020615 square inch).

A ground electrode shall be furnished and installed at each service point. Ground electrodes shall be one-piece lengths of copperweld ground rod not less than 8 ft in length and ½ inch in diameter, installed in accordance with the Code. Grounding of conduit and neutral shall be accomplished as required under the Code except that grounding conductors shall be No. 6 AWG (0.020615 square inch) or approved equal, at a minimum. Exposed ground conductors shall be enclosed in ½-inch-diameter conduit and shall be bonded to the electrode with a copperweld ground clamp.

730.25—Field Test.

Prior to completion of the work, the Contractor shall cause the following tests to be made on all traffic signal and lighting circuits in the presence of the Engineer:

1. Test for ground in circuit.
2. A megger test on each circuit between the circuit and the ground. The insulation resistance shall be not less than the values specified in Section 119 of the Code.
3. A functional test in which it is demonstrated that each and every part of the system functions as specified or as intended herein.
4. Testing of all detector loops and leads before and after they are sealed in the pavement to be sure there are no shorts to ground in the system and that the loop plus lead-in inductance is within the operating range of the detector.

Any fault in any material or in any part of the installation revealed by these tests shall be replaced or repaired by the Contractor in a manner approved by the Engineer, and the same test shall be repeated until no fault appears.

730.26—Inspection.

After completion of the installation and before final acceptance of the project, a full operational check of the system under actual traffic conditions shall be made as part of the inspection. The operational check shall cover a minimum time period of 30 calendar days. During this period, the Contractor shall perform any necessary adjustments and replace any malfunctioning parts of the equipment required to place the system in an acceptable operational condition at no extra compensation. All work to be performed and materials to be furnished under these specifications shall be subject to the direct supervision and inspection of the Engineer and in all respects shall meet with the Engineer's approval as conforming with the provisions and requirements prescribed herein. The Engineer and the Engineer's authorized representatives shall at all times

be given access to the work or any part thereof, and to any plant, yard, shop, mill, or factory where, or in which, any article or material to be used or furnished in connection with such work is being prepared, fabricated, or manufactured; the Contractor shall be required to provide every reasonable facility for obtaining full and sufficient information relative to the performance of the work and the character of materials, and for ascertaining that the quality of workmanship and materials is in accordance with the intent of these specifications. Warranty for the work shall begin at the time the traffic signal is activated.

The work shall be performed only in the presence of the Engineer or Inspector appointed by the Engineer, unless permission to do otherwise has first been obtained; any work thereof that is performed or constructed during the absence of the Engineer or appointed Inspector, without such permission having been so granted, either expressly or by implication, shall be subject to rejection.

The inspection of the work, however, shall not relieve the Contractor of any obligation to properly fulfill its contract as prescribed. If the work or any part thereof, or any materials used in connection therewith, is found to be defective or unsuitable at any time prior to final acceptance, the Contractor shall be required to forthwith make good or replace such defective or unsuitable work or material.

Application for an Engineer or Inspector in connection with work under these specifications shall be made by the Contractor at least 24 hours before the services thereof shall be required.

SIGNAL HEADS

730.27—Signal Heads.

A signal head consists of a signal mounting assembly, backplate, and signal face. Each vehicle signal head shall be of the adjustable, colored lens, vertical type with the number and type of lights detailed herein and as shown on the Plans; shall provide a light indicator in one direction only; shall be capable of adjustment (without attachments) through 360 degrees about a vertical axis; and shall be mounted as shown on the Plans or as specified by the Engineer. The arrangement of the lenses in the signal faces shall be in accordance with the MUTCD. All lenses shall be glass. All circular indications shall use 12-inch lenses unless otherwise shown on the Plans. All arrow indications shall use 12-inch lenses. All new vehicle signal heads installed at any one intersection shall be of the same style and from the same manufacturer. All signal heads, signal head mountings, and outside of hoods shall have one or more coats of primer followed by two coats of high-quality synthetic resin enamel of Traffic Signal Yellow or as noted on Plans and shall meet or exceed Federal Specification TTC-595 Gloss Yellow.

Louvers as specified, interior of signal hoods, and backplates shall have one or more coats of primer followed by two coats of Lusterless Black Enamel meeting or exceeding Master Painters Institute (MPI) Reference 94. All factory-enameled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer. Factory-applied enamel finish in good condition and of appropriate color shall be acceptable.

Suspensions for span wire mounting of multi-faced signal heads and signal head clusters (such as a five-section signal head) shall include an approved swivel type balance adjuster for proper vertical alignment.

Signal heads shall be fabricated from die-cast bodies. Sand castings will not be acceptable.

All signal head wire entrances shall use a rubber gasket to prevent chaffing of signal cable by signal head movement.

All signal heads shall meet the minimum requirements for adjustable face vehicle traffic control signal heads as specified in ITE Technical Report No. 1 (1970) and its latest revisions.

In addition to these standards, the following shall be applicable:

Optical Units. All new red, yellow, and green vehicle signal indications, both arrow and circular, shall be 12-inch LED type and meet standards set forth by ITE for light output. All LED lenses shall have a minimum of a five-year warranty. LED voltage shall be determined by the type of controller cabinet installed.

Signal Head Mounting and Mounting Brackets. Signal heads either shall have integral serrations or shall be equipped with positive lock rings and fittings designed to prevent heads from turning due to external forces. Lock ring and connecting fittings shall have serrated contacts. Signals shall be provided with watertight fittings using neoprene washers. Each signal head shall be secured to the assembly with a tri-stud type connection.

Bracket-mounted signal heads, as shown on the Plans, shall be supported by mounting brackets consisting of assemblies of 1½-inch steel or galvanized conduit. All members shall be either plumb or level, symmetrically arranged, and securely assembled. Construction shall be such that all conductors are concealed within poles and mounting assembly. Each slip fitter shall be secured to the pole.

Directional Louvers. Where shown on the Plans, louvers shall be furnished and installed in the hoods of the signal head sections designated.

Directional louvers shall be so constructed as to have a snug fit in the signal hoods. The outside cylinder and vanes shall be constructed of a nonferrous metal or galvanized sheet steel. Louvers shall be painted with two coats of black enamel as specified in these specifications.

Backplates. Where shown on the Plans, backplates shall be furnished and attached to the signal heads. Backplates should maintain improved visibility of signals by providing a maximum of a 5-inch border around the perimeter of the signal, while also reducing effective projected area (EPA) as wind speed increases. The backplate shall be manufactured from extruded, exterior-grade PVC, which is chemically and mechanically bonded to a flexible rubber strip. Backplates shall properly fit on three-, four-, and five-section signal heads. Backplates are to be formed in two or more sections and bolted together, thus permitting installation after signal heads are in place.

Material:

- Ridged, exterior-grade PVC: Tensile impact strength of 75 lbf/square inch.
- Rubber polymer: Durometer of 68 Shore A Hardness.
- Hardware stainless alloys have minimum yield strength of 30 kilopounds per square inch.
- All backplate surfaces are flat and straight and are free from defects, blemishes, and excessive trimming marks.
- The material color is flat black and is consistent throughout the entire piece, with a minimum of a 2-inch yellow retro reflective border around the perimeter of the backplate.

The retro reflective border is to be made of a Type III prismatic material and shall meet ASTM D 4956 Type XI 4081 reflective specifications.

Backplates shall be AeroFlex or approved equal.

Wiring. Signal head leads shall be No. 18 AWG (0.001271 square inch) stranded with 221°F thermoplastic insulation. A separate white (common) lead shall be wired to each socket shell, and a colored lead, corresponding to the color code specified in the Plans, shall be wired to each socket terminal. Leads shall be of sufficient length to allow connection to the terminal block specified herein. Each complete signal head shall be provided with a minimum 4-point terminal block, properly mounted in a signal section. Stud type terminal blocks shall have not less than ¼-inch edge clearance to any portion of the stud. Exterior wiring shall have a 360-degree drip loop in advance of entering the head.

Spare conductors shall be provided for each signal head. Vehicular signal heads shall be wired with a 7-conductor cable to each signal head from the handhole to the signal head. Cables shall be one continuous length to each head, with no splices being permitted. The individual 7-conductor cables shall be spliced in the pole base with a 12-conductor cable run from the pole base to the controller. All spare conductors shall be terminated in the signal head and grounded in the controller cabinet. Pedestrian signals shall be wired using 7-conductor cable, and pedestrian pushbuttons shall be wired using 2-conductor shielded cable.

Pedestrian Signals. A pedestrian signal head consists of a pedestrian signal mounting assembly and a pedestrian signal face comprising a pedestrian signal housing, an LED countdown pedestrian signal face module, and a front screen.

When shown on the Plans, pedestrian signals shall conform to the following:

1. Pedestrian indications should attract the attention of and be readable to the pedestrian both day and night and at all distances from 10 ft to the full width of the area to be crossed.
2. All pedestrian indications shall be rectangular in shape and shall consist of the filled symbol messages Hand and Man. For the purposes of these specifications, the messages MAN and HAND shall be interpreted to be equivalent to the international symbols of a "Walking Figure" and "Upraised Hand," respectively. Countdown pedestrian heads shall be of the "self-learning" type, which does not require separate programming, for the HAND indication. All new pedestrian indications shall be countdown type.
3. When illuminated, the MAN indication shall be lunar white meeting ITE standards, with an opaque material obscuring all but the letters.
4. When illuminated, the HAND indication shall be Portland Orange meeting ITE standards, with an opaque material obscuring all but the letters.
5. When not illuminated, the MAN and HAND messages shall not be distinguishable by pedestrians at the far end of the crosswalk they control.
6. All pedestrian indications shall be LED type and meet ITE specifications for light output.

Indications shall have a five-year warranty at a minimum.

Countdown pedestrian signals shall conform to the following:

1. The requirements of the MUTCD.
2. Applicable provisions of the current specification of the ITE standard titled Vehicle Traffic Control Signal Heads – Part 2: L.E.D. Vehicle Traffic Signal Modules.
3. Current specification of the ITE standard titled Pedestrian Traffic Control Signal Indications.
4. Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 on Emission of Electronic Noise.
5. Current NEMA Standard TS 2 for operational compatibility.

Pedestrian Signal Housings

Pedestrian signal housings shall be two-piece 16-inch clamshell mount. Housings shall be aluminum, of federal yellow color, with a black door, with dimensions as shown below:

Housing: 15.8 inches high x 17.4 inches wide x 7.3 inches in diameter.

Door (including tabs): 18.7 inches high x 18.5 inches wide x 1.8 inches in diameter.

Overall: 18.7 inches high x 18.5 inches wide x 9.1 inches in diameter.

The manufacturer shall supply certification, which includes a copy of the test report by an independent technical laboratory, as to the module compliance with ITE specifications (where it applies). The report shall also indicate that the tests were performed only after the modules received a 30-minute operational warm-up period immediately preceding the tests.

The housing door, door latch, and hinges shall be of aluminum, or approved equal. Hinge pins shall be stainless steel. The door shall be provided with a neoprene gasket capable of making a weather-resistant, dust-proof seal when closed, and shall be clamshell design.

All pedestrian signal heads, mountings outside of hoods, and pedestrian push button housings shall have one or more coats of primer followed by two coats of high-quality synthetic resin enamel of Traffic Signal Yellow, and shall meet or exceed Federal Specification TTC-595 Gloss Yellow. The interior of signal hoods shall have one or more coats of primer followed by two coats of Lusterless Black Enamel meeting or exceeding Federal Specification TT-E-489. All factory-enamelled equipment and materials shall be examined for damaged paint after installation, and such damaged surfaces shall be repainted to the satisfaction of the Engineer. Factory-applied enamel finish in good condition and of appropriate color will be acceptable.

Signal Head Installation. Signal heads shall be installed with the faces completely covered until the entire installation is ready for operation.

Accessible Pedestrian Signals

The audible-tactile pedestrian signal system shall consist of all electronic control equipment, mounting hardware, push buttons, and signs, to provide both a push button with a raised vibrating tactile arrow on the button along with a variety of audible sounds for different pedestrian signal functions.

A two-wire accessible pedestrian signal (APS) system consists of push button stations (PBSs) installed on poles with existing or new pairs of button wires and a Central Control Unit (CCU) installed in the traffic cabinet. The CCU powers the PBSs over the two wires and uses digital data, including pedestrian interval information and pedestrian calls for each phase, to communicate with each PBS over the two low-voltage button wires.

Substantiating documentation for meeting ISO, NEMA, International Electrotechnical Commission (IEC), and FCC requirements shall be supplied from an outside testing services laboratory.

General Description

1. The system shall consist of a CCU and PBSs, as described below, and be capable of communicating with and programming with devices that support an iOS client application, an Android client application, or Windows PC with Bluetooth[®] Low Energy dongle and Windows client application, for programming the system settings.
2. The system shall be manufactured by an ISO 9001:2015 (minimum) registered company.
3. The system shall meet the requirements of Made in America and/or The Buy American Act.

Design Compliance

1. The system shall meet the functionality requirements of MUTCD 11th ed. – Section 4K and California MUTCD 2011 – Section 4E.
2. The system shall meet NEMA TS 2 Section 2.1 Temperature & Humidity requirements, or TS 4 equivalent.
3. The system shall meet NEMA TS 2 Section 2.1 Transient Voltage Protection requirements, or TS 4 equivalent.
4. The system shall meet NEMA TS 2 Section 2.1 Mechanical Shock and Vibration requirements, or TS 4 equivalent.
5. The system shall meet IEC 61000-4-4 and IEC 61000-4-5 Transient Suppression requirements.
6. The system shall meet FCC Title 47, Part 15, Class A Electronic Noise requirements.
7. The PBS enclosure shall meet NEMA 250 – Type 4X requirements.
8. The CCU enclosure shall meet NEMA 250 – Type 1 requirements.

Functional Requirements

1. The system shall support at least 16 PBSs per intersection (on at least one channel) controlled by a single base unit located in the traffic control cabinet.
2. The system shall vibrate a tactile arrow button during the WALK interval following a button push and/or every time the walk comes up.
3. The system shall have the field-selectable function known as “LOCATE TONE.” This means that during the FLASHING DON’T WALK and DON’T WALK intervals, the system shall provide a locating tone that emanates from the PBS. The system shall provide at least three different sounds to choose from.
4. The system shall have the field-selectable function known as “Extended Push Activation.” This is defined as the audible WALK message and shall only be activated and audible during the WALK interval if the button is depressed for a field-selectable minimum period of time (from 0.5 to 6 seconds). Also, for the walk and clearance intervals that follow an extended push, the volumes shall have a separately settable minimum and maximum volume level.
5. The system shall have the field-selectable function known as “Informational Message.” This means that a custom message giving the location of the street to cross and the intersection (or other information) will be vocalized only when the button is depressed for a minimum field-selectable time.
6. The system shall provide a “Wait” message that plays once the button is activated, and until the Walk cycle goes into effect. This message shall have the field-selectable option of OFF, or repeating every 4, 6, 8, or 10 seconds.
7. The system shall have standard “Travel Direction” options that can be selected at the time of installation.
8. The system shall have at least 10 field-selectable WALK sound options including a cuckoo, a chirp, an MUTCD rapid tick, or a custom voice message.
9. The system shall provide at least seven Ped-clearance sound choices including audible countdown (field selectable). The audible countdown shall represent the time remaining during the pedestrian clearance interval. Timing is automatically adjusted to the CLEARANCE INTERVAL timing, provided by the traffic controller. Due to flasher relay timing variables, audible and pedestrian (PED) head numbers may vary by approximately 1 second.
10. The system shall provide two language capabilities, selectable by user (as a field-selectable feature).
11. The PBSs shall have wireless synchronization capabilities, from button to button (including between a two-wire PBS and a three-wire PBS), matched to a phase partner. Sync distance may vary based on the environment. Pedestrian button presses are communicated between phase partners to keep the pilot LED in sync, as well as the audible messages during the Walk and Clearance PED intervals.

Wireless synchronization shall be implemented on corners that do not contain button wires. The wireless synchronization capability shall include sending standard and extended push information to allow a call to be placed from a PBS without button wires (or degraded button wires) via a phase partner PBS that has button wires to the traffic controller.

12. The system shall provide an emergency preemption message in conjunction with a preemption system (selectable feature). This feature is only available with the CCU-S (shelf-mount CCU, not the card rack version).
13. The system LOCATE TONE, WALK, and DON'T WALK audible features shall have independent assignable minimum and maximum volume limits. CLEARANCE volume level shall be controlled by WALK volume setting.
14. All sounds for all PBSs shall be synchronized.
15. The system shall have a non-visible, ambient sensing microphone located in the pedestrian station in an environmentally protected housing.
16. The LOCATE TONE volume shall adjust automatically in response to ambient noise with field-selectable adjustment levels from -30 dB below to +20 dB above ambient in 2.5-dB increments.
17. All other sound volumes shall adjust automatically in response to ambient noise with field-selectable adjustment levels from -30 dB below to +20 dB above ambient in 5-dB increments.
18. The system shall utilize high-quality digital audio technology, with a minimum 16-bit sample at a 48-kilohertz sample rate.
19. The PBS firmware and voice messages shall be updatable via Bluetooth Low Energy level 5 at a minimum. There shall be no requirement for integrated circuit (IC) chips or module hardware to be removed or exchanged in order to complete a firmware or audio update.
20. The system shall have the option to mute sounds on all crosswalks except activated crosswalk (selectable feature).
21. The system shall have a real-time clock capable of keeping time when there is no system power, for at least 2 years from the date of manufacture.
22. The system shall have the ability to have four separate program configurations with all features available, and any single configuration can be selected through an external input.
23. The system shall provide a user settable calendar function, allowing four separate configuration profiles to be configured to become active at different times of the day on a daily, weekly, or holiday basis.
24. The entire system shall be configurable from any PBS over Bluetooth Low Energy.
25. The entire system shall be configurable from the CCU over Wi-Fi or Ethernet.
26. All field access to selectable options using Bluetooth Low Energy, Wi-Fi, or Ethernet devices shall be protected using password security.
27. Each PBS shall be capable of interacting with a pedestrian app on iOS or Android smartphones, via Bluetooth Low Energy.
28. Each PBS shall be capable of interacting with the PedApp® smartphone application to allow pedestrians to remotely actuate a pedestrian call into a PBS. PedApp can be configured to help provide visually impaired and all pedestrians with location/directionality information, as well as to place calls and receive pedestrian interval information via smartphone.
29. The touchless actuation option when ordered/included in the PBS shall be capable of detecting movement within 1 to 4 inches to actuate/place a pedestrian call via the PBS.
30. The touchless actuation option shall be capable of adjusting the distance or range of detection from 1 to 20 inches.
31. The touchless actuation option shall be capable of adjusting minimum wave detection time (amount of time that a wave shall be performed before a call is activated). The setting times shall be in milliseconds (ms) and be settable to 0 ms, 50 ms, 250 ms, and 500 ms.

32. The touchless actuation option performance shall not be impeded or affected by ice buildup on the PBS.
33. The touchless actuation option – detection system shall be inconspicuous and vandal resistant.

Central Control Unit – The CCU is the control unit that provides data for the PBSs. The CCU shall be either a shelf-mount (CCU-S) or a card-rack-mount (CCU-C) assembly.

1. The CCU-S shall be installed inside the traffic cabinet and be powered by the alternate current (AC) supply mains (115 volts alternate current [VAC]).
2. The CCU powers the PBSs over two wires and uses digital data including pedestrian interval information and pedestrian calls for each phase to communicate with each PBS over the two low-voltage button wires.
3. The CCU-C shall be installed inside a 300 series traffic cabinet's input file, replacing two PED isolator boards and receiving power from the rack (24 volts direct current [VDC]).
4. The CCU-S shall provide internal power to operate up to 16 PBSs.
5. A 24-volt power brick shall power up to 16 PBSs in a CCU-C configuration.
6. The CCU shall control at least 16 PBSs.
7. The CCU shall be logically configurable to assign any PBS to one of 16 traffic/PED phases.
8. The CCU through synchronous data link control (SDLC) shall be able to place PED calls on up to eight phases.
9. The CCU-S shall receive pedestrian phase Walk, Don't Walk, and Clearance inputs from either the traffic cabinet load switches or an SDLC input.
10. The CCU-C shall receive pedestrian phase Walk, Don't Walk, and Clearance inputs from a Transport Electrical Equipment Specification (TEES) C4S connector.
11. The CCU shall be able to self-test all PBSs and put a corresponding phase into recall should a PBS assigned to a phase fail the self-test.
12. The CCU-S shall provide optically isolated general-purpose inputs.
13. The CCU-S shall incorporate four separate cable assemblies to access all functions, so any combination of the four cable assemblies can be used to access any combination of functions.
14. The CCU shall have internal storage to log several thousand events with a date-time stamp for each event.
15. The CCU shall have an internal real-time clock capable of being set in the field and propagating the time to each connected PBS.
16. The CCU firmware shall be updatable via either Wi-Fi or Ethernet. There shall be no requirement for IC chips or module hardware to be removed or exchanged to complete the firmware update.
17. The CCU shall monitor PED interval conflicts and set affected PBSs to an off/safe mode when a conflict occurs.
18. The CCU-S shall meet NEMA 250 – Type 1 enclosures requirements.
19. The CCU shall have a backlit liquid-crystal display (LCD) screen and button interface to allow placing test calls and display status.

Pedestrian Push Button Station – The PBS allows the pedestrian to place calls to the traffic controller and provides vibro-tactile feedback during the Walk cycle. This equipment is typically mounted on a pole, near the start of the crossing.

1. The PBS shall be mounted to a pole by banding or bolting.
2. The PBS shall be a single fixture that contains a 2-inch activation area, in which resides an Americans with Disabilities Act (ADA) compliant vibro-tactile push button with a raised directional tactile arrow, and a sign mounted above the button.
3. The PBS speaker shall be 8 ohms, 6 watts, and weatherproof.

4. The button shall be cast aluminum, nickel-plated, and powder-coated black around the arrow, to provide high contrast to arrow color. The PBS arrow shall allow for change in orientation to one of four directions.
5. The PBS button actuation shall use Hall Effect Sensor technology rated to greater than 20 million operations.
6. The PBS button push force shall have three adjustable pressure settings “Light, Medium, and Firm” over a range of approximately .5 LB to 3.5 lbs to activate a button push.
7. The PBS button shall pulse and vibrate at approximately 20 hertz (Hz) with a displacement factor based on pounds of force used to actuate.
8. The PBS shall have a rear-facing speaker projecting sound from front and back, providing 360-degree omnidirectional sound performance.
9. The PBS shall include internal conflict monitoring that monitors WALK and DON’T WALK input signals for conflict conditions and disables system operation and logs errors if conflict occurs.
10. The PBS firmware and voice messages shall be updatable via Bluetooth Low Energy. There shall be no requirement for the hardware to be changed out to update.
11. The system shall operate with the vendor’s client application to record and upload cumulative PED count and call data.
12. The PBS shall meet or exceed NEMA 250 type 4X enclosure requirements.
13. The PBS construction shall be:
 - A. Frame and Button Cover: Cast aluminum, powder coated.
 - B. Housing: Reinforced, UL-listed thermoplastic.
 - C. Message Sign: Aluminum, powder coated, ink markings, or reflective vinyl sheeting.
 - D. Push Button: Aluminum, nickel plated, powder coated.
14. Electronic circuits (printed circuit board assemblies) shall be in a thermoplastic housing/enclosure having a UL 94-V0 flammability rating. The housing/enclosure shall provide NEMA 250 type 4X protection to all covered components.
15. At time of order, customer shall be able to specify sign size and message sign markings to be either the International Walking Person or the Informational Explanations for the three distinct pedestrian displays (WALK, DON’T WALK, and PED CLEARANCE) that a pedestrian would see on an active pedestrian signal.
16. The PBS shall be a modular design with a separate speaker compartment that can be field-replaced.
17. A two-wire PBS shall include a three-position terminal block to support the capability of operating as a three-wire PBS (three-wire pedestrian head-based system) by adding a control unit in the pedestrian signal head that converts 115 VAC to 24 VDC, and a three-wire cable that carries power, data, and ground wires from the control unit to the PBS.
18. The PBS shall have Bluetooth Low Energy communication that allows a pedestrian to use an application to obtain PED status information, and to place a PED call when in proximity to a button without having to touch/push the button.

Field Programming via Client Application (Apple iOS v9.0 or higher devices, or Android 5.0 or a PC with Windows 8 or 10)

1. The system shall use Bluetooth Low Energy 5 or higher technology to program firmware and audio voice messages, and to communicate to other buttons or external devices.
2. The system shall be password protected through the programming/configuration interface.
3. The iOS, Android, and PC applications shall be upgradable.
4. The iOS, Android, and PC applications shall notify the user when a newer version of the application is available.
5. The iOS, Android, and PC applications shall notify the user when newer PBS and CCU firmware is available.

6. The iOS, Android, and PC applications shall provide the mechanism to download the latest PBS and CCU firmware.
7. The iOS, Android, and PC applications shall be capable of setting all volumes and features of the APS system specific to the PBSs.
8. The iOS, Android, and PC applications shall be capable of setting/updating configuration options for a single PBS or all PBSs on the intersection for most functions from a single PBS or CCU (global updating).
9. The iOS, Android, and PC applications shall be capable of storing, modifying, loading, and emailing PBS configuration settings, audio files, and health logs.

When shown on the Plans, the APS shall comply with the MUTCD, Chapter 4 and shall conform to the following:

1. Size: 5 inches x 3.75 inches x 5 inches.
2. Weight: 3 lbs.
3. Humidity range: 5 to 95% relative humidity.
4. Color: Federal Yellow.
5. Output: Cuckoo (north/south) (Duration 0.6 seconds $\pm 20\%$, Frequency 1,100 Hz $\pm 20\%$, and Frequency Deviation +120 Hz $\pm 20\%$) and Peep-Peep (east/west) (Duration 0.2 seconds $\pm 20\%$, Frequency 2,800 Hz $\pm 20\%$, Frequency Deviation -800 Hz $\pm 20\%$).
6. Voltage: 115 Volts AC ($\pm 22\%$).
7. Power: 60 Hz, 3 Watts.
8. Temperature Range: -35° F to +165 ° F.
9. Output: 90dB at 1 watt/3 feet.

Measurement. The APS shall be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing, warranties, full operation, and configuring the APS equipment including push buttons, CCUs, mounting hardware, power cable, cabinet equipment, user manuals, testing, warranties, and any and all other equipment required to complete installation of the unit in accordance with applicable standards, specifications, and requirements. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

CONTROLLERS – GENERAL

730.28—Controllers.

A controller shall consist of the complete electrical mechanism for controlling the operations of traffic control signals, including the timing mechanism and necessary auxiliary equipment, mounted in a cabinet. Depending on the type of controller cabinet, the controller shall be either rack-mounted or shelf-mounted as specified on the Plans.

The controller unit shall be compatible with NDOT's current central software. See NDOT's current Qualified Products List (QPL) for approved controllers. The controller shall be fully compliant with the Advanced Traffic Controller (ATC) 5.2b and proposed ATC Standard 6.10. The controller shall support Linux-based software.

Control features are to include:

1. The controller unit shall meet the environmental requirements as set forth in Section 2 of the NEMA Standards Publication No. TS 2-2003 or later revision.
2. The controller shall be 10/100 Base T Ethernet ready.
3. The controller unit shall be solid state, digital based upon microprocessor design.

4. The controller shall utilize an input/output interface set forth in Section 3.5 of NEMA Standard Publication TS 2-2003 or later revision for malfunction management units and detector racks.
5. NEMA Section 3.5.2 shall be used for input/output functions for terminal facilities, detectors, and auxiliary devices.
6. The controller shall be capable of operating as a TS-2 type A 1 or type A 2.
7. The following interface connectors shall be accessible from the front of the controller:
 - A. Connector A shall mate with MS3116()-22-55S.
 - B. Connector B shall mate with MS3116()-22-55P.
 - C. Connector C shall mate with MS3116()-24-61P.
 - (1) Synchronous Data Link Control (SDLC) – 15 pin metal shell D sub-miniature (gold-plated female contacts).
 - (2) Recommended Standard (RS) 232 – 25 pin metal shell D sub-miniature (gold-plated female contacts).
 - (3) Registered Jack (RJ)-45 10/100 Base T Ethernet Port.
8. If input/output or communications functions in addition to those covered in TS 2-2003 are requested in the Plans and supplied, an additional connector may be used.
9. Programming Methods: The methods listed below shall be available for controller unit programming:
 - A. Manual data entry via the front panel keyboard.
 - B. Data downloading via a central system.
 - C. Data downloading from a personal computer.
 - D. Data downloading from one controller unit to another using the serial port of each controller unit.
 - E. Data downloading via a USB flash drive.
 - F. Flashable firmware via a computer or USB drive.
10. Controller functionality is to include:
 - A. 16 phases, 8 configurable concurrent groups in 4 timing rings.
 - B. 16 vehicle overlaps that can be configured as normal, green / yellow, protected-permissive left turn (PPLT) / flashing yellow arrow (FYA).
 - C. 16 pedestrian phases that can be configured as pedestrian overlaps.
 - D. Exclusive pedestrian operation.
 - E. Dynamic max operation.
 - F. Extendable walk and pedestrian clearance.
 - G. Advanced walk.
 - H. Bike input and green timing.
 - I. Adaptive red clearance.
 - J. Transit signal priority.
 - K. Emergency and railroad preemption.
11. Coordination features are to include:
 - A. 120 coordination event plans, each with its own cycle, offsets, split timing, coordinated phases, vehicle and pedestrian recall, and phase omits.
 - B. Offset and split entries displayed in percent or seconds.
 - C. Automatic permissive periods.
 - D. Fixed or floating force-off.
 - E. Crossing arterial coordination.
12. The controller shall have all of the following keyboard-entered values or parameters:
 - A. Phases to start in.
 - B. Phase display to be on.
 - C. Overlap display start-on condition.
13. Normal start-up display shall be main street green phase(s), with concurrent overlaps green.

14. The controller shall have a backlit liquid crystal display to provide an English language menu for programming or reading all controller features. The dynamic displays for real-time operation shall be able to display the following values for each ring or phase(s) concurrently:
 - A. Per Phase Display:
 - (1) Phase Vehicle Call.
 - (2) Phase Pedestrian Call.
 - (3) Phase is Next in Service.
 - (4) Phase is in Service.
 - (5) Phase Pedestrian Intervals in Service.
 - B. Per Ring Display:
 - (1) Ring Gapped Out.
 - (2) Ring Maximum Green Termination.
 - (3) Ring was Force Off Terminated.
 - (4) Ring Maximum Green II in Effect.
 - C. Ring Phase in Service Operating:
 - (1) Lock Call.
 - (2) Non-Lock Call.
 - (3) Minimum Recall.
 - (4) Maximum Recall.
 - (5) Pedestrian Recall.
 - (6) Non-Actuated Mode.
 - D. Per Ring Display of Timing Values (Real Time). The following values shall be selectable display the current value in a real-time mode:
 - (1) Minimum Green Interval.
 - (2) Passage Timer.
 - (3) Pedestrian Interval Timing.
 - (4) Maximum Green Timer.
 - (5) Time Before Reduction Timer.
 - (6) Time to Reduce Timer.
15. It shall be possible to inspect and alter any currently programmed value while the controller is in operation without affecting the field operation. The controller shall continue to operate the intersection as values are inspected or altered. This requirement does not apply to ring structure or other programmed values that require the controller to perform a start-up sequence.
16. All controller firmware shall be flashable and software shall be supplied with revisions of firmware to flash into the controller. NDOT requires ongoing firmware support for the lifecycle of the product.

