MONTANA STATE UNIVERSITY

UNIVERSITY FACILITIES MANAGEMENT
Sixth Avenue and Grant Street • P.O. Box 172760 • Bozeman, Montana 59717-2760
Phone: (406) 994-5413 • Fax: (406) 994-5665

ADDENDUM NO. 3 - OUTLINE AND SUMMARY INFORMATION

Project Name: MSU Stadium Lots PPA No.: 22-0012
Location: 1 Bobcat Circle, Bozeman, MT 59717 Date: 04-04-2024

To: All Plan Holders of Record

*The Plans and Specification prepared by **DJ&A P.C.** dated **04-04-2024,** shall be clarified and added as follows. The bidder proposes to perform all the following clarifications or changes. It is understood that the Base Bid shall include any modification of Work or Additional Work that may be required by reason of the following change or clarifications.*

The Bidders are to acknowledge the receipt of this Addendum by inserting its number and date into their Bid Forms. Failure to acknowledge may subject the Bidder to disqualification and rejection of the bid. This Addendum forms part of the Contract Documents as if bound therein and modifies them as follows:

I. AMENDMENTS TO THE PROJECT MANUAL

03 Invitation to Bid – Updated bid due date.

06 Bid Proposal Long Form 098 – Addition of bidder acknowledgement of receipt of addenda.

012200 Unit Prices – Updated quantities and addition of two tabulated bid items. Contractor to verify all quantities provided and base their bids off of Contractor-verified quantities. Bid is lump sum per the Contract Plans.

A. REVISE - Item A5 REUSE EXISTING GRAVEL: The estimated quantity was updated to 30,000 SY. This is an estimate only; Contractor shall verify their estimated quantities based on the Geotechnical Report and recommendations therein.

B. REVISE – Item A15 updated to 36 ea.

C. REVISE – Item A34 PLAZA CONCRETE (Heavy duty 5” + fiber mesh additive): The estimated quantity shown in Alternate No. 2 was updated to reflect the same area of plaza concrete bid item shown in the base bid.

D. ADD – Items A67 & A68 with respective estimated quantities.

012200 UNIT PRICES – Clarification provided on lump sum approach to the project. Updates on bid quantity estimation on bid items—Contractor to review and verify estimated quantities and work required to complete the project as shown in Project Plan Sheets. Addition of A67 and A68.

DIV 02 SPECIFICATIONS – Various measurement and payment within the Division 02 specifications were struck-through and updated to reinforce that this project is to be bid lump sum for the work required to perform the work shown in the Project Plan Sheets. See also updates to 012200 UNIT PRICES. Contractor to review Div 02 Specifications updates. Strike-throughs were used to assist in the review of deletions/changes.

II. GENERAL INFORMATION

A. No design changes are proposed within the Project Plan Sheets for the civil and landscape/irrigation design.

III. PLANS

E10.1 - Pole details updated so that steel conduit and adapters are not required.

ED1.1 - Luminaire phased as existing (mistake) changed to demolished phase.

EP2.0 - Keynotes #4 and #5 updated.

EP2.1 - Circuit numbers updated for every circuit.

EP2.2 - Circuit numbers updated for every circuit. Keynotes #3 and #4 updated to clarify pole-mounted cameras will be provided by MSU.

EP2.3 - Circuit numbers updated for every circuit.

EP2.4 - Circuit numbers updated for every circuit.

EP2.5 - Circuit numbers updated for every circuit. Keynote #1 updated to clarify new luminaire, pole and base. Keynotes #3 and #4 updated to clarify pole mounted cameras will be provided by MSU.

EP2.6 - Circuit numbers updated for every circuit. Keynote #2 updated.

EP2.7 - Circuit numbers updated for every circuit. Keynote #1 updated to clarify new luminaire, pole and base.

E6.1 - Luminaire schedule model numbers changed to 480V to accommodate voltage drop. Rearrangement of power packs in storage building and additional keynotes #3 and #4 added for further clarification. Lighting circuits on Panel HA were changed from 277V, 1 pole circuits to 480V,2 pole circuits. EV charging circuits removed from panel LB and replaced with space to clarify that these will be installed later on.

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INVITATION TO BID

Sealed bids will be received until **2:00 PM (MST)** on **Thursday, April 11th, 2024,** and will be publicly opened and read aloud in the offices of **MSU University Facilities Management, Plew Building, 6th & Grant, Bozeman, Montana**, for: **MSU Stadium Lots, PPA No. 22-0012.**

Bids shall be submitted on the form provided within the Contract Documents. Contract documents may be obtained at the offices of:

Montana State University
UNIVERSITY FACILITIES MANAGEMENT
Plew Building, 6th & Grant
PO Box 172760
Bozeman, Montana 59717-2760

On the web at:
http://www.montana.edu/pdc/bids.html

A PRE-BID WALK-THROUGH IS SCHEDULED FOR Thursday, March 21st, 2024, AT 8:00 AM PARTICIPANTS SHOULD MEET AT Bobcat Stadium (1 Bobcat Circle, Bozeman, MT 59717), Gate 11 (Southeast stadium entrance near the Track & Field Complex). ATTENDANCE IS STRONGLY RECOMMENDED. Bidders should thoroughly review the contract documents before the pre-bid conference.

Bids must be accompanied by a bid security meeting the requirements of the State of Montana in the amount of 10% of the total bid. After award, the successful bidder must furnish an approved Performance Security and a Labor & Material Payment Security each in the amount of 100% of the contract for contracts equal to or greater than $150,000.

No bidder may withdraw his bid for at least thirty (30) calendar days after the scheduled time for receipt of bids except as noted in the Instructions to Bidders.

The Owner reserves the right to reject any or all bids and to waive any and all irregularities or informalities and the right to determine what constitutes any and all irregularities or informalities.

Time of Completion
Bidder agrees to commence work immediately upon receipt of the Notice to Proceed and to substantially complete the project **by August 17th, 2024**.

The State of Montana makes reasonable accommodations for any known disability that may interfere with an applicant's ability to compete in the bidding and/or selection process. In order for the state to make such accommodations, applicants must make known any needed accommodation to the individual project managers or agency contacts listed in the contract documents.

State of Montana - Montana State University

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BID PROPOSAL

MSU Stadium Lots
PPA No. 22-0012

TO:
State of Montana, Montana State University
University Facilities Management
Attn: Contract Administrator
Plew Building, 6th & Grant,
PO Box 172760
Bozeman, Montana 59717-2760

Prospective Bidders:

The construction contract operates on a lump sum basis. Unit prices are used in event of change order, see Section 012200 Unit Price.

The undersigned, having familiarized themselves with the Contract Documents, site, location, and conditions of the Work as prepared by **DJ&A, 220 West Lamme Street, Suite 1D, Bozeman, MT 59715, Phone: (406) 721-4320** or **UNIVERSITY FACILITIES MANAGEMENT** by submission of this Bid Proposal, hereby agrees to provide all materials, systems, equipment and labor necessary to complete the Work for the total sum as follows:

BASE BID UNIT PRICES:

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
M1	MOBILIZATION & MISC WORK	LS			
M2	PERMITTING	LS			
A1	TEMPORARY TRAFFIC CONTROL	LS			
A2	TEMPORARY CONSTRUCTION FENCING	LS			
A3	SOIL EROSION AND POLLUTION CONTROL	LS			
A4	RECLAIM AND REUSE EXISTING ASPHALT	SY			

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A5	REUSE EXISTING GRAVEL	SY			
A6	CLEARING AND GRUBBING	SF			
A7	EARTHWORK	CY			
A8	HAUL OFF/SPREAD EXISTING CUT MATERIAL	CY			
A9	REMOVE TREES	EA			
A10	REMOVE EXISTING CURB & GUTTER	LF			
A11	REMOVE CHAIN LINK FENCING	LF			
A12	REMOVE & SALVAGE SIGNAGE	EA			
A13	REMOVE & SALVAGE FLAG POLES & PLAQUES	EA			
A14	REMOVE & SALVAGE MEMORIAL BRICKS	SF			
A15	REMOVE & SALVAGE LIGHT POLES (including wiring, conduit, base, etc.)	EA			
A16	REMOVE CONCRETE LIGHT POLE BASE	EA			
A17	REMOVE & SALVAGE EXISTING PIN DOWN CURBS	EA			
A18	SAWCUT EXISTING ASPHALT PAVEMENT	LF			
A19	SAWCUT EXISTING CONCRETE	LF			
A20	REMOVE & RELOCATE FIRE HYDRANT (+ ductile iron extension)	EA			
A21	REMOVE BOLLARD	EA			

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A22	REMOVE EXISTING PARKING DIVIDER FENCE	LF			
A23	REMOVE EXISTING CONCRETE DRIVEWAY	SF			
A24	REMOVE & SALVAGE EXISTING INLET	EA			
A25	REMOVE LANDSCAPE WALL	LF			
A26	REMOVE CONCRETE STEPS & RAILING	EA			
A27	MISC. DEMOLITION WORK	EA			
A28	LANDSCAPE ROCK/GRAVEL MULCH	SF			
A29	BASE STABILIZER TREATMENT PRODUCT (See Geotech Report)	LS			
A30	WOVEN GEOTEXTILE FABRIC (Mirafi 180N)	SF			
A31	GRAVEL PARKING SECTION (3" Replacement of Asphalt)	SY			
A32	ASPHALT PAVEMENT (light duty – 3")	SF			
A33	ASPHALT PAVEMENT (heavy duty – 4")	SF			
A34	PLAZA CONCRETE FLATWORK (heavy duty – 5" + fiber mesh additive)	SF			
A35	PLAZA CONCRETE FLATWORK (heavy duty – 6" + fiber mesh additive)	SF			
A36	CONCRETE SIDEWALK	SF			
A37	INSTALL CURB & GUTTER	LF			
A38	INSTALL SOLID INLET	EA			

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
	COVER				
A39	INSTALL HEEL PROOF INLET	EA			
A40	INSTALL CONCRETE VALLEY GUTTER (4' Wide)	LF			
A41	INSTALL CONCRETE VALLEY GUTTER (2' Wide)	LF			
A42	CONCRETE DRIVEWAY APPROACH (Traffic-rated pad)	EA			
A43	INSTALL CONCRETE WHEEL STOPS	EA			
A44	INSTALL REMOVABLE BOLLARDS	EA			
A45	INSTALL ADA PARKING SIGN & PAVEMENT MARKING	EA			
A46	INSTALL CHAIN LINK FENCE	LF			
A47	INSTALL NEW MONUMENT SIGN	EA			
A48	PERMANENT PAVEMENT MARKINGS ~ 4" STRIPING	LF			
A49	CHAMBER SYSTEM (Lot 20)	CF			
A50	CHAMBER SYSTEM (Lot 25)	CF			
A51	STORM DRAIN STRUCTURE + INLET + ENVIROHOOD	EA			
A52	ADJUST EXISTING UTILITIES TO GRADE	EA			
A53	UPGRADE EXISTING UTILITIES WITHIN TRAVEL WAY TO BE TRAFFIC RATED	EA			

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A54	ELECTRICAL SYSTEM	LS			
A55	12” HDPE STORM DRAIN PIPE	LF			
A56	18” HDPE STORM DRAIN PIPE	LF			
A57	BIKE RACKS	EA			
A58	LANDSCAPE IRRIGATION	LS			
A59	TREES (Canopy, Evergreen, Ornamental)	EA			
A60	SHRUBS	EA			
A61	EDGING	LF			
A62	SEEDING & SOIL AMENDMENTS	LS			
A63	16” IRRIGATION VALVE	EA			
A64	4” HDPE IRRIGATION PIPE	LF			
A65	LANDSCAPE BOULDERS	EA			
A66	MISC. WORK	LS			
A67	SUBGRADE STABILIZATION	SF			
A68	PRECAST STORM DRAIN STRUCTURE + INLET	EA			
				TOTAL	

BASE BID LUMP SUM:

_____ and _____ /100 DOLLARS

(ALPHA notation)

$_____

(NUMERIC notation)

ALTERNATE NO.1 CHANGES

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A31	GRAVEL PARKING SECTION (3" Replacement of Asphalt)	SY			
A32	ASPHALT PAVEMENT (Light Duty – 3")	SF			
A33	ASPHALT PAVEMENT (Heavy Duty – 4")	SF			
A48	PERMANENT PAVEMENT MARKINGS – 4" STRIPING	LF			
				TOTAL	

ALTERNATE NO. 1: ADD - LOT 25 – REPLACE 3" GRAVEL WITH 3" ASPHALT
THE BIDDER AGREES TO **ADD/ALTER** THE SPECIFIED SCOPE OF WORK FOR THE TOTAL SUM OF:

_____and _____ /100 DOLLARS
(ALPHA notation) $_____
(NUMERIC notation)

ALTERNATE NO. 2 CHANGES

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A34	PLAZA CONCRETE FLATWORK (Heavy duty 5" + fiber mesh additive)	SF			
A35	PLAZA CONCRETE FLATWORK (Heavy duty 6" + fiber mesh additive)	SF			
				TOTAL	

ALTERNATE NO. 2: ADD – 1" ADDITIONAL THICKNESS CONCRETE SECTION
THE BIDDER AGREES TO **ADD** THE SPECIFIED SCOPE OF WORK FOR THE TOTAL SUM OF:

_____and _____ /100 DOLLARS
(ALPHA notation) $_____
(NUMERIC notation)

This bidder acknowledges receipt of the following addenda:

ADDENDUM No.1: _____ Dated: March 27, 2024

ADDENDUM No.2: _____ Dated: April 2, 2024

ADDENDUM No.3: _____ Dated: April 4, 2024

By signing below, the bidder agrees to all terms specified and AGREES TO fulfill the requirements of the CONTRACT in strict accordance with the bidding documents.

Company Name: _____

Business Address: _____

_____

_____

Construction Contractor Registration No.: _____

Phone No.: _____

Fax No.: _____

Email: _____

Date: _____

Bid Proposals entitled to consideration shall be signed by the proper representative of the firm submitting the proposal as follows (Initial which requirement you meet):

☐ The principal of a single owner firm;

☐ A principal of a partnership firm;

☐ An officer of an incorporated firm, or an agent whose signature is accompanied by a certified copy of the resolution of the Board of Directors authorizing that agent to sign; or (attach a copy of the resolution),

☐ Other persons signing for a single-owner firm or a partnership shall attach a power-of-attorney evidencing his authority to sign for that firm.

Signature: _____

Print Name: _____

Title: _____

SECTION 011000
SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 PROJECT DESCRIPTION

A. The project involves the reconstruction multiple MSU stadium parking lots, including Lot 20 (West Stadium Lot), Lot 25 (East Stadium Lot), the stadium service entrance (approximately south/southeast of the stadium), and the necessary accommodations for the future Indoor Practice Facility (a.k.a "IPF", a.k.a. "IAC"). The base bid encompasses the complete reconstruction of Lot 20 with adjacent/surrounding curb and gutter, concrete flatwork, and utility/storm drain improvements, asphalt and concrete section installation, pavement striping and marking, lighting installation, utility improvements, stormwater drainage improvements, construction of concrete plaza area, signage, fencing, landscaping and irrigation installation, and other improvements shown on the plan. Lot 25 will undergo the same reconstruction and improvements as Lot 20, with the exception of the omission of asphalt and substitution of an equivalently-thick replacement gravel section; the parking area will be a gravel section, as per the Project Plans. This paragraph generally describes the base bid—the Project Plans provide additional detail of proposed improvements that may not be specifically described in this paragraph.

1.3 SITE INFORMATION

A. Location: The project site is located at 1 Bobcat Circle, Bozeman, Montana 59717, generally described as the "block" between 7th Avenue and 11th Avenue, south of Kagy Boulevard in Bozeman, MT.

B. Scope of work includes but is not necessarily limited to: Lot 20 will provide approximately 655 parking spaces, while Lot 25 will provide approximately 650 spaces. Furthermore, provisions for a track/"back of house" area with approximately 64 spaces and 4 bus spaces are included. Construction of the University Indoor Practice Facility (IPF a.k.a. IAC) will be managed separately by other entities. The total area for the project spans approximately 30.5 acres.

C. The scope explicitly excludes the construction of the indoor practice facility, athletics complex, and existing football stadium. No work to the existing irrigation pond is included, however some regrading of the northern portion of the berm adjacent to the pond with nearby fencing improvements is included.

1.4 CONTRACTS

A. Contracts shall be under one General Contract and shall include, but not be limited to, all labor, materials, and supervision necessary to furnish and install the Work.

1.5 WORK SEQUENCE

A. The work will be conducted in one (1) phase to provide the least possible interference to the activities of the Owner's personnel and activities.

B. The Contractor will have access to the entire project site starting May 12, 2024 after the receipt of the contract.

1.6 CONTRACTOR USE OF PREMISES

A. Work on this contract is expected to be done during regular working hours Monday through Friday. Any variation from this will require prior approval of the Consultant and Owner.

B. All work must be coordinated with MSU at all times and MSU must be informed about any work impacting campus operations 72 hours or 3 working days in advance of work being conducted and shall require MSU approval.

C. General: Limit use of the premises to construction activities in areas indicated; allow for Owner/MSU occupancy and use by the public. Confine operations to areas within contract limits indicated. Portions of the site beyond areas in which construction operations are indicated are not to be disturbed.

D. Contractor shall conduct all his work in such a manner as to minimize the inconvenience and disruption of MSU’s daily schedule.

E. Confine operations at the site to the areas permitted under the Contract. Portions of the site beyond areas on which work is indicated are not to be disturbed. Conform to site rules and regulations affecting the work while engaged in project construction.

F. Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials to the areas designated on the drawings. If additional storage is necessary, obtain and pay for such storage off-site.

G. Contractor shall establish a staging area for storage of materials and equipment.

H. The Contractor is to coordinate with MSU for the location of the job site trailer office.

I. Keep driveways and entrances serving the premises clear and available to MSU and MSU's employees, staff and visitors at all times, unless otherwise agreed by MSU. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on site.

1.7 PARKING AND SITE ACCESS

(See also Supplemental Conditions of the Contract for Construction.)

A. MSU Bozeman Vehicle Regulations state: "All students, faculty, staff, and visitors must register any motor vehicle they park on the University campus, for any reason. A visitor is anyone not defined as student, staff or faculty."

B. All Contractor and Contractor employees shall comply with Montana State University parking regulations. MSU parking permits can be purchased at the University Police Office located in the Huffman Building at Seventh Avenue and Kagy Boulevard. Violators of MSU Bozeman Vehicle Regulations may be ticketed and towed.

C. A maximum of three (3) Contractor Permits (or as agreed with MSU) will be made available to the Contractor for parking of essential vehicles within the designated parking lot (as designated on the Cover Sheet of the Contract Documents). Essential vehicles are vehicles used for delivery of equipment and tools required to be parked in close proximity to the construction area. All allowed vehicles only to be parked on hard surfaced areas within the Staging Area. All other Contractor and Contractor employee vehicles on campus shall be parked in designated parking lots to be agreed with MSU. No personal vehicles shall be parked at the project site in any event. If a driver of a vehicle not allowed to be parked at the project site must unload equipment, tools, or materials, the vehicle must be immediately thereafter move to a designated lot or leave campus.

D. Access and egress to and from the project site shall be coordinated with the owner. In cases where a different route must be used for a specific purpose, permission must be obtained from MSU. Access routes are for delivery of equipment, tools, and materials and not for parking.

E. The site Staging Areas for materials and equipment are designated on the Cover Sheet of the Contract Documents. Staged materials and equipment must be secured on the ground surface or in trailers. Site staging areas shall be fenced in accordance with the Contract Documents. Vehicles in addition to those allowed to be parked may not be used for staging of equipment, tools, or materials.

1.8 OWNER OCCUPANCY

A. Full Owner/MSU Occupancy: The Owner/MSU will occupy the site during the entire construction period. Cooperate with MSU during construction operations to minimize conflicts and facilitate MSU usage. Perform the work so as not to interfere with MSU’s operations.

1.9 SAFETY REQUIREMENTS

A. General: The safety measures required by the Contract Documents are not meant to be inclusive. The Contractor shall be solely responsible for safety on a 24-hours-per-day, 7 days-per-week basis and shall take whatever additional measures are necessary to insure the health and safety of the buildings' occupants, or pedestrians at or near the construction site and access routes and of all other persons in all areas affected by the Contractor's activities. Prior to the start of construction, the Contractor is to submit to the Consultant a detailed written plan specifying the safety procedures that will be followed. Include (but not by way of limitation) the following: Verbiage, size and locations of warning signs; construction sequence as related to safety; use of barricades (type and location); employee policies as related to safety; and delivery of

materials as related to safety. Revise the safety plan as required during construction and resubmit to the Owner.

B. All application, material handling, and associated equipment shall conform to and be operated in conformance with OSHA safety requirements.

C. Comply with Federal, State, local, and the Owner's fire, health and safety requirements.

D. Advise MSU whenever work is expected to be hazardous or inconvenient (including objectionable odors) to MSU's employees, students, visitors or the building occupants.

E. Construction materials or equipment shall be placed so as not to endanger the work or prevent free access to all emergency devices or utility disconnects.

F. Maintain the proper rated fire extinguishers within easy access where power tools, sanding or other equipment is being used.

G. The Contractor shall erect and maintain, as required by law, conditions and progress of the work, warning signs, barricades and other reasonable safeguards for safety and protection.

H. Emergency and Public Safety Alert System: Montana State University has an Emergency and Public Safety Alert System that warns the campus community in the event of an emergency or public safety event. Because contractors, consultants, and vendors are considered members of the campus community when working on campus, they must be familiar with the alert system and understand when the system is used. Montana State University requires all contractors, consultants, vendors, and their employees working on or entering the MSU-Bozeman campus to register for the Emergency and Public Safety Alert System. The link to register is: http://www.montana.edu/msualert/

1.10 EXISTING PREMISES CONDITION

A. The Contractor is responsible for adequately documenting in photos the existing condition of the premises, to include external road surfaces, curbing and landscaped areas, specifically the cleanliness of areas. Any damage to the premises which is found after construction and is not so documented will be the responsibility of the Contractor to repair or replace.

1.11 DISCREPANCIES IN THE DOCUMENTS

A. The Contractor shall bring any discrepancies between any portions of the drawings and specifications to the attention of the Owner and the Consultant in writing. The Owner and Consultant shall review the discrepancy and clarify the intent desired in the Contract Documents. Unless specifically directed otherwise, the Contractor shall be obligated to provide the greater quantity or quality without any change in contract sum or time.

END OF SECTION

SECTION 012200

UNIT PRICES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes administrative and procedural requirements for unit prices.

1.2 DEFINITIONS

A. Unit price is an amount proposed by bidders, a price per unit of measurement for materials or services added to or deducted from the Contract Sum by appropriate modification, if estimated quantities of Work required by the ~~Contract Documents~~ Project Plan Sheets are increased or decreased.

B. Appropriate Modification, as described in A above, requires directive from Owner to Contractor to add or reduce or substitute improvements, materials, surface treatments, etc. from what is shown in the Project Plan Sheets.

1.3 PROCEDURES

A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.

B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices. Methods of measurement and payment for unit prices are specified in those Sections.

C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.

D. List of Unit Prices: A list of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF UNIT PRICES

A. GENERAL
   1. Quantities are estimated and to be verified by Contractor.
   2. Full descriptions of Bid Alternates can be found in SECTION 012300 ALTERNATES and as shown in Project Plans.

3. The construction contract operates on a lump sum basis. The bid documents contain a tabulation of major construction items intended to assist the Contractor in calculating their lump sum bid. However, some necessary work items may not be fully tabulated or estimated within these documents. It is the Contractor's responsibility to thoroughly review the Project Plans and supporting documents, conduct necessary takeoffs, estimations, and other calculations to formulate the proposed lump sum bid accurately. The provided bid tabulation does not encompass a comprehensive itemized list of all work essential for project completion.
4. ~~Unit prices will only be employed in the event of a change order, with pricing derived from the unit prices specified within these bid documents.~~ Unit prices are used in event of change order resulting from a change from the improvements shown in the Project Plan Sheets (e.g. MSU requests additional monument signage beyond that which is shown in the project plan sheets or a substitution of concrete plaza flatwork for asphalt pavement, vice versa, etc.) The Contractor is accountable for itemizing and delineating the work required within each bid item labeled as 'Miscellaneous' or 'Misc.' The quantification or estimation of quantities in the tabulations below do not reflect a comprehensive itemization nor a comprehensive quantification of work required to complete the improvements, complete the project, or complete the work shown in the Project Plan Sheets. The lump sum bid shall represent any work, materials, labor, effort, etc. to complete the improvements shown in the Project Plan Sheets per Owner standards and specifications.
5. The following unit abbreviations are used throughout this manual for measurement purposes:
    a. Each EA
    b. Cubic Feet CF
    c. Cubic Yard CY
    d. Lineal Feet LF
    e. Lump Sum LS
    f. Square Feet SF
    g. Square Yard SY

B. BASE BID

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
M1	MOBILIZATION & MISC WORK	LS	1		
M2	PERMITTING	LS	1		
A1	TEMPORARY TRAFFIC CONTROL	LS	1		
A2	TEMPORARY CONSTRUCTION FENCING	LS	1		
A3	SOIL EROSION AND POLLUTION CONTROL	LS	1		

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A4	RECLAIM AND REUSE EXISTING ASPHALT	SY	21000		
A5	REUSE EXISTING GRAVEL	SY	30000		
A6	CLEARING AND GRUBBING	SF	60000		
A7	EARTHWORK	CY	11000		
A8	HAUL OFF/SPREAD EXISTING CUT MATERIAL	CY	6000		
A9	REMOVE TREES	EA	23		
A10	REMOVE EXISTING CURB & GUTTER	LF	350		
A11	REMOVE CHAIN LINK FENCING	LF	2000		
A12	REMOVE & SALVAGE SIGNAGE	EA	24		
A13	REMOVE & SALVAGE FLAG POLES & PLAQUES	EA	3		
A14	REMOVE & SALVAGE MEMORIAL BRICKS	SF	310		
A15	REMOVE & SALVAGE LIGHT POLES (including wiring, conduit, base, etc.)	EA	36		
A16	REMOVE CONCRETE LIGHT POLE BASE	EA	15		
A17	REMOVE & SALVAGE EXISTING PIN DOWN CURBS	EA	11		
A18	SAWCUT EXISTING ASPHALT PAVEMENT	LF	1000		
A19	SAWCUT EXISTING CONCRETE	LF	500		

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A20	REMOVE & RELOCATE FIRE HYDRANT (+ ductile iron extension)	EA	2		
A21	REMOVE BOLLARD	EA	12		
A22	REMOVE EXISTING PARKING DIVIDER FENCE	LF	1500		
A23	REMOVE EXISTING CONCRETE DRIVEWAY	SF	750		
A24	REMOVE & SALVAGE EXISTING INLET	EA	4		
A25	REMOVE LANDSCAPE WALL	LF	200		
A26	REMOVE CONCRETE STEPS & RAILING	EA	1		
A27	MISC. DEMOLITION WORK	EA	1		
A28	LANDSCAPE ROCK/GRAVEL MULCH	SF	13000		
A29	BASE STABILIZER TREATMENT PRODUCT (See Geotech Report)	LS	1		
A30	WOVEN GEOTEXTILE FABRIC (Mirafi 180N)	SF	560000		
A31	GRAVEL PARKING SECTION (3” Replacement of Asphalt)	SY	25400		
A32	ASPHALT PAVEMENT (light duty – 3”)	SF	184000		
A33	ASPHALT PAVEMENT (heavy duty – 4”)	SF	43364		
A34	PLAZA CONCRETE FLATWORK (heavy duty – 5” + fiber mesh additive)	SF	95910		

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A35	PLAZA CONCRETE FLATWORK (heavy duty – 6” + fiber mesh additive)	SF	0		
A36	CONCRETE SIDEWALK	SF	1580		
A37	INSTALL CURB & GUTTER	LF	5800		
A38	INSTALL SOLID INLET COVER	EA	3		
A39	INSTALL HEEL PROOF INLET	EA	3		
A40	INSTALL CONCRETE VALLEY GUTTER (4’ Wide)	LF	577		
A41	INSTALL CONCRETE VALLEY GUTTER (2’ Wide)	LF	45		
A42	CONCRETE DRIVEWAY APPROACH (Traffic-rated pad)	EA	1		
A43	INSTALL CONCRETE WHEEL STOPS	EA	31		
A44	INSTALL REMOVABLE BOLLARDS	EA	62		
A45	INSTALL ADA PARKING SIGN & PAVEMENT MARKING	EA	31		
A46	INSTALL CHAIN LINK FENCE	LF	400		
A47	INSTALL NEW MONUMENT SIGN	EA	4		
A48	PERMANENT PAVEMENT MARKINGS ~ 4” STRIPING	LF	22000		
A49	CHAMBER SYSTEM (Lot 20)	CF	3589		

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
A50	CHAMBER SYSTEM (Lot 25)	CF	4685		
A51	STORM DRAIN STRUCTURE + INLET + ENVIROHOOD	EA	13		
A52	ADJUST EXISTING UTILITIES TO GRADE	EA	51		
A53	UPGRADE EXISTING UTILITIES WITHIN TRAVEL WAY TO BE TRAFFIC RATED	EA	51		
A54	ELECTRICAL SYSTEM	LS	1		
A55	12” HDPE STORM DRAIN PIPE	LF	1376		
A56	18” HDPE STORM DRAIN PIPE	LF	75		
A57	BIKE RACKS	EA	13		
A58	LANDSCAPE IRRIGATION	LS	1		
A59	TREES (Canopy, Evergreen, Ornamental)	EA	21		
A60	SHRUBS	EA	205		
A61	EDGING	LF	75		
A62	SEEDING & SOIL AMENDMENTS	LS	1		
A63	16” IRRIGATION VALVE	EA	1		
A64	4” HDPE IRRIGATION PIPE	LF	645		
A65	LANDSCAPE BOULDERS	EA	72		
A66	MISC. WORK	LS	1		
A67	SUBGRADE	SF	30,000		

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	TOTAL
	STABILIZATION				
A68	PRECAST STORM DRAIN STRUCTURE + INLET	EA	4		

C. BID ALTERNATE NO. 1:

CHANGED LINE-ITEM ESTIMATED QUANTITIES, AS A RESULT OF ALTERNATE NO. 1

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	ADD/DEDUCT
A31	GRAVEL PARKING SECTION (3" Replacement of Asphalt)	SY	25400		DEDUCTION
A32	ASPHALT PAVEMENT (Light Duty – 3")	SF	159,500		ADDITION
A33	ASPHALT PAVEMENT (Heavy Duty – 4")	SF	68,936		ADDITION
A48	PERMANENT PAVEMENT MARKINGS – 4" STRIPING	LF	23000		ADDITION

D. BID ALTERNATE NO. 2:

CHANGED LINE-ITEM ESTIMATED QUANTITIES, AS A RESULT OF ALTERNATE NO. 2

ITEM NO.	ITEM DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	ADD/DEDUCT
A34	PLAZA CONCRETE FLATWORK (Heavy duty 5" + fiber mesh additive)	SF	95910		DEDUCTION
A35	PLAZA CONCRETE FLATWORK (Heavy duty 6" + fiber mesh additive)	SF	95910		ADDITION

END OF SECTION 012200

SECTION 02110
GEOTEXTILES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work consists of furnishing and placing a geotextile as a subsurface drainage fabric permeable separator between dissimilar materials (such as between subgrade and subbase/base), stabilization fabric, temporary and/or permanent erosion control measures or as waterproofing/stress releasing membrane within pavement structures.

1.2 REFERENCES

A. The current publications listed below form part of this specification.

B. ASTM Standards

D123	Standard Terminology Relating to Textiles
D276	Standard Test Methods for Identification of Fibers in Textiles
D4354	Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products for Testing
D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles (Gra Method)
D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
D3786	Standard Test Method for Bursting of Textile Fabrics - Diaphragm Bursting Strength Tester Method
D4833	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
D4491	Standard Test Method for Water Permeability of Geo- textiles by Permeability
D4751	Standard Test Method for Determining the Number of Constrictions “m” of Non-Woven Geotextiles as a Complementary Filtration Property
D4354	Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products for Testing

D4759	Standard Practice for Determining the Specification Conformance of Geosynthetics
D276	Standard Test Methods for Identification of Fibers in Textiles
D4355	Standard Test Method for Deterioration of Geotextiles by Expōsure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus
D4873	Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
D5141	Standard Test Method for Determining Filtering Efficiency and Flow Rate of the Filtratīon for Component of a Sediment Retention Device
D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
D1140	Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft- lbf/ft3 (600 kN-m/m3)

C. AASHTO Specifications – Standard Specifications for Transportation Materials and Methods of Sampling and Testing

1. Augmenting and prevailing over this specification section.

PART 2 - PRODUCTS

2.1 PHYSICAL AND CHEMICAL REQUIREMENTS

A. Assure that fibers used in the manufacture of geotextiles, and the threads used in joining geotextiles by sewing, consist of long-chain synthetic polymers, composed of at least 95 percent by weight polyolefins or polyesters. They must be formed into a network so the filaments on yarns retain dimensional stability relative to each other, including selvedges. Furnish materials meeting the physical requirements listed in Section 2.4 or as shown on the plans.

B. Provide moderate or high survivability non-woven polypropylene fabric that is inert to commonly encountered chemicals and soils and that remains stable over a temperature range of -50 degrees Fahrenheit (-46° C) to 150 degrees Fahrenheit (66° C) and at a pH

range of 2 to 13.

2.2 CERTIFICATION

A. Assure the manufacturer furnishes the purchaser a certificate stating: the name of the manufacturer, the chemical composition of the filaments or yarns, and other information fully describing the geotextile. The manufacturer must include in the certificate a guarantee stating that the geotextile furnished meets specifications. The certificate must be attested to by a person having legal authority to bind the company. Mismarking, or misrepresentation by the manufacturer is reason to reject the geotextile under these specifications. Notice sent to the manufacturer by the purchaser regarding rejection of, will be considered to be notice to all wholesalers, jobbers, distributors, agents and other intermediaries handling the manufacturer's product.

B. Label the fabric and its container with the manufacturer's name and fabric type or trade name, lot number and quantity.

2.3 SHIPMENT AND STORAGE

A. During shipment and storage, protect the fabric from direct sunlight, ultra-violet days, temperatures exceeding 160 degrees Fahrenheit (71°C), mud, dust and debris. Keep the fabrics in the manufacturer's wrapping until just before use. Include with each shipping, a document, a certification showing that the geotextile meets the manufacturer's certificate and a guarantee that has been previously filed with the purchaser.

B. At the time of installation, the fabric will be rejected if it has defects, seams or weakness, rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or storage.

2.4 MATERIALS

A. Drainage Fabric

1. Furnish Class 2 fabric as specified in AASHTO M 288 – Geotextile Specifications for Highway Applications.

B. Separation Fabric

1. Furnish Class 1 fabric as specified in AASHTO M 288 – Geotextile Specifications for Highway Applications.

C. Stabilization Fabric

1. Furnish Class 1 fabric as specified in AASHTO M 288 – Geotextile Specifications for Highway Applications

D. Permanent Erosion Control

1. Furnish Class 1 fabric, as specified in AASHTO M 288 – Geotextile Specifications

for Highway Applications, with an Apparent Opening size of #40, #60, #70, or #100 (US Sieve No.), as shown on the plans.

E. Silt Fence Fabric

1. Support silt fence with either wood or metal fence posts.

2. Assure silt fence geotextile meets the minimum requirements in the following table:

Required Properties for Silt Fence		
Property	*Test Method*	*Value*
Minimum Grab Tensile Strength (lbs)	*ASTM D4632*	*>125*
Minimum Grab Tensile Strength, X Direction (lbs)	*ASTM D4632*	*>100*
Minimum Permittivity (sec^{-1})	*ASTM D4491*	*≥0.05*
Maximum Apparent Opening (US Sieve No.)	*ASTM D4751*	*#30*
Ultraviolet Stability (% Retained After 500 hrs of Exposure)	*ASTM D4355*	*≥70*

F. Landfill Cell Filter Fabric

1. Assure landfill cell filter fabric minimum requirements in the following table:

Required Properties for Landfill Cell Filter Fabric		
Property	*Test Method*	*Value*
Minimum Grab Tensile Strength (lbs)	*ASTM D4632*	*390*
Grab Tensile Elongation (%)	*ASTM D4632*	*50*
Puncture (lb)	*ASTM D4833*	*240*
Maximum Apparent Opening Size (US sieve number)	*ASTM D4751*	*100*

PART 3 - EXECUTION

3.1 GENERAL

A. Where placing geotextiles on native ground, cut the trees and shrubs flush with the ground surface. Do not remove the topsoil and vegetation mat. Remove all sharp objects and large rocks. Fill depressions or holes with a suitable material to provide a firm foundation.

B. Replace or repair all geotextile that is torn, punctured, or muddy. Remove the damaged area and place a patch of the same type of geotextile overlapping 3 feet, in all directions, (0.9m) beyond the damaged area.

3.2 DRAINAGE, SEPARATION AND STABILIZATION APPLICATIONS

A. Shape the subgrade to a smooth surface and to the cross section required. Shape slopes to gradually transition into slope adjustments without noticeable breaks. At the ends of cuts, the intersection of cuts, and embankments, adjust slopes in the horizontal and vertical planes to blend into each other or into the natural ground.

B. Remove all material larger than 6 inches (15 cm) within the top 6 inches (15 cm) of the roadbed. Remove unsuitable material from the roadbed and replace with suitable material. Finish the roadbed and ditches to the required elevation and cross-section.

C. Place the geotextile smooth and free of tension, stress, or wrinkles. Fold and cut the geotextile to conform to curves. Overlap in the direction of construction. Overlap the geotextile a minimum of 2 feet (0.6m) at the ends and sides of adjoining sheets or sew the geotextile joints according to the manufacturer's recommendations. Do not place longitudinal overlaps below anticipated wheel loads. Hold the geotextile in place with pins, staples, or piles of cover material.

D. End dump the cover material onto the geotextile from the edge of the geotextile or from previously placed cover material. Do not operate equipment directly on the geotextile. Spread the end-dumped pile of cover material maintaining a minimum lift thickness of 10 inches (250mm). Compact the cover material with rubber-tired or nonvibratory smooth drum rollers. Avoid sudden stops, starts, or turns of the construction equipment. Fill all ruts from construction equipment with additional cover material. Do not regrade ruts with placement equipment.

E. Place subsequent lifts of cover material in the same manner as the initial lift. Vibratory compactors may be used for compacting subsequent lifts. If foundation failures occur, repair the damaged areas and revert to the use of nonvibratory compaction equipment.

3.3 TEMORARY AND PERMANENT EROSION CONTROL APPLICATIONS

A. Place and anchor the geotextile on the approved smooth-graded surface. For slope protection, place the long dimension of the geotextile down the slope. For stream bank protection, place the long dimension of the geotextile parallel to the centerline of the channel.

B. Overlap geotextile a minimum of 24 inches (60 cm) at the ends and sides of adjoining sheets or sew the geotextile joints according to the manufacturer’s recommendations. Overlap the uphill or upstream sheet over the downhill or downstream sheet. Offset end joints of adjacent sheets a minimum of 5 feet (1.5 m). Pins may be used to hold the geotextile sheets in place other than on interior slopes of lagoons or ponds. Space pins along the overlaps at approximately 3-foot (1 m) centers.

C. Place aggregate, slope protection, or riprap on the geotextile starting at the toe of the slope and proceed upward. Place materials by overhead construction methods or in such a manner that no vehicles or equipment operate directly on the fabric. Place riprap onto the geotextile from a height of less than 12 inches (30 cm). Place slope protection rock or aggregate backfill onto the geotextile from a height less than 3 feet (1 m). In underwater applications, place the geotextile and cover material in the same day.

3.4 PAVEMENT APPLICATIONS

A. Use SS-1 crack filler meeting the applicable section for crack filler for surface preparation of cracks between 1/8-and 1/4-inch wide. Fill cracks exceeding 1/4- inch (6 mm) width with an asphalt emulsion slurry consisting of 20% by volume of SS-1, 2 percent by volume Portland Cement and the remaining portion fine sand.

B. Use distributors for spraying a Performance Graded (PG) Asphaltic Binder meeting the specifications for the asphalt cement being used in the asphalt concrete overlay.

C. Place fabric using manufacturer recommended equipment.

D. Handle and place all fabric following the manufacturer's recommendations.

E. Clean pavement to receive fabric, free of dirt, water, and vegetation. Clean all cracks between 1/8-inch (3 mm) and 1/4-inch (6 mm) wide and fill flush to the surface with SS-1 bituminous material. Top with sand. Repair larger cracks or holes using the asphalt emulsion slurry. Pour the mixture into the cracks until full. Re-fill with slurry the following day, any cracks which are not filled initially. When a leveling course is required, place it before installing the fabric. Areas to be covered with a leveling course do not require surface preparations for cracks unless the leveling courses will be less than 0.3 foot (10cm).

F. Uniformly apply the asphaltic binder at the rate determined by the Engineer. The quantity will vary with pavement porosity. Take care to place sufficient binder to satisfy the fabric and make the membrane impervious to water without causing a slippage plane. The applications rates are typically 0.25 to 0.30 gallon per square yard. Apply binder using a distributor.

G. Heat the asphalt binder high enough to permit a uniform spray pattern. Ensure air temperature is at least 50 degrees Fahrenheit (10° C) and rising before applying binder and fabric.

H. Place the paving geotextile onto the asphalt sealant with minimal wrinkling. Slit, lay flat and tack all wrinkles or folds higher than 1inch (25 mm). Broom and/or roll the paving geotextile to maximize fabric contact with the pavement surface.

I. At geotextile joints, overlap the geotextile 1 to 3 inches (25 to 75 mm) to ensure full closure. Overlap transverse joints in the direction of paving to prevent edge pickup by the paver. Apply additional asphalt sealant to paving geotextile overlaps to ensure proper bonding of the double fabric layer.

J. If asphalt sealant bleeds through the fabric, treat the affected areas with lotter. Minimize traffic on the geotextile. If circumstances require traffic on the fabric, apply blotter and place "slippery when wet" signs.

K. Broom the excess blotter from the geotextile surfaces before placing the overlay. Repair all damaged fabric before placing overlay. Apply a light tack coat before placing the overlay. To avoid damaging the geotextile, do not turn equipment on the geotextile.

L. Place a hot asphalt concrete overlay within 48 hours after placing the paving geotextile. Limit the lay-down temperature of the mix to a maximum of 325°F (163°C) except when the paving geotextile is composed of polypropylene fibers, limit the lay-down temperature of the mix to a maximum of 300°F (149°C).

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

~~A.~~ All geotextiles will be measured by the square yard on a plane parallel to the ground surface, excluding overlaps. ~~The accepted quantities, measured as provided above, will be paid at the contract price per unit of measurement for the pay item that is shown in the bid schedule.~~

B. Payment indicated to include complete compensation for all labor, equipment, materials and incidentals required for the completion of the work as shown in the Project Plan Sheets.

4.2 PAVING FABRICS

A. Fabric is measured and paid per square yard of roadway surface covered, complete and in place. No allowance is made for additional fabric required for overlap joints. No allowance is made for blotter sand (if occasionally required).

B. Crack filling is measured per job and payment is at contract lump sum price, complete in place.

C. Asphalt cement binder is measured and paid by the ton, corrected to standard temperature, complete in place.

D. Fabric to follow Geotechnical recommendation and design document requirements.

END OF SECTION

SECTION 02111

CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work consists of removing and disposing of existing features, trees, stumps, brush, roots, shrubs, logs, windfalls, and all miscellaneous debris and other objectionable matter.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 PROTECTION

A. Locate and protect all above ground and below ground utilities or relocate as directed by the Contract.

B. Protect benchmarks and survey monuments from damage and displacement.

C. Protect land outside of construction/disturbance limits as indicated in the construction documents.

D. Protect existing roads from damage.

E. Retain and protect any trees and vegetation not designated for removal.

1. No equipment, vehicles, building materials, chemicals, stockpiles or debris shall be placed within the tree protection area.

2. No changes in grade should be made within the tree protection area.

3. Should excavation damage or break roots greater than 1 inch in diameter, make a clean saw cut through the undamaged portion of the root behind the break perpendicular to the root.

4. Should excavation result in damage to roots greater than 2 inches in diameter, branches, or bark, notify the CLIENT immediately.

5. If required by the CLIEN, hire an approved tree service to trim trees, prior to beginning excavation.

F. The Contractor is responsible for damage resulting from construction operations.

G. Preserve and protect all vegetation and ground cover not within the construction area, including areas not requiring grading, as directed.

3.2 REMOVAL AND DISPOSAL

A. Complete clearing and grubbing as required within the disturbance limits defined by a line drawn as shown on the Contract Documents or as directed.

B. Unless otherwise provided, all merchantable timber in the clearing area not removed from the project area prior to the beginning of construction becomes the property of the Contractor.

C. Remove all brush and shrubs from the site including the roots. Dispose of the shrubs and brush off-site at a location provided by the Contractor.

D. Strip all soils, heavy growths of grass, and sod that comprise the organic root-zone.

E. Unless otherwise directed remove all stumps within the clearing disturbance limits.

F. Dispose of all removed materials at offsite locations that comply with all Federal, State, and Local Regulations.

3.3 CLEANUP

A. Upon completion of the site work and project, clean the entire work area. Remove all excess excavated material, rocks, boulders, brush, trees, pipe, or debris of any type from the site and dispose at a site acceptable to Federal, State, and Local Regulations.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Payment indicated to include complete compensation for all labor, equipment, materials and incidentals required for the completion of the work.

B. ~~Payment will be made under Clearing and Grubbing – per square foot~~.

END OF SECTION

SECTION 02112

REMOVAL OF EXISTING PAVEMENT, CONCRETE CURB, SIDEWALK, DRIVEWAY AND/OR STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work consists of removing and disposing of existing pavement, concrete curb, combined curb and gutter, sidewalk, private driveways, and crosswalks, along with any structures designated for removal in the contract documents. Additional details of removals are specified in the contract documents.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 GENERAL

A. Dispose of all existing pavement, concrete curb, crosswalk and/or combined curb and gutter specified for removal in the contract documents or directed by the Engineer. Exercise care in such removal to assure that remaining nearby facilities and/or structures are not disturbed. Restore to original condition any such existing facilities or structures damaged by construction activities.

B. Remove and dispose of designated existing pavement to the lines indicated on the contract documents or directed by the Engineer. Make straight and approximately vertical cuts of edges along which new pavement is to be placed.

C. Remove and dispose of existing private concrete driveways and/or sidewalks which interfere with construction of street improvements, or which do not match the new grade as shown on the contract documents or as directed by the Engineer. Remove such driveways and/or sidewalks to a distance of 8 inches behind curbs, or to greater distance if required to properly match the new curb and gutter grade. Remove along the neat line produced by a concrete saw cut. Make cuts to a depth of the thickness of the driveway and/or sidewalk or to a maximum depth of 6 inches, whichever is lesser, and take care in removing the concrete assuring the slab breaks on the sawed neat line.

PART 4 - MEASUREMENT AND PAYMENT

4.1 ASPHALTIC CONCRETE PAVEMENT REMOVAL

A. Removal and disposal of asphalt concrete pavement is part of Section 2230, Street Excavation, Backfill and Compaction. No separate payment will be made for this item.

4.2 CONCRETE REMOVAL

A. All concrete required to be removed shall be measured by the lineal foot, square yard, or cubic yard as described by the contract documents. No separate payment will be made for this item.

B. Concrete removal and disposal shall be paid for as part of lump sum bid ~~at the contract unit price bid~~, constituting full compensation for all equipment, tools and labor, including the performance of all work to provide incidentals necessary to complete this item as shown in the Project Plan.

~~C. Measurement and payment for concrete removal and disposal will be made only if listed as a separate pay item in the contract documents. If not listed separately in the contract as a bid item, concrete removal and disposal will be included as part of Section 2230, Street Excavation, Backfilling and Compaction.~~

D. Payment will be made under one of the following if identified in the contract documents: Lump sum for work shown in Project Plan Sheets.

~~1. Concrete Removal – Per Lineal Foot~~

~~2. Concrete Removal – Per Square Yard~~

~~3. Concrete Removal – Per Cubic Yard~~

4.3 CONCRETE SAW CUT

A. For those projects where concrete saw cutting is a substantial item of work, this item may be measured and paid for at the contract unit price bid per lineal foot, constituting full compensation for all equipment, tools and labor, including the performance of all work to provide incidentals necessary to complete this item. No separate payment will be made for this item.

B. Payment will be made under the following:

~~1. Saw Cut for Concrete Pavement, Sidewalk, Driveway, and Curb and Gutter – Per Lineal Foot.~~

~~C. Measurement and payment for concrete saw cuttings will be made only if listed as a separate item in the bid documents. If not listed in the contract as a bid item, saw cutting shall be part of the Concrete Removal in Section 4.2 above, or part of the Excavation Above Subgrade item in Section 2230, Street Excavation, Backfill and Compaction, Excavation. Concrete saw cut work will not be paid in the event that there is an existing joint within the concrete that provide a means of tying to concrete or asphalt resulting in the same or comparable end product.~~

4.4 GENERAL

A. Payment indicated to include complete compensation for all labor, equipment,

materials and incidentals required for the completion of the work as shown in the Project Plan Sheets.

END OF SECTION

SECTION 02113

ADJUSTING EXISTING MANHOLES, INLETS, WATER VALVE BOXES, WATER SERVICES, UTILITY VAULTS, AND FIRE HYDRANTS TO GRADE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section consists of locating and adjusting to grade existing manholes, inlets, water valve boxes or services, utility vaults or accesses, and fire hydrants as shown in the contract documents, staked in the field or as required in the Special Provisions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide all materials including concrete, brick and mortar, complying with the specification section for the particular material involved, or if the material is not covered in these specifications, the material used for adjusting shall be equal, and comparable to that in the existing structure. If extensions for water valve boxes or services and fire hydrants are required beyond the length found to exist, provide items comparable to those in the existing structure.

PART 3 - EXECUTION

3.1 GENERAL

A. Bring to required grade all existing manholes, inlets and water valve boxes by either lowering or raising in accordance with the details shown in the contract documents. Do not lower manholes or inlets by removal of portions of the cones or barrel sections. Accomplish downward adjustments by replacement of existing sections with shorter sections. Assure that all structures have a minimum of one 2-inch concrete adjusting ring and a maximum of 12 inches of rings under the casting. Do not use brick and/or mortar for adjustment of castings.

B. On manholes requiring steps, assure that maximum spacing between steps is 16 inches and that 10 inches is the maximum distance from the top of the manhole cone section to the first step.

