11.0 Geotechnical and Roadway Pavements

This Section includes the requirements for the geotechnical and Roadway pavements Work for the US 160 Elmore's Corner to Dry Creek Design-Build Project (Project). This Work shall be completed in accordance with the Contract Documents.

11.1 Administrative Requirements

11.1.1. Standards

The Contractor shall design and construct the Project in accordance with the Contract, including the Project Special Provisions and Standard Special Provisions in Book 2, Section 21, requirements of the standards in the documents listed in Table 11-1 and those referenced in Book 3. The Contractor shall use the latest adopted edition at the time of the Proposal Due Date.

Table 11-1: Standards

Author or Agency	Title
American Association of State Highway and Transportation Officials (AASHTO)	AASHTOWare Pavement Mechanistic-Empirical Design Software, Version 2.3.1
AASHTO	Load and Resistance Factor Design (LRFD) Bridge Design Specifications
Colorado Department of Transportation (CDOT)	Standard Specifications for Road and Bridge Construction (Standard Specifications)
CDOT	Mechanistic-Empirical (M-E) Pavement Design Manual
CDOT	Field Materials Manual
CDOT	Bridge Design Manual
CDOT	Geotechnical Design Manual
CDOT	M&S Standard Plans
Federal Highway Administration (FHWA)	Geotechnical Engineering Circular No. 5, Geotechnical Site Characterization
FHWA	Design and Construction of Mechanically Stabilized Earth Walls and Reinforced Soil Slopes
FHWA	Soils and Foundations Reference Manual

11.2 Geotechnical Investigations

The results of geotechnical investigations performed by CDOT are provided in Book 3, Geotechnical Data Report (GDR) dated January 9, 2026, by Yeh and Associates, Inc.

Geotechnical investigations conducted in the area of the Structures and pavements are included in the GDR in Book 3. The soil and rock samples collected as part of this geotechnical engineering exploration and remaining after laboratory testing referenced in the GDR will be made available at the CDOT Durango facility:

CDOT Region 5
3803 North Main Avenue
Durango, CO 81301

The Contractor shall have 90 Days from NTP1 to take possession of these geotechnical samples. If the Contractor has not taken possession within this timeframe, CDOT will dispose of these materials. If the Contractor does take possession of these samples, the Contractor shall assume full responsibility for both storage and disposal.

The Contractor shall be responsible for supplemental subsurface investigation necessary to complete the Work, to support the proposers' design and to meet required sampling frequency and depth. When planning and conducting additional investigations, the Contractor shall refer to the referenced Book 3 geotechnical documents completed for this Project. Geotechnical investigations and analysis shall comply with the requirements of the CDOT Geotechnical Design Manual, the CDOT Field Materials Manual, the CDOT M-E Pavement Design Manual, the AASHTO LRFD Bridge Design Specifications, where applicable, Table 11-2, and any other applicable standards necessary to perform the Work.

The Contractor shall prepare a geotechnical investigation plan prior to commencing field Work. The plan shall include locations, investigation methods, anticipated depths, anticipated sampling and testing, and discussion of the criteria and rationale used to develop the proposed geotechnical investigations with respect to planned elements of the Project. The plan shall be submitted to CDOT for Review at least 4 weeks prior to commencing field Work.

If groundwater observation wells are necessary to monitor water level or water quality, it shall be the Contractor's responsibility to properly permit and abandon or renew the permits of these wells in accordance with Colorado Division of Water Resources requirements.

The Contractor shall perform geotechnical investigations to evaluate existing pavement settlement and distress in the general vicinity of MP 96.0. This investigation shall be included in the supplement geotechnical investigations report submitted to CDOT for Acceptance. This investigation shall include remediation recommendations to be included in the Design Documents to be submitted per Book 2, Section 4.

Supplemental investigations made by the Contractor shall be documented in supplemental geotechnical investigation reports of format similar to those in the referenced geotechnical documents. These supplemental investigations shall be submitted to CDOT for Acceptance within 90 Days following completion of the field Work. Supplemental investigations made by the Contractor for County or other municipal Roads shall be documented in separate supplemental geotechnical investigation reports according to the maintaining agency's requirements and shall be submitted to CDOT for Acceptance within 90 Days following completion of the field Work.

The minimum depth and frequency of geotechnical borings for subsurface explorations is provided in Table 11-2. Roadway subgrade sampling is required for all pavement areas and shall conform to the Region Soil Survey Sampling Checklist for Soil Survey of Constructed Roadbeds presented in Chapter 200 of the CDOT Field Materials Manual. The soil survey shall be completed prior to beginning construction of the pavement Subbase course.

