

Article 10 Construction Specifications

Table of Contents

I.	General	10-1
A.	Permits	10-1
B.	Standard Details	10-1
C.	Transportation Control and Maintenance	10-1
D.	Safety, Security, and Protection of Property	10-4
E.	Work Restrictions and Site Access and Control	10-5
F.	General Conditions	10-8
G.	Project Clean-up and Restoration	10-10
H.	Digital Audio-Visual Coverage	10-11
I.	Project Supervision	10-13
J.	Exploratory Excavation	10-16
K.	Hand Dig or Hydro Excavation	10-18
L.	Work in Railroad Right-of-Way	10-18
M.	Required Submittals and Resubmittals	10-19
II.	Utilities	10-20
A.	Work Required of Contractor - General	10-20
B.	Materials	10-20
C.	Excavation - General	10-21
D.	Trenching	10-23
E.	Trench Dewatering	10-24
F.	Crossing Existing Structures & Facilities	10-26
G.	Pipe Undercut	10-27
H.	Pipe Bedding	10-27
I.	Pipe Backfill	10-28
J.	Laying Pipe - General	10-28
K.	Installation of Water Main	10-30
L.	Water Main Testing	10-32

M.	Tapping Existing Water Mains	10-37
N.	Water Main Directional Drilling	10-39
O.	Temporary Water Main Line Stops.....	10-41
P.	Installation of Storm Sewer	10-45
Q.	Curb Drain Installation.....	10-47
R.	Installation of Sanitary Sewers	10-48
S.	Manholes, Drainage Structures, and Gate Wells	10-51
T.	Reconstruct Structures	10-53
U.	Structure Adjustment.....	10-54
V.	Drainage Structure Covers.....	10-55
W.	Testing Sanitary Sewer	10-56
X.	Cleaning and Televising Sewer	10-59
Y.	Sewer Flow Control	10-66
Z.	Sewer Main and Service Lead Repairs	10-71
AA.	Abandonment and Removal of Sewers and Drainage Structures	10-71
BB.	Abandoning and Removal of Water Main and Appurtenances	10-72
CC.	Removal and Disposal of Contaminated Soil	10-74
DD.	CIPP Sewer Lining	10-77
EE.	Sanitary Manhole Rehabilitation	10-88
III.	Street Construction and Repair	10-103
A.	General.....	10-103
B.	Maintaining Traffic and Site Control.....	10-104
C.	Temporary Pedestrian Facilities	10-104
D.	Temporary No Parking Signs.....	10-108
E.	Pavement Removal	10-109
F.	Subbase and Base Removal and Replacement	10-113
G.	Underdrain Installation	10-114
H.	Subgrade, Subbase, and Base Construction	10-115
I.	Concrete Curb & Gutter, Sidewalk, and Drive Construction	10-123

J.	Bituminous Pavement Construction	10-127
K.	Bituminous Finish Wedging	10-129
L.	Concrete Pavement Construction	10-130
M.	Patching.....	10-132
N.	Pavement Markings.....	10-135
O.	Brick Unit Paving	10-138
P.	Micro-Surfacing.....	10-143
Q.	Chip Seal.....	10-143
IV.	Streetlights and Signals	10-145
A.	General.....	10-145
B.	Foundation	10-147
C.	Poles.....	10-147
D.	Service Disconnect	10-149
E.	Handholes	10-149
F.	Conduit and Wiring	10-150
G.	Conduit Directional Drilling	10-153
H.	Grounding	10-153
I.	Street Light Fixture - Luminaire	10-155
J.	Rectangular Rapid Flashing Beacon Assembly.....	156
V.	Soil Erosion and Sedimentation Control	10-160
A.	General.....	10-160
B.	Mulch Blankets.....	10-161
C.	Mud Mats.....	10-161
D.	Check Dams.....	10-161
E.	Riprap.....	10-161
F.	Gabions	10-162
G.	Dewatering Filters	10-163
VI.	Landscaping and Restoration	10-164
A.	Plant Materials and Layout.....	10-164

B.	Turf Establishment	10-164
C.	Tree Removal	10-169
D.	Tree Planting	10-169
E.	Plugs, Shrubs and Live Stakes Planting	10-171
F.	Rain Garden and Bioswale Planting	10-172
G.	Acceptance and Warranty	10-172
H.	Landscape Maintenance and Guarantee (for Projects with this requirement).....	10-173
I.	Protecting and Preserving Irrigation Systems.....	10-179
J.	Underground Sprinkling Systems, Restore	10-180
K.	Chain Link Fencing.....	10-181
L.	Removal of Fence	10-183
M.	Protective Fence and Tree Protection	10-183

I. General

A. Permits

1. Prior to the start of construction, the Contractor shall obtain all necessary permits as set forth in Article 1 (General), Section VIII (Permits) of these Standards.
2. For City Projects, fees for permits will be paid by the capital project for “Right-of-Way,” “Grading,” “Street Tree,” and “Traffic Control” permits.

B. Standard Details

1. Construction shall conform to Article 12 (Standard Details) of these Standards. Such Details shall, for purposes of this Article, be referred to hereafter as Standard Details.

C. Transportation Control and Maintenance

1. All work shall conform to, and all permitted road closure notifications be issued, in accordance with Article 1 (General), Section XX (Transportation Control and Access), of these Standards.
2. The Contractor shall furnish, erect, maintain, and upon completion of the work, remove all traffic control devices within the project and around the perimeter of the project for the safety and protection of all traffic regardless of travel mode. This includes, but is not limited to: temporary advance, regulatory, and warning signs for vehicular traffic, bicycle traffic, and pedestrians; traffic regulator control; barricades, barrels, cones, and channelizing devices at intersections, streets, sidewalks, trails, and pathways; temporary signals and warning devices; arrow boards; temporary pavement markings; and moving traffic control devices for construction operations. Pedestrian channelizing devices shall be ADA/PROWAG compliant.
3. All traffic control devices shall be in place prior to beginning the work.
4. Traffic shall be maintained in accordance with Sections 104 (Control of the Work), 812 (Temporary Traffic Control for Construction Zone Operations), and 922 (Temporary Traffic Control Materials), of MDOT Specifications, and in accordance with the MMUTCD, NACTO, PROWAG, ABA and City Plans and Specifications

including Figures 1 and 2 Maintenance of Traffic Flow Charts for Pedestrians and Bicyclists provided in Article 1 (General), Section XX (Transportation Control and Access), Subsection B. 2, of these Standards.

5. When lane closures or lane shifts are in place the Contractor shall completely cover all conflicting warning, regulatory and guide signs in accordance with MDOT Specifications, Subsection 812.03.D.2 (Sign Covers), and all applicable details therein.
6. When lane closures or lane shifts are in place the Contractor shall remove or completely cover all conflicting pavement markings and install temporary pavement markings in accordance with the approved MOT plan.
7. The Contractor shall place temporary pavement markings, as directed by the PSAA, and in accordance with the requirements of the MMUTCD and the Plans, when the final pavement markings are not placed prior to opening to traffic. These markings shall be removed prior to the installation of the final pavement markings.
8. All temporary traffic control devices furnished by the Contractor shall remain the property of the Contractor. The City shall not be responsible for stolen or damaged signs, barricades, barricade lights, or other traffic maintenance items. The Contractor shall replace missing traffic control devices within 24 hours of notification.
9. The Contractor shall maintain traffic such that no driver, cyclist, or pedestrian shall be able to enter active work zones or staging areas.
10. The Contractor shall maintain access for emergency vehicles at all times in accordance with Plans and Specifications.
11. Where the Contract Documents identify certain areas within the construction limits, such as sidewalks, drives, buildings, and trails that must be kept open for the public or the City's use during construction, the Contractor shall be responsible for protection and maintenance of these areas as well.
12. The City will provide, install, control and relocate temporary signals on span wires or mast arms and poles as required for the various phases as indicated on the Plans or as otherwise required. The Contractor shall coordinate their work with Detroit Edison and City of Ann Arbor Signs and Signals.

13. To coordinate such signal modifications, the Contractor shall notify City of Ann Arbor Signs and Signals at least 5 working days (Monday - Friday) in advance of when the signal modifications will need to be completed.
14. It is the responsibility of the Contractor to ensure that City of Ann Arbor Signs and Signals is scheduled, kept apprised of the progress of construction, and notified within 4 working hours prior to altering the traffic control.
15. No additional or extra compensation will be paid for any delays caused by City of Ann Arbor Signs and Signals.
16. The Contractor will remove and store warning, regulatory and guide signs in conflict with construction. After construction is complete, but before opening any roadway to traffic, City of Ann Arbor Signs and Signals will reinstall all signs in their proper, permanent location.
17. To coordinate sign installation, the Contractor shall notify City of Ann Arbor Signs and Signals at least 5 working days (Monday-Friday) in advance of when the sign work will need to be completed.
18. It is the responsibility of the Contractor to ensure that City of Ann Arbor Signs and Signals is scheduled, kept apprised of the progress of construction, and notified a second time 24 working hours prior to the need to complete the sign work.
19. It is the responsibility of the Contractor to provide Traffic Regulator Control, as directed by the PSAA. Flag Persons performing this work must have adequate professional experience and safety training to perform the work of directing and managing the movement of pedestrians, vehicles, and other sidewalk and street users in a manner that protects the safety of all those present on the job site.
20. As necessary during construction, the Contractor shall be responsible for logging the legend and location of any signs not shown on the Plans that:
 - a) Must be removed to facilitate the construction process;
 - b) Are to be permanently removed; or,
 - c) Are to be permanently relocated.

D. Safety, Security, and Protection of Property

1. The Contractor shall carry out their operations and secure the site in strict accordance with the requirements of MDOT Specifications, Subsection 104.07 (Contractor Obligations) and all pertinent regulatory agencies, including, but not limited to OSHA, MIOSHA, ADA/PROWAG, and all applicable manufacturer's safety requirements.
2. The Contractor shall perform all work in accordance with the Construction Safety Standards as adopted by the Michigan Department of Labor Construction Safety Standards for Occupational Health adopted by reference and cross referenced under authority of Sections 19 and 21, Act No. 154 of the Public Act of 1974, as amended, being 408.1021 of the Michigan Compiled Laws.
3. Prior to beginning any work, the Contractor shall submit a proposed Safety Plan to the PSAA detailing their safety plan and procedures and identifying all competent persons. The plan shall include a description of a daily safety program for the job site, Contractor's safety program for confined space entry in accordance with current OSHA and MIOSHA requirements, and all emergency procedures to be implemented in the event of a safety incident. All work shall be performed in accordance with the Contractor's submitted Safety Plan.
4. The Contractor shall designate a qualified and experienced safety representative at the site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs. The Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the work.
5. The Contractor, including subcontractors, shall comply with all applicable laws and regulations and the City's safety programs, if any, relating to safety.
6. Prior to entry into any confined space, the Contractor shall submit to the PSAA a copy of their "daily" entry permit in accordance with current OSHA and MIOSHA requirements.
7. During non-working hours, the Contractor shall properly secure any open trench, excavation, or structures with protective fencing and temporary cover(s). Temporary covers over excavations or chambers shall be capable of withstanding the weight of a human and other wildlife such as deer.

8. Damages to property by Contractor shall be governed by Article 1 (General), Section XXIV (Protection of Property and Safety), Subsection B (Damages by Contractor) of these Standards.

E. Work Restrictions and Site Access and Control

1. Hours of work shall be as stated in the [City Code, Title IX \(Police Regulations\), Chapter 119 \(Noise Control\), Article I \(Non-Vehicular Noise\), Sec. 9.363\(5\)](#), Monday through Saturday, between the hours of 7:00 a.m. and 8:00 p.m.
2. Per [City Code, Title IX \(Police Regulations\), Chapter 119 \(Noise Control\), Article I \(Non-Vehicular Noise\), Sec. 9.364](#) through Sec.9.367, all noise generated by construction activities shall not exceed the specified decibel limits for areas beyond the property line of the property on which the work is being conducted. The Contractor shall provide screening, noise absorption, and Level II sound attenuation as required on equipment to meet the noise limitations set therein. Any "off-hour" work will require a temporary exemption from the City of Ann Arbor City Administrator and any other affected entities (U-Mas applicable). A temporary exemption may be granted in accordance with each respective entities' code of ordinance.
3. Work shall be conducted in accordance with Article 1 (General), Sections XVII (Working Conditions and Good Will), and Section XVIII (Work in Right-of Way: General) of these Standards.
4. Under special circumstances the Contractor may perform work at night or on Sundays if there is an emergency or special need and the work is approved by the PSAA. All non-emergency requests to work during off hours shall be included in the Contractor's progress schedule and submitted to the PSAA for approval a minimum of 5 working days prior to beginning the work.
 - a) Where paving and/or underground utility work at night is required and approved in advance by the PSAA, the night work shall be lighted to an average intensity of 10 foot-candles minimum. Sufficient light sources shall be provided to achieve this illumination requirement. The lighting shall allow the inspector to clearly see and inspect all work and operations. Lighting systems may be fixed, portable, or equipment mounted. A power source shall be supplied with sufficient capacity to operate the lighting system. The PSAA shall suspend all night work except for traffic control if lighting is inadequate on any nighttime work operation.

- b) All floodlighting shall conform to the current edition of the MMUTCD. In no case shall floodlighting be permitted to glare, shine, or be directed into the eyes of oncoming drivers. The adequacy of flood light placement and elimination of potential glare can best be determined by driving through and observing the floodlight area from each direction on the main roadway after initial floodlight setup.
- 5. Material storage and delivery and handling of excavated materials shall be in accordance with Article 1 (General), Sections XXII (Material Delivery and Storage), and XXI (Handling Excavated and Backfill Materials on Construction Sites) of these Standards. The Contractor may store materials and equipment in the staging areas along the designated portions along the Project as indicated on the Plans. The Contractor shall store materials in an orderly arrangement allowing maximum access and unimpeded drainage and traffic. Material storage shall at no time impede pedestrian or emergency vehicle access. The storage of hazardous materials onsite shall not occur without the express approval of the PSAA.
- 6. Trees and shrubs in the staging and storage areas shall be protected per Article 1 (General), Section XXV (Protection of Trees) of these Standards and in conformance with Article 12 (Standard Details), SD-L-3 (Tree Protection) of these Standards.
- 7. All necessary measures shall be taken to prevent spillage of fuel, oil, chemicals, and hazardous materials. In the case of any fuel, oil, chemical, or hazardous material spill, the Contractor shall notify the PSAA and the EGLE Pollution Emergency Alerting System (PEAS) at (800) 292-4706. The Contractor shall be responsible for cleaning up the spill and remediating the site in accordance with EGLE requirements and as approved by the PSAA at no additional cost to the project.
- 8. Secondary containment shall be provided for diesel generators, equipment containing oil or grease, and storage of hazardous materials, in accordance with governing authorities or agencies.
- 9. Storage and work areas shall be kept clean with no accumulation of scrap, debris, waste material, and other items required for construction of the work.

10. The Contractor shall inspect the site daily, and more often if necessary, to ensure the site is maintained in a neat and orderly condition and that required controls for maintenance of traffic are in place. The Contractor shall also inspect storage areas weekly, and more often if necessary, to ensure the storage areas are maintained in a neat and orderly condition. One nighttime inspection shall be performed to insure proper retro-reflectivity of maintenance of traffic measures.
11. If the Contractor fails to correct unsatisfactory conditions within 24 hours after due notification, the PSAA may arrange for such work to be performed by other means at the Contractor's expense.
12. Any and all necessary measures required to avoid interruption in mail delivery and solid waste pick-up shall be taken by the Contractor including temporary relocation of mailboxes where required by the PSAA. Contractor shall also, in coordination with the Ann Arbor Area Transportation Association (AAATA), be responsible to maintain/make provisions for bus stops impacted by construction.
13. Mailboxes requiring relocation due to construction shall be removed and reset immediately by the Contractor in a temporary location approved by the PSAA.
14. The Contractor shall coordinate their operations with all utilities, contractors and/or subcontractors performing work on this and other projects within, or adjacent to, the Construction Influence Area (hereafter CIA).
15. A minimum of one driveway and one pedestrian access route shall be maintained at all times to all residences and businesses. Entrances to buildings shall not be blocked.
16. Undercuts or excavations immediately adjacent to active traffic lanes shall be restricted to a 1:4 slope from the edge of the roadway at the end of each working period. If this condition is not met, a nighttime shoulder closure shall be established according to MDOT Specifications, Subsection 812.03.G (Maintaining Traffic along Project). The cost of the shoulder closure will not be paid for separately but shall be deemed to be included in the cost of the work being performed.
17. All Temporary Facilities shall conform to Article 1 (General), Section XXIII (Temporary Facilities) of these Standards.

F. General Conditions

1. This work shall consist of performing all needed preparatory work and operations needed to begin the work of the project. All elements of this item of work are to be performed in accordance with these Standards, as shown on the plans, and as directed by the PSAA.
2. This item shall include all work described and required by the Plans and Specifications for which no item of work is listed in the Bid Form, including but not limited to:
 - a) Scheduling and organization of all work, subcontractors, suppliers, material testing, inspection, and construction surveying and staking;
 - b) Coordination of, and cooperation with, other contractors, agencies, departments, and utilities;
 - c) Coordination with City forces to stockpile and load used castings, hydrants, and signs onto City vehicles;
 - d) Protection and maintenance of all existing utilities, including support, protection, capping, repair, replacement, connection or re-connection of existing pipes, and utilities damaged by the Contractor's operations;
 - e) Maintaining and removing all soil erosion and sedimentation controls (as specified herein or as shown on project plans) for which no pay item exists;
 - f) Maintaining the site, and all areas within the CIA, in a well-graded and drained state at all times during the course of the project including de-watering and drainage of all excavations as required to maintain a stable, open hole;
 - g) The continuous maintenance of the temporary road surface within the CIA throughout the duration of the construction. This includes any needed grading to maintain the surface in a smooth condition free of potholes, ruts, bumps, or other objectionable conditions.
 - h) Temporary sheeting, bracing, and shoring of excavations in accordance with the applicable MIOSHA Standards;

- i) Maintaining driveway openings, sidewalks, bike paths, mail deliveries, and solid waste/recycle pick-ups. This includes the placement and maintenance of maintenance aggregate in driveway openings and across sidewalk ramps all as needed and as directed by the PSAA;
- j) Using quantities of dust palliative, maintenance aggregate, and hot patching mixture for use as temporary base, surfacing, and dust control at utility crossings, side roads and driveways;
- k) Storing all materials and equipment off lawn areas;
- l) Temporary removal/relocation, storage, and re-installation/re-setting of existing mailboxes, newspaper tubes, etc. which conflict with the proposed construction;
- m) Site clean-up on a daily basis during the course of the project's construction including daily sweeping of paved areas to remove soil and construction spoils;
- n) Coordination efforts to furnish the various required HMA mixtures as directed by the PSAA;
- o) Coordination efforts to furnish and operate various-size vehicles and equipment as directed by the PSAA;
- p) Furnishing and operating vacuum-type street cleaning equipment a minimum of once per week, or more frequently, if directed by the PSAA;
- q) Noise and dust control in accordance with the applicable City of Ann Arbor Ordinances;
- r) Mobilization(s) and demobilization(s) of all needed materials, equipment, and personnel;
- s) Furnishing of all required shop drawings, informational submittals, and material certifications for all needed materials and supplies incorporated into the project;
- t) The proper off-site disposal of all excavated materials and debris;
- u) Removal of shrubs, brush, and trees less than 6" diameter (DBH) as shown on the plan sheets or as directed by PSAA;

- v) Fencing to protect excavation over 1 foot in depth during non-work hours. The fencing must be a minimum of 36 inches high, be constructed of orange HDPE material, and reasonably secured to prevent unwanted access;
- w) All miscellaneous and incidental items such as overhead, insurance, and permits, and;
- x) Meeting all requirements relating to Debarment Certification, Davis Bacon Act, and Disadvantaged Business Enterprise, and providing the necessary documentation.

G. Project Clean-up and Restoration

1. The project site shall be left in a condition that is clean and free of all project-generated debris and to the satisfaction of the Engineer. This work shall consist of removing and disposing of miscellaneous packing materials and debris, soil erosion control fences, protective fences, fallen timber, logs, brush, rocks, boulders and any rubbish generated from the Contractor's operations within the project limits, or areas impacted by their operations. All utility structures shall be inspected to verify that no construction debris is present and cleaned by the Contractor as directed.
2. The Contractor shall perform final restoration and establish the turf areas as described in Section VI. B (Turf Establishment) of this Article.
3. The re-restoration of disturbed areas shall be performed in accordance with the applicable project specifications and as directed by the Engineer. Grade, spread topsoil, remove rocks over 2 inches in diameter, place additional topsoil (as needed), place permanent seeding, and furnish, place, and anchor erosion control straw mulch blanket in all areas disturbed by the Contractor's operations.
4. Damage to seeded areas resulting from erosion or subsequent construction activities shall be repaired by the Contractor at the Contractor's expense. Scattered bare spots in seeded areas will not be allowed over 3 percent of the area nor greater than 6- by 6-inch in size.
5. Clean existing culverts, ditches, depressions, or other areas that contain sediment or debris from the work operations.

6. Neatly fill any ruts or depressions resulting from removal of soil erosion control materials with existing materials after their removal. Maintenance of silt fencing and other soil erosion control materials until such time as they are no longer needed, then removal and proper disposal of them from the site, shall be included in the bid price for the related soil erosion control device.

H. Digital Audio-Visual Coverage

1. The Contractor shall furnish 2 copies of the completed digital audio-visual coverage to the PSAA at, or prior to, the Preconstruction Meeting. An index of the recording, which will enable any area of the project to be easily found on the recording, shall be included. The Contractor shall retain a third copy of the recording for their own use.
2. Any portion of the recording determined by the PSAA to be unacceptable for the documentation of existing conditions shall be recorded again, at the Contractor's sole expense, and submitted to the PSAA prior to mobilizing onto the site.
3. The digital audio-visual coverage shall be:
 - a) Of professional quality, providing a clear and accurate audio and visual record of existing conditions;
 - b) Prepared during the 3-week period immediately prior to the Preconstruction Meeting; and
 - c) Furnished to the PSAA a minimum of 2 weeks prior to bringing any materials or equipment to the site.
4. The digital audio-visual coverage shall be completed in accordance with the following minimum requirements:
 - a) The digital audio-visual coverage shall be performed using equipment that allows audio and visual information to be recorded simultaneously and in color. The recording shall be provided on a USB Flash Drive or portable drive in DVD format. The quality of the recording shall be equal to or better than the standard in the industry. The recording shall not be edited.

- b) To ensure proper perspective, the distance from the ground to the camera lens shall not be less than 12 feet and the recording must proceed in the general direction of travel at a speed not to exceed 48 feet per minute (0.55 miles per hour). Pan and zoom rates shall be controlled sufficiently so that playback will ensure quality of the object viewed.
 - c) The recording equipment shall have transparent time and date stamp and digital annotation capabilities. The final copies of the recording shall continuously and simultaneously display the time (hours:minutes:seconds) and the date (month/date/year) in the upper left-hand corner of the frame. Accurate project stationing shall be included in the lower half of the frame in standard station format (i.e., 1+00). Below the stationing, periodic information is to be shown, including project name, name of area shown, direction of travel, viewing direction, etc.
 - d) Locations relative to project limits and landmarks must be identified by both audio and video means at intervals no longer than 100 feet along the recording route. Additional audio commentary shall be provided as necessary during the recording to describe streets, buildings, landmarks, and other details, which will enhance the record of existing conditions.
 - e) The recording shall be performed during a time of good visibility. The recording shall not be performed during periods of precipitation or when snow, leaves, or other natural debris obstruct the area being recorded.
5. The digital audio-visual coverage shall include the following:
- a) This general criterion shall apply to all recording and shall include all areas where construction activities will take place or where construction vehicles or equipment will be operated or parked, and/or where materials will be stored or through which they will be transported. The recording shall extend an additional 50 feet outside of all areas. The recording shall include all significant, existing man-made and natural features such as driveways, sidewalks, utility covers, utility markers, utility poles, other utility features, traffic signal structures and features, public signs, private signs, fences, landscaping, trees, shrubs, other vegetation, and other similar or significant features.
 - b) All private property that may be utilized by the Contractor in conjunction with this project shall be recorded. These project areas must be disclosed by the Contractor prior to using them for the work of this project.

- c) The digital coverage shall:
 - (1) Extend to 50 feet outside of the right-of-way and easements area as indicated on the Drawings.
 - (2) Extend 50 feet outside the construction limits on all streets, including side streets.
 - (3) Record both sides of each street.
- d) Recording of all areas bordering the project where work is scheduled to occur or where construction traffic could damage the private property. This is to include buildings, hydrants, pavements, curbs, driveways, decks, landscaping, trees, and all other similar features.
- e) The Contractor shall record, at their sole expense, other areas where, in their opinion, the establishment of a record of existing conditions is warranted. The Contractor shall notify the PSAA in writing of such areas.
- f) The PSAA may direct the recording of other minor areas not specified herein at the Contractor's sole expense.

I. Project Supervision

- 1. The Contractor shall designate a full-time Project Supervisor to act as the Contractor's agent/representative, and to be responsible for scheduling and coordination of all subcontractors, suppliers, other governmental agencies, and all public and private utility companies.
- 2. The Project Supervisor shall not be an active crew member of the Contractor, shall not be an active member or employee of any subcontractor's work force, and shall not perform general or specialized labor tasks. The Project Supervisor shall be a full-time employee of the General Contractor and shall have all needed authority to make binding decisions on behalf of the Contractor in all matters pertaining to performance and execution of the work of the project.
- 3. The Project Supervisor shall work exclusively on this project and shall put forth full effort into the organization and coordination of the work of this project.

4. One week prior to the pre-construction meeting, the Contractor shall designate a proposed Project Supervisor by name, and shall furnish the PSAA with a current, thorough, detailed summary of the proposed Project Supervisor's work history, outlining all previous supervisory experience on projects of a similar size and nature. The detailed work history shall include personal and professional references (names and phone numbers) of persons (previous owners or agents) who can attest to the qualifications and work history of the proposed Project Supervisor. Proposed candidates for Project Supervisor shall have a demonstrated ability to work harmoniously with the PSAA, the City, the public, subcontractors, and all other parties typically involved with work of this nature. The PSAA will have the authority to reject a proposed Project Supervisor who, in the opinion of the PSAA, is deemed unqualified.
5. The Project Supervisor shall be available 24 hours-per-day to provide proper supervision, coordination and scheduling of the project for the duration of the Contract. The Contractor shall furnish the City with telephone numbers of the Project Supervisor in order to provide 24 hour-per-day access during business and non-business hours, including weekends and holidays.
6. The Project Supervisor shall be equipped by the Contractor with a "smart" mobile telephone with data and text capabilities to provide the City with 24 hour-per-day access to said Project Supervisor during daily construction activities, during transit to and from the construction site, and during all non-business hours including weekends and holidays.
7. The Project Supervisor shall be equipped with assistants as necessary to provide project supervision as specified herein, and in accordance with the Contract.
8. The Project Supervisor shall work harmoniously with the PSAA, the City, the public, subcontractors, and all other parties typically involved with work of this nature.
9. The Project Supervisor shall have a thorough, detailed understanding and working knowledge of all construction practices and methods specified elsewhere herein, as well as the handling, placement, testing and inspection of aggregates, aggregate products, bituminous concrete, Portland cement concrete materials, and other such materials and products related to the work of this project.
10. The Project Supervisor shall be responsible for all of the work of all of the Contractor's, subcontractors' and suppliers' work forces.

11. The Project Supervisor shall be responsible for proper and adequate maintenance (emissions, safety, and general operation) of all of the Contractor's, subcontractors' and suppliers' equipment and vehicles. The Project Supervisor shall make all needed diligent and good-faith efforts to ensure that all equipment utilized in the performance of the work is properly maintained, safe, and complies with all legal and environmental requirements of the work as set forth in MDOT Specifications, Subsection 107.15 (Compliance with Laws; Environmental Protection).
12. The Project Supervisor shall be responsible for the legal, proper and safe parking/storage of all of the Contractor's, subcontractors' and suppliers' equipment, work vehicles, and employee's vehicles.
13. The Project Supervisor shall schedule and coordinate the work of all parties involved in the project, including utility companies, testing agencies, governmental agencies, all City departments (such as Utilities and Transportation), and City inspectors.
14. The Project Supervisor shall coordinate and schedule the work of any independent survey crews that may be retained by the PSAA or City to witness and reset existing and new geographic/benchmark monuments. Failure to have existing monuments witnessed and reset may result in delays to the Contractor's work. Costs for such delays will be the Contractor's sole responsibility. The Project Supervisor shall also schedule and complete all needed survey request forms that are needed in order to schedule the services of survey personnel to properly layout all elements of the project work in accordance with these Standards and MDOT Specifications.
15. The Project Supervisor shall coordinate, and schedule inspection performed by the City and Consultants (including material testing firms) in a timely manner, to assure proper and timely testing and inspection of the work.
16. The Project Supervisor shall submit to the PSAA an updated, detailed schedule of the proposed work on a weekly basis, and an update of all proposed changes on a daily basis.
17. The Project Supervisor and all subcontractors shall attend a weekly progress meeting chaired by the PSAA to discuss the work. Upon the completion of each meeting, the PSAA shall prepare and distribute, to all present, a written summary of the meeting's minutes. Those in attendance shall review the minutes and, if necessary, comment on any deficiencies or errors prior to or at the next scheduled progress meeting.

18. If, in the sole opinion of the PSAA, the Project Supervisor is not adequately performing the duties as outlined in this specification, the following system of notices will be given to the Contractor with the associated penalties:
 - a) A warning will be issued in writing to the Contractor detailing the deficiencies in the Project Supervision. The Contractor must respond within 7 calendar days in writing with a plan to correct the stated deficiencies. Failure to respond within 7 calendar days will result in the issuing of a second notice.
 - b) A second warning will be issued in writing to the Contractor further detailing the deficiencies in the Project Supervision. The Contractor must respond within 7 calendar days in writing with a plan to correct the stated deficiencies. Failure to respond within 7 calendar days will result in the issuing of a third notice. At this time, the PSAA reserves the right to meet with personnel with the necessary authority within the Contractor's organization to discuss the deficiencies in the Project Supervision.
 - c) A third notice will be issued in writing to the Contractor further detailing the deficiencies in the Project Supervision and the Project Supervisor shall be removed from the project and replaced immediately with another individual to be approved by the PSAA.
19. Should, in the sole opinion of the PSAA, the Project Supervisor fail to perform their duties and responsibilities as described herein to such a degree that the successful completion of the project is put in jeopardy, the above system of notices may be waived, and the Contractor shall immediately replace the Project Supervisor upon receipt of written notice. Failure to provide adequate project supervision, as determined by the PSAA, shall be considered basis for the PSAA to suspend work without extension of contract time or additional compensation.

J. Exploratory Excavation

1. This work consists of conducting a vertical exploratory investigation to expose an existing culvert, sewer, utility/utility service, or the existing pavement section to verify the location, condition, size, material, alignment and/or composition; allowing the PSAA to document the necessary information; and backfilling the excavation. It includes providing necessary lane, shoulder and/or sidewalk closures required to perform the work.

2. The intent of "Exploratory Excavation" is not to provide a means for the Contractor to locate each existing utility throughout the project, but for those that appear to conflict with the proposed work and where their location is unclear or unknown. The use of "Exploratory Excavation" shall only be as directed and approved by the PSAA. The Contractor is responsible for "using reasonable care to establish the precise location of the underground facilities in advance of construction" (Public Act 174 of 2013 - Miss Dig Law) as a part of the overall project contract.
3. The owner of any sewer or utility to be exposed will not take the facilities out of service during the exploratory investigation. Contractor shall contact utility owners in accordance with MDOT Specifications, Subsection 107.12 (Contractor's Responsibility for Utility Property and Services).
4. Necessary lane, shoulder and/or sidewalk closures required to perform work shall be established.
5. The exploratory excavation shall be advanced using hydro excavation, hand digging, conventional machine excavation, or a combination thereof subject to approval of the PSAA. The PSAA shall be allowed access to document the necessary information. If the technique used to advance the excavation causes any damage to the existing facilities, Contractor shall immediately contact the utility owner and cease all work until PSAA approves of an alternate method.
6. Care shall be taken to protect any exposed culvert, sewer or utility from damage during construction. Any culvert, sewer or utility, damaged during exploratory excavation shall be repaired or replaced in accordance with the standards of the utility owner and as approved by the PSAA. Contractor shall contact the owner of such utility to coordinate the repair.
7. The Contractor is responsible for all costs associated with the repair work and out of service time of all broken or damaged existing culverts, sewers or utilities resulting from any action by the Contractor.
8. In between time of completing excavation and backfilling, excavation shall be barricaded, plated, or fenced. The PSAA's approval shall be obtained before backfilling the excavation. Backfilling shall be completed no later than 24 hours after approval. Backfilling shall be in accordance with MDOT Specifications, Subsection 204.03.C (Backfilling). Excess material shall be disposed of in accordance with those Specifications.

K. Hand Dig or Hydro Excavation

1. Remove miscellaneous materials covering the tree root system using hand tools or hydro excavating machinery, or other methods as approved by the engineer, in a manner that reveals, without damaging, tree roots 1½-inch or greater in diameter for pruning operations.
2. All excavated material which is unsuitable for backfill shall be immediately removed from the site by the Contractor.
3. Hand dig or hydro excavate to achieve rough grades or removals, as shown on plans.
4. Tree roots exposed during construction that are 1½-inch or greater in diameter must be pruned. All pruning operations shall be reviewed and approved by the Engineer. All root pruning shall be performed with sharp tools and shall provide clean cuts that do not unnecessarily damage the remaining bark or root. The Contractor shall not perform any backfilling operations until all root maintenance has been performed.
5. Perform removals and backfill with Class II granular material unless otherwise specified to rough grade as specified.
6. Any damage to trees within the areas designated for hand digging due to the Contractor's activities, including subcontractors or suppliers, shall be repaired under the direction of the City Forester. The costs of these repairs shall be the sole responsibility of the Contractor.
7. Should the Contractor's operations damage a plant's roots to the extent that it must be removed, the Contractor shall either replace the plant with a commensurate number of plants, 2½-inch caliper trees of the species as determined by the City or compensate the City of Ann Arbor for the cash value of the plant or tree as determined by the City of Ann Arbor's Forester. The City of Ann Arbor shall be solely responsible for determining which compensation method is used.

L. Work in Railroad Right-of-Way

1. Railroad Company shall be notified a minimum of 10 calendar days (or more if required by Railroad) prior to beginning any work within the railroad right-of-way.

2. Contractor shall obtain, at Contractor's sole expense, the insurance required by the Railroad. For purposes of compliance with this specification, any provision of the Railroad Company that indicates that the permittee and/or its Contractor shall either perform work or provide documentation shall be interpreted as being the sole responsibility of the Contractor.
3. The Contractor shall be responsible for procuring all required insurance coverages required by the Railroad Company. Insurance required shall be considered primary with respects to any other valid or collectible insurance that the City may possess, including any self-insured retentions the City may have; and any other insurance the City does possess shall be considered excess insurance only and shall not be required to contribute with this insurance. Further, the Contractor agrees to waive any right of recovery by its insurer against the City.
4. Contractor shall coordinate with the Railroad the scheduling of railroad inspectors, flaggers, etc. This is to be arranged at time of notification.
5. Contractor shall fully comply with all Railroad permit requirements for working within the railroad rights-of-way or areas covered by its requirements for the Project.
6. Contractor shall provide any Railroad Company training for each person involved in the work as described in the Railroad Company documents.
7. Contractor shall provide coordination with the Railroad needed to complete the work of the Project.
8. Work within or adjacent to the railroad rights-of-way shall not proceed until all approvals from the Railroad Company have been granted.

M. Required Submittals and Resubmittals

1. For each required submittal or resubmittal per these Specifications, the Contractor shall allow at least 14 calendar days from the date of the submittal to receive the PSAA's acceptance or request for revisions.
2. The PSAA's comments shall be incorporated into the resubmitted plans, calculations, and descriptions. The PSAA's acceptance of the submittal is required before beginning the work.

3. Resubmittals shall be reviewed and returned to the Contractor within 14 calendar days. Required revisions will not be a basis of payment for additional compensation, extra work, or an extension of contract time. The Contractor shall include time for this entire review process in their schedule.

II. Utilities

A. Work Required of Contractor - General

1. Contractor shall furnish all materials, equipment, tools, and labor necessary to do the work required by this Section, and unload, haul, distribute, store, and install all pipe, castings, fittings, valves, manholes, hydrants, and accessories as specified or as shown on the Plans.
2. Trenches, pits and other excavations shall be excavated to the dimensions as required to complete the work per MIOSHA safety regulations.
3. The excavation and adjoining ground or structures shall be sheeted, braced, and supported in accordance with federal, state, and local requirements.
4. The pipes, castings, fittings, valves, manholes, hydrants, and accessories shall be installed and tested as specified.
5. All excavations shall be backfilled and compacted, surfaces restored, surplus materials removed and disposed of offsite, work site cleaned, and the adjoining street or other surfaces maintained as specified.
6. All materials, equipment, tools, and labor required to alter existing connections to water mains or sewers and to reconfigure sewers, service lines, conduits, ducts, pipes, or other structures shall be furnished in accordance with the Plans and Specifications.

B. Materials

1. All utility materials shall conform to specifications as set forth in these Standards in:
 - a) Article 2 (Sanitary), Section II (Sanitary Sewer Materials);
 - b) Article 3 (Water), Section II (Water Materials);
 - c) Article 4 (Stormwater), Section II (Stormwater Materials); and

- d) Any other applicable material specifications and Standard Details of these Standards.
- 2. Manufacturer's Certifications shall be submitted for all pipe to be used on the Project per the cited Sanitary, Water, and Stormwater Materials sections of these Standards (hereafter collectively Utility Materials Standards).
- 3. Pipe Marking and Material Handling shall be in conformance with the Utility Materials Standards.
- 4. All pipe materials are subject to Material Inspection per the Utility Materials Standards and may be rejected as set forth therein.
- 5. Backfill Materials
 - a) All material to be used as backfill shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways.
 - b) Hydrants, manholes, valve boxes, curb stop boxes, call boxes, and other utilities or facilities shall not be obstructed by backfill materials.
 - c) Streets and gutters shall be kept clear or other provisions shall be made for street drainage; natural water courses shall not be obstructed.