C. Excavate water valve boxes and services to readily determine whether height adjustment can be made without substituting a longer section. Adjust water valve boxes and services laterally so the valve stems can be operated by the extension. Adjust water services by raising or lowering the curb key stop and extension box.

D. Adjust manholes and water valve boxes to final grade before placing the final pavement surface. If required, make preliminary adjustment to allow placement of base courses and paving adjacent to the manhole or water valve.

E. Provide backfill material conforming to the requirements of Section 02235, 1 inch Minus Crushed Base Course, and compacted to at least 97% percent of the maximum dry density as determined by AASHTO T99 or ASTM D698.

F. If required, make minor adjustments 5 feet to 10 feet in the horizontal location of existing fire hydrants to ensure that they are the required minimum distance behind the back of curb. At the time of construction staking, any hydrants which require horizontal adjustment will be located by the Engineer and the adjusted location will be staked by the Engineer.

G. Make any minor adjustments required as dimensioned in the contract documents to the height of existing fire hydrants to ensure that they are at a reasonable height above the back of curb. At the time of construction staking, any hydrants which require vertical adjustment will be located by the Engineer and the adjusted height will be staked by the Engineer. Accomplish extension of fire hydrant height only by the use of standard extension spools provided by the hydrant manufacturer.

H. Before final acceptance, clean all manholes, inlets and water valve boxes/services. Assure that all water valve boxes, services and fire hydrants are operational.

I. All requirements of this section shall apply to new, as well as to existing, manholes, valve boxes, water services and fire hydrants.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Payment indicated to include complete compensation for all labor, equipment, materials and incidentals required for the completion of the work.

4.2 ADJUSTING EXISTING MANHOLES, LAMPHOLES, INLETS, WATER VALVE BOXES, WATER SERVICES, AND OTHER UTILITIES WITHIN PROJECT AREA

A. These items are measured and paid for as part of lump sum bid ~~for by the number of existing facilities adjusted, complete in place, at contract unit price bid for the item~~, constituting full compensation for all necessary materials, excavation, backfill, compaction, cleaning, labor, tools and incidentals. No separate payment will be made for this item.

B. Payment will be made under:

~~1. Existing Sewer Manholes to Adjust - Per Each~~

~~2. Existing Sewer Lampholes to Adjust - Per Each~~

~~3. Existing Storm Drain Inlets to Adjust - Per Each~~

~~4. Existing Water Valve Boxes to Adjust - Per Each~~

5. Existing Water Services to Adjust - Per Each

6. Existing Utility Service/Access/Vault/Box to Adjust – Per Each

4.3 LOCATION ADJUSTMENT FOR EXISTING FIRE HYDRANTS

A. This item is measured and paid for by the number of existing fire hydrants adjusted horizontally, complete in place, at the contract unit price bid for "Horizontal Adjustment for Existing Fire Hydrants", constituting full compensation for all material, excavation, backfill, compaction, labor, tools and incidentals. No separate payment will be made for this item.

B. Payment will be made under:

1. Horizontal Adjustment for Existing Fire Hydrant - Per Each

4.4 VERTICAL ADJUSTMENTS FOR EXISTING FIRE HYDRANTS

A. This item shall be measured and paid for by the vertical adjustment of existing fire hydrants, complete in place, as measured in the field to the nearest one-half foot, at the contract unit price bid for "Vertical Adjustment for Existing Fire Hydrants", materials, including any additional stem length, excavation, backfill, compaction, concrete, labor, tools and incidentals.

B. Payment will be made under:

1. Vertical Adjustment of Existing Fire Hydrant - Per Vertical Foot

END OF SECTION

SECTION 02114
RELOCATING OR REMOVING UTILITY POLES, SIGNS AND MAILBOXES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This item consists of relocating or removing existing streetlights, signs, power poles, telephone poles, and mailboxes, as shown in the contract documents.

PART 2 - PRODUCTS - NOT USED

PART 3 - EXECUTION

3.1 POWER, STREET LIGHT, AND TELEPHONE POLES

A. Affected utility companies are to move power, streetlight, and telephone poles unless they are designated in the contract documents to be removed or relocated by the CONTRACTOR. If a utility company is non-responsive, notify ENGINEER. Coordinate all utility relocation activity with the construction activity.

B. When relocating or removing power poles, street light poles, and telephone poles, comply with the contract documents' applicable requirements.

3.2 STREET, TRAFFIC CONTROL, AND ADA SIGNS

A. Remove and reinstall all street, stop, and other traffic control/direction signs designated to be relocated by the CONTRACTOR as shown in the contract documents or as designated by the ENGINEER. Include removing, temporarily installing, storing, and permanently installing the signs.

B. The locations shown in the contract documents for streetlights, street signs, power poles, telephone poles, and private mailboxes to be relocated are approximate. The specific locations are to be designated by the ENGINEER in the field.

C. Relocate all signs within the staked grading limits whose existing locations do not conform to final plan locations. Also, relocate signs outside the staked grading limits to conform to final plan locations.

D. Preserve all street, stop, ADA, and other traffic control and direction signs that are to remain in place. Should any such signs be moved for the CONTRACTOR's convenience, permanently reinstall the signs after curb and gutter construction is complete. Assume responsibility for any damage to such signs. No extra compensation will be allowed for preserving, removing, or replacing stop and traffic control and direction signs designated to remain in place since this work is considered incidental to the contract unit prices for the various items of the contract.

E. Where stop signs and traffic direction or control signs are temporarily removed but are

needed for traffic reasons during construction, temporarily install a similar stop sign or traffic direction sign in locations acceptable to the ENGINEER. Assure that the temporary signs remain in place until the permanent stop or traffic control signs are in place.

F. Do not install street signs temporarily.

G. Store signs which are not used for temporary installation.

H. Set all permanent signs in fresh concrete, the pole supporting the sign being vertical, and the bottom of the sign being 7'-0" above the top of the curb or sidewalk. Replace all signs which are damaged during removal with new signs.

I. Assure that all sign locations conform to the latest issue of the Manual on Uniform Traffic Control Devices and MSU Standards.

3.3 MAILBOXES

A. Mailboxes within the staked grading limits generally are not shown in the contract documents. Mailboxes are not to be removed in this project. Any Mailbox damaged or reset will be replaced and installed at CONTRACTOR expense. Within 48 hours following the damage or removal, reinstall the mailboxes behind the curb in accordance with current U.S. Post Office regulations and applicable City standards.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Measurement and payment for the following items are made only if listed as separate pay items in the contract documents. If not so listed separately, these items will not be paid separately but are to be included as incidental to the other pay items of the contract documents.

4.2 POWER, STREET LIGHT, AND TELEPHONE POLES

A. Reinstall all power, street light, and telephone poles removed for the Contractor's convenience at no cost.

B. Power, street light, and telephone poles designated for relocation or removal shall be measured and paid for by the number of poles relocated or removed at the unit price bid for "Existing Power, Light, and Telephone Poles to be Relocated" or "Existing Power, Light and Telephone Poles to be Removed," which price and payment constitute full compensation for all materials, excavation, temporary and/or permanent installation, forming and curing of concrete, equipment, tools, labor, and incidentals necessary to complete this item.

C. Payment will be made under:

1. Existing Power, Light, and Telephone Poles to be Relocated - Per Each.

2. Existing Power, Light, and Telephone Poles to be Removed - Per Each.

4.3 STREET, TRAFFIC CONTROL, AND ADA SIGNS

A. Reinstall all street, stop, ADA, and traffic control or direction signs removed for the Contractor's convenience at no cost.

B. Street, stop, ADA, and traffic control or direction signs designated for relocation or removal shall be measured and paid for by the number of street, stop, and traffic control or direction signs relocated or removed at the unit price bid for "Existing Signs to be Relocated" or "Existing Signs to be Removed," which price and payment constitute full compensation for all materials, excavation, temporary and/or permanent installation, forming and curing of concrete, equipment, tools, labor, and incidentals necessary to complete the item. If two or more signs exist on one post, they are defined as one sign for payment purposes.

C. Payment will be made under:

1. Existing Signs to be Relocated - Per Each.

2. Existing Signs to be Removed - Per Each.

4.4 MAILBOXES

A. Reinstall existing mailboxes removed for the Contractor's convenience at no cost.

B. Mailboxes designated for relocation shall be measured and paid for by the number of mailboxes relocated at the unit price bid for "Existing Mailboxes to be Relocated," which price and payment constitute full compensation for all materials, excavation, temporary and/or permanent installation, forming and curing of concrete, equipment, tools, labor, and incidentals necessary to complete the item.

C. Payment will be made under:

1. Existing Mailboxes to be Relocated - Per Each.

4.5 GENERAL

A. Payment indicated to include complete compensation for all labor, equipment, materials, and incidentals required for the completion of the work.

END OF SECTION

SECTION 02221
TRENCH EXCAVATION AND BACKFILL FOR PIPELINES & APPURTENANT STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work is the excavation, trenching, and backfilling for pipelines and appurtenances. It includes all clearing, grubbing, site preparation, removal, and disposal of debris from the excavation, handling and storing materials for fill and backfill, all bracing, shoring and trench protection, construction dewatering, all backfill, subgrade preparation, final grading, site dressing, and cleanup.

1.2 REFERENCES

A. The current publications listed below form a part of this specification.

AASHTO T99	Moisture-Density Relations of Soils Using 5-lb (2.5kg) Rammer and 12- inch (305mm) Drop
ASTM D698	Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)(600 kn-m/m^3))
AASHTO T191 (ASTM D1556)	Density of Soil In-Place by the Sand-Cone Method
AASHTO T310 aggregate (ASTM D6938)	In-Place density and water content of the soil and soil by Nuclear Method (Shallow Depth)
AASHTO T11 (ASTM C117)	Materials Finer Than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T27 (ASTM C136)	Sieve Analysis of Fine and Coarse Aggregate
AASHTO T89	Determining the Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
ASTM D4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4253 Vibratory Tube	Maximum Index Density and Unit Weight of Soils Using a
ASTM D4254 of	Minimum Index Density and Unit Weight of Soils and Calculation Relative Density

1.3 TESTING

A. Field Density Testing

1. Meet the quality control and quality assurance testing requirements in Section 014000, QUALITY REQUIREMENTS.

2. In-place field density tests for quality assurance are at Owner expense meeting AASHTO T191 (ASTM D1556), Sand Cone Method; or by AASHTO T310 (ASTM D6938) Nuclear Densometer Methods. Quality assurance field density testing frequency is at the ENGINEER's discretion.

3. Retesting failing areas is at the expense of the CONTRACTOR. Where ENGINEER provides testing on behalf of the Owner, the CONTRACTOR will be assessed the cost of all retests conducted by the ENGINEER, with that cost deducted from the progress payments.

4. At the direction of the ENGINEER, provide the necessary equipment and labor to excavate and replace materials for test holes up to 5 feet deep into the compacted backfill to allow testing below the surface of any layers covered without inspection and approval by the ENGINEER.

B. Laboratory Maximum Density and Optimum Moisture

1. Quality assurance tests will be made by the ENGINEER for each on-site natural soil or each source of off-site material, including borrow material, to determine the laboratory maximum density values and optimum compaction moisture content according to AASHTO T-99 or ASTM D698.

C. Material Submittals

1. Submit to the ENGINEER material quality test results, including Type 1 Bedding gradation and plasticity index, and Type 2 Bedding gradation.

2. Submit to the ENGINEER laboratory moisture-density relationship testing results of on-site and off-site borrow soils.

PART 2 - PRODUCTS

2.1 PIPE BEDDING MATERIALS

A. Type 1 Pipe Bedding

1. Type 1 Pipe Bedding includes the material placed from 4 inches below the bottom of the pipe to 6 inches over the pipe.

2. Provide Type 1 Bedding consisting of crushed stone or gravel, which is free of cementitious substances or thin, flat particles in an amount that would cause the material to cake, pack, or otherwise form and unyielding support for the pipe.

3. Provide imported granular material with a gradation as follows and a maximum plasticity index of 6, determined by AASHTO T89 and T90 or by ASTM D4318.

Percent by Weight Passing	
Sieve Size	% Passing
1" (25 mm)	100
3/4” (19.0 mm)	90 - 100
3/8” (9.5 mm) No.	20 - 55
4 (4.75 mm) No.	5 - 10
8 (2.36 mm)	0 - 5

4. Crush material so that the percentage of fractured particles in the finished product is as constant and uniform as practical. Crush to produce material where at least 50 percent of the material retained on the No. 4 sieve has at least one fractured face.

5. To prevent migration of material from around the pipe, do not use sand, sandy gravel, or material composed mainly of sand for bedding material in the pipe zone where groundwater is or will be present or where existing material contains voids which would allow migration. Where trench excavation encounters wet or unstable material, Type 1 Pipe Bedding must be well graded, free- draining, and non-plastic.

6. Refer to the Special Provisions and details in the Drawings for other requirements.

B. Type 2 Pipe Bedding

1. Type 2 Pipe Bedding is used as directed by the ENGINEER to replace unsuitable material encountered in the trench bottom.

2. Place Type 2 Pipe Bedding from the bottom of the Type 1 Bedding material to the depth required to adequately support the pipe.

3. Type 2 Bedding consists of granular material meeting the following gradation and having a maximum plasticity index of 6 and a maximum liquid limit of 25%.

Percent by Weight Passing	
Sieve Size	Type B-Modified
3" (75 mm)	100
No. 4 (4.75 mm)	0 - 25
No. 8 (2.36 mm)	0 - 10

C. Separation Geotextile

1. The plans may require, or the ENGINEER may direct, the use of non-woven geotextile fabric intended to provide materials separation. The fabric will wrap all or part of the Type 1 Pipe Bedding and Select Type 1 Pipe Bedding to prevent materials migrating into the trench bottom and trench walls as shown on the plans or as directed by the ENGINEER. The fabric shall be AASHTO M288 Class 1, 2, or 3 as specified or determined by the ENGINEER and shall fully comply with MPW Section 2110.

2.2 TRENCH BACKFILL MATERIALS

A. Materials from Trench Excavation

1. Backfill material obtained from trench excavations must be free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious materials. Backfill materials and placement are further described in the Execution Section of this specification.

B. Imported Backfill Material

1. Imported backfill material is from borrow source(s) outside the project limits and is used when, in the opinion of the ENGINEER, an adequate volume of suitable backfill material is not available within the project limits. Imported Backfill Materials must comply with the requirements of Section 2.2.A, MATERIALS FROM TRENCH EXCAVATION.

2.3 FLOWABLE FILL

A. Flowable fill will not be used.

2.4 DETECTABLE BURIED WARNING TAPE

A. Detectable buried warning tape is to have a minimum 6-inch width and 5-mil thickness and a solid aluminum core running the full length and width of the tape enclosed in a color-coded inert plastic jacket, impervious to alkalis, chemical reagents and solvents in the soil. The tape is to meet APWA/ULCC Color Code requirements and is to have a maximum 36-inch imprint.

PART 3 - EXECUTION

3.1 PROTECTION OF EXISTING PROPERTIES

A. General

1. Take precautions to protect all adjoining private and public property and facilities, including underground and overhead utilities, curbs, sidewalks, driveways, structures, and fences. Restore or replace all disturbed or damaged facilities to its original condition at the CONTRACTOR's expense.

2. Contact utility owners using the Montana One Call System for utility locates

before starting work. Protect the utilities exposed during the work and prevent damaging underground utilities adjacent to excavations. Immediately notify the utility owner of any construction damage. Repairs of damage to marked utilities are at the expense of the CONTRACTOR.

3. Re-locate existing water mains, sanitary sewers, and storm drains shown on the plans that conflict with new pipelines or structures, as indicated in the contract documents. No separate payment will be made for this work unless shown as a payment item. If the Owner authorizes the relocation of mains or sewers, which are not indicated in the bid documents, and the ENGINEER determines the work was not included in the original contract, payment will be made under the applicable sections of the General Conditions.

4. Cut and replace existing service lines interfering with trenching operations only with the ENGINEER's permission and at the CONTRACTOR's expense.

5. Show all repaired and/or adjusted water and sewer lines on the As-Built Plans.

6. Protect existing water and sewer mains and water and sewer services from freezing at all times during construction.

B. Privately Owned Utilities

1. If any existing private utility interferes with the work in either alignment or grade and has to be moved, the work will be performed by the appropriate Utility Owner unless otherwise specified in the contract documents. Such private utilities may include gas mains, underground electrical and telephone cables, telephone poles, light poles, etc.

2. If, however, such private utility relocation is performed by the CONTRACTOR, and the relocation is not a separate payment item, payment will be made under Section 02221 conditions covering such changes.

3. Such payment will be made only if the work is determined by the ENGINEER to be a change from the original contract work scope.

C. Existing Structures

D. Prevent damage to existing buildings or structures in the work area. Repair all construction related damage to the satisfaction of the Owner Existing Overhead Utilities

1. Use extreme caution to avoid conflict, contact, or damage to overhead utilities during the work.

E. Exploratory Excavation

1. The location of existing buried public utilities may need to be verified by exploratory excavation before construction.

2. Where authorized by the ENGINEER, the CONTRACTOR will be reimbursed for exploratory excavation work at the unit price bid per hour for a backhoe/excavator with an operator and a laborer to assist. Use a backhoe/excavator having at least 60 horsepower, as rated by the manufacturer.

3. The unit price per hour includes the backhoe/excavator, operator, and one laborer based upon the actual time, to the nearest one-half hour, that the equipment and personnel are used in actual excavating and backfilling operations, including standby time between excavation and backfilling, which allows the ENGINEER to make the necessary survey of the underground utilities.

4. Exercise care to prevent damaging all utilities and repair any utility damage caused by exploratory excavation.

F. Pavement Removal and Stripping

1. Where trench excavation or appurtenant structure excavation requires removing curb and gutter, concrete sidewalks, asphalt concrete pavement, or Portland cement concrete pavement, cut the concrete or pavement in a straight line parallel to the excavation's edge using a spade-bitted air hammer, concrete saw or other suitable equipment to produce a straight, square and clean break. Re-cut edges broken during construction, before concrete or paving operations.

2. For trenches passing through the existing pavement, cut the pavement along a neat vertical line at least 12 inches from the trench edge. Where the neat line cut is less than 3 feet from the edge of the existing pavement, remove and replace the entire pavement section between the trench and edge of the pavement.

3. Dispose of the asphalt concrete and/or Portland cement concrete debris off-site according to applicable state and local regulations.

G. When excavating across existing gravel streets or other developed surfaces, remove the surfacing material full depth and stockpile for inclusion in the trench backfill or legally dispose of the surfacing material.

H. When excavating across cultivated or sodded areas, remove full topsoil depth or a maximum 12-inch depth, whichever is less, and stockpile for possible project use.

I. Re-sod or reseed all established lawn areas cut by trenching or damaged during the construction.

3.2 MAINTENANCE OF FLOWS

A. Maintain the flow of sewers, drains, and watercourses encountered during construction. Restore culverts, ditches, fences, crosswalks, and structures disturbed by construction to their original condition upon completion of the work.

3.3 TRENCH EXCAVATION

A. General

1. Meet current OSHA Safety and Health Standards for all excavation, trenching, shoring, and related work.

2. Excavate at the specified locations for pipeline installations and appurtenant structures.

3. Crossings under sidewalks or curbs may be made by tunneling if approved by the ENGINEER. If a portion of a sidewalk or curb is removed, use a concrete saw to make joints, compact the backfill as specified, and replace the removed Section with a new concrete sidewalk or curb.

4. During excavation, stockpile backfill materials away from the trench banks to assure trench wall stability. Stockpile excavated materials on only one side of the trench without obstructing existing fire hydrants, valves, manholes, and other appurtenances. Assure surface drainage of adjoining areas is unobstructed.

5. Remove and dispose of all excess or unsuitable excavated materials.

6. Prevent surface water from flowing into excavations. Promptly remove all water accumulating in trench excavations. Do not permit water to accumulate in any open trench. Remove and re-lay all pipe out of alignment or grade caused by trench flooding.

7. Grade the trench bottoms to the specified lines and grades. Assure bedding material provides uniform bearing and support for each pipe section along its entire length. Excavate for bell and joints after the trench bedding is graded, limiting the excavation to the required length, depth, and width for making the particular type of joint used. Backfill over-excavations with Type 2 Bedding Material.

8. No classification of trench excavated materials will be made. Excavation and trenching work includes the removal and subsequent handling of all earth, loose or cemented gravel, loose or solid rock, and other materials excavated or otherwise removed in the performance of the contract work, regardless of the type, character, composition, or condition thereof. All materials excavated or otherwise removed, including asphalt, curb, gutter, sidewalk, soils, etc., will become the property of the CONTRACTOR, who will be responsible for environmentally sound disposal of said material in accordance with state and federal regulations.

9. The use of trench digging machinery is permitted, except in places where its operation is likely to cause damage to existing structures or features, in which case hand methods are to be employed.

B. Trench Dimensions

1. Excavate to the trench dimensions specified below.

2. Width

    a. Excavate to provide room to install and join the pipe as specified. The minimum trench width is 3'-6", for outside pipe diameters of 18 inches or less. The minimum trench width is 2'-0" plus the outside pipe diameter, for pipe sizes exceeding 18 inches. Maximum trench width may be specified in the contract documents.

    b. If the trench is excavated wider than the specified minimum, provide Type 1 Pipe Bedding for the additional width to yield a consistent backfill for the entire width of the trench or take such other measures as the ENGINEER may direct to protect the pipe against the crushing forces of trench backfill at the CONTRACTOR's expense.

3. Depth

    a. Excavate the trench as required for the invert grade or pipe bury as specified in the contract documents, plus 4 inches for the Type 1 Pipe Bedding. If bedrock, boulders, or large stones are encountered at the bottom of the trench, excavate at least 6 inches below the bottom of the pipe for backfilling with Type 1 Pipe Bedding.

C. Soft or Unsuitable Trench Subgrade

1. When soft or unstable material is encountered at the trench subgrade, which will not uniformly support the pipe, excavate the material to the depth directed by the ENGINEER and backfill to trench subgrade elevation with Type 2 Pipe Bedding.

D. Blasting

1. Not approved for this project.

E. Pavement Damage Cause by Equipment

1. Equip all track-mounted equipment operated on pavement surfacing with pads to prevent pavement damage.

2. Remove and replace all pavement damaged during construction by the CONTRACTOR's equipment, or the use thereof, to at least a depth of 1 inch. Patches will not be allowed less than 1 inch in thickness.

3. Replace all asphalt pavement damaged during construction outside of restoration pay limits in conjunction with asphalt restoration and as otherwise required by the ENGINEER. Provide asphalt meeting the requirements of Section 02510: Asphalt Concrete Pavement, and place asphalt to produce a final surface uniform in texture and consistent with the line and grade of

adjacent pavement or as directed by ENGINEER. No compensation will be allowed for removal and replacement of damaged pavement outside of the pay limits for asphalt restoration.

4. Assure work and materials for pavement restoration is in accordance with Section 02510: Asphalt Concrete Pavement.

F. Shoring, Bracing, and Sheeting

1. Provide all shoring, bracing, and tight sheeting required to prevent caving and protect workers, meeting current Occupational Safety and Health Act Requirements, and to protect adjacent property and structures. The cost of this work is included in the price of trench excavation.

G. Excavation for Appurtenances

1. Make excavations for manholes, hydrants, structures, and other appurtenances of the size and depth to permit compacting of backfill on all sides to the specified density. The requirements for removing water and other applicable portions of these specifications apply to excavation for appurtenances.

3.4 DEWATERING

A. General

1. Furnish all necessary labor, equipment, and incidentals necessary to dewater the project site during construction.

2. Keep all excavation dry and free from water during construction and the placement of materials. Do not place pipe, bedding, or backfill materials below the groundwater elevation established by dewatering operations. Do not allow groundwater or stormwater to enter or flow through the underground piping during installation.

3. The cost of dewatering operations will be incidental to the cost of pipeline and appurtenance installation, and no additional payment will be made for dewatering. Consider shifts in the groundwater level caused by changing seasons or local conditions in estimating the cost of dewatering operations, as no additional payments will be made for fluctuating groundwater levels.

4. Protect all structures that could be potentially impacted by dewatering operations. Repair any damage to structures caused as a result of dewatering at CONTRACTOR's expense.

B. Discharge

1. Do not discharge or dispose of water from dewatering operations in such a manner as to flood existing landscaped areas, graveled areas, or structures

unless approved by ENGINEER. Written permission from the appropriate landowner shall also be required for discharge or disposal on private property.

2. It is the CONTRACTOR's responsibility to comply with requirements and regulations of federal, state, and local agencies that govern areas affected by dewatering of the construction site and application for and maintenance of any required permits.

3.5 EXCAVATION STABILITY AND SAFETY

A. The stability of construction excavations and associated worker safety, including slope geometry and shoring/bracing considerations, are the CONTRACTOR's responsibility. Meet current OSHA regulations. This may require the design of temporary slopes and/or shoring by a licensed professional ENGINEER.

3.6 TRENCH FILLING AND BACKFILLING

A. General

1. Backfill all trenches as specified immediately after grade, alignment, and pipe jointing has been inspected and approved by the ENGINEER. Conduct any pipe testing as specified in the respective water distribution, sewerage/drainage sections. Correct all defects discovered by tests prior to backfilling.

2. Storage of all imported backfill materials, including protecting said materials from adverse conditions that would disqualify them from use under these specifications, is the responsibility of the CONTRACTOR.

B. Pipe Bedding Placement

1. Type 1 Bedding

a. Place Type 1 Pipe Bedding material 4 inches under, around the pipe, and to a point 6 inches above the top of the pipe in 6-inch lifts, using hand or other compaction methods without damaging or disturbing the pipe including mains and service lines and all appurtenances.

b. Place bedding material in equal lifts on both sides of the pipe for the full trench width. Thoroughly compact each lift of pipe bedding by tamping, vibration, slicing with a shovel, rodding, or by a combination of these methods. Take special care to assure complete compaction under the haunches of the pipe.

2. Type 2 Pipe Bedding

a. Use Type 2 Pipe Bedding described in PRODUCTS SECTION as specified or as directed by the ENGINEER to replace unsuitable material encountered in the trench bottom, placing it from the bottom of the Type 1

Bedding material to the depth required to adequately support the pipe.

3. Separation Geotextile

    a. Place Separation Geotextile where shown on the plans or where directed by the ENGINEER.

C. Trench Backfill

1. After the pipe bedding materials are placed and compacted as specified, backfill the trench.

    a. Use backfill material free of cinders, ash, refuse, organic or frozen material, boulders, or other deleterious material.

    b. From the top of the Type 1 Bedding to 6 inches below the ground surface, or the subgrade elevation, material containing stone up to 8 inches in the greatest dimension may be used.

    c. Cost of screening, drying, or moistening excavated backfill to comply with specifications will be considered incidental to the CONTRACTOR's bid price per linear foot of pipe and service lines and unit prices for appurtenances, and no additional payment will be made for such work.

2. Trench backfill from the top of the pipe bedding to ground surface or to the street subgrade is separated into three classifications.

    a. Type A Trench Backfill is compacted backfill typically used in streets or paved areas.

    b. Type B Trench Backfill is typically used for unpaved alleys, cultivated areas, borrow pits, unimproved streets or other un-surfaced areas, and other areas where compaction is less critical.

    c. Type C Trench Backfill is typically used in open and unimproved areas outside of the public right-of-way.

3. Meet the backfill and compaction requirements for all of the backfill types described in the contract documents.

4. Watering

    a. Apply uncontaminated water, when required, at the locations and in the amounts required to compact the backfill material to the specified requirements. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.

b. Apply water during the work to control dust and to maintain all embankment and base courses in a damp condition in accordance with these contract documents.

c. Water required for compacting trench backfill may be obtained from the municipal system if approved by the Owner or from other sources.

5. Remove, replace, and re-compact backfill in trenches where settlement has occurred as directed by the ENGINEER at the CONTRACTOR's expense.

6. Trench backfill types are designated as follows:

a. Type A Trench Backfill. Place trench backfill in maximum 8 inch compacted lifts within 3% of optimum moisture content and compact to at least 95% of maximum dry density determined by AASHTO T99 or by ASTM D698. For materials that do not exhibit a typical well-defined moisture-density curve, compact backfill to 70% relative density as determined by ASTM D4253 and D4254.

b. Type B Trench Backfill. Place trench backfill in maximum 8 inch compacted lifts within 3% of optimum moisture content, and compact to at least 90% of maximum dry density determined by AASHTO T99 or by ASTM D698. For materials that do not exhibit a typical well-defined moisture-density curve, compact backfill to 50% relative density as determined by ASTM D4253 and D4254.

c. Type C Trench Backfill. Place and compact Type C Trench Backfill in maximum 12-inch lifts at densities equal to or greater than the densities of adjoining undisturbed soil. Mound earth over the trench top, if directed by the ENGINEER. In cultivated areas, place stripped topsoil uniformly over the backfilled trench to the original depth. Do not compact the topsoil, but grade to provide a smooth surface conforming to the adjoining ground surfaces.

D. Replacement of Unsuitable Backfill Material

1. Remove and dispose of excavated soils that are saturated, contain deleterious materials, or have characteristics that, in the opinion of the ENGINEER, render the soils unsuitable as backfill and/or which cannot be readily conditioned or dried to be made suitable.

2. Replace unsuitable soils with material obtained from trench excavations within the project limits at the expense of the CONTRACTOR.

3. If suitable replacement material is not available within project limits, notify the ENGINEER. The ENGINEER will quantify the extent of any unsuitable soils to be removed and replaced with material from an approved source, to be paid for as

Imported Backfill Material, and provide written notification of the approved quantities to the CONTRACTOR. Payment for Imported Backfill Material will not be approved if the CONTRACTOR fails to notify the ENGINEER and/or proceeds with removal and disposal of unsuitable material prior to receiving written notice from the ENGINEER.

4. Provide imported backfill material with a gradation as follows and a maximum plasticity index of 10, determined by AASHTO T89 and T90 or by ASTM D4318. Imported backfill may not contain rock measuring greater than 6 inches in the greatest dimension.

Percent by Weight Passing	
Sieve Size	% Passing
1"	70 -100
No. 4	40 - 80
No. 10	25 - 60
No. 200	2 - 35

5. Place and compact all imported material according to the applicable backfill specification requirements.

E. Backfill of Appurtenances

1. Place and compact backfill for appurtenances to finished grade around manholes, inlets, valve boxes, and other underground items without disturbing appurtenance alignments.

2. Meet the backfill material, placement, and compaction requirements specified for the adjoining trench.

F. Detectable Buried Warning Tape

1. Provide warning tape, as described in this Section. Bury tape a minimum of 6 inches and a maximum of 12 inches below finish surface grade.

3.7 SURVEY MARKERS AND MONUMENTS

A. Protect all survey markers and monuments. Protection includes marking with flagged high lath and supervising work near markers and monuments. Do not disturb monuments without prior approval from the ENGINEER.

B. Replace all CONTRACTOR-disturbed or destroyed survey markers or monuments not approved during construction using a licensed land surveyor.

3.8 CLEANUP

A. As work progresses, remove debris and complete to finish grade each portion of the work. Once the work is complete, clear debris and finish the entire site to smooth, uniform slopes presenting a neat and workmanlike appearance. Remove and dispose of all rocks brought to the surface during excavation or backfilling.

B. Dispose of vegetation; coarse debris resulting from pavement or sidewalk removal; stones, junk, debris, and other materials encountered in excavation work; and other similar waste materials away from the site of the work at the CONTRACTOR's expense.

3.9 TIME AND DISTANCE OF OPEN TRENCHES

A. Perform the work so that trenches will remain open the minimum time required to accomplish the work.

B. Do not begin trench excavating until appropriate compaction equipment is at the excavation site.

C. The maximum permissible distance between backfilling/compaction operations and the end of newly installed pipe is 100 feet in existing streets (and/or alleys) and 200 feet in all other areas.

D. The maximum distance between the newly installed pipe and the excavator is to be 100 feet in existing streets (and/or alleys) and 200 feet in all other areas.

E. For each workgroup consisting of a trench excavator, a pipe laying crew, and a backfilling/compaction crew, the maximum allowable open ditch at any time is 200 feet in existing streets (and/or alleys) and 400 feet in all other areas.

F. The maximum distance behind the end of the new pipe is 1,500 feet for gravel surfacing replacement, base placement, or pavement replacement.

G. At the completion of each working day, fill all trenches and/or provide safety netting, Jersey barrier, and other barricades required for public safety.

3.10 DRAINAGE CROSSINGS

A. Where trenches are constructed in or across roadway ditches or other watercourses, protect the backfill from surface erosion by adequate means. Where the grade of the ditch exceeds 1 percent, prevent erosion by a suitable method approved by the ENGINEER. Backfill trenches in such a manner that water will not accumulate in unfilled or partially filled trenches.

B. Remove all material deposited in roadway ditches or other water courses crossed by the trench immediately after backfilling is completed and restore the section, grades, and contours of such ditches or watercourses to their original conditions, in order that the surface drainage is obstructed no longer than necessary.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. The following items constitute pay items for the work covered under this Section. Payment for these items is full compensation for providing all materials, tools, labor, and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.

4.2 TRENCH EXCAVATION AND BACKFILL

A. No separate measurement and payment are made for TRENCH EXCAVATION AND BACKFILL. Include all costs for this item in the ~~unit price bid for pipe, complete in-place~~ lump sum bid amount to perform the work shown in the Project Plan Sheets.

B. The upper limit of the TRENCH EXCAVATION AND BACKFILL item is defined as the top of subgrade. Details of the various types of surface restoration are found in the contract documents.

4.3 TYPE 1 AND SELECT TYPE 1 PIPE BEDDING

A. Include approved material for Type 1 and Select Type 1 Pipe Bedding in the pipe installation price. No measurement or additional payment is made for furnishing or placing Type 1 and Select Type 1 Pipe Bedding materials.

4.4 TYPE 2 BEDDING

A. Approved material for Type 2 Pipe Bedding to replace soft or unsuitable material is measured in cubic yards of material furnished, in-place, for the depth directed.

B. Payment for Type 2 Pipe Bedding is made at the contract unit price bid per cubic yard, which includes furnishing, placing, and compacting the Type 2 Bedding material as specified and all other work necessary or incidental for completion of the item.

C. Payment quantity is based upon an excavation width of 2.0 feet plus the outside pipe diameter with a minimum payment width of 3.5 feet.

D. If Type 2 Bedding is placed without the Engineer's authorization, the Type 2 Bedding is a construction expedient solely for the Contractor's convenience, and no payment for Type 2 Bedding is made.

E. Payment will be made under: Type 2 Pipe Bedding - Per Cubic Yard.

4.5 IMPORTED BACKFILL MATERIAL

A. When satisfactory backfill material is not available within the project limits, backfill material imported from borrow sources outside the limits of the project site are measured in cubic yards of material furnished, in place (compacted), for the depth directed by the Engineer.

B. The trench width for measurement and payment is 2.0 feet plus the outside pipe

diameter, with a minimum payment width of 3.5 feet, measured between vertical planes for the depth required.

C. Payment for imported backfill material is made as part of the lump sum bid ~~at the contract unit price bid per cubic yard~~, which includes furnishing, placing, and compacting the backfill material as specified and all other work necessary or incidental for completion of the item.

D. No separate measurement and payment is made for this item when, in the Engineer's opinion, suitable surplus material is available within the project limits, in which case all costs for this item are to be included in the unit price bid for pipe, complete in-place.

~~E. Payment for Imported Backfill will be made only if the Engineer determines surplus material is not available within the project limits.~~

~~F.~~ Payment is made under the lump sum bid amount: ~~Imported Backfill Material -Per Cubic Yard.~~

4.6 EXPLORATORY EXCAVATION

A. Measurement of this item is made for the actual time, to the nearest one-half hour, for which the equipment and personnel are used and authorized by the Engineer for actual exploratory excavation and backfilling operations, including standby time between excavation and backfilling, to allow the Engineer to survey the underground utility.

B. Payment is made at the contract lump sum bid amount ~~unit price bid per hour~~, which includes providing the equipment on-site, with operator and fuel. Where exploratory excavation is outside of planned excavation limits, payment also includes any time required for compaction of the backfill, if necessary.

C. Surfacing repair will be paid separately if required.

~~D. Payment will be made under Exploratory Excavation - Per Hour.~~

4.7 GEOTEXTILE FABRIC

A. Measurement ~~and payment~~ for geotextile fabric shall be by the linear foot of the trench. Payment will be paid as part of the lump sum bid to complete the work per Project Plan Sheets.

B. Payment for this item is full compensation for providing all materials, tools, labor, and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not.

END OF SECTION

SECTION 02234

SUB-BASE COURSE

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work is constructing a sub-base course of either crushed or uncrushed materials meeting the specified gradations and other quality criteria specified herein. In the event that there is any discrepancy between this specification section and the Geotechnical Report within the Project Documents, the Geotechnical Report shall govern.

1.2 REFERENCES

AASHTO T11	Amount of Material Finer Than No. 200 (0.075 mm) Sieve in Aggregate
AASHTO T27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T89	Determining Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T176	Plastic Fines in Graded Aggregates and Soils by the Use of the Sand Equivalent Test
AASHTO T96	Resistance to Degradation of Small-Size Course Aggregate By Abrasion and Impact in the Los Angeles Machine
AASHTO T99 (ASTM D698)	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5kg) Rammer and 12-Inch (305mm) Drop
ASTM D5821	Determining the percentage of Fractured Particles in Coarse Aggregate
AASHTO T310 by (ASTM D6938)	In-Place density and water content of the soil and soil aggregate Nuclear Method (Shallow Depth)

1.3 DENSITY CONTROL TESTING

A. Field Density Testing

1. Meet the quality control and quality assurance testing requirements in section 01400, CONTRACTOR Quality Control and Owner Quality Assurance.

2. In-place field density tests for quality assurance are at Owner expense meeting AASHTO T191 (ASTM D1556) Sand Cone method or AASHTO T310 (ASTM D 6938), Nuclear Densometer method. Quality assurance field density testing frequency is at the discretion of the ENGINEER.

3. Retesting of failing areas is at the expense of the CONTRACTOR.

B. Laboratory Maximum Density and Optimum Moisture

1. Moisture density curves will be provided by the CONTRACTOR for each base material supplied. These will be provided at the expense of the CONTRACTOR.

C. Materials Submittals

1. Submit to the ENGINEER gradations, moisture density curves and other preliminary test results for sources to be used for base materials prior to delivery to the site for approval by the ENGINEER. If recycled materials are proposed, CBR test data must be submitted to the ENGINEER to assure consistency with design requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish select sub-base material meeting the applicable aggregate quality and geotechnical recommendations.

2.2 UNCRUSHED SUBBASE

A. Furnish material consisting of hard, durable stone, gravel or other similar materials mixed or blended with sand, stone dust, recycled concrete and/or asphalt or other binding or filler materials produced from approved sources, providing a uniform mixture meeting these specifications and compacted into a dense and well-bonded subbase. Oversize material of acceptable quality may be crushed and used in the base material, if the blend meets the specified gradations.

B. Assure the material retained on the No.4 sieve has a wear not exceeding 50% at 500 revolutions as determined by AASHTO T96.

2.3 CRUSHED SUBBASE

A. Furnish material having both fine and coarse crushed stone or crushed gravel, and/or natural gravel, and when approved, blended with soil, sand, screenings, recycled concrete and/or asphalt or other materials.

B. Furnish crushed gravel or stone consisting of hard, durable particles, not containing excessive flat, elongated, soft or disintegrated rock, dirt, or other deleterious matter, and having a wear not exceeding 50% at 500 revolutions as determined by AASHTO T96.

C. Use production methods that produce a percent of fractured rock in the finished product that is constant and uniform. Crush aggregate so that at least 25% of the material is retained on the No.4 sieve and has one or more mechanically fractured

faces.

2.4 GRADATION

A. Produce material, including any added binder or filler, meeting the following Table of Gradations as determined by AASHTO Methods T11 and T27:

TABLE OF GRADATIONS

PERCENTAGES BY WEIGHT PASSING SQUARE

MESH SIEVES

Passing	4” Minus	3" Minus	2" Minus	1 1/2" Minus	1" Minus
4 Inch	100				
3 Inch	---	100			
2Inch	---	---	100		
11/2 Inch	---	---	---	100	
1 Inch	---	---	---	---	100
No.4	25-60	25-60	25-60	25-60	25-70
No.40	10-30	10-30	10-30	10-30	10-30
No.200	2-10	2-10	2-10	2-10	2-10

B. Up to 5% "oversized" material is permitted provided that the "oversized" material passes the screen size immediately larger than the top size specified. The material between the maximum screen opening and the No.4 sieve shall be reasonably well graded.

C. Suitability of the aggregate is determined by the gradation testing of material placed in the project as required in the Contract documents, within the allowable limits described by the Table of Gradations for the particular grading specified.

D. Assure the liquid limit for the aggregate fraction passing a No.40 sieve does not exceed 25, nor the plasticity index exceed 6, as determined by AASHTO T89 and T90.

E. Crushed leveling base course shall be 3” minus OR one half the thickness of the base course, whichever is less.

2.5 WATERING

A. Use water from an approved source.

PART 3 - EXECUTION

3.1 PREPARATION

A. Immediately before placing the base course, blade smooth and shape the underlying

subgrade, subbase or base course to the plan cross-section before the base course is placed on the street. Do not place sub-base course on wet or muddy subgrade or subbase course. Maintain at least 1 completed area of finished and accepted subgrade or sub-base course in advance of placing base course.

3.2 PLACEMENT AND SPREADING

A. Mix and place the material in maximum 6-inch horizontal layers loose thickness.

B. Deposit and spread each load of material on the prepared subgrade, or on a completed sub-base course layer continuously without breaks. Assure hauling over the subgrade or over any completed subbase course does not damage the subgrade, sub-base or base course.

C. Spread using dump boards, spreader boxes, or moving vehicles equipped to distribute the material in a uniform layer or a windrow. Place and spread the material in a uniform layer to the specified depth without causing segregation. Once the base course is spread, blade- mix it the full depth by alternately blading the entire layer to the centerline and back to the roadway edge.

D. For multiple layers, mix each layer as specified above. Blade smooth and compact each layer before placing the succeeding layer.

E. Uniformly add water, when required, on site and place in amounts required to compact the material as necessary to aid in densification and to limit segregation. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.

F. Apply water during the work to control dust and to maintain the base course in a damp condition.

G. Where crushed sub-base is specified, produce a product with at least 25% of the material retained on the No.4 sieve having one or more fractured faces.

H. Water required for compacting base gravel may be obtained from the municipal system if approved by the Owner, or from other sources.

I. Compact the material using appropriate tamping equipment or power rollers. Correct all irregularities or depressions that develop under rolling by scarifying the material and adding or removing material, as required, until the surface meets specifications.

J. Blade and compact alternately, as required to produce the specified surface until final inspection. Tamp the material along curbs, headers, manholes, and similar structures and all places inaccessible to rollers using approved mechanical tampers or hand tampers meet field density requirements.

3.3 FIELD DENSITY REQUIREMENTS

A. Furnish watering and rolling to obtain a minimum field density of 95% of the maximum dry density determined by AASHTO T99. No separate compensation is allowed for rolling and watering the sub-base course other than the sub-base course bid item or items listed on the Contract documents.

3.4 SURFACE TOLERANCES

A. Finish the sub-base course so that when tested using a 10-foot straight edge placed on the surface with its center line parallel to the street center, the maximum surface deviation from the straight edge does not exceed ½ inch. Additionally, the finished grade cannot deviate more than 0.1 foot at any point from the staked elevation and the sum of the deviations from two points not more than 30 feet apart cannot exceed 0.1 feet.

B. Perform all sub-base course corrections to meet the above tolerances using approved methods and materials. Payment for patching aggregate is at the unit price bid for the sub-base course material.

PART 4 - MEASUREMENT AND PAYMENT

4.1 CUBIC YARD BASIS: SUB-BASE COURSE

A. This item is measured and paid for as part of the lump sum bid of the project improvements as shown in the Project Plan Sheets ~~by the cubic yards~~ of uncrushed or crushed, sub-base course of the specified gradations, complete in place, at the contract unit price bid for _____ " Minus Crushed or Uncrushed Sub-Base Course", which constitutes full compensation for furnishing, loading, hauling, spreading, blending, shaping, watering, and compacting the sub-base course material, and for all tools, labor and incidentals necessary to complete this item.

B. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~1. _____" Minus Uncrushed Sub-Base Course - per cubic yard.~~

~~2. _____" Minus Crushed Sub-Base Course - per cubic yard.~~

4.2 SQUARE YARD BASIS: SUB-BASE COURSE

A. This item is measured ~~and paid for~~ by the square yard (square meter) of sub-base surface area for furnishing crushed or uncrushed, sub-base course of the thickness and gradations specified, complete in place, lump sum ~~at the contract unit price~~ bid ~~for _____" Thickness of _____" Minus Crushed or Uncrushed Sub-Base Course"~~, which constitutes full compensation for furnishing, loading, hauling, spreading, shaping, blending, watering and compacting the subbase course material, and for all tools, labor and incidentals necessary to complete this item.

B. Payment is made under: lump sum bid for project improvements shown in Project Plan

Sheets.

1. ~~_____" Thickness of _____" Minus Uncrushed Sub-Base Course-per square yard.~~

2. ~~_____" Thickness of _____" Minus Crushed Sub-Base Course-per square yard.~~

4.3 LINEAR FOOT BASIS: SUB-BASE COURSE

A. This item is measured ~~and paid for~~ by the linear feet of trench restored, measured along the trench centerline, with crushed or uncrushed, sub-base course of the gradations specified, complete in place, at the contract lump sum ~~unit price~~ bid ~~for _____" Minus Crushed or Uncrushed Sub-Base Course~~, which constitutes full compensation for furnishing, loading, hauling, spreading, blending, shaping, watering, and compacting the sub-base course material, and for all tools, labor and incidentals necessary to complete this item.

B. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

1. ~~_____" Minus Uncrushed Sub-Base Course - per linear foot.~~

2. ~~_____" Minus Crushed Sub-Base Course - per linear foot.~~

END OF SECTION

SECTION 02235

CRUSHED BASE COURSE

PART 1 - GENERAL

1.1 DESCRIPTION

- This work is the placing of one or more base courses composed of crushed gravel, stone or other similar materials meeting the gradation and other quality criteria specified herein. In the event that there is any discrepancy between this specification section and the Geotechnical Report within the Project Documents, the Geotechnical Report shall govern.

1.2 REFERENCES

AASHTO T11	Materials Finer than No. 200 (0.075 mm) Sieve in Aggregate
AASHTO T27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T89	Determining Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T176	Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
AASHTO T96	Resistance to Degradation of Small-Size Coarse Aggregate By Abrasion and Impact in the Los Angeles Machine
AASHTO T99 (ASTM D698)	Moisture-density Relations of Soils and Soil-Aggregate Mixtures Using 5-lb (2.5 kg) Rammer and 12-Inch (305 mm) Drop
ASTM D5821	Determining the Percentage of Fractured Particles in Coarse Aggregate
AASHTO T310 by (ASTM D6938)	In-Place density and water content of the soil and soil aggregate Nuclear Method (Shallow Depth)

1.3 DENSITY CONTROL TESTING

A. Field Density Testing

1. Meet the quality control and quality assurance testing requirements in section 01400, CONTRACTOR Quality Control and Owner Quality Assurance.

2. In-place field density tests for quality assurance are at Owner expense meeting AASHTO T191 (ASTM D1556) Sand Cone method or AASHTO T310 (ASTM D6938) Nuclear Densometer method. Quality assurance field density testing frequency is at the discretion of the ENGINEER.

3. Retesting of failing areas is at the expense of the CONTRACTOR.

B. Laboratory Maximum Density and Optimum Moisture

1. Moisture density curves will be provided by the CONTRACTOR for each base material provided. These will be provided at the expense of the CONTRACTOR.

1.4 MATERIALS SUBMITTALS

A. Submit to the ENGINEER gradations, moisture density curves and other test results for sources to be used for base materials prior to delivery to the site for approval by the ENGINEER. If recycled materials are proposed, CBR test data must be submitted to the ENGINEER to assure consistency with design requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish aggregate base material meeting the applicable aggregate quality requirements and geotechnical recommendations.

2.2 CRUSHED BASE MATERIAL

A. Consists of both fine and coarse fragments of crushed stone or crushed gravel, and/or natural gravel, and when approved, blended with sand, finely crushed stone, crusher screenings, recycled concrete and/or asphalt or other similar materials. Where recycled materials are permitted, project specifications shall state the minimum required CBR value (design minimum) of the Crushed Base Course.

B. Use crushed stone or gravel consisting of hard, durable particles of fragments of stone, free of excess of flat, elongated, soft or disintegrated pieces, dirt, or other deleterious matter, and having a percent of wear of not exceeding 50 at 500 revolutions when tested under AASHTO T96.

C. Crush material so that the percentage of fractured particles in the finished product is as constant and uniform as practical. Crush to produce material where at least 50% of the material retained on the No. 4 sieve has at least one fractured face.

D. Incorporate all material produced in the crushing operation and passing the No. 4 mesh sieve into the base material necessary to meet the gradation requirements.

2.3 GRADATION

A. As determined by AASHTO Methods T11 and T27, furnish material for the grading specified in the contract documents including binder or filler, which may have been added at the plant or at the site, meeting the requirements of that grading in the Table of Gradations below:

TABLE OF GRADATIONS

PERCENTAGES BY WEIGHT PASSING SQUARE MESH SIEVE

Passing	1½" Minus	1" Minus	¾" Minus
1½ Inch	100		
1 Inch	—	100	
¾ Inch	—	—	100
½ Inch	—	—	—
No. 4 Sieve	25 - 60	40 - 70	40 - 70
No. 10 Sieve	—	25 - 55	25 - 55
No. 200 Sieve	0 - 8	2 - 10	2 - 10

B. Up to 5% "oversized" material is permitted provided that the "oversized" material passes the screen size immediately larger than the top size specified. The produced material between the maximum screen opening and the No.4 sieve shall be reasonably well graded.

C. Suitability of the aggregate is based on samples obtained during placement in the project within limits allowed in the table for the particular grading specified.

D. That portion of the fine aggregate passing the No. 200 sieve must be less than 60% of that portion passing the No. 40 sieve.

E. The liquid limit for that portion of the fine aggregate passing a No. 40 sieve cannot exceed 25, nor the plasticity index exceed 6, as determined by AASHTO T89 and T90.

F. Crushed leveling base course shall be 1.5"minus.

2.4 WATERING

A. Use water from an approved source.

PART 3 - EXECUTION

3.1 GENERAL

A. Before placing the base course, smooth and shape the surface of the underlying subgrade, sub-base or base course to the cross section shown on the plans before placing the base course.