All operator-entered data shall be stored on a USB flash drive or secure digital (SD) card.

Documentation

1. A schematic wiring diagram and maintenance manual shall be provided for all equipment.
2. If a separate operations manual is published, it shall also be provided. All documentation shall be provided in two hard copies and in PDF electronic format.
3. The manual shall show in detail all circuits and parts. Such parts shown shall be identified by common name and part number.
4. Any manufacturer unique components shall be identified as such.

Training. When four or more controller assemblies are provided under a contract, the Contractor will provide a training session for up to eight staff members. This session shall be within Davidson County and include:

1. 4 hours of classroom instruction.

2. 4 hours of laboratory instruction.
3. Theory of operation.
4. Detailed troubleshooting techniques.
5. Use of technical data including parts identification.

Software. The controller shall meet, as a minimum, all applicable sections of the NEMA Standards Publications for TS 2, National Transportation Communications for ITS (Intelligent Transportation Systems) Protocol (NTCIP) 1202 Version 03B, and ATC standard 6.25. Controller versions shall be available to comply with NEMA TS 2 Types 1 and 2. Current NDOT-approved software shall be loaded onto the controller. The software shall have the following features:

1. Advanced coordination such as adaptive and responsive timing.
2. Transit signal priority.
3. Alternate timing for bicycles, pedestrians, or special vehicles.
4. Supports NTCIP.

730-29—Controller Cabinets.

Controllers shall be housed in a rigid, weatherproof cabinet, constructed, finished, and equipped as follows, and as shown on the Standard Details. Controller cabinets shall be NEMA TS 2 or ATC as specified in the Plans. Cabinets shall be wired to TS 2 Type 2 standards and shall support 16 channels with plugins.

NEMA TS 2 Cabinets

1. Material
 - A. All cabinets shall be of weather-tight construction fabricated from aluminum sheet a minimum of 0.125 inch thick or cast aluminum alloy a minimum of 0.25 inch thick.
 - B. Painting of cabinets is not required unless required in the Plans.
 - C. All pad-mounted cabinets shall be 44 inches x 26 inches x 55 inches.
 - D. Cabinets shall meet the Standards Publication No. TS 2-2003 or later revision unless a different size is required in the Plans.
 - E. All pole-mounted cabinets shall be 36 inches x 50 inches x 18 inches unless a different size is required in the Plans or approved by NDOT.
 - F. All pole-mounted cabinets shall be equipped with a removable bottom panel to facilitate optional pad mounting.
 - G. All shelves and panels shall be mounted on U-channel type rails and be fully adjustable by loosening panel bolts.
 - H. Cabinet main back panel shall be an 8 over 8 load switch configuration and shall be sized to fit in both 36-inch-wide and 44-inch-wide cabinets. All power, neutral, and ground connections shall be labeled with color-coded silkscreen or industrial smudge-proof stickers. All controller input and output functions shall be grouped in logical order.
 - I. Cabinet main back panel shall have a hinged-type device at the bottom of the panel to facilitate the lowering of the panel for inspection of the rear wiring without removal of shelving.
 - J. All feed through terminals shall be soldered. The use of spade-type connectors will not be accepted.
 - K. All pad foundations shall be built to Section 7, Figure 7-2 of NEMA Standards Publication No. TS 2-2003 or later revision.
 - L. Cabinet shall include 14" Din Rail on right side for mounting of Ethernet switches, fiber equipment, etc.
2. Doors
 - A. Cabinets shall have a hinged front opening door, which shall include substantially the full area of the front of the cabinet.

- B. The door shall be equipped with a positive holdfast device to secure the door in at least two open positions: one position at approximately 90 degrees and the other at 120 degrees or more.
- C. The holdfast device shall be easily secured and released without the use of tools.
- D. Cabinets shall also be equipped with a switch compartment and the manual switches specified in this section and shall have a hinged front opening auxiliary door. Each door shall have a gasket to provide a weatherproof seal when closed.
- E. The main door shall have a lock as specified in the Plans or by NDOT. Two keys shall be provided for each lock.
- F. The auxiliary door shall have a standard police sub-treasury lock.
- 3. Cabinet Mounting – Cabinets shall be mounted as shown on the Plans or Standard Details.
- 4. Ventilation—Unless otherwise specified, ventilation shall be provided as follows:
 - A. All cabinets shall be ventilated through an internal baffle located in the top of the cabinet.
 - B. Inlet ventilation openings shall be filtered.
 - C. Cabinets shall be provided with two independently controlled exhaust fans.
 - D. Exhaust fans shall be electric with ball or roller bearings and a capacity of at least 100 cubic feet per minute.
 - E. The fans shall be mounted in a rain-tight housing attached to the plenum inside the top of the cabinet.
 - F. Each fan shall be controlled by thermostats having a temperature differential between turn-on and turn-off of 15°F (0, +5°F), adjustable for turn-on through a minimum calibrated range of 100° to 150°F.
- 5. Auxiliary Equipment—Except for cabinets used in special applications, all cabinets shall be fitted with the following:
 - A. No less than two shelves shall be provided to support controller and auxiliary equipment.
 - B. All terminal panels shall be arranged for adequate electrical clearance.
 - C. One ground fault receptacle and a minimum of a four-position surge type strip located on the left side of the cabinet, mounted so as not to interfere with shelf space.
 - D. LED-type lighting mounted on the plenum and under the lower shelf controlled by a door switch.
 - E. Wetted mercury switches are not acceptable; install Crydom A2475 solid state relay or equivalent.
 - F. Circuit breakers for:
 - (1) Main power input to provide all power associated with normal operation (40 amps).
 - (2) Equipment power to provide power to all associated cabinet equipment (15 amps).
 - (3) Flasher power input to provide all power associated with flash operation (15 amps).
 - (4) Service power to provide power for the lamp and duplex receptacle (10 amps).
 - (5) Service power to provide power to street name signs.
 - G. Copper ground buss (minimum of two 12-position bars).
 - H. The Malfunction Management Unit (MMU) sampling inputs shall be terminated at the closest tie point to the field termination of the signal displays.
 - I. Where required to perform specified functions, general purpose relays shall be provided.
 - J. A minimum of 24 available bare ground positions tied to AC Common Return.
 - K. Earth (driven) ground tie point to terminate a single No. 4 AWG (0.03286 square inch) copper ground.
 - L. Tie point to tie all ground systems within the cabinet to a single reference point. All grounds (AC – return, chassis, and logic ground) shall be referenced to a single ground point at the electric service.
 - M. Isolate logic ground from AC – return and earth ground. Provide ped isolation devices to protect logic ground input to the cabinet.

- N. A panel behind the auxiliary door to contain the following switches:
 - (1) An Automatic Flash switch wired when in the Flash position, that causes the cabinet to provide Flash Operation and Stop Time shall be applied to the controller.
 - (2) Switch to activate Manual Control Enable.
 - (3) Manual control pushbutton switch with 4-foot minimum cord. Cord shall attach to a 2-position terminal strip via fork-type connectors. Terminal strip to be located on the backside of the police panel.
- O. A panel mounted inside the main door to contain the following switches:
 - (1) A technician Stop-Time switch to apply Stop Time to both controller rings.
 - (2) An Interval Advance switch, enabled only by the Stop Time switch, to be momentary pushbutton switch to apply Interval advance to the timer.
 - (3) A Signal On-Off switch that will remove the AC power applied to the signal heads for normal operation while the controller continues to operate.
 - (4) A Signal Normal/Flash switch to enable intersection flash when in the Flash position.
 - (5) 16 individual phase vehicle and 8 pedestrian detector test switches located on the ped isolation unit to be toggle type of the On-Off-Momentary type located on the left side of the cabinet above the detector panel or on the tech panel to place:
 - a. No call – Call provided by detectors.
 - b. Locked detector call.
 - c. Momentary detector call.
 - (6) Switch terminals on back of main cabinet door shall be insulated or shielded so that no live parts are exposed.
 - (7) Tech panel shall have a clear fold-down Lexan panel to protect the switches from accidental activation
- P. Leads to the auxiliary door switches shall be no less than No. 18 AWG (0.000127 square inch) stranded.
- Q. All connections within the cabinet that have AC voltage shall be protected with a clear Lexan cover to prevent accidental shock.
- 6. Wiring—The cabinet shall be wired to TS 2 Mode “B” standard. The back panel shall be labeled to reflect Mode “B” operation. The cabinet shall be wired according to the following:
 - A. Controllers shall be wired for 8 vehicle movements, 4 pedestrian phases, and 4 overlaps (16 phases). Sixteen NEMA input and output indicating load switches and bases shall be provided. There shall be 4 – 2-channel detection cards for each of the 8 vehicle phases.
 - B. Detector rack (8 position) shall be wired and labeled as described in the TS 2 specification (Table 5-9, configuration 2).
 - C. Channels 1, 3, 5, and 7 green and yellow circuits shall be terminated at a load resistor. Pedestrian channels 9, 10, 11, and 12 green circuits shall be terminated at a load resistor. Load resistors shall terminate via fork-type connectors.
- 7. Power Supply—The cabinet shall include a power supply meeting the requirements of NEMA TS 2 specification. The cabinet power supply shall provide all direct current (DC) voltages to the cabinet and be monitored as 24 volts 1 & 2. The controller 24 VDC line shall not be terminated in the cabinet or be monitored. The power supply shall be completely enclosed in an aluminum housing, shall be shelf mounted, and shall provide the following voltage and current outputs:
 - A. +12 VDC $\pm$ 1 VDC, 2.0 Amps.
 - B. +24 VDC $\pm$ 1 VDC, 2.0 Amps.
 - C. 12 VAC, 0.25 Amps.
 - D. Outputs shall be fused with slow blow fuses of the ratings indicated.
 - E. AC power input shall be protected against over current with a 2-amp slow blow fuse.

- F. LED indicators on the front panel shall denote the presence of 12 VAC, 24 VDC, and 12 VDC, and the 60-Hz reference signal test points for logic common and +24 VDC shall also be provided on the front panel.
- 8. Bus Interface Unit (BIU)—The cabinet shall include a BIU and detector rack as defined in Section 8 of NEMA Standards Publication No. TS 2-2003 or later revision. The BIU shall be a NEMA designated BIU2 as listed in Table 8-1 of the TS 2 specification. The detector rack vehicle outputs shall be wired in parallel with the BIU to accomplish use of the detectors with or without use of the BIU by plugging or unplugging the vehicle input suppressors.
- 9. Lightning Protectors and Interference Suppressors—Ample lightning protectors to provide effective defense against high transient voltages caused by lightning discharges or other sources shall be provided. Each controller cabinet shall be furnished with the following surge protection devices:
 - A. Main power suppressor shall be EDCO SHA-1250 or approved equal with contact wired to Alarm 1 for all but flasher or remote detector cabinets and shall have the following characteristics:
 - (1) Peak Surge Current: 20,000 Amps.
 - (2) Clamp Voltage: 250 volts.
 - (3) Response Time: Voltage NEVER exceeds 250 volts.
 - (4) Continuous Current: 10 Amps at 120 VAC.
 - (5) It shall be socket mounted allowing replacement in less than 2 minutes.
 - B. Power protector for controller flasher, flashing beacon, and remote detector cabinets shall have the following characteristics:
 - (1) Peak Current: 15,000 Amps.
 - (2) Power Dissipation: 15 watts.
 - (3) Peak Voltage: 212 volts.
 - C. Controller detector input terminals (vehicle and pedestrian) shall be terminated at a plug-in surge suppressor, EDCO PC-642C-030 or equivalent, and have the following characteristics:
 - (1) Peak Surge Current: 400 amps differential mode.
 - (2) Response Time: 40 nanoseconds.
 - (3) Input Capacitance: 35 power factor (pf) typical.
 - (4) Clamp Voltage: 30 volts maximum (either mode).
 - D. Auxiliary relays and fan shall be provided with a resistor/capacitor circuit to suppress generated noise.
 - E. Radio frequency (RF) filter shall be provided in controller cabinets and shall provide filtering of RF noise over the range of 60 Hz through 20 megahertz (MHz). The RF filter may be incorporated as part of the main power suppressor.
- 10. Cabinet shall include a sliding storage drawer mounted under the lower shelf in accordance with the following:
 - A. Approximate exterior dimensions of 1.75 inches high x 16 inches wide x 14 inches in diameter.
 - B. Telescoping drawer guides to allow full extension from the rack cage.
 - C. Opening storage compartment lid to access storage space for cabinet documentation and other items.
 - D. Supports a weight of 25 lb when extended.
 - E. Non-slip plastic laminate surface attached to the compartment lid that covers a minimum of 90% of the surface area of the lid.

Auxiliary Devices. All auxiliary devices shall meet the requirements of Section 6 of the TS 2 specification with the following additions:

1. Load Switches—Each cabinet shall be provided complete, with the necessary number of NEMA TS 2 load switches and flash transfer relays to fully populate the cabinet. Unused switches and relays will become spares. Load switches shall meet the following requirements:
 - A. Shall meet NEMA TS 2 Standards.
 - B. Shall have front-face-mounted LED indicators to indicate the "On" condition of both the input and output circuits.
 - C. Shall utilize replaceable "cube" type circuitry or encapsulated discrete component construction. No unencapsulated discrete component construction shall be acceptable.

Malfunction Management Unit. All cabinets shall be supplied with an MMU that meets the requirements set forth in Section 4 of the NEMA Standards Publication No. TS 2-2003 or later revision. The MMU shall be the 16-channel type and shall have the following features:

1. Liquid crystal display to show all data in English language format.
2. Capable of being configured to work in a NEMA TS 2 12-channel mode.
3. Shall monitor all Green/Yellow/Red/Walk field display outputs.
4. Shall be installed with controller 24 VDC monitor not latched.
5. Shall be installed with the controller voltage monitor not latched.
6. Front panel mounted over-current protection (no internally mounted fuses are acceptable).
7. Front panel mounted reset switch.
8. The MMU shall log all faults as to the:
 - A. Date of fault.
 - B. Time of fault.
 - C. Fault condition.
 - D. Power failure.
9. The MMU shall store fault conditions in non-volatile memory for user retrieval.
10. The monitor shall be able to store at least 10 such faults.
11. The internal time clock shall automatically adjust for Daylight Savings Time changes.
12. Time and date shall be updated from the controller unit.
13. There shall be a keyboard method for the user to display and clear the stored event log.
14. There shall be an Ethernet Communication port (RJ-45) on the MMU to allow the print or save to a laptop all data or communication back to the TMC. The laptop Ethernet switch shall interface with the MMU via a standard cat6 cable. (Printer and laptops to be supplied by others.)
15. The MMU shall be equipped with a 15-pin metal shell D sub-miniature (gold-plated female contacts) for SDLC communication.
16. No functional field display shall be permitted unless monitored by the MMU.

Advanced Traffic Controller Cabinets

This section sets forth the minimum requirements for High-Voltage (HV) ATC Cabinet (ATCC). The cabinet assembly shall meet, as a minimum, all sections of ATC 5301 Standard Publication No. v02.02 dated March 18, 2019, or the most recent version. Additionally, the manufacturer shall be in compliance with the Customs Trade Partnership Against Terrorism (CTPAT), with active and ongoing/continuing employee training as part of the manufacturing processes for critical and secure transportation infrastructure equipment. UL Bulletin of Research No. 23, "Rain Tests of Electrical Equipment." Where differences occur, this specification shall govern.

General

The ATCC is built to meet the ATC 5301 v02.02 ATCC Standard. The ATCC uses high-speed serial communications, providing modern features such as simplified wiring, cabinet space availability, and more. Benefits of the ATCC include advanced diagnostics, enhanced safety, and long-term true cost of ownership,

making it a sound investment for any agency. The ATCC supports both 120-VAC and 48-VDC LED signals, while high-density switch packs and quad detector modules allow for up to 32 channel signal outputs and 120 detector inputs. The ATCC provides both voltage and current monitoring of all signal outputs, including ultra-low-power LEDs.

The cabinet dimensions shall vary depending on location, foundation, right-of-way, maintenance access, and the Plans:

- Existing NEMA Type P/R Foundations: Install Type 350i or 356i ATCC, dependent on height of existing foundation.
- Proposed Foundation: Install Type 356i ATCC on new foundation per NDOT standards.

This specification describes the 120-VDC low-voltage Model 350i ATCC.

1. General ATC Configuration

The ATCC shall include Service Assembly, Input Assembly, Output Assembly, Communication and Power Bus Assembly, Field Input Termination Assembly, and Field Output Termination Assembly.

The ATCC configuration shall include the following:

- Cabinet housing defined by the ATC 5301 Standard.
- Electronic door locks.
- Cabinet ventilation consisting of dual fan panel assembly.
- Air filter.
- Cabinet lighting.
- Cabinet finish.
- EIA cabinet cage – 2.
- Drawer shelf.
- Communication and power bus assembly.
- 32 channel output assembly.
- 16 channel field output termination assembly – 2.
- 24 channel input assembly – 2.
- 24 channel field input termination assembly – 2.
- Service assembly (32 channel configuration) with main surge arrestor.
- Auxiliary display unit.
- ATCC power supply.

The following plug-in devices shall be provided with each ATCC:

- 16 High-Density Flash Transfer Relays (HDFTRs).
- 16 High-Density Switch Packs (HDSPs).
- 16 High-Density Output Suppressors.
- 2 High-Density Flasher Units (HDFUs).
- 1 ATCC Cabinet Monitor Unit.
- 4 Serial Interface Units (SIUs).
- 4 Dual Channel DC Isolator Cards (242L).

2. Cabinet Housing

The housings shall include, but not be limited to, the following:

- Enclosure.

- Doors.
- Gasketing.
- Lifting Eyes and External Bolt Heads.
- Latches and Locks.
- Ventilation.
- Hinges and Door Catches.
- Police Panel.
- Cage Supports and Mounting.

A. Housing Construction

The housing shall be rainproof. It shall have two front and two rear doors, each equipped with a lock and handle. The enclosure top shall be crowned to prevent standing water.

B. Material Thickness

The enclosure, doors, lifting eyes, gasket channels, police panel door, spacer supports, and all supports welded to the enclosure and doors shall be fabricated of 0.125-inch minimum thickness aluminum sheet. The filter shell, filter trough, fan support, and police panel enclosure shall be fabricated of 0.080-inch minimum thickness aluminum sheet. The spacer supports shall have the option to use 0.059-inch minimum stainless-steel sheet.

C. Welds

All exterior seams for enclosure and doors shall be continuously welded and shall be smooth. All edges shall be filled to a radius of 0.03125 inch at a minimum. Exterior cabinet welds shall be done by gas tungsten arc TIG process only. ER5356 aluminum alloy bare welding electrodes conforming to AWS A5.10 requirements shall be used for welding on aluminum. Procedures, welders, and welding operators shall conform to the requirements and practices in AWS B3.0 and C5.6 for aluminum. Internal cabinet welds shall be done by gas metal arc MIG or gas tungsten arc TIG process.

D. Aluminum Surface Protection

Anti-Graffiti Paint

If anti-graffiti paint is requested, each stage in the process shall be as follows:

- Perform treatment with a moderately acidic, liquid cleaner concentrate for thorough cleaning.
- Clean water rinse from reverse osmosis system (< 2,500 parts per million [PPM]).
- Clean water rinse from reverse osmosis system (< 500 PPM).
- Apply a conversion coating to form an excellent base for bonding powder to parts and producing good resistance to corrosion.
- Clean water rinse from reverse osmosis system (< 800 PPM).
- Clean water rinse from reverse osmosis system to decrease any solids on surfaces (< 100 PPM).
- Apply a final seal rinse to enhance corrosion resistance.
- Convey through a dry-off oven at a cycle of 10 to 20 minutes at 380° F to eliminate any trapped water and gases in the parts.
- Apply polyester dry powder at 90,000 volts for maximum mil transfer. Thickness of the powder coating shall nominally be 2 to 5 mils.

- Convey into the cure oven for a thermal setting [cure] cycle of 10 to 20 minutes at 380 to 425°F.
- E. NDOT, at its option, may require the vendor to submit written certification of compliance to the requirements listed in this section of the specification.
- F. Enclosure Door Frames and Door Seals
The enclosure door frames shall be double flanged out on all four sides and shall have strikers to hold tension on, and to form a firm seal between, the door gasketing and the frame. The dimension between the door edge and the enclosure external surface when the door is closed and locked shall be 0.156 inch (± 0.08 inch).
- G. Gasketing
Gasketing shall be provided on all door openings and shall be dust tight. Gaskets shall be 0.25-inch minimum thickness closed cell neoprene or silicone (BOYD R-108480 or approved equal) and shall be permanently bonded to the metal. A gasket top and side channels shall be provided to support the top gasket on the door to prevent gasket gravitational fatigue.
- H. Lifting Eyes and Exterior Bolt Heads
The housing shall be provided with two lifting eyes for placing the cabinet on its foundation. Each eye opening shall have a minimum diameter of 0.75 inch. Each eye shall be able to support a weight load of 1,000 lbs. All bolt heads shall be tamperproof type.
- I. Door Latches and Locks

Latching Handles

The latching handles shall have provision for padlocking in the closed position. Each handle shall be a minimum of 0.75-inch-diameter stainless steel with a minimum 0.5-inch shank. The padlocking attachment shall be placed 4.0 inches from the handle shank center to clear the lock and key. An additional 4.0-inch minimum gripping length shall be provided.

Latching Mechanism

The latching mechanism shall be a three-point draw roller type. The pushrods shall be turned edgewise at the outward supports and have a cross section of 0.25 inch thick by 0.75 inch wide at a minimum.

Locks and Handles

When the door is closed and latched, the door shall be locked. The lock and lock support shall be rigidly mounted on the door. In the locked position, the bolt throw shall extend a minimum of 0.25 ± 0.03125 inch into the latch cam area. A seal shall be provided to prevent dust or water entry through the lock opening.

Locks

The locks shall be electronic to allow NDOT to configure and monitor access to each cabinet. One key shall be supplied with each lock. The keys shall be removable in the locked position only.

Bolt Heads

The locks shall have rectangular, spring-loaded bolts. The bolts shall have a 0.281-inch throw and shall be 0.75 inch wide by 0.75 inch thick (tolerance is ± 0.035 inch).

Center Latch Cam

The center latch cam shall be fabricated of a minimum thickness 0.1875-inch steel or aluminum. The bolt surface shall horizontally cover the cam thickness. The cam shall be structured to only allow the door to open when the handle is moved toward the center of the door.

Rollers

Rollers shall have a minimum diameter of 0.875 inch with nylon wheels and steel ball bearings.

Hinges

Stainless-steel hinges (two bolts per leaf) shall be provided to bolt the enclosure to the doors. Each door shall have four hinges per door. Each hinge shall be 3.5-inch minimum length and have a fixed pin. The pin ends shall be welded to the hinge and ground smooth. The pins and bolts shall be covered by the door edge and not be accessible when the door is closed. A ground strap between the door and the main cabinet housing shall be required when 120-VAC devices are mounted on the door.

Door Catches

Front and rear doors shall be provided with catches to hold the door open at both 90 and 165 (± 10) degrees. The catch minimum diameter shall be 0.375-inch aluminum rods. The catches shall be capable of holding the door open at 90 degrees in a 60-mile-per-hour (mph) wind acting at an angle perpendicular to the plane of the door.

J. Police Panel

A police panel assembly shall be provided to allow limited control access. The panel door shall be equipped with a lock and master police key. The front and back of the panel shall be enclosed with a rigid metal covering so that no parts having live voltage are exposed. The panel assembly shall have a drain to prevent water from collecting within the assembly. The drain shall be channeled to the outside. The cabinet shall have one switch provided and labeled "SIGNALS ON / OFF" and one switch provided and labeled "FLASH / AUTO." The MANUAL CONTROL ENABLE ON / OFF switch and a receptacle for the INTERVAL ADVANCE cord shall be provided. An INTERVAL ADVANCE cord, 6 feet in length, shall be provided.

K. Rack Cage

Two standard rack cages shall be installed inside the housing for mounting of the ATC and cabinet assemblies. The EIA rack portion of the cage shall consist of four continuous, adjustable equipment mounting angles. The mounting angle nominal thickness shall be 11-gauge plated steel. The mounting angles shall be tapped with 10 to 32 threads with EIA universal spacing. The mounting angle shall comply with standard EIA-310-B and shall be supported at the top and bottom by either welded or bolted support angles to form a cage. The mounting angles shall provide holes to mount the side panels.

L. Cage Connection

The cage shall be bolted to the cabinet at four points via the housing cage supports and four points via associated spacer brackets (top and bottom).

- M. Cage Location
The cage shall be centered within the cabinet door opening(s).
 - N. Cage Mounting Supports
Cage mounting supports shall be provided on either side, level with the bottom edge of the door opening, for horizontal support and bolt attachment; side cage supports shall be provided for the bracket cage supports and attachments.
 - O. Clearance between Rails
Clearance between rails for mounting assemblies shall be 17.75 inches.
 - P. Housing Ventilation
Housing ventilation shall include intake, exhaust, filtration, fans, and thermostat.
 - Q. Intake and Filter
The louvered vent depth shall be a maximum of 0.25 inch. A removable and reusable air filter shall be housed behind the left front door vents and right rear door vents. The filter filtration shall cover the vent opening area. A filter shell shall be provided to fit over the filter and to provide mechanical support for the filter. The shell shall be louvered to direct the incoming air downward. The shell sides and top shall be bent over a minimum of 0.25 inch to house the filter. The filter resident in its shell shall be held firmly in place with a bottom trough and spring loaded upper clamp. No incoming air shall bypass the filter. The bottom filter shall be formed into a waterproof sump with drain holes to the outside housing. The filter shall be 16 inches wide by 12 inches high by 0.875 inch thick. The filter shall be an ECO-AIR Product E35S or approved equal.
 - R. Fans
Each electric fan shall be equipped with ball or roller bearings and shall have a minimum capacity of 100 cubic feet of free air delivery per minute. Two DC-powered fans shall be mounted within the housing and protected with a finger guard. A Fan Test switch shall be provided.
 - S. Temperature Controlling
The fans shall be thermostatically controlled and shall be manually adjustable to turn on between 32° F and 140° F with a differential of not more than 20° F between automatic turn on and off. The fan circuit shall be protected at 125% of the fan motor ampacity. The manual adjustment shall be graded in a 20° F increment scale. The thermostat shall be an Omega KT01101141900 or approved equal.
 - T. Cabinet Lights
The cabinet shall be equipped with two LED lights activated by door switches and equipped with fuses.
3. Model 350I ATCC Assemblies
- A. Output Assembly (32-Channel)

The Output Assembly shall be a 6U high rack mounted assembly. The Output Assembly shall house 16 Model 2202-LV-MC HDSPs / Flasher Units (FUs) and shall provide 96 output circuits.

The Output Assembly shall accommodate two Model 2218 SIUs to provide interface and control via system SB1/SB2.

The Output Assembly shall house one model 2212-HV Cabinet Monitor Unit (CMUip), the main contactor, stop time switch, flash / auto switch, one circuit breaker, and momentary 24 VDC bypass switch. The main contactor shall be located at the back of the Output Assembly access door. Circuit breakers and toggle switches shall be equipped with a guard.

B. Field Output Termination Assembly (2qty 16-Channel)

Each Field Output Termination Assembly shall be coupled with the 32-channel Output Assembly and shall house eight Model 21XBXL-48VDC HDFTRs. The HDFTRs and Flash Program Blocks (FPBs) shall be provided to control and select the color (red, yellow, or dark) during ATC (LV) cabinet flash mode. HDSP suppressors shall be provided at the field terminals for the protection of the HDSP. Each HDFTR position shall be labeled with the number of its associated HDSP (1-16). Each FPB position shall be labeled with the number of its associated channel (1-16).

The Field Output Termination Assembly shall be provided with 16qty 6-position Phoenix Contact terminal block model number 18-04-94-6 plugs and 18-61-19-6 sockets or approved equal. Each Load Terminal Block receptacle shall be labeled with the number of its associated channel (1-16). Additional labels shall be provided to clearly indicate which terminals correspond to the red, yellow, and green switch pack outputs. The color of these labels shall match the color of their associated output (red, yellow, or green). Each 16-Channel Field Output Termination Assembly shall be mounted across the EIA rails, and it shall swing down to provide access to the HDSP suppressors.

C. Input Assembly (2qty 24-channel)

The Input Assembly shall be a 3U high rack mounted assembly providing 12 slots of 22/44 pin printed circuit board (PCB) sockets. One Model 2218-MC SIU shall be provided and mated to a DIN 96-pin connector. The SIU shall provide interface and control between the controller and the input devices via system SB1/SB2. The Input Assembly shall house either 2-channel or 4-channel detection modules. The Input Assembly shall house twelve 2-channel detection modules, or six 4-channel detection modules, or a combination of 2- and 4-channel detection modules up to 24 channels. Each Input Assembly shall be equipped with an Opto Input Card. The Opto Input Card shall be equipped with four LED indicators and four toggle switches. Activation of switches 1-4 shall place a call into SIU Opto 1-4 input, respectively.

D. Field Input Termination Assembly (2qty 24-channel)

Each 24-channel Field Input Termination Assembly shall be coupled with each 24-channel Input Assembly and shall have positions for landing 24qty, two-wire inputs and their associated earth ground wires. The Field Input Termination Assembly shall have positions for 12 detection module suppressors. The detection module suppressors shall be supplied with the cabinet if procurement requires. The 24-channel Field Input Termination Assembly shall be mounted across the EIA rails, and it shall swing down to provide access to the back of the assemblies mounted in the opposite side.

E. Service Assembly (32-channel)

The Service Assembly shall be a 3U high rack mounted assembly. It shall house two Model 2202-HV-MC HDSPs / FUs, cabinet suppressor filter, 7-position utility and battery backup system (BBS) landing wire terminal, ground fault circuit interrupter (GFCI) with Type A/C USB connection, one convenience outlet NEMA 5-15 format, one convenience outlet NEMA 6-15 format, eight HDFU output fuses, four HDFU spare fuses, five circuit breakers, and a raw AC+ and an AC- terminal block having four screw terminals. Circuit breakers shall be equipped with guards.

F. Communication and Power Bus

Communication and Power Bus shall include eight DB25 d-submodular socket connectors to interconnect the SB1/SB2 communication ports of the assemblies and controller. It shall include an internal termination circuit at the end of the connections (S8) to prevent radio frequency signal reflection. It shall include one Phoenix Contact plug block or approved equal to bring the DC power to the Bus; such power shall be distributed to the ATC (HV) Cabinet Assemblies through seven Phoenix Contact receptacle blocks or approved equal. The copper traces for the DC voltages shall support at least 10 amps.