C. Excavation - General

- 1. Excavation shall include the clearing of the site, and the removal and disposal of all material, including rock, boulders, or buried obstructions necessary to be removed to construct the work.
- 2. Contractor shall determine location of underground facilities and comply with MISS DIG 811 utility notification system requirements. Damages to utilities by the Contractor's operations shall be repaired by the utility owner at the Contractor's expense.
- 3. Excavation normally shall be by open cut from the surface except as otherwise specified, or in special cases where crossing under trees, pavements, or structures. The Contractor may use tunnel methods if permitted in writing by the PSAA, provided Contractor's method of backfill is such, in the judgment of the PSAA, as to avoid any present or future injury to the tree, pavement, or structure.

4. Excavation shall be in such manner to provide adequate room for the construction and installation of the work to the lines, grades and dimensions shown on the Plans.
5. The Contractor shall proceed with caution in the excavation and preparation of the trench so that the exact location of underground structures, both known and unknown, may be determined, and the Contractor shall be held responsible for the repair of such structures when broken or otherwise damaged.
6. When in the opinion of the PSAA it is necessary to explore and excavate to determine the location of existing underground structures, the Contractor shall make explorations and excavations for such purposes.
7. Hand methods for excavation shall be employed in locations as shown on the Plans. In other locations the Contractor may use appropriate equipment or employ hand methods.
8. In excavating for pipe installation, the excavation shall always be finished to the required grade in advance of laying the pipe, but not more than 50 feet of trench shall be open at one time. Incompletely backfilled trenches shall not be left open without written permission from the PSAA.
9. At the end of each day, no more than 10 feet of trench may be left open, and access to all drives shall be restored. Excavation shall be plated or surrounded by fencing and lighted barricades. All other areas shall always be available for safe vehicular and pedestrian traffic.
10. All excavated material approved by the PSAA as backfill material and any imported backfill material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. All excavated material which is unsuitable for backfill shall be immediately removed from the site by the Contractor.
11. Fire hydrants, manholes of any kind, valve boxes, curb stop boxes, fire and police call boxes, traffic signals, and other utility controls shall be left unobstructed and accessible until the work is completed unless directed otherwise by the PSAA. Gutters shall be kept clear, or other satisfactory provisions made, for street drainage, and natural water courses shall not be obstructed.

D. Trenching

1. Trench Widths and Depths

- a) Trench shall be of sufficient width to provide adequate working space to permit the installation of the pipe and the compaction of the bedding material under and around the pipe. However, for rigid pipe, the width of the trench from below the pipe bedding to 12 inches above the top of the pipe shall not exceed the dimensions per Table A of this Article:

Table A Trench Width	
Diameter of Pipe	Width of Trench
6-inch thru 12-inch	30 inches wide
15-inch thru 36-inch	outside diameter plus 16 inches
42-inch thru 60-inch	outside diameter plus 20 inches
over 60-inch	outside diameter plus 24 inches

- b) For each size of pipe, the minimum trench width shall provide clearance of 4 inches on each side of the bell of the pipe or fitting or 6 inches on each side of the pipe barrel, or as recommended by the manufacturer, whichever is greater.
- c) The maximum trench width shall be in keeping with good construction practice, such that existing structures are not undermined.
- d) The trench shall be excavated to a minimum of 4 inches below the final location of the pipe. For reinforced concrete pipe 66 inches or larger in diameter, the trench will be excavated to a minimum of 6 inches below the pipe. This cut shall be filled to the level of the bottom quadrant of the pipe with Class II granular material as specified herein, shaped and compacted to the pipe barrel.

2. Trench Shoring and Bracing

- a) Where required to support the surfaces of adjacent roadway, structures, or excavations, or to protect the construction work, adjacent work, or workers, sheeting, bracing, and shoring shall be provided. The placing of such supports shall not release the Contractor from the responsibility for the sufficiency and integrity of the trench.

- b) In the removing of sheeting and bracing after the construction has been completed, special care shall be taken to prevent any caving of the sides of the excavation and injury to the completed work or to adjacent property.
- c) Sheeting, bracing, and shoring shall not be left in place after completion of the work, except as required by the PSAA. In such cases, shoring and bracing shall be cut off a minimum of 4 feet below the established surface grade.

E. Trench Dewatering

1. The Contractor shall take all necessary precautions to keep the trenches and other excavations entirely clear of water and sewage during construction of pipelines and structures.
2. Where existing sewers, drains, or ditches are encountered in this work, adequate provisions shall be made for diverting their flow, so that the excavation will be kept dry. Upon completion of the construction work, the existing sewers, drains, or ditches shall be restored as directed by the PSAA.
3. Any water that may accumulate in any excavations shall be removed by well points, pumping, bailing, or other acceptable methods.
4. The Contractor shall be responsible for the complete design of all structures and methods proposed for dewatering the project site, including the implementation of all materials, tools, and equipment proposed for use in the work. Temporary wiring associated with the de-watering shall comply with the applicable portions of the National Electric Code.
 - a) Dewatering system(s) shall be designed by a Professional Engineer registered in the State of Michigan with a minimum of 7 years of documented experience in the design, installation, and operation of de-watering systems and as specified.
 - b) Electrical power shall be provided from the local utility provider or portable generators. Stand-by power and any other required auxiliary dewatering equipment shall be provided to assure continuous de-watering capability. De-watering, where required, shall be continuous.
 - c) Dewatering shall not be stopped during work stoppages without the approval of the PSAA. Construction operations shall be coordinated to minimize duration and extent of de-watering required.

- d) Dewatering wells are to use properly designed filters to prevent migration of soil fines into the well.
 - e) Sumps and wells used as a part of the dewatering system shall be strongly sheathed and braced to protect the construction while in use. Tops of well casings shall be covered to prevent animals and debris from entering and shall be 2 to 3 feet above ground level. Sumps and wells, when abandoned, shall be backfilled and compacted, or grouted in place, to the satisfaction of the PSAA.
 - f) Methods used in drilling wells associated with dewatering systems shall be the responsibility of the Contractor and shall be acceptable to the PSAA. Drilling methods shall insure proper placement of well materials and shall not involve displacement of earth formations.
5. Equipment for pumping and pumping methods associated with dewatering systems shall be the responsibility of the Contractor and shall be acceptable to the PSAA. The Contractor shall furnish and construct adequate discharge piping systems to conduct and dispose of the water so as to prevent damage to existing structures or property. Pumping equipment shall be of proper type and size for the work, be in good working condition, and be properly maintained throughout the life of the project until it is no longer needed. The Contractor shall provide all anchors and supports for pumping equipment.
6. All water that is removed from excavations, or directed away from work areas, shall be directed to existing storm sewers or other water courses as approved by the PSAA. In areas of known ground water contamination or as shown on the plans, water shall be directed to sanitary sewer after the Contractor obtains a permit from the Wastewater Treatment Plant. In handling and directing this water, the Contractor is required to comply with all applicable local, state, and federal requirements regarding soil erosion and sedimentation control and shall provide filters, filter bags, check dams, or any other measure that is necessary in order to comply with the applicable laws and ordinances. No drainage ditches shall be placed within the area to be occupied by any structure except as permitted in writing by the PSAA.
7. Upon completion of dewatering work for the project, all holes, trenches, ditches and other earth excavations created by the work of this Section and not scheduled to remain shall be filled. All filling, backfilling, grouting, and grading to restore excavations and earth banks shall be performed to the lines and grades as indicated

on the Plans and as determined by the PSAA. All earth fills shall be compacted to 95% of the material's maximum unit weight outside of roadway pavement influence or compacted to 98% of the material's maximum unit weight within roadway pavement influence.

8. Any and all method(s) of dewatering proposed by the Contractor shall be effective. The Contractor is responsible for de-watering the site in an effective, timely, manner, that will not unduly delay the work of the project. Delays due to dewatering efforts will not be a basis of payment for additional compensation, extra work, or an extension of contract time. The PSAA's acceptance of a particular method of dewatering shall not relieve the Contractor of their responsibility of performing the work in a manner that meets the requirements of the specifications, the Contract Documents, and all other local, state, and federal requirements.
9. Newly placed concrete thrust blocking or other concrete shall be adequately protected from injury resulting from ground water or sewage.
10. The Contractor shall always have sufficient pumping equipment ready for immediate use on the work site to carry out the intent of this Section.

F. Crossing Existing Structures & Facilities

1. During construction it may be necessary to cross under or over other utility structures and facilities. The Contractor shall make every effort to prevent damage to such underground structures and facilities. The Contractor shall not intentionally damage or break existing structures or facilities and repair them in order to expedite the main installation process.
2. Wherever such structures or facilities may inadvertently be disturbed or broken, they shall be restored to a condition that is equal to, or better than, that was encountered prior to the damage; and to the satisfaction of the utility owner at Contractor's expense.
3. Contractor shall maintain minimum vertical and horizontal clearance between facilities as specified in Separation Clearance Sections in Article 2 (Sanitary), Section I.H, Article 3 (Water), Section I.B.6, and Article 4 (Stormwater), Section I.H. of these Standards.

G. Pipe Undercut

1. In locations where, in the opinion of the PSAA, the soil at the bottom of the trench is unsuitable, e.g., organic soils, frozen material, debris, highly compressible soils or other deleterious material which would cause differential settlement of the pipe trench, the Contractor shall excavate below the trench bottom to such depth as directed by the PSAA and shall backfill with compacted 6A coarse-graded aggregate to the springline of the pipe, per Article 12 (Standard Details), SD-TD-2 (Utility Trench - Type 2) of these Standards.
2. If backfill with compacted coarse-graded aggregate is required during sanitary or storm sewer construction, it shall be placed for the entire sewer run from manhole to manhole.

H. Pipe Bedding

1. Pipe Bedding is described as the material from 4 inches below the pipe (or 6 inches below the pipe for reinforced concrete pipe 66-inch diameter or larger) up to the top of pipe.
2. The pipe bedding shall be in conformance with Article 12 (Standard Details), SD-TD-1 through SD-TD-5 of these Standards (hereafter Trench Details). The Trench Detail Type shall be specified on the Plans. MDOT Granular Material Class II shall be compacted to 95% of its maximum dry density in maximum lifts of 12 inches.
3. After the pipe is laid, the bedding shall be continued to the top of pipe. Care shall be taken to assure filling and tamping all spaces under, around and above the top of the pipe.
4. A continuous, uniform, and compacted bedding shall be provided in the trench for all buried pipe.
5. Bedding material shall be compacted as specified in this Section. Each lift shall be thoroughly compacted by hand tamps, pneumatic "pogo-sticks, hoe packs, or other approved methods, to its specified dry density at optimum moisture content. Each lift shall extend the full width of the space between the pipe and trench wall, and the bedding shall be brought up evenly on both sides of the pipe. The bedding under the haunches of the pipe shall be consolidated by the use of a tee-bar.

I. Pipe Backfill

1. Pipe backfill is the material from the top of pipe to the surface restoration cross section, as specified elsewhere. Material shall be in conformance with Trench Details.
2. Backfill of MDOT Class II sand shall be compacted to 95% of its maximum dry density. If machine tamping includes manually-operated vibrating plate compactors or self-propelled vibrating rollers, the backfill material shall be compacted in lifts not exceeding 12 inches, loose measure. If a backhoe-mounted compactor is employed, the backfill material shall be compacted in lifts of 36 inches, loose measure.
3. In cases where backfill of native material is approved by the PSAA; pipe bedding shall extend to 12 inches above the top of pipe and native material backfill shall be uniformly spread and compacted to 90% of its maximum dry density.
4. Backfilling shall not be done in freezing weather except by written permission of the PSAA, and it shall not be made with frozen material. No fill shall be made where the material already in the trench is frozen.
5. No trench backfill shall contain debris or organic material within 24 inches above the top of pipe.
6. Approval to use a particular compaction method will be withdrawn by the PSAA if the method causes injury to the pipe or adjacent structures or movement of the pipe. The PSAA may consider written permission to increase the thickness of the lifts specified in this paragraph if satisfactory compaction is achieved and no undesirable side effects occur.
7. When directed by the PSAA, Flowable Fill shall be used as backfill for the pipe installation. Where flowable fill is called for as pipe backfill or bedding, care shall be used to avoid displacing the pipe due to fluid pressure or the buoyancy effect.

J. Laying Pipe - General

1. Each pipe shall be inspected for defects prior to being lowered into the trench. The inside of the bell and outside of spigot shall be cleaned of any earth or foreign matter.

2. Proper implements, tools, and facilities satisfactory to the PSAA shall be used for the safe and convenient execution of the work.
3. All pipe, fittings, valves, and hydrants shall be carefully lowered into the trench by means of slings, cables, or other suitable tools or equipment as recommended by the manufacturer, in a manner to prevent damage to them and their protective coatings and linings. Under no circumstances shall materials be dropped or dumped into the trench.
4. The Contractor shall take every precaution to prevent foreign material from entering the pipe while it is being placed. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe.
5. When pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug. This provision shall apply during the noon hour as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.
6. No pipe shall be laid until a cut sheet for that pipe has been approved by the PSAA.
7. The Contractor shall excavate for all bell holes and shall place the bell of the pipe in the excavated bell hole. Pipe shall be laid on the prepared trench bottom with the bell ends facing the direction of laying, unless otherwise directed by the PSAA.
8. Pipe shall be jointed as specified elsewhere herein. The pipe shall be secured in place with approved backfill material tamped under it except at the bells.
9. Gasket lubricant shall only be applied immediately before connection to the next segment of pipe. Pipe with lubricant applied shall not come in contact with the ground. If the lubricated portion of the pipe end contacts the ground, it shall be thoroughly cleaned to the satisfaction of the PSAA, prior to its installation.
10. Each section of pipe, when placed to grade and line, shall have firm bearing on the trench bedding throughout its length between bell holes. All pipe shall be laid at the correct line and grade as indicated by the grade stakes and offset line.

K. Installation of Water Main

1. All ductile iron pipe, fittings, and valves shall be fully wrapped with polyethylene per ANSI/AWWA C105/A21.5 (Polyethylene Encasement for Ductile Iron Pipe), Method A. Service taps, bends, tees and other connections made to polyethylene encased pipe shall be in accordance with Section 4.4.6 of said AWWA C105.
2. Cutting cast iron or ductile iron pipe for inserting valves, fittings, or closure pieces shall be performed in a neat and workmanlike manner without damage to the pipe or cement lining and to leave a smooth end at right angles to the longitudinal axis.
3. Where the type of pipe joint in use is such that it employs push-on assembly to affect the joint seal, the outside of the cut end shall be tapered back $\frac{1}{8}$ inch with a coarse file or a portable grinder at an angle of about 30 degrees. The tapering must remove all sharp and/or rough edges which might injure the gasket.
4. Mechanical means shall be used for pulling home all rubber-gasket pipes regardless of trench condition where manual means will not result in pushing and holding the pipe home.
5. For pipe of any diameter, all plugs, caps, tees, hydrants, and 90 degree horizontal bends shall be provided with 3500 psi concrete thrust blocks per Article 12 (Standard Details), SD-W-2 (Thrust Block) of these Standards, in addition to restrained push-on rubber joint gaskets as specified in Article 3 (Water), Section II. A. 3. a) (Ductile Iron Pipe).
 - a) Thrust blocks shall be placed between unexcavated solid ground and the fitting to be anchored. The thrust blocks shall be placed so that the pipe and fitting joints will be accessible for repairs. This shall include adequate protection of any bolts from direct contact with the concrete.
 - b) Metal harnesses of tie rods or clamps may not be used instead of concrete thrust blocks. Mechanical joint restraint systems and restrained, push-on joint, pipe shall be used where connections to existing lines require immediate pressurization. These instances shall be reviewed prior to approval.
 - c) If the PSAA determines a change in the thrust blocks, anchorage or design is required due to unsuitable earth conditions, changes may be ordered by the PSAA.

6. Wherever it is necessary to deflect ductile iron pipe from a straight line, either in the vertical or horizontal plane, to avoid obstructions, to plumb valve stems, or where long-radius curves are permitted, the amount of deflection shall not exceed that allowed. Amount of deflection shall be approved by the PSAA and shall not exceed amount as recommended by the manufacturer and AWWA C600.
7. The tapping of water mains, the installation of all corporation stops, and the operation of valves and hydrants is reserved for City personnel. The Contractor is required to assist in valve and hydrant operation.
8. Tracer wire shall be provided in compliance with Article 3 (Water), Sections I.B.18 and II.F (Tracer Wire) of these Standards. Tracer wire shall be placed on top of the pipe at the centerline of the pipe longitudinal axis. Wire shall be extended to all hydrants, blowoffs, dead ends, and post indicator valves.
9. For open cut construction, the tracer wire shall be installed at a height of not more than six inches above the main line pipe.
10. For directional drilling or pipe bursting, the tracer wire shall be installed at the same time as the pipe.
11. Tracer wire shall be brought to grade, leaving enough excess material to avoid loss or damage to the wire during construction and subsequent activities. Wire shall be properly terminated at access points following pipe installation.
12. Tracer wire terminations shall be made by one of the following methods:
 - a) Tracer wire shall be terminated at hydrants with an access point terminal installed directly to the hydrant flange. Hydrant access points shall include 2-terminal connections with ground connection made within the terminal. Rigid PVC conduit from the access point shall extend to a minimum of 24-inches below grade.
 - b) Gate well terminations shall be made by running the tracer wire through a maximum 3/8-inch drilled hole sealed with epoxy in the upper section of the precast structure and up the wall leaving the stub accessible a maximum of 18-inches below the casting. Wire shall be terminated in an 18-inch long blue polyethylene tube with aluminum cap that acts as a connection point. The cap shall include dielectric gel to seal the wire connection. Wire and termination tube shall be fixed to the gate well wall with stainless steel wire clamps.

- c) Terminations at existing water mains without tracer wire or a dead end shall be made at the nearest hydrant or gate well as outlined above. If no hydrant or gate well is available, a ground level tracer wire access point shall be installed.
 - d) Tracer wire terminations shall be located at a maximum spacing of 600 feet. If an additional termination is required, a ground level tracer wire access point shall be installed.
- 13. An 18-inch long magnesium grounding rod with AWG 12 connecting wire shall be installed at all hydrants and ground level access points along the proposed tracer wire. Grounding rod connection shall be made at the identified (or bottom) terminal at all access points.
 - 14. Contractor shall test tracer wire for continuity after backfilling is complete and before the water main is placed in service. Continuity test to consist of locating all water main with an electronic-type pipe locator. If test for continuity fails, repair or replace as necessary to achieve continuity.
 - 15. Underground utility caution tape shall be placed one foot above the pipe as the pipe is backfilled.

L. Water Main Testing

- 1. All water mains shall be bacteriological tested, pressured tested, and approved by the PSAA prior to being connected to existing water main facilities. Flushing, chlorination and bacteriological testing must precede pressure testing when it is connected to the main. Where mains can be totally isolated from existing facilities with air gaps or double valves, pressure testing may precede chlorination and bacteriological testing. All testing shall be in accordance with AWWA C600 and C651.
- 2. The normal sequence and time requirements for water main testing are provided in Table B of this Article:

Table B Water Main Testing Sequence		
	Isolated (Gapped) Water Main	Connected Water Main
Step 1	Fill main	Flush and Swab*
Step 2	Pressure test	Chlorinate
Step 3	Connect one end of main	Wait; 24 hours
Step 4	Flush and Swab*	Flush **
Step 5	Chlorinate	Wait; 24 hours
Step 6	Wait; 24 hours	Bacteriological Samples
Step 7	Flush**	Wait; 24 hours
Step 8	Wait; 24 hours	Bacteriological Samples
Step 9	Bacteriological Samples	Wait; 48 hours
Step 10	Wait; 24 hours	Pressure Test (If both sets of sets of bacteriological samples pass)
Step 11	Bacteriological Samples	Flush*
Step 12	Wait; 48 hours	Wait; 24 hours
Step 13	Make Final Connection(s) - Place in Service (If both sets of bacteriological samples pass)	Bacteriological Samples
Step 14		Wait; 24 hours
Step 15		Bacteriological Samples
Step 16		Wait; 48 hours
Step 17		Place in Service (If both sets of bacteriological samples pass)
*Collect flush water in operable stormwater retention/detention facility		
**Discharge flush water into approved sanitary sewer		

3. The Contractor shall give the City 48 hours prior written notice of intent and desire to test water mains.
4. The water main shall be disinfected and tested by the Contractor in the presence of the PSAA in accordance with the requirements below. The Contractor shall furnish all piping, pumps, hoses, gauges, RPZ backflow preventer (if unavailable from Public Works), and other materials and equipment required to carry out the tests using water from the City's water mains.
5. All chlorinated water shall be discharged directly to the sanitary sewer and will not be allowed to be discharged to the ground or any surrounding water course.

6. The City shall furnish and install 1-inch corporation stops at all necessary locations, at the expense of the Contractor.
7. Flushing, Chlorination and Bacteriological Testing:
 - a) After completion of water main installation, water main shall be cleaned using a high-density poly-pig (2 lbs/ft³ density) swab and flushed.
 - b) New mains, valves, hydrants and appurtenances shall be flushed completely as acceptable to PSAA. The pipe shall be flushed until the water runs clear for a minimum of 15 minutes or until two full pipe volumes have been flushed (whichever is longer).
 - c) Prior to final approval of the system, Contractor shall pump down all fire hydrants and verify that the hydrant valve is properly seated to prevent the hydrant standpipe from filling with water.
 - d) After the water mains have been acceptably flushed, they shall be disinfected in accordance with AWWA C651, (Disinfecting Water Mains), and these Specifications.
 - e) All new mains and fittings, and any existing mains contaminated by the Contractor, shall be chlorinated to a minimum residual of 50 parts per million (ppm) with commercial liquid chlorine solution (sodium hypochlorite - pool type). Other forms of chlorination and disinfection methods of water mains may be presented by the Contractor and shall receive prior approval in writing by the PSAA before being used.
 - f) During the chlorination process, the proper level of chlorination must be achieved throughout the entire length pipe. Chlorine levels shall be checked at intermediate locations as directed by the PSAA and the Contractor shall add chlorine until such time as the required levels are achieved at all points.
 - g) The minimum recommended dosage of sodium hypochlorite shall conform to Table C of this Article (based on 10% available chlorine):

Table C Recommended Minimum Chlorine Dosage to Disinfect 100 L.F. of Pipe	
Pipe Diameter (inches)	10% Chlorine Solution (gallon)
6	0.153
8	0.272
10	0.426
12	0.613
16	1.090
20	1.703
24	2.452

- h) The chlorinated water shall remain in the mains for a minimum of 24 hours, at the end of which period the chlorinated water at all parts of the main must show free available chlorine residual of at least 25 ppm.
- i) If less than 25 ppm residual is shown at the end of the first 24-hour period, additional chlorine shall be added until a residual of 25 ppm is achieved in all parts of the system after a 24-hour period.
- j) The chlorinated water shall then be removed from the mains and disposed of into an existing, approved City sanitary sewer main, or other location as approved in writing by the PSAA. The mains shall then be left full of potable water ready for bacteriological testing.
- k) The City will obtain bacteriological samples of the water in the mains for analysis from testing blow-offs, corporations, or other sampling points as determined acceptable by the City.
- l) The water samples will only be bacteriologically tested at the City's Water Treatment Plant Laboratory. The use of other laboratories or testing locations shall not be allowed under any circumstance.
- m) No samples will be deemed acceptable until they meet all City requirements.
- n) If the newly constructed water main is connected at one end to an in-service section of the City water main, and the chlorination precedes pressure testing, the City will also take samples after satisfactory pressure testing.

- o) Two sets of samples shall be taken. 24 hours must elapse between flushing of the main and drawing of the first samples. The second samples will be drawn 24 hours after the first samples were drawn. For each sample, a minimum of 48 hours is required to obtain test results. All samples must pass the bacteriological test.
- p) If a new water main fails two consecutive sets of bacteriological tests, the PSAA may require the Contractor to re-swab the water main as described above.

8. Water Main Pressure Testing

- a) As much as possible, mains shall be pressure tested between valves. The maximum length of water main to be tested in any one test shall be 1500 feet.
- b) The section of main to be tested shall be slowly filled with potable water, the entrained air within the pipe removed or absorbed, and water main pumped up to a pressure of 150 psi (or other pressure if specified).
- c) The test period shall start immediately thereafter. The lines shall be maintained under a test pressure of 145-155 psi for a continuous period of three hours by pumping chlorinated (25 ppm) water into the line at frequent intervals.
- d) The volume of water so added, referred to as the makeup water, shall be measured and considered to represent the leakage from the line under test during the interval.
- e) Visible leaks shall be repaired regardless of test results.
- f) The makeup water under the conditions of the test shall not exceed the values shown in Table D of this Article. If one side of a double disc gate valve is under test pressure, that seat shall count as four joints.

Table D									
Hydrostatic Testing Allowance per 1,000 ft at 150 psi Avg. Test Pressure									
Pipe Diameter (in)	6	8	10	12	16	20	24	30	36
Makeup Water (gal/hr)	0.50	0.66	0.83	0.99	1.32	1.66	1.99	2.48	2.98

- g) If the makeup water exceeds the maximum allowable as specified, the joints in the line shall be carefully inspected for leaks and repaired where necessary. Any pipes or fittings found to be leaking shall be removed and replaced with new pieces by the Contractor. After this work has been performed, all tests shall be repeated.

M. Tapping Existing Water Mains

1. New water main construction shall not be connected into the existing system until it has been tested and accepted by the PSAA.
2. The Contractor may not operate City water main valves. For valve operation, contact City of Ann Arbor Public Services Area personnel. The City personnel will direct the operation of all valves by Contractor personnel. It is recommended that the Contractor request that the existing valves, which will need to be operated in order to perform the water main work, are checked in advance of the work to ensure that they operate properly. If the Contractor elects not to request the operation of the valves in advance of any required water main operation, then a request for extension of contract time will not be allowed.
3. All pipe materials and appurtenances in contact with potable water after the water service reconnections shall be disinfected with a strong chlorine solution prior to installation. This includes the pipe section to be tapped, the two halves of the sleeve, gaskets, and the gate valve.
4. Where proposed water mains or fittings connect with existing water mains or fittings, the possibility exists that some of the existing water mains may have been constructed using oversized, cast iron, pipe. Where tie-ins or interconnections are specified and the existing main is found to be oversized, the Contractor shall furnish and install Tyler Dual Sleeve 5-146L, or Smith-Blair 441 Coupling Sleeves. These sleeves are to be present on the jobsite prior to the excavation for the water main connection, or the work will not be allowed to commence.
5. Wet Taps
 - a) Prior to the installation of a tapping sleeve, the section of pipe to be tapped shall be cleaned of all foreign material and wire brushed to a smooth surface. The two halves of the sleeve shall be placed around the pipe with the gaskets installed per the manufacturer's instructions. Bolts shall be tightened evenly

from the center toward the ends. The bolts shall be tightened to the manufacturer's specified torque.

- b) When performing a wet tap in a prestressed concrete cylinder pipe (PCCP), grout is to be placed under the tapping saddle whether or not the saddle is epoxy coated.
- c) Prior to installation of the end gaskets, the sleeve shall be blocked with cement bricks such that the outlet is in proper position. The end gaskets shall be installed with an overlap as specified by the manufacturer.
- d) The glands shall be assembled on the pipe. The bolts around the gland shall be tightened evenly, causing the gaskets to uniformly compress.
- e) The valve shall be installed on the sleeve following the manufacturer's instructions.
- f) Prior to tapping, the assembly shall be tested using the test plug tap in the sleeve with the valve closed, or by placing a tapped plug on the outlet of the valve with the valve open. The assembly shall be pressurized to 150 psi and hold the pressure fifteen minutes. After the pressure test is complete, the pipe shall be tapped.

6. Dry Taps

- a) When a connection to an existing water main is to be made in the dry, the existing main to which a connection is to be made shall be isolated by the closing of the existing valves, and the water from the existing main shall then be pumped out or removed by other means so that the connection may be made in the dry.
- b) Due to the size and length of pipe being shut down and leaking valves, large amounts of water may need to be removed from the excavation. Where possible, the water shall be run directly into nearby storm sewer inlets via pumps and hose.
- c) It is possible that the valves which need to be operated to facilitate a shutdown will not close entirely, thereby allowing water to leak past the valve into the area of the shutdown. The Contractor shall provide the necessary labor, material, and equipment to enable work to be completed regardless of water leaking past the valves. Under no circumstances shall the Contractor be

compensated for "downtime" associated with water main valve or appurtenance failure or its inability to properly operate or close fully. An extension of contract time may be allowed if the Contractor has requested that the water main valves have been exercised in advance of the intended water main shutdown.

- d) The Contractor shall have all pipe, fittings and appurtenances required to complete the water main connection prior to the excavation for the connection, or the work will not be allowed to commence.
- e) The Contractor shall complete the water main work in a manner which minimizes the disruption of water service to the greatest extent possible.
- f) The City must notify all businesses and residents 48 hours in advance of a water main shut- down. To give the City an opportunity to provide such notification, the Contractor shall schedule the water main shutdowns at least 72 hours in advance, and preferably a full 4 or 5 days in advance, of the water main shut-down.
- g) No water main shutdown shall take place after 12:00 p.m. (noon), unless written permission has been granted by the PSAA and the Contractor has sufficient lighting equipment to provide a safe and efficient work area for working after dark. No water main will be shut down until the main has been exposed and cleaned and is ready to be cut.
- h) There shall be no gap larger than $\frac{1}{4}$ inch left in the existing water main as a result of the tie-in. If needed, a closure piece ("thrust ring") of such size to meet this requirement shall be installed.

N. Water Main Directional Drilling

1. A minimum of 14 calendar days prior to beginning actual drilling operations, the Contractor shall submit a Directional Drilling Plan for review and acceptance by the PSAA. The Plan shall indicate entrance and exit locations, stationing, depth of cover, and curve data. The plan shall also describe the method to be used for handling drilling fluid and emergency procedures for containing fluids in cases of accidental discharge. Work shall not commence on any directional drilling activities until such time as the Directional Drilling Plan has been accepted by the PSAA. Contract time shall continue during the review period of the Directional Drilling Plan.

2. As the drilling proceeds, the Contractor shall create an accurate as-built record of the alignment and elevation of the pipe with stationing.
3. Prior to beginning drilling operations, the Contractor shall prepare the entrance and exit locations and provide adequate supplies of drilling fluid, dewatering equipment, drill rods, and boring equipment to ensure a continuous operation when drilling begins.
4. The Contractor shall be responsible for any sheeting and shoring, dewatering with well points where necessary and determining types of subsurface materials which may be found, and determining their effect on subsequent construction operations.
5. The minimum depth of cover at any location shall be 5½ feet and the maximum depth of cover at any location shall not exceed 15 feet. Depth of cover is measured from the finished grade to the top of the pipe.
6. All HDPE pipe joints shall be fusion welded butt joints.
7. The method of installation shall consist of drilling or jacking a steerable rod with equipment capable of continuous, accurate monitoring of the drill bit location. Upon reaching the exit point, the Contractor shall attach a cone or wing cutter to the rod which, when pulled back, will obtain the required diameter.
 - a) Each joint fusion shall be recorded and logged by an electronic monitoring device (data logger) affixed to the fusion machine. Joint fusion data shall be submitted to the PSAA in accordance with this specification.
8. The diameter of the cone or wing cutter shall not exceed the diameter of the HDPE pipe by more than 1½ times. When the diameter of the cone or wing cutter is more than 2 inches larger than the pipe diameter, flowable fill shall be pumped into the void between the pipe and the drill hole to displace the drilling fluid. The method of placement of the flowable fill shall be approved prior to the issuance of the permit to place pipe.
9. The HDPE pipe shall be connected to the rods per the manufacturer's specifications to be pulled back through the hole.
10. Due to the fact that linear dimensions will vary with temperature change, connections to HDPE pipe shall not be made until it has reached an equilibrium temperature with its surrounding environment.

11. Restrained connections to conventional ductile iron water main, valves, or appurtenances shall be made using a mechanical joint adaptor with a stainless-steel stiffener inserted, unless otherwise shown on the plans.
12. Connections of HDPE pipe to existing water mains shall consist of a full-circle Flex Restraint Collar fused to the HDPE pipe embedded in a 30-inch x 30-inch concrete thrust block poured to undisturbed earth placed a maximum of 5 feet from the connection point.
13. All HDPE pipe shall be properly aligned at all transitions to conventional ductile iron pipe. The detectable trace wire installed in conformance with Article 3 (Water), Section II.F (Trace Wire) of these standards, shall be installed the entire length of the pipeline and shall terminate in the gate wells located at each end of the water main installation, or as directed by the PSAA.
14. After completion of each run, the HDPE pipe shall be hydrostatically tested by the Contractor in the presence of the PSAA after it has reached equilibrium temperature with the surrounding environment and prior to connections with conventional ductile iron pipe. The Contractor may elect to test both the HDPE and the Ductile Iron Pipe simultaneously. However, the Ductile Iron Pipe shall then be required to meet the testing requirements of the HDPE.
15. Pressure testing shall comply with AWWA C906 (Polyethylene (PE) Pressure Pipe and Fittings, 4 in. Through 65 In. (100 mm Through 1,650 mm) for Waterworks). Testing shall be in accordance with Section II.L (Water Main Testing) of this Article. The makeup water allowance for fused HDPE pipe joints is zero. The makeup water allowance for ductile iron pipe is as noted in the Water Main Testing section.
16. Disinfection and bacteriological testing shall be in accordance with AWWA Standards and as noted in the Water Main Testing section.

O. Temporary Water Main Line Stops

1. The existing mains upstream and downstream of the proposed line stop(s) cannot be shut down or taken out of service. To ensure that the entire operation shall be accomplished without interruption of service or flow, the installation shall be accomplished by Contractor personnel skilled and experienced in the procedures specific to line stops of the required size(s).

2. The work shall include, but not be limited to; pavement saw cutting; excavation and disposal of excavated material; the furnishing, installation, and removal of sheeting and/or shoring where needed; the furnishing, placement and compaction of approved bedding and backfill materials; furnishing and placing suitable, clean, gravel to create a stable working surface at the bottom of the excavation; de-watering; pipe cleaning, measuring, and performing all advance work necessary to prepare for the performance of the line stop; nighttime lighting as required; the removal of all materials and equipment associated with the work when no longer needed; and, any other items needed to complete the work as detailed on the plans and as specified herein.
3. The Contractor shall submit to the PSAA 2 sets of drawings, furnished by manufacturers, fully and distinctly illustrated and describing the Line Stop fittings proposed to be furnished. Work shall not commence until such time as the drawings have been reviewed and accepted by the PSAA.
4. The equipment shall consist of a cylindrical plugging head that contains a flat, expandable elastomer sealing element. The plugging head shall be advanced into and retracted from the main by means of a linear actuator. When retracted, the plugging head and carrier are housed in an adapter bolted pressure tight between the tapping valve and the actuator.
5. The sealing element shall be monolithically molded from a suitable polyurethane compound. The element shall be flat in a plane perpendicular to the flow in the main. Minimum thickness of the element shall be 4 inches. The bottom of the element shall be semi-circular to conform to the bore of the main.
6. Drilling equipment shall be in good working condition, equipped with power drive to ensure smooth cutting, and to minimize shock and vibration. Cutting equipment shall be carbide tipped and capable of being replaced without removal from the jobsite.
7. The diameter of the cylindrical plugging head shall be slightly smaller than the bore of the line stop nozzle. The plugging head shall have a suitable circumferential gasket to seal against the shoulder in the line stop nozzle. This gasket shall also seal against the sealing element to prevent bypass flow around the line stop.
8. The semi-cylindrical bottom of the plugging head shall be designed to break and dislodge tuberculation and other deposits in the bore of the main which might interfere with a satisfactory line stop.

9. Installation of proposed line stops in mains will require work in close proximity to existing utilities. This must be taken into consideration when the Contractor determines the required trench safety requirements. All excavation shall conform to MIOSHA Standards. The Contractor is solely responsible for determining all excavation and trench safety requirements.
10. If necessary, The City will reduce the pressure to 100 psi or less for the duration of the installations. The entire operation of installing the line stop shall be accomplished without reduction of water pressure in the main(s) below 100 psi. It shall be the responsibility of the Contractor to verify pressure prior to commencing the installation.
11. Prior to ordering material, Contractor shall excavate at each proposed location and carefully measure the outside diameter of the water main with calipers along at least 4 locations to determine ovality and the critical outside diameter of the water main. The Contractor shall determine main wall thickness, uniformity, and structural integrity by means of ultrasonic testing. Data shall be taken to determine extent of internal deposits, tuberculation, etc.
 - a) In addition, the Contractor shall anticipate that exterior main conditions, bells, service connections, or presence of adjoining utilities may require relocation of proposed line stop.
 - b) If the PSAA determines that Contractor's data is not adequate, the PSAA may direct Contractor to make one or more pressure taps on main to obtain test pipe coupons for the PSAA's evaluation. The minimum size of the test coupon shall be 5 inches in diameter, drilled through a nominal 6-inch valve. Pressure tapping saddles and other materials used for inspection taps shall conform to the City's requirements. The Contractor shall anticipate that heavy interior corrosion and/or tuberculation exists within the water main.
 - c) If in PSAA's opinion the proposed location is unsatisfactory based on measurements of the existing pipe at the locations of the proposed line stops, the PSAA will direct excavation at another site.