B. Do not place base course on a wet or muddy subgrade or sub-base course. Complete at least one area of finished and accepted subgrade, sub-base or underlying base before the placing of any base course.

3.2 PLACEMENT AND SPREADING

A. Mix and place the material in maximum 8 inches compacted layers unless otherwise

approved. Deposit and spread each load of material on the prepared subgrade, or on a completed sub-base or base course layer continuously without interruption. Discontinue operating haul units over subgrade, or over any sub-base or base course completed if the haul units damage the subgrade, sub-base or base course.

B. Deposit and spread the material in a uniform layer, without segregation, to a loose depth so that when compacted, and making allowance for any filler to be blended on the road, the layer has the specified thickness.

C. Spread material using dump boards, spreader boxes, or vehicles equipped to distribute the material in a uniform layer. The material may be deposited in windrows mixed and spread as described below.

D. Construct each layer meeting these requirements. Blade smooth and thoroughly compact each layer as specified before placing the succeeding layer.

E. If segregation or moisture problems exist, or if the material was placed on the road in windrows, thoroughly blade-mix the material of the affected layer by alternately blading to the center and back to the edges of the street.

F. Uniformly add water, when required, on site and place in amounts required to compact the material as necessary to aid in densification and to limit segregation. Maintain an adequate water supply during the work. Assure the equipment used for watering is of the capacity and design to provide uniform water application.

G. Apply water during the work to control dust and to maintain the base course in a damp condition in accordance with Section 01500 under Dust Control.

H. Uncontaminated water required for compacting base gravel may be obtained from the municipal system if approved by the owner, or from other sources.

3.3 FIELD DENSITY REQUIREMENTS

A. Compact placed material the full width by rolling with suitable tamping equipment or power rollers. Correct all irregularities or depressions that develop during rolling by loosening the material in these places and adding or removing material, as required.

B. Perform blading and compacting alternately as required or directed, to maintain a smooth, even, uniformly compacted surface until the final inspection. Along curbs, headers, manholes, and similar structures, and at all places not accessible to the roller, compact the base course material with suitable mechanical tampers or hand tampers to reach the compaction requirements.

C. Provide the watering and rolling required to obtain a minimum field density of 95% of maximum dry density as determined by AASHTO T99. No separate compensation is made for rolling and watering the base course other than the base course bid item or items listed on the contract documents.

3.4 SURFACE TOLERANCES

A. The base course surface when finished and tested with a 10-foot straight edge placed on the surface with its center line parallel to the center line of the street, will not have a surface deviation from the straight edge exceeding 3/8- inch. Additionally, the finished grade cannot deviate more than 0.05 feet at any point from the staked elevation, and further, the sum of the deviations from two points not more than 30 feet apart cannot exceed 0.05 feet.

B. For base course receiving asphalt concrete surfacing, the finished grade cannot deviate more than 0.02 feet at any point from the staked elevations, and the sum of the deviations from two points not more than 30 feet apart cannot exceed 0.02 feet.

C. If patching of the base course is necessary to meet the tolerances, perform patching using methods and aggregates approved by the ENGINEER. Payment for patching aggregate is at the unit price bid for the base course material.

PART 4 - MEASUREMENT AND PAYMENT

4.1 CUBIC BASIS: CRUSHED BASE COURSE

A. This item is measured ~~and paid for~~ by the cubic yards of crushed base course of the gradations specified in the Contract documents, complete in place, at the contract lump sum ~~unit price~~ bid ~~for _____" Minus Crushed Base Course. Price and payment is~~ which constitutes full compensation for furnishing, crushing, loading, hauling, spreading, shaping, watering and compacting the base course material, and for all tools, labor and incidentals necessary to complete this item.

- Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~1. _____" Minus Crushed Base Course - per cubic yard.~~

4.2 SQUARE YARD BASIS: CRUSHED BASE COURSE

A. This item is measured ~~and paid for~~ by the square yards (square meters) of crushed base course surface area for furnishing crushed base course of the thickness and gradations specified in the Contract documents, complete in place, at the contract lump sum ~~unit price~~ bid for _____" Thickness of _____" Minus Crushed Base Course. Price and payment is constituting full compensation for furnishing, crushing, loading, hauling, spreading, shaping, watering and compacting the base course material, and for all tools, labor and incidentals necessary to complete this item.

B. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~1. _____" Thickness of _____" Minus Crushed Base Course - per square yard.~~

4.3 LINEAR FOOT BASIS: CRUSHED BASE COURSE

A. This item is measured ~~and paid for~~ by the linear feet (~~linear meters~~) of trench restored, measured along the trench centerline, with crushed base course of the gradations specified in the Contract documents, completed in place, at the contract lump sum ~~unit price~~ bid ~~for _____" Minus Crushed Base Course". Price and payment is~~ constituting full compensation for furnishing, crushing, loading, hauling, spreading, shaping, blending, watering and compacting the base course material, and for all tools, labor and incidentals necessary to complete this item.

B. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~1. _____" Minus Crushed Base Course - per linear foot.~~

END OF SECTION

SECTION 02502
ASPHALT PRIME AND/OR TACK COAT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work is the single application of asphalt material as specified in the contract documents on a prepared sub-grade, sub-base, base, or asphalt surface meeting the plans and specifications.

PART 2 - PRODUCTS

2.1 GENERAL

A. Unless otherwise specified, furnish asphalt material grade and typed as specified below.

1. Furnish Liquid Asphalt, MC-70 meeting the requirement of Section 702 of the MDT Standard Specifications for all asphalt prime coat applications.

2. Furnish Liquid Asphalt, MC-800 and/or MC-3000 meeting the requirement of Section 702 of the MDT Standard Specifications for all chip seal applications on gravel roads.

3. Furnish Emulsified Asphalt, SS-1 meeting the requirements of Table 1 in this section for all asphalt tack coat applications.

4. Furnish Emulsified Asphalt, CRS-2 or CRS-2P meeting the requirements of Table 2 in this section for all asphalt chip seal applications.

B. Furnish Blotter Sand as specified below meeting the requirements of MDT 07.02.2.

1. Blotter material shall be 100% passing the ½-inch screen having a PI of 6 or less.

TABLE 1
SPECIFICATIONS FOR ANIONIC EMULSIFIED ASPHALTS

TYPE	RAPID SETTING				MEDIUM SETTING						SLOW SETTING			
GRADE	RS-1		RS-2		MS-1		MS-2		MS-2h		SS-1		SS-1h	
Test of Emulsions:	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Viscosity, Saybolt-Furol at 77°F (25°C)	20	100	…	…	20	100	100	…	100	…	20	100	20	100
Viscosity, Saybolt-Furol at 122°F (50°C)	…	…	75	400	…	…	…	…	…	…	…	…	…	…
Demulsibility*, 35ml, 0.02N $CaCl_2$, percent	60	…	60	…	…	…	…	…	…	…	…	…	…	…
Residue by Distillation, percent	55	…	63	…	55	…	65	…	65	…	57	…	57	…
Test on Residue from distillation tests														
Penetration, 77°F (25°C), 100g, 5s	100	200	100	200	100	200	100	20	40	90	100	200	40	90
Ductility, 77°F (25°C), 5cm/min, cm.	40	…	40	…	40	…	40	…	40	…	40	…	40	…
Solubility in Trichloroethylene	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…	97.5	…
Suggested Uses:	Surface treatment penetration macadam and tack coat		Surface treatment and penetration macadam		Plant or road mixture with course aggregate, substantially all of which is retained on a No. 8 (2.36 mm) sieve and practically none of which passes a No. 200 (0.075 mm) sieve, tack		Plant or road mixture with course aggregate, substantially all of which is retained on a No. 8 (2.36 mm) sieve and practically none of which passes a No. 200 (0.075 mm) sieve.				Plant or road mixture with graded and fine aggregates, substantially quantity of which passes a No. 8 (2.36 mm) sieve and a portion of which may pass a No. 200 (0.075 mm) sieve. Slurry seal treatment.			

* The demulsibility test shall be made within 30 days from the date of shipment.

TABLE 2
SPECIFICATIONS FOR CATIONIC EMULSIFIED ASPHALTS AASHTO M208

TYPE	RAPID SETTING				MEDIUM SETTING				SLOW SETTING				
GRADE	CRS-1		CRS-2		CMS-1		CMS-2h		CSS-1		CSS-1h		
Test of Emulsions:	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
Viscosity, Saybolt-Furol at 77°F (25°C)	…	…	…	…	…	…	…	…	…	20	100	20	100
Viscosity, Saybolt-Furol at 122°F (50°C)	…	20	100	100	400	50	450	50	450	…	…	…	…
Demulsibility[A] 35ml, 0.08% sodium dioctyl sultrosuccinate, %	40	…	40	…	…	…	…	…	…	…	…	…	…
Particle Charge Test	Pos	…	Pos	…	Pos	…	Pos	…	Pos [B]	…	…	…	Pos [B]
Distillation: Oil distillation by volume of emulsion, percent	…	…	3	…	3	…	12	…	12	…	…	…	…
Residue, percent	60	…	…	65	…	65	…	65	…	…	57	…	57
Test on Residue from distillation tests													
Penetration, 77°F (25°C), 100g, 5s	100	250	100	250	100	250	40	90	100	250	40	90	…
Ductility, 77°F (25°C), 5cm/min, cm.		40	…	40	…	40	…	…	40	…	40	…	40
Solubility in Trichloroethylene	97.5	…	…	97.5	…	97.5	…	97.5	…	…	97.5	…	97.5
Suggested Uses:	Surface treatment, penetration macadam and tack coat		Surface treatment and penetration macadam		Plant or road mixture with course aggregate, substantially all of which is retained on a No. 8 (2.36 mm) sieve and practically none of which passes a No. 200 (0.075 mm) sieve.				Plant or road mixture with graded and fine aggregates, a substantial quantity of which passes a No. 8 (2.36 mm) sieve and a portion of which may pass a No. 200 (0.075 mm) sieve. Slurry seal treatment.				

[A] The demulsibility test shall be made within 30 days from the date of shipment.
B If the particle charge test result is inconclusive, material having a maximum pH value of 6.7 will be acceptable.

PART 3 - EXECUTION

3.1 DISTRIBUTORS

A. Use a pressure distributor for prime and tack coats that distributes the required amount of asphaltic material at the specified temperature in a uniform spray, without atomization. Assure the distributor is pneumatic tired and does not rut or otherwise damage the surface being sprayed. Equip it with a bitumeter having a dial visible to the truck driver for maintaining the constant speed required for application at the specified rate.

B. Assure the pump is operated by a separate power unit or by the truck power unit. Equip the pump with a tachometer having a dial readily visible to the operator, registering gallons per minute passing through the nozzles.

C. The distributor shall be designed so that the normal width of application shall be not less than 12 feet, with provision for the application of lesser or greater width when necessary. The distributor shall be designed or equipped so that the height of the spray bar above the surface to be sprayed, may be set and maintained within a tolerance of 1/2 inch (plus or minus) of the height required to provide a uniform application.

D. Assure the distributor is equipped and operated so that the asphaltic material is circulated or agitated throughout the entire heating system. Provide a means for constant, accurate temperature indication of the asphaltic material is provided. Assure the thermometer well is placed without contacting the heating tube.

3.2 ASPHALT PRIME COAT

A. Asphalt prime coat will be applied only if specified in the plans or special provisions.

B. Apply MC-70 at a rate of 0.20 gallons per square yard on all asphalt prime coat application.

C. Immediately before applying the prime coat, clean the surface to be primed of all dirt and loose materials using blowers or a power broom, supplemented by hand brooming if necessary. Finish the surface to receive the asphalt material to the specified requirements for smoothness, compaction, and grade. Apply prime coat when the surface is dry or slightly damp and when the air temperature in the shade is not less than 50° Fahrenheit (10° C).

D. Apply asphalt material using a pressure distributor at the rate or rates directed by the Engineer.

E. Before spraying, spread building paper over the surface from the joint back, for the distance required for the spray bar to begin spraying and operating at full force when the surface to be treated is reached. Once the asphalt is applied, remove and dispose of the building paper. Assure the spray bar is shut off instantaneously at each

construction joint to assure a straight line and full application of asphalt prime up to the joint. If required to prevent dripping, insert a drip pan under the nozzle where the application ends. Use a hand sprayer to apply primer material to touch up all spots missed by the distributor.

F. Protect the surfaces of structures and trees adjacent to the area being treated from being spattered or marred. Do not discharge asphalt material into borrow pits or gutters.

G. After the prime coat has been applied, assure it is left undisturbed for at least 24 hours or until it is cured or blotted. Blot all excess asphalt material remaining on the surface after 24 hours with sand before opening the surface to traffic. Maintain the primed or tacked surface until the surfacing has been placed. Maintenance includes spreading any additional sand required to prevent asphalt material adhering to the tires of vehicles using the surface and patching all breaks in the surface with additional bituminous material. Any area of surface disturbed by traffic or otherwise, is to be cleaned before the next course is placed. Before placing the surface course, sweep all excess and/or loose sand used for blotter from the surface.

3.3 ASPHALT TACK COAT

A. The asphalt tack coat is the application of a diluted, slow-breaking, SS-1 asphalt emulsion to ensure bond between the surface being paved and the overlying course. Immediately before applying the tack coat, clean the surface to be tacked of all dirt and loose materials using blowers or power brooms, supplemented by hand brooming if necessary.

B. Apply tack coat when the surface is dry or slightly damp, and when the air temperature in the shade is at least 50° Fahrenheit (10° C).

C. Dilute the asphalt emulsion, SS-1, with water at one part emulsion to one part water. Apply the diluted emulsion using a pressure distributor at the rate of 0.1 gallon per square yard.

D. Before application, spread building paper over the surface, from the joint back, for the required distance for the spray bar to begin spraying and operating at full force when the surface to be treated is reached. Once the asphalt is applied, remove and dispose of the building paper. Shut off the spray bar instantaneously at each construction joint to assure a straight line and full application of asphalt tack up to the joint. If required to prevent dripping, insert a drip pan under the nozzle where the application is stopped. Use a hand sprayer to apply primer material for touching up all spots missed by the distributor.

E. After the tack coat has been applied, assure it is undisturbed until the asphalt emulsion has “broken”, generally within 30 minutes of application. Place the next paving course after the emulsion has broken.

F. Schedule operations so that all tack coats are placed with the asphalt-paving course in the same day.

PART 4 - MEASUREMENT AND PAYMENT

4.1 ASPHALT PRIME COAT

A. This item is measured ~~and paid for~~ by the square yard or ton asphalt prime coat material, complete in place, at the contract unit price bid for “MC-70 Asphalt Prime Coat”.

B. Price and payment via the lump sum bid are full compensation for all demurrage, storage, handling, and other charges; all material (including the asphalt prime coat material), tools, equipment, labor and performance of all work necessary to the furnishing, testing, delivery, unloading, heating, hauling and spreading of the asphalt prime coat, cleaning the surface to be primed, blotting excess prime material, maintaining the primed surface, and all incidentals necessary to complete the item.

C. Payment is made by the lump sum bid ~~only for the asphalt prime coat material required and actually used in the work.~~ The Owner accepts no responsibility for any material shipped onto the project in excess of requirements because of tank-truck or tank-car capacities or for other reasons.

D. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~1. MC-70 Asphalt Prime Coat:~~

~~a. Per square yard~~

~~b. Per ton~~

4.2 ASPHALT TACK COAT

A. This is measured ~~and paid for~~ by the gallon (liter) or square yard (square meter) of undiluted, asphalt tack coat material, complete in-place, at the contract lump sum ~~unit price~~ bid for SS-1 Asphalt Tack Coat.

B. Price and payment are full compensation for all demurrage, storage, handling, and other charges; all material (including the asphalt tack coat material and water for diluting), tools, equipment, labor and performance of all work necessary to the furnishing, testing, delivery, unloading, heating, diluting, hauling and spreading of the asphalt tack coat, cleaning the surface to be tacked, maintaining the tacked surface, and all incidentals necessary to complete the item.

C. Payment is made by the lump sum ~~only for the asphalt tack coat material required and actually used in the work.~~ The Owner accepts no responsibility for any material shipped onto the project in excess of requirements because of tank-truck or tank-car capacities

or for other reasons.

D. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~1. SS-1 Asphalt Tack Coat~~

~~a. per gallon~~

~~b. per square yard~~

4.3 TONNAGE BASIS: BLOTTER – SAND

A. This item is measured ~~and paid for~~ by the ton for the item in the ~~Contract documents~~ Project Plan Sheets at the contract ~~unit price~~ lump sum bid for Blotter - sand.

B. Price and payment within the lump sum bid constitute ~~are~~ full compensation for the furnishing, delivering, and placing of the material; for brooming, for cleaning the existing surface, for removal of the excess aggregate and cleaning gutters, and for all labor, equipment, tools, and incidentals necessary to complete this item.

C. Payment is made under:

~~1. Blotter – Sand~~

~~a. per ton~~

END OF SECTION

SECTION 02504
ASPHALT SEAL COAT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work is applying a single application of asphalt material on a prepared asphalt surface, followed by spreading seal coat aggregate meeting these specifications.

1.2 REFERENCES

AASHTO T11	Amount of Material Finer than No. 200 (0.075 mm) Sieve in Aggregate
AASHTO T27	Sieve Analysis of Coarse and Fine Aggregates
AASHTO T89	Determining the Liquid Limit of Soils
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T96	Resistance to Degradation of Small-Size Coarse Aggregate by ASTM C131 Abrasion and Impact in the Los Angeles Machine
MT 309	Determining the Percentage of Adhesion of Bituminous Materials to Aggregate
MT 228	Method of Test for Evaluating Cleanness of Cover Coat Material

PART 2 - PRODUCTS

2.1 ASPHALT

A. Furnish asphalt material meeting the specifications in Section 02502; ASPHALT PRIME AND/OR TACK COAT and the contract requirements.

2.2 AGGREGATE

A. Unless otherwise specified, furnish ½ inch seal coat aggregate meeting the requirements of Section 2510: Asphalt Concrete Pavement and Table 1 in this section for all chip seal applications on gravel roads.

B. Unless otherwise specified, furnish 3/8-inch seal coat aggregate meeting the requirements of Section 2510: Asphalt Concrete Pavement and Table 2 for all chip seal applications on asphalt roads.

C. Furnish material consisting of crushed stone or crushed aggregate that is clean, durable fragments free from an excess of flat, elongated, soft or disintegrated pieces, clay balls or other deleterious material. Assure the material produced is free from adherent films of clay

or rock dust and is washed thoroughly. No combination of shale, clay, coal, or soft particles can exceed 1.5 percent. Assure the aggregate has a minimum cleanness value of 75 when tested under Montana Test Method MT228.

D. The material cannot exceed a wear of 40% at 500 revolutions when tested under AASHTO Method T96 Grading C. A minimum of 70% by weight of the coarse aggregate (retained on No.4 Sieve) must have at least one fractured face.

E. The aggregate, or a composite mixture, must show no detrimental stripping when tested under Montana Test Methods MT-309. If stripping exceeds 5%, the aggregate will be rejected or an alternate grade of asphalt substituted to reduce stripping below 5%.

F. For all gradings, that portion of the aggregate passing a No. 40 sieve must be non-plastic as determined by AASHTO T89 and T90.

G. When tested by AASHTO Methods T11 and T27 in conjunction with water wash, chips must meet the grading requirements of the following tables:

TABLE 1
1/2" SEAL COAT AGGREGATE - TABLE OF GRADATION

Sieve Designation	Percentage of Weight Passing Sieve
5/8-inch Sieve	100
3/8-inch Sieve	35 - 55
No. 4 Sieve	0 - 15
No. 8 Sieve	0 - 5
No.200 Sieve	0 – 2

TABLE 2
3/8" SEAL COAT AGGREGATE - TABLE OF GRADATION

Sieve Designation	Percentage of Weight Passing Sieves
1/2-inch Sieve	100
3/8-inch Sieve	85 - 100
No. 4 Sieve	10 - 30
No. 10 Sieve	0 - 10
No. 40 Sieve	0 - 2

TABLE 3
1/4" SEAL COAT AGGREGATE - TABLE OF GRADATION

Sieve Designation	Percentage of Weight Passing Sieves
3/8-inch Sieve	100
1/4-inch Sieve	85-100
No. 8 Sieve	0-25
No. 16 Sieve	0-10
No. 40 Sieve	0-2

TABLE 4
SAND SEAL COAT AGGREGATE - TABLE OF GRADATION

Sieve Designation	Percentage of Weight Passing Sieves
1/4-inch Sieve	100
No. 8 Sieve	10-40
No. 16 Sieve	0-10

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Distributor

1. Furnish distributors meeting the requirements of Section 02502; ASPHALT PRIME AND/OR TACK COAT.

B. Brooms

1. Provide power brooms, or a power blower or both.

3.2 AGGREGATE SPREADER

A. Furnish an independent, self-propelled aggregate spreading equipment (Flaherty Spreadmaster or equal) that can be adjusted to spread the specified quantity of cover aggregate per square yard.

3.3 CONSTRUCTION METHODS

A. Seasonal Limitations

1. Seal coating operations cannot be performed after September 1 for areas higher than 3,500 feet above sea level. For areas below 3,500 feet above sea level, seal coating operations are not permitted after September 15.

B. Weather Limitations

1. Do not apply asphalt material when the street face is damp or wet, or when the atmospheric temperature in the shade is less than 65° F (18° C). Do not start work

without the Engineer's approval and terminate work at once in event of rain. Terminate seal coating work just before dark, and stop work during wind that blows sand, dust or other foreign matter into the spread asphalt material before the aggregate is applied.

2. Do not perform seal coat work if the local weather forecast includes a predicted temperature lower than 45 degrees Fahrenheit (7° C) within 12 hours after the intended close of the work for the day.

3. Do not perform seal coat work if the local weather forecast includes a probability of precipitation greater than 45% within the intended schedule of operations for the day. Regardless of the weather forecast, seal coat work may be suspended if impending adverse weather conditions occur in the vicinity of the work.

C. Preparation of Surfaces

1. General

a. Do not start coat operations until the Engineer determines the asphalt surface course to be seal coated is thoroughly compacted and rolling and all holes and breaks in the surface and edges are repaired. In no event, unless ordered in writing by the Engineer, is the seal coat to be placed on newly constructed or reconditioned surfaces within 7 days of the surface having been placed.

2. Cleaning

a. Immediately before applying the asphalt material, clean the surface of all dust, dirt, sand or other objectionable material that prevents complete coverage or bond between the asphalt material and the street surface, using a rotary power broom or blower, by hand sweeping, or both, as required. Thoroughly clean the outer edges adjacent to vertical curbs. Do not mix material removed from the surface with the cover aggregate.

D. Application of Asphalt Material

1. Apply asphalt material at a rate of 0.35 gallons per square yard when using Emulsified Asphalt CRS-2 or CRS-2P, and at a rate of 0.50 gallons per square yard when using Liquid Asphalt MC-800 or MC-3000.

2. Apply asphalt material at a rate of 0.20 gallons per square yard for sand seal applications.

3. Apply the asphalt material uniformly at the rate specified.

4. The Engineer may require adjustments in the application during the work. When heating is required, take precautions to avoid fire hazard. Thoroughly clean the distributor before use unless its last use was with the same type of asphaltic

material specified for the work.

5. Before application, spread building paper over the surface, from the joint back, for the distance required for the spray bar to begin spraying and operating at full force when it reaches the surface to be treated. After the asphalt is applied, remove and dispose of the building paper.

6. Shut off the spray bar instantly at each construction joint to assure a straight line and the full application of asphaltic binder up to the joint. If required to prevent dripping, insert a drip pan under the nozzles when the application is stopped.

7. Use a hand sprayer to apply asphaltic binder to touch up all spots missed by the distributor.

8. Before and during seal coating operations, calibrate or check the adjustments on the distributor as follows:

    a. Tank calibration

    b. Nozzle adjustment and pressure

    c. Spray bar height

    d. Bitumeter calibration

    e. Transverse and Longitudinal Spread of Asphalt Material.

        i. Transverse spread variation shall not exceed 15%

        ii. longitudinal spread variation shall not exceed 10% plus or minus of the rate specified.)

E. Application of Seal Coat Material

1. Apply seal coat material at a rate of 25 pounds per square yard on all chip seal applications. Apply seal coat material at a rate of 15 pounds per square yard on all sand seal applications. During the course of the work, make adjustments in the rate of application as required or as directed by the Engineer.
2. Assure the cover coat material is stockpiled enough in advance of the work so that excess water has drained from the aggregate. Do not spread seal coat aggregate if the moisture content of the aggregate exceeds 2 percent.
3. Uniformly distribute the cover coat at the specified rate using a mechanical or a self-propelled spreader immediately after the asphaltic material application. If weather or surface conditions require, restrict the application of asphalt material to the area coverable by the cover coat material available in the trucks. Assure cover aggregate is available at all times to assure continuous seal coating operations. Do not apply seal coat aggregate to cold, dried or partially dried asphalt material.
4. Immediately after spreading, roll the aggregate with self-propelled,

pneumatic- tired rollers. Roll in a longitudinal direction, beginning at the outer edges of the treatment and working toward the center. Overlap the previous strip by about one-half the roller width. Complete the first rolling of the aggregate within one- half hour of it being spread. Continue rolling until a smooth, thoroughly compacted surface is obtained. Roll at least 3 complete passes with each roller. If the seal coat is finished in partial widths at a time, leave 4 to 6 inches of the inside edge uncovered with aggregate to permit overlap of asphaltic material when the remaining portion of the surface is treated.

5. Remove all loose aggregate from the pavement after the work is completed and dispose of at the specified location. If a location is not designated the chips become the Contractor's property.

3.4 PROTECTION OF STREET SIDE STRUCTURES AND TRAFFIC CONTROL

A. Protect all signposts, streetlamp posts, trees, shrubs and tops of curbs and gutters from splashing asphaltic material. Compensation for furnishing, erecting, and removing such protection is included in the unit price bid for the application of asphalt material.

B. Keep traffic off of freshly sprayed asphalt.

PART 4 - MEASUREMENT AND PAYMENT

4.1 TONNAGE BASIS – SEAL COAT AGGREGATE

A. This item is measured ~~and paid for~~ by the ton of 2,000 pounds for the gradation(s) in the Contract document at the contract lump sum ~~unit price~~ bid for Seal Coat-Aggregate Gradation.

B. ~~Price and payment in~~ The lump sum bid constitutes ~~are~~ full compensation for the furnishing, delivering, and placing of the material; for brooming, compacting and rolling; for cleaning the existing surface; for covering excess asphaltic material; for removal of the excess aggregate cleaning gutters, and for all labor, equipment, tools, traffic control and incidentals necessary to complete this item.

C. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~1. Seal Coat Aggregate - 1/2" Gradation - per ton~~

~~2. Seal Coat Aggregate - 3/8" Gradation - per ton~~

~~3. Seal Coat Aggregate - 1/4" Gradation - per ton~~

~~4. Seal Coat Aggregate - Sand Gradation - per ton~~

4.2 TONNAGE BASIS – EMULSIFIED ASPHALT

A. This item is measured and paid for by the ton of 2,000 pounds at the contract unit price

bid for “CRS-2 Emulsified Asphalt”.

B. ~~Price and payment are~~ Total lump sum bid constitutes full compensation for all demurrage, storage, handling, and other charges, materials (including the asphalt), tools, equipment, labor and performance of all work necessary or incidental to the furnishing, delivering, unloading, heating, hauling and spreading of the asphalt material specified.

C. Payment is made within the total lump sum bid~~only for the asphalt required and actually used in the work~~. The Owner accepts no responsibility for any oil shipped onto the project exceeding that required due to tank-truck or tank-car capacities or for other reasons.

D. Payment is made under:

1. CRS-2 Emulsified Asphalt - per ton

2. CRS-2lm Emulsified Asphalt - per ton

4.3 SQUARE YARD BASIS – ASPHALT SEAL AND CHIP COAT

~~A.~~ This item is measured ~~and paid~~ for by the square yards (square meters) of asphalt pavement surface area at the contract lump sum ~~unit price~~ bid ~~for CRS-2 Asphalt Seal and Chip Coat _____ Gradation.~~

B. ~~Price and payment are~~ Total lump sum bid constitutes full compensation for the furnishing, delivering, and placing of the aggregate material; for brooming, compacting and rolling; for cleaning the existing surface; for covering excess asphaltic material; and for removal of the excess aggregate and cleaning gutters.

C. The ~~price and payment are~~ lump sum bid constitutes full compensation for all demurrage, storage, handling, and other charges, materials (including the asphalt), tools, equipment, labor and performance of all work necessary or incidental to the furnishing, delivering, unloading, heating, hauling and spreading of the asphalt material specified, and for all labor, equipment, tools, traffic control and incidentals necessary to complete this item.

1. CRS-2 Asphalt Seal and Chip coat, 1/2" Gradation - per square yard

2. CRS-2 Asphalt Seal and Chip coat, 3/8" Gradation - per square yard

3. CRS-2 Asphalt Seal and Chip coat, 1/4" Gradation - per square yard

4. CRS-2 Asphalt Seal and Chip coat, Sand Gradation - per square yard

END OF SECTION

SECTION 02505
CONSTRUCTION SEAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work is the application of a dilute mixture of an asphalt rejuvenating agent and water.

1.2 REFERENCES

ASTM D244	Test Methods for Emulsified Asphalts
ASTM D2006	Maltenes Distribution Ration Test

PART 2 - PRODUCTS

2.1 ASPHALT REJUVENATING AGENT

A. Furnish an asphalt rejuvenating agent composed of a petroleum, resin-oil base uniformly emulsified with water and meeting the following physical and chemical requirements:

Specification Designation	Test Method	Requirements
Viscosity, S.F., at 77^0 F, sec.	ASTM D244	15 - 40
Residue, % Min. (1)	ASTM D244 (Mod)	60 - 65
Miscibility Test (2)	ASTM D244 (Mod)	No coagulation
Sieve Test, % Max. (3)	ASTM D244 (Mod)	0.10
Particle Charge Test	ASTM D244	Positive
Tests on Residue from	ASTM D244-60 (Mod):	
Viscosity, cs., 140° F	ASTM D445	100-200
Asphaltenes, % Max	ASTM D2006	0.75
Maltenes Dist. Ratio $\frac{P C + A L \quad (4)}{S+A2}$	ASTM D2006	0.3 - 0.5

B. ASTM D244 Modified Evaporation Test for percent of residue is made by heating 50-gram sample to 300 degrees Fahrenheit (149° C) until foaming ceases, then cooling, immediately and calculating the results.

C. Test procedure identical with ASTM D244 except that 0.02 normal calcium chloride solution shall be used in place of distilled water.

D. Test procedure identical with ASTM D244 except that distilled water shall be used in place of 2 percent sodium oleate solution.

E. In the Maltenes Distribution Ratio Test by ASTM Method D2006:

1. PC = Polar Compounds A I = First Acidaffins

2. A2 = Second Acidaffins S =Saturates

F. The materials must have a record of satisfactory service as an asphalt rejuvenating agent. Satisfactory service is based on the capability of the material to increase the ductility and penetration of the asphalt binder in the pavement surface.

2.2 WATER

A. Use water in the seal mixture that is potable and free from harmful, soluble salts.

PART 3 - EXECUTION

3.1 GENERAL

A. Dilute the asphalt rejuvenating agent following the manufacturer's recommendations, typically at a ratio of 2:1 and apply at a rate of approximately 0.1 gallon per square yard. Follow the manufacturer's recommendations in applying the Construction Seal.

PART 4 - MEASUREMENT AND PAYMENT

4.1 CONSTRUCTION SEAL

A. The unit of measurement is the gallon. The gallonage paid is the number of gallons of diluted asphalt rejuvenating agent (construction seal) used as ordered for the accepted work. Gallons used are determined by measuring the material at 60 degrees Fahrenheit (16° C).

B. Payment is made at the contract lump sum ~~unit price~~ bid for "Construction Seal (Asphalt Rejuvenating Agent)". ~~Price and payment are~~ The lump sum bid constitutes full compensation for all demurrage, storage, handling, and other charges, materials (including the asphalt rejuvenating agent and water for dilution), tools, equipment, labor, and the performance of all work necessary or incidental to the furnishing, delivering, unloading, heating, hauling and spreading of the Construction Seal.

C. Payment is made under: lump sum bid for project improvements shown in Project Plan

Sheets.

~~1. Construction Seal (Asphalt Rejuvenating Agent) - per gallon~~

END OF SECTION

SECTION 02510
ASPHALT CONCRETE PAVEMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. This Work is the production and placement of plant mix asphalt concrete pavement.

B. Hot plant mix asphalt concrete is a mineral aggregate and asphalt material mixed at a hot plant meeting these specifications and placed in one or more courses on a newly prepared or existing street roadway in accordance with the contract documents.

C. In the event that there is any discrepancy between this specification section and the Geotechnical Report within the Project Documents, the more stringent requirement shall govern.

1.2 REFERENCES

AASHTO T11 (ASTM D1140)	Amount of Material Finer than No. 200 (0.075 MM) Sieve in Aggregate
ASTM D5361	Standard Practice for Sampling Compacted Bituminous Mixtures for Laboratory Testing
AASHTO T27 (ASTM C136)	Sieve Analysis of Fine and Coarse Aggregate
AASHTO T89 (ASTM D4318)	Determining Liquid Limit of Soils
AASHTO T90 (ASTM D4318)	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T283 (ASTM D4867)	Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage
AASHTO T176 (ASTM D2419)	Plastic Fines in Graded Aggregates and Soils by Use of The Sand Equivalent Test
AASHTO T96 (ASTM C131)	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
AASHTO T312 (ASTM D6925)	Standard Test Method for Preparation and Determination of the Relative Density of Asphalt Mix Specimens by Means of the Superpave Gyratory Compactor
ASTM D2041	Theoretical Maximum Specific Gravity and Density of Bituminous Mixtures

ASTM C1097	Hydrated Lime for Use in Asphalt Cement or Bituminous Paving Mixtures
ASTM D3666	Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D5821	Percentage of Fractured Particles in Coarse
ASTM C123	Lightweight Particles in Aggregate
ASTM D6307	Asphalt Content of Asphalt Mixture by Ignition Method
ASTM C142	Clay Lumps and Friable Particles in Aggregates
MS-2	Asphalt Institute – Mix Design Methods

PART 2 - PRODUCTS

2.1 GENERAL

A. The Asphalt Concrete Surface Course must have at least a 3-bin separation, when continuous flow mixing types of plants are used. When a drum dryer is used with a weight batching system from dry bins, separate and stockpile the crushed aggregate into two sizes.

B. Unless otherwise specified, furnish Type B or B-Modified aggregate meeting the requirements of Table 1 in this section for all asphalt pavement applications.

C. Unless otherwise specified, furnish ¾” (PGAB) PG58-28 Asphalt Binder Material meeting the requirements of Table 2 in this section for all asphalt pavement application.

D. Prepare pavement course to conform to the lines, grades, thickness and typical cross sections shown in project documents and plans, and shall be rolled, finished, and approved by the ENGINEER before the placement of the next course.

2.2 PLANT MIX AGGREGATES

A. Furnish aggregates from acceptable sources approved by the ENGINEER.

B. Furnish test data as outlined in this section on each source to be used for acceptance by the ENGINEER.

C. Designation of the source of supply and the acceptability of the material there from, does not extend to the grading of the material as it may naturally come from the pit or crusher. Adjust the crusher and screens to remove certain portions of the material as

may be necessary to furnish gravel that will comply with the specifications in the contract. No additional compensation will be allowed for such adjustment of the equipment or the rejection of waste. It is understood that the ENGINEER may order procurement of material from any portion of any area designated as a pit site and may reject portions of the deposit as unacceptable.

D. Aggregate materials shall not contain more than 1.5% by weight of clay lumps, shale, or coal, nor shall light weight particles exceed 3.5% by weight. No combination of clay, shale, coal, or lightweight particles shall exceed 3.5% by weight. Do not use Scoria (fired clay). Aggregate materials shall conform to the grading stipulated in the contract documents. Use reasonable care in the selection of material in a pit so that uniform product will be produced at all times. No compensation will be allowed for such stripping of the pit as may be required in order that satisfactory material may be secured.

E. Aggregate used shall consist of gravel, crushed to the specified size, crushed stone, composed of hard durable pebbles or stone fragments, reclaimed asphalt pavement, and finely crushed stone filler, sand or natural clean material, or other fine mineral material. The portion of the material retained on the No. 4 sieve will be called coarse aggregate and that passing the No. 4 sieve and retained on the #200 sieve will be called fine aggregate. The material Passing the #200 will be called mineral filler. The reclaimed asphalt pavement shall be removed from its original location and reduced by suitable means to such particle size as may be required for use in hot plant mix asphalt concrete.

F. For all gradings of fine aggregate, including any blended fine aggregate and mineral filler, passing a No 40 sieve, shall have a liquid limit not exceeding 25 and a plasticity index of not more than 6.

G. Produce coarse aggregate retained on the No. 4 sieve having a minimum of 75% by weight of particles with at least two mechanically fractured faces. When fractures are contiguous, ensure the angle between the fracture planes is at least 30 degrees to count as two fractured faces.

H. Preliminary acceptance of aggregates proposed for use may be made at the point of production. Final acceptance will be made only after tests of the aggregates are complete and in place.

I. Surface Course Asphalt Plant Mix Aggregate:

TABLE 1
REQUIREMENTS FOR GRADING OF SURFACE COURSE AGGREGATE

Percentage by Weight Passing Job Mix Target Bands						
Sieve Size	A 1”	B ¾”	C ½”	D 3/8”	E #4	Job Mix Tolerances
1” (25.0 mm)	90 - 100	100				---

¾" (19.0 mm)	90 Max	90 - 100	100			+/- 5
½" (12.5 mm)		90 Max	90 - 100	100	100	+/- 5
3/8" (9.5 mm)			90 Max	90 - 100	95 - 100	+/- 5
No 4 (4.75 mm)				90 Max	90 - 100	+/- 5
No 8 (2.36 mm)	19 - 45	23 - 49	28 - 58	32 - 67		+/- 4
No 30 (0.600 mm)						+/- 3
No 200 (0.075 mm)	1 - 7	2 - 8	2 - 10	2 - 10	6 - 13	+/- 2

1. The above gradation bands represent the job mix target limits, which determine the suitability of aggregate for use. The final job mix target gradation must be within the specified bands and uniformly graded from coarse to fine and not vary from the low limits on one screen to the high limits on the adjacent screen, or vice versa. The final job mix gradation limits are established by applying the job mix tolerances to the job mix targets.

2. The job mix formula establishes target values. During production of the mix, the gradations shall lie within the job mix gradation limits specified in Table 1. For example, "Type A, No. 200" band is "1-7". QA job mix target of 5 has been selected for the final mix. The job mix gradation limits is 5, plus and minus 2. Therefore, the job mix gradation limits for production is 3-7.

2.3 ASPHALT BINDER MATERIAL

A. Furnish asphalt binder material to be used as specified in the contract documents that meet the type and grade specified requirements in this section in Table 2.

1. Grades:

a. (PGAB) PG 58-28

b. (PGAB) PG 64-22

c. (PGAB) PG 64-28 (Polymer Modified)

d. (PGAB) PG 70-28 (Polymer Modified)

B. The percentage of asphalt by weight to be added to the aggregate will be, generally, between 4 and 8% of the weight of the total mix. A minimum effective asphalt binder content of 4.5% is required for ¾" for Type B and ½" mixes, 5.0% for ½" for Type C mixes. The mix design will establish the exact percentage of asphalt in the mix, based upon preliminary laboratory tests, sieve analysis and grading and character of the aggregate furnished within the specification limits. No claim is allowed for the payment for rejecting any batch or load of mixture containing an excess or deficient amount of asphalt binder varying more than 0.4 of a percent from the fixed mix design percentage.

C. Obtain ENGINEER approval of the asphalt material source before shipments are made to any project. The source of supply cannot change after work is started unless approved in writing by the ENGINEER. The ENGINEER is not liable for the quantity

shipped.

D. Samples of asphalt binder material may be taken, as directed by the ENGINEER, and placed in uncontaminated one-quart containers. When sampled, these shall be taken from the tanker car or truck at the point of delivery on the project and submitted to the ENGINEER.

E. All transport vehicles must be equipped with a spigot or gate valve installed in either: (1) the unloading line, (2) in the tanker at the centerline on the tank, (3) in the pressure line from the unloading pump, or other locations approved by the ENGINEER. Assure the spigot or gate valve has a diameter of between 3/8 inch and 3/4 inch. The spigot valve must be located to prevent contamination from plant dust or other contaminants.

F. The supplier furnishing the asphalt binder material shall inspect each tanker car or truck before it is loaded and ship only in clean, uncontaminated, fully insulated cars or trucks, sealed after loading by the supplier.

G. The material supplier shall issue, in duplicate, a certificate showing full compliance with the specifications for the designated grade of material, together with the following information. Project number, date of shipment, source of the material, car or truck initial and number, destination, gross quantity loaded, loading temperature, and net quantity in gallons at 60° F (15.5° C) or tons, whichever unit of measurement is stipulated. Assure the certificate of compliance accompanies the shipment and is furnished to the ENGINEER. The certificate, signed by the supplier representative, must also certify that the conveyance vessel was inspected and found to be free of contaminating material.

H. The certificate of compliance is the basis for tentative acceptance and use of the material. Samples taken according to applicable sampling methods and retained by the ENGINEER may be tested at the ENGINEER's discretion. Failure of the asphalt material to meet these specifications may result in rejection of the entire, associated work. If rejected, removed and replace rejected work.

I. Apply asphalt material at temperatures that assure uniform mixing or spreading. Application temperature ranges for each grade of material should be accompanied with the mix design. Application temperature for mixing applications will be in accordance with the mix design.

J. Upon request by the ENGINEER, furnish the ENGINEER and/or laboratory (responsible for completing the mix design) with data or a report showing the temperature-viscosity relationship of each asphalt binder used on the project. Assure this data covers the range of temperatures used for mixing and compaction. In addition, the ENGINEER may request a complete set of test results from Table 2 for each grade used on the project.

TABLE 2
PERFORMANCE GRADED ASPHALT BINDER (PGAB)

Performance Grade	PG 58	PG 64		PG 70	Test Methods
	-28	-22	-28	-28	
Average 7-day Maximum Pavement Design Temperature, °C	<58	<64		<70	
Minimum Pavement Design Temperature, °C	>-28	>-22	>-28	>-28	
Original Binder					
Flash Point Temp.: Minimum °C	230				AASHTO T48
Viscosity: Maximum, 3 Pa ·s (3000 CP), Test Temp, °C	135				ASTM D4402
Dynamic Shear: G* / sin delta, Minimum, 1.00 kPa Test Temp @ 10 rad / s, °C	58	64		70	AASHTO T315
Rolling Thin Film Oven (AASHTO T240) or Thin Film Oven (T179) Residue					
Mass Loss, Maximum, %	1.0				AASHTO T240
Dynamic Shear: G* / sin delta, Minimum, 2.20 kPa Test Temp @ 10 rad / s, °C	58	64		70	AASHTO T315
Pressure Aging Vessel Residue (AASHTO PP1)					
PAV Aging Temp, °C	100	100		100	AASHTO R28
Dynamic Shear: G* / sin delta, Maximum, 5000 kPa Test Temp @ 10 rad / s, °C	19	25	22	25	AASHTO T315
Creep Stiffness [a]: S, Minimum, 300 MPa m-value, Minimum, 0.300 Test Temp, @ 60 sec, °C	-18	-12	-18	-18	AASHTO T313
Direct Tension [a]: Failure Strain, Minimum, 1.0%, Test Temp @ 1.0 mm/min. °C	-18	-12	-18	-18	AASHTO T314

1. If creep stiffness is below 300 MPa, the direct tension test is not required. If the creep stiffness is between 300 and 600 MPa the direct tension failure strain requirement can be used in lieu of the creep stiffness requirement. The m-value requirement must be satisfied in both cases.

2.4 COMPOSITION OF MIXES

A. General

1. Submit to the ENGINEER for approval a mix design for each mix required on the project. Assure the job-mix formula is within the gradation limits in Part 2 Products in this section.

2. Have the job-mix formula prepared by an independent testing laboratory approved by the ENGINEER and performed under the supervision of a Professional ENGINEER. The requirements of ASTM D-3666 are the guidelines for testing laboratory approval. The cost of the job-mix formula(s) is at CONTRACTOR expense.

3. Keep the job mix formula current and contain the following minimum information:

    a. Gradation of all constituent aggregates.

    b. Specific gravity of constituent aggregates and asphalt cement.

    c. Source of supply of all materials and grade of asphalt cement.

    d. Marshall design curves for stability, unit weight, flow and volumetric requirements (VMA and total voids) at asphalt contents below and above optimum (four points minimum).

    e. Measured void less (Rice's) specific gravity used in voids computations.

    f. Composite aggregate grading.

    g. Recommended asphalt cement content.

    h. Marshall or gyratory compactive effort.

    i. Date of mix design (job mix formula).

    j. Index of retained strength.

4. In addition to the job mix formula, all asphalt concrete surfacing mix submittals will have laboratory tests indicating that the Tensile Strength Ratio (TSR) as determined by AASHTO T-283 is at least 70%. Test shall be performed at 7.0 +/- 0.5% air voids and shall include the freeze cycle. Mixtures that fail to meet this minimum criteria may be resubmitted with and approved anti-strip agent meeting the same 70% criteria.

B. Asphalt Concrete Surface Course

1. The maximum permissible variation from the job-mix formula within the specification limits is as follows:

    a. Aggregate gradation within job mix tolerances

b. Asphalt ± 0.4%*

c. Temperature of mix ± 20°F.

*This tolerance will be permitted only if the job mix parameter curves indicate that the corresponding design limits are not exceeded.

2. Produce Hot Plant Mix Asphalt Concrete Surface courses having the following characteristics as measured by AASHTO T245, ASTM D6726 & D6927 "Resistance to Plastic Flow of Bituminous Mixtures by Means of the Marshall Apparatus":

a.	Number of compaction blows, each end of specimen	50
b.	Stability, minimum	1500
c.	Flow	8 – 18
d.	Air voids, percent	3-5
e.	Percent voids in mineral aggregate	(minimum)

3. All type B-modified asphaltic concrete surfacing shall meet the following Marshall Design criteria as determined by ASTM D1559.

a.	Number of Compaction Blows, Each End of Specimen	75
b.	Stability, Minimum	1500 lbs.
c.	Flow	8 – 16
d.	Air Voids, Percent	3 - 5
e.	Percent Air Voids Filled with Bitumen	65-75

4. As an alternative to Marshall mix production, SuperPave Hot Plant Mix Asphalt Concrete Surface courses can be produced having the following characteristics as measured by AASHTO R 35 and M 323.

TABLE 3
SUPERPAVE GYRATORY COMPACTION EFFORT

20-Year Design ESALs" (in millions)	Compaction Parameters			Typical Roadway Applications
	N_{intial}	$N_{maximum}$	$N_{maximum}$	

< 0 .3	6	50	75	Applications include roadways with very light traffic volumes, such as local roads, county roads and city streets where truck traffic is prohibited or at a very minimal level. Traffic on these roadways would be considered local in nature, not regional, intrastate or interstate. Special-purpose road ways serving recreational sites or areas may also be applicable to this level.
0.3 to< 3	7	75	115	Applications include collector roads or access streets. Medium- trafficked city streets and the majority of county roadways may be applicable to this level.

a. Air voids, percent 3-5

b. Voids Filled with Asphalt. 65-80

c. Dust to Effective Binder ratio 0.6-1.4

d. NMax 98

e. NMin 91.5

f. NDesign 95-97

g. Percent Voids in Mineral Aggregate . . See Table 4.

TABLE 4
REQUIRED VOIDS IN MINERAL

Nominal particle size (Table 2)	Voids in Mineral Aggregate, Min.
No 4 (4.75 mm) 3/8– inch (9.5 mm) ½ - inch (12.5 mm) ¾ - inch (19.0 mm) 1 – inch (25.0 mm)	16 15 14 13 12
Nominal maximum particle size is one size larger than the first sieve to retain more than 10 percent.	

PART 3 - EXECUTION

3.1 CRUSHING

A. Crushing Equipment

1. Fit crushing plant-screening equipment, when required, with blowers or other devices capable of removing excess and undesirable fines.

B. Screening Plants

1. Screening plants consist of a revolving trommel screen, shaker screen, vibrating screen, or other devices capable of removing oversize material, excess and undesirable fines.

C. Scales

1. Furnish scales, when required, satisfactory to the ENGINEER. Test and certify scales prior to their use on the project and as often thereafter as the ENGINEER may consider necessary to ensure their accuracy. Have on hand not less than ten, 50- pound weights for testing scales.

2. House the recording devices of the scales in a suitable manner. Place the scales in a location suitable to facilitate accurate weighing of loads. The scales shall be accurate to one-half of one percent at any weight. Alternate methods or devices for weighing may be acceptable, provided that these methods or devices produce the same degree of accuracy as required of platform scales.

3.2 MATERIAL HANDLING

A. All work involved in clearing and stripping pits and quarries, including handling unsuitable material encountered, are performed with no additional compensation being allowed for this work. The pits as utilized shall immediately be opened so as to expose the vertical faces of the various strata of acceptable material and, unless otherwise directed, the material shall be secured in successive vertical cuts extending through all the exposed strata.

B. Provide, unless otherwise specified, material containing as large a proportion as possible of crushed aggregate. Combine the crushed material with the screened material to obtain a uniform product.

C. No material will be accepted which is loaded into hauling units in a segregated condition or which does not meet the required grading. In case the material deposit contains sand or other material in excess of the specification gradation requirements, or of an unacceptable quality, such excess or undesirable material shall be removed and disposed of prior to crushing, or during screening operations, if crushing is not required.

D. Provide a storage bin of ample capacity to ensure uniform quality and delivery of material. Loading of trucks directly from the conveyor belt, from the crusher or screening plant will not be permitted.

3.3 STOCKPILES

A. Grub and clean sites for aggregate stockpiles prior to storing aggregates. Assure the site is firm, smooth and well drained. Maintain a bed of aggregate suitable to avoid the inclusion of soil or foreign material.

B. Build up coarse aggregate stockpiles in tiers of not more than 4 feet in thickness. Assure each tier is completely in place before the next tier is placed. Do not allow material to “cone” down over the next lower tier.

C. Dumping, casting or pushing over the sides of stockpiles will be prohibited, except in the case of fine aggregate stockpiles.

D. Space stockpiles of different gradations of aggregate far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.

E. Any method of stockpiling aggregate, which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate, will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated and failure of such samples to meet all grading requirements for the aggregate discontinuance of such stockpiling procedures.