Table 11-2: Geotechnical Boring Depth and Minimum Frequency Table

Exploration Type	Recommended Minimum Number of Borings	Minimum Boring Depth
Drilled Shaft Foundations	One per substructure unit < 100 feet width Two per substructure unit > 100 feet width	10 feet into bedrock (N ≥ 50) or 3D below tip elevation.
Driven Piles Foundations	One per substructure unit < 100 feet width Two per substructure unit > 100 feet width	10 feet into bedrock (N ≥ 50) or 20 feet below tip elevation.
Spread Footing Foundations	One per substructure unit < 100 feet width Two per substructure unit > 100 feet width	2B where L < 2B, 4B where L > 2B and interpolate for L between 2B and 4B or 10 feet into bedrock (N ≥ 50).
Concrete Box Culvert Foundations	One at each end and every 100 feet along axis	3H or 10 feet into bedrock (N ≥ 50).
Mechanically Stabilized Earth (MSE)/Cast in Place Walls	One at each end and every 200 feet along wall	2H or 10 feet into bedrock (N ≥ 50).
Soil Nail Walls	One in nail zone 1H from wall face every 200 feet along wall	2H or 10 feet into bedrock (N ≥ 50).
Pavement Settling	Determined by size and extent of distressed area.	Determined by size and extent of distressed area.
Pavement Heaving	Determined by size and extent of distressed area.	20 feet.
Pavement realignment or widening Material Soil Survey	One every 1,000 feet along centerline or determined by CDOT	Minimum of 5 feet below top of proposed pavement elevation or determined by CDOT.
Cut sections – road widening Material Soil Survey	One at each end of cut section and every 500 feet or determined by CDOT.	Minimum of 5 feet below top of proposed pavement elevation or determined by CDOT.
Embankment Fill > 5 feet Material Soil Survey	One every 500 feet with at least one at the location of the greatest height of proposed fill.	Borings shall extend at least 2 times the total height of the proposed fill below the base elevation or 5 feet into hard substratum (N > 30).

Modified from CDOT Geotechnical Design Manual, Chapter 3; CDOT M-E Pavement Design Manual, Chapter 4; CDOT Field Materials Manual, Chapter 200; and AASHTO LRFD Bridge Design Specifications, Table 10.4.2-1.
D = Diameter B = Footing Width H = Wall Height L = Footing Length N = Blow count values in 12 inches

11.3 Design Requirements

11.3.1. Submittals

All submittals shall be prepared, reviewed, and submitted in accordance with the requirements set forth in Book 2, Section 4.

11.3.2. Sulfate Resistant Concrete

Concrete for Structures and pavements shall be designed for Class 2 Severity of Sulfate Exposure unless field sampling and laboratory testing indicates a greater sulfate resistance is required.

11.3.3. Structure Foundation Analysis and Design

Structure foundation analysis and design shall follow the requirements provided in Book 2, Section 16. Subsurface conditions at major Structures identified in Book 2, Section 16 have been investigated by

CDOT and are documented in the GDR in Book 3. Foundation designs for sign Structures, and other minor Structures may require supplemental geotechnical investigations. Performance and reporting of supplemental geotechnical investigations shall be in accordance with Section 11.2. Foundation analysis and design for Structures shall conform to the AASHTO LRFD Bridge Design Specifications, the CDOT Bridge Design Manual, and the CDOT Geotechnical Design Manual.

A Preliminary Foundation Design Report shall be submitted for Review for each major structure and minor structure as required in Book 2, Section 16, for the design of foundations for Bridges, retaining walls, noise walls, and other Structures. The report shall be in draft form and contain design recommendations and substantiating analysis for foundation elements, lateral earth load parameters, soil corrosivity analysis, seismic design parameters, and any other geotechnical design or analysis parameters necessary to complete the design. The Preliminary Foundation Report shall be submitted to CDOT for Review with the Preliminary Design Plans submittal.

The Foundation Design Report shall be revised from the Preliminary Foundation Design Report and be the basis for the load analysis from seismic and earth loads and the basis for the design of foundation elements. Supplemental soil borings required for Structures design shall have been completed. Foundation Design Reports shall be submitted to CDOT for Acceptance 90 Days following completion of supplemental field Work or with the Release for Construction (RFC) Documents per Book 2, Section 4.

11.3.4. McClean Spring and Unnamed Seep

There are a known spring and seep between MP 93.2 to MP 93.5. There are existing pipes and underdrain systems in place that can remain or be removed. New subsurface drainage shall be provided to prevent saturation of subgrade Materials for pavements, Structures, and embankments. Design of Structures, pavements, and embankments shall consider the potential for saturated conditions. Permanent design solutions shall provide drainage away from Structures, pavements, and embankments. Additional design requirements are provided in Book 2, Sections 6, 9, 13, 14 and 16.

The Contractor shall perform geotechnical investigations in this area. The investigation shall be included in the supplement geotechnical investigations report submitted to CDOT for Acceptance. This investigation shall include remediation recommendations to be included in the Design Documents to be submitted per Book 2, Section 4.

11.3.5. Baseline Roadway Pavement Analysis and Design

11.3.5.1 Pavement Structure

The Pavement Structure is defined as the combination of Subbase, Base Course, and Surface Course placed on a prepared Subgrade to support the traffic load and distribute it to the Roadbed:

1. **Subgrade.** The top surface of a Roadbed upon which the Pavement Structure and Shoulders are constructed.
2. **Subbase.** The layer or layers of specified or selected Material of designed thickness placed on a Subgrade to support a Base Course, Surface Course, or both.
3. **Base Course.** The layer or layers of specified or selected Material of designed thickness placed on a Subbase or a Subgrade to support a Surface Course.
4. **Surface Course.** The upper most component of a Pavement Structure designed to accommodate the traffic load, the top layer of which resists skidding, traffic abrasion, and the disintegrating effects of climate.