12. Because of possible internal corrosion and deposits in existing water mains, a "bottle-tight" shut down may not occur. A satisfactory shutdown which allows the work to be accomplished (i.e. valve replacement, water main tie-in, etc.) using drainage pumps to dewater excavations, with workers wearing boots and raingear, if necessary, must be obtained. The Contractor will not be allowed to proceed with further work until an acceptable shutdown is achieved. The Contractor shall be aware that this may require the halting of work and re-scheduling of all work operations.
13. Contractor shall power wire brush and grind the exterior of the water main to remove any debris, corrosion deposits, or other surface irregularities that might interfere with proper seating and sealing of each line stop fitting against each main. Any structural defects in the water main, service connections, appurtenances, adjacent utilities, etc., that could interfere with the line stop installation shall be immediately reported to PSAA.
14. All line stop fittings and appurtenances shall be cleaned and disinfected in accordance with current AWWA Standards prior to bolting any of the line stop fittings in place or commencing any pipe cutting.
15. Contractor shall fit upper and lower saddle plate assemblies to main, thoroughly checking for proper fit to main. Under no circumstances shall Contractor attempt to force, reshape, or bend saddle plates by excessive tightening of saddle studs while the line stop fitting is assembled around the main. Any required retrofitting shall be accomplished with the fitting removed from the main. Any damage to fitting, accessories, or main shall be repaired at Contractor's expense to the satisfaction of PSAA.
16. Upper and lower saddle halves shall be drawn together by bolt assemblies and the saddle plates shall be bolted together in the horizontal position.
17. All line stop work shall be performed in accordance with the equipment manufacturer's approved work procedures and installation guidelines.
18. Final closure of the water main shall be accomplished by insertion of a manufacturer-approved completion plug. The Contractor shall test the completion plug sealing through the use of a bleed off assembly in the machine housing.
19. The Contractor shall remove the temporary valve and the installation of a blind flange shall be completed.

20. The Contractor shall place polyethylene encasement meeting these Standards around the upper and lower saddle halves, the blind flange, and to a point at least 1 foot on either side of the saddle halves. All polyethylene encasement shall be securely taped to the water main such that water entry is minimized to the greatest extent possible.

P. Installation of Storm Sewer

1. All storm sewer pipe and pipe joints shall be the class, type, and size as shown on the Plans or specified and shall conform to Article 4 (Stormwater), Section II (Stormwater Materials) of these Standards. Bedding and backfill shall be as specified elsewhere in this Section.
2. The Contractor shall dig up and expose all utility crossings prior to laying any storm sewer pipe. This will allow the PSAA to adjust the grade of the storm sewer, if possible, to avoid the existing utilities. The PSAA may require that some exploratory excavation be performed out of the current construction stage or phase where the storm sewer work is taking place in order to aid in alignment decisions.
3. Should the storm sewer conflict with abandoned sewers or water mains, the conflicting section of abandoned sewer or water main shall be removed, and the remaining sections shall be bulk headed or capped.
4. All pipes shall be bed on the proper thickness of compacted pipe bedding material unless pipe undercutting is required. Any required pipe undercutting shall be performed as directed by the PSAA.
5. Bell holes shall be provided in the trench bottom at each joint to permit the joints to be made properly.
6. Each pipe shall be inspected for defects prior to being lowered into the trench. Inside of pipe and outside of spigot shall be cleaned of any earth or foreign matter.
7. Proper implements, tools, and facilities satisfactory to the PSAA shall be provided and used by the Contractor for the safe and convenient prosecution of the work. All pipe, manhole bases, manhole sections, and other similar items shall be carefully lowered into the trench piece by piece by means of suitable tools or equipment as recommended by the manufacturer, in such a manner as to prevent damage to them and their protective coatings and linings. Under no circumstances shall materials be dropped or dumped into the trench.

8. Storm sewer pipe may not be cut when the cut end will be used in making a pipe joint. Cut ends may only occur in situations such as a manhole or headwall. Cut ends shall be carefully and neatly made with a saw, pipe cutter, or other approved means.
9. Construction of storm sewers shall begin at the outlet end and proceed upstream. Pipe shall be laid on the prepared subgrade with the bell ends facing the direction of laying, unless otherwise directed by the PSAA.
10. The Contractor shall take every precaution to prevent foreign material from entering the pipe while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug. This provision shall apply during the noon hours as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.
11. Pipe shall be jointed as specified elsewhere in this Section.
12. No pipe shall be laid until a cut sheet for that pipe has been approved by the PSAA. All pipe shall be laid at the correct line and grade as indicated by the grade stakes and offset line.
 - a) The correct line and grade shall be maintained by the use of a laser alignment system. Each pipe, as laid, shall be checked by the Contractor to ensure that this result is obtained. The grade as shown on the Plans is that of the pipe invert for sewers and the work must conform to this profile.
 - b) A variation of $\frac{1}{4}$ inch from this profile grade will be deemed sufficient reason to cause the work to be rejected and re-laid. Storm sewer pipe alignment shall be maintained so as to not vary more than one-half inch from the correct line on pipes up to 36 inches in diameter nor more than 1 inch on pipes 42 inches in diameter and larger. Any pipe found out of line shall be re-laid properly by the Contractor.
13. Mechanical means shall be used for pulling home all rubber-gasketed pipe regardless of trench condition where manual means will not result in pushing and holding the pipe home. When a trench box or liner is used, a cable shall be used to pull the joints home and hold them in position.

14. Where work is performed in wet trenches or trenches with running sand, the Contractor shall provide and use mechanical means for pulling the pipe home in making up the joint and for holding the pipe joints tight until completion of the line. Mechanical means shall consist of a cable placed inside or outside of the pipe with a suitable winch, jack, or come-along for pulling the pipe home and holding the pipe in position.
15. Where not required by these Standards, manual means will be acceptable only if the joints can be pushed home and hold themselves securely in place.
16. Pipe bedding shall be in conformance with Section II.H (Pipe Bedding) of this Article.
17. All storm sewers shall be television inspected by the Contractor in accordance with Section II.X (Cleaning and Televising of Sewer) of this Article.

Q. Curb Drain Installation

1. Connections to the curb drain from sump pump discharge lines shall be made with thermally welded HDPE saddles. Saddle size shall match existing discharge line size and as directed by the Engineer. Transition from HDPE to existing discharge line shall be with stainless steel reinforced Fernco couplings or approved equivalent.
2. All drilling mud and other excavated materials shall be prevented from entering the storm sewer system by using silt capturing devices on all storm structures which may be impacted. Prior to pulling the curb drain into place, relief excavations shall be installed on either side of each driveway, driveway extension or sidewalk intersecting with the proposed run. All drilling mud discharged from the relief excavation shall be immediately removed using vacuum methods.
3. Curb drain runs installed using trenching (open cut) construction methods as shown on the plans shall have a minimum grade of one-half (1/2) inch per ten (10) feet of run. Bellies and non-sloped sections will not be allowed. Suitable back fill for bedding of the pipe will consist of four (4) inches crushed limestone.
4. Following curb drain installation, water shall be placed into the curb drain through the cleanout and televised (by Contractor) to determine if any bellies or non-sloped sections exist. Copies of these videos will be provided to construction management team for review, and each installation must be approved before payment can be made on the corresponding invoice.

5. If bellies or non-sloped sections are found, they shall be corrected and televised again to gain approval. Corrections may include, but are not limited to, exposing the pipe, re-grading, and adding or removing backfill around or below the pipe. An approved tracing/locating wire (12 gauge wire w/ green HDPE coating) is required to be placed during installation. Tracer wire shall be placed intact (no cutting or splicing) from the cleanout, where it is to be coiled around the end of the pipe to the storm water connection, below ground level, where it is to be wrapped around a self-tapping screw into the wall of the structure.
6. Contractor shall install a cleanout for video inspection and cleaning purposes on the upstream end of the 6-inch HDPE curb drain, as directed by the Engineer. This work will include installing a long sweep 90-degree elbow (6-inch, fabricated) with a threaded, removable end cap and sufficient magnets securely fastened (using both glue and screw, or other mechanical connector) to the cap to allow for ease in locating with a magnetic locating device. The top of cleanout cap will be installed at a depth of 4 inches below the existing ground surface. The maximum distance between cleanouts or an existing stormwater structure shall not exceed 300 feet.
7. All HDPE Pipe and Fittings shall be fused as outlined in ASTM D2657, Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings.
8. Connections to the curb drain from sump pump discharge lines shall be made with thermally welded saddles. Units shall be a HDPE 6x2 or 6x4 (direction will be provided by the PSAA regarding which size per location) Branch Saddle or Approved Equivalent.

R. Installation of Sanitary Sewers

1. Installation must conform to ASTM D2321 for PVC pipe and ASTM C12 for rigid pipe.
2. New sanitary sewer construction shall be plugged at the outlet and not be connected into the existing system until the new sewer been tested and accepted. Construction of sanitary sewers shall begin at the outlet end and proceed upstream, unless otherwise directed by the PSAA. Pipe shall be laid on the prepared trench bedding with the bell ends facing the direction of laying.

3. The Contractor shall take every precaution to prevent foreign material from entering the pipe while it is being placed in the line. During laying operations, no debris, tools, clothing or other materials shall be placed in the pipe. At times when pipe laying is not in progress, the open ends of pipe shall be closed by a watertight plug. This provision shall apply during the break period as well as overnight. If water is in the trench, the seal shall remain in place until the trench is pumped completely dry.
4. All pipe shall be laid at the correct line and grade as indicated by the grade stakes and offset line. The correct line and grade shall be maintained using an internal pipe laser. The staking shall be provided by the PSAA. No pipe shall be laid until a cut sheet for that pipe has been approved by the PSAA.
5. The grade as shown on the Plans is that of the pipe invert for sewers; the work must conform to this profile. A variation of $\frac{1}{4}$ inch from this profile grade will be deemed sufficient reason to cause the work to be rejected and re-laid. Sanitary sewer pipe alignment shall be maintained so as to not vary more than $\frac{1}{2}$ inch from the correct line on pipes up to 36 inches in diameter, nor more than 1 inch on pipes 42 inches in diameter and larger. Any pipe found out of line or grade shall be re-laid properly by the Contractor.
6. Due to conditions in the field, changes to the proposed vertical and horizontal alignment of the proposed sanitary sewer may become necessary. The Contractor shall, when directed by the PSAA, excavate up to 60 feet in advance of the pipe laying operation to expose existing underground facilities thereby enabling the PSAA to make changes to alignment decisions. The Contractor is required to realign (re-lay) the sanitary sewer up to 2 feet vertically and/or horizontally as directed by the PSAA. The excavation in advance of the pipe laying is intended to help eliminate the need for re-laying pipe.
7. Making Joints:
 - a) Mechanical means shall be used for pulling home all rubber-gasket pipe regardless of trench condition where manual means will not result in pushing and holding the pipe home. When a trench box or liner is used, a cable shall be used to pull the joints home and hold them in position.

- b) Where work is performed in wet trenches or trenches with running sand, the Contractor shall provide and use mechanical means for pulling the pipe home in making up the joint and for holding the pipe joints tight until completion of the line. Mechanical means shall consist of a cable placed inside or outside of the pipe with a suitable winch, jack, or come along for pulling the pipe home and holding the pipe in position.
 - c) Where not required by these Standards, manual means will be acceptable only if the joints can be pushed home and held.
- 8. The pipe shall be secured in place with approved bedding material tamped under it except at the bells. Pipe and fittings which do not allow proper and uniform space for joints shall be removed and replaced with pipe and fittings of correct dimensions to insure such uniform space. Precautions shall be taken to prevent dirt from entering the joint space.
- 9. Sanitary sewer pipe may not be cut when the cut end will be used in making a pipe joint. Cut ends may only occur in situations such as a manhole. Cut ends shall be carefully and neatly made with a saw, pipe cutter, or other approved means.
- 10. Wyes and Tees
 - a) One 6-inch wye shall be provided for each lot or parcel that is served by the sewer unless otherwise indicated on the Plans or determined by the PSAA. In all cases, it shall be the responsibility of Contractor to see that the wyes are so placed.
 - b) Wyes to developed lots or parcels shall be placed at the location nearest the existing sanitary service lead.
 - c) Wye openings shall be closed with a 6-inch stopper, as recommended by the manufacturer, to make a watertight closure.
- 11. Risers and Building Leads
 - a) Risers shall be installed where the sewer is more than 12 feet below the established grade or future grade and carried to between 9 and 10 feet of the established grade or future grade, unless otherwise determined by the PSAA.
 - b) Riser openings shall be closed with a stopper, as recommended by the manufacturer, to make a watertight closure.

- c) Building leads shall conform to Article 2 (Sanitary), Section I.L (Sanitary Service Leads) and depth requirements per Section I.G (Depth and Cover), of these Standards.
- d) Each building lead shall be closed with a stopper, as recommended by the manufacturer, to make a watertight closure.
- e) Unless otherwise determined by the PSAA, prior to the backfilling of a wye, riser, or building lead, a 2-inch x 2-inch (minimum cross section) wooden marker shall be placed at a point immediately in front of the service connection to 1 foot below the finish ground surface. Do not rest the marker on any portion of the service connection or stopper.

S. Manholes, Drainage Structures, and Gate Wells

- 1. Sanitary manholes shall conform to Article 2 (Sanitary), Section II.B. (Manholes) and Article 12 (Standard Details), SD-SN-1 (Sanitary Manhole) of these Standards.
- 2. Stormwater manholes, catch basins, and inlets shall conform to Article 4 (Stormwater), Section II.B. (Manholes and Drainage Structures) and to applicable stormwater Standard Details of these Standards.
- 3. Gate wells shall conform to Article 12 (Standard Details), SD-W-3 (Precast Gate Well (Watermains 16 inch and Smaller)) of these Standards, or SD-W-4 (Precast Gate Well (Butterfly Valves)) as indicated on Plans.
- 4. Concrete block construction shall only be allowed for storm sewer manholes and inlets where specifically approved by the PSAA and shall be built of the size and dimensions shown on the Plans. The block shall be clean, laid in a full bed of mortar, and thoroughly bonded by completely filling the vertical end grooves with mortar so as to interlock with the adjacent block.
 - a) The mortar beds and joints shall not exceed $\frac{3}{4}$ inch thickness. The vertical joints are to be completely filled with the joints on the inside face rubbed full of mortar and all joints struck smooth as the manhole, inlet or structure is built up.

- b) The entire inside and outside faces of the structure shall receive a ½ inch thick mortar coat and struck smooth. All masonry materials, sand, and water shall be heated to over 50° F during freezing weather, and the completed work shall be covered and protected from damage by freezing. Backfilling shall not occur until the exterior mortar coating has cured.
- 5. All structures shall be designed to accommodate HS-20 Live Load requirements as determined by a Professional Engineer licensed by the State of Michigan, regardless of where they are to be installed.
- 6. Manholes, gate wells and drainage structures shall be constructed within 2-½ inches of plumb.
- 7. Sewer pipes shall extend into structures a minimum of ½ inch and a maximum of 3 inches.
- 8. Flow channels for sanitary sewer shall be full depth pipe diameter.
- 9. Flow channels for sewer structures shall be finished in accordance with the Standard Details. All flow channels shall be screeded and floated to a smooth, uniform surface and troweled to a hard surface finish.
- 10. Stubs for future sewer connections shall be furnished and placed by the Contractor as shown on the Plans or as directed by the PSAA. Connections shall be properly supported and braced when not resting on original ground so that any settlement will not disturb the connection. Stubs shall consist of 1 length of sewer pipe, of the size indicated on the Plans, with a watertight plug.
- 11. As soon as practicable after a precast structure has been set, forms and debris have been removed from the structure, and the structure has been inspected and approved, the excavated area around the structure shall be backfilled up to the specified grade with MDOT Granular Material, Class II. No boulders, rocks, stones, masonry, lumber, or debris shall be allowed within the backfill. Backfill shall be compacted to 95% of its maximum unit weight.
- 12. An exterior drop connection, in accordance with the Article 12 (Standard Details), SD-SN-2 (Drop Manhole Connection) of these Standards, shall be provided where a branch sanitary sewer is brought into a manhole more than 24 inches above the invert elevation in the manhole.

13. Connections to existing manholes shall be made in accordance with the Plans. If tapping an existing manhole, an opening shall be cored into the receiving structure of the proper size to allow the installation of an approved boot.
 - a) The Contractor shall take care not to cause undue damage to the existing manhole while coring the new opening. Repair or replacement of existing manhole(s) damaged by Contractor operations during tapping shall be at the Contractor's expense.
 - b) Any taps into a lined manhole shall be restored to ensure warranty compliance at the Contractor's expense.

T. Reconstruct Structures

1. Removing and disposing of portions of existing brick or block masonry drainage structures, and rebuilding drainage structures of concrete block masonry shall be done in conformance with MDOT Specifications, Section 403 (Drainage Structures) except as specified herein. Water main gate wells and gate box covers shall be considered to be included in this item of work.
2. Structures to be reconstructed shall be as called for on the Plans or as determined by the PSAA. Reconstruction of structures shall apply where the elevation of the casting must be raised in excess of 12 inches, lowered in excess of 6 inches, or to rebuild portions of the existing structure which are deteriorated.
3. For structures in existing pavement, the pavement shall be saw cut a minimum of 6 feet by 6 feet unless otherwise shown on the plans. Saw cutting, removal and replacement of concrete and bituminous pavement, and aggregate base course, shall be incidental to the reconstructing the structure unless otherwise noted in the Contract Documents.
4. The existing frame and cover shall be carefully removed and stored and shall be reinstalled on the same structure unless a new frame and cover are called for on the Plans.
5. The existing ring and chimney/corbel entrance sections shall be removed along with any additional brick courses or precast concrete sections necessary to achieve the amount of reconstruction called for on the Plans or as determined by the PSAA.
6. The necessary brick work and precast concrete sections shall be installed to meet the design grade.

7. Manhole steps, where required, shall be furnished and shall be installed, as necessary, so that maximum spacing is 16 inches.
8. Brick or concrete adjustment rings shall be set in mortar or installed as shown on the Plans and as determined by the PSAA.
9. The outside surface of any new brick or block structures shall receive a masonry plaster coat, a minimum of ½ inch thick. The structure shall be properly backfilled with Class II granular material, compacted in place, and meeting the approval of the PSAA.
10. The flow in the entire system shall be maintained, at the Contractor's expense, while performing the Work. The manhole structure shall be cleaned, and all unsuitable material shall be disposed of at the Contractor's expense.

U. Structure Adjustment

1. Manhole covers, water valve boxes and all other public utility underground access or control point covers shall be adjusted to conform to the finished surface section and elevation, including excavation, backfill, compaction and patching.
2. After the removal of the casting, the structure's opening shall be covered by a steel plate. The plate shall be properly placed in order to avoid any slippage due to traffic or construction machinery movements. The opening shall be covered to prevent construction debris from entering the structure. The plate shall be covered with MDOT 21AA gravel to existing surface elevation or as directed by PSAA. Steel plates shall be sufficiently strong and thick enough to carry the traffic and construction equipment without any deflection. Steel plates shall also be pegged as shown on the Plans and Details in order to prevent their shifting and/or moving. Steel plates are the property of the Contractor and shall be removed by the Contractor upon completion of the work.
3. The PSAA shall be given the opportunity by the Contractor to witness all survey monuments prior to their being disturbed and/or adjusted.
4. For concrete pavement, prior to placement all structures shall be raised to grade . The structures shall be adjusted prior to paving.
5. Either of the following methods shall be used for for bituminous pavement, per Article 12 (Standard Details), SD-GU-5 (Structure Cover Adjust):

- a) All covers shall be adjusted to grade after the initial leveling, base course(s), and/or patching course has been placed, but before the placement of the wearing course. Prior to the leveling or base course(s) being placed, the structures shall have their covers and castings removed and the structures covered by a steel plate. This plate will be removed, and the structure adjusted after the completion of all base and leveling courses.
 - b) All covers shall be adjusted to grade (by coring, and not saw cutting) after the placement of the wearing course. Prior to the bituminous pavement being placed, the structures shall have their covers and castings removed and the structures covered by a steel plate.
- 6. The frame and cover shall be set in MDOT P-NC concrete per Article 12 (Standard Details), SD-GU-5A (Structure Cover Adjust), SD-GU-5B (Structure Cover Adjust), and SD-GU-6 (Valve and Monument Box Adjustment) of these Standards and checked by using a 10-foot straight edge parallel with the pavement centerline.
 - 7. All structures are to be adjusted to a level that results in their surface being flush with the finished grade. Failure to meet these conditions will result in the readjustment of the structure and finish patching of the area as directed by the PSAA at the Contractor's expense.
 - 8. Frames shall be pointed with mortar on the interior of the structure to a smooth brushed finish.
 - 9. All non-public utility structures (Electric, Gas, Telephone, Cable TV, etc.) shall be adjusted by the Utility Company or their contractor. It is the sole responsibility of the Contractor to give adequate notice to the Utility Company and to arrange for and coordinate any adjustment of structures or valves by the Utility Company.
 - 10. The Contractor shall replace frames and covers as directed by the PSAA.
 - 11. All salvaged frames and covers (of any type) shall be returned by the Contractor to the City's Public Works yard within two days from the date of their removal.

V. Drainage Structure Covers

- 1. Drainage structure covers shall conform to Article 12 (Standard Details), SD-GU-1 (Standard Casting Schedule) of these Standards.

2. All cast iron covers, frames, adjusting rings, and anchors shall be furnished by the Contractor and installed to the elevation indicated on the Plans.
3. The covers shall be set flush with pavement or ground surfaces. In gravel streets, covers shall be set 6 to 8 inches below finished gravel surface.

W. Testing Sanitary Sewer

1. All sanitary sewers, including leads, less than 36-inch diameter shall be air tested by the Contractor. All sanitary sewers 36-inch diameter or greater shall be infiltration or exfiltration tested by the Contractor. Infiltration testing is appropriate where the groundwater is two feet above the top of the pipe. Below that level, exfiltration testing should be conducted .
2. All sewers, except 4-inch and 6-inch leads, shall be television inspected by the Contractor. All PVC sanitary sewer mains shall be deflection tested.
3. All sewers must successfully complete each test, in order (deflection testing, air or infiltration/exfiltration testing, television inspection), before the next test is performed.
4. The Contractor shall furnish all labor, equipment and materials necessary for testing. Only after all tests have been successfully completed and acknowledged by the PSAA in writing, may the sewer be placed in service.
5. Air Test:
 - a) The air test can be dangerous. Lack of understanding, carelessness, or an improperly prepared line must be avoided. It is extremely important that the plugs be installed in such a way as to prevent blowouts. Sudden expulsion of a poorly installed or partially deflated plug can cause serious injury or damage. As a safety precaution, pressurizing equipment must include a relief valve set at not more than 10 psig. No one will be allowed in the manholes during testing.
 - b) In areas where ground water is known to exist and the sewer is to be air tested, the Contractor shall install a ½-inch diameter by approximately 10-inch long pipe nipple, through the manhole wall above one of the sewer lines entering the manhole. The pipe nipple shall be capped on the inside of the manhole at the time the sewer line is installed. Backfill around the outside of the pipe nipple shall be large sized, open graded course aggregate.

- c) Immediately prior to the performance of the air test, the ground water level shall be determined by removing the pipe cap, blowing air through the pipe nipple into the ground to clear it, and then connecting a clear plastic tube to the pipe nipple. The tube shall be held vertically and a measurement of the height in feet of water above pipe centerline shall be taken after the water stops rising in this plastic tube. The height in feet is divided by 2.31 to establish the average ground water pressure (in psig) over the pipe.
- d) The normal sequence and time requirements for air testing are:
 - (1) After a manhole-to-manhole section of line has been backfilled and cleaned, it shall be plugged at each manhole with pneumatic plugs. The design of the pneumatic plugs shall be such that they will hold against the line test pressure without requiring external blocking or bracing. There shall be 3 hose connections to the pneumatic plug. One hose shall be used only for inflation of the pneumatic plug. The second hose shall be used for continuously reading the air pressure rise in the sealed line. The third hose shall be used only for introducing low pressure air into the sealed line.
 - (2) Low pressure air shall be introduced into the sealed line until the internal air pressure reaches 4.0 psig greater than the average ground water pressure over the pipe. At least 2 minutes shall be allowed for the air pressure to stabilize. After the stabilization period, the pressurization hose shall be disconnected to prevent air from entering or escaping from the line.
 - (3) There shall be a pressure gauge for reading the internal pressure of the line being tested. The gauge shall be capable of showing pressure as low as 0 psig up to no greater than 20 psig. In the 0-10 psig range, the gauge shall be both calibrated and accurate to one-tenth of one pound and the gauge dial shall cover at least one-half of the complete dial range. This gauge shall have a tee fitting to allow simultaneous pressure reading by a City gauge.
 - (4) The time requirement for the pressure to decrease from 3.5 to 2.5 psig (greater than the average ground water pressure over the pipe) shall not be less than the time given in Table E of this Article:

Table E Pressure Holding Table			
Pipe Size (inches)	VCP & RCP Sewers	PVC Sewers	
	Minimum Holding Time (seconds/100ft. pipe)	Holding Time (Seconds)	Minimum Holding Time (min:sec)
4	18	0.380 x Length	3:46
6	42	0.854 x L	5:40
8	72	1.520 x L	7:34
10	90	2.374 x L	9:26
12	108	3.418 x L	11:20
15	126	5.342 x L	14:10
18	144	7.692 x L	17:00
21	180	10.470 x L	19:50
24	216	12.674 x L	22:40
30	288	21.366 x L	28:20
36	360	30.768 x L	34:00
Comply with ASTM F1417 for PVC, ASTSM C828 for VCP, and ASTM C924 for RCP			

6. Infiltration Test

- a) The Contractor shall place temporary weirs for testing purposes in such manholes as necessary to measure the amount of infiltration. Test sections shall be no longer than 1,200 feet.
- b) The allowable amount of infiltration shall not be more than 100 gallons per inch of pipe diameter per mile of sewer per 24 hours, including manholes. The Contractor shall repair all visible leaks regardless of the results of the infiltration test.
- c) If the allowable limit of infiltration is exceeded on any test section, the Contractor shall reconstruct or repair the defective portion of the sewer, and re-test.

7. Exfiltration Test

- a) The standpipe method will be used from manhole to manhole for the length of pipe to be tested. A hydrostatic head of 10 feet above the sewer's average centerline elevation will be required, with adjustments for external submergence due to water in the trench. The PSAA will establish time durations and procedures for each test. The maximum allowable exfiltration rate will be 200 gallons per inch of pipe diameter per mile of sewer per 24 hours including manholes. Upon completion of this test on a sanitary sewer, the Contractor shall pump all water out of the downstream manhole and discharge it to a storm sewer.

8. Deflection Testing/Mandrel Testing

- a) All PVC sanitary sewer pipe shall be tested for deflection, but no sooner than 30 days following the backfilling of the pipe.
- b) Maximum allowable deflection (reduction in vertical inside diameter) shall be 5 percent.
- c) Locations with excessive deflection shall be excavated and repaired by re-bedding and/or replacement of the pipe.
- d) Device options for testing include a deflectometer, or a properly sized "go, no go" mandrel. Mandrel shall have a minimum of 9 legs. Mandrel calibration shall be verified by PSAA on-site before use.

X. Cleaning and Televising Sewer

- 1. The Contractor shall provide a detailed sewer cleaning and televising plan to the PSAA for review and acceptance prior to beginning the work. This plan must include descriptions outlining all provisions and precautions to be taken by the Contractor regarding the handling of existing flow.
- 2. The cleaning plan and televising must be specific, including such items as schedules, locations, type of equipment, details on water source, plans for disposal, and all other incidental items necessary and/or required to ensure proper protection of the facilities and surroundings, including protection of the access locations from damage, and compliance with the requirements and permit conditions specified in Contract Documents.

3. No work shall begin until all provisions and requirements have been reviewed and accepted by the PSAA.
4. The PSAA's comments shall be incorporated into the resubmitted plans, calculations, and descriptions. The PSAA's acceptance of the plan is required before beginning the work. Resubmittals shall be reviewed and returned to the Contractor within 14 calendar days. Required revisions will not be a basis of payment for additional compensation, extra work, or an extension of contract time. The Contractor shall include time for this entire review process in their schedule.
5. Sewer cleaning and televising plan and submittals shall include at a minimum:
 - a) Copy of PACP/MACP Certifications for sewer televising personnel and manhole inspection personnel;
 - b) Proof of PACP/MACP certified software;
 - c) Safety program for confined space entry;
 - d) Information on equipment, trucks, tanks, etc., including, but not limited to, dimensions, required turning radius, fuel type, any special requirements, etc.;
 - e) Staging areas for equipment, trucks, tankers, etc.;
 - f) Schedule for cleaning and televising of pipe lines, manholes, and chambers;
 - g) Planned hours of operation, including equipment idling, etc.;
 - h) Number, size, material, and location of hose/piping;
 - i) Information on cleaning equipment;
 - j) Siphon dewatering plan;
 - k) Sludge and debris dewatering, transportation, and disposal procedure and location;
 - l) Environment protection including equipment and pipe containment, leak detection, and/or remediation plan; and,
 - m) Method of noise control for all equipment.
6. The Contractor shall carry out their operations in strict accordance with all MIOSHA and manufacturer's safety requirements.

7. The Contractor shall be solely responsible for safety of all those involved with the work during the performance of all work. The Contractor shall not enter into any sewer segment where hazardous conditions may exist until such time as the source of those conditions is identified and eliminated by the Contractor. The Contractor shall perform all work in accordance with the latest OSHA confined space entry regulations. The Contractor shall coordinate their work with local fire, police, and emergency rescue unit.
8. The Contractor shall be responsible for any damage to public or private property resulting from their televising and cleaning activities and shall repair or otherwise make whole such damage at no cost to City and owner of the property.
9. The Contractor shall provide for the transfer of main line flow around the section or sections of pipe that are to be cleaned and televised, as required to complete cleaning, televising, and inspection work. The diverting and lateral bypass pumping work shall be performed in accordance with this Article and as directed by the PSAA.
10. If the Contractor chooses to only divert part of the flow during their sewer cleaning operations, the Contractor must indicate that in their submittal, including which plugs would be installed. Contractor to note that all plugs, level sensors, and lateral bypass pumping system shall be in operation for the new sewer televising, manhole inspections, and chamber inspections.
11. Sewer Cleaning
 - a) Each sewer section shall be cleaned to a degree sufficient to allow video inspection. The Contractor shall take precautions to protect the sewer lines from damage. The Contractor shall assume the sewer will require heavy cleaning with unlimited passes to achieve a clean sewer and that rodding and root cutting shall be required and the costs are included in the Work.
 - b) For CIPP pipe, the Contractor must adhere to the requirements of ASTM F1216 (Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube), or ASTM F1606 (Standard Practice for Rehabilitation of Existing Sewers and Conduits with Deformed Polyethylene (PE) Liner), for the following types of cleaning: hydraulic cleaning, high velocity hydro-cleaning, and mechanical cleaning.

- c) Dirt, grease, rocks, sand, roots, and other solid or semisolid materials and obstructions shall be removed from the sewer line and manholes. Cleaning shall be of the entire reach between manholes and/or chambers.
- d) It shall be the responsibility of the Contractor to clear the line of obstructions such as solids, dropped joints, debris from collapsed pipe, sediment deposits, mineral deposits, stalactites, and all major blockages that would prevent sewer rehabilitation work from being performed.
- e) The sewers shall be cleaned by using a high-pressure water cleaning machine with minimum capability of 5,000 pounds per square inch (psi) at 80 gallons per minute (gpm).
- f) A high-pressure hose with a jet nozzle shall be introduced into the sewer so that a spray shall scour and clean the sewer line without applying internal pressure and damaging the pipe.
- g) This will require an unlimited number of passes of the jet nozzle, or other cleaning measures, to remove all debris. The hose shall be self-propelled by a minimum water pressure of 1,000 psi. Cleaning pressures to 5,000 psi may be required to remove heavy tuberculation and adhered debris from the pipe interior.
- h) The jet nozzle hose, upon withdrawal, will scour the pipe (invert, walls, and crown), flushing all materials into the downstream manhole for removal.
- i) For major blockages where cleaning cannot be completed, the Contractor shall notify the PSAA for review and approval before proceeding.
- j) Material removal shall be performed at the manholes identified for access for the cleaning operation. At no time during cleaning shall material be allowed to enter or flow in the sewer past the downstream access manhole. Passing material from manhole section to manhole section shall not be permitted. All debris and waste material shall be completely removed from the sanitary sewer system and shall be disposed of by the Contractor in accordance with federal, state and local requirements.
- k) Mechanical root cutting shall be performed with powered equipment. The Contractor shall furnish suitable power machinery which shall be used to remove tree roots and deposits remaining after jet cleaning that prevent passage of television inspection equipment or prevent the lining of the sewer.

- l) The Contractor shall provide high quality digital video in a digital format approved by the PSAA that verifies that the sewer is clean and free of sediment and debris to the satisfaction of the PSAA. If any sewer is not satisfactorily cleaned, it shall be promptly cleaned and reinspected by closed circuit television camera and video provided to the PSAA for review and approval.
- m) If the sewer has material and debris that prevents the proper installation of the CIPP, prohibits video inspection, or is not cleaned to the satisfaction of the PSAA, the sewer shall be re cleaned and re-televised at the Contractor's sole expense.
- n) The sewer shall not be lined until such time as the cleaning operations have been approved in writing by the PSAA. Field Inspection personnel shall not be allowed to authorize the Contractor to begin installation of the CIPP sewer liner.
- o) Extensions of contract time will not be granted for delays associated with recleaning and re-televising the sewer.
- p) Fire hydrants used, when permitted by the PSAA as additional source of water during the cleaning operation shall be provided with PSAA-approved device to meter water usage and prevent backflow into the potable water system. The backflow and metering equipment shall be furnished and installed by Public Works.

12. Manhole Cleaning

- a) The manhole structures shall be cleaned below their invert elevations with a power vacuum, or other PSAA approved method, to remove all sediment to allow for the inspection of the bottom of the structures.
- b) The Contractor shall assume the manholes and chambers require heavy cleaning with multiple passes to achieve a clean manhole. Manhole and chamber cleaning shall be incidental to the sewer cleaning and no additional payment shall be provided.
- c) If the preliminary inspection of walls determines that any additional work in the manhole will compromise the integrity of the walls or structure, all cleaning of the manhole or chamber shall immediately stop. The PSAA will instruct the Contractor on how to proceed.

- d) If the preliminary inspection determines cleaning of the walls may proceed, the structure cleaning shall remove all sediment, sand, grease, debris and unsound or loose material, old coatings, and other deleterious materials from the floor, walls, and roof. Cleaning equipment may include high pressure water (3,500 psi or greater), abrasive blasting, grinding, or acid etching. Use of detergents and/or hot water may be required to remove fats, oils, and grease. The removal of the spalling on the walls shall be performed as directed by the PSAA during the inspection. The Contractor shall take care as not to damage the steel reinforcement in the walls.
- e) The Contractor shall identify any surface material that cannot be removed using conventional equipment or methods listed above and submit to the PSAA for review.
- f) The Contractor is to note the chambers may also contain weirs and internal walls that need to be cleaned as well.

13. Television Inspection of Sewer

- a) All sewer television inspections shall conform to NASSCO CCTV inspection performance specifications published at the time of Contract award unless otherwise specified herein.
- b) The Contractor shall furnish all labor, equipment and materials necessary for the television inspection. The PSAA shall be given 24-hour notice so that an Inspector may witness the television inspection. All sewer lines are to be thoroughly cleaned prior to television inspection by jetting of the lines or other approved methods.
- c) Television inspection shall consist of wetting the invert of the section by pouring clean water in the upstream manhole until it appears in the downstream manhole, and then, after the water has stopped flowing, passing a television camera through the section of sewer. The television camera shall be passed through the section of pipe from the downstream to upstream end. Any runs of sewer not televised in this manner shall be re-televised at the Contractor's expense.

- d) Lighting for the camera shall be adequate to allow a clear picture of the entire periphery of the sewer and shall be varied as required to be effective for all pipe diameters inspected. Remote control of lighting brilliance, camera focus, and camera movement shall be from a control panel inside the mobile recording studio. Cables and equipment used to propel the camera shall not obstruct the camera view or interfere with the documentation of the sewer conditions.
- e) The camera shall be moved through the sewer line at a uniform rate, maximum 30 feet per minute. Whenever possible, the camera shall move in an upstream direction. The camera shall be stopped for no less than 10 seconds at the manhole entrances, each service lateral, exit manholes, and at all points where the sewer is damaged or deficient. The camera shall pan and tilt to provide full view of each service lateral, and at all points where the sewer is damaged or deficient.
- f) If the camera fails to pass through a pipe section, the Contractor shall reset the equipment and attempt to perform the inspection coming back from the next upstream, identified for access, manhole. If the inspection cannot be completed from the next manhole, the inspection shall be considered complete and the PSAA will provide written instructions to the Contractor describing how to proceed with the work in that reach of sewer.
- g) The camera shall be connected to a monitor and a digital video recorder capable of generating high quality digital format video on a video format approved by the PSAA. The video inspection record shall indicate the date, the section tested, and the actual distance from the beginning manhole to the ending manhole and shall note any and all visible defects, tees and wyes and their direction, and any other features; with a distance measurement to the nearest $\frac{1}{10}$ foot. Defect coding shall be the most recent NASSCO version or that published at the time of contract award as approved by the PSAA.
- h) The Contractor shall supply the PSAA with two electronic copies of the entire and final televised program conforming to NASSCO guidelines, including PACP database, MACP database, video pipe recordings, defect photos, and reports in a format approved by the PSAA. The submittal format may be physical (e.g., external hard drive, flash drive) or digital (e.g., a shared folder accessible by the PSAA). Digital submittals shall remain accessible at least three years after the end of the Contract. The data shall be provided within 15 working days of

completion of field work. The information for individual databases, sewer segments, and recordings shall not be split into several drives. The flash drives or portable hard drives and information within it shall become the property of the City.

- i) The Contractor shall provide to the City inspection reports listing the location in relation to adjacent manholes of: each infiltration point; service leads; unusual conditions; roots; sewer connections; collapsed sections; presence of scale and corrosion; cracked pipe; wide joints; and other discernible features.
- j) The reports shall indicate size and type of pipe material, length of line from manhole, and direction of sewage flow, if present. The reports shall also indicate the time and date of recording. Each report shall be named with the pipe inspections from starting manhole to terminus manhole for each stretch of sewer. All reports shall be in accordance with NASSCO, PACP, and MACP standards, outlined above.
- k) The Contractor shall provide color photographs of sewer laterals and all problem areas.
- l) The television inspection will be deemed satisfactory if no visible defects, including, but not limited to, dips or low spots, high spots, deviations in horizontal or vertical alignment, offset joints, leaks, cracks, standing water greater than ¼ inch, or debris are present. Only after all tests have been successfully completed and acknowledged by the PSAA in writing, may the sewer be placed into service.