F. Transfer the aggregate from the stockpiles in such a manner that uniform grading of the material is preserved.

3.4 TRUCK STOCKPILING

A. Materials stockpiled by trucks shall construct the stockpile in tiers approximately 4 feet in thickness. Complete each tier before the next tier is started.

3.5 ASPHALT MIXING PLANTS

A. Use mixing plants of either the weight batching type, the continuous flow mixing type, or drum dryer type. Use drum dryer mixers specifically designed and constructed for producing hot mix.

B. Equip all plants with approved conveyors, power units, aggregate handling equipment, aggregate screens and bins that are coordinated and operated to produce a uniform mixture within the specified job mix tolerances.

C. Use batch-type plants having a minimum batch production capacity of 2,000 pounds. Use continuous flow or drum dryer plants having a minimum production capacity of 60 tons per hour. These capacity requirements may be modified if specified in the Contract Documents.

D. Stop production and remove from the project mixing plants that fail to continuously produce a mixture meeting requirement as specified.

3.6 INSPECTION AND CONTROL OF ASPHALT MIXING PLANT

A. For verification of weights and measures, character of materials and determination of temperatures used in the preparation of the paving mixes, the ENGINEER or ENGINEER’s authorized representative will, at all times, have access to all portions of

the mixing plant, aggregate plant, storage yards and other facilities for producing and processing the materials for the work. All sampling and testing of processed and unprocessed material is performed in accordance with the provisions of the Contract Documents.

3.7 MIX DESIGN

A. The Owner's acceptance testing agency may make gradation analyses of the completed mix to assure that the materials being produced and used are within the tolerances of the mix design and the specifications of the mix being used.

3.8 SAMPLING AND TESTING FOR ACCEPTANCE

A. Sampling and testing of aggregates or other constituent materials may be performed by the Owner's testing agency at a frequency determined by the Owner or the Owner's representative. Field control is performed under AASHTO T245, ASTM D6926 & D6927, and ASTM D6925. Field density testing is by core testing for acceptance purposes. Densities to conform to Section 2510,3.28. Gradations to be within the job mix gradation limits. Oil content to be within 0.4% of the Mix Design.

B. Samples will be used to verify compliance with the requirements set forth in this Section. If there is a dispute, a third-party testing firm may be retained by the CONTRACTOR for additional retesting.

3.9 WEATHER LIMITATIONS

A. When the moisture in the stockpiled aggregate or the dryer adversely affects the quality of mix production, normal plant operations, or when pools of water are observed on the base, mixing and placing of hot-mix asphalt is prohibited.

B. Do not place asphalt hot-mix surface course mixture when the air temperature is less than 40° F (4° C) and rising. Do not place asphalt hot-mix base course mixtures of compacted lifts 4 inches or more when the air temperature is less than 30° F (-1° C) and rising. Do not place asphalt upon a surface which is frozen or that has a temperature of less than 32° F (0 ° C). Do not place paving during rainfall or in standing water.

3.10 SURFACE PREPARATION

A. Assure the area to be paved is true to line and grade and has a dry and properly prepared surface before starting paving operations. Assure the surface is free from all loose screenings and other loose or foreign material.

3.11 NEW WORK

A. For new work, meet the surface preparation requirements in Sections 02230, 02234 or 02235 of these specifications. Prime prepared soil or aggregate bases if indicated as a bid item in the Contract Documents.

B. Before paving, proof-roll the base with equipment having at least one 18 kip single axle load or equivalent. Excavate and replace areas that yield or crack under these wheel loads as directed. This does not replace or relax the base or subgrade compaction requirements.

C. Paint the surfaces of curbs and gutters, vertical faces of existing pavements and all structures in contact with asphalt mixes with a thin coating of asphaltic material to provide a water-tight joint.

3.12 OVERLAYS OVER EXISTING PAVEMENTS AND OLD BASE

A. Where a base is rough or uneven, place a leveling course using a paver or motor grader and compact before the placing of subsequent courses.

B. When specified, place construction fabric to control reflective cracking.

C. When a leveling course is not specified, patch or correct all depressions and other irregularities, subject to the ENGINEER's approval, before starting other paving operations. Remove all rich and unsuitable patches, excess crack or joint filler, and all surplus bitumen from the area to be paved. Do not blot excessive deposits of asphalt with sand or stone.

D. Apply a tack coat when the surface to be paved is an existing Portland Cement concrete, brick or asphalt pavement. When a tack coat is required, use the asphalt material indicated, at the rate specified in Section 02502.

E. Coat the surfaces of curbs and gutters, vertical faces of existing pavements and all structures in actual contact with asphalt mixes with a thin, complete coating of asphalt material to provide a water-tight joint.

3.13 PATCHING

A. Weather Limitations

1. Follow procedures set out in section 3.10.

B. Surface Preparations

1. Assure the area to be paved is true to line and grade, is dry and properly prepared surface before starting paving operations. Clean the surface of all loose screenings and other loose or foreign material.

2. Before paving, proof roll the base. Areas that yield excessively or crack under such wheel loads will be excavated and replaced, to correct yielding and cracking problems. This does not replace the base or subgrade compaction requirements. Cut the edge of existing pavements against which additional pavement is to be placed straight and vertical.

3. Minimum standards for patching new or existing pavement include the following:

a. Neatly cut all asphalt edges using an asphalt saw.

b. Cut asphalt edges to form as regular a patch shape as practical and should, in general, approximate a rectangle.

c. Cut asphalt edges at least 12 inches wider than the trench width on each side of trench excavations; and, in general, be cut parallel to the street centerline for mainline construction and perpendicular to the street centerline for service lateral construction.

d. Skin patches will not generally be considered a satisfactory method of repair.

e. Tack coat all existing edges prior to placing new asphalt concrete.

4. Remove and replace asphalt surface widths of less than 3 feet.

C. Compaction

1. Compact to a density equal to or greater than 92% of Maximum Theoretical Density (RICE) as determined by ASTM D2041.

3.14 TRANSPORTATION OF MIX

A. Transport the mix in vehicles cleaned of all foreign material which may affect the mix. The truck beds must be painted, or sprayed with a lime-water, soap or detergent solution at least once a day or as often as required. After this operation elevate the truck bed and thoroughly drain it, with no excess solution being permitted. Dispatch the vehicles so that all material delivered is placed in daylight, unless the ENGINEER approves artificial light. Deliver material to the paver at a uniform rate and in an amount well within the capacity of the paving and compacting equipment.

3.15 SPREADING AND FINISHING

A. Spread and finish meeting the following requirements;

1. The minimum lift thickness shall be no less than three times the Nominal Maximum Aggregate Size for gradations above the Maximum Density Line, and no less than four times the Nominal Maximum Aggregate Size for gradations below the Maximum Density Line.

2. The maximum lift thickness is 3 inches for surface courses and 6 inches for base courses.

3.16 MECHANICAL PAVERS

A. Spread and strike off the base and surface courses with a mechanical paving machine. Operate the paving machine so that material does not accumulate and remain along the sides of the receiving hopper.

B. Do not use equipment which leaves tracks or indented areas, which cannot be corrected in normal operation, produces flushing or other permanent blemishes, or fails to produce a satisfactory surface.

C. Construct longitudinal joints and edges to true line markings. Establish lines for the paver to follow in placing individual lanes parallel to the centerline of the proposed roadway. Position and operate the paver to follow closely the established lines.

D. When using pavers in echelon, assure the first paver follows the marks or lines with the second paver following the edge of the material placed by the first paver. To assure a hot joint and obtain proper compaction, assure the pavers work as close together as possible not exceeding 100 feet apart. In backing trucks against the paver, take care not to jar the paver out of its proper alignment.

E. As soon as the first load of material has been spread, check the texture of the unrolled surface to determine its uniformity. Segregation of materials is not permitted. If segregation occurs, suspend spreading operation until the cause is determined and corrected.

F. Offset transverse joints in succeeding courses at least 2 feet. Offset longitudinal joints at least 6 inches.

G. Correct all irregularities in alignment left by the paver by trimming directly behind the machine. Immediately after trimming, thoroughly compact the edges of the course by tamping. Avoid distorting the pavement during this operation.

H. Assure edges against which additional pavement is to be placed is straight and approximately vertical. Use a lute or covered rake immediately behind the paver, when required, to obtain a true line and vertical edge. Correct all irregularities in the surface of the pavement course directly behind the paver. Remove excess material forming high spots by a shovel or lute. Fill low areas with hot mix and smooth it with the back of a shovel pulled over the surface. Fanning of material over such areas is not permitted.

3.17 MOTOR GRADER

A. When motor graders are used for the spreading of leveling courses, place the material on the roadbed so that the proper amount of material is available. Spread the mix to the required thickness, line and grade, with a uniform surface texture, while at a workable temperature.

3.18 HAND SPREADING

A. In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand, if so directed by the ENGINEER. Wood or steel forms, approved by the ENGINEER, rigidly supported to assure correct grade and cross section, may be used. In such instances, measuring blocks and intermediate

strips must be used to obtain the required cross-section. Perform hand placing carefully. Uniformly distribute the material to avoid segregation of the coarse and fine aggregate. Broadcasting of material is not permitted. During the spreading operation, loosen and uniformly distribute all material using lutes or covered rakes. Reject material that has formed into lumps and does not break down readily. Following placing and before rolling, check the surface with templates and straightedges and correct all irregularities.

B. Maintain the project heating equipment for keeping hand tools free from asphalt. Exercise caution to prevent heating that may burn the material. Assure the temperature of the tools when used is not greater than the temperature of the mix being placed. Use heat only to clean hand tools; petroleum oils or solvents are not permitted.

3.19 COMPACTION

A. Furnish the number of rollers necessary to provide the specified pavement density. During rolling, keep the roller wheels moist to avoid picking up the material.

B. After the longitudinal joints and edges have been compacted, start rolling longitudinally at the sides and progress toward the center of the pavement. For transverse graded streets, begin rolling on the low side and progress to the high side, overlapping passes by at least one-half the width of rollers and uniformly lapping each preceding pass. Operate the rollers at a slow, uniform speed with the drive roll or wheel nearest the paver. Do not exceed 3 miles per hour.

C. Do not quickly change the line of rolling reversing direction suddenly. If rolling displaces the material, re-work the area using lutes or shovels and restore to the original grade of the loose material before re-rolling. Do not permit heavy equipment or rollers to stand on the finished surface before it has been compacted and has thoroughly cooled.

D. When paving in single width, roll the first lane placed as follows:

1. Transverse joints
2. Outside edge
3. Initial or breakdown rolling, beginning on the low side and progressing toward the high side
4. Second rolling, same procedure as 3
5. Finish rolling

E. When paving in echelon, or abutting a previously placed lane, perform the longitudinal joint rolling the same as transverse joint rolling.

F. When paving in echelon, leave 2 or 3 inches of the edge unrolled, which the second

paver can match unrolled. Then the joint between the lanes can be rolled together. Do not leave edges exposed more than 15 minutes without being rolled.

G. In laying a surface mix adjacent to any finished area, place it high enough so that, when compacted, the finished surface is true and uniform.

H. On slight grades, check gutters with a straightedge and test with running water to assure drainage to the planned outlet.

I. The average density shall be equal to or greater than 93% of the maximum density as determined by ASTM D2041 and no individual sample shall be less than 92% of maximum density.

3.20 TRANSVERSE JOINTS

A. Construct and compact transverse joints to provide a smooth riding surface. Joints will be straight edged, and string lined to assure smoothness and true alignment.

B. Joint formed with bulkheads to provide a straight line and vertical face will be checked with a straightedge before fresh material is placed against it to complete the joint. If bulkheads are not used to form the joint and the roller is permitted to roll over the edge of the new material, locate the joint line in back of the rounded edge the distance required to provide a true surface and cross-section. If a joint has been distorted by traffic or by other causes, trim it to line. Paint the joint face with a thin coating of asphalt before the fresh material is placed against it.

C. Place the material against the joints vertical face with the paving machine positioned so that the material overlaps the edge of the joint 1 to 2 inches. Maintain a uniform depth of the overlapped material. Remove and dispose of the coarse aggregate in the overlapped material that dislodged during raking.

D. Position rollers on the previously compacted material transversely so that no more than 6 inches of the rolling wheel rides on the edge of the joint. Operate the roller to pinch and press the mix into place at the transverse joint. Continue rolling along this line, shifting position gradually across the joint, in 6-to 8-inch increments, until the joint has been rolled by entire width of the roller wheel.

E. Keep the number of transverse joints to a minimum. When paving single width and maintaining traffic, pave one lane no farther than one block. Complete all lanes to the same station at the end of each paving day. When paving in echelon, bring the lanes up even as is practical.

3.21 LONGITUDINAL JOINTS

A. Roll longitudinal joints directly behind the paving operation. Assure the first lane placed is true to line and grade and has a vertical face. Place the material in the lane being paved up firmly against the face of the previously placed lane. Position the paver during spreading to assure the material overlaps the edge of the lane previously placed

by 1 inch to 2 inches. Uniformly maintain the width and depth of the overlapped material at all times. Keep the paver aligned with the line or markings placed along the joint for alignment purposes. Before rolling, remove and dispose of the coarse aggregate in the material overlapping the joint.

B. Shift rollers onto the previously placed lane so that not more than 6 inches of the roller wheel rides on the edge of the fine material left by brooming. Operate the rollers to compact the fines gradually across the joint. Continue rolling until a compacted, neat joint is obtained. When the abutting lane is not placed in the same day, paint the joint with a very thin coating of asphalt before placing the abutting lane. If the joint is distorted during the day's work by traffic or by other causes, carefully trim the edge of the lane to a neat line.

3.22 EDGES

A. Roll the pavement edges concurrently with or immediately after rolling the longitudinal joint.

B. Exercise care in consolidating the course along the entire length of the edges. In rolling pavement edges, extend the roller wheels 2 to 4 inches beyond the pavement edge.

3.23 BREAKDOWN ROLLING

A. Immediately begin breakdown rolling following the rolling of the longitudinal joint and edges. Operate rollers as close to the paver as required to obtain density without causing undue displacement. Operate the breakdown roller with the drive roll or wheel nearest the finishing machine. The ENGINEER may make exceptions when working on steep slopes or super-elevated curves.

3.24 SECOND ROLLING

A. Assure the second rolling follows the breakdown rolling as close as possible while the paving mix is still at a temperature that will provide the specified density.

3.25 FINISH ROLLING

A. Perform the finish rolling while the material is still warm enough to remove roller marks. If necessary, the ENGINEER may require using pneumatic-tired rollers. Complete finish rolling the same day the mixture is placed.

B. In places inaccessible to standard rollers, perform compaction using trench rollers or others to meet the specified compaction requirements. Operate the trench roller as directed until the course is compacted. Hand, manual or mechanical tamping, may be used in such areas if it is proved to the ENGINEER that the operation will provide the specified density.

3.26 SHOULDERS

A. Where paved shoulders or curbs are not specified, do not place the shoulder material against the pavement edges until the surface course rolling is completed. Take care to prevent distortion of the pavement edge from specified line and grade. When shoulders are paved (except in conjunction with the traveled way paving), cold joint construction procedure is required to assure a tight bond at the joint.

B. When the rolling of the surface course has been completed and the edges have been thoroughly compacted, immediately place shoulder material against the edges and roll it.

3.27 DENSITY AND SURFACE REQUIREMENTS

A. The average mat density shall be equal to or greater than 93% of the maximum density as determined by ASTM D2041 for single lift applications. For two lift applications, the first lift on base course shall be a minimum of 92% of the maximum density and the second lift shall be a minimum of 93% of the maximum density. In both cases individual sample shall be no less than 92% of maximum (Rice's) density, prepared as specified in Part 2-Products in this section and made from plant mix meeting the job-mix formula. Verification of maximum density as determined by ASTM D2041 from plant produced material during production is recommended.

B. The longitudinal joints shall be compacted to a target density of 91 percent of the theoretical maximum specific gravity as determined by ASTM D2041 and no individual sample shall be less than 89 percent of maximum (Rice's) density. The theoretical maximum specific gravity used to determine the joint density will be the average of the daily theoretical maximum specific gravities for the material that was placed on either side of the joint.

C. Produce a final surface that is uniform in texture and meets the line and grade specified. Before final acceptance of the project or during the progress of the work, the ENGINEER will determine the thickness of all courses. Repair or replace all unsatisfactory work.

D. Assure density and thickness meets the plans and specifications. During compaction, preliminary tests to aid in controlling the thickness, may be performed by inserting a flat blade, correctly graduated, through the material to the top of the previously placed base, or by other approved methods.

E. In checking compacted depth, the cutting of the test holes, refilling with acceptable materials and proper compaction may be performed by the Owner's testing agency.

F. For testing the surface on all courses, a 10-foot straightedge will be used with the centerline of the straightedge placed parallel to the roadway centerline.

G. Any variations that exceed 5/16-inch in 10 feet for base course and 1/4- inch in 10 feet

for surface course must be corrected. Correct irregularities that may develop before the completion of rolling by loosening the surface mix and removing or adding materials as is required. If any irregularities or defects remain after the final compaction, remove the surface course and place and compact new material to a true and even surface. All minor surface projections, joints and minor honeycombed surfaces must be rolled smooth to grade, as directed.

H. Remove and replace areas of new pavement requiring patching as directed. Patching material will be tested for meeting specifications. The cost of testing is at CONTRACTOR expense.

3.28 PAVEMENT AND MATERIAL TESTING REQUIREMENTS

A. CONTRACTOR will produce their own core samples of the asphalt surface courses under the supervision of the Owner's testing agent and give completed cores to the Owner's testing agency to check in place density and compacted depth. The cores are 4-inch diameter. Materials and acceptance tests will be made by the Owner's testing agency to determine the CONTRACTOR's compliance with the specifications.

B. Materials failing to meet the tests specified may be retested if approved and as directed by the ENGINEER. The CONTRACTOR shall pay the costs of any required re- testing for acceptance purposes. Re-testing will be performed by the Owner's testing agency unless otherwise approved by the owner. If there is a dispute, a third-party testing firm may be retained by the CONTRACTOR for additional retesting for the ENGINEER's review and consideration.

C. The costs of the following tests are at CONTRACTOR expense:

1. Initial aggregate quality tests

2. Job-mix formula

3. Any tests the CONTRACTOR requires to control his crushing, screening or other construction operations

4. Retesting of failing tests as provided above

D. Correct all pavement composition, field density, or thickness, deficiencies at CONTRACTOR expense.

E. The field density and thickness of the pavement is determined by measuring the cores tested. The actual thickness must be no less than 1/4-inch from the specified thickness.

F. When the measurement of any core is less than the plan thickness by more than the allowable deviation, the actual thickness of the pavement in this area may be determined by taking additional cores at intervals parallel to the centerline in each direction from the affected location. Continue in each direction until a core is found

which is not deficient by more than the allowable deviation. The ENGINEER will evaluate areas found deficient in thickness and determine which areas warrant removal. Remove and replace the areas with asphaltic concrete of the thickness shown on the plans. Additional coring is considered as re-testing of failing areas.

PART 4 - MEASUREMENT AND PAYMENT

4.1 SQUARE FOOT BASIS

A. Asphalt Concrete Pavement

1. These items are measured by the square foot of asphalt pavement surface area. The quantities measured for payment are the square feet of specified thickness of asphalt paving in the completed and accepted work as measured in the field. _____" Thickness of Asphalt Concrete Pavement Base or Surface Course. Grade is paid for at the unit price bid per square foot.

2. ~~Price and payment is~~ The lump sum bid constitutes full compensation for cleaning base or underlying course; for producing, furnishing, transporting, stockpiling, heating, drying and screening of aggregate materials; for furnishing, handling, measuring, mixing, manipulating and placing of materials; for hauling, placing, shaping, compacting and finishing of the paving mix; for improving unsatisfactory areas; for furnishing samples; for all materials (exclusive of asphalt and mineral filler), manipulation, labor, tools, equipment and incidentals necessary to complete the work in full compliance with the plans and specifications.

3. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

   ~~a. Asphalt pavement (light duty – 3") – per square foot.~~

   ~~b. Asphalt pavement (heavy duty – 4") - per square foot.~~

4. Asphalt Cement

   a. No separate measurement and payment is made for this item. The cost for this item is to be included in the cost for Asphalt Concrete Pavement Base and/or Surface Course.

5. Hydrated Lime

   a. This item is measured by the ton of 2,000 pounds for the amount of hydrated lime actually used in the completed and accepted work. The quantity of Hydrated Lime, measured as provided above, is paid for at the unit price bid per ton.

   b. ~~Price and payment is~~ The lump sum bid constitutes full compensation for

furnishing, storing, handling and other charges, all tools, equipment, labor and performance of all work necessary to mix the hydrated lime with the asphalt concrete and all other incidentals necessary to complete this item.

c. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~i. Hydrated Lime - per ton.~~

4.2 LINEAR FOOT BASIS

A. Asphalt Concrete Pavement Base and Surface Courses

1. These items are measured by the linear foot of asphalt pavement trench restoration. The quantities measured for payment are the linear feet of specified thickness of asphalt paving in the completed and accepted work as measured in the field along the trench centerline.

2. The lump sum bid constitutes ~~Price and payment is~~ full compensation for cleaning base or underlying course; for producing, furnishing, transporting, stockpiling, heating, drying and screening of aggregate materials; for furnishing, handling, measuring, mixing, manipulating and placing of materials; for hauling, placing, shaping, compacting and finishing of the paving mix; for improving unsatisfactory areas; for furnishing samples; for all materials (exclusive of asphalt and mineral filler), manipulation, labor, tools, equipment and incidentals necessary to complete the work in full compliance with the plans and specifications.

3. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~a. _____" Thickness of Asphalt Concrete Pavement - Base Course - per linear foot.~~

~~b. _____" Thickness of Asphalt Concrete Pavement - Surface Grade _____ Course - per linear foot.~~

4. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~a. Asphalt Concrete Pavement Base Course - per linear foot.~~

~~b. Asphalt Concrete Pavement Surface Course Grade ____ - per linear foot.~~

B. Asphalt Cement

1. No separate measurement and payment is made for this item. The cost for this item is to be included in ~~the cost for Asphalt Concrete Pavement Base and/or Surface Courses~~ the lump sum bid.

C. Hydrated Lime

1. This item is measured by the ton of 2,000 pounds for the amount of hydrated lime actually used in the completed and accepted work.

2. The quantity of “Hydrated Lime”, measured as provided above, is paid for within the lump sum bid, which constitutes ~~at the unit price bid per ton. Price and payment is~~ full compensation for furnishing, storing, handling and other charges, all tools, equipment, labor and performance of all work necessary to mix the hydrated lime with the asphalt concrete and all other incidentals necessary to complete this item.

3. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~**a.** Hydrated Lime - per ton.~~

4.3 PATCHING

A. Patching is paid for at the contract unit price bid. Price and payment is full compensation for work and incidentals necessary to complete this item.

1. Payment is made within the lump sum bid ~~by either of the following~~ as identified under in the Contract documents:

2. Square Foot Basis

a. These items are measured by the square foot of asphalt pavement. The quantities measured for payment are the square feet of specified thickness of asphalt paving in the completed and accepted work as measured in the field.

3. Tonnage Basis

a. These items are measured by the ton of 2,000 pounds of asphalt paving mixture, including the weight of the asphalt cement. The quantities measured for payment are the amount of asphalt paving materials actually used in the completed and accepted work in accordance with the plans and specifications.

~~b. Payment will not be made for correction of defective work as described in Section 3.29.~~

4. ~~Price and payment is~~ The lump sum bid constitutes full compensation for cleaning base or underlying course; for producing, furnishing, transporting, stockpiling, heating, drying and screening of aggregate materials; for furnishing, handling, measuring, mixing, manipulating and placing of materials; for hauling, placing, shaping, compacting and finishing of the paving mix; for improving

unsatisfactory areas; for furnishing samples; for all materials (exclusive of asphalt and mineral filler), manipulation, labor, tools, equipment and incidentals necessary to complete the work in full compliance with the plans and specifications.

5. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~a. _____" Thickness of Asphalt Concrete Pavement - Base Course - per ton or square foot.~~

~~b. _____" Thickness of Asphalt Concrete Pavement - Surface Grade _____" Course - per ton or square foot.~~

END OF SECTION

SECTION 02528
CONCRETE CURB AND GUTTER

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work is constructing combined curb and gutter using structural concrete and meeting the lines, dimensions, and grades shown on the plans and these specifications.

1.2 REFERENCES

AASHTO M 213	Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction
AASHTO M 148	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete

PART 2 - PRODUCTS

2.1 PRE-FORMED EXPANSION JOINT MATERIAL

A. Furnish pre-formed expansion joint material meeting the requirements of AASHTO 213.

2.2 GRAVEL BASE MATERIAL

A. Furnish gravel base meeting all applicable portions of Section 02221 TRENCH EXCAVATION AND BACKFILL.

2.3 CURING AND PROTECTIVE COATING MATERIALS

A. Liquid Membrane-Forming Compounds for Curing Concrete

1. Furnish liquid membrane-forming compound meeting the requirements of AASHTO M148, Type 1, clear or translucent.

2. Apply liquid membrane forming compound between April 15 and August 14 of each year unless daily temperatures outside of that date range are between 40- and 90-degrees Fahrenheit.

B. Emulsified Linseed Oil Compound

1. Assure it meets all requirements of AASHTO M148 and contains at least 2.7 pounds of linseed oil per gallon. Furnish a manufacturer's certification showing that the formulated weight of linseed oil per gallon equals or exceeds this limit.

2. Apply water-soluble or emulsified linseed oil compound between August 15 and April 14 of each year.

PART 3 - EXECUTION

3.1 GENERAL

A. Concrete curb and gutter may be machine-laid or hand-formed.

3.2 FOUNDATION PREPARATION

A. Excavate the foundation to the specified depth. Assure the subgrade or base course for the concrete has a firm and even surface and is compacted.

B. Complete excavation to the lines shown in the contract documents or as specified by the Engineer.

C. Place at least 6 inches of gravel base material and compact it to 95% of ASTM D- 698. This requirement is waived if curb and gutter is installed on a portion of street base course material of 3 inches or more in thickness.

D. For new street construction or street reconstructing, place gravel base course for the street 9 inches beyond back of the curb.

3.3 FORMS

A. Use metal forms unless otherwise approved of the depth equal to the face of the item being constructed. Obtain Engineer approval of in-place forms before placing concrete.

B. Assure forms produce the shape, lines, and dimensions shown on the plans and/or drawings. Assure forms prevent leakage of mortar and maintain position and alignment. Thoroughly clean and oil before placing and do not remove forms until the concrete has hardened sufficiently to prevent damage.

C. Where the curb and gutter is to abut an existing sidewalk, use an approved face-of-gutter form secured to maintain an established gutter grade. Vary the curb height to assure the top of curb matches as nearly as possible the standard curb and gutter cross section. Obtain Engineer approval to hand form lengths not exceeding 10 feet.

D. Form radii using flexible or curved metal forms set to fit the specified curvature. Obtain Engineer approval before using wood forms. Radii may be formed by using segments of straight forms if the length of the straight segment does not exceed $1/10^{th}$ of the length of the radius.

3.4 REINFORCEMENT

A. Place reinforcement as required. Place and hold in position before placing concrete.

3.5 PLACING CONCRETE

A. Place and compact the subgrade to the specified grade before placing concrete. Dampen the subgrade just before placing the concrete. Spade and tamp the concrete thoroughly into the forms to provide a dense, compacted concrete free of rock pockets. Float, finish,

and broom the exposed surfaces. Each placing/finishing crew shall have at least one ACI Flatwork Finishing Technician level or above, on site at all times.

B. Do not place concrete at a rate that exceeds the finishing operation's ability to meet these specifications.

C. Machines or equipment that extrude curb and gutter may be used when approved, provided they produce a finished product matching that obtained by the set-form method. Use slip-form machines that are automatically controlled for longitudinal grade, alignment, and transverse slope by sensing devices operating from string lines set from construction stakes placed by the Engineer or a stringless slip-form machine operating from an integrated machine control model.

3.6 STRIPPING FORMS AND FINISHING

A. Forms

1. Remove forms when the concrete is sufficiently set to prevent chipping or spalling. When forms are removed before the curing period has expired, protect the concrete edges with moist earth or spray edges with curing compound. Clean, oil, and examine all forms for defects before they are used again.

B. Finishing

1. Finish the surface of concrete curbs and gutters true to the lines and grades shown on the plans. Work concrete until the coarse aggregate is forced down into the body of the concrete and no coarse aggregate is exposed.

2. Fill honeycomb or other blemishes in formed surfaces with grout to the specified finish. Tool all edges to a ¼-inch radius. Float the surface using a magnesium float to a smooth and uniform surface. When the concrete in the curb and gutter has hardened sufficiently, give the surface a broom finish. Obtain Engineer approval of the broom before use. Broom the surface without tearing the concrete. Broom to produce regular corrugations not exceeding 1/8-inch deep.

3. After finishing and brooming, stamp and mark into the concrete to mark sewer and/or water service lines if required by MSU.

C. Crew

1. Do not apply additional surface water. The Engineer may permit adding water, but it must be applied by fog spray only. Use of an evaporation retardant, Confilm, or equal, following the manufacturer's directions is permitted.

3.7 JOINTS

A. Place curb and gutter monolithically with no construction joints permitted, except at planned expansion joints.

B. Construct expansion joints at construction joints, junctions with existing concrete, and opposite to or at expansion joints in adjacent concrete, and at maximum 300-foot

intervals in a continuous run of concrete being placed. Form expansion joints using ½-inch thick, pre-formed expansion joint filler, as specified in Section 02528.2.3.

C. Form or cut contraction joints 1/8-inch wide to one-fourth the depth of the concrete being placed. Construct the joints to coincide with the joints in adjacent concrete or in uniform sections 10 feet in length. Where required to make a closure, sections less than 10 feet in length will be permitted with the minimum length being 4 feet. When contraction joints are made by approved forming or grooving before the concrete has set, tool the edges to the approved radius.

3.8 CURB BACKFILL

A. Complete the curb backfill to 6 inches below the top of curb before final grading of the subgrade and placing the street section base course.

B. Backfill using impervious dirt up to 6 inches below top of curb. Do not use sand or gravel backfill in this area.

C. In areas of existing lawns, use black loam or approved topsoil for the top 4 inches of backfill. Place it out from the curb and in the amount required to replace the turf or lawn removed during installation. Place the backfill to a point level with the top of the curb, immediately adjacent to the curb, and grade and blend to match the existing undisturbed lawn area.

D. Where lawns do not exist, place the top 4 inches of backfill using impervious dirt and conforming to the typical sections shown on the plans.

E. Compact backfill to prevent settlement and level the surface to be free draining. Complete all backfill within 3 days of adequate curing.

3.9 PRIME AND SEAL COAT PREPARATION

A. Paint the edge of the gutter adjacent to the asphalt surfacing with an asphalt prime coat before placing the pavement surface course. When an asphalt seal coat is specified, apply the oil and cover aggregate 3 inches on to the gutter to provide a good seal on the joint between the concrete and pavement.

3.10 TOLERANCES

A. Perform the work to produce a curb and gutter meeting the specified line and grade uniform in appearance and structurally sound. Remove and replace at contractor expense curb and gutter having unsightly bulges, ridges, and/or low spots in the gutter, or other defects as directed. Grade cannot deviate more than 1/8-inch, and alignment not vary more than ¼-inch from plan elevation, grade, or alignment. Tolerances may be checked using survey instruments, straight edges, or water puddling. Puddled water cannot exceed ¼- inch in depth.

PART 4 - MEASUREMENT AND PAYMENT

4.1 COMBINED CONCRETE CURB AND GUTTER

A. This item is measured ~~and paid for~~ by the lineal feet of combined curb and gutter in place at the contract lump sum ~~unit price~~ bid to perform the work shown in the Project Plan Sheets ~~for "Combined Concrete Curb and Gutter".~~ ~~Price and payment is~~ The lump sum bid constitutes full compensation for all materials, curing of concrete, painting face gutter with primer, all pre-molded mastic material for expansion joints, contraction joints, steel dowels and sleeves, all equipment, tools, labor, and for the performance of all work and incidentals necessary to complete the item. The lineal feet measurement is the horizontal distance measured along the face of the curb.

~~B. Curb excavation and backfill is paid for separately, as specified in Section 02230, STREET EXCAVATION, BACKFILL, AND COMPACTION. Payment is made under Combined Concrete Curb and Gutter – per lineal foot.~~

END OF SECTION

SECTION 02529

CONCRETE SIDEWALKS, PLAZA, DRIVEWAYS, APPROACHES, CURB TURN FILLETS, VALLEY GUTTERS AND MISCELLANEOUS NEW CONCRETE CONSTRUCTION

PART 1 - GENERAL

1.1 DESCRIPTION

i. This work is the construction of concrete sidewalk, sidewalk finishes, and driveway approaches, curb turn fillets, valley gutters, new street monuments, and all other miscellaneous new concrete construction complete in place. In the event that there is any discrepancy between this specification section and the Geotechnical Report within the Project Documents, the more stringent requirement shall govern.

ii. Section includes finish materials and methods for producing decorative exposed aggregate slab finish, including the use of chemical surface retarders and curing and sealing of concrete surfaces.

1.2 REFERENCES

AASHTO M 213	Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction
AASHTO M 148	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete American Concrete Institute

1.3 SUBMITTALS

A. **Action Submittal:**

1. Product Data: Manufacturer’s descriptive data and product attributes for each product.

2. Samples:

i. Selection samples of exposed aggregate finish for exposure level verification.

ii. 10-lb sample of exposed aggregate. Information from aggregate supplier indicating source, type, color, and gradation of aggregate shall accompany sample.

1.4 QUALITY ASSURANCE

A. Mockups: Cast mockups of full-size sections of plaza concrete pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship.

1. Build a 4’ x 4’ mockup on site. If location not indicated, as directed by Owner’s

representative.

2. Notify Owner's representative seven days in advance of dates and times when mockups will be constructed.

3. Obtain approval from Owner's representative before starting mockup construction.

4. Contractor shall use the methods and materials proposed for use on the final installation. Uniformity in appearance of each panel shall be the responsibility of the contractor.

5. Maintain approved mockups during construction for the duration of the project in an undisturbed condition as a standard for judging the completed pavement.

6. Demolish and remove approved mockups from the site when directed by Owner's representative.

PART 2 - PRODUCTS

2.1 STRUCTURAL CONCRETE

A. Furnish structural concrete meeting the requirements of Section 03310, STRUCTURAL CONCRETE.

2.2 PRE-FORMED EXPANSION JOINT FILLER MATERIAL

A. Furnish joint material meeting the requirements of AASHTO M213.

2.3 GRAVEL BASE MATERIAL

A. Furnish crushed base material meeting applicable requirements of Section 02235, CRUSHED BASE COURSE, and meeting the gradation requirements for 1 inch minus material.

2.4 CURING AND PROTECTIVE COATING MATERIALS

A. Liquid Membrane-Forming Compounds for Curing Concrete

1. Use liquid membrane-forming compounds meeting the requirements of AASHTO M148, Type 1, clear or translucent. Apply the compound between April 15 and August 14 unless daily temperatures outside of that date range are between 40- and 90-degrees Fahrenheit (4-32° C).

B. Emulsified Linseed Oil Compound

1. Apply water-soluble or emulsified linseed oil compound between August 15 and April 14 as a protective coat. Assure it meets all requirements of AASHTO M148 and contains at least 2.7 pounds of linseed oil per gallon. Furnish a

manufacturer's certification showing that the formulated weight of linseed oil per gallon equals or exceeds this limit.

2.5 EXPOSED AGGREGATE CONCRETE MATERIALS

A. Aggregate:

1. Graded and washed aggregate and sand to achieve consistent appearance.

2. Pea gravel to be used shall consist of naturally occurring, semi-round, smooth, water washed, river stone. Pea gravel color ranges include brown, tan, white, and buff colors.

3. Aggregate size shall be 1/4 inch minimum to 3/8 inch maximum.

4. Aggregate size/color to be approved at mockup.

5. Exposed hard, sound, durable, and free of all deleterious materials and staining qualities.

6. Ratio of sand to aggregate per manufacturer's recommendation to achieve the desired exposure depth and appearance.

7. Provide aggregates and cements from a single source for batch consistency for the entire project.

8. Store select aggregates off the ground and protected from moisture.

B. Water: Potable

C. Colloidal Silica Concrete Surface Treatment: Single component colloidal silica-based admixture for improving surface properties; Reducing efflorescence in colored concrete, improving workability for consistent aggregate exposure, Improving the bond between aggregate and concrete paste for more durable exposed aggregate finishes.

1. Product: Day 1 Surface Technology by Solomon Colors, Inc.

2. Substitute: or approved equal.

D. Surface Retarder: Water based treatment designed to retard the hydration of top layer of concrete paste, producing an exposed aggregate, or sand finish appearance.

1. Source: Brickform Select-Etch by Solomon Colors, Inc.

   i. SE75 Blue

2. Substitute: or approved equal.

3. Exposure depth shall be 1/8".

4. Curing and Sealing: Curing and sealing products to be determined at time of mockup. Some products or methods may not be compatible with project requirements. Considerations include VOC requirements, desired sheen, color enhancement, and environmental conditions.

    i. Concrete Curing Compound: Clear, film-forming curing/sealing compound, suitable for decorative concrete. Reference ACI 310R

        1. Water based

        2. Product: Brickform Gem Cure and Seal by Solomon Colors, Inc.

        3. Substitute: or approved equal.

    ii. Concrete Surface Sealer: VOC compliant, clear acrylic or penetrating sealer, designed to reduce porosity of exposed aggregate concrete surface.

        (a) Water-Based Penetrating Sealer: Natural look with no sheen and no film.

            1. Product: Brickform Stealth Seal WB by Solomon Colors, Inc.

            2. Substitute: or approved equal.

PART 3 - EXECUTION

3.1 GENERAL

A. Construct sidewalks and driveway approaches, either new or replacement, valley gutter and curb turn fillets at the locations shown on the plans and where directed by the Engineer meeting these specifications and the applicable portions of Section 03310, STRUCTURAL CONCRETE.

B. The use of slip form machines is prohibited for items in this section unless otherwise specified or permitted by the Engineer.

C. During periods of cold weather, Contractor must submit to Engineer a cold weather concreting plan applicable to Section 03310 for approval.

3.2 FOUNDATION PREPARATION

A. Excavate to the specified depth, or as directed by the Engineer. Assure the concrete subgrade has a firm and even surface and is compacted as specified in Section 02230: Street Excavation, Backfill, and Compaction, as may be modified by the Standard Modifications.

B. Place and compact at least 3 inches of gravel base material compacted to 95% of ASTM D-698. This requirement is waived for concrete if it is to be installed on street base course material exceeding 3 inches or more in thickness and is approved by

Engineer.

C. Do not remove sidewalks, private driveways, or conduct foundation preparation activities more than 4 days prior to the planned concrete pour.

3.3 FORMS

A. Furnish forms to produce the shape, lines, and dimensions shown on the plans and/or drawings. Assure forms prevent leakage of mortar and are maintained in proper position and accurate alignment. Thoroughly clean and oil forms with an approved form oil before placing concrete and remove forms only after the concrete has hardened sufficiently to support all loads without damage.

B. Form radii using flexible or curved forms set to the required curvature. Use wood forms only with the Engineer's approval. Radii may be formed by using segments of straight forms if the length of the straight segment does not exceed one-tenth of the length of the radius.

C. Use forms and pre-formed expansion joint filler material for same depth as concrete.

3.4 REINFORCEMENT

A. Fiber reinforcement: Polypropylene fibers engineered and designed for secondary reinforcement of concrete slabs, complying with ASTM C1116, Type III, not less than ¾" long, 1.5 lb per cubic yard.

1. Products: Subject to compliance with requirements, provide one of the following:

Durafiber, Durafiber corp.

Fiberstrand 100, Euclid Chemical co.

Fibermesh, Fibermesh Co., Div Synthetic Industries, Inc.

Or approved equal.

3.5 PLACING CONCRETE

A. Assure the subgrade is compacted and brought to specified grade before placing concrete. During extreme drying conditions, dampen the subgrade immediately before placing the concrete. Spade and tamp the concrete into the forms providing a dense, compacted concrete free of rock pockets. Float, finish and broom the exposed surfaces. Each placing/finishing crew shall have at least one ACI Flatwork Finisher Technician level or above, on site at all times.

B. Assure the rate of concrete placement does not exceed the rate at which the various placing and finishing operations can be performed in accordance with these specifications.

3.6 STRIPPING FORMS AND FINISHING

A. Forms

1. Remove forms when the concrete is sufficiently set to prevent chipping or spalling. When forms are removed before the curing period has expired, protect the concrete edges with moist earth or spray edges with curing compound. Clean, oil, and examine all forms for defects before they are used again.

B. Finishing

1. Finish the concrete surface true to lines and grades shown on the drawings. Work concrete until the coarse aggregate is forced down into the body of the concrete and no coarse aggregate is exposed. Float the concrete surface using a magnesium float to a smooth and uniform surface. Plastering of the surface is prohibited. Edge all outside edges of the slab and all joints using a ¼ inch radius edging tool.

2. Immediately after the forms have been removed, remove all form bolts and tie wires to a depth of at least ½ inch below the surface of the concrete. Clean and fill all holes and depressions caused by the removal or setting back of form bolts or tie wires with Portland Cement mortar composed of 1 part cement by volume and 2 parts sand. Chip out, clean and fill all rock pockets, honeycombs, and air pockets with mortar, in compliance with instruction of the Engineer. If, in the judgment of the Engineer, rock pockets are of such an extent or character as to materially affect the strength of the structure or to endanger the life of the steel reinforcement, they may declare the concrete defective and order the complete removal and replacement of that portion of the structure so affected.

3. Carefully make all mortar patches using a very dry mortar tamped firmly in the void. Keep the patches wet for a period of 3 days after which it will be inspected for shrinkage cracks. Excessive cracking will require complete removal and replacement of the patch.

4. Screed, float and light broom finish sidewalks, exterior slabs, approaches, etc. and membrane cure. After concrete has hardened sufficiently, give the surface a broom finish. Obtain Engineer approval of the broom before use. Assure the broom strokes are square across the concrete from edge to edge, overlapping adjacent strokes. Broom without tearing the concrete. Assure the broomed finish produces regular corrugations not exceeding 1/8 inch in depth.

5. Steel trowel finish interior floor surfaces which will be exposed after construction is completed, surfaces to be covered with resilient floor coverings or seamless floor coverings, the exposed portion of the top of equipment bases, the top of interior curbs, and other surfaces designated on the drawings. Perform troweling after the second floating when the surface has hardened sufficiently to prevent an excess of fines from being drawn to the surface. Produce a dense, smooth, uniform

surface free from blemishes and trowel marks.

6. Apply liquid or shake-on floor hardener to all interior concrete floors which are subject to foot or equipment traffic and are not required to be covered with resilient floor coverings or seamless flooring. Prior to application, thoroughly clean the floor of all dirt, grease, and other foreign matter. Do not apply curing compounds to floors scheduled to receive floor hardener unless compatibility with the hardener is demonstrated in manufacturer's data.

7. Do not apply additional surface water. The Engineer may permit adding water, but it must be applied by fog spray only. Use of a film forming evaporation retardant, following the manufacturer’s directions, is permitted.

8. Exposed Aggregate Finish:

    i. General

        (a) Apply materials in accordance with manufacturer’s recommendations.

        (b) Methods and materials shall match that of approved mockup production.

    ii. Finishing

        (a) Do not use tools that may force the aggregate away from the surface creating a non- uniform surface after exposure

        (b) Finish slab surface to be uniform, flat, without low spots or ridges. Do not overwork the surface to be exposed.

    iii. COLLOIDAL SILICA SURFACE TREATMENT INSTALLATION

        (a) Apply per manufacturer’s recommendations based on application time.

        (b) Prevent overspray of material to adjacent equipment and construction materials.

    iv. CONCRETE SURFACE RETARDER INSTALLATION

        (a) Protect all adjacent concrete surfaces, pavers, stones, borders, etc. that are not to receive retarder finish prior to concrete placement and retarder application.

        (b) Application

            1. Spray the Concrete Surface Retarder with low-pressure sprayer at a rate of 250- 300 ft^2/gallon.

            2. Maintain an even continuous application.

            3. Once dry, Concrete Surface Retarder will yield a coating that provides

intermittent rain protection. Protect the surface if heavy extended rains are predicted or during extremely hot weather to retain moisture and protect the etch retention.

(c) Removal

1. Concrete Surface Retarder can be removed when the underlying concrete has sufficiently hardened, typically ranging from 5 to 12 hours after initial placement. Do not exceed 24 hours before removing

2. Wash surface with running water with a push broom, high pressure washing, or a rotary buffer with bristle attachment and water.

3. Timing and removal should be determined by the project testing and jobsite samples. When using light etches, it is generally better to remove Surface Retarder the same day.

4. Dispose of wash water slurry in accordance with environmental regulations per relevant jurisdictional authority.

(d) Curing Compound, as determined: After water from removal has dissipated from the slab, apply curing compound uniformly. Follow manufacturer's recommendations for coverage, methods, and environmental allowances.

(e) Sealer, as determined: After recommended cure time has been achieved, apply surface sealer. Follow manufacturer's recommendations for coverage, methods, and environmental allowances.

3.7 CURING

A. Cure meeting Section 03310, STRUCTURAL CONCRETE requirements.

3.8 JOINTS

A. Plaza areas within the project shall conform to the jointing requirements as indicated in the Project Plans.

B. Extend isolation joints the full depth of the concrete and fill using ½-inch thick, pre-formed expansion joint filler material as specified in Section 02529.3.3. Place isolation joints meeting this requirement where new concrete abuts existing concrete. Form isolation joints around all appurtenances, such as manholes, utility poles, etc. extending into and through the concrete.

C. Install pre-formed joint filler between concrete and any fixed structure, such as a building or bridge. Assure all expansion joint materials extend the full depth of the concrete. Place isolation joints at radius points, junctions with existing concrete, and opposite to or at expansion joints in adjacent concrete. Form cold joints at unions of

consecutive pours as shown on the plans or directed by the Engineer. Assure the cold joint is vertical, the full depth of the concrete, and tooled to a ¼-inch radius.

D. Divide sidewalk into sections using contraction joints formed by a jointing tool or other approved methods. Extend the contraction joints into the concrete for at least 25% of its depth and be approximately 1/8-inch wide. Unless otherwise directed, space contraction joints at maximum 10-foot intervals or at a distance equal to the sidewalk width, whichever is less. In continuous sidewalk runs, install isolation joints every 100 feet at intervals equal to the nearest multiple of the contraction joint interval.

3.9 BACKFILL

A. In areas adjacent to existing lawns, backfill the top 4 inches using black loam or good topsoil suitable for lawn growth. Place it out from the sidewalk or driveway to replace turf or lawn removed during installation. Place the backfill level with the top of the curb, immediately adjacent to the curb, graded and blended to match the existing undisturbed lawn area.

B. Where lawns do not exist, backfill the top 4 inches with impervious dirt and place to meet the typical sections shown on the plans.

C. Compact backfill to prevent settlement and level the surface to a neat appearing and free draining surface within 4 days after concrete is placed. Where required by the contract, topsoil shall be placed to the lines and grades of the work. The addition of topsoil, seed, and/or sod and all finish grading work shall be completed and ready for inspection within 6 days of concrete placement.

3.10 TOLERANCES

A. Assure all items of construction covered by this section present clean, uniform surfaces and lines free of irregularities and distortions. Plane surfaces and vertical tangent lines are tested with a 10-foot straightedge and cannot deviate more than ¼-inch from the straightedge.

3.11 MISCELLANEOUS NEW CONCRETE CONSTRUCTION

A. Construct new street monuments, new street light bases, and other miscellaneous concrete construction in accordance with detail drawings, or as directed by the Engineer.

B. New concrete construction required to maintain or restore existing structures will be considered incidental to the cost of pipe installation and no additional payments made. Include the concrete costs associated with thrust blocks with the unit costs bid for the valve, fittings, or appurtenance requiring the thrust block. New concrete work not included above, or specifically called out on the drawings, must first be approved by Engineer.

C. Construct all curb ramps with detectable warning surfaces in conformance with the

requirements of the Americans with Disabilities Act Accessibility Guidelines (ADAAG). Detectable warning surfaces shall be considered deficient and subject to replacement by the Contractor if more than 5% of the truncated domes on a ramp surface are missing or damaged, if the detectable warning product has lost any adhesion to the concrete, or if the detectable warning product is cracked or shows other signs of distress, at the end of the two-year warranty period.

PART 4 - MEASUREMENT AND PAYMENT

4.1 CURB TURN FILLETS

A. This item is measured ~~and paid for~~ by the number of curb turn fillets constructed, complete in place, including curb, at the contract lump sum ~~unit price~~ bid ~~for "Curb Turn Fillets~~". ~~Price and payment~~ The lump sum bid constitutes ~~are~~ full compensation for all material, excavation, backfill, curing of concrete, pre-molded mastic material, equipment, tools and labor, and for the performance of all work and incidentals necessary to complete this item.

~~1. Payment is made under Curb Turn Fillets – Per each.~~

4.2 CONCRETE VALLEY GUTTERS

A. This item is measured ~~and paid~~ for by square foot at the contract lump sum ~~unit price~~ bid for "Concrete Valley Gutters". ~~Price and payment~~ The lump sum bid constitutes ~~are~~ full compensation for all material, excavation, backfill, curing of concrete, pre-molded mastic material, reinforcing steel, equipment, tools and labor, and for the performance of all work and incidentals necessary to complete this item.

~~1. Payment is made under:~~

~~i. Concrete Valley Gutters (4' wide) – per lineal foot.~~

~~ii. Concrete Valley Gutters (2" wide) - per lineal foot.~~

4.3 CONCRETE DRIVEWAY APPROACH

A. This item is measured ~~and paid for~~ per each (as defined on the plan detail and excluding curb) at the contract lump sum ~~unit price~~ bid ~~for "Concrete Driveway Approach". Price and payment are~~ The lump sum bid constitutes full compensation for all material, excavation, backfill, curing of concrete, pre-molded mastic material, equipment, tools and labor, and for the performance of all work and incidentals necessary to complete this form.

~~1. Payment is made under: Concrete Driveway Approach (Traffic-rated pad) – each~~

4.4 CONCRETE SIDEWALK AND PLAZA

A. This item is measured ~~and paid~~ for by the square foot. ~~Price and payment are~~ The lump sum bid constitutes full compensation for all material, excavation, backfill, curing

of concrete, pre-molded mastic material, equipment, tools and labor, and for the performance of all work and incidentals necessary to complete this item. Item includes formwork, grading, preparation, and installation of all ADA appurtenances including truncated domes (Detectable Warning Surfaces), and all other items to ensure ADA compliance of ADA pedestrian access ramps.