The AC Clean Power Bus shall also include eight NEMA 5-15 receptacles to provide AC Clean Power to the ATC (HV) Cabinet Assemblies, the controller, and cabinet power supply. SB1/SB2 and DC/Clean Power Bus shall be mounted across the EIA rails, and it shall swing down to provide access to the back of the assemblies mounted in the opposite side.

G. Drawer Shelf Unit

A telescopic slide-out drawer to store document shall be provided. The drawer shelf unit shall be mounted across the EIA rails and shall have a non-conductive top, locking provision, and pulling handle or lip.

H. ATCC Components

Model 2202-HV-MC High-Density Switch Pack / Flasher Unit

The HDSP-FU shall be compact, pluggable, modular PCB-based, and equipped with a DIN connector. The HDSP-FU shall be compatible with ultra-low power LED signal heads, and it shall have a current monitoring feature for each output of each channel. The HDSP-FU shall use real-time standardized high-speed serial bus #3 (SB3) communications with the cabinet monitor unit to send a complete set of root-mean-square (RMS) voltage and load current measurements. The HDSP-FU shall be 4.5 inches in height and 6.5 inches in diameter and shall be equipped with a handle, reset push button switch, six red, yellow, green (RYG) LED indicators, four flasher LED indicators, one power LED indicator, and two Rx/Tx LED indicators. The HDSP-FU can function as either a switch pack (HDSP) or as a flasher unit (HDFU).

When installed in the Output Assembly, the HDSP shall provide two RYG channels of operation (six outputs). When installed in the Service Assembly, the HDFU shall function as a four-output flasher.

Model 2212-HV-MC Cabinet Monitor Unit

The CMUip shall be compact, pluggable, and modular. The CMUip shall use real-time standardized 614.4-kilobits per second (Kbs) SDLC communications with the ATC to transfer command and response data on Serial Bus #1 (SB1). The CMUip shall be capable of monitoring up to 32 physical switch pack channels (RYG) and shall have four optional virtual channels. The CMUip shall provide a Flasher Alarm feature. The CMUip shall analyze the ATC output commands and field input status to isolate the failure source by channel and color. The CMUip configuration programming shall be provided by an interchangeable Datakey non-volatile memory device. This rugged key shall store all CMUip configuration parameters and shall eliminate programming using jumpers, diodes, or DIP switches. The CMUip shall maintain a non-volatile event log recording the complete intersection status as well as time stamped previous fault events, 48-VDC line events, configuration changes, monitor resets, cabinet temperature, and true RMS voltages and currents for all field inputs. The signal sequence history log stored in non-volatile memory graphically shall display up to 30 seconds of signal status prior to the fault trigger event with 50-milliseconds (ms) resolution to ease diagnosing of intermittent and transient faults.

Model 2218-MC Serial Interface Unit

The Model 2218-MC SIU shall be compact, pluggable, and modular. The SIU shall use real-time standardized 614.4-Kbs SDLC communications with the ATC to transfer command and response data on SB1. The SIU shall be equipped with 54 programmable input/out pins, four optically isolated input pins, one line sync reference input pin, and four address select input pins. The optically isolated inputs shall work with either 12 VAC or 24 VDC. The SIU outputs shall be rated at 150-milliamperes (mA) continuous sink current. Each output shall provide a 500-mA typical current limit, shall be rated to 50 volts, and shall utilize a voltage clamp for inductive transient protection. The SIU shall be equipped with a front panel LED indicator that can report the current SIU assembly address assignment of the SIU for cabinet configuration verification.

Model 2220-MC Auxiliary Display Unit

The Auxiliary Display Unit (ADU) shall be installed in a 1U height 19-inch rack space and shall provide a menu-driven user interface to the enhanced features of the CMUip monitor including the built-in Diagnostic Wizard. The ADU shall provide 32 channels of RYG LED indicators that display full intersection status and 32 Blue fault status LED indicators that shall identify faulty channels. The ADU shall provide proper electrical termination to SB3. The ADU shall have a 4-line by 20-character menu-driven liquid crystal display with backlight and heater. The ADU built-in Diagnostic Wizard shall automatically pinpoint faulty signals, offer troubleshooting guidance, and isolate and identify problems. The ADU shall be equipped with Event Logging displaying the CMUip time-stamped non-volatile event log records with the complete intersection status as well as AC Line events, monitor resets, temperature, and true RMS voltages and currents.

Monitor Key Programming Tool (optional)

The Programming Tool provides the capability to read and write data from the CMUip Datakey device. The Monitor Key software shall be compatible with the CMUip-2212-LV-MC

Model 21XBXHL-48VDC High-Density Flash Transfer Relay

The HDFTR shall have a hermetically sealed cover and shall be moisture proof. The HDFTR shall be filled with dry nitrogen to protect contacts from corrosion and to prevent condensation. The HDFTR shall have a shock-/impact-resistant metal can cover with solid and bend-proof pins. The HDFTR contacts shall be rated at 120 VAC at 5 amps. The coil of the HDFTR shall be rated at 48 VDC. The HDFTR shall have an LED indicator to display contact transfer position.

Main Contactor

The main contactor (MC) shall be mercury free and shall be rated at 48 VDC. The coil of the MC shall be rated at 48 VDC. The MC shall be equipped with an input indicator and shall have single pole single throw normally open (SPST- NO) contacts. The MC shall be placed on a removable panel for maintenance access.

Service Assembly Cabinet Suppressor-Filter

The cabinet shall be equipped with a cabinet suppressor-filter. The unit shall incorporate the use of warning and failure indicators and shall have a dry relay contact remote sensing circuit. The unit shall be modular and pluggable with a 6-position Beau 5406 connector. The unit shall be rated at a continuous service current of 15 amps and maximum clamp voltage of 390 VAC. The unit dimensions shall be 3.5 inches high x 3.5 inches wide x 2.8 inches in diameter.

High-Density Output Suppressors

The HDSP suppressor shall be modular and pluggable. The unit shall be epoxy encapsulated and equipped with 9-position 0.2-inch Phoenix Contact connector or approved equal. The unit shall be able to protect 6 circuits. The device operating voltage shall be 120 VAC and clamping voltage shall be 340 VAC. The unit dimensions shall be 2 inches high x 0.7 inch wide x 2 inches in diameter.

Model PS-2216-24 Cabinet Power Supply

The cabinet power supply (CPS) shall be installed in a 1U height 19-inch rack space. The CPS shall be rated at 168 watts, 48 VDC at 1 amp, and 24 VDC at 5 amps. The CPS shall use modern switching technology and provide full output regulation across changes in AC line voltage and output load over the full operating temperature range of -34° C to +74° C without the need for a fan. Power Factor Correction shall be provided. The CPS shall have separate LED indicators that display AC input status, DC output status, and associated fuse integrity. The CPS outputs shall be fused for over-current protection and shall be protected against voltage transient suppressor.

4. ATCC Electrical, Environmental, and Testing Requirements

A. General

The requirements called out in this specification in association with equipment evaluation are a minimum and shall not limit the testing and inspection to ensure compliance.

B. Certification

These test procedures shall be followed by the manufacturers, which shall certify that they have conducted inspection and testing in accordance with this specification.

C. Inspection

A visual and physical inspection shall include mechanical, dimensional, and assembly conformance of all parts of this specification.

D. Environmental and Electrical

All components, where applicable, shall properly operate within the following limits unless otherwise noted:

- Applied Line Voltage: 90 to 135 VAC.
- Frequency: 60 $\pm$ 3.0 Hz.
- Humidity: 5% to 95%.
- Ambient Temperature: -34.6°F to +165.2°F.
- Shock: Test per Specification MIL-STD-810G Method 516.6.
- Vibration: per Specification MIL-STD-810G Method 514.6.

E. Commencement Operation

All circuits, where applicable unless otherwise noted, shall commence operation at or below 90 VAC as the applied voltage is raised from 50 to 90 VAC at a rate of 2 ($\pm$ 0.5) volts/second.

F. Equipment Compliance

All equipment shall be unaffected by transient voltages normally experienced on commercial power lines. Where applicable, equipment purchased separately from the cabinet (which normally is resident) will be evaluated for compliance.

G. Power Line Surge Protection

The power line surge protection shall enable the equipment being tested to withstand (nondestructive) and operate normally following the discharge of a 25-microfarad (μ F) capacitor charged to $\pm$ 2,000 volts, applied directly across the incoming AC line at a rate of once every 10 seconds for a maximum of 50 occurrences per test. The unit under test will be operated at 68°F $\pm$ 41°F and at 120 ($\pm$ 12) VAC.

H. Operating

The equipment shall withstand (nondestructive) and operate normally when one discharge pulse of $\pm$ 300 volts is synchronously added to its incoming AC power line and moved uniformly over the full wave across 360 degrees or stay at any point of line cycle once every second. Peak noise power shall be 5 kilowatts with a pulse rise time of 500 nanoseconds. The unit under test will be operated at 68°F $\pm$ 41°F and at 120 ($\pm$ 12) VAC.

I. UL Requirements

Equipment shall comply only with the requirements of UL Bulletin of Research No. 23, "Rain Tests of Electrical Equipment."

J. Operational Conditions

All equipment shall continue normal operation when subjected to the following:

Low Temperature Test

With the item functioning at a line voltage over Electrical Range the Device in its intended operation, the ambient temperature shall be lowered from 68°F to 34.6°F at a rate of not more than 64.4°F per hour. The item shall be cycled at -34.6°F for a minimum of 5 hours and then returned to 68°F at the same rate.

High Temperature Test

With the item functioning at a line voltage over Electrical Range the Device in its intended operation, the ambient temperature shall be raised from 68°F to 165.2°F at a rate of not more than 64.4°F per hour. The item shall be cycled at 165.2°F for 5 hours and then returned to 68°F at the same rate. The test shall be repeated with the line voltage at 135 VAC.

Normal Operation

All equipment shall resume normal operation following a period of at least 5 hours at -34.6°F and less than 10% humidity and at least 5 hours at 165.2°F and 22% humidity, when 90 VAC is applied to the incoming AC.

Humidity and Ambient Temperature

The relative humidity and ambient temperature values in the following table shall not be exceeded.

Ambient Temperature/ Dry Bulb (in °F)	Relative Humidity (in percent)	Ambient Temperature/ Wet Bulb (in ° F)
-34.6 to 33.98	10	1.04 to 108.86
33.98 to 114.8	95	108.86
119.84	70	108.86
129.92	50	108.86
140	38	108.86
149.72	28	108.86
160.16	21	108.86
165.2	18	108.86

K. Quality Control/Final Acceptance Testing

A complete quality control/final test report shall be supplied with every ATCC. The test report shall indicate the name of the tester and shall be signed by a responsible manager.

L. Cabinet Print

Wiring diagram sheets for the cabinet shall be furnished in a weatherproof plastic pouch placed in the cabinet. Cabinet wiring diagrams shall be non-fading.

5. Warranty

A. ATC Cabinet and Assemblies

The ATCC is covered by a standard two-year warranty from the date of shipment. The manufacturer warrants its products to be free of defects in workmanship and/or material. Repair or replacement of any units found to be defective within the first 24 months from the date of delivery shall be according to the following:

- The first 12 months shall be covered with full replacement of defective products.

Before returning any products, the customer shall call the manufacturer representative to start the Return Material Authorization process. The customer must prepay all freight, insurance, and other transportation costs to send the product back to the manufacturer for warranty coverage verification. Repair, replacement, and shipment back to the customer shall be covered as part of the warranty coverage.

B. ATCC Components

All ATCC components are covered under the manufacturer's standard warranty.

730-30—Communications Equipment.

This section specifies the communications equipment needed for communication to NDOT's network and central software. Depending on the available infrastructure, each location may require a specific configuration as specified in the Special Provisions, shown on the Plans, or directed by the Engineer.

1. Ethernet Switch

A. Copper – Etherwan 3575 or approved equal (only applicable for traffic signals with copper interconnect)

- (1) Hardened managed 6-port 10/100base-tx + 2-port gigabit combo small form-factor pluggable (SFP) switch with 2-port copper pair extender.
- (2) Fully managed switch capabilities with Layer 2 features.
- (3) 12- to 48-VDC input voltage security – MAC address filtering; enable/disable port; IEEE802.1X LAN access control.
- (4) Ethernet Ports
 - 10/100BASE-TX: 6 ports.
 - 10/100/1000BASE-T and 100/1000BASE-X SFP combo: 2 ports.
- (5) Ethernet Extender Ports
 - RJ-11 and Terminal Block port: 2 ports.
 - Cable: Telephone wire No. 24 AWG (minimum 0.02-inch diameter, 1-pair wire).

B. Fiber Switch – Cisco Industrial Ethernet 3300 series switch IE 3300 8U2X

- (1) 2 10-Gig SFP ports and 8 Copper Gigabit Ethernet ports on the base with PoE/PoE+, UPoE (60W 802.3bt type 3).
- (2) Network Advantage (-A) – Layer 3 (IPv4 and IPv6) feature set that includes dynamic routing, VRF, Cisco TrustSec, MACsec-256 bit.
- (3) Cisco DNA Advantage – At least 3-year subscription license for Cisco Catalyst Center Software-Defined Access (SD-Access) Extended Nodes.
- (4) SFPs – 1 Gbps and 10 Gbps. Plans shall specify quantities and rating.
- (5) Power supply – PWR-IE480W-PCAC-L.

2. VPN Firewall – Cisco Meraki Z4C or approved equal. This device shall only be used where there is no fiber optic communication and basic network connectivity for traffic controller is required.

- A. Built-in Wi-Fi 6.
- B. Built-in LTE cellular capabilities.
- C. 6-gigabit Ethernet ports.
- D. Built-in PoE+ capabilities.

3. VPN Firewall – Cisco Meraki Z3 or approved equal. This device shall only be used where there is no fiber optic communication and traffic cameras are required.

- A. 4-gigabit Ethernet ports.
- B. 1 PoE-enabled port.
- C. 1 USB (cellular failover).
- D. Auto VPN for intelligent site-to-site VPN connectivity.
- E. Power supply – 50 watts (54 volts/0.92 amp).

4. Cellular Modem – Cisco Meraki MG21 or approved equal. This device shall only be used where there is no fiber optic communication and traffic cameras are required.

- A. 2-gigabit Ethernet ports.
 - B. Built-in category (CAT) 6 LTE connectivity.
 - C. Power supply – 12 volts/1 amp, 48-57 volts DC/0.35 amps.
 - D. Patch Antenna – Meraki MG21E.
5. Cellular Modem – Cisco Meraki MG41 or approved equal. This device shall only be used where there is no fiber optic communication and traffic cameras are required.
- A. 2-gigabit Ethernet ports.
 - B. Built-in CAT 18 integrated cellular.
 - C. Power supply – 12 volts/1 amp, 48-57 volts DC/0.35 amps.
 - D. Patch Antenna – Meraki MG41E.

All Meraki dashboard licenses should be purchased for a 5-year term.

Measurement. The Communication Equipment shall be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing, and configuring the communication equipment, providing warranties, mounting hardware, serial port cables or connectors, power cable, user manuals, testing, and any necessary items for full operation in accordance with applicable standards, specifications, and requirements. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

FLASHING SCHOOL SIGNALS

730.31—Flashing School Signals.

Flashing school signals shall conform to the following:

1. The signal shall produce two alternate flashing lights within the marginal limits of a school speed limit sign. Details of the sign construction shall be as specified on the Plans. Sign colors shall conform to the MUTCD and be constructed of materials complying with these specifications.
2. The two lenses shall be LED, yellow in color, and a minimum of 12 inches in diameter.
3. The flasher unit shall be the two-circuit type to provide alternating equal on-off operation. The flashing mechanism shall produce between 50 and 60 flashes per minute through two 120-volt, 60-cycle AC, 15-ampere circuits. The flasher shall be of solid-state construction and to NEMA standards.
4. The unit shall be wired for external circuits.
5. The signal shall be actuated by a momentary key switch (key number Chicago Lock Co. No. 2382). The timing device shall be digital (National Controls Corp. Model TMM-0999M-461, or equal) and located in a remote mounted control cabinet.
6. Where an illuminated speed limit indication is specified on the Plans, the numeral message shall be illuminated in Portland Orange in a rectangular lens and illuminated only during the period when the signal produces two alternately flashing amber lights.

DETECTORS

730.32—Detectors.

Detectors shall be used for actuating signal phases of traffic-actuated controllers and shall be of the type specified in the Plans.

1. Lightning protection shall be EDCO SRA6LCA916 or an approved equivalent.
 - A. The lightning protection unit must withstand repeated 400-ampere surges on a 9 x 20 microsecond waveform.

- B. The unit must be 2-stage device capable of clamping a minimum of (100-) 300-ampere surges to 25 volts within 40 nanoseconds. The surge shall be applied across the 2 detector leads.
- 2. Inductive Loop Detectors
 - A. Loop amplifiers shall be rack-mounted 2-channel units that meet the requirements of Section 6 of NEMA Standards Publication No. TS 2-2003 or later revision.
 - B. The loop detector amplifier shall be Type CC as listed in Table 6-1 of NEMA Standards Publication No. TS 2-2003 or later revision. There shall be 4 – 2-channel detection cards for each of the 8 vehicle phases.
 - C. The detector rack shall be wired and labeled as defined in Table 5-9, Configuration 2 of NEMA Standards Publication No. TS 2-2003 or later revision.
 - D. The loop detector amplifier shall be fully automatic, requiring no adjustments to effect operational ability other than setting of the operating frequency and sensitivity. The amplifier shall:
 - (1) Sense any legal motor vehicle traveling at speeds up to 65 mph.
 - (2) Have both a “Pulse” and “Presence” Output:
 - a. Pulse output shall generate an output of 125 ±25 milliseconds for each vehicle entry.
 - b. Presence output shall provide a continuous output for up to 60 minutes as long as a vehicle is within the detection zone.
 - (3) Provide at least four user-selectable sensitivity ranges.
 - (4) Be supplied with at least three frequency ranges for crosstalk minimization.
 - (5) Have a front-face-mounted indicator to indicate active output of the internal relay. This indicator shall indicate the presence of:
 - a. Normal output.
 - b. Delayed output.
 - c. Extended output.
 - (6) Have a front-panel-mounted “Reset” switch that when pressed shall cause the unit to completely re-tune itself.
 - (7) Have delayed or extended timing features with the following ranges:
 - a. Delayed output of 0 to 30 seconds in 1-second increments.
 - b. Extended output of 0 to 10 seconds in 1/4-second increments.
 - (8) Have internal diagnostics to determine the operational ability of the loop. These diagnostics shall determine if a loop is opened or shorted and shall provide a visible indication of such condition. Additionally, if such a condition occurs, the amplifier unit shall default to a “constant” output.
 - (9) Provide output by a mechanical relay, which shall be “off” to provide an output.
 - (10) Have all delay functions wired to the associated plan green phase to inhibit that function during controller green phase.
 - (11) Be able to operate with loop lead-in lengths of at least 2,000 ft.

730.33—Video Detection.

This section specifies the minimum requirements for Video Detection System (VDS) equipment furnished and installed. The work shall consist of providing all labor, materials, equipment, and incidentals necessary to furnish, install, and test video detection equipment. This work consists of furnishing and installing video detection equipment complete and ready for service.

- 1. The VDS shall consist of power supply, hard-wired video cameras, all necessary video and power cabling with end connectors, mounting brackets, lightning protection as recommended by the manufacturer, and video detection processors/extension modules capable of processing the number of camera and phase combination video sources shown on the Plans or in the purchase order. A

sufficient number of cameras shall be provided to process vehicle presence, passage, and system detection zones as shown on the plans or listed on the purchase order.

2. Warranty
 - A. A 36-month warranty or the manufacturer's standard warranty, whichever is greater, shall be provided for all VDS components.
 - B. The warranty period begins on the date of installation to the project. Each system shall be marked with a permanent label or stamp indicating the date of installation.
 - C. The warranty shall include technical support available from the supplier, at no cost, via telephone within 4 hours of the time a call is made 7 days a week, from factory-certified personnel or factory-certified installers.
 - D. The warranty shall include updates to video detection processor and application software from the manufacturer without charge.
3. General Capabilities and Performance Requirements
 - A. Camera systems provided shall be able to transmit National Television System Committee (NTSC) video signals up to 1,000 ft.
 - B. Furnished VDS configuration shall utilize video processors with one or more video inputs and one video output, responding to specific site applications, camera locations and detection zones shown on the project Plans.
 - C. Video processors provided shall plug directly into TS-1 and TS-2 detector racks without adapters.
 - D. Extension modules provided shall allow detection zones from one camera to be routed to other card slots.
 - E. Remote programming and monitoring capability from a distant TMC are mandatory.
 - F. VDS shall be Ethernet compatible with an RJ45 port.
4. Interface
 - A. Provide video inputs that accept RS170 (NTSC) signals from an external video source. Provide a Bayonet Neill-Concelman (BNC) type interface connector located on the front of the video processing unit.
 - B. Provide an LED indicator to indicate the presence of the video signal. The LED indicator shall illuminate upon valid video synchronization and turn off when the presence of a valid video signal is removed.
 - C. Provide one video output per processor module. The video output shall be RS170 compliant and shall pass through the input video signal. The video output shall have the capability to show text and graphical overlays to aid in system setup. The overlays shall display real-time actuation of detection zones upon vehicle detection or presence. Control of the overlays and video switching shall also be provided through the serial communications port. The video output interface connector shall be BNC or RCA type. If an RCA connector is used, an RCA to BNC adapter shall be provided.
 - D. Provide a serial communications port on the front panel. The serial port shall be compliant with RS-232 or RS-422 electrical interfaces and shall use a DB9 or RJ45 type connector. The serial communications interface shall allow the user to remotely configure the system and/or to extract calculated vehicle/roadway information.
 - E. Furnish interface software. The interface protocol shall support multi-drop or point-to-multipoint communications. Each VDS shall have the capability to be individually IP addressable either built in or with third-party video server units.
 - F. Provide open collector contact closure outputs meeting NEMA TS 2 requirements. The open collector output will be used for vehicle detection indicators; discrete outputs will be used for alarm conditions.

- G. Provide LED status indicators on the front panel. The LED indicators shall illuminate when a contact closure output occurs. Provide one output LED for each contact closure output.
 - H. Provide a mouse compatible port (PS-2 or USB) on the front panel of the video processing unit. The mouse port shall be used as part of the system setup and configuration. Provide a compatible mouse with each video detection system.
5. Functionality
- A. Detection zones shall be programmed via an on-board menu displayed on a video monitor and a pointing device connected to the video detection processor. The menu shall facilitate placement of detection zones and setting of zone parameters or to view system parameters.
 - B. The video detection processor shall detect vehicles in real time as they travel across each detection zone.
 - C. The video detection processor shall have an RS-232 (DB9 or RJ45) port for communications with an external computer.
 - (1) The video detection processor port shall be multi-drop capable.
 - (2) It shall be possible to upload and save all configuration data including loop placement and save the file on a computer.
 - (3) It shall be possible to download a configuration file from a computer to the detection device.
 - (4) The video detection processor shall accept new detection patterns from an external computer through the RS-232 port when the external computer uses the correct communications protocol for downloading detection patterns.
 - D. Provide a Windows™-based software designed for local and remote connection with video capture, real-time detection indication, and detection zone modification capability.
 - E. The video detection processor shall send its detection patterns to an external computer through the RS-232 port.
 - F. The video detection processor shall default to a safe condition, such as minimum recall, fixed recall, or constant call on each active detection channel, in the event of unacceptable interference with the video signal, low-visibility conditions, or power failure.
 - G. A user-selected output shall be active during the low-visibility condition that can be used to modify the controller operation if connected to the appropriate controller input modifier(s). The system shall automatically revert to normal detection mode when the low-visibility condition no longer exists.
6. Vehicle Detection
- A. A minimum of 24 detection zones per camera input shall be possible, and each detection zone shall be capable of being sized to suit the site and the desired vehicle detection area.
 - B. A single detection zone shall be able to replace multiple inductive loops and the detection zones shall be OR'ed as the default or may be AND'ed together to indicate vehicle presence on a single phase of traffic movement.
 - C. Placement of detection zones shall be done by using a pointing device, and a graphical interface built into the video detection processor and displayed on a video monitor, to draw the detection zones on the video image from each video camera. Detection zones created in this manner shall be compatible with the PC-based software provided with the system.
 - D. The video detection processor's memory shall be non-volatile to prevent data loss during power outages.
 - E. When a vehicle is detected crossing a detection zone, the corners or entire zone of the detection zone shall flash/change color on the video overlay display to confirm the detection of the vehicle.
 - F. It shall be possible to record the operation of the unit in real time with the detection zones operating.

- G. Detection shall be at least 98% accurate in good weather conditions, with slight degradation acceptable under adverse weather conditions (e.g., rain, snow, or fog) that reduce visibility.
 - H. The video detection processor shall maintain normal operation of existing detection zones when one zone is being added or modified.
 - I. The video detection processor shall output a constant call on any detector channel corresponding to a zone being modified and shall resume normal operation upon completion.
 - J. Detection zones shall be directional to reduce false detections from objects traveling in directions other than the desired direction of travel in the detection area.
 - K. The video detection processor shall process the video input from each camera using a microprocessor at 30 frames per second at 1 volt peak to peak, 75 ohms, or EIA 170 NTSC video standard.
 - L. The video detection processor shall output minimum recall, fixed recall, or constant call for each enabled detector output channel if a loss of video signal occurs. The recall behavior shall be user selectable for each output. The video detection processor shall output a constant call during the background "learning" period.
 - M. Detection zone outputs shall be configurable to allow the selection of presence, pulse, extend, and delay outputs. Timing parameters of pulse extend and delay outputs shall be user definable between 0.1 to 25.0 seconds in increments of 0.1 second.
 - N. Up to six detection zones per camera view shall have the capability to count the number of vehicles detected and to measure classification and speed. The data values shall be internally stored within the processor module for later retrieval through the RS-232 port. The data collection interval shall be user definable in periods of 5, 15, 30, or 60 minutes or by intersection cycle. Real-time data shall be retrieved from the PC-based software provided with the system.
7. Camera
- A. Cameras shall be completely compatible with the video detection processor and shall be certified by the manufacturer to ensure proper system operation.
 - B. The detection system shall produce accurate detector outputs under all roadway lighting conditions, regardless of time of day. The minimum range of scene luminance over which the camera shall produce a usable video image shall be the minimum range from nighttime to daytime, but not less than the range 0.009 to 930 foot-candles (0.1 lux to 10,000 lux).
 - C. The camera shall use a color charge-coupled device (CCD) sensing element with resolution of not less than 470 lines horizontal and 400 lines vertical.
 - D. The camera shall include mechanisms to compensate for changing of lighting by using an electronic shutter and/or auto-iris lens.
 - E. The camera shall include a motorized variable focal length lens with factory preset focus that requires no field adjustment. Zooming of the camera lens to suit the site geometry shall be accomplished by means of a portable interface device designed for that purpose. The horizontal field of view shall be adjustable from 8.1 to 44.3 degrees. Camera configuration shall be customized for each approach based on field site conditions and the project Plans. One interface device shall be supplied at no additional cost.
 - F. The camera electronics shall include automatic gain control (AGC) to produce a satisfactory image at night.
 - G. The camera shall be housed in a weather-tight, sealed enclosure. The housing shall be field rotatable to allow proper alignment between the camera and the traveled road surface.
 - H. The camera enclosure shall be equipped with a sunshield. The sunshield shall include a provision for water diversion to prevent water from flowing in the camera's field of view.
 - I. The camera enclosure shall include a thermostatically controlled heater to ensure proper operation of the lens shutter at low temperatures and prevent moisture condensation on the

optical faceplate of the enclosure. The heater shall directly heat the glass lens and require less than 5 watts over the temperature range.

- J. Power consumption of the camera shall be 15 watts or less under all conditions.
 - K. The camera enclosure shall be equipped with separate, weather-tight connections for power and setup video cables at the rear of the enclosure. These connections shall allow diagnostic testing and viewing of video at the camera while the camera is installed on a mast arm or pole using a lens adjustment module furnished under this bid item.
 - L. The video signal output by the camera shall be in accordance with NTSC standards.
 - M. All necessary mounting brackets shall be mounted to pole shafts, mast arms, or other structures to mount cameras as indicated on the project Plans. Mounting brackets shall result in a fixed-position mounting. Mounting hardware shall be of the Astro Bracket type with a minimum of 6-ft height adjustment. Mounting brackets shall be included at no additional cost.
8. Video Cable
- A. The cable provided shall be as recommended by the manufacturer for optimal video detection performance. Coaxial cable can be used between the camera and the video detection processor in the traffic signal controller cabinet and shall be Belden 8281 or equivalent. The signal attenuation shall not exceed 0.78 dB per 100 ft at 10 MHz.
 - B. Nominal outside diameter shall be approximately 0.305 inch.
 - C. Coaxial cable shall be suitable for installation in conduit and in an exposed sunlight environment; 75-ohm BNC plug connectors shall be used at both the camera and cabinet ends. The coaxial cable, BNC connector, and crimping tool recommended by the manufacturer of the VDS shall be used and installed per the manufacturer's recommended instructions to ensure proper connection.
9. Power Cable
- A. Power cable for 120-VAC cameras shall be rated for 194 F, 300-volt, No. 16 AWG, stranded, three-conductor cable with a nominal outside diameter of approximately 0.330 inch. Conductor insulation color code shall be black, white, and green. Outside jacket shall be black.
 - B. Power cable for 28-volt cameras shall be the cable recommended by the manufacturer.
 - C. Camera power cable shall be suitable for installation in conduit and in an exposed sunlight environment, and be UL listed.
 - D. The power and video cable may be installed under the same outer jacket.
10. Surge Protection
- A. Surge protection devices shall be provided for all new or added video detection devices as recommended by the manufacturer.
 - B. Coaxial cable shall be protected with an inline surge suppressor as recommended by the manufacturer or with a panel-mounted surge suppressor as recommended by the manufacturer or approved equal, installed and grounded per the video detection manufacturer's recommendations.
11. Physical and Environmental Specifications
- A. VDS Processor—Provide a VDS processor that operates reliably in a typical roadside traffic cabinet environment. Provide internal cabinet equipment and a video detection system processor that meet the environmental requirements of NEMA TS 2-2003 Section 2.
 - B. Video Camera Sensor
 - (1) Operating ambient temperature range: -30°F to 140°F. Additionally, include a heater to prevent the formation of ice and condensation in cold weather. Do not allow the heater to interfere with the operation of the video camera sensor electronics, or cause interference with the video signal.
 - (2) Vibration: Meet the requirements of TS 2-2003 Section 2.1.9.
 - (3) Shock: Meet the requirements of TS 2-2003 Section 2.1.10.