11.3.5.2 Subgrade Treatment

Expansive and high plasticity surficial soil and bedrock Subgrade Materials have been identified within the alignment as documented in the GDR. These Subgrade conditions shall be treated by the subexcavation method as defined in Chapter 4 of the CDOT M-E Pavement Design Manual. This is the only subgrade treatment allowed. This treatment is not ATC eligible. In order to achieve the Project goal of maximizing the use of available on Site Materials and for the long-term resiliency and benefit of the Project, the subexcavation shall be backfilled with a minimum thickness of 12 inches of moisture conditioned, recompacted subgrade and a minimum of 15 inches of Subbase course Materials consisting of suitable Material meeting the minimum requirements of Class 2 Aggregate Base Course (ABC), AASHTO classification of A-1 and with an R-value of at least 70, in accordance with Book 2, Section 12. Subbase course constructed on expansive and high plasticity subgrade Materials (surficial soils and processed bedrock) shall be constructed with ditches, edge drains or other drainage measures to collect and divert water from the Subbase Materials and prevent saturation of the Subgrade and Pavement Structure. ATCs, including those prepared using the AASHTOWare Pavement M-E Design software, shall not propose reductions in the minimum requirements of this section including the subexcavation method. These minimum requirements are not ATC eligible.

Where proposed embankment fill thickness is greater than 4 feet measured from the bottom of the Subbase to existing subgrade, Material placed in the top 4 feet below the bottom of the Subbase shall have an R-Value of at least 40. Where proposed embankment fill thickness is less than 4 feet measured from the bottom of the Subbase to existing Subgrade, Material placed between the existing Subgrade and Subbase shall have an R-Value of at least 40.

Existing Subgrade within 12 inches of the bottom of the Subbase and containing non-durable bedrock shall be pulverized, broken down, watered, and processed to a 6-inch maximum particle size and a maximum of 30 percent retained on the 3/4-inch sieve to a depth of 12 inches, the moisture content increased or reduced as necessary and compacted to the specified embankment density for the material type present. Existing Subgrade within 12 inches of the bottom of the Subbase and containing expansive and high plasticity soil shall be scarified to a depth of 12 inches, the moisture content increased or reduced as necessary and compacted to the specified embankment density for the material type present.

11.3.5.3 Baseline Pavement Design

CDOT has prepared the baseline pavement design, as described in the Pavement Justification Report, and performed the Life-Cycle Cost Analysis (LCCA) to determine the types and thicknesses of pavement surface courses, thicknesses of Base Courses and Subbase courses, and Subgrade treatments that meet the requirements of this Project. The CDOT baseline pavement design has accounted for the reworked Subgrade and Subbase course layers to meet the subexcavation requirements of this section and Chapter 4 of the CDOT M-E Pavement Design Manual. The Pavement Justification Report is included in the Reference Documents. This baseline Pavement Structure is provided below and Contractor proposed ATC pavement designs shall include the same components as the baseline design. Proposed ATCs for pavement designs shall utilize the baseline pavement design parameters and the baseline pavement design calibration factors defined in this Section. Output reports for the baseline pavement design are provided in the Reference Documents. Due to statewide calibration issues, CDOT performed the baseline pavement design using AASHTO Design Analysis and Rehabilitation for Windows (DARWin). All DARWin-specific referencing was done using the 2013 CDOT Pavement Design Manual. The 2025 CDOT M-E Pavement Design Manual was referenced for all other aspects of the baseline pavement design.

11.3.5.4 Baseline Pavement Types and Thickness Requirements

The LCCA performed by CDOT indicates Portland Cement Concrete Pavement (PCCP) and Hot Mix Asphalt (HMA) pavement types have life-cycle costs that are similar such that neither has a distinct cost advantage. The two life-cycle costs are within the range where CDOT policy requires designs for both types of pavement be presented as baseline pavement designs. The Contractor shall select either the PCCP or HMA CDOT design for the entire extent of the US 160 mainline within the Project limits, except for the CR 225 roundabout which shall be PCCP.

Permanent patching of HMA pavement shall conform to Section 403 of the CDOT Standard Specifications. Patching on US 160 shall consist of a minimum of 8-inches of HMA. Access Roads shall have a minimum Surface Course thickness of 3 inches of HMA and a minimum Base Course thickness of 4 inches of ABC Class 6. County Roads shall have a minimum Surface Course thickness of 4 inches of HMA and a minimum Base Course thickness of 6 inches of ABC Class 6.

11.3.5.4.1 Portland Cement Concrete Pavement

PCCP shall meet compressive strength requirements as identified in the most current CDOT Standard Specifications and any currently approved Standard Special Provisions as detailed in Book 2, Section 21.

1. PCCP shall be required for the CR 225 roundabout.

The baseline PCCP design shall have the minimum thicknesses shown in Table 11-3 for the design parameters provided as determined in accordance with CDOT M-E Pavement Design Manual for locations where new construction of the pavement section is required.

Table 11-3: Minimum Pavement Design Parameters for PCCP (New Construction)

Segments	Pavement Type	Design Life (Years)	2024 Daily Truck Volume (AADTT)	Thickness of PCCP Surface Course (in.)	Thickness of ABC Class 6 (in.)	Thickness of ABC Class 2 Subbase (in.)
US 160 Mainline Reconstruction	Rigid	30	840	9.5	6	0
CR 225 Roundabout	Rigid	30	840	9.5	6	0

Baseline PCCP designs based on use of 1.25-inch diameter dowel bars and 15-foot joint spacing.
ABC = Aggregate Base Course.

11.3.5.4.1 Hot Mix Asphalt Pavement

The baseline HMA pavement design shall have the minimum thicknesses shown in Table 11-4 for the design parameters provided based on the M-E Design software for HMA. All segments with widening shall be overlayed the full width of the roadway.