Y. Sewer Flow Control

1. The work covered by this Section shall consist of furnishing all labor, supervision, tools, equipment, appliances, materials, incidental items, and the installation, operation, and maintenance needed to perform all operations in connection with the diversion of flow and bypass pumping of sanitary sewage for cleaning and inspecting of sewers and manholes, and sewer repairs, and sewer rehabilitation. The purpose is to provide uninterrupted sewerage service and to prevent sewage overflows.
2. The design, installation, and operation of the temporary sewer flow control system shall be the Contractor's sole responsibility.

3. When working inside manholes or sewer, the Contractor shall exercise caution and comply with OSHA and City requirements for working in confined spaces.
4. The Contractor shall manage, plan, and execute their operations such that there will be no backups, leaks, or unauthorized discharges of sewerage. The Contractor shall be completely responsible for the proper clean up and any environmental remediation as may be required by the City or the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for any backup, leak, spill, or sanitary sewerage overflow.
5. The Contractor shall provide a detailed Sewer Flow Control Plan to the PSAA for review and acceptance prior to the start of any flow control work. This plan must include descriptions outlining all provisions and precautions to be taken by the Contractor regarding the handling of existing flow.
6. The Sewer Flow Control Plan must be specific, including such items as schedules, locations, elevations, capacities of the equipment, materials, and all other incidental items necessary and/or required to ensure proper protection of the facilities, including protection of existing structures and pipes, and compliance with the requirements and conditions specified in these Contract Documents.
7. No construction shall begin until all provisions and requirements have been reviewed and accepted by the PSAA.
8. For each submittal and resubmittal, the Contractor shall allow at least 14 calendar days from the date of the submittal to receive the PSAA's acceptance or request for revisions. The PSAA's comments shall be incorporated into the resubmitted plans, calculations, and descriptions.
9. Resubmittals shall be reviewed and returned to the Contractor within 14 calendar days. Required revisions will not be a basis of payment for additional compensation, extra work, or an extension of contract time. The Contractor shall include time for this entire review process in their schedule.
10. Sewer Flow Control Plan submittal shall include at a minimum:
 - a) Overall flow control plan and sequence of construction;
 - b) Flow control schedule including times when the flow control system shall be temporarily shut down and flow allowed to return to normal operations;

- c) Overall plan for removal of flow control system during wet weather events and/or emergency situations;
- d) Plan for providing redundancy for all aspects of the system especially the plugs;
- e) Safety Program for confined space entry and procedure for entering manholes and installing plugs under live flow conditions;
- f) Emergency clean-up plan should a spill occur or backups in the system occur. The plan should include contact names and 24-hour phone numbers;
- g) Procedure for continuous (24 hour) monitoring of system, including verifying that plugs are sealed, and lateral bypass pumping system is operating. The plan is to include type and location of level sensors, method of installation, set elevations of sensors, and continuous monitoring system;
- h) Maintenance of traffic plan for plug installation and removal in public roadways;
- i) Sewer plug types, method of installation and removal, anchors and restraints, and hydraulic head limits;
- j) Lateral bypass pump sizes, capacities, power requirements, and number of each size to be provided at each manhole including redundancy;
- k) Calculations giving flow capacity provided by each pump given the system's Total Dynamic Head (TDH), including the calculations that are used to derive the system TDH. This data should also include the calculations determining what the Net Positive Suction Head available is in comparison to the Net Positive Suction Head required by each pump.
- l) Pump curves;
- m) Number, size, material, and location of lateral bypass pumping suction and discharge piping, procedure for protecting lines, and location of bypass pumping discharge manhole;
- n) Lateral bypass pumping system flushing and drainage plan;
- o) Buried bypass pipe locations and details;
- p) Environment protection including pump containment and leak detection;

- q) Method of protecting discharge manholes or structures from erosion and damage;
 - r) Method of noise control for each pump; and,
 - s) Design plans for access to bypass pumping locations indicated on the Drawings.
11. Contractor shall provide materials and equipment suitable for, and known to be reliable to meet, the flow diversion requirements as shown on the Drawings and as needed for the Contractor's operations. Equipment used for bypass pumping shall be sufficient to handle anticipated average and peak flows from each sewer. The Contractor shall maintain sanitary sewer flows within their bypass pumping system, including all wet weather flows. Specific equipment requirements include:
- a) Pipe plugs shall be a temporary plug that allows for quick removal in case of emergency or wet weather situation and reinstallation after wet weather event has passed. Plugs shall be capable of withstanding minimum static head pressure of 15 feet. Plugs shall include form or bracing, anchoring, or restraint to keep plugs properly installed. Plugs should be of the type capable of being installed under live flow conditions and in depths as shown on the Drawings. Plugs should be able to be installed in either the incoming or outgoing pipe in a manhole and allow for quick removal under surcharged conditions.
 - b) Pressure gauges shall be installed with the plugs to continuously monitor the plugs and adjust the air pressure as needed to maintain full blockage of flow.
 - c) Ultrasonic level sensors shall be installed, at a minimum, at the locations as necessary to monitor the head conditions in the sewer. The Contractor shall be responsible for the installation and maintenance of the sensors. The level sensors shall provide continuous level readings that the Contractor shall be able to review remotely to monitor the level in the system during flow diversion. The level sensors shall provide notifications and alarms to allow the Contractor time to remove the plugs should an emergency or a wet weather event occur.
 - d) The pumps must be capable of passing a minimum of a 3-inch solid. All pumps must be constructed to allow dry running for long periods of time to accommodate the cyclical nature of effluent flows.
 - e) The Contractor shall take into account seasonal variations and include a safety factor above the indicated peak flow values in sizing pumping equipment.

- f) For sanitary sewerage, bypass piping shall be PVC Schedule 80, or equivalent, with solvent welded joints, or HDPE with butt fused joints. The Contractor shall perform hydrostatic testing of bypass pump discharge pipes in accordance with ASTM F2164 (Standard Practice for Field Leak Testing of Polyethylene (PE) and Crosslinked Polyethylene (PEX) Pressure Piping Systems Using Hydrostatic Pressure), latest addition, for HDPE or ASTM F2261 (Standard Test Method for Pressure Rating Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 and 80 Socket-Type), for PVC pipe, prior to operating bypass pumping system to ensure structural integrity of pipeline. Any defects or leaks found during testing shall be repaired and the pipeline shall be re tested until results are satisfactory in accordance with the ASTM standard, and as acceptable to the PSAA.
- 12. The Contractor shall have redundant flow diversion equipment including, but not limited to, plugs and level sensors, available for immediate use at the job site at all times in the event of a failure.
- 13. Any damage to the Contractor's equipment, sewer system, or delays to the Contractor's operations due to equipment or plug failure/leakage shall be the Contractor's sole responsibility and no additional payment shall be made for these occurrences. The Contractor shall take all necessary precautions to verify that the plugs and flow diversion plan is operational prior to performing the work.
- 14. The Contractor shall have redundant lateral bypass pumping equipment installed and ready for immediate operation and use in the event of an emergency or primary system breakdown or failure. The standby system shall be capable of pumping dry weather and peak flow.
- 15. The standby pump(s) shall not be considered as any part of the primary system as designed for peak flow. The Contractor shall also furnish and have available onsite, and ready for operation, redundant pumping ancillary equipment in case of any failure of the pumping system including piping, electrical equipment, pipe appurtenances, etc. Redundant pumping facilities shall also include having a backup power generator in case the primary power source fails.
- 16. The Contractor shall not obstruct flows in the sewer unless the primary and redundant equipment is onsite and in operable condition and authorization has been granted by the PSAA.

Z. Sewer Main and Service Lead Repairs

1. If a sewer repair is required as a result of damage during construction operations or television inspection failure, the Contractor shall expose the sewer pipe and perform the required correction(s), as specified herein and as directed by the PSAA.
2. If the repair is required due to the pipe being out of alignment or off grade, the pipe shall be adjusted to place it in proper alignment and grade. 6-A coarse-graded aggregate material shall be carefully placed under the haunches of the realigned pipe and compacted with a tee-bar. From the haunches of the pipe, backfilling shall be performed in accordance with the requirements for backfilling as outlined in Section II.I (Pipe Backfill) of this Article.
3. If the pipe cannot be satisfactorily realigned or an open joint satisfactorily closed, or if the pipe is cracked, broken, or permanently deflected, the affected pipe shall be removed and replaced with the same pipe material or other similarly performing pipe material as approved by the PSAA. The pipe to be removed is to be sawed on each side of the damaged section in a neat and workmanlike manner without damage to the adjacent pipe. The replacement pipe section shall fit flush to the remaining pipe at each end. These sawed joints shall be coupled using a PSAA-approved flexible pipe coupling and stainless-steel shear ring. The remaining pipe backfill shall be performed in accordance with the applicable requirements for backfilling as outlined in Section II.I (Pipe Backfill) of this Article.

AA. Abandonment and Removal of Sewers and Drainage Structures

1. Sewers, manholes, and drainage structures designated to be removed, shall be removed and disposed of off-site in such a manner as not to damage any new work, or work or material which is to remain in-place.
2. Abandonment of all storm and sanitary sewers shall include placing flowable fill the full length and cross section of the abandoned sewer or removing the entire run of sewers. The Contractor's method to accomplish this will be subject to approval of the PSAA. See Article 5 (Streets), Section II.P (Flowable Fill), of these Standards for additional requirements.

3. The Contractor is responsible to provide all needed materials and appurtenances to properly introduce the flowable fill into the pipe being abandoned. The Contractor shall also provide the needed vent device(s) in order to remove air that becomes trapped during the grouting operations. All measures provided by the Contractor for the introduction and venting of the grouting operations shall be effective.
4. The resulting hole left in a structure from a removed or abandoned sewer shall be bulkheaded with bricks and mortar to provide a watertight seal and constructed such that the remaining flow in the structure is not impeded.
5. Abandoning structures shall include completely removing the top part of the structure to 4 feet below finished grade. The remaining portion of the structure shall be backfilled in a manner approved by the PSAA to the top of the portion of the structure left in place.
6. Within 2 days of their removal, the Contractor shall stockpile on-site, in a location that is mutually agreeable to the PSAA and Contractor, the existing structure frames and covers. The Contractor shall deliver the frames and covers to Public Works within this 2-day period. The Contractor shall provide the equipment and manpower to unload the castings at the Public Works yard at a location indicated by City staff.
7. If located within public rights-of-way, railroad rights-of-way, or within the influence of paved surfaces, the hole or trench resulting from the removal or abandonment of any manhole, sewer, or drainage structure shall be backfilled with MDOT Granular Material, Class II, in maximum lifts of 12 inches, and be compacted to 95% of its maximum unit weight. Otherwise, backfill shall be PSAA approved native material, compacted to 90% of its maximum unit weight, in lifts of 12 inches or less.

BB. Abandoning and Removal of Water Main and Appurtenances

1. The Contractor shall abandon water mains where shown on the Plans. This includes, but is not limited to:
 - a) Cutting the main at each end;
 - b) Plugging the live main at the end(s) with push-on joint plug(s) and thrust block(s);
 - c) Plugging the abandoned main at its end(s) with brick and mortar, concrete, or mechanical joint plug;

- d) Breaking down any gate wells or valve boxes (removing frame and cover, and the top 4 feet of the gate well structure, and backfilling as specified herein) in the abandoned line;
 - e) Removing and salvaging any valves and fittings, as directed;
 - f) Removing and salvaging all fire hydrants, unless otherwise directed;
 - g) Plugging the pipe in manholes with brick and mortar, concrete, or mechanical joint plug; and
 - h) Abandoned water main in MDOT ROW, or where directed, shall be filled with flowable fill, the Contractor is responsible to provide all needed materials and appurtenances to properly introduce the flowable fill into the full length and cross section of the pipe being abandoned. The Contractor shall also provide the needed vent device(s) in order to remove air that becomes trapped during the filling operations. The ends of an abandoned water main shall be capped or bulkheaded with bricks and mortar to provide a watertight seal such that any remaining pipes in the structure are not impeded. Method of filling water main is subject to approval by the PSAA. See Article 5 (Streets), Section II.P (Flowable Fill), of these Standards, for additional requirements.
2. In locations as shown on the Plans or where abandoned water main, valves, or valve wells are within 30 inches of the proposed subgrade, the pipe, valves or valve wells shall be removed completely. If located within the public rights-of-way, railroad rights-of-way, or within the influence of paved surfaces or structures, the resulting hole or trench shall be backfilled with MDOT Granular Material, Class II, in maximum lifts of 12 inches, and be compacted to 95% of its maximum dry density. Otherwise, backfill shall be PSAA approved native material, compacted to 90% of its maximum dry density, in lifts of 12 inches or less.
3. Abandoned (salvaged) or removed valves, gate well castings and covers, and fire hydrant assemblies shall be neatly stacked on-site in a single location and delivered to Public Works within 2 days of removal. The Contractor shall provide the equipment and manpower to unload the salvaged components at the Public Works yard at a location indicated by City staff.

4. When abandoning asbestos concrete water main pipes, the pipe shall be kept wet at all times while cutting or crushing operations are occurring. High-speed friction saws shall not be used to cut the pipe. Asbestos concrete pipe shall be abandoned by capping it on both ends and burying it in the trench. At no time shall any asbestos concrete pipe be removed from the site unless specifically directed to do so in writing by the PSAA.

CC. Removal and Disposal of Contaminated Soil

1. The Contractor shall be aware that soils within the City of Ann Arbor and Washtenaw County contain levels of naturally-occurring, regulated, elemental metals. The City of Ann Arbor has completed testing on numerous projects and levels of these naturally-occurring, regulated, elemental metals that may be encountered within the City of Ann Arbor and have found that they generally correspond to concentrations presented in the 2005 State of Michigan Background Soil Survey approved by EGLE on October 4, 2019 for the Huron-Erie glacial Lobe.
2. All excavated material generated on the project shall become the property of the Contractor. Any excavated material that cannot be incorporated into the project work, in accordance with the material requirements of the work being performed, must be properly disposed of off-site by the Contractor.
3. Consequently, excavated soils that do not exhibit odors, discoloration, or other indications of contamination, and meet the definition of an inert material in accordance with Part 115 Solid Waste Management of the Michigan Natural Resources and Environmental Protection Public Act 451 of 1994 (MNREPA Act 451), are not required to be disposed of in a landfill. These soils shall be disposed of by the Contractor by the method of their choice.
4. The City of Ann Arbor suggests a disposal method that minimizes future human contact with the soil or the soil's contact with a water course or ground water sources, due to the possibility of elevated concentrations of naturally-occurring, regulated, elemental metals. The Contractor shall be responsible for any disposal or relocation methods that they chose to employ in the disposal of these soils.
5. The Contractor's excavation of soil on the project shall be considered prima facie evidence that they have considered these facts and have included all necessary resources to perform all work of this project and to properly dispose of excavated soils from this project off-site.

6. If the Contractor encounters soil suspected of containing contaminated constituents other than those of naturally-occurring, regulated, elemental metals it must be tested and classified prior to transport and disposal in accordance with EGLE Waste Characterization Guidance.
7. Contaminated soil characterized as non-hazardous or hazardous may not be reused on-site within the project area.
8. Non-hazardous, non-Resource Conservation and Recovery Act (RCRA) contaminated material shall be managed in accordance with Part 201 Environmental Remediation of the MNREPA Act 451. RCRA hazardous material shall be managed in accordance with Part 111 Hazardous Management of the MNREPA Act 451.
9. Soils containing elevated levels of naturally-occurring, regulated, elemental metals that are determined to be above EGLE-regulated background levels are excluded from the definition of "Contaminated Soil." During the performance of work on a City project, if such soils are found or determined to exist after a course of testing and characterization, the off-site disposal of those soils shall not be paid.
10. Contaminated soil shall be placed in a vehicle equipped to carry the class of the material on public roads to the disposal site in accordance with applicable federal, state, or local regulations applicable to such soil, whether it is non-hazardous or hazardous.
11. The Contractor shall be responsible for all sampling and analysis required for the disposal of contaminated material. Refer to EGLE Waste Characterization Guidance for guidance on the type of analysis required.
12. If the results of the analysis show the material to be non-hazardous or hazardous as defined by Part 111, of the Natural Resources and Environmental Act, Act 451, P.A. 1994, the PSAA shall be notified immediately. The material shall then be disposed of at a licensed Type I or Type II landfill as required by the applicable EGLE guidance.

13. This work shall be performed in accordance with MDOT Specifications, Subsections 104.07.B (Contractor Obligations) and 107.01 (Laws to be Observed), and Sections 204 (Removing Miscellaneous Structures and Materials) and 205 (Roadway Earthwork), except as modified herein or as directed by the PSAA. The Contractor shall have all manifests signed by its representative, the PSAA's representative, the authorized representative of the waste hauler and the waste disposal facility.
14. Excavated non-hazardous or hazardous contaminated soil which is to be temporarily stockpiled shall be placed on plastic sheeting or tarps having a minimum thickness of 6 mils or in trucks, roll-off boxes, or other containers, such that no liquid may escape from the containment. At the end of each work day, the contaminated material shall be covered securely with plastic sheeting of 6 mils thickness or greater.
15. Excavated hazardous or non-hazardous material shall be disposed of as soon as approval is received from the disposal site. In no case shall this material be stockpiled for longer than 30 days prior to disposal.
16. The Contractor is responsible for the necessary coordination such that Contractor's work activities are not adversely impacted by the stockpiling of contaminated soil. Stockpiled soil shall not impair sight distance or drainage. Time extensions shall not be granted by the PSAA for delays in receiving approval for the disposal of contaminated material at the appropriate landfill or other similar circumstances.
17. Disposal of non-hazardous contaminated soil shall be at a licensed Type II sanitary landfill. Disposal of hazardous contaminated soil shall be at a licensed Type I hazardous waste landfill. The Contractor shall submit at the pre-construction meeting the name of the Type II or Type I landfill to be used for disposal, the sampling and analysis requirements of the landfill, and verification that the use of the proposed landfill will meet the requirements of the County solid waste plan.
18. The disposal facility must be acceptable to the City of Ann Arbor and therefore approval must be obtained from the PSAA prior to commencing disposal operations. Prior to obtaining approval for the disposal from the City, the Contractor shall provide a copy of the laboratory analysis to the PSAA.

DD. CIPP Sewer Lining

1. Description

- a) This work shall consist of rehabilitating pipelines by the insertion of a resin impregnated flexible lining and cured in place to form a pipe. The cured in place pipe (CIPP) shall be saturated with a thermosetting resin, styrene free unless otherwise approved by the PSAA, and inserted into the existing pipeline. Curing shall be accomplished by a method approved by the PSAA to harden the resin into a hard, impermeable pipe. When cured, the hardened CIPP shall be a tight-fitting watertight pipe within a pipe. The CIPP shall be continuous from manhole to manhole with no circumferential joints or seams.
- b) All work shall be performed in accordance with these Standards and as directed by the PSAA.
- c) For a CIPP system to be considered acceptable, the CIPP system must have at least 2,000,000 lineal feet of successful, documented installations, a minimum of 250,000 lineal feet of which shall have been in the Midwestern United States or Canada. Newer CIPP systems may be approved at the discretion of the PSAA.
- d) When requested by the PSAA, the Contractor shall submit test results from previous field installations of the same resin system and tube materials as proposed for this installation. The test results must verify that the CIPP physical properties specified in this specification have been achieved in the field.
- e) The lining operation shall not begin until the sewer has been cleaned and video inspected in accordance these Standards and authorization to begin by the PSAA has been granted.
- f) Cleaning and television inspections of sewers for CIPP Lining shall not be paid for separately but shall be included in the cost for the CIPP Lining.

2. Design Considerations

- a) The required structural CIPP wall thickness shall be based, at a minimum, on the physical properties of the cured composite and per the design of the Professional Engineer. The finished liner shall be designed per ASTM F1216 (Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube), Appendix X1, for the following condition:

Condition Fully deteriorated gravity pipe
 Safety Factor 2
 Ovality As measured by Contractor during sewer inspection;
 assume 2% for bidding purposes
 Soil Density 130 pounds per cubic foot (lbs/cft)
 Soil Modulus 700 pounds per square inch (psi) for pipe inverts up to
 and including 15 feet deep, 1,000 psi for pipe inverts
 greater than 15 feet deep
 Groundwater Depth As field verified
 Surcharge Loading HS 20 (Highway) when any part of the sewer is under
 any major street, county road, or state highway; E 80
 (Railroad) when under any railroad

- b) The Contractor shall determine the liner thickness and resin quantity for this project per ASTM F1216, Appendix X1. Liner thickness, resin, and resin quantity shall be furnished to the PSAA for review and approval prior to beginning work. The design calculations for wall thickness shall be completed by a Professional Engineer proficient in the design of pipeline systems, licensed in the State of Michigan, with design calculations signed and sealed. The CIPP design shall assume no bonding to the original pipe wall.
- c) The Contractor shall submit, prior to installation of the lining materials, certification of compliance with these specifications. Certified material test results shall be included that confirm that all materials conform to these specifications. Materials not complying with these requirements will be rejected.

3. Material

- a) All materials shipped to the project site shall be accompanied by test reports certifying that the material conforms to the latest ASTM standards listed herein. Materials shall be shipped, stored, and handled in a manner consistent with written recommendations of the CIPP system manufacturer to avoid damage. Onsite storage locations shall be as indicated on the Drawings and approved by the PSAA.

b) Preliner Tube

- (1) The preliner shall be a polyethylene material compatible with the lining system, and shall be utilized where necessary to accommodate infiltration, damaged, or missing pipe.

c) Felt Tube Liner

- (1) The tube shall consist of one or more layers of absorbent, flexible felt material. The tube shall be capable of carrying the specified resin, constructed to be able to withstand installation pressures and curing process, have sufficient strength to bridge missing pipe and stretch to fit irregular pipe sections at all pipe locations, and be compatible with the resin used.
- (2) The outer tube coating shall consist of an impermeable, flexible membrane that contains the resin and allows for visual inspection and verification of proper resin impregnation ("wet out") procedure. The coating shall hold the resin inside the tube without leakage, accommodate installation, and stretch to the size and shape of the existing sewer, and shall not delaminate before, during, or after curing.
- (3) The tube shall have a uniform thickness that when compressed at installation pressures will meet, or exceed, the design thickness.
- (4) The tube shall be fabricated to a size and length that when installed will fit sufficiently tight within the existing pipe so as to not leak at manholes, at service connections, or through the wall of the installed pipe. The tube shall be properly sized to the diameter of the existing pipe and the length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends.
- (5) The Contractor shall determine the minimum tube length necessary to effectively span the designated run between manholes. The Contractor shall verify the lengths in the field prior to impregnation of the tube with resin, to ensure that the tube will have sufficient length to extend the entire length of the run. The Contractor shall also measure the inside diameter of the existing pipelines in the field prior to ordering liner so the liner can be installed in a tight fitted condition. Allowance for circumferential stretching of the tube during insertion shall be made as per manufacturer's recommendations. Overlapped layers of felt in the

longitudinal seam that cause lumps in the final product shall not be utilized.

- (6) The tube shall be homogeneous across the entire wall thickness and contain no intermediate or encapsulated elastomeric layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shall be evident.
- (7) The wall color of the interior pipe surface of the CIPP after installation shall be a light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made. The hue shall be dark enough to distinguish a contrast between the fully resin saturated felt fabric and dry or resin-lean areas.
- (8) Seams in the tube shall be stronger than the un-seamed felt and shall meet the requirements of ASTM D5813 (Standard Specification for Cured-In-Place Thermosetting Resin Sewer Piping Systems). Where the length of the tube to be installed requires joining along the circumference of the tube, the sewn joint shall not be perpendicular to the long axis but spirally formed and sewn.
- (9) The outside of the tube shall be marked for distance at regular intervals along its entire length, not to exceed 5 feet. Such markings shall include the manufacturers name or identifying symbol. The tubes must be manufactured in the USA.
- (10) The length of the tube shall be that deemed necessary by the Contractor to effectively carry out the insertion and seal the pipe at the inlet and outlet points, plus that amount required to run in and run out for the installation process. The Contractor shall verify the lengths in the field before cutting the tube to length. Lengths of sewer shall be lined over one or more access points as shown on the Plans.

d) Resin

- (1) Thermoset, non-styrene resin shall be a polyester, enhanced polyester, vinyl ester, or epoxy system including all required catalysts, initiators, or hardeners that when cured within the tube creates a composite that satisfies the requirements of ASTM F1216 and ASTM F1743 (Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe Systems

(CIPP)), the physical properties herein, and those which are to be utilized in the design of the CIPP for this project. Resin selected shall be resistant to the chemical composition of the sewage and comply with the structural requirements of this specification.

- (2) The resin shall be thermosetting resin that is compatible with the lining process and shall meet the requirements of ASTM F1216 except as otherwise specified in this specification. The resin shall be able to cure in water with an initiation temperature for cure as required by the liner manufacturer, but not greater than maximum temperatures required under ASTM F1216. The cured resin/felt system shall be suitable for the expected conditions within the existing sanitary sewer.
- (3) The Contractor is responsible for choosing a resin system that is capable of meeting the physical and cured-in-place properties and performance requirements as detailed in this specification.

4. Construction

- a) The completed liner as installed and fully cured-in-place shall meet the minimum physical properties for short term flexural modulus and flexural strength as specified herein.
- b) Fiber optic probes shall be installed to monitor the average temperature along the entire length of the tube as it cures. Devices shall be provided by VeriCure or a PSAA-approved equal.
- c) The Contractor shall carry out their operations in strict accordance with all OSHA, MIOSHA, and manufacturer's safety requirements. The Contractor shall be solely responsible for safety during the performance of all work. The Contractor shall not enter into any sewer segment where hazardous conditions may exist until such time as the source of those conditions is identified and eliminated by the Contractor and/or the City. The Contractor shall coordinate their work with local fire, police, and emergency rescue unit.
- d) The Contractor shall be responsible for any damage to public or private property resulting from their sewer lining or televising activities and shall repair or otherwise make whole such damage at no cost to the City.

- e) Prior to rehabilitation of any sewer, it shall be the responsibility of the Contractor to remove all internal deposits from the pipeline. This shall include dirt, debris, mud, bricks, grease or oils, mineral deposits, root masses, pieces of broken pipe, etc.
- f) Inspection of pipelines shall be performed after the pipe has been cleaned by experienced personnel trained in locating breaks, obstacles, and service connections by closed circuit television.
- g) The interior of the pipeline shall be carefully inspected to determine the location and extent of any structural failures. The location of any conditions which may prevent proper installation of lining materials into the pipelines shall be noted so these conditions can be corrected as specified in this specification.
- h) It shall be the responsibility of the Contractor to clear the line of obstructions such as solids, dropped joints, root masses, protruding branch connections, or broken pipe that will prevent proper insertion of the liner in accordance with these Standards.
- i) The Contractor shall provide for the transfer of main line and/or lateral flow around the section or sections of pipe that are to be cleaned, televised, and rehabilitated. The work shall consist of diverting, pumping, and bypassing flow in the existing sewers as directed by the PSAA and in accordance with Section II.Y (Sewer Flow Control) of this Article.

5. Installation of Resin Impregnated Tube

- a) The Contractor shall designate a location where the uncured resin in the original containers and the unimpregnated liner will be resin impregnated prior to installation. The Contractor shall allow the PSAA to inspect the materials and procedure.
- b) A resin and catalyst system compatible with the requirements of this specification shall be used. The quantities of the liquid thermosetting materials shall be provided in accordance with manufacturer's standards to provide the cured liner properties specified. Sufficient resin shall be used to fill the volume of air voids in the liner with additional allowance for polymerization, shrinkage, and loss of resin through cracks and irregularities in host pipe wall. The Contractor shall ensure the proper amount of resin is uniformly distributed throughout the entire length of the tube.

- c) The wetting out, installation, and curing of the resin impregnated tube shall be in accordance with ASTM F1216 and per manufacturer's specifications. The tube shall be inserted through existing manholes by means of an inversion process, the application of a hydrostatic head sufficient to fully extend the liner to the next manhole, or other means as approved by the PSAA.
- d) The process will be adjusted as necessary to ensure a complete lining without overstressing or tearing the lining, with sufficient pressure to hold the liner snug to the pipe wall, and to produce dimples at side connections and flared ends at the entrance and exit access points. The use of a lubricant is recommended and, if used, such lubricant shall be compatible with the rehabilitation process.
- e) The manufacturer's standards shall be closely followed during the elevated curing temperature so as not to over stress the felt fiber and cause damage or failure of the liner prior to cure.

6. Curing

- a) Hot water curing is required for full length liners. After installation of the resin impregnated liner is completed, the Contractor shall supply a suitable heat source and water recirculation equipment as necessary to cure the liner. The equipment shall be capable of delivering hot water to the far end of the liner through a hose which has been perforated per manufacturer's recommendations, to uniformly raise the water temperature in the entire pipe above the temperature required to affect a cure of the resin. This temperature shall be determined by the resin/catalyst system employed.
- b) All water necessary for the cleaning and lining operations shall be furnished by the City at agreed access places. Hydrants used by the Contractor shall be pumped down by the Contractor to prevent freezing. Frozen hydrants that were used by the Contractor and not properly closed or pumped down shall be repaired by the Contractor at no additional cost.

- c) For quality control during the CIPP lining operation, the Contractor shall utilize remote temperature sensing devices placed between the host pipe and the liner to continuously monitor the liner cure incrementally every 18 inches or less to verify that an exothermic reaction has occurred and that a full cure has taken place along the full length of the CIPP liner. Measuring temperatures at the liner endpoints only will not be permitted. The cure information must be taken from the bottom third of the pipe liner. Cure parameter information shall be provided by the resin manufacturer.
- d) Liner and/or host pipe interface temperature shall be monitored and logged during curing of the liner. The monitoring system must have the ability to be remotely viewed live by the PSAA. Data collected shall be provided to the PSAA in Excel spreadsheet and graphical viewer formats at the same time as the post-lining inspection videos are provided.
- e) Initial cure shall be deemed to be completed when the remote sensing devices reflect that the cure temperature, as recommended by the resin/catalyst system manufacturer, have been achieved. The cure period shall be of a duration recommended by the resin manufacturer, as modified for site specific conditions, during which time the recirculation of the water and cycling of the heat exchanger to maintain the temperature in the liner shall continue.
- f) The Contractor shall cool the CIPP in accordance with the CIPP manufacturer's recommendations to a temperature below 100°F before relieving the static head in the liner. Temperatures and curing data shall be monitored and recorded by the Contractor throughout the installation process to ensure that each phase of the process is achieved in accordance with the CIPP manufacturer's recommendations.
- g) Cool down may be accomplished by the introduction of cool water into the liner to replace water being drained from the downstream end. Care shall be taken in the release of the static head such that a vacuum will not be developed that could damage the newly installed liner. The cooled water shall be released to the existing sanitary sewer at a rate that is approved by the PSAA and the City of Ann Arbor's Wastewater Treatment Plant (WWTP) superintendent.

7. Completion of Liner

- a) The cured liner shall be continuous over the entire length of an insertion run and be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The lining shall be impervious and free of any leakage.
- b) Any defects which will affect the integrity of the liner, or any deficiencies in required strengths or thicknesses, shall be repaired or removed and replaced at the Contractor's expense, in a manner acceptable to the PSAA.
- c) A seal, consisting of a hydrophilic sealing gasket compatible with the installed CIPP, shall be installed at each manhole/pipe wall interface. The seal shall be a seamless molded tubular design that swells in the presence of water. The seal shall be secured in place by a retaining ring.
- d) The completed liner shall be television inspected and color videotaped, by the Contractor, in accordance with these Standards.
- e) After the liner has been cured, the Contractor shall reconnect the existing service connections. This shall generally be done without excavation and, in the case of non-man entry pipes, from the interior of the pipeline by means of a television camera and a cutting device that re-establishes them to operational capacity.
- f) Reconnection of services shall begin immediately after curing of the CIPP has been completed. No service shall be interrupted for more than 12 hours unless otherwise approved by the PSAA.
- g) Each lateral shall be fully reopened as much as possible without damaging the host pipe. Brushing of all lateral connections shall be completed to remove all rough and burned edges.
- h) The Contractor shall have a second robotic cutting device as a backup unit for reinstating the service connections on site prior to commencing the installation of the CIPP.

8. Acceptance Tests

- a) The PSAA shall perform Acceptance Testing in accordance with ASTM F1216 (including appendices) and ASTM D5813.

- b) The Contractor shall prepare plate test samples to be cured with the CIPP operation. The Contractor shall capture and prepare 10 sample specimens of the liner for the Acceptance Testing to be performed by the PSAA for each section of sewer lined in accordance with Section 8 of ASTM F1216, for testing flexural strength and delamination.
- c) The Contractor shall prepare the samples for shipment to the laboratory, including cutting samples to proper length and width as described in the applicable ASTM test procedures. Samples shall be labeled for date, diameter, section of sewer, and delivered to the PSAA for testing. The cost of the sample postage, shipping, and testing will be paid for by the City.
- d) When tested, each sample shall meet the physical properties for flexural modulus and flexural strength used in the design calculations.
- e) Air testing on isolated sections of sewer (minimum of 2 to 3 feet in length) shall be required if post-rehabilitation inspection indicates leaks in the liner. Air testing shall be performed on longer sections or multiple sections of sewer as required to identify the location(s) and full extent of defects. Such testing shall be performed by the Contractor at no additional expense to the project.
- f) CIPP wall thickness shall be verified in accordance with Section 8.6 of ASTM F1216 and using test methods consistent with Section 8.1.2 of ASTM D5813.
- g) The PSAA will have all flexural and delamination testing performed by an independent, ASTM certified testing laboratory. The testing laboratory shall submit all test results directly back to the PSAA within 14 calendar days. The PSAA will provide a written copy of the test results to the Contractor within 3 business days of receiving them from the laboratory.
- h) The Contractor may elect to restore flow in the mainline sanitary sewer during this period of time. However, if the test results indicate that the liner fails to meet the Project requirements and that remedial work is required to be performed, the Contractor shall perform any required cleaning in order to allow the remedial work to be performed at no additional cost to the project.

- i) Should the test results indicate that the liner fails to meet the required physical properties as specified herein, the work shall be rejected. The Contractor shall have up to 10 calendar days to propose a repair/replacement plan consistent with the requirements of this specification for the PSAA's review and acceptance. The Contractor's repair/replacement plan shall include the following elements.
- j) The Contractor shall outline specific repair or replacement procedures for potential defects that may occur in the installed liner, in accordance with recommendations by the liner system manufacturer.
- k) The manufacturer shall provide a detailed step by step repair procedure, resulting in a finished product meeting the estimated life cycle of the component and requirements of these specifications. For the purposes of these Standards the lifecycle of this rehabilitation shall be considered to be 50 years.
- l) Should a potential issue be unrepairable, in the opinion of the PSAA, the Contractor, together with the manufacturer, shall define the best recommended procedure for the total removal and replacement of the system.
- m) The Contractor shall receive no additional compensation for the repair or replacement of systems deemed non-conforming to the requirements of the Contract Documents and unacceptable by the City.
- n) While repair/replacement work is performed, the Contractor shall continue to be responsible for maintaining flows in the mainline and lateral sanitary sewers in accordance with the requirements of this Section. The Contractor will not be allowed any increase in the contract unit price due to the repair or replacement of defective any materials or faulty workmanship.
- o) The Contractor shall remove and replace or repair any defects in the installed liner to the satisfaction of the PSAA at no additional cost to the project. Contract time will continue during the period of time from the receipt of failing test results to the completion of the repairs.

9. Warranty

- a) The materials used for the project shall be certified by the manufacturer for the specified purpose. The Contractor shall warrant the liner material and installation for a period of 2 years.

- b) During the Contractor warranty period, any defect which may materially affect the integrity, strength, function, and/or operation of the pipe, shall be repaired at the Contractor's expense in accordance with procedures described in this specification, and as recommended by the manufacturer.
- c) The Contractor shall conduct warranty CCTV inspection of sewers which were lined. This work shall be completed at the Contractor's expense, no sooner than 2 months prior to the expiration of the original warranty period.
- d) The televising shall be performed in the presence of the PSAA. Television inspection that is not performed within the presence of the PSAA will not be accepted and shall be performed again at the Contractor's sole expense. Any areas that do not meet the requirements of this specification will be repaired or re lined at no additional cost to the City.