- (4) Acoustic Noise: Provide a video camera sensor and enclosure that can withstand 150 dB for 30 minutes continuously, with no reduction in function or accuracy.
12. Training
 - A. Furnish two 8-hour training sessions.
 - B. Prior to training, submit resume and references of instructor(s). The instructor shall be factory trained on the equipment and have a minimum of 3 years of instructor experience on the VDS. Also submit an outline of the training course in a Training Plan. Submit the Training Plan within 90 calendar days of Contract Notice-to-Proceed. Obtain approval of the Training Plan from the Engineer. Explain in detail the contents of the course and the time schedule of when the training will be given.
 - C. Training shall cover the operation, setup, and maintenance of the VDS as part of the Contract or purchase order.
 - D. Furnish all handouts, manuals, and product information.
 - E. For the training, use the same models of equipment furnished for the project. Furnish all media and test equipment needed to present the training.
 - F. Training shall be conducted in the Nashville area. Training instructor(s) shall be manufacturer-certified, experienced in the skill of training others, and have conducted a minimum of three, 2-day trainings on VDSs.
13. Installation Requirements. All equipment shall be installed according to the manufacturer recommendations, the Plans, and as follows:
 - A. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.
 - B. The Contractor shall furnish all tools, equipment, materials, supplies, cabling, and manufactured hardware, and shall perform all operations and equipment integration necessary to provide complete, fully operational communications equipment as specified herein, within the Plan set, and/or in the Contract Documents. It is the responsibility of the Contractor to ensure that its equipment performs its required function when installed.
 - C. The Contractor shall provide the Engineer with a written inventory of items received and the condition in which they were received. Once received, the equipment becomes the Contractor's responsibility. The Contractor shall provide all labor and equipment necessary to move inventory out of the designated storage facility and to transport it to the installation location. All equipment shall be installed according to the manufacturer recommendations or as directed by the Engineer.
14. Testing Requirements. Testing shall include, but not be limited to, the following general requirements:
 - A. The Contractor shall conduct a project testing program for all video detection equipment. The project testing program shall include but is not limited to the additional specific requirements in this subsection.
 - B. All test results shall confirm physical and performance compliance with this specification.
 - C. A pre-installation test shall consist of an inspection of all supplied equipment for damage and completeness of parts and manuals.
 - D. An SAT shall consist of a complete check of the system after installation.
 - E. A conditional acceptance test shall include programming of all functions and integration to the traffic controller inputs.
 - F. One-hour videos shall be made of each approach and compared to actual detection calls.
 - G. Thirty-minute videos shall be made starting 15 minutes prior to sunrise and sunset for each approach and compared to actual detection calls.
 - H. All videos shall be date and time stamped.

- I. All videos shall be provided to the Engineer with a summary of the results including total calls, missed calls, and false calls.
 - J. All test results must meet a 98% accuracy requirement.
 - K. The burn-in period will start after successful completion of the conditional acceptance test.
 - L. All test result documentation shall be submitted to the Engineer within 14 calendar days of completion of the tests. The Engineer will review test documentation and inform the Contractor of any exceptions noted.
 - M. Any failure of the equipment including but not limited to lost calls, loss of program data, or excessive false calls shall cause the burn-in period to start over.
15. Measurement.
- A. The VDS shall be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing, warranties, full operation, and configuring the VDS including the mounting hardware, cables, serial port cables or connectors, power cable, user manuals, testing, warranties, and any and all other equipment required to complete installation of the unit in accordance with applicable standards, specifications, and requirements. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

730.34—Radar Detection System.

This section specifies the minimum requirements for RDS equipment furnished and installed. The work shall consist of providing all labor, materials, equipment, and incidentals necessary to furnish, install, and test the RDS. This work consists of furnishing and installing radar detection equipment complete and ready for service.

1. System Components

- A. Each sensor shall be mounted to a pole or mast arm using a stainless-steel multi-angle bracket that includes etched markings to facilitate accurate sensor horizontal and elevation angles.
- B. Central control unit (CCU) for Sensor connection to the traffic signal controller can be achieved by Ethernet communications.
- C. Sensor setup and configuration to be performed via a web browser using the web-server functions stored within the in-cabinet CCU and/or off site in the Traffic Management Center.

2. Sensor Unit

The sensor shall operate in the 24GHz range as permitted by local rules and regulations. The system shall have the required FCC Part 15, NEMA certifications for use in a traffic cabinet environment.

The main components of the radar sensor shall include:

- A. Shall allow for forward-fire operation for detecting of both approaching and receding traffic simultaneously. Up to 12 lanes should be possible.
- B. Shall allow for both stop bar and advanced detection simultaneously with an advanced detection range up to 1000ft line of sight. All detection shall be lane by lane and/or vehicle classification basis.
- C. Shall be able to detect passenger vehicles up to 656ft (200m) from sensor location.
- D. Shall be able to classify up to 7 classes: pedestrian, Bicycle, Motorbike, Passenger Car, Transporter, Truck/bus, Long Truck.
- E. Shall be capable to detect stationary objects.
- F. Shall include optional video camera for monitoring and troubleshooting of the device.

3. System Detection Zones and Outputs

The sensor system should exhibit the following user operational characteristics:

- A. The sensor should be able to support a minimum of 32 detection zones.
 - B. The sensor shall be able to support up to 64 output channels per sensor.
 - C. The sensor shall have a configurable Event Trigger mechanism for each zone to:
 - (1) Presence detection
 - (2) Speed detection
 - (3) Vehicle class
 - (4) Queue length estimation
 - (5) Custom trigger – combination of above events.
 - (6) Bicycle timing and detection
 - D. The sensor shall be able to map detection zones to output channels in any type of configuration (one to one or one to many).
 - E. The sensor shall be able to support the configuration of lanes lines to follow the curvature of the actual road to optimize lane by lane detection.
 - F. The sensor shall be able to define channel output extend and delay functionality.
 - G. The sensor shall be able to minimize or mitigate adjacent lane or cross traffic detection through the placement of polygons or areas of no interest to be excluded from detection movement.
 - H. The sensor shall have fail-safe capabilities that can detect RF interference, pitch and roll misalignment, rain or snow, and other sensor blind conditions that would otherwise impact the sensor's performance. Upon detection of one or more of the preceding conditions, the sensor shall provide configurable outputs to the controller to signal that the controller should fall back to fixed-timed programming, on a sensor-by-sensor basis.
4. Central Control Unit (CCU)
- The CCU sensor shall be supplied by the RDS manufacturer and installed in the traffic signal cabinet. The CCU shall include the following:
- A. The CCU shall be supplied in one of the three form factors. Users may choose one form factor for use within their controller cabinet system:
 - (1) Standard One (1) Rack Unit (1U) 19" rack format. There shall be brackets to allow the CCU to be mounted under shelves where a 19" frame is not available.
 - (2) Shelf-Mount format; TS1 version. The CCU shall be able to stand up on available shelf-space within the cabinet. All connections shall be made from the front of the CCU, including connections to separate RDPs located within the cabinet.
 - (3) Shelf-Mount format; TS2 version. The CCU shall be able to stand up on available shelf-space within the cabinet. All connections shall be made from the front of the CCU, and no external RDPs will be required.
 - B. An Ethernet communications port shall be provided on the front panel. The Ethernet port shall be compliant with IEEE 802.3 and shall use a RJ-45 type connector mounted on the front panel of the CCU. The Ethernet communications interface shall allow the user to remotely configure the system and/or to extract calculated vehicle/roadway information. The interface protocol shall be documented or interface software shall be provided. The RDS shall have the capability to be addressable. The RDP shall support data rates of up to 100Mbps.
 - C. The CCU shall:
 - (1) provide an SDLC connection to the Traffic Controller. The connector shall be a 'D-15' type, in compliance with NEMA TS-2 specifications.
5. Installation

- A. The cable to be used between the camera and the CCU in the traffic cabinet shall be provided by the manufacturer. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. The manufacturer's instructions must be followed to ensure proper connection.
 - B. The cabling between the traffic cabinet interface (CCU) and the sensor head shall be a continuous run and shall not include the use of power injectors, signal boosters, or repeaters between the two devices.
- 6. Warranty
 - A. The supplier shall provide a limited three-year warranty on the RDS.
 - B. During the warranty period, technical support shall be available from the supplier via telephone, and this support shall be available from factory-certified personnel or factory-certified installers.
 - C. During the warranty period, updates to the RDS firmware shall be available from the supplier without charge.
- 7. Installation
 - A. The cable to be used between the camera and the CCU in the traffic cabinet shall be Cat5e or Cat6, shielded, direct burial. This cable shall be suitable for installation in conduit or overhead with appropriate span wire. Shielded RJ45 connectors shall be used where applicable. The Cat5e or Cat6 cable, RJ45 connector, and stripping and crimping tool shall be approved by the supplier of the VDS, and the manufacturer's instructions must be followed to ensure proper connection.
 - B. The cabling between the traffic cabinet interface (CCU) and the sensor head shall allow distances of up to 1,000 ft. The cabling between the traffic cabinet interface (CCU) and the sensor head shall be a continuous run and shall not include the use of power injectors, signal boosters, or repeaters between the two devices.
 - C. The radar sensor assembly shall be installed by factory-certified installers as recommended by the supplier and documented in installation materials provided by the supplier. Proof of factory certification shall be provided.
- 8. Warranty
 - A. The supplier shall provide a limited three-year warranty on the RDS.
 - B. During the warranty period, technical support shall be available from the supplier via telephone within 4 hours of the time a call is made by a user, and this support shall be available from factory-certified personnel or factory-certified installers.
 - C. During the warranty period, updates to RDP software shall be available from the supplier without charge.
- 9. Maintenance and Support
 - A. The supplier shall maintain an ongoing program of technical support for the RDS. This technical support shall be available via telephone or via personnel sent to the installation site upon placement of an acceptable order at the supplier's then-current pricing and terms of sale for on-site technical support services.
 - B. Installation or training support shall be provided by a factory-authorized representative and shall be a minimum of IMSA-Level II Traffic Signal Technician certified.
 - C. All product documentation shall be written in the English language.

10. Measurement

- A. The RDS shall be measured in units of each system and paid for at the contract price per each. The price bid shall include furnishing, installing warranties, full operation, and configuring the RDS including the mounting hardware, radar units, CCUs, power cable, user manuals, testing, warranties, and any and all other equipment required to complete installation of the unit in accordance with applicable standards, specifications, and requirements. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

TRAFFIC SIGNAL SUPPORTS

730.35—Cantilever Signal Supports.

This specification applies to the manufacture of steel poles and mast arms for the support of traffic signals. The height of poles, shaft dimensions, and wall thickness shall meet the design requirements and mounting height of traffic signals as set forth in these specifications and in the Plans. Bracket arm lengths are indicated in the Plans. All signal supports shall meet NDOT's guidelines and shall be in conformance with applicable streetscape guidelines concerning the type of poles to be used. The Contractor shall submit shop drawings for all signal supports, stamped and sealed by an engineer registered in the State of Tennessee, to NDOT for review and approval. Designs shall be in compliance with current American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals. These standards apply to strain pole supports as well.

The poles shall consist of a straight or uniformly tapered shaft, cylindrical, or approved geometric shape, in cross section, having a base welded to the lower end and complete with anchor bolts. All castings shall be clean and smooth with all details well defined and true to pattern. Steel castings shall conform to ASTM A 27, Grade 65-35. Gray iron castings shall conform to ASTM A 126, Class A. All mast arms shall be compatible with the poles in material, strength, shape, and size.

Anchor Base. An anchor base of one-piece cast steel or steel plate of adequate strength, shape, and size shall be secured to the lower end of the shaft. The base shall telescope the shaft and be welded at the top and bottom faces with continuous fillet welds so that the welded connection shall develop the full strength of the adjacent shaft section to resist bending action. Each base shall be provided with a minimum of four holes to receive the anchor bolts. Cast steel bases shall be provided with removable cast iron covers for anchor bolts and tapped holes for attaching covers with hex head cap screws.

A welded frame handhole, 5 x 10 inches at a minimum and located 1.5 ft above the base, shall be provided. A 0.5-inch, 13 UNC grounding nut shall be welded to the inside of the pole at a point readily accessible for wiring.

Shaft. The shaft shall be fabricated from the best, hot-rolled basic open hearth steel, and shall have only one longitudinal electrically welded joint and may have electrically welded intermediate transverse full penetration circumferential joints, at intervals of not less than 10 ft. The shaft shall be longitudinally cold-rolled to flatten the weld and increase the physical characteristics so that the metal will have a minimum yield strength of 48,000 psi. Where transverse full penetration circumferential welds are used, the fabricator of the shaft shall furnish to the Engineer certification that (1) all such welds have been radiographed and ultrasonically tested by an independent testing laboratory using a qualified Nondestructive Testing (NDT) technician and (2) the NDT equipment has been calibrated annually.

The shaft shall be fitted with a removable pole cap, a J-hook wire support welded inside near the top, and a flange plate assembly to match that welded to the butt end of the mast arm.

Mast Arms. Mast arms shall be fabricated and certified in the same manner as the upright shafts and shall have the same physical characteristics.

The mast arms shall meet the design requirements necessary to support rigidly mounted traffic signals as designated in the Plans. All arms shall include a removable cap at the tip, grommets wire outlets, and signal hanger assemblies of the type and number shown on the Plans, and a flange plate welded to the butt end to provide a rigid connection to the mast. The assembly shall be constructed so that all wiring can be concealed internally. A 5-ft rise for the mast arm from the signal support is required per NDOT guidelines. The Contractor shall submit shop drawings for all signal supports and mast arms, stamped and sealed by an engineer registered in the State of Tennessee, to NDOT for review and approval.

Mast arms shall be connected to the upright pole at a height necessary to provide a minimum clearance of 15 ft, 0 inch under the traffic signal heads or backplates and a maximum clearance of 25 ft, 7.2 inches to the top of the traffic signal heads. Separate signal heads shall be installed to provide these same clearances.

Finish. Steel poles, mast arms, and hardware shall be galvanized in accordance with ASTM A 123.

All steel and cast iron components, hardware, and threaded fasteners, except anchor bolts, shall be galvanized after fabrication in accordance with ASTM A 123, A 153, or A 385, as applicable.

730.36—Steel Strain Poles.

Steel strain poles shall consist of a uniformly tapered or equivalent upright shaft fitted with a removable pole top, J-hook wire support, and 45-degree wire inlet near the top; a span wire clamp; a 5- x 8-inch handhole with reinforced frame and cover; bent anchor bolts; and any other accessories to make a complete installation. The pole and all of its component parts shall be designed to support tethered traffic signals of the type and number indicated on the Plans, suspended from a span wire assembly. The poles shall be fabricated and certified in the same manner as the upright shafts as outlined in Section 730.35.

The shaft length shall be determined by the Contractor as required to meet field conditions and vertical clearances of signal heads over the roadway. The signal head clearance shall be a minimum of 15 ft., 0 inch under the traffic signal heads or backplates and a maximum of 25 ft, 7.2 inches to the top of the traffic signal heads. The span wire shall be fastened no closer than 1 ft, 6 inches from the top of the pole.

Unless otherwise specified, all strain pole traffic signal supports shall be provided with a one-piece anchor-type base. The base shall be fabricated from drop forged or cast steel of sufficient cross section to fully develop the ultimate strength of the poles. The base shall be fastened to the pole by means of a welded connection and shall develop full strength of the pole. The base shall be provided with a minimum of four holes of sufficient size to accommodate the proper size anchor bolts that are capable of resisting at yield strength stress and the bending moment of the shaft at its yield strength stress. Removable cast iron covers for the anchor bolts shall be provided.

The shaft shall be fabricated from material providing a minimum yield strength of 48,000 psi after fabrication.

Finish. Steel poles and hardware shall be galvanized in accordance with ASTM A 123.

All steel and cast iron components, hardware, and threaded fasteners, except anchor bolts, shall be galvanized after fabrication in accordance with ASTM A 123, A 153, or A 385, as applicable.

730.37—Pedestal Support Signal Poles.

The pedestal poles shall consist of one upright pole with suitable base and any other accessories or hardware as required to make a complete installation.

All poles shall be made of one continuous piece from the top of the base connection for the entire height of the pole. The cross section shall be either cylindrical or octagonal and may or may not be uniformly tapered from butt to tip.

The cross section at the tip shall have a 4.5-inch outside diameter.

Type "A" Pedestal (Aluminum). Pedestals shall be of a uniform octagonal or cylindrical cross section of the tubular tapered type fabricated of one full-length sheet.

Bases shall be octagonal or square in shape, of the ornamental type fabricated of cast material. A handhole shall be provided in each base.

Caps shall be of the nipple or tenon type mounting fabricated of cast material.

Bases shall be furnished with four steel anchor bolts of sufficient size and length to securely anchor the base to the concrete footing. The shaft shall be welded to the cast metal base. Refer to the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals (current edition).

Type A pedestal shaft shall be fabricated from aluminum tubing 6063-T4 heat treated to T6 temper after fabrication, and meeting ASTM B 221.

Type A anchor base shall be made of sand-cast aluminum alloy 356-T6 meeting ASTM B 26 – SF 70A-T5 specifications.

Type "B" Pedestal (Steel). Pedestal shall be fabricated from a 4.5-inch (outside diameter) seamless steel pipe.

Bases shall be octagonal in shape of the ornamental type fabricated of cast or malleable iron and shall have a minimum height of 12 inches. The top opening of the base shall be threaded to receive the shaft. A handhole shall be provided in each base.

Bases shall be furnished with four steel anchor bolts of sufficient length to securely anchor the base to the concrete footing.

730.38—Camera Poles and Structures.

This section specifies the minimum requirements for equipment poles furnished and installed in accordance with these specifications and the Plans. This work shall consist of furnishing, installing, and testing 50' galvanized steel camera poles with foundations in accordance with these specifications and the TDOT Standard Specifications for Road and Bridge Construction.

1. Materials

- A. Galvanized Steel Poles—A 50-ft closed-circuit television (CCTV) pole and foundation, conduit, connections, clamps, anchor bolts, shoe bases, and all other members shall be designed and fabricated in accordance with the standards and requirements listed below. Design and materials

documentation shall be furnished as part of the approval request submittal. Certifications shall be furnished upon request by the Engineer.

- (1) 2009 AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals including all interims and updates shall be met. Design life shall be 50 years for all poles. The “Fatigue,” “Galloping Loads”, and “Truck-Induced Gust Loads” category do NOT apply to the poles.
- (2) Poles shall be designed to withstand the specified forces including those produced by a 90-mph wind with a 1.14 gust effect factor.
- (3) The Contractor shall submit manufacturer’s shop drawings, layout drawings, and specifications for equipment and appurtenances for the approval of the Engineer 90 calendar days after notice to proceed.
- (4) Fabricator: The Fabricator shall be certified under Category I, “Conventional Steel Structures” as set forth by the American Institute of Steel Construction Quality Certification Program. Proof of this certification shall be required.
- (5) Welding: All welding shall be in accordance with Sections 1 through 8 of the AWS DI. 1 Structural Welding Code.
- (6) Tackers and welders shall be qualified in accordance with the AWS Structural Welding code.
- (7) Tube longitudinal seam welds shall be free of cracks and excessive undercut, performed with automatic processes, and be visually inspected. Inspection records shall be furnished to the Engineer.
- (8) Longitudinal welds suspected to contain defects shall be magnetic particle inspected. All circumferential butt-welded pole and arm splices shall be ultrasonically and radio graphically inspected. Inspection records shall be furnished to the Engineer.
- (9) Camera Pole System shall consist of a pole, anchor bolts, base plate, ground rod array, and communication and power conduits to the nearest pull box, grounding conduit, spare conduit, and foundation as shown in Plans.
- (10) Design computations for the camera poles shall be complete and shall include but not be limited to the following:
 - a. Consideration for all parts of the structure.
 - b. Consideration of all possible loading combinations including wind and ice loads.
 - c. Design stresses and allowable stresses for all components that comprise the proposed structure.
 - d. The top of the pole deflection shall not exceed the following: 1-inch deflection from center (2-inch deflection diameter) due to 30-mph (non-gust) winds for the 50-ft poles.
 - e. All complete shop drawings and design computations shall bear the stamp of a registered Professional Engineer.
 - f. Shop drawings shall be approved prior to fabrication. Approval of the shop drawings does not relieve the Contractor of responsibility for the design, fabrication, and erection of the structure.
 - g. The Engineer reserves the right to reject a pole design if the calculated deflection exceeds that specified herein.
 - h. The foundation design shall be based on actual soil conditions from soil borings conducted by the Contractor. The cost of the soil borings shall be included in the cost of the pole.
- (11) The calculations shall include a pole, base plate, and anchor bolt analysis. The pole calculations shall be analyzed at the pole base, at 5-ft pole intervals, and at each slip joint splice.
- (12) For each pole as shown in the Plans, the following information shall be given:
 - a. The pole’s diameter, thickness, section modulus, moment of inertia, and cross sectional area.

- b. The centroid, weight, projected area, drag coefficient, velocity pressure, and wind force of each trapezoidal pole segment.
 - c. The axial force, shear force, primary moment, total moment, axial stress, bending stress, allowable axial stress, allowable bending stress, and combined stress ratio at each elevation.
 - d. The pole's angular and linear deflection at each elevation.
- (13) Handholes:
 - a. The handhole openings shall be reinforced with 2-inch-wide hot-rolled steel bar. The opening shall be rectangular and 5 inches x 8 inches nominal.
 - b. The cover shall be 11-gauge steel and shall be secured to a clip-on lock with a tamper-proof screw.
 - c. The reinforcing rim shall be provided with a 0.5-inch tapped hole and 0.5-inch hex head cap screw for grounding.
 - d. Handholes on poles with pole-mounted cabinets and transformers shall be placed toward oncoming traffic. For all other poles, handholes shall face away from traffic.
- (14) Pole Top Junction Box: All 50-ft camera poles shall have a pole top connector box fastened to the pole top for cable strain relief.
- (15) Cable Supports (J-Hooks and Eyelets): Top and bottom J-hooks and eyelets shall be located within the pole directly aligned with each other.
- (16) Base Plate:
 - a. Base plates shall conform to ASTM A572.
 - b. Plates shall be integrally welded to the tubes with a telescopic welded joint or a full penetration butt weld with backup bar.
 - c. Plates shall be hot-dip galvanized.
- (17) Anchor Bolts:
 - a. Anchor bolts shall conform to the requirements of AASHTO M314-90 (105 ksi minimum yield). The upper 12 inches of the bolts shall be hot-dip galvanized per ASTM A153.
 - b. Each anchor bolt shall be supplied with two hex nuts and two hardened washers.
 - c. The strength of the nuts shall equal or exceed the proof load of the bolts.
 - d. The top nut shall be torqued so as to produce 60% yield stress of the anchor bolt.
 - e. The Contractor shall not grout between the bottom of the base plate and the top of the concrete foundation.
- 2. Installation Requirements. All equipment shall be installed according to the manufacturer's recommendations and the Plans. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.
 - A. Poles. Standards and posts for the camera poles shall be installed as indicated on the Plans and shall be installed in accordance with the National Electric Safety Code and ASSHTO requirements.
 - B. Foundations:
 - (1) The Contractor shall submit a design for pole foundations that has been sealed by a registered Professional Engineer.
 - (2) The foundation design shall adhere to the prescribed loading and wind deflection as specified in the TDOT Standard Specifications.
 - (3) The foundations shall be constructed in accordance with the TDOT Standard Specifications and shall adhere to the approved shop drawings for the loading specified.
 - (4) If soil conditions require the use of any shoring, casings, or sonotube for proper installation of the foundations, the cost of the shoring, casings, or sonotube shall be included in the cost of the pole and foundation.
 - C. The dimensions and reinforcing steel shall be in accordance with the requirements of the Plans and specifications.

- D. The cast-in-place concrete pole foundation shall cure a minimum of 28 calendar days before any load is applied to the foundation. The Engineer may approve early installation of the pole based on the results of a 7-day test.
 - E. Conduit shall be installed in the pole foundation for access and include conduit to the nearest pull box as shown on the Plans.
 - F. A minimum of one 2-inch spare conduit shall be installed in all pole foundations as shown in the Plan Typical Details. Spare conduits in pole foundations shall be sealed with blank duct plugs.
 - G. Grounding System
 - (1) The Contractor shall supply and install a grounding system with ground rod array at the base of all poles as shown on the Plans.
 - (2) The ground rod array system shall be connected to the pole through an appropriate ground clamp.
 - (3) A No. 6 AWG copper stranded bonding wire shall be installed between the pole and the field cabinet providing a common ground system for each site.
 - (4) All ground bonding wires shall be unspliced.
 - H. The installation method for the CCTV poles and cameras shall be such that the camera can be rotated as needed around the pole for optimum placement.
3. Measurement. CCTV Pole and Foundation (50-ft pole) shall be measured in units of each and paid for at the contract price of each. The price bid shall include a 50-ft steel strain pole, foundation, conduit inside foundation and to the nearest pull box, wiring between camera and field cabinet, connections to support structures, and satisfactory completion of testing and training requirements, and all work, equipment, and appurtenances as required to effect the full operation including remote and local control of the CCTV site complete in place and ready for use. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.
 4. Payment. The contract unit price shall be full compensation for all work specified in this section. Payment shall be made under:

Item No.	Description	Unit
730-38	CCTV Pole 50-Ft Pole Height	Each

The CCTV pole shall be paid per each as follows:

- 25% of the contract unit price upon complete installation of foundations.
- Additional 45% of the contract unit price upon delivery of poles or structure to the site.
- Final 30% of the contract unit price upon complete installation of poles or structure.

730.39—Wooden Pole Signal Supports.

Wooden poles shall be class II 35 ft in length or as described in the Plans and shall meet the requirements of Subsection 917.11 of the Standard Specifications. Poles shall be set to the depth shown in the Plans and fitted with all necessary hardware to make the installation complete.

The signal head clearance shall be a minimum of 16 ft, 6 inches to the bottom of the traffic signal heads or backplates and a maximum of 25 ft, 0 inch to the top of the traffic signal heads. The span wire shall be fastened no closer than 2 ft, 0 inch from the top of the pole.

Guying Components—Guy clamps shall be steel, three-bolt type, 6 inches in length, and of the proper strand size to fit the wire used. The clamp bolts shall have upset shoulders fitting into the clamp plate. Substitution of the cable grip is subject to approval by the Engineer.

Guy wire shall be attached to the pole with a 5/8-inch-diameter x 12-inch-long single-strand bolt with approved guy wire attachment hardware and 2- x 2-inch square cut washers, lock washer, and square nut.

Sidewalk guy fittings shall consist of 2-inch-inner-diameter standard galvanized steel pipe of the required length with a malleable iron pole plate and guy clamp. The pole plate shall be fastened to the pole with a 5/8-inch-diameter thru bolt and 0.5-inch lag screws.

All guying components and hardware shall be galvanized in accordance with ASTM A 123 or A 153.

Anchors for guys shall be of the pressed steel four-way expanding fluke type or of the steel or malleable iron sliding plate type. The minimum unexpanded diameter shall be 8 inches, and the minimum expanded area shall be 110 square ft. Anchors shall be coated with a black asphaltic paint.

Guy anchor rods shall be drop-forged steel, 0.75 inch in diameter and a minimum of 7 ft in length, threaded, of the single thimble eye type, with a square anchor bolt nut.

730.40—Pole Location.

All signal support poles shall be installed at locations shown on the Plans or where directed by the Engineer.

MISCELLANEOUS SYSTEMS

730.41—CCTV Camera Systems.

This section specifies the minimum requirements for CCTV camera systems furnished and installed. The CCTV camera system will provide TMC personnel with live streaming video of the roadway network via CCTV cameras installed at locations shown in the Plans.

1. Materials

All materials furnished, assembled, fabricated, or installed shall be new, corrosion resistant, and in strict accordance with all of the details shown in the Plans and described in these specifications.

The CCTV camera system shall comply with the following minimum materials specifications:

A. General Capabilities and Performance Requirements. Overall CCTV camera system capabilities and performance requirements include the following:

- (1) All outdoor cameras shall be tamper-proof with vandal-resistant housings, capable of being surface or flush mount according to the surface it is being mounted to.
- (2) Outdoor cameras shall be color, IP, PoE 802.3af, and capable of recording in H.264 or H.265 format.
- (3) The outdoor cameras shall have a day night cut filter and be able to operate in temperatures ranging from -40°F to 120°F.
- (4) Outdoor cameras shall be complete with weatherproof housing and internal heater/blower/wiper as required for suitable operation under varying environmental conditions. Hood extensions and shields shall be provided where required to prevent picture degradation due to direct sunlight or lamp glare.
- (5) Outdoor camera brackets and hardware shall be furnished with weather-resistant coatings to prevent corrosion and staining. The housings shall be capable of mounting on poles parapets, and walls.
- (6) Pan-tilt-zoom (PTZ) cameras shall be color, IP, PoE, with a minimum resolution of 1080 pixels (p), and capable of a minimum of a 35x optical zoom, and high-speed with low light

day/night operation capability with 360 degrees rotation in less than 3 seconds. Domes will mount on poles, parapets, and walls located to provide optimum unobstructed viewing of the area under surveillance. PTZ cameras will have the ability to mask portions of view through software and remote programming.

- (7) Camera resolution shall be:
 - a. Outdoor Dome Camera – 1920x1080 (high-definition television [HDTV] 1080p) to 320x180.
 - b. Frame Rate: 50/60 frames per second (fps) (50/60 Hz) in 1080p.
- (8) Standard of Acceptance:
 - c. Axis Q6100-E, Axis Q6135-LE PTZ, or approved equal.

B. All cameras shall have a three-year warranty (minimum).

2. Installation Requirements. All equipment shall be installed according to the manufacturer's recommendations, the Plans and as follows:
 - A. Materials and associated accessories/adapters shall not be applied contrary to the manufacturer's recommendations and standard practices.
 - B. All materials needed to permanently mount the CCTV camera to the support structure as indicated in the Plans shall be included.
 - C. Power, video, and data cables and all ancillary equipment required to provide a complete and fully operational CCTV system shall be furnished and installed.
 - D. All wiring shall be verified to meet NEC requirements where applicable.
 - E. Cameras shall be mounted in positions that allow 360-degree continuous rotation.

3. Measurement

CCTV Camera System shall be measured in units of each and paid for at the contract price per each. The price bid shall include furnishing, installing, system integration, training, documentation, and testing of a complete CCTV camera system including the CCTV camera assembly, pan and tilt (PT) unit, zoom lens, enclosure, Cat6 cable (video, data, power), surge suppressors and conduit between the camera and the cabinet, connections to support structures, attachment hardware and brackets, and all incidental items to provide and install the CCTV camera system as intended. The price bid shall also include all system documentation including shop drawings, operation and maintenance manuals, wiring diagrams, block diagrams, and other materials necessary to document the operation of the CCTV camera system. This price shall be full compensation for all labor, tools, materials, equipment, and incidentals necessary to complete the work.

4. Payment. The contract unit price shall be full compensation for all the work specified in this section. Payment shall be made under:

Item No.	Description	Unit
725-41	CCTV Camera System	Each

The CCTV camera system shall be paid per each as follows:

- 50% of the contract unit price upon approval of bench test component, bench test system, and pre-installation test results.
- Additional 20% of the contract unit price upon approval of site SAT results.
- Additional 20% of the contract unit price upon approval of conditional system acceptance test results.
- Final 10% of the contract unit price upon final system acceptance.

730.42—LED Illuminated Street Name Sign.

