DIVISION II
CONSTRUCTION DETAILS

2021

Mobilization

2021.1 DESCRIPTION
This item shall consist of preparatory work and operations, including, but not limited to, those necessary for the movement of personnel, equipment, supplies and incidentals to the Project site; for the establishment of all Contractor's offices and buildings or other facilities necessary for work on the Project.

2021.5 BASIS OF PAYMENT
Based on the lump sum Contract price for mobilization, partial payments will be made as follows:
(a) On the first partial estimate that shows work performed on at least one major Contract item or after 5% of the original Contract amount has been completed, exclusive of the Mobilization item, 50 percent of the amount bid for mobilization will be paid, but not to exceed 3 percent of the original Contract amount; or
(b) When 15% of the original Contract amount has been completed, exclusive of the Mobilization item, 75 percent of the amount bid for mobilization will be paid, but not to exceed 5 percent of the original Contract amount; or
(c) On the first partial estimate that shows work performed on each and every major Contract item, 100 percent of the amount bid for mobilization will be paid; or
(d) When any previous partial estimate shows that 25 percent or more of the original Contract amount has been earned, exclusive of mobilization payments, 100 percent of the amount bid for mobilization will be paid on the next partial estimate.

The original Contract amount shall be the total value of all Contract items, including the mobilization item. Major Contract items may be listed as such in the Special Provisions or Bid Schedule. In the absence of such listing, these items shall be any Contract item or items having an individual amount in excess of 5 percent of the original Contract amount.

When the amount bid for the mobilization item exceeds 5 percent of the total original Contract amount, the Department reserves the right to withhold (on any partial estimate) the portion in excess of 5 percent
2021.5

until 95 percent or more of the original Contract amount is earned.

The total sum of all payments shall not exceed the original Contract amount bid for the mobilization item, regardless of the fact that the Contractor may have, for any reason, shut down work on the Project or moved equipment away from the Project and then back again.

Nothing herein shall be construed to limit or preclude partial payments otherwise provided by the Contract.

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<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
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<tr>
<td>2021.501</td>
<td>Mobilization</td>
<td>.................................. Lump Sum</td>
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2031

Field Office and Laboratory

2031.1 DESCRIPTION

This Specification covers the furnishing, maintaining, and removing field office and laboratory facilities for the exclusive use of Department personnel in making field tests and reports, for storage of records and equipment, and as field headquarters for the Engineer.

2031.2 GENERAL PROVISIONS

The Contractor shall furnish all field office and laboratory facilities in accordance with these provisions. The facilities shall remain the property of the Contractor. The Contractor shall furnish, maintain, and service the facilities with fuel, electrical power, sanitary services, access roads, and other required items. The Contractor shall provide telephone service to all field office and laboratory facilities. The phone service shall include a modular jack and a voice activated, beeperless, telephone recorder. The Contractor shall pay for the telephone installation, basic monthly phone service charges, and the removal of the telephone. The Contractor shall submit invoices for long distance telephone charges to the Engineer for payment.

The Contractor shall not place field offices, laboratories, equipment, or supplies within a distance of 8 m (26 feet) outside of the dripline of specimen trees or other vegetation designated to be preserved without approval of the Engineer. The Contractor shall also restrict traffic movement from this protected area. The Engineer may specify temporary fence and other protection measures according to 2572.

The Contractor shall locate, relocate, and maintain the facilities as approved by the Engineer unless the Contract specifies otherwise. The Contractor shall locate the field office and laboratory sites within the Right of Way whenever possible. If it is not possible within the Right of Way, the Contractor shall arrange for a site adjacent to the Right of way. If it is necessary to rent the site, the Contractor will receive compensation for rent costs as Extra Work. The Engineer will give the Contractor reasonable advance notice before any unit is to be delivered.
to the Project, readied for occupancy, and relocated or removed. The Contractor shall not relocate or remove any unit from the Project without the Engineer's consent. However, the Contractor shall remove the facilities from the Project when released by the Engineer.

The Engineer may utilize field office units for the full life of the Contract including periods of work suspension and until the Certificate of final acceptance has been executed.

The Engineer will release field laboratory units upon completion of all field inspection work and acceptance as provided for in 1516, unless otherwise specified in the Contract. The Engineer will not utilize the laboratory units during periods of authorized winter suspension without the Contractor's permission or unless such use is otherwise specified in the Contract.

The Engineer will decide all disputes concerning site selection, placement conditions, service needs, and other functional matters.

\section*{2031.3 REQUIREMENTS}

\subsection*{A Basic Requirements}

Each field office and laboratory shall be a separate mobile unit or building. The Engineer may approve other equivalent facilities. Separate quarters in stationary structures or combination trailer units will be accepted only if and when the location and mobility needs can be satisfied without appreciable inconvenience or loss of serviceability to the Department.

Each field office or laboratory unit shall be constructed and equipped to meet the following basic requirements:

1. Weatherproof thermal resistant construction with finished interior walls, ceiling, and floor, capable of being easily maintained and cleaned.
2. Exterior width of 2.4 m (8 feet) or more, and a floor to ceiling height of not less than 2.1 m (7 feet).
3. Two or more entrance doors with inside latches, at least one of which shall be an exterior door equipped with an outside lock and an opening of not less than 750 x 1930 mm (30 x 76 inches).
4. Commercial type windows of normal number and size, with a total window area not less than 20 percent of the unit floor area, and with inside latches on all vent windows.
5. Ceiling ventilator or exhaust fan, insect-proof screening on each exterior door and all vent windows, and Venetian blinds or effective awnings over all windows.
6. Artificial lighting system with fixtures providing adequate illumination over each desk and all work areas.
7. Portable or wall mounted plans rack.
One or more multipurpose fire extinguishers that comply with applicable Federal and State safety and health regulations.

Electric heating system capable of maintaining a reasonably uniform temperature of 22°C (70°F) or more throughout the interior in all zones.

Minimum floor area, based on exterior dimensions, of not less than 21 m² (230 square feet) for the field office or 14 m² (150 square feet) for the field laboratory.

The exterior doors shall provide convenient and safe egress from the ends of the unit. Dimensions of the main door shall be not less than 750 x 1930 mm (30 x 76 inches). A smaller auxiliary door may be allowed on laboratory units, at the discretion of the Engineer, provided it fulfills the basic needs for an emergency exit. The doors and passageways shall provide easy access to all areas of the unit.

Specific Requirements

The interior layout of each unit shall be designed or arranged to make the furnishings easy to use, accommodate the use and storage of ordinary office machines and testing apparatus, and provide a reasonably modern and universally acceptable facility. Built-in furnishings and fixtures shall meet conventional standards. All desk, table, and work top surfaces shall be surfaced or finished with mar resistant materials.

All appliance installations, sanitary facilities, electrical circuitry, waste and water supply systems, venting, and safety features, shall meet Federal, State, and local regulations.

The field office or laboratory shall also be equipped to meet the following specific requirements:

**B1 Field Office Furnishings**

B1a Two or more pedestal type desks with supply drawers, and a top width of at least 750 mm (30 inches). The desks may be either the portable or built-in type, having a top length of at least 1500 mm (60 inches). If one or both ends of the desk are mounted flush with a wall, however, the top length shall be at least 1800 mm (72 inches). Vacant wall space shall be provided for placement of a Department-furnished stenographic desk if one is not furnished.

B1b Three or more letter or legal size file drawers, either of the built-in or portable cabinet type, located for convenient access.

B1c One drafting desk with plan sheet and pencil drawer and with top dimensions not less than 900 x 1800 mm (36 x 72 inches). It shall be a commercially built, tilt or slant top desk of the wall mounted, pedestal, or cabinet style, but neither end shall be mounted flush with a wall.
B1d An enclosed storage cabinet or closet with adequate space for the usual outdoor garments, office supplies, and other materials not separately stored on open shelves or in desk drawers.

B1e At least 6 m (20 linear feet) of open shelving not less than 300 mm (12 inches) wide above desks or at other convenient locations.

B1f One drafting stool and sufficient desk chairs, preferably of a swivel type, for all desks and for at least two additional persons.

B2 Field Laboratory Furnishings

B2a One sturdily built workbench situated along a side wall, with a work top not less than 3 m x 600 mm (10 feet x 24 inches), and with open space below for placement of a curing tank or other needed equipment.

B2b One 300 mm (12 inches) deep service sink located near one end of the workbench and with a capacity of not less than 75 L (20 gallons). The sink shall be recessed into the workbench and have a water supply, faucet, and an outside drain.

B2c An enclosed storage cabinet or closet with adequate space for the usual outdoor garments, standard supplies, and other miscellaneous equipment or apparatus that would ordinarily be stored for convenience or protection.

B2d One desk or table with a suitable work top not less than 750 x 1500 mm (30 x 60 inches) located conveniently for clerical use and plans reviewing.

B2e Two or more letter or legal size file drawers, either of the built-in or portable cabinet type, located for convenient access.

B2f Two or more stools or chairs of suitable height to provide seating at both workbench and clerical desk.

B2g At least 3600 mm (12 linear feet) of open shelving not less than 300 mm (12 inches) wide above the workbench or at other convenient locations.

B2h One electric kitchen stove with four heating plates and electric oven. Separate heating plates may be substituted only with approval by the Engineer.

B2i Blank

B2j An electric exhaust fan or other approved mechanical means of achieving satisfactory air circulation and of exhausting air pollution.

C Special Requirements

All units shall be leveled and supported at the site as necessary for satisfactory placement. Unless other means are provided for acceptable
weigh scale support, the field laboratory shall be rigidly supported to eliminate floor and work bench vibrations to an acceptable degree for accurate weighing on a bench-supported scale.

A curing tank shall be furnished by the Contractor for concrete test cylinder curing when the construction work involves casting of standard concrete test cylinders. The tank shall have adequate capacity and have dimensions that permit its installation below a laboratory workbench. The Engineer may authorize outside placement of the tank when it is to be used at the site of a field office.

The field office or laboratory shall also be equipped with the following special services, as indicated for the Type specified.

C1  Type A Service
Water supply of sufficient capacity to serve all needs for materials testing and test cylinder curing, as required for the work in progress. A storage tank with a capacity of 180 L (50 gallons) or more shall be furnished and installed at each field laboratory site where a pressurized water supply is not provided. The tank installation shall provide sufficient gravity pressure to maintain constant flow through the sink faucet.

C2  Type B Service
All Type A services, together with toilet and lavatory facilities, drinking water facilities, and trash disposal service. Detached portable toilets shall be conveniently located. A closed, faucet equipped, drinking water container or cooler with adequate supply of potable water shall be furnished when a potable pressure water system is not provided. Suitable trash containers shall be furnished and the accumulated trash shall be regularly removed from the premises. All of these facilities and services shall be provided to the satisfaction of the Engineer.

C3  Type C Service
All Type B services, together with electrical power supply and fixtures, including duplex outlet receptacles capable of providing adequate amperage for electric lighting and other appliance needs.

An electrically powered mechanical sieving apparatus shall also be furnished for determining particle size distribution of fine aggregate (minus 4.75 mm (#4) sieve). The apparatus shall accommodate six full height 200 mm (4 inch) round sieves with pan and cover (which will be furnished by the Department). The apparatus shall be equipped with an automatic timing device of at least 15 minutes duration. The complete apparatus must be approved by the Materials Engineer, by verification of sieving sufficiency in accordance with AASHTO T-27, before its acceptance.
C4  Type D Service
All Type C services, together with a thermostatically controlled heating and cooling system capable of maintaining a uniform temperature between 22 and 29°C (72 and 85°F) in all zones. Separate systems may be provided.

C5  Type X Service
Type X Service shall apply only to field laboratory units, and then only in combination with one of the above described Types. When Type AX, BX, CX, or DX Service is specified, the Engineer shall have the right to utilize the prescribed laboratory unit as a combination office-laboratory facility for the full life of the Contract, including periods of work suspension and until the Certificate of Final Contract Acceptance has been executed according to 1516. Otherwise, the service requirements shall be as indicated for the first “letter” of the type designation.

2031.4  METHOD OF MEASUREMENT
The accepted field office and field laboratory units will be measured separately by the number and type furnished and utilized in accordance with the provisions of the Contract, regardless of the duration of its use at any one or different locations.

2031.5  BASIS OF PAYMENT
Payment for field office or field laboratory units of each type at the Contract bid price, or at any adjusted price provided for in the Contract, shall include full compensation for all costs of furnishing, placing, relocating, maintaining, and servicing the complete facility as required, including any removal and relocation costs incurred, but not including any costs incurred for public utility connections made necessary as the result of relocating the unit at the Engineer’s direction, after its initial placement. Once the initial public utility connections have been made at the original site, any charges for utility connections will be at the Department's expense, unless the move is made by request of the Contractor. No extra compensation will be made for ordinary relocation expenses not involving public utility changes.

No payment will be made for field office or field laboratory units if the facility is not for the exclusive use of Department personnel for the contracted Project.

Payment for field office and laboratory facilities will be made on the basis of the following schedule:

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<tr>
<th>Item No.</th>
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<th>Unit</th>
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<tr>
<td>2031.501</td>
<td>Field Office, Type</td>
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<tr>
<td>2031.503</td>
<td>Field Laboratory, Type</td>
<td>Each</td>
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2051

Maintenance and Restoration of Haul Roads

2051.1 DESCRIPTION
This work shall consist of the maintenance, repair, and restoration of designated haul roads over which materials of the kinds and for the purposes named are hauled for the work covered by the Contract.

2051.2 DEFINITIONS
For the purpose of this Specification, the term "designated haul road" means any public road or street officially designated as a "haul road" (except a Minnesota trunk highway or road which has been officially designated by the Commissioner as a detour around a construction Project), over which materials from any source, of the kinds and for the purposes listed below are hauled. The hauling may be to points within the geographic limits of the Project or to points outside those limits if use of the material outside such limits is required.

(a) Soil or other material for embankment construction.
(b) Sand, gravel, or other material for backfill.
(c) Sand, gravel, or crushed rock for base or surfacing courses.
(d) Aggregates for bituminous surfacing, including the hauling of bituminous mixtures from the mixing plant.
(e) Aggregates for concrete base or pavement, including the hauling of concrete batches from batch plants.
(f) Bituminous materials and Portland cement for paving mixtures.

2051.3 DESIGNATION AND USE OF HAUL ROADS
Where Maintenance and Restoration of Haul Roads is a bid item under the Contract, material of the kinds and for the purposes described above shall not be hauled from any source until the haul road from that source has been officially designated as a haul road. Thereafter, all materials hauled from that source shall be hauled over that road.

All vehicle trips, either loaded or unloaded, between material source(s) and the Project for the purpose of hauling materials described above shall be made only on a designated haul road.

If the Contract is with the Minnesota Department of Transportation for State Trunk Highway Projects, the Contractor shall select a haul road (or roads) to haul the materials previously described, and notify the Engineer as to the road (or roads) so selected. Within 15 calendar days after being notified of the haul road selection, the Commissioner will determine if the selected road (or roads) is an acceptable route. If the route is acceptable, the Commissioner will designate that road as a temporary trunk highway haul road.

If the Contract is with or for a governmental agency other than the Minnesota Department of Transportation, the Contractor shall select a haul road (or roads) to haul the materials, as previously described, and
notify the Engineer representing that governmental agency as to the road (or roads) so selected. Within 15 calendar days after being notified of the haul road selection, the Engineer will determine if the selected road (or roads) is an acceptable route. If the route is acceptable, the Engineer will approve that road as a designated haul road.

After a haul road has been officially designated, the Contractor may select a different road for official designation under the same conditions as previously stated. However, any changes made in haul road designation shall not relieve the Contractor of the obligation to restore the previously designated haul road if any of the above described materials were hauled over that road.

The Contractor will be required to reimburse the local government agency(s) for its haul road use on certain bituminous roadways as set forth below.

The Contractor shall verify spring load capacities of proposed haul roads with the local government agency(s). Reimbursement to local government agency(s) for concrete surfaced roadways is not required.

When a designated haul road has a bituminous surface and a spring load capacity of less than nine (9) tons, reimbursement to the local government agency(s) for haul road use shall be made at the rates as follows: $0.007/metric ton of material per kilometer ($0.01/ton of material hauled per mile).

The contractor shall make full payment to the local government agency(s) upon receiving notice of payment due and computations from the Engineer. The contractor shall provide the Engineer with confirmation of payment to the local agency(s). Should the amount due an individual local government agency be less than $500.00, no payment will be required.

**2051.4 MAINTENANCE AND RESTORATION**

While hauling operations are in progress, the Contractor shall maintain the haul road in a condition satisfactory to the Engineer. This work shall include application of water, bituminous material, or calcium chloride to the road surface as may be necessary to alleviate dust nuisance and eliminate traffic hazards.

When hauling operations over any haul road are completed, the Contractor shall either:
(a) Restore that haul road to a condition at least equal to that which existed at the time the hauling operations were started, or

(b) Compensate the local road authority in an amount satisfactory to that road authority and concurred in by the Engineer for the restoration of that haul road by the local authority.

The fact that other traffic has used the haul road concurrently with the hauling of the above described materials shall not relieve the Contractor of the obligation to maintain and restore the haul road as above provided, except that, if any other contractor (or contractors) engaged in highway construction under a contract with the same governmental agency also has materials of the kinds and for the purposes described above hauled over that road concurrently with the hauling of materials for the Contract work, the Engineer will determine the amount of maintenance and restoration obligation to be shared by each.

The Engineer's determination as to the kind and amount of maintenance and restoration work required to restore the haul road to a condition equal to that which existed at the time the hauling operations were started shall be final, binding, and conclusive.

When hauling over any designated haul road has been completed and the Contractor has restored that road or has compensated for that restoration as required, the Engineer will accept such restoration or concur in such financial settlement for the restoration of the haul road in writing, and such acceptance will relieve the Contractor of any additional obligation in connection with the restoration of that road.

2051.5 BASIS OF PAYMENT

Payment for the Item, Maintenance and Restoration of Haul Roads, at the Contract lump sum shall be considered compensation in full for all costs of maintenance, restoration and the reimbursement to local government agency(s) as specified for use of haul roads officially designated and used in conjunction with the Contract work.

No payment will be made under the these provisions unless one or more haul roads have been both officially designated and used for hauling materials of the kinds and for the purposes described. When these two conditions are met, payment will be made at the lump sum Contract price regardless of the amount of maintenance and restoration work required, provided work has been completed acceptably or receipt of payment for such restoration has been certified by the local road authority.
If the Contractor fails or refuses to perform haul road restoration or to make satisfactory financial settlement for such restoration as required within the period specified in a written notice by the Engineer, the Department will cause the restoration work to be done and deduct the costs from any moneys that are or may become due the Contractor or require reimbursement from the Contractor's Surety.

Payment for maintenance and restoration of haul roads will be made on the basis of the following schedule:

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<td>2051.501</td>
<td>Maintenance and Restoration of Haul Roads</td>
<td>Lump Sum</td>
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Clearing and Grubbing

2101.1 DESCRIPTION
This work consists of removing and disposing of the trees, brush, stumps, roots, and other plant life, including dead and decayed matter, that exist within the construction area and that are not specifically designated to remain.

2101.2 BLANK

2101.3 CONSTRUCTION REQUIREMENTS
The Engineer will establish the Right of Way lines and construction limits within which the clearing and grubbing operations are to be confined. The Engineer will designate those trees, brush, and other vegetation that are to be preserved and those that are to be removed. The Contractor shall remove and dispose of the trees, brush, stumps, and roots from the limits designated for clearing and grubbing.

The Contractor shall salvage topsoil to the extent feasible in accordance with 2105.

The Contractor shall protect the items designated to remain in accordance with 1712 and 2572, place temporary fence, and conduct all clearing and grubbing operations in a manner that will not damage or jeopardize the surrounding plant life and property.

The Contractor shall prune low hanging, unsound, or unsightly branches from the trees and brush designated to remain. Pruning shall be performed in accordance with 2571.3.

A Clearing and Grubbing Operations
The Contractor shall cut off, remove, and dispose of the trees, brush, stumps, and roots from designated areas within the construction limits as a clearing and grubbing operation, for clearing operations, and for grubbing operations. The Contractor shall perform clearing and grubbing as required on the Project to construct the proposed improvements as planned, including the clearing and grubbing of designated areas outside those construction limits, either as indicated in the Plans or as designated by the Engineer in consideration of the following:

(1) Within the Right of Way, the Engineer will designate and require the removal of trees, brush, stumps, and aesthetically undesirable items that can be viewed from the traveled way.

(2) Within 5 m (15 feet) of the construction limits outside of structures, the Engineer will designate and require the removal of trees, stumps, roots, brush, and branches as necessary to protect and maintain the completed improvements.

B Clearing Operations
The Contractor shall cut off, remove, and dispose of trees and brush in the areas designated as a clearing operation. When grubbing is not
required, the point of cut off shall be within 150 mm (6 inches) of the ground.

C  Grubbing Operations
The Contractor shall remove and dispose of the brush, stumps, roots, and other remains in the designated areas as a grubbing operation. Stumps shall be removed completely unless permitted to remain. If stumps are permitted to remain, they shall be cut off not more than 150 mm (6 inches) above ground, and flush with or below ground surface if so directed.

The Contractor shall fill all depressions resulting from the grubbing operations with suitable material and compact the material to the satisfaction of the Engineer, except in those areas to be excavated as part of the Contract work.

D  Disposal Limitations
The Contractor shall dispose of trees, brush, stumps, roots, and other debris or byproducts by chipping, marketing, burning, or burying. The Contractor:

1. May chip the wood through a chipping machine and use or dispose of the chips to the satisfaction of the Engineer.
2. Shall use unchipped marketable trees or make them available to wood-using industries and individuals.
3. Shall comply with the disposal requirements for pine, elm, and oak wilt infected red oak trees.
4. Shall conduct burning according to 2104.3, Minnesota Rules Chapter 7009 and any applicable local ordinances. At no time shall waste tires, rubber or plastics or similar materials be used to ignite these wastes.
5. Shall conduct burying operations according to 2104.3, Minnesota Rules Chapter 7035 and any applicable local ordinances. The Contractor must first receive approval from the Engineer to bury vegetation material.

D1  Marketable Trees
The Contractor shall make marketable trees, which are designated for removal, available to wood-using industries or individuals. Marketable trees are all trees, except elm and oak wilt infected red oak trees, that have a diameter of 150 mm (6 inches) or more measured at a point 600 mm (24 inches) above the ground surface. The Contractor:

a. Shall not burn or waste marketable trees without having written proof from three potential wood-using industries or individuals that the wood is not wanted. This requirement only applies when the volume of marketable trees on the Project exceeds 75 m³ (100 cubic yards).

b. Shall not dispose of marketable material remaining after harvesting by wood-using industries or individuals, without having written
proof of first offered them to the public for use as firewood in accordance with the intent of Minnesota Statute 116F.30.

(c) Is not required to make non-marketable trees available to wood-using industries or individuals.

(d) Is not required to cut trees in lengths of less than 2.5 m (6 feet).

D2  Elm and Oak Wilt Infected Red Oak Trees

D2a  Elm Trees

The Contractor shall dispose of all elm trees, brush, stumps, roots, and debris, together with the bark and byproducts with adhering bark of elm tree origin according to Minnesota Rules 1505.0230, 1505.0240, and 1505.0250 and local ordinances.

D2b  Oak Wilt Infected Red Oak Trees

The Contractor shall dispose of all stumps, roots and debris from all oak wilt infected oak trees of the red oak and white oak families consistent with Minnesota Rules 1505.0320 and 1505.0340 and local ordinances.

D2c  Disposal Deadlines and Locations

The Contractor shall dispose of elm and oak wilt infected red oak trees:

1. Within 20 calendar days of notification or of clearing and grubbing, whichever comes first, when the cutting operations are performed between April 1 and September 15.

2. By April 1 when cutting operations are performed between September 15 and March 31.

3. Within the Right of Way by burning, burying, or chipping, when allowed.

4. Off the Right of Way provided the trees, with intact bark, are processed within the time limitations.

D3  Pine

The Contractor shall dispose of all non-marketable pine trees, brush, stumps, roots, and debris by chipping, debarking, burning, burying, or covering with an air tight tarp within 20 calendar days of being cleared during the growing season.

D4  Blank

D5  Burning ................................................................. 2104.3

D6  Burying ................................................................. 2104.3

The Contractor must obtain the Engineer's approval before burying vegetation material.

E  Temporary Fencing ....................................................... 2572
2101.4 METHOD OF MEASUREMENT

The Department will measure clearing and grubbing by area, lump sum, or individual unit basis as indicated in the Contract. Diameter will be determined by dividing the measured circumference by 3.14.

A Qualifying Trees and Stumps

The Engineer will only measure trees for payment that have a diameter of more than 100 mm (4 inches) at a point 600 mm (24 inches) above the ground surface.

The Engineer will only measure stumps for payment that have a diameter of more than 100 mm (4 inches) at:
(a) A point 600 mm (2 feet) above the ground surface when the tree was cleared under the same Contract, or
(b) The point of cutoff when the tree was not cleared under the same Contract.

No measurement will be made for the removal and disposal of brush nor of stumps having a diameter of 100 mm (4 inches) or less at the point of cutoff.

B Area Basis

When the hectare is the unit, quantities will be determined by measuring (to the nearest 0.02 ha (0.05 acre)) all areas cleared and all areas grubbed, within the limits shown in the Plans or staked by the Engineer. All measurements will be made horizontally to points 3 m (10 feet) outside the trunks of qualifying trees or stumps on the perimeter of the area being measured. Separate areas smaller than 0.02 ha (0.05 acre) will be considered to be 0.02 ha (0.05 acre).

Whenever isolated trees or stumps are to be removed outside the areas designated to be cleared or grubbed by the hectare, and no unit price is provided in the Contract for clearing and grubbing individual trees or stumps, payment will be made on the following basis:
(1) Each isolated qualifying tree measuring less than 1 m (40 inches) in diameter at a point 600 mm (2 feet) above the ground surface, and each isolated qualifying stump measuring less than 1 m at the point of cutoff, will be considered as being 0.02 ha (0.05 acre).
(2) Each isolated tree or stump measuring 1 m (40 inches) or more in diameter, at the points described above, will be considered as being 0.04 ha (0.1 acre).

C Individual Unit Basis

When the tree is the unit, quantities will be determined by counting the number of qualifying trees cleared and the number of qualifying stumps grubbed.

D Lump Sum Basis

No measurement will be made of an individual area, tree, or stump when clearing and grubbing is a lump sum item.
2102.1  

**2102.1  DESCRIPTION**  
This work shall consist of the removal of pavement markings that conflict with revised traffic patterns. The markings will usually be in the form of 100 mm (4 inches) wide widths, in solid line or skip line lengths, but may include other patterns or widths and the type will be as (one) of the following:  
A)  **Pavement Marking Removal:** this work shall consist of the removal of non-durable pavement markings such as paint type markings.
B) **Pavement Marking Removal - Temporary:** this work shall consist of the removal of Temporary Reflectorized Pavement Marking Tape or Removable Preformed Plastic Pavement Markings.

C) **Pavement Marking Removal - Permanent:** this work shall consist of the removal of durable pavement markings.

2102.2 **BLANK**

2102.3 **REMOVAL REQUIREMENTS**

Before effecting a change in traffic pattern, the Contractor shall remove all conflicting pavement markings approved by the Engineer, using methods and equipment that will not significantly damage the pavement structure or surface texture. Should the removal operations result in significant damage, as determined by the Engineer, the Contractor shall repair the damaged areas as the Engineer directs at no expense to the Department.

Whatever methods of removal are employed, the Contractor shall control or restrict operations to avoid exposing traffic to hazardous or detrimental conditions. Any expended materials or agents used in the removal process shall not be allowed to accumulate on the pavement surface but shall be promptly removed by suction or other approved methods as the work progresses.

Linear paint markings shall be removed so as not to leave a distinguishing pattern of removal. Where unsatisfactory results are achieved, the Contractor shall obliterate any deceptive lines remaining by applying a color-matched paint or asphalt sealer that will blend with the surface texture satisfactorily.

2102.4 **METHOD OF MEASUREMENT**

Pavement marking removal will be measured by either area or length of the original markings as acceptably removed. Unless otherwise provided, markings of all types will be included for payment under a single Contract item.

Removal areas will be computed on the basis of nominal widths and actual lengths as originally applied and still evidenced at the time of removal. Other irregular shaped markings will be measured as enclosed within rectangular boundaries of least dimension as determined by the Engineer.

Removal length will be computed by the actual length of each pavement marking removed and will not include the gap between the broken lines.

2102.5 **BASIS OF PAYMENT**

Payment for pavement marking removal at the Contract price per unit of measure will be compensation in full for all costs of obliterating the markings as specified and for all costs of restoring the original pavement texture as needed.
Payment for this work will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>2102.501</td>
<td>Pavement Marking Removal – Permanent</td>
<td>square meter (square foot)</td>
</tr>
<tr>
<td>2102.501</td>
<td>Pavement Marking Removal – Temporary</td>
<td>square meter (square foot)</td>
</tr>
<tr>
<td>2102.501</td>
<td>Pavement Marking Removal – Permanent</td>
<td>square meter (square foot)</td>
</tr>
<tr>
<td>2102.502</td>
<td>Pavement Marking Removal – Permanent</td>
<td>linear foot</td>
</tr>
<tr>
<td>2102.502</td>
<td>Pavement Marking Removal – Temporary</td>
<td>linear foot</td>
</tr>
</tbody>
</table>

2103

Building Removal

2103.1 DESCRIPTION

This work consists of removing from the Right of Way those buildings that have been vacated and are not considered to have salvage value as buildings.

This work includes sewer and water service disconnections.

This work does not include the removal of sidewalks, driveways, or miscellaneous structures unless so indicated in the Contract.

2103.2 BLANK

2103.3 REMOVAL REQUIREMENTS

A General

The Contractor shall do all work in accordance with the applicable laws and ordinances.

The Contract will list the buildings to be removed, show the approximate location of each building by the street address or by reference to a survey station, and give a general description of the building. Building removal shall also include the listed miscellaneous removals from the locations indicated in the Contract.

In doing building removal work, the Contractor may remove any buildings (including all fixtures except those owned by public or private utilities) by demolition before removal from the Right of Way or remove any buildings from the Right of Way without demolition.

If the Contractor elects to move any building to another location, the Contractor shall obtain all necessary permits including those required by the Department.
The Department assumes no responsibility for the condition of any buildings at any time, and no guarantee is made or implied that any building will remain in the condition the bidder finds it at the time of examination before preparing the Proposal.

B  Removal
The Contractor shall entirely remove all buildings and structures, including steps, basement walls, floor slabs, and footings from the Right of Way. Where the building rests on a concrete surface slab, the Contractor shall remove the entire slab and related footings.

C  Utilities

C1  Disconnection of Sewer and Water Services
The Contractor shall locate, expose, cut off, and plug all sewer and water service connections at the sewer and water mains. The Contractor shall, at no additional compensation, plug all sewers leading from the building using watertight plugs.

The Contractor shall abandon wells in accordance with 2104.

C2  Other Utilities
The utility owners are responsible for disconnecting telephone, electric power, and other wire services, and gas service pipes outside the buildings, and removing fixtures belonging to such utility companies; however, the Contractor's attention is directed to 1507.

D  Disposal of Materials and Debris
All materials removed, other than utility owned fixtures, and all debris resulting from the removal operations, shall become the property of the Contractor and the Contractor shall dispose of them in accordance with 2104.3C.

E  Filling Basements
If the building was removed under a separate Contract, the Contractor shall fill all basements and other excavations made, as specified in the Contract. The Contractor shall fill the excavation to the level of the existing ground surface using sand, gravel, clay, loam, or other inorganic soil. The Contractor shall furnish the fill material from sources outside the Right of Way, subject to 1405. The Engineer will not require mechanical compaction of the fill material.

If the building removal is included in the same Contract as the grading, the Contractor shall remove the foundations according to 2103.3B and fill basements according to 2105.3G.

2103.4 METHOD OF MEASUREMENT

A  Building Removal
The Department will measure all buildings listed for removal as a single lump sum.
2104.3

B Basement Fill
When the Contractor is required to furnish the material for filling basements, and only then, the Engineer will measure basement fill as the volume of the air space within the basements, below the ground surface.

C Disconnection of Sewer and Water Services
The Department will measure each sewer and water service connection cut off and plugged at the main.

2103.5 BASIS OF PAYMENT
The Department will pay for the building removal item at the Contract lump sum as compensation for all costs of the work described above, except filling basements when the Contractor is required to furnish the fill material and for sewer and water disconnections.

The Department will pay for disconnect of sewer and water services at the main at the Contract unit price for each disconnection. This payment will be compensation in full for all costs involved, including restoration of street and property surfaces.

The Department will pay for building removal by the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2103.501</td>
<td>Building Removal</td>
<td>lump sum</td>
</tr>
<tr>
<td>2103.505</td>
<td>Disconnect Sewer Service</td>
<td>each</td>
</tr>
<tr>
<td>2103.507</td>
<td>Disconnect Water Service</td>
<td>each</td>
</tr>
<tr>
<td>2103.511</td>
<td>Basement Fill</td>
<td>cubic meter (cubic yard)</td>
</tr>
</tbody>
</table>

2104 Removing Pavement and Miscellaneous Structures

2104.1 DESCRIPTION
This work shall consist of the removal, in part or wholly, and satisfactory disposal of pavement, sewers, culverts, guardrails, abandoned structures, and other obstructions existing on the Right of Way, but not including bridges, covered under 2442, and buildings. The work shall include salvaging designated materials and backfilling the resulting trenches, holes, and depressions.

2104.2 BLANK

2104.3 CONSTRUCTION REQUIREMENTS

A General
Those structures and facilities that are to remain in place will be indicated in the Contract or designated by the Engineer.

The Engineer may determine that the existence of a structure or an obstruction does not interfere with, endanger, or detract from the new construction in any way, and therefore, may remain in place.