Table 11-4: Minimum Pavement Design Parameters for HMA (New Construction)

Segments	Pavement Type	Design Life (Years)	2024 Daily Truck Volume (AADTT)	Thickness of HMA Surface Course (in.)	Thickness of ABC Class 6 (in.)	Thickness of ABC Class 2 Subbase (in.)
US 160 Mainline Reconstruction	Flexible	20	840	6	6	15
US 160 Widening	Flexible	20	840	6	6	15
US 160 Overlay	Flexible	20	840	2	NA	NA

ABC = Aggregate Base Course.

NA = Not Applicable

11.3.6. Alternate Pavement Designs

CDOT has performed an LCCA for the baseline pavement design that shows HMA and PCCP as equally suitable pavement type alternatives. ATCs for pavement designs proposed by the Contractor shall include analysis of life-cycle costs to show maintenance costs and demonstrate required design life according to the CDOT M-E Pavement Design Manual.

The Contractor shall prepare the final ATC pavement designs using Version 2.3.1 of the AASHTOWare Pavement Mechanistic-Empirical Design software (M-E Design software) for all pavement constructed as part of this Project. In addition to M-E Design output, pavement design ATCs will be evaluated based on the requirements of the CDOT M-E Pavement Design Manual, in particular section 4.9 Expansive Subgrade soils. Contractor designs shall utilize the Colorado-specific calibration model and the inputs, calibration factors, Material properties, etc., set forth in the Pavement Justification Report and as provided in Exhibit 11-A. The Material properties of the Surface Course, Base Course, Subbase course, and Subgrade used during construction shall follow those used in the CDOT M-E Pavement Design Manual and CDOT baseline pavement design. Level 2 design parameters shall be used. The Contractor may use Level 1 design parameters when better information is available. Level 3 design parameters will not be applicable and shall not be used without specific written Acceptance of their applicability from CDOT. Items in conflict between the CDOT M-E Pavement Design Manual and the CDOT baseline design shall follow inputs provided in the CDOT baseline design and Exhibit 11-A. HMA and PCCP mixes from the CDOT material databases shall be used in all M-E Design analyses. Generic, nationwide, or similar, samples of HMA and PCCP shall not be used in the analysis.

Properties of Materials proposed for the Pavement Structure must be able to be represented within the M-E Design software. Materials incompatible with the M-E Design software will not be Accepted. Performance properties of alternative Materials shall be verified through documentation of the Materials' structural value within the Roadway prism and with formal guidance on how they should be modeled within the M-E Design software. The Contractor shall be required to provide the documentation and formal guidance for incorporation of Materials into the M-E Design software. CDOT will not Accept proposed pavement Materials modifications with insufficient documentation and/or lack of adequate modeling of a Material's structural value.

The Contractor's Alternate Pavement Design Report shall explicitly state any differences between the CDOT baseline pavement design and the ATC pavement design model proposed by the Contractor. All pages of the M-E Design software output reports for designs proposed by the Contractor shall be provided to CDOT for Review. The exact model (electronic file) that generated the associated design shall also be provided to CDOT for Review. A narrative detailing the changes from the CDOT baseline

model and associated detailed description and justification of changes and/or assumptions shall be provided with every ATC pavement design for Review. Review and any associated Review and comment time periods will not begin until all Requests for Information (RFI), narratives, and assumptions/descriptions are received from the Contractor. The Preliminary Alternate Pavement Design Report package shall be submitted to CDOT for Review as part of the Preliminary Design Plans submittal. The Alternate Pavement Design Report packages shall be submitted to CDOT for Acceptance as part of the Pre-RFC Documents and Final RFC Documents submittals. It is the Contractor's responsibility to furnish this information in a timely manner. CDOT is not responsible for any delays associated with the Contractor furnishing incomplete information to CDOT for ATC pavement designs.

The minimum required pavement section thicknesses for ATC pavement designs within the Project are provided in Table 11-5. The Contractor shall select either PCCP or HMA for the entire extent of the US 160 mainline within the Project limits, except for the CR 225 roundabout which shall be PCCP. All segments with widening shall be overlayed the full width of the roadway. The minimum requirements listed in Table 11-5 and the selection of PCCP or HMA are not ATC eligible.

Table 11-5: Minimum Pavement Section Thicknesses

Parameters	US 160 Mainline Reconstruction	CR 225 Roundabout	US 160 Widening	US 160 Overlay
HMA Surface Course	5.5 inches	NA	5.5 inches	2 inches
PCCP Surface Course	9 inches	9.5 inches	NA	NA
Base Course	6 inches	6 inches	6 inches	NA
Subbase course (HMA Only)	15 inches	NA	15 inches	NA

Chemical stabilization of Base Courses, Subbases, and Subgrades is not allowed on this Project. Any Full Depth Reclamation (FDR) Treatment Material shall be considered as the upper portion of the Subbase course. This design requirement is not ATC eligible.

The use of geogrid to reduce the pavement section shall be limited to a maximum of a 6 inch reduction in the Subbase layer (i.e. ABC Class 2) for HMA designs. Geogrid shall not be used to reduce the pavement section on PCCP designs. Any pavement design utilizing geogrid shall follow the procedures outlined in the CDOT M-E Pavement Design Manual.

Required modifications to Contractor pavement design ATCs as a result of conditions identified by post-design subsurface investigations or Subgrade soil survey performed by the Contractor after CDOT Approval of the ATC shall be the sole responsibility of the Contractor.

Calibration factors used in ATC pavement designs shall be the same as those for the baseline pavement design and Exhibit 11-A. Modifications of calibration factors will not be allowed.