EE. Sanitary Manhole Rehabilitation

- 1. At all times proper measures are to be implemented to protect debris and materials from falling into the flow channel; all debris and materials shall be removed promptly.
- 2. Internal Chimney Seal
 - a) A plural component, urethane or other PSAA approved material, internal manhole frame-chimney sealant, as specified herein shall be applied in all assigned manholes within the areas included in the project. If excavation is required to repair, rebuild, or replace a manhole, or if manhole linings or coatings are required, the sealant shall be applied after that work has been completed.
 - b) The manhole frame-chimney sealant shall be designed to prevent leakage of water through the above-described portions of the manhole throughout its design life.
 - c) The manhole frame-chimney sealant shall remain flexible and bonded to the inside surfaces of the manhole frame and masonry throughout its design life.
 - d) Manhole frame-chimney sealant material and application methods shall meet current ASTM standards and consist of a PSAA-approved plural component, spray applied, quick setting urethane material conforming to the following requirements:

(1) Viscosity

- (a) Part A, 12,000-17,000 cps @ 25C, 20 RPM per ASTM D2393 (Test Method for Viscosity of Epoxy Resins and Related Components)
- (b) Part B, 300-510 cps @ 25C, 300 RPM per ASTM D4287 (Standard Test Method for High-Shear Viscosity Using a Cone/Plate Viscometer)

(2) Weight

- (a) Weight/Gallon Part A, 8.90-9.20 lb/gal per ASTM D1875 (Standard Test Method for Density of Adhesives in Fluid Form)
- (b) Weight/Gallon Part B, 9.60-9.75 lb/gal per ASTM D1875
- (c) Weight/Gallon Mixed, 9.25-9.48 lb/gal per ASTM D1875

(3) Processing

- (a) Mix Ratio by Weight, 100:107
- (b) Mix Ratio by Volume, 100:100
- (c) Cure Schedule, Hours, 4-5 hours @ 25C

(4) Gel Time

- (a) Gel Time, Seconds, 0-15 seconds @ 25C, 100 grams per ASTM D3056 (Standard Test Method for Gel Time of Solventless Varnishes)

(5) Cured Properties

- (a) Hardness, Shore A, 95-100 per ASTM D2240 (Standard Test Method for Rubber Property—Durometer Hardness)
- (b) Elongation, 379-473% per ASTM D638 (Standard Test Method for Tensile Properties of Plastics) or ASTM D412 (Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension)
- (c) Tensile Strength, 2616-3216 psi per ASTM D638 or ASTM D412
- (d) Peel Strength, 30.8-46.8 PLI (AL to AL) per ASTM D1876 (Standard Test Method for Peel Resistance of Adhesives (T-Peel Test))

- e) All concrete and masonry surfaces must be clean. Grease, organic matter, roots must be completely removed.
- f) The Contractor shall have the manufacturer's recommended plural cartridge dispensing tool and all other equipment/tools necessary to prepare the surfaces of the manhole and apply the manhole frame-chimney sealant.
- g) All loose and protruding mortar and brick that would prevent proper application of the seal, shall be removed and the appropriate areas of the manhole frame, chimney and or cone/corbel cleaned and prepared. All areas to be sealed shall be free of surface contaminants and be dry and free of any excessive voids or defects.
- h) If an adequate sealing surface does not exist on the masonry, cementitious grout or other PSAA approved material shall be used to fill voids and profile the chimney area of the manhole.
- i) Cementitious grout shall be a premixed, non-metallic, high strength, non-shrink grout which meets the requirements of ASTM C191 (Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle) and ASTM C827 (Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures) as well as Corps of Engineers CRD-C-588 (Nonshrink Grout) and CRD-C-621 (Non-shrink Grout). When mixed to a mortar or "plastic" consistency, it shall have minimum 1 day and 28-day compressive strength of 6,000 and 9,000 psi, respectively.
- j) All surface preparation shall be completed in strict accordance with the frame-chimney sealant manufacturer's published instructions.
- k) The internal frame-chimney sealant shall be applied to cover the entire circumference of the chimney section regardless of depth at a minimum thickness 100 mils.

3. External Chimney Seal

- a) This specification includes the materials and procedures required for the wrap or external sealing of the entire chimney area of all sanitary manholes.
- b) Manhole chimney shall be sealed in full, from the exterior using a wrap seal.
- c) All surface preparation shall be completed in strict accordance with the frame-chimney sealant manufacturer's published instructions.

- d) Manholes shall be excavated, backfilled, and restored as specified herein.
- e) The manhole frame shall be clean, dry and free from surface rust and foreign objects. Abrade and/or prepare the surfaces strictly according to manufacturer's recommendations.
- f) Contractor shall ensure that the sleeve is in full contact with the substrate, that there are no cracks or holes in the polyethylene backing and no voids are present below the sleeve, and that the adhesive has flowed beyond the sleeve edges.
- g) Manufacturer shall provide complete installation guides with clear illustrations enclosed in each factory carton of sleeves. Installer shall follow all manufacturer's procedures to ensure proper application.
- h) Wrap Seal shall be wrapped tightly around casting and adjustment rings. Seal must extend a minimum of 3 inches onto casting and 3 inches below top of cone section with a 6-inch overlap.

4. Chemical Grouting of Manholes

- a) Grouting manhole defects may include corbel, wall, pipe connections, manhole joints, and/or bench/trough. The PSAA will determine areas of the manhole designated to be grouted. If entire manhole is scheduled for grouting, grouting shall include corbel, wall, pipe connections and bench/trough. Pipe connections grouting shall include all pipe connections in the specified manhole and grouting of the specified manhole including the bench/trough to the maximum height of 18 inches above the crown.
- b) Materials, additives, mixture ratios, and procedures utilized for the grouting process shall be in accordance with manufacturer's recommendations or PSAA approved equal. A list of currently approved chemical sealing materials can be found in Appendix A (Material Requirements) of these Standards.
- c) The following properties shall be exhibited by the grout:
 - (1) Documented service of satisfactory performance in similar usage.
 - (2) Controllable reaction times and shrinkage through the use of chemicals supplied by the same manufacturer. The minimum set time shall be established so that adequate grout travel achieved.

- (3) Chemical resistance to most organic solvents and to mild acids and alkali.
 - (4) The chemical shall be essentially non-toxic in a cured form.
 - (5) Sealing material shall not be rigid or brittle when subjected to dry atmosphere. The material shall be able to withstand freeze/thaw and moving load conditions.
 - (6) Acrylate grouts may not be used.
- d) Mixing and handling of chemical grout, which may be toxic under certain conditions shall be in accordance with the recommendations of the manufacturer and in such a manner to minimize hazard to personnel. It is the responsibility of the Contractor to provide appropriate protective measures to ensure that authorized personnel handle chemicals or gels in the proper manner. All equipment shall be used in accordance with the manufacturer's specifications. Only trained personnel thoroughly familiar with the handling of the grout material and additives shall perform the grouting operations.
 - e) Manholes to be grouted may be of brick, concrete, or fiberglass construction.
 - f) Manhole grouting shall not be performed until the repair of the manhole frame and grade rings or any other structural manhole repairs are complete.
 - g) The Contractor shall cut and trim all roots within the manhole.
 - h) The Contractor shall seal all unsealed lifting holes, unsealed step holes, or voids larger than approximately ½ inch in thickness.
 - i) All cracked or deteriorated material shall be removed from the area to be patched and replaced with a waterproof quick setting mortar in accordance with manufacturer's specifications.
 - j) The Contractor shall perform the Expanded Gasket Placement (EGP) technique to control in-flowing water in larger cracks, joints or pipe to manhole boots by soaking dry Oil Free Oakum (AV-219) with (AV-202) Multigrout and forcing the Oakum/Resin plug into opening until it sets. (See: Avanti EGP Technical Manual for details.)
 - k) The Contractor shall perform the EGP to seal intruding drop or lateral connections, slip line terminal seals, and open joints in RCP manholes.

- l) The Contractor shall perform the EGP to seal between the corbel and grade rings, and between the manhole frame and grade rings.
- m) Normal grouting operations shall be performed in accordance with manufacturer's recommendations.
- n) Drilling and injecting grout shall be performed as follows:
 - (1) Injection holes shall be drilled through the manhole wall at locations as recommended by the manufacturer.
 - (2) Grout shall be injected through the holes under pressure with a suitable probe. Injection pressure shall not cause damage to the manhole structure or surrounding surface features.
 - (3) Grout shall be injected through the lowest holes first. The procedure shall be repeated until the manhole is externally sealed with grout.
 - (4) Grouting from the ground surface shall not be allowed.
 - (5) Grout travel shall be verified by observation of grout to defects or adjacent injection holes. Provide additional injection holes if necessary to ensure grout travel.
 - (6) Injection holes shall be cleaned with a drill and patched with a waterproof quick setting mortar for brick and concrete manholes.

5. Testing Rehabilitated Manholes

- a) If exfiltration or vacuum testing is used, usually 10 percent of the sealed manholes, as chosen by the PSAA, are tested. Manholes that fail are reworked and retested by the Contractor.
- b) If more than 5 percent of the manholes tested fail the initial test, an additional 10 percent of the sealed manholes are tested. This process continues until the testing is satisfactory, or until all manholes have been tested.
- c) Limitations and considerations include recognizing that exfiltration and vacuum testing may be impractical or cost-prohibitive for all manholes; therefore, the use of either method of testing is subject to the determination of the PSAA.

6. Cementitious Manhole Liner

- a) Sanitary sewer manhole cementitious liner consists of spray-applied or centrifugally cast light-weight structural reinforced concrete. The cementitious liner shall be applied on the manhole base, bench, walls, corbel/cone, and chimney of brick, block, or precast manholes.
- b) Contractor must demonstrate a minimum of 3 years of recent documented experience in successfully applying cementitious manhole liners.
- c) Contractor shall submit the following to the City for review and acceptance at least 14 days prior to starting manhole cementation:
 - (1) Manufacturers' Certificate of Compliance certifying compliance with the applicable Specifications and Standards. The certifications shall list all materials furnished under this Section.
 - (2) Certified copies of factory tests required by the applicable Standards, the Manufacturer, and this Section.
 - (3) Manufacturer's handling, storage, and installation instructions and procedures.
- d) The materials used shall be designed, manufactured, and intended for sewer manhole rehabilitation and the specific application in which they are used.
- e) The materials shall have a proven history of performance in sewer manhole rehabilitation. The materials shall be delivered to the job site in original unopened packages clearly labeled with the manufacturer's identification and printed instructions.
- f) All materials shall be stored and handled in accordance with recommendations of the manufacturer.
- g) All materials shall be mixed and applied in accordance with the manufacturer's written instructions.
- h) The material applied to the surface of the manhole shall be a cementitious blend of calcium aluminate cement and manufactured calcium aluminate aggregates for constructing a liner that is impervious to the flow of water, is resistant to sulfide attack, and restores structural integrity to existing manhole walls.

- i) A monolithic liner shall be formed which covers all interior manhole surfaces and shall have the following minimum requirements at 28 days:

(1) Compressive Strength (ASTM C579)	3,000 psi
(2) Tensile Strength (ASTM C496)	300 psi
(3) Flexural Strength (ASTM C293) (Modified)	600 psi
(4) Shrinkage (ASTM C596)	0% at 90% R.H.
- j) Contractor will perform preliminary cleaning of the structure with high-pressure water-blasting at a minimum of 4000 psi and 4 gpm to obtain the desired Concrete Surface Profile (CSP) of 3 or greater. If the desired CSP is not achieved by high-pressure water-blasting, other methods of obtaining the surface profile such as abrasive blasting and acid etching shall be used.
- k) The Contractor shall remove all the existing manhole steps. The metal portion of all steps will be removed to within ½ inch of the manhole interior wall surface. The remaining protruding metal portion of the step shall be covered with a cementitious material to provide a smooth surface on and around the protrusion for the liner to bond.
- l) All open joints, voids, holes, cracks, and missing bricks larger than 3 inches in diameter or equivalent shall be patched with a cementitious material to provide a smooth surface for the cementitious liner to bond.
- m) All roots, loose, cracked or disintegrated material shall be removed from the area to be patched exposing a sound substrate. The cementitious patch material shall be allowed to cure according to the manufacturer's specifications before continuing with the cementitious liner installation process.
- n) Benches shall be sloped so that water will flow back into the flow channel.
- o) When the flow channel is required to be lined, the Contractor shall plug the inlet pipe, inspect for infiltration leaks around the inlet and outlet pipes and in the channel. All leaks present shall be stopped by the use of chemical grout injection and/or by the use of fast-setting cement.
- p) The final prepared surface shall have a concrete surface profile of 3 or greater and have a smooth uniform appearance.

- q) The finished cementitious liner shall be continuous over the entire length of the structure from the cover seat to the invert, including the flow channel. Liner shall be bonded to the structure, as required by design, and in such a way as to not allow any water to flow behind the liner and enter back into the waste stream.
- r) The liner shall be visually inspected from inside the structure for any defects that may affect performance of the liner. All defects shall be fixed to conform with these specifications.
- s) Contractor shall clean up the entire project area after the work is completed and all testing accepted and shall remove and dispose of all excess material and debris not incorporated into the permanent installation.
- t) Manufacturer and Installer of the liner system shall provide a 10-year warranty on materials and labor.

7. Synthetic Manhole Liner

- a) Contractor shall install a synthetic manhole liner including flexible polyurea and closed cell foam. See Appendix A (Material Requirements) for additional detail.
- b) The use of specialized equipment combined with rigorous surface preparation requirements shall be used to apply the products without the use of solvents. The equipment adds high heat and pressure the monolithic surfacing system resulting in a high build and quick set of the completed system. When working near the flow channel, the Contractor shall plug the inlet pipe, inspect for infiltration leaks around the inlet and outlet pipes and in the channel. All leaks present shall be stopped by the use of chemical grout injection and/or by the use of fast-setting cement.
- c) Product application requirements and procedures described herein include surface preparation, mixing application, material handling and storage, qualification of the applicator and application quality control.
- d) The Contractor shall submit the following information to the PSAA for approval prior to beginning the installation of the protective coating:
 - (1) Manufacturer's data sheets for the coating materials.
 - (2) Third party test results verifying that the physical properties of the coating materials meet or exceed the requirements of these specifications.

- (3) Applicator's procedures for preparing the surface of the structure and installing the coating system.
 - (4) Documentation that the applicator of the coating has been trained and certified by the manufacturer and meets the experience requirements of these specifications.
- e) The coating system shall be a spray-applied 100% solids epoxy monolithic surfacing system for use in coating new manholes, wet wells, lift stations, treatment plants, and other structures. All products seeking approval from the PSAA shall submit the following information:
- (1) Documentation that the proposed product meets the above minimum physical characteristics including results of testing performed by a bonded, third-party testing company.
 - (2) An affidavit attesting to the successful use of the product as a protective coating for concrete or masonry structures for a minimum continuous period of 5 years in wastewater conditions recognized as corrosive or otherwise detrimental to concrete and masonry.
 - (3) A verifiable list of references that document the successful installation and use of the product in a minimum of 750,000 square feet of sanitary sewer structures.
- f) An approvable product must have the following minimum physical characteristics as measured by the applicable ASTM Standards referenced herein.
- (1) Minimum Compressive Strength: 12,000 psi
 - (2) Minimum Tensile Strength: 7,000 psi
 - (3) Minimum Flexural Strength: 11,000 psi
 - (4) Minimum Bond Strength: 500 psi
 - (5) Minimum corrosion resistance suitable for environments with pH of 0.5 or higher.

g) Installer Qualifications

- (1) All products must be installed by an Installer that has been trained and certified by the manufacturer.
- (2) The Installer must provide verifiable documentation of the above certification and the successful installation of 250,000 square feet of the product in sanitary sewer structures.
- (3) The Installer must provide verifiable documentation of the above certification and the successful completion of prior installation.

h) Quality Control Assurance

- (1) Applicator shall initiate and enforce quality control procedures consistent with applicable current ASTM standards.
- (2) Applicator shall use an adequate number of skilled workers who are thoroughly trained and experienced in the necessary crafts. These workers shall be completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- (3) Applicator shall use approved specialty equipment adequate in size, capacity, and number sufficient to accomplish the work of this Section in a timely manner.

i) Surface Preparation

- (1) Applicator shall inspect all surfaces specified to receive the monolithic surfacing system prior to surface preparation. Applicator shall promptly notify the PSAA of any noticeable disparity in the surfaces that may interfere with the proper preparation or application of the monolithic surfacing system.
- (2) All concrete that is not sound or has been damaged by chemical exposure shall be restored to a sound concrete surface. All contaminants including all oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, roots or other contaminants shall be removed.

(3) Surfaces to receive protective coating shall be cleaned to produce a sound concrete or masonry surface with adequate profile and porosity to provide a strong bond between the monolithic surfacing system and the substrate. Surface preparation methods shall be based upon the conditions of the substrate and the requirements of the monolithic surfacing system to be applied, but as a minimum, shall be in accordance with the procedures listed below. Discharges of contaminants and cleaning chemicals to storm sewer is prohibited; such materials shall be captured and properly disposed of.

(a) All surfaces shall be cleaned with high pressure water to remove all loose or contaminated debris. Other equipment and methods may be required to remove all unsound material.

(b) When all loose, contaminated, and unsound debris has been removed, the surface shall be etched with a solution of 20% muriatic acid to clean and open the pores of the substrate.

(c) The surface shall be washed again, and the wash water shall contain a dilute solution of chlorine to diminish microbiological bacteria growth and to kill any bacteria residing on the surface.

(d) The surface shall be tested with litmus paper at various points throughout the structure to ensure that the pH is within acceptable limits (not to exceed 8.5). If the surface does not meet the pH requirements, the above steps shall be repeated until the surface pH is within acceptable limits. All tests results will be retained for review by the PSAA.

(e) Active water infiltration shall be stopped by using a cementitious water plug that is compatible and suitable for top coating with the specified monolithic surfacing system.

(f) If pre-installation inspection reveals infiltration (defined as visible and consistent movement of water) through the wall of the structure, a collapse in an area of the wall, a bench needing to be rebuilt/repared, a necessity for sandblasting or anything that will require more than typical preparation of the structure, the Contractor shall notify the PSAA. Such extra work will be approved in writing between the Owner and the Contractor prior to the

commencement of the work and shall be considered as a separate pay item.

j) Application

- (1) The interior surfacing system shall be applied to the chimney, walls, bench, and flow channel of all manholes and to the specified surfaces of all other structures.
- (2) The interior surfacing system shall be continuously bonded to all brick, mortar, concrete, chemical sealant, grout, pipe and other surfaces inside the manhole according to ASTM C882 (Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear) testing and therefore shall be designed for hydrostatic loading.
- (3) The cured surfacing shall be monolithic with proper sealing connections to all unsurfaced areas and shall be placed and cured in conformance with the recommendations of the monolithic surfacing system manufacturer.
- (4) When cured, the system shall form a continuous, tightfitting, hard, impermeable surfacing that is suitable for sewer system service and chemically resistant to any chemicals, bacteria or vapors normally found in domestic sewage.
- (5) The system shall effectively seal the interior surfaces of the manhole and prevent any penetration or leakage of groundwater infiltration.
- (6) The system shall be compatible with the thermal conditions of the existing sewer manhole surfaces.
- (7) Heated, plural component, specially designed equipment for use in the spray or spin-cast application of the specified system approved for use by the monolithic surfacing system manufacturer shall be utilized for each coat of the system.
- (8) Application procedures shall conform to the recommendations of the interior surfacing system manufacturer, including material handling, mixing, and environmental controls during application, safety, and equipment.

- (9) The equipment shall be specially designated to accurately ratio and apply the specified materials and shall be regularly maintained and in proper working order.
- (10) An approved installer of the monolithic surfacing system must apply the specified materials.
- (11) The walls, bench, and flow channel of the structure shall be lined with the monolithic surfacing system to provide a thickness as previously specified based on the condition of the existing structure.
- (12) The cured surfacing shall be monolithic with proper sealing connections to all unsurfaced areas and shall be placed and cured in accordance with the recommendations of the monolithic surfacing system manufacturer.
- (13) The minimum coating thickness shall be per manufacturer recommended minimum thickness.

k) Warranty

- (1) All approved products must provide a ten-year performance limited warranty that the installed product will:
 - (a) Stop deterioration of the lined surfaces by sewer gas induced corrosion.
 - (b) Prevent infiltration of ground water into the collection system through the lined surfaces.
 - (c) Stop root intrusion through the lined surfaces.

8. Reconstruct Flow Channel

- a) This work shall consist of reconstructing flow channel in accordance with MDOT Specifications, Section 403 (Drainage Structures) and as specified herein.
- b) Manhole bases and flow channels shall be formed of fast setting ready mix concrete such as Quickrete Fast Setting Concrete Mix, Product No. 1004-50, or PSAA approved equal.
- c) The use of PVC SDR-26 may be used to establish and form the flow channel as approved by the PSAA.

- d) All concrete and masonry surfaces must be clean. Grease, organic matter, loose bricks, mortar, unsound concrete, roots and other materials must be completely removed.
- e) Contractor shall thoroughly clean existing flow channel and remove any accumulated sediment, debris, and broken or loose concrete and properly dispose of all materials removed from the flow channel.
- f) Where the process requires interruption of flow, the Contractor shall provide all necessary diversion or bypass pumping equipment in accordance with this Article to handle the flow for the duration of the flow channel rehabilitation, including curing times where applicable.
- g) Contractor shall form and place the concrete mix, meeting these Standards, to create new flow channel up to the springline of the flow channel.
- h) Contractor shall install concrete flow channel to the springline of the pipe with a $\frac{3}{4}$ -inch to 1-inch gap at pipe ends provided to maintain joint flexibility.
- i) Changes in direction of the sewer and entering branch or branches shall be laid out in smooth curves of the longest possible radius which is targeted to the centerlines of adjoining pipelines. Regardless of differences in entrance and exit elevations, flow channels for all pipes are to be formed to present a smooth transition of flow and shall be subject to the approval of the PSAA.
- j) Flow channels and surface surrounding it for sewer structures shall be built and finished in accordance with City Standard Details. All flow channels shall be properly consolidated and hand-trowel finished to a hard finish.
- k) All necessary adjustments required to accommodate encountered field conditions for reconstructed flow channel, including all necessary dewatering, shall be included in the cost of the flow channel reconstruction and will not be paid for separately.

III. Street Construction and Repair

A. General

1. The Contractor shall furnish all materials, equipment, tools, and labor necessary to perform the work required by this Section. The Contractor shall also: remove pavement as specified; properly handle all drainage or ground water; provide traffic and pedestrian control, barricades, guards, and warning lights; fill and consolidate the pavement area(s); restore the surface; remove and dispose of surplus excavated material; clean the site of excess materials and construction debris; and maintain the street or other surfaces as specified.
2. All work shall be in accordance with MDOT Specifications except as specified herein.
3. The Contractor shall segment the pavement construction as necessary to satisfactorily complete the work and to safely maintain traffic in accordance with the MMUTCD and PROWAG, or as indicated on the Plans. This includes pavement gapping at drives and intersections if required by the PSAA, to complete the work. This work shall also include the installation and removal of dust palliative, maintenance aggregate, and cold patching mixtures as required.
4. Utility lines may become exposed at, above, or below, the subgrade elevation during machine grading or subgrade undercutting operations. If this occurs, the Contractor shall excavate around, above and/or below the utility lines, as directed, to complete the machine grading or subgrade undercutting work.
5. The Contractor shall remove, and properly dispose of off-site, all abandoned cables, conduit, and pipe encountered at, or above the bottom of any earthwork excavation or undercut. Where the inverts of abandoned conduits or pipe are less than 16 inches below the bottom of any earth excavation or undercut, the conduits and/or pipe shall be removed, and the resulting void filled with material as approved by the PSAA. The fill material shall be compacted to 95% of its maximum unit weight in lifts not exceeding 12 inches.
6. All sewers, and structures, including manholes, gate wells, valve boxes, inlet structures and curbs shall be protected from damage and contamination by debris and construction materials. Structures shall be kept clean and properly covered during the construction. The Contractor shall immediately clean any structures and/or sewers that become fouled with construction debris. The Contractor shall

be responsible for all damages which are caused by sewers or structures which do not operate properly due to the Contractor's operations.

B. Maintaining Traffic and Site Control

1. Traffic maintenance and control shall conform to Section I.C (Transportation Control and Maintenance) of this Article.
2. The Contractor shall use dust palliative and maintenance aggregate to maintain local and emergency access at all locations where pavement has been temporarily removed.
3. The Contractor shall maintain ADA/PROWAG-compliant pedestrian crossings and walkways.

C. Temporary Pedestrian Facilities

1. The Contractor shall construct the TPAR in accordance with PROWAG, MMUTCD, Plans, Article 12 (Standard Details) SD-TPR 1-8, as directed by the Engineer, and the following:
 - a) Usable surface of the path shall be a minimum of 48 inches wide with a maximum cross slope of 2 percent. The path, including transitions to the adjacent surface at both ends, shall be free of vertical discontinuities greater than 1/4 inch. Any vertical discontinuities greater than 1/4 inch up to 1/2 inch shall be eliminated or beveled with a slope not steeper than 1:2. If a vertical discontinuity greater than 1/2 inch or a running slope greater than 1:20 occurs on the project, a Temporary Pedestrian Ramp (paid for separately) is required.
 - b) If not constructed with asphalt materials, the surface material shall be firm, stable, and anti-slip.
 - c) If the surface of the path is constructed from oriented strand board (OSB), plywood, or dimensional lumber, the Contractor shall securely connect all sections with appropriate fasteners to provide a continuous, uniform, flat surface that does not deflect due to pedestrian traffic and materials shall support the weight of pedestrians as well as motorized scooters and wheelchairs.

- d) The temporary pedestrian path shall include passing spaces at intervals of 200 feet maximum. The passing spaces shall be of the same material as the rest of the temporary pedestrian path. Passing spaces shall be dimensioned with a minimum width of 60 inches and minimum length of 60 inches. Passing spaces are not required if the path is already 60 inches wide.
- e) Clear all debris and construction material from the path throughout its use. Remove snow and ice; use of an approved de-icing agent may be required.
- f) Repair or replace the path, or segments thereof, if it becomes uneven, unstable, or displaces due to weather events, construction activities, or other causes.
- g) Following the use of the temporary path, the Contractor shall remove and dispose of all materials used to construct the path, and restore the area.

2. Temporary Pedestrian Ramp

- a) Within the TPAR, use temporary pedestrian ramps to facilitate pedestrian travel on accessible facilities over curbs or other uneven terrain features with a vertical difference of 1/2 inch or greater.
- b) Construct the temporary pedestrian ramp in accordance with the manufacturer's recommendations (if applicable), PROWAG, ADA, MMUTCD, the plans, and the following:
 - (1) Usable surface of the ramp shall be 48 inches wide and does not deflect due to pedestrian traffic. Apply an anti-skid surface treatment to the useable area of the ramp if it is not made from asphalt materials. The maximum cross slope of the ramp is 2 percent. Both ends of the ramp shall smoothly transition to the adjacent surface, with 1/4 inch or less vertical difference.
 - (2) Construct the ramp to maintain a longitudinal slope from 1:10 to 1:12 where possible. Otherwise, a longitudinal slope from 1:8 to 1:10 may be used for a maximum rise of 3 inches. Temporary pedestrian ramps with longitudinal slopes greater than 1:8 are prohibited.

- (3) Provide a handrail on both sides of the ramp, if required, as stated herein. The top of the handrail shall be between 34 and 38 inches above the surface of the ramp. A minimum width of 36 inches shall be maintained between the handrails, with a minimum clearance of 1.5 inches behind and 18 inches above. When the ramp is exposed to traffic, in lieu of handrails, use a protective edge 2.5 inches minimum height above the ramp surface or 1:10 flare on both sides of the ramp.
- (4) Construct the handrail such that the stress applied by a bending moment created by a 250-pound force is less than the allowable stress for the materials and the construction of the handrail. Construct the handrail to withstand the shear stress induced by a 250-pound force. Ensure all fasteners, mounting devices and support structures are also able to withstand shear stress induced by a 250-pound force.
- (5) Construct a detectable edging anytime a handrail is required, and anytime the path changes direction. This includes a turn onto the ramp from the path. Detectable edging must begin at a maximum of 2.5 inches above the ramp surface and extend at least 6 inches above the ramp surface.
- (6) Provide a clear space (minimum 48 inches by 48 inches) above and below the ramp.
- (7) Ramps shall not be located in areas of drainage collection, ponding or running water, which can produce slippery or unsafe conditions. If the ramp is located over a gutter pan or other drainage structure, provide features to facilitate water movement around or under the ramp as approved by the Engineer.
- (8) Clear all debris and construction material from the path throughout its use. Remove snow and ice; use of an approved de-icing agent may be required
- (9) Repair or replace the ramp if it becomes uneven, unstable, or displaces due to weather events, construction activities, or other causes as directed by the Engineer.

3. Temporary Pedestrian Channelizers

- a) Guide pedestrians along a temporary non-motorized facility and create separation of pedestrians from construction areas near existing facilities by using a temporary pedestrian channelizer. Replace damaged temporary pedestrian channelizers.
- b) Where required, provide a temporary pedestrian channelizer that is crashworthy in accordance with the National Cooperative Highway Research Program Report 350 (NCHRP 350) or Manual for Assessing Safety Hardware (MASH), in addition to meeting the following requirements:
 - (1) Design the channelizer to interconnect to maintain continuous delineation along the entire installation; this includes provisions to accommodate non-linear alignment as well as variations in elevation.
 - (2) The top surface of the channelizer shall function as a hand-trailing edge and have a height between 32 and 38 inches. The top surface shall have a 2-inch horizontal gap between the top edge and the support (if so equipped), to allow for continuous hand-trailing without obstructions. The bottom edge of the bottom rail shall be a maximum of 2 inches above the surface or the channelizer may have a solid continuous face. Finally, all features on the front face of the channelizers (the face in contact with pedestrians) shall share a common vertical plane.
 - (3) Equip both sides of the channelizer with bands of alternating 6-inch-wide orange and white vertical stripes of reflective sheeting. Two bands of sheeting 6 inches tall and a minimum of 36 inches long containing at least two orange and two white stripes each are required. One band placed near the top and one near the bottom if the channelizer section has a solid face. If the channelizer consists of two rails, affix one band of sheeting to each rail. Stripes of reflective sheeting shall be aligned vertically and meet or exceed the requirements of ASTM D4956, Type IV sheeting.

4. Temporary Pedestrian Type II Barricade

- a) Provide a temporary pedestrian Type II barricade that meets the requirements of National Cooperative Highway Research Program Report 350 (NCHRP 350) or Manual for Assessing Safety Hardware (MASH), in addition to meeting the following requirements:

- (1) Provide barricade sections at least 43 inches wide, interconnected to provide a continuous accessible tactile barrier. The connection shall include provisions to accommodate non-linear alignment as well as variations in elevation at the installation area.
- (2) The top surface of the barricade shall function as a hand-trailing edge and have a height between 32 and 38 inches. The bottom edge of the bottom rail shall be a maximum of 2 inches above the surface or the channelizer may have a solid continuous face. All features on the front face of the barricade (the face in contact with pedestrians) shall share a common vertical plane.
- (3) Equip both sides of the barricade with bands of alternating 6-inch-wide orange and white vertical stripes of reflective sheeting. Two bands of sheeting 6 inches tall and a minimum of 36 inches long containing at least two orange and two white stripes each are required. One band placed near the top and one near the bottom if the barricade section has a solid face. If the barricade consists of two rails, affix one band of sheeting to each rail. Stripes of reflective sheeting shall be aligned vertically and meet or exceed the requirements of ASTM D4956, Type IV sheeting.

D. Temporary No Parking Signs

1. This work consists of installing, maintaining and removing of "No Parking" signs and posts as outlined herein and as referenced on the plans. Install "No Parking" signs in accordance with the section 812 of the Michigan Department of Transportation (MDOT) 2012 Standard Specifications for Construction Standard Specifications and the 2011 Michigan Manual of Uniform Traffic Control Devices (MMUTCD).
2. The City will furnish "No Parking" signs to the Contractor at no cost. The Contractor will furnish the sign support and mounting hardware materials in accordance with those specified in section 919 of the MDOT 2012 Standard Specifications for Construction.
3. Place temporary "No Parking" signs prior to the commencement of any construction activity as directed by the Engineer. Obtain a permit for "Temporary Permission of Reserve Parking Lane for Work Related Purposes" from the City's Engineering Unit. Obtain this permit a minimum of five (5) business days prior to the posting of "No Parking" signs.

4. Securely bolt the signs to the sign supports as directed by the Engineer. Imbed all sign supports at least two feet into the ground and ensure that installations are stable and safe. Provide a minimum six feet and maximum seven feet of clearance between the bottom of the installed sign and the ground. Place signs at intervals no greater than 75 feet, and as necessary to eliminate parking in the construction area.
5. Install temporary "No Parking" signs be in accordance with the permit, as directed by the Engineer, and at least 48 hours prior to the proposed start-of-work/enforcement date. Cover temporary "No Parking" signs to allow for on-street parking until 48 to 24 hours prior to the start of the work. Cover temporary "No Parking" signs during non-working periods longer than 72 hours. Prior to beginning work and during construction, cover existing/permanent "No Parking" signs having messages that conflict with those that are temporary. Remove temporary "No Parking" signs and posts upon the completion of work at each location. Return signs to the City upon completion of all contract work, and/or when no longer needed.

E. Pavement Removal

1. General
 - a) The Contractor shall saw cut and remove pavement as shown on the Plans, as marked in the field, and as directed by the PSAA.
 - b) The Contractor shall remove and properly dispose of all excavated material and debris, including all asphalt and concrete in conformance with these Standards. The Contractor shall not stockpile excavated materials overnight on or adjacent to the site.
 - c) In areas where pavement removal is to be performed adjacent to existing pavement that is to remain in place, the pavement shall be saw cut prior to removal. Backhoe teeth, jackhammers equipped with spike points, milling machines, and backhoe mounted wheel cutters shall not be used.
 - d) Damage to adjacent pavement, pavement base, subbase, curb, curb and gutter, sidewalk, utility structures, or other site features, due to removal operations, shall be repaired by the Contractor at the Contractor's expense, as directed by the PSAA.
 - e) The Contractor shall remove pavements full depth unless otherwise shown on the plans or directed by the PSAA.

- f) Paving bricks within the right-of-way shall be salvaged and neatly stacked/stockpiled by the Contractor. Paving bricks not being reinstalled shall be delivered by the Contractor to a City-owned facility as directed by the PSAA.
- g) At various times throughout the work, the PSAA may direct the Contractor to use smaller and/or lighter equipment, or to defer certain work tasks in order to protect the grade and/or adjacent areas.

2. Bituminous Pavement Cutting and Removal

- a) The proper disposal of asphalt, concrete and all other excess excavated material shall be the responsibility of the Contractor. At no time shall the Contractor stockpile excavated material overnight on or adjacent to the site.
- b) All pavement cuts shall be made full depth and perpendicular to, or parallel with, the centerline of the pavement.
- c) For utility construction patches or repair, the existing pavement shall be removed to provide for a replacement of not less than 1 foot wider and longer than the utility trench on each side. All patches shall be rectangular (four-sided in shape) and performed in accordance with Section III.M (Patching) of this Article. If these removals will result in existing pavement less than 5 feet wide from the patch to a lane line, gutter line, edge-of-metal, or existing patch, this existing pavement shall also be removed to the lane line, gutter line, edge-of-metal, or existing patch.
- d) The pavement shall be removed full depth unless otherwise specified on the Plans.
- e) Butt joints must be saw cut straight (if not already straight), cleaned, and bond coated just prior to bituminous paving.

3. Cold-Milling for Concrete Curb and Gutter Reveal

- a) This work consists of cold-milling existing concrete curb and gutter areas overlaid with HMA material to fully reveal the curb and gutter.

- b) The bituminous surface shall be removed to the depth, width, grade and cross section as indicated on the Plans. Following the initial cold-milling specific to the curb and gutter reveal, and ahead of mainline cold-milling, Contractor shall complete subsequent handwork and/or necessary machine work to remove remaining HMA overlay material from the gutter pan and dispose of this material properly. Upon completion of the work, a safety edge of 1 on 2 shall be established along the edge of metal.
- c) Completion of this work shall allow for a condition inspection in advance of curb repair or replacement.
- d) The equipment for removing the bituminous surface shall be capable of accurately removing the bituminous material having a thickness of up to 4 inches with precise and variable depth control, in one or more passes, to the grade and cross section shown on the Plans. The equipment shall also have an effective means for removing excess material from the surface and for preventing any dust resulting from the operation from escaping into the air. Cold-milling machines shall have complete automation for slope control when required by the PSAA.
- e) The bituminous surface removal shall be completed without excessive damage to concrete gutter pan below.

4. Cold-Milling of Bituminous Pavement

- a) The bituminous surface shall be removed to the depth, width, grade and cross section as indicated on the Plans.
- b) The equipment for removing the bituminous surface shall be capable of accurately removing the bituminous material having a thickness of up to 4 inches, in one or more passes, with precise and variable depth control to the grade and cross section shown on the Plans. The equipment shall also have an effective means for removing excess material from the surface and for preventing any dust resulting from the operation from escaping into the air. Cold-milling machines shall have complete automation for slope control when required by the PSAA.

- c) After milling, locations may exist where it is necessary for the Contractor to remove and/or reshape and recompact the existing roadbed materials. When these areas are encountered, the Contractor shall provide the necessary personnel and equipment to properly construct the roadway to the cross-section as indicated on the Plans or as directed by the PSAA. This may require the use of a blade grader and vibratory roller, or equivalent equipment to accurately grade and compact the roadbed to the required cross-section and density as shown on the Plans, as detailed in the Specifications, or as determined by the PSAA. Further, additional materials may be required to be added or removed in order to properly complete the work.
- d) Where material is removed below the grade specified, the resulting void or depressions shall be backfilled with bituminous patching material and compacted by the Contractor in accordance with MDOT Specifications, Subsection 501.03.C.9 (Hand Patching). This work shall be done at the Contractor's expense.
- e) After initial milling, the finished work will be inspected by the PSAA. The PSAA may choose to have additional bituminous milling performed by the Contractor, as Cold-Milling HMA Surface, Plunge Cut. This work may be repeated more than once to achieve satisfactory results where applicable.
- f) The number of intersections and areas to be milled may be increased or decreased by the PSAA as necessary to complete the work.
- g) Where Cold-Milling HMA Surface, Plunge Cut is required, areas less than the width of the on-site paver equipment shall be restored by hand patching.

5. Concrete Pavement, Curb & Gutter, Sidewalk, and Drive Removal

- a) The limits of removal of concrete pavement, curb, gutter, sidewalk, sidewalk ramps, drive openings and drives shall be as specified on the Plans and as determined by the PSAA.
- b) The removal of pavement, curb & gutter of any type, sidewalks, sidewalk ramps, drive openings and drives shall include saw cutting at the removal limits as indicated on the Plans and as determined by the PSAA. All cuts shall be made at the locations as determined and/or marked by the PSAA.