The Contractor shall remove and dispose of all structures and obstructions specifically included for payment in the Contract, except
those that are specified to be removed by others or that are permitted to remain by the Engineer.

In an excavation area, excavation includes removal of all obstructions unless the obstruction is specifically identified for removal in the Contract as a separate pay item. If obstructions are encountered in the excavation operations that require removal, and that require equipment and handling substantially different from that employed in the excavation operation, the Engineer may pay for the removal as Extra Work.

B  Removal Operations

All removal operations that may endanger new construction shall be completed prior to construction of the affected work. All materials that have been designated for salvage shall be removed in a manner that will not result in unwarranted damage. The salvaged material shall be dismantled into section or assembly units as required to facilitate removing in undamaged condition and permit convenient handling. Pipe materials shall be completely emptied of infiltrated material prior to being stockpiled.

B1  Remaining Portion of Structure

Where a portion of an existing structure is to be retained for use, that portion shall not be damaged during the removal operations. Where a portion of a reinforced concrete structure is to be removed and the structure extended, existing reinforcement bars shall be left in place for a distance of not less than 40 diameters from the face of the cut, to provide bond between the old and new concrete. Where a concrete box culvert is to be extended, the old structure shall be removed to the extent shown in the Plans.

B2  Pavements and Sidewalks

In removing pavements, sidewalks, and similar structures, where the cut will be exposed in the finished work, the structure shall be sawed along the removal line(s) with a concrete saw, unless the removal is made to an existing joint. The use of wedges driven into the saw cut to break off the portion to be removed will not be permitted. Elsewhere, the structure shall be cut and chipped to true lines and vertical faces.

The Contractor shall saw the existing concrete or bituminous pavement at the location(s) shown in the Plans and as staked by the Engineer for the purpose of establishing a neat line from which to extend the new work.

B2a  Sawing Concrete Pavement

The Contractor shall saw concrete pavement along the removal line(s) to the depth indicated in the Plans, the pertinent Specification, or, in the absence thereof, to a depth 30 percent of the thickness of the concrete prior to breaking off the pavement.
B2b  Sawing Bituminous Pavement

When sawing is specified, the Contractor shall saw bituminous pavement along the removal line(s) to a minimum depth of 75 mm (3 inches) prior to breaking off the pavement. When sawing is not specified, the Contractor may use other methods of removal that will produce a neat line acceptable to the Engineer.

B3  Integrant Curb

The Contractor shall remove integrant curb by controlled blasting, utilizing detonating cord of sufficient core load and so placed that the explosive force will effectively remove the curb to within 15 mm (0.5 inches) of the designated break line conforming to the normal pavement surface. Any projections extending more than 15 mm (0.5 inches) above the designated break line after blasting shall be removed by chipping with pneumatic hammers or by other approved methods. Overbreakage shall be held to a practical minimum by careful control of the blasting force. If any unacceptable overbreakage occurs, repairs shall be made as directed by the Engineer, using suitable patching mixture properly placed to restore the surface acceptably. Unless otherwise approved, the patching material shall be a suitable Portland cement concrete or mortar mix. All loose material shall be removed from the areas to be patched and an approved bonding agent shall be applied to the depression surfaces prior to placing the patching mixture.

After each blasting operation, the Contractor shall clean the traveled portions of the roadway of all debris before allowing resumption of traffic. All shoulder depressions resulting from the Contractor's operations shall be backfilled to the Engineer's satisfaction, prior to suspension of each day's operations.

All concrete removal debris shall be disposed of outside the Right of Way in accordance with this Specification.

B4  Blank

B5  Concrete and Masonry Structures

Within municipalities the Contractor shall entirely remove concrete and masonry structures located within the roadbed. Elsewhere, concrete and masonry structures located within the roadbed shall, unless they are specified to be removed entirely, be removed to an elevation at least 1200 mm (4 feet) below the surface of the subgrade. Concrete and masonry structures located outside the roadbed shall be removed to an elevation not less than 600 mm (2 feet) below the final ground surface.

The Contractor shall remove septic tanks, cisterns, and cesspools to the extent required above and in accordance with Minnesota Department of Health regulations.

The Contractor shall rebuild and reconnect live sewers when related manholes, catch basins, and drop inlets are removed. The Contractor
shall provide a by-pass and maintain the service during the operations, to the satisfaction of the Engineer.

The upgrade ends of all drainage or sewer pipes leading from abandoned basements, manholes, or similar structures shall be plugged with concrete or masonry.

Before filling abandoned basements, manholes, cesspools, septic tanks, cisterns, and similar structures that are not completely removed, the Contractor shall make holes in the bottom to prevent the entrapment of water.

B6 Timber Structures and Underground Tanks

The Contractor shall completely remove all timber structures and all underground tanks in accordance with applicable regulations.

B6a Underground Petroleum Tank

Contractors removing underground petroleum tanks and all related liquids and sludge residues must have MPCA certification.

The Contractor shall:
1. Give written notification to the Engineer at least 15 days prior to removal of the underground tank,
2. Obtain any required permits,
3. Have a MPCA Certified Supervisor on site during tank removal,
4. Drain all connecting pipes,
5. Close all connections except vents,
6. Remove all fluids, sludge residue, and explosive vapors from the tank,
7. Dispose of tanks in accordance with applicable Motor Carrier Safety and Hazardous Materials Transport requirements. During transport, all tanks shall be secured so that no material leaks from the tank onto the vehicle or onto the road, and
8. Give written certification to the Engineer within 30 days after removal of the tank that the tank, liquids, and residue have received proper disposal.

B7 Wells and Holes

All wells, well shafts, elevator shafts, environmental bore holes, and the like that are to be abandoned shall be filled and sealed by a Contractor licensed by the Minnesota Department of Health in accordance with the "Water Well Construction Code," Chapter 4725. Until permanently abandoned in accordance with the Code, wells, shafts, etc., shall be sealed or otherwise protected as necessary during the work to prevent any surface drainage from entering the opening. After abandonment and sealing has been completed, wells, shafts, etc., shall be removed to the elevations specified on the Plans or as designated by the Engineer. A copy of the completed Well Sealing Certificate shall be filed with the Department's Central Office Property Management Supervisor.
B8  Miscellaneous Items

When removing railroad tracks, the Contractor shall remove all rails, ties, paving, crossings, track encasements, and other appurtenances.

When removing guardrail and fences that are to be salvaged, the Contractor shall neatly coil the wire and cable, pull posts from the ground, and remove nails and staples from posts and boards.

C  Disposal of Materials and Debris

The Contractor shall provide the Engineer with information and documentation substantiating proper disposal arrangements and operations. The Contractor's attention is directed to burying regulations, including Minnesota Rules 7035.2825. If waste materials or debris have been or are being disposed of improperly, the Engineer may order the Contractor to take corrective action. The Engineer may withhold payments until compliance is ensured.

The Contractor shall dispose of trees, brush, stumps, roots, and related vegetation according to 2101.3 and these requirements.

C1  Disposal of Salvageable Materials

The Contractor shall stockpile materials designated for salvage by the Department on the Right of Way at locations approved by the Engineer upon being removed, dismantled, and cleaned as required.

The Contractor shall dispose of materials not designated for salvage by the Department and all debris resulting from the removal and demolition operations as provided for in these requirements and in specific regulations imposed by laws, ordinances, orders, and decrees.

Materials of marketable value that are removed in accordance with these provisions, but that are not to be possessed by the Department, shall become the property of the Contractor and shall be removed from the Right of Way.

C2  Disposal Within Right of Way

The Contractor may dispose of noncombustible materials and debris other than metallic substances in the roadway embankments in accordance with 2105 for rock placement or by burying them under a minimum covering of 600 mm (2 feet) of earth material at locations approved by the Engineer.

The Contractor may burn combustible materials and debris within the Right of Way, provided the required burning permits are obtained. The Contractor shall conduct burning operations under the constant care of a competent caretaker and in accordance with all applicable regulations.

The Contractor may bury metallic materials and combustible materials or remains within the Right of Way at locations approved by the Engineer outside the roadbed, but not within the limits of a
municipality. Before burying, the bulk must be reduced to a practicable
minimum prior to being covered with earth.

C3 Disposal Outside Right of Way

The Contractor shall dispose of all materials and debris outside the
Right of Way when so designated in the Contract. The Contractor shall
also dispose of all materials and debris, resulting from removal or
demolition operations, which have no specific disposal provisions, at
locations outside the Right of Way. The Contractor shall dispose of the
materials and debris in a manner that will not create a public nuisance
nor result in unsightly conditions within view of a public road,
recreational area, residential district, or other place of public concern.

The Contractor shall arrange for and secure suitable disposal sites
for materials and debris to be removed from the Project for disposal
outside the Right of Way. The Contractor shall assume full
responsibility for acceptable disposition of the material as well as for
damages resulting from the disposal operations.

The Engineer will not give final acceptance of the work:
(a) Unless disposal is made at a publicly controlled dumping site or
some other established facility where the Engineer is satisfied that
the material will be properly disposed of by and at no additional
expense to the Department.
(b) Until the disposal areas are in acceptable condition with respect to
the Contractor's obligations.

D Backfilling Depressions

If the remains of partially removed structures prevent natural
filtration of water, the Contractor shall make perforations in the
structure bottoms prior to placing the backfill to prevent entrapment of
water.

All depressions and air spaces within partially removed structures
shall be backfilled with suitable material in accordance with 2105.

2104.4 METHOD OF MEASUREMENT

No measurement will be made of any removals that are not required
nor of any removals that are specifically designated as being covered by
other Contract items.

Removal and salvage items will be measured separately by type of
structure as identified in the item name. Measurements will be
separated by size and kind of material only to the extent stated in the
item Name.

A Area

Pavements, sidewalks, surfacing, and other uniform thickness items
will be measured by area, without specifying thickness.

Pavement removal will be classified by kind of paving material
whenever the material is comprised entirely of Portland cement concrete
(remove concrete pavement) or entirely of bituminous-aggregate
mixtures (remove bituminous pavement). Otherwise, when the pavement is comprised of a combination of different paving materials such as a concrete base or pavement overlaid with bituminous surfacing, removal of the entire structure will be accomplished under the unclassified item of “remove pavement.” Regardless of classification, pavement removal shall include the removal of any integrant curb removed in conjunction therewith.

Removal of pavement in connection with the excavation of trenches for installation of drainage structures or utility items will be measured separately from other pavement removals, under the item of remove trench pavement, which shall include the removal of all paving courses including unclassified materials.

Removal of surfacing will be limited to the stripping of a wearing course overlaid on a concrete base preparatory to placement of a new wearing course thereon. This item will be classified by kind of material, such as: remove bituminous surfacing, remove brick surfacing, etc. Removal shall include any granular cushion course existing on top of the concrete base, if so required.

B  Length

Length measurements will be made along the longitudinal centerline of the structure, parallel to the base or foundation upon which the structure is placed, and from end to end of the structure as removed. Pipe measurements will be made from center to center of junction fittings, catch basins, or manholes, and will include the length of any aprons required to be removed in conjunction therewith.

Sawing of concrete and bituminous pavements will be measured by length along the saw cut line(s) as staked by the Engineer when these pay items appear in the Proposal.

C  Volume

In the case of concrete or masonry structures, volume will be determined from measurements taken on the in place structure as it is being uncovered and removed except where the structure dimensions or volumes are otherwise established.

D  Number (Complete Unit)

All items designated for payment on a per each basis will be measured separately by the number of individual units removed, salvaged, or abandoned, including all appurtenances.

2104.5  BASIS OF PAYMENT

Payment for the accepted quantities of remove, salvage, or abandon items at the Contract price per unit of measure will be compensation in full for all costs of removing the material or specified portions thereof, for disposing of the materials removed and the salvaging of parts thereof as may be specified, for the backfilling of depressions and other restoration work required, and for well abandonment procedures and the
performance of all other work of a special nature that may be specified or imposed by laws, ordinances, and regulations.

Payment for sawing will only be made for acceptable sawing of concrete and bituminous pavements when these pay items appear in the Proposal. All other sawing will be considered as incidental work to the Contract item.

Unless the Proposal includes an item for fence removal, the removal of abandoned fences shall be done at no expense to the Department, without any direct compensation being made therefor.

No direct compensation will be made for removing bituminous curbing, bituminous pavements less than 150 mm (6 inches) in thickness, and other minor encumbrances encountered within the limits of the roadway excavation that are not to be salvaged and that can be excavated and disposed of in the embankment or elsewhere without separate handling or the use of special equipment.

No direct compensation will be made for removing open metal flumes, metal curbs and gutters, and other similar metal items unless such materials are required to be salvaged.

In the case of salvage items, only those item units that are removed in acceptable condition will be measured for payment under the salvage items. Where removal is necessary, unacceptable units that are either damaged or deteriorated will be measured for payment under appropriate removal items or as Extra Work items in absence thereof. Otherwise, materials having insufficient salvage value shall be left in place where possible, without incurring removal expense.

If any materials designated for salvage are damaged due to negligence by the Contractor, the Department will deduct from any monies due or becoming due the Contractor an amount equal to 60 percent of the current delivered price of new material of the same type and size as that damaged and equal to the quantity of material so damaged. The damaged material shall then become the property of the Contractor.

Removing the ends of old box culverts preparatory to extending the structure will be paid for by the cubic meter (cubic yard) of removal or by each unit.

Backfilling depressions resulting from the removal of structures will be considered to be embankment construction, and no extra compensation will be made.

Payment for removing miscellaneous structures will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Unit</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2104.501</td>
<td>Remove (1)........................ meter (linear foot)</td>
<td></td>
</tr>
<tr>
<td>2104.503</td>
<td>Remove (1)....................... square meter (square foot)</td>
<td></td>
</tr>
<tr>
<td>2104.505</td>
<td>Remove (1)........................ (square yard)</td>
<td></td>
</tr>
</tbody>
</table>
2105.2

2104.507  Remove (1) ............................................. cubic meter (*cubic yard*)
2104.509  Remove (1) ............................................................ each
2104.511  Sawing Concrete Pavement .................. meter (*linear foot*)
2104.513  Sawing Bituminous Pavement .............. meter (*linear foot*)
2104.521  Salvage (1)............................................ meter (*linear foot*)
2104.523  Salvage (1)............................................................ each
2104.525  Abandon (1)........................................................ each

NOTE: (1) Specify item name, such as: culvert pipe, sewer pipe, drain pipe, curb and gutter, curb, sidewalk, fence, concrete or masonry structures, railway track, manholes or catch basins, integrant curb, concrete pavement, bituminous pavement, pavement, trench pavement, guardrail, water well, etc.

2105

Excavation and Embankment

2105.1  DESCRIPTION

This work shall consist of constructing roadway excavations and embankments within the Right of Way and easements, including any grading that may be specified on roadside areas.

2105.2  MATERIALS

A  Excavation Material

Classification of excavated materials on each section of the Project will be made by the Engineer as the work progresses. The excavations will be classified for payment in accordance with the following provisions:

A1  Common Excavation

Common excavation shall consist of all excavation materials not classified herein as rock excavation, muck excavation, common channel excavation, or rock channel excavation, and shall include the excavations classified as subgrade excavation when a separate item therefor is not included in the Proposal.

A2  Rock Excavation

Rock excavation shall consist of all materials that cannot, in the Engineer's opinion, be excavated without drilling and blasting or without the use of rippers, together with all boulders and other detached rock each having a volume of 1 m (*1 cubic yard*) or more, but exclusive of those quantities that are to be paid for separately under the item of rock channel excavation.

A3  Muck Excavation

Muck excavation shall consist of all saturated and unsaturated mixtures of soil and organic matter not suitable for foundation material regardless of moisture content, that is removed from below the natural ground level of marshes, swamps, and bogs over which embankments are to be constructed, where the excavation is required:
(a) To provide a stable foundation for embankments, or
(b) To accelerate the subsidence of unstable material under embankment load.

A4 Subgrade Excavation
Subgrade excavation shall consist of all excavations made below the top of the final graded surface of the road and between the shoulder slopes that are not made for the purpose of obtaining topsoil and where the excavation materials are not classified for payment as rock excavation or muck excavation.

A5 Common Channel Excavation
Common channel excavation shall consist of the excavation of channel changes outside the limits of the normal roadway excavation and embankment, together with the excavation of waterways leading to and from culverts but outside the roadway section, and includes the excavation of all materials encountered except for that which is to be classified for payment as rock channel excavation.

A6 Rock Channel Excavation
Rock channel excavation shall consist of the same material as previously described for rock excavation, but includes only the material that is excavated in areas outside the normal roadway grading section as defined for common channel excavation.

A7 Unclassified Excavation
Unclassified excavation does not include excavation that would be classified as muck excavation, common channel excavation, or rock channel excavation, but includes all other excavations, regardless of character or classification of material, that are not included for payment under separate items.

B Borrow Material
Borrow material is material required for embankment construction or other specified purposes that is not available or is not to be obtained from the roadway excavations defined in 2105.2A. Unless otherwise provided in the Contract, borrow material shall be furnished by the Contractor from sources selected by the Contractor outside the Right of Way, subject to 1405 and 1602.

Borrow material will be classified in accordance with the material requirements given below. All borrow material furnished from sources selected by the Contractor must be approved by the Engineer prior to being delivered to the Project. The Contractor shall give the Engineer sufficient notice to permit any testing of the material that may be required for approval.

When measurement of borrow material is to be made at the source by cross-section methods, the Contractor shall allow sufficient time, and arrange the operations, so as to leave the excavated areas in a condition
that will permit the taking of original and final cross-sections as necessary for accurate determination of quantities.

Borrow material shall be furnished and placed only to the extent that the required materials are not obtainable from the excavations within the Right of Way.

If the Contractor places more borrow material than is required or ordered by the Engineer, and thereby causes materials excavated from within the Right of Way to be wasted, the quantity wasted will be deducted from the borrow material measurements.

If materials are encountered within the planned roadway excavation limits which are excess materials and which meet all specified requirements for a Plan designated borrow item, the Contractor may, at his/her option, utilize those materials in that portion of the roadway where said borrow item was designated. This does not apply to topsoil items.

If the Contractor elects to use such excess material as a borrow item, payment will be made at the respective Contract unit prices for both the excavation of the material and the item for which the excavated material is used. If the particular borrow item is not established in the Plan as a (P) Plan Quantity measurement, the Contractor shall perform its operations in cooperation with and as directed by the Engineer to provide for measurement of the material by the Department.

Whether the Contractor chooses to provide borrow from outside the excavation limits or as outlined above, any resultant excess material shall be disposed of outside the Right of Way at no additional cost to the State.

B1 Granular Borrow ......................................................... 3149

Material meeting the requirements for select granular borrow shall be furnished if so specified.

B2 Common Borrow .........................................................

Common borrow shall consist of materials approved by the Engineer for use in the embankment construction or other specified purposes as the Engineer considers suitable.

B3 Topsoil Borrow ......................................................... 3877

Material meeting the requirements for select topsoil borrow shall be furnished if so specified.

C Salvage Material .........................................................

Salvage material shall consist of material available on the Project, such as native topsoil or aggregates in existing pavement and base courses, which is to be reserved for a specific use, either in the work under Contract or in future construction. Salvage of these materials will be required only when the Proposal contains separate and specific items therefor.
2105.2

The material to be salvaged shall be stockpiled for future use or utilized in the new construction as indicated in the Plans. All salvage material used in the new construction shall be placed in accordance with the Specification requirements for the class of work in which it is used. Salvage operations shall be in accordance with the following provisions.

C1 Salvaged Aggregate
Salvaged aggregate shall include all existing sand, gravel, or crushed rock materials that can be salvaged and utilized without pulverization.

C2 Salvaged Topsoil
Salvaged topsoil for general use as a growth medium shall be obtained from the soil horizons normally designated as "A" or "B", or shall be obtained from alluvial deposits.

As part of the salvaging operations, all debris and any stones exceeding 75 mm (3 inches) in greatest dimension shall be removed prior to stockpiling.

D Stabilizing Aggregate ................................................. 3149

2105.3 CONSTRUCTION REQUIREMENTS

A General
The Contractor shall complete all clearing and grubbing operations in an area according to 2101 prior to excavation and embankment operations. During winter construction, the Contractor shall remove all ice and snow from an area just prior to excavation or embankment construction operations.

The Contractor shall not begin excavation operations on any area until the necessary cross-sections have been taken and the necessary construction stakes and grades have been established to the satisfaction of the Engineer. No excavating shall be performed beyond the elevations, slopes, and limits established, without approval of the Engineer.

The Contractor shall schedule and conduct erosion control operations according to 1717.2.

The Contractor shall maintain all excavations and embankments in a well drained condition at all times. The Contractor shall install planned drainage facilities concurrently with the embankment construction, temporarily crown grades to minimize infiltration, and install temporary drainage facilities as directed by the Engineer. No material shall be stockpiled in a manner that will restrict surface drainage.

If the Contractor interrupts existing surface drainage, sewers, or subsurface drainage, the Contractor shall, at no expense to the Department, provide and maintain temporary drainage facilities as approved by the Engineer until permanent facilities are completed and operative.
**B  Preparation of Embankment Foundation**

Before placing embankment on an existing slope steeper than 1 vertical to 4 horizontal, the Contractor shall either:

(a) Flatten the existing slope to the extent that it will not be steeper than 1 vertical to 4 horizontal; or

(b) Construct steps in the slope, with the back surface being as nearly vertical as practicable and with the horizontal cuts being made as close together as the slope permits, but with no step being less than 300 mm (12 inches) in width. All work required by these provisions is incidental work for which no direct compensation will be made.

Before placing any embankment 1 m (3 feet) or less in height, all soil that the Engineer considers unsuitable for use in the upper 1 m (3 feet) of the roadbed shall be removed from the area between the shoulder lines and disposed of as hereinafter provided.

Where embankment is to be constructed over swamp or marsh areas or at other locations where the foundation material is unstable, the foundation shall be excavated to remove unstable material as indicated in the Plans or as directed by the Engineer. Where non-granular soils are to be used for excavation backfill and embankments, the foundation area shall be free of standing water. No direct compensation will be made for removing such water from the excavation.

Wherever practicable, the foundations for all embankments shall be compacted between the shoulder lines by a tamping roller. Four passes shall be made on each strip the width of the roller. Other rollers may be used with permission of the Engineer. No direct compensation will be made for compacting the embankment foundations.

Before placing embankment over an old road, the Contractor shall remove any surfacing that is specified to be salvaged and excavate the old road core to an elevation 300 mm (12 inches) below subgrade, unless a greater depth is required by the Plans.

Before backfilling depressions within the roadway caused by the removal of foundations, basements, and other structures, the Contractor shall enlarge the depressions as directed.

**C  Excavating Operations**

All excavations shall be made in conformity with the lines, grades, and slopes staked by the Engineer and as the Engineer may otherwise direct, based on the typical section and elevation controls shown in the Contract. Any excavating performed beyond the limits described by the stakes that was not authorized or ordered by the Engineer will be considered to be unauthorized work.

Excavations below final grade, for the purpose of removing unstable foundation materials or removing materials that are considered unsuitable for use in the upper portion of the roadbed, shall be
conducted with the understanding that the excavation limits staked will be subject to change as the actual subsurface conditions are disclosed. Where granular backfill is used, seepage trenches shall be excavated for drainage as directed by the Engineer.

Excavations in rock shall be made to secure uniformity of grade and cross-section. All rock outcroppings shall be removed from within the slope lines staked and above the elevations shown in the Plans. All loosened material shall be removed from the backslopes. Roadbed excavating shall be conducted to provide drainage to the shoulder slopes and not to leave depressions that cannot be drained. Unless otherwise specified, presplitting will be required for all rock backslopes steeper than 1:1 in hard rock types such as igneous, metamorphic, and carbonates.

Blasting operations shall be controlled to produce a shattering effect on the rock that will not throw the material out of the excavation areas. The "coyote" method of blasting will not be permitted. Any rock blasted away from the excavation and embankment areas shall be recovered as directed. If seismic methods are used to monitor blasting, a record shall be furnished to the Engineer.

Disposition of Excavated Material

Excavated materials shall be utilized, to the fullest extent practicable and so far as the material is suitable, for construction of the embankments or as otherwise indicated in the Plans. Each layer of the roadbed shall be constructed of uniform material. When excavation operations disclose the presence of different types of soil, the Contractor shall select the different materials and place them in the embankments or elsewhere as directed. In general, when granular materials are uncovered, they shall be placed in the uppermost portion of the embankment. Granular material shall not be removed from the Project without the written approval of the Engineer.

When the soils are so varied that selection and placement of uniform soils is not practical, the Contractor shall use disks, plows, graders or other equipment to blend and mix suitable soils to produce a uniform soil texture, moisture content, and density; except that, all soils that contain 20 percent or more particles passing the 75 μm (200) sieve shall be blended, mixed, and dried with a disk meeting 2123 within the entire upper 2 meters (6 feet) of embankment. A disk is also to be used below the upper 2 meters (6 feet) of the embankment fill area if, in the opinion of the Engineer, the contractor is not producing a uniform soil texture. No capping of granular materials with nongranular materials will be permitted at or within 300 mm (12 inches) of the subgrade surface. In the event that the Engineer orders the Contractor to select materials to an extent greater than could be normally expected with the
loading method employed by the Contractor, any additional costs incurred by the Contractor will be compensated for as Extra Work.

The Engineer will designate those soils that are considered unsuitable or unstable with respect to the requirements of the Plans and the provisions hereof.

The Contractor shall remove the topsoil, store it in locations selected by the Contractor, and use it for topsoil covering at locations and to the minimum depths shown in the Plans. The Plans will indicate the quantity of topsoil considered necessary. If, at the time the Plans are prepared, it is known that there will not be sufficient topsoil available in the areas indicated above, the Proposal will contain a bid item for topsoil borrow, in which case the Contractor shall furnish the topsoil in excess of the quantity available within the Right of Way.

Peat, muskeg, and other unstable materials that are not to be used in the roadbed embankments shall be deposited in the areas indicated in the Plans or elsewhere as approved by the Engineer. All other material, including bituminous and concrete waste, that is considered unsuitable for use in the upper portion of the roadbed shall be placed in embankments at least 1 m (3 feet) below the top of the subgrade or outside of a 1:1 slope down and outward from the shoulder lines on fills under 10 m (30 feet) in height or outside of a 1 vertical to 1.5 horizontal slope down and outward from shoulder lines on fills over 10 m (30 feet) in height, or used to flatten the embankment slopes, or disposed of elsewhere as approved by the Engineer.

If no other disposition is specified, the excavated materials in channels outside of the roadway construction limits shall be used to fill abandoned portions of the channels and any remaining material shall be deposited in spoil banks or elsewhere as approved by the Engineer. Spoil banks shall be properly shaped and shall be provided with sufficient openings to permit natural drainage from adjoining property. Any topsoil excavated shall be used to cover the other fill material.

Snow, ice and frozen lumps exceeding 150 mm (6 inches) in greatest dimension will not be permitted in the roadbed embankments. Sod and frozen lumps less than 150 mm (6 inches) in greatest dimension may be placed only in that portion of the embankment which is outside of a 1:1 slope down and outward from the shoulder lines, but not over or adjacent to structures.

No stone, broken concrete or bituminous fragments exceeding 75 mm (3 inches) in greatest dimension will be permitted in the upper 150 mm (6 inches) of the roadbed embankment nor within 500 mm (20 inches) of a structure. No stones exceeding 150 mm (6 inches) in greatest dimension will be permitted in the upper 300 mm (12 inches) of the roadbed embankment. Stones or broken concrete exceeding 150 mm (6 inches) in greatest dimension, and other solid materials shall
not be placed in embankment areas where piling is to be installed. Concrete and bituminous pavement or other such slabs of solid materials shall be processed or pulverized to the extent that the maximum size particles shall not exceed 150 mm (6 inches) in greatest dimension when used in the upper 1 m (3 feet) of embankment or backfill.

All combustible debris materials (stumps, roots, logs, brush, etc.), together with all noncombustible materials other than soils (oversized rock, broken concrete, metals, etc.) that cannot be placed satisfactorily in the embankments, shall be disposed of in accordance with 2104.3C.

All surplus excavated soils and rock that are not wasted, stockpiled, or otherwise disposed of as specifically allowed or required by the Contract shall become the property of the Contractor and shall be disposed of by the Contractor outside of the Project limits in accordance with a satisfactory Disposal Plan. This disposal plan shall constitute the Contractor's proposal for acceptable disposition of surplus materials outside of the Project limits in compliance with applicable environmental regulations, permit requirements, and any requirements or limitations imposed by the Contract. A satisfactory Disposal Plan shall be submitted to the Engineer prior to starting the disposal operations.

In the absence of Contract provisions requiring off-project disposal, such disposition of material will only be ordered as Extra Work, in which case an acceptable disposal plan will be required as a basis for agreement.

Whenever disposal sites are indicated in the Contract, whether on or off the Project, they are to be considered as being possible sites with the Contractor having the option of choosing other sites after award of the Contract under the disposal plan provisions, except in cases where mandatory disposition is intended.

E  Placing Embankments

Roadbed embankments shall not be constructed during periods when the embankment material freezes while being placed and compacted, nor shall any embankment material be placed on soil that is frozen to a depth greater than 100 mm (4 inches). Where the foundation soil is frozen to a depth exceeding 100 mm (4 inches), at a time when weather conditions are such that embankment construction could be continued without the material freezing as it is being placed and compacted, the Contractor may be permitted to excavate the frozen foundation soil and proceed with the embankment construction for so long as the weather will permit, but only if and to the extent approved by the Engineer, and with the understanding that the additional costs involved shall be borne by the Contractor. The frozen soil shall be
wasted and replaced with other suitable soil as may be necessary to construct the embankments as specified.

Excavations below subgrade, together with any seepage trenches excavated to provide drainage, shall be backfilled in accordance with the requirements for embankment construction and with the material specified in the Contract, or with suitable materials obtained from the excavations if no other material is specified.

Before backfilling roadbed subcuts that are 750 mm (30 inches) or less in depth, the upper 150 mm (6 inches) of soil below the bottom of the excavation shall be compacted to 95 percent of maximum density.

Embankment material shall be deposited and spread in relatively uniform layers approximately parallel to the profile grade, and extending over the full width of the embankment. Earth moving equipment shall be routed evenly over the entire width of the roadway being constructed. Embankment widening construction shall proceed from the toe of the proposed slope inward toward the existing fill slope. Layers in the upper 1 m (3 feet) of the roadbed shall not be more than 200 mm (8 inches) in thickness (loose measurement) and those below the upper 1 m (3 feet) shall be not more than 300 mm (12 inches) in thickness (loose measurement), except under the following conditions:

1. Where the foundation for the embankment (or backfill) is under water or is so unstable that it will not support the hauling equipment without appreciable displacement of the underlying soils, the embankment thereon may be constructed as one layer up to the lowest elevation at which the hauling equipment can operate over it without causing intrusion of the underlying soils into the upper 200 mm (8 inches) of the embankment so placed, but in no case shall the top of that layer be less than 1 m (3 feet) below the subgrade. The top of that layer shall be compacted to the satisfaction of the Engineer before any additional material is placed thereon.

2. When the embankment material is of a granular nature, not more than 20 percent of which will pass a 75 µm (#200) sieve, the thickness of the layers in the upper 1 m (3 feet) of the roadbed may be increased to not more than 300 mm (12 inches) provided compaction is obtained by an approved compactor.

3. When the embankment material consists predominantly of stone, broken concrete, or rock fragments of such sizes that the material cannot be compacted, that material may be placed in the embankment up to an elevation 1200 mm (4 feet) below the top of the subgrade, in layers not to exceed 600 mm (24 inches) in thickness, and with the exception that larger stones may be placed outside of the shoulder lines but not within the median area of a roadway.
(4) Except as otherwise permitted in (2) above, embankment materials placed adjacent to structures within the roadbed shall be placed in layers not more than 200 mm (8 inches) in loose thickness, for a distance of at least 15 m (50 feet) on each side of pipes 1200 mm (4 feet) or less in diameter and 30 m (100 feet) on each side of other structures, and for the full height from the embankment foundation to the top elevation of the structure.

(5) Except as may be necessary to obtain satisfactory compaction, layer construction will not be required in constructing such items as ditch blocks and entrances where the use of conventional equipment is impractical, nor in constructing such items as channel fills, spoil banks, and berms that do not provide foundation support for structural items.

(6) Granular Materials (3149.2B) which are excavated below the water surface or table shall not be placed on embankment soils if the water content of the excavated material, in the Engineer’s opinion, is causing saturation of the previously placed embankment soils and resulting in the loss of stability and density of these soils.

Each layer consisting predominantly of rock or broken concrete shall be leveled prior to placing the next layer thereon, using suitable equipment operated in a manner that will provide even distribution of the larger rock or broken concrete and fill the voids with finer material to form a compact mass.

If sufficient suitable material has not been made available to construct the embankments as specified, additional suitable material shall be obtained from sources designated by the Engineer. If additional material is obtained from sources outside the Right of Way, the furnishing of that material will be paid for as Extra Work.

If, at any time prior to or during construction, the Engineer determines that it is necessary to resort to a surcharge, the Contractor shall construct the embankment as directed by the Engineer. The surcharge shall continue until the Engineer considers that satisfactory subsidence has been obtained. If, at any time during the construction, the Engineer considers it necessary, the Contractor shall excavate relief trenches as directed by the Engineer adjacent to the toes of the embankment, and backfill them as required.

The Department reserves the right to install settlement plates within the approach embankments at any bridge site as well as in other embankment areas, together with measurement control points outside the embankments, all in such locations and numbers as the Engineer deems necessary to determine the stability of the embankments. The Contractor's operations shall not disturb such installations. Any settlement plates damaged or destroyed by the Contractor's operations shall be replaced at no expense to the Department. No compensation in
addition to Contract prices will be made to the Contractor for any inconvenience or expense incurred as a result of these settlement plate installations.

At a time designated by the Engineer, the Contractor shall complete the embankment by adding more material or removing any excess. After satisfactory settlement of the embankment has been obtained and the slopes have been roughly finished, the excavated material temporarily deposited outside the embankment slopes shall be disposed of as shown in the Plans or as approved by the Engineer.