Typical CDOT HMA and PCCP mixtures from the Pavement Design Manual materials databases shall be used in all M-E Design analysis. Generic, nationwide, or similar samples of HMA and PCCP shall not be utilized in the analysis without prior Approval by CDOT, as applicable for use and design within CDOT Roadways.

The appropriate Performance Grade (PG) binder shall be determined using the web-based tool, LTPPBind Online. The binder selection output from LTPPBind shall be included in the ATC pavement design submittal.

All Material being modeled within the M-E Design software for ATC pavement designs shall be representative of actual Materials that will be installed. Deviation of modeling procedures in ATC pavement designs from to-be-installed Materials will only be allowed with CDOT's Approval. Recycled PCCP will not be allowed as a component in the new pavement surface Materials.

The maximum allowable Resilient Modulus (M_r) for design purposes shall be:

- 25,000 psi for Base Course
- 15,000 psi for Subbase course and Subgrade

This design requirement is not ATC eligible.

Rigid pavement Surface Course designs consisting of PCCP shall contain load transfer devices tied to inside and outside Shoulders with doweled outside Shoulders. PCCP shall have a 30-year design life for new pavement. Continuously reinforced PCCP will not be permitted. Precast concrete panels will not be allowed for the permanent pavement surface.

HMA pavement shall be used for tie-ins to existing flexible pavement. Flexible pavement shall have a 20-year design life for new pavement.

Consistent subsurface drainage shall be provided as necessary to prevent saturation of the Subgrade Materials under pavement areas where Subgrade consists of reworked bedrock or surficial soil. Where subsurface drains are used, they shall extend laterally to a location at least 2 feet beyond the edge of pavement to an enclosed water conveyance system or daylighted to an open gravity flow ditch. The Contractor is responsible for managing and mitigating subsurface water per the CDOT Pavement Design Manual and Book 2, Section 13.

Where vertical sag areas in alignments can collect and concentrate subsurface water or surface water infiltration, they shall have longitudinal and/or transverse subsurface drains installed under the Pavement Structure to provide gravity drainage of the Subbase and Base Courses. Drains shall be located at the lowest point of the sag and shall be sufficient in size to drain the area. Drain outlets shall be located at culvert inlets or other appropriate locations.

The Contractor shall use the design parameters listed in Table 11-6 to prepare ATC pavement designs. This requirement is not ATC eligible.

Table 11-6: Minimum M-E Design Parameters

Parameters	Input			
	US 160 Mainline Reconstruction	CR 225 Roundabout	US 160 Widening	US 160 Overlay
Reliability	95%	95%	95%	95%

Parameters	Input			
	US 160 Mainline Reconstruction	CR 225 Roundabout	US 160 Widening	US 160 Overlay
Two-way Annual Average Daily Truck Traffic (AADTT) (OTIS as of November 2025)	840	840	840	840
Number of Lanes in Design Direction	2	1	NA	2
Percent of Trucks in Design Direction	50	60	NA	60
Percent of Trucks in Design Lane	90	100	NA	90
Operational speed (in miles per hour [mph])	45 mph	20 mph	NA	60 mph
Vehicle Class Distribution (CDOT)	Cluster 3	Cluster 3	Cluster 3	Cluster 3
Growth Rate %	1.25	1.25	1.0	NA
Growth Function	Compound	Compound	Compound	NA
Climate Station	Durango, CO	Durango, CO	Durango, CO	NA
Depth of Water Table	10	10	10	NA
Design life (Rigid) (New Construction)	30-year minimum	30-year minimum	NA	NA
Design Life (Flexible) (New Construction)	20-year minimum	NA	20-year minimum	NA
Performance Criteria Thresholds	Per CDOT M-E Pavement Design Manual			

All M-E designs for PCCP pavement shall use 13-foot design lane width. Modification of the design lane width shall require appropriate modification of the traffic wander deviation and supporting justification for the modification.

11.3.7. Detours

The Contractor shall be responsible for designing, providing, and maintaining detour pavements in a safe and serviceable condition, subject to CDOT Acceptance and per Book 2, Section 21. The Contractor shall determine the type and thickness of detour pavement through the use of M-E Design software and shall submit a detour pavement design to CDOT for Acceptance a minimum of 14 Days prior to detour construction. Detour pavements shall be designed in accordance with the CDOT M-E Pavement Design Manual and CDOT baseline design parameters. The minimum detour thickness design shall be based on the actual Subgrade strength and traffic loading for the length of time the detour is anticipated to be in service or a minimum 2-year design life in M-E Design, whichever is greater. If the Contractor's detour pavement design requires thicknesses greater than the minimum to serve for the life of the detour pavement, these shall be provided at no additional cost. Where detours will include existing paved Shoulders, the Contractor shall verify that there is sufficient Pavement Structure within the Shoulders to accommodate detour traffic.

11.3.8. County Road Pavements

The Contractor shall verify the required Pavement Structure thicknesses for pavements associated county Roads utilizing M-E Design software and the CDOT M-E Pavement Design Manual for pavement design. Designs shall be in conformance with the minimum requirements in subsections 11.3.5 and 11.3.6. Additional geotechnical investigation may be required to verify Subgrade conditions. Supplemental Geotechnical and Pavement Design Reports shall be submitted for CDOT Acceptance prior to the pre-paving conference and at least 30 days prior to placement of HMA on the Project.