- c) Concrete pavement to be removed as a result of utility construction shall be removed to the nearest joint to provide for a replacement of not less than 1 foot wider and longer than the utility trench on each side. If the concrete pavement has a bituminous overlay, the bituminous removal limits shall be as required in Section III.E.2 of this Article (Bituminous Pavement Cutting and Removal).
- d) Where existing concrete curb or curb & gutter is to be replaced on a street with a concrete (or brick) base, the PSAA may direct the Contractor to remove a 1-foot to 2-foot wide, full-depth section of pavement and pavement base from immediately in front of the curb & gutter. As part of this pavement/base removal, the Contractor shall perform additional (double) full-depth saw cutting along the entire removal limits and shall take sufficient care so as not to damage and/or disturb any adjacent pavement, pavement base, and/or any other amenities. The removals shall be a sufficient width and depth to allow for the placement and removal of the curb and gutter formwork. After the removal of the formwork, the Contractor shall replace the concrete base to its original thickness and elevation(s).
- e) Curb and gutter, sidewalk, sidewalk ramps, drive openings and drives shall be replaced within 2 working days of their removal. Areas that have been excavated and are not yet up to finish grade shall be adequately protected with lighted barricades or fencing.
- f) Removed materials not incorporated into the work shall become the property of the Contractor and shall be properly and immediately disposed of off-site by the Contractor at the Contractor's expense. Removed materials may not be stockpiled overnight on or adjacent to the site.
- g) The removal of subbase or subgrade, not authorized by the PSAA, shall be replaced and compacted by the Contractor at the Contractor's expense, with materials as specified by the PSAA.

F. Subbase and Base Removal and Replacement

1. All unsuitable subbase and/or base material beneath areas of bituminous or concrete pavement, shall be removed for the full depth of the unsuitable material at the direction of the PSAA.

2. The unsuitable material shall be replaced with new material as specified by the PSAA and compacted to the required density.
3. The removal of subbase or subgrade, not authorized by the PSAA, shall be replaced and compacted by the Contractor at the Contractor's expense with materials specified by the PSAA.

G. Underdrain Installation

1. Geotextile wrapped underdrain shall be installed as shown on the Plans or as directed by the PSAA. The installation of underdrain shall occur after establishment of final subgrade and shall precede normal road construction activities including, but not limited to; construction of sand subbase, aggregate base course, curb and gutter placement/replacement, and road paving.
2. The underdrain shall be installed at the line, grade, and depth as shown on the Plans. The Contractor shall maintain line and grade by means of an automatic grade and alignment control system or string control.
3. Underdrain trench shall be in conformance with Article 12 (Standard Details), SD-TD-5 (Typical Edge Drain Trench) of these Standards.
4. Bedding and backfill shall be compacted-in-place to not less than 95 percent of its maximum unit weight, as determined by the AASHTO T 180 (Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop).
5. The trench shall be constructed to have a minimum width of 18 inches. The underdrain shall be placed on a 3-inch thick bedding, with subsequent lifts placed at a maximum thickness of 12 inches to the bottom of the aggregate base course grade.
6. Upstream ends of the pipe shall be closed with manufactured caps to prevent entrance of foreign material. All couplings, tees and other fittings shall be manufactured for the intended purpose and shall be installed to prevent any infiltration of trench backfill material. Geotextile wrap shall be pulled over the end of the underdrain, overlapped and taped.

7. During the construction of underdrain, it may be necessary to terminate construction due to conflicts with buried obstructions or for other reasons. The PSAA will review conflicts on a case-by-case basis and shall decide where to continue or terminate underdrain runs.
8. All downstream ends of the underdrain shall be tapped into a storm sewer structure as shown on the Plans or as determined by the PSAA.

H. Subgrade, Subbase, and Base Construction

1. Pulverizing Bituminous Pavement
 - a) Equipment used for pulverizing shall have continuously variable depth control adjustments and shall be capable of pulverizing, in a single pass, up to 4 inches of bituminous material. The cutting drums shall be enclosed and shall have a sprinkling system around the reduction chamber for pollution control and for preventing any dust resulting from the operation from escaping into the air.
 - b) The bituminous pavement shall be scarified and uniformly pulverized to a maximum size of 1½ inches, and to the depth indicated on the Plans or as specified by the PSAA. The pulverized material shall be graded, shaped and compacted to the line and grade specified on the Plans or as determined by the PSAA. Excess material not incorporated into the finished work shall become the property of the Contractor and shall be removed and immediately disposed of off-site by the Contractor at the Contractor's expense.
 - c) The Contractor shall perform final grading, compaction and proof rolling of the pulverized material.
 - d) Prior to placing a bituminous overlay over a pulverized bituminous pavement, the entire surface shall be compacted to not less than 98% of its maximum unit weight as determined by the AASHTO T 180 test, or as determined by the PSAA.
2. Machine Grading
 - a) The Contractor shall maintain access to all drives and entrances within the construction limits at all times.

- b) Contractor shall grade around mailboxes, trees, light poles, power poles, and other similar items that are to remain in place. The Contractor shall be responsible for any damage caused to such structures. Work shall be coordinated with utility companies and any others that need to complete work within the project limits.
- c) Earth grades shall be constructed by saw cutting and excavating and disposing of existing bituminous pavement, concrete pavement, sidewalks, curbs, gutters, culverts, soil, rock, vegetation (including trees, stumps, brush, shrubs, roots, and logs) or other deleterious materials; removing and salvaging or disposing of topsoil; and by placing and compacting existing approved fill material or imported MDOT Class II Granular Material.
- d) The Contractor shall shape and prepare the subgrade to the grades and cross-sections indicated on the Plans or as directed by the PSAA.
- e) Contractor shall proof roll the subgrade and perform all other work necessary to prepare for the placement of the sand subbase, aggregate base, underdrains and all other items to be constructed. The subgrade shall be prepared to ensure uniform support for the pavement structure.
- f) All areas of the work shall be kept graded and well drained at all times. All areas of the work that become damaged as a result of rain shall be repaired by the Contractor at the Contractor's expense.
- g) In areas where the existing grade is to be cut to achieve the proposed subgrade elevation (cut-sections), rubber-tired equipment including scrapers, wheel loaders, and graders may be used but only to within 2 feet above the subgrade elevation.
- h) After the grade has been cut to within 2 feet above the subgrade elevation, all proposed underground utilities and underdrains within the 1:1 influence of the proposed pavement section shall be installed.
- i) Following the installation of utilities, the remaining cutting shall be performed using only tracked equipment. The Contractor shall only excavate an amount of the "grade" that the Contractor can maintain and protect and keep well drained at all times.

- j) In areas where the existing grade is to be filled to achieve the proposed subgrade elevation (fill-sections), filling shall not take place until all proposed underground utilities within the 1:1 influence of the proposed pavement have been installed. However, if the existing grade does not provide the required minimum cover for a portion of any utility, filling for the road subgrade shall be performed to provide such minimum cover. This filling shall be for the entire width of the roadway (to 1 foot behind the curb) at a length as determined by the PSAA.
- k) Fill sections shall be constructed using suitable approved material obtained from the site where available or imported MDOT Class II Granular Material.
- l) Fill shall be placed only after topsoil and other unsuitable material, as determined by the PSAA, has been removed from the area to be filled.
- m) Fill shall be placed in 6-inch lifts and compacted to 95% of the maximum unit weight as determined by the AASHTO T 180 test.
- n) The Contractor is advised there may be imbalances between the amount of earth cut which is suitable for reuse as fill, and the amount of earth needed to construct the subgrade to the lines and grades shown on the Plans or as determined by the PSAA. The Contractor shall make provisions for such imbalances and shall include all cost of importing, furnishing, placement and compaction of either MDOT Class II Granular or approved clay/cohesive soil as directed by the PSAA as well as the cost of all stockpiling and re-handling of imported and/or on-site materials as necessary to complete the work of constructing the subgrade to the cross-section as shown on the Plans.
- o) The finished subgrade shall be graded as shown on the Plans or as determined by the PSAA. A tolerance that allows for gradual, isolated variations of no more than $\frac{3}{4}$ inch above or 1 inch below the specified grade will be allowed. Variations will be corrected with the placement of compacted granular subbase. The tolerances for the pavement structure strata are not additive.
- p) The entire subgrade, whether in cut or fill sections, shall be compacted to not less than 95% of the maximum unit weight as determined by the AASHTO T 180 test, to a depth of at least 9 inches.

- q) If in the opinion of the PSAA, the subgrade cannot be compacted to 95% as specified above, the PSAA may authorize or direct the use of other methods to attain compaction such as subgrade manipulation, scarifying, plowing, disking, subgrade undercutting or other repair method such as subgrade stabilization fabric.
- r) Immediately following the completion of the grading and compaction of the subgrade as required above, the Contractor shall notify and allow the PSAA to inspect the finished subgrade for soft or uncompacted areas, and for areas of unsuitable and deleterious soils. The Contractor shall proof roll the grade or other surfaces as directed by the PSAA.
- s) Equipment for proof rolling shall be a pneumatic-tired roller and shall have suitable body for ballast loading with such capacity that the gross load may be varied between 25 and 40 tons. The Contractor may use an appropriately loaded single axle or tandem axle dump truck in lieu of the specified roller to achieve the loads specified above.
- t) The proof rolling vehicle shall be operated at walking speed. The proof roller shall make one or more passes to complete coverage of the completed subgrade. Where proof rolling shows the subgrade to be unstable, such areas shall be undercut and repaired as determined by the PSAA.
- u) Following the completion and approval of all undercuts required as a result of the proof rolling, the subgrade shall be considered "established."
- v) The PSAA shall issue to the Contractor a "Permit to Place" for the aggregate base. If the Contractor does not immediately place the aggregate base, the Contractor shall be solely responsible for the protection of the subgrade and shall conduct operation(s) and provide the necessary equipment to ensure the satisfactory completion of the work without damaging the subgrade. This may require the transportation and movement of materials over additional distances in lieu of driving upon the unprotected or partially unprotected, subgrade
- w) The Contractor shall not operate rubber-tired equipment on the "established" subgrade unless specifically authorized in writing by the PSAA.

- x) The Contractor shall be responsible for the maintenance of the subgrade. Any damage to the subgrade due to the Contractor's activities or the activities of its subcontractors, shall be repaired by the Contractor at the Contractor's expense including any additional undercuts required after the subgrade had been established.
- y) The PSAA shall have the authority to suspend the work wholly or in part for any periods of time as may be deemed necessary due to unsuitable weather or such other conditions which are considered unfavorable for the prosecution of the work or for any other condition or reason deemed to be in the best interest of the project. The Contractor shall not suspend work without giving prior written notification to the PSAA.

3. Subgrade Undercutting

- a) After the Contractor has completed rough grading the subgrade, the PSAA shall inspect the grade and witness the proof rolling to determine if undercutting is needed and identify the limits of any such undercutting.
- b) After the Contractor has excavated the undercut area to the depth determined by the PSAA, the excavated area shall be evenly graded and recompactd to not less than 95% of the soil's maximum unit weight as determined by the AASHTO T 180 test. Any excess removed material shall become property of the Contractor and shall be properly and immediately disposed of off-site by the Contractor at the Contractor's expense.
- c) Undercuts required as a result of the Contractor's failure, in the opinion of the PSAA, to provide proper drainage or protect the subgrade once it has been "established" (as described in this Section) shall be completed by the Contractor at the Contractor's expense.
- d) Subgrade Undercutting-Type I shall be backfilled with selected clay or other similar approved material as approved by the PSAA.
- e) Subgrade Undercutting-Type II shall be backfilled with MDOT Class II Granular Material or other material(s) as approved by the PSAA. Type II Undercuts shall be constructed such that they are drained by available underdrain.
- f) Subgrade Undercutting-Type III shall be backfilled with MDOT 21AA dense-graded aggregate.

4. Construction of Subbase and Base Courses

- a) Prior to the placement of the granular subbase and/or the aggregate base course, the Contractor must obtain a "Permit to Place" from the PSAA. This "Permit to Place" shall be issued once subgrade has been compacted and graded and approved by the PSAA.
- b) The base, subbase and subgrade shall be shaped to the specified crown and grade and maintained in a smooth condition. If the Contractor's equipment should cause any rutting or other damage in the base, subbase or subgrade, the equipment will be immediately restricted from the grade and the Contractor shall restore the area to the satisfaction of the PSAA at the Contractor's expense.
- c) The subbase and base course material shall be placed in uniform layers to such a depth that when compacted, the material will have the grade and cross section as shown on the Plans or as determined by the PSAA. The loose measure of any layer shall not be more than 9 inches nor less than 4 inches.
- d) The granular subbase or aggregate base course shall not be placed when there are indications that the mixture may become frozen before the specified density is obtained. At no time shall the material be placed on frozen subbase or subgrade.
- e) All materials shall be handled and/or stockpiled on-site in a manner that minimizes segregation. Base course aggregate shall be deposited from trucks or through a spreader in a manner approved by the PSAA that will minimize segregation of material. Should it be necessary, the Contractor may be required to wet the materials prior to and/or during placement to minimize segregation and to aid in compaction of the material.
- f) Except for the use of vibratory rollers, the granular subbase shall be placed and finished with the use of tracked equipment. The finished granular subbase shall be constructed to the grade and cross section as shown on the Plans or determined by the PSAA. A tolerance that allows for gradual isolated variations of the top surface of no more than $\frac{1}{2}$ inch above or below the specified grade will be allowed. These variations will be corrected with the placement of the successive aggregate base. The tolerances for the pavement structure strata are not additive. The granular subbase shall be compacted to 95% of its maximum unit weight as determined by the AASHTO T 180 test.

- g) The aggregate base shall be placed and rough-graded with the use of tracked equipment. Fine grading may be performed with the use of either tracked equipment or a rubber-tired blade grader. The finished aggregate base shall be constructed to the grade and cross section as shown on the Plans or determined by the PSAA. A tolerance that allows for gradual, isolated variations of the top surface of no more than $\frac{1}{4}$ inch above or $\frac{1}{2}$ inch below the specified grade will be allowed. The aggregate base shall be compacted to 98% of its maximum unit weight as determined by the AASHTO T 180 test.
- h) No pavement course, concrete curb and gutter, concrete driveway or driveway opening shall be placed until the subbase has been compacted to not less than 95 percent, and aggregate base course to not less than 98 percent of their respective maximum dry densities and until a "Permit to Place" has been issued by the PSAA.
- i) Manholes, valve boxes, monument boxes, inlet structures and curbs shall be protected from damage. All utility structures of any type shall be properly covered at all times during the construction. All inlet structures shall have inlet filters installed and properly maintained. Upon completion of each days' work, any extraneous material in manholes, water valve boxes, inlets, catch basins or any other utility structure resulting from the Contractor's operations shall be removed and properly disposed of. The Contractor may be charged for cleaning and damages resulting from accumulated construction debris in the utility structures.
- j) The Contractor shall comply with the requirements as specified in Section V (Soil Erosion and Sedimentation Control) of this Article.

5. Geotextile Fabrics

- a) Geotextile fabrics consist of geotextile separator fabric, geotextile stabilization fabric, or geotextile filter fabric and shall meet the requirements as shown on the Plans or as Specified elsewhere. Geotextile fabric shall be placed as shown on the Plans or as determined by the PSAA.
- b) Geotextile fabric shall be wrapped in a heavy duty covering which will protect the fabric from direct sunlight, ultraviolet rays, temperatures greater than 140° F, mud, dirt, dust, debris and the elements.

- c) Prior to installation of any geotextile fabric, Contractor shall verify that the surfaces to receive fabric are prepared to relatively smooth grades, free of obstructions, depressions, debris and soft or low-density pockets of material. All defects and/or deficiencies shall be corrected prior to installation of fabric so that fabric will not be damaged.
- d) Prior to installation, Contractor shall inspect all geotextile fabric for defects, rips, holes, contamination, or deterioration and replace all defective geotextile fabric as directed by the PSAA.
- e) Mechanical or manual laydown equipment capable of handling full rolls of fabric and laying the fabric smoothly, without wrinkles or folds shall be used. The equipment shall be in accordance with the fabric manufacturer's recommendations or as approved by the engineer.
- f) Geotextile fabric shall be placed on the prepared subbase in the manner and at the locations shown on the Plans. Fabric shall be laid smooth and free of tension, stress, folds, wrinkles or creases.
- g) The fabric strips shall be placed to provide a minimum overlap of 24 inches for each joint. Fabric shall be placed so that the upper strip will overlap the next lower strip. Securing pins with washers shall be installed through both strips of overlapped fabric along a line through the midpoint of the overlap at center to center spacings as recommended by manufacturer unless otherwise indicated on the Plans. Washers shall bear against fabric to secure firmly to subbase.
- h) Geotextile shall be folded and cut to conform to the shape of the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of subbase or aggregate. Additional pins shall be installed as necessary to prevent slippage of the fabric.
- i) Securing pins shall be steel, 3/16-inch minimum size, pointed at one end, of lengths as recommended by manufacturer unless otherwise indicated on the Plans, but not less than 18 inches long. Washers shall have an outside diameter of not less than 1½ inches.
- j) Work shall be scheduled so that fabric is covered with materials specified within two days maximum after placing fabric. Fabric shall be protected from damage until placing other material.

- k) Geotextile fabric shall be inspected prior to covering to ensure that the geotextile has not been damaged (i.e., holes, tears, rips) during installation. Damaged geotextiles, as identified by the PSAA, shall be repaired immediately. The area shall be covered with a geotextile patch that covers entirely and extends beyond the damaged area approximately 3 feet.
- l) Placement procedures shall be modified to eliminate further damage from taking place (i.e., increase initial lift thickness, decrease equipment loads, etc.). Repair or replacement of all damaged geotextile shall be at Contractor's expense.

I. Concrete Curb & Gutter, Sidewalk, and Drive Construction

1. General

- a) Concrete curb, curb and gutter, sidewalks and driveways shall be constructed as shown on the Plans and Standard Details.
- b) Concrete mixtures and curing compound shall meet the Materials requirements of Articles 5 (Streets), and 6 (Drive Approaches, Active Transportation Facilities, & Lawn Extensions) of these Standards.
- c) Prior to placing any concrete, the subbase and/or aggregate base shall be completed within the limits of the work area in accordance with Section III.H (Subgrade, Subbase, and Base Construction) of this Article.
- d) The subbase and/or aggregate base shall be trimmed to final elevation before placing the curb, curb and gutter, or driveways. The curb, curb and gutter, and driveways shall not be placed on a pedestal or mound.
- e) The subbase and/or aggregate base and adjacent concrete shall be wet down prior to placement of concrete to prevent water loss through the road base. If a construction joint is required, the existing concrete surface is to be cleaned with compressed air to expose the aggregate in the concrete.
- f) Sidewalk and curb and gutter joints and spacing shall be constructed in accordance with current MDOT Ramp Detail R-28 and Article 12 (Standard Details), SD-DS-4 (Sidewalk and Curb & Gutter Joints) of these Standards.
- g) Water shall not be added to the concrete surface to aid in finishing.

- h) After finishing operations have been completed on the freshly placed concrete, and immediately after the free water has left the surface, the surfaces shall be completely coated and sealed with a uniform layer of white membrane curing compound, unless otherwise specified. This curing compound shall meet the requirements of MDOT Specifications, Section 903 (Admixtures and Curing Materials for Concrete), and shall be applied in accordance with MDOT Specifications, Subsection 602.03.M (Curing).
- i) The concrete items being placed shall not be opened to construction or vehicular traffic until the concrete has reached 85% of its design flexural strength in accordance with ASTM C293 (Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading)). Sampling, molding test specimens, curing, and testing shall meet the approval of the PSAA.

2. Concrete Curb & Gutter

- a) All curb and gutter shall be constructed prior to placement of street pavement unless integral with a concrete pavement. A minimum 7-day cure of the concrete curb and gutter shall be required before paving of adjacent bituminous or concrete pavement.
- b) Concrete curb and gutter shall be finished in a neat and workmanlike manner with a light broom finish. The top-of-curb or edge-of-metal shall not vary by more than $\frac{3}{16}$ inch in 10 feet when checked with a 10-foot straight edge. The balance of the exposed surfaces shall not vary more than $\frac{3}{8}$ inch from the Plan elevations, alignment and typical cross section. Variation from these requirements will be grounds for rejection and replacement of the curb and gutter.
- c) Any curb and gutter which cracks (other than at joints), is marked by graffiti, or otherwise damaged before it has been accepted by the PSAA, shall be replaced by the Contractor at the Contractor's expense.

3. Concrete Sidewalk and Ramps

- a) All concrete sidewalks outside of the Downtown Development Authority (DDA) limits must be constructed in accordance with Article 12 (Standard Details), SD-DS-5 (Sidewalk Cross Section) of these Standards.

- b) Sidewalks within the DDA shall be constructed in accordance with Article 12 (Standard Details), SD-DDA-1 through SD-DDA-8 of these Standards.
- c) Sidewalk ramps shall be constructed in accordance with MDOT Standard Detail R-28.
- d) The concrete sidewalk shall be finished in a neat and workmanlike manner with a light broom finish.
- e) The Contractor is responsible to construct all sidewalk, sidewalk ramps, curbs, and all other concrete items within current ADA/PROWAG guidelines and standards.
- f) The detectable warning surface for sidewalk ramps shall be colored as Federal Number 22144 (frequently referred to as “Colonial Red” or “Brick Red”). The detectable warning tiles shall meet the following material properties, dimensions, and tolerances using the most current test methods:
 - (1) Water Absorption: Not to exceed 0.35% when tested in accordance with ASTM D570 (Standard Test Method for Water Absorption of Plastics).
 - (2) Compressive Strength: 18,000 psi minimum, when tested in accordance with ASTM D695 (Standard Test Method for Compressive Properties of Rigid Plastics).
 - (3) Tensile Strength: 10,000 psi minimum, when tested in accordance with ASTM D638 (Standard Test Method for Tensile Properties of Plastics).
 - (4) Flexural Strength: 24,000 psi minimum, when tested in accordance with ASTM D790 (Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials).
 - (5) Flame Spread: 25 maximum when tested in accordance with ASTM E84 (Standard Test Method for Surface Burning Characteristics of Building Materials).
 - (6) Gardner Impact: 50 in.-lbs. minimum, when tested in accordance with Geometry “GE” of ASTM D5420 (Standard Test Method for Impact Resistance of Flat, Rigid Plastic Specimen by Means of a Striker Impacted by a Falling Weight (Gardner Impact)).

- (7) Accelerated Weathering of Tile when tested by ASTM G155 (Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials) or ASTM G151 (Standard Practice for Exposing Nonmetallic Materials in Accelerated Test Devices that Use Laboratory Light Sources) shall exhibit the following result: $\Delta E < 6.0$ as well as no deterioration, fading or chalking of surface when exposed to 3000 hours minimum exposure.
- (8) Wheel Loading: The cast-in-place tile shall be mounted on a concrete platform with a ½-inch airspace at the underside of the tile top plate then subjected to the specified maximum load of 10,400 lbs., corresponding to an 8,000 lb. individual wheel load and a 30% impact factor. The tile shall exhibit no visible damage at the maximum load of 10,400 lbs.
- (9) Salt and Spray Performance of Tile and Adhesive System when tested to ASTM B117 (Standard Practice for Operating Salt Spray (Fog) Apparatus) not to show any deterioration or other defects after 100 hours of exposure
- g) Any sidewalk which cracks (other than at joints), is marked by graffiti, or otherwise damaged before it has been accepted by the PSAA shall be replaced by the Contractor at the Contractor's expense.

4. Concrete Drives

- a) Concrete drives shall be finished in a neat and workmanlike manner, with a light broom finish.
- b) Concrete drives shall conform to Article 12 (Standard Details), SD-DS-1 through SD-DS-5 of these Standards, as appropriate.
- c) Concrete drive approaches shall be placed on either aggregate base course or a sand subbase as shown on the Plans or as directed by the PSAA.
- d) The method of forming joints shall be approved by the PSAA prior to construction.
- e) Any drive that cracks (other than at joints), that is marked by graffiti, or otherwise damaged before it has been accepted by the PSAA, shall be replaced by the Contractor at the Contractor's expense.

J. Bituminous Pavement Construction

1. Cleaning

- a) Before placing the bond coat, the existing pavement surface including joints, cracks and edges shall be thoroughly cleaned to a minimum depth of 1 inch with compressed air, vacuum cleaning type equipment, or other approved mechanical or hand methods to remove all dirt, debris, and all foreign material. The equipment shall have an effective means for preventing any dust resulting from the operation from escaping into the air.
- b) The Contractor is required to spray an approved vegetation killer on all vegetation, prior to placement of bituminous overlay.

2. Bituminous Placement

- a) The materials for this work shall meet the requirements of Article 5 (Streets), Section II (Materials Standards) of these Standards. The job mix design formula must be submitted to, and approved by, the PSAA prior to commencement of paving operations.
- b) Prior to the placement of the bituminous pavement, the Contractor must obtain a "Permit to Place" from the PSAA. This "Permit to Place" shall be issued once the base course section has been approved by the PSAA as to its compaction and grading. In addition, the final structure adjustments must be approved by the PSAA prior to issuance of the "Permit to Place" for the wearing course.
- c) The Contractor shall apply a bond coat material at an application rate as approved per MDOT Specifications, Subsections 501.02 (Materials) and 501.03 (Construction), on all areas to be paved, except the gravel base, prior to the placement of bituminous material. Care shall be taken to apply a uniform bond coat on all surfaces that are to be paved and to avoid covering the face of curbs, sidewalk or other surfaces that are not to be paved. After September 15, the bond coat shall not be diluted by more than 25%.
- d) The Contractor is not permitted to place bond coat or pave when rain is threatening or when the moisture on the existing surface would prevent satisfactory bonding. Paving operations shall be halted at any time of the day if rain starts. Any quantity of unused bituminous material is the complete responsibility of the Contractor.

- e) The Contractor shall schedule the paving operation to avoid longitudinal cold joints. In all cases, the Contractor shall pave the primary road's through-traffic lanes ("main line") first, from the point-of-beginning to the point-of-ending. All other paving including but not limited to acceleration and deceleration lanes, intersection approaches, and center left-turn lanes shall be paved following completion of the main line paving, unless authorized by the PSAA prior to pavement placement.
- f) The Contractor shall have a 10-foot long straight edge on every paver. Complete automation shall be required on all main line pavers. In addition to all MDOT Specification requirements, the Contractor may be required by the PSAA to use two 30-foot grade referencing skis at any time during main line paving. The use of rubber-tired pavers must be approved by the PSAA except for bituminous patching and shared use path paving.
- g) The rate of the paver shall be such that the paving operation will be continuous, resulting in no transverse cold joints, but shall never exceed the rate of 50 feet per minute. The Contractor shall coordinate the paving operation so as to have enough trucks available to keep the paver(s) moving continuously at all times.
- h) Wearing and leveling courses shall be placed in lifts of 1½ inches to 2 inches in thickness, and base material in lifts of 2 inches to 3 inches in thickness, as indicated on the Plans or as directed by the PSAA. The wearing course shall be placed with a ¼-inch lip at the gutter edge-of-metal.
- i) If the PSAA directs the Contractor to place a feather joint, it shall be constructed so as to vary the thickness of the asphalt from zero inches to the required paving thickness of approximately 1½ inches over a distance of 10 feet. The Contractor shall rake the larger pieces of aggregate out of feather joints prior to compaction.
- j) All bituminous thickness dimensions shall be compacted in place depth.
- k) The Contractor shall carefully observe the paving operation for signs of faulty mixtures. Points of weakness in the surface shall be removed or corrected by the Contractor prior to paving any subsequent lift of bituminous material. Such corrective action may include removal and replacement of thin or contaminated sections of pavement including sections that are weak or unstable.

- l) Once the Contractor or Contractor's representative is notified by the PSAA that the material being placed is out of allowable tolerances, or that there is a problem with the paving operation, the Contractor shall stop the paving operation at once and the Contractor will not be permitted to continue placing bituminous material until again authorized by the PSAA.
- m) In-place density of each layer of bituminous mixture shall be compliant with MDOT Special Provision for Acceptance of Hot Mix Asphalt Mixture on Local Agency Projects.
- n) No traffic shall be allowed on newly placed asphalt surfaces until rolling has been satisfactorily completed and the surface has cooled sufficiently to prevent damage from traffic. This is to be accomplished by traffic regulators (flaggers) and by relocating traffic control devices to prevent traffic from entering the work area until such time that traffic can be safely maintained without damaging the new construction. The Contractor shall provide flaggers in sufficient number to maintain traffic as required to keep traffic off sections being surfaced and provide for safe travel at all times as determined by the PSAA.
- o) HMA shall be placed in compliance with MDOT Specifications, Subsection 501.03.I (Weather Limitations).
- p) HMA shall comply with the QA/QC requirements as defined by the MDOT Special Provision for Acceptance of Hot Mix Asphalt Mixture on Local Agency Projects.

K. Bituminous Finish Wedging

1. The material shall meet the requirements of Article 5 (Streets), Section II (Materials Standards) of these Standards, with specific HMA mix as directed by PSAA.
2. The Contractor shall construct bituminous finish wedges as shown on the Plans and at all drive approaches, sidewalk ramps, and other areas where wedging is needed to make a good vertical and/or horizontal transition between old construction and the new pavement surface and/or to eliminate areas of standing water in the wearing surface.
3. Prior to placement of wedging material, the surface shall be cleaned with compressed air or vacuum cleaning type equipment.

4. The Contractor shall complete the wedging of driveway approaches within 2 days after the placement of the finished wearing course.
5. The Contractor shall construct feather joints at all wedges (including the raking out of large pieces of aggregate) to provide a high-quality riding surface and appearance.

L. Concrete Pavement Construction

1. Concrete Placement

- a) Concrete pavement may be constructed adjacent to new or existing concrete curb, curb and gutter, or with integral curb and gutter.
- b) Where the new concrete pavement is to be constructed adjacent to curb of any type, the Contractor shall install epoxy-coated lane ties or deformed bars in accordance with MDOT Specifications, Subsection 602.03. F (Constructing Joints).
- c) The Contractor shall perform all concrete placement operations in weather that is suitable for the successful placement and curing of the concrete materials. Concrete shall not be placed during periods of active precipitation.
- d) The Contractor shall complete all needed formwork, base and/or sub-base preparation, and any other related items that are deemed necessary for the proper completion of the work.
- e) Concrete raised devices (e.g., speed hump, speed table, raised intersection) shall be installed per Article 12 (Standard Details), SD-VT-1 through SD-VT-7, of these Standards, at locations identified in the plan set or field marked by the PSAA. Contractor shall saw cut the full depth of existing pavement at the device limit for removal and placement. Remove existing pavement and shape base aggregate to maintain minimum thickness as specified, compacted to 95% of its maximum dry density. Place form at the device limit and install device as specified. Broom finish and place curing compound.
- f) The Contractor shall not commence the placement of concrete until they receive a "Permit to Place" for the pavement from the PSAA. The PSAA's approval of the Contractor to place concrete shall not relieve the Contractor of their responsibility for the proper placement and protection of the concrete materials or its long-term performance.

- g) During periods when precipitation is threatening, Contractor shall provide durable plastic sheeting, approved by the PSAA, in sufficient quantity to cover and protect all freshly placed concrete such that precipitation does not come into contact with the concrete. The Contractor shall arrange the placement of the plastic sheeting such that the surface of any freshly placed concrete is not marred by contact with the plastic. Any seams in the plastic sheeting shall be watertight. The Contractor shall place adequate supports along and over the freshly placed concrete to prevent contact of the plastic and concrete.
- h) The Contractor shall ensure that sufficient dams or barriers are placed along the edges of the freshly placed concrete to prevent erosion of the underlying materials or damage to the edges of the freshly placed concrete.
- i) Any concrete damaged by precipitation shall be removed and replaced at the Contractor's expense. The PSAA shall decide if the concrete has been damaged and the limits of removal and replacement.
- j) Concrete shall only be placed when the rate of surface evaporation at the site is less than 0.20 pounds per square foot per hour, according to MDOT Specifications, Figure 706-1 (Surface Evaporation for Concrete). The Contractor shall provide approved equipment for determining the relative humidity and wind velocity at the site.
- k) Water shall not be added to the placed concrete in order to aid finishing. Any water added to the concrete for slump adjustments shall be done by adding water to the mixing unit and thoroughly re-mixing the concrete for 30 revolutions of the mixing unit at mixing speed. Water shall not be added such that the design water-to-cement ratio of the concrete mixture or the design slump of the concrete mix is exceeded.
- l) Concrete curing shall be performed in accordance with MDOT Specifications, Subsection 602.03.M (Curing). Curing operations shall take precedence over texturing operations and continued concrete placement. All curing compound applied shall provide uniform coverage over the entire surface being protected.
- m) The placement of curing compound shall be free of spots, blotches, or uncovered or non-uniformly covered areas. Should any such non-uniformly covered areas be determined to exist by the PSAA, the curing compound shall be immediately reapplied by the Contractor at no additional cost to the project.

- n) The Contractor shall take all precautions when placing concrete to protect it from damage due to the elements.
- o) Concrete shall be protected from weather and temperature according to the requirements of MDOT Specifications, Subsection 602.03.T (Weather and Temperature Limitations). Concrete shall not be placed when the temperature of the plastic concrete mixture itself is greater than 90°F.
- p) In conditions where low temperature protection is required, the Contractor shall cover the concrete with insulated blankets or other means as approved by the PSAA to protect the concrete from damage.
- q) The concrete shall remain protected until it has reached a compressive strength of at least 1000 psi, or as directed by the PSAA.

2. Cleaning and Sealing Joints

- a) The Contractor shall clean, plow, and hot seal Portland cement concrete pavement joints and cracks at the locations specified by the PSAA.
- b) All joints and cracks shall be sandblasted (vertical face) to a minimum depth of 1 inch and a minimum horizontal surface width of 1 inch on both sides of the crack or joint. The joints and cracks shall be plowed and blown out by using compressed air as necessary to remove all dirt, vegetation and old seal material. Compressed air shall be applied at a minimum pressure of 90 psi, at a rate of 150 cubic feet per minute at the nozzle.
- c) The Contractor shall completely fill joints and cracks with rubber-asphalt, hot-applied sealing compound in conformance with ASTM D6690 (Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements). The PSAA shall inspect all sealed joints and cracks for low spots and may direct the Contractor to reseal low spots with additional rubber asphalt material.

M. Patching

1. Bituminous Pavement Patching and Repair

- a) The material used for this work shall meet the requirements of Article 5 (Streets), Section II (Materials Standards) of these Standards.

- b) The pavement shall be removed full depth unless otherwise specified on the Plans. If additional aggregate or clay base is removed without written approval of the PSAA, it shall be replaced and compacted by the Contractor, with MDOT 21AA aggregate or other material as directed by the PSAA.
- c) Prior to placing the bituminous patching mixture, the sand subbase and aggregate base shall be evenly graded, trimmed and compacted to 95% and 98% respectively, of their maximum unit weights as determined by the AASHTO T 180 test (Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop). The surface of all pavement cuts shall be cleaned with compressed air or vacuum cleaning equipment and then covered with approved MDOT bond coat applied at a rate of .05 gallons/s.y. The bond coat shall be applied with a power distributor hand sprayer.
- d) Prior to filling the excavated areas with patching material, if the base has become damp/wet due to rain or due to the Contractor's operation, it shall be dried by the Contractor by aerating or other approved method(s). Prior to patch placement, the excavation(s) shall be cleaned with compressed air to remove dirt and loose material. The Contractor shall use an air source that provides a minimum 90 psi and 150 cubic feet per minute of air at the nozzle. The base shall then be recompactd with a vibratory plate compactor or other approved method.
- e) The exposed bituminous edges of each patch shall be sprayed with bituminous bond coat by a power sprayer.
- f) Bituminous patching mixture shall be placed in lifts not exceeding 2 inches (approximately 2½ inches loose). Each layer of bituminous mixture shall be compacted to at least 97% of the control density, as determined by using the MDOT Modified Marshall Test.
- g) All areas excavated in one day shall be prepared, patched, compacted and opened to traffic in that same day.
- h) The Contractor shall use an asphalt paver or spreader box to place the asphalt patching material. The Contractor shall not use a grader or front-end loader or similar device for placing the bituminous patching material.

- i) For small areas, where approved by the PSAA, the Contractor may place the material by hand directly in the area intended to be patched. Under no circumstances shall the Contractor place bituminous material on adjacent pavement surfaces.
- j) All patches shall be compacted with an approved roller, unless it is impossible to use a roller due to the patch size, in which case, the Contractor may use a vibratory plate compactor on the patch.
- k) All patching shall be performed so as to provide a smooth riding surface.
- l) For patching in bike lanes, patching shall be the full width of the bike lane.
- m) Pavement markings disturbed due to pavement cuts or construction related activities shall be restored as directed by PSAA.
- n) All joints in patches made in streets under the street cut moratorium described in Article I, Section XIX (ROW Disturbances) of these Standards, shall be sealed with an approved asphaltic sealant.

2. Concrete Pavement Patching and Repair

- a) The Contractor shall patch existing concrete pavements in accordance with the Plans and Details and in accordance with MDOT Specifications, Subsection 603.03 (Construction) and MDOT Standard Plan R-44 and in accordance with Section III.E.5 (Concrete Pavement, Curb & Gutter, Sidewalk, and Drive Removal) of this Article.
- b) Prior to placement of concrete, the Contractor shall install deformed tie bars as specified elsewhere in this Section.
- c) The road base and adjacent concrete shall be wet down prior to placement of concrete to prevent water loss through the road base, and to form a better bond between old and new concrete. If a construction joint is necessary, the existing concrete surface shall be cleaned with compressed air to remove loose and unsound concrete and to expose the aggregate in the concrete.
- d) During the placement of concrete for the pavement repair, the Contractor shall use a high-frequency mechanical vibrator to consolidate the concrete to insure even placement and to prevent voids or pockets of air from forming. The vibrator shall not be used to move the concrete within the patch limits. The vibrator shall be used minimally to avoid segregation of the aggregate.

3. Brick Pavement Patching and Repair

- a) The brick patch shall match the existing brick material and pattern.
- b) MDOT Class II Granular Material subbase shall be placed from the bottom of the excavation to 8 inches below the bottom of the brick pavement and compacted to 95% of its maximum unit weight as determined by the AASHTO T-180 test.
- c) A concrete base of matching the existing thickness or 7 inches, whichever is greater, shall be placed on the evenly graded, trimmed and compacted subbase. The brick pavement shall then be placed on top of the concrete base and set in a minimum 1-inch thick dry mortar leveling bed (one part Portland Cement, four parts MDOT Class II granular material).