If embankment surcharge is ordered to achieve subsidence, in the absence of Contract provisions requiring the same, any equipment movement required thereby that would not otherwise be necessary will be compensated for as Extra Work. Unless otherwise specified, removal of excess materials deposited by order of the Engineer will be paid for as Extra Work to the extent the removal is ordered by the Engineer.

Before any embankment is placed behind abutments that support steel superstructures, the Contractor shall place temporary hardwood wedges, as directed by the Engineer, between the superstructure and abutment parapets. These wedges shall be removed when, in the opinion of the Engineer, satisfactory settlement of the embankment has been secured.

When the design of a structure is such that the strength of the substructure is dependent upon the restraining effect of the superstructure, the abutting embankment shall not be constructed until the superstructure has been completed to the extent necessary to provide the required restraint.

F Compacting Embankments

The rate of depositing material on the embankment shall not exceed the capacity of the leveling and compaction equipment. Compaction of this material should not be delayed after being placed.

Rollers shall be used to compact the embankment materials in totality (area, layers, etc.). The type of roller(s) used for compaction shall be sufficient to meet the density requirements, as specified. The minimum size, gross weight, and applied pressure exerted by the roller(s) shall be in accordance with the equipment requirements specified under 2123.

The use of equipment to haul material (trucks, carryalls, scrapers, etc.) shall not be considered in lieu of the specified compaction equipment. Construction traffic from such hauling equipment shall be distributed uniformly over the entire embankment to the maximum extent possible.
All roadbed embankment material shall be compacted as required herein for the Specified Density Method, except as otherwise provided for specific materials or portions of embankments.

Materials placed outside of a 1 vertical to 1.5 horizontal slope down and outward from the grading shoulder PI (point of intersection) on fills over 10 m (30 feet) in height, or outside of a 1:1 slope down and outward from the grading shoulder PI on fills of 10 m (30 feet) or less in height, will not be subject to the specified density requirements but shall be compacted to the satisfaction of the Engineer.

Mechanical compaction will not be required on those portions of the embankment that are constructed with material consisting predominantly of stone or rock fragments, nor in conjunction with placement of topsoil covering or roadside grading involving the filling of channels and depressions where acceptable consolidation is obtained with the grading equipment.

Density control shall not apply to waste materials (peat, muskeg, etc.) nor to any other non-rock material utilized for incidental drainage or landscape filling outside the roadbed embankment. However, such materials shall be consolidated to the satisfaction of the Engineer.

The Engineer shall have full authority to suspend hauling operations and the placement of additional embankment materials at any time, until the preceding layer has been blended and compacted, and its surface has been properly leveled.

F1 Specified Density Method

Where this method is specified, the Engineer will sample and test the soils that are to be used, to determine the maximum density and Optimum Moisture, and will make density and moisture tests on the compacted embankment, using methods described in the Mn/DOT Grading and Base Manual.

The upper 1 m (3 feet) of the embankment, together with those portions of the embankment that are below the upper 1 m (3 feet) but that are adjacent to structures and are subject to the same maximum layer thickness as the upper 1 m (3 feet), shall be compacted to a density of not less than 100 percent of maximum density. Those portions of the embankment that are below the upper 1 m (3 feet) and that are not adjacent to structures shall be compacted to a density of not less than 95 percent of maximum density.

At the time of compaction, the moisture content of the embankment material shall be not less than 65 percent nor more than 115 percent of Optimum Moisture where 95 percent of maximum density is required and shall be not less than 65 percent nor more than 102 percent of Optimum Moisture where 100 percent of maximum density is required.
2105.3

F2 Quality Compaction (Visual Inspection) Method

When this method is specified, the equipment used in constructing the embankment shall meet 2123 and each layer of embankment material shall be compacted until there is no evidence of further consolidation. Embankment construction shall not continue when, in the opinion of the Engineer, the existing soil moisture content does not allow proper compaction.

The Engineer may elect to perform moisture and density tests as shown in the Mn/DOT Grading and Base Manual, as needed to assist Visual Inspection. The actual density or moisture obtained by testing the road embankment must meet or exceed the requirements shown in 2105.3F1 Specified Density of the Standard Specifications in order to be acceptable.

Compaction shall be obtained with a tamping roller or an approved type of vibratory compactor, except as otherwise provided for specific materials and portions of the embankments.

In plastic soils, pneumatic-tired, steel-wheeled, or grid rollers may be used for compacting embankment layers 75 mm (3 inches) or less in loose thickness or for compacting the upper 75 mm (3 inches) of thicker layers where a tamping roller will not produce an increase in density. In nonplastic soils, pneumatic-tired, steel-wheeled, or grid rollers may be used for compacting layers of 200 mm (8 inches) or less in loose thickness.

Compaction shall be obtained with special compacting equipment or by hand tamping methods where the use of conventional rollers is not feasible.

G Finishing Operations

All excavation, embankment and roadside areas involved in or disturbed by the construction shall be finished in reasonably close conformity with the established lines and grades, including any tolerances specified. The subgrade shall be finished and maintained as required by the applicable provisions of 2112.3. When compaction was obtained by the quality compaction method, the final shaping of the roadbed shall be done when, in the opinion of the Engineer, the moisture content of the upper portion of the roadbed is suitable for that work. If necessary, in conjunction with the final shaping, the Contractor shall, at no expense to the Department, scarify the roadbed to a depth of 150 mm (6 inches) and recompact it.

In conjunction with the final subgrade finishing operations, the upper portion of a granular subgrade shall be stabilized by incorporation of stabilizing aggregate if necessary to achieve satisfactory surface stability as determined by the Engineer. The aggregate shall be spread to the depth and width shown in the Plans or as needed and shall be mixed (if required) with the subgrade to the extent that stability is best
achieved. After incorporation of the aggregate, the subgrade shall be recompacted and shaped to produce a stable surface meeting the specified surface tolerances. When the material needing stabilization was furnished by the Contractor as a borrow material item, the furnishing and placing of stabilizing aggregate shall be at no expense to the Department. Otherwise, this work will be compensated for under the item "stabilizing aggregate", or as Extra Work in the absence of a Contract item therefor.

Earthwork finishing and topsoil covering operations shall be conducted concurrently with the grading operations so as to permit prosecution and completion of erosion control items at the earliest practicable time. Topsoil covering operations shall be carried out as soon as possible after the subsoil has been finished to grade on any significant area. At the time the topsoil covering is placed, the subsoil shall be in a loose, friable condition for a uniform depth of at least 75 mm (3 inches), and there shall be no erosion rills or washouts in the subsoil surface exceeding 75 mm (3 inches) in depth. To achieve this condition scarification of the subsoil will be required as directed by the Engineer, wherever the subsoil has been compacted by equipment operation or has become dried out and crusted, and where necessary to obliterate erosion rills.

Subsoiling shall be required to reduce soil compaction in all areas where turf establishment is shown on the Plan. Subsoiling shall be performed by the prime or excavating contractor and shall occur after topsoil placement.

The contractor shall schedule a 15 meter (50 foot), two directional test and demonstrate competence to the Engineer prior to continuing operations. The Engineer shall identify the test area. Subsoiled areas shall be loosened to less than 1400 kPa (200 psi) to a depth of 500 mm (20 inches) of the inplace and top soil. When directed by the Engineer, the Contractor shall verify that the subsoiling work conforms to the specified depth. To test for conformance, the Contractor shall use a cone penetrometer that meets standard ASAE Soil Testing Specifications of a 20 mm (13/16 inch) insertion rate per second.

After obtaining approval by the Engineer that the equipment and methods are sufficient to perform the work, the Contractor may proceed and complete the subsoiling operation. Work done without the Engineers approval will be considered as unauthorized work.

Subsoiling shall form a two-directional (90º) grid. Channels shall be created by a commercially available, multi-shanked, parallelogram implement attached to track-type equipment. The equipment shall be capable of exerting a penetration force necessary for the site. No disc cultivators, chisel plows, or spring-loaded equipment will be allowed. The grid channels shall be spaced a minimum of 300 mm
(12 inches) to a maximum of 910 mm (36 inches) apart, depending on equipment, site conditions, and the Plan. The channel depth shall be a minimum of 500 mm (20 inches) or as specified in the Plan. If soils are saturated, the Contractor shall delay operations until the soil dries to field capacity or less.

Only one pass shall be performed on erodible slopes greater than 1 vertical to 3 horizontal. Work shall be at right angles to the direction of surface drainage, whenever practical. Exceptions to subsoiling include areas within the dripline of any existing trees, over utility installations within 750 mm (30 inches) of the surface, where trenching/drainage lines are installed, where compaction is by design (abutments, footings, or inslopes), and inaccessible slopes, as approved by the Engineer. In cases where exceptions occur, the Contractor shall observe a minimum setback, as directed by the Engineer.

Those portions of an old road that are abandoned, which are outside the grading areas as staked, shall be graded and finished to an acceptable contour that blends with the adjoining terrain. On all areas where an old roadbed or temporary haul road have been located, and are to receive turf, the existing soils and granular material shall be removed and replaced and/or subsoiled to provide not less than 500 mm (20 inches) of loose, friable soil below the finished surface. All structural material including granular, shall be removed. Any temporary haul removal costs will be incidental to the Project. Removed material may be disposed of off the Project site or recycled on the Project if approved by the Engineer.

All depressions resulting from structure removals, debris burying, grubbing operations, and other causes, shall be backfilled with suitable material to the designated contour and so as to conform with any pertinent requirements. All debris and any stones exceeding 75 mm (3 inches) in diameter on the soil surface at the time of performing the final blading operations shall be removed from the Project site. They shall be disposed of in accordance with 2104.3C (Disposal of Materials and Debris). If pre-existing to the Project, debris and stone removal will be paid for as Extra Work.

All work involved in the finishing operations, as specified herein and as otherwise required by the Contract, shall be compensated for as part of the payment for Contract items covering excavation, removals, or the furnishing of material.

2105.4 METHOD OF MEASUREMENT

The Department will determine quantities for excavation and embankment according to 1901 as modified by these provisions.

A Excavation Material

The Department will determine the quantities by excavated volume (EV) of the excavation material in its original position. Volumes will be
computed by the average end area method determined from original and final cross-sections.

In excavations classified as rock, the measurement will include a volume allowance for overbreakage if the plane of the bottom of the excavation falls within a layer or stratum of rock. Unless other limits are shown on the typical grading sections, measurements will include a 150 mm (6 inches) overbreak allowance outside the grading section as staked, with the exception that 500 mm (20 inches) (measured horizontally) will be allowed outside of backslopes in hard rock types where pre-splitting is not required. No overbreak allowance will be made for pre-split backslopes.

The Engineer will determine the actual limits between different material classifications by field measurements during construction as true elevations are disclosed. If any changes are made in the Plan grading sections or grades that affect the excavation limits as indicated in the Contract, measurements will be taken as necessary to establish the actual limits of excavation. Where topsoil covering is required, measurements will be taken on the finished surface after placement of the topsoil, and a quantity allowance will be made equal to the thickness of topsoil placed. In excavations made below finished grade, the limits of excavation measurement will be as defined by the grades and slope lines staked, unless actual field measurements are taken.

The Contractor may dispute the Engineer's determination of excavation quantities after completing the excavations within a specific balance (as planned) when the Contractor has a reasonable cause for dispute. The Contractor must submit a written dispute within 7 days after completing the excavations within a balance except for final finishing. The Contractor shall have waived the right to dispute the pay quantity determinations in that balance if these conditions are not met. However, at any time prior to completion of all roadway excavations on the Project, the Engineer will honor any request for investigation of quantity irregularities that may be submitted in writing by the Contractor, and if findings so warrant, quantity adjustments will be made on the basis of any measurements taken at the Engineer's discretion.

The limits for determination of quantities will be defined by the cross-sections. The limits for quantity determinations will not extend beyond the authorized grading sections as staked, except for the allowances specified. Quantity deductions will be determined by actual or fixed dimensions to exclude materials encompassed by the excavation measurements that are to be removed or salvaged under other Contract items. Excavation quantities will be recomputed or otherwise adjusted on the basis of actual limits as measured or
otherwise fixed, and payment for excavation items will be made as altered thereby.

B **Borrow Material**

The Engineer will measure borrow material by volume according to 1901 and as specified in the Contract as one of the following:

1. Excavated volume (EV),
2. Loose volume (LV),
3. Compacted volume (CV), or
4. Stockpile volume (SV).

Only those materials accepted for use on the Project will be measured for payment under the borrow material items.

C **Salvage Material**

The Engineer will measure salvage material by loose volume unless a different basis of measure is indicated in the item name, in which case the designation symbols will be the same as given for borrow materials in 2105.4B. The Engineer will select either:

1. Loose volume (LV), or
2. Stockpile volume (SV).

Salvaging, processing, stockpiling (if necessary), and placing operations will all be considered a single operation (one complete unit of measure), unless the item name is expanded to include the words "in Stockpiles" or "from Stockpiles." Also see 1901.

The operations of salvaging material from the existing roadway, processing the material as specified, and placing the processed material in stockpiles will be one operation constituting a complete unit of measure. The operations of removing material from stockpiles and placing it in the work as specified will be one operation constituting a complete unit of measure.

D **Stabilizing Aggregate**

The Engineer will measure stabilizing aggregate according to 1901 by mass or loose volume (LV) as furnished and incorporated into the subgrade.

E **Subsoiling**

The Engineer will measure subsoiling according to 1901 by area field measurement.

2105.5 **BASIS OF PAYMENT**

If it should be ordered by the Engineer, but not otherwise required by the Contract, that excavated material or salvage material be stockpiled and later loaded and hauled to a different location, rehandling the material will be paid for at the same Contract prices as that paid for the initial excavation or salvage work.

Payment for salvage material under items of salvaged aggregate or salvaged topsoil at the Contract prices per unit of measure will be compensation in full for all costs of excavating, processing, loading,
hauling, and placing the material in the new construction as specified.
Salvage material "in Stockpiles" will cover all costs incurred in
production of the stockpiled material, and salvage material "from
Stockpiles" will cover all costs of placing stockpiled material in the new
construction as specified.

Payment for the accepted quantities of borrow material or
stabilizing aggregate at the Contract prices per unit of measure will be
compensation in full for furnishing and placing the material as specified,
including final finishing operations.

No separate compensation will be made for any incidental pit
stripping, waste excavation, clearing and grubbing, topsoil replacement,
pit shaping, seeding, or other expenses incurred in supplying borrow
material from Contractor selected sources, whether indicated as a
possible source or not. However, when the Contractor is required to
obtain borrow material from a source specifically stipulated in the
Contract, any required incidental pit excavation (stripping, waste, etc.)
will be compensated for separately, or as Extra Work in the absence of
such payment provisions.

Payment for the accepted quantities of roadway excavation items at
the Contract prices per unit of measure of excavation, subject to the
price adjustment and Extra Work compensation specified herein, will be
compensation in full for all costs of scalping and preparing the
excavation and embankment construction areas; of excavating, loading,
hauling and placing, or disposing of the materials as specified; of
compacting the embankments and finishing the construction areas as
specified; and of all other operations incidental to the work. No direct
compensation will be made for water used in conjunction with the
mixing, placing, and compacting operations.

Extra Work compensation will be provided for the removal and
disposal of any debris encountered in the excavations to the extent that
its existence was not known to the Contractor at the time of bidding, and
then only when its satisfactory removal and disposition requires separate
handling or the use of special equipment.

Compensation for roadway excavation items will include any
increased haul costs not qualifying for Extra Work compensation or bid
price adjustment in consideration of I-402.

When the Proposal contains an item for common excavation but
does not provide an item for common channel excavation, any
excavation ordered and performed that would otherwise be classified as
common channel excavation will be paid for separately at the Contract
price for common excavation plus $1.30 additional per cubic meter
($1.00 per cubic yard).

If the Proposal fails to include a bid item for rock excavation or rock
canal excavation, and material is uncovered that is so classified,
excavation of the rock will be paid for separately at the Contract price for common excavation or common channel excavation, plus an additional $16.00 per cubic meter ($12.00 per cubic yard). If no bid item is provided for common channel excavation, excavation of materials classified as rock channel excavation will be paid for at the Contract price for common excavation plus an additional $18.00 per cubic meter ($13.50 per cubic yard). Such stipulated prices for rock excavation will apply up to a maximum of 200 m³ (260 cubic yards) of excavation per item or to such quantity as may be performed by mutual consent prior to execution of an Extra Work agreement.

When payment for muck excavation on the basis of equipment rental is specified, all operations of excavating and disposing of the materials so classified will be paid for at the Contract prices for the equipment used, in accordance with 2123. In the absence of Contract prices covering removal of material classified as muck excavation, payment will be made for its removal as Extra Work.

If any muck excavation in addition to that indicated in the Plans is required by the Engineer, when payment is made on the basis of excavation volumes, the increased quantity will not be considered as a basis of claim for increased compensation, except as provided by the following:

(a) That portion of the additional excavation that is removed from below a plane parallel to and 5 m (15 feet) below the natural ground surface will be measured in 2 m (5 foot) depth zone increments and paid for separately at adjusted unit prices. The adjusted unit price will be equal to the Contract bid price for muck excavation plus $0.20 per cubic meter ($0.15 per cubic yard) for the additional excavation within the 5-7 m (15-20 foot) depth zone and an additional $0.05 per cubic meter ($0.05 per cubic yard) for each additional 2 m (5 foot) increment of depth beyond 7 m (20 feet).

(b) If any portion of the additional excavated material should be required to be placed in a disposal area other than shown or described for the planned excavation, any additional costs incurred will be compensated for as Extra Work.

The adjusted unit prices specified above for muck excavation will be compensation in full for all additional costs incurred in excavating to depths greater than planned, in finishing the additional disposal quantities and areas, and in rehandling any materials deposited within the extended excavation limits. Payment at the Contract price will include full compensation for all pumping and dewatering specifically required, for all rehandling and hauling of the excavated material that is necessary for its disposal as planned, and for all finishing of the planned disposal areas.
Partial payments will be subject to withholding of a portion of the Contract amount to cover the reasonable value of any uncompleted operations that are designated as a part of the complete unit. The amounts so withheld will be based upon the estimated surface area exposed to probable erosion without the required surface finishing and turf establishment operations being completed.

All areas within the grading construction limits, exclusive of roadbed areas, on which the natural vegetation has been rendered ineffective by the grading or grubbing operations, will be considered as being exposed to probable erosion until such time that the final surface finishing and turf establishment operations have been completed.

The amounts to be withheld on each partial estimate will be the product of $7413.00 per hectare ($3000.00 per acre), unless otherwise stated in the Contract, and the estimated number of unfinished hectares (acres) exposed to probable erosion at the time the estimate is prepared.

This withholding will apply to the entire Project or to any area, as determined by the Engineer.

For application and release purposes, the Project may be divided into separate control areas based on earthwork balance points, drainage area boundaries, or roadway segments as indicated in the Contract or as otherwise deemed appropriate by the Engineer.

Upon completion of the rough grading operations and placement of topsoil in each control area, the amount withheld for that area will be reduced by 50 percent. Once mulch has been placed, the amount will be reduced by an additional 30 percent. Full release of the amount withheld will be made when the seeding has been accepted.

Whenever the possibility for erosion damage or water pollution exists, release of withheld amounts will not be made for a control area until adequate temporary or permanent erosion control measures have been provided.

Topsoil borrow will be accepted for payment in accordance with the provisions of Table 2105-1.
### Table 2105-1

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Full Payment Range</th>
<th>Price Reduction Range</th>
<th>Corrective Action Required When</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent passing the 2.00 mm (#10) Sieve</td>
<td>85% or Greater</td>
<td>80.0 - 84.9</td>
<td>75.0 - 79.9</td>
</tr>
<tr>
<td>Clay Content</td>
<td>5% or Greater</td>
<td>3.0 - 4.9</td>
<td>2.0 - 2.9</td>
</tr>
<tr>
<td></td>
<td>30% or Less</td>
<td>30.1 - 35.0</td>
<td>35.1 - 40.0</td>
</tr>
<tr>
<td>Silt Content</td>
<td>10% or Greater</td>
<td>7.0 - 9.9</td>
<td>4.0 - 6.9</td>
</tr>
<tr>
<td></td>
<td>70% or Less</td>
<td>70.1 - 75.0</td>
<td>75.1 - 78.0</td>
</tr>
<tr>
<td>Sand and Gravel Content</td>
<td>10% or Greater</td>
<td>7.0 - 9.9</td>
<td>4.0 - 6.9</td>
</tr>
<tr>
<td></td>
<td>70% or Less</td>
<td>70.1 - 75.0</td>
<td>75.1 - 78.0</td>
</tr>
<tr>
<td>Organic</td>
<td>3% or Greater</td>
<td>2.0 - 2.9</td>
<td>1.5 - 1.9</td>
</tr>
<tr>
<td></td>
<td>20% or Less</td>
<td>20.1 - 22.0</td>
<td>22.1 - 25.0</td>
</tr>
<tr>
<td>pH</td>
<td>6.1 or Greater</td>
<td>(A)</td>
<td>(A)</td>
</tr>
<tr>
<td></td>
<td>7.8 or Less</td>
<td>7.9 - 8.0</td>
<td>8.1 - 8.2</td>
</tr>
</tbody>
</table>

**NOTE:** The price reductions for multiple failure are cumulative.

*(A)* May be corrected by the addition of agricultural lime at a rate determined by the Engineer.

Payment for excavation and embankment construction will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2105.501</td>
<td>Common Excavation</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.503</td>
<td>Rock Excavation</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.505</td>
<td>Muck Excavation</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.507</td>
<td>Subgrade Excavation</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.511</td>
<td>Common Channel Excavation</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.513</td>
<td>Rock Channel Excavation</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.515</td>
<td>Unclassified Excavation</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.521</td>
<td>Granular Borrow (1)</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.522</td>
<td>Select Granular Borrow (1)</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.523</td>
<td>Common Borrow (1)</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.525</td>
<td>Topsoil Borrow (1)</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.526</td>
<td>Select Topsoil Borrow (1)</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.533</td>
<td>Salvage Aggregate (1)</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.535</td>
<td>Salvaged Topsoil (1)</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2105.541</td>
<td>Stabilizing Aggregate</td>
<td>cubic meter (cubic yard)</td>
</tr>
</tbody>
</table>
2105.5

2105.543 Stabilizing Aggregate ......................... metric ton (ton)
2105.550 Subsoiling........................................ hectare (acre)

NOTE: (1) Specify basis of measure: EV, LV, SV, or CV. See 2105.4 and 1901.
See 2105.4C and insert the words "in Stockpile" or "from Stockpile" if appropriate.

2111

Test Rolling

2111.1 DESCRIPTION
This work shall consist of testing the bearing capacity of the roadbed by rolling with heavy rollers.
Test rolling will be required only when and where specifically provided in the Contract.

2111.2 EQUIPMENT
The roller shall be pneumatic-tired, towed by suitable tractive equipment and shall conform to the following requirements:
(a) The roller shall have 2 wheels spaced not less than 1.8 m (6 feet) apart (center to center transversely).
(b) The tire size shall be either 18 x 24 or 18 x 25. Each tire shall be inflated to a pressure of 650 kPa (95 psi).
(c) The gross mass of the roller shall be not less than 13.5 metric tons (14.9 tons) and not more than 13.7 metric tons (15.1 tons) on each wheel.

2111.3 CONSTRUCTION REQUIREMENTS
Test rolling shall be performed on the roadbed as required at a time when the grading grade is completed within 100 mm (4 inches) of the grade staked by the Engineer, and shall cover the full top width of the proposed pavement structure as defined by the bottom width of the typical subcut sections shown in the Plans, unless other specific dimensions are given. Test rolling shall not be performed until the Engineer and Contractor mutually agree that the subgrade has been properly prepared and is acceptable for test rolling.

The test rolling shall be performed by making one pass over each strip covered by the width of a tire. Unrolled areas between tire paths shall not be wider than 300 mm (12 inches). The roller shall be operated at a speed of not less than 4 km/h (2.5 mph) nor more than 8 km/h (5 mph) and in a pattern approved by the Engineer.

The Contractor shall take precautions to protect culverts and other structures during the test rolling. Where a culvert or other structure has, or will have, insufficient protective cover to withstand test rolling, the test rolling may be performed prior to installing the structure or performed on the surface of any additional cover that may be provided.
as protection for in place structures. Any structures damaged by the test rolling shall be replaced at no expense to the Department.

On those portions of a Project where the Plans require treatment of the upper portion of a granular subgrade by the addition of aggregate or binder soil, the test rolling may be performed either before or after the treatment work is performed.

The roadbed will be considered to be unstable if, under the operation of the roller, the surface shows yielding or rutting (at the time the roller passes over the grade) of more than 50 mm (2 inches) measured from the top of the constructed grade to the bottom of the rut, except that an additional 25 mm (1 inch) will be allowed when a granular subgrade is to be treated after test rolling. The Contractor will be required to furnish a device that will mark the surface of the roadbed where rutting or yielding occurs as approved by the Engineer.

Where test failure occurs on a roadbed not constructed by the Contractor under the same Contract, the unstable sections shall be repaired by the Contractor, as directed by the Engineer, at the Department's expense.

If, on a roadbed constructed by the Contractor under the same Contract, test rolling shows any sections of the roadbed to be unstable, the Contractor shall, at no expense to the Department, scarify the roadbed and aerate or add moisture to the material as necessary, and recompact the material to the extent that it will be stable when retested by rolling. However, where test failure occurs on an isolated section of roadbed less than 50 m (2 road stations) in length, retesting of that section by rolling will not be required if the Engineer is satisfied that the corrective measures taken have eliminated the cause of failure and have produced acceptable stability as evidenced by density tests or visual inspection.

### 2111.4 METHOD OF MEASUREMENT

If the roadbed tested was constructed under a previous Contract, and only then, test rolling (together with any retesting required by the Engineer after unstable sections have been repaired) will be measured by length where such work is performed. The work on each separate roadbed, in the case of divided highways, will be measured separately. If the Engineer orders testing on any portion of the roadbed to an extent less than the full width specified, the measurement will be in proportion to the width tested.

### 2111.5 BASIS OF PAYMENT

If the roadbed tested was constructed by the Contractor under the same Contract, the Contractor shall perform test rolling (including all repairs to unstable sections and retesting) as incidental work with no direct compensation.
2111.5

If the roadbed tested was constructed under a previous Contract, and only then, all repairs to unstable sections ordered by the Engineer will be paid for as Extra Work and the test rolling will be paid for on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2111.501</td>
<td>Test Rolling</td>
<td>meter (road station)</td>
</tr>
</tbody>
</table>

2112

Subgrade Preparation

2112.1 DESCRIPTION

This work shall consist of shaping and compacting the subgrade prior to placing a base or surface course thereon.

2112.2 BLANK

2112.3 CONSTRUCTION REQUIREMENTS

This work shall be performed after any unstable sections of the subgrade have been repaired and after any existing base or surface courses required to be removed have been removed.

The Contractor shall compact and shape the subgrade for its full width as may be necessary to produce, at the time the base or surface course is placed, the required density and stability in the top 150 mm (6 inches) of the subgrade and the required grade and cross-section. The Contractor shall scarify, dry the material, or apply water as may be necessary to obtain the required density and stability. Unless otherwise provided in the Contract, the density shall be 100 percent of maximum density as defined by the Specified Density Method.

The required stability shall be such that when any material for base or surface courses is deposited on the subgrade, no rutting or displacement of the roadbed will occur.

The required grade and cross-section shall consist of a smooth subgrade surface conforming to the prescribed elevations for the particular subgrade being prepared prior to constructing an additional course thereon. The prescribed elevation for any point on the subgrade surface where measurement is made shall be as determined from the grades staked by the Engineer and the typical sections shown in the Plans, within the following tolerances:
(a) When the subgrade is being prepared for placement of an aggregate wearing course or is being finished for acceptance of the grading construction, the elevation of the finished surface shall not vary by more than 30 mm (0.1 foot) from the prescribed elevation at any point where measurement is made.

(b) When the subgrade is being prepared for placement of an aggregate base course, the elevation of the finished surface at the time the next layer is placed, shall not vary by more than 15 mm (0.05 foot) above or 30 mm (0.1 foot) below the prescribed elevation at any point where measurement is made.

(c) When the subgrade is being prepared for placement of a surface course, the elevation of the finished surface at the time the next layer is placed, shall not vary by more than 15 mm (0.05 foot) from the prescribed elevation at any point where measurement is made.

In conjunction with the operations of subgrade preparation, the Contractor shall produce, load, and haul aggregate (of the same type as that used in the subgrade or in the course to be constructed) where and in such quantities as the Engineer directs, and incorporate such material into the subgrade. This work will be paid for at the appropriate Contract prices for the material in place or, in the absence of such prices, as Extra Work.

2112.4 METHOD OF MEASUREMENT

Subgrade preparation will be measured by length, along the centerline of the roadbed. The work on each separate roadbed, in the case of divided highways will be measured separately. Locations where grading or subgrade excavation (as described in 2105) is required will not be included in the measurements. On ramps and loops, the length will be measured between the ends of the exit and entrance noses, along the centerline of the ramp or loop roadbed.

2112.5 BASIS OF PAYMENT

If the roadbed or other course being prepared was constructed under the same Contract, the Contractor shall perform subgrade preparation as incidental work with no direct compensation. Payment for subgrade preparation, as a separate item, will be made only when the roadbed or other course being prepared was constructed under a previous contract.

Payment for subgrade preparation at the Contract price per unit of measure will be compensation in full for all costs of preparing the subgrade as specified, except that any expenses incurred in correcting unstable conditions below the top 150 mm (6 inches) will be compensated for separately as Extra Work, or at the Contract prices for the equipment used if so provided for in the Contract.
2112.5

Payment for subgrade preparation will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2112.501</td>
<td>Subgrade Preparation..............</td>
<td>meter (road station)</td>
</tr>
</tbody>
</table>

2118

Aggregate Surfacing

2118.1 DESCRIPTION

This work shall consist of constructing an aggregate wearing course on a prepared Subgrade.

2118.2 MATERIALS

A Aggregate ........................................................................ 3138

The class of aggregate to be used will be as shown in the Contract.

2118.3 CONSTRUCTION REQUIREMENTS

The specified quantity of aggregate shall be deposited on the road and spread to the required cross-section only when the roadbed is so dry and compact that no rutting or displacement will occur, and only on sections of such length as will meet the Engineer's approval. Aggregate shall be deposited and spread on public road approaches and private entrances in the quantities directed by the Engineer.

Aggregate windrows shall be moved as necessary to permit drying and reshaping of the subgrade. The aggregate shall be mixed prior to spreading, as necessary to produce uniformity in the gradation of the material.

No compaction will be required of the aggregate surfacing unless the quantity of aggregate placed results in a surface thickness in excess of 50 mm (2 inches), in which case the aggregate surfacing shall be compacted in accordance with 2211.3, quality compaction method.

2118.4 METHOD OF MEASUREMENT

Aggregate surfacing will be measured, as indicated in the Proposal, by mass (weight) or by volume (vehicular measure) of aggregate deposited on the road.

2118.5 BASIS OF PAYMENT

Payment for the accepted quantity of aggregate surfacing at the Contract price per unit of measure will be compensation in full for all costs of furnishing and placing the aggregate surfacing as specified.

Payment for the aggregate surfacing will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2118.501</td>
<td>Aggregate Surfacing, Class ......</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2118.502</td>
<td>Aggregate Surfacing, Class ......</td>
<td>cubic meter (cubic yard)</td>
</tr>
</tbody>
</table>
2123

Equipment Rental

2123.1 DESCRIPTION
This work shall consist of furnishing laborers and of furnishing and operating equipment, in cases where the Contract provides that the work is to be performed as directed by the Engineer and at the Department's expense.

2123.2 GENERAL REQUIREMENTS
All equipment shall be in a mechanical condition such that it will operate in a manner satisfactory to the Engineer.

All equipment that operates on bituminous or concrete surfaces shall be equipped with rubber tires or smooth street plates.

Tractive equipment used to draw any other equipment shall be of a type that will not damage the work being performed and that has sufficient power to effectively operate the drawn equipment.

2123.3 SPECIFIC REQUIREMENTS
Equipment rented under this Specification shall meet the following specific requirements regarding type, size, capacity, power, or dimensions.

A  Motor Grader
The motor grader shall be of the self-propelled type with pneumatic-tired wheels and power-operated controls and shall have a mass of not less than 8600 kg (19,000 pounds). It shall have a moldboard at least 3.6 m (12 feet) long with a suitable cutting edge and shall be equipped with a suitable scarifier.

B  Dozer
The dozer may be of either the angle-dozer or bull-dozer type attached to a crawler-type tractor having at least 56 kw (75 horsepower) at the draw-bar and power operated controls. The dozer blade shall be not less than 2.3 m (90 inches) wide. Angle-dozers shall be adjustable to an angle of 90 degrees with the direction of travel of the tractor. The dozer and tractor will be considered as a single unit.

C  Scraper
The scraper may be the carryall type mounted on pneumatic-tired wheels or the rotary type drawn by a tractor of suitable size. It shall have not less than the volumetric capacity indicated in the Proposal, which shall be construed to be the manufacturer's rated heaped capacity.

D  Dragline
The dragline shall be of the full-revolving type, equipped with a bucket of at least the size specified in the Proposal, but in no case larger than that for which the machine is designed.

The 0.75 m³ (1 cubic yard) dragline shall have at least a 13.7 m (45 foot) boom and a working radius of at least 10.6 m (35 feet).
2123.3

The 1.9 m³ (2.5 cubic yard) dragline shall have at least a 24.3 m (80 foot) boom and a working radius of at least 18.2 m (60 feet). Any other size of dragline shall have the boom length and working radius specified in the Contract.

For swamp work, one set of mats shall be furnished for each dragline. Each mat shall have a length of not less than twice the distance between the outside edges of the crawler treads. The combined width of all the mats shall equal at least twice the bearing length of the crawler treads.