11.3.9. Existing Pavement Sections

Existing pavement within segments of reconstruction shall be removed or reclaimed as Approved by CDOT prior to construction of the new pavement section.

11.4 Construction Requirements

Excavation to the profile grades shown on the Reference Drawings, and possible alternative profile grades proposed by the Contractor, will expose transitions in Subgrade Materials. The Contractor shall perform subsurface exploration at Subgrade transition areas to confirm and document thickness of suitable native Subgrade and adequate depth of subexcavation for placement of Subbase Materials.

The Contractor shall construct the PCCP, HMA, and all other pavements in accordance with the requirements of the Contract Documents. Project Special Provisions for pavement construction are included in Book 2, Section 21. Construction of permanent pavement ATCs shall not commence until the pavement design has been Accepted by CDOT.

A minimum of 30 Days prior to the proposed construction of any pavement on the Project, a pre-paving conference shall be conducted. Prior to the pre-paving conference, the Contractor shall present mix designs to CDOT for Acceptance. The Contractor shall also present construction Paving Quality Control Plans (QCP) for HMA and PCCP to CDOT for Approval.

Where it is required to cut existing pavement, the cutting shall be done to a neat work line, full-depth, with a pavement-cutting saw or other method as Approved by CDOT.

The Contractor shall modify existing valve boxes, manholes and inlets located in paving areas so that the pavement can be placed without covering or impacting their function. The Contractor shall submit an inlet/manhole modification plan for CDOT Acceptance with the applicable Traffic Control Plan for each paving operation.

11.4.1. PCCP Construction

Concrete pavement Acceptance shall be by compressive strength criteria.

The Contractor shall texture US 160 Shoulders in a manner consistent with the CDOT M&S Standard Plans. Station stamping is not required.

All jointing plans shall be submitted on 1:50 scale plans with fully scalable and legible letters, numbers, and details. Preliminary PCCP Jointing Plans shall be submitted to CDOT for Review as part of the Preliminary Design Plans Submittal. PCCP Jointing Plans for new construction and for connecting new to existing pavement shall be submitted to CDOT for Acceptance as part of the Pre-RFC Documents and Final RFC Documents submittals.

The jointing plan shall include jointing details for surface features including inlets, valves, and manholes.

The concrete jointing plan shall follow American Concrete Paving Association (ACPA) guidelines and CDOT M Standard Plan No. M-412-1.

Disincentives for PCCP properties shall apply per the CDOT Standard Specifications.

11.4.2. HMA Pavement Construction

Asphalt pavement Acceptance shall be by gradation criteria.

Hot Mix Asphalt shall be constructed in lifts with maximum thickness of 3-inches for new construction, and in lifts with maximum thickness of 2-inches for widening and overlay sections. In widening sections, a minimum depth of 2 inches and a minimum width of 2 feet of the existing HMA adjacent to the widened section shall be milled and overlayed with a minimum of 2 inches of HMA prior to placing the HMA surface course and overlay.

Tack coats for asphalt products shall be utilized in accordance with the following:

1. Tack coat (diluted) for asphalt products on this Project shall be one part emulsified asphalt (slow setting) and one part water. The rate of application shall be 0.1 gallons per square yard.
2. A tack coat of emulsified asphalt (slow setting) is to be applied to improve bond at the following locations:
    A. Before placing new pavement over existing pavement.
    B. Along the face of all curbs, gutters, manholes, adjacent existing pavement, and other surfaces against which asphalt will be placed.
    C. Between new pavement courses.

The Contactor shall prepare a Quality Control Plan (QCP) outlining the steps taken to minimize segregation of HMA. This plan shall be submitted to CDOT for Approval at the pre-paving conference and at a minimum of 30 Days prior to the planned placement of any HMA/PCCP on the Project.

Disincentives for HMA properties shall apply per the CDOT Standard Specifications.

11.4.2.1 Pavement Smoothness

The Contractor shall construct the PCCP or flexible pavement for the Project to the smoothness requirements as set forth in Table 11-7.

Table 11-7: Smoothness Requirements

Location	Pavement Smoothness Category
US 160 Mainline Reconstruction and Widening	MRI Category A (inches/mile)
US 160 Mainline Overlay	MRI Category B (inches/mile)

Pavement smoothness requirements shall apply to new Shoulders (greater than 12 feet in width), rehabilitated Shoulders (greater than 12 feet in width), and ramps in addition to the mainline pavement. Shoulders less than 12 feet in width and medians constructed as part of this Project shall be measured in accordance with subsection 105.07(a). An incentive for pavement smoothness will not be paid under this Contract. Full payment of the Upset Amount (UA) constitutes acknowledgment of meeting smoothness objectives. Disincentives for poor pavement smoothness shall apply per the CDOT Standard Specifications.

11.4.3. Shouldering

The Contractor shall use Shouldering Material as required in Book 2, Section 14. The shouldering Materials and placement shall conform to the requirements of Revision of Section 304 and 703 Aggregate Base Course (Special) included in Book 2, Section 21.