~~1. Payment is made under:~~

~~i. Plaza concrete flatwork (heavy duty – 5" + fiber mesh additive reinforcement – per square foot.~~

ii. ~~Concrete Sidewalk – per square foot~~.

4.5 STREET MONUMENTS

A. This item is measured ~~and paid for~~ by the number of monuments constructed as shown on the plans at the contract lump sum bid ~~unit price bid for "Install Monuments, Type I or II". Price and payment are~~, which constitutes full compensation for all materials, excavation, backfill, forming and curing of concrete, equipment, tools and labor, and for the performance of all work and incidentals necessary to complete this form.

~~1. Payment is made under Install Monuments:~~

~~i. Type I – per each.~~

~~ii. Type II – per each.~~

END OF SECTION

SECTION 02530
ADA PARKING IMPROVEMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. This specification covers the installation of American with Disabilities Act (ADA) parking lot improvements to pavement markings, grading improvements, sidewalk improvements, and truncated domes as per the Drawings and Specifications.

1.2 REFERENCES

American with Disabilities Act of 1990 (ADA) Standards for Accessible Design

American with Disabilities Act Accessibility Guidelines (ADAAG) 2010

ASTM D 2628 - Standard Specification for Preformed Polymeric Pavement Marking Tape for Nonairfield Applications

ASTM D 794 - Standard Test Method for Shear Strength of Plastics by Punch Tool

ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension

ASTM D 638 - Standard Test Method for Tensile Properties of Plastics

ASTM D 695 - Standard Test Method for Compressive Properties of Rigid Plastics

ASTM D 792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

ASTM D 882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting

ASTM E 1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs

ASTM E 303 - Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester

PART 2 - PRODUCTS

2.1 GENERAL

A. Pavement Markings

1. All pavement markings shall be preformed polymeric pavement marking tape as per ASTM D 2628.

2. All pavement markings shall be installed in accordance with the manufacturer's recommendations.

3. All pavement markings shall be reflective.

4. All pavement markings shall have a minimum shear strength of 15 pounds per inch as per ASTM D 794.

B. Grading Improvements

1. All grading improvements shall be made in accordance with the requirements of the ADA Standards for Accessible Design and the ADAAG 2010.

2. All grading improvements shall be compacted to a minimum of 95% of maximum density as determined by ASTM D 695.

C. Sidewalk Improvements

1. All sidewalk improvements shall be constructed in accordance with the requirements of the ADA Standards for Accessible Design and the ADAAG 2010.

2. All sidewalks shall have a minimum width of 36 inches.

3. All sidewalks shall have a maximum cross slope of 2% and a maximum running slope of 5%.

D. Truncated Domes

1. All truncated domes shall be constructed in accordance with the requirements of the ADA Standards for Accessible Design and the ADAAG 2010.

2. All truncated domes shall be made of durable material that is resistant to wear and weathering.

3. All truncated domes shall be placed at a spacing of 24 inches center-to-center in a grid pattern.

4. All truncated domes shall have a maximum heigh of 0.2 inches and a minimum height of 0.1 inches.

5. All truncated domes shall have a base diameter of 0.9 inches and a top diameter of 0.45 inches.

6. All truncated domes shall be tested for slip resistance.

PART 3 - EXECUTION

3.1 PREPERATION

A. The CONTRACTOR shall ensure the parking lot area designated for ADA access is graded to the required slope and cross slope.

3.2 PAVEMENT MARKINGS & SIGNS

A. The CONTRACTOR shall apply ADA markings, if required, in accordance with the approved Drawings and Specifications. The pavement markings shall be applied using traffic paint or thermoplastic material. The CONTRACTOR shall ensure that the pavement markings have a non-slip surface.

B. The CONTRACTOR shall install ADA Accessible Parking signs in accordance with the approved Drawings and Specifications. MSU shall provide the signs.

3.3 GRADING IMPROVEMENTS

A. The CONTRACTOR shall install the sidewalks in accordance with the approved Drawings and Specifications. The CONTRACTOR shall ensure that the sidewalks have a minimum width of 36 inches and shall have a non-slip surface. The CONTRACTOR shall also ensure that the sidewalks have a running slope of no more than 4.8%.

3.4 TRUNCATED DOMES

A. The CONTRACTOR shall install the truncated domes in accordance with the approved Drawings and Specifications. The CONTRACTOR shall ensure that the truncated domes are made of durable and non-slip material. The color of the truncated domes shall be ~~yellow~~ per Project Plan Sheets or as directed by the Owner.

PART 4 - MEASUREMENT AND PAYMENT

4.1 PAVEMENT MARKINGS & SIGNS

A. Payment is made ~~under ADA Parking sign and pavement marking – per each.~~ within the total lump sum bid to perform the work shown in the Project Plan Sheets.

4.2 GRADING IMPROVEMENTS

A. No separate measurement and payment is made for this item. The cost for this item will be included in SECTION 02529 - CONCRETE SIDEWALKS, PLAZA, DRIVEWAYS, APPROACHES, CURB TURN FILLETS, VALLEY GUTTERS, AND MISCELLANEOUS NEW CONCRETE CONSTRUCTION.

4.3 TRUNCATED DOMES

A. No separate measurement and payment is made for this item. The cost for this item is to be included in SECTION 02529 - CONCRETE SIDEWALKS, PLAZA, DRIVEWAYS, APPROACHES, CURB TURN FILLETS, VALLEY GUTTERS, AND MISCELLANEOUS NEW CONCRETE CONSTRUCTION.

END OF SECTION

SECTION 02581
PAVEMENT MARKINGS AND MARKERS
(PRE-FORMED PLASTIC, PAINTS AND ENAMELS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. This work is painting pavement lines, words and symbols, or applying plastic lines, words, symbols, channelization buttons, and other reflective markers meeting these specifications, the standard drawings, and in reasonably close conformity with the lines and dimensions shown in the contract documents or established by the Engineer.

PART 2 - PRODUCT

2.1 PRE-FORMED PLASTIC PAVEMENT MARKING MATERIAL

A. Furnish plastic pavement markings and legends consisting of reflectorized, pre-fabricated, homogeneous, thermoplastic ribbon of the specified thickness. Assure the plastic contains reflective glass spheres uniformly distributed throughout its cross section and is capable of being affixed to bituminous or Portland Cement concrete pavements using a liquid contact cement or pre-coated, pressure-sensitive adhesive. Furnish white and yellow meeting standard highway colors. Assure the white plastic material is non- yellowing, and the yellow plastic material is non-fading for their expected useful life.

B. For strip line widths of 6 inches or less, furnish plastic pavement striping material in a single manufactured width equal to the specified width. For specified stripe line widths exceeding 6 inches, furnish plastic pavement striping material in a single manufactured width equal to the specified width or in two or more widths totaling the specified width.

C. Cut the plastic marking material edges clean and true. Use at least 0.09-inch thick plastic material for inlaying into new asphaltic surfaces. Use at least 0.06-inch-thick plastic material for application to existing surfaces or to hardened new surfaces.

D. Assure plastic pavement markings for inlay into new asphaltic surfaces are capable of being applied just before the final rolling of the new surface and can be rolled into place with conventional pavement rollers. For inlay applications, assure the plastic and adhesive are not damaged by pavement temperatures exceeding 175° F (79° C) or by water on roller drums.

E. Assure the plastic pavement marking material and its adhesive are tack free to provide easy handling without using a protective backing and can be repositioned on the surface before being permanently fixed in position. Pre-coated adhesive must be uniformly distributed over the entire contact surface of the plastic material.

F. Furnish plastic pavement marking material capable of molding itself to pavement contours, breaks, and other surface irregularities under traffic at normal pavement

temperatures. Assure the plastic material will fuse with itself and with previously applied markings of the same composition under normal use conditions.

G. Assure pavement legends and symbols meet the applicable shapes and sizes specified by the “Manual on Uniform Traffic Control Devices” as adopted by the FHWA.

H. Assure product agents or distributors furnish the manufacturer’s specifications showing that the material furnished meets or exceeds these requirements and submit evidence of successful product use over a one-year period under similar climatic conditions. Plastic pavement marking material not meeting this use requirement will be rejected.

I. Submit a 4-inch by 1-foot sample from each lot of plastic material proposed for use on the project to the Engineer for approval. Use only approved plastic pavement marking material on the project.

1. Composition Requirements

i. Furnish pre-formed plastic pavement marking material consisting of plasticizers, pigments, and graded glass spheres combined and proportioned to meet the following requirements.

a) Pigments: Minimum 20 percent titanium dioxide of total pigment for white marking material; minimum 18 percent medium chrome yellow of total pigment for yellow marking material. Use graded glass spheres that are clean, transparent, and meet the requirements of Section 02581.2.02.A.1. Assure the glass spheres are uniformly distributed throughout the entire material.

2. Physical Requirements

i. Tensile Strength

a) Assure the plastic material has a minimum tensile strength of 40 psi of cross section when tested under ASTM D638. The break resistance is based on an average of at least three (3) samples tested at a temperature of 70° – 80° F (22° – 27° C) using a jaw speed of 0.25 inches per minute.

ii. Plastic Pull Test

a) A 1”-6” sample of the plastic material must support a dead weight of 0.66 lb per 0.01 inch of material thickness for at least 5 minutes at 70° –80° F (22°-27° C).

iii. Bend Test

a) The plastic material must be flexible so that at 80° F (27° C), a 3” by 6” sample of the material can be bent over a 1” diameter mandrel until

the end faces are parallel and 1” apart without showing any fracture lines in the uppermost surface under unassisted visual inspection.

iv. Skid Resistance

a) The surface friction of the plastic cannot be less than 35 BPN when tested under ASTM E303.

v. Reseal Test

a) The plastic must reseal to itself without adhesives when tested as follows: Overlap 2 1-inch by 3-inch piece face-to-face so that they form a single 1-inch by 5-inch with a 1 square inch overlap in the center.

b) Place the piece on a hard surface with a 1000-gram weight resting uniformly on the entire overlap area and maintain at 140° to 190° F (60°-88° C) for 2 hours. The actual temperature to be maintained depends on the material being tested but must be within the specified range. After cooling to room temperature, the pieces must not separate without tearing.

vi. Reflectivity

a) Furnish reflective pavement marking material having reflective values not less than those listed in the table below. Reflective values are measured under Federal Specifications L-S-300C. The reflective values must be measured on a 2 by 2-1/2 foot panel at 85° incidence and be expressed as average candlepower per foot-candle per 5 square feet of material.

Divergence Angle	White	Yellow
0.2 Degrees	0.20	0.15
0.5 Degrees	0.15	0.10

2.2 WATERBORNE PAVEMENT MARKING PAINT

A. Waterborne Pavement Marking Paint

1. Furnish acrylic latex white and lead-free yellow waterborne pavement marking paint meeting the following requirements.

i. Composition – The exact composition is at the manufacturer’s discretion except that the vehicle is to be 100 percent acrylic polymer and the paint is not to contain any ingredient listed below.

a) Lead or chromate compounds; mercury; lead; chromate compounds; chlorinated solvents; hydrolysable chlorine derivatives; ethylene-

based glycol ethers and their acetates.

b) Meet the following requirements:

	White	Yellow
Pigment, % solids ASTM D-3723	68 max	68 max
Total Solids, % by weight ASTM D-2369	75 min	75 min
Titanium Dioxide, lbs./gal. ASTM D-4563 & D-1394	1 lb. min.	0.15 lb.
% Non-volatile vehicle of total vehicle weight ASTM D-2697	41 min.	41 min.
VOC content, maximum EPA Method 24	150 g/L	150 g/L
pH, min. ASTM E-70	9.6	9.6
	White	Yellow
Viscosity (Krebs Stormer), K.U., ASTM D-562 @ 77°F, (25° C)	80-95	80-95
Grind, Hegman, min. ASTM D-1210	2	2
Deviation in percent weight per gallon, max. (from manufacturer specified weight)	±.30	±.30
Daylight[1] Reflectance, min. ASTM D-2805	85	59.1[2]
Contrast Ratio, 15 mils wet min., ASTM D-2805	0.92	0.88

[1]The Y-Tristimulus value (luminance) is obtained using a standardized Tristimulus colorimeter using a C illuminant at a two- degree observation angle. The paint sample is drawn to a 15-mil wet film thickness over a white substrate. The department uses a Hunter Lab Miniscan XE Colorimeter and Leneta Corporation Form 5C opacity charts to determine this value.

[2]Color to match the V+ color on the Hale color chart ±6%.

ASTM TEST	WHITE AND YELLOW
D 711 mod.[1]	Dry Time, 15 mil wet film, 65% RH, minutes, max. 10
D1640 mod.[2]	Dry Through @ 90% RH, 15 mil wet film, minutes, max. 130

ASTM TEST	WHITE AND YELLOW
D 2243[3]	Freeze-Thaw, White and Yellow Pass
D 2486	Scrub Resistance, cycles min…..... 600
D-969	Bleeding Ratio, min… .....

[1]Use a wet film thickness of 15 plus or minus 1 mil. Immediately place in a humidity chamber controlled at 65± 3% relative humidity and 72.5° F ± 2.5° F (22.5°C ± 1.4° C) with minimal airflow.

[2]Apply a 15± 1 mil thick film to a non-absorbent substrate and place in a humidity chamber controlled at 85±5% R.H. and 72.5°F ± 2.5°F (22.5°C ± 1.4°C). Determine dry through time under ASTM D 1640 exerting the minimum pressure needed to maintain contact with the thumb and film.

[3]See B(7), Freeze-Thaw Stability.

c) Titanium. Use Titanium Dioxide meeting ASTM D-476, Type I or II.

ii. Characteristics

a) Flexibility and adhesion. Apply 15 mil wet film thickness to a 3” by 5” (75 mm by 130 mm) tin panel. Dry at 77°F (25°C) for 24 hours followed by two hours at 122°F (50°C). Bend sample over a ½-inch (13 mm) mandrel. Paint to adhere firmly without showing cracking or flaking.

b) Water resistance. Apply 15 mil wet film thickness to a 4” by 8” (102 mm by 203 mm) glass plate. Dry at 77°F (25°C) for 72 hours. Immerse in distilled water at 77°F (25°C) for 24 hours. Air dry for two hours on a flat surface. Paint to not show blistering or adhesion loss.

c) Skinning and lumps. Fill a pint (0.473 L) container ¾ full of paint and

seal tightly. After 72 hours, strain paint through a 100 mesh screen. No lumps or skin retained on the screen is permissible.

d) Settling. Fill a centrifuge tube with paint and revolve for two hours at 1112 Newtons (250 ft/lbs). Separation from top of vehicle to top of pigment not to exceed 13 mm (1/2- inch).

e) Skinning. Fill ½ pint (0.236 L) container half full of paint and seal. Let stand for 24 hours. No skinning to be visible.

f) Bleeding. When tested under ASTM D-969, paint to not show perceptible bleeding when painted on a bituminous surface.

g) Freeze-thaw stability. When tested under ASTM D-2243, paint to not show coagulation or viscosity change exceeding 10 Krebs units.

h) Static heat stability. Pour paint into a pint (473 mL) within 0.25 inches (6.4 mm) of the top, put the lid on and seal with tape, and place the container in an oven heated to 60°C ± 1°C (140°F ± 2°F) for seven days. Equilibrate the paint at standard conditions and thoroughly mix by stirring for at least five minutes. Ensure the paint does not show signs of livering, hard settling, coagulation, lumps or course particles. Perform a consistency test meeting ASTM D-562 at 25°C (77°F). Paint viscosity to not vary 10 K.U. from the original viscosity measured at 25°C (77°F).

iii. Packaging and Marking. Meet subsection 714.04.9 requirements.

iv. Sampling and Acceptance. Draw three samples meeting subsection 714.04.8 requirements.

v. Retro-reflective Glass Beads. Use silene-coated moisture resistant glass beads meeting subsection 714.05 requirements.

vi. Application. Follow the manufacturer’s requirements for pavement cleaning and traffic paint application or as follows, whichever is more restrictive.

a) Apply to a dry surface.

b) Clean the pavement of all loose rock, dirt, and debris immediately before applying the traffic paint.

c) Do not heat the traffic paint to exceed 110°F (43.3°C) before and during application.

d) Apply the traffic paint when the ambient temperature is 50°F (10°C) and rising. Stop application when the temperature is 50°F (10°C) and dropping and when rain or other weather adverse to the traffic paint

during its drying time is imminent.

e) Apply traffic paint at 15 mils (0.38 mm) wet thickness in a single application meeting subsection 620.03.3(A).

f) Remove and replace all defective pavement marking damaged by weather at Contractor expense.

g) Re-paint, at Contractor expense, all striping represented by paint samples where any specified property is outside 20 percent of the specified value.

vii. Reflective Glass Beads

a) Glass beads for use in reflectorizing traffic paint markings on pavement by the drop-on method must be spherical and transparent with smooth, lustrous surfaces. The beads, as delivered, must be spherical and transparent with smooth, lustrous surfaces. The beads, as delivered, must be free from extraneous material and clumps of beads that cannot be broken up easily when applying to the stripe.

b) Imperfections – The glass beads cannot include more than 25 percent irregularly shaped particles when tested under ASTM D1155. Assure the beads are free of scratches, pits, milkiness, dark particles, and excessive air bubbles.

c) Color – The glass beads must be colorless to the extent that they do not impart a noticeable daytime hue to white pavement markings.

d) Chemical Stability – The beads must withstand refluxing in distilled water in a Soxhlet extractor for 90 hours without noticeable dulling of surface luster and not more than 2.5 percent loss in weight.

e) Index of refraction – The glass from which the beads are made must have an index of refraction of at least 1.50 by the immersion method using tungsten light.

f) Gradation – Assure the glass beads meet the following gradation requirements when tested under the Standard Method of Test for Sieve Analysis of Glass Spheres, ASTM D1214.

Sieve No.	Total Percent Passing
20	100%
30	75-95%
50	15-35%
100	0-5%

g) Packaging and Marking – Furnish glass beads in bags containing 50

lb. (26 kg) net. Assure the shipping bags are moisture proof, paper-lined burlap bags meeting specification ICC-36-C under Interstate Commerce Commission Regulation Section 78-234. Mark each bag with the name of contents, manufacturer of beads, and net weight.

h) Certification – Submit certification from a testing laboratory approved by the Engineer certifying the beads meet these expectations.

PART 3 - EXECUTION

3.1 APPLICATION OF PLASTIC PAVEMENT MARKING MATERIAL

A. Apply plastic pavement marking materials only to clean, dry surfaces free of paint, dirt, and foreign matter. On newly constructed surfaces to which a sealer has been applied, clean the surface receiving the plastic pavement marking to neutralize any acid and remove the sealer.

B. Apply following the manufacturer's recommended procedures. Apply plastic pavement marking materials only to surfaces at temperatures within the range specified by the manufacturer for optimum adhesion.

C. When activators are required for the adhesive or when various special coatings are required for different pavement surfaces, supply such information to the Engineer, indicating special application procedures.

D. Assure the width and layout of stripes or the area of application of plastic pavement markings and legends meet the dimensions shown in the contract documents or standard drawings.

E. Before applying the plastic striping material, the Engineer will establish control points on the roadway for striping alignment. The Engineer will establish control points every 100 feet on tangent, at least every 100 feet on curves of 2 degrees or less, and at 50-foot intervals for curves over 2 degrees. The Engineer will also designate other pavement striping locations such as stop bars, crosswalks, and the like. Maintain all lines within 2" of established lines.

F. Place asphaltic surfacing on the roadway just before final compaction and roll into the new surface during final completion. Assure pavement markings or legends are flush with the finished surface.

3.2 PAINTING TRAFFIC LINES

A. Clean the surface to be painted for dirt, rocks, gravel and any other foreign matter. Apply the paint by hand or mechanical means consistent with the scope of the job. Assure the width and layout of stripes or the area to be painted meets the plans or standard drawings.

B. Paint the top and traffic side of curbs at those locations where parking is to be

restricted, as shown in the contract documents or in the pavement marking manual. Paint the top and traffic sides of all island curbs, median curb, and other specified curb. Paint by uniformly applying one (1) coat of yellow traffic line paint meeting the requirements of Section 02581.2.2.A.1 as applicable. Paint the curb after it has cured at least 30 days after being cast. Apply the paint at a rate that the curb surface is completely covered and hidden. Assure surfaces to be painted are clean and free of all foreign matter before painting.

C. Before applying paint, mark the roadway between control points established by the Engineer. The Engineer will establish such control points on tangent every 100 feet and on curves at least every 100 feet for under 2- degree curves and at 50-foot intervals on curves over 2-degree curvature. Maintain the line within 2” of the established lines. The Engineer will also designate other pavement striping locations such as stop bars, crosswalks, and the like.

D. Apply highway traffic striping during daylight hours when the air and pavement temperatures are 40° F (4° C) or higher, the pavement surface is dry and the weather is not foggy, rainy, or stormy.

E. Apply paint and glass beads with equipment manufactured specifically for that purpose and using workmen experienced in operating such equipment. Locate the bead applicator directly behind and synchronized with the paint applicator. Assure both devices are shielded to avoid spraying of paint or loss of beads outside of the designated width of line. Assure the equipment is also capable of painting a stripe or stripes of the specified width with a tolerance of plus or minus ¼ inch. In “no passing zones”, the machine must be able to paint three (3) stripes simultaneously. For centerline painting, assure the machine is equipped with an automatic skip control giving the specified broken-line pattern within a tolerance of 6 inches over each cycle.

F. Use hand-operated equipment to stripe stop bars, crosswalks, and other areas not readily accessible to the pavement striping machine.

G. Apply the pavement striping paint at the following rates per gallon:

1. Four-inch stripe – at least 250 but not more than 275 linear feet per gallon.

2. Four-inch dashed stripe (9-foot stripe-15 foot gap) – at least 665 but not more than 735 linear feet per gallon.

3. Four-inch dashed stripe (10 foot – 30-foot gap) at least 1000 but not more than 1100 linear feet per gallon.

H. Apply beads at the rate of 6 pounds per gallon of paint, plus or minus 0.1 pound.

I. For quality control, the Engineer will check the application at the beginning of each day’s paint striping and as often as considered necessary. If equipment settings fail to produce quality striping within the limits specified, stop striping work until corrected.

J. Protect all markings until dry by placing approved guarding or warning devices as necessary. Correct all markings smeared or otherwise damaged at no expense to the owner.

K. Sufficient quantities of paint have been included in the contract to provide for an interim application and a final application of traffic line paint. The need for applying an interim application will be determined by the Engineer.

L. When plastic pavement markings are specified, use paint for the interim markings of the specified color and apply as specified in the contract documents. The final application must be plastic.

M. Apply two (2) full applications of the specified centerline and shoulder line striping on open graded friction course and seal coat pavement surfaces meeting the following table. Apply the second application a minimum of 30 days after the first application.

3.3 PAVEMENT STRIPING – OGFC AND SEAL COATED SURFACES

Pavement Surface Type		Number of Applications	Striping Application Direction of Travel	
			First Application	Second Application
OGFC and Seal Coated Surfaces	2 lane	2	Not Specified	Apply in opposite direction of first application
	2-way	2	Apply in same direction as traffic flow	Apply in same direction as traffic flow
	4-way			

*All transverse lines must receive two (2) applications applied in opposite directions

3.4 REMOVAL OF PAVEMENT MARKINGS

A. As shown in the contract documents or directed by the Engineer, remove temporary pavement markings or markings that are no longer appropriate to the roadway.

B. Approved methods of removing markings include sand blasting with air or water; high pressure water; steam or superheated water; mechanical grinders, sanders, scrapers, brushes, burning, and the like.

C. Choose, subject to Engineer approval, the removal method best suited to the existing condition of the paint and pavement surface.

D. No other methods of removal other than those specified here will be allowed. The contractor may make written request to the Engineer for approval to use other methods, materials, or equipment. The Engineer may subsequently disapprove any prior approved method should it prove detrimental to the pavement surface or inadequate in removing the markings.

E. Remove sand or other material deposited on the pavement resulting from removing traffic markings as the work progresses. If the striping removal results in light or discolored lines on the roadway, cover the areas with a thin asphalt fog coat. Repair all

damage to the pavement or surfacing caused by pavement marking removal at no cost to the owner.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. Plastic pavement striping is measured ~~for payment~~ by the number of linear feet of line of the specified width and thickness in place and accepted. Length of dashed, longitudinal pavement line is the actual length placed, e.g. 25% of the total roadway length where 10-30 lines gap ratio is used.

B. Plastic pavement marking words and symbols are measured ~~for payment~~ by the number of square feet of words and symbols in place and accepted.

C. Painted traffic lines, words, and symbols are measured ~~for payment~~ by the number of gallons of paint used and accepted.

D. Unless otherwise provided in the contract, removal of pavement markings is measured ~~for payment~~ by the linear foot. Words and symbols are measured by the square foot and converted to the equivalent linear foot of 4 inches wide line.

E. Paint and painting of curbs, island curbs, and median curbs in accordance with Section 02581.3.2 are measured by the actual gallons of paint used and accepted.

F. Plastic pavement striping is paid for at the contract lump sum bid ~~unit price per linear foot of striping of the specified width and thickness~~ to perform the work shown in the Project Plan Sheets.

G. Plastic pavement marking words and symbols are paid for at the contract lump sum bid, which constitutes ~~unit price per square foot of plastic words and at the contract unit price per square foot plastic words and symbols. Payment for plastic lines, words, and symbols is~~ full compensation for furnishing all necessary materials and equipment and doing all required work as shown in the Project Plan Sheets.

H. Painting of traffic lines and words and symbols is paid for at the contract lump sum bid, which constitutes ~~unit price per gallon for “Highway Traffic Striping” complete in place, including the furnishing and application of beads. Payment is~~ full compensation for all work necessary to complete the item per the Project Plan Sheets.

I. Removal of pavement markings is paid for at the contract lump sum bid ~~unit price per linear foot~~.

~~J.~~ The cost of paint and the painting of curbs, island curbs, and median curbs in accordance with Section 02581.3.2 are paid for at the contract lump sum bid ~~unit price per gallon for curb marking.~~

END OF SECTION

SECTION 02720
STORM DRAIN SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish and install all storm drains, including manholes, inlets, service lines and other appurtenant structures as specified in the Contract and this section. Pipe strength classifications are specified on the plans, listed in the Contract Documents or herein.

1.2 CERTIFICATION BY MANUFACTURER

A. Furnish a manufacturer's certification on all pipe, certifying that the pipe and fittings meet the contract requirements.

1.3 REFERENCES

AASHTO M36	Corrugated Steel Pipe, Metallic Coated, for Sewers and Drains
AASHTO M196	Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M245	Corrugated Steel Pipe, Polymer-Precoated, for Sewers and Drains
AASHTO M274	Steel Sheet, Aluminum Coated (Type-2), For Corrugated Steel Pipe
AASHTO M294	Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60- in.) Diameter
ASTM C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C361	Reinforced Concrete Low Head Pressure Pipe
ASTM C443	Joints for Circular Concrete Sewer and Culvert Pipe, using Rubber Gaskets
ASTM C478	Circular Precast Reinforced Concrete Manhole Sections
ASTM C506	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Reinforced Elliptical Culvert, Storm Drain and Sewer Pipe

ASTM C655	Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer
ASTM C665	Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing
ASTM C789	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers
ASTM C850	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with less than 2 ft of Cover Subjected to Highway Loadings
ASTM D1784	Rigid Polyvinyl Chloride (PVC) Compounds and chlorinated Polyvinyl Chloride (CPVC) Compounds
ASTM D3034	Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
ASTM 3350	Polyethylene Plastics Pipe and Fittings Material
AWWA C151	Ductile Iron Pipe, Centrifugally Cast
ASTM F949	Polyvinyl Chloride (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings
ASTM M294	High Density Polyethylene Pipe (HDPE)

PART 2 - PRODUCTS

2.1 GENERAL

A. Furnish all storm drain piping as specified in the Contract Documents and meeting the materials and testing requirements of this Section. Furnish wye and tee branches of the same material and design as the specified storm drain pipe. Furnish the pipe sizes and strength classifications shown in the Contract documents.

B. References to ASTM, ANSI or AASHTO designation, means the latest revision at the time of call for bids.

C. Assure all pipe is clearly marked with type, class and/or thickness as applicable. Assure lettering is legible and permanent under normal handling and storage conditions.

D. Furnish the joint type, class, thickness designation, casting, lining, marking, testing, etc. as specified.

2.2 PIPE MATERIALS

A. Concrete Pipe

1. Furnish concrete storm drain and culvert pipe meeting ASTM C76 or C655. Use round reinforced pipe having O-ring rubber gasket joints meeting ASTM C443 with the O-ring gasket confined in the pipe tongue groove.

B. Polyvinyl Chloride (PVC) Pipe

1. Furnish PVC pipe produced by a continuous extrusion process employing a prime grade of unplasticized polyvinyl chloride. Assure the grade used is highly resistant to hydrogen sulfide, sulfuric acid, gasoline, oil, detergents and other chemicals found in sewage and industrial wastes. Assure the material meets “Rigid Polyvinyl Chloride Compounds”, ASTM D1784 requirements. Assure the pipe has self-extinguishing flammability characteristics. Assure the pipe meets ASTM D3034, “Standard Specifications for Polyvinyl Chloride Sewer Pipe and Fittings”, with an SDR of 35 4"-15" ASTM F679, “Standard Specification for PVC Large Diameter Plastic Gravity Sewer Pipe and Fittings: 18” – 36”, or ASTM F949, “Standard Specification for PVC Corrugated (Open Profile) Sewer Pipe With a Smooth Interior and Fittings”, 12” – 36”.

2. The nominal laying length is a minimum 12.5 feet, 13 feet or 20 feet except shorter lengths are permitted adjacent to manholes, lampholes or other appurtenances. Assure each pipe length is marked with size, SDR, “Sewer Pipe” and Code Number. Assure each pipe length has a bell providing a watertight joint when jointing the bell and spigot with a rubber ring. Make the rubber gasket joint using a rubber gasket compressed between the outer surface of the spigot and the inner surface of the bell. Assure the joint is completely sealed by the gasket providing a watertight joint under all service conditions, including expansion, contraction, settlement and pipe deformation. Assemble the rubber ring joint assembly following the manufacturer’s recommendations.

3. Furnish wye or tee fittings of the same material, construction and joint design as the main sewer pipe.

C. An Owner may allow ‘ULTRA FLO’ or approved equivalent steel pipe. Connections must be made with minimum coupling band width of 10-1/2” and appropriate gasketing material. When specified by the Engineer, materials shall meet the following standards:

ASTM A760 (AASHTO M36)	Specifications for Corrugated Steel Pipe, Metallic-coated for Sewers and Drains
ASTM A762 (AASHTO M245)	Specifications for Corrugated steel Pipe, Polymer Pre-coated for Sewers and Drains
ASTM A742 (AASHTO M246)	Specifications for Steel Coated and Polymer Sheet, Metallic Pre-coated for Corrugated Steel Pipe

ASTM A929 (AASHTO M274)	Specifications for Steel Sheet Metallic Coated for the Hot Dip Process for Corrugated Steel Pipe

D. Other Pipe Material

1. An Owner may select other materials as appropriate for applications where an Engineer has reviewed the circumstances and provided specifications for installation. When specified by and Engineer, materials shall meet the following standards:

ASTM C 76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C 506	Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C 507	Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C 655	Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C 789	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains and Sewers
ASTM C 850	Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with less than 2 ft of Cover Subjected to Highway Loadings
ASTM 3350	Polyethylene Plastics Pipe and Fittings Material
AASHTO M 36	Corrugated Steel Pipe, Metallic Coated, for Sewers and Drains
AASHTO M 196	Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M 245	Corrugated Steel Pipe, Polymer-Precoated, for Sewers and Drains
AASHTO M 274	Steel Sheet, Aluminum Coated (Type-2), For Corrugated Steel Pipe
AASHTO M 294	Corrugated Polyethylene Pipe 300- to 1500-mm (12- to 60-in.) Diameter
ASTM M294	High Density Polyethylene Pipe (HDPE)

2.3 MANHOLES

A. General

1. Furnish manholes constructed of precast concrete sections with frames, covers and steps meeting Standard Drawing Details.

B. Precast Concrete Sections

1. Furnish manholes meeting ASTM C478: “Precast Reinforced Concrete Manhole Sections”.

C. Steps

1. Furnish non-corrosive type, 12 inches in width, of 1/2-inch steel rod encased with polypropylene. Assure steps withstand 400 pound vertical loads and 1,000 pound pull-out resistance.

D. Frames and Covers

1. Furnish frames and covers. Furnish 2 hole type covers unless noted or specified otherwise.

E. Concrete Bases

1. Concrete bases may be precast or field-poured on undisturbed earth.

2.4 INLETS AND CATCH BASINS

A. Furnish standard cast iron inlet frames and grates meeting standard drawing requirements or as specified.

PART 3 - EXECUTION

3.1 PIPE AND SERVICE LINE INSTALLATION

A. Excavation and Backfill

1. Excavate and backfill pipelines meeting the applicable portions of SECTION 02221: TRENCH EXCAVATION AND BACKFILL FOR PIPELINES AND APPURTENANT STRUCTURES.

B. Responsibility for Materials

1. Be responsible for all material furnished. Replace all material found defective in manufacture or damaged in handling after delivery by the manufacturer. This includes furnishing all material and labor required for the replacement of installed material discovered defective before final acceptance of the work or during the guarantee period.

2. Be responsible for the safe storage of material for the work until it has been incorporated in the completed project.

C. Handling of Pipe

1. Deliver and distribute all Contractor furnished pipe. Load and unload pipe, fittings and accessories by lifting with hoists or skidding so as to avoid shock or damage. Do not drop the materials. Do not skid or roll pipe handled on skidways against

pipe already on the ground.

2. In distributing the material at the work site, unload each piece opposite or near the place where it is to be laid in the trench. Keep the pipe interior and other accessories free from dirt and foreign matter at all times.

3. Handle pipe to prevent coating or lining damage. Repair or replace all coating or lining damage in a manner satisfactory to the Engineer.

D. Laying Pipe

1. Lay and maintain all pipe to the specified lines and grades with fittings, tees and manholes at the specified locations.

2. Install wye or tee fittings in the mainline sewer for service line connections. Furnish wye or tee fittings of the same material, design and specifications as the sewer main pipe. Joint service pipe to tee branches or main line pipe other than PVC using special joint adapters manufactured specifically for jointing the two types of pipe.

3. Use tools and equipment meeting Engineer approval for the safe and convenient prosecution of the work. Carefully lower all pipe and fittings into the trench preventing damage to pipe materials and protective coatings and linings. Do not dump or drop materials into the trench.

4. Exercise care to prevent foreign material from entering the pipe as it is installed. When pipe laying is not in progress, close the open ends of pipe using a plug or other means approved by the Engineer. Remove and clean all sand, gravel, concrete and cement grout that has entered the lines during construction.

E. Tolerances

1. Install pipe within 1/2-inch of the specified alignment and within 1/4- inch of the specified grade for pipe 15-inch in diameter and smaller and 1/2-inch of specified grade for pipe larger than 15-inch diameter. These tolerances apply to any point along the entire pipe length.

3.2 MANHOLES

A. Construction

1. Construct manholes to the specified dimensions. Assure invert channels are smooth and semi-circular in shape conforming to the inside of the adjacent pipe section. Make flow direction changes with a smooth curve of as large a radius as the size of the manhole will permit. Make changes in channel size and grade gradually and evenly. Form the invert channels directly in the manhole base concrete or by laying a half-pipe in the concrete. Smooth and slope the manhole floor outside the channel toward the channel at one inch per foot.

2. Joint all connections between manhole walls and base and between wall sections making the manhole watertight.

3. Install adjusting rings on each manhole to adjust the manhole top elevation to the existing or specified ground elevations, with the total ring height of 2-inch minimum and 12-inch maximum. Assure adjusting rings are reinforced with the same percentage of steel as the riser and top.

3.3 INLETS AND CATCH BASINS

A. Construct inlets and catch basins meeting the standard drawing for the type specified.

B. Construct inlet structures to the line, cross-section and dimensions specified. Inlet structures may be precast or cast-in-place.

3.4 STORM DRAIN SERVICE LINES

A. Install the service line to the property line. Plug the end of the service line with a stopper and gasket, using a gasket of the same type used for pipe jointing. Do not grout the plugs.

B. Mark the sanitary sewer and storm drain service line ends at the property line using a steel fence post 5 feet (1.5 m) long, buried at least 2 feet. Place a 2" X 2" wood marker extending from the pipe invert to ground line. Wire the 2" X 2" marker to the steel fence post. Where applicable, mark the concrete curb to identify the service locations. Paint sanitary sewer service markers green and storm drain service markers gray.

3.5 TESTS

A. Light Test (Visual)

1. Once the trench is backfilled, perform a light test between manholes to check alignment and grade for pipe displacement. Except for specified curved alignments, the completed pipeline must permit a true circle of light to be seen from manhole to manhole.

2. If alignment or grade does not meet specifications, correct alignment or grade at Contractor expense.

B. Leakage Test

1. Unless specified, a leakage test will not be required. Obvious and concentrated leaks, such as open joints, pinched gaskets, cracked barrels or bells, are not allowed.

C. Deflection Test

1. The Engineer may require deflection testing of all flexible pipe installations to assure the construction quality.

2. Conduct deflection tests meeting ASTM D3034 and satisfy either of the following deflection limitations:

TABLE 3.1
DEFLECTION TESTING LIMITATIONS

Minimum Period Between Trench Backfilling & Testing	Minimum Mandrel Diameter as a Percent of Inside Pipe Diameter
7 Days	95.0
30 Days	92.5

3. Mandrels must have at least nine arms. Perform the mandrel test without mechanical pulling devices.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. The following are pay items for the work covered under this section. Payment for these items is full compensation for providing all materials, tools, labor, and equipment necessary to complete the item and all incidental work related thereto, whether specifically mentioned herein or not. Payment for all work described within this section is included in the contract lump sum bid amount to perform the work as shown in the Project Plan Sheets.

4.2 STORM DRAINS

A. Measurement of storm drain pipe is lineal feet of the various sizes and classes along the centerline of pipe from center to center of manholes, or center of inlet to center of manhole. Payment for storm drain pipe is made at the contract lump sum bid ~~unit price bid per lineal foot of the various sizes and classes called for,~~ which includes furnishing and installing pipe, trench excavation and backfill, furnishing and placing Type I bedding, specials required for connection to manholes and inlets, testing and all other work necessary or incidental for completion of this item.

4.3 MANHOLES

A. Measurement of each manhole ~~for payment~~ is made in two parts: (1) for a basic manhole, and (2) for any additional vertical height over and above the basic depth. A basic manhole is defined as 5 feet deep from the lowest invert to the top of the manhole frame and cover. Any manhole less than 5 feet deep is considered as one basic manhole. Any manhole over 5 feet deep is considered as one basic manhole plus a vertical height measurement to the nearest 0.1 foot. Basic manholes are measured by numerical count and the additional vertical feet of manhole. The measurement of the additional vertical height of manhole is the vertical height of the manhole from the lowest invert to the top of the cast iron frame minus 5 feet.

B. Payment for furnishing and installing a basic manhole complete, is made at the

contract lump sum bid amount ~~unit price bid per each for "Basic Manholes", 5.0 feet deep.~~ Payment within the lump sum bid amount includes base, manhole sections, steps, cast iron ring and cover, joint sealer and all other incidentals required to complete the item.

~~C.~~ Payment for furnishing and installing manholes deeper than the basic manhole depth is made at the contract lump sum ~~unit price~~ bid ~~per vertical foot for "Additional Manhole Depth" and includes manhole sections, steps, joint sealer and all other incidentals to complete the item.~~ to perform the work shown in the Project Plan Sheets.

D. Payment is made under: lump sum bid for project improvements shown in Project Plan Sheets.

~~a. Basic Manhole, 5'0" Depth – Per each~~

~~b. Additional Manhole Depth – Per vertical foot~~

4.4 STORM DRAIN INLETS

A. Storm drain inlets shall be measured ~~and paid for~~ by the number of drain inlets installed, complete in place, at the contract lump sum bid, which constitutes ~~unit price bid for the various types of inlets listed in the Contract documents, which price and payment shall constitute~~ full compensation for all excavation and backfill, furnishing and installing all materials required (including grates), compaction, labor, tools and incidentals necessary to complete the item.

4.5 STORM DRAIN SERVICE LINES

A. Measurement is made along the pipe from the tee or wye of the main sewer through tees, wyes and other fittings to the street margin or right-of-way margin. Measurement is to the nearest foot.

B. Payment for services is based on the following bid items as specified in the contract: lump sum bid for project improvements shown in Project Plan Sheets.

~~a. Trench excavation and backfill is included in in the linear foot price bid for sewer service pipe.~~

~~b. (size)(class) Sewer Service Pipe in Place, per linear foot.~~

4.6 GENERAL

A. The contract lump sum bid price shall include full payment for labor, materials, tools, and other incidentals as may be required to complete the items of work in the Contract as shown in the Project Plan Sheets.

END OF SECTION

SECTION 02810
IRRIGATION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of each Contract, including General Conditions and Supplementary Conditions, apply to work of this section.

1.2 DESCRIPTION

A. The work of this section consists of all items necessary to install the proposed irrigation system as indicated on the plans, and the protection and splicing required to maintain all parts of the existing irrigation system in operation, with the exception of those parts designated to be removed or abandoned. This includes required sleeves for pipe and wire, back-flow prevention devices, reconnections, and miscellaneous modifications to the existing irrigation distribution lines including, but not limited to:

1. Automatic controller and remote-control valves.
2. Lawn and planting beds sprinkler system.
3. Connection to proposed irrigation water source and power supply.

1.3 RELATED WORK DESCRIBED ELSEWHERE

A. Plants Section 02940

B. Turf & Grass Section 02930

1.4 QUALITY ASSURANCE

A. Qualifications of Installer

1. Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials of installation and who shall direct all work performed under this section. All work of this section and related work listed above shall be performed by the same CONTRACTOR.

B. Codes and Standards

1. In addition to complying with all pertinent codes and regulations, comply with the latest rules of the National Electrical Code for all electrical work and materials.
2. Comply with National Plumbing code at all connections to potable water systems.
3. Where provisions of pertinent codes and standards conflict with the requirements of this section of these Specifications, the more stringent provisions shall govern.

1.5 SUBMITTALS

A. Material List

1. Before any irrigation system materials are delivered to the job site, submit to the OWNER'S REPRESENTATIVE a complete list of all irrigation system materials to be furnished and installed.
   a. Show manufacturer's name and catalog number for each item, furnish complete catalog cuts and technical data, and furnish the manufacturer's recommendations as to method of installation. Note selected materials if multiple materials are shown on one page. Where materials proposed differ from those specified, furnish complete shop drawings and design calculations to demonstrate equivalent performance of the proposed installation.
   b. Do not permit any irrigation system component to be brought onto the job site without prior approval by the OWNER'S REPRESENTATIVE. Provide one sample of each element of the system to the OWNER'S REPRESENTATIVE for approval (sprinkler heads, valves, couplings, etc.). These samples will be returned to the CONTRACTOR, and if approved, may be used in the project.

B. Shop Drawings

1. CONTRACTOR shall submit Five (5) copies of the proposed sprinkler layout in a schematic form to the OWNER'S REPRESENTATIVE for approval. Any modifications to these proposed drawings will be returned to the CONTRACTOR for the preparation of five (5) copies of the final revised layout. The material list will be coordinated with the final shop drawings by the CONTRACTOR. Show all sleeve locations.

C. Field Verification

1. CONTRACTOR shall field verify all dimensions, existing and proposed conditions, and as required to provide one complete and operable system. The proposed system shall be laid out above ground using locate flags to show location of all sprinkler heads, valves, and sleeve locations. This layout shall be signed off on by MSU Irrigation Manger before any excavation shall begin.

D. As-built Drawings
   a. Provide a complete set of Mylar reproducible as-built shop drawings to the OWNER'S REPRESENTATIVE for approval prior to final payment.

1.6 PRODUCT HANDLING

A. Protection

1. Use all means necessary to protect irrigation system materials before, during, and after installation and to protect the installed work and materials of all other trades.

B. Replacements

1. In the event of damage, immediately make all repairs and replacements necessary to the approval of the OWNER'S REPRESENTATIVE and at no additional cost to the OWNER.

1.7 PERFORMANCE REQUIREMENTS

A. Minimum Requirements

1. The following shall be the minimum requirements of the system. They are not intended to limit the overall intent, which is to obtain a fully operational and completely automatic sprinkler system. Specific requirements of this project manual shall apply to all elements typically. Conflicts between the drawings and the project manual or between specific and general performance of material requirements shall be assumed to be the most expensive.

B. Project Zones

1. Refer to the drawings for the general zones to be served by this system.
   a. Irrigation layout must be adaptable to the future modification of the system to smaller heads, more intense head arrays and minimal spraying over the sidewalks.
      1) This should be accomplished by running the laterals near sidewalk edges whenever possible, and by positioning the mains with this future intent.
   b. CONTRACTOR will advise himself of all existing and proposed site conditions and related planting and grading as required to coordinate and schedule with the work of other contractors.
   c. Heads shall be positioned to prevent damage from spraying on the building envelope and/or causing inside flooding in any and all cases.
   d. Organize zones to allow walking across the area on dry sidewalk while the irrigation system is on.

PART 2 - MATERIALS

2.1 PIPE

A. PVC Pipe

1. PVC pipe 4" and under in diameter shall be rigid non-plasticized Schedule 40 PVC IPS solvent-welded conforming to ASTM D-1784 and D-2241 standard specifications for PVC plastic pipe. Plastic pipe 6" and larger in diameter shall be rigid non-plasticized Class 200 PVC IPS gasket fit conforming to ASTM D-1784 and D-2241 standard specifications for PVC plastic pipe. The pipe shall be homogeneous throughout and free from visible cracks, holes, foreign materials, blisters, deleterious material, wrinkles, and dents.

2. All pipes shall be continuously and permanently marked with the following information:
   a. Manufacturer's name or trademark, size, schedule and type of pipe, working pressure at 73 deg. F and National Sanitation Foundation (N.S.F.) approval.

3. All main lines shall be a minimum of two inches (2”) in diameter, unless otherwise noted. Only full inch increment pipe sizes may be used.

4. All lateral lines shall be a minimum of one and one-half inches (1-½”) in diameter, unless otherwise noted.

5. All plastic pipe fittings to be installed shall be molded fittings manufactured of the same material as the pipe, rated as a pressure fitting (no DWV fittings shall be allowed) and shall be suitable for solvent weld, slip joint ring-tight seal, or threaded connections. All pipe six inches (6”) in diameter and above shall be Class 200 PVC IPS gasket end. All smaller pipes shall be Schedule 40 PVC IPS solvent-welded.

6. Slip fitting socket taper shall be so sized that a dry, unsoften pipe end, conforming to these specifications, can be inserted no more than halfway into the socket. Plastic saddle and flange fittings will not be permitted. Only schedule 80 pipe may be threaded.

7. When connection is plastic to metal, Schedule 80 PVC plastic male adapters shall be used. Joint compound shall be Teflon Tape on Water Based Teflon Paste. Male adapters will be visually inspected for leaks.

8. All mainline pipes that are not located in the same trench as the control wire shall require a traceable purple or blue-colored 14-gauge single strand direct burial wire. The wire should be free from moving valve parts to prevent damage. The tracer wire shall surface at and be secured to the controller. This is not necessary for lateral pipelines with irrigation heads attached.

9. All lateral line pipe size shall stay consistent throughout the zone. Do not reduce the lateral pipe size as the lateral line progresses away from the control valve, unless otherwise specified by the OWNER.

B. HDPE Pipe

1. All HDPE pipe must be SDR11 manufactured in accordance with AWWA C901/C906, ASTM D2239, ASTM D2737, ASTM D3035, ASTM F714 and ANSI/NSF 14/16 listings.

2. HDPE pipe as noted on the drawings shall be manufactured with PE4710 resin.

3. Pipe shall conform to ASTM D3350 with the cell classification of 445574C/E.

4. Pipe pressure design shall be DR 11, rated to 200 PSI.

5. Marking:
   a. The following shall be clearly marked on the exterior surface of the pipe:
      1) Class and size
      2) Date of manufacture
      3) Name or trademark of manufacturer
      4) Deflection angle for bends

6. All fittings and joints must be fusion welded using butt joints with mechanical fittings or electro fusion fittings designed for use with HDPE.

7. Fittings
   a. Elbows and fitting shall be mitered from pipe sections welded together on the interior and exterior of all junctions and follow manufacturer's instructions.

b. All fusion welds must be done by a certified technician. Certification to be provided to OWNER at time of submittal.

8. Joints
   a. Watertight joints shall be accomplished by rubber gasket in accordance with ASTM D3212.
   b. All fusion welds must be done by a certified technician. Certification to be provided to OWNER at time of submittal.

C. Pipe Sleeves

1. Pipe sleeves shall be Schedule 40 PVC pipe, in sizes shown in the schedule below, or equal approved by OWNER'S REPRESENTATIVE.
   a.

ITEM	REQUIRED SLEEVE SIZE & QUANTITY
Irrigation Mainline & Lateral Line	6" PVC (1)
Control Wires	4" PVC (1)
Empty	4" PVC (1)

2. Installation
   a. Provide empty sleeves along all paved driveway and pathways as noted on the drawings. Extend sleeves at least one foot (1') beyond pavement on both sides. Sleeves shall be installed 18 inches below finished grade. All sleeves shall be installed at a depth in line and grade with existing or proposed irrigation lines. Sleeves with excessive or shallow invert depth will be rejected. Cap ends of empty sleeves with duct tape.
      1) Coordinate sleeve placement during grading/ paving work.

3. Sleeve Location Marking
   a. New Pavement
      1) The location of each sleeve must be marked along both of the extreme edges of any new pavement installed over the sleeve. This shall be accomplished by pressing the end section of pipe, between the diameters of 1" to 2," into the uncured pavement surface to make an imprint.
   b. Existing Pavement
      1) For sleeves pushed under existing pavement, sleeve locations shall be marked along the extreme edges of the pavement on both sides where the sleeve emerges from under the pavement. Markings shall consist of scoring the surface of the existing pavement with a core drill, between the diameters of 1" to 2," just enough to make the impression of a circle in the pavement surface.

2.2 RISERS/SWING JOINTS

A. Flexible Risers

1. Stationary Pop-up and Surface Sprinkler Heads shall be installed using "funny pipe" or four-piece swing joints. Sprinkler Heads with one-half inch (1/2") and/or three-quarter inch (3/4") inlets shall connect with "funny pipe" exclusively, in

lengths no longer than two feet (2'). Sprinkler Heads with one-inch (1") inlets shall connect with four-piece swing joints only.