1. Scope. This section describes specifications and requirements for LED internally illuminated street name signs (single or double faced) that will be attached to traffic signal mast arms. The sign installation details are shown in the Plans.
2. General. The Contractor shall provide the required signs as shown in the Plans and as per the guidelines stated in this document. The signs shall include all mounting accessories, housing, door, sign face, fasteners, LED light source, gaskets, and peripherals as per the Plans. All signs shall be clearly legible and shall show the same shape and similar color by both day and night. The sign shall have an easy access service door that swings open and away from the sign body.
3. Hardware
 - A. The sign shall be rigid mount directly to the signal mast arm with no moving parts. Sign bracket shall be able to be leveled to accommodate mast arms that are not level.
 - B. All external screws, nuts, and locking washers shall be stainless steel. All materials furnished shall be new, first quality, and used in accordance with the highest industry practices.
4. Materials
 - A. All parts shall be made of corrosion-resistant materials or shall be plated to resist corrosion. All materials used in construction shall be resistant to fungus growth and moisture-related deterioration.
 - B. The signs shall have the message as shown on the Plans. The face legend shall consist of continuous piece diamond-grade translucent vinyl applied over the polycarbonate sign face having the appearance of a white legend on a green background unless otherwise specified on the Plans. Color and letter size and style shall be consistent with the requirements of the MUTCD.
 - C. Wiring shall be accomplished using three-conductor cable.
5. Sign Body
 - A. The body of the sign shall consist of an aluminum (6000 series or approved alternative) one-piece box-type enclosure and separate hinged door assembly. The top of the sign body shall include drip rails to prevent water from entering the electrical housing. All seams shall be continuously welded, or provide alternatively approved weatherproofing, to ensure a watertight seal. A minimum of three 0.25-inch drain holes shall be located in the bottom of the sign body, a maximum of 1 ft from each end of the sign.
 - B. The sign shall have a removable face. The door shall be one-piece frame construction. A continuous steel hinge shall mount the door to the housing.
 - C. Sign faces must be able to be removed from the sign and be changed while still installed on the pole. The sign face shall be 1/8-inch white or clear polycarbonate as designated by the Engineer.
 - D. Signs shall have airlock fasteners/thumb screws to secure the door to the sign body.
 - E. UL-listed foam gasket shall seal the sign between the door and the sign body, and between the face panel and doorframe.
6. Photocell. All internally illuminated LED signs installed at an intersection shall be controlled by one photocell. This device shall turn the unit ON during the hours of darkness. The photocell needs to be mounted so street lighting, auto headlights, and other light sources will not interfere with its operation. The preferred location is inside the traffic control cabinet, above the main door, just below the screened vent.
7. Dimensions. The sign assembly shall be capable of being constructed in standard length from 4 ft up to 8 ft. The height of the sign shall be a minimum of 12 inches and a maximum of 24 inches. The overall thickness of the sign shall be a maximum of 9.5 inches.
8. Environmental
 - A. The sign and power supply shall be able to withstand and operate at temperature extremes of -40°F to +120 °F.

- B. The sign shall have a front panel that is UV, weather, abrasion, and impact resistant.
- C. The sign shall be designed and constructed to prevent deformation or failure due to fatigue, shock, vibration, and wind loads up to 110 mph in conformance with the requirements of the AASHTO LTS-4 2001.
- D. The sign shall be tested and certified for exclusion of water test and strain relief test.
- 9. Finish
 - A. The color of the exterior of the sign assembly shall be glossy black. All exterior surfaces of the sign assembly shall be powder-coat painted in accordance with Military standards MIL-C-24712 and MIL-1-45208A.
 - B. The interior of housing shall be painted white. The front panel shall be replaceable so that maintaining agencies have the option to supply their own sheeting and electrocut film for the sign faces.
- 10. LED Light Engine System/Panel
 - A. The LED light engine shall be a single, self-contained device for installation in the sign housing. The LED light engine shall be mounted within the inner portion of the housing.
 - B. There shall be sufficient quantity of white LEDs to uniformly illuminate the viewing area. The failure of one LED shall not reduce the light output by more than 8% per foot of the sign face.
 - C. The LED Edge Lit Internally Illuminated Street Name Sign modules shall be composed of LEDs with a minimum viewing angle of 110 degrees mounted on rugged, secure, non-corrosive material consuming no more than 6 watts per linear foot. The thermal resistance path from the LED to the most external surface of the aluminum extrusion shall be no more than 20 degrees per watt at an ambient temperature of 77°F to reduce wear and tear on the individual LEDs and to extend usable lifetime. The LED light modules shall be sufficient coupled directly to the aluminum extrusion using stainless-steel mounting screws.
 - D. The LED light engine panel shall consist of a circuit board comprising an insulated aluminum substrate, with a minimum thickness of 0.125 inch. The assembly and manufacturing processes of the LED light engine shall be designed to ensure that all LEDs and electronic components are adequately supported to withstand mechanical shocks and vibrations in compliance with the specifications of ANSI C136.31-2001 Standards. All interconnections between LED light modules shall be hard-soldered connections, or approved alternative, to eliminate thermal fatigue and microcracking associated with power cycling.
 - E. The manufacturer name and date of manufacture along a quality control tracking sticker shall be mounted on the inside of the LED light engine panel.
 - F. There shall be one power supply for the sign. The sign shall have an input voltage of 120 VAC. The input voltage will then be reduced and power-conditioning circuitry shall be provided so that the LED's current will operate at the manufacturer's recommended specifications.
 - G. There shall be one separate 15-amp circuit breaker for all signs at the intersection, located in the signal control cabinet on the power panel to feed termination panel. Internally illuminated street name signs shall be wired to a separate 6-position terminal block and a separate 6-position ground bar located in the controller cabinet.
- 11. Manufacturer. The manufacturer agrees, upon the request of the Engineer, to deliver a sample of each assembly to be supplied in compliance with these specifications for inspection and testing before acceptance. After completion of the test, the sample shall be returned.
- 12. Training
 - A. Prior to the acceptance of the first unit, training shall be provided for NDOT's engineering, maintenance, and operations staff at a facility located in Nashville. The training shall include all material and manuals required for each participant.
 - B. The training shall be provided for a minimum of 1 hour for at least 10 engineering, maintenance, and operations personnel. The training shall include a complete demonstration of the operation and

capabilities of the system. This session should include a complete review of any field adjustments or calibration of the equipment that may be necessary for optimum performance and should stress day-to-day operation and isolation of problems down to the unit level.

13. Warranty
 - A. All components shall carry a five-year warranty from the date of acceptance against any imperfections in workmanship or materials.
 - B. The LED light engine shall be fully guaranteed for three years from the date of acceptance. The LED light engine shall be guaranteed free of workmanship or material defects for a period of five years from the date of acceptance.
14. Repairs. Any repairs made by a manufacturer or representative shall be documented and returned with units when warranty repaired. This documentation shall include an explanation of the exact repairs made and identification of parts replaced by part number and circuit number. All warranty repairs shall be completed within 30 calendar days of delivery of the equipment to the designated repair depot.
15. Maintenance. All equipment shall be designed for ease of maintenance. All component parts shall be readily accessible for inspection and maintenance. The only tools and test instruments required for maintenance by maintenance personnel shall be simple handheld tools and basic meters.
16. Documentation. The Contractor shall submit two sets of complete schematics, operating manuals, and maintenance manuals for each device/equipment type. The maintenance manuals shall include complete subcomponent parts listing and diagnostics procedures.

COMPENSATION

730.43—Method of Measurement.

Measurement for traffic signals shall be on a per-item basis for each item to be furnished and installed, as specified herein and shown on the Plans.

With regard to items for signal head assemblies, each item to be furnished and/or installed shall be distinguished with a code number as follows:

1. The first digit is the number of faces per assembly.
2. The second digit indicates the number of 12-inch lenses per assembly (including arrow lenses).
3. The third digit is the quantity of 8-inch lenses per assembly.
4. The letter "A" indicates an arrow lens and the digit following the "A" indicates the number of 12-inch arrow lenses per assembly.
5. The letter "H" or "V" indicates the arrangement of arrow signal lenses to be horizontal or vertical with respect to solid ball indications.

EXAMPLE:

1 5 0 A 2 H

Digits indicate the following:

1 = one face

5 = five 12-inch senses

0 = zero 8-inch lenses

A2 = two 12-inch arrow lenses

H = arrow lenses placed horizontally with respect to circular indications

Removal of Signal Equipment

Items of equipment or material designated or required for removal shall be measured as a lump sum for each intersection. Removal and salvage of all signal heads, poles, control equipment, cabinets, span wire, cable, etc., to be performed at an intersection shall be included as a unit cost per each intersection. This includes

the cost of returning salvable equipment to NDOT for proper disposal. Salvable items will be determined by the Engineer or his or her representative.

Signal Head Assembly (includes pedestrian signal heads)

Signal heads of the type indicated in the Plans shall be measured by the individual assembly complete in place, per each. This item shall include the signal heads, terminals, lamps, attachment hardware, cable connection, and testing.

Pull Box

Each pull box of the type required shall be measured as one complete unit, installed, per each. This item includes the pull box, excavation, backfilling, crushed stone base, and other incidental items as called for in the Plans or standard drawings.

Electrical Service Connection

Electrical service connections shall be measured on a per each signal installation basis. This item includes the electrical service supplied to the weatherhead by the local utility, all necessary materials and labor for connection of the electrical service from the controller to the weatherhead, the wiring of the controller and detectors, and all incidentals necessary to render a complete and operable system. Each connection shall include an external disconnect. Electric service is to be obtained by the Contractor through a written request to the Nashville Electric Service. This request should include electric loads and/or the number and types of signal lenses. The request shall be submitted once the signal, including the controller cabinet, is ready for electrical inspection and shall be submitted in a timely manner so as to activate the traffic signal as scheduled.

Signal Cable

The length of signal cable of each size (number of conductors) installed shall be measured in linear feet to the nearest foot from point to point along the routing for each cable.

Horizontal measurements shall be made by center-to-center measurement from:

1. Pole to pole.
2. Pole to signal head (when terminating in a signal head).
3. Pull box to pull box.
4. Pull box to pole.
5. Pull box to pole-mounted or base-mounted controller.

For cable inside mast arms, measurement shall be made from the center of vertical support to the signal head where the cable terminates.

Vertical measurement shall be made by one of the following:

1. For cable inside poles or conduit risers, the distance from ground level to the point of attachment of the span wire.
2. For cable inside mast arm supports, the distance from ground level to the mast arm connection.
3. For cable to pole-mounted controller from:
 - A. Ground level to bottom of controller.
 - B. Bottom of controller to point of attachment of span wire.
4. For cable to pole-mounted signal head or pushbutton from:
 - A. Ground level to bottom of signal head or pushbutton.
 - B. Bottom of signal head or pushbutton to point of attachment of span wire.

No additional allowance shall be made for slack length, length inside equipment or supports (except as noted), length for the required 360-degree drip loop, and similar instances where additional length of cable is required.

Span Wire

Span wire assembly, tether wire assembly, and messenger cable by type shall be measured in linear feet to the nearest foot. The measurement shall be made from center to center of poles. These items include attachment hardware, strain insulators, and other hardware shown in the Plans as part of the assembly. No additional allowance shall be made for slack length and other instances where additional length of wire is required.

Steel Conduit Riser Assembly

Conduit riser assemblies shall be measured per each for each size conduit riser installed on the outside of a pole, as required in the Plans. This item includes conduit, weatherhead, conduit, fittings, nuts, washers, banding, clamps, grounding, and other items necessary for installation.

Conduit

Conduit shall be measured in linear feet to the nearest foot for each size and type of conduit installed. Underground conduit shall be measured along the conduit by one of the following:

1. From the face of curb to the center of a pull box, pole, or controller foundation.
2. From center to center of pull boxes.
3. From center to center of a pull box and a pole or controller foundation.
4. From center to center of pole foundations or pole foundation and controller foundation.

Three feet shall be added to the above measurements for each entry to a pull box or pole foundation and each exit of a pull box or pole foundation. Three feet shall be added to the measurement for each capped extra entry (conduit stub) or exit to a pull box or pole foundation installed, as directed in the Plans. Three feet shall be added to the measurement for each connection between underground conduit and aboveground riser. Three feet shall be added to the measurement for each entry or exit to a foundation for a base-mounted controller.

This item includes, unless noted otherwise on the Plans, trenching, backfilling, sealing, capping, fittings, bushings, banding, grounding, and other accessories and hardware required for installation of the conduit system.

Vehicle Loop Detector (Amplifier)

Vehicle detector loop amplifier shall be measured per each unit and include the cable and associated hardware necessary to electrically connect the amplifier to the controller and loop lead-in. Two and four channel card rack type amplifiers shall be measured per each unit and include the cable, card rack(s), and associated hardware necessary to electrically connect the amplifiers to the controller and loop lead-ins.

Shielded Detector Cable

Two-conductor shielded detector cable installed between the controller cabinet and the loop detector wires shall be measured in linear feet to the nearest foot. Horizontal measurements (overhead and underground) shall be made by one of the following:

1. From center to center of pull boxes.
2. From center to center of pull box and pole.
3. From center to center of poles.
4. From center to center of pull box or pole and controller foundation.

Vertical measurements shall be made by one of the following:

1. From ground level to the point of attachment of span wire, inside pole, or conduit riser.
2. From the bottom of controller cabinet to the point of attachment of span wire.
3. From ground level to the bottom of controller.

No additional allowance shall be made for slack length, length inside equipment or supports (except as noted), splices, and similar instances where additional length of cable is required.

Saw Slot

Length of saw slot for installation of detection loop and lead wiring shall be measured in linear feet to the nearest foot. Measurement for detection loops in the traffic lanes shall be made based on the loop size specified in the Plans, i.e., the nominal length plus the nominal width times two. No additional allowance shall be made for saw overruns to obtain full depth of saw slot or diagonal cuts to prevent sharp bends in the loop wire. Measurement of saw slot for detection loop leads shall be made from the conduit entry at the face of curb or edge of pavement and along the route of the lead-in to the detection loop. For new construction or for projects where roadway resurfacing is involved, saw cuts for detection loops shall be made in the binder course.

This item includes backing rods, or polyethylene foam sealant, loop sealant, and any other incidentals necessary to render a complete and operable system.

Loop Wire

Length of loop wire for installation of detection loops and lead-ins shall be measured in linear feet to the nearest foot. Measurement shall be made from the pull box or pole to the detection loop, around the loop the required number of turns, and back to the pull box, pole, or point of splice. No additional allowance shall be made for slack length, length inside equipment or supports, splices, and similar instances where additional length of wire is required.

This item includes electrical connections, testing, and any other incidentals necessary to render a complete and operable system.

Controller

Controllers shall be measured as one complete unit, installed, per each. This item includes all auxiliary equipment indicated in the Plans to provide signalization control as specified in the Plans, and all hardware necessary for installation.

Cabinet

Cabinets shall be measured as one complete unit, installed, per each. This item includes all hardware to mount a pole-mounted cabinet to the signal support pole, or the foundation required for a base-mounted cabinet.

Wood Pole

Wood poles, of the type and size indicated in the Plans, shall be measured per each, installed.

Guying Device

Guying devices, of the type indicated in the Plans, shall be measured per each, installed. This item includes the guy wire, anchor, clamps, and all other components indicated in the Plans necessary for installation.

Steel Strain Pole

Steel strain poles of the type and size shown in the Plans, shall be measured per each, installed, unless provided for the project by NDOT. This item includes the pole, foundation, anchor bolts, grounding, and all other hardware indicated in the Plans necessary for a complete installation. In those instances where the poles are to be provided, the Contractor is responsible for providing a foundation with anchor bolts and for installing the pole on this foundation.

Cantilever Signal Support

Cantilever signal supports, of the type and size shown in the Plans, shall be measured per each, installed, unless provided for the project by NDOT. This item includes the vertical pole shaft, mast arm, foundation, anchor bolts, grounding, and all other hardware indicated in the Plans necessary for a complete installation. In those instances where the poles are to be provided, the Contractor is responsible for providing a foundation with anchor bolts and for installing the cantilever signal support on this foundation.

Service Cable

Two conductor power service cable of the type and size indicated in the Plans shall be measured in linear feet to the nearest foot, installed. Horizontal runs shall be measured center to center of poles. Vertical runs shall be measured from the ground to the weatherhead inside a pole or conduit riser, from the ground to the bottom of the controller, or from the bottom of the controller to the weatherhead. This item includes all necessary attachment hardware. No additional allowance shall be made for slack length or other instances where additional length of cable is required.

Pedestrian Pushbutton with Sign

Pedestrian Pushbutton with Sign shall be measured as one complete unit, in place, per each. This item includes the pushbutton, sign, mounting hardware, wiring of pushbutton, testing, and all other incidentals necessary for a complete installation.

Pedestrian Signal Display with Pushbutton and Sign

Pedestrian Signal Display with Pushbutton and Sign shall be measured as one complete unit, in place, per each. This item includes the signal heads, terminals, lamps, cable connections, pushbutton, sign, all attachment hardware, testing, and other incidentals necessary for a complete installation.

730.44—Basis of Payment.

The unit price to be paid shall include the cost of furnishing and installing, complete in place, each of the various types of equipment required by the Summary of Quantities that are a part of the Plans. Total payment shall be payment in full for all materials, labor, equipment, and incidentals necessary to produce a completely operative and finished installation of a traffic signal or traffic signal system as shown on the Plans and as herein specified, including restoration of pavements, sidewalks, and appurtenances damaged or destroyed during construction and tests. This payment shall be issued once a Notice of Acceptance letter has been prepared for the installation. Full compensation for all additional materials and labor not specifically shown or called for, which are necessary to complete the traffic signal installation or traffic signal system described, shall be considered and included in the total payment for the system and no additional allowance shall be made therefore.

(end of TDOT 730N spec)

APPENDIX C

DESIGN-BUILD CONTRACT FORMS APPENDED TO BOOK 2 (DESIGN-BUILD CONTRACT)

Form Name	Form Designation
Attestation Regarding Personnel Used in Contract Performance	Form AT
Conflict of Interest Disclosure Statement	Form COI
Contract Payment and Performance Bond	Form CP&PB
Lobbying Certificate	Form LC
Technical Proposal Signature Page	Form TPSP



TENNESSEE DEPARTMENT OF TRANSPORTATION

Design-Build

Book 3 Project Specific Information

Gallatin Pike (SR-6) Safety Project

Gallatin Pike: (Walton to Wiley) and (Liberty to Northside)

Davidson County, Tennessee

Project Identification Number (PIN): **125526.09 (Walton to Wiley)** and **132524.00 (Liberty to Northside)**

State Project Number: **19025-1233-94 and 19025-3233-94 (Walton to Wiley)** and **19S006-F1-006 and 19S006-F3-006 (Liberty to Northside)**

Federal Project Number: **HSIP-6(145) (Walton to Wiley)** and **HSIP-6(155) (Liberty to Northside)**

Contract# **DB2504**

June 2026

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1 GENERAL

This Book 3 (Project Specific Information) contains the requirements and conditions by which the Design-Builder shall design and construct the Project, except for any portions of the work that may be stipulated within this Book 3 (Project-Specific Information) to be performed by the Tennessee Department of Transportation (“TDOT”, or “the Department”).

The order of precedence of this Book 3 (Project Specific Information) with the other Contract Documents is described in Book 2 (Design-Build Contract).

The definition of terms corresponding with this Book 3 (Project-Specific Information) are found in the most recent version of the Department’s *Standard Specifications for Road and Bridge Construction* (TDOT Standard Specifications) and *Design-Build Standard Guidance* (DB Standard Guidance) as of 30 days prior to the Proposal due date. Additionally, the Design-Builder shall use the most current version of any listed standard or reference as of 30 days prior to the Proposal due date, unless expressly stated otherwise in the Contract Documents.

1.1 General Project Description; Scope of Work

The Design-Builder shall perform all surveying, design, construction, administration, project management, and other necessary services and Work required to construct the Gallatin Pike (SR-6) Safety Project (the “Project”) in accordance with the Contract Documents.

Safety improvements are required along two sections of Gallatin Pike (SR-6). The first section is from Walton Lane to Wiley Street (PIN 125526.09). The second section is from Liberty Lane to north of Northside Drive (PIN 132524.00).

PIN 125526.09 includes pedestrian and bicycle safety improvements at various intersections:

- Walton Lane
- Berkley Drive
- Palestine Avenue
- Moving Center Court
- Webster Street
- Emmitt Avenue
- Neelys Bend Road
- Harrington Street
- Harris Street
- Woodruff Street
- Hickory Street
- Maple Street
- East Old Hickory Boulevard
- West Old Hickory Boulevard (SR-45)

As shown in the Base Technical Concept, the required improvements include designing and constructing sidewalks, pedestrian curb ramps, bicycle lanes, bus boarding islands, midblock crossings, signing, pavement

markings, and signals. The length of this section is approximately 1.922 miles extending from Station 3+20.41 to Station 105+31.08 (the Walton to Wiley section of the “Project Limits”).

PIN 132524.00 includes pedestrian and bus lane improvements from Liberty Lane to north of Northside Drive, inclusive of all Work between these two intersections. As shown in the Base Technical Concept, the required improvements include designing and constructing sidewalks, multi-use paths, pedestrian curb ramps, curb and gutter, signing, pavement markings, signals, and lighting. This roadway section also includes the conversion of a portion of the existing shoulder to a proposed bus lane. The length of this section is approximately 0.277 mile extending from Station 106+74.54 to Station 121+39.96 (the Liberty to Northside section of the “Project Limits”).

As described in Section 7, the Department has established the Project’s proposed right-of-way (ROW) limits and TCE boundaries as shown on the ROW Exhibits (the “Planned ROW Limits”). These acquisitions (to be completed by the Department) include the properties and interests listed in Tables 1 and 2 for identified use when constructing the Work.

Beyond the items of Work listed above, the Design-Builder’s general responsibilities with respect to the Work include:

- Meet or exceed minimum Project design criteria for all improvements as defined in Section 3 and Section 4.
- Coordinate with all utility owners through the construction phase as detailed in Section 8.
- Install new roadway signs and sign structures within each of the Project Limits.
- Provide traffic control during the construction Work, including maintaining detour signs where needed.
- Acquire necessary construction and use permits not previously obtained by the Department.
- Meet all environmental commitments and perform environmental services in accordance with the approved C-List Categorical Exclusion and technical appendices (the “NEPA Document”).

A detailed description of the Work is included within the various sections of this Contract Book 3 (Project-Specific Information). Figures 1 and 2 depict both Project locations.

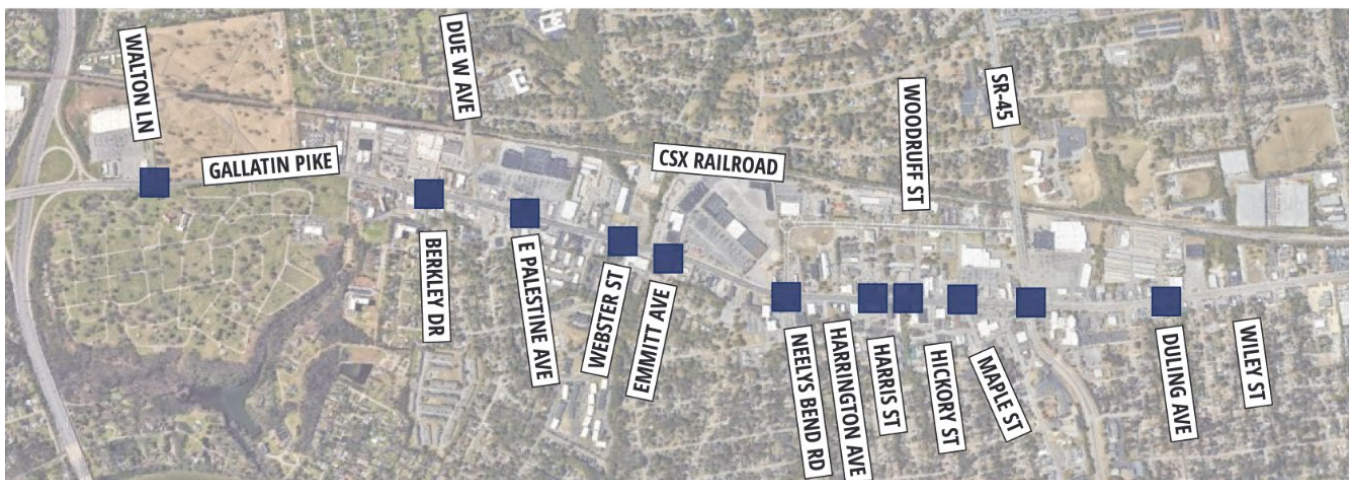


Figure 1: Location Map (Walton Lane to Wiley Street) (PIN 125526.09)

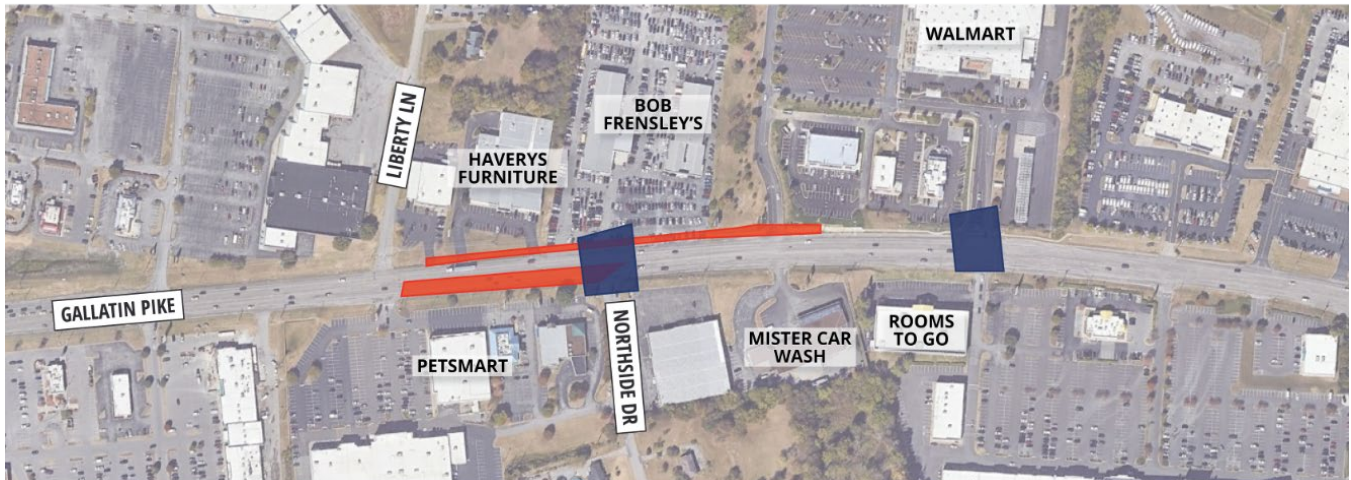


Figure 2: Location Map (Liberty Lane to North of Northside Drive) (PIN 132524.00)

1.2 Project Goals

The Project goals are as follows:

1. Implement pedestrian safety measures, such as improved sidewalks and crosswalks, along SR-6 (Gallatin Pike).
2. Minimize impacts to business access and traveling public along SR-6 during construction.
3. Support the Department in mitigating known risks related to right-of-way acquisitions and utility relocations.

1.3 Reference Documents

Information on the Project has been included as Reference Documents, published on the Department's Project website.

The Design-Builder shall acknowledge that the Reference Documents are preliminary and provided solely to assist the Design-Builder in the development of its Design Documents. The Design-Builder shall be fully responsible for the accuracy and completeness of all Design Documents and related Work performed under this Contract. The Design-Builder shall be fully liable and hold the Department harmless for any additional costs and all claims against the Department that may arise due to any Department errors or omissions to the Reference Documents or due to the errors, omissions, or negligence of the Design-Builder in performing the Work required by this Contract.

The Department-provided Reference Documents include:

- Field survey data files
 - The .dgn files will be sent to the Design-Builder upon receipt of an executed CAD Disclaimer form (provided on the Project website) to the TDOT point of contact listed in Section 1.5 of Book 1 (Instructions to Proposers).
- The NEPA Document
 - PIN 125526.09 (Walton Lane to Wiley Street)
 - PIN 132524.00 (Liberty Lane to North of Northside Drive)

- Base Technical Concept (in .dgn format and sheet files)
 - The Base Technical Concept is provided for information only; the scope of the Project listed in the Contract Documents takes precedence.
 - The .dgn files will be sent to the Design-Builder upon receipt of an executed CAD Disclaimer form (provided on the Project website) to the TDOT point of contact listed in Section 1.5 of Book 1 (Instructions to Proposers).
- Department's Utility Impact Matrix
- Subsurface Utility Exploration (SUE) data (forthcoming in Summer 2026)
- ROW Exhibits delineating the Planned ROW Limits
 - The .dgn files will be sent to the Design-Builder upon receipt of an executed CAD Disclaimer form (provided on the Project website) to the TDOT point of contact listed in Section 1.5 of Book 1 (Instructions to Proposers).

The Design-Builder shall establish datum adjusted survey control tied to the Tennessee Geodetic Reference Network (TGRN) in accordance with Section 2.1 of the TDOT Survey Manual. The existing coordinates, dimensions, and elevations used in the Reference Documents are provided for information only. The Design-Builder shall verify all existing elevations, dimensions, and horizontal and vertical alignments in the field. This shall include elevations at interfaces of existing and proposed pavement, sidewalks, signals and lighting poles, and grading limits. The Design-Builder shall be responsible for all surveys, including those relating to the work and utilities and including locating the Planned ROW Limits established by the Department to perform the work. The Design-Builder shall provide survey control to the Department prior to submission of its Definitive Design.

1.4 Construction Engineering Inspection

The Department will be responsible for Construction Engineering Inspection (CEI) work and Quality Acceptance Testing. The Design-Builder shall provide and maintain a communication matrix to support coordination of Work for all parties during both the design and construction phases.

2 PROJECT MANAGEMENT

The Design-Builder shall prepare and administer a Project Management Plan (PMP) containing the Design-Builder's approach to managing the design and construction activities of the Project in accordance with the *DB Standard Guidance* and the specific requirements defined herein.

The PMP shall contain, at a minimum, the following component parts:

- Organizational Structure and Staffing Plan
- Critical Path Method (CPM) Initial Project Schedule (IPS)
- Quality Management Plan (as listed in Section 2.3)
- Public Relations and Public Information Plan (PIP)
- Records Management Plan

Within 30 Days of Contract Award, the Design-Builder shall meet with the Department at the Post-Award Meeting to discuss the development of the components of the PMP for Review and Acceptance by the Department prior to the start of any Work.

The Design-Builder shall use its Proposal as a foundation to prepare the PMP and its component plans/parts. The Design-Builder shall implement all elements of the PMP over the duration of the Project.

The Design-Builder shall use an agreed-to e-plans software for the Project, including coordinating with the Department on setting and organizing the Project record in the Department's ProjectWise. All Project submittals shall be in Adobe pdf and native file format and include an email with the transmittal letter to the Department to initiate review of all submittals.

2.1 Organizational Structure and Staffing Plan

The Design-Builder shall prepare an Organizational Structure and Staffing Plan to ensure the appropriate number of qualified staff are employed by the Design-Builder to perform the Work in a manageable and safe manner.

The plan shall identify the Key Personnel and key management staff, including Level "1" Personnel identified in the Design-Builder's proposal documents (minimally those staff listed in Section 3.4 of Contract Book 2).