N. Pavement Markings

1. Removal of Pavement Markings

- a) Inappropriate or conflicting pavement markings shall be removed by the Contractor at locations as shown on the Plans or as directed by the PSAA prior to any change in traffic patterns. If permanent pavement markings on an open roadway are removed more than 24 hours in advance of a change in traffic pattern, temporary markings shall be placed before the end of the workday.
- b) The removal of pavement markings shall be accomplished in a manner and by methods meeting the approval of the PSAA. Methods which can provide acceptable results are: sandblasting using water or air; high-pressure water; steam or superheated water; or mechanical devices such as grinders, sanders, scrapers, and wire brushes.
- c) Pavement markings shall be removed in such a manner as to cause as little damage as possible to the surface texture of the pavement.
- d) Sand or other material deposited on the pavement as a result of removing pavement markings shall be removed and disposed of as the work progresses. Accumulations of sand or other material which might interfere with drainage or which may constitute a hazard to traffic will not be permitted and shall be removed by the Contractor immediately.

- e) Where blasting is used for the removal of pavement markings or for the removal of objectionable material, and such removal operation is being performed within 10 feet of a lane occupied by public traffic, the residue (including dust) shall be removed immediately as work progresses. Such removal shall be by a vacuum attachment operating concurrently with the blast cleaning operation or by other equally effective methods meeting the approval of the PSAA.

2. Temporary Pavement Markings, Type R

- a) The Contractor shall place temporary removable-type pavement markings (Type R), as shown on the Plans and as directed by the PSAA.
- b) Temporary pavement markings for bituminous surfaces over which traffic is to be maintained shall be made with reflective marking tape. Markings which lose their reflectorizing properties shall be removed and replaced.
- c) Temporary pavement markings shall be placed after each day's paving, or as directed by the PSAA.
- d) All markings shall have a nominal width of 4 inches and shall be either white or yellow in accordance with the MMUTCD or as directed by the PSAA.
- e) Temporary longitudinal pavement markings shall be in accordance with MDOT PAVE 904 Pavement Marking Special Details. Markings less than 4 feet in length shall be removed and replaced by the Contractor at the Contractor's expense.
- f) Markings shall be applied so that they adhere adequately to the pavement surface. The Contractor shall clean the pavement surface as necessary to affix the marking tape.

3. Temporary Pavement Markings, Type NR

- a) The Contractor shall place temporary non-removal (Type NR) pavement markings, as shown on the Plans and as directed by the PSAA.
- b) Temporary pavement markings for bituminous surfaces over which traffic is to be maintained shall be made with reflectorized marking tape or paint. Markings which lose their reflectorizing properties shall be removed and replaced.
- c) Temporary pavement markings shall be placed after each day's paving or as directed by the PSAA.

- d) All markings shall have a nominal width of 4 inches and shall be either white or yellow in accordance with the MMUTCD or as directed by the PSAA.
- e) Temporary longitudinal pavement markings shall be in accordance with MDOT PAVE 904 Pavement Marking Special Details. Markings less than 4 feet in length shall be removed and replaced by the Contractor at the Contractor's expense.
- f) Markings shall be applied so that they adhere adequately to the pavement surface. The Contractor shall clean the pavement surface as necessary to affix the marking tape or paint.

4. Permanent Pavement Markings

- a) Furnish all labor, equipment, and materials necessary to install pavement markings at the locations specified on the Plans, and with the materials and widths specified on the Plans, in accordance with MDOT Specifications, Sections 811 (Permanent Pavement Markings) and 920 (Permanent Pavement Marking Materials) except as specified herein.
- b) Where applicable, pavement markings shall conform to the current requirements of the MMUTCD issued under provisions of the Michigan Vehicle Code, Act 300, PA 1949, as amended.
- c) Prior to the placing of any pavement markings, Contractor shall examine the limits of the new work and ascertain that the existing surfaces are adequate to receive the material to be installed.
- d) Layout work necessary for the location and placing of markings, as specified on the Plans or as determined by PSAA, shall be the responsibility of Contractor and shall be at his expense. Layout shall be approved by PSAA prior to final placement of pavement markings.
- e) Pavement marking shall be performed during the period May 1 to November 1, unless otherwise approved in writing by PSAA. No markings shall be applied when the air temperature is less than 50 degrees Fahrenheit, unless otherwise approved by the PSAA.
- f) Surfaces must be thoroughly dry and free from dirt, loose paint, oil, grease, wax and other contaminants before pavement markings are applied.
- g) Markings shall not be placed when rain is threatening or when the surface to be painted is wet.

- h) The Contractor shall be responsible for removal of any deposits or materials detrimental to the application of durability of the pavement markings.
- i) Markings shall be applied so that they adhere adequately to the surface.
- j) New markings and/or retraced markings shall be placed, with reasonable tolerance, in their proper locations.
- k) Incorrect or misplaced markings shall be obliterated and re-marked in accordance with PSAA's instructions. Costs incurred to obliterate and remark incorrect or misplaced markings will be at Contractor's expense.
- l) Protection of the uncured pavement markings shall be the responsibility of Contractor, and all costs incurred to provide the protection will be at Contractor's expense.
- m) Permanent pavement markings shall be applied in compliance with MDOT Subsection 801.03. D. (Application, Temperature, and Seasonal Restrictions).
- n) Permanent longitudinal pavement markings shall be in accordance with MDOT PAVE 905 Pavement Marking Standards. Markings less than 4 feet in length shall be removed and replaced by the Contractor at the Contractor's expense.

O. Brick Unit Paving

- 1. One sample of each shape and color of paver shall be submitted for approval to the PSAA. Where necessary, additional pavers showing extreme range of color and texture for specified items shall be submitted.
- 2. Brick used in areas subject to traffic shall meet ASTM C1272 (Standard Specification for Heavy Vehicular Paving Brick), Durability Type F, and Appearance Application PS.
- 3. Mockups shall be built to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
- 4. Mock-ups will be 40 square feet minimum in size, utilizing the pattern and joints required for the project. The approved mock-up shall be considered a minimum standard of workmanship to be matched or bettered throughout the Project.

5. The mock-up may be constructed as part of the Project and, if approved, will be accepted as part of the Work. However, should the mock-up fail to meet PSAA's approval, the area shall be removed and reconstructed until approved.
6. Frozen materials or materials mixed or coated with ice or frost shall not be used nor shall a frozen subgrade or setting beds be built upon. Any unit paver work damaged by frost or freezing shall be removed and replaced.
7. Each type of unit paver, joint material, and setting material shall be obtained from a single source with resources to provide materials and products of consistent quality in appearance and physical properties.
8. Surfaces to receive unit paving shall be inspected for compliance with requirements for installation tolerances and other conditions affecting performance. Installation shall proceed only after unsatisfactory conditions have been corrected.
9. Prepared subgrade shall be proof rolled according to requirements in this Article to identify soft pockets and areas of excess yielding. Contractor shall proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.
10. Sand Setting Bed
 - a) The sand shall be of uniform moisture content when screeded and shall be protected against rain when stockpiled on site prior to screeding. For installation, the moisture content shall be in the range of 4 to 8 percent.
 - b) The bedding sand shall be spread loose in a uniform layer to give a depth after compaction of the paving units of a maximum $\frac{3}{4}$ -inch thickness as required to achieve design grades.
 - c) The spread sand shall be carefully maintained in a loose condition and protected against pre-compaction by traffic or rain both prior to and following screeding. Under no circumstances shall the sand be screeded in advance of the laying face to an extent to which paving will not be completed on that day.
 - d) Any screeded sand which is pre-compacted prior to laying of paving unit shall be brought back to profile in a loose condition. Neither pedestrian nor vehicular traffic shall be permitted on the screeded sand.

- e) The Contractor shall screed the bedding sand using either an approved mechanical spreader or by the use of screed guides and boards.

11. Placing Pavers

- a) Pavers with chips, cracks, voids, discolorations or other defects shall not be installed.
- b) The pavers shall be laid in the pattern as specified on Plans or as determined by the PSAA.
- c) Paving units shall be installed from a minimum of three bundles simultaneously drawing the paver vertically rather than horizontally.
- d) Joint spacing shall be consistent and of approximately $\frac{1}{8}$ inch unless noted otherwise. This spacing must also be provided for the first row abutting the edge restraint and/or concrete sidewalk.
- e) String lines or chalk lines on bedding sand should be used to hold all pattern lines true.

12. Cutting Pavers

- a) Contractor shall make all efforts to use full bricks to the maximum extent possible. Where cutting of brick is required to achieve the desired pattern, brick shall be cut to leave a clean edge to the traffic surface using a mechanical hydraulic cutter, guillotine cutter, or masonry saw.
- b) Discontinuities in patterns will not be permitted. Pavers shall be laid out in all areas so as to eliminate slivers at edges.
- c) Pavers shall be carefully placed by hand in straight courses with hand-tight joints and uniform top surface. Good alignment shall be maintained and provide the pattern indicated.
- d) Radius section curb segments shall be utilized as supplied by manufacturer and that most closely match the existing road curb radii. Where the manufacturer does not provide radius sections to match the existing road curb radii, Contractor may cut pavers in half or thirds (as determined by PSAA) to more closely follow the existing curb line.

- e) To prevent depressions and protect paver alignment, Contractor shall protect newly laid pavers at all times by panels of plywood, on which the installer stands, which can be advanced as work progresses. However, plywood protection shall be kept in areas which will be subjected to continued movement of materials and equipment.
- f) If additional leveling of the pavers is required, and before sweeping in joint filler, pavers shall be rolled with a power roller after sufficient heat has built up in the surface from several days of hot weather.
- g) After sweeping and prior to compaction, the paved area shall be inspected by the PSAA to ensure satisfactory color blending. Areas deemed poorly blended shall be removed and re-installed in order to achieve satisfactory color distribution.

13. Compaction of Pavers

- a) After inspection of the pavers, they shall be compacted to achieve consolidation of the sand bedding and brought to design levels and profiles by not less than 3 passes of a suitable plate compactor.
- b) Compaction shall be accomplished by the use of a plate compactor capable of a minimum of 5,000-pound compaction force.
- c) Initial compaction should proceed as closely as possible following installation of the paving units and prior to acceptance of any traffic or application of jointing sand.
- d) Care shall be taken not to damage pavers or surface finish during compaction.

14. Joint Treatment

- a) Jointing sand shall be spread over the pavement after initial compaction has been completed. The jointing sand shall be spread as soon as is practical after initial compaction and prior to the termination of work on that day. The Contractor shall not use wet sand.
- b) The jointing sand shall be broomed to fill the joints. Excess sand shall then be removed from the pavement surface and the pavers shall be compacted again to settle the jointing sand.
- c) This operation shall be repeated a minimum of 2 times.

15. Final Compaction

- a) After jointing sand has been installed and the pavement surface swept clean, final compaction shall be accomplished by not less than 2 passes of the plate compactor.
- b) Final compaction should proceed as closely as possible following installation of jointing sand and prior to the acceptance of any traffic.

16. Proof Rolling

- a) The completed installation shall be proof rolled with pneumatic tire equipment which replicates anticipated service traffic. Contractor shall subject each individual paver to at least 1 passage of load.
- b) Equipment and procedures are subject to approval by the PSAA and proof rolling will be observed and recorded by the PSAA.
- c) Units cracked or otherwise damaged by proof rolling, shall be removed and replaced.

17. Allowable Tolerances

- a) Finished surface of pavement shall be smooth, even, and true to the lines, grades and cross section indicated. Maximum deviation when tested with a 10-foot straightedge parallel to the centerline of the surfaced area shall be $\frac{1}{4}$ inch in 10 feet.
- b) Maximum offset from flush from paver surface to paver surface, or from paver surface to a fixed flush edge shall be $\frac{1}{16}$ inch.
- c) Finished walk shall be sloped for drainage without any ponded water on the finished surface.

18. Repair, Cleaning and Protection

- a) Paver surface shall be cleaned of all debris, dirt, and sand.
- b) Pavers which are chipped, broken, stained or otherwise damaged or which do not match adjoining units shall be removed and replaced. New units shall be provided to match adjoining units and installed in the same manner as original units and with same joint treatment to eliminate evidence of replacement.

- c) Final protection of pavers shall be provided until Substantial Completion in a manner acceptable to the PSAA.
- d) Finished area shall be free of bumps or depressions, evenly graded to levels shown, and shall be guaranteed against defects of materials and workmanship for a period of two years from the date of Substantial Completion.

P. Micro-Surfacing

- 1. Materials and equipment shall be in accordance with MDOT Specifications except as otherwise noted in Materials Specifications elsewhere in these Standards.
- 2. Preparation of pavement, furnishing and installing surfacing mixture, rut filling, and all other work shall be done in accordance with MDOT Specifications, Section 504 (Micro-Surfacing), as directed by the PSAA, and as described herein.
- 3. A vacuum style pick-up sweeper shall be used to perform any sweeping required to prepare the existing surface.
- 4. Extreme care shall be taken not to place micro-surface mixture on any concrete curb and gutter.

Q. Chip Seal

- 1. Preparation of pavement, furnishing and installing chip seal and all other work shall be done in accordance with MDOT Specifications, Section 504 (Micro-Surfacing), as directed by the PSAA, and as described herein.
- 2. Immediately prior to placing the chip seal, all pavement markings shall be removed using an abrasion method.
- 3. Asphalt emulsion shall be applied at a rate within the range of 0.39 - 0.41 gallons per square yard. The Job Mix Formula (JMF) target rate for the asphalt shall be 0.40 gallons per square yard. Asphalt emulsion shall be applied at a minimum temperature of 290°F, followed by a uniform application of coarse aggregate.
- 4. MDOT Class 34CS aggregate shall be placed at a rate within the range of 18-20 pounds per square yard. The JMF target rate for the asphalt shall be 19 pounds per square yard.

5. If the target rates are not the optimum application rates due to the gradation of the coarse aggregate or due to existing surface conditions of the pavement, the Contractor shall notify the PSAA. The Contractor shall then submit new rates and a new JMF for approval by the PSAA prior to work commencing.
6. Coarse aggregate shall be rolled before the asphalt emulsion has set. No more than 150 feet of unrolled cover material shall be left at any time. No cover material shall be left unrolled for more than 5 minutes.
7. A minimum of 2 complete rolling trips shall be completed over the cover aggregate. A complete trip is one pass, forward and backward, over the same patch. Each trip shall overlap the previous trip.
8. Coarse aggregate shall be rolled sufficiently to embed it into the asphalt emulsion. If the PSAA determines that the rolling procedures are not sufficiently embedding the aggregate into the emulsion, then the Contractor will submit modifications for improving the rolling procedures to the PSAA for approval.
9. Cover (course) aggregate shall not be placed on asphalt emulsion after the asphalt emulsion "breaks."
10. An initial sweeping on the final surface shall be performed before the end of each day's work or within 24 hours of application with the approval of the PSAA. Initial sweeping shall begin within 3 hours after application unless otherwise directed by the PSAA.
11. Temporary raised pavement markings shall be placed prior to the application of the chip seal, at intervals specified below, or as directed by the PSAA:
 - a) On tangent sections of roadway and on gentle curvatures of roadways, markers shall be placed at 50-foot intervals.
 - b) On severe curvatures of roadways, markers shall be placed at 25-foot intervals.
12. Temporary raised pavement markings shall be installed no more than 24 hours prior to the placement of the chip seal. Markings shall be offset from the centerline or lane line(s) to facilitate placement of the first pass of the micro-surfacing. Markings under the lane closure of the adjacent pass shall be removed, and temporary pavement markings placed upon completion of the micro-surfacing to ensure they are always present.

IV. Streetlights and Signals

A. General

1. All streetlight design, Plans, construction, and materials shall conform to Article 7 (Streetlights) and Appendix A (Material Requirements) of these Standards.
2. The Contractor shall furnish all materials and equipment required to install and place in operation Street Light Fixtures. All electrical components shall be furnished new and be listed by, and bear the label of Underwriter's Laboratories, Inc.
3. Prior to beginning construction, the Contractor shall submit to the PSAA product data sheets and shop drawings for all light standards including luminaires, poles, bases, bracket arms, and fixtures to be used in the project and Manufacturer's certifications of all wiring, splices, lamps, rods, base plates, anchor bolts, and other parts used in the construction of the light pole assembly.
4. Certifications shall indicate that all materials meet the minimum requirements of these Standards.
5. For each submittal or resubmittal, the Contractor shall allow at least 14 calendar days from the date of the submittal to receive the PSAA's acceptance or request for revisions. The PSAA's comments shall be incorporated into the submitted plans, calculations and descriptions. The PSAA's acceptance is required before beginning the work.
6. Resubmittals shall be reviewed and returned to the General Contractor within 14 calendar days. Required revisions will not be a basis of payment for additional compensation, extra work, or an extension of contract time. The Contractor shall include time for this entire review process in their critical path schedule.
7. The PSAA reserves the right to request standard production model fixture samples for inspection and to require such tests as deemed necessary to ensure complete compliance with the Specifications. Luminaires that do not meet these tests or those luminaires with improper or inadequate light distribution will be subject to rejection.
8. All costs associated with submitting and testing of replacement luminaires or lamps due to rejection of submitted luminaires shall be paid by the Contractor.

9. One manufacturer, responsible for coordination of fixtures, poles, brackets, luminaires, and all other appurtenances as shown on the drawings or detailed in the specifications, shall provide all required lighting elements.
10. Connections to equipment, lighting standards, contactors, etc., shall be made in accordance with the shop drawings and rough-in measurements furnished by the manufacturer of the equipment. Any and all additional connections not shown on the Plans but called for by the equipment manufacturer's shop drawings or required for the successful operation of the particular equipment furnished, shall be installed by the Contractor as part of his Contract with no additional compensation.
11. Contractor must provide adequate storage space for all electrical equipment, conduit, and materials delivered to the job site under a weather-protected enclosure. Location of the space must be approved by the PSAA. Equipment set in place in unprotected areas must be provided with temporary protection.
12. The Contractor shall be responsible for maintenance of, and repair of damage as a result of accident or vandalism to, the light fixtures, bases, luminaries, and all other materials installed, or to be installed, related to, or necessary for the light fixture installation on the project. This shall remain the Contractor's responsibility until the installation is complete, tested, and accepted by the PSAA.
13. All trenching and backfilling to install electrical work shall be by the Electrical Contractor. When backfilling the trenches and around streetlight foundations, the earth must be compacted in place in 12-inch layers to 95% of the material's maximum dry density.
14. During backfilling of trenches continuous underground-line warning tape shall be installed directly above line at 6 to 8 inches below finished grade. Multiple tapes shall be used where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
15. Any excess excavated material shall be disposed of offsite at no additional cost.
16. Upon completion of the underground work, the Contractor shall grade the work area smooth, fill any trench settlements, eliminate any large piles of earth, and clean up any debris or leftover construction materials, disposing of it offsite in an approved manner and at an approved location.

17. Areas disturbed by trenching, storing of dirt, cable laying, and other work shall be restored. Vegetation shall also be restored and shall include necessary topsoil, fertilizer, seed, sod, and mulch in conformance with Section VI (Landscaping and Restoration) of this Article.
18. All factory-finished equipment shall be cleaned at the completion of the work by the Contractor. Equipment showing marks or rust shall be refinished by the Contractor in a manner acceptable to the PSAA.

B. Foundation

1. Concrete foundation shall be installed as indicated on the Plans. Approved forms shall be constructed and placed so they will not move or deflect upon placement of concrete and will not leak. All concrete work shall be properly cured as required and, upon removal of forms, exposed concrete surfaces shall be pointed and troweled smooth.
2. Concrete for foundations shall be immediately and carefully placed after mixing and shall be vibrated during and immediately after the pouring to prevent voids and assure a dense concrete structure. The exact location of all concrete bases shall be staked by the PSAA prior to digging.
3. Anchor bolts shall be set according to templates furnished by pole manufacturer.

C. Poles

1. Areas and conditions shall be examined, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.
2. Poles, luminaire-mounting devices, lowering devices, and pole accessories shall be examined before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.
3. Roughing-in for foundation and conduit shall be examined to verify actual locations of installation.
4. Installation shall proceed only after unsatisfactory conditions have been corrected.
5. Pole foundations and poles shall be aligned for optimum directional alignment of luminaires and their mounting provisions on pole.

6. The following minimum horizontal distances of poles from surface and underground features shall be maintained unless otherwise indicated on Plans:
 - a) Fire Hydrants and Water Piping: 5 feet.
 - b) Water, Gas, Electric, Communications, and Sewer Lines: 10 feet.
 - c) Trees: 15 feet from tree trunk.
7. Pole shall be mounted with leveling nuts and top nuts tightened to torque level according to pole manufacturer's written instructions.
 - a) Anchor bolts and nuts used shall be selected to resist seismic forces defined for the application and approved by manufacturer.
 - b) Lubricant may be used on threads, in compliance with manufacturer specifications.
 - c) Base covers shall be installed unless otherwise indicated.
8. Poles shall be installed in paved areas with a minimum 6-inch wide unpaved gap between the pole or pole foundation and the edge of the adjacent pavement. The unpaved ring shall be filled with pea gravel inserted to a level 1 inch below top of adjacent pavement.
9. Pole shall be raised and set using web fabric slings (not chain or cable) at locations indicated by manufacturer.
10. Luminaire shall be installed square, level, and plumb with finish grade and shall be fastened to structural support as follows:
 - a) Sized and rated for luminaire weight.
 - b) Able to maintain luminaire position after cleaning and re-lamping.
 - c) Supports luminaires without causing deflection of finished surface.
 - d) Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.
11. Receptacles and other devices shall be installed as called for on the plans.

D. Service Disconnect

1. The Contractor shall furnish and install disconnect box mounted in a cabinet meeting the requirements of Article 7 (Streetlights) of these Standards. Also included is all labor, material and equipment necessary to furnish, install, and coordinate with the Detroit Edison Company for installation of secondary electrical power to the disconnect box.
2. At the disconnect cabinet, the Detroit Edison neutral, the disconnect cabinet, and the ground mat system shall all be permanently grounded together. The resistance of the ground rod to ground shall not exceed 25 ohms when tested with a megger. In case the resistance is more than 25 ohms, additional or longer ground rods shall be installed.
3. A master photoelectric controller meeting the requirements of Article 7 (Streetlights) shall be furnished and capable of handling the electric load on the designed circuit.

E. Handholes

1. Handholes shall be installed level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances. An extension shall be used if required to match depths of duct, and seal joint between handhole and extension as recommended by manufacturer.
2. Unless otherwise indicated, units shall be supported on a level bed of crushed stone or gravel, graded from ½-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
3. In paved areas and trafficways, cover shall be set flush with finished grade. For other areas, covers shall be set 1 inch above finished grade.
4. Handholes shall be installed with bottom below frost line, 42 inches below grade.
5. Removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, shall be installed as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

6. Openings for duct shall be field cut according to enclosure manufacturer's written instructions. Wall of enclosure shall be cut with a tool designed for material to be cut. Holes shall be sized for terminating fittings to be used, and seal around penetrations after fittings are installed.

F. Conduit and Wiring

1. All excavation for main electrical runs shall be of a depth to leave at least 30 inches from the top of the electrical run (conduit encasement, buried rigid conduit, or direct buried cable) to the grade of the top of pavement or surrounding terrain. The trench shall be graded to handhole and pole location so that the finished conduit run will contain no pockets where water might accumulate or drain into a handhole or pole.
2. Layout and installation of duct, duct bank, manholes, handholes, poles, and boxes shall be coordinated with final arrangement of other utilities, site grading, and surface features as determined in the field. PSAA shall be notified if there is a conflict between areas of excavation and existing structures or other material to remain.
3. Elevations of duct and duct-bank entrances into manholes, handholes, and boxes shall be coordinated with final locations and profiles of duct and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Locations and elevations shall be revised as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes.
4. Conduit shall be cut with a hacksaw or other approved tool. The ends shall be square after cutting and the conduit shall be reamed.
5. All conduits must be securely fastened to boxes with locknuts and bushings of an approved make, care being taken that the full number of threads project into the bushings. Rigid galvanized conduit shall be assembled by means of approved threaded galvanized coupling, unions, and fittings. PVC conduit shall be assembled by means of approved threaded or solvent-welded fittings.
6. Sleeves shall be installed with mechanical sleeve seals for penetrations through concrete slabs or walls unless core-drilled holes or formed openings are used. Sleeves shall be installed during erection of slabs and walls.

7. Sleeve seals of type and number of sealing elements recommended by manufacturer for cable material and size shall be used. Cable shall be positioned in center of sleeve.
8. Mechanical sleeve seals shall be assembled and installed in the annular space between cable and sleeve. Bolts shall be tightened against pressure plates that cause sealing elements to expand and make a watertight seal.
9. Conduits which are installed underground or concealed in concrete, foundations, or other structures, shall be cleared of foreign material and obstructions after installation and before conductors or pull wire are drawn in.
10. Leather-washer-type duct cleaner, with graduated washer sizes, shall be pulled through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Rubber duct swab shall follow for final cleaning and to assist in spreading lubricant throughout ducts.
11. Conduits shall be cut a minimum of 1 inch above the light pole base and a maximum of 2 inches above the base.
12. Manufacturer-approved pulling compound or lubricant shall be used where necessary. The compound used must not deteriorate conductor or insulation. Manufacturer's recommended maximum pulling tensions and sidewall pressure values shall not be exceeded.
13. Cable shall be pulled into ducts using a proper cable grip for the purpose. The cable shall be so handled that it is not subjected to excessive strain or kinked when pulled through the conduit.
14. Damaged or kinked cable shall not be used. Where more than one cable is to be installed in a duct, all cables shall be pulled through simultaneously. Splices in ducts will not be permitted.
15. Pulling means to be used, including fish tape, cable, rope, and basket-weave wire/cable grips, shall be such as not to damage cables or raceway.
16. Conductors shall not be installed in conduit until all work which might cause damage to the conduits or cables has been completed.
17. Conductors shall be installed in continuous lengths from light to light with connections in the base of lights or streetlight pull boxes.

18. Cables shall be neatly racked and identified on cable racks in all handholes after being formed to their final position. Cables shall be racked slightly higher than the duct entrances so that they will not rest on the edges of the duct.
19. All splices and connections shall be made as described herein and as shown on the Plans and Plan details. Where cable is installed but not immediately spliced, the cable ends shall be thoroughly sealed and racked out of the way of possible danger.
20. All splices shall be accessible through the handhole in the pole and shall extend 4 inches to 6 inches outside the handhole. No splices will be allowed which are inaccessible inside the pole. Street lighting splices required in ground handholes shall be terminated using splice kits that insulate, seal, and protect the splices.
21. All connections shall be per the manufacturer's recommendation. Electrical connectors and terminals shall be tightened according to manufacturer's published torque tightening values. If manufacturer's torque values are not indicated, Contractor shall use those specified in UL 486A (Wire Connections and Soldering Lugs for Use with Copper Connectors) and UL 486B (Standard for Safety Wire Connectors for Use with Aluminum Conductors).
22. Splices and taps shall be compatible with conductor material and possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
23. All connections shall be wire brush and applied with approved corrosion inhibiting compound.
24. Cables shall be properly tagged in all handholes and poles. For street light circuits, printed color code phase identification shall be repeated at all connections. The printing of the conductor coding shall adhere to covering and not be readily removed by rubbing.
25. Identity of each item shall be verified before installing identification products.
26. Installation sequence shall then be as follows:
 - a) Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
 - b) Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

- c) Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- d) Apply color coding tape in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- e) Colors for 208/120-V Circuits shall be:
 - (1) Phase A: Black.
 - (2) Phase B: Red.
 - (3) Phase C: Blue.

G. Conduit Directional Drilling

- 1. Shall comply with Section II. N (Water Main Directional Drilling), items 1-4, 6-7 and 9-10 of this Article.
- 2. The minimum depth of cover at any location shall be 3 feet. Depth of cover is measured from the finished grade to the top of the pipe.
- 3. Inject drilling fluid through reamer to stabilize bore and lubricate pipe. Ratio of reaming diameter to pipe outer diameter is a maximum of 1.5.

H. Grounding

- 1. Work shall comply with the latest National Electric Code, IEEE C2 grounding requirements and with details as shown on the Plans.
- 2. Work shall comply with National Fire Protection Agency (NFPA) 780 (Standard for the Installation of Lightning Protection Systems) and UL 96 (Standard for Lightning Protection Components) when interconnecting with lightning protection system.
- 3. Electrical power system ground shall be bonded directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Bonding conductor used shall be sized the same as system grounding electrode conductor and installed in conduit.
- 4. Pressure-type connectors shall be used to connect the ground cable to poles and electrical equipment. The cable shall be properly attached to the ground rods.

5. Exothermic-welded connectors shall be used for outdoor locations. If a disconnect-type connection is required, a bolted clamp shall be used.
6. Insulated equipment grounding conductors shall be installed with all feeders and branch circuits. Grounding conductors shall be routed along shortest and straightest paths possible unless otherwise indicated or required by Code.
7. Obstructing access or placing conductors where they may be subjected to strain, impact, or damage shall be avoided.
8. Ground rods shall be copper clad steel and shall be either 2½-inch diameter round by 6-feet long rods, or 1 and five-eighths inch diameter round by 8-feet long rod. Rods shall be driven until tops are 2 inches below finished floor or final grade unless otherwise indicated.
9. Ground rods shall be interconnected with grounding electrode conductor below grade and as otherwise indicated. Connections shall be made without exposing steel or damaging coating if any.
10. For grounding electrode system, at least three rods shall be installed, spaced at least one rod length from each other and located at least the same distance from other grounding electrodes and connected to the service grounding electrode conductor.
11. Manholes and handholes shall be grounded by driving a ground rod through the manhole or handhole floor, close to wall, and rod depth shall be set so that 4 inches will extend above finished floor.
12. If necessary, ground rod shall be installed before manhole is placed and No. 1/0 AWG bare, tinned-copper conductor provided from ground rod into manhole through a waterproof sleeve in manhole wall.
13. Ground rods shall be protected passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Floor opening shall be sealed with waterproof, non-shrink grout.
14. All fixtures and poles shall be thoroughly and permanently grounded at each location. A grounding electrode and a separate un-insulated equipment grounding conductor shall be installed in addition to grounding conductor installed with branch-circuit conductors.

15. Completed grounding system shall be tested at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Tests at ground rods shall be made before any conductors are connected. Testing shall include the following:
 - a) Measure ground resistance no fewer than 2 full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b) Perform tests by fall-of-potential method according to IEEE 81 (Guide for Measuring Earth Resistivity, Ground Impedance, And Earth Surface Potentials of a Grounding System).
 - c) Report measured ground resistances that exceed the following values:
 - (1) Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
 - (2) Manhole and Handhole Grounds: 10 ohms.
 - (3) Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
 - (4) Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
 - (5) Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

I. Street Light Fixture - Luminaire

1. The street light fixture and pole assembly shall be as shown on the Plans. The catalog numbers as provided may not be complete to designate all the accessory parts and appurtenances required for the particular use or function. The light fixtures shall be complete, fitted with LED assembly and driver, fuses, support brackets, etc. Contractor shall arrange with the manufacturer for the purchase of all items required for the complete installation.

2. The Contractor shall examine all fixtures delivered to jobsite prior to installation to ensure all specification requirements and shop drawing notes and comments have been incorporated by manufacturer. Installation of fixtures signifies Contractor's acceptance and approval of fixtures from manufacturer.
3. Fasteners and hardware sized and rated for luminaire weight shall be used and shall be able to maintain luminaire position after cleaning and re-lamping.
4. Streetlight fixtures shall be provided complete with wiring from the base to the luminaires including pole base fuse holders. All wire within the streetlight fixture and pole assembly shall be copper.

J. Rectangular Rapid Flashing Beacon Assembly

1. This work shall consist of furnishing and installing wireless solar-powered, Rectangular Rapid Flashing Beacon (RRFB) assemblies at the locations shown in the Plans. Each RRFB assembly includes lightbar(s), solar panel(s), battery(s), controller enclosure, control circuit, on-board user interface, wireless communication, pedestal, pole, pushbutton, signs, stainless steel mounting hardware, and all associated material required to complete the work. RRFBs shall be bi-directional (two-sided) unless otherwise specified on the Plans.
2. Materials shall be provided conforming to MDOT Specifications, Sections 918 (Electrical and Lighting Materials) and 921 (Permanent Traffic Signal Materials) and in conformance with the following:
 - a) Controller Enclosure
 - (1) Construction shall be NEMA 3R aluminum housing with lockable tamperproof hinged door.
 - (2) Solar batteries, on-board user interface, and wireless communications shall be housed within the enclosure.
 - b) On-board User Interface (OBUI)
 - (1) The OBUI shall have an adjustable auto-scrolling LED display, and include the following selectable features:
 - (a) Flash duration, adjustable from 10 - 60 seconds, in one-second increments

- (b) Ambient auto-adjust
 - (c) Night time dimming
 - (d) Update configuration settings to other units in the system
 - (e) Channel Selection
 - (f) System test, status, and fault detection
 - (g) Activation data reporting
- c) Lightbar
 - (1) Lightbar housing must be black powder-coated aluminum, measuring 24" x 4.5" x 1.5"
 - (2) A lightbar shall consist of two forward-facing primary beacons:
 - (a) Each beacon must have an array of eight amber LEDs, each array measuring 7" x 3"
 - (b) Beacons must meet SAE J595 Class 1 intensity, and SAE J578 chromaticity
 - (c) LEDs must meet 90% lumen maintenance (L90) based on IES LM-80
 - (3) The lightbar must include side-mounted pedestrian amber LED beacons which flash concurrently with the primary beacons.
 - (4) The mounting assembly shall allow the lightbars to pivot 40 degrees horizontally in order to aim the lightbar independent of the wire hole location on the pole.
 - (5) A bi-directional RRFB shall consist of two lightbars mounted back to back, which can pivot independently from each other.
 - (6) The lightbar assembly shall open for access to the wiring connections for the LED modules. LED modules shall be rated to MIL-STD-810F, Method 506.4 for ingress protection.
- d) Beacon operation meeting the following requirements:
 - (1) The RRFB is dark until pedestrian actuation

- (2) Initiates operation upon pedestrian actuation and ceases operation at a predetermined time after actuation. This predetermined duration of operation shall be set as indicated in the Plans or as determined by the Engineer.
 - (3) Simultaneously begins (upon actuation) and ends (after the predetermined duration) the operation of all RRFB's associated with a given crosswalk within 150 milliseconds of activation.
- e) Solar/battery system meeting the following requirements:
- (1) Underwriters Laboratories Incorporated (UL) approved solar panel, solar engine, and battery system. Solar panel and battery system sized for use north of the 40th parallel, including the state of Michigan.
 - (2) The system shall include one 50-watt solar panel supplied with mounting hardware. The controller enclosure shall house one 35 Ah sealed valve-regulated lead-acid battery. The battery shall be readily available from multiple suppliers and non-proprietary. Solar panel and battery system shall be 12 Volt DC (nominal).
- f) Pushbutton and Signs
- (1) The pushbutton housing shall be cast aluminum with a yellow powder coat finish, with watertight O-ring seals. The housings shall be a minimum 14"H, 5½"W, 2 ½"D and contain the sign, arrow, speaker and LED's.
 - (2) The pushbuttons shall be provided with a two-inch diameter adjustable arrow indication to indicate the direction of travel.
 - (3) The signs shall include the following:
 - (a) One pushbutton housing sign, "Push Button to Turn on Warning Lights"
 - (b) One W11-2, measuring 30" x 30"
 - (c) One W16-7PL, measuring 24" x 12
 - (d) One W16-7PR, measuring 24" x 12
 - (4) The pushbuttons shall be ADA/PROWAG compliant, with visual LED, audible location tone, and an audible voice message.

- (5) The message shall be repeatable while the crosswalk lights are active. The pushbuttons shall be provided with a standard message "Cross street with caution, vehicles may not stop" or a custom message as required by the engineer.
- (6) Each pushbutton shall be provided with a locating tone with a selectable repeat rate. The locating tone and message shall be capable of having maximum and minimum limits set.
- (7) Each pushbutton shall be provided with an automatic volume adjustment to compensate for changes in ambient noise levels.
- (8) The pushbutton shall come complete with the sign, mounting hardware and control unit for mounting on the pedestal and pole.

g) Pedestals and Poles

- (1) Pedestal bases shall be aluminum square conforming to the following specifications. Bases shall accommodate bolt circles from 12 inches to 14 ½ inches. The bases shall be designed to accommodate (4) four anchor bolts from 5/8 inch to 1 inch in diameter. There shall be slots in the bottom of each base to allow adjustment for anchor bolt placement.
- (2) The bases shall be fabricated from aluminum, nominally 15 inches tall by 14 inches square. The bases shall be provided with an accessible hand-hole opening and a cast aluminum door with one stainless steel set screw. The collar of the base shall be provided with a stainless steel hex head bolt.
- (3) Poles shall consist of 6061-T6 aluminum alloy, poles textured for a uniform rough grain pattern that is perpendicular to the axis of the pole for the full length of the pole. The poles shall have a length of 14-feet, wall thickness of .237 inches, and an O.D. of 4.5 inches. The poles shall be provided with four inches of NPT (National Standard Taper Pipe Thread).
- (4) The threaded end of the poles shall have a protective cap installed to prevent thread damage. A cardboard sleeve shall cover the entire length of the shaft to protect the surface finish during shipment.

h) Warranty

- (1) A manufacturer's warranty, transferable to City of Ann Arbor, that the supplied materials are free from all defects in material and workmanship shall be provided. The warranty, other applicable documents from the manufacturer, and a copy of the invoice showing date of shipment to the Engineer shall be furnished prior to acceptance.

3. Construction

- a) Shop drawing approval from the Engineer shall be obtained prior to installation of units.
- b) The predetermined duration of operation of the RRFBs shall be set as indicated in the Plans or as specified by the Engineer.
- c) The RRFB assemblies shall be mounted per manufacturer's requirements and as specified, in locations directed by the Engineer.

V. Soil Erosion and Sedimentation Control

A. General

1. All construction activities and soil erosion and sedimentation control measures and materials shall be accordance in Article 8 (Soil Erosion) of these Standards and as indicated on Plans.
2. Temporary soil erosion measures shall be put in place prior to disturbance of surface cover.
3. All Soil Erosion and Sedimentation Control Devices shall be constantly maintained in an effective functioning condition during the course of the Project.
4. Soil Erosion control measures shall be inspected by the Contractor a minimum of once per week and within a minimum of 24 hours after every rainfall. Any soil erosion control measures damaged or rendered ineffective shall be immediately repaired or removed and replaced at no additional cost.
5. Temporary soil erosion control measures shall be maintained until permanent measures have been established. Temporary measures shall be removed when permanent measures have been established.