2. Installation with "funny pipe", which is one-half inch (1/2") low density, polyethylene pipe, rated 80 PSI at 100 deg. F, must use Teflon-taped barbed street ells. Use of flexible pipe such as "funny pipe" is limited to connecting laterals to irrigation heads.

3. Four-piece swing joints for 1" inlet heads shall consist of an assembly using three (3) one-inch (1") Marlex street elbows, with a 1" SCH 80 Nipple of required length to set head at grade. Three-quarter inch (¾") swing joints for Quick Couplers shall consist of the same combination of like parts in three-quarter inch (3/4").

2.3 VALVES

A. Valve will be located in greenspace lawns only, with a minimum distance of 4 feet away from hard surfaces/sidewalks/buildings. Valves/boxes must remain a minimum distance of 4 feet away from trees/ornamental plantings.

B. All valves will be installed using SCH 40 PVC Male Adapters (SCH 80 PVC for metal valves) and glued directly onto the pipe incoming and outgoing from the valve.

C. Ball Valves

1. Only use ball valves when detailed. Not to be used above ground unless approved by the Irrigation Department.

2. All manual ball valves, sizes 1-1/2" inches and smaller, shall be schedule 80 PVC or all bronze double with integral taper seats and with rising stem.

3. All valves 2" and larger shall be gate valves.

4. All ball valves shall be, schedule 80 PVC, or full port, with chromium or stainless ball with Teflon seats 150 PSI rated, Hammond.

D. Pressure Reducing Valves

1. Provide pressure-reducing valves on main lines only, Watts, Series U5, U5B ½" to 2" Standard Capacity.

E. Gate Valves

1. All manual gate valves, sizes four-inch (4") and smaller, shall be made in the U.S.A., brass body, threaded, non-rising stem, full port, 200 PSI/13.8 bar non-shock cold working pressure up to 180 deg. F./82 deg. C., NSF/ANSI 61-8 compliant: NIBCO model TI-8.

2. All gate valves of 6-inch (6") size or larger shall be at least 150 PSI rated, AWWA-C509 resilient wedge gate valve, made in the U.S.A., featuring non-rising stem, iron body, epoxy coated interior, mechanical joint with appropriate size gaskets for corresponding pipe as per drawing.

F. Automatic Remote Control Valves

1. Rain Bird PESB Series, 24 volts, contamination resistant valve with a pressure operating range of 20-200 psi and a 0.25 to 200 g.p.m. flow range. Glass-filled nylon construction, one-piece solenoid with captured plunger, flow control handle adjusts, manual internal and external bleeds, stainless steel studs molded into the body, nylon screen scrubber and purple flow control handles for easy identification of non-potable water systems.
    a. All bubbler zones must be controlled by a Rain Bird PESB Series Valve incorporating a Rain Bird PRS regulator.

2.4 VALVE BOXES

A. All remote-control valves, pressure regulating valves, manual control valves, zone shut-off valves, quick coupler valves, gate valves or globe valve filters and drains, unless otherwise indicated, shall be installed in a valve access box of proper size as required for no less than 4” of spherical access to the valve.

B. Valve boxes/valves will be located in greenspace lawns or planting beds only, prioritize locating in greenspace lawns where feasible, with a minimum distance of 4 feet away from hard surfaces/sidewalks/buildings. Valves/boxes must remain a minimum distance of 4 feet away from trees/ornamental plantings.

1. Valve box to be Carson brand, with round, locking green cover ten inches (10") in diameter for single valve application or a twelve-inch minimum (12”) standard rectangular box for multiple valve assemblies or described otherwise in the contract drawings. A maximum of two (2) valves is allowed in any 12” standard valve box. Bolt on and Purple Top valve boxes are not necessary. All round valve boxes shall be supported underneath the bottom edges with two bricks (minimum) and all standard rectangular valve boxes shall be supported underneath bottom edges with four bricks (minimum). The base of the valve box should be at or below the body of the valve. The lid of the valve box should be flush or within 1” of turf grade.
2. Valve boxes installed within pavement shall be Tier 15 rated boxes for heavy duty non-deliberate traffic.

2.5 AUTOMATIC IRRIGATION CONTROLLER

A. Controller Type

1. Contractor shall connect to existing controllers at locations identified on the plans. Contractor shall field verify equipment is the same as, or compatible with, listed standard remote access equipment listed below. The Contractor shall field verify capacity of controller to meet system requirements in coordination with the Owner.
    a. The automatic controller shall be 120-volt input, soft-wired, 26.5 volt output, capable of controlling the number of zone valves indicated on the plans. It shall be a Rain Bird IQ ESP-LXME2 PRO with an IQNCC-RS Radio Cartridge or IQNCC-EN Ethernet Cartridge. Controller station capacity must meet or exceed the quantity specified per drawing. Station wiring and run time schedule specified per drawing. All station wiring must be terminated in the pedestal or wall mounted wire trough. If a Radio Cartridge is used, the controllers must be equipped with a Rain Bird RBSS-TN9B radio with a

University licensed and authorized frequency. The radio will be hooked to a Rain Bird TRA9023NP Omni Antenna or GSP-YAGI-6 Antenna or Owner approved substitute. All Rain Bird IQ components must be ordered and installed by a certified installation technician.

B. Electrical Power

1. Contractor shall field verify power at the existing controller. Any impacts to power for the controllers by the construction of the project shall be the responsibility of the sprinkler installer to rectify.
   a. Meet all electrical specifications for installation of controllers and power to the controllers. The controllers must be wired to the power source in the pedestal or wall via an Isobar Ultra 4 surge protector and a two-receptacle Ground Fault Interrupter (GFI) outlet. A pigtail that can reach from the controller to the outlet is required. Power source must be pre-approved by Owner prior to connection.

C. Flow Meter

1. A Rain Bird IQ-compatible flow meter must be installed at every point of connection. This may be either a Rain Bird Brass Insert Sensor (FS350B) for pipe three inches or larger, or a Rain Bird PVC Tee Sensor of the appropriate size: FS150P for 1-1/2" pipe, FS200P for 2" pipe, and FS300P for 3" pipe. The flow meter must be directly connected to the controller using PE43 communication cable (the blue/blue white wire pair must be used for the flow meter/pulse transmitter connection) and a PT 322 pulse transmitter. All splices using this type of cable must meet Rain Bird IQ standards. Programming and hook up of the PT322 shall be completed by MSU Irrigation Employee.

D. Certified Installation

1. All Rain Bird IQ components must be ordered and installed by a certified installation technician.

2.6 IRRIGATION HEADS

A. Rotary Sprinklers

1. All rotary sprinkler heads shall be Rain Bird 5004+PCSAMRNP Series, manufactured by Rain Bird Sprinkler Mfg. Corp., Glendora California; or Owner approved equivalent rotor head.
   a. Provide Match Precipitation Rate nozzles as indicated on the plans.

B. Spray Heads

1. All spray head sprinklers shall be Rain Bird Models RD-04-SP30F-NP and 1812 Series SAM with MPR nozzles, manufactured by Rain Bird Sprinkler Mfg. Corp., Glendora California or approved equal. Rain Bird 1812 SAM Spray Heads with Side Inlet feature is allowed however, the use of the side inlet feature is **prohibited**. 1806 Series SAM heads are allowed upon approval by Owner.

C. Bubblers

1. All bubbler zones must be controlled by a Rain Bird PESB Series Valve incorporating a Rain Bird PRS regulator. There must be a Rain Bird WYE Filter System installed directly downstream of the valve, located inside the valve box in a manner that allows easy maintenance. The bubbler heads must be Rain Bird 1400 Series Full-Circle Bubbler mounted on a rigid riser or approved equal. A minimum of 2 bubbler heads will be set at each tree at a minimum of 1' off of trunk. Please refer to Landscape Spec or OWNER for clarification.

D. Drip Irrigation

1. No drip irrigation systems are allowed at Montana State University.

2.7 CONTROL CABLE

A. Type

1. All electrical control and ground wire shall be Baron irrigation control cable or approved equal, 14-gauge unless otherwise indicated on the drawings. All wiring to be used for connecting the automatic remote control valve to the automatic controllers shall be Type "UF", 600 volt, solid copper, single conductor wire with PVC or polyethylene insulation and bear UL approval for direct underground burial feeder cable.

B. Insulation

1. Insulation shall be four-sixty-fourths inch (4/64") thick minimum covering of ICC-l00 compound for positive waterproofing protection. All control or "hot" wires shall be red and all common or "ground" wires shall be white. A minimum of one black extra wire shall be included in the wiring run for every four (4) wires installed. All black extra wires shall be intact and usable from the controller to the end of each mainline run with slack wire available at each valve location.

C. Code Compliance

1. Verification of wire types and installation procedures shall be checked to conform to local codes.

D. Splices

1. All splices are to be completed within valve boxes using one-piece, jelly-filled, water-proof wire connectors with a minimum of twelve inches (12") of extra wire per side, per splice, allowing for repair work to be completed at ground level. A 6" round valve box will be acceptable for splices under 10 zone wires. Above 10 zone wires will require a 10" round valve box or larger. Self-connecting wire splices will not be allowed. All splices shall be located on as-built drawings.

E. Trench Installation

1. Tape and bundle all wiring at ten-foot (10') intervals.

2. Attach tracer wire to main line pipes that are not along the control wire path. See Part 2.01, Point 8.

3. All 120-volt wiring shall be in conduit with marker tape installed in the ditch six inches (6") above the conduit.
4. All wiring under pavement and through sleeves shall be in conduit.
5. Tie a loose twenty-inch (20”) loop in wiring at all changes in direction greater than 30 degrees. Untie all loops after making connections.

2.8 TRACER WIRE

1. Tracer wire shall be solid copper per ASTM B-3.
2. Insulation shall be yellow color.
3. Wire size shall be 14 AWG, nominal thickness .030 inches.

2.9 OTHER MATERIALS

A. Concrete

1. Provide and coordinate installation of all concrete thrust blocks. Refer to Division 3 for concrete requirements. Provide thrust blocks for all lines larger than 3-inch diameter, at all tees and ells.

B. Other Materials

1. All other materials not specifically described but required for a complete and proper irrigation system installation, shall be new, first quality of their respective kinds, and subject to the approval of the OWNER’S REPRESENTATIVE.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

A. Inspection

1. Prior to all work of this section, carefully inspect the installed work of all other trades and verify that such work is complete to the point where this installation may properly commence.
2. Verify that irrigation system may be installed in strict accordance with all pertinent codes and regulations, the original design, the referenced standards, and the manufacturer’s recommendations.

B. Discrepancies

1. In the event of discrepancy, immediately notify the OWNER’S REPRESENTATIVE.
2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 FIELD MEASUREMENTS

A. Make all necessary measurements in the field to ensure precise fit of items in accordance with the original design.

3.3 TRENCHING AND BACKFILLING

A. General

1. Perform all trenching required for the installation of items where the trenching is not specifically described in other sections of these specifications.
2. Make all trenches in accordance with OSHA Requirements with sufficient width to provide free working space at both sides of the trench and around the installed item as required for gluing, joining, backfilling, and compacting while minimizing width of trenches.
3. The CONTRACTOR will be required to conduct his work so that trenches will remain open a minimum possible time.

B. Depth

1. Trench as required to provide the elevations shown on the Plans.
2. Trench to sufficient depth to give a minimum of eighteen inches (18”) of fill above the top of the pipe measured from the adjacent finished grade under driveways and sidewalks.
3. All mainline and control cables shall have a minimum cover of eighteen inches (18”) above the pipe or wire. All laterals shall have a minimum cover of twelve inches (12”) above the pipe.
4. All sleeves shall be installed at a depth in line and grade with existing or proposed irrigation lines. Sleeves with excessive or shallow invert depth will be rejected.

C. Correction of Faulty Grades

1. Where trench excavation is inadvertently carried below proper elevations, backfill with material approved by the OWNER’S REPRESENTATIVE and then compact to provide a firm and unyielding sub grade to the approval of the OWNER’S REPRESENTATIVE and at no additional cost to the OWNER.

D. Trench Bracing

1. Properly support all trenches in strict accordance with all pertinent rules and regulations.
2. Brace, sheet, and support trench walls in such a manner that they will be safe and that the ground alongside the excavation will not slide or settle, and that all existing improvements of every kind will be fully protected from damage.
3. In the event of damage to such improvements, immediately make all repairs and replacements necessary to the approval of the OWNER’S REPRESENTATIVE and at no additional cost to the OWNER.

4. Arrange all bracing, sheeting, and shoring so as to not place stress on any portion of the completed work until the general construction thereof has proceeded far enough to proven, sufficient strength.

E. Removal of Trench Bracing

1. Exercise care in the driving and removal of sheeting, shoring, bracing, and timbering to prevent collapse or caving of the excavation faces being supported.

F. Grading and Stockpiling Trenched Material

1. Control the stockpiling of trenched material in a manner to prevent water from running into the excavation.

2. Do not obstruct surface drainage but provide means whereby storm and wastewater are diverted into existing gutters, other surface drains, or temporary drains.

G. Methods

1. All trench excavation shall be made by open cut. During excavation, material suitable for backfilling shall be piled in an orderly manner, a sufficient distance from the banks of the trench to avoid overloading, and to prevent slides or cave-ins. All material not required for backfill or not suitable for backfill shall be removed from the site by the CONTRACTOR. Banks of trenches shall be kept as nearly vertical as possible and shall be properly sheeted and braced as may be necessary to prevent caving.

2. The CONTRACTOR shall provide, place, maintain, and remove all necessary barricades, warning signs, and other safety devices from the start to the finish of the project to prevent pedestrians from falling in open trenches.

3. Trench widths in paved streets or in areas where proximity to other structures requires vertical cuts, shall not be wider than is required for proper handling, jointing and bedding of the pipe.

4. The bottom of the trenches shall be accurately graded to line and grade and provide uniform bearing and support for each section of the pipe on undisturbed soil, at every point along its entire length. Depressions for joints shall be dug after the trench bottom has been graded, and shall be only of such length, depth, and width as required for properly making the particular type joint. Care shall be taken not to excavate below the depths indicated.

5. Where rock occurs in trench excavation, the rock shall be removed to a depth of six inches (6”) below the established grade line, and to a width of twelve inches (12”) greater than the outside diameter of the pipe to be installed in the trench.

6. No water shall be permitted to rise or stand in trenches not yet backfilled until after the pipe has been placed, tested and covered with backfill for a depth of at least ten inches (10”). Any pipe having its alignment or grade changed as a result of a flooded trench shall be removed and re-laid after the trench is graded once again at no additional cost to the OWNER.

H. Pavement Removal

1. Where excavation of trenches requires the removal of pavement, the pavement shall be cut in a straight line along the edge of the excavation by use of a spade-bit air hammer, concrete saw or similar approved equipment to obtain straight, square and clean break. After backfilling and sub grade preparations are completed, the pavement section and surfacing shall be replaced.
2. Pavement replacement shall utilize the same materials and design as the original pavement.
3. Excess material, including rock, broken concrete, bituminous materials, debris, or other materials not suitable for backfill, shall be removed from the site and disposed of by the CONTRACTOR.

3.4 BORING

A. Locations

1. Boring shall be used to route pipe, wiring, or both under structures such as walks or curbs where trenching is impractical. Sleeves shall be installed in all bored holes.

B. Method

1. Boring shall be accomplished with a drill, auger, water jet, or any other instrument approved by the OWNER'S REPRESENTATIVE capable of producing a precise hole. Boring shall not disturb overlaying structures or cause settlement and damage to those structures.

3.5 SLEEVES

A. Locations

1. Sleeves shall be installed wherever routing of a pipe, wiring, or both crosses a paved area or passes through a bored hole.

B. Methods

1. Sleeves laid in open trenches shall be uniformly and evenly supported by undisturbed soil on the trench bottom. Backfill shall conform to standards hereinafter specified.
2. Sleeves installed in borings shall be forced through and shall have a snug fit throughout the length of the bored hole. Sleeves cracked or broken shall not be accepted.

3.6 BACKFILL

A. Material

1. Backfill material shall be free of clods, lumps of frozen material, or stones larger than one inch (1") in their maximum dimension. The bedding and select material under, around and six inches (6") above the top of the pipe shall be placed by hand

in maximum layers of six inches (6”) and carefully compacted in a manner which will not displace the pipe. Compaction of the select backfill shall be at least ninety percent (90%) of the maximum density as determined by AASHTO T-180. Water settling will not be allowed.

B. Inspection

1. The trenches shall not be backfilled until inspection has been completed and the pipe installation, including the grade, alignment and jointing has been found to be in compliance with the requirements of the plans and specifications.

C. Around and Over the Pipe

1. Select backfill material consisting of sand, fine gravel or select earth, free of large lumps or rocks larger than three-quarters of an inch (¾”) shall be used in backfilling around and over the installed pipe.
2. The select material shall be obtained from the excavation material removed from the trench and shall be processed by screening, sifting, or selective sorting, so as to produce the type of backfill herein specified. The CONTRACTOR may at his option and expense provide an acceptable imported material.
3. This backfill material shall be carefully deposited around and over the pipe in layers not more than six inches (6”) thick, loose measurement, unless otherwise permitted by the OWNER’S REPRESENTATIVE, wetted to optimum moisture content and uniformly compacted to at least ninety-five percent (95%) of the maximum density obtainable at optimum moisture content as determined by ASTM D698 (latest revision), until the pipe has a cover depth of at least one foot (1’).

D. Remainder of Trench Backfill

1. The remaining depth of the trench shall be backfilled with excavation material removed from the trench, which shall be wetted or dried to near optimum moisture content.
2. This material shall be carefully deposited in layers not to exceed six inches (6”) in compacted thickness and compacted to at least ninety-five percent (95%) of the maximum density as determined by ASTM D698 (latest revision). The method of compaction selected by the CONTRACTOR shall not cause damage of any nature to the installed pipe. Replace topsoil on trench fill and compact to eighty-five percent (85%) of maximum density at optimum moisture.
3. The use of water settlement for this portion of the trench backfilling is permissible if the specified density can be obtained and the backfill material is suitable for this type of trench compaction.

3.7 INSTALLATION OF PIPING

A. General

1. Layout the piping system in strict accordance with the Plans.
2. Where piping is shown on the Plans to be under paved areas but running parallel and adjacent to planted areas, the intention is to install the piping in the planted areas.

B. Line Clearance

1. All lines shall have a minimum clearance of four inches (4”) from each other, and six inches (6”) from lines of other trades, except through pipe sleeves.

2. Parallel lines shall not be installed directly over one another.

C. Inspection of Pipe and Fittings

1. Carefully inspect all pipe and fittings before installation, removing all dirt, scale, and butts and reaming as required; install all pipe with stamped markings oriented up to allow visual inspection and verification.

D. Plastic Pipe

1. Plastic pipe shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer.

2. All plastic pipe joints shall be solvent-weld joints or gasket fit joints. Only the solvent cement recommended by the pipe manufacturer shall be used and it must be a two-part system consisting of primer and cement. No single part cement system shall be used. All plastic pipe and fittings shall be installed as outlined and instructed by the pipe manufacturer and it shall be the CONTRACTOR's responsibility to make arrangements with the pipe manufacturer for any field assistance that may be necessary. The CONTRACTOR shall assume full responsibility for the correct installation.

3. All plastic (PVC) to metal joints shall be made with Schedule 80 PVC plastic threaded male adaptors into metal threaded female fittings.

4. The solvent-weld joints shall be made on dry pipe.

5. The solvent-weld joints shall be allowed to set at least 24 hours before pressure is applied to the system on PVC pipe.

E. Thrust Blocks

1. Provide concrete thrust blocks for all pipes as shown on the plans. All thrust blocks shall bear directly on undisturbed earth. Center the pipe in the middle of the thrust block.

3.8 INSTALLATION OF EQUIPMENT

A. General

1. All fittings, valves, etc., shall be carefully placed in the trenches with concrete thrust blocks, placed where required.

2. All sprinklers, having adjustable nozzles, shall be adjusted for proper and adequate distribution of the water over the coverage pattern of the sprinkler.

3. All nozzles on stationary pop-up sprinklers or stationary spray heads shall be tightened after installation. All sprinklers having an adjusting screw, adjusting stem or adjusting friction collars shall be adjusted as required for the proper arc of coverage, radius, diameter and/or discharge.

4. All control wires shall be clearly labeled by station, using weatherproof material, at the controller and at the valve ends. Mark the underside of all valve box covers, indicating the valve controller station number. All markings shall be made in a neat and legible manner using white enamel paint.

5. All control or “hot” wires shall be red and all common or “ground” wires shall be white. A minimum of one black extra wire shall be included in the wiring run for every four (4) wires installed.

B. Sprinkler Heads

1. Install lawn sprinkler heads where indicated on the plans and in strict accordance with the manufacturer s recommendations and as necessary to provide complete uniform coverage and precipitation.

2. Upon completion of installation, reset all lawn sprinkler heads flush with grade and firmly anchored with soil.

C. Master Automatic Control Valves

1. A master automatic control valve shall be installed at the point of connection to the main for any remotely controlled portion of the irrigation system. In cases where there are multiple points of connection, a master valve shall be installed for each, with no more than three points of connection allowed. Each master valve will have its own separate yellow “hot” wire.

3.9 TESTING AND INSPECTION

A. Covering or Enclosing Work Prior to Inspection

1. Do not allow or cause any of the work in this section to be covered up or enclosed until it has been inspected, tested, and approved by the OWNER’S REPRESENTATIVE.

B. Flushing

1. Before backfilling the mainline, and with all control valves in place, but before lateral pipes are connected, completely flush and test the mainline and repair for all leaks; flush out each section of lateral pipe before sprinkler heads are attached. Complications due to this not being done during install will result in charges to the contractor.

C. Testing

1. Make all necessary provisions for thoroughly bleeding the line of air and debris.

2. After valves have been installed, test all live water lines hydrostatically for leaks at a pressure of one hundred fifty (150) psi for a period of two (2) hours, with all couplings exposed and with all pipe sections center loaded.

3. Furnish all necessary testing equipment and personnel.

4. Correct all leaks and retest until acceptance by the OWNER’S REPRESENTATIVE and THE OWNER.

D. Final Inspection

1. Thoroughly clean, adjust, and balance all systems.

2. Demonstrate the entire system to the OWNER'S REPRESENTATIVE and OWNER, proving that all remote control valves are opening and closing on command, that all heads are properly adjusted for radius and arc of coverage, that all emitters are functioning, and that the installed system is workable, clean, and efficient.

3. Existing irrigation system(s) or portions of systems which have had their performance altered by any of the work related to this project shall be repaired or adjusted using materials and installation methods in accordance with this specification and in a manner to restore head-to-head sprinkler coverage, uniform precipitation rates, control zone integrity, and elimination of the spraying of water on building walls and sidewalks.

3.10 CLEANUP

A. Upon completion of the work, the entire site shall be cleared of all debris, and ground surfaces shall be finished to smooth, uniform slopes and shall present a neat and workmanlike appearance. Cleanup shall be considered an incidental item, and no additional payment shall be made for any cleanup item. All improvements or other obstructions removed during construction shall be replaced in a condition at least equal to their existing condition.

3.11 MAINTENANCE

A. The CONTRACTOR shall, for a period of one (1) year after completion and final acceptance of the work, maintain and repair any trench or boring settlement which may occur, and shall make suitable repairs to any pavements, or other structures which may become damaged as a result of settlement. All such maintenance and repair shall be at the CONTRACTOR's expense.

B. The CONTRACTOR shall inform the OWNER of the location and the nature of all damage done to the existing irrigation system not slated for demolition within eight hours of the occurrence of the damage.

C. The CONTRACTOR shall maintain the existing and proposed irrigation system in operation during the construction period. Upon completion of the proposed irrigation work the CONTRACTOR shall balance and adjust the entire (new and existing) system.

3.12 AS-BUILT DRAWINGS, CHARTS AND EQUIPMENT MANUALS

A. Record Drawings

1. Accurately record on one set of black and white prints of the site plan all installed work including both pressure and non-pressure lines.

2. Upon completion of each increment of work, transfer all such information and dimensions to the print. The dimensions shall be recorded in a legible and workmanlike manner.

3. Dimension from two permanent points of reference (buildings, monuments, sidewalks, curbs, pavement, etc.). Locations shown on as-built drawings shall be kept day-to-day as the project is being installed. All dimensions noted on drawings shall be one-eighth inch (1/8") in size (minimum).

4. Show locations and depths of the following items:
   Point of connection
   Routing of pressure lines (max. dimension=one hundred feet {100'} along lines)
   Gate valves
   Sprinkler control valves
   Quick coupling valves
   Routing of control wires
   Sprinkler heads
   Other related equipment

5. Maintain as-built drawings on site at all times.

6. Make all notes on drawings in pencil (no ball point pen).

B. Controller Charts

1. OWNER'S REPRESENTATIVE must approve as-built drawings before charts are prepared.

2. Provide one controller chart for each controller supplied showing the area covered by automatic controller, of the maximum size controller door will allow.

3. The chart is to be a reduced drawing of the actual as-built system.

4. Chart shall be black line print and different colored shading used to show area of coverage for each station.

5. When completed and approved, the chart shall be hermetically sealed between two pieces of plastic.

6. The chart shall be mounted using Velcro or equal type of semi-permanent fastening device.

7. These charts must be completed and approved prior to final acceptance of the irrigation system by the OWNER.

C. Operation and Maintenance Manuals

1. Prepare and deliver to the OWNER'S REPRESENTATIVE within ten calendar days prior to completion of construction, all required and necessary descriptive material in complete detail and sufficient quantity, properly prepared in two (2) individually bound copies of the operations and maintenance manual. The manual shall describe the material installed and shall be in sufficient detail to permit operating personnel to understand, operate and maintain all equipment. Spare parts lists and related manufacturer information shall be included for each equipment item installed. Each complete, bound manual shall include the following information:

a. Index sheet stating CONTRACTOR's address and telephone number, duration of guarantees period, list of equipment with names and addresses of local manufacturer representatives.
b. Complete operating and maintenance instructions on all major equipment.
c. System start-up and shut down instructions.

2. In addition to the above maintenance manuals, provide the maintenance personnel with instructions for system operation and show written evidence to the OWNER at the conclusion of the project that this service has been rendered.

3.13 GUARANTEE

A. Warranty

1. The entire irrigation and water system shall be guaranteed to give satisfactory service for a period of one year from the date of acceptance by the OWNER.

2. Should any trouble develop within the time specified above due to inferior or faulty materials or workmanship, the trouble shall be corrected at no expense to the OWNER.

3. Any and all damages resulting from faulty materials or workmanship shall be repaired by the CONTRACTOR to the satisfaction of the OWNER, at no cost to the OWNER.

PART 4 - MEASUREMENT AND PAYMENT

A. The engineer will measure actual quantities of work completed as described in subsections for individual pay items.

B. The engineer will measure the completed work as follows:

1. Lump Sum for all work shown in the project Plan Sheets, which provide design for:
   a. West Side Irrigation System
   b. East Side Irrigation System

2. HDPE Mainline replacement includes new HDPE mainline, connections, fittings, bedding material, backfilling and compaction, testing, isolation valves, etc.

END OF SECTION

SECTION 02930
TURF & GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydromulch.
3. Turf area topsoil preparation.
4. Application of lime and fertilizers.
5. Maintenance of turf areas.
6. Condition and Inspection for Final Acceptance.

B. Related Requirements:

1. Section 02940 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings.

2. Section 02810 “Irrigation” for complete irrigation systems.

3. The Montana Department of Transportation Standard Specification for road and bridge construction, 1987 Edition, Section 610, roadside development shall govern the work as if bound herein. Where provisions of this section and the referenced standard conflict, this section shall govern.

1.3 DEFINITIONS

A. Finish Grade: Elevation of finished surface of planting soil.

B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and

slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

F. Topsoil: Topsoil refers to the uppermost layer of soil and includes fine particles, small roots, rocks, and cobbles. It is usually darker in color and is the layer in which most roots grow, and beneficial microorganisms exist.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at project site prior to initiating seeding work.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For landscape Installer.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging. No seed shall be sown until the Contractor has submitted these certificates, or as approved by the Owner.

C. Product Certificates: For fertilizers, from manufacturer.

D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

E. Manufacturer Product Data:

1. Submit material specifications and installation instructions where applicable attesting that the following materials meet the requirements specified
    a. Fertilizer.
    b. Seed.
    c. Lime.
    d. Fiber hydromulch.

F. Soil Test Reports:

1. Material Test Reports: For existing in-place surface soil and imported topsoil. Report shall contain recommendations for conditioners to achieve planting soil as outlined in “Quality Assurance” Article.

2. Prior to placing the topsoil, submit soil test report to the Owner for review and approval. Do not place materials until approval has been obtained.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required maintenance periods.

1.7 SUBMITTAL SCHEDULE:

A. Before installation:

1. Manufacturer's product data for seed.
2. Soil test reports.

B. After installation and before Final Acceptance

1. Maintenance Manual.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf establishment.

1. Installer's Field Supervision: Provide at least one person who shall be present at all times during execution of this portion of the work and who shall be thoroughly familiar with the type of materials being installed and the best methods for their installation and who shall direct all work performed under this section.

B. Pesticide Applicator: State licensed, commercial.

1. The Contractor shall have at least two (2) years of weed control spraying experience. Proof of experience will be required. The Contractor must have a valid Montana Commercial Herbicide Applicator’s License.

C. Chemical Registration

1. All weed control chemicals must be registered with the Environmental Protection Agency and the State of Montana.

D. Equipment Requirements

1. The Contractor shall furnish, operate, and maintain suitable and adequate equipment necessary to perform the above operations in an approved and workman-like manner without delays. Spray nozzles shall be raindrop or similar drift control type.

E. Liability and Contractor’s Responsibilities

1. Weather conditions must be such that no damage outside the sprayed area will occur and the Contractor will cease spraying whenever the application of spray could cause such damage.

2. The Contractor agrees to hold harmless the Owner and Landscape Architect and/or Engineer against any and all claims for damage arising from operations covered in this proposal.

F. Time of Application

1. Because of varied climatic conditions, it will be the Contractor's responsibility to coordinate spraying activities to achieve the best results. To avoid possible chemical exposure and general alarm among campus users, time of application must not coincide with other nearby outside campus activities. If nearby activity encroaches during spraying operations, spraying must cease immediately until people leave the area.

G. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

H. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating:
   a. percentages of organic matter;
   b. gradation of sand, silt, and clay content;
   c. cation exchange capacity;
   d. deleterious material;
   e. pH;
   f. mineral and plant-nutrient content of the soil
   g. a test for electrical conductivity (EC)

2. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.

3. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from the Owner. A minimum of six representative samples shall be taken from varied locations at the project site.

4. Report suitability of tested soil for turf growth.
   a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
   b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.
   c. Results of tests shall be reviewed by the Owner prior to purchase of fertilizer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.

B. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk materials with appropriate certificates.
4. Store materials in a manner that their effectiveness and usability will not be diminished or destroyed. Materials shall be uniform in composition, dry, unfrozen, and free flowing.

C. Any material which has become caked or otherwise damaged or which does not meet specified requirements will be rejected.

1.10 FIELD CONDITIONS

A. Planting Restrictions: Plant during one of the following periods, except as otherwise authorized in writing by the Owner. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of planting completion through establishment period until Final Acceptance.

1. Spring Planting: April 15 to June 1.
2. Fall Planting: August 10 to September 10.
3. Irrigation system must be operational prior to seeding.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

C. The Contractor shall provide a weed control plan and schedule prior to bed preparation, for approval of the Owner’s Representative.

1.11 CONDITIONS & INSPECTION FOR FINAL ACCEPTANCE

A. Inspection and Final Acceptance:

1. Landscape turf acceptance will occur after completion of Turf Maintenance & Establishment Period. Contractor to have completed, located, and installed all turf according to drawings and specifications. All turfgrass are expected to be living and in healthy condition at time of inspection and acceptance.

2. Upon written request of the Contractor, the Owner will inspect all vegetated areas to determine completion of work. This request must be submitted at least one week prior to the anticipated inspection date.

3. If the vegetated areas are not acceptable, the Owner will indicate corrective measures to be taken and shall extend the Turf Maintenance & Establishment Period as necessary for the completion of the work. The Contractor shall request a second inspection of the vegetated areas after corrective measures have been accomplished. This process shall be repeated until the total vegetated area being inspected is acceptable.

4. When the vegetated areas are acceptable, a meeting of the Contractor and Owner will be arranged to accept the vegetated work. A final inspection will be a part of this meeting. At this meeting, the Contractor shall be furnished with a written acceptance of the vegetated area being approved.

5. Following the acceptance of vegetated areas, the Contractor shall provide the Owner with access to all vegetated areas as required for the Owner's maintenance work.

B. Conditions of Final Acceptance:

1. Acceptance shall be given for the entire portion of the vegetated areas. No partial acceptance will be given.

2. Satisfactory Seeded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, bare areas, and surface irregularities.
   a. Vegetated areas shall exhibit a uniform, thick, well-developed stand of grass. Vegetated areas shall have no bare spots in excess of five inches in diameter with coverage exceeding 95 percent over any 10 square feet, applicable to the total vegetated area.
   b. Vegetated areas shall not exhibit signs of damage from erosion, washouts, gullies, or other causes.
   c. Turfgrass has obtained minimum of 98 percent generally weed free surface cover.

3. Finish grades at the edges of sidewalks, curbs or other hard surface boundaries must be at a level such that the established turf surface will be one (1) inch below the plane of the hard surface for a minimum distance of six (6) feet from the edge.

4. Pavement surfaces and site improvements adjacent to vegetated areas shall be clean and shall be free of spills or overspray from placing or handling of topsoil and seeding operations.

C. Site Cleanup:

1. The Contractor shall leave the site in a clean and neat condition. Final Acceptance will not be granted until this condition is met.

PART 2 - PRODUCTS

2.1 SOILS

A. Refer to Montana Standard Specifications Subsections 203.80 Topsoil Salvaging and placing, 610.00 Topsoiling and 713.06 Topsoil Material.

B. Imported Topsoils

1. In the event sufficient quantities of native topsoil cannot be salvaged from the site, the Contractor shall provide imported topsoil to supplement the project requirements. The Contractor shall provide topsoil that meets or exceeds the quality of the native topsoil material available on site. Contractor shall provide source and analysis information to the Owner's Representative, for his approval, prior to delivery. The Contractor shall incorporate into the topsoil, amendments necessary to provide topsoil fertility and quality, equal to or exceeding the characteristics of the native topsoil.Planting Soils

C. Planting Soil: Existing or imported topsoil with Amendments as recommended by soil testing laboratory with pH range of 6.5 to 7.5, a minimum of 5 percent organic material content; free of stones 1-1/2 inch or larger in any dimension and other extraneous materials harmful to plant growth.

2.2 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species:

1. Quality, State Certified: State-certified seed of grass species as listed below for solar exposure.
2. Sun and Partial Shade, Cool-Season Grass: Seed of grass species as follows, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed. Germination Test date no older than 6 months:

a. Turf Type Tall Fescue/ Kentucky Bluegrass seed mix, or approved equal. Seed at a rate of 10 lbs/1000 SF.

1) 90% by weight Turf Type Tall Fescue, minimum 2 types
2) 10% by weight 'Midnight' Kentucky Blue Grass

2.3 SOIL CONDITIONING MATERIALS

A. INORGANIC SOIL AMENDMENTS

1. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

2. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.

3. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

4. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

5. Aluminum Sulfate: Commercial grade, unadulterated.

6. Perlite: Horticultural perlite, soil amendment grade.

7. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

B. ORGANIC SOIL AMENDMENTS

1. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

2. Organic Matter Content: 50 to 60 percent of dry weight.

3. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

4. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or granular texture, with a pH range of 3.4 to 4.8.

5. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

6. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

7. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. of loose sawdust or ground bark.

8. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

C. FERTILIZER:

1. Fertilizer shall be a complete, standard product complying with state and federal fertilizer laws. The fertilizer shall be uniform in composition, dry and free flowing, and shall be delivered to the site in the original, unopened containers, each bearing the manufacturer's guaranteed analysis, and submitted to the Owner for approval.

2. Exact percentages of fertilizer may vary in accordance with the soil test report.

3. Any fertilizer that becomes caked or otherwise damaged (making it unsuitable for use) will be rejected. If stored at the site, protect fertilizer from the elements at all times.

4. Fertilizer shall be manufactured by Anderson ProTurf, or equal approved by the Owner. Application rates shall be in accordance with manufacturer recommendations. Fertilizer shall be complete, uniform in composition, dry and free flowing. The fertilizer shall be delivered to the site in the original waterproof containers, each bearing the manufacturer's statement of analysis.

5. Fertilizer to be spread on areas to be seeded shall be commercially prepared by Anderson ProTurf or an equal product pre-approved by the Owner. Fertilizer shall be a slow release, Poly-S urea, and shall contain the following percentages by weight:
   a. 10% Nitrogen
   b. 20% Phosphorus
   c. 10% Potassium
   d. 12% Sulfur

6. Grow - in Fertilizer shall be a slow-release, Poly-S urea, and shall be formulated as 25-3-4-Fe-2% and commercially prepared by Anderson ProTurf or equal approved by the Owner.

2.4 PESTICIDES

A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer. Roundup, or approved equal, provide compatible surfactant and drift control agents as required.

C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated. "TRIMEC" 2.4.D.M.C.P.P. DICAMBA (BANVIL) manufactured by P.B.I. Gordon 816-421-4070 distributed by Wilbur Ellis Company (406)-248-1176 or West Chemical Agricultural Chemicals, Inc., (406)-252-3834, or other appropriate control which best fits the weed problem and necessary applications.

2.5 MULCHES

A. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5. Weyerhauser, Conweb, or approved equal.

B. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

1. Mulch tackifier must be natural, non-asphaltic, vegetable gum with gelling and hardening agents, Terra Tack or approved equal.

2.6 WATER

A. Water will be available on site. Provide necessary hoses and other watering equipment required to complete work.

B. Water shall be clean irrigation quality water.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Owner and replace with new planting soil.
3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
5. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

B. Identify and review all underground utility locations before commencing work and exercise caution when working close to utilities. Notify Owner of apparent conflicts with construction and utilities to plan adjustment before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.

1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
2. Protect grade stakes set by others until directed to remove them.
3. Protect existing construction and completed work from damage.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 TURF AREA PREPARATION

A. Obtain Owner's written approval of rough grading work before incorporating organic soil amendments.

B. Limit turf subgrade preparation to areas to be planted.

C. Do not handle subsoil or organic soil amendment material when wet or frozen.

D. Newly Graded Subgrades:

1. Preparing areas: Decompact the site prior to topsoil application. Scarify and loosen subgrades too compact to drain water or based upon compaction tests to a minimum depth of 6 inches prior to placing topsoil. Soil decompaction shall be done with equipment that has ripping teeth, placed a maximum of 12 inches apart, then regrade surface. Clean subgrade of stones larger than 1-1/2 inches and debris or rubbish and remove from project site. Pressing rocks into the soil is not an acceptable method of removing rocks from the surface.
    a. After ripping subgrade for topsoil bonding, place and uniformly spread topsoil to a minimum 6 inches deep. Spread approximately 1/2 the thickness of topsoil over loosened subgrade. Mix thoroughly into the top 4 inches of subgrade to avoid soil layering. Spread additional topsoil as required to meet finish grades.
    b. Do not spread topsoil when frozen or excessively wet or dry.
    c. After the topsoil has been spread, large stiff clods, stones, or other foreign material that would seriously affect the effectiveness or appearance of the topsoil, shall be raked up and removed from the area to provide a uniform textured soil.
    d. Correct irregularities in finished surfaces to eliminate depressions.
    e. Following topsoil placement there shall be no traffic on the placed topsoil.

E. Unchanged Subgrades:

1. If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
    a. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
    b. Loosen surface soil to a depth of at least 6 inches. Soil decompaction shall be done with equipment that has ripping teeth, placed a maximum of 12 inches apart, then regrade surface.

2. Remove rocks, debris, clods and other undesirable substances larger than 1-1/2 inches and maintain grading and drainage patterns. Pressing rocks into the soil is not an acceptable method of removing rocks from the Seeding shall be done immediately after final grading, provided the bed has remained in a good, friable condition, and has not become muddy or compacted. Any undulations or irregularities in the surface resulting from fertilizing, tilling, or other causes, shall be regraded prior to seeding. The surface shall be free of stones, cleared of all

trash, debris, roots, brush, wire, grade stakes, and other objects that would interfere with establishment of vegetation and vegetation maintenance operations.

a. surface.

1) Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

F. Application Of Fertilizer And Soil Amendments For Turfgrass Areas

1. Apply soil amendments as recommended by soils report.

2. Apply organic amendments to depth sufficiently greater than specified depth so after natural settlement and light rolling, specified minimum settled depth conform to lines, grades and elevations indicated on drawings. Incorporate soil amendment by disc harrowing, rototilling or other means in uniform manner. Incorporate organic matter deep enough to produce finished soil with organic matter content of between 4 and 6 percent. Provide additional organic soil amendment material, after in-place testing and approval, as required for organic matter content and finished grades at no additional cost to Owner.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.

b. Incorporate soil amendments into soil to a minimum depth of 4 inches in finish grading operation.

1) At existing trees, the depth shall be adjusted to avoid disturbance of the tree roots.

G. Finish Grade:

1. Immediately restore soil to an even condition before seeding. Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation.

2. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3. Limit finish grading to areas that can be planted in the immediate future.

4. Set sufficient number of grade stakes to check finished grades. Set stakes in bottom of swales and at top of slopes. Connect contours and spot elevations with even slope.

5. Complete seed installation only after areas are brought to finished grade. Lawn areas will be left at ± 0.1 feet of finish grade as shown on plans. Before planting, obtain Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

6. Protect areas from damage by vehicular or pedestrian traffic.

H. For areas disturbed outside of the project limits, restore as outlined in “Turf Renovation” Article.

I. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.4 WEED CONTROL

A. Prior to application of seed or sod, the bed shall be roughed up to a depth of 1/8th inch.

B. Moisten the seedbed to a depth of 1" to promote germination of any seeds contained in the topsoil. If rhizomatous grasses, field bindweed (morning glory) or noxious weeds are evident, the Contractor shall be required to eliminate those undesirable plants prior to seeding or sodding, at the discretion and direction of the Owner's Representative.

C. Spray areas showing weed growth with approved herbicides, mow, and remove clippings prior to final grading. Seeding and sodding shall be executed 72 hours following Roundup application.

3.5 SEEDING

A. Seeding shall be done immediately after final grading, provided the bed has remained in a good, friable condition, and has not become muddy or compacted. Any undulations or irregularities in the surface resulting from fertilizing, tilling, or other causes, shall be regraded prior to seeding. The surface shall be free of stones, cleared of all trash, debris, roots, brush, wire, grade stakes, and other objects that would interfere with establishment of vegetation and vegetation maintenance operations.

B. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.

1. Plant turfgrass seed before application of mulch material.
2. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other. Drag seeded area using approved device.
3. Do not use wet seed or seed that is moldy or otherwise damaged.
4. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

C. Sow seed at a total rate of **10 lbs/1000 sq. ft.**

D. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.

E. Compact seeded areas using a roller or other acceptable method prior to hydromulching

F. In areas having slopes 1:4 or steeper, and in drainage swales, the Contractor shall carry out a separate overseeding operation immediately after sowing the specified seed mix. The overseeding shall be sown at the rate of 5 lbs. per 1,000 square feet. Protect seeded areas with slopes exceeding 1:4 with application of tackifier at a rate of 100 pounds per acre.

3.6 HYDROMULCHING

A. Hydro Mulching: Mix slow-release starter fertilizer and approved wood cellulose mulch material, and tackifier in required amount of water to produce homogenous slurry, using

equipment specifically designed for hydromulching application. Uniformly apply slurry under pressure to deliver recommended quantity of fertilizer per 1000 sq. ft.

B. Protect seeded areas from erosion by applying matrix mulch hydromulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch and roll surface smooth.

C. Hydromulch application shall follow seeding as soon as practical, with consideration for minimal soil erosion through washing. All seeded areas shall be mulched before work is terminated on any day.

3.7 TACKIFIER

A. Mulch tackifiers shall be mixed with water at a rate specifically by the manufacturer and shall be applied at a minimum rate of 40 pounds per acre.

3.8 TURF RENOVATION

A. Renovate turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
2. Install new planting soil as required.

B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

C. Remove topsoil containing foreign materials, such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing turf.

E. Remove weeds before turf installation. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.

H. Apply soil conditioning material required for establishing new turf as indicated in accordance with the soil test report and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

I. Apply seed as required for new turf.

J. Water newly planted areas and keep moist until new turf is established.

3.9 Staking and Fencing

A. General

1. All newly sodded or seeded areas are to be fenced so as to prevent trampling by foot or vehicular traffic. Fencing shall be removed by Contractor when Owner has determined that the lawn area is successfully established, as dictated in this section.

B. Materials

1. Posts to be five-foot minimum, six foot maximum green steel t-posts.
2. Fencing to be four-foot Tenax in guardian orange, length variable. Color substitutions allowed only with the direction and approval of the Project Manager.

C. Performance

1. Staking shall not be performed without prior identification of underground utilities, including but not limited to irrigation.
2. Stakes shall be installed every 16 feet or less, using a t-post driver.
3. Fencing to be attached to posts with nylon fence ties, zip ties or flexible wire.

3.10 TURF MAINTENANCE & ESTABLISHMENT PERIOD

A. Maintenance of turf areas shall begin immediately after installation, with Owner's approval, and continues through growing season sufficiently long for turfgrass to become established and prove satisfactory to the Owner, but in no case less than forty-five (45) days.

1. Maintenance includes watering, weeding, mowing and edging, reseeding, disease and insect pest control, repair of all erosion damage, and any other procedures consistent with good horticultural practice, required to ensure normal, vigorous, and healthy growth.
   a. Maintenance shall continue until Final Acceptance of the work, as defined in "Conditions & Inspection for Final Acceptance" Article.
2. Roll, regrade, and replant bare or eroded areas to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   a. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
4. Eradicate weeds. Water, fertilize, overseed, and perform other operation necessary to promote growth of turfgrass. Remove weeds and foreign grasses in planted areas at least once per week. Herbicides may be used only when approved by the Owner's Representative.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 2 inches. Coordinate with Irrigation Contractor.

1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:

1. Mow Tall Fescue Turf grass to a height of 3 inches each time its height reaches 4 inches. Maintain through a minimum of three mowings to provide an even stand over the entire seeded area, until final inspection and acceptance.

D. Provide a "grow-in" fertilizer, as specified, for all irrigated lawns. Apply six weeks after seed germination. In the case of fall seeding, apply prior to May 1, the following year.

E. Apply post emergence herbicide per the manufacturer's recommendations and application rates, whenever and wherever weed growth jeopardizes or inhibits the development of a mature grass lawn. Apply herbicide in late spring or early summer. Apply only when mean high temperatures are between 60° and 85° F with wind velocities less than five (5) miles per hour. Prior to application, Contractor shall notify Owner, in writing, of the proposed schedule for applying herbicides. Written notice shall include the following items:

1. Date of proposed application
2. Specific area of proposed application
3. Proposed herbicide for application
4. Proposed concentration and application rate.

F. The application area must be signed with Owner-approved signs informing the public of the application and duration of restricted use.

G. Fencing: Provide four (4’) foot tall orange plastic snow fencing and metal tee fence post spaced at a maximum of eight (8’) feet apart around all walks at seeded and sodded areas. Maintain until lawn is accepted.

3.11 SATISFACTORY TURF

A. Turf installations shall meet the conditions for Final Acceptance as outlined in “Conditions & Inspection for Final Acceptance” Article.

3.12 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents according to requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

3.13 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

D. Remove nondegradable erosion-control measures after grass establishment period.

3.14 MAINTENANCE SERVICE

A. Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in "Turf Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, and until Final Acceptance by Owner.

B. When the initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season until Final Acceptance condition and inspection is achieved.

C. See “Conditions & Inspection for Final Acceptance” Article for information on Final Acceptance.

PART 4 - MEASUREMENT AND PAYMENT

~~A.~~ The engineer will measure actual quantities of work completed as described ~~in subsections for individual pay items.~~ per the Project Plan Sheets. Payment shall be made via lump sum bid amount.

B. The engineer will measure the completed work as follows:

1. Lump Sum of all improvements shown within the Project Plan Sheets:

a. Site seeding and turf establishment
   1) Seeding will include all items contained in this specification including associated soil testing and preparation, amendments, mulches, erosion control material, installation, staking and fencing and required maintenance through Final Acceptance.

END OF SECTION

SECTION 02940
PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

A. The work in this section includes landscape construction, protection of existing site and landscape conditions and landscape maintenance during construction.

B. See drawings for extent of landscaping.

1.3 SUMMARY

A. Section Includes:

1. Plant materials.
2. Fertilizers.
3. Weed-control barriers.
4. Mulches.
5. Herbicides and pesticides.
6. Tree-stabilization materials.
7. Landscape edgings.
8. Boulders.

B. Related Requirements:

1. Section 02810 "Irrigation" for complete irrigation systems.
2. Section 02930 "Turf & Grasses" for turf (lawn) and soil testing and preparation requirements.

1.4 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than sizes indicated; wrapped with burlap, tied, rigidly

supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than sizes indicated.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

I. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

J. Planting Area: Areas to be planted.

K. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

O. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

P. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

Q. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

R. Topsoil: Top layer of soil not containing more than 40 percent clay in a portion passing through a no. 10 sieve. Topsoil shall contain between 5 and 20 percent organic matter.

1.5 REFERENCED STANDARDS

A. ANSI Z60.1: American Standard for Nursery Stock, latest edition, American National Standards Institute.

B. Hortus Third: A Concise Dictionary of Plants Cultivated in the United States & Canada, Staff of the L.H. Bailey Hortorium, Cornell University, 1999.

C. ASTM C33: Specification for Concrete Aggregate, American Society of Testing Materials.

D. Alex Shigo, Tree Pruning, Shigo & Tree Associates, LLC, 1989.

E. Guide for Plant Appraisal, latest edition, Council of Tree and Landscape Appraisers.

F. Species Ratings and Appraisal Factors Guide, latest edition, International Society of Arboriculture, Rocky Mountain Chapter.

G. ANSI A300: Standards for Tree Care Operations, American National Standards Institute.

H. Tree Planting Specifications, Dr. Delmar Gilman, University of Florida, http://hort.ifas.ufl.edu/woody/summary-planting.shtml, Copyright 2011, University of Florida

I. Guideline Specifications for Nursery Tree Quality, Dr. Delmar Gilman, University of Florida, http://search.ufl.edu/web/#gsc.tab=0&gsc.q=Guideline%20Specifications%20for%20nursery%20stock%20%20site%3Ahort.ifas.ufl.edu , Copyright 2011, University of Florida.