11.4.4. Park and Ride Pavement

The existing park and ride Pavement Section is 4 inches of HMA over 6 inches of ABC Class 6 over 12 inches of ABC Class 2. The minimum rehabilitation and repair of the existing park and ride pavement section shall be as follows:

1. Full depth patch areas of exposed Base Course, Subbase, or Subgrade, or "alligator" cracking.
2. Repair cracking within the existing pavement in accordance with the CDOT Standard Specifications, Section 408, for cracks smaller than 1 inch in width. Cracks larger than 1 inch in width shall be cut out and repaved full depth at a width of at least 2 feet. Crack repair Materials shall be a high heat (385 degrees or higher) applied product to mitigate the crack filler from liquifying and rising into the overlay mat during paving operations.
3. If Contractor operations cause excessive damage or deterioration in any area within the park and ride, the existing Pavement Section within that area shall be fully reconstructed to the existing Pavement Section.
4. Overlay the entire park and ride with a 2 inch HMA mat in accordance with Book 2, Section 21 and Section 400 of the CDOT Standard Specifications using SX(75) PG 58-28 HMA.

11.5 Deliverables

At a minimum, the Contractor shall submit the items specified in Table 11-8 to CDOT for Review, Acceptance, or Approval:

Table 11-8: Deliverables

Deliverables	Review, Acceptance, or Approval	Schedule
Geotechnical Investigation Plan	Review	At least 4 weeks prior to commencing field Work
Supplemental Geotechnical Investigation Reports (CDOT)	Acceptance	Within 90 Days following completion of the field Work

Deliverables	Review, Acceptance, or Approval	Schedule
Supplemental Geotechnical Investigation Reports (County)	Acceptance	Within 90 Days following completion of the field Work
Preliminary Foundation Design Reports	Review	As part of the Preliminary Design Plans submittal
Foundation Design Reports	Acceptance	Within 90 Days following completion of supplemental field Work or as part of the RFC Documents submittals
Preliminary Alternate Pavement Design Report, including M-E Design software output reports	Review	As part of the Preliminary Design Plans submittal
Alternate Pavement Design Report	Acceptance	As part of the Pre-RFC Documents and Final RFC Documents submittals
Detour Paving Design	Acceptance	14 Days prior to beginning detour construction
Supplemental Pavement Design Reports (County)	Acceptance	Prior to the pre-paving conference and at least 30 days prior to placement of HMA on the Project.
HMA and Mix Designs	Acceptance	Prior to the pre-paving conference and at least 30 Days prior to the planned placement of any HMA on the Project
Paving Quality Control Plan (QCP)	Approval	At the pre-paving conference and at a minimum of 30 Days prior to the planned placement of any HMA/PCCP on the Project.
Inlet/Manhole Modifications Plans	Acceptance	Concurrently with each applicable Traffic Control Plan (TCP)
Preliminary PCCP Jointing Plan	Review	As part of the Preliminary Design Plans Submittal.
PCCP Jointing Plan and PCCP Jointing Plan for Connecting New to Existing Pavement	Acceptance	As part of the Pre-RFC Documents and Final RFC Documents submittals

Deliverables	Review, Acceptance, or Approval	Schedule
QCP Outlining the Steps Taken to Minimize Segregation of HMA	Approval	At the pre-paving conference and at a minimum of 30 Days prior to the planned placement of any HMA on the Project

11.6 Exhibits

Exhibit 11-A Colorado Specific M-E Pavement Design Calibration Factors, 2019

Table 11-A1: New PCCP Calibration Factors

Distress Criteria	Calibration Factor
PCC Cracking	
PCC Cracking C1	2
PCC Cracking C2	1.22
PCC Cracking C4	0.6
PCC Cracking C5	-2.05
PCC Reliability Cracking Standard Deviation	Pow(57.08*CRACK,0.33) + 1.5
PCC Faulting	
PCC Faulting C1	0.51040000000000008
PCC Faulting C2	0.00838
PCC Faulting C3	0.00147
PCC Faulting C4	0.008345
PCC Faulting C5	5999
PCC Faulting C6	0.8404
PCC Faulting C7	5.9293000000000005
PCC Faulting C8	400
PCC Reliability Faulting Standard Deviation	0.0831*Pow(FAULT,0.3426) + 0.00521
PCC IRI-CRCP	
PCC IRI C1	3.15
PCC IRI C2	28.35
PCC IRI Initial CRCP Std. Dev.	5.4
PCC IRI-JPCP	
PCC IRI J1	0.8203
PCC IRI J2	0.44170000000000004
PCC IRI J3	1.4929000000000001
PCC IRI J4	25.240000000000002
PCC IRI Initial JPCP Std. Dev.	5.4
PCC Longitudinal Cracking	
PCC Longitudinal Cracking C4	0
PCC Longitudinal Cracking C5	0
PCC Reliability Longitudinal Cracking Standard Deviation	
PCC Punchout	
PCC CRCP C1	2
PCC CRCP C2	1.22
PCC CRCP C3	107.73
PCC CRCP C4	2.475
PCC CRCP C5	-0.785

Distress Criteria	Calibration Factor
PCC CRCP Crack	1
PCC Reliability PO Standard Deviation	2.208 * Pow(PO,0.5316)

Table 11-A2: New AC Calibration Factors

Distress Criteria	Calibration Factor
AC Cracking	
AC Cracking Bottom Standard Deviation	1 + 15/(1+exp(-3.1472-4.1349*LOG10(BOTTOM+0.0001)))
AC Cracking C1 Bottom	0.021
AC Cracking C1 Top	7
AC Cracking C2 Bottom	2.35
AC Cracking C2 Top	3.5
AC Cracking C3 Bottom	6000
AC Cracking C3 Top	0
AC Cracking C4 Top	1000
AC Cracking Top Standard Deviation	200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001)))
AC Fatigue	
AC Fatigue BF1	130.3674
AC Fatigue BF2	1
AC Fatigue BF3	1.2177989999999999
AC Fatigue K1	0.007566
AC Fatigue K2	3.9492000000000003
AC Fatigue K3	1.2810000000000001
AC Rutting	
AC Rutting BR1 (1)	4.3
AC Rutting BR2 (1)	1
AC Rutting BR3 (1)	1
AC Rutting K1 (1)	-3.35412
AC Rutting K2 (1)	1.5606
AC Rutting K3 (1)	0.3791
AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001
IRI	
IRI Flexible C1	50
IRI Flexible C2	0.55
IRI Flexible C3	0.0111
IRI Flexible C4	0.02
IRI Flexible Over PCCC1	40.800000000000004