The Design-Builder shall provide an organizational chart that graphically represents the hierarchy and functional interaction of the Key Personnel and indicates the functional responsibilities of each staff member. The organization shall be monitored, and the chart updated and provided to the Department when changes to the Design-Builder's organizational chart occur.

The Design-Builder shall provide to the Department, within 15 calendar days after the initial Notice to Proceed (NTP), a list of the contacts (and contact details) of Key Personnel on site and Key Personnel on call who are available 24 hours per day during the execution of the Work.

The Design-Builder shall include a procedure for a structured and managed replacement of Key Personnel, as requested for Department approval, on the Design-Builder's Project team.

Any licenses or certifications that are required to meet the requirements of the Request for Proposals (RFP) shall be in place by the time the initial NTP is issued.

2.2 Project Schedule and Cost Management

2.2.1 CPM Schedule Requirements

For review at the Post-Award Meeting, the Design-Builder shall prepare a Critical Path Method (CPM) Initial Project Schedule (IPS), in accordance with the Department's Circular Letter 108.03.C, TDOT Standard Specifications, Chapter 3 of the DB Standard Guidance, and the requirements described herein.

2.2.1.1 INITIAL, BASELINE, AND MONTHLY SCHEDULE SUBMITTALS

In accordance with Chapter 2 and 3 of the DB Standard Guidance, the Design-Builder shall use the preliminary CPM schedule submitted with its Proposal as a foundation to prepare the CPM IPS and shall submit it to the Department for Review and Acceptance. Acceptance of the CPM IPS by the Department shall be a condition for starting any Work per Section 3.2.1 of the DB Standard Guidance.

Following acceptance of the CPM IPS, the Design-Builder shall submit its Baseline Schedule in accordance with the Department's Circular Letter 108.03.C. Review comments made by the Department on the Baseline Schedule shall not relieve the Design-Builder from compliance with the Contract.

The Design-Builder shall submit an updated CPM Schedule monthly for the Department's Review and Comment in accordance with Department's Circular Letter 108.03.C, TDOT Standard Specifications, and Chapters 3 and 9 of the DB Standard Guidance. Monthly progress payment requests and CPM updates shall be submitted no later than ten (10) Calendar Days (or as agreed to with the Department) prior to the estimate cutoff date. Each month, the Design-Builder shall provide a narrative with each CPM Schedule submittal that includes:

- A detailed description of the status of the Project and changes to the CPM Schedule;
- Identification of strategies for mitigation of Project risks or issues impacting the CPM Schedule (describing constraints and discussing contingencies);
- How the proposed Project phasing, sequence of Work, and allocation of resources enable the Design-Builder to progress the Work to achieve completion of the Project in accordance with Contract requirements, including achievement of the Contract Completion Date(s);
- How the phasing ensures timely deliveries of materials to achieve the CPM Schedule milestones;
- Identification of categories of Work performed by Design-Builder's own direct labor force and those performed by Subcontractors;
- Pay Item activities and all Work included in the Pay Item activities corresponding to totals as reflected on the Schedule of Items; and
- Any other requirements from the Department's Circular 108.03.C, TDOT Standard Specifications, and Chapters 3 and 9 of the DB Standard Guidance.

Acceptance by the Department shall not be construed to imply approval of any particular method or sequence of construction or to relieve the Design-Builder of providing sufficient materials, equipment, and labor, including subcontractors, to guarantee completion of the Project in accordance with all Contract requirements. The Department's acceptance shall not be construed to modify or amend the Contract, Project milestones, Interim Completion Date(s) (as applicable), or the Contract Completion Date.

Furthermore, the Department's acceptance of any schedule update does not relieve the Design-Builder of responsibility for the accuracy or feasibility of the CPM Schedule, does not modify the Contract, will not be construed as an endorsement or validation of the Design-Builder's plan, and does not guarantee that the

Project can be performed or completed as scheduled. The Department's acceptance of the CPM Schedule in no way attests to the validity of the assumptions, logic constraints, dependency, relationships, resource allocations, resource availability, manpower and equipment, or any other aspect of the means and methods of performing the Work.

In all, the Design-Builder shall remain solely responsible for the scheduling, sequencing, planning, and execution of the Work to meet the Project milestones, Interim Completion Date(s) (as applicable), the Contract Completion Date(s), and all other Contract requirements.

2.2.1.2 PROJECT CPM SCHEDULE REQUIREMENTS

In addition to the requirements from the Department's Circular Letter 108.03.C, TDOT Standard Specifications, and the DB Standard Guidance, the CPM Schedule shall detail adequate planning and execution of the Work, allow the Design-Builder and Department an opportunity to evaluate the progress of the Work, and shall follow the applicable categories within the Schedule of Items and other cost control systems, including the Progress Payment process.

The CPM Schedule shall include all major activities of Work required under the Contract, in sufficient detail to evaluate design and construction progress. The CPM Schedule shall not contain open-ended activities, except for the first and last activity in the CPM Schedule. The Design-Builder shall provide adequate time in the CPM Schedule for all parties involved with the Project to complete their work, including submittal and procurement activities, inspections, and testing. The Design-Builder shall include in the CPM Schedule the work of subcontractors, vendors, suppliers, utilities, railroads, permitting agencies, the Department, and all other parties associated with the Project. The CPM Schedule may be utilized to facilitate the Department's Construction Engineering and Inspection (CEI) and Quality Assurance/Acceptance (QA) activities.

Failure by the Design-Builder to include any element of its Work or the work of others required for completion of the Project will not excuse the Design-Builder from completing the Project by the Contract Completion Date(s).

The scheduling software employed by the Design-Builder shall be compatible with the current and any future scheduling software used by the Department. The Department's current software is *Oracle Primavera P6 (v 18.8)*. The software shall be compatible with the electronic file version of the CPM Schedule that can be loaded or imported by the Department using the Department's scheduling software with no modifications, preparation, or adjustments.

The CPM Schedule shall show the order in which the Design-Builder proposes to complete the Work, the time frame which it will start the major items of work, and the critical features of such work (including procurement of materials, plant, and equipment). The CPM Schedule shall include, at a minimum, the following items:

- Controlling items of Work, major Work, and activities to be performed;
- Seasonal weather limitations;
- Land disturbance restrictions;
- Phase duration or milestone events, based on selected option as applicable; and
- Specified Contract Completion Date(s) from the Contract.

The CPM Schedule shall be time and cost loaded, depicting Pay Items and subordinated activities and their respective prices (distributed over time) in accordance with the DB Standard Guidance. The Design-Builder shall assign a percentage of the Pay Item Cost to each activity in the proposed CPM Schedule that reflects an accurate percentage value to each activity based on estimated costs plus associated profit and

overhead. The profit and overhead assigned to the individual activities shall be equal to or less than the mark-up applied to the Work when establishing the Contract Amount. The CPM Schedule shall be in a suitable scale to indicate graphically the total percentage of Work scheduled to be completed at any time.

2.2.1.3 SUBMITTAL REQUIREMENTS

In addition to the requirements of Section 2.7 of the DB Standard Guidance, Design-Build submittals shall be scheduled and submitted based on the approved CPM Schedule. The Design-Builder shall include all review submittals and any resubmittals in the CPM Schedule in order for the Department to appropriately allocate resources for performing the reviews and to track and document any possible schedule impacts.

Ten (10) business days shall be allocated in the CPM Schedule for activities requiring the Department's Review and Acceptance or Review and Comment, unless otherwise indicated in a Special Provision or third-party review. In accordance with the DB Standard Guidance, submittals requiring the Department's Review and Acceptance shall be limited to two concurrent submittals per Division unless indicated otherwise by the TDOT Project Manager.

All submittals required to be reviewed and approved by third-party stakeholders shall be tracked individually. Each such submittal shall have separate activities that track submittal development, required reviews, and revisions required by third-party stakeholders, the Department, or the Design-Builder.

2.2.1.4 TIME ADJUSTMENTS

Notwithstanding any other provision to the contrary, no time adjustments will be allowed for:

- Adverse weather conditions (e.g., weather days should be accounted for in the CPM Schedule);
- The time required for the Department's review and response to any initial submittal and any required resubmittal to resolve the Design-Builder noncompliance or nonconformance with the Contract Documents;
- The time required to review value engineering cost proposals (VECPs);
- The time to process Change Orders or plan revisions requiring additional Department or other agency review and/or approval;
- The time to complete any Work that the Design-Builder did not account for in its CPM Schedule as required by the Contract Documents (including time to correct all defects, deficiencies, or errors and time to address any other non-compliance with the provisions of the Contract);
- Work that could have been re-sequenced or rescheduled to avoid delays; or
- Any delays typically encountered during a Project regardless of the source.

The Department may consider time adjustments for:

- The time for plan revisions requiring additional third-party or other agency (i.e., non-Department) review and/or approval if the Design-Builder is unable to work on the controlling item of work without revised plans or shop drawings;
- The time for ordering and delivery of materials for extra work as directed by the Department that affects the CPM Schedule;
- Delays encountered due to a force majeure event as defined in Section 108.07B of the TDOT Standard Specifications that is beyond the control of the Design-Builder that the Department determines adversely affected the progress of the Work.

In accordance with Section 2.7 of the DB Standard Guidance, submittals must be stamped into the Department-designated contact office before 12:00 p.m. CST to start the review period that day. If submittals are received after 12:00 p.m. CST, the review period will begin on the following business day. The review period includes only the Department workdays.

2.2.2 Schedule and Cost Controls

The Design-Builder shall develop procedures for schedule and cost control on the Project, including the cost control and schedule management system to be used to control and coordinate the Work.

The cost-control approach shall include a description of the proposed approach for calculating progress performance for preparing the monthly payment requests using the Pay Item activities, Schedule of Items, and the CPM Schedule. The Design-Builder shall include a procedure for re-scheduling its Work to achieve schedule recovery objectives and how these objectives will be enforced with its workforce and Subcontractors.

2.2.3 Liquidated Damages for Failure to Meet Completion Deadline

The Design-Builder shall complete the Project within the time limitations set forth in Book 2 (Design-Build Contract) and Special Provision 108B.

If the Design-Builder fails to complete the Project within the time limitations set forth in the Contract, then the Department will suffer substantial losses and damages. Special Provision 108B provides the daily sum that shall be deducted from monies due the Design-Builder, not as a penalty, but as Liquidated Damages, if the Contract Completion Date of the Project is delayed.

2.3 Quality Management Plan

The Design-Builder shall establish and implement a Quality Program and prepare a Quality Management Plan in accordance with Section 2.5 of the DB Standard Guidance and the requirements described herein. The Quality Management Plan shall include:

- Design Quality Management Plan (DQMP);
- Construction Quality Management Plan (CQMP);
- Environmental Compliance Plan (ECP); and
- Safety and Health Plan (S&H Plan).

The Department expects the Design-Builder to implement Quality Program improvements over the Project's duration. It is of the utmost importance that the Design-Builder involves its staff and partners with the Department to ensure overall Project satisfaction. The Department will strive for an oversight role in the Quality Program for the Project; however, this will only be possible if the Design-Builder's Quality Program exhibits sufficient staff and sound processes and practices that place quality design and workmanship above production and/or cost by all team members.

2.3.1 Design Quality Management Plan (DQMP)

The Design Quality Management Plan (DQMP) shall conform to the requirements of Section 5 of the DB Standard Guidance and describe:

- Quality roles and responsibilities of the Design-Builder's design Quality Team, including the Design Quality Manager (DQM) and Design Manager;

- Procedures for implementing the design work;
- Design development, submittal, and design review process for preparation of final signed and sealed construction plans and specifications used to construct the Project (the Readiness-for-Construction Plans and Specifications);
- Processes and procedures for the Department's Review and Acceptance of necessary submittals prior to starting any design work; and
- Quality control and quality assurance procedures for ensuring the quality of design work and conformance, including design-quality checks and certifications, and independent design reviews prior to submittal for the Department's Review and Acceptance.

The DQMP shall provide all Design Documents and perform design reviews in accordance with the design review schedule established in the CPM Schedule and in accordance with Contract requirements.

The Design Engineer or Manager shall be responsible for design quality control and ensuring that the design submittals and design reviews are performed in accordance with the DQMP and the Contract Documents. In accordance with Section 2.5.2 of the DB Standard Guidance, the DQM shall provide an independent review and certify that the Design Documents comply with all Contract requirements (QA/QC Stamps) prior to requesting Review and Acceptance by the Department. Failure by the Design-Builder to perform its Quality Management function will result in the immediate rejection of the Design Documents and the Design-Builder shall revise and resubmit. Additional review comments may be added to the resubmission by the Department.

The DQMP shall describe how nonconformances are identified and tracked, how resolutions to nonconformances are developed, and how the actions taken to correct nonconformances are documented, either in Design Documents or construction records and reviewed or re-inspected. This section will apply to both design and construction of the Project. The Design Engineer who signed the applicable Design Documents shall review and approve all resolutions of nonconformances that require design changes, repairs, or rework.

The DQMP shall describe the corrective and preventive actions the Design-Builder will take upon the identification of actual or potential major and systemic nonconformances, identified internally or by the Department. The Design-Builder shall advise the Department when corrective action has been implemented so that the Department may verify implementation, should the Department so choose. This section will apply to both design and construction of the Project.

The DQMP shall be submitted for the Department's Review and Acceptance prior to starting any design work.

2.3.2 Construction Quality Management Plan (CQMP)

The Construction Quality Management Plan (CQMP) shall describe the quality roles and responsibilities of the Design-Builder's construction Quality Team and procedures for implementing the construction work in accordance with Chapter 7 of the DB Standard Guidance.

Although the Department will provide CEI and QA testing, the Design-Builder is responsible for ensuring the quality of the work and shall prepare procedures in the CQMP for quality control of materials and how the Design-Builder plans to inspect the Project to ensure compliance with the Contract Documents. The Design-Builder shall guarantee and provide full cooperation in relation to the Department's CEI and QA audits, reviews, request for information, etc.

The Construction Manager shall be responsible for quality control during construction and ensuring that quality control testing and inspections are performed in accordance with the CQMP and the Contract Documents.

In accordance with Section 2.5.3 of the DB Standard Guidance, the Design-Builder shall provide a Construction Quality Manager (CQM) to oversee, manage, certify, and perform construction Quality Management activities. The CQM shall independently review the submittals for the Department, and upon completion shall certify to the Department that the information is accurate and complete. The CQM shall certify that all Work Product has been checked and/or inspected by the Quality Team and that all work complies with the Contract Documents. The CQM shall also certify to the Department that the CQMP and all measures, protocols, and procedures provided therein, are functioning properly and are being followed.

The CQMP shall be submitted for the Department's Review and Acceptance prior to starting any construction work.

2.3.3 Environmental Compliance Plan (ECP)

The Design-Builder shall prepare an Environmental Compliance Plan (ECP) in accordance with Section 2.5.4 of the DB Standard Guidance.

2.3.4 Safety and Health Plan (S&H Plan)

The Design-Builder shall prepare a Safety and Health Plan (S&H Plan) in accordance with Section 2.5.5 of the DB Standard Guidance.

2.4 Public Relations and Public Information Plan

The Design-Builder shall comply with Section 7.4.5 of the DB Standard Guidance and address the following Project-specific requirements.

2.4.1 Internal and External Communications

The Design-Builder shall describe the internal and external communication process between the Design-Builder and the Department's staff, external stakeholders, third parties, and public affected by the Work.

The Design-Builder shall provide all information required for communication purposes. The communication activities are primarily intended for the Department and Department staff (internal stakeholders), but shall also focus on neighboring public and communities, local residents, companies and organizations, emergency services, Davidson County, surrounding communities, environmental agencies, railroads (as applicable), impacted utilities, and other external services.

The focus of Project/construction communication shall support the following goals:

- Ensure that the entire Project is executed in the least disruptive and positive manner possible for the Department, external stakeholders, and the traveling and local public;
- Maintain the best possible long-term relations with all relevant external stakeholders; and
- Ensure that the Work is performed in the most effective and efficient way.

2.4.2 Handling Complaints

The Design-Builder shall process complaints that result from performing the Work, whether received directly or through the Department to the Design-Builder, as soon as possible in a proactive way.

- The Design-Builder shall notify the Department within two hours after receiving a complaint and inform the Department of what actions will be taken to resolve the cause of the complaint.
- The Design-Builder shall keep a complete and updated complaint register of all complaints received, addressed directly to the Design-Builder or through the Department.
- The complaint register shall include all relevant information in relation to the complaint (who, when received, contents), the actions planned concerning the complaint, the person(s) responsible for the communication, and the status of the complaints (open, closed), which shall be available to the Department upon request.

The Design-Builder shall coordinate all public communication with the Department.

2.4.3 Information for Project Website

The Design-Builder shall coordinate with the Department and provide Project-related information to the Department at least monthly and at least two (2) weeks in advance of significant events or milestones for Review and Approval, including:

- Contact information,
- Project maps,
- Current Project activities and progress,
- Timing of roadway closures and openings,
- Newsletters and meeting materials, and
- Calendar of, and announcements for, meetings and special events.

2.4.4 Liaison with the Media

Unless otherwise authorized in writing by the Department, the Design-Builder shall provide no news release, press release, or any other statement to a member of the news media regarding this Project. The Design-Builder shall require this clause to be within all Subcontractor agreements.

2.5 Records Management Plan

The Design-Builder shall describe its procedures for managing and maintaining Project record documents in accordance with Sections 5.2.11 and Chapter 7 of the DB Standard Guidance and the Project-specific requirements described herein.

The Department will perform a combination of audits, reviews, and inspections to assess whether the Design-Builder's integrated project management responsibilities and its PMP are functioning properly and determine whether its records and information are reliable and up to date.

Submitted at the time listed in the DB Standard Guidance, the Design-Builder shall provide the TDOT Alternative Delivery Office a transmittal letter, an electronic copy (CAD and signed PDFs) of the As-Built Plans and final foundation type (if applicable), including footing elevations and lengths of subsurface foundational elements, prior to final payment of funds to the Design-Builder.

The Professional Engineer in charge of the development of the Project's Plans and specifications shall place his/her seal, including signature and date, on the right side of the title sheet. All plan sheets shall contain the seal, including signature and date, of the Professional Engineer in charge of its development.

The As-Built Plans and the Design-Builder Specifications (following construction completion) shall incorporate any changes to the Readiness-for-Construction Plans and Specifications, changes made during construction Work, as well as all utility locations within the right-of-way (ROW) as described in the DB Standard Guidance.

3 ROADWAY

3.1 Standards and References

The Design-Builder shall design and construct the Work to adhere to following roadway standards.

- *TDOT Roadway Standard Drawings*
- *TDOT Roadway Design Guidelines – PDN*
- *TDOT Roadway Design Documents – PDN* (and Instructional Bulletins)
- *TDOT Drainage Manual*
- *TDOT Design CADD Standards*
- *TDOT Project Scoping Guide*
- *TDOT Traffic Design Manual*
- *TDOT Standard Traffic Operations Drawings*
- *TDOT Supplement to the Standard Highway Signs*
- *TDOT Survey Manual*
- *TDOT Standard Specifications*
- The Department accepted *AASHTO Policy on Geometric Design of Highways and Streets*, *AASHTO Roadside Design Guide*, *AASHTO Guide for the Development of Bicycle Facilities*, *Manual on Uniform Traffic Control Devices (MUTCD)*
- *Public Right-of-Way Accessibility Guidelines (PROWAG)*

The Design-Builder shall use OpenRoads Designer (ORD) in its development of 3D parametric modeling to provide model-centric design deliverables. Use of ORD shall be in accordance with requirements and guidelines provided on the Department's website: [ORD \(tn.gov\)](http://ORD.tn.gov)

3.2 Design Requirements

The Department has developed the roadway design criteria for Design-Builder use on this Project in accordance with *TDOT Roadway Design Guidelines – PDN*. The Design-Builder shall design and construct the improvements detailed in Section 1.1 within the two Project Limits based on the following criteria:

- Sidewalks (horizontal and vertical alignments of sidewalks shall meet Americans with Disabilities Act (ADA) and PROWAG compliance.)
 - Minimum width: 5 feet
 - Maximum cross slope: 1.5%
 - Maximum grade: 5.0% or as matching roadway grade
- Curb ramps
 - Minimum width: 4 feet
 - Desired cross slope: 1.5%
 - Maximum cross slope: 2.0%
 - Maximum running slope: 8.33%

- Midblock crosswalks
 - Desired median width: 8 feet
 - Minimum median width: 4 feet
 - Minimum cut through width: 5 feet
- Bike lanes
 - Desired width: 5 feet
 - Minimum width: 4 feet
 - Maximum width: 8 feet
- Bus lanes
 - Width: 12 feet
 - Cross slope: 2.0%

Design-Builder shall design and construct all sidewalks, curb ramps, and midblock crosswalks in accordance with the *TDOT Multimodal Standard Drawings* and ADA and PROWAG rules and regulations.

The Design-Builder shall prepare final signed and sealed construction plans to construct the Project, including:

- Preparing the plans in accordance with *TDOT Roadway Design Guidelines – PDN* and the previous design standards referenced in this section.
- Identifying the need for any special roadway design details (i.e., any special drainage structures, special ditches, etc.) and providing special design drawings to the Department for Review and Comment.
- Ensure that all applicable “General and Special Notes” found in Section IX of the current edition of the *TDOT Roadway Design Guidelines – PDN* and Instructional Bulletins (IBs) are included in the Design Documents and are adhered to during the construction Work.

The Design-Builder shall design geometric configurations of all safety improvements to provide adequate drainage and prevent ponding (when complete). Design-Builder shall design and construct all cross slopes in accordance with the requirements of the roadway typical section. The Design-Builder shall provide hydraulic calculations (including spread calculations) to the Department.

The Design-Builder shall coordinate with NDOT on Choose How You Move (CHYM) adjacent to the proposed intersection improvements at Harris Street (PIN 125526.09)

3.3 Waivers and Exceptions

The Base Technical Concept does not require any design waivers or exceptions. Design waivers or exceptions shall not be allowed without the Department’s approval.

3.4 Safety Appurtenances

All permanent and temporary safety appurtenances (i.e., sign supports, traffic drums, barrier rail, impact attenuators, etc.) shall meet current Department standards and shall have all required Department certification documents.

Specific to guardrail, Design-Bulder shall:

- Remove and replace existing guardrail that does not meet TDOT standard in accordance with the TDOT Standard Specifications and TDOT Standard Drawings.

- All new guardrail and end terminals shall be MASH-compliant TL-3 and be on the Department's Qualified Products List (QPL).

3.5 Drainage

The Design-Builder shall analyze, design, and construct adequate drainage within each of the Project Limits, including, stormwater conveyances (open-channel and closed-conduit), stormwater inlets, and stormwater collection systems in accordance with the Department's *Drainage Manual*.

- All stormwater runoff that flows through the Project, whether originating within or outside of the respective Project Limits, must be accounted for in the design of the drainage system.
- The analysis, design, and construction of all components of the stormwater management system shall address the interim conditions during design and construction of the Project.

3.5.1 Drainage Design Requirements

The Design-Builder shall use a 10-year design storm (50-year at roadway sag locations) for all new (and existing to remain) storm sewer systems in accordance with the Department's *Drainage Manual*.

- All drainage systems shall be designed to convey the 10-year storm (50-year at roadway sag locations) without overtopping of any existing or proposed drainage or transportation elements.

The Design-Builder shall design culvert and pipe outfalls, channels, and ditches (including special ditches) within each of the Project Limits in accordance with requirements of the *TDOT Drainage Manual*.

The Design-Builder shall re-establish drainage in situations where sedimentation has changed the flow line from the existing profile. No Work should be done to Waters of the State or US, which might appear to be a ditch, without proper permits.

The Design-Builder shall provide erosion control for the construction Project per the guidelines specified in the *TDOT Drainage Manual* and this Book 3.

The Design-Builder shall design the drainage system to accommodate construction staging. Spread requirements for temporary traffic control may be reduced to a 5-year storm event; however, permanent conditions must meet the requirements of the *TDOT Drainage Manual*. The design shall include temporary erosion control and other Best Management Practices (BMPs) needed to satisfy NPDES, local municipality, and other regulatory requirements. All environmental commitments related to drainage design and erosion control shall be included as "notes" on the plans for each stage of construction.

3.5.2 Existing Drainage Systems

The design of stormwater management facilities shall be compatible with existing or any known proposed improvements to drainage systems on adjacent properties and shall preserve existing drainage patterns.

If existing drainage patterns must be altered due to a temporary or permanent aspect of the design, the Design-Builder shall provide documentation of any/all impacts to upstream/downstream and/or adjacent properties and/or road crossings for Department's Review and Approval prior to alteration of existing drainage patterns. The Design-Builder shall collect survey data for all upstream/downstream/adjacent properties that are impacted, such as road crossing information, structure elevations, and channel cross sections (at a minimum), which shall be used in support of hydraulic calculations for the offsite drainage systems. The Design-Builder shall provide engineering analyses and certifications to the Department for Review and Approval prior to performing the alteration.

3.6 Pavement Markings

The Design-Builder shall prepare pavement marking Plans as part of its Design Documents for Department Review and Comment and shall install the pavement markings in accordance with the Department standards and the following requirements.

- The design and installation of permanent pavement markings shall be done in accordance with the *Manual on Uniform Traffic Control Devices (MUTCD)*, *TDOT Roadway Design Guidelines -- PDN*, *TDOT Standard Drawings*, *TDOT Standard Traffic Operations Drawings*, *TDOT Traffic Design Manual*, and the TDOT Standard Specifications.
- All pavement marking removal on final surfaces shall be accomplished by water blasting or another non-marring method.
- Any damage to the pavement surface caused by the selected method shall be removed and replaced at the Design-Builder's cost and time.

3.7 Signing

The Design-Builder shall design, reuse existing signs, and/or install new signage throughout each of the Project Limits in accordance with the *MUTCD*, *TDOT Roadway Design Guidelines -- PDN*, *TDOT Standard Drawings*, the *Standard Highway Signs*, the *TDOT Supplement to the Standard Highway Signs*, the TDOT Standard Specifications, and *TDOT Traffic Design Manual*.

The Department has provided a conceptual signage design in the Base Technical Concept for information only, and the Design-Builder shall verify location, type, size, and use of each sign in its signing Plans. All permanent signing Plans, signing layouts, sign schedules, and miscellaneous detail sheets shall be coordinated as follows prior to ordering and construction/installation.

- The Design-Builder shall prepare and submit signage Plans and related details and schedules for Department Review and Comment prior to ordering and installing all signs.
- After the permanent sign locations have been staked, but prior to ordering any material for supports, the Design-Builder shall lead a field review for acceptance by the Department.
- The Design-Builder shall verify all support lengths at the site prior to erection.
- The Design-Builder shall install Project Information and 511 Signs during the installation of the construction signage, as per Traffic Memorandum No. 2403, which can be found in the Reference Documents.

All sign sheeting with a silver-white, yellow, red, green, brown, or blue background shall provide reflective sheeting of Encapsulated Lens or Micro-prismatic Lens material meeting or exceeding the minimum requirements for Type D or better as specified by AASHTO M 268. All existing signs that do not meet the retro-reflectivity requirements shall be replaced. All existing post-mounted signing shall be removed and replaced with new sign faces and new breakaway supports.

All new sign sheeting shall be Type 3 Prismatic or better. All new signs shall meet the retro-reflectivity requirements. All new yellow reflective warning signs shall be fluorescent yellow.

3.8 Pavement

The Design-Builder shall construct all bus lane asphalt pavements (as part of PIN 132524.00, Liberty Lane to north of Northside Drive) using the pavement design in Attachment A and the *TDOT Roadway Design Guidelines -- PDN*. The Design-Builder's CPM Schedule shall include time for installing tack coat and prime

coat per the application rates in *TDOT Roadway Design Guidelines – PDN* and TDOT Standard Specifications.

The Design-Builder shall provide full-depth reconstruction of the asphalt pavement at any location where the Design-Builder vertically or horizontally realigns, adjusts (e.g. raises a grade), or removes and replaces a portion of the roadway cross section within either of the Project Limits (including travel lanes and shoulders).

No pavement scope is expected for PIN 125526.09 (the Walton to Wiley section) beyond needed pavement tie-in for the sidewalk work in accordance with the pavement design in Attachment A.

4 Traffic/Pedestrian Signals and Lighting

4.1 Standards and References

The Design-Builder shall design and construct the Work to adhere to following signals and lighting standards.

- Traffic signals shall be designed and constructed in accordance with Supplemental Specification, Special Provision 700SIG, Nashville Department of Transportation and Multimodal Infrastructure (NDOT) specifications, NDOT Special Provision 730N, TDOT Standard Traffic Design Drawings, the TDOT Traffic Design Manual, and the Manual on Uniform Traffic Control Devices (MUTCD).
- Lighting shall be designed and constructed in accordance with TDOT Traffic Design Manual, TDOT Standard Specifications, AASHTO Roadway Lighting Design Guide, National Fire Protection Association (NFPA) 70 – the National Electric Code (NEC), Institute of Electrical and Electronics Engineers (IEEE) – National Electric Safety Code (NESC), American National Standards Institute/Illuminating Engineering Society (ANSI/IES) RP-8 – Recommended Practice: Lighting Roadway and Parking Facilities, and FHWA Lighting Handbook.
- All proposed roadway lighting and signal infrastructure (including foundations) shall be designed in accordance with the requirements of the LRFD Standard Specifications for Structural Support for Highway Signs and Luminaires and Traffic Signals published by the American Association of State Highway and Transportation Officials, in addition to the TDOT Standard Traffic Design Drawings and TDOT Standard Specifications.
- All materials required for installation of lighting and signal infrastructure (including wire, conduit, and pull boxes) shall meet or exceed the requirements of TDOT, Nashville Electric Service (NES), and NDOT standards.
- The Design-Builder shall obtain all permits required for installation of lighting and signals. The Design-Builder shall coordinate with TDOT and/or NES to determine electric feed points.

4.2 Design and Construction Requirements

The Design-Builder shall obtain all permits required for installation and testing of the lighting and signals Work. The Design-Builder shall allocate fifteen (15) business days in the CPM Schedule for activities requiring NDOT, NES, or other third-party Review and Acceptance or Review and Comment.

The Design-Builder shall coordinate with the respective utility owner (e.g., NES) and provide electrical service for all signal and lighting devices included on the Project, including coordinating with TDOT, NDOT, and the utility owner (e.g., NES) to determine and implement the appropriate electric feed point. The Design-Builder shall pay all costs for providing electrical service. In addition, the Design-Builder shall pay all electric service's recurring costs until Substantial Completion.

4.2.1 Traffic/Pedestrian Signals

The Design-Builder shall prepare and submit signal Plans and construct the proposed traffic and/or pedestrian signals (including cabinets, controllers, traffic signal heads, wiring, detection equipment, conduit and pull boxes, traffic signal poles and associated traffic signal timing and all other materials and methods required to provide a fully functional and operational traffic signal) at the following intersections along Gallatin Pike (SR-6).