J. International Society of Arboriculture (ISA) Best Management Practices publications

1.6 COORDINATION

A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.7 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.8 ACTION SUBMITTALS

A. Product Data:

1. Plant materials.
2. Soil Test Reports.
3. Fertilizers.
4. Weed-control barriers.
5. Mulches.
6. Herbicides and pesticides.
7. Tree-stabilization materials.
8. Landscape edgings.
9. Boulders.

B. Product Data Submittals: For each type of product indicated.

1. Plant Materials: Include quantities, plant dimensions, container/root ball size, quality, and verified sources and suppliers for plant materials. Each plant of the same species shall be supplied by one grower only unless otherwise approved the Owner. Submit within 30 days after award of contract, complete list of materials to be furnished under this section and confirmed sources for materials.
    a. Requests for substitution of plants not available in size, quantity or type specified must be made in writing prior to Contract award. Submit written evidence that a specified plant cannot be obtained.

C. Samples for Verification: Actual sample of finished products for each of the following:

1. Organic Mulch: 1-quart volume of each organic mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Provide an accurate representation of color, texture, and organic makeup.
2. Mineral Mulch: 5 lb of each mineral mulch required; typical of the lot of material to be furnished, in sealed plastic bags labeled with source of mulch. Provide accurate indication of color, texture, and makeup.
3. Weed-Control Barrier: 12 by 12 inches.
4. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
5. Pictures or samples of Selected Boulders.

1.9 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of Owners' contact persons.

B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with manufacturer's certified analysis of standard products.

C. Material Test Reports: For existing in-place surface soil and imported topsoil.

1. See Section 02930 "Turf & Grasses" for planting soils testing and preparation requirements.

D. Identify source location of topsoil proposed for use on the project if imported from off-site.

1. See Section 02930 "Turf & Grasses" for requirements.

E. Pesticides and Herbicides: Product label and manufacturer's written application instructions specific to Project.

F. Warranty.

1.10 CLOSEOUT SUBMITTALS

A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

1.11 QUALITY ASSURANCE

A. Comply with applicable Federal, state and local regulations governing landscape materials and work.

B. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.

1. Experience: Three years' experience in landscape installation.
2. Installer's Field Supervision: Maintain an experienced full-time supervisor on Project site when work is in progress.
3. Pesticide Applicator: State licensed, commercial.

C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

D. Measurements: Measure in accordance with ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inchcaliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

E. Plant Material Observation: Owner may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Owner retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Owner's representative reserves right to review and reject materials at growing site and as delivered to site. Remove rejected trees or shrubs immediately from Project site.

1. Notify Owner's representative of delivery schedule 48 hours in advance so plant material may be observed upon arrival at job site and can be inspected immediately after being unloaded at site.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

B. Bulk Materials:
   a. Do not dump or store bulk materials near structures, utilities, or walkways and pavements; or on existing turf areas or plants.
   b. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
   c. Accompany each delivery of bulk materials with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

F. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees

in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

1.13 FIELD CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.

1. Spring Planting: April 15 to June 15.
2. Fall Planting: August 15 to September 31.
3. Irrigation system must be operational prior to planting.

C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions in accordance with manufacturer's written instructions and warranty requirements.

1.14 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

    a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
    b. Structural failures, including plantings falling or blowing over.
    c. Faulty performance of tree stabilization.
    d. Warranty excludes replacement of plants after final acceptance because of injury by storm, drought, drowning, hail, freeze, insects, or disease. Materials damaged by “Acts of God” prior to final acceptance are responsibility of Contractor.

2. Warranty Periods: From date of Final Acceptance. See Article “Conditions & Inspection for Final Acceptance.”

    a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
    b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:

    a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
    b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
    c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.
    d. Trees should be replaced at start of next planting or digging season. In such cases, remove dead trees immediately. Protect irrigation system and other piping conduit or other work during replacement. Repair damage immediately.
    e. Provide extended warranty for period equal to original warranty period, for replaced plant material.
    f. At end of warranty period, remove staking and guying materials from the site.

1.15 CONDITIONS & INSPECTION FOR FINAL ACCEPTANCE

A. Inspection and Final Acceptance:

1. Landscape plant acceptance will occur after completion of PLANT MAINTENANCE & ESTABLISHMENT PERIOD. Contractor to have completed, located, and installed all plants according to drawings and specifications. All plants and turfgrass are expected to be living and in healthy condition at time of inspection and acceptance.

2. Upon written request of the Contractor, the Owner will inspect all vegetated areas to determine completion of work. This request must be submitted at least one week prior to the anticipated inspection date.

3. If the vegetated areas are not acceptable, the Owner will indicate corrective measures to be taken and shall extend the PLANT MAINTENANCE & ESTABLISHMENT PERIOD as necessary for the completion of the work. The Contractor shall request a second inspection of the vegetated areas after corrective measures have been accomplished. This process shall be repeated until the total vegetated area being inspected is acceptable.

4. When the vegetated areas are acceptable, a meeting of the Contractor and Owner will be arranged to accept the vegetated work. A final inspection will be a part of this meeting. At this meeting, the Contractor shall be furnished with a written acceptance of the vegetated area being approved. The Contractor shall turn over maintenance of the vegetated areas to the Owner at this meeting.

5. Following the acceptance of vegetated areas, the Contractor shall provide the Owner with access to all vegetated areas as required for the Owner’s maintenance work.

B. Conditions of Final Acceptance:
   1. Acceptance shall be given for the entire portion of the vegetated areas. No partial acceptance will be given.
      a. Planter beds and earth mound water basins are properly mulched and free of weeds.
      b. Tree support stakes, guys, and turnbuckles are in good condition.
      c. Total plants on site as required by specifications and required replacements have been installed.
      d. Remedial measures directed by Owner have been completed.
   2. Pavement surfaces and site improvements adjacent to vegetated areas shall be clean and shall be free of spills or overspray from placing or handling of topsoil and sodding operations.

C. Site Cleanup:
   1. The Contractor shall leave the site in a clean and neat condition. Final Acceptance will not be granted until this condition is met.

PART 2 - PRODUCTS

2.1 PLANT MATERIALS

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

   1. Trees with damaged, crooked, or multiple leaders; with tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); with crossing trunks; with cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots are unacceptable.

   2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare in accordance with ANSI Z60.1.

D. Labeling: Label at least one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for plant.

E. Special Requirements

1. Shade trees are to be procured a minimum of 30 days prior to scheduled installations. Trees to be shipped in enclosed truck or the branches/leaves protected by appropriate fabric during shipping. Trees are to be healed in at job site or at Contractor's holding facility and maintained until site is ready. Owner's representative will review trees at holding area prior to planting.

2.2 FERTILIZERS

A. Type A – as recommended by testing agency.

B. Type B – Scotts "Osmocote" at a 14-14-14 ratio, incorporated into the soil according to instructions on the bag.

2.3 PLANTING SOILS

1. Existing Soil with Amendments as recommended by soil testing laboratory, with a pH range of 5.0 to 8; 5 to 12 percent organic material content total dry weight; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

2. Imported Topsoil
   a. In the event sufficient quantities of native topsoil cannot be salvaged from the site, the Contractor shall provide imported topsoil to supplement the project requirements. The Contractor shall provide topsoil that meets or exceeds the quality of the native topsoil material available on site. Contractor shall provide source and analysis information to the Owner's Representative, for his approval, prior to delivery. The Contractor shall incorporate into the topsoil, amendments necessary to provide topsoil fertility and quality, equal to or exceeding the characteristics of the native topsoil.

2.4 SHARP SAND

a. Sharp sand shall be clean, washed and fine aggregate and shall meet ASTM C33 standards.

2.5 PEAT MOSS

1. Peat moss shall be commercially produced, sterilized, reed-sedge peat, equivalent to Martins Peat, Big Fork, Montana. Peat must have a pH between five and seven and organic matter content not less than 90 percent.

2.6 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, composed of fibers inert to biological degradation and naturally resistant to chemicals, alkalis, and acids, formed into a stable network so that fibers retain their relative position.

1. Class A type equal to DMS-6200 Type 1, 4.0 oz per sq. yd. to 6.0 oz. per sq. yard or approved equal.

2.7 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

1. Type: Shredded medium grade, Douglas Fir Bark, free of wood chips and sawdust
2. Size Range: Chip size of 1-1/2 to 2-1/2 inch average
3. Color: Natural.
4. As manufactured by Model Log Homes, 75777 Gallatin Road, Gallatin Gateway, Montana, 59730, or approved equal.

B. Mineral Mulch: Hard, durable stone, washed free of loam, sand, clay, and other foreign substances, of the following type, size range, and color:

1. Type: Black Basalt Rock Mulch, or equal, as approved by the Owner.
2. Size Range: 1-1/2 inches minimum, 3 inches maximum
3. Color: Uniform dark gray with tans color range as acceptable to the Owner.

2.8 HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

B. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

C. Pesticides: Registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended in writing by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

2.9 ANTI-DESICCANT

A. Protective film emulsion for protection of plant surfaces during transport. Permeable to permit transpiration, as manufactured by Wilt Pruf, Inc., P.O. Box 4280, Greenwich, Connecticut, 06830. Mixed and applied in accordance with manufacturer’s instructions.

B. Owner’s representative approved equal.

2.10 DRAINAGE FILL

A. No drainage without Owner’s written permission.

2.11 TREE-STABILIZATION MATERIALS

A. Trunk-Stabilization Materials:

1. Metal posts: 8’-0” t-stakes
2. Tree-Tie Webbing: UV-resistant nylon webbing with brass grommets.
3. Guy Straps: Fabric or nylon designed specifically to guy newly planted trees. Wire will not be permitted.
4. Eye Bolts: Galvanized or cadmium plated steel with 1 inch diameter eye and minimum 1 1/2 inches screw length.
5. Turnbuckles: Galvanized or cadmium plated steel with minimum 3-inch-long openings fitted with screw eyes.
6. Turnbuckles: Galvanized or cadmium plated steel with minimum 3-inch-long openings fitted with screw eyes.
7. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
8. Proprietary Staking-and-Guying Devices: Proprietary stake or anchor and adjustable tie systems to secure each new planting by plant stem; sized as indicated and in accordance with manufacturer's written instructions.

2.12 LANDSCAPE EDGINGS

A. Aluminum Edging: Standard-profile extruded-aluminum edging, ASTM B221, Alloy 6063, fabricated in standard lengths with interlocking sections with loops stamped from face of sections to receive stakes.

1. Edger to be Permaloc Cleanline, or approved equal.
2. Edging Size: 3/16 inch thick by 5-1/2 inches deep
3. Stakes: Heavy Duty Aluminum per manufacturer, 12 inches long. Spaced per manufacturer recommendation.
4. Finish: Black DuraFlex, or as approved by Owner.

2.13 BOULDERS

A. To be natural stone in three approximate varying sizes: 24”, 36”, and 48” diameter. Refer to plan for boulder locations. Vary sizes per grouping.

B. Boulders shall be similar in shape and size as depicted on the plan, rough face, firmly anchored, and level. All boulders shall be free of sharp edges and surfaces that could be harmful to pedestrians. Contractor to provide samples or images for approval by Owner prior to delivery.

C. Type: Native Boulder sourced in the Gallatin Valley region, free of sharp edges.

D. Color: Natural Dark Grays, Tans, and Golds to match mineral mulch selection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
3. Suspend planting operations during periods of excessive soil moisture until moisture content reaches acceptable levels to attain required results.
4. Uniformly moisten excessively dry soil that is not workable or which is dusty.

B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove soil and contamination as directed by Architect and replace with new planting soil.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Owner's acceptance of layout before excavating or planting. Make minor adjustments as required.

3.3 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 6 inches. Remove stones larger than 1 inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property. Pressing rocks into the soil is not an acceptable method of removing rocks from the surface.

1. Spread topsoil over loosened subgrade, apply soil amendments and fertilizer on surface as recommended by soils report, and thoroughly blend planting soil. Incorporate soil amendment by disc harrowing, rototilling or other means in uniform manner. Incorporate organic matter deep enough to produce finished soil with

organic matter content of between 4 and 6 percent. Provide additional organic soil amendment material, after in place testing and approval, as required for organic matter content and finished grades at no additional cost to Owner.

a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
b. Mix lime with dry soil before mixing fertilizer.

2. Spread planting soil to a depth of 12 inches but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

a. Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Before planting, obtain Owner's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits.

1. Excavate planting pits with sides sloping inward at a 60-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
2. Excavate approximately three times as wide as ball diameter for balled and burlapped and container-grown stock.
3. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
4. Do not excavate deeper than depth of root ball, measured from the root flare to the bottom of root ball.
5. If area under the plant was initially dug too deep, add soil to raise it to correct level and thoroughly tamp the added soil to prevent settling.
6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
7. Maintain supervision of excavations during working hours.
8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

B. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless amended to meet soils report recommendations before being used as planting soil.

C. Obstructions: Notify Owner if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Owner if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.5 TREE AND SHRUB PLANTING

A. Stake locations for approval by Owner's representative.

B. Before planting, verify that root flare is visible at top of root ball in accordance with ANSI Z60.1. If root flare is not visible, remove soil in a level manner from root ball to where the top-most root emerges from the trunk. After soil removal to expose root flare, verify that root ball still meets size requirements.

C. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

D. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades.

1. Backfill: Use Planting soil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove Top and Sides 1/3 of burlap, and all twine, rope, and wire baskets from root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.
6. Construct a temporary 4 inch raised ring of soil at edge of root ball to contain water for deep watering. Contractor is responsible for deep watering until final acceptance. Remove or breach before winter.
7. Construct a mulch ring with a minimum 36" diameter to a depth of 3" – 4"; leave 3" bare ground between mulch and tree trunk.
8. Set stakes, if required, as outlined in Article "Installation of Tree-Stabilization Materials"

E. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 2 inches above adjacent finish grades, or as indicated on the drawings.

1. Backfill: Planting soil.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Distribute granular fertilizer around each planting pit when pit is approximately one-half filled. Do not place in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.
6. Construct a temporary 4 inch raised ring of soil at edge of root ball to contain water for deep watering. Contractor is responsible for deep watering until final acceptance.
7. Construct a mulch ring with a minimum 36” diameter to a depth of 3” – 4”; leave 3” bare ground between mulch and tree trunk.
8. Set stakes, if required, as outlined in Article “Installation of Tree-Stabilization Materials”.

F. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of root ball.

G. Root Balls

1. Root balls shall be properly located in relationship to adjacent soil as required by referenced standards.
2. Balls set too deep or too shallow shall be carefully removed and replanted as required by the Owner’s representative.

3.6 PERENNIAL PLANTING

A. Prepare planting beds as indicated on drawings. Provide one foot of thoroughly mixed and prepared soil consisting of 50 percent sand loam topsoil; 25 percent coarse pumice, 3/8 inch size; and 25 percent peat moss. Thoroughly mix in 20 pounds of Scott, Ortho or Lilly-Miller nitrogen fertilizer per cubic yard with formulation of 10-20-10.

B. Replace existing soil with planting mix.

C. Space plants as indicated on drawings. Obtain approval of plant layout from Owner’s representative before planting. Owner’s representative reserves the right to change the location of plants prior to planting.

3.7 MECHANIZED TREE-SPADE PLANTING

A. Plant trees with approved mechanized tree spade at designated locations. Do not use tree spade to move trees larger than maximum size allowed for similar field-grown, balled-and-burlapped, root-ball diameter in accordance with ANSI Z60.1, or trees larger than manufacturer's maximum size recommendation for tree spade being used, whichever is smaller.

B. Use same tree spade to excavate the planting hole as will be used to extract and transport the tree.

C. When extracting tree, center the trunk within the tree spade and move tree with solid ball of earth.

D. Cut exposed roots cleanly during transplanting operations.

E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in same direction as in its original location.

3.8 TREE, SHRUB, AND VINE PRUNING

A. Follow referenced standards and prune material as directed by Owner’s represenative.

B. Prune, thin, and shape trees, shrubs, and vines in accordance with standard professional horticultural and arboricultural practices. Unless otherwise indicated by Owner, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character. Do not prune for shape.

C. Do not apply pruning paint to wounds.

3.9 INSTALLATION OF TREE-STABILIZATION MATERIALS

A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated:

1. Upright Staking and Tying:

    a. Stake all proposed trees. Use a minimum of two stakes of length required to penetrate at least 24 inches below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
    b. Stake trees with two stakes for trees up to 12 ft. high and 2-1/2 inches or less in caliper; three stakes for trees less than 14 ft. high and up to 4 inches in caliper. Space stakes equally around trees.

2. Support trees with bands of flexible ties at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

3. Support trees with 1” wide minimum, flexible belt-like fabric. Do not use rope or wire. Do not overtighten around tree. Allow enough slack to avoid rigid restraint of tree.

4. Remove ties within one year after installation. Coordinate with Owner prior to removal on timeline for removal of stakes and tree guards.

B. Trunk Stabilization by Staking and Guying: Stake and guy trees more than 14 ft. in height and more than 3 inches in caliper unless otherwise indicated.

1. Site-Fabricated, Staking-and-Guying Method: Install no fewer than three guys spaced equally around tree.
   a. For trees more than 6 inches in caliper, anchor guys to wood deadmen buried at least 36 inches below grade. Provide turnbuckle for each guy wire and tighten securely.
   b. Support trees with bands of flexible ties at contact points with tree trunk and reaching to turnbuckle. Allow enough slack to avoid rigid restraint of tree.
   c. Attach flags to each guy wire, 30 inches above finish grade.

2. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and in accordance with manufacturer's written instructions.

3.10 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in equidistance spacing in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.11 INSTALLATION OF MULCHES

A. After planting has been completed and approved by the Owner’s representative, install weed-control barriers before mulching in accordance with manufacturer's written instructions, in areas as indicated on Drawings. Completely cover area to be mulched, overlapping edges minimum of **12 inches**.

1. At the bed margins, fabric should be installed under the bottom of the edging. Fabric lapping outside the edging should be trimmed to below grade and buried when the edging is backfilled. Fabric should be well anchored with 6 inch staples pounded flush with the grade. Plant openings must be large enough to allow for future growth.

B. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not create a mulch cone or place mulch within 3 inches of trunks or stems.

2. Mineral Mulch in Planting Areas: Apply 3-inch average thickness of mineral mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.12 INSTALLATION OF LANDSCAPE EDGINGS

A. Aluminum Edging: Install aluminum edging where indicated in accordance with manufacturer's written instructions. Set edging as indicated in true lines as designed with top of edging one inch above finish grade.

3.13 INSTALLATION OF BOULDERS

A. Boulders shall be installed as indicated on the drawings, firmly anchored in planting beds, level, with approximately 1/3 bottom of boulder buried. Place mulch up to base of boulder.

B. Final boulder placement locations may be adjusted in the field by the Owner.

3.14 APPLICATION OF HERBICIDES AND PESTICIDES

A. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written instructions. Do not apply to seeded areas.

B. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written instructions.

C. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and in accordance with manufacturer's written instructions. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.15 PLANT MAINTENANCE & ESTABLISHMENT PERIOD

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.

B. Water will be available on site. Provide necessary hoses and other watering equipment required to complete work.

1. Coordinate watering schedules with irrigation contractor or Owner's representative during installation and until final acceptance. Provide deep root watering to newly installed trees.

C. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

D. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

E. Weeding: Remove weeds and foreign grasses in planted areas at least once per week. Herbicides may be used only when approved by the Owner's Representative.

F. PLANT MAINTENANCE AND ESTABLISHMENT shall be the period of time required to meet conditions of Final Acceptance. See Article "Conditions & Inspection for Final Acceptance."

3.16 REPAIR AND REPLACEMENT

A. Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Owner.

1. Trees removed during demolition or construction are to be replaced following consultation with Owner's Arborist or Owner's Representative. Appraised values of existing trees have been determined according to industry standards and will be provided by the Owner if applicable.

2. Submit details of proposed pruning and repairs.

3. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.

4. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Owner.

5. Remove and replace trees that are more than 25 percent dead or in unhealthy condition or are damaged during construction operations that Owner determines are incapable of restoring to normal growth pattern.

3.17 CLEANING AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

PART 4 - MEASUREMENT AND PAYMENT

A. The engineer will measure actual quantities of work completed as described in subsections for ~~individual pay items.~~ lump sum bid to perform the work described in the Project Plan Sheets.

B. The engineer will measure the completed work as follows:

1. Trees, shrubs, and perennials will be measured by each and will include all associated soil testing and preparation, mulches, tree stabilization, installation, warranty, and required maintenance through Final Acceptance.
2. Boulders will be measured by each.
3. Mineral mulch will be measured by cubic yard and include landscape weed barrier fabric.
4. Edging will be measured by linear feet and include all associated stakes.

C. Payment shall be made as part of total lump sum of the contract lump sum bid amount.

END OF SECTION

SECTION 03310

STRUCTURAL CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish structural concrete meeting all specified requirements that is composed of Portland cement, supplementary cementitious materials, aggregates, chemical admixtures and water. Furnish Ready-mixed concrete meeting ASTM C94 unless otherwise specified. Furnish concrete reinforcement to concrete as specified in the construction documents.

1.2 REFERENCES

A. References to ASTM, AASHTO, ANSI and ACI designations, means the latest revision at the time of the call for bids:

ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C150	Specification for Portland Cement
ASTM C618	Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989	Specification for Slag Cement for Use in Concrete and Mortars ASTM C1240 Specification for Silica Fume Used in Cementitious Mixtures ASTM C595 Specification for Blended Hydraulic Cements
ASTM C1157	Performance Specification for Hydraulic Cement
ASTM C157	Length Change of Hardened Hydraulic-Cement Mortar and Concrete
ASTM C33	Specification for Concrete Aggregates
ASTM C260	Specification for Air-Entraining Admixtures for Concrete
ASTM C494	Specification for Chemical Admixtures for Concrete
ASTM C1017	Specification for Chemical Admixtures for Use in producing Flowing Concrete
ASTM C138	Test Method for Density (Unit Weight), Yield, and Air Conten (Gravimetric) of Concrete
ASTM C173	Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C231	Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C31	Practice for Making and Curing Concrete Test Specimens in the Field

ASTM C39	Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C172	Practice for Sampling Freshly Mixed Concrete ACI 301 Standard Specification for Structural Concrete ACI 305 Hot Weather Concrete
ACI 306	Cold Weather Concrete
ACI 318	Building Code Requirements for Structural Concrete and Commentary

1.3 QUALITY ASSURANCE

A. Codes and Standards: The codes and standards referred to in this section are declared to be part of this specification as if fully set forth herein. In addition, the following ACI Standards are incorporated in their entirety, unless specifically required otherwise:

1. ACI Standard 301, "Specifications for Structural Concrete," American Concrete Institute, current edition.

2. ACI Standard 318, "Building Code Requirements for Structural Concrete", American Concrete Institute, current edition.

3. Concrete Reinforcing Steel Institute, "Manual of Standard Practice".

4. International Building Code of I.C.B.O.

B. Employ, at the Contractor’s expense, a testing laboratory acceptable to the Engineer to perform material evaluation tests and/or perform the mix design prior to placing any concrete, and all acceptance testing during the onsite placement of the concrete. Retesting or additional testing of concrete or materials failing to meet the requirements of these specifications must be done by the Contractor at no additional cost to the Owner.

PART 2 - PRODUCT

2.1 CLASSIFICATION

A. Concrete is classified as set forth by aggregates size referenced in ASTM C33, sizes 4 and 467 for Class C concrete and 56, 57, and 6 for Class M concrete. Place the specified class of concrete for each structure element as specified.

1. Use M-4500 (f’c = 4,500 psi) concrete for curb and gutter, sidewalks, driveways, approaches, curb turn fillets and valley gutters and structural concrete. The maximum allowable water cement (w/c) for this concrete is 0.45.

2. Use M-3000 (f’c = 3,000 psi) concrete for manholes, storm drain inlets and miscellaneous or C-3000 Concrete Construction class. The maximum allowable w/c for this concrete is 0.50.

B. If concrete strength or durability requirements established by design exceed the above strength classifications, the Engineer may specify additional concrete classifications to meet those requirements.

2.2 COMPOSITION OF CONCRETE

A. Upon receipt of the notice of award of the contract, furnish the Engineer with names of suppliers and locations of sources of materials proposed for use.

1. Materials

a. Cementitious Material: Cementitious material consists of Portland Cement meeting ASTM C150 Type I, II, III, or V, with or without the addition of cementitious or pozzolanic mineral admixtures meeting, ASTM C618 or ASTM C989, and ASTM C1240, or blended hydraulic cement meeting ASTM C595 Type 1P, 1S, or 1L, or hydraulic cement meeting ASTM C1157 Type GU, MS, HS, or HE. Unless otherwise specified, assure cementitious material meets ASTM C 150 Type I or Type II. Assure cementitious material used in concrete is the same brand and type and from the same plant of manufacture as the cementitious material used in the concrete represented by the submitted field test date or used in the trial mixtures.

b. Aggregates: Assure aggregates meet ASTM C33. When a single size or a combination of two or more sizes of coarse aggregates are used, assure the final gradation meets the grading requirements of ASTM C33 or provide an optimized combined aggregate gradation plan. Obtain concrete aggregates from the same source and use the same size ranges as the aggregates used in the concrete represented by submitted historical data, or used in trial mixtures.

c. Water and Ice: Use concrete mixing water and water to make ice meeting requirements of ASTM C94.

d. Admixtures: Use admixtures meeting the following requirements:

i. Air entraining, admixtures - ASTM C260

ii. Chemical admixtures- ASTM C494

iii. Chemical admixtures for use in producing, flowing concrete- ASTM C1017

iv. Calcium Chloride - ASTM D98

v. Use admixtures in the concrete that are the same as those used in the concrete represented by submitted field test data or in trial mixtures.

2. Change of materials

a. When brand, type, size, or source of cementitious materials, aggregates, water, ice or admixtures are requested to be changed, submit new field data or data from new trial mixtures or furnish evidence that indicates that the change will not adversely affect the relevant properties of the concrete for acceptance before using the concrete.

B. Performance and Design Requirements

1. Assure the cementitious material content is adequate to meet the specified requirements for strength, water-cement ratio and finishing requirements. For

concrete exposed to freezing and thawing or concrete exposed to deicers, assure a maximum water-cement ratio of 0.45.

2. Furnish concrete at the point of delivery having a slump of 4 inches (max) determined by ASTM C143. Meet slump tolerances in ACI 117. When a plasticizing admixture is used meeting ASTM C1017 or when a Type F or G high range water reducing admixture meeting ASTM C494 is approved to increase the concrete slump, assure the concrete has a slump of 2 to 4 inches before the admixture is added and a maximum slump of 8 inches at the point of delivery after the admixture is added.

3. Assure the nominal maximum size of coarse aggregate does not exceed three fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sided of forms or one-third of the thickness of slabs or toppings.

4. Concrete exposed to cycles of freezing and thawing or in the presence of deicers must be air entrained. Montana is considered a “severe” exposure state. Measure air content under ASTM C 138, C 173 or C231. Unless otherwise specified, ASTM C231 shall be used. Table 2.1 lists the required air contents for various nominal maximum size aggregates.

TABLE 2.1

TOTAL AIR CONTENT* OF CONCRETE FOR VARIOUS SIZES OF COARSE AGGREGATE

Nominal maximum Size of aggregate in.	Total air content, percent
	Severe exposure
Less than 3/8	9
3/8	7.5
1/2	7
3/4	6
I	6
1-1/2	5.5
2	5
3	4.5
6	4

* Measure in accordance with ASTM C 138, C 173, or C 231. Air content tolerance is plus 2 percent (+2%) to minus 1 percent (-1%).

a. When admixtures are specified in the Contract documents for particular parts of the work, use types specified. Use of calcium chloride or other admixtures containing chloride ions is subject to the limitations in Table 2.2 Chloride Ion Concentration. When approved, use calcium chloride in solution form only, when introduced into the mixture.

   i. Assure the maximum water-soluble chloride ion concentrations in hardened concrete at ages from 28 to 42 days attributed to the ingredients including water, aggregates, cementitious materials and

admixtures do not exceed the limits of Table 2.2. Use tests to determine water soluble chloride ion content meeting AASHTO T260. The type of member described in Table 2.2 applies to the work as indicated in the Contract Documents.

TABLE 2.2

MAXIMUM ALLOWABLE CHLORIDE ION CONTENT

Type of Member	Maximum water-soluble chloride (CI) Content in concrete, percent by weight of cement
Prestressed concrete	0.06
Reinforced concrete exposed to chloride in service	0.15
Reinforced concrete that will be dry or protected from moisture in service	1.00
Other reinforced concrete construction	.30

b. When the air temperature has fallen to or is expected to fall below 40oF (4oC) during the protection period, deliver concrete in accordance with minimum temperatures identified in ASTM C94. The protection period is defined as the time required to prevent concrete from being affected by exposure to cold weather.

c. Furnish the compressive strength and the water-cement or water cementitious, material ratio of concrete for each portion of the work as specified in the Contract documents.

   i. If cementitious or pozzolanic mineral admixtures meeting, ASTM C618 or ASTM C989, or ASTM C1240 are used, the cement portion of the water-cement ratio must be the total weight of cementitious material.

   ii. The combined weight of fly ash and other pozzolans, slag cement, silica fume meeting applicable ASTM standards, cannot exceed limits in ACI 318-14, Table 26.4.2.2 (b). The fly ash and pozzolan present in an ASTM Type IP cement meeting ASTM C595 must be included in the calculated percentage.

ACI Table 26.4.2.2(b) – Limits on cementitious materials for concrete assigned to Exposure Class F3

Cementitious Materials	Maximum Percent of Total Cementitious Materials by Mass
Fly ash or other pozzolans conforming to ASTM C618	25
Slag cement conforming to ASTM	50
Silica fume conforming to ASTM C1240	10
Total of fly ash or other pozzolans	35
Total of fly ash or other pozzolans, slag cement, and	50

iii. Strength requirements are based on the 28-day compressive strength determined on 6" x 12" (average of two specimens), or 4” x 8” (average of three specimens) cylindrical specimens made and tested under ASTM C31 and C39 respectively.

2.3 PROPORTIONING AND DESIGN OF MIXES

A. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to the Engineer for preparing and reporting proposed mix designs.

B. Submit written reports of each proposed mix for each class of concrete at least 15 days prior to start of work. Do not begin concrete production until design mixes have been reviewed and approved.

PART 3 - EXECUTION

3.1 CONCRETE MIXES

A. Job-Site Mixing: Mix materials for concrete in appropriate drum type batch match mixer. For mixers of 1 cu. yd., or small capacity, continue mixing at least 1-½ minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than one cu. yd., increase minimum 1-½ minutes of mixing time by 2.5 minutes for each additional cu. yd., or fraction thereof. Aggregates or bags of cement containing lumps or crusts shall not be used.

B. Provide batch ticket in compliance with ASTM C94 for each batch discharged and used in work.

C. When air temperature is between 85°F (30°C) and 90°F (32°C), reduce mixing and delivery time from 1-½ hours to 75 minutes, and when air temperature is above 90°F (32°C), reduce mixing and delivery time to 60 minutes, unless a hot weather concreting plan has been approved.

D. The mix may be designed for delayed set time to allow for long haul or other project conditions. Information pertaining to the delayed set admixture needs to be included

on the Batch Ticket. Include with the mix design submittal information on the delayed set provisions of the design and specific time to final placement requirements.

3.2 MIXING

A. Thoroughly mix concrete to assure a uniform distribution of the materials throughout the mass. Mix concrete only in quantities required for immediate use and place it within the time limits specified. Waste all concrete which initial set has begun. Retempering of concrete is prohibited. Mix concrete in an approved truck mixer meeting the requirements of ASTM C94 herein.

1. WATER

    a. Do not exceed the approved w/c ratio

    b. The addition of water is allowed only one time and a minimum of 30 revolutions at mixing speed are required before discharge of concrete

    c. Do not add water if part of the batch has been discharged as a W/C ratio cannot be determined

    d. Do not add water if the slump is within specified range

2. ADMIXTURE

    a. Do not exceed manufacturer’s recommended dosage rates unless otherwise approved in the mix design stage

    b. Only admixtures included in the approved mix design may be dosed on-site.

    c. A minimum of 30 revolutions at mixing speed are required before discharging of concrete.

    d. Do not add admixtures if any concrete has been discharged from the mixer other than the minimal amount for initial testing

    e. When measured plastic air content or slump exceeds the upper test limit and there is time available within the discharge time limit specified, rotate the load at agitation speed and re-test the air content and/or slump.

    f. Do not use additives to reduce the air content and/or slump

B. The capacity of the plant and the transportation equipment must ensure delivery at a rate that will permit proper handling, placement and finishing at the point of delivery. Maintain the concrete delivery rate to provide for the continuous operation of placing, handling and finishing concrete as is practical. Maintain the interval between delivery of loads so that layers or lifts of concrete in place do not harden before succeeding layers or lifts are placed. In general, no lift or layer of concrete can remain exposed for more than 20 minutes before being covered by fresh concrete.

C. The volume of mixed concrete in the mixing drum shall not exceed the manufacturer's rating, on the capacity plate.

D. A recording water metering device is always required at the primary point of the batching operation.

E. Do not add water to concrete in transit. Water may be introduced into the mixer at the job site, one time only, under direction of the Engineer, if the specified water-cement ratio is not exceeded. Water must be added in accordance with ASTM C94, Assure the drum revolves continuously after the introduction of the cement and water until the concrete is discharged.

F. Begin mixing immediately after introduction of the cement and water and continue for at least 70 revolutions of the drum at mixing speed. This minimum revolution count will be waived when the concrete is produced at a central mixing plant. Not more than 100 drum revolutions can exceed 6 revolutions per minute. All other revolutions must be at agitating speed of not less than 2 or more than 6 revolutions per minute.

G. Provide a revolution counter on each truck that registers the number of revolutions of the drum.

H. Mount the counter so it can be easily read by both the operator and the Engineer.

3.3 PLACING CONCRETE

A. Thoroughly consolidate concrete into its final position. Assure it is thoroughly consolidated around fittings and embedded items. Assure all reinforcement and embedded items are accurately placed as shown on the plans and are clean and free from coatings of dried mortar, detrimental rust, scale, oil or foreign matter. Place concrete meeting the applicable requirements of Sections 02528 and 02529.

3.4 CURING CONCRETE

A. Protect freshly placed concrete from freezing, high temperature, large temperature differentials, premature drying, excessive moisture, and moisture loss for a period of time necessary to develop the desired concrete properties.

B. Thoroughly cure concrete surfaces by covering as soon as possible with canvas, plastic sheets with sealed joints, burlap and sand or other satisfactory materials and keep concrete moist. If the concrete surfaces are not covered, keep them moist by flushing or sprinkling. Continue curing for at least 7 days after placing the concrete. Concrete surfaces placed against forms may be cured by leaving the forms in place for at least 7 days, when approved.

C. Protect concrete against freezing or other conditions detrimental to strength development meeting the applicable requirements of this specification.

D. To aid finishing, side forms on ornamental work, curbs and sidewalks, railing and parapets may be removed after 12 hours, not to exceed 48 hours, depending on weather conditions. Continue moist curing during the concrete finishing operation.

E. Untreated forms and existing concrete must be kept continuously wet for at least 1 hour before any concrete is placed. Keep wet until covered with concrete except that

adequately treated forms must be thoroughly washed with a water spray immediately before placing the concrete.

F. The curing of concrete, by either water curing or membrane curing, must be as follows unless otherwise approved by the Engineer.

1. Water Curing

a. Keep all concrete top surfaces continuously moist after finishing, with a fine water spray, until the concrete has set. Cover the moist concrete with water or an approved curing covering.

b. Cure concrete deck slabs and concrete floors for at least 7 days. Cure by placing burlap, cotton mats or other absorptive material as close behind the finishing operation as possible without marring the finished surface. Keep the absorptive material continuously moist for the full time it is used. The absorptive material may be kept in place for the entire curing period or it may be removed as soon as practical and the entire surface covered with approximately 1-1/2 inches (38.1 mm) of sand, kept continuously moist for the entire curing period.

c. Remove forms and repair surface irregularities without interfering with any of the curing requirements. As soon as the vertical forms have been removed and the surface irregularities repaired, cover the concrete with absorptive material, kept continuously wet for the balance of the curing period.

2. Impervious Membrane Curing

a. Assure membrane curing compounds are delivered to the job in the manufacturer’s original container, clearly labeled to show the name of the manufacturer and the contents. The clear curing compound must be sufficiently transparent and free from permanent color that would change the color of the natural concrete. Use clear compound containing a fugitive dye having color sufficient to render the film visible on the concrete for at least 4 hours after application. The concrete surface must maintain its natural color after curing.

b. Use a compound ready for use as shipped by the manufacturer. Dilute following the manufacturer's recommendations. Use curing compound only with written approval. Sampling will not be required if manufacturer's certification is available. Apply the curing compound under pressure with a spray nozzle to cover the entire exposed surface thoroughly and completely with a uniform film not exceeding manufacturer's specifications. Maintain the required pressure in the spray machine to force the material to leave the nozzle in a fine mist. Keep all concrete surfaces moist with a fine water spray or with wetted burlap until the sealing compound is applied. Keep the curing compound application close to the finishers of the top surface of concrete at all times. Seal the concrete immediately after the

finishing operations have been completed, to the satisfaction of the Engineer.

c. If it is necessary to allow workers or equipment on the surface before the 7 day curing period is completed, protect the concrete from damage and maintain the curing environment.

d. Keep concrete, which has not completed its curing period, continuously moist during the stripping and surface repair operations. Remove all surface irregularities, repair all depressions, voids or holes, including those formed by trapped air, to the satisfaction of the Engineer. Immediately apply the curing compound before the surface has had an opportunity to dry out. Keep concrete, from which forms have been stripped, continuously moist until surface repair and finishing are completed, and the impervious membrane curing has been applied.

3.5 WEATHER & NIGHT LIMITATIONS

A. General

1. Stop concreting operations when darkness prevents obtaining the specified placing and finishing work. Night operations may be conducted with written approval and when approved artificial lighting is provided.

2. Cold weather concreting is governed by ACI 306.1 unless otherwise specified herein. Cold weather exists when the ambient air temperature has fallen or is expected to fall below 40oF during the protections and curing period. The protection and curing period is defined as the time required to prevent concrete from being affected by exposure to cold weather.

3. When cold weather conditions are expected, all concreting operations will be suspended unless authorized by the Engineer. Contractor may receive authorization from concrete placement in cold weather by submitting a cold weather concreting plan for review and approval. The plan shall include detailed procedures to protect the fresh concrete from freezing during placement and maintaining the concrete surface temperature at a minimum of 55oF during the curing period.

4. Assume all risk of placing concrete in cold weather. Placing concrete during cold weather does not relieve the Contractor of the responsibility for obtaining the specified results. Remove and replace all concrete injured by frost at Contractor expense.

5. Before any concrete is placed, remove all ice, snow and frost completely from the formwork receiving the concrete. The subgrade must be frost free and above freezing before any concrete can be placed. Increase the temperature of formwork, reinforcement, subgrade, and base gravel to a minimum of 35°F (2°C).

6. Concrete shall be mixed, placed, and maintained according to Table (306-R10 5.1) 3.1.

7. Protection of Concrete

a. Unless otherwise approved, Maintain the surface temperature of the concrete in place between 55° F and 75° F for a minimum of 7 days using approved heating devices or enclosures during the protection and cure period. The minimum 7 day protection and cure period is intended only to protect the concrete from the effects of cold. A longer protection period may be needed for the concrete to gain additional strength to support the loads it will experience when in service. Contractor may, bearing all expenses, field cure concrete test cylinders with the in-place concrete and discontinue protection and curing when the field test cylinders reach 3500 psi. Contractor shall monitor the concrete temperature daily throughout the protection and cure period and make adjustments as needed to maintain the temperature between 55° F and 75° F. Forms shall be kept in place for the duration of the protection and cure period. When the protection and cure period has ended reduce the heat gradually so the concrete surface temperature does not decrease faster than 15° per hour until the concrete temperature is the same as the outside temperature. Modifications may be allowed if approved by Engineer and in conformance with ACI 306.1.

b. A Contractor may, at their expense, determine the in-place strength of the concrete using appropriate test methods and discontinue protection when those test methods indicate the concrete has reached 3500 psi.

3.6 TESTING

A. All concrete quality assurance testing must be performed by an ACI Grade I certified testing technician. Unless otherwise specified, the Engineer shall be responsible for all quality assurance testing during the on-site placement of the concrete.

1. Materials

a. The Engineer or their representative must have access to the ready mix production facility for sampling constituent materials during production to assure the materials meet these specifications and represent those stated on the approved mix design.

2. Standard Slump Tests

a. The Engineer shall, during each day’s placement, check the consistency of the concrete by slump test. A slump test will also be made each time that strength specimens are made. Slump tests are performed meeting ASTM C143 "Method of Test for the Slump of Portland Cement Concrete".

3. Air Content Tests

a. The Engineer shall during each strength test, check the air content by either the "Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method" (ASTM C231), "Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method" (ASTM C173) or "Method of Test for Unit Weight, Yield and Air Content (Gravimetric) of Concrete" (ASTM C138).

4. Compressive Strength Tests.

   a. A minimum of three specimens, 6 inch diameter or four 4 inch diameter, shall be made and tested for every concrete placement. Mold and test 1 set of test cylinders for every 50 cubic yards of concrete or fraction thereof placed each day or once per class of concrete supplied per day. On a given project, if the total volume of concrete is such that frequency of testing required above would generate less than 5 strength tests for a given class of concrete, make tests from at least 5 randomly selected batches or from each batch if fewer than 5 batches are used. Cure these cylinders under laboratory conditions except that additional test cylinders cured entirely under field conditions may be required by the Engineer to check the adequacy of curing and protection of the concrete.

   b. Take samples for strength tests in accordance with ASTM C172, entitled "Standard Practice for Sampling Freshly Mixed Concrete".

   c. Mold test cylinders and laboratory-cure in accordance with ASTM C31. Test cylinders in accordance with ASTM C39, entitled " "Method of Test for Compressive Strength of Cylindrical Concrete Specimens", ASTM C39, using an independent testing laboratory, as approved by the Engineer.

   d. Each set of cylinders cast per placement, test 1 for information strength at 7 days and test the remaining cylinders for acceptance strength at 28 days. To meet this specification, average strength of 28-day cylinders from the same sample is classified at the compressive strength test result. Strength level of an individual class of concrete is considered satisfactory if both of the following requirements are met:

      i. The average of all sets of 3 consecutive tests equal or exceed the specified strength.

      ii. No individual strength test (average of 28-day cylinders) falls below specified strength by more than 500 psi (3400 kPa).

   e. Cure field cylinders under field conditions meeting the provisions of “Field Curing” of the Standard Practice for “Making and Curing Concrete Test Specimens in the Field" (ASTM C31).

   f. Mold field cured test cylinders at the same time and from the same samples as laboratory cured test cylinders. Improve procedures for protecting and curing concrete when strength of field cured cylinders at the test age designated for measuring specified strength is less than 85% of that of companion laboratory cured cylinders. When laboratory cured cylinder strengths are appreciably higher than the specified strength, field cured cylinder strengths need not exceed the specified strength by more than 500 psi (3400 kPa) even though the 85% criterion is met.

   g. The strengths of any specimens cured on the job are to indicate the adequacy of protection and curing of the concrete and may be used to determine when the forms may be stripped, shoring removed or the

structure placed in service. When the strengths of the job cured specimens are below those specified above, the Contractor must improve the procedures for protecting and curing the concrete. The strengths of any field cured specimens should never be used solely for concrete acceptance purposes.

h. When concrete fails to meet the requirements above or when tests of field cured cylinders indicate deficiencies in protection and curing, the Owner's representative may order tests on the hardened concrete in accordance with ACI-301 for that portion of the structure where the questionable concrete has been placed. In the event the core tests also indicate that the structure is unsatisfactory, make all modifications as directed by the Engineer to make the structure sound. If the core tests indicate the concrete is satisfactory, all cost of testing shall be paid by Owner.

5. Temperature

a. Performed each time a set of compressive strength test specimens is made.

6. Testing Reports

a. In addition to the reports provided to the Owner and Engineer, the Contractor shall ensure that the concrete producer is provided copies of all reports of tests performed on concrete samples taken to determine compliance with the specification requirements. Reports shall be provided on a timely basis.

PART 4 - MEASUREMENT AND PAYMENT

4.1 GENERAL

A. The method of measurement and basis of payment is as outlined in the specifications for the various items of concrete work.

4.2 REQUIRED SUBMITTALS

A. The submittals required to become an approved source of supply for Portland Cement concrete:

1. Complete concrete mix design meeting all specification requirements. Meet the mix proportions specified in ACI 301. Submittals will include the following:

MIX PROPORTIONS	
-cement in lbs	Type and source of supply
-coarse aggregate	Size and source of supply
-fine, aggregate	Source of supply
-water, gallons	City of well
-admixtures, oz/yd^3	Brand and description*

*description as retarder, accelerator, air entraining, etc.

2. Items directly affecting a facility's ability to properly proportion, transport, and deliver concrete may be reason for disqualifying that facility as a source of supply until such deficiencies are corrected. Examples would include cement and aggregate scales that will not accurately weigh materials or mixer units which will not thoroughly mix concrete materials.

B. **MATERIALS INFORMATION**

1. Specific gravity (bulk s.s.d. Basis) of coarse and fine aggregate and 1% absorption-coarse aggregate unit weight (dry-rodded)-ASTM C33 quality tests including the following:

    a. Fine aggregate

        i. gradation AASHTO, T27 and T11 deleterious substances soundness (AASHTO T104) organic impurities (AASHTO T21) mortar-making properties (AASHTO T71)

    b. Coarse aggregate

        i. Deleterious substances gradation (AASHTO T27 and T11) soundness (AASHTO T104) percentage of wear (AASHTO T96)

    c. Current chemical analysis of mixing water (if well)

    d. Current cement and fly ash mill analyses

2. CONCRETE MIX DATA

    a. slump

    b. % air content

    c. unit weight

    d. 7 day and 28 day compressive strength

3. VARIATIONS

    a. The following variations will be cause for submittal of a new mix design.

        i. Change of aggregate source

        ii. Change of cement content

        iii. Addition or exclusion of certain admixtures including, but not limited to, pozzolans, accelerators, retarders and water reducers

        iv. Change in aggregate size

        v. Change in type of cement

        vi. Failure to attain strength requirements as outlined in ACI 301 or ASTM C94

b. A variation in any of the following will require informing the Engineer and Owner.

i. Change of cement supplier

ii. Change of admixture brands or dosages (not types)

iii. Minor adjustments of aggregate proportions accompanying materials changes or to accommodate placement conditions (same w/c ratio).

C. Certification of Ready Mixed Concrete Production Facilities

1. Concrete producers are to allow access to their facilities by Engineer or the Owner representatives for inspecting their facilities and/or sampling materials. All facilities should meet the requirements of the "National Ready-Mix Concrete Association" check list for concrete production facilities.

2. Items directly affecting a facility's ability to properly proportion, transport and deliver concrete may be reason for disqualifying that facility as a source of supply until such deficiencies are corrected. Examples would include cement and aggregate scales that will not accurately weigh materials or mixer units that will not thoroughly mix concrete materials.

D. The following chart indicates the submittal frequency for each item required for approval as a source of supply.

END OF SECTION

SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 – GENERAL

1.01 SUMMARY

A. Section Includes:
   1. The following specification details the work and related criteria for a complete electrical system.
   2. Subcontractor shall furnish services, materials, labor, and equipment for the complete installation of lighting & control systems in accordance with these Specifications and the accompanying Drawings.

1.02 REFERENCES

A. General
   1. The following documents form part of the Specifications to the extent stated. Where differences exist between codes and standards, the one affording the greatest protection shall apply.
   2. Unless otherwise noted, the edition of the referenced code or standard that is current at the time of the "date of record" for the Work shall be considered the effective code or standard for the duration of the project.
   3. Refer to specific Division 26 Sections for additional referenced codes and standards.

B. Execute and inspect all work in full accordance with the latest applicable rules, regulations, requirements, and specifications of the following.
   1. ANSI/NFPA 70 – National Electric Code (NEC), most recent addition adopted by Authority Having Jurisdiction, including all applicable amendments and supplements.
   2. NFPA – National Fire Protection Association: Standard for Electrical Safety in the Workplace (NFPA 70E).
   3. NECA 1 – National Electrical Contractors Association (NECA) Standard of Installation.
   4. National Electrical Manufacturers Association (NEMA)
   5. American National Standards Institute (ANSI).
   6. National Electrical Safety Code (NESC).
   7. Underwriters Laboratories (UL)
   8. Illuminating Engineering Society of North America (IES).

1.03 SUBMITTALS

A. Provide complete manufacturer's data sheets, product literature and shop drawings for all equipment, material and devices furnished under Division 26 – Electrical, demonstrating compliance with these Specifications and accompanying Drawings.

B. Manufacturer's standardized elementary diagrams will not be acceptable unless applicable portions of the diagram have been clearly identified and nonapplicable portions deleted or crossed out.

1.04 QUALITY ASSURANCE

A. If the Drawings or Specifications do not appear clear or definite, the Subcontractor shall request from the Project Manager through the 'Request for Information' (RFI) process an interpretation and decision of same, and shall have such questions decided before proceeding with the Work.

B. Manufacturer's Directions: Follow manufacturer's directions covering points not shown on the drawings or specified herein. Manufacturer's directions do not take precedence over Drawings and Specifications. Where these conflict with the Drawings and Specifications, notify the Project Manager for clarification before installing the work.

C. Protection of Equipment:
   1. Care shall be exercised during construction to avoid damage or disfigurement. Equipment shall be protected from dust and moisture prior to and during construction. The Subcontractor is cautioned that concrete finishing, painting, etc., in electrical rooms shall not proceed if unprotected equipment is installed.

2. Where required or directed, construct temporary protection for equipment and installations to protect same from dust and debris caused by construction.

D. Materials and Equipment:
   1. Materials and equipment shall be new. Materials and equipment for which tests have been established by Underwriter's Laboratories, Inc. shall be approved by that body and shall bear its label of approval or the label of an OSHA approved nationally recognized testing laboratory (NRTL).
   2. Unless otherwise approved by the Project Manager, the materials to be furnished under this Specification shall be the standard products of manufacturers regularly engaged in the production of such equipment equal to or superior to material specified, and shall be the manufacturer's latest standard design that complies with the Specification requirements.