E  Power Shovel

The power shovel shall be of the full-revolving crawler-type with a bucket of the size recommended by the manufacturer. The size of the shovel will be indicated in the Proposal by the capacity of the bucket.

F  Tractor

The tractor shall be of the crawler type and shall have the specified power at the draw-bar as indicated in the Proposal. The power shall be measured in kilowatts (horsepower).

G  Pneumatic-Tired Roller

The pneumatic-tired roller shall have a compacting width of 1.5 m (5 foot) or more and shall be so constructed that the gross mass can be varied, as directed by the Engineer, within the range of 1700-4400 kg/meter (100-250 pounds/inch) of rolling width. The arrangement of the tires shall be such that compaction will be obtained over the full compacting width with each pass of the roller.

The roller may be self propelled or provided with suitable tractive equipment, unless the Proposal specifies a certain type. If more than one roller is propelled by a single tractive unit, the combination will be counted as a single roller unit.

H  Tamping Roller

For the purposes of this Specification, a tamping roller consists of two sections, each having a drum at least 1.2 m (48 inches) in diameter, a gross mass and number of pads as approved by the Engineer, and drawn by suitable tractive equipment.

I  Blank

J  Steel-Wheeled Roller

The steel-wheeled roller shall be self propelled and have a minimum total mass of 7.3 metric tons (8 tons), or as otherwise specified in the Contract. When vibratory rollers are used, they shall produce 45 kN per meter (250 pounds/inch) of width. The roller shall be capable of reversing without backlash and shall be equipped with spray attachments for moistening all rolls on both the front and back.

Unless otherwise specified in the Proposal, steel-wheeled rollers may be either the tandem type or the three wheeled type.
K  Truck
The truck shall have a minimum manufacturer's rated capacity of at least 1.3 metric tons (1.5 tons) and shall have a volumetric capacity of not less than 3.8 m$^3$ (5 cubic yards). It shall be equipped with a power-operated hoist and a metal dump box of the end dump type. The rear axle of the truck shall be equipped with dual wheels and tires not less than 200 mm (8 inches) in width (manufacturer's designated size).

L  Rotary Tiller
The rotary tiller shall be at least 1370 mm (54 inches) wide and adjustable for any depth up to 225 mm (9 inches), and shall be drawn by suitable tractive equipment.

M  Front End Loader
The front end loader shall consist of a crawler type or rubber-tired tractor, equipped with a power-operated loader having a bucket with at least the struck capacity specified in the Proposal. It shall be capable of excavating to a depth of at least 250 mm (10 inches) below the bottom of the treads (or tires) and loading the excavated material on the trucks used for hauling.

2123.4 METHOD OF MEASUREMENT
A  Equipment Hours
Rental of each unit of equipment will be measured by the number of hours of actual working time and necessary traveling time within the Project limits.

B  Common Laborer Hire
Common laborer hire will be measured by the hours of actual working time and necessary traveling time within the Project limits.

2123.5 BASIS OF PAYMENT
Payment for the use of any equipment at the Contract price per hour will be compensation in full for the use and operation of such equipment, including the operator or operators and any tractive equipment and other accessories required in connection with such use, subject only to these provisions for additional compensation in cases where the Contractor is obligated to pay overtime wages for work performed by order of the Engineer on Sundays, holidays, or during overtime periods.

Payment for laborers at the Contract price per hour will include compensation for the use of any hand tools used by such laborers, subject only to these provisions for additional compensation in cases where the Contractor is obligated to pay overtime wages for work performed by order of the Engineer on Sundays, holidays, or during overtime periods.

No compensation in addition to the Contract price per hour for equipment rental or common laborer hire will be made because of any overtime or work performed on Sundays or holidays except when such
work is ordered by the Engineer to be performed during those times. If
the Engineer orders the use of equipment or common laborers during
overtime periods or on Sundays or holidays, compensation will be made
in addition to the Contract price per hour for equipment rental or
common laborer hire only for the increased wages for which the
Contractor is obligated under the terms of wage agreements. Such
additional compensation will be made by increasing the Contract price
per hour for the equipment or common laborers used by an amount
equal to the difference between the normal hourly wage for straight time
work and the overtime hourly wage actually paid the laborers employed
in operating the equipment or performing the labor, as determined from
the Contractor's payroll.

Payment as provided above will include such supervision by the
Contractor as may be necessary to accomplish the work in the manner
directed by the Engineer, except that, if the Engineer considers that a
full time foreman is necessary and so orders, payment for furnishing
such a foreman will be as Extra Work on a Force Account basis.

Payment for equipment rental and common labor hire will be
made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2123.501</td>
<td>Common Laborers</td>
<td>hour</td>
</tr>
<tr>
<td>2123.503</td>
<td>Motor Grader</td>
<td>hour</td>
</tr>
<tr>
<td>2123.506</td>
<td>m³ (cubic yard) Dragline</td>
<td>hour</td>
</tr>
<tr>
<td>2123.507</td>
<td>m³ (cubic yard) Shovel</td>
<td>hour</td>
</tr>
<tr>
<td>2123.508</td>
<td>m³ (cubic yard) Scraper</td>
<td>hour</td>
</tr>
<tr>
<td>2123.509</td>
<td>Dozer</td>
<td>hour</td>
</tr>
<tr>
<td>2123.510</td>
<td>m³ (cubic yard) Truck</td>
<td>hour</td>
</tr>
<tr>
<td>2123.511</td>
<td>kW (hp) Tractor</td>
<td>hour</td>
</tr>
<tr>
<td>2123.512</td>
<td>Rotary Tiller</td>
<td>hour</td>
</tr>
<tr>
<td>2123.514</td>
<td>m³ (cubic yard) Front End Loader</td>
<td>hour</td>
</tr>
<tr>
<td>2123.521</td>
<td>Pneumatic-Tired Roller</td>
<td>hour</td>
</tr>
<tr>
<td>2123.522</td>
<td>Pneumatic-Tired Roller (Tractor Drawn)</td>
<td>hour</td>
</tr>
<tr>
<td>2123.523</td>
<td>Pneumatic-Tired Roller (Self Propelled)</td>
<td>hour</td>
</tr>
<tr>
<td>2123.524</td>
<td>Tamping Roller</td>
<td>hour</td>
</tr>
<tr>
<td>2123.525</td>
<td>metric ton (ton) Steel-Wheeled Roller</td>
<td>hour</td>
</tr>
</tbody>
</table>
2130

Application of Water

2130.1 DESCRIPTION
This work shall consist of furnishing and applying water for dust control within the Project limits as directed by the Engineer or stipulated in the Contract.

2130.2 MATERIALS
The water shall be furnished by the Contractor and it shall be reasonably clean.

2130.3 CONSTRUCTION REQUIREMENTS
A  Equipment
Water supply tanks shall be equipped with distributing bars or other apparatus that will ensure uniform application of the water. Application of water on the road shall be with a self-propelled distributor of the pressure type, mounted on pneumatic-tired wheels. Pump capacity shall be sufficient to permit application of the whole load uniformly at any rate up to 940 L (250 gallons) per minute.

B  Application
The water supply and equipment used shall be sufficient to apply the quantity required within the time interval necessary to secure optimum results and avoid unwarranted loss of water through evaporation, absorption, or drainage. The water shall be applied at such times and in such quantities as the Engineer approves.

2130.4 METHOD OF MEASUREMENT
Water applied for dust control within the Project limits, by direct order of the Engineer or when application is specified at the Department's expense, will be measured for payment by volume. Deductions may be made for any water wasted through failure of the Contractor to coordinate the application of water with other operations as may be directed.

2130.5 BASIS OF PAYMENT
Payment for the accepted quantities of water at the Contract price per unit of measure will be compensation in full for all costs of furnishing, transporting, and applying the water as directed.
These provisions apply to water used for dust control in the Project limits as directed by the Engineer. These provisions do not apply to any sprinkling or other uses for water required in conjunction with the construction of concrete pavements; to any water used in the production or curing of concrete; to any water used to maintain plant life; to any water used in conjunction with compacting soil and aggregate; or to any water used for dust control on any Contractor selected haul roads, detours, or work sites outside of the Project limits; all costs of which will be incidental to the Contract items involved.
2130.5

Water applied by order or approval of the Engineer for dust control will be paid for at a unit price of $3.00 per cubic meter ($11.00 per 1000 gallons) in the absence of the Contract bid item 2130.501.

Payment for the application of water will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2130.501</td>
<td>Water</td>
<td>cubic meter (1000 M Gal)</td>
</tr>
</tbody>
</table>

2131

Application of Calcium Chloride

2131.1 DESCRIPTION
This work shall consist of furnishing and applying calcium chloride, either as a surface treatment or as an admixture, in conjunction with grading or the construction of an aggregate base or surface course, or as a surface application on the road.

2131.2 MATERIALS
A  Calcium Chloride, type as specified or permitted ..................................................................... 3911
B  Water

Water used for preparing solutions shall be reasonably clean and free of suspended matter.

2131.3 CONSTRUCTION REQUIREMENTS
A  Surface Application
Calcium chloride in dry form shall be applied on the road with a spreader capable of distributing the material uniformly at the rate directed. Calcium chloride solutions shall be applied on the road with a distributor meeting the requirements of 2321.3C1.

Unless otherwise specified, application rates shall be as directed by the Engineer.
B  Admixture Application

When used as an admixture, the calcium chloride may be mixed with the aggregate at the aggregate producing plant, applied on the road as a surface application and there mixed with the aggregate, or applied on the road in solution with the mixing water.

If the calcium chloride is added at the aggregate producing plant, it shall be introduced into the aggregate at a uniform rate and in the required proportions, by a separate conveyor or metering device approved by the Engineer.

2131.4 METHOD OF MEASUREMENT
In the case of bulk shipments of dry calcium chloride, the material of each type as delivered and used will be measured by the net railroad or truck mass. In the case of bag or drum shipments, the mass of the material as delivered and used will be computed from the bag or drum mass.
Calcium chloride solutions will be measured by volume as adjusted to 15°C (60°F). Tank volumes will be corrected for temperature by using the correction factors for asphalt emulsion as shown in the Mn/DOT Bituminous Manual. Conversion of shipping mass to volume will be on the basis of 1390 kg/m³ (11.6 pound/gallon) in the case of solutions of 38 percent concentration.

For application, measurement, and payment purposes, the percentage of anhydrous chloride in the various types of material as delivered will be assumed to be as follows:

<table>
<thead>
<tr>
<th>Material</th>
<th>Anhydrous Chloride Percentage by Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium Chloride, Type 1</td>
<td>77%</td>
</tr>
<tr>
<td>Calcium Chloride, Type 2</td>
<td>94%</td>
</tr>
<tr>
<td>Calcium Chloride Solution</td>
<td>38%</td>
</tr>
</tbody>
</table>

If the material as delivered does not conform to the above specified percentages, the application rates and pay quantities will be adjusted by the Engineer so as to make payment for equivalent quantities based on conversion factors established by the Department in accordance with the assumed percentages for each type.

In the event of unseasonably cold weather, which might cause crystallization in the 38 percent calcium chloride solution, a solution containing 35 percent anhydrous chloride may be furnished with the Engineer’s approval, in which case conversion of shipping mass to volume will be on the basis of 1360 kg/m³ (11.35 pounds/gallon). For payment, the net volume of 35 percent solution will be converted to equivalent volume of 38 percent solution by multiplying by 0.921.

**2131.5 BASIS OF PAYMENT**

Payment for calcium chloride at the Contract price per unit of measure will be compensation in full for furnishing and applying the material as specified.

Application of water in conjunction with the use of dry calcium chloride will be paid for in accordance with 2130, as a separate item, only to the extent that water is used by order of the Engineer.

Payment for application of calcium chloride will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2131.501</td>
<td>Calcium Chloride, Type</td>
<td>metric ton</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(ton)</td>
</tr>
</tbody>
</table>
| 2131.502 | Calcium Chloride Solution     | cubic meter | (gallons)
Concrete Base

2201.1 DESCRIPTION
This work shall consist of constructing a base course of Portland cement concrete, with or without reinforcement, on a prepared subgrade.

2201.2 MATERIALS
A Concrete ................................................................. 2461
   Mix designations shall be as given below for the method of placement to be used.
   Manual Placement ................................................ Mix No. 3B42
   Standard Machine Placement ................................. Mix No. 3B32
   Vibratory Machine Placement ................................. Mix No. 3B22
   In the event Class C aggregate is used meeting the requirements for CA-15 as given in 3137, the cement content required will not exceed the values given in 2461.3C.
B Reinforcement Bars ............................................ 3301
C Dowel Bars ............................................................ 3302
D Steel Fabric ............................................................ 3303
E Blank
F Preformed Joint Filler .......................................... 3702
G Emulsified Asphalt .............................................. 3151
H Curing Paper ....................................................... 3752
I Blank
J Plastic Sheeting .................................................... 3756
K Membrane Curing Compound .............................. 3754

2201.3 CONSTRUCTION REQUIREMENTS
Construction requirements shall be the same as those specified in 2301.3, Concrete Pavement, except as modified by the following:
A Joint Construction
   When emulsified asphalt is used for curing and the joints are sawed, the sawing operations shall be completed within 24 hours after concrete placement.
   When a widening strip is constructed adjacent to an existing pavement, a transverse joint shall be constructed opposite each old joint and, where the old joints are more than 9 m (30 feet) apart, additional joints shall be constructed approximately half-way between the old joints.
B Surface Finishing
   When a concrete base is constructed to widen an existing concrete pavement and the Plans show the top of the base at the same elevation as the existing pavement surface, the surface of the base shall conform to the pavement surface.
After the surface has been screeded, no additional surface finishing will be required except for a final brooming to roughen the surface and such other finishing as may be necessary to produce a surface conforming to the requirements specified hereinafter.

C Integrant Curb
Concrete for integrant curb shall be Mix No. 3A22, 3A32, or 3A42, depending on the slump requirements for the equipment used.

D Concrete Curing
The concrete base shall be cured by the use of curing paper or plastic sheeting as provided for in 2301.3M, or by the use of emulsified asphalt applied by means of power spraying equipment at a total rate that will provide a moisture-proof film over the entire surface of the base.

Within 2 hours after application of asphalt emulsion, a coating of whitewash made of hydrated lime and water shall be applied. The proportions used in the whitewash and the rate of application shall be such that a uniform color, not darker than uncoated concrete after curing, will be produced on the surface of the base. After September 15th, the use of the whitewash application may be discontinued with the consent of the Engineer.

E Workmanship and Quality
The workmanship and quality requirements of 2301.3P shall apply to concrete base construction except that: (1) the surface smoothness requirements set forth hereinafter shall apply in lieu of 2301.3P; (2) the permissible deviations in average thickness of the base shall be 6 mm ($\frac{1}{4}$ inch); and (3) the riding quality requirements of 2301.3P shall not apply.

After completion of the curing period, the Department will test the surface of the base for slope and grade uniformity. Except for any irregularities induced by grade requirements when the base is constructed adjacent to an existing concrete pavement or gutter, the surface of the base shall not vary more than from a 3 m (10 foot) straightedge.

Areas that are found to vary from the 3 m (10 feet) straightedge by more than 10 mm (3/8 inch) will not be excluded from the pay quantities, but in lieu of being removed and replaced acceptably, a deduction will be made from the moneys due the Contractor equal to the product of the defective area and: (1) $1.25/ \text{m}^2$ ($1.00 \text{ per square yard}$) for those areas where the maximum deviation is more than 10 mm (3/8 inch), but not more than 15 mm (5/8 inch), and (2) $2.50/\text{m}^2$ ($2.00 \text{ per square yard}$) for those areas where the maximum deviation exceeds 15 mm (5/8 inch).
2201.4

2201.4 METHOD OF MEASUREMENT
The methods of measurement will be the same as specified in
2301.4 with the substitution of the term "base" for "pavement."

2201.5 BASIS OF PAYMENT BASIS OF PAYMENT
The basis of payment will be the same as specified in 2301.5 except
for substituting the term "base" for "pavement" and using the following schedule.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2201.501</td>
<td>Concrete Base ..................................</td>
<td>square meter (square yard)</td>
</tr>
<tr>
<td>2201.502</td>
<td>Concrete Base, Standard Width ...............</td>
<td></td>
</tr>
<tr>
<td>2201.503</td>
<td>Concrete Base, Irregular Width ..............</td>
<td></td>
</tr>
<tr>
<td>2201.511</td>
<td>Structural Concrete .........................</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2201.521</td>
<td>Base Reinforcement, Type ....................</td>
<td></td>
</tr>
<tr>
<td>2201.529</td>
<td>Reinforcement Bars ...........................</td>
<td>kilogram (pound)</td>
</tr>
<tr>
<td>2201.531</td>
<td>Expansion Joints, Design ....................</td>
<td>meter (linear foot)</td>
</tr>
<tr>
<td>2201.536</td>
<td>Dowel Bar .......................................</td>
<td></td>
</tr>
<tr>
<td>2201.541</td>
<td>Integrant Curb, Design ......................</td>
<td>meter (linear foot)</td>
</tr>
</tbody>
</table>

2211 Aggregates Base

2211.1 DESCRIPTION
This work shall consist of constructing one or more courses of
Contractor certified aggregate base on a prepared subgrade. The
aggregate base shall be produced and placed under the Contractor's
quality control program in accordance with Section 5-692.705 of the
Mn/DOT Grading and Base Manual.

2211.2 MATERIALS
A AGGREGATE .................................................. 3138
The class of aggregate to be used in each course will be shown in
the contract. Gradation acceptance for Classes 1, 2, 3, 4, 5, 6 and 7
aggregates will be by the random sampling method in accordance with
2211.3F.

2211.3 CONSTRUCTION REQUIREMENTS
A GENERAL
Aggregate removed from below water shall be stockpiled and
allowed to drain for at least 24 hours before being delivered on the road
when its water content is such that, in the Engineer's opinion, it will
cause saturation of the subgrade soils.

The base shall be constructed in layers not more than 75 mm
(3 inches) in compacted thickness, except that each layer compacted
with approved types of special compacting equipment may be increased
to a maximum of 150 mm (6 inches). Class 7 materials shall be constructed in layers not more than 75 mm (3 inches) in compacted thickness unless approved by the Engineer. Vibratory rollers will be allowed for use on a performance basis in accordance with 1805.

Where successive courses are to be constructed with different classes of aggregate, the Engineer may allow the Contractor to construct any course in accordance with the material requirements for the next above course. However, the Engineer will make payment for the combined work on the basis that each course was constructed according to the Plans.

B Placing and Mixing
When the base is constructed in a single layer, aggregate shall not be deposited on the roadbed more than 3 km (2 miles) in advance of the completed portion of the base. When the base is constructed in more than one layer, the aggregate for one layer shall not be deposited more than 5 km (3 miles) in advance of the completed portion of the succeeding layer, except that a single class of aggregate may be placed and compacted for the entire length of the Project before another class of aggregate is placed thereon. At the time of depositing the aggregate on the road, the roadbed shall be so dry and compact that no rutting or displacement will occur. Aggregate shall be placed on public road approaches and private entrances in the quantities designated by the Engineer.

If so required by the Contract, calcium chloride shall be furnished and mixed with the aggregate in accordance with 2131. Water may be added to the aggregate during mixing operations in the quantity necessary to produce proper compaction.

Aggregate windrows shall be moved, as directed by the Engineer, to permit satisfactory maintenance and drying of the subgrade. Any material that becomes contaminated after placement shall be removed and replaced, or corrected and retested.

When any surfacing is included in the same Contract as the aggregate base, the Contractor shall conduct operations in such a manner that, before suspending operations for the winter, all base aggregate deposited on the roadbed shall be covered with the initial surface course or otherwise protected in a manner approved by the Engineer. A bituminous penetration prime coat is not considered to be a surface course.

C Spreading and Compacting
At the time of spreading the base material for compaction, the aggregate shall be so uniformly mixed that it will meet specified gradation requirements, based on the results of gradation tests run on aggregate samples obtained after mixing and prior to compaction.
The material for each layer shall be spread and compacted with adequate moisture content, to the required cross section and density before placing aggregate thereon for a succeeding layer. The surface of each layer shall be maintained, with uniform texture and firmly keyed particles, until the next layer required by the Contract is placed thereon or until the completed base is accepted if no other construction is required thereon.

Compaction shall be obtained by the:
(1) Specified Density Method,
(2) Quality Compaction Method, or
(3) Penetration Index Method
whichever method is prescribed for the particular course. Compaction by the Specified Density Method will be required on all base courses except those that are otherwise designated in the contract for compaction by either the quality compaction or penetration index method. If Class 7 is specified or substituted for another class of aggregate, then densification shall only be obtained by the Quality Compaction Method or the Penetration Index Method.

C1 Specified Density Method
The full thickness of each layer shall be compacted to not less than 100 percent of maximum density. For test purposes, a layer will be considered to be 75 mm (3 inches) in compacted thickness. At the time of compaction, the moisture content of the base material shall be not less than 65 percent of optimum moisture.

The Engineer will make tests to determine the actual field density of the compacted base. The field density, optimum moisture, and maximum density will be determined in the field by methods described in the Mn/DOT Grading and Base Manual.

C2 Quality Compaction Method
Each layer shall be compacted until there is no further evidence of consolidation using a steel-wheeled roller or pneumatic-tired roller meeting 2123 unless the use of vibratory or other special compaction equipment is approved by the Engineer.

Water shall be applied to the base material during the mixing and spreading operations so that at the time of compaction the moisture content is not less than 5 percent of the dry weight.

The Engineer may elect to perform density tests as shown in the Mn/DOT Grading and Base Manual, as needed to assist inspection. The actual density obtained by testing the aggregate base must meet or exceed the requirements shown in 2211.3C1 Specified Density in order to be acceptable.

C3 Penetration Index Method
The full thickness of each layer of Class 5, 6 or 7 shall be compacted to achieve a penetration index value less than or equal to
10 mm (0.4 inch) per blow, as determined by a Mn/DOT standard
dynamic cone penetrometer (DCP) device. For test purposes, a layer
will be considered to be 75 mm (3 inch) in compacted thickness but a
testing layer can be increased in thickness to a maximum of 150 mm
(6 inch) if compacted in one lift by a vibratory roller. Two DCP tests
shall be conducted at selected sites within each 800 m³ (1000 cubic
yard) (CV) of constructed base course. If either of the tests fails to
meet the specified requirements, the material represented by the test
shall require corrective action and be retested for penetration index
compliance.

All aggregates prescribed to be tested under the Penetration Index
Method 2211.3C3 must be tested and approved within 24 hours of
placement and final compaction.

Water shall be applied to the base material during the mixing and
spreading operations so that at the time of compaction the moisture
content is not less than 5 percent of the dry weight.

D Workmanship and Quality

The Contractor shall construct each base course in conformity with
the cross-sectional dimensions shown in the Plans and the staked grades.
When the final layer of base has been completed, and at the time any
additional construction is to be placed thereon, the finished surface of
the base shall not vary more than 15 mm (0.05 foot) from the elevation
prescribed for that point as determined from the staked grades and the
typical sections shown in the Plans. When the base is placed adjacent to
a pavement, the elevation of the finished surface of the base shall be
referenced to the edge of the pavement.

When fine grading operations are required on the finished base prior
to constructing pavement thereon, the surface elevation tolerance shall
be met at the time of completing the fine grading. Any excess material
deposited on the shoulders as a result of those operations, that is
contaminated to the extent that it does not meet the Specification
requirements for use in the aggregate shouldering, will be deducted
from the pay quantities.

E Aggregate in Stockpiles

When the Proposal contains an item for stockpile aggregate, the
Contractor shall, in addition to the aggregate required for the base
construction, produce, deliver, and stockpile aggregate of the class
specified at the designated sites as directed by the Engineer.

F Random Sampling Gradation Acceptance Method

The following provisions shall apply to the use of Class 1, 2, 3, 4, 5,
6 and 7 aggregates:

F1 Gradation Control

The Contractor and/or aggregate producer shall be responsible for
maintaining a gradation control program in accordance with the random
sampling acceptance method described in Section 5-692.705 of the Mn/DOT Grading and Base Manual. The Contractor will be permitted to proceed with and complete the base construction on the basis of the Contractor’s Certification (on Form 24346 furnished by the Engineer) that the material supplied and used conforms to the appropriate specification requirements. The Contractor shall assume full responsibility for the production and placement of uniform and acceptable materials. All payments for aggregate base materials shall be withheld until the Project Engineer receives and accepts the Contractor’s Certification and quality control testing results.

F2 Acceptance Testing
Aggregate gradation compliance will be determined in accordance with following table:

<table>
<thead>
<tr>
<th>TABLE 2211-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCEPTANCE TESTING SCHEDULE (a)</td>
</tr>
<tr>
<td><strong>Quantity</strong> (b)</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>less than 500</td>
</tr>
<tr>
<td>≥500 but less than 4,000</td>
</tr>
<tr>
<td>≥4,000 but less than 10,000</td>
</tr>
</tbody>
</table>

(a) In accordance with 1503, Conformity with Plans and Specifications, it is the intent of these specifications that materials and workmanship shall be uniform in character and shall conform to the prescribed target value or to the middle portion of the tolerance range. The purpose of the tolerance range is to accommodate occasional minor variations from the median zone. The production and processing of the materials and the performance of the work shall be so controlled that the material or workmanship will not be of borderline quality.

(b) Or equivalent in cubic meters loose volume or cubic meters compacted volume:

1 metric ton = 0.6 m³ (1 ton = 0.7 cubic yard) (LV) or
1 metric ton = 0.46 m³ (1 ton = 0.55 cubic yard) (CV).

(c) The use of any one kind or class of material from more than one source is prohibited without permission of the engineer according to 1601. If the contractor changes sources (with Mn/DOT’s approval), a new lot consisting of four sublots will be established provided that
the quantity equals or exceeds 4000 metric tons (tons). When a material source is changed prior to completing a lot, the remainder of the 4 samples will be taken from the previously placed materials, provided that the quantity equals or exceeds 4000 metric tons (tons). However, if the quantity placed is less that 4000 metric tons (tons), acceptance testing will be used on one test per thousand metric tons (tons).

d) Samples for gradation testing will be taken randomly by the Engineer prior to compaction, in accordance with the random sampling method described in the Grading and Base Manual. All gradation tests will be reported to the nearest one-tenth of one percent for the specified sieves.

e) Classes 1, 2 and 7, Shoulder Surfacing Aggregate, may be sampled from the stockpile for testing and acceptance, in accordance with 3138.3.

f) Each lot will be divided into four sublots which are approximately equal in quantity.

g) Each individual sample will be analyzed separately for payment.

h) Each lot shall consist of a maximum of approximately 10000 metric tons (tons) of material, although lesser sized lots may occur due to construction constraints.

i) Each lot will be analyzed separately for payment.

j) One gradation sample will be taken from each sublot and tested. Payment will be based on the average results from the four sublot samples (to the nearest one-tenth of one percent) for each specified sieve.

k) Quantities shown are the same for both metric and English units. The Engineer will have each sample tested in the field by a Mn/DOT Certified Tester or submit them to the laboratory approved by the Project Engineer for testing. A delay of at least 3 working days is anticipated before laboratory test results are available but a maximum of 8 working hours delay is anticipated for field gradations.

The individual test results or sublot averages, which are based on Table 2211-A, Acceptance Testing Schedule, shall be compared with tolerances shown in Tables 2211-B or 2211-C, Aggregate Base Payment Schedules. Acceptance for non-complying material shall be made in accordance with the respective tables. To qualify for full payment the Contractor may correct, at no cost to the Department, any lot of non-compliance material where acceptance is based on the lot criteria (greater than 4,000 metric tons (tons)) and/or the quantity of material represented by a failing test where acceptance is based on the individual sample criteria.

A 5.0% price reduction will be assessed to both individual or averaged test lots for each test result that fails to meet specified
2211.3

gradations for sieve sizes not listed in Tables 2211-B and 2211-C by more than 2.0%. These price reductions are cumulative and shall be analyzed both separately and averaged by lot when applicable.

When corrective action is required for acceptance of the work, in accordance with Tables 2211-B and 2211-C, the Contractor shall perform the corrective work at no cost to the Department. The Contractor shall remove the unacceptable material and replace it with acceptable material, or correct the unacceptable material on the road. In lieu of replacement or correction, the Engineer may allow (in the best interest of the Department) the Contractor to accept a price reduction instead of corrective action.

Upon completion of any corrective work required for full payment, whether it is by blending, mixing, adding and/or replacing material, the corrected material will be sampled and tested for acceptance. The entire lot shall be retested, in accordance with Table 2211-A, when the acceptance is based on the lot criteria; otherwise, retesting will be based on one sample per thousand metric tons (tons).

TABLE 2211-B
AGGREGATE BASE PAYMENT SCHEDULE
(4 Sublots/4 Samples)

<table>
<thead>
<tr>
<th>% Passing Outside Specified Limits*</th>
<th>4.75 mm (#4), 2.00 mm (#10), And 425 µm (#40) Sieves</th>
<th>75 µm (#200) Sieve</th>
<th>Acceptance Schedule (Price Reduction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.5%</td>
</tr>
<tr>
<td>--------------</td>
<td>0.3</td>
<td>0.4</td>
<td>0.9%</td>
</tr>
<tr>
<td>--------------</td>
<td>0.4</td>
<td>0.5</td>
<td>1.1%</td>
</tr>
<tr>
<td>--------------</td>
<td>0.5</td>
<td>&gt;0.6</td>
<td>Corrective Action</td>
</tr>
</tbody>
</table>

*Based on average of 4 tests

Price reductions for more than one failing sieve size shall be cumulative. The compensation due to the Contractor for the quantity of material represented by the failing test results shall be reduced by the sum of the respective percentages.

The Contractor does not have the option of taking a price reduction in lieu of complying with the Specifications.
TABLE 2211-C
AGGREGATE BASE PAYMENT SCHEDULE
(Individual Test)

<table>
<thead>
<tr>
<th>% Passing Outside Specified Limits*</th>
<th>4.75 mm (#4), 2.00 mm (#10), and 425 µm (#40) Sieves</th>
<th>75 µm (#200) Sieve</th>
<th>Acceptance Schedule (Price Reduction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1-0.5</td>
<td>0.6</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>0.6</td>
<td>0.7</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td>0.8</td>
<td>0.9-1.0</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>1.1</td>
<td>1.2</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>1.2</td>
<td>1.3</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>1.3</td>
<td>1.4</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>1.4</td>
<td>1.5</td>
<td>7%</td>
</tr>
<tr>
<td>2</td>
<td>1.6-1.7</td>
<td>1.8</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>1.8</td>
<td>1.9</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>1.9</td>
<td>2.0</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>2.0</td>
<td>2.1</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>2.1</td>
<td>&gt;2.5</td>
<td>14%</td>
</tr>
<tr>
<td>3</td>
<td>2.2-2.5</td>
<td>&gt;2.5</td>
<td>15%</td>
</tr>
<tr>
<td>&gt;3</td>
<td>&gt;2.5</td>
<td>Corrective Action</td>
<td></td>
</tr>
</tbody>
</table>

*Based on individual sample test results.
Price reductions for more than one failing sieve size shall be cumulative. The compensation due to the Contractor for the quantity of material represented by the failing test results shall be reduced by the sum of the respective percentages; however, the reduction will not exceed 50 percent.
The Contractor does not have the option of taking a price reduction in lieu of complying with the Specifications.
TABLE 2211-D
BITUMEN CONTENT ACCEPTANCE SCHEDULE

<table>
<thead>
<tr>
<th>Bitumen Content (Composite Mixture)</th>
<th>Acceptance Schedule (Price Reduction)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1%</td>
<td>Substantial Compliance</td>
</tr>
<tr>
<td>3.2%</td>
<td>7%</td>
</tr>
<tr>
<td>3.3%</td>
<td>10%</td>
</tr>
<tr>
<td>3.4%</td>
<td>14%</td>
</tr>
<tr>
<td>3.5%</td>
<td>18%</td>
</tr>
<tr>
<td>3.6%</td>
<td>21%</td>
</tr>
<tr>
<td>3.7%</td>
<td>25%</td>
</tr>
<tr>
<td>3.8%</td>
<td>28%</td>
</tr>
<tr>
<td>3.9%</td>
<td>32%</td>
</tr>
<tr>
<td>4.0%</td>
<td>35%</td>
</tr>
<tr>
<td>4.1%</td>
<td>39%</td>
</tr>
<tr>
<td>4.2%</td>
<td>43%</td>
</tr>
<tr>
<td>4.3%</td>
<td>46%</td>
</tr>
<tr>
<td>4.4% to 4.5%</td>
<td>50%</td>
</tr>
<tr>
<td>&gt;4.5%</td>
<td>Corrective Action</td>
</tr>
</tbody>
</table>

2211.4 METHOD OF MEASUREMENT

The Engineer will measure aggregate base according to 1901 and as specified in the Contract, by mass or volume. No deductions will be made for the mass or volume of water and admixtures.

A Aggregate Base

Aggregate base of each class will be measured as indicated by:
(1) Mass,
(2) Loose volume (LV),
(3) Compacted volume (CV), or
(4) Stockpile volume (SV).

Where variables or placement conditions make it impractical to determine the volume of placed material, the base material will be measured by mass or by loose volume (LV). The mass so measured will be converted to equivalent compacted volume on the basis of 2160 kg/m$^3$ (135 pounds per cubic foot) of compacted base. Vehicular measure will be converted to compacted volume by methods determined by the Engineer.

B Stockpile Aggregate

Aggregate of each class placed in stockpiles will be measured as indicated by:
(1) Mass,
(2) Loose volume (LV), or
(3) Stockpiling volume (SV)

2211.5  BASIS OF PAYMENT

Payment for the accepted quantities of aggregate base of each class at the Contract prices per unit of measure will be compensation in full for all costs of furnishing the materials and constructing the base as specified, except that separate payment will be made for any admixtures that may be specified.

No direct compensation will be made for water used in conjunction with the mixing, placing, and compacting operations.