- PIN 125526.09
 - Walton Lane
 - Berkley Drive
 - Midblock crossing near E. Palestine Avenue
 - E. Palestine Avenue
 - Webster Street
 - Emmitt Avenue
 - Harrington Avenue
 - Madison Street / Harrison Street
 - Woodruff Street
 - Maple Street
 - Old Hickory Boulevard (SR-45)
 - Midblock crossing near Duling Avenue
- PIN 132524.00
 - Northside Drive
 - North Walmart Drive

The Design-BUILDER shall submit its signal Plans as part of its Definitive Design Plans for Department and NDOT Review and Comment, which shall be advanced prior to procuring any signal equipment. The Design-BUILDER shall develop and submit equipment cut sheets and/or shop drawings to the Department and NDOT (for Review and Comment) prior to installation of any signal equipment. The Design-BUILDER shall submit a material list to the Department and NDOT (for Review and Comment) prior to starting related construction Work.

The Design-BUILDER shall be responsible for active management of signals and operations until final acceptance of the Project. During this time, the Design-BUILDER shall implement and adjust (as needed) final signal timing to provide optimal traffic signal operations.

The Design-BUILDER shall warrant all equipment, except for the signal heads, to be free from defects in material and workmanship for three (3) years from Substantial Completion, unless otherwise noted. The signal heads shall be warranted for five (5) years to be free from defects in material and workmanship for three (3) years from Substantial Completion, unless otherwise noted.

4.2.1.1 SIGNAL HEADS

Signal heads shall be black with black aluminum back plates. Signal head equipment (i.e., the frame and illumination type) shall be reviewed by NDOT prior to the Design-BUILDER's ordering and installation.

Backplates shall be aluminum louvered dull non-reflective black finish with yellow raised reflective stripe. Signal heads shall include louvered backplates with a 1-inch minimum to 3-inch maximum yellow retro reflective border around the perimeter of the face of the backplate. The retro reflective border shall be fabricated of a type III prismatic or better material.

Visors shall be dull non-reflective black finish.

4.2.1.2 CONTROLLERS

The traffic signal cabinet shall be 8-phase NEMA TS2 type 1 compliant with NDOT specifications.

The Design-Builder shall procure and install traffic signal controllers complete with all incidental and auxiliary equipment (16 channel reno malfunction management unit (MMU), hardware and cabinet) necessary for installation and operation either as an isolated location or as part of a system of intersections. The Design-Builder shall procure and install all wiring and equipment necessary to activate the signal heads and operate the traffic signal to adhere to NDOT specifications.

All traffic controllers shall be Econolite Cobalt-C, capable of providing fully actuated operation, containing an ethernet port for communications to NDOT's network and complete with all software, firmware, and cabinet connections to allow the signal to operate on the existing NDOT communications system.

All traffic controllers shall be completely wired and configured as follows:

- A NDOT standard eight phase cabinet
- An eight-phase controller with flash memory / ethernet ports
- Signal monitor with download cable
- Eight load switches
- Eight flash transfer relays
- Radar detection unit with detectors for four approaches
- Flasher and any other equipment necessary to make an operational traffic signal based on the Design Documents
- Closed loop side panel
- Emergency vehicle preemption unit for approved approaches.

All equipment shall meet all national electrical manufacturer association standards.

4.2.1.3 RADAR DETECTION

Radar detection shall be Wavetronix Smartsensor Matrix. The Design-Builder shall procure and install all equipment necessary for radar detection in the traffic signal cabinet. Radar detection system shall include a system interface card to support ethernet communications to all processor units. The Design-Builder shall include all wiring and any control equipment necessary for a fully operational radar detection system.

4.2.1.4 SIGNAL TIMING

The Design-Builder shall contact NDOT a minimum of thirty (30) days prior to activation of any signal to obtain the initial signal timings. NDOT will institute the signal timing, including coordination and time-base programming, in the traffic signal controller.

4.2.1.5 ELECTRICAL SERVICE

The Design-Builder shall obtain any electrical permits required by NDOT and/or power service provider prior to beginning its related construction Work.

The Design-Builder shall install a 50-amp, 2-pole weatherproof external disconnect on pole with service connection. Enclosure shall be metallic with 50-amp, single-pole circuit breaker, or as required by the utility owner providing service.

4.2.1.6 PEDESTRIAN PUSH BUTTONS

No splicing of pushbutton control wires shall be permitted.

If more than one APS unit is installed on one corner of an intersection, the Design-Builder shall separate the units by a minimum of 10 feet. The Design-Builder shall provide a minimum of 5 feet of separation between multiple APS units installed in a median or on an island. If it is not feasible to provide the required spacing, all accessibility features required by MUTCD Section 4E.10-03 must be provided and configured.

4.2.1.7 WIRING

The Design-Builder shall label all cables in the traffic signal cabinet. The Design-Builder shall identify each wire by a circular plastic tag that is 1-inch in diameter with pre-printed lettering. Wiring shall be 14 gauge or larger per NDOT specifications. All cables shall be continuous runs with no splice points allowed, unless prior approved by NDOT.

4.2.2 Lighting

The Design-Builder shall prepare and submit lighting Plans and construct Project lighting as follows

- PIN 125526.09: lighting luminaires shall be attached to proposed signal poles at the following intersections
 - Midblock crossing near E. Palestine Avenue
 - Webster Street
 - Harrington Avenue
 - Woodruff Street
 - Maple Street
 - Midblock crossing near Duling Avenue
- PIN 132524.00: lighting luminaires shall be installed throughout the Liberty to Northside Project Limits
 - From Liberty Lane to N. Walmart Drive

The Design-Builder shall submit its lighting Plans and related calculations as part of its Definitive Design Plans for Department Review and Comment, which shall be advanced prior to procuring any lighting equipment. The Design-Builder's lighting Plans and calculations shall include design files using AGI32 software and layout sheets, which illustrate that photometric target values are met for roadway, intersection, crosswalk, and sidewalk average illuminance and uniformity ratios.

All lighting shall be 3,000 K Correlated Color Temperature (CCT) LED lighting.

The Design-Builder shall procure and install only lighting fixtures and poles from the approved list of NES approved fixtures and approved poles detailed in Nashville Electric Service – Lighting Guidelines.

The Design-Builder shall not allow light pollution/light hindrance into residential areas during the construction Work. The maximum distance between offset or mast arm light poles shall not exceed 250 feet.

The Design-Builder shall conceal all wiring underground in minimum 2-inch schedule 40 PVC rigid conduit. The Design-Builder shall install a minimum depth of 26 inches as measured from finished subgrade.

5 STRUCTURES

If the Design-Builder elects to use a retaining wall, the Design-Builder shall design and construct each wall in accordance with TDOT Standard Drawings and TDOT Standard Specification, including Special Provision 624 (Retaining Walls).

6 GEOTECHNICAL ENGINEERING

The Design-Builder shall perform a design-level geotechnical investigation and engineering to validate its Design Documents related to earthwork slopes, retaining walls [if used], and signal pole and lighting foundations.

6.1 Geotechnical Investigations

The Design-Builder shall perform all geotechnical subsurface investigations and laboratory testing in accordance with the current TDOT *Geotechnical Guidelines*. In submitting a Proposal, the Design-Builder acknowledges that it has scoped and priced the appropriate amount and level of the geotechnical investigations and engineering to cover geotechnical risks associated with this Project, including taking on all cost and time risk if any differing site conditions are encountered.

- All borings shall be deep enough to show a complete soil and rock profile to the depth of the foundation supporting layer.
- The Design-Builder shall perform a slope analysis for all proposed slopes.

The Design-Builder is solely responsible for undercutting and disposal of unsuitable soils and replacement with suitable material at no additional cost or time to the Department. The need for undercutting shall be determined by the TDOT Resident Engineer.

The Design-Builder shall provide traffic control for all drilling activities occurring within the Department's ROW, including lane closures and shoulder closures.

6.2 Geotechnical Reports

The Design-Builder shall provide geotechnical reports and design and construction summaries that contain pertinent subsurface investigations, tests, and engineering evaluations.

Prior to any geotechnical design submittal, as outlined in the TDOT *Geotechnical Guidelines*, the foundation design recommendation reports shall be sealed and signed by a Professional Engineer registered in the State of Tennessee who has completed a minimum of three geotechnical design projects of the scope and complexity similar to that anticipated for this Project.

7 RIGHT-OF-WAY (ROW)

The Department will acquire and provide for the Design-BUILDER's use (at the Department's costs) the right-of-way (ROW) and TCEs needed to construct the Project as depicted on the ROW Exhibits (the "Planned ROW Limits").

The Department's responsibilities include performing all ROW acquisition activities, including advancing the ROW design (as depicted on the Base Technical Concepts) and completing all title reports and related ROW documentation, appraisals, appraisal reviews, and acquisitions in accordance with Tennessee Uniform Relocation Assistance Act of 1972 and the Uniform Relocation and Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646, as amended by Public Law 100-17).

Tables 1 and 2 list the ROW and availability dates that the Department will acquire for the Project, including TCEs that may be used to construct the Project.

Table 1: ROW Acquisition for PIN 125526.09

TRACT NO.	PROPERTY OWNER	FEE SIMPLE AREA TO BE ACQUIRED (SQ. FT.)	TEMPORARY CONST. ESMT (TCE) (SQ. FT.)	AVAILABILITY DATE (on or before)
4	Wildflower Properties, LLC a Delaware limited liability company	45	251	March 31, 2027
5	Borchert Properties, Inc., a Florida Corporation	80	598	March 31, 2027
6	Saint Joseph Catholic Church	309	1058	March 31, 2027
7	Farad Davachi and Mehrnoosh Davachi	57	228	March 31, 2027
8	WNR5 – Madison, LLC, a Tennessee Limited Liability Company	33	353	March 31, 2027
12	Lisa D. Harris, James Robert Rippeteau, Trustee of the James Robert Rippeteau Trust and Jacqueline Marie Poe Conner	89	550	March 31, 2027
14	Lisa D. Harris, James Robert Rippeteau, Trustee of the James Robert Rippeteau Trust and Jacqueline Marie Poe Conner	13	313	March 31, 2027
15	James Sawyer Watts	0	1045	March 31, 2027
17	1130 Gallatin Pike, LLC	0	1421	March 31, 2027
19	Synced Properties, LLC	406	847	March 31, 2027
20	Reality Income Corporation	70	165	March 31, 2027
26	Jonathan D. Runion & Randall Volland	0	895	March 31, 2027
30	McDonald's Corporation, a Delaware corporation	0	862	March 31, 2027
34	Tennessee Quick Cash, Inc.	76	219	March 31, 2027
36	Tennessee Operations, LLC, a Florida limited liability company and the Estate of Adel Gayed	0	502	March 31, 2027
38	Mid Madison Marketplace, LLC	161	185	March 31, 2027
39	721 Madison Square, LLC, a Texas limited liability company	424	0.323 AC.	March 31, 2027
40	Salah Girgis	0	994	March 31, 2027
42	7-Eleven, Inc., a Texas corporation	21	274	March 31, 2027
51	Starr Frierson	122	835	March 31, 2027

TRACT NO.	PROPERTY OWNER	FEE SIMPLE AREA TO BE ACQUIRED (SQ. FT.)	TEMPORARY CONST. ESMT (TCE) (SQ. FT.)	AVAILABILITY DATE (on or before)
52	Metropolitan Government of Nashville and Davidson County, Tenn. for the use and benefit of the Board of Education	0	578	March 31, 2027
53	Pate Sisters Properties	173	345	March 31, 2027
60	Walid M. Anki and Hanna M. Anki	0	364	March 31, 2027
63	Truitt Clayton Ellis, as Trustee of the TCE 2025 Exempt Irrevocable Trust under Agreement dated February 21, 2025	0	192	March 31, 2027
73	Salah Ayoub Girgis	125	229	March 31, 2027
75	Juan A. Cruz and wife, Maria A. Pena Martinez	0	718	March 31, 2027
76	BFS Retail & Commercial Operations, LLC, a Delaware limited liability company	0	550	March 31, 2027
80	Ellen Rebecca Ramsay	0	0	March 31, 2027
85	Elite Globe Home and Trade LLC, a Tennessee limited liability company	0	569	March 31, 2027
86	Kroger Limited Partnership I, an Ohio limited partnership	0	468	March 31, 2027
87	Hill Center Five Points-Madison, LLC	0	386	March 31, 2027
90	David Kim and Sun Y. Kim	0	473	March 31, 2027
94	Urban Gate Properties, LLC, a Tennessee limited liability company	0	141	March 31, 2027
95	Henry B. Ellis & Flory Daugherty Ellis, Co-Trustees, Ellis Davidson County Property Trust	0	778	March 31, 2027
96	Madison Church of Christ, a Tennessee not for profit corporation	165	574	March 31, 2027

Table 2: ROW Acquisition for PIN 132524.00

TRACT NO.	PROPERTY OWNER	FEE SIMPLE AREA TO BE ACQUIRED (SQ. FT.)	TEMPORARY CONST. ESMT (TCE) (SQ. FT.)	AVAILABILITY DATE (on or before)
3	127 AMM LLC, a Florida limited liability company	0	777	March 31, 2027
6	Jerries Salim Husari, Salim Husari and Phillip Husari, as tenants in common	0	388	March 31, 2027
7	Silverman Properties, LP, a Tennessee limited partnership	0	216	March 31, 2027
9	Bank of the Ozarks, an Arkansas state bank	0	219	March 31, 2027
15	Lois Madison LLC, a Delaware limited liability company	0	865	March 31, 2027

If the actual acquisition date extends beyond the anticipated date, the Department will review the Design-Builder's time impact analysis for impacts to the Critical Path that may justify additional Contract Time. If warranted, additional time will be granted to extend the Contract Completion Date, but this extension will be non-compensable.

Additionally, the Design-Builder may rely on the Planned ROW Limits in the ROW Exhibit to construct the Project. If the Design-Builder identifies in its Definitive Design Plans that additional ROW is required to fully adhere to the design and construction requirements detailed in Section 3, the Design-Builder may request a Change Order for the Department to acquire additional ROW. If warranted, additional time will be granted to extend the Contract Completion Date, but this extension will be non-compensable. A Change Order will not be granted for the circumstances detailed in Section 7.2 or if the Design-Builder identifies the need for additional ROW after submittal of its initial Definitive Design Plan submittal.

In either instance, the Design-Builder shall work with the Department to re-sequence its CPM Schedule to reduce potential schedule delays associated with the additional ROW acquisition to the extent practicable.

7.1 ROW Limitations

7.1.1 Access and Use

Physical construction shall not commence on any phase, segment, individual properties, or a group of properties until the Design-Builder receives a notice to proceed for construction Work from the Department on each phase, segment, individual properties, or a group of properties. The decision to advance a ROW segment to the construction stage shall not impair safety with respect to unacquired or occupied properties on the same or adjacent segments of ROW.

The Design-Builder shall provide adequate access to all occupied properties to ensure emergency and personal vehicle access. Utility service must be available to all occupied properties at all times. Open burning should not occur within 1,000 feet of an occupied dwelling.

The Design-Builder shall maintain a sufficient buffer or hold off zone around parcels that have not been acquired and/or around occupied properties to ensure compliance with ROW procedures prior to starting any construction-related Work in the affected areas. There should be no construction-related Work within the hold-off zone until the property is acquired and/or vacated. The Department will provide written notification before the Design-Builder can enter the hold-off zone.

7.1.2 Temporary Interest (including Temporary Construction Easements)

The Department does not anticipate the need for any temporary construction easements beyond what is listed in Tables 1 and 2 to complete the Project. The Design-Builder, at its sole cost and time in accordance with Section 7.2, shall be responsible for acquisition of any additional temporary locations or other temporary interests in property which the Design-Builder determines are necessary, desirable, or advisable to complete the Project. Such temporary interests may include rights for temporary Project-specific activities, such as construction work sites, temporary work areas, lay down areas, staging areas, storage areas, stockpiling areas, earth work material borrow sites, equipment parking areas, as well as any property needed for any temporary utility facilities being constructed by the Design-Builder.

As identified (either as part of the Planned ROW Limits or acquired in accordance with Section 7.2), the Design-Builder shall only use a temporary location, interest, or listed TCE for associated Work activities, access to properties, or other facilities. No permanent Project infrastructure, which will be owned and maintained by the Department or any others, shall be located within a temporary location or interest, including within the TCEs listed in Table 1 and 2.

7.2 Design-Builder's Additional ROW

If the Design-Builder's Design Documents require additional ROW or easements (temporary or permanent) beyond the Planned ROW Limits for the Design-Builder convenience, specific construction means and

methods, or due to any errors, omissions, or negligence of the Design-Builder in performing the Work required by this Contract, the Design-Builder shall:

1. Obtain a concurring opinion from the Department as to the necessity for said additional ROW.
2. Be responsible for performing all of the required environmental studies, reports, and public involvement activities to comply with the NEPA requirements and obtain any required governmental approvals, including environmental approvals.
3. Be responsible for coordinating with all adverse impacts to utility owners caused by Design-Builder's proposed additional ROW.
 - a. Any utility rights acquired will require a replacement of rights. Design-Builder shall be responsible for acquiring any replacement utility property interests at the Design-Builder's sole cost and time.
 - b. All proposed utility easements must be agreed to and be acceptable to the receiving utility owner and be limited in replacing existing rights held by the utility owner.
 - c. The Department's assigned utility coordinator shall be included in all negotiations for replacing existing utility rights.
4. Bear all cost and time associated with the associated design and ROW change, including the costs and time of relocating displaced businesses or residents and the costs and time to secure a ROW certification from the Department for each additional property.
5. Provide mapping for additional ROW that includes proper survey location information. Obtain concurrence from the Department on the ROW plans and associated legal descriptions.
6. Comply with the Department's ROW standards, in addition to any other applicable governmental approval and governmental law.

If requesting additional property, the Design Documents (showing the approved priority and phasing) shall be submitted to the Department, and the ROW boundaries shall be surveyed and staked prior to the Design-Builder and Department proceeding with the ROW process. The Department is not liable for acquisition delays resulting from incomplete Design Documents or acquisition of any parcels not shown on the Base Technical Concept.

Once the Final Definitive Design Plans (Final DD Plans) are accepted, the Design-Builder shall account for the following durations (up to 20 months) in its CPM Schedule to complete the ROW acquisition process for each impacted tract. The Design-Builder shall account for the various ROW NTPs detailed in Section 6.1 of the DB Standard Guidance before proceeding to the related steps in the process.

Table 3: ROW Acquisition Timelines

Activity	Estimated Timeframe	Responsible Party
Prepare ROW estimate (in parallel with the utility estimate)	5 weeks	Design-Builder
Prepare the Preliminary Group Inspection (PGI) Report	10 weeks	Department
Stake the ROW and perform appraisals (including time for TDOT's appraisal reviews)	5 months	Design-Builder
Make offers to landowners	3 months	Design-Builder
Gain right-of-entry/possession (including time for condemnation if needed)	Up to 9 Months	Design-Builder/Department (Department will lead condemnation efforts as encountered)

8 UTILITIES

The Project is not a Chapter 86 eligible project.

8.1 Utility Coordination Responsibilities

8.1.1 Department Responsibilities for Move Prior Utilities or Protect-in-Place Utilities

The Department has identified the following utilities (as listed in Tables 4 and 5) within each of the Project Limits and has evaluated potential impacts from the Base Technical Concept as either a “move prior” utility or a utility that can be protected-in-place or has no conflict. More information for each utility is provided on the Department’s Utility Impact Matrix.

Table 4: Move Prior or Protect-in-Place/No Conflict Utility Information for PIN 125526.09

Utility Owner	Utility Type and Location	Location Reference (see Utility Impact Matrix)	Base Technical Concept Disposition	Anticipated Relocation/ Adjustment Date
COMCAST (Cable)	Underground Communications Line	1+96.65 LT 54+81.93 LT 76+80.23 LT 87+43 - 92+12 LT 98+21 - 99+80 LT	Minor line adjustments, protect-in-place	March 31, 2027
Nashville Electric Service (Overhead & Underground Electric)	Underground Electric Lines And Power Poles	1+96.56 LT 2+76.95 RT 31+15.55 RT 32+67.26 RT 32+73.29 RT 32+75.41 LT 33+66.13 LT 33+63.14 RT 33+61.95 RT 39+72.37 RT 41+44.91 RT 41+54.38 RT 43+09 LT 43+77.07 LT 43+87.59 RT 44+42.42 LT 44+50.57 LT 49+43.03 LT 50+26.5 LT 54+25.8 LT 55+17.13 LT 61+04.17 LT 60+83.8 RT 59+81 LT 76+90.87 RT 81+31.54 RT 81+44.08 LT 82+04.72 LT 88+71.48 RT 87+24.89 RT 91+88 RT 93+63.33 RT 88+15.08 LT 98+40.75 LT	Move prior (raise overhead lines at identified locations, guy wire relocation)	March 31, 2027

Utility Owner	Utility Type and Location	Location Reference (see Utility Impact Matrix)	Base Technical Concept Disposition	Anticipated Relocation/ Adjustment Date
Spire (Formerly Piedmont Gas (Gas))	Underground Gas Lines and valves	1+65.35 - 100+08.00 LT/RT	Move prior	March 31, 2027
AT&T Fiber Optic Cable (Fiber Optic)	Underground Fiber Optic Line	41+40.50 - 43+66.5 LT 54+15 - 57+00 LT 59+83.55 - 61+10 LT 59+83.55 - 61+10 LT 96+30 - 100+15 LT	No conflict	N/A
Google Network (Fiber Optic)	Underground Fiber Optic Line	Outside the Project Limits	No conflict	N/A

Table 5: Move Prior or Protect-in-Place/No Conflict Utility Information for PIN 132524.00

Utility Owner	Utility Type and Location	Location Reference	Base Technical Concept Disposition	Anticipated Relocation/ Adjustment Date
COMCAST XFINITY (Cable)	Communications Pedestal	110+67 RT 110+64.75 - 118+48.50 RT	Protect-in-place	N/A
Nashville Electric Service (Electric)	Underground Electric Lines And Power Poles	107+56 RT 109+03.25 LT 109+74.75 RT 110+67 RT 111+30.75 LT 113+52.25 RT 117+44.75 RT 119+41.25 RT	Protect-in-place	March 31, 2027
Madison Suburban Utility (Water)	Water Facility / Fire Hydrant	119+79.37 RT	Avoid	N/A
Metro Water & Sewer Service (Sanitary Sewer)	Underground Sewer Line and Manholes	109+53.50 LT 111+11.25 RT	Protect-in-place	N/A

While it is anticipated that construction Work will be required around the utilities being protected in place (as listed in Tables 4 and 5), the Department will coordinate relocation efforts for the move prior utilities before the Design-Builder's construction Work begins (the "Advanced Utility Adjustments"). The Department's responsibilities include submitting utility coordination plans and receiving, reviewing, and approving responses, reimbursement agreements, easement agreements (if needed), and authorizing the utility owner to proceed with the Advanced Utility Adjustments.

The Design-Builder's Design Documents shall accommodate the Advanced Utility Adjustments. Any subsequent relocation, adjustments, removal, or alteration of the Advanced Utility Adjustments or alteration of a protect-in-place disposition listed in Tables 4 and 5, as required by the Design-Builder's Design Documents or its construction Work, shall be considered a change in design and the responsibility of the Design-Builder in accordance with Section 8.3.

The Design-Builder shall coordinate its construction Work considering the Advanced Utility Adjustments, limiting its construction of temporary or permanent improvements in or around the adjustment areas, not prevent the utilities from accessing the respective Project Limits to complete the utility owner's work, or otherwise not occupy the areas a utility owner is working in until after the relocation dates listed in Tables 4 and 5.

If the actual relocation/adjustment date extends beyond the anticipated relocation date, the Department will review the Design-Builder's time impact analysis for impacts to the Critical Path that may justify additional Contract Time. The Design-Builder shall work with the Department to re-sequence its CPM Schedule to reduce potential schedule delays associated with the additional utility adjustment to the extent practicable. If warranted, additional time will be granted to extend the Contract Completion date, but this extension will be non-compensable.

8.1.2 Design-Builder Responsibilities for Move-In-State Utilities

Through the early utility notification process and the Department's initial survey efforts, the Department has identified the following "move-in-state" (MIS) utilities within each of the Project Limits as listed in Table 6 and Table 7. More information for each utility is provided on the Department's Utility Impact Matrix.

Table 6: MIS Utility Information for PIN 125526.09

Utility Owner	Utility Type and Location	Location Reference	Notes
AT&T (Telephone & Fiber Optic)	Overhead Communications and Fiber Optic Line	50+21 - 50+75 LT 50+26.5 LT 49+64.52 52 LT 41+40.50 - 43+66.5 LT 54+15 - 57+00 LT 59+83.55 - 61+10 LT 59+83.55 - 61+10 LT 76+80.23 - 76+96.23 LT 96+30 - 100+15 LT	
COMCAST (Cable)	Underground Communications Line	TBD	
Metro Water & Sewer Service (Sanitary Sewer)	Underground Water and Sewer Lines	2+57.90 - 3+43.00 LT 87+77 - 92+12 LT 104+60 - 104+71 LT/RT	
	Sewer Manhole	2+57.90 - 3+43.00 LT 87+17 LT 88+40 LT 104+60 RT 104+71 LT	
Madison Suburban Utility (Water)	Underground Water Line	TBD	
Nashville Electric Service (Overhead & Underground Electric)	Underground Electric Lines And Power Poles	1+96.56 LT 31+15.55 RT 32+73.29 RT 32+75.41 LT 33+66.13 LT	
XO Communications Verizon (Fiber Optic)	Underground Fiber Optic Line	86+73 - 88+13 LT	

Table 7: MIS Utility Information for PIN 132524.00

Utility Owner	Utility Type and Location	Location Reference	Notes
Nashville Electric Service (Electric)	Underground Electric Lines And Power Poles	111+30.75 LT	Light pole to be removed
AT&T Fiber Optic Cable (Fiber Optic)	Underground Copper Line	106+00 - 110+75 RT	
XO Communications Verizon (Fiber Optic)	Underground Fiber Line	107+27 - 109+51.52 LT	

After acceptance of the final Definitive Design Plans (Final DD Plans), the Design-Builder shall lead coordination efforts for all MIS utilities (as listed in Table 6 and 7) or any other utility not identified in accordance with Section 8.2.2. This includes the Design-Builder:

- Preparing the Utility Coordination Plans (based on the Final DD Plans) and associated correspondence to send to the impacted utility owners. The Design-Builder's responsibilities during this time may include leading a kickoff meeting with the utility owners to communicate forthcoming work efforts and utility requirements.
- Overseeing the utility coordination timeline required under TCA 54-5-854, which states:
 - The utility owner is to respond within one hundred and twenty (120) calendar days of receiving the Definitive Design Plans (A-date). A utility owner's response will include the "A-Date Package," which includes color coded relocation plans (rainbows), a schedule of calendar days, and an estimate of cost in order to generate the Utility Relocation Agreement. The "A-date" may be extended an additional forty-five (45) calendar days upon request of the utility owner and approval by TDOT, meaning that the CPM Schedule shall account for a total duration of one hundred and sixty-five (165) days for this step in the utility coordination process.
 - The Design-Builder's responsibilities during this time may include leading a kickoff meeting and deconfliction meeting(s) with the impacted MIS utility owners.
 - The Department will be responsible for the following during this timeline:
 - Reviewing and approving any engineering packages/contracts requested by the MIS utility owner to complete its relocation design work.
 - Reviewing any other utility consultant documentation, including any established MOUs, certification of consultant, proposed scopes of work, and estimate of costs.
- Receiving and reviewing the A-Date Packages in coordination with the Department's Environmental and Utilities divisions.
- Receiving and reviewing the B-Date Packages for the MIS utility relocations, as agreed to by the parties.
 - MIS utility relocation work is only to be accomplished if a MIS contract is executed by both the Department and the utility owner.

- MIS contracts will require that the utility owner provide the detailed construction plans, construction specifications, and quantities, collectively known as the “B-Date Package” in the Utility Agreement, no later than thirty (30) calendar days after the utility receives the fully executed contract back from the Department.
- In the event the Design-Builder designs and/or performs any utility relocation work as part of an MIS relocation, the Design-Builder shall complete any necessary Environmental Document reevaluation and obtain all applicable permits (including necessary environmental permits) to complete the work.
- The Department will revise the Contract Documents (for added cost only) to include any MIS work per Standard Specification 109.04.
- Certifying that in a written statement to the Department that the proposed relocation of utilities will not conflict with the proposed highway improvement or with another utility’s relocation plan.
- Supporting the Department in generating the relocation contracts and “put to work” letters with the impacted utility owners.
- After construction NTP, authorizing the utilities to begin work and continuing coordination efforts and record keeping (as detailed in Section 6.3 of the DB Standard Guidance) during the construction Work.
- Locate all final utility locations on the As-built Plans as described in the DB Standard Guidance.

8.1.3 Utility Coordination Timelines

Once the Final Definitive Design Plans (Final DD Plans) are accepted, the Design-Builder shall account for the following sequential durations in its CPM Schedule to complete the utility coordination process for each MIS impacted utility (or any other utility that was not previously identified or listed in the tables above).

Table 8: Utility Timelines

Activity	Estimated Timeframe	Responsible Party
Develop and distribute utility coordination plans	2 weeks	Design-Builder
Utility review (utility owner to prepare A-Date package)	165 calendar days	Utility Owner
Submit rainbows (from the A-Date Package) to the Department utilities and environmental division	2 weeks	Design-Builder
Generate and execute relocation contracts	6 weeks	Department
Send “put to work” letters	3 weeks	Department
Receive B-Date Package(s) (if an MIS) and/or complete the relocation/adjustment work	Timing to be coordinated with the utility owner based on the A-Date Package and/or B-Date Package (for MIS work)	Utility Owner

8.2 Design and Construction Requirements

8.2.1 Utility Survey

As part of its initial field survey Work, the Design-Builder shall locate all utilities in each of the Project Limits and shall include the survey data in the Definitive Design Plans. Additionally, the Design-Builder shall develop its Design Documents and its Utility Conflict Matrix (see requirements in Section 8.2.2 below) to include all required utility information as listed in Section 6.2.2 of the DB Standard Guidance. The Design-

Builder shall determine the exact locations of each utility in the field by contacting the utility owners involved. Notification by calling the Tennessee One Call System (as required by TCA 65-31-106) is required, in addition to the Design-Builder monitoring each utility owner's responses to its locate requests per TCA 65-31-118. The Design-Builder shall submit a property packet used to establish the existing ROW, One-Call tickets for utility location, and any other pertinent information via email or file share to the Department.

8.2.2 Utility Due Diligence

Additionally, the Department has provided certain utility information in the Reference Documents (see the Department's Utility Impact Matrix) and this Section 8. The Design-Builder shall analyze the utility information, contact and make inquiries of utility owners, perform surface inspections and field survey of the Project's ROW (see Section 8.2.1 above), and perform such additional inspections (including potholing) as it deems appropriate to verify that the information provided by the Department fully and accurately identifies all utilities within each of the Project Limits, addresses all field conditions, and to supplement the utility information. Within ninety (90) Calendar Days from the initial NTP, the Design-Builder shall submit for Department Review and Approval the Design-Builder's Utility Conflict Matrix reflecting the existence and disposition of any and all utilities likely to be impacted by the Project (including all Department prior move and Design-Builder MIS utilities).