6. If erosion or sedimentation occurs due to non-compliance with these requirements, Contractor shall remove deposited sediment or restore eroded areas at no additional cost.

B. Mulch Blankets

1. Mulch blankets shall conform to Article 12 (Standard Details), SD-SESC-4 (Mulch Blanket) of these Standards.

C. Mud Mats

1. The gravel surface on mud mats shall be removed and replaced when it becomes clogged with mud and dirt and ineffective.

D. Check Dams

1. Check dams, if required, shall be constructed as detailed on the Plans.
2. Check dams shall be installed immediately after ditch/channel stabilization (i.e., seeding and mulching or installation of rolled erosion control products).
3. Check dams shall be installed all the way across the ditch or channel, perpendicular to the flow.
4. Check dams shall be configured so the sides extend up the bank slopes, with the overflow in the middle.

E. Riprap

1. Riprap shall conform to Article 5 (Streets), Section II.K (Riprap) of these Standards.
2. The Contractor shall provide a sample of the stone to the PSAA for review upon request.
3. Riprap shall be placed in accordance with MDOT Specifications, Subsection 813.03.E (Riprap) to the elevations, thickness and lateral limits shown on the Plans.
4. Brush, trees, stumps and debris shall be cleared from areas to be protected by riprap.
5. All grades shall be shaped to the required cross section, including excavation for toe and header.

6. Geotextile liner, as shown on the Plans, shall be placed on the prepared grades and in a manner that ensures installation does not damage the geotextile liner.
7. When placing riprap under structures, Contractor shall ensure there is no damage to the existing substructure and superstructure elements. The Contractor is solely responsible for determining and utilizing suitable methods of preparing the area for riprap placement and placing the riprap such that the material is placed in accordance with the requirements of the Plans and specifications.
8. The use of hand methods to prepare areas for riprap placement and placing riprap may be necessary and/or required. Any damage to the existing structure resulting from the placement of riprap under structures shall be repaired as directed by the PSAA at no additional cost to the City.

F. Gabions

1. The Contractor shall be solely responsible to determine a suitable method of construction and construction sequence such that flow in a creek or channel is maintained during the performance of the work. The requirements of any EGLE and U.S. Army Corps of Engineers (USACE) Permits shall be followed by the Contractor during the performance of the work.
2. The Contractor shall perform all necessary excavation in accordance with all applicable MIOSHA requirements. The Contractor shall also perform de-watering as needed to complete the work and to maintain a safe working environment and provide a stable surface on which to place the gabion baskets.
3. Additional requirements regarding the performance of the work are detailed as follows.
4. Assembly and erection of the baskets shall be in accordance with the manufacturer's recommendations and as approved by the PSAA.
5. The coconut fiber blanket shall be attached to the front face of the unit such that there is an overlap of 12 inches at the top and bottom of the unit.
6. The units shall be assembled and carried to the job site and placed in their proper location. For structural integrity, all adjoining empty baskets shall be connected along the perimeter of their contact surface in order to obtain a monolithic structure.

7. Baskets shall be filled with rock (50% minimum) and topsoil (unless otherwise specified on the Plans) carefully placed by hand or machine to assure alignment and avoid bulges with a minimum of voids. Along all exposed faces and edges, the outer layers of stone shall be carefully placed and packed by hand, ensuring a neat, compact, square appearance. Care shall be taken when placing fill material to ensure that the sheathing on PVC coated baskets is not damaged.
8. Gabions shall be filled in three layers. The cells in any row shall be filled in stages so that local deformation is avoided, that is, at no time shall a cell be filled to a depth exceeding 12 inches more than the adjoining cell. Compacted backfill material shall be placed behind the units simultaneously with the gabion filling operation.
9. The last layer of stone shall be leveled with the top of the basket to assure proper closing of the lid and provide an even surface for the next course. The last layer of stone shall be overfilled a minimum of 2 inches from the top of the basket to allow for settlement and provide an even surface for the next course.
10. Once the baskets are completely full, the lids shall be pulled tight using a lid closer until the lid meets the perimeter edges of the basket. The lid shall be closed with an approved lid closure tool to minimize mesh deformation. Single point tools (stakes or pry bars) are not permitted. The lid shall then be tightly laced and/or fastened along all edges, ends, and tops of diaphragm(s) as described above.
11. Where shown on the Plans or otherwise directed by the PSAA, the basket mesh shall be cut, folded and fastened together to suit existing site conditions. The mesh must be cleanly cut and the surplus mesh folded back and neatly wired to an adjacent gabion face. The cut edges of the mesh shall be securely fastened together with lacing wire or fasteners in the manner described herein. Any reshaped gabion shall be assembled, installed, filled, and closed as specified in the previous sections.
12. Vegetation shall be incorporated into the gabions where shown on Plans.

G. Dewatering Filters

1. Should it be necessary for the Contractor to do any dewatering during the course of construction, the Contractor shall filter all discharge through a discharge filter bag or other sediment control device that will filter all discharge water. No dewatering discharge shall be allowed to flow unfiltered from the construction site.

VI. Landscaping and Restoration

A. Plant Materials and Layout

1. Plant Materials, Street Trees, and Landscaping Vegetation in Public rights-of-way shall conform to Article 9 (Landscaping) of these Standards.
2. Locations of all plantings shall be established by the Contractor according to Plans. The PSAA shall approve all planting layouts prior to commencing any planting activities.
3. Herbaceous plug, live stake, and cultivated perennial zones shall be laid out by paint.
4. Locations for balled and burlapped trees, 1-gallon trees, 3-gallon shrubs, 1-gallon shrubs and plug shrubs shall be identified with stakes. Different species shall be clearly labeled and marked with different color ribbon, paint or permanent marker on the stake.
5. The Contractor shall notify the PSAA when staking and layout is completed and allow 2 working days for modifications and notice to proceed with planting.

B. Turf Establishment

1. General
 - a) The Contractor shall restore all lawn areas disturbed by construction to a condition better than or equal to their original condition. This includes the placement and compaction of topsoil, seed/sod, fertilizer and mulch. Restoration shall also include the replacement of any brickwork, decorative stone, or other adjacent materials. Visible germination of seed or establishment of sod shall be evident across the majority of the disturbed area.
 - b) Immediately after completion of construction phase or segment, the Contractor shall clean the entire area within the influence of construction, including but not limited to all pavement, sidewalks, lawn areas, and underground utility structures, of all materials which may have accumulated prior to or during the construction.

- c) All holes and ruts resulting from the work operations shall be filled with PSAA-approved material. All backfill materials shall be compacted, and ruts and holes restored to the surrounding contour as directed by the PSAA.
- d) The existing earth bed shall be graded such that the placement of topsoil will meet the final Plan grades. Grading, soil preparation, and removal and disposal of excess or unsuitable materials shall be considered as part of the restoration work. All rocks larger than 1-inch shall be removed from the seed bed. All lumps and clods greater than 1-inch shall be pulverized and raked into the seed bed before planting
- e) A minimum of 4 inches of topsoil shall be placed on all areas that are to be restored with seeding or sodding.
- f) Prepared area shall be moistened before planting if soil is dry. Surface shall be watered thoroughly and allowed to dry before planting. Muddy soil shall not be created.
- g) Before planting, PSAA's acceptance of finish grading shall be obtained. Planting areas shall be restored if eroded or otherwise disturbed after finish grading.
- h) Restoration must be performed upon the completion of each stage of work, to prevent erosion, and not as one single operation at the completion of the entire project.
- i) If, in the judgment of the PSAA, adequate site restoration efforts are not being expended, then the City will take the necessary steps to perform such restoration and shall charge the Contractor for all the costs until restoration is completed satisfactorily.
- j) The Contractor shall maintain all lawn areas until they have been accepted by the PSAA. Lawn maintenance shall begin immediately after the grass seed or sod is in place and shall continue until final acceptance.
- k) Lawns shall be protected and maintained by watering, mowing, and reseeding as necessary, until the period of time when the final acceptance and payment is made.
- l) The Contractor shall establish a uniform, dense, vigorous, and weed-free stand of specified grasses.

- m) Maintenance includes but is not limited to: deposition of additional topsoil; re-seeding; watering; fertilizing; mowing, and any other work as required to correct all settlement, erosion, germination, and establishment issues until the date of final acceptance by the PSAA.
- n) When the above requirements have been fulfilled, the PSAA will accept the lawn.

2. Seeding

- a) Seed shall be sown at the rate of 250 lbs/acre with spreader or seeding machine. Seeds shall not be broadcast or dropped when wind velocity exceeds 5 mph. Seed shall be evenly distributed by sowing equal quantities in two directions at right angles to each other.
- b) Seed shall be lightly raked into top ⅛-inch of soil, rolled lightly, and watered with fine spray.
- c) Seeded areas with slopes exceeding 1:4 shall be protected with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- d) Seeded areas with slopes not exceeding 1:4 shall be protected by spreading straw mulch uniformly at a minimum rate of 2 tons per acre to form a continuous blanket 1½ inches in loose thickness over seeded areas.
- e) Seed shall be spread by hand, blower, or other suitable equipment.
- f) Straw mulch shall be anchored by crimping into soil with suitable mechanical equipment.
- g) Any portion of a seeded area that fails to show a uniform germination shall be reseeded. Such reseeded shall be at the Contractor's expense and shall continue until a dense weed-free lawn is established in a growing and vigorous condition.
- h) Damage to seeded areas resulting from erosion shall be repaired by the Contractor at the Contractor's expense. Scattered bare spots in seeded areas will not be allowed over three (3) percent of the area nor greater than four (4) square inches in size.

3. Sodding

- a) Contractor shall submit copies of Sod Growers Certificate to the PSAA indicating nursery from which sod was taken, grass species, and percentage in accordance with the Michigan State Department of Agriculture Regulations.
- b) Prior to commencement of sodding operations, the PSAA shall be notified of the off-site sources from which sod is to be furnished. The PSAA may elect to inspect the sod at the off-site source.
- c) Sod shall be delivered to the project site on suitable wooden pallets in manageable rolls. The amount of sod delivered shall not exceed that which can be installed in one 24-hour period. Sod that has been damaged during delivery will be rejected.
- d) Sod shall be lifted from trucks or storage piles and placed on a moist earth bed by hand, making close joints without overlapping. All gaps between sections of sod and openings at angles shall be plugged with sod.
- e) When placing sod on slopes, the work shall begin at the base of the slope and progress upward by carefully placing the sod on the smooth slope, in rows, with the lengths running at right angles to the slope.
- f) The transverse joints of sod strips shall be staggered, and the sod carefully laid to produce tight joints.
- g) When the tops of slopes are reached, the sod shall be carried back at least 2 feet over the crest and trimmed to a line which is parallel to the top of the bank. The areas back of the crest shall have been previously graded and the surface of the sod, when placed, shall be 2 inches below the level of this area and covered with a layer of topsoil at least 2 inches in depth and thoroughly compacted in a manner that will conduct the surface water from runoff over the edge of the sod.
- h) No frozen sod shall be laid nor shall sod be laid on frozen soil.
- i) On slopes steeper than 1:3, unless otherwise specified, the sod shall be staked with wooden pegs. There shall be at least 1 peg in each piece of sod with a maximum between pegs of 2 feet.

- j) Pegs shall be driven flush with the surface of the sod. Laying and staking of the sod shall be done simultaneously. Where sod may be displaced during sodding operations, workmen shall work from ladders or treaded planks.
- k) Rolling of the sod shall be done after initial watering and after the water has sufficiently soaked into the ground so that distortion of the sod surface and excessive compaction of the sod and the soil will not occur.
- l) The roller used shall be a water-filled type at least 3 feet wide and 30 inches in diameter and shall weigh approximately 300 pounds. Roller shall be adequate to cause sod to make firm contact with the soil.
- m) A tamper, acceptable to the PSAA, shall be used to press the sod firmly in place in areas not accessible to a roller. After tamping or rolling, the sod shall present a smooth, even surface, free from bumps or depressions.
- n) Damaged, deteriorated or otherwise defective sod will be rejected by the PSAA and except as otherwise provided herein, removed from the Project.
- o) Sod which has been permitted to dry out or become otherwise injured during transportation, handling, storage or placing shall be rejected. Where permitted by the PSAA, rejected sod, if suitable, may be pulverized and used for filling, where necessary.
- p) After laying, the sod shall be watered until saturated. Sod shall be watered whenever excessive drying is evident during the period set for establishment. Sufficient water shall be applied to wet the sod completely and to wet at least 2 inches of the sod bed each time watering is required. Watering shall be done in a manner that will prevent erosion due to the application of large quantities of water.
- q) The watering equipment shall be of a type that will prevent damage to the finished surfaces of topsoil and sod. The sod shall be watered as required until firmly knit in place and in a vigorous growing condition.
- r) The establishment period shall extend for a period from the time of sodding until the sodded area have received final acceptance of the entire work covered by the Contract. The minimum period shall be 45 days.

C. Tree Removal

1. Only trees identified for removal on the Plans and that have been approved by the City (and U-M where applicable), may be removed. No additional trees shall be removed without the written permission of the PSAA (and U-M where required). The Contractor shall be aware that the request for removal of additional trees to facilitate the work may not be allowed and may require substantial additional time for review of the request.
2. Prior to removal of any street trees, Contractor must submit a ROW Street Tree Permit.
3. The Contractor must clearly mark the trees for removal at least 1 week prior to the date of their intended removal.
4. Only the removal and disposal of trees greater than 6 inches in diameter, as indicated on the Plans, shall be paid for. The cutting, removal, and disposal of trees less than 6 inches in diameter, bushes, brush, or the trimming of trees will not be paid for separately and shall be considered as incidental to the Project.
5. Trees shall be cut and felled in a manner so as not to damage surrounding areas, fences, features, and adjacent trees designated to remain.
6. Stumps and roots shall be grubbed and removed. All resulting holes or excavations shall be backfilled with PSAA-approved material and all debris disposed of before ending the day's work.
7. Burning of any removed materials is strictly prohibited.
8. All trees, branches, brush and debris cut and removed as part of the work completed for this project shall be removed from the property and properly disposed of unless otherwise requested by the City. All wood requested by the City shall be cut into logs approximately 10 feet in length and placed at a location onsite as designated by the PSAA.

D. Tree Planting

1. Tree planting shall be conformance with Article 12 (Standard Details), SD-L-1 (Tree Planting) of these Standards.

2. Balled and burlapped (B&B) trees shall be dug with solid balls of standard size, the balls securely wrapped with non-synthetic, untreated, biodegradable burlap, and tightly bound with non-synthetic, biodegradable rope or twine.
3. Alternatively, B & B trees may be placed in a wire basket lined with non-synthetic, untreated, biodegradable burlap and tightly bound with non-synthetic, biodegradable rope or twine. Plants balled with plastic burlap will not be accepted.
4. Planting for trees shall be performed after April 1st and before June 1st; or, after October 1st and before December 1st or until the ground freezes unless otherwise approved by the PSAA.
5. Material delivery for trees shall be the same day as planting. No trees shall be stored at the site without permission of the PSAA.
6. Trees shall be carefully loaded and unloaded so as not to damage branching or root mass. Dropping of material will not be allowed.
7. Trees in full leaf shall be thoroughly wetted down and completely covered with a wet tarpaulin during transportation.
8. All tree roots must be kept in a moist condition.
9. Trees which are poorly packed, or which arrive with the roots in a dry condition, as a result of improper packing, delay in transit, or from any other cause, will not be accepted.
10. Stock shall be handled in such a manner that the roots shall remain intact, the branches unbroken, and the bark intact and not loosened from the wood.
11. Stock shall be protected from drying and from temperatures below 50° F and in excess of 90° F prior to planting.
12. The sides and bottoms of all tree planting beds, trenches and pits shall be scarified and shall receive a minimum of 6 inches of topsoil if planted in severely disturbed soil or building rubble.
13. Trees shall be planted such that when settled, they will bear the same relation to finish grade as they did before being transplanted. No filling will be permitted around trunks or stems before or after settling.

14. All non-biodegradable materials shall be removed from the root balls prior to planting. Burlap and string shall be removed from around the root ball to the extent possible without damaging roots or disturbing the root ball. If a wire basket has been provided, the wire basket shall be removed to a depth of 10 inches.
15. Mulch shall be placed on the soil surface over the root ball of the tree and to the lateral extent as shown on Plans and Details. Mulch shall not touch the root collar of the tree trunk.
16. Mulch depth is to be no less than 2 and no more than 3 inches.
17. The Contractor shall be responsible to keep trees adequately watered during the warranty period, as necessary, to ensure their survival. At minimum, trees shall be watered twelve (12) times during the warranty period.

E. Plugs, Shrubs and Live Stakes Planting

1. Planting for herbaceous plugs shall be performed after May 1st and before June 15th or, after August 15th but before September 15th, or as otherwise approved by the PSAA.
2. Live stake plant stock shall be kept stored in field, cool, and sheltered from drying effects of direct sunlight and prevailing winds. Plant stock stored in field or in a refrigerated locker shall not be subjected to freezing, drying, or warming. Adequate water shall be supplied to maintain plant stock in a healthy condition.
3. Shrub and live stake planting shall be subject to the following:
 - a) All containers and packaging material shall be removed before planting and removed from site;
 - b) Plants shall be set plumb;
 - c) Root structure shall not be damaged;
 - d) Root matter shall be thoroughly soaked with water; and
 - e) Where shrubs and/or plugs are planted in areas of mulch blankets, planting shall be through the mulch blanket after its installation.

4. Live Stake Planting shall be subject to the following:
 - a) A minimum of 2 to 4 inches and two live buds (bud side pointing up) of the live stake shall be exposed above the stone fill or soil layer.
 - b) In areas where both live stakes and mulch blanket are present, live stakes shall be planted through the blanket after its installation.
 - c) Live stakes shall be cut to a point on the basal end for insertion in the ground.
 - d) For ditches or creek side area, live stake shall be installed at an angle slightly downstream.
 - e) A dead blow hammer shall be used to drive stakes into the ground. The hammer head should be filled with shot or sand. A dibble, iron bar, or similar tool shall be used to make a pilot hole to prevent damaging the material during installation.
 - f) When possible, soil shall be tamped around live stakes.
 - g) Care shall be taken not to damage the live stakes during installation. Those damaged at the top during installation shall be trimmed back to undamaged material.
 - h) The Contractor shall be responsible to keep the live stakes adequately watered, if necessary, to ensure their survival.

F. Rain Garden and Bioswale Planting

1. Establishment of a dense stand of wet meadow perennial grasses and/or flowers as specified in Plans is the responsibility of the Contractor. Any part of the area that fails to thrive shall be re-planted until a dense planting in these areas is established.

G. Acceptance and Warranty

1. The Contractor, prior to requesting a letter of Provisional Acceptance from the PSAA shall submit 2 copies of a maintenance schedule detailing the work items identified under the Contract.
2. This schedule shall include a 52-week table covering the 1-year warranty period, identifying all weekly site visits and the tasks to be performed during each visit.

3. The schedule shall show that no maintenance will occur between the periods of October 15th and April 1st, unless otherwise required by related specification.
4. After planting zone/type is finished, the PSAA and Contractor shall perform a site evaluation to determine if planting is complete. After any additional changes have been performed by the Contractor, the PSAA will issue a written Provisional Acceptance letter, after which the Maintenance and Warranty Periods will commence for 1 full year.
5. Acceptance of Native Seeded Areas
 - a) Provisional Acceptance shall be granted when 20% of the native species and 80% total cover with no bare areas as large as 4 square feet exist as determined by the PSAA. The PSAA will utilize a meander/search method for reviewing the area(s).
 - b) Final Acceptance for Native Seeded Areas shall be granted when 40% of the native species and 90% total cover with no bare areas as large as 1 square foot exist as determined by the PSAA. The PSAA will utilize a meander/search method for reviewing the area(s).
6. Acceptance of Rain Garden and Bioswale and Adjacent Planting Areas
 - a) Provisional Acceptance shall be granted when 90% total cover with no bare areas as large as 4 square feet exist as determined by the PSAA. The PSAA will utilize a meander/search method for reviewing the area(s). Bare areas as large as 4 square feet shall be “re-plugged” by the Contractor without additional compensation. Ditch/creek side re-vegetation areas only planted in riprap with no plugs will not allow bare areas as large as 1.5 square feet to exist as determined by the PSAA.
 - b) Final Acceptance shall be granted when no bare areas as large as 1.5 square feet exist as determined by the PSAA. Bare areas as large as 1.5 square feet shall be “re-plugged” by the Contractor without additional compensation.

H. Landscape Maintenance and Guarantee (for Projects with this requirement)

1. General
 - a) Maintenance shall include all measures necessary to establish and maintain plants in a vigorous and healthy growing condition.

- b) Maintenance of plantings shall begin immediately after Provisional Acceptance is granted and shall continue as required until Final Acceptance at the end of the warranty period.
- c) Maintenance required prior to Provisional Acceptance shall be incidental to the Project. Provisional Acceptance may be granted for different planting zones/types (e.g. B&B trees, ditch planting, etc.) within the project based on project schedule constraints.
- d) The Contractor shall submit to the PSAA copies of all field reports prepared by the maintenance supervisor identifying the date of each visit and work items completed during each visit.
- e) The Contractor shall inspect the plantings at least once per week during the warranty period and promptly perform needed maintenance.
- f) Weekly maintenance shall be conducted for 1 full year after Provisional Acceptance is granted.
- g) During the warranty period, the Contractor shall replace at Contractor's sole expense plant materials that are dead or that are, in the opinion of the PSAA, in an unhealthy or unsightly condition. Rejected plant materials shall be removed from the site and legally disposed of by the Contractor at their sole expense.
- h) The Contractor shall be aware that plants may need to be replaced more than once during the warranty period should the plants be deemed to be in an unhealthy or unsightly condition by the PSAA. The Contractor shall provide the necessary resources in the unit price bid for the work to cover the cost of any needed replacements.
- i) Plants shall be replaced no later than the next succeeding planting season. Areas damaged by replacement operations shall be fully restored by the Contractor at Contractor's expense.
- j) All damaged guys and stakes shall be repaired during the warranty period.
- k) All stakes, guys, labels and support material shall be removed at the end of the warranty period and removed from site.
- l) The Contractor shall remove and replace dead and unacceptable plants as their condition becomes apparent at Contractor's sole expense.

- m) Planted area shall be protected from traffic and erosion. Safety fences and/or silt fence with appropriate signage may be used at the Contractor's expense until the grasses and flowers are fully established.

2. Watering

- a) Water shall come from a source approved by the PSAA.
- b) All plants shall be monitored during site visits for signs of stress due to lack of adequate moisture in the root zone.
- c) Plants shall be watered as required to keep them in optimum condition (1 inch of total water per week, including rainfall) and maintain an optimum supply of moisture within the root zone. Recurring overly dry or wet conditions shall be grounds for rejection of plant material.
- d) Watering of all deciduous plants and trees shall be performed using the probe method and by the use of water reservoir bags.
- e) Each balled and burlapped tree shall receive its own individual water reservoir bag.
- f) Water shall not be applied with a force that will displace mulch or cause soil erosion and shall not be applied so quickly that the mulch and plants cannot absorb it. Water shall be applied in such a manner that it will penetrate down into root zone of plant.
- g) Herbaceous plugs in the deepest ponding area may require more watering than other planting areas.
- h) If newly planted bioswales (within first 3 months of planting) have 3 inches of standing water or more for over 12 hours, the Contractor shall pump the affected area(s) out to ensure the survival of the planting. The pumping activities shall occur within 24 hours of the overwhelming rain event.

3. Weeding/Cultivating

- a) Weeds shall be removed by hand and include removing the entire root mass of the weed. Before application of any herbicide, the Contractor shall receive approval of the PSAA. A selective herbicide shall be applied according to manufacturer's directions.

- b) Herbicides shall only be used when and where necessary as approved by the PSAA. Manufacturer's directions and precautions must be followed rigorously. Excess herbicides shall be properly removed from the site.
- c) The posting of signs as a public notification of herbicide application will be required 24 hours before and maintained for 48 hours following application.
- d) Weeding of all planting areas shall occur with each maintenance visit and in no instance shall they be allowed to propagate such that invasive weed species (Sweet Clover, Burdock, Wild Carrot, Purple Knapweed, Canada Thistle, Queen Anne's Lace, Purple Loosestrife, Phragmites, Bindweed, Crab Grass, Lamb's Quarters, non-native honeysuckle, buckthorn, autumn olive, Norway maple, bindweed, barnyard grass, etc.) may set their seed. Additional weeding activities may need to be performed as determined by PSAA.
- e) Post-planting management procedures for bioswales and adjacent planting areas, ditch/creek side re-vegetation and native seed planting areas may consist of, but are not limited to, the following:
 - (1) Pulling invasive weed species to remove the entire root mass;
 - (2) Spring or fall dormant seasons application of a non-selective herbicide to control invasive weeds as directed by the PSAA;
 - (3) Summer application of a selective herbicide to control invasive weeds as directed by the PSAA. City of Ann Arbor signage requirements for herbicide application shall be followed; and
 - (4) Initial mowing of the native seed areas (using flail mower) may occur after one season of growth when the weeds are 10 inches high or prior to invasive weeds setting seed. Mowed height shall be 5 inches. Weeds on slopes 1:3 or greater shall be mowed with a hand-held flail mower or common weed whacker.
- f) Herbicide applications for aggressive weeds shall conform to the following guidelines:
 - (1) Invasive grasses such as crabgrass, smooth brome, reed canary, barnyard or other invasive grass shall be spot-controlled beginning in May on an on-going basis with an appropriate herbicide through the end of the second growing season and/or before the plants set seed.

- (2) Invasive forbs such as purple knapweed, purple loosestrife, garlic mustard, Queen Anne's Lace, Canada thistle, bindweed, lamb's quarters, phragmites or other invasive forbs shall be spot controlled on an on-going basis beginning in June with an appropriate herbicide through the end of the second growing season and/or before the plants set seed.
- (3) Invasive woody plants such as non-native honeysuckle, buckthorn, autumn olive, Norway maple, shall be spot controlled beginning in June on an on-going basis with an appropriate herbicide through the end of the second growing season and/or before the plants set seed.
- (4) Planting areas adjacent to open water that contain invasive weeds shall be spot controlled beginning in June with an appropriate Herbicide until the end of the first full growing season and/or before the plants set seed.

4. Mulching

- a) All mulch beds shall be reviewed in June and September for each Maintenance and Warranty Period. Any beds that do not meet the following conditions shall be replenished:
 - (1) Depth shall be a minimum of 2 inches and a maximum of 3 inches throughout the mulch saucer for individual trees.
 - (2) Depth shall be 2 inches throughout a bioswale areas.
 - (3) Mulch shall be kept away from root collar of trees.

5. Disease and Insect Control

- a) Monitoring for diseases and insects shall be the responsibility of the Contractor. The Contractor shall monitor all plants at all times for disease and insect problems.
- b) Treatment shall take place in accordance with common Integrated Pest Management (IPM) practices.
- c) Pesticides shall only be used when and where necessary as approved by the PSAA. Manufacturer's directions and precautions must be followed rigorously. Excess pesticides shall be properly removed from the site.

- d) The posting of signs as a public notification of pesticide application will be required 24 hours before and maintained for 48 hours following application.

6. Pruning

- a) All dead wood shall be pruned at the first live lateral bud in accordance with standard horticulture practices using sharp instruments cleaned frequently. Pruning shall enhance plant development and ornamental qualities.
- b) Terminal leaders and branch tips shall not be pruned.
- c) A plant's natural form shall not be compromised by any pruning activities.
- d) Additional pruning may be required at the request of the PSAA in order to decrease public liability factors.
- e) All standing dead material shall be removed from perennials and grasses at the earliest spring maintenance visit.
- f) Immediately after pruning, all dead, broken and diseased growth and other pruning debris from the site shall be removed and disposed of in an environmentally sensitive manner.
- g) Plant material that is "topped" by the Contractor shall be replaced at the Contractor's expense.

7. Fertilizing

- a) Maintenance fertilizer application for lawn shall occur during the period of May through October as needed to establish and maintain healthy, vigorous, turf during the Acceptance and Warranty Periods.
- b) For spring seeding, commencement of maintenance fertilizer shall begin during the first growing season. For Fall seeding, commencement of maintenance fertilizer shall begin the subsequent spring.
- c) Fertilizer for lawns shall be spread at a rate of 1 pound of nitrogen per 1,000 square feet.
- d) Maintenance Fertilizer application for woody plants shall occur in November of the Second Maintenance and Guarantee Period. Topdressing shall be at a rate of 1 pound of nitrogen per 1,000 square feet.

- e) The final inspection of all planting work, or phase of planting work, will be made by the PSAA and the Contractor just before the final warranty period expires. All plant replacements shall be completed, and the site shall be cleaned-up, prior to the inspection.
- f) The final acceptance inspection of plantings or material planted during recognized planting seasons will be made during September for fall planting and by June for spring planting.
- g) Planted areas which do not meet the contract requirements, shall be replanted to the original project specifications and within acceptable planting dates as directed by the PSAA.

I. Protecting and Preserving Irrigation Systems

- 1. The Contractor shall locate, save, and protect from damage irrigation systems within the Project limits. This includes the removal and replacement of irrigation system components as necessary and ensuring the proper operation of the irrigation system as determined by the PSAA.
- 2. The Contractor shall perform the necessary investigations to determine the precise location of the irrigation systems, and all affected components, prior to the commencement of construction operations.
- 3. The Contractor shall take all actions necessary to maintain the original functionality of the system to the greatest extent possible throughout the duration of the Project.
- 4. The Contractor shall contact all property owners prior to the commencement of the work in order to determine the impacts to the irrigation systems and coordinate the project's work with them to ensure satisfactory operation of the irrigation systems during construction.
- 5. All work shall be approved by the PSAA and the affected property owner(s) at the conclusion of the project's work.

J. Underground Sprinkling Systems, Restore

1. Restore existing privately owned underground sprinkling systems within the project site as described herein. This work shall be paid with an allowance for the actual work required to restore and modify existing privately owned underground sprinkling systems. The Contractor shall take care to avoid disturbance of existing underground sprinkling systems within the project site. These typically will be encountered in the parkway adjacent to the roadway.
2. Materials used to restore or modify existing underground sprinkling systems shall be of the same brand, model and specifications as the removed or damaged portion(s) of the sprinkling system and shall be compatible with the rest of the system.
3. The Contractor shall take precautions to prevent or minimize damage and disruption to private lawn sprinkling systems, including, but not limited to, completing visual inspections of the project site to determine areas in which lawn sprinkling equipment exists. This work of inspection shall be considered incidental to the disturbing work in the project area.
4. The Contractor shall repair or replace all lawn sprinkling systems disturbed by their operations and shall contact and coordinate any necessary work with the appropriate owners of such sprinkling systems. The Contractor shall obtain written permission from property owners prior to completing any work outside the right-of-way on private property and shall provide copies of these documents to the Engineer for the project file.
5. The Contractor shall employ an underground sprinkling specialist to make necessary repairs or modifications to the affected underground sprinkling systems. During construction activities, the disturbed portions of the system shall be isolated and/or removed in such a way that the undisturbed portions of the system remain operational until the entire system is completely restored. The existing underground sprinkling systems shall be restored or modified so that spray from the sprinkler heads does not spray over sidewalks or into driving lanes of the road.

K. Chain Link Fencing

1. The Contractor may be required to submit shop drawings, manufacturer's catalog cuts with printed specifications, framework, and fabric samples to the PSAA for review and approval a minimum of 14 days prior to the proposed delivery of materials.
2. The shop drawing submittal shall include complete details of fence construction, fence height, post spacing, dimensions and unit weights of framework, and concrete footing details. The framework sample shall include one 12-inch long piece of each size. The fabric sample shall be one 12-inch square piece of fabric.
3. Fence installation shall be in accordance with ASTM F567 (Standard Practice for Installation of Chain-Link Fence), except as modified herein.
4. The fence shall be installed at the height indicated on the Plans.
5. Where "Salvage and Re-erect" is called for on the Plans, the Contractor may utilize new or salvaged zinc-coated chain link fencing materials, posts, and all related hardware meeting the requirement of MDOT Specifications, Subsection 907.04 (Steel Chain Link Fence). Salvaged fencing materials and posts shall be free from significant defects, bends, kinks, old concrete, or corrosion that will compromise the performance of the fence. Fencing materials and posts shall be in a condition such that they do not contain large (greater than 1 square foot) or unsightly defects in the fence fabric or posts. The PSAA will decide if the defects in the materials are significant.
6. All vinyl-coated materials shall be handled with care. Any damage to the vinyl coating shall be repaired by the Contractor to the satisfaction of the PSAA, or, at the PSAA's direction, the damaged item(s) shall be replaced by the Contractor, all at the Contractor's expense.
7. The fence shall be stepped at all grade changes. The fence shall not be stepped on any wall or barrier.
8. Terminal, turning, gate, and line posts shall be set plumb in concrete footings as indicated on Plans Details. Plumb shall mean 1 inch in 6 feet.
9. The top of the concrete footing shall be 2 inches above the adjacent finish grade and shall be sloped so as to direct water away from the post.

10. Terminal, turning, and gate posts shall be braced back to adjacent line posts with horizontal brace rails and diagonal truss rods.
11. Caps shall be provided that fit snugly over posts to exclude moisture. Cone-type caps shall be used for terminal, turning, and gate posts. Loop-type caps shall be used for line posts.
12. The top rail shall be installed through the line post loop caps and fastened at the terminal posts. Sections shall be connected with sleeves to form a continuous rail between terminal posts.
13. The sleeves shall be spaced 20 feet center-to-center, with every fifth sleeve containing a heavy spring to take up expansion and contraction of the top rail.
14. The middle and bottom rails shall be joined to the line posts with boulevard clamps. The brace rails and truss rods shall be installed and adjusted prior to the stretching of the fabric.
15. A top and bottom tension wire shall be provided, and stretched between the terminal, turning, and gate posts, 6 inches above the finish grade (bottom wire), and threaded through the top row of the fabric diamonds (top wire). They shall be securely fastened to the outside of all line and terminal posts.
16. The top and/or bottom tension wire may be omitted when a top or bottom rail is provided, respectively, unless otherwise specified.
17. The fabric shall be pulled taut to provide a smooth, uniform appearance, free from sag. The bottom selvage shall be 2 inches above the finish grade.
18. The fabric shall be fastened to the terminal, turning, and gate posts with tension bars threaded through the fabric and secured with tension bands at maximum 15-inch intervals, including one at the top and bottom of the fabric.
19. The fabric shall also be tied to the line posts with tie wires spaced at maximum 12-inch intervals, including one at the top and bottom of the fabric.
20. The fabric shall be tied to all horizontal rails with tie wires spaced at maximum 24-inch intervals.
21. The fabric shall be attached to the bottom tension wire (if applicable) with hog rings at maximum 24-inch intervals.

22. Nuts for fittings, bands and hardware bolts shall be installed on the inside of the fence. The ends of the bolts shall be peened, or the threads scored, to prevent their removal.
23. Gates shall be hung and adjusted to operate properly. The bottom of the gate frame shall be 2 inches above the finish grade. The top of the gate shall align with the top rail of the fence.
24. The finished fence shall be substantially true to line, taut, and solid at all points. All surplus excavated material and other debris resulting from the construction shall be promptly removed from the jobsite and properly disposed of off-site.

L. Removal of Fence

1. Fences shall be removed and replaced or shall be removed as indicated on the Plans. If any of the existing material is damaged or destroyed, the Contractor shall replace the material at his expense.
2. Where fencing is encountered during construction, and its removal was not called for on the Plans, it shall be replaced or restored, at the Contractor's expense, to a condition comparable to that prior to construction.
3. After the fence removal or relocation operations are complete, all surplus material shall be removed and disposed of by the Contractor, at Contractor's expense, unless otherwise called for in the Contract Documents.

M. Protective Fence and Tree Protection

1. Contractor shall install protective fence at the limits of the construction area as shown on the Plans or as directed by the PSAA.
2. Posts for protective fencing shall be driven a minimum of 42 inches into the earth and be spaced close enough to maintain a taut fabric between posts. At no time shall fence fabric protrude into the pedestrian pathway. If steel bases are used, Contractor shall constantly monitor spacing to ensure fabric remains taut. Fabric shall be attached utilizing a minimum of 4 wire clamps or other methods as approved by the PSAA.
3. The Contractor shall not operate equipment within the tree protection fence of any existing tree without the approval of the PSAA.

4. Construction material, supplies, or equipment shall not be stockpiled or stored within the limits of the tree protection fence.
5. Vehicles and personnel are not permitted within the limits of the tree protection fence.
6. The Contractor shall not attach chains, cables, ropes, nails, or other articles to any tree at any time.
7. Tree roots exposed during construction that are 1½ inches or greater in diameter must be pruned. All pruning operations shall be reviewed and approved by the PSAA.
8. All root pruning shall be performed with sharp tools and shall provide clean cuts that do not unnecessarily damage the remaining bark or root. The Contractor shall not perform any backfilling operations until all root maintenance has been performed.
9. Any trees owned by the City of Ann Arbor or other trees designated to be protected that are damaged due to the Contractor's activities or activities of the Contractor's subcontractors or suppliers, shall be repaired under the direction of the Urban Forestry and Natural Resources Planning Coordinator or by an approved forestry specialist. The costs of these repairs shall be the sole responsibility of the Contractor.
10. Should the Contractor's operations damage a plant's roots to the extent that it must be removed, the Contractor shall either replace the plant with a commensurate number of plants, 2½-inch caliper trees of the species as determined by the City, or compensate the City of Ann Arbor for the cash value of the plant or tree as determined by the Urban Forestry and Natural Resources Planning Coordinator. The City of Ann Arbor shall be solely responsible for determining which compensation method is used.
11. The Urban Forestry and Natural Resources Planning Coordinator shall supervise the replacement of any trees at the sole expense of the Contractor.
12. Contractor shall remove tree protection fence when directed by the PSAA.