Payment for the accepted quantities of stockpile aggregate of each class at the Contract prices per unit of measure will be compensation in full for all costs of furnishing and delivering the material as specified.

Payment will be made under items selected from the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2211.501</td>
<td>Aggregate Base, Class _____</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2211.502</td>
<td>Aggregate Base (LV), Class _____</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2211.503</td>
<td>Aggregate Base (CV), Class _____</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2211.505</td>
<td>Stockpile Aggregate, Class _____</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2211.506</td>
<td>Stockpile Aggregate (LV), Class _____</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2211.507</td>
<td>Stockpile Aggregate (SV), Class _____</td>
<td>cubic meter (cubic yard)</td>
</tr>
</tbody>
</table>

NOTE: See 2105.4C and insert the words "in Stockpile" or "from Stockpile" if appropriate.

2221  Aggregate Shouldering

2221.1  DESCRIPTION

This work shall consist of constructing one or more courses of Contractor certified aggregate on shoulders adjacent to concrete or bituminous pavements. The aggregate shall be produced and placed under the Contractor’s quality control program in accordance with Section 5-692.705 of the Mn/DOT Grading and Base Manual.

2221.2  MATERIALS

A  Aggregate

The class of aggregate to be used in each course will be shown in the contract.

Gradation acceptance for Classes 1, 2, 3, 4, 5, 6, and 7 will be by the random sampling method in accordance with 2211.3F. The Engineer may elect to sample Classes 1, 2 and 7 shoulder surfacing aggregate from the stockpile. The stockpile sampling and testing will be
performed by Mn/DOT project personnel at the rate of one field gradation test per 1000 metric ton (ton). Acceptance will be in accordance with the provisions of 3138.3.

2221.3 CONSTRUCTION REQUIREMENTS

Construction requirements for the aggregate shouldering shall be the same as those specified in 2211.3 for aggregate base, except that surfacing aggregate may not be substituted for lower courses.

A Subgrade Preparation

The existing shoulders, or that part of the subgrade on which the shouldering is to be placed, shall be shaped and compacted to the required grades and cross sections as given for the bottom of the shouldering, provided, however, that removal of excess material will not be required if it meets the Specification requirements for the shouldering aggregate. Contaminated material shall be removed and disposed of as directed.

The Contractor may place excess aggregate from the roadbed base construction operations on the shoulder when:

1. The Engineer accepts the aggregate for use in shouldering.
2. The Contractor shapes and compacts the shoulder to a uniform grade and cross-section, permitting placement of the remaining shoulder aggregate at a relatively constant spread, so far as this can be accomplished without loading and hauling materials.

When placing aggregate shouldering on an existing shoulder, the preparation of the existing shoulder shall be as directed by the Engineer. Removal of vegetation and the shaping and compacting of the shoulder subgrade shall be incidental work for which no direct compensation will be made. Removal of excess materials from the existing shoulders will be paid for as Extra Work in the absence of specific Contract items therefore, but only to the extent that the Engineer orders the excess material to be loaded and hauled away from the immediate shoulder area.

B Placing and Mixing

The aggregate shall not be deposited or mixed on the adjoining concrete pavement or bituminous wearing course surface. Any material spilled on the pavement surface shall be removed by sweeping.

At the time of depositing the aggregate on the shoulders, the subgrade shall be so dry and compact that no rutting or displacement will occur.

In conjunction with the placement of shoulder aggregate, additional material shall be placed on private entrances and road approaches as the Engineer directs.

The Contractor may place and compact the shoulder aggregate the same day that the bituminous base or surfacing is placed, if the bituminous is not damaged by this operation.
C Spreading and Compacting
When Class 1, 2, or 7 aggregates are used for shouldering, compaction shall be obtained by the Quality Compaction Method.

D Construction Under Traffic
The Contractor shall protect the traffic from drop-off conditions when traffic is carried during construction.
Drop-off conditions will be covered by the most current Mn/DOT Field Manual.
The final construction of the shoulder shall be in accordance with the typical section shown in the Plan.

2221.4 METHOD OF MEASUREMENT
Aggregate shouldering of each class specified will be measured by the same methods as prescribed in 2211.4.

2221.5 BASIS OF PAYMENT
Payment for the accepted quantities of aggregate shouldering of each class at the Contract prices per unit of measure will be compensation in full for all costs of furnishing the materials and constructing the shouldering as specified, except that separate payment will be made for any admixtures that may be specified.
No direct compensation will be made for water used in conjunction with the mixing, placing, and compacting operations.
Except as otherwise provided for in the Contract, all costs incurred in preparing and maintaining the shoulder subgrade shall be compensated for as a part of work required in 2112 or 1514.
Payment will be as follows:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2221.501</td>
<td>Aggregate Shouldering, Class ____</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2221.502</td>
<td>Aggregate Shouldering (LV), Class ____</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2221.503</td>
<td>Aggregate Shouldering (CV), Class ____</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2221.505</td>
<td>Stockpile Aggregate, Class ____</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2221.506</td>
<td>Stockpile Aggregate (LV), Class ____</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2221.507</td>
<td>Stockpile Aggregate (SV), Class ____</td>
<td>cubic meter (cubic yard)</td>
</tr>
</tbody>
</table>

NOTE: See 2105.4C and insert the words "in Stockpile" or "from Stockpile" if appropriate.
2231

2231   Bituminous Surface Reconditioning

2231.1 DESCRIPTION
This work shall consist of reconditioning the existing bituminous surface prior to construction of bituminous overlay or surfacing courses. It shall include the reconditioning of old pavements and all types of base courses other than an untreated aggregate base.

This work does not include the removal and replacement of pavement structure items to full depth, which may be necessary to remove unstable foundation material or facilitate other subsurface construction.

2231.2 MATERIALS
A  Bituminous Patching Mixture
Bituminous patching mixture shall be the same material as will be used in the initial bituminous surfacing course that is to be constructed on the reconditioned base.

B  Mixture for Joints and Cracks
Mixture for joints and cracks shall consist of a prepared mix containing fine aggregate and bituminous material conforming to the following:

<table>
<thead>
<tr>
<th>Aggregate Gradation</th>
<th>Percent by Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passing 12.5-mm (½ inch) sieve</td>
<td>100</td>
</tr>
<tr>
<td>Passing 2.00-mm (# 8) sieve</td>
<td>45 – 80</td>
</tr>
<tr>
<td>Passing 75-µm (# 200) sieve</td>
<td>2.0 – 7.0</td>
</tr>
</tbody>
</table>

Maximum spall content in the total aggregate sample shall not exceed 5.0 percent.

Bituminous Material Percent by Mass

| Asphalt Cement | 6.5-7.0 |

The Engineer will designate the kind and grade of bituminous material to be used. The bituminous material used shall meet 3151.

Mixing operations shall be conducted as approved by the Engineer.

C  Joint and Crack Filler (As specified in the Plans or Special Provisions)

2231.3 CONSTRUCTION REQUIREMENTS
A  General
Where so indicated in the Plans or ordered by the Engineer, the existing base or pavement shall be removed and replaced in accordance with other provisions of the Contract.
B  Surface Repair
Surface repairs shall be made as directed by the Engineer, so as to produce a satisfactory base on which to construct the pavement provided for in the Contract. All loose, unstable, or deteriorated portions of the existing base or pavement shall be removed to the extent that a stable surface will be achieved upon completion of the patching operations. All waste or surplus material shall be disposed of to the satisfaction of the Engineer.

All holes and depressions shall be filled with bituminous patching mixture in layers of a thickness approved by the Engineer. Compaction shall be obtained with mechanical tampers in areas not accessible to conventional rolling equipment. Specified density requirements will not apply.

C  Joint Repair
Existing joints and cracks in concrete pavement that are more than 6 mm (1/4 inch) shall be cleaned and refilled as specified herein, if and to the extent that the required material is provided for as a Contract item.

Joints and cracks more than 6 mm (1/4 inch) but not more than 20 mm (3/4 inch) in width shall be cleaned of old filler material and foreign matter to a depth of at least 20 mm (3/4 inch), after which they are to be filled with joint and crack filler material.

Joints and cracks more than 20 mm (3/4 inch) in width shall be cleaned of old filler material and foreign matter to a depth of at least 25 mm (1 inch), after which they are to be refilled with mixture for joints and cracks. The material shall be thoroughly tamped into place.

2231.4  METHOD OF MEASUREMENT
The accepted quantities of bituminous patching mixture, mixture for joints and cracks, and joint and crack filler, as furnished and placed, will each be measured separately by the mass or by the LV of material, as indicated in the Proposal.

2231.5  BASIS OF PAYMENT
Payment for the accepted quantities of bituminous patching mixture, mixture for joints and cracks, and joint and crack filler, at the appropriate Contract price per unit of material furnished and placed, will be compensation in full for all costs of removal and disposal of the existing deteriorated materials, and for all costs of furnishing and placing the patching or filler materials as specified.

Removal of a concrete base or pavement to full depth and width between existing joints, or by sawing, shall be accomplished as Extra Work in the absence of an item covering its removal under the provisions of 2104.
2231.5

Payment for base reconditioning will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2231.501</td>
<td>Bituminous Patching Mixture</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2231.502</td>
<td>Bituminous Patching Mixture.........</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2231.505</td>
<td>Mixture for Joints and Cracks........</td>
<td>kilogram (pound)</td>
</tr>
<tr>
<td>2231.507</td>
<td>Joint and Crack Filler...............</td>
<td>kilogram (pound)</td>
</tr>
</tbody>
</table>

2232

Mill Pavement Surface

2232.1 DESCRIPTION

This work shall consist of improving the profile, cross slope, and surface texture of an existing pavement surface by machine (cold) milling preparatory to placement of another course thereon.

2232.2 BLANK

2232.3 CONSTRUCTION REQUIREMENTS

A  Equipment

Pavement milling shall be accomplished with a power operated, self-propelled cold milling machine capable of removing concrete and bituminous surface material as necessary to produce the required profile, cross slope, and surface texture uniformly across the pavement surface. The machine shall also be equipped with means to control dust and other particulate matter created by the cutting action.

The machine shall be equipped to accurately and automatically establish profile grades along each edge of the machine, within plus or minus 3 mm (1/8 inch), by referencing from the existing pavement by means of a ski or matching shoe, or from an independent grade control. The machine shall be controlled by an automatic system for controlling grade, elevation, and cross slope at a given rate.

B  Operations

The pavement surface shall be milled to the depth, width, grade, and cross slope as shown in the Plans or as otherwise directed by the Engineer. Machine speeds shall be varied to produce the desired surface texture grid pattern. Milling shall be performed without excessive tearing or gouging of the underlying material.

The pavement milling operations shall be referenced from an independent grade control in those areas where the Engineer considers such control is essential. The control shall be established and maintained by the Contractor in a manner and in such position as the Engineer approves.

Milling operations shall be conducted so that the entire pavement width is milled to a flush surface at the end of each work period, whenever the pavement is open to traffic. In case of uncompleted operations resulting in a vertical or near vertical longitudinal cutting
face, it shall be the Contractor's responsibility to minimize the hazardous effects to traffic by resloping the longitudinal face to provide a suitable taper, by constructing a temporary bituminous taper, or by otherwise providing the necessary protective measures, as approved by the Engineer. Transverse cutting faces shall be tapered at the end of each working period where traffic is permitted. To further provide for traffic, the Contractor shall also construct temporary bituminous tapers at intersecting streets, around utility appurtenances, and at all appropriate entrances during the milling operations, as ordered by the Engineer.

The Contractor shall construct the temporary milled tapers and furnish, place, and remove temporary bituminous tapers as incidental work for which no direct compensation will be made.

In areas inaccessible to the milling machine, the work shall be accomplished by other equipment or methods acceptable to the Engineer.

The surfacing removed in conjunction with the milling operations may be recycled for use on the Project in accordance with the applicable Specifications, or disposed of outside of the Right of Way as specified in 2104.3.

After the milling operations are completed to the planned depth, the milled area shall be cleaned by sweeping or vacuuming with equipment approved by the Engineer. Such cleaning shall be performed to the satisfaction of the Engineer.

Debris resulting from milling and cleaning operations shall be disposed of outside of the Right of Way as specified in 2104.3, except as otherwise authorized by the Engineer.

Milling at previously patched areas shall be performed to the required depth below the pavement surface existing prior to the previous patch being placed, and not from the surface of the patch.

The Contractor shall take care to avoid disturbing or damaging any existing drainage or utility structures on the Project. Any damage resulting from the Contractor's operations shall be repaired by the Contractor at no expense to the Department.

**2232.4 METHOD OF MEASUREMENT**

Pavement milling will be measured by the area of each type of surface removed. Measurements will be of those areas milled as specified, based on actual finished dimensions of the work.
2232.5

**BASIS OF PAYMENT**

Payment for pavement milling at the appropriate Contract price per unit of measure will be compensation in full for all costs of performing the work as specified, including, but not limited to, traffic safety, cleanup, and disposal operations.

Payment for pavement milling will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2232.501</td>
<td>Mill Bituminous Surface (___ mm (inches))</td>
<td>square meter (square yard)</td>
</tr>
<tr>
<td>2232.502</td>
<td>Mill Concrete Pavement Surface (___ mm (inches))</td>
<td>square meter (square yard)</td>
</tr>
</tbody>
</table>
2301.2

Concrete Pavement

2301.1 DESCRIPTION
This work shall consist of constructing Portland cement concrete pavement on a prepared base.

2301.2 MATERIALS

A Concrete..............................................................................2461

A1 Incentives/Disincentives
When the Contract includes concrete aggregate and water-cementitious incentive/disincentive provisions, they shall apply only to materials provided for or produced by the Contractor's primary concrete paving plant. The primary paving plant may be a batch plant or a ready mix plant. The use of any one kind or class of material from more than one source is prohibited without permission from the Engineer. Permission, if granted, will set forth the conditions under which the change of source is allowed.

The incentive/disincentive provisions shall not apply to materials provided for or produced by a secondary concrete plant providing mixture for minor work such as fill-ins or other work not provided by the Contractor's primary concrete plant.

A2 Blank

A3 Class R as the Coarse Aggregate
For 100 percent Class R coarse aggregate concrete mixes, the mix designations shall be as given below for the method of placement to be used.

Manual Placement....................................................... Mix No. 3A40R
Standard Machine Placement...................................... Mix No. 3A30R
Vibratory Machine Placement ................................. Mix No. 3A20R

A4 Blank

A5 Concrete Paving Aggregate

A5a Required Preliminary Aggregate Testing
As soon as coarse and fine aggregate is available for testing, the Contractor shall contact Mn/DOT or designated representative to coordinate preliminary sampling of aggregate for concrete paving. Mn/DOT will sample and test the aggregate to update specific gravity and absorption data and perform other tests as determined by the Engineer.

A5b Blank

A5c Coarse Aggregate Quality Control/Quality Assurance (QC/QA) Incentive/Disincentive
Acceptance of the coarse aggregate for paving concrete shall be by statistical methods. This provision is in addition to all other requirements of 2301, 2461, and 3137. Sufficient aggregate must be produced 4 weeks prior to the commencement of paving operations to provide sufficient time for verification testing.

The QC/QA program for CLASS B and C Aggregates will comply with the following procedure:

(1) The aggregate producer will produce a 1000 metric ton (ton) stockpile of each fraction of aggregate that is to go into the work.
Then, production shall cease for 4 business days to check aggregate quality. The Engineer and the aggregate producer, in the presence of one another, shall take 3 split samples of each stockpile and each run the appropriate test, depending on the aggregate class, to examine aggregate quality. The aggregate producer can use this correlation to aid in the quality control of the aggregates. If the Mn/DOT test results indicate that the aggregate is acceptable, production can resume. If the test results are unacceptable, the stockpile will be rejected and the procedure will start again after the aggregate producer has corrected the operation.

(2) After acceptability is verified, the aggregate producer will continue to take quality control samples for testing at the rate of 1 sample per fraction per ½ day of production during the entire period of aggregate production. The appropriate test for the aggregate class will be run as soon as possible after sampling. For each fraction, the aggregate producer will plot the test results on a chart indicating the specification limits for the appropriate test. The aggregate producer shall make changes in the operation if the material approaches the specification limit.

(3) The Engineer will take acceptance samples at a location as close as possible to incorporation into the work (the belt leading to the weigh hopper is the suggested location). The acceptance sampling rate shall be as follows:

<table>
<thead>
<tr>
<th>Plan m³ (cubic yards) of concrete</th>
<th>Samples per fraction (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,000 – 10,000</td>
<td>5</td>
</tr>
<tr>
<td>10,000 – 40,000</td>
<td>10</td>
</tr>
<tr>
<td>40,000+</td>
<td>15</td>
</tr>
</tbody>
</table>

The acceptance samples will be randomly chosen. A lot representing the plan m³ (cubic yards) of concrete will be divided by the number of samples to form sublots. The number of m³ (cubic yards) in a sublot is multiplied by a random number (Attachment A) between 0.00 and 0.99 to obtain the position in the sublot for the sample. The samples will be split and half left for the aggregate producer. The Engineer's laboratory will test the samples and report the individual results. The Engineer will calculate a Quality Index (QI) for each fraction as follows:

\[ QI = X + k(s) \]

where:

- \( X = \frac{\sum X_i}{n} \)
- \( X_i \) = individual quality test results

<table>
<thead>
<tr>
<th>K</th>
<th>No. of Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.23</td>
<td>5</td>
</tr>
<tr>
<td>1.26</td>
<td>10</td>
</tr>
<tr>
<td>1.27</td>
<td>15</td>
</tr>
</tbody>
</table>
\[ s = \text{standard deviation} \]
\[ s = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n-1}} \]

For Class B aggregate the special quality requirement is absorption and:

<table>
<thead>
<tr>
<th>QI for Fraction %</th>
<th>Structural Concrete m³ (cubic yards)</th>
<th>Payment Change Per Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 1.00</td>
<td></td>
<td>+ $1.30 ($1.00)</td>
</tr>
<tr>
<td>1.01 - 1.45</td>
<td></td>
<td>+ $0.65 ($0.50)</td>
</tr>
<tr>
<td>1.46 - 1.76</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>1.77 - 1.85</td>
<td></td>
<td>- $1.30 ($1.00)</td>
</tr>
<tr>
<td>≥ 1.86</td>
<td></td>
<td>Recommendation of State Concrete Engineer</td>
</tr>
</tbody>
</table>

For Class C aggregate the special quality requirement is % carbonate, and:

<table>
<thead>
<tr>
<th>QI for Fraction %</th>
<th>Structural Concrete m³ (cubic yards)</th>
<th>Payment Change Per Fraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 15.0</td>
<td></td>
<td>+ $1.30 ($1.00)</td>
</tr>
<tr>
<td>15.1 - 24.0</td>
<td></td>
<td>+ $0.65 ($0.50)</td>
</tr>
<tr>
<td>24.1 - 31.0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>31.1 - 35.0</td>
<td></td>
<td>- $1.30 ($1.00)</td>
</tr>
<tr>
<td>≥ 35.1</td>
<td></td>
<td>Recommendation of State Concrete Engineer</td>
</tr>
</tbody>
</table>

Class A aggregates (including quartzite and gneiss), if meeting all other Mn/DOT requirements, qualify for $1.30 per m³ ($1.00 per cubic yard) per fraction incentive.

Class R aggregates are not considered in this incentive/disincentive program.

If the concrete mixture contains 3 or more fractions of coarse aggregate (such as 19 mm+, 19 mm-, 9.5 mm- (¾ inch+, ¾ inch-, 3/8 inch-)), only the 2 containing the highest percentage by weight are eligible for incentive. Two or more sub-fractions may be combined (such as 19 mm- (¾ inch-) and 9.5 mm- (3/8 inch-) sub-fractions combined to produce the 19 mm- (¾ inch-) fraction) to form either the coarse or fine fraction of the coarse aggregate. The sub-fractions shall be blended by weight. Therefore, the maximum incentive for aggregate quality is $2.60 per m³ ($2.00 per cubic yard) of structural concrete.
A5d  Optional Incentive for Well-Graded Aggregate

An optional incentive of $2.60 per m$³$ ($2.00 per cubic yard) of concrete is available to the Contractor provided a concrete mixture is designed and produced with a combined aggregate gradation that meets the following requirements:

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>% Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mm (2 inch)</td>
<td>0%</td>
</tr>
<tr>
<td>37.5 mm (1 ½ inch)</td>
<td>≤ 8%</td>
</tr>
<tr>
<td>25 mm (1 inch)</td>
<td>8% to 18%</td>
</tr>
<tr>
<td>19 mm (3/4 inch)</td>
<td>8% to 18%</td>
</tr>
<tr>
<td>12.5 mm (1/2 inch)</td>
<td>8% to 18%</td>
</tr>
<tr>
<td>9.5 mm (3/8 inch)</td>
<td>8% to 18%</td>
</tr>
<tr>
<td>4.75 mm (# 4)</td>
<td>8% to 18%</td>
</tr>
<tr>
<td>2.36 mm (# 8)</td>
<td>8% to 18%</td>
</tr>
<tr>
<td>1.18 mm (# 16)</td>
<td>8% to 18%</td>
</tr>
<tr>
<td>600 µm (# 30)</td>
<td>8% to 18%</td>
</tr>
<tr>
<td>300 µm (# 50)</td>
<td>≤ 18%</td>
</tr>
<tr>
<td>150 µm (# 100)</td>
<td>≤ 8%</td>
</tr>
<tr>
<td>75 µm (# 200)</td>
<td>≤ 1.6%</td>
</tr>
</tbody>
</table>

If the previous gradation is not met an optional incentive of $0.65/m$³$ ($0.50 per cubic yard) of concrete is available to the Contractor provided a concrete mixture is designed and produced with a combined aggregate gradation that meets the following requirements:

<table>
<thead>
<tr>
<th>Sieve Sizes</th>
<th>% Retained</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mm (2 inch)</td>
<td>0%</td>
</tr>
<tr>
<td>37.5 mm (1 ½ inch)</td>
<td>≤ 7%</td>
</tr>
<tr>
<td>25 mm (1 inch)</td>
<td>7% to 18%</td>
</tr>
<tr>
<td>19 mm (3/4 inch)</td>
<td>7% to 18%</td>
</tr>
<tr>
<td>12.5 mm (1/2 inch)</td>
<td>7% to 18%</td>
</tr>
<tr>
<td>9.5 mm (3/8 inch)</td>
<td>7% to 18%</td>
</tr>
<tr>
<td>4.75 mm (# 4)</td>
<td>7% to 18%</td>
</tr>
<tr>
<td>2.36 mm (# 8)</td>
<td>7% to 18%</td>
</tr>
<tr>
<td>1.18 mm (# 16)</td>
<td>7% to 18%</td>
</tr>
<tr>
<td>600 µm (# 30)</td>
<td>7% to 18%</td>
</tr>
<tr>
<td>300 µm (# 50)</td>
<td>≤ 18%</td>
</tr>
<tr>
<td>150 µm (# 100)</td>
<td>≤ 7%</td>
</tr>
<tr>
<td>75 µm (# 200)</td>
<td>≤ 1.6%</td>
</tr>
</tbody>
</table>

Compliance is determined based on the Contractor's composite aggregate gradation test results as verified by Agency testing.

The Agency's statistical analysis of samples for well-graded aggregate
control incentive will be based on a lot basis representing one days paving. The incentive payment shall be calculated on a lot basis. The lot represents the cumulative average of the sublot values on each sieve.

A6 Cementitious Materials – General

The minimum cementitious material requirements shall be (315 kg/m³) (530 pounds per cubic yard). Of the cementitious fraction, the minimum portland cement content shall be 237 kg/m³ (400 pounds per cubic yard) whether using fly ash or ground granulated blast furnace slag as a portland cement replacement (See below for Special Requirements for Quartzite and Gneiss). Any additional cementitious material necessary to meet any requirement described herein shall be the responsibility of the Contractor with no additional compensation from the Agency. Total cementitious shall not exceed 356 kg/m³ (600 pounds per cubic yard) except for high-early mixes.

Mn/DOT 2461.3D is modified to allow up to 30 percent replacement with fly ash. Portland cement may be replaced with up to 35 percent ground granulated blast furnace slag (GGBFS), however, ternary mixes (Portland cement, GGBFS, fly ash or other cementitious materials) are not allowed.

Specification 3101 is hereby modified such that the total alkalis in the portland cement (Na₂O + 0.658 K₂O) shall not exceed 0.60 percent. The total alkalis in the cementitious material shall not exceed 3.0 kg/m³ (5.0 pounds per cubic yard).

A6a Special Cementitious Requirements for Quartzite and Gneiss

If the Contractor selects to use coarse aggregate from sources identified by Mn/DOT as quartzite or gneiss and the aggregate does not comply with the 0.04 percent expansion limits of ASTM C-1293, the other cementitious material shall be:

1. 30% of an approved fly ash meeting the following requirements:

   Mn/DOT 3115 is modified such that fly ash used as cementitious material in the concrete mixture shall have a minimum Si₀₂ + Fe₂O₃ + Al₂O₃ of 66.0% on a dry weight basis. In addition, it shall have a minimum Si₀₂ content of 38.0%.

   -or-

2. 35% of an approved ground granulated blast furnace slag.

A7 Concrete Mix Design

The Contractor shall review the Special Provisions of the Contract to determine which of the following specifications apply. If nothing is specified then 2301.A7a shall apply. If the concrete paving is < 385 m³ (500 cubic yards) then 2461.4D7a shall apply.

A7a Small Concrete Paving Projects > 385 m³ (500 cubic yards) and ≤ 3825 m³ (5000 cubic yards)

   Unless modified in the Special Provisions of the Contract, the following
2301.2

shall apply:

A7a(1) Mix Design

Grade A paving concrete shall be designed and placed at a water cementitious ratio not greater than 0.40. The Mn/DOT Concrete Engineering Unit shall provide the mix design. In lieu of a mix design provided by the Mn/DOT Concrete Engineering Unit, the Contractor has the option to supply the mix design.

A7a(2) Optional Contractor Mix Design

The Contractor shall design the concrete paving mixture based on a volume of 1.000 m³ (cubic yard) according to industry standard practice.

The concrete pavement placement may commence 15 days after preliminary approval of the Contractor's concrete pavement mix design by the Concrete Engineer. Final approval of the mixture is based on satisfactory field placement.

A7a(3) Coarse Aggregate Gradation

All coarse aggregate for concrete pavement that does not contain 100% recycled concrete shall meet the following gradation:

<table>
<thead>
<tr>
<th>Sieve</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 mm (2 inch)</td>
<td>100</td>
</tr>
<tr>
<td>37.5 mm (1 1/2 inch)</td>
<td>95-100</td>
</tr>
<tr>
<td>19 mm (3/4 inch)</td>
<td>35-70</td>
</tr>
<tr>
<td>9.5 mm (3/8 inch)</td>
<td>10-30</td>
</tr>
<tr>
<td>4.75 mm (#4)</td>
<td>0-7</td>
</tr>
</tbody>
</table>

A7a(4) Admixtures (Other than Mineral Admixtures)

An approved Type A water reducing admixture shall be used. (Approved list on file at the Departments' Concrete Engineering Unit Website) The use of any admixtures other than air entraining agents and Type A water reducers require the approval of the Concrete Engineer.

A7b Large Concrete Paving Projects > 3825 m³ (5000 cubic yards)

Unless modified in the Special Provisions of the Contract, the following shall apply:

A7b(1) General

The concrete pavement placement may commence 15 days after preliminary approval of the Contractor's concrete pavement mix design and job mix formula (JMF) by the Concrete Engineer. Final approval of the mixture is based on satisfactory field placement.

A7b(2) Contractor Concrete Mix Design

The Contractor shall design the concrete paving mixture based on a volume of 1.000 m³ (cubic yard) according to industry standard practice.

Grade A paving concrete shall be designed and placed at a water cementitious ratio not greater than 0.40.

High early mixes may have up to 100% portland cement. High-early mixes are not eligible for incentive payments for water/cementitious ratio.
For the minor work such as fill-ins or other work not provided by the Contractor's primary concrete plant, the Contractor may choose to use a 3A41HE mix designed by Mn/DOT in lieu of the Contractor mix design requirement.

A7b(3) Job Mix Formula

A Formula (JMF) containing proportions of materials and individual gradations of each material plus a composite gradation. All admixtures shall also be included. The JMF shall be based on the combination of coarse and fine aggregate for the following sieves:

50 mm (2 inch), 37.5 mm (1-1/2 inch), 25 mm (1 inch), 19 mm (3/4 inch), 12.5 mm (1/2 inch), 9.5 mm (3/8 inch), 4.75 mm (# 4), 2.36 mm (# 8), 1.18 mm (# 16), 600 µm (# 30), 300 µm (# 50), 150 µm (# 100) and 75 µm (# 200). During the testing process, additional fill-in sieves may need to be added to prevent overloading. Table 3137-1 and Table 3137-2 and the gradation requirements of Mn/DOT 3126 are hereby deleted. The percent passing the 50 mm (2 inch) sieve shall be 100 percent; the percent passing the 75 µm (# 200) sieve shall not exceed 1.6 percent.*

*(Note: See Mn/DOT 3137.2D1i for additional requirements for coarse aggregate cleanliness.)

The JMF submittal shall include working ranges based on the composite gradation of the above sieves.

The working range limits of the composite gradation are based on a moving average of 4-tests (N=4). The working ranges are:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Working Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.75 mm (# 4) sieve or greater</td>
<td>+/- 5 %</td>
</tr>
<tr>
<td>2.36 mm (# 8) to 600 µm (# 30)</td>
<td>+/- 4 %</td>
</tr>
<tr>
<td>300 µm (# 50) sieve</td>
<td>+/- 3 %</td>
</tr>
<tr>
<td>150 µm (# 100) sieve</td>
<td>+/- 2 %</td>
</tr>
</tbody>
</table>

A new concrete mix design and JMF shall be submitted if the moving average falls outside of the JMF working range or any proportions of the mix design are adjusted.

A7b(4) Admixtures (Other than Mineral Admixtures)

An approved Type A water reducing admixture may be used at the discretion of the Contractor. (Approved list on file at the Departments' Concrete Engineering Unit Website). The use of any admixtures other than air entraining agents and Type A water reducers require the approval of the Concrete Engineer.

A7b(5) Water/Cementitious Ratio

The water/cementitious ratio shall conform to the requirements of Table WC-1. Statistical analysis may indicate a percentage of the production is
above or below the specified requirement. Concrete represented by water/cementitious ratios above the limits listed in the Table may be removed and replaced by the Contractor. If the Contractor elects not to remove the material and the level of payment is not defined in the table, the material will be evaluated by the Concrete Engineer as to the adequacy for the use intended. All concrete evaluated as unsatisfactory by the Concrete Engineer for the intended use shall be removed and replaced by the Contractor at no expense to the Agency.

The Agency's determination of the water/cementitious ratio will be based on the following procedures:

1. **Water Content**
   a. For a concrete paving batch plant, the water added to the mix (including temper water) shall be recorded by an electronic meter approved by the Engineer that records and prints the amount of total water including temper water as part of each batch ticket.
   b. For a ready mix plant, the water added to the mix (including temper water added and other trim water added prior to placement) shall be recorded on the computerized Certificate of Compliance. The water content for calculating w/c shall be based on the average water computed from 10 batch tickets/Certificates of Compliance surrounding the randomly selected batch ticket sample (4 previous tickets, ticket representing the random sample, 5 following tickets).
   c. For a batch plant, the water content in the mix determined in "a" shall be verified with samples taken from the plastic concrete at the plant site.
   d. For a ready-mix plant, the water content shall be verified in the field or at the plant site at the discretion of the Engineer. Samples transported to the plant site for testing must be packaged in a manner that will prevent moisture loss.

The water content in the plastic concrete mixture is determined by test procedure AASHTO Designation: TP23-93 "Standard Test Method for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying". The test must commence within 45 minutes after the water has contacted the cementitious material.

**The Contractor shall supply the microwave oven and the ancillary equipment necessary to perform the above test.**

The water content in the concrete mix used for the determination of the water-cementitious ratio consists of the free water (water in excess to absorbed water) carried by the aggregate plus the water added to the mixer. The moisture contents of the aggregates (all fractions) are determined by the Agency according to the Agency Quality Assurance Testing Rate. Close coordination is required to assure that the aggregate samples taken for moisture determination represent the same material as the plastic concrete mix sample taken for microwave water content determination.

2. **Cementitious Content**

The cementitious content is the target value (mix design weights) printed
on the batch ticket/Certificate of Compliance as verified by cement cutoffs. Adjustments for mix going to commercial or other agency work may be necessary.

The Agency’s statistical analysis of acceptance samples for water/cementitious ratio will be based on a lot basis representing one day’s paving. Paving includes integrant curb and gutter and curb and gutter placed adjacent to the concrete mainline with the same mixture as used in the paving. A new mix design shall dictate a new lot. On the last day of paving or on the last day of using a specific mix design, the concrete involved shall constitute separate lot/sublot unless the above applies regarding less than 3 sublots.

The Agency’s acceptance samples shall be randomly chosen. The location of the sample shall be determined using a random number chart and multiplying the random number by the sublot size. (Example: Random number (0.65) X 750 m³ (1000 cubic yards) results in taking a sample from the load representing the 488th cubic meter (650th cubic yard)).

The samples will be tested by Agency personnel and the individual results recorded.

The Engineer will calculate a Quality Index (QI) for each lot as follows:

\[ QI = \frac{\sum X}{n} \]  

where: \[ X = \text{mean} = \frac{\sum X}{n} \] (Rounded to the nearest hundredth)

\[ X = \text{Individual water/cementitious tests} \] (Rounded to the nearest hundredth)

\[ n = \text{Number of tests} \]

Concrete mix not meeting the 0.40 water/cementitious requirement shall not knowingly be placed in the work. Should any non-conforming material be inadvertently placed in the work, it will be accepted for payment according to Table WC-1.