If any utility—located within either of the Project Limits **and** that requires actual relocation—is not identified in the utility information provided by the Department or is misidentified therein, but is timely identified by the Design-Builder on the Design-Builder's Utility Conflict Matrix within the first ninety (90) days, then the Design-Builder may be entitled to a Change Order for performing Work directly attributable to such lacking or inaccurate information. The Design-Builder shall work with the Department to re-sequence its CPM Schedule to reduce potential schedule delays associated with the additional utility adjustment to the extent practicable. If warranted, additional time will be granted to extend the Contract Completion Date, but this extension will be non-compensable.

However, the Design-Builder shall not be entitled to a Change Order for any of the following:

- Increased costs of the Work attributable to unidentified or misidentified Utilities to the extent that the existence of the facility was known to the Design-Builder as of the Proposal due date or could have been inferred from a reasonable investigation or the presence of other facilities, such as buildings, meters, junction boxes, manholes or identifying markers, visible during a surface inspection of the area conducted prior to the Proposal due date;
- Increased costs of the Work attributable to unidentified or misidentified utilities where Design-Builder failed to provide timely notice in the time allowed (i.e., on its Utility Conflict Matrix submitted within 90 days of the initial NTP).
- Increased costs of the Work attributable to misidentified or unidentified utilities that can be protected in place or removed rather than physically relocated;
- The costs of Design-Builder's supplemental utility investigation performed in accordance with its due diligence of the Project Limits; or
- Delay and disruption damages.

8.2.3 General

The Design-Builder shall make all reasonable efforts to design and construct the Project to continue to avoid conflicts with utilities and minimize impacts where conflicts cannot be avoided.

The Design-Builder shall be familiar with and adhere to TDOT Rule Chapter 1680-06-01, Rules and Regulations for Accommodating Utilities within Highway Rights-of-Way; Tennessee Code Annotated, Title 54, Part 8, Relocation of Utilities (T.C.A. § 54-5-801 through § 54-5-856); 23 CFR Part 645 -- Utilities; and TDOT Policy 340-07, Utility Relocation from Public Highway Right-of-Way Under TCA § 54-5-804 (Chapter 86), *TDOT ROW Procedures Manual*, and Section 6 of the DB Standard Guidance.

The Design-Builder shall notify each individual utility owner of its intent/plan of operation in the area of the utilities. Prior to commencing any Work, the Design-Builder shall contact the utility owners and request the owners to properly locate their respective utility on the ground. This notification shall be given at least three (3) Business Days prior to commencement of operations around the utility in accordance with T.C.A. § 65-31-106. Notification by calling the Tennessee One Call System, at 1-800-351-1111 as required by T.C.A. § 65-31-106 will be required.

The Design-Builder shall provide all necessary protective measures to safeguard existing utilities from damage during construction. In the event that special equipment is required to work over and around the utilities, the Design-Builder shall be required to furnish such equipment. The Design-Builder shall include the cost of protecting utilities from damage and furnishing special equipment in the Contract Amount.

The Design-Builder shall accommodate utility adjustments, emergency construction, new installation, and routine maintenance work by others that may be underway or take place during the progress of the Contract. No additional compensation or time shall be granted for any delays, inconveniences, or damage sustained by the Design-Builder or its Subcontractors due to interference from utilities or the operation of relocating utilities.

In the event the Design-Builder performs any utility relocation work, it is the Design-Builder's responsibility to obtain all applicable property rights and applicable permits, including any environmental permits.

8.3 Design-Builder's Changes in Design

For purposes of this Section 8, a change in design is the modification of the Design-Builder's Design Documents that:

- Require a change to the disposition of a utility listed in Table 4 and 5,
- Requires adjustment of a utility that was not listed in Table 4 and 5,
- Require subsequent relocations, adjustments, removals, or alterations for any of the Advanced Utility Adjustments, or
- Necessitate acquisition of a utility easement not included in the Department-provided property.

In any of these circumstances, the Design-Builder shall bear all cost and time for the Design-Builder and Department's utility coordination and the utility owner's relocation/adjustment efforts. If the Department agrees with the Design-Builder's alterations, the Design-Builder shall complete at its cost and account for the noted utility coordination tasks and timelines (as listed in Section 8.1.2 and Section 8.1.3, respectively) in the CPM Schedule without any increase to the Contract Amount or extension to the Contract Completion Date.

9 ENVIRONMENTAL

9.1 NEPA Document

The Department has obtained and provided the NEPA Document in the Reference Documents.

9.1.1 NEPA Commitments

Expanded upon in Section 5.2.9 of DB Standard Guidance, the Design-Builder shall review and adhere to the approved NEPA Document and technical reports

9.1.2 Environmental Technical Study Area (ETSA)

The environmental technical study areas (ETSAs) for Project location are the same as Planned ROW Limits (including TCEs) shown on the ROW Exhibit. Changes to the ETSA limits or Work outside of the ETSA limits shall be governed by the requirements in this Section 9.

9.1.3 Environmental Boundaries

Should an unknown environmental feature within the ETSA be uncovered, all construction Work shall stop immediately in that area, and the Design-Builder shall contact the Department for consultation.

For impacts to any streams, springs, wetlands, sinkholes, or other water resource features not previously documented, the Design-Builder shall provide the data sheets and forms listed below to the Department for Review and Comment prior to submittal to the applicable regulatory agencies.

Streams

- Hydrologic Determination Field Data Sheet (Version 1.4).
- Ecology Water Resources Field Data Sheet.
- Tennessee Department of Environment and Conservation (TDEC) – Division of Water Resources: Habitat Assessment Field Data Sheet – Moderate to High Gradient Stream.
- A location map, plan sheets with resources clearly marked and labeled, and a U.S. Geological Survey (USGS) Quad map showing the proposed stream(s) using Department-provided map templates.
- Photo summary of each feature including photo views of the location of the proposed alteration, upstream, downstream, and along the centerline of the Project.

Wetlands

- U.S. Army Corps of Engineers (USACE): Wetland Determination Data Form – Eastern Mountain and Piedmont Region: Version 2.0.
- TDEC – Division of Water Resources: Tennessee Rapid Assessment Methodology (TRAM) documentation for wetlands, including TRAM Decision Key, TRAM Outstanding Natural Resource Water or Exceptional Tennessee Water Decision Table, appropriate Hydrogeomorphic (HGM) field data forms (if applicable) or Non-HGM field data forms (if applicable) for the wetland type being assessed, and TRAM Quantitative Summary Table.
- A location map, plan sheets with resources clearly marked and labeled, and a USGS Quad map showing the proposed wetland(s) using Department-provided map templates.

- Photo summary of each feature including photo views of the location of the proposed alteration and wetland boundaries.

Water resource determinations shall be completed by a Tennessee Qualified Hydrologic Professional (TN-QHP). The certification for the TN-QHP must be submitted along with the Hydrologic Determination Field Data Sheet for the individual preparing the data sheets and forms. All additional environmental field studies are to be performed by the Design-Builder's personnel with the required qualifications.

9.1.4 State or Federal Endangered / Threatened Species

Based on the Pedestrian Road Safety Initiative, a field review of the Project area and a review of the TDEC Division of Natural Areas Rare Species Database, both Project PINs are covered by the 2022 Grouped Programmatic No Effect Activities Agreement between TDOT and FHWA, the 2023 Memorandum of Agreement between TDOT, FHWA, and the TDEC Division of Natural Areas, and the 2022 Memorandum of Agreement between TDOT, FHWA, and the Tennessee Wildlife Resources Agency.

If the Design-Builder requires any additional ROW (e.g., fee simple or easement) or needs to work outside the ETSA or alters the scope to require additional study not previously completed within the Project's ETSA, the Design-Builder shall be responsible for the time and cost to coordinate any additional review(s) and lead all effort to document and address any proposed changes with the appropriate environmental agency. The Design-Builder shall contact the Department prior to any coordination with the resource agencies.

The Design-Builder's coordination with resource agencies shall, at a minimum, include the following information:

- A clear description of the Project changes to be reviewed,
- Timing and schedule for implementation of the changes,
- Maps showing location of changes (if applicable),
- Plans documenting the changes,
- Description of how the changes maintain compliance with existing environmental commitments, and
- Previous coordination responses from the resource agencies.

If a NEPA re-evaluation is required (also see Section 9.1.7), the Design-Builder shall be responsible for the time and cost necessary to prepare the re-evaluation and adhere to any additional environmental commitments required by the resource agencies because of the agency review. These commitments may include preparation of species reports or biological assessments, species surveys, species sweeps and relocations, additional prohibitions on the Work during designated time periods, and any required species monitoring.

If required, the Design-Builder shall (in consultation with the Department) allow adequate time in the CPM Schedule for this agency coordination to occur.

9.1.5 Other Natural Resources

The Design-Builder shall ensure identification, survey, and monitoring of other natural resources. The Design-Builder shall work with the Department to coordinate with regulatory agencies (e.g., TDEC) as necessary and to obtain any necessary permits for modifications to the natural resources.

9.1.6 GPS/GIS Data Collection

The Design-Builder's data collection for streams, wetlands, springs, sinkholes, or other jurisdictional features shall be with mapping grade accuracy (defined as sub meter).

9.1.7 Design-Builder Required Reevaluations

If the Design-Builder's design footprint or construction limits extend beyond the ETSA, including for use of permanent and/or temporary interests, or alters the scope to require additional study not previously completed within the Project's ETSA, either of which results in changes to impacts of identified resources, the Design-Builder shall bear all cost and time associated with the:

- Design-Builder's preparation of revised environmental technical studies and the NEPA Document re-evaluation(s),
- Department's Review and Approval of the NEPA Document re-evaluation(s), and
- All agency coordination, as required, of the NEPA Document re-evaluation(s).

Additionally, if the Design-Builder's changes result in changes to impacts of the environmental features, the Design-Builder shall bear all cost and time to incorporate additional compensatory mitigation documented in the updated EBR or for additional features identified prior to and during construction Work.

The Design-Builder shall provide the Department with a notification and copy of the revised Plans.

9.2 Mitigation of Streams and Wetlands

The Base Technical Concept does not impact any streams or wetlands and therefore does not require any stream or wetland mitigation.

If the Design-Builder's design alters this mitigation determination, then the Design-Builder shall bear all cost and time required to:

- Modify the Project's environmental water quality permits
- Design and construct stream/wetland mitigation or purchase necessary stream/wetland credits to address the additional impacts to the permittable features.

9.3 Environmental Water Quality and Construction Permits

While there are no water quality permits anticipated on this Project based on the Base Technical Concept, the Design-Builder is still responsible, under federal and state environmental laws and regulations, to avoid and minimize, to the maximum extent practicable, impacts to Waters of the State and/or Waters of the U.S. when designing and constructing the Project. As applicable, the Design-Builder assumes all responsibility as the Authorized Agent of the Department (Permittee) as indicated in the permit that relates to protection of the "Waters of the United States" and/or "Waters of the State of Tennessee" pursuant to the regulatory permits listed in Section 5.2.10 of the DB Standard Guidance.

The Design-Builder is responsible for obtaining all necessary water quality permits and a TDEC National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) to construct the Project.

For all other permits, the Design-Builder shall be responsible for and obtain the necessary state and federal environmental permits and approvals resulting from its design and construction Work. If environmental permits are necessary, prior to completion of the Definitive Design Plans, the Design-Builder shall contact the Department for guidance.

9.3.1 Design and Construction Requirements

9.3.1.1 PERMITTING FOR DESIGN-BUILDER'S TEMPORARY INTEREST

The Design-Builder shall bear all cost and time for complying with and obtaining any necessary building, demolition, grading, and environmental and regulatory permits or approvals, including archaeology, ecology, historical, hazardous materials, air quality and noise, TVA 26a, TDEC, and USACE permits from federal, state, and/or local agencies regarding any Design-Builder temporary interest, including material and staging areas, storage areas, excess excavated materials disposal areas, and the operation of any Project-dedicated asphalt, concrete plants, and waste or borrow sites that will be used. These areas are to be addressed in accordance with the *TDOT Waste and Borrow Manual*. Design-Builder shall submit all such permits to the Department prior to the commencement of activities in the permitted area(s).

The Department shall be included in all correspondence and/or negotiations with agencies.

The Design-Builder shall be aware that environmental permits may also be required when activities such as core sampling, seismic exploratory operations, geotechnical investigations, ROW fence replacement, utility relocations, and historic resources surveys are within Waters of the State or Waters of the U.S. These permits may also be required for placement and operations of scientific measurement devices.

9.3.1.2 EROSION PREVENTION AND SEDIMENT CONTROL (EPSC)

The Design-Builder shall be responsible for all Erosion Prevention and Sediment Control (EPSC) designs and implementation. The Design-Builder shall place all permanent stabilization at locations to prevent damage to adjacent facilities and property due to erosion on all newly graded cut and fill slopes that have permanently ceased.

- Pre-construction vegetative ground cover shall not be destroyed, removed, or disturbed (i.e., clearing and grubbing initiated) more than 14 calendar days prior to grading or earth moving activities, unless the area is mulched, seeded with mulch, or other temporary cover is applied.
- Clearing, grubbing, and other disturbances to riparian vegetation shall be limited to the minimum necessary for slope construction and equipment operations. Existing vegetation, including stream and wetland buffers (unless permitted), should be preserved to the maximum extent possible.
- Unnecessary vegetation removal is prohibited.

Design-Builder shall initiate temporary stabilization within 14 calendar days when construction activities on a portion of the site are temporarily ceased, and earth disturbing activities shall not resume until after 14 calendar days. Permanent stabilization measures in disturbed areas shall be initiated within 14 calendar days after final grading of any phase of construction.

Steep slopes shall be temporarily stabilized no later than seven calendar days after construction activity on the slope has temporarily or permanently ceased. For this Project, steep slopes shall be defined as natural or created slopes of greater than 3H:1V, regardless of height.

Permanent stabilization shall replace temporary measures as soon as practicable. Priority shall be given to finishing operations and permanent EPSC measures over temporary EPSC measures.

The Design-Builder shall perform inspection, repair, and maintenance of EPSC structures on a regular basis and remove sediment from sediment control structures when the design capacity has been reduced by fifty percent (50%). During sediment removal, the Design-Builder shall take care to ensure that structural components of EPSC structures are not damaged and thus made ineffective. If damage does occur, the Design-Builder shall repair the structures at their own expense.

EPSC controls shall be inspected according to permit requirements to verify measures have been installed and maintained in accordance with TDOT standard drawings, specifications, and good engineering practices. EPSC inspections shall be documented on the TDOT EPSC inspection report, and Design-Builder shall provide a copy of each inspection report to the Department.

The Design-Builder shall place and treat sediment removed from sediment control structures in a manner so that the sediment is contained within each of the Project Limits and does not migrate onto adjacent properties or into Waters of the State/United States.

The Design-Builder shall establish and maintain a comprehensive and proactive method to inspect and prevent the off-site migration or deposit of sediment off either of the Project Limits (i.e., ROW, easements, etc.), into Waters of the State/United States, or onto roadways used by the general public. If sediment escapes the construction site, off-site accumulations of sediment that have not reached a stream must be removed at a frequency sufficient to minimize off-site impacts (e.g., fugitive sediment that has escaped the construction site and has collected in a street must be removed so that it is not subsequently washed into storm sewers and streams by the next rain and/or so that it does not pose a safety hazard to users of public streets). Arrangements concerning removal of sediment on adjoining property must be settled with the adjoining property owner before removal of sediment.

Upon conclusion of the inspections, the Design-Builder shall repair, replace, or modify EPSC measures found to be ineffective before the next rain event, if possible, but in no case more than 24 hours after the inspection or when the condition is identified. If the repair, replacement, or modification is not practical within the 24-hour timeframe, the Design-Builder shall provide written documentation in the field diary and EPSC inspection report. An estimated repair, replacement, or modification schedule shall be documented within 24-hours of identification. The Design-Builder shall bear all costs and time associated with modifications made to these measures, and all modifications shall be concurred with by the Department.

The Design-Builder may remove temporary EPSC measures at the beginning of the workday but must be replaced at the end of the workday or before/during a precipitation event. Delaying planting of cover vegetation until winter months or dry months shall be avoided.

The Design-Builder shall minimize offsite vehicle tracking of sediments and the generation of dust. The Design-Builder shall provide a stabilized construction access (a point of entrance/exit to the construction project) to reduce the tracking of mud and dirt onto public roads by construction vehicles.

The Design-Builder shall have a plan in place for dust control. The dust control plan shall be developed prior to the start of any construction activities and shall be submitted to the Department for Review and Approval.

The Design-Builder shall update the EPSC plans whenever EPSC inspections indicate, or where State or Federal officials determine EPSC measures are proving ineffective in eliminating or significantly minimizing pollutant sources or are otherwise not achieving the general objectives of controlling pollutants in storm water discharges associated with the construction activity.

The accepted EPSC plan shall require that EPSC measures be in place before clearing, grubbing, excavation, grading, culvert construction, cutting, filling, or any other earthwork occurs, except as such work may be necessary to install EPSC measures.

EPSC measures shall be installed and functional prior to any earth moving operations and shall be maintained throughout the construction period except as such work may be necessary to install EPSC measures.

The Design-Builder shall establish and maintain a proactive method to prevent litter and construction wastes from entering Waters of the State/United States. The Design-Builder shall remove these materials from

stormwater exposure prior to anticipated storm events, before being carried offsite by wind, or as otherwise needed to prevent these materials from becoming a pollutant source for stormwater discharges. After use, the Design-Builder shall remove materials used for EPSC from the site.

9.3.1.3 NPDES PERMIT REQUIREMENTS

A TDEC National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction stormwater runoff is required for this Project. The Design-Builder shall develop its EPSC sheets and the Storm Water Pollution Prevention Plan (SWPPP) to obtain the NPDES CGP for the Project.

The Design-Builder shall prepare a SWPPP, Documentation and Permits Binder, and a Notice of Intent (NOI) using the Department's template prior to submittal of the NPDES CGP to TDEC. A copy of the SWPPP template used by the Department to develop SWPPPs and the Documentation and Permits Binder can be obtained from the Department's Environmental Division, Ecology and Permits Office: [NPDES Stormwater Permitting Program \(tn.gov\)](https://www.tn.gov/environment/npdes). The Design-Builder shall use the SWPPP template as a guide in preparation of the SWPPP, and the Design-Builder is responsible for complying with all requirements of the CGP.

The SWPPP shall include the EPSC plans for application of coverage under the CGP. The Design-Builder shall submit the SWPPP and NOI at least forty-five (45) business days prior to beginning construction activities. Once a Notice of Coverage (NOC) is received by the Design-Builder, the EPSC submitting the SWPPP for coverage under the CGP shall be submitted to both TDEC and the Department for their records.

The Design-Builder shall prepare EPSC plans detailing best management practices (BMPs) to prevent erosion, control sedimentation, and prevent the discharge of any pollutants from leaving either of the Project Limits and the Department's ROW or easements, or from entering jurisdictional features or stormwater conveyances, and be transported to receiving waters during the construction of the Project. The Design-Builder shall identify all outfall locations on the EPSC plans with an appropriate numbering or lettering system.

The Design-Builder shall revise the SWPPP and the EPSC plans as necessary based on actual construction activities throughout the duration of the Project. All SWPPP and EPSC revisions shall be documented. The Design-Builder shall certify that the individual who prepared and reviewed the EPSC plans and SWPPP is currently certified according to the CGP. The Design-Builder shall also certify that the BMPs are designed so that if properly implemented, installed, and maintained, they will manage erosion and prevent sedimentation to Waters of the State/United States or on adjacent property owners, as well as comply with the terms of the TDEC NPDES CGP.

9.3.1.4 INSPECTIONS

The Design-Builder shall complete Project site inspections of the erosion control measures, disturbed areas, areas used for storage of material, construction entrance/exit, and all outfalls. Following the inspection, the Design-Builder shall prepare and maintain a report with the SWPPP. The CGP requires the inspections to be performed at least twice a week, 72 hours or more apart. The inspector must document the findings of the inspection fully in the report and provide a copy to the site operator and the Design-Builder, document that the rain gauge has been read and rainfall recorded on a daily basis or that a reference site has been used to document rainfall. The inspector shall also document that all records are being completed and maintained per the TN CGP.

The inspector shall use photo documentation to clearly convey recommendations to the site operator and the Design-Builder. All photos shall be saved to document site conditions over time to support the inspection report findings when the site is audited by TDEC or other regulators.

The Design-Builder shall maintain a rain gauge on-site that measures up to 6-inches of rainfall. The rain gauge shall be located within each of the Project Limits in an open area such that measurements will not be influenced by outside factors. The Design-Builder shall initiate rainfall monitoring prior to clearing, grubbing, excavation, grading, cutting or filling. The rain gauge shall be read and emptied after every rainfall event occurring on the Project site (at approximately the same time of day). The rainfall records shall be recorded and maintained with the SWPPP. Recorded data should include the date of the rain event, amount of rainfall and the approximate duration.

Inspectors performing the required twice weekly inspections must have:

- A valid certification from the "Fundamentals of Erosion Prevention and Sediment Control Level I" course and licensed professional engineer or landscape architect,
- Certified Professional in Erosion and Sediment Control (CPESC) certification, or
- A person who has successfully completed the "Level II Principles for Erosion Prevention and Sediment Control for Construction Sites" course.

A copy of each inspector's certificate, license, or training record shall be kept on site.

As outlined in the NPDES CGP, the Department will perform the monthly Environmental Quality Assurance Project Compliance Assessments (QA Inspections) on this Project, which will include any Design-Builder temporary interest sites (including waste and borrow areas).

9.3.1.5 NONCOMPLIANCE DETERMINATIONS

If at any time, the Design-Builder is not in compliance with any applicable permit regulations, all noncompliance items must be addressed by the Design-Builder within 24 hours of such identification. The Department has the authority to suspend Work until such time as the deficiencies have been corrected.

The Design-Builder shall not be granted any compensation or time extension for any work suspension associated with a non-compliance determination. Any monetary fees and/or fines associated with any violations shall be the sole responsibility of the Design-Builder. In the event that a Notice of Violation (NOV) is issued by a regulatory agency, the response to the NOV shall be written by the Design-Builder and approved by the TDOT Environmental Division – Environmental Engineering Office – Permits Unit prior to submittal to the agency.

9.3.2 Permit Register

The Design-Builder shall maintain a permit register and provide updates with every progress report. The permit register shall include an overview of all permits required of the Project. The permit register requires each permit to be indicated as follows:

- Name and address of the granting authority,
- Purpose of the permit,
- Reference to the document in which the permit conditions are defined,
- Status of permit,
- Date by which the authorization of the specific permit is anticipated,
- Permit conditions relevant for the Work,
- Date by which the permit is required (milestone),
- How the Design-Builder ensures that it will comply with the permit requirements and conditions, and

- Validity and the expiry date (if any) of the permit.

9.3.3 Permit Modification Due to Design-Builder Design Changes

If the Design-Builder's design substantially alters the Base Technical Concept resulting in additional or altered impacts to the environmental features in the area, the Design-Builder shall bear all cost and time to procure any environmental water quality permit(s), design and construct any required mitigation, and/or acquire any mitigation credits needed to address the impacts from the Design-Builder's design.

If permit modifications are necessary prior to completion of the Definitive Design Plans, the Design-Builder shall contact the Department for guidance and requirements.

10 CONSTRUCTION

The Design-Builder's construction Work shall meet the requirements of the TDOT Standard Specifications, supplemental specifications, the relevant Special Provisions, the *Manual on Uniform Traffic Control Devices* (MUTCD), and regulations of the Tennessee Occupational Safety and Health Administration (TOSHA).

The Design-Builder shall ensure that all applicable "General and Special Notes" found in Section VI of the current edition of the State of Tennessee Department of Transportation Design Division *Roadway Design Guidelines – PDN* are adhered to during all construction Work.

10.1 Construction Services

The Design-Builder shall supervise and administer all construction Work in accordance with the Contract requirements. The Design-Builder shall perform all other construction Work required to complete the Project in conformance with all Contract requirements. Notably, the Design-Builder shall:

- Comply with all applicable laws.
- Keep the Work location and its vicinity free from accumulation of waste materials and rubbish caused by the Design-Builder's operations.
- Repair, at its expense, any area that is disturbed outside limits of the construction Work over the duration of the Project. Note: all repaired areas shall be inspected and be deemed satisfactory by the Department.
- Coordinate its Work with that of other contractors and utility owners working on or near either of the Project Limits. Note: The Design-Builder shall consider the schedule of other contractors when developing the CPM Schedule to maintain continuity of Work and compliance with the Contract Time.

10.2 Construction Submittals

The Design-Builder shall submit Plan revisions of approved design and field changes to the Department within two weeks after approval of each change. As required in the DB Standard Guidance, all field design changes shall be incorporated into the As-Built Plans.

10.3 Acceptance of Material

All materials used on this Project shall meet the requirements set forth in the Contract Documents, Design Documents/Plans, and specifications. Materials incorporated into the Project must have certifications, test reports, and/or acceptance testing as specified in the Department's Quality Assurance Program for the Sampling and Testing of Materials and Products (SOP 1-1) ([Standard Operating Procedures](#)). The Design-Builder shall communicate what materials will be used in the Project, along with estimated quantities, in sufficient time that adequate samples and/or acceptance testing can be performed by Department representatives. The Design-Builder shall provide the Department an estimated quantities list using the Department's pay item list for each lump sum item so that the Department may determine the number(s) and type(s) of testing required.

The Design-Builder is responsible for determining all means and methods of its construction Work for the Project. However, this does not relieve the Design-Builder of the responsibility to protect the public, environment, and private property.

No partial payments, including payment for stockpile materials, shall be made before Work begins.

10.4 Maintenance During Construction

The Design-Builder shall prepare and submit (prior to starting any construction Work) a Maintenance Plan for Department Review and Approval that meets the requirements of the TDOT Standard Specifications (including Section 104.05), the DB Standard Guidance, and this Section. The Design-Builder is responsible for the maintenance of each of the Project Limits in accordance with these requirements and the approved Maintenance Plan from the date of the Notice to Proceed for the construction Work until Project completion and acceptance by the Department.

10.4.1 General Requirements

The Design-Builder shall maintain all components of the transportation system within each of the Project Limits, which shall include asphalt roadway, signing, existing signals and lighting infrastructure, and guardrail.

Prior to receiving Notice to Proceed for the construction Work, the Department and Design-Builder shall complete a preconstruction maintenance survey of the existing conditions within each of the Project Limits. For any existing areas/facilities previously in a state of disrepair or damaged prior to when the Design-Builder's maintenance responsibilities begin, the Department will coordinate with Design-Builder on the extent of the repair, timing for the repair, and potential payment for the repair as additional Work.

10.4.2 ROW Mowing and Litter Removal

As part of its Maintenance Plan, the Design-Builder shall detail its approach to general housekeeping of each of the Project Limits (e.g., mowing, litter removal, vandalization mitigation). The Design-Builder shall perform ROW mowing (minimally four mowing cycles each year) and litter and graffiti removal (minimally monthly) within each of the Project Limits to provide a consistent vegetation height and a clean, non-littered appearance.

The Design-Builder shall propose and the Department will direct the Design-Builder on the exact dates for the annual mowing cycles.

10.4.3 Acceptance of the Project

Upon completion and acceptance of the Project, the Department will assume responsibility for the operation and maintenance of the two Project Limits. Nothing contained herein shall otherwise limit any warranty obligations of the Design-Builder with respect to any defect or non-conforming Work.

10.4.4 Maintenance of Traffic

Prior to starting any Work requiring traffic control, the Design-Builder shall prepare and submit a Transportation Management Plan (TMP) for Department Review and Approval (also see Section 5.2.14 of the DB Standard Guidance for additional information). The TMP shall include related temporary traffic control (TTC) strategies and TTC Plans (inclusive of pedestrian and bicycle protection) prepared alongside the Design Documents. Traffic control design shall be in accordance with TDOT Standard Traffic Design Drawings and the MUTCD.

10.4.4.1 WORK RESTRICTIONS

The Design-Builder shall only work on a single block at a time within the Walton to Wiley section of the Project Limits. Within these Project Limits, Work at an intersection shall be limited to one corner of the intersection at a time in order to maintain pedestrian movement/access throughout construction.

Throughout both the Walton to Wiley section of the Project Limits and the Liberty to Northside section of the Project Limits, pedestrian and bicycle traffic shall be maintained in accordance with TDOT Standard Traffic Design Drawings. Traffic shall be maintained on existing travel and bicycle lanes, except in areas where closures are needed for construction. Lane closures shall be permitted, but shall be limited to single day activities and only during active work periods in accordance with SP 108B.

Lane closures shall be maintained in accordance with TDOT Standard Traffic Design Drawings. As detailed in SP 108B, the Design-Builder shall obtain the required permits from NDOT for any temporary lane closures on roadways under NDOT jurisdiction. For lane closures where an existing bicycle lane is present, a temporary 4-foot bike lane shall be provided.

The Design-Builder shall not close or prevent use of consecutive bus stops throughout both sections of the Project Limits.

10.5 Construction Signage

Access to all side roads, business entrances, and driveways shall be maintained during the construction Work unless specified elsewhere in the Contract Documents.

All construction signing shall be in strict accordance with the current edition of the MUTCD.

10.6 Disposal

All disposal activities shall be in accordance with the TDOT *Waste and Borrow Manual*.

Borrow and waste disposal areas shall be located in non-wetland areas and above the 100-year FEMA floodplain. Borrow and waste disposal areas shall not affect any Waters of the State/U.S. unless these areas are specifically covered by environmental water quality and construction permits.

10.7 Department Inspections

The Department will review and monitor the Project (Quality Assurance Inspections), including all temporary interests and waste and borrow areas, to ensure compliance with all applicable environmental regulations and stormwater management activities throughout the duration of the Project.

Should the Project have repeat non-conformance reports on QA Inspections, water quality violations, or a NOV, the Department may increase the frequency of QA inspections to two per month. The extra QA inspection will occur until the Project has been brought back into compliance for two consecutive QA inspections.

The Design-Builder will bear all cost and time associated with any work related to the additional QA inspections or non-compliance determinations, including compensating the Department for the additional QA inspections. The Design-Builder shall be solely responsible for any monetary fees and/or fines associated with any violations, as assessed by the Department or the regulatory agencies.

Attachment A

Pavement Design Report

Tennessee Department of Transportation	Flexible Pavement Design	Materials and Pavements Section
County Davidson		PIN 132524.00
Route SR-6		Design YR 2025
Description (Gallatin Pike), From Liberty Lane to north of Northside Drive		
Road Bus Lane		

Pavement Schedule

Mainline			
	Item #	Description	Depth (in)
Pavement	411-02.10	ACS MIX(PG 70-22)Grading D	1.25
	307-02.08	Asphalt Conc Mix(PG 70-22)(BPMB-HM) GR B-M2	2
	307-02.01	Asphalt Conc Mix(PG 70-22)(BPMB-HM) GR A	3
Base	303-01	Mineral Aggregate, Type A	10
Subgrade			

Note: Add Tack Coat Per Standard Specification 403.05 between each pavement layer

Note: Add Prime Coat @ 0.35 Gal/SY between base and pavement