Distress Criteria	Calibration Factor
IRI Flexible Over PCCC2	0.57500000000000007
IRI Flexible Over PCCC3	0.0014
IRI Flexible Over PCCC4	0.00825
Subgrade Rutting	
Fine Subgrade Rutting BS1	0.37
Fine Subgrade Rutting K1	1.35
Fine Subgrade Rutting Standard Deviation	0.0663 * Pow(SUBRUT,0.5) + 0.001
Granular Subgrade Rutting BS1	0.22
Granular Subgrade Rutting K1	2.0300000000000002
Granular Subgrade Rutting Standard Deviation	0.0104 * Pow(BASERUT,0.67) + 0.001
Thermal Fracture	
AC Thermal Cracking Level 1K	6.3
AC Thermal Cracking Level 1 Std. Dev.	0.1468 * THERMAL + 65.027
AC Thermal Cracking Level 2K	0.5
AC Thermal Cracking level 2 Std. Dev.	0.2841 * THERMAL + 55.462
AC Thermal Cracking Level 3K	6.3
AC Thermal Cracking Level 3 Std. Dev.	0.3972 * THERMAL + 20.422

Table 11-A3: AC over AC Rehabilitation Calibration Factors

Distress Criteria	Calibration Factor
AC Cracking	
AC Cracking Bottom Standard Deviation	1+15 /(1+exp(-3.1472-4.1349*LOG10(BOTTOM+0.0001)))
AC Cracking C1 Bottom	0.021
AC Cracking C1 Top	7
AC Cracking C2 Bottom	2.35
AC Cracking C2 Top	3.5
AC Cracking C3 Bottom	6000
AC Cracking C3 Top	0
AC Cracking C4 Top	1000
AC Cracking Top Standard Deviation	200 + 2300/(1+exp(1.072-2.1654*LOG10(TOP+0.0001)))
AC Fatigue	
AC Fatigue BF1	130.3674
AC Fatigue BF2	1
AC Fatigue BF3	1.2177989999999999
AC Fatigue K1	0.007566

Distress Criteria	Calibration Factor
AC Fatigue K2	3.9492000000000003
AC Fatigue K3	1.2810000000000001
AC Rutting	
AC Rutting BR1 (1)	4.3
AC Rutting BR2 (1)	1
AC Rutting BR3 (1)	1
AC Rutting K1 (1)	-3.35412
AC Rutting K2 (1)	1.5606
AC Rutting k3 (1)	0.3791
AC Rutting Standard Deviation	0.1414 * Pow(RUT,0.25) + 0.001
IRI	
IRI Flexible C1	50
IRI Flexible C2	0.55
IRI Flexible C3	0.0111
IRI Flexible C4	0.02
IRI Flexible Over PCCC1	40.800000000000004
IRI Flexible Over PCCC2	0.57500000000000007
IRI Flexible Over PCCC3	0.0014
IRI Flexible Over PCCC4	0.00825
Reflective Fatigue Cracking AC	
Reflective Fatigue Cracking AC C1	0.38
Reflective Fatigue Cracking AC C2	1.6600000000000001
Reflective Fatigue Cracking AC C3	2.72
Reflective Fatigue Cracking AC C4	105.4
Reflective Fatigue Cracking AC C5	-7.0200000000000005
Reflective Fatigue Cracking AC K1	0.012
Reflective Fatigue Cracking AC K2	0.005
Reflective Fatigue Cracking AC K3	1
Reflective Fatigue Cracking AC Std. Dev.	1.1097 * Pow(FATIGUE,0.6804) + 1.23
Reflective Transverse Cracking AC	
Reflective Transverse Cracking AC C1	3.22
Reflective Transverse Cracking AC C2	25.7
Reflective Transverse Cracking AC C3	0.1
Reflective Transverse Cracking AC C4	133.4
Reflective Transverse Cracking AC C5	-72.4
Reflective Transverse Cracking AC K1	0.012
Reflective Transverse Cracking AC K2	0.005
Reflective Transverse Cracking AC K3	1

Distress Criteria	Calibration Factor
Reflective Transverse Cracking AC Std. Dev.	70.98 * Pow(TRANSVERSE,0.2994) + 30.12
Subgrade Rutting	
Fine Subgrade Rutting BS1	0.37
Fine Subgrade Rutting K1	1.35
Fine Subgrade Rutting Standard Deviation	0.0663 * Pow(SUBRUT,0.5) + 0.001
Granular Subgrade Rutting BS1	0.22
Granular Subgrade Rutting K1	2.0300000000000002
Granular Subgrade Rutting Standard Deviation	0.0104 * Pow(BASERUT,0.67) + 0.001
Thermal Fracture	
AC Thermal Cracking Level 1K	6.3
AC Thermal Cracking Level 2K	0.5
AC Thermal Cracking Level 3K	6.3