<table>
<thead>
<tr>
<th>QI Value</th>
<th>Payment incentive/disincentive per m³ (cubic yard)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.35 or less</td>
<td>$5.20 ($4.00)</td>
</tr>
<tr>
<td>0.36</td>
<td>$3.90 ($3.00)</td>
</tr>
<tr>
<td>0.37</td>
<td>$2.60 ($2.00)</td>
</tr>
<tr>
<td>0.38</td>
<td>$1.62 ($1.25)</td>
</tr>
<tr>
<td>0.39</td>
<td>$0.65 ($0.50)</td>
</tr>
<tr>
<td>0.40</td>
<td>0.00</td>
</tr>
<tr>
<td>0.41</td>
<td>-$0.65 ($0.50)</td>
</tr>
<tr>
<td>0.42</td>
<td>-$1.62 ($1.25)</td>
</tr>
<tr>
<td>0.43</td>
<td>-$2.60 ($2.00)</td>
</tr>
<tr>
<td>0.44</td>
<td>-$3.90 ($3.00)</td>
</tr>
<tr>
<td>0.45+</td>
<td>Determined by the Concrete Engineer</td>
</tr>
</tbody>
</table>
Price adjustments based on the Table WC-1 shall apply to Item 2301.511 (Structural Concrete) only.

A7b(6) Contractor Testing

As part of the Contract, the Contractor shall provide qualified personnel and sufficient equipment meeting the requirements listed in the Mn/DOT Concrete Manual to conduct quality control testing.

The Contractor shall calibrate and correlate the testing equipment with prescribed procedures and conduct tests in conformance with specified testing procedures as listed in the Mn/DOT Concrete and Laboratory Manuals. Gradations for both coarse and fine aggregate shall be mechanically sieved.

The Contractor shall maintain and keep current control charts. The charts shall be an easily readable size and be displayed on the testing facility wall or stored in a 3-ring binder. Test data from such characteristics as moisture content of aggregates and total water in mix, w/c ratio, composite gradation, air content and flexural strength shall be plotted on control charts.

The charts shall contain the following characteristics: date, time, lot and sublot, applicable specifications and other data necessary to facilitate control of the process. Batch weight adjustments shall be noted on the control charts under a remarks column. The Engineer will approve all charting procedures.

Reports, records, and diaries developed during the progress of construction activities shall be filed at the direction of the Engineer and will become the property of the Agency. Reports shall include:

(1) Copies of all test results and control charts at the completion of concrete paving operations

(2) Copies of all failing test results sent by facsimile on a daily basis to the Project Engineer and the District Materials Engineer. Failure to provide daily test results shall be grounds for suspension of plant operations.

A8 Testing Rates

Testing rates shall comply with the Schedule of Materials Control unless modified in the Special Provisions of the Contract.

B Reinforcement Bars ................................................................. 3301
C Dowel Bars ........................................................................ 3302
D Steel Fabric ....................................................................... 3303
E Blank
F Concrete Joint Sealers,  
  F1 Hot-Poured, Crumb Rubber Type ................................. 3719  
  F2 Hot-poured, Low Modulus Type ................................. 3720  
  F3 Preformed Type .......................................................... 3721  
  F4 Hot-poured, Elastic Type ............................................. 3723  
  F5 Hot-poured, Elastic Type ............................................. 3725  
  F6 Silicone Type.............................................................. 3722
G Preformed Joint Filler .......................................................... 3702
H Curing Materials  
  H1 Waterproof Curing Paper............................................. 3752  
  H2 Plastic Curing Blankets............................................... 3756
2301.3 CONSTRUCTION REQUIREMENTS

Unless otherwise stated in the Special Provisions, the "Slip Form" method of construction is the standard construction method. In this case references to the use of fixed side forms or to the use of equipment designed to ride on fixed forms shall not apply.

A General

A1 Operation and Supervision

Construction operations shall not be started until the Engineer has determined that all equipment, tools, inspection facilities, preliminary testing, and accessories necessary for the phases of work being undertaken at the time are on the work site and meet the Specification requirements as to design, capacity, and mechanical condition.

The Contractor shall submit to the Engineer an organizational chart listing names and phone numbers of individuals and alternates responsible for mix design, process control administration, and inspection. The organizational chart shall be posted in the Contractor's on site facility.

The Contractor's quality control organization or private testing firm shall have Mn/DOT Certified Technicians. All testing and plant operations shall be overseen by a Quality Control Supervisor who is a Concrete Plant Level II Technician certified by Mn/DOT. The Quality Control Supervisor must be on site at all times or have a cellular phone in their possession and must be able to be at the plant site in a reasonable time frame when called. Individuals performing mix design calculations or mix design adjustments must be certified as a Concrete Plant Level II Technician. Individuals performing process control testing must be certified as a Concrete Plant Level I Technician.

The Agency and Contractor shall complete and sign a Paving Contact Report to verify all requirements are met.

The Contractor shall have in the Project organization a separate foreman, sub-foreman, or designated worker in charge of each phase of the work requiring direct supervision, who is authorized to receive instructions and orders in the absence of the general foreman or superintendent. Major phases of the work requiring this direct supervision shall be as follows:

(a) Aggregate producing plant, if operated as a part of the Contract.
(b) Concrete batching and mixing plant.
(c) Subgrade preparation and fine grading.
(d) Form setting (if required)
(e) Concrete placing.
(f) Finishing and curing.
(g) Joint sealing and cleanup.
The Contractor should also have available a manufacturer's manual that explains the operation and adjustments of the major pieces of power operated equipment to be used.

A2 Combination Plant Lab – Office Requirements

The following special requirements apply for concrete paving projects which meet the requirements of 2301.2A7b.

A separate combination Plant Lab-Office shall be furnished for use during the concrete paving operation. This combination Plant Lab – Office shall be shared equally by the Concrete Paving Contractor QC technicians and the Agency QA technicians. This combination Plant Lab – Office supplied by the Concrete Paving Contractor shall be considered incidental and shall meet the requirements of Mn/DOT 1604.

The Contractor's testing facility shall be located at the plant site and be approved by the Engineer prior to the commencement of concrete production. Any other location must be approved by both the Engineer and the Concrete Engineer. The Contractor shall provide suitable space and specified testing equipment for their quality control personnel to perform the required tests.

The combination Plant Lab – Office will be constructed and equipped to all provisions of Mn/DOT 2031.3A except as modified below:

a. Minimum total floor area, based on exterior dimensions, will not be less than 21 m² (224 square feet).

b. Minimum Plant Lab floor area, based on exterior dimensions, will not be less than 13.5 m² (144 square feet).

c. Minimum Plant Office floor area, based on exterior dimensions, will not be less than 7.5 m² (80 square feet).

d. Plant Lab and Plant Office areas will be separated by a wall to effectively isolate the Plant Lab from the Plant Office.

In addition to the requirements set forth above, each combination Plant Lab – Office will be equipped to meet all the provisions of Mn/DOT 2031.3B1 (Field Office Furnishings) and Mn/DOT 2031.3B2 (Field Laboratory Furnishings) except as modified below:

(a) Plant Office Furnishings

1. Two (2) desks with minimum total exterior dimensions of ¾ m by 1.50 meters (30 x 60 inches). One each for the Agency and Contractor.

2. Sufficient desk chairs to utilize all desks and provide seating for at least two additional persons.

3. Two (2) file cabinets with two or more file drawers. One each for the Agency and Contractor.

4. To facilitate communication between the Contractor and the Engineer regarding quality control, the Contractor shall provide a working telephone, working copy machine and working fax machine. The Contractor shall provide local and long distance telephone service in the Plant office only for the duration of concrete paving operations. The Contractor shall pay for the telephone installation, the basic monthly phone service charges and the
eventual removal of the telephone. Payment for local telephone service will be considered incidental for which no direct payment will be made. The Contractor shall bill Mn/DOT for long distance phone charges by sending an invoice and a copy of the long distance charges, provided said charges were not incurred by the Contractor, his employees, his subcontractors, or suppliers.

(b) Plant Laboratory Furnishings
1. One sturdily built workbench or countertop with minimum dimensions of 0.75 x 3.65 m (30 x 144 inches) to be shared equally between the contractor and agency.
2. Shelf space above workbench or countertop or at other convenient locations, totaling a minimum of 2.5 m (8 linear feet) length by (0.20 m (8 inches) minimum width).
3. Electronic balances/scales for all materials testing.

In addition to the requirements set forth above, the combination Plant Lab – Office will meet requirements of Mn/DOT 2031.3C. Type D service will be provided with the exception that toilet and lavatory facilities are not required. Concrete paving operations will not be permitted to begin until the combination Plant Lab – Plant Office meets all requirements herein.

A3 Equipment Restrictions

Equipment, other than sawing equipment, shall not operate on the new pavement slab until the joints have been sealed. Equipment operated on a slab shall be designed, equipped, and operated so as not to cause damage. Should any damage result, the operations shall be suspended until corrective action has been taken. In no case shall the equipment wheels or tracks be operated within 100 mm (4 inches) of the slab edge.

The Contractor shall not operate paving or other heavy equipment on a new pavement slab until the concrete has attained an age of 7 days or until it has a minimum flexural strength meeting the minimum requirements of 2301.3A7 and then only when authorized by the Engineer. The concrete test specimens shall be cast, cured, and tested as prescribed in the Mn/DOT Concrete Manual. When such paving operations are authorized, the following conditions shall be complied with:

(a) Before moving on and off the pavement, a ramp of compacted earth or other suitable material of sufficient strength and elevation shall be constructed to prevent undue stress in the pavement slab.

(b) The paving equipment shall operate on protective mats consisting of wood strips, belting, or other suitable material to prevent damage to the pavement surface and joints. The pavement surface shall be swept free of debris prior to placing the protective mats.

A4 Integrant Curb

Integrant curb is a curb that is constructed monolithically with the pavement.
A5  Permanent Terminal Headers
This work shall consist of constructing concrete pavement terminal
headers at the locations shown in the Plans and as directed by the Engineer in
accordance with Mn/DOT 2301, the details shown on Standard Plate No.
1150.

A6  High Early Strength Sections
Where so indicated in the Plans or directed by the Engineer, a section of
pavement shall be constructed of high early strength concrete at important
road crossings, intersections, driveway entrances, or other locations where
early use of the pavement may be required to accommodate traffic.
Because of the accelerated rate of hardening of high early strength
concrete, the Contractor shall take such extra precautions as necessary to
ensure satisfactory finishing of these sections.

High-early concrete is defined as a concrete mixture having a
cementitious content greater than 356 kg/m³ (600 pounds per cubic yard).
High Early mixes shall be designed to provide a maximum water/cementitious
ratio of 0.40 and a minimum flexural strength of 3450 kPa (500 psi) or a
minimum compressive strength of 20.7 Mpa (3000 psi) in 48 hours. High
early mixes may have up to 100% portland cement. High-early mixes are not
eligible for incentive payments for water/cementitious ratio.

For the minor work such as fill-ins or other work not provided by the
Contractor's primary concrete plant, the Contractor may choose to use a
3A41HE mix designed by Mn/DOT in lieu of the Contractor mix design
requirement.

A7  Closed Period for New Pavement
New pavement shall not be opened to use by any traffic until the joints
have been sealed.
Newly constructed pavement may be opened to use by light vehicles
(axle loads of 2700 kg (6000 pounds) or less) 72 hours after the concrete has
been placed.
New pavement shall be closed to use by construction and general public
traffic for 7 days or according to the values listed in the Table 2301-A
whichever is the shorter. When the opening of new pavement to traffic is to
be determined by flexural strength, the test specimens shall be cast and tested
as prescribed in 2461.4A5. The test specimens shall be cured in the same
manner and under the same conditions as the pavement represented.
Table 2301-A
Minimum Strength Requirements for Opening Pavements to Construction and General Public Traffic

<table>
<thead>
<tr>
<th>Slab Thickness (mm in.)</th>
<th>Flexural Strength (Mpa psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 (6.0)</td>
<td>3.4 (500)</td>
</tr>
<tr>
<td>165 (6.5)</td>
<td>3.4 (500)</td>
</tr>
<tr>
<td>175 (7.0)</td>
<td>3.4 (500)</td>
</tr>
<tr>
<td>190 (7.5)</td>
<td>3.3 (480)</td>
</tr>
<tr>
<td>200 (8.0)</td>
<td>3.2 (460)</td>
</tr>
<tr>
<td>215 (8.5)</td>
<td>3.0 (440)</td>
</tr>
<tr>
<td>225 (9.0)</td>
<td>2.7 (390)</td>
</tr>
<tr>
<td>240 (9.5)</td>
<td>2.4 (350)</td>
</tr>
<tr>
<td>255 (10.0)</td>
<td>2.4 (350)</td>
</tr>
<tr>
<td>≥265 (≥10.5)</td>
<td>2.4 (350)</td>
</tr>
</tbody>
</table>

B Subgrade Preparations

The aggregate base construction and subgrade preparations, as provided for in 2211 and 2112 respectively, shall be completed in sufficient time to permit all tests and measurements to be completed prior to the fine grading operation. The subgrade shall then be fine graded to the required shape and grade to ensure construction of pavement meeting the specified thickness and cross section. Fine grading shall be accomplished with a template planer or other suitable machine capable of producing the necessary finish. Fine grading operations shall be completed at least 3 hours in advance of concrete placement, except on crossovers and other such small areas as the Engineer exempts.

If the slipform method of construction is used, the base course from out to out of the paver treads shall be accurately fine graded to the required elevation by an approved fine grading machine mounted on crawler treads. Base construction shall be completed and the required subgrade density obtained to a width at least 1 m (3 feet) beyond the outside edges of the pavement treads before the fine grading is performed. The aggregate base shall have sufficient stability and firmness to support the fine grading equipment and slipform paver without any serious distortion of the alignment or grade line.

Following the fine grading operations, the subgrade shall be recompacted as necessary to produce a firm smooth subgrade. Water shall be added as necessary during the recomping actions, and the subgrade shall be maintained in a moist condition until placement of the concrete. The subgrade shall be rechecked with a suitable device prior to placing the concrete, if paving equipment or hauling equipment has been operating thereon. The Engineer may recheck the density of the base after completion.
of fine grading operations. Any disturbed material shall be recompacted. The Contractor shall shape the shoulders in such a manner and to such an extent that surface water will drain away from the pavement and off the shoulders. The Contractor shall maintain the shoulders in that condition.

C Form Placement and Removal
C1 Form Sections

Regardless of type or design, forms shall have a height at least equal to the edge thickness of the pavement and shall have a strength and rigidity such that, when they are set in place and braced, they will withstand the mass (weight) and action of passing equipment without springing, settlement, or lateral displacement. Individual form sections shall be connected by methods that will secure the effect of a continuous form.

Form sections shall be not less than 3 m (10 feet) long except that wood forms may be 2.4 m (8 feet) or more in length. Approved flexible or curved forms of proper radius shall be used on curves having a radius of 45 m (150 feet) or less, except that, on curves having a radius greater than 30 m (100 feet), straight forms not over 3 m (10 feet) in length may be used when power operated strike-off and finishing equipment is used. The finished face of all curbing shall be constructed and finished to a line closely conforming to the Plan curvature and location. Straight forms longer than 3 m (10 feet) shall not be used on any curved line unless specifically authorized by the Engineer.

The top surfaces of all forms shall be smooth and free of localized indentations and deformities, and shall show no deviations greater than 3 mm (1/8 inch) from a straight edge having a length equal to the form section. The faces of straight forms shall show no deviations greater than 13 mm (½ inch) from a 3 m (10 foot) straight edge.

Integrant curb forms shall conform to the applicable requirements for paving forms and shall be equipped with clamps or other satisfactory means to ensure their support and alignment.

C2 Form Setting

The Contractor shall set the forms to the proper alignment and grade for a distance equal to at least 3 hours of paving time ahead of the paver, except when less than that quantity of paving remains to be done.

The foundation upon which the forms will be set shall be compacted in accordance with 2301.3B. The forms shall have a firm and uniform bearing over their whole base area; shall be tightly joined and securely staked; and shall be clean and free of accumulations of hardened concrete. The contact faces of the forms shall be coated with a chemical release agent conforming to 3902 prior to placing the concrete against them.

In the event of rain, the forms shall be removed and reset as necessary to permit drainage and comply with the above requirements.

C3 Keyway Forms

Keyway forms that are attached to the side forms may be cut off not more than 75 mm (3 inches) from each end of the form section length. All keyway forms for fixed form paving shall be manufactured to the Plan dimensions.
C4  Removal of Forms

Side forms for pavement and back forms on integrant curb shall not be removed earlier than 12 hours after the concrete has been placed, except that the Engineer may authorize earlier removal based on the procedure to be used.

Forms shall be removed in a manner that exerts no apparent shock or strain on the pavement or curb and under satisfactory conditions of visibility (such as natural daylight), as determined by the Engineer.

D  Batch Hauling

Concrete shall be hauled in trucks that are mortar tight and capable of complete discharge of the concrete. The trucks shall be equipped with vibrators to aid in such discharge. Dump type trucks shall not dump concrete directly on the grade unless approved by the Engineer, and such approval will only be granted when the dimensions of the work make other methods impractical.

Any truck operations on the base will be subject to 2301.3B.

E  Placing Metal Reinforcement

All metal reinforcement shall be clean when used. The forms shall be of the type, style, and dimensions shown in the Plans, unless otherwise approved.

Metal reinforcement shall be placed at the locations shown in the Plans and in accordance with the following:

E1  Blank
E2  Bar Reinforcement

All bar reinforcement except dowel bars will be classified as Reinforcement Bars. Reinforcement bars include, but are not limited to, joint ties and construction headers.

All reinforcement bars shall be epoxy coated in accordance with 3301.

Bar reinforcement of greater section area than that specified in the Plans may be used at the Contractor's option, but the spacing between the individual members shall not exceed the spacing shown in the Plans for the type of reinforcement and bar size specified.

Unless otherwise shown in the Plans, splices in reinforcement bars shall not be less than 40 diameters and the overlapped ends shall be securely tied with wire. All reinforcement bars shall be placed on chairs or by appropriate equipment for depressing the bars to the specified location.

The tie bar steel required for L1T joints shall be placed by an approved mechanical device attached to the spreader or paver. Such device shall space and depress the tie bar steel to the desired depth and location.

E3  Dowel Bars

The Contractor shall:

(a) Furnish dowel bar assemblies that are fabricated in single units for the appropriate lanes. Use not more than two assembled sections in any one joint for ramps, loops, and tapered sections.

(b) Secure the dowel bar assemblies so movement does not occur while concrete is being placed. See Standard Plate 1103.
2301.3

(c) Remove assembly ties and other similar materials that are parallel to the dowel bars so that there is at least a clearance of 150 mm (6 inches) from the anticipated joint centerline to ensure proper joint movement.

(d) Blank

(e) Coat the dowel bars:

1. With a thin uniform coating of an approved form coating material meeting 3902,
2. For a minimum of one-half of the dowel length plus 50 mm (2 inches), and
3. Within 1 hour before covering with concrete.

(f) Mark the location of all doweled contraction joints in order to ensure accurate placement of the weakened plane of the joint during subsequent operations.

F Batching and Mixing

The Contractor shall batch and mix the concrete, and perform all related operations in accordance with 2461 and the following additional requirements.

F1 General

The Contractor shall check measuring equipment before paving operations are started and at any other time when there is evidence of improper operation. The batching and mixing of concrete shall not start until proper operations are ensured. The Engineer may suspend paving when improper operations are observed.

Admixtures shall be agitated in order to ensure homogeneous concentrations. When mixing operations are first started on the Project, the mixer timing device shall be set to produce an operating timed cycle of 75 seconds for all single drum mixers and 55 seconds for all dual drum mixers. This cycle shall remain in effect until the mechanical operating constants of the mixer can be accurately determined. The Engineer will then make such modifications in the cycle as may be necessary to conform to 2461.4C.

Batching and mixing operations shall be suspended whenever satisfactory finishing and curing of the pavement cannot be carried on properly.

F2 Cement Cutoff and Yield

The Contractor shall make positive cement cutoffs, except when the proportioning is performed in a commercial ready-mix plant and the batch is delivered to the construction site in revolving drum agitator type trucks. The positive cement cutoffs shall be made in accordance with the following provisions:

(a) A cement cutoff shall be made when approximately 250 metric tons (500,000 pounds) of cement have been used and again prior to the use of 1000 metric tons (2,000,000 pounds). Thereafter, a cement cutoff shall be made at least every 1500 metric tons (3,000,000 pounds) or once a week, whichever provides the longer time interval between cutoffs.

(b) When bulk cement is delivered directly to the concrete batching plant in
railroad cars or sealed transport trucks, the Contractor shall deliver to the Engineer copies of the freight bills the same day they are received from the transporting company.

(c) Blank

(d) The Contractor shall advise the Engineer of the method and schedule of cement unloading. The unloading of cement shall not begin until the Engineer approves the operation.

Individual cutoffs shall not show an underrun in cement usage exceeding 1.5 percent of the quantity specified, nor shall the final cutoff show an overall underrun exceeding 1.0 percent. If either one or both of these limitations are exceeded, the concrete represented thereby will not be paid for at the Contract unit bid prices. Unless the Engineer determines that the pavement is so deficient in cement content as to constitute unacceptable work, the defective concrete will be paid for at an adjusted unit price having the same ratio to the Contract unit price as the quantity of cement used has to the quantity of cement required. The quantity required will be the specified quantity less the allowable underrun. In case both tolerances are exceeded, the price adjustment will not be applied to both conditions, but only to the one that produces the greatest payment deduction.

F3  Basic Scale Requirements

The Contractor shall inspect, test, and calibrate the scales according to 1901 and the Mn/DOT Concrete Manual, after being set up. The initial spot check for accuracy and sensitivity shall be made before starting production operations. A copy of the inspection certificate shall be furnished to the Engineer.

F4  Cement Batching

The Contractor shall:

(a) Weigh bulk cement within a tolerance of 1 percent.

(b) Submit the cement records to the Engineer.

F4a Interlocking Device

The Contractor shall furnish an interlocking device when the quantity of concrete to be produced and placed is more than 750 m³ (1000 cubic yards).

The cutoff gates for cement batching shall be automatic and shall be controlled by the scale mechanism. The hopper inlet mechanism of the cement batching equipment shall be interlocked with the discharge gate to prevent opening the hopper inlet gate while the discharge gate is open. The hopper discharge mechanism shall be interlocked with the scale mechanism to prevent:

(1) Opening the discharge gate during filling until the full quantity of the cement is in the hopper and the scale is balanced.

(2) Opening the discharge gate if the quantity of cement in the hopper is out of range of the specified tolerance.

(3) Closing the discharge gate until the cement is entirely discharged from the hopper and the scale is back in zero balance.
2301.3

F4b Cement Scale and Cement Recorder
The Contractor shall equip the cement scale with an automatic cement recorder that will record the mass of cement in each batch.

The automatic cement recorder shall be graphic, digital, or photographic, and shall meet the requirements shown in the Mn/DOT Concrete Manual. It shall register both empty balance and total mass (weight) of each batch. The recorder shall be located and housed to protect against dust, moisture, and vibration. The housing shall be capable of being locked and, unless the recorder is photographic, the batch mass (weight) shall be observable without unlocking.

The cement scale may be equipped with manual controls for emergency use in the event of trouble with the automatic controls. In the event of trouble with the automatic controls, manual weighing will be permitted for a period not to exceed 5 days, provided the cement recorder is in proper working order.

In the cement batching operation, the Contractor will be permitted to override the automatic controls infrequently for periods not exceeding 15 minutes duration, provided the cement recorder is in proper working order. In the event of trouble with the cement recorder, the cement batching operation will be permitted to continue for a period not to exceed 1 working day, provided the automatic controls are in proper working order and the batching is performed automatically. The Contractor may substitute a photographic recorder if the malfunctioning recorder cannot be repaired within the 1 working day. The Contractor shall immediately cease batching operations if the substitute recorder is not fully operational.

F5 Aggregate Batching
The batching of aggregates shall conform to 2461.4B4.

F6 Other Cementitious Materials Batching
The batching of any other cementitious materials shall conform to 2301.3F4.

G Placing Concrete
All main line pavement constructed by standard or vibratory machine placement methods shall be constructed in a single layer of concrete.

The Contractor shall sprinkle the subgrade as necessary to provide a moisture content in the upper 75 mm (3 inches) of the subgrade (at the time of concrete placement) such that there will not be excessive absorption of water from the concrete into the subgrade soil.

The concrete shall be deposited so as to form a continuous mass requiring a minimum of rehandling or redistribution and of sufficient depth to provide the necessary excess for subsequent finishing operations. The concrete shall not be dumped or discharged in any manner that will cause its displacement. Premixed concrete may be hauled to the placement site in dump trucks, subject to 2301.3D.

The concrete along header joints shall be consolidated by internal vibration prior to final finishing.
Manhole and catch basin frames or rings shall be set to the required elevation during the paving operations.

Water shall not be added to the surface of the concrete to aid in finishing without the approval of the Engineer. The Engineer will only give this approval to replace evaporated surface water directly behind the paver caused by a halt in forward progress from a short-term breakdown in equipment or supply of concrete. The Contractor shall supply sufficient trucks to assure a steady forward progress of the paver. Pavement sections where water is added without the approval of the Engineer shall not be eligible for incentive payment for w/c or ride and are subject to the provisions of Mn/DOT 1503 and 1512.

Should placement of concrete be temporarily suspended, the placement operations shall be resumed in such manner that will not result in a cold joint or honeycombing. If the suspension period exceeds 90 minutes, a standard header joint shall be constructed.

When placing concrete adjacent to inplace concrete pavement joints, protect all ends of transverse joints to the satisfaction of the Engineer to prevent concrete mortar from infiltrating into the existing joints and causing compression spalls.

**H Fixed-Form Construction**

In all cases the concrete shall be struck-off as soon as practicable after it has been deposited on the subgrade, after which it shall be screeded twice. Manual placement methods will be permitted only when the dimensions of the work make the use of standard power-operated equipment impractical or as a temporary measure in cases when the power-operated equipment breaks down. Self-propelled, power-operated finishing equipment will not be required on pavements less than 3 m (10 feet) in width nor when there is less than 2500 m² (3000 square yards) of pavement to be placed.

**H1 Vibratory Machine Placement**

The following requirements shall apply to fixed-form pavement construction using concrete designed for vibratory machine placement:

H1a Strike-off and Screeding

The Contractor shall use sufficient strike-off and screeding equipment to keep pace with the placement of concrete.

The Contractor shall provide at least one mechanical spreader equipped with a reciprocating screed at least 300 mm (12 inches) wide and with full width vibratory equipment, plus one standard finishing machine. A mechanical spreader shall be a unit designed for the sole purpose of spreading and consolidating the concrete between the side forms to a uniform cross section.

There shall be an initial strike-off, followed by a first and second screeding operation. The machine used for these operations shall carry a proper excess of concrete or mortar ahead of and along the full length of the screeds and vibrators, and the operations shall be conducted in a manner that will not displace or damage joint assemblies. Excess water and laitance brought to the surface by these operations shall be wasted over the forms.
Power-operated finishing machines shall be equipped with either a single reciprocating screed not less than 500 mm (12 inches) wide or with two reciprocating screeds, one of which shall be at least 300 mm (20 inches) wide.

The second screeding movement shall be carried forward for a distance of not less than 30 m (100 feet) at a time, except that, if the rate of paving progress is less than 30 m (100 feet) per hour, the distance shall be equal to 1 hour's paving progress. If the forward progress is such that the second screeding operation cannot be performed properly, the rate of concrete placement shall be reduced or additional screeding equipment shall be used.

H1b Portable Vibrator Operation

Concrete adjacent to side forms and fixed structures shall be consolidated by means of portable vibrators or by "fins" attached to full width vibratory equipment. The portable vibrator shall operate at a speed of not less than 60 Hz (3600 VPM). While in operation, the vibrator head shall not be permitted to come in contact with the subgrade. In the event of failure of the vibrator, and if no replacement unit is available, the concrete in these areas may be consolidated by means of hand spading for the remainder of the day.

H1c Full-Width Vibrator Operation

Full-width vibrators shall operate between 60 (3600 VPM) and 100 Hz (6000 VPM) in the concrete and between 70 (4150 VPM) and 115 Hz (6900 VPM) when checked in air. The vibrators may be either of the surface or internal vibration type. The vibrator impulses shall be delivered directly to the concrete and the intensity of vibration shall be sufficient to consolidate the concrete mass thoroughly and uniformly throughout its entire depth and width.

The rate of progress of the vibratory equipment and the duration of the application shall be so regulated that the concrete is fully but not excessively vibrated. Excessive vibration, as indicated by segregation or undesirable water gain in the upper zone of the pavement, will not be permitted. The operation of vibrators shall be suspended when the forward progress is interrupted.

If the vibratory equipment temporarily fails or if its use is discontinued, the work may continue by using the standard machine placement method of consolidation, provided the concrete mixture is redesigned for that method. Any increase in concrete or cement costs resulting from such change shall be borne by the Contractor.

H1d Pan Finishing

Except as otherwise provided hereinafter, all concrete that has been consolidated and screeded with power-operated machines shall be further smoothed by a pan-type float finisher. The pan-type finishing unit shall include two reciprocating screeds and the pan float. The second screed board and the pan float shall be suspended from the frame of the unit near the mid-span of the wheel base. The pan float shall not be supported by or permitted to ride on the side forms. The screeds on the pan-type finisher will be considered as performing the second screeding operation. The pan-type finishing machine shall be operated in the forward direction only, without
stops or reversals, except in case of emergency.

The use of power-operated pan floats will not be permitted on areas of pavement where the crown or elevation must be adjusted or warped to meet that of an intersecting pavement, or where the number, size, or location of manholes or other appurtenances will interfere with or delay the operation of the float. In such cases, the surface shall be finished with metal-shod long-handled floats.

H2 Standard Machine Placement

The concrete shall be designed for standard machine placement. The operations and equipment shall be the same as those specified for the vibratory machine method of placement, except as modified hereinafter.

There shall be at least one mechanical spreader and one standard finishing machine. On single lane construction and on widening lanes, the floating may be performed either with manual or power operated floats. Mechanical spreaders will not be required on pavements constructed 6 m (19 feet) or less in width.

Full width vibratory equipment will not be required. No consolidation of the concrete will be required, other than that obtained through operation of the finishing machine, and except as provided for concrete consolidation by means of the portable vibrator according to 2301.3H.

H3 Manual Placement

The concrete shall be designed for manual placement, and the manually operated screeds shall be operated over each section of the pavement so constructed as many times as necessary to produce a surface conforming to the Plan crown and gradient of the pavement.

Manually operated screeds shall be steel-shod and be equipped with vibrators, pull rods, and handles. They shall be shaped as required by the nature of the work.

I Blank

J Slipform Construction

The concrete shall be designed for vibratory machine placement when the slipform method of construction is to be used, and the concrete shall be placed with an approved slipform paver designed to spread, consolidate, screed, and float finish the freshly placed concrete in such manner that a minimum of hand finishing will be necessary to provide a dense and homogenous pavement in conformance with the Contract. The slipform paver shall have (as one of its components) a non-oscillating extrusion plate with an adjustable angle of entry.

Consolidation shall be accomplished with vibrating tubes or arms working in the concrete or with a vibrating screed or pan operating on the surface of the concrete. Vibrators shall operate at the frequencies listed for full-width vibrators in 2301.3H. Internal vibrators shall be spaced at 600 mm (24 inches) intervals maximum for slipform machine speeds of less than 5 m (16 feet) per minute and at 450 mm (18 inch) maximum intervals for speeds of 5 m (16 feet) per minute or greater. The outer vibrators shall operate at a distance of 150 to 225 mm (6-9 inches) from the edge of
An electronic monitoring device displaying the operating frequency of each individual internal vibrator shall be required for concrete pavement that is placed by the slipform method. The monitoring device shall have a readout display near the operator's controls visible to the paver operator and the Contracting Authority. It shall operate continuously while paving, and shall display all the vibrator frequencies with manual and automatic sequencing among all individual vibrators. The monitoring system shall also record at a minimum, the following: clock time, station location, paver track speed and operating frequency of individual vibrators. Recordings shall be made (at a minimum) after each 7.62 m (25 feet) of paving or after each 5 minutes of time. A record of the data (CD) shall be provided to the Contracting Authority upon completion of the concrete paving operation or daily, if requested.

The cost of furnishing, installing, and monitoring vibrators and vibrator monitoring devices shall be considered incidental to the Contract unit price for PCC pavement.

The concrete shall be maintained at a uniform consistency, as will produce no appreciable edge slump or irregular edge alignment. Consistency requirements will be modified as necessary. Edge slump in excess of 5 mm (1/8 inch) will not be allowed.

The slipform paving operations for mixing, delivering, spreading, and extruding the concrete shall be coordinated to provide uniform progress of the paver. If, for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately.

When specified for automatic grade control, the paver shall be so equipped. These automatic controls shall be capable of maintaining the proper elevation at both sides of the paver by controlling the elevation of one side and controlling the crown, or by controlling the elevation of each side independently. The grade reference shall be achieved by means of an erected string line.

Erected string line control shall consist of a tightly stretched wire or string, offset from and parallel to the pavement edge on one or both sides, and set parallel to the established grade for the pavement surface. The Contractor shall set this control reference and shall support the line at intervals as close as necessary to maintain the established grade and alignment. The control line shall be set sufficiently in advance of paving to avoid delays.

K Joint Construction

Unless otherwise indicated in the Plans, all joints shall be perpendicular to the subgrade. Dowel bars shall be placed parallel to the subgrade and parallel to the centerline of the pavement.

Contraction joints shall be spaced at the intervals shown in the Plans except that, adjacent to header joints, reinforced panels, railroad grade crossings, and the free ends of pavement, the spacing shall be shortened as necessary to provide panel lengths not less than 3 m (10 feet) long.

Initial joint sawing shall be approximately 3 mm (1/8 inch) wide and to
the full joint depth. The initial sawing shall be accomplished as soon as the condition of the concrete will permit without raveling and before random cracking occurs. The sequence of initial sawing shall be at the Contractor’s option. Widening of the joints to full width shall not be performed until the concrete is at least 24 hours old and shall be delayed longer when the sawing causes raveling of the concrete.

The location of each transverse joint shall be marked in a manner satisfactory to the Engineer, prior to placement of the concrete and, in the case of joints that are to be sawed, the markings shall be transferred to the fresh concrete as soon as the final finishing operations have been completed. Water under nozzle pressure shall be used to remove the sawing residue from each joint and the pavement surface immediately after completing the sawing of that joint.

Preformed joint filler material for expansion joints shall be staked in place in order to maintain its proper position during concrete placement. The filler material shall have a metal shield on the top edge to protect the material and maintain proper alignment. The shield shall be removed after completion of the longitudinal floating over the joint and while the concrete is still plastic.

Transverse joints constructed in the pavement shall be extended through the integrant curb.

When placing concrete adjacent to inplace concrete pavement joints, protect all ends of transverse joints to the satisfaction of the Engineer to prevent concrete mortar from infiltrating into the existing joints and causing compression spalls.

1. Surface Finishing

After the concrete has been consolidated, screeded, and floated, the pavement surface shall be given a final finish texture. This final finish shall be obtained by drawing a carpet drag longitudinally along the pavement before the concrete has attained its initial set. The drag shall be mounted on a bridge. The dimensions of the drag shall be the width of the concrete placed by a longitudinal length having sufficient surface contact to produce a texture satisfactory to the Engineer.

The carpeting for the carpet drag shall be an artificial grass type having a molded polyethylene pile face with a blade length of 15 to 25 mm (\(5/8\) -\(1\) inch) and a total minimum mass of 2.35 kg/m² (weight of 70 ounces per square yard). The backing shall be of a strong, durable material not subject to rot, that shall be adequately bonded to the facing to withstand use as specified.

In addition to and immediately following the carpet drag, provide the pavement surface with a transverse metal-tine texture. This operation requires a mechanized device providing a randomized spacing of 16-26 mm (approximately \(5/8\) -\(1\) inch). The required tine width is 2-3 mm (approximately \(1/12\) -\(1/8\) inch) and the required tine depth is 3-8 mm (approximately \(1/8\) - \(5/16\) inch) with care not to dislodge coarse aggregate particles. Manual methods for achieving similar result may be used on ramps and other locations approved by the Engineer. Other texturing equipment
may be approved for use provided an equivalent texture is obtained.

The above specified metal-tine texturing will not be required on such subsidiary paving areas as cross-overs and parking lanes as the Engineer exempts, or on certain restricted speed limit areas (under 55 km/h (35 miles per hour)) as specifically exempted in the Contract or by the Engineer.

M  Concrete Curing and Protection

The Contractor shall:

(1) Cure and protect the concrete by the blanket curing method or one of the membrane curing methods.

(2) Cure the entire pavement surface and edges as soon as surface conditions permit after the finishing operations.

(3) Continue curing and protecting the concrete for at least 72 hours.

(4) Place the curing media on the pavement edges within 30 minutes after removal of the forms when side forms are used.

(5) Extend the minimum curing period to 96 hours when fly ash or Portland-pozzolan cement substitutions are used.

(6) Use the extreme service membrane curing method after September 15 north of the 46 degree parallel, after October 1 south of the 46 degree parallel, and before April 15.

(7) Provide sufficient curing blankets as described in 2301.3M1 to readily protect the concrete from rain and cold temperature when the membrane curing method is used.

M1 Blanket Curing Method

The pavement surfaces shall be covered with waterproof paper or plastic sheeting as soon as possible (without marring the pavement) after completion of the finishing operations.

The curing blankets shall be in such a condition and shall be so placed as to provide an airtight and moisture proof covering that will prevent loss of water vapor from the underlying pavement during the curing period. When placed, the adjoining blankets shall overlap at least ½ m (18 inches). This lap shall be secured with a windrow of earth to form a closed joint, and each blanket shall have a windrow of earth along the edges of the pavement to hold the blanket in place. Additional mounds of earth shall be placed at random over the blanket to prevent displacement or billowing of the blankets by the wind. After removal of forms, the extra width provided in the blankets or the stringer strips shall be folded down over the sides of the pavement and be secured by a continuous windrow of earth as a seal. Plowing of this windrow into place will not be permitted.

M2 Membrane and Extreme Service Membrane Curing Method

The exposed surfaces of the concrete shall be coated with membrane curing compound immediately after the last texturing operation. The only exception is when the concrete must be protected from adverse weather conditions and the Contractor elects to do this by placing plastic sheeting over the concrete; the curing membrane must then be applied immediately after the sheeting is removed. The compound shall be applied with an approved fully-automatic spraying machine, at the minimum rate of 4 m²/L (150 square
feet per gallon) of surface area.

Hand operated spray equipment may be used for applying the compound on pavement edges and irregular shaped surfaces.

Before being placed in the spray equipment, the compound shall be thoroughly mixed in the shipping containers by the use of compressed air, or by other approved means. All emulsion type cures shall be protected from freezing while in storage on the job site and while in the spray equipment.

The equipment shall be operated in a manner that will direct the membrane compound to the surface from two different lateral directions. When a single set of nozzles is mounted on a bar that extends longitudinally over the pavement, the compound shall be applied in two passes of the nozzles over the surface, one in each direction. When two sets of nozzles are mounted on two transverse lines over the pavement in a staggered manner and the membrane compound from either set of nozzles will uniformly cover the pavement surface, application may be accomplished in one pass of the unit. If used, the spray bar drive system shall operate independently of the wheels or track drive system. The equipment shall also include a storage tank with an agitator, a filter system, check valve nozzles, and a shield to control loss of material by wind action.

Should any spot check indicate a deficiency in material usage appreciably below the specified minimum rate, the surface area in question shall be resprayed or shall be covered with curing blankets. Also, should the membrane film become damaged at any time within the required curing period, the damaged areas shall be repaired immediately by respraying.

Joint Sealing

The Contractor shall not seal joints until they have been inspected and approved by the Engineer. At the time they are sealed, the concrete shall be surface dry and the joints shall be thoroughly cleaned of all debris, dirt, dust, and other foreign matter, including accumulations of concrete. Just before the joints are sealed, the Contractor shall clean the joints with a jet of compressed air under pressure of not less than 580 kPa (85 pounds per square inch). The Contractor shall seal integrant or tied curb joints with the same joint sealer as used to seal the pavement joints.

Table 2301-N defines what type of sealant shall be used in the longitudinal joints based on what sealant type is used in the transverse joints.
Table 2301-N

<table>
<thead>
<tr>
<th>If the transverse joints is:</th>
<th>Seal the longitudinal joints with:</th>
</tr>
</thead>
<tbody>
<tr>
<td>3721 – Preformed Elastomeric</td>
<td>3723 – Hot Pour</td>
</tr>
<tr>
<td>3722 – Silicone</td>
<td>3723 – Hot Pour</td>
</tr>
<tr>
<td>3725 – Hot Pour</td>
<td>3725 – Hot Pour</td>
</tr>
</tbody>
</table>

If the type of sealant for transverse joints is not specified elsewhere in the Contract, the Contractor shall select an approved 3722 silicone sealant from the list of approved products available on Mn/DOT’s Concrete Engineering Unit website.

When any fraction of the coarse aggregate in the concrete mixture is Class B aggregate, joint sealing with 3722 silicone is not allowed.

The handling and placing of joint sealer material shall be performed in accordance with the following provisions:

N1 Hot Poured Sealers

Hot poured sealers shall be heated in a double-boiler type kettle or melter having the space between inner and outer shells filled with oil or other heat transfer medium. The heating equipment shall include automatic temperature control, mechanical agitation, and recirculating pump provisions. Since some materials are subject to damage by overheating, reheating, or prolonged heating, proper care and equipment shall be used as recommended by the manufacturer of the sealer material.

Prior to final compressed air cleaning, the joint walls shall be lightly sandblasted.

The ambient temperature of the pavement shall be above 4°C (39°F) during application of the sealer.

N2 Silicone Sealers

Silicone sealers shall be installed according to manufacturers recommendations.

Joints shall be filled in a neat, workmanlike manner and in conformance with the tolerances shown in the Plans. The use of a backup material or bond-breaker in the bottom of the joint will be required to control the depth of sealant, achieve the desired shape of the sealant, and support the sealant against indentation and sag. The backup and bond-breaker materials shall be compatible with the sealer. Any joints filled above permissible level shall be corrected by removing and replacing the sealer at no expense to the Department.

As the joint filling operations progress, the sealant surface shall be dusted with talc or be covered with single layer paper tissue to prevent small incompressible particles (stone pebbles and chips) from bonding to the exposed tacky surface.

Heating and filling operations shall be coordinated so that no more sealer material is melted than can be used the same day. Once the sealer material has been heated to application temperature it shall be so maintained until it is
placed. The sealer material shall be placed within 4 hours after the initial heating to the application temperature.

N3 Preformed Sealers

The seals shall be furnished in one continuous length for each joint, except that:

(a) In contraction joints, butt splices will be permitted at longitudinal joints, and

(b) In expansion joints, one butt splice per lane width will be permitted, provided the splice is made by factory methods that have been approved by the Materials Engineer.

In its final position in the joint, the upper corners of the preformed seals shall be below the pavement surface as shown in the Plans, and the walls of the seal shall not fold over at the top of the joint.

Stretching of the sealer material in the installation process shall not exceed 5 percent of the joint length.

Wherever an expansion joint abuts aggregate or bituminous surfaced shoulders, the ends of the expansion joint shall be sealed in the same manner as the top portion of the joint. A wedge-shaped section shall be removed from the bottom part of the seal where it makes a right angle turn from the top to the side of the joint. The seal shall extend to the bottom of the pavement. No shouldering shall be placed in the areas of the expansion joints until the vertical joint ends have been so sealed.

N4 Preformed E-8 Expansion Joint Sealer

The preformed material utilized for sealing the E-8 expansion joints shall be one of the following or an approved equal:

(A) "Pressure-Relief"

(B) "Eva Seal"

Material shall be installed according to the manufacturers recommendations.

O Blank

P Workmanship and Quality

P1a Surface Requirements

The Engineer will only accept pavement that meets the specified requirements within permissible tolerances for payment at the Contract bid prices. Pavement that fails to meet the minimum requirements when tested in the prescribed manner is considered defective. Defective pavement is subject to the provisions made herein for correction or adjusted payment. In addition, the concrete incorporated in the work is subject to 2461.

The Engineer will determine the limits of each individual defective pavement area and, when such areas are subject to price adjustment, the area is computed to the nearest whole square meter (square yard), except that areas of less than 1 m² (square yard) are considered 1 m² (square yard). The condition of each individual defective area of pavement is assessed based on the greatest deficiency within that area.

If any random or uncontrolled crack occurs in concrete pavement, the Engineer may require replacement of the pavement or portions thereof or require repairs and/or may require a reduced payment. If the Engineer
approves repair of the pavement, the Contractor shall repair the pavement using dowel load-transfer techniques listed in the latest Department's Rehabilitation Standards/Details. The Contractor shall submit to the Engineer for approval, the specific standard technique intended for repair. After approval by the Engineer, the Contractor shall perform replacement or repair work at no expense to the Department. The Contractor shall replace failed repairs at no expense to the Department. Acceptance of the repairs shall comply with the acceptance procedure for the pavement portion of the Project.

P1b Surface Smoothness

After completion of the initial curing period and prior to the opening of the roadway to traffic, the Contractor shall test the pavement surface for surface smoothness and ride quality. Surface Smoothness and Ride Quality shall be measured with a 7.62 m (25 foot) California type profilograph, or a Lightweight Inertial Profiler (IP), which produces a profilogram (profile trace of the surface tested). Either type of device must be certified according to the procedure on file in the Mn/DOT Concrete Engineering Unit. See 2301.3P1c to determined if ride quality is required.

The Contractor shall furnish a properly calibrated, documented, and certified 7.62 m (25 foot) wheel base, California type, computerized profilograph or Lightweight Inertial Profiler (IP) and competent operator in its operation to measure pavement surface deviations in the longitudinal direction. The computer shall smooth the profile using a third-order Butterworth filter with a cutoff wavelength of 0.6096 m (2.0 feet). The computer shall generate a profile index using 0.2 inch blanking band and shall use a 7.62 mm (0.3 inch) bump threshold to identify "must grind" locations. Operate the profilograph in accordance with the manufacturer's instructions and at a speed no greater than a normal walk. Operate the IP at the optimum speed as defined by the manufacturer. To determine the profile index for mainline pavement, irregular pavement and ramps, make one pass in the right wheel path (2.7 m (9 feet) from center line). Run the profilograph or IP in the direction of driving traffic.

Make runs continuous and stop approximately 30 m (100 feet) prior to a construction header. Evaluate construction headers for smoothness on the next subsequent pass. Evaluate for smoothness all terminal headers that tie into existing pavement and the existing portland cement concrete pavement existing approximately 15 m (50 feet) adjacent to the terminal header. Bridge approach panels and bridge surfaces are exempt from these requirements; however, paving start-up areas are not exempt. Lift the test wheel and clearly label the profilogram to mark the beginning and end of each trace, each equation and each 152.4 m (500 foot) marker. Completely label each trace to show the Project number, stationing, lane, wheel pass, date paved, date tested and the operator’s name. Make runs within 48 hours of pavement placement.

Turn over the profile index (California Test Method 526 on file) test results and the trace to the Engineer within 48 hours of each run. The trace shall include identification of all bumps and dips and the signature of the
operator. This data is also used for ride quality determination when required.
The Engineer may test the entire Project length by a Mn/DOT certified independent source. If the Engineer determines that the Contractor's certified test results are inaccurate, the Contractor is charged for this work at a rate of $500 per lane 1.6093 km (1 mile), with a minimum charge of $1000.

When the profile trace shows a successive, uninterrupted bump, dip, or dip, bump combination (up to a maximum of 3 alternating trace deviations that relate to one bump or dip on the roadway), identify and evaluate these occurrences as one event.

In the longitudinal direction, determine deviations according to California Test Method 526. In the transverse direction, determine deviations using a 0.9144 m (3 foot) straight edge.
The Contractor shall correct all pavement areas represented by bumps having deviations of 7.62 mm (0.3 inches) or more in 7.62 m (25 feet) in the longitudinal direction, or 7.62 mm (0.3 inches) in 0.9144 m (3 feet) in the transverse direction using an approved texture planing grinding device consisting of multiple diamond blades.

Bumps between 7.62 mm (0.3 inches) and 10.16 mm (0.4 inches) may remain in place without correction or penalty in sections with a speed limit of greater than 68 km/h (42 MPH) if the ride is satisfactory in the judgment of the Engineer.

Bumps between 7.62 mm (0.3 inches) and 13 mm (½ inches) may remain in place without correction or penalty in sections with a speed limit of less than 68 km/h (42 miles per hour) if the ride is satisfactory in the judgment of the Engineer. For uncorrected bumps greater than 13 mm (½ inches) which the Engineer allows to remain inplace, the Engineer will assess a $900 penalty for each bump in each traffic lane.

If the Engineer orders, the Contractor shall correct all pavement areas represented by dips of 13 mm to 25 mm (½ inch to 1.0 inch) in 7.62 m (25 feet) in the longitudinal direction, or in 0.9144 m (3 feet) in the transverse direction by removal and replacement of the pavement or by using an approved texture planing grinding device consisting of multiple diamond blades. If the Engineer does not order corrective action, the Contractor is assessed a $900 penalty per lane for each uncorrected dip between 13 mm to 25 mm (½ inch to 1.0 inch). If dips exceed 25 mm (1 inch), the Contractor shall remove and replace the pavement.

At no cost to the Agency, the Contractor shall remove all bumps and dips described above, surface test and provide necessary additional corrective work to achieve the required surface smoothness or riding quality.

All costs relative to Contractor providing the profilograph and the appropriate profile index and traces are included in the unit bid price for 2301.502, Concrete Pavement, Standard Width and Item 2301.503, Concrete Pavement, Irregular Width.
P1c Ride Quality
The Engineer will determine the final ride quality based on the results of the California profilograph or IP data provided under 2301.3P1b as modified
2301.3

Paving Projects less than 0.8 km (½ mile) in continuous length and those portions of a paving project where the posted vehicle speed is anticipated to be less than 68 km/h (42 miles per hour), as determined by the Engineer are exempted from these riding quality requirements. The occurrence of bridges shall not interrupt the continuity determination, but the bridge surface and approach panels are not included in the ride quality determination. All pavements within 75 m (250 feet) of a terminal header that is not adjacent to a paved surface are exempt.

(1) Each lane is divided into 0.1609 km (one-tenth mile) sections and tested by the California profilograph or IP.

(2) Remaining subsections shorter than 0.1609 km (one-tenth mile) is tested according to (1) above, but is prorated for equivalency in the riding quality.

(3) Sections or subsections not excluded, which have riding quality greater than 63.13 mm/km (4.00 in/mile) but less than or equal to 94.70 mm/km (6.00 in/mile) as measured by the California profilograph or IP are accepted at the unit bid price.

(4) Sections or subsections not excluded, which have riding quality greater than 94.70 mm/km (6.00 in/mile) but less than or equal to 126.26 mm/km (8.00 in/mile) as measured by the California profilograph or IP are accepted at the unit bid price less a payment deduction determined according to Table 2301-P1.

(5) Sections or subsections that have a profile index greater than 126.26 mm/km (8.00 in/mile) will require removal and replacement or texture planing to a profile index of 94.70 mm/km (6.00 in/mile) or less at the Contractor’s option. Sections or subsections that have a profile index greater than 94.70 mm/km (6.00 in/mile) may be texture planed to eliminate payment reductions. Planing to provide a bonus is not acceptable.

(6) Sections or subsections not excluded, which exhibit an exceptional riding quality less than 63.13 mm/km (4.00 in/mile), when tested by the California profilograph or IP, are paid at the unit bid price plus a bonus according to Table 2301-P1.
Table 2301-P1 (Metric)

<table>
<thead>
<tr>
<th>PI (millimeters per kilometer)</th>
<th>Pay adjustment per 0.1 km segment</th>
<th>$ Per 0.1 km segment per lane (Lane width may vary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00 – 63.13</td>
<td>(63.13 – PI) x 7.762</td>
<td>$0.00 - $490.00</td>
</tr>
<tr>
<td>63.13 – 94.70</td>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>94.70 – 126.26</td>
<td>0.2195(PI)^2 – 55.43(PI) + 3062</td>
<td>-$218.73 to -$437.41</td>
</tr>
<tr>
<td>&gt;126.26</td>
<td>Corrective Action **</td>
<td></td>
</tr>
</tbody>
</table>

** Remove and Replace or Diamond Grind to a PI of 94.70 or less

Table 2301-P1 (English)

<table>
<thead>
<tr>
<th>PI (inches per mile)</th>
<th>Pay adjustment per 0.1 mile Segment</th>
<th>$ Per 0.1 mile segment per lane (Lane width may vary)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0 – 4.0</td>
<td>(4.0 – PI) x 197.12</td>
<td>$0.00 - $788.48</td>
</tr>
<tr>
<td>4.0 – 6.0</td>
<td>0</td>
<td>$0.00</td>
</tr>
<tr>
<td>6.0 – 8.0</td>
<td>88(PI)^2 – 1408(PI) + 4928</td>
<td>-$352.00 to -$704.00</td>
</tr>
<tr>
<td>&gt;8.0</td>
<td>Corrective Action **</td>
<td></td>
</tr>
</tbody>
</table>

** Remove and Replace or Diamond Grind to a PI of 6.00 or less

The ride quality determination by the California profilograph method requires that the profilograph or IP is computerized to assimilate and store pavement profile data. All mainline pavement except those sections exempt above, are subject to (1) thru (6) above.

For easy review by the Engineer, the Contractor shall provide a profile index test summary report including the: station, length, square meters (square yards) represented, and price adjustment for each 0.1609 km (one-tenth mile) section. Adjacent lane results are reported in an adjacent column on the summary report.

No section or subsection will receive a riding quality bonus if more than 5 percent of the section or subsection is corrected by surface texture planing. Texture planed areas of sections are not eligible for incentive bonuses.
P2 Thickness Requirements

The finished pavement thickness will conform to the thickness shown in the Plans or as modified, in writing, by the Engineer. Modifications by the Engineer will be considered as being the plan thickness. Prior to the final acceptance of the work, the Contractor will core the pavement, as marked by the Department, for use as test specimens to verify the pavement thickness.

Coring will not begin until the new pavement has attained an age of 7 days or until control beams have attained a flexural strength of 3450 kPa (500 pounds per square inch). The Contractor will be responsible for filling the core holes with 3U18 concrete or another concrete mix approved by the Engineer. The Contractor will be responsible for all traffic control related to coring. All unacceptable cores and cores taken to delineate deficient pavement as outlined in 2301.3P2 or 2301.3P3 will be at the Contractor's expense. Coring will be in accordance with the following procedure:

The Engineer will calculate the number of cores required and their location using a random number procedure. The number of cores required will be calculated as follows:

(a) On each Project (and on each roadbed of a divided highway), main line pavement of each width, thickness and type will be divided into a series of 1500 m (5,000 foot) sections and one fractional section (or one fractional section if the total length is less than 1500 m (5,000 feet)), beginning at the point nearest the end of the Project shown in the Plans as the Beginning of the Project. Each loop and each ramp at each grade separation will be considered as one fractional section provided the thickness is the same; however a minimum of one core must be taken from each loop and/or ramp.

(b) One random core will be drilled from each 300 meter (1,000 foot) increment in each traffic lane of each 1500 meter (5,000 foot) section. In each fractional section over 150 meter (500 feet) in length, random cores will be drilled at the minimum rate of one core per 300 meter (1,000 feet) of traffic lane, but not less than a total of three cores.

(c) Selective cores may be taken as the Engineer directs, in addition to the random core program described above, but they will not be considered or used in computing the average thickness of acceptable pavement sections.

The Engineer will mark core locations on pavement and make any necessary location adjustments.

The Contractor will cut 100 mm (4 inch) nominal diameter cores at marked locations, other size cores will not be accepted. The cores will then be laid next to their holes in a curing condition (e.g., wrapped in wet burlap).

NOTE: If the age of the concrete pavement is older than 28 days, the cores will not be required to be stored in a curing condition. The Contractor will take precautions to ensure the quality of the cores. Cores that are out of round, have ridges, not perpendicular, etc. will not be accepted.

The Engineer will field measure the core thickness and verify (Field ID Number) the cores. Exploratory cores will be taken if the field measurements show any thin pavement, as described herein.

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The contractor, accompanied by the Engineer, will pick up the cores and store them, in a curing condition (water tank, 15-25°C (60-80°F)) if necessary, at the Department's field office.

The Contractor, accompanied by the Engineer, will transport the cores to the Mn/DOT's Office of Materials in a manner that will ensure their integrity. Examples of this would be to transport the cores in a bed of wet sand or to band the cores in a pyramid shape on a pallet, wet down and cover with plastic.

The contractor will be responsible for supplying all materials required for ensuring the integrity of the cores.

The pavement thickness will be determined by measuring the length of the cores in accordance with the procedure on file at the Office of Materials. This procedure provides for obtaining the average length of the core in one operation by the use of nine probes that are interconnected in a hydraulic linkage. The core length will be recorded to the nearest millimeter (0.05 inch).

Whenever any core shows a length deficiency of more than 10 mm (½ inch) from the planned thickness, exploratory cores will be taken. The first exploratory cores at any location will be taken 5 m (10 feet) on each side of the deficient core location and at the same distance from the pavement centerline, and one will be taken in the adjacent traffic lane if it was placed in the same operation. If the length of each one of the first exploratory cores is equal to or greater than the plan thickness of the pavement minus 10 mm (½ inch), no additional cores will be taken in that location. If any or all of these cores are not within such limitations, additional exploratory cores will be taken at intervals of 5 to 10 m (10-25 feet), as directed by the Engineer, at the same distance from the pavement centerline in the same lane as the original core. The coring will proceed in the direction of the deficiency until cores of satisfactory length are obtained.

Wherever the cores show a thickness deficiency greater than 10 mm (½ inch), the pavement will be considered to be defective. The defective pavement area will be considered as the entire area surrounding the deficient core (or cores) within a traffic lane and between acceptable cores. The remaining areas in an increment where the cores show a thickness deficiency no greater than 10 mm (½ inch) will be considered as acceptable pavement.

Where the cores are deficient in length by more than 10 mm (½ inch) and the concrete also has an air content less than 3.0 percent, the Contractor will remove and replace the defective pavement.

Where the cores are found to be deficient in length by more than 10 mm (½ inch) and the pavement represented by those cores is not required to be removed and replaced for other deficiencies, the Contractor may at his option either remove and replace the defective pavement or leave it in place in consideration of the payment deductions provided for herein, with the exception that the Engineer may order the removal and replacement of any pavement that is deficient in thickness by more than 25 mm (1 inch), in which case the following deductions will not apply.
Where the cores show a thickness deficiency exceeding 10 mm (½ inch), but less than 25 mm (1 inch), the pavement represented by those cores will not be excluded from the pay quantities; however, a deduction will be made from the moneys due the Contractor equal to the product of the defective areas and $25.00 per square meter ($20.00 per square yard). Pavement represented by cores showing a thickness deficiency of 25 mm (1 inch) or more will be excluded from all payments plus a deduction will be made from the moneys due the Contractor equal to the product of the defective areas and $25.00 per square meter ($20.00 per square yard). These deductions will be assessed in lieu of removing and replacing the areas of pavement which are deficient in thickness.

All acceptable random core lengths (not over 10 mm (½ inch) thickness deficiency) in each increment of a section or fractional section will be used to compute the average pavement thickness in each increment, except that where the length of any core exceeds the Plan thickness by more than 5 mm (0.30 inch), that core length will be limited to the Plan thickness plus 5 mm (0.30 inch). The average pavement thickness for each section or fractional section will be computed as the summation of the average thicknesses of the individual increments in the section or fractional section divided by the number of increments.

Whenever the average thickness of the acceptable pavement in a particular section or fractional section of the mainline pavement is found to be less than the Plan thickness by more than 3 mm (0.10 inch) or when the average thickness of the acceptable pavement in a fractional section of a Loop or Ramp is found to be less than the Plan thickness by more than 5 mm (¼ inch), the acceptable pavement in that section or fractional section (excluding any areas of defective pavement whether or not they have been removed and replaced acceptably) will be paid for at the Contract bid price, less a payment deduction determined in accordance with the following schedule:

<table>
<thead>
<tr>
<th>TABLE 2301-3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DEDUCTIONS FOR THICKNESS DEFICIENCY</strong></td>
</tr>
<tr>
<td>Thickness Deficiency Exceeding the Permissible Deviations</td>
</tr>
<tr>
<td>2 mm and below (0.01 to 0.08 inch, Incl.)</td>
</tr>
<tr>
<td>Over 2 mm to 4 mm (0.08 to 0.16 inch, Incl.)</td>
</tr>
<tr>
<td>Over 4 mm to 6 mm (0.16 to 0.24 inch, Incl.)</td>
</tr>
<tr>
<td>Over 6 mm to 8 mm (0.24 to 0.32 inch, Incl.)</td>
</tr>
<tr>
<td>Over 8 mm to 10 mm (0.33 to 0.40 inch, Incl.)</td>
</tr>
</tbody>
</table>
2301.5

3 mm (0.10 inch) for Mainline Pavement
5 mm (¼ inch) for Ramp or Loop Pavement, and for all Concrete Base

2301.4 METHOD OF MEASUREMENT
Concrete pavement construction will be measured in terms of the several items of work as provided for herein, with all measurements being subject to adjustment as provided for in 2301.3P.

A  Concrete Pavement
Concrete pavement will be measured by area based on the specified dimensions, including the area covered by integrant curb, and the area thus obtained will represent the surface area of the pavement as constructed. Irregular width pavement will be measured and paid for separately, if so indicated in the item name, but the pavement of every thickness and type will be included under the same item. Included in the standard width measurement will be all uniform width pavement. Irregular width pavement will include all tapers and irregular shapes.

B  Structural Concrete
Structural Concrete will be measured by volume based on the Plan thicknesses and the computed areas of concrete pavement. High early strength concrete sections will be measured separately only when and to the extent that separate compensation is provided therefor. Otherwise, the volumes of all pavement will be included in a single pay item, without regard to grade or strength of concrete or the type, width, and thickness of pavement.

C  Pavement Reinforcement
Pavement reinforcement will be measured by area of pavement constructed with metal reinforcement. Areas will be measured separately by type of reinforcement as shown in the Plans, without regard to the number of layers used, and with no allowance for laps, splices, waste, and supporting devices.

D  Expansion Joints
Expansion joints of each design designation, as detailed in the Plans, will be measured separately by length along the joint line.

E  Reinforcement Bars
Reinforcement bars will be measured by mass (weight) prior to coating with epoxy, in accordance with 2472.4A. No measurement will be made under this item of those bars that are paid for as pavement reinforcement.

F  Integrant Curb
Integrant curb of each design will be measured separately by length.

G  Dowel Bars
Dowel bars will be measured by the actual number of individual dowels placed. No measurement will be made under this item for dowels that are paid for as a part of expansion joint construction.

H  Bridge Approach Panels
When the Proposal contains an item (or items) for construction of bridge approach panels, their construction will be measured and paid for separately as complete in place items. Measurements will be as indicated in the
Proposal, either by the number of complete panels of each design, or by the total area of all panels of the same basic design. In the absence of such items, the panel construction will be measured for payment under the several items provided for pavement construction.

I  Blank

J  Concrete Coring

The Engineer will measure the number of cores designated in the Contract or ordered by the Engineer that are acceptably taken, identified, and delivered as required.

K  Permanent Terminal Headers

Measurement will be made by the meter (linear foot) of terminal header constructed as specified.

2301.5  BASIS OF PAYMENT

Payment for concrete pavement under 2301.501, 2301.502, or 2301.503, at the Contract bid prices per unit of measure will be compensation in full for all costs of constructing the pavement as specified, exclusive of those costs that are compensated for separately under other Contract items. The bid price includes all costs of fine grading, forming, spreading, screeding, finishing, curing, and protecting (the concrete, together with any other costs incidental to the pavement construction that are not covered by other items.

Payment for structural concrete at the Contract price per unit of measure will be compensation in full for all costs of producing, delivering, and depositing the concrete as specified, including all costs of the batch materials, mixing operations, and other incidentals involved in furnishing concrete for the work, except as otherwise provided by the following:

(a) Blank
(b) Blank
(c) High Early Concrete Mixes - Separate Pay Item: No extra compensation will be provided for the additional cement required in the production of high early strength concrete furnished as a separate pay item.
(d) High Early Concrete Mixes - Engineer's Ordered: In absence of a separate pay item for high early strength concrete, compensation will be provided in the amount of 20 percent above the Contract cubic meter (yard) price for standard strength concrete for the quantity ordered by the Engineer. The Contractor will also receive compensation for additional cement when the total cementitious exceeds 130% of the minimum cement content for the concrete mixture designation involved at a rate of invoice plus 15 percent. The Contractor shall also be compensated for the difference in cost of substituting cement for fly ash at the rate of the differences of the increased invoice costs plus 15 percent.
(e) Blank
(f) High Early Concrete Mixes – Contractor Requested, Engineer Approved: No extra compensation will be provided for high early strength concrete when requested by the Contractor.

Payment for pavement reinforcement of each type specified at the Contract prices per unit of measure of pavement in which the reinforcement is
placed will be compensation in full for all costs of furnishing and placing the metal reinforcement as specified, including all costs of tie wires, supporting devices, splicing, intermediate strike-off, and any other operations or materials incidental to furnishing and placing the reinforcement.

Payment for expansion joints of each design designation at the Contract price per unit of measure will be compensation in full for all costs of constructing the joints complete in place as detailed in the Plans, including the furnishing and placing of all required materials such as dowel bar assemblies, filler, and sealer materials.

Payment for dowel bars and reinforcement bars at the Contract prices will be compensation in full for all costs of furnishing and placing the materials as specified. No payment will be made under these items for those quantities that are compensated for on a complete unit basis as a part of other Contract items.

Payment for integrant curb at the Contract price per unit of measure for each design specified will be compensation in full for all costs of furnishing and placing the concrete, forming and finishing the curb, protecting and curing the concrete, and any other costs incidental to the completed curb.

Payment for construction of bridge approach panels at the Contract price per each panel complete in place, or at the Contract price per unit of measure for all panels, will be compensation in full for all costs of constructing the bridge approach panels as detailed in the Plans, including the costs of furnishing and placing concrete and steel, construction of integrant curb, terminal headers, concrete sills, protecting and curing the concrete, and other incidental work not specifically included for payment under other Contract items.

Payment for permanent terminal headers shall be compensation in full for all excavation, material and labor costs relative thereto.

The Department will pay the Contract unit price for each measured core. The Contractor shall accept this payment as compensation in full or all costs of material, labor, and equipment necessary to take the cores, deliver the cores as directed, fill core holes, provide traffic control, and provide other incidentals to the concrete coring.

Payment for concrete pavement construction will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2301.501</td>
<td>Concrete Pavement</td>
<td>square meter (square yard)</td>
</tr>
<tr>
<td>2301.502</td>
<td>Concrete Pavement, Standard Width</td>
<td>square meter (square yard)</td>
</tr>
<tr>
<td>2301.503</td>
<td>Concrete Pavement, Irregular Width</td>
<td>square meter (square yard)</td>
</tr>
<tr>
<td>2301.511</td>
<td>Structural Concrete</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2301.513</td>
<td>Structural Concrete, HE (High Early Strength)</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2301.521</td>
<td>Pavement Reinforcement, Type___</td>
<td>square meter (square yard)</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
<td>Unit</td>
</tr>
<tr>
<td>----------</td>
<td>--------------------------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>2301.529</td>
<td>Reinforcement Bars (Epoxy Coated)</td>
<td>kilogram (pound)</td>
</tr>
<tr>
<td>2301.531</td>
<td>Expansion Joints, Design</td>
<td>meter (linear foot)</td>
</tr>
<tr>
<td>2301.538</td>
<td>Dowel Bar</td>
<td>each</td>
</tr>
<tr>
<td>2301.541</td>
<td>Integrant Curb, Design</td>
<td>meter (linear feet)</td>
</tr>
<tr>
<td>2301.545</td>
<td>Concrete Coring</td>
<td>each</td>
</tr>
<tr>
<td>2301.551</td>
<td>Bridge Approach Panel</td>
<td>each</td>
</tr>
<tr>
<td>2301.553</td>
<td>Bridge Approach Panels</td>
<td>square meter (square yard)</td>
</tr>
<tr>
<td>2301.561</td>
<td>Permanent Terminal Header</td>
<td>meter (linear foot)</td>
</tr>
<tr>
<td>2301.562</td>
<td>Concrete Shoulder</td>
<td>square meter (square yard)</td>
</tr>
</tbody>
</table>
2321

Road-Mixed Bituminous Surface

2321.1 DESCRIPTION

This work shall consist of constructing one or more courses of road-mixed bituminous surfacing on a prepared base.

Subject to approval of the Engineer, hot plant mixtures conforming to 2360 may be substituted for the cold mixture provided for herein, in which case the mixing, spreading, and rolling shall be done in accordance with 2360, with compaction being in conformance with the ordinary compaction method as described therein.

2321.2 MATERIALS

A Aggregate

The aggregate shall conform to 2360 mixture type SPWEB240, with the exception that the aggregate for any course other than a wearing course may consist of Class 5 aggregate conforming to 3138 and the following modifications:

1. Not less than 1 percent nor more than 7 percent of the aggregate shall pass the 75 µm (#200) sieve.
2. Within the specified gradation limits, the aggregate shall be uniform at the time of mixing.

If so requested by the Engineer, to determine quality and mixture proportions, representative production samples of the aggregate to be used in the production of wearing course mixture shall be submitted to the Materials Laboratory at least 15 days in advance of starting the wearing course mixture production.

B Bituminous Material

The bituminous material for the mixture shall conform to the requirements for one of the following kinds and grades, subject to any limitations imposed by the Contract. If any options are permitted, the kind to be used shall be optional with the Contractor, but the grade shall be as designated by the Engineer.

- MC Liquid Asphalt
- SC Liquid Asphalt
- Emulsified Asphalt

C Anti-Stripping Additive

If any additive is to be used, it may be added to the bituminous material at either the refinery or the job site. The blending shall be performed at a time and in a manner approved by the Engineer. When the additive is to be added on the job, the combined materials shall be mixed by not less than five complete circulations. No compensation in addition to the Contract prices will be made because of any additive that may be used.
2321.3

2321.3 CONSTRUCTION REQUIREMENTS

A General

These requirements provide for the construction of a base course, a leveling course, a binder course, and a wearing course, or any combination thereof, and are based on methods of construction by which the bituminous material is be applied to and mixed with the aggregate by road-mixing methods or in a central mixing plant.

B Restrictions

Bituminous materials and mixtures shall not be applied to or placed on an untreated subgrade at any time when the moisture content of the top 75 mm (3 inch) of the subgrade is more than 65 percent of optimum moisture.

If emulsified asphalt is used for the mixture, the aggregate shall, at the time the emulsion is applied, contain sufficient moisture to ensure satisfactory mixing. (Note: This may require the addition of water.) If any other bituminous materials are used for the mixture, the aggregate shall not contain more than 2 percent of free moisture at the time the bituminous material is applied.

An anti-stripping additive may be used only with the consent of the Engineer. In this case, the aggregate may contain free moisture up to a maximum of 4 percent.

If mixing is performed on the road by blade-mix methods, the bituminous material shall be applied with distributors.

If the blade-mix method is employed, bituminous material shall be applied and mixing performed only during daylight hours and when the air temperature is 10°C (50°F) or higher if the blade mix method is employed. The bituminous material shall be at least partially mixed with the aggregate before dark on the same day that it is applied.

If the mixing is performed by traveling plant or central mixing plant, it shall be performed when the air temperature is 4°C (40°F) or higher.

Spreading and compacting shall be performed only during daylight hours and when the air temperature is 10°C (50°F) or higher.

All mixtures shall be kept in windrows during rains and shall be free of surface moisture at the time of spreading and rolling operations.

The operations of depositing aggregates on the road, mixing aggregate with bituminous material, and spreading and rolling the mixture shall be conducted only on sections of such length as will meet the approval of the Engineer.

Each course shall be compacted and cured to such a degree that it will not be displaced or otherwise damaged before another course is placed thereon.
In general, no work within the roadbed will be permitted in the spring until seasonal load restrictions on roads in the vicinity have been removed. However, work within the roadbed may be permitted before that time if, in the opinion of the Engineer, it can be conducted without damage to the subgrade.

C  Equipment

C1  Distributor

The distributor shall be so designed, equipped, maintained, and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to 4.5 m (15 feet) at readily determined and controlled rates up to 9.0 L (2.0 gallons) per square meter (square yard), with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.1 L (0.02 gallon) per square meter (square yard). Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or calibrated tank, and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump and full circulation spray bars adjustable laterally and vertically.

C2  Pneumatic-Tired Rollers

Pneumatic-tired rollers shall have a mass of not less than 3600 kg/m (200 pounds per inch) of rolling width. "Wobbly wheeled" rollers will not be permitted.

C3  Steel-Wheeled Rollers

Steel-wheeled rollers shall be of the self-propelled and have a minimum total mass of 7.3 metric tons (8 tons), or as otherwise specified in the Contract. When vibratory rollers are used, they shall produce 45 kN/m (250 pounds per linear inch) of width. The roller shall be capable of reversing without backlash and shall be equipped with spray attachments for moistening all rollers on both sets of wheels.

C4  Motor Graders

Motor graders shall be of the self-powered type, mounted on pneumatic tires. They shall be equipped with a blade not less than 3 m (10 feet) long and shall have a wheel base of not less than 4.5 m (15 feet). Motor graders used for the final layout and finishing of the surface shall be equipped with smooth pneumatic tires.

C5  Traveling Mixing Plants

The traveling plant shall be self-propelled and capable of maintaining a uniform rate of travel while mixing. It shall be mounted on pneumatic-tired wheels or smooth tread crawler tracks of such size that the underlying road surface will not be rutted or damaged when the plant is loaded to capacity. The plant shall be so designed and constructed that it will pick up all of the aggregate cleanly from the road without damaging the underlying road surface.
2321.3

The traveling plant shall be capable of constantly measuring the bituminous material accurately, mixing it thoroughly with the aggregate, and depositing the mixture in a uniform windrow.

The traveling plant shall be equipped with sufficient valves and a stub pipe in the bitumen line between the pump and the spray bar to facilitate calibration of the output of the pump. They shall also be equipped with temperature and metering devices that will determine accurately the temperature and quantity of bituminous material being applied to the aggregate.

C6  Central Mixing Plants

When heating of the aggregate is not required, central mixing plants may be of any type that will produce a bituminous mixture conforming to the mix requirements of this Specification. However, as minimum requirements, the plant shall be equipped with temperature and metering devices that will determine accurately the temperature and quantity of bituminous material being applied to the aggregate. Feeding of the aggregate and bituminous materials into the mixer shall be synchronized by interlocking mechanical means or other positive method approved by the Engineer.

D  Treatment of the Surface

D1  Prime Coat

If so indicated in the Plans or directed by the Engineer, a bituminous prime coat shall be applied to the prepared base in accordance with 2358 prior to placement of the first course of bituminous mixture.

D2  Tack Coat

A bituminous tack coat shall be applied to existing bituminous or concrete surfaces and to the surface of each course constructed other than the final course, with the application being done in accordance with 2357 prior to placement of the next course thereon.

E  Depositing and Mixing Aggregate with Bituminous Material

After satisfactory absorption of the prime coat, if used, the required quantity of new aggregate shall be deposited on the road. The new aggregate and float aggregate, if used, shall be thoroughly mixed and then bladed into a single windrow of uniform cross section for measurement and adjustment as directed by the Engineer.

If the mixing is performed by the road-mix method or by a traveling plant that depends on a uniform forward speed to measure the aggregate windrow, a windrow proportioner (evener) shall immediately precede the mixing operations. The windrow shall be evened or shaped until all measured cross-sections taken at 30 m (100 foot) intervals are not less
than 95 percent or more than 105 percent of the average of all measured cross sections for the portion of the windrow involved.

If, on any portion of the Project, the base course is required to carry traffic during the interim period between its completion and the construction of the next course thereon, the bitumen content of the mixture for the base course on that section of the roadbed may be increased, at the option and direction of the Engineer, beyond the maximum limits provided above, but not to exceed the maximum application rate for wearing course mixtures.

The bituminous material shall be applied to the aggregate at a total rate designated by the Engineer, within the following limits:

TABLE 2321-1
BITUMINOUS APPLICATION RATE

<table>
<thead>
<tr>
<th>Kind of Bituminous Material</th>
<th>Rate in Liters per Metric Ton (Gallons/ton) of Dry Aggregate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Base, Leveling Binder Courses</td>
</tr>
<tr>
<td>SC</td>
<td>33 to 46 (8 to 11)</td>
</tr>
<tr>
<td>MC</td>
<td>42 to 58 (10 to 14)</td>
</tr>
<tr>
<td>SS, CSS</td>
<td></td>
</tr>
</tbody>
</table>

If the method of mixing employs equipment requiring the bituminous material to be applied in a separate operation, no single application of bituminous material shall be applied to the aggregate in a quantity exceeding 2.3 L/m² (½ gallons per square yard). The number and rate of applications shall be as directed by the Engineer. After each application, the bituminous material and aggregate shall be mixed sufficiently to produce a mixture of uniform color and, after the last application, the mixing shall continue until all particles of the aggregate are thoroughly coated and the mixture is free from fat or lean spots, balls, and uncoated particles.

The temperature of the bituminous material at the time of application shall be as approved by the Engineer, within the limits specified below:
TABLE 2321-2
TEMPERATURE OF BITUMINOUS MATERIAL

<table>
<thead>
<tr>
<th>Liquid Asphalt</th>
<th>MC-250, SC-250</th>
<th>40-105ºC (105-220ºF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC-800, SC-800</td>
<td></td>
<td>60-125ºC (135-255ºF)</td>
</tr>
<tr>
<td>Emulsified</td>
<td>SS-1, SS-1h,</td>
<td>20 to 70ºC (70 to 160ºF)</td>
</tr>
<tr>
<td>Asphalt</td>
<td>CSS-1, CSS-1h</td>
<td>20-70ºC (70-160ºF)</td>
</tr>
</tbody>
</table>

During the application of bituminous material, the changing of speed or the shifting of gears will not be permitted.

F Spreading

Before spreading the mixture, aeration by manipulation will be required until the mixture has become tacky and free of surface moisture to a degree satisfactory to the Engineer.

The bituminous mixture shall be spread without segregation to produce a layer of uniform thickness and the specified cross section.

The contact surface of curbs, concrete pavements, or other fixed structures shall be painted with a thin uniform coat of liquid bituminous material just before any bituminous mixture is placed against them.

After final compaction, all bituminous surfaces adjacent to gutters, manholes, pavement headers, or other fixed structures shall be slightly higher (but not to exceed 6 mm (¼ inch)) than the surface of such structures.

G Rolling

Rolling shall begin at the time the mixture is being spread and continue until after the mixture has been shaped to the required cross-section.

Each course shall be thoroughly and uniformly compacted for its full thickness with pneumatic-tired rollers traveling at speeds not to exceed 8 km/h (5 miles per hour). The final rolling on the last course constructed under the Contract shall be performed with steel wheeled rollers traveling at speeds not to exceed 5 km/h (3 miles per hour). The rolling shall begin at the lower edge of the course and progress toward the upper edge or centerline. Each pass of the roller shall overlap the preceding pass by at least half the width of the roller and shall terminate at least 1 m (3 feet) in advance of or to the rear of the termination of the preceding pass.

The entire surface shall be rolled until there is no further compaction and until all roller marks are eliminated. Rolling shall be discontinued whenever it begins to produce excessive crushing or pulverizing of the aggregate or displacement of the mixture. In places inaccessible to the roller, compaction equal to that obtained with rollers shall be secured by means of mechanical tampers.
As necessary to prevent adhesion of the mixture to the roller wheels, the contact surfaces of the wheels shall be kept properly moistened, using water or a water solution containing small quantities of detergent or other approved material. During the final spreading and compacting operations on each course, the Contractor shall check the thickness and surface for conformance with the thickness and surface requirements specified in 2321.3H. Any area that does not conform may be corrected by loosening the compacted surface, adding more mixture or reshaping the mixture, and recompacting. Lean, fat, or segregated areas shall be removed and replaced with new material. All corrections shall be made at no expense to the Department.

H Thickness and Surface Requirements

After compaction, the finished surface of any course shall show no variation greater than 6 mm (¼ inch) from the edge of a 3 m (10 foot) straightedge laid thereon parallel to the centerline.

After compaction, the alignment of the outside edges of any course shall be such that the distance between the edge and the established centerline shall not vary more than 75 mm (3 inches) from the distance shown in the Plans for that course.

After compaction, no portion of any course other than a leveling course shall vary from the thickness shown in the Plans for that course by more than 13 mm (½ inch). No individual test shall show a thickness deficiency of more than 13 mm (½ inch). On any area where tests show a thickness in excess of the Plan thickness plus 13 mm (½ inch), the Department reserves the right to exclude from the final pay quantities the materials used in the excess mixture, above that required to construct the course in that area to a thickness equal to the Plan thickness plus 13 mm (½ inch).

I Blank

J Seal Coat

When specified in the Contract or ordered by the Engineer, designated areas of the finished surface shall be given a light bituminous seal coat in accordance with 2356.

If the Contract does not provide for application of a seal coat with cover aggregate, or if weather conditions at the time the seal coat would be applied in the normal sequence of operations do not permit its application at the time, the Contractor shall apply a fog seal if the Engineer so directs, using bituminous material of any kind and grade approved by the Engineer. Slow curing liquid asphalt will not be approved for use as fog seal material. The time and rate of application shall be as directed by the Engineer, with the rate of application not to exceed ½ L/m² (0.1 gallon per square yard).
2321.3

K  **Aggregate in Stockpiles**
When the Contract contains an item for stockpile aggregate, the Contractor shall, in addition to the aggregate required for the bituminous surfacing, produce and deliver aggregate of the class specified to the Department at the designated sites. Delivery shall be made when and as approved by the Engineer. Construction of stockpiles shall be as directed by the Engineer.

2321.4  **METHOD OF MEASUREMENT**
A  **Aggregate**
Aggregate will be measured, as indicated in the Proposal, by mass or LV of material deposited on the road. When mixing is performed in a hot-mix plant, the measured weights will include the weight of the bituminous material incorporated into the mixture.

B  **Bituminous Material**
Bituminous materials will be measured by volume. Bituminous material used for fog seal will be measured and included for payment with the measured quantity of bituminous material for mixture.

C  **Stockpile Aggregate**
Stockpile aggregate of each class specified will be measured as indicated in the Proposal, by mass or loose volume of material delivered in stockpiles.

2321.5  **BASIS OF PAYMENT**
Payment for the accepted quantities of aggregate and bituminous material incorporated in the mixture at the Contract prices per unit of measure will be compensation in full for all costs of constructing the bituminous surfacing as specified.

Payment for stockpile aggregate of each class specified, at the Contract prices per unit of measure, will be compensation in full for all costs of producing and delivering the material to the Department at the designated sites, including all costs of constructing the stockpiles as specified.

Payment for the road-mixed bituminous surface will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2321.503</td>
<td>Bituminous Material for Mixture</td>
<td>liter (gallon)</td>
</tr>
<tr>
<td>2321.506</td>
<td>Aggregate</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2321.507</td>
<td>Aggregate</td>
<td>cubic meter (cubic yard)</td>
</tr>
<tr>
<td>2321.511</td>
<td>Stockpile Aggregate, Class</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2321.513</td>
<td>Stockpile Aggregate, Class</td>
<td>cubic meter (cubic yard)</td>
</tr>
</tbody>
</table>
2355

Bituminous Fog Seal

2355.1 DESCRIPTION
This work shall consist of treating an existing bituminous pavement to seal the surface.

2355.2 MATERIALS
A Bituminous Material
The bituminous material for fog seal shall be one of the following kinds and grades conforming to 3151.
RC liquid Asphalt..................................................................... RC-70
Emulsified Asphalt
  Anionic ....................................................................... SS-1, SS-1h
  Cationic........................................................................ CSS-1, CSS-1h

2355.3 CONSTRUCTION REQUIREMENTS
A Restrictions
Fog seal operations shall be conducted in a manner that will offer the least inconvenience to traffic, with movement in at least one direction permitted at all times without pickup or tracking of the bituminous material.

The fog seal shall not be applied until the road surface and weather conditions are acceptable to the Engineer.

For air temperatures greater than 4°C (40 °F), asphalt emulsion shall be used unless it is no longer available for the season. When conditions require that liquid asphalt (RC-70) be used, the Engineer may require a light application of sand to prevent material pickup or tacking.

B Equipment
The bituminous material shall be applied with a distributor meeting the requirements of 2321.3C1.

C Road Surface Preparations
At the time of applying bituminous material, the road surface shall be dry and clean, and all necessary repairs or reconditioning work shall have been completed as provided in the Contract.

All objectionable foreign matter on the road surface shall be removed and disposed of by the Contractor as approved by the Engineer.

D Application of Bituminous Material
The bituminous material shall be applied at a uniform rate of
(1) 0.45 to 0.70 L/m² (0.10 to 0.15 gallon per square yard) for diluted asphalt emulsion, or,
(2) 0.45 L/m² (0.10 gallon per square yard) for RC-70 cutback asphalt.
The time and rate of application shall be as directed by the Engineer.

The temperature of the bituminous material at the time of application shall be as directed by the Engineer, within the limits specified below:

- **Liquid Asphalt RC-70**: 50 to 80°C (120-175°F)
- **Emulsified Asphalt SS-1, SS-1h, CSS-1, CSS-1h**: 20 to 70°C (120-175°F)

The asphalt emulsion shall be diluted with water, 50 percent by volume, to improve the material application and distribution characteristics. However, the added water will be excluded from the pay quantities.

Sand shall be spread on the newly fogged surface at pedestrian crossings unless otherwise directed by the Engineer.

**2355.4 METHOD OF MEASUREMENT**

**A Bituminous Material**

Bituminous material used for fog seal will be measured by volume at 15°C (60 °F).

**2355.5 BASIS OF PAYMENT**

Payment for the accepted quantity of bituminous material used for fog seal at the Contract price per unit of measure will be compensation in full for all costs of furnishing and applying the material as specified.

Furnishing and applying sand on the newly fogged surfaces shall be at no expense to the Department.

Payment for fog seal will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item Description</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2355.502</td>
<td>Bituminous Material for Fog Seal</td>
<td>liter (gallon)</td>
</tr>
</tbody>
</table>

**2356 Bituminous Seal Coat**

**2356.1 DESCRIPTION**

This work shall consist of an application of bituminous material followed by an application of cover aggregate on designated areas of an existing bituminous pavement.

**2356.2 MATERIALS**

**A Bituminous Material**

The bituminous material for seal coat shall be one of the following kinds and grades conforming to 3151. When the Contract quantity exceeds 7500 L (2000 gallons), and unless other options are permitted by the Plans or Special Provisions, the kind to be used shall be emulsified asphalt, cationic grades. In all cases the grade to be used shall be as designated by the Engineer.
2356.3 CONSTRUCTION REQUIREMENTS

A Restrictions

Seal coating operations (including traffic restrictions on the freshly constructed seal coat) shall be conducted:

1. Not before May 15 nor after August 31;
2. Only during daylight hours;
3. When the pavement and air temperature are 20°C (70°F) or higher;
4. When the relative humidity is less than 75 percent; and
5. When the road surface is dry and clean.

The seal coating operations shall not be started, and shall be suspended, when any one of the above conditions cannot be met.

B Equipment

B1 Distributor

The bituminous material shall be applied with a distributor meeting the requirements of 2321.3C1.

B2 Aggregate Spreader

The cover aggregate shall be applied with an approved mechanical type aggregate spreader that is capable of distributing the aggregate uniformly to the required width and at the designated rate, with the application sharply defined at the edges.

The aggregate spreader shall be a self-propelled type mounted on pneumatic-tired wheels that are so located as to operate on the freshly applied aggregate.

B3 Pneumatic-Tired Roller

The pneumatic-tired roller shall have a compacting width of 1.5 m (5 feet) or more and shall be so constructed that the gross mass of not less than 3500 kg/m (200 pounds per inch) of rolling width can be varied as directed by the Engineer. The tire arrangement shall
be such that full compaction will be obtained over the full width with each pass of the roller.

The roller may be self propelled or provided with suitable tractive equipment, unless the Contract specifies a certain type. If more than one roller propelled by a single tractive unit, the combination will be counted as a single roller unit.

B4  Paver Brooms
A rotary power broom shall be provided that is capable of cleaning the road surface prior to spraying bituminous material and to remove loose particles after treatment as required.

C  Road Surface Preparations
At the time of applying bituminous material, the road surface shall be dry and clean, and all necessary repairs or reconditioning work shall have been completed as provided for in the Contract.

All objectionable foreign matter on the road surface shall be removed and disposed of by the Contractor as the Engineer approves.

When specified in the Contract or ordered by the Engineer, a tack coat shall be applied to the prepared road surface in accordance with 2357.

D  Application of Bituminous Seal Material
Application of bituminous material shall be governed by the rate at which the cover aggregate is applied and by the provisions made for maintenance of traffic. No traffic shall be permitted on uncovered bituminous material.

Bituminous material shall not be applied until the loaded aggregate spreader is on hand ready to begin application of aggregate immediately, with sufficient truck loads of aggregate at the site to cover the length of the anticipated applications of bituminous material.

The bituminous material for seal coat shall be applied to the road surface at a rate designated by the Engineer, within the limits specified below for the class of aggregate to be used.

<table>
<thead>
<tr>
<th>Aggregate</th>
<th>Emulsified or Liquid Asphalts</th>
<th>AsphaltCement</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA-1</td>
<td>0.68-0.91 (0.15 - 0.20)</td>
<td>-</td>
</tr>
<tr>
<td>FA-2</td>
<td>0.68-1.1 (0.15 - 0.25)</td>
<td>-</td>
</tr>
<tr>
<td>FA-3</td>
<td>0.91-1.6 (0.20 - 0.35)</td>
<td>0.59-0.82 (0.13 - 0.18)</td>
</tr>
<tr>
<td>FA-4</td>
<td>1.4-2.0 (0.30 - 0.45)</td>
<td>0.68-0.91 (0.15 - 0.20)</td>
</tr>
<tr>
<td>FA-5</td>
<td>1.8-2.3 (0.40 - 0.50)</td>
<td>2.0-2.5 (0.45 - 0.55)</td>
</tr>
</tbody>
</table>
To prevent overlapping at the end junction at transverse joints, means shall be provided to ensure positive cutoff for the bituminous material and cover aggregate. A section of building paper or other suitable material shall be placed across the lane to be coated and be positioned so that the forward edge is at the desired joint location. The distributor, traveling at the correct speed, shall start spraying on the building paper so that when the exposed surface is reached, the spray will be full and uniform. The same procedure shall apply to cover aggregate placement. The masking material used shall be removed and be disposed of in a manner approved by the Engineer.

Application of the bituminous material shall produce a uniform film without ridges and skips. Adjustments to the spray bar and nozzles shall be made prior to application of the bituminous material on the areas to be sealed.

The temperature of the bituminous material at the time of application shall be as approved by the Engineer, within the limits specified below:

- Asphalt Cement ................................................... 175ºC (350 ºF) Max.
- RC Liquid Asphalt  
  - RC-250.............. 74 to 105ºC (165 to 220º F)  
  - RC-800.............. 93 to 107ºC (200 to 225º F)  
  - RC-3000............ 110 to 145ºC (230 to 290º F)
- Cationic Emulsified Asphalt  
  - CRS-1,2...52 to 85ºC (125 to 185º F)
- Anionic Emulsified Asphalt  
  - RS-1...........21 to 60ºC (70 to 140º F)  
  - RS-2............52 to 85ºC (125 to 185º F)

E Application of Cover Aggregate

The cover aggregate shall be spread immediately following the application of bituminous material. Under no circumstances shall operations proceed in such manner that the bituminous material remains uncovered for more than 1 minute so as to set-up or dry-out to an extent that will impair retention of the cover aggregate.

The aggregate, at the time of spreading, shall not contain more than 2 percent (by mass) of free surface moisture, except that when FA-1 aggregate or an asphalt emulsion is used, the aggregate shall contain not more than 4 percent of free surface moisture.

The aggregate shall be spread uniformly over the full width of the bituminous application, at a rate designated by the Engineer, within the range of 20 to 25 kg/m² (40 to 50 pounds per square yard) when FA-5 aggregate is used, or at the rate of 14 kg (100 pounds) of aggregate for each liter (gallon) of bituminous material used, per square meter (square yard).
To determine the volumetric rate of application, the mass per volume (truck measure) shall be determined by weighing a measured truck load on a scale furnished or made available by the Contractor.

Immediately after spreading the cover aggregate, any areas having non-uniform coverage shall be corrected to the satisfaction of the Engineer by removing excess material and spreading additional material over deficient areas. Variations in coverage exceeding 10 percent of the designated rate of application shall be corrected as ordered.

**F Rolling Operations**

Initial rolling shall follow immediately behind the spreading of cover aggregate, with the initial coverage completed within 5 minutes after spreading the aggregate. The surface rolling shall be continued until five complete coverages over the full width have been obtained. All rolling operations on an area shall be completed within 30 minutes after spreading the cover aggregate on that area.

All rolling shall be performed with approved self-propelled, smooth-tread pneumatic-tired rollers. A minimum of two rollers shall be used for rolling operations. The rollers shall not be operated at speeds exceeding 8 km/h (5 miles per hour). Rolling shall begin at the outer edge of the aggregate cover and proceed in a longitudinal direction, working toward the center of the road.

The completed surface shall present a uniform appearance. The surface shall be lightly broomed or otherwise maintained as necessary during the rolling operations to achieve uniform appearance.

**G Protection of the Surface**

No traffic shall be permitted on the sealed road surface until after all rolling has been completed and the bituminous material has set to a degree satisfactory to the Engineer and will not pick up on vehicle tires.

In addition to other barricades and warning signs required by the Contract, the Department will furnish and deliver to the Project such other barricades and warning signs as the Engineer deems necessary for use in conjunction with the seal coat construction. The Contractor shall erect and maintain those barricades and signs at locations directed by the Engineer.

The Contractor shall furnish traffic cones at least 450 mm (18 inches) in height and place them at intervals of not more than 60 m (200 feet) on the inner longitudinal edge of the freshly applied seal coat. These cones shall be maintained in place until the road is opened to unrestricted use by traffic.
When the road under construction is open to traffic during daylight hours, the Contractor shall furnish a minimum of two flagpersons and a pilot vehicle to direct and guide traffic through the construction zone. One flagger shall be stationed in advance of the seal coat operations and another at the rear barricade at the beginning of the uncovered bituminous material. It shall be the duty of the flagger to stop all traffic and to acquaint the traveling public with the nature of the work underway, the limitations on the road surface available for traffic use, and the reason for reduced driving speed.

The contractor shall provide a Traffic Control Plan consistent with the "Minnesota Manual on Uniform Traffic Control Devices (MN MUTCD) and approved by the Engineer."

On the morning following each day of seal coat operations, the Contractor shall sweep the surplus aggregate from the previous day's seal coat construction. This operation shall be conducted while the road surface is still cool, and care shall be exercised that the aggregate that has set is not disturbed. Where sealing is done in municipalities, the Contractor shall dispose of the surplus aggregate in a manner satisfactory to the Engineer.

2356.4 METHOD OF MEASUREMENT
A  Bituminous Material
   Bituminous material applied on the road will be measured by volume at 15ºC (60º F).
B  Seal Coat Aggregate
   Seal coat aggregate will be measured as indicated in the Proposal, by mass or LV of material deposited on the road.

2356.5 BASIS OF PAYMENT
   Payment for the accepted quantities of bituminous material (including any required additives) and seal coat aggregate at the appropriate Contract prices will be compensation in full for all costs of constructing the seal coat as specified.

   Payment for the bituminous seal coat will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2356.505</td>
<td>Bituminous Material for Seal Coat</td>
<td>liter (gallon)</td>
</tr>
<tr>
<td>2356.507</td>
<td>Seal Coat Aggregate</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2356.509</td>
<td>Seal Coat Aggregate (LV)</td>
<td>cubic meter (yard)</td>
</tr>
</tbody>
</table>

2357

Bituminous Tack Coat

2357.1 DESCRIPTION
   This work shall consist of treating an existing bituminous or concrete surface with bituminous material preparatory to placing a bituminous course or seal coat thereon.
2357.2 MATERIALS

A Bituminous Material................................................... 3151

The bituminous material for tack coat shall be one of the following kinds and grades conforming to 3151. When the Contract quantity exceeds 7500 L (2000 gallons), and except during periods of freezing temperatures, the tack coat material to be used will be limited to one of the kinds of emulsified asphalt. Otherwise, the kind to be used shall be optional with the Contractor. The grade to be used shall be as designated by the Engineer.

MC liquid Asphalt........................................................... MC-250, 800
RC Liquid Asphalt....................................................... C-70, 250, 800
Emulsified Asphalt,
   Anionic ........................................ SS-1, SS-1H, MS-2, RS-1, RS-2
   Cationic ...................................... CSS-1, CSS-1H, CRS-1, CRS-2

2357.3 CONSTRUCTION REQUIREMENTS

A Restrictions

Tack coat operations shall be conducted in a manner that offers the least inconvenience to traffic, with movement in at least one direction permitted at all times without pickup or tracking of the bituminous material. The tack coat shall not be applied when the road surface or weather conditions are unsuitable. The daily application of tack coat shall be limited to approximately the area on which construction of the subsequent bituminous course can reasonably be expected to be completed that day.

B Equipment

The bituminous material shall be applied with a distributor meeting the requirements of 2321.3C1.

C Road Surface Preparations

At the time of applying bituminous material, the road surface shall be dry and clean, and all necessary repairs or reconditioning work shall have been completed as provided for in the Contract.

All objectionable foreign matter on the road surface shall be removed and disposed of by the Contractor as the Engineer approves.

Preparatory to placing an abutting bituminous course, the contact surfaces of all fixed structures and the edge of the in-place mixture in all courses at transverse joints and in the wearing course at longitudinal joints shall be given a uniform coating of liquid asphalt or emulsified asphalt, applied by methods that will ensure uniform coating.

D Application of Bituminous Material

The bituminous material shall be applied at a uniform rate not to exceed:

1. 0.23 L/m² (0.05 gallon per square yard) for cutback asphalt and undiluted asphalt emulsion (as supplied from the refinery).
2357.5

(2) 0.91 L/m² (0.20 gallon per square yard) for diluted asphalt emulsion (with water added in the field).

The time and rate of application shall be as directed by the Engineer.

The temperature of the bituminous material at the time of application shall be as approved by the Engineer, within the limits specified following:

<table>
<thead>
<tr>
<th>Bituminous Material</th>
<th>Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Asphalt</td>
<td></td>
</tr>
<tr>
<td>RC-70</td>
<td>49 to 82°C (120 to 180°F)</td>
</tr>
<tr>
<td>RC-250, MC-250</td>
<td>74 to 104°C (165 to 220°F)</td>
</tr>
<tr>
<td>RC-800, MC-800</td>
<td>93 to 124°C (200 to 255°F)</td>
</tr>
<tr>
<td>Emulsified Asphalt</td>
<td></td>
</tr>
<tr>
<td>SS-1, SS-1H, MS-2, CSS-1, CSS-1H</td>
<td>21 to 71°C (70 to 160°F)</td>
</tr>
<tr>
<td>RS-1</td>
<td>21 to 60°C (70 to 140°F)</td>
</tr>
<tr>
<td>SS-2, CRS-1, CRS-2</td>
<td>52 to 85°C (120 to 185°F)</td>
</tr>
</tbody>
</table>

For asphalt Grades SS-1, SS-1H, CSS-1, and CSS-1H, water may be added up to 50 percent by volume to improve the material application and distribution characteristics. However, the added water will be excluded from the pay quantities.

Unless otherwise directed, sand shall be spread on the newly tacked surface at pedestrian crossings.

2357.4 METHOD OF MEASUREMENT

A Bituminous Material

Bituminous material used for tack coat will be measured by volume at 15°C (60°F).

2357.5 BASIS OF PAYMENT

Payment for the accepted quantity of bituminous material used for tack coat at the Contract price per unit of measure will be compensation in full for all costs of furnishing and applying the material as specified.

Furnishing and applying sand on newly tacked surfaces at pedestrian crossings shall be at no expense to the Department with no direct compensation being made therefore.

Should the Contract fail to include a Contract Item covering payment for the bituminous material used for tack coat, all costs of furnishing and applying bituminous tack coat material will be included in the compensation provided for the bituminous mixture, with no measurement made of the bituminous material used and with no direct compensation being made therefore.

Payment for the tack coat will be made on the basis of the following schedule:
2357.5

Item No. Item Unit
2357.502 Bituminous Material for Tack Coat .......... liter (gallon)

2358

Bituminous Prime Coat

2358.1 DESCRIPTION
This work shall consist of treating a prepared base with bituminous material preparatory to placing a bituminous course thereon.

2358.2 MATERIALS
A Bituminous Material ........................................... 3151

The bituminous material for the prime coat shall conform to the requirements for one of the following kinds and grades, subject to any limitations imposed by the Contract. If any options are permitted, the kind to be used shall be optional with the Contractor but the grade shall be as designated by the