E. Approval of Materials:
   1. A complete list of materials and equipment proposed shall be submitted to the Project Manager for approval. The list shall include for each item: the manufacturer, the manufacturer's catalog number, type or class, the rating, capacity, size, NRTL label/listing, etc.
   2. The Subcontractor shall submit a brochure containing catalog cuts or drawings and data for, but not limited to, the following items:
      a. Before installation of the equipment, the Subcontractor shall submit for approval detailed construction drawings for each item of fabricated equipment required for the electrical installation. Drawings shall be to scale and fully dimensioned and shall provide sufficient detail to clearly indicate the arrangement of equipment, including its components, and conduit/raceway system routing and configuration.
      b. Installation of approved substituted equipment is the Subcontractor's responsibility, and changes required to work included under other divisions for installations of approved substituted equipment must be made to the satisfaction of the Architect/Engineer and without change in Subcontract price.

1.05 COORDINATION

A. Coordinate schedules, access to MSU facilities, material supply, and all construction related processes through McKinstry.

1.06 RECORD DRAWINGS

A. As-built Drawings shall be prepared by the Contractor to show departures from original Drawings and to indicate installed conditions for:
   1. Major raceway systems, size, and location, for both exterior and interior; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
   2. Electrical, Lighting & Lighting Control Equipment locations (exposed and concealed).
   3. All hidden equipment requiring future maintenance or replacement, such as power packs, mini-inverters, etc, must be documented within Record Drawings by Installer, per Montana State University Engineering Guidelines.
   4. Approved substitutions and actual equipment and materials installed.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver products to project identified with names, model numbers, types, compliance labels and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.

B. Store equipment and materials in an environmentally controlled area that meets ambient and storage temperatures per manufacturer product literature.
   1. Major raceway systems, size, and location, for both exterior and interior; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.
   2. Equipment locations (exposed and concealed), dimensioned from established building lines.
   3. Approved substitutions and actual equipment and materials installed.

1.08 WARRANTY

A. Provide complete warranty information for each item, including start date of warranty and duration of warranty.

B. See individual specification sections within this document.

PART 2 – PRODUCTS

2.01 MATERIALS AND EQUIPMENT REQUIREMENTS

A. General
   1. All materials provided shall be new and free of defects, and suitable for the space provided.
   2. Equipment of the same type shall be of the same manufacturer.
   3. Provide materials and equipment listed for the intended purpose by Underwriters (UL) or an equivalent testing firm and bearing its label of approval.
   4. Unless otherwise indicated, provide materials and equipment which are the standard products of manufacturers regularly engaged in the production of such materials and equipment.

B. Hazardous Areas
   1. Provide materials and equipment acceptable to the regulatory AHJ for the Class, Division and Group of hazardous area indicated.

PART 3 – EXECUTION

3.01 ELECTRICAL INSTALLATIONS

A. General
   1. General work practices for electrical construction shall be in accordance with NECA 1 Standard of Installation for good workmanship.
   2. Coordinate electrical systems, equipment and materials installation with General Contractor and work of other trades to mitigate conflicts, errors, and delays during construction.
   3. Drawings are diagrammatic and indicate general arrangement. Check the approximate locations electrical system components shown on Drawings for conflicts with components of other systems and equipment. Headroom and space condition to be maintained.
   4. Drawings and accompanying specifications are intended to describe and illustrate systems which will not interfere with the structure of the building and which will fit into the available spaces. Install electrical equipment to conform to NEC clearances and to avoid obstructions with architectural, structural, mechanical and site conditions.

B. Layout and Coordination
   1. Layout of the various equipment is specific with the relative location shown on the drawings. Call attention to any error, conflict, or discrepancy in the drawings or specifications. Do not proceed with any questionable items of work until clarification has been received.
   2. Verify the physical dimensions of each item of electrical equipment and required clearances to fit the available space and provide prompt notification prior to roughing-in if conflicts appear. Coordinate equipment to fit into the available spaces and coordinate access routes through the construction site.

3.02 PROTECTION

A. Electrical work, wire and cable, materials, and other equipment specified in this division shall be protected against damage by other construction activities, weather conditions, or any other causes as a part of this work. Equipment found damaged or in other than new condition shall be rejected as defective.

B. Conduit and raceways shall be kept closed during construction to prevent entrance of dirt, moisture, concrete, or foreign objects. Raceways shall be clean and dry before installation of wire and shall be so at the time of acceptance.

3.03 ELECTRICAL TESTS

A. Upon completion of the work, the entire electrical system shall be tested and shall be shown to be in proper working condition in accordance with the intent of these Specifications and accompanying Drawings.

B. After the electrical system installation is completed, conduct an operating test for approval. Demonstrate that the equipment operates in accordance with the requirements of these Specifications and accompanying Drawings. Demonstrate that functions are operating correctly and are properly incorporated in control system.

C. Tests shall be made in the presence of the Owner's designated representative.

END OF SECTION

SECTION 260505
SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical demolition.

PART 3 EXECUTION

2.01 EXAMINATION

A. Verify field measurements and circuiting arrangements are as indicated.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents.

D. Report discrepancies to Engineer before disturbing existing installation.

E. Beginning of demolition means installer accepts existing conditions.

2.02 PREPARATION

A. Disconnect electrical systems in walls, floors, and ceilings to be removed.

B. Coordinate utility service outages with utility company.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
   1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
   2. Make temporary connections to maintain service in areas adjacent to work area.

2.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
   1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
   2. PCB- and DEHP-containing lighting ballasts.
   3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.

B. Remove, relocate, and extend existing installations to accommodate new construction.

C. Remove abandoned wiring to source of supply.

D. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.

E. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.

F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories, unless hangers are suitable for re-use.

H. Repair adjacent construction and finishes damaged during demolition and extension work.

I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.

J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

2.04 CLEANING AND REPAIR

A. See Section 017419 - Construction Waste Management and Disposal for additional requirements.

B. Clean and repair existing materials and equipment that remain or that are to be reused.

C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single conductor building wire.

B. Underground feeder and branch-circuit cable.

C. Metal-clad cable.

D. Wiring connectors.

E. Electrical tape.

F. Heat shrink tubing.

G. Wire pulling lubricant.

H. Cable ties.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 260505 - Selective Demolition for Electrical: Disconnection, removal, and/or extension of existing electrical conductors and cables.

C. Section 260526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.

D. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013 (Reapproved 2018).

B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011 (Reapproved 2017).

C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010, with Editorial Revision (2020).

D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2020).

E. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2017.

F. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2020.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

H. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable; 2018.

I. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2021.

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.

L. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.

M. UL 267 - Outline of Investigation for Wire-Pulling Compounds; Current Edition, Including All Revisions.

N. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.

O. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.

P. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.

Q. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.

R. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

B. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

C. Nonmetallic-sheathed cable is not permitted.

D. Underground feeder and branch-circuit cable is not permitted.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductor Material:
   1. Provide copper conductors only. Aluminum conductors are not acceptable for this project. Conductor sizes indicated are based on copper.
   2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
   3. Tinned Copper Conductors: Comply with ASTM B33.

H. Minimum Conductor Size:

1. Branch Circuits: 12 AWG.
    a. Exceptions:
        1) 20 A, 120 V circuits longer than 75 feet (23 m): 10 AWG, for voltage drop.
        2) 20 A, 120 V circuits longer than 150 feet (46 m): 8 AWG, for voltage drop.
        3) 20 A, 277 V circuits longer than 150 feet (46 m): 10 AWG, for voltage drop.

I. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
2. Color Coding Method: Integrally colored insulation.
3. Color Code:
    a. 480Y/277 V, 3 Phase, 4 Wire System:
        1) Phase A: Brown.
        2) Phase B: Orange.
        3) Phase C: Yellow.
        4) Neutral/Grounded: Gray.
    b. 208Y/120 V, 3 Phase, 4 Wire System:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.
        4) Neutral/Grounded: White.
    c. Equipment Ground, All Systems: Green.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Description: Single conductor insulated wire.

B. Conductor Stranding:
1. Feeders and Branch Circuits:
    a. Size 10 AWG and Smaller: Solid.
    b. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation:
1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
    a. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 METAL-CLAD CABLE

A. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

B. Conductor Stranding:
1. Size 10 AWG and Smaller: Solid.
2. Size 8 AWG and Larger: Stranded.

C. Insulation Voltage Rating: 600 V.

D. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.

E. Grounding: Full-size integral equipment grounding conductor.

F. Armor: Steel, interlocked tape.

2.05 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 260526.

2.06 ACCESSORIES

A. Electrical Tape:
   1. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   2. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil (0.18 mm); resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F (-18 degrees C) and suitable for continuous temperature environment up to 221 degrees F (105 degrees C).
   3. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil (0.76 mm); suitable for continuous temperature environment up to 194 degrees F (90 degrees C) and short-term 266 degrees F (130 degrees C) overload service.
   4. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil (3.2 mm); suitable for continuous temperature environment up to 176 degrees F (80 degrees C).
   5. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil (2.3 mm).

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.

C. Wire Pulling Lubricant:
   1. Listed and labeled as complying with UL 267.
   2. Suitable for use with conductors/cables and associated insulation/jackets to be installed.
   3. Suitable for use at installation temperature.

D. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.

C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.

D. Verify that field measurements are as indicated.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION

A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated without specific routing, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft (3.0 m) of location indicated.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Common Neutrals: Unless otherwise indicated, sharing of neutral/grounded conductors among single phase branch circuits of different phases installed in the same raceway is

not permitted. Provide dedicated neutral/grounded conductor for each individual branch circuit.

B. Install products in accordance with manufacturer's instructions.

C. Perform work in accordance with NECA 1 (general workmanship).

D. Install metal-clad cable (Type MC) in accordance with NECA 120.

E. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.

F. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
   1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.

G. Terminate cables using suitable fittings.
   1. Metal-Clad Cable (Type MC):
      a. Use listed fittings.
      b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

H. Install conductors with a minimum of 12 inches (300 mm) of slack at each device.

I. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

J. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

K. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.

L. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
   3. Wet Locations: Use heat shrink tubing.

M. Insulate ends of spare conductors using vinyl insulating electrical tape.

N. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

O. Identify conductors and cables in accordance with Section 260553.

P. Install firestopping to preserve fire resistance rating of partitions and other elements, using listed materials and methods..

Q. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.

3.04 FIELD QUALITY CONTROL

A. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Grounding and bonding requirements.

B. Conductors for grounding and bonding.

C. Connectors for grounding and bonding.

1.02 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.

B. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 467 - Grounding and Bonding Equipment; Current Edition, Including All Revisions.

1.04 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS

A. Do not use products for applications other than as permitted by NFPA 70 and product listing.

B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.

C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

D. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
   6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled as suitable for the purpose intended.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 260526:
   1. Use insulated copper conductors unless otherwise indicated.

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
   2. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Perform work in accordance with NECA 1 (general workmanship).

C. Make grounding and bonding connections using specified connectors.
   1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
   2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
   3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
   4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

D. Identify grounding and bonding system components in accordance with Section 260553.

END OF SECTION

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS

A. Section 260533.13 - Conduit for Electrical Systems: Additional support and attachment requirements for conduits.

B. Section 260533.16 - Boxes for Electrical Systems: Additional support and attachment requirements for boxes.

C. Section 260548 - Vibration and Seismic Controls for Electrical Systems.

D. Section 265100 - Interior Lighting: Additional support and attachment requirements for interior luminaires.

E. Section 265600 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS

A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.

B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.

C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.

D. MFMA-4 - Metal Framing Standards Publication; 2004.

E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with actual equipment and components to be installed.
   2. Coordinate work to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at installed locations.
   4. Coordinate arrangement of supports with ductwork, piping, equipment and other potential conflicts.
   5. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. NFPA 70.
      b. Requirements of authorities having jurisdiction.
   2. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for complete installation of electrical work.

3. Provide products listed, classified, and labeled as suitable for purpose intended, where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Steel Components: Use corrosion-resistant materials suitable for environment where installed.
    a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Components for Vibration Isolation and/or Seismic Controls: See Section 260548.

C. Conduit and Cable Supports: Straps and clamps suitable for conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
2. Conduit Clamps: Bolted type unless otherwise indicated.

D. Outlet Box Supports: Hangers and brackets suitable for boxes to be supported.

E. Metal Channel/Strut Framing Systems:
1. Description: Factory-fabricated, continuous-slot, metal channel/strut and associated fittings, accessories, and hardware required for field assembly of supports.
2. Comply with MFMA-4.

F. Hanger Rods: Threaded, zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
    a. Outlet Boxes: 1/4-inch (6 mm) diameter.
    b. Luminaires: 1/4-inch (6 mm) diameter.

G. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use anchor and fastener types indicated for specified applications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive support and attachment components.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install hangers and supports in accordance with NECA 1.

C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.

D. Unless specifically indicated or approved by Engineer, do not provide support from suspended ceiling support system or ceiling grid.

E. Do not penetrate or otherwise notch or cut structural members.

F. Equipment Support and Attachment:
1. Use metal, fabricated supports or supports assembled from metal channel/strut to support equipment as required.
2. Use metal channel/strut secured to studs to support equipment surface mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.

3. Use metal channel/strut to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.

G. Box Support and Attachment: See Section 260533.16 for additional requirements.

H. Interior Luminaire Support and Attachment: See Section 265100 for additional requirements.

I. Exterior Luminaire Support and Attachment: See Section 265600 for additional requirements.

J. Secure fasteners in accordance with manufacturer's recommended torque settings.

K. Remove temporary supports.

3.03 FIELD QUALITY CONTROL

A. Inspect support and attachment components for damage and defects.

B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

C. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION

SECTION 260533.13
CONDUIT FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Galvanized steel rigid metal conduit (RMC).

B. Stainless steel rigid metal conduit (RMC).

C. Galvanized steel intermediate metal conduit (IMC).

D. Stainless steel intermediate metal conduit (IMC).

E. Flexible metal conduit (FMC).

F. Galvanized steel electrical metallic tubing (EMT).

G. Stainless steel electrical metallic tubing (EMT).

H. Aluminum electrical metallic tubing (EMT).

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Cable assemblies consisting of conductors protected by integral metal armor.

C. Section 260526 - Grounding and Bonding for Electrical Systems.
   1. Includes additional requirements for fittings for grounding and bonding.

D. Section 260529 - Hangers and Supports for Electrical Systems.

E. Section 260533.16 - Boxes for Electrical Systems.

F. Section 260548 - Vibration and Seismic Controls for Electrical Systems.

G. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC); 2020.

B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S); 2020.

C. ANSI C80.6 - American National Standard for Electrical Intermediate Metal Conduit; 2018.

D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT); 2020.

F. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. UL 1 - Flexible Metal Conduit; Current Edition, Including All Revisions.

I. UL 6 - Electrical Rigid Metal Conduit-Steel; Current Edition, Including All Revisions.

J. UL 6A - Electrical Rigid Metal Conduit-Aluminum, Red Brass, and Stainless Steel; Current Edition, Including All Revisions.

K. UL 514B - Conduit, Tubing, and Cable Fittings; Current Edition, Including All Revisions.

L. UL 797 - Electrical Metallic Tubing-Steel; Current Edition, Including All Revisions.

M. UL 797A - Electrical Metallic Tubing - Aluminum and Stainless Steel; Current Edition, Including All Revisions.

N. UL 1242 - Electrical Intermediate Metal Conduit-Steel; Current Edition, Including All Revisions.

O. UL 2419 - Outline of Investigation for Electrically Conductive Corrosion Resistant Compounds; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate minimum sizes of conduits with actual type and quantity of conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate arrangement of conduits with structural members, ductwork, piping, equipment, and other potential conflicts.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment.
   4. Notify Engineer of conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit between termination points is complete.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70, manufacturer's instructions, and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use conduit types indicated for specified applications. Where more than one listed application applies, comply with most restrictive requirements. Where conduit type for particular application is not specified, use galvanized steel rigid metal conduit.

C. Concealed Above Accessible Ceilings: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

D. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

E. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit (RMC), stainless steel rigid metal conduit (RMC), galvanized steel intermediate metal conduit (IMC), stainless steel intermediate metal conduit (IMC), galvanized steel electrical metallic tubing (EMT), or stainless steel electrical metallic tubing (EMT).

F. Flexible Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit (FMC).
   1. Maximum Length: 6 feet (1.8 m).

2.02 CONDUIT - GENERAL REQUIREMENTS

A. Comply with NFPA 70.

B. Existing Work: Where existing conduits are indicated to be reused, they may be reused only where they comply with specified requirements, are free from corrosion, and integrity is verified by pulling mandrel through them.
   1. Where permitted, existing conduits to be reused may be used as sole equipment grounding conductor only when continuity of conduit pathway, including associated boxes and fittings, is verified; see Section 260526.

C. Fittings for Grounding and Bonding: See Section 260526 for additional requirements.

D. Provide conduit, fittings, supports, and accessories required for complete raceway system.

E. Provide products listed, classified, and labeled as suitable for purpose intended.

F. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 3/4-inch (21 mm) trade size.
   2. Branch Circuit Homeruns: 3/4-inch (21 mm) trade size.
   3. Control Circuits: 1/2-inch (16 mm) trade size.
   4. Flexible Connections to Luminaires: 3/8-inch (12 mm) trade size.

G. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.04 STAINLESS STEEL RIGID METAL CONDUIT (RMC)

A. Description: NFPA 70, Type RMC stainless steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6A.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 6A.
   2. Material: Use stainless steel with corrosion resistance equivalent to conduit.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.05 GALVANIZED STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use threaded type fittings only. Threadless fittings, including set screw and compression/gland types, are not permitted.

2.06 STAINLESS STEEL INTERMEDIATE METAL CONDUIT (IMC)

A. Description: NFPA 70, Type IMC galvanized steel intermediate metal conduit complying with ANSI C80.6 and listed and labeled as complying with UL 1242.

B. Fittings:
   1. Nonhazardous Locations: Use fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B or UL 1242.

2.07 FLEXIBLE METAL CONDUIT (FMC)

A. Description: NFPA 70, Type FMC standard-wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.

2.08 GALVANIZED STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT galvanized steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Material: Use steel or malleable iron.
   3. Connectors and Couplings: Use compression/gland or set-screw type.
      a. Do not use indenter type connectors and couplings.

2.09 STAINLESS STEEL ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT stainless steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797A.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
   2. Connectors and Couplings: Use compression/gland or set-screw type.

2.10 ALUMINUM ELECTRICAL METALLIC TUBING (EMT)

A. Description: NFPA 70, Type EMT aluminum electrical metallic tubing listed and labeled as complying with UL 797A.

B. Fittings:
   1. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B; listed for use with aluminum EMT.
   2. Material: Use aluminum.
   3. Connectors and Couplings: Use compression/gland or set-screw type.
      a. Do not use indenter type connectors and couplings.

2.11 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive compound listed as complying with UL 2419; suitable for use with conduit to be installed.

B. Pull Strings: Use nylon or polyester tape with average breaking strength of not less than 1,250 lbf (5.6 kN).

C. Firestop Sleeves: Listed; provide as required to preserve fire resistance rating of building elements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install conduit in accordance with NECA 1.

C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.

D. Install intermediate metal conduit (IMC) in accordance with NECA 101.

E. Conduit Routing:
   1. Unless dimensioned, conduit routing indicated is diagrammatic.
   2. When conduit destination is indicated without specific routing, determine exact routing required.
   3. Conceal conduits unless specifically indicated to be exposed.
   4. Conduits in the following areas may be exposed, unless otherwise indicated:
      a. Electrical rooms.
      b. Mechanical equipment rooms.
      c. Within joists in areas with no ceiling.
   5. Arrange conduit to maintain adequate headroom, clearances, and access.

6. Arrange conduit to provide no more than equivalent of four 90-degree bends between pull points.
7. Arrange conduit to provide no more than 150 feet (46 m) between pull points.

F. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 using suitable supports and methods approved by authorities having jurisdiction; see Section 260529.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel/strut with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel/strut with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of wire for support of conduits is not permitted.

G. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.
5. Provide insulating bushings, insulated throats, or listed metal fittings with smooth, rounded edges at conduit terminations to protect conductors.
6. Secure joints and connections to provide mechanical strength and electrical continuity.

H. Penetrations:
1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
2. Make penetrations perpendicular to surfaces unless otherwise indicated.
3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
4. Conceal bends for conduit risers emerging above ground.
5. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
6. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty.
7. Install firestopping to preserve fire resistance rating of partitions and other elements.

I. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
2. Where conduits are subject to earth movement by settlement or frost.

J. Conduit Sealing:
1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
   a. Where conduits enter building from outside.
   b. Where service conduits enter building from underground distribution system.

c. Where conduits enter building from underground.
d. Where conduits may transport moisture to contact live parts.

2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
   a. Where conduits pass from outdoors into conditioned interior spaces.
   b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

K. Provide grounding and bonding; see Section 260526.

L. Identify conduits; see Section 260553.

3.02 FIELD QUALITY CONTROL

A. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.

B. Correct deficiencies and replace damaged or defective conduits.

3.03 CLEANING

A. Clean interior of conduits to remove moisture and foreign matter.

3.04 PROTECTION

A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

END OF SECTION

SECTION 260533.16
BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Outlet and device boxes up to 100 cubic inches (1,650 cu cm), including those used as junction and pull boxes.

B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches (1,650 cu cm).

1.02 RELATED REQUIREMENTS

A. Section 083100 - Access Doors and Panels: Panels for maintaining access to concealed boxes.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260533.13 - Conduit for Electrical Systems:
   1. Conduit bodies and other fittings.

E. Section 260548 - Vibration and Seismic Controls for Electrical Systems.

F. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

B. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); 2020.

D. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable; 2014.

E. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports; 2013 (Reaffirmed 2020).

F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations; Current Edition, Including All Revisions.

H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations; Current Edition, Including All Revisions.

I. UL 508A - Industrial Control Panels; Current Edition, Including All Revisions.

J. UL 514A - Metallic Outlet Boxes; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   2. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
   3. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
   4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.05 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 BOXES

A. General Requirements:
   1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
   2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
   3. Provide products listed, classified, and labeled as suitable for the purpose intended.
   4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   5. Provide grounding terminals within boxes where equipment grounding conductors terminate.

B. Outlet and Device Boxes Up to 100 cubic inches (1,650 cu cm), Including Those Used as Junction and Pull Boxes:
   1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
   2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
   3. Use suitable concrete type boxes where flush-mounted in concrete.
   4. Use suitable masonry type boxes where flush-mounted in masonry walls.
   5. Use raised covers suitable for the type of wall construction and device configuration where required.
   6. Use shallow boxes where required by the type of wall construction.
   7. Do not use "through-wall" boxes designed for access from both sides of wall.
   8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
   9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
   10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
   11. Boxes for Ganged Devices: Use multigang boxes of single-piece construction. Do not use field-connected gangable boxes unless specifically indicated or permitted.
   12. Wall Plates: Refer to Lighting Control Equipment Schedule.

C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
   1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
   2. NEMA 250 Environment Type, Unless Otherwise Indicated:
   3. Junction and Pull Boxes Larger Than 100 cubic inches (1,650 cu cm):
      a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that mounting surfaces are ready to receive boxes.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install boxes in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Box Locations:
   1. Locate boxes to be accessible.
   2. Unless dimensioned, box locations indicated are approximate.
   3. Locate boxes so that wall plates do not span different building finishes.
   4. Unless otherwise indicated, where multiple outlet boxes are installed at the same location at different mounting heights, install along a common vertical center line.
   5. Locate junction and pull boxes in the following areas:
      a. Concealed above accessible suspended ceilings.
      b. Within joists in areas with no ceiling.
      c. Electrical rooms.
      d. Mechanical equipment rooms.

E. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 260529 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
   3. Installation Above Suspended Ceilings: Do not provide support from ceiling grid or ceiling support system.

F. Install boxes plumb and level.

G. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch (6 mm) or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch (3 mm) at the edge of the box.

H. Install boxes as required to preserve insulation integrity.

I. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.

J. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 078400.

K. Close unused box openings.

L. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.

M. Provide grounding and bonding in accordance with Section 260526.

N. Identify boxes in accordance with Section 260553.

3.03 CLEANING

A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.04 PROTECTION

A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION

SECTION 260548
VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Seismic control requirements.

B. Seismic restraint systems.

1.02 RELATED REQUIREMENTS

A. Section 260529 - Hangers and Supports for Electrical Systems.

1.03 DEFINITIONS

A. Electrical Component: Where referenced in this section in regards to seismic controls, applies to any portion of the electrical system subject to seismic evaluation in accordance with applicable codes, including distributed systems (e.g., conduit, cable tray).

B. Seismic Restraint: Structural members or assemblies of members or manufactured elements specifically designed and applied for transmitting seismic forces between components and the seismic force-resisting system of the structure.

1.04 REFERENCE STANDARDS

A. ASCE 19 - Structural Applications of Steel Cables for Buildings; 2016.

B. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; Most Recent Edition Cited by Referring Code or Reference Standard.

C. ASTM E580/E580M - Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions; 2022.

D. FEMA 413 - Installing Seismic Restraints for Electrical Equipment; 2004.

E. FEMA E-74 - Reducing the Risks of Nonstructural Earthquake Damage; 2012.

F. MFMA-4 - Metal Framing Standards Publication; 2004.

G. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

H. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

I. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; 2008.

1.05 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate selection and arrangement of vibration isolation and/or seismic control components with the actual equipment to be installed.
   2. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   3. Seismic Controls:
      a. Coordinate the arrangement of seismic restraints with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
      b. Coordinate the work with other trades to accommodate relative positioning of essential and nonessential components in consideration of seismic interaction.
   4. Notify Engineer of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

PART 2 PRODUCTS

2.01 SEISMIC CONTROL REQUIREMENTS

A. Component Importance Factor (Ip): Electrical components to be assigned a component importance factor (Ip) of 1.5 unless otherwise indicated.

B. Component Importance Factor (Ip): Electrical components essential to life safety to be assigned a component importance factor (Ip) of 1.5 as indicated or as required. This includes but is not limited to:
   1. Electrical components required to function for life safety purposes after an earthquake.

C. Seismic Restraints:
   1. Provide seismic restraints for electrical components except where exempt according to applicable codes and specified seismic design criteria, as approved by authorities having jurisdiction.
   2. Seismic Restraint Exemptions:
      a. Conduit, Cable Tray, and Raceway Exemptions, All Seismic Design Categories:
         1) Raceways with component importance factor (Ip) of 1.0 where flexible connections are provided between cable tray or raceway and associated components, where cable tray or raceway is positively attached to the structure, and where one of the following apply:
            (a) Trapeze supported conduits, cable trays, or raceways with trapeze assemblies using 3/8 inch (10 mm) diameter rod hangers not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 100 pounds (445 N) or less.
            (b) Trapeze supported conduits, cable trays, or raceways with trapeze assemblies using 1/2 inch (13 mm) diameter rod hangers not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 200 pounds (890 N) or less.
            (c) Trapeze supported conduits, cable trays, or raceways with trapeze assemblies using 1/2 inch (13 mm) diameter rod hangers not exceeding 24 inches (610 mm) in length from support point connection to the supporting structure, and the total weight supported by any single trapeze is 100 pounds (445 N) or less.
            (d) Hanger supported conduits, cable trays, or raceways with individual rod hangers 3/8 inch (10 mm) or 1/2 inch (13 mm) in diameter not exceeding 12 inches (305 mm) in length from support point connection to the supporting structure, and the total weight supported by any single rod is 50 pounds (220 N) or less.
         2) Conduits less than 2-1/2 inch (64 mm) trade size.
      b. Lighting Exemptions, All Seismic Design Categories:
         1) Suspended luminaires where attachments are designed to accommodate 1.4 times the operating weight acting in both the vertical and horizontal directions and connections to structure allow for 360 degree range of motion in the horizontal plane; arrange to prevent impact between luminaires and the structure or other nonstructural components.
         2) Lay-in luminaires weighing less than 56 pounds (25 kg) secured to ceiling grid and provided with safety wires in accordance with ASTM E580/E580M.
   3. Comply with applicable general recommendations of the following, where not in conflict with applicable codes, seismic design criteria, or other specified requirements:
      a. ASHRAE (HVACA).
      b. FEMA 413.
      c. FEMA E-74.
      d. SMACNA (SRM).

4. Seismic restraint capacities to be verified by a Nationally Recognized Testing Laboratory (NRTL) or certified by an independent third-party registered professional engineer acceptable to authorities having jurisdiction.
5. Seismic Restraint Systems:
    a. Except where otherwise restricted, use of either cable or rigid restraints is permitted.
    b. Use only cable restraints to restrain vibration-isolated electrical components, including distributed systems.
    c. Use only one restraint system type for a given electrical component or distributed system (e.g., conduit, cable tray) run; mixing of cable and rigid restraints on a given component/run is not permitted.
    d. Size restraint elements, including anchorage, to resist seismic loads as necessary to restrain electrical component in all lateral directions; consider bracket geometry in anchor load calculations.
    e. Use rod stiffener clips to attach bracing to hanger rods as required to prevent rod buckling from vertical (upward) compressive load introduced by cable or rigid restraints loaded in tension, in excess of downward tensile load due to supported electrical component weight.
    f. Select hanger rods and associated anchorage as required to accommodate vertical (downward) tensile load introduced by rigid restraints loaded in compression, in addition to downward tensile load due to supported electrical component weight.
    g. Clevis hangers may only be used for attachment of transverse restraints; do not use for attachment of longitudinal restraints.
    h. Where seismic restraints are attached to clevis hangers, provide clevis bolt reinforcement accessory to prevent clevis hanger deformation.
    i. Do not introduce lateral loads on open bar joist chords or the weak axis of beams, or loads in any direction at other than panel points unless approved by project Structural Engineer of Record.

D. Seismic Attachments:
1. Attachments to be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity.
2. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) or qualified evaluation service acceptable to authorities having jurisdiction for compliance with applicable building code, and qualified for seismic applications; concrete anchors to be qualified for installation in both cracked and uncracked concrete.
3. Do not use power-actuated fasteners.
4. Do not use friction clips (devices that rely on mechanically applied friction to resist loads). Beam clamps may be used for supporting sustained loads where provided with restraining straps.
5. Comply with anchor minimum embedment, minimum spacing, minimum member thickness, and minimum edge distance requirements.

2.02 SEISMIC RESTRAINT SYSTEMS

A. Description: System components and accessories specifically designed for field assembly and attachment of seismic restraints.

B. Cable Restraints:
1. Comply with ASCE 19.
2. Cables: Pre-stretched, galvanized steel wire rope with certified break strength.
3. Cable Connections: Use only swaged end fittings. Cable clips and wedge type end fittings are not permitted in accordance with ASCE 19.
4. Use protective thimbles for cable loops where potential for cable damage exists.

C. Rigid Restraints: Use MFMA-4 steel channel (strut), steel angle, or steel pipe for structural element; suitable for both compressive and tensile design loads.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that mounting surfaces are ready to receive vibration isolation and/or seismic control components and associated attachments.

C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install products in accordance with applicable requirements of NECA 1 (general workmanship).

C. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.

D. Secure fasteners according to manufacturer's recommended torque settings.

E. Install flexible conduit and cable connections to provide sufficient slack for vibration isolation and/or seismic relative displacements as indicated or as required.

F. Seismic Controls:
   1. Use only specified components, anchorage, and hardware evaluated by seismic design. Comply with conditions of seismic certification where applicable.
   2. Where mounting hole diameter exceeds bolt diameter by more than 0.125 inch (3 mm), use epoxy grout, elastomeric grommet, or welded washer to reduce clearance to 0.125 inch (3 mm) or less.
   3. Equipment with Sheet Metal Housings:
      a. Use Belleville washers to distribute stress over a larger surface area of the sheet metal connection interface as approved by manufacturer.
      b. Attach additional steel as approved by manufacturer where required to transfer loads to structure.
      c. Where mounting surface is irregular, do not shim housing; reinforce housing with additional steel as approved by manufacturer.
   4. Seismic Restraint Systems:
      a. Do not attach seismic restraints and gravity supports to dissimilar parts of structure that may move differently during an earthquake.
      b. Install restraints within permissible angles in accordance with seismic design.
      c. Install cable restraints straight between component/run and structural attachment; do not bend around other nonstructural components or structural elements.
      d. Install cable restraints for vibration-isolated components slightly slack to prevent short-circuiting of isolation.
      e. Install hanger rod stiffeners where indicated using only specified clamps; do not weld stiffeners to hanger rod.

3.03 FIELD QUALITY CONTROL

A. Inspect vibration isolation and/or seismic control components for damage and defects.

B. Correct deficiencies and replace damaged or defective vibration isolation and/or seismic control components.

END OF SECTION

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Electrical identification requirements.

B. Identification nameplates and labels.

C. Wire and cable markers.

D. Voltage markers.

1.02 RELATED REQUIREMENTS

A. Section 260519 - Low-Voltage Electrical Power Conductors and Cables: Color coding for power conductors and cables 600 V and less; vinyl color coding electrical tape.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.

B. Sequencing:
   1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.
   2. Do not install identification products until final surface finishes and painting are complete.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS

A. Existing Work: Unless specifically excluded, identify existing elements to remain that are not already identified in accordance with specified requirements.

B. Identification for Conductors and Cables:
   1. Color Coding for Power Conductors 600 V and Less: Comply with Section 260519.
   2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

C. Identification for Raceways:
   1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet (6.1 m).
   2. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.

D. Identification for Boxes:
   1. Use voltage markers to identify highest voltage present.
   2. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.

E. Identification for Devices:
   1. Use identification label or engraved wallplate to identify serving branch circuit for all lighting control devices.

2.02 IDENTIFICATION NAMEPLATES AND LABELS

A. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.

2.03 VOLTAGE MARKERS

A. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.

B. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.

C. Minimum Size:
   1. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
   2. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches (29 by 110 mm).
   3. Markers for Junction Boxes: 1/2 by 2 1/4 inches (13 by 57 mm).

D. Legend:
   1. Markers for Voltage Identification: Highest voltage present.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   1. Surface-Mounted Equipment: Enclosure front.
   2. Flush-Mounted Equipment: Inside of equipment door.
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
   5. Interior Components: Legible from the point of access.
   6. Conduits: Legible from the floor.
   7. Boxes: Outside face of cover.
   8. Conductors and Cables: Legible from the point of access.
   9. Devices: Outside face of cover.

C. Install identification products centered, level, and parallel with lines of item being identified.

D. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

E. Mark all handwritten text, where permitted, to be neat and legible.

END OF SECTION

SECTION 260924
LIGHTING CONTROLS - LUTRON VIVE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Single space wireless lighting control systems and associated components:
   1. Wired load control modules with wireless communication inputs.

B. Wireless hub(s) for centralized control, monitoring, and system integration.

C. Software data and analytics dashboard, including server requirements.

1.02 RELATED REQUIREMENTS

A. Section 260553 - Identification for Electrical Systems: Identification products and requirements.

1.03 REFERENCE STANDARDS

A. 47 CFR 15 - Radio Frequency Devices; current edition.

B. ASTM D4674 - Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments; 2019.

C. IEC 60929 - AC and/or DC-Supplied Electronic Control Gear for Tubular Fluorescent Lamps - Performance Requirements; 2011, with Amendment (2015).

D. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test; 2008.

E. ISO 9001 - Quality Management Systems — Requirements; 2015.

F. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

G. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2016.

H. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2020.

I. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2020).

J. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

K. UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
   1. Occupancy/Vacancy Sensors: Include detailed basic motion detection coverage range diagrams.

B. Project Record Documents: Record actual installed locations and settings for lighting control system components.

C. Operation and Maintenance Data: Include detailed information on lighting control system operation, equipment programming and setup, replacement parts, and recommended maintenance procedures and intervals.

D. Warranty: Submit sample of manufacturer's Warranty or Enhanced Warranty as specified in Part 1 under "WARRANTY". Submit documentation of final executed warranty completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

C. Manufacturer Qualifications:
   1. Company with not less than ten years of experience manufacturing lighting control products using wireless communication between devices.
   2. Registered to ISO 9001, including in-house engineering for product design activities.
   3. Provides factory direct technical support hotline available 24 hours per day, 7 days per week.
   4. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.
   1. Basis of Design System Requirements - Lutron, Unless Otherwise Indicated:
      a. Ambient Temperature:
         1) Lighting Control System Components, Except Fluorescent Electronic Dimming Ballasts: Between 32 and 104 degrees F (0 and 40 degrees C).
      b. Relative Humidity: Less than 90 percent, non-condensing.
      c. Protect lighting controls from dust.

1.09 WARRANTY

A. Manufacturer's Standard Warranty, With Manufacturer Full-Scope Start-Up; Lutron Standard 2-Year Warranty; Lutron LSC-B2:
   1. Manufacturer Lighting Control System Components, Except Lighting Management System Computer, Ballasts/Drivers and Ballast Modules:
      a. First Two Years:
         1) 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a lighting issue.
         2) First-available on-site or remote response time.
         3) Remote diagnostics for applicable systems.
      b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer: Lutron Electronics Company, Inc; Vive; www.lutron.com/#sle.

2.02 LIGHTING CONTROLS - GENERAL REQUIREMENTS

A. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.

B. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, programming, etc. as necessary for a complete operating system that provides the control intent indicated.

C. Design lighting control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C) and 90 percent non-condensing relative humidity.

D. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.

E. Power Failure Recovery: When power is interrupted for periods up to 10 years and subsequently restored, lights to automatically return to same levels (dimmed setting, full on, or full off) as prior to power interruption.

F. Wireless Devices:
   1. Wireless device family includes area or fixture level sensors, area or fixture level load controls for dimming or switching, and load controls that can be mounted in a wallbox, on a junction box, or at the fixture.
   2. Wireless devices including sensors, load controls, and wireless remotes or wall stations, can be set up using simple button press programming without needing any other equipment (e.g. central hub, processor, computer, or other smart device).
   3. Wireless hub adds the ability to set up the system using any smart device with a web browser (e.g. smartphone, tablet, PC, or laptop).
   4. System does not require a factory technician to set up or program the system.
   5. Capable of diagnosing system communications.
   6. Capable of having addresses automatically assigned to them.
   7. Receives signals from other wireless devices and provides feedback to user.
   8. Capable of determining which devices have been addressed.
   9. RF Range: 60 feet (18 m) line-of-sight or 30 feet (9 m) through typical construction materials between RF transmitting devices and compatible RF receiving devices.
   10. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.

G. Wireless Network:
   1. RF Frequency: 434 MHz; operate in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.
      a. Wireless sensors, wireless wall stations and wireless load control devices do not operate in the noisy 2.4 GHz frequency band where high potential for RF interference exists.
      b. Wireless devices operate in an uncongested frequency band providing reliable operation.
      c. Fixed network architecture ensures all associated lights and load controls respond in a simultaneous and coordinated fashion from a button press, sensor signal, or command from the wireless hub (i.e. no popcorning).
   2. Distributed Architecture: Local room devices communicate directly with each other. If the wireless hub is removed or damaged, local control, sensing, and operation continues to function without interruption.
   3. Local room devices communicate directly with each other (and not through a central hub or processor) to ensure:
      a. Reliability of system performance.
      b. Fast response time to events in the space (e.g. button presses or sensor signals).
      c. Independent operation in the event of the wireless hub being removed or damaged.

H. Device Finishes:
   1. Standard Colors: Comply with NEMA WD 1 where applicable.
   2. Color Variation in Same Product Family: Maximum delta E of 1, CIE L*a*b color units.
   3. Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

2.03 LOAD CONTROL MODULES

A. Provide wireless load control modules as indicated or as required to control the loads as indicated.

B. Junction Box-Mounted Modules:
   1. Plenum rated.
   2. 0-10 V Dimming Modules:
      a. Product(s):

1) 8 A dimming module with 0-10V control, without emergency mode; Lutron PowPak Dimming Module Model RMJS-8T-DV-B.

b. Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.

c. Single low voltage dimming module with Class 1 or Class 2 isolated 0-10V output signal conforming to IEC 60929 Annex E.2; source or sink automatically configures.

d. Selectable minimum light level.

e. Configurable high- and low-end trim.

f. Relay: Rated for 0-10 V ballasts, LED drivers, or fixtures that conform with NEMA 410.

3. Relay Modules:

a. Product(s):

1) 16 A relay module, without emergency mode, without contact closure output; Lutron PowPak Relay Module Model RMJS-16R-DV-B.

b. Communicates via radio frequency with up to ten compatible occupancy/vacancy sensors, ten wireless control stations, and one daylight sensor.

c. Relay:

1) Rated Life of Relay: Typical of 1,000,000 cycles at fully rated 16 A for all lighting loads.

2) Load switched in manner that prevents arcing at mechanical contacts when power is applied to and removed from load circuits.

3) Fully rated output continuous duty for inductive, capacitive, and resistive loads.

2.04 WIRELESS HUBS

A. Product(s):

1. Wireless hub without BACnet; Lutron Vive Hub.

a. Surface-mount wireless hub; Model HJS-1-SM; as indicated on drawings, supports up to 700 total paired devices.

B. Integrated multicolor LED provides feedback on what mode the hub is in for simple identification and diagnosis.

C. Integrated processor and web server allows hub to set up and operate the system without any external connections to outside processors, servers, or the internet.

D. Utilizes Ethernet connection for:

1. Networking up to 64 hubs together to create a larger system.

2. Remote connectivity capabilities, including maintaining system date/time and receiving periodic firmware updates (requires internet connection).

E. A single hub or network of hubs can operate on either a dedicated lighting control only network or can be integrated with an existing building network as a VLAN.

F. Communicates directly to compatible Lutron Vive RF devices through use of Lutron Clear Connect radio frequency communications link; does not require communication wiring; RF range of 71 feet (23 m) through walls to cover an area of 15836 square feet (1471 sq m) (device and hub must be on the same floor).

G. Communicates directly to mobile device (smartphone or tablet) or computer using built-in Wi-Fi. 2.4 GHz 802.11b/g; wireless range of 71 feet (23 m) through walls (device and hub must be on the same floor).

1. Does not require Wi-Fi router for connecting to the hub.

H. Allows for system setup, control, and monitoring from mobile device or computer using Vive web-based software:

1. Supports paired devices up to maximum number indicated including compatible wireless sensors, wireless control stations, and wireless load devices.

2. Allows for timeclock scheduling of events, both time of day and astronomic (sunrise and sunset).

a. Timeclock is integrated into the unit and does not require a constant internet connection.

b. Retains time and programming information after a power loss.
c. 365-day schedulable timeclock allows for:
1) Scheduling of events years in advance.
2) Setting of recurring events with exceptions on holidays.
d. Timeclock events can be scheduled to:
1) Send lights to a desired level and select the fade rate desired to reach that level.
2) Adjust level lights go to when occupied.
3) Adjust level lights go to when unoccupied.
4) Enable/disable occupancy.

3. Allows for control, monitoring, and adjustment from anywhere in the world (Lutron Vive wireless hub internet connection required).
4. Uses RF signal strength detection to find nearby devices for quick association and programming without having to climb ladders.
a. Association and setup does not require a factory technician to perform.
5. System using Lutron Vive wireless hub(s) can operate with or without connection to the internet.
6. Supports energy reporting.
a. Reports measured energy data for PowPak fixture control modules at accuracy of plus/minus 2 percent or 0.5 W (whichever is higher).
b. Reports calculated energy data for PowPak junction box mounted modules at accuracy of 10 percent.
7. Supports automatic demand response for load shedding via:
a. Local contact closure without need for separate interface.
b. OpenADR® 2.0b compliant utility command.
8. Support automatic generation of alerts in Lutron Vive web-based application for designated events/triggers, including:
a. Low-battery condition in battery-operated sensors and controls; alert cleared when battery is replaced.
b. Missing device (e.g., control or sensor); alert cleared when device is detected.
9. Wireless hub can be firmware upgraded to provide new software features and system updates.
a. Firmware update can be done either locally using a wired Ethernet connection or Wi-Fi connection, or remotely if the wireless hub is connected to the internet.

I. Lutron Vive Web-Based Application:
1. Accessibility and Platform Support:
a. Web-based; runs on most HTML5 compatible browsers (including Safari and Chrome).
b. Supports multiple platforms and devices; runs from a tablet, desktop, laptop, or smartphone.
c. User interface supports multi-touch gestures such as pinch to zoom, drag to pan, etc.
d. Utilizes HTTPS (industry-standard certificate-based encryption and authentication for security).
e. Multi-level Password Protected Access: Individual password protection on both the integrated Wi-Fi network and web-based software.
f. WPA2 security for Wi-Fi communication with wireless hub.
2. System Navigation and Status Reporting:
a. Area Tree View: Easy navigation by area name to view status and make programming adjustments through the software.
b. Area and device names can be changed in real time.
3. Setup app available for iOS and Android that allows for:
a. Job registration to extend product warranty.
b. Management of setup for multiple projects in different locations.
c. Creation of handoff documents that are sent directly to a facility manager via email once setup is complete.
d. Backup of Vive wireless hub database to Lutron cloud for hub replacement.

e. Access to native help and instructions to assist user with Vive system setup.

J. Scenes:
1. Support programmable scenes to control individual devices, areas, or groups of areas on demand.
2. Scenes may be activated via:
a. Contact closure input.
b. API integration.
c. Manual activation in app.

K. Contact Closure Interface: Provide two contact closure inputs; accepts both momentary and maintained contact closures that can be used for automatic demand response.

L. Rated for use in air-handling spaces as defined in UL 2043.

M. Provide Ethernet switch(es) as required for inter-hub network wiring per manufacturer's instructions; do not exceed manufacturer's required maximum wiring segment lengths.

2.05 SOURCE QUALITY CONTROL

A. Factory Testing; Lutron Standard Factory Testing:
1. Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.
2. Perform factory burn-in of 100 percent of all ballasts at 104 degrees F (40 degrees C).

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that ratings and configurations of system components are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive system components.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.

B. Install products in accordance with manufacturer's instructions.

C. Identify system components in accordance with Section 260553.

3.03 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements, for additional requirements.

B. Manufacturer's Full-Scope Start-Up Service: Provide manufacturer's On-Site Full-Scope Start-Up Service.
1. On-Site Full-Scope Start-Up Service; Lutron LSC-OS-SU-VIVE: Manufacturer's authorized Service Representative to conduct site visit upon completion of lighting control system installation to perform system start-up and verify proper operation:
a. Verify connection of power wiring and load circuits.
b. Verify connection and location of controls.
c. Energize wireless hubs.
d. Associate occupancy/vacancy sensors, daylight sensors, wireless remotes, and wall stations to load control devices.
e. Provide initial rough calibration of sensors; fine-tuning of sensors is responsibility of Contractor unless provided by Lighting Control Manufacturer as part of Sensor Layout and Tuning service where specified in Part 2 under "LIGHTING CONTROLS - GENERAL REQUIREMENTS".
f. Program timeclock schedules per approved sequence of operations.
g. Configure load shed parameters per approved sequence of operations.
h. Verify system operation control by control.

i. Obtain sign-off on system functions.
j. Train Owner's representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".

C. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

3.04 CLEANING

A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.05 CLOSEOUT ACTIVITIES

A. Demonstration:
1. Demonstrate proper operation of lighting control devices to Engineer, and correct deficiencies or make adjustments as directed.

B. Training:
1. Include services of manufacturer's certified service representative to perform on-site training of Owner's personnel on operation, adjustment, and maintenance of lighting control system as part of on-site system start-up services.

END OF SECTION

SECTION 265600
EXTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Exterior luminaires.

B. Poles and accessories.

1.02 RELATED REQUIREMENTS

A. Section 033000 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.

B. Section 260526 - Grounding and Bonding for Electrical Systems.

C. Section 260529 - Hangers and Supports for Electrical Systems.

D. Section 260923 - Lighting Control Devices.

1.03 REFERENCE STANDARDS

A. IES LM-80 - Approved Method: Measuring Maintenance of Light Output Characteristics of Solid-State Light Sources; 2021.

B. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.

C. NECA/IESNA 501 - Standard for Installing Exterior Lighting Systems; 2000 (Reaffirmed 2006).

D. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. UL 1598 - Luminaires; Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
   2. Notify Engineer of any conflicts or deviations from Contract Documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
   2. Luminaires & poles are MSU

B. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.

C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

D. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

E. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.06 QUALITY ASSURANCE

A. Comply with requirements of NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.

B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 WARRANTY

A. Provide 5-year manufacturer warranty for all LED luminaires, including drivers.

PART 2 PRODUCTS

2.01 LUMINAIRE TYPES

A. Furnish products as indicated in luminaire schedule included on the drawings.

2.02 LUMINAIRES

A. Provide products that comply with requirements of NFPA 70.

B. Provide products that are listed and labeled as complying with UL 1598, where applicable.

C. Provide products listed, classified, and labeled as suitable for the purpose intended.

D. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.

F. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

G. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.

2.03 POLES

A. Manufacturers:
   1. Ameron, as

B. All Poles:
   1. Provide poles and associated support components suitable for the luminaire(s) and associated supports and accessories to be installed.
   2. Unless otherwise indicated, provide with the following features/accessories:
      a. Pole-top tenon, sized to match luminaire slip fitter.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.

C. Verify that suitable support frames are installed where required.

D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.

E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION

A. Clean dirt, debris, plaster, and other foreign materials from existing pole tops.

3.03 INSTALLATION

A. Perform work in accordance with NECA 1 (general workmanship).

B. Install products in accordance with manufacturer's instructions.

C. Install luminaires in accordance with NECA/IESNA 501.

D. Provide required support and attachment in accordance with Section 260529.

E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

F. Pole-Mounted Luminaires:
   1. Foundation-Mounted Poles:
      a. Provide cast-in-place concrete foundations for poles as indicated, in accordance with Section 033000.
         1) Install anchor bolts plumb per template furnished by pole manufacturer.
         2) Position conduits to enter pole shaft.
      b. Install foundations plumb.
      c. Install poles plumb, using leveling nuts or shims as required to adjust to plumb.
      d. Tighten anchor bolt nuts to manufacturer's recommended torque.
      e. Install non-shrink grout between pole anchor base and concrete foundation, leaving small channel for condensation drainage.
      f. Install anchor base covers or anchor bolt covers as indicated.
   2. Embedded Poles: Install poles plumb as indicated.
   3. Grounding:
      a. Bond luminaires, metal accessories, metal poles, and foundation reinforcement to branch circuit equipment grounding conductor.

G. Install accessories furnished with each luminaire.

H. Bond products and metal accessories to branch circuit equipment grounding conductor.

3.04 FIELD QUALITY CONTROL

A. Inspect each product for damage and defects.

B. Operate each luminaire after installation and connection to verify proper operation.

C. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Engineer.

3.05 CLEANING

A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.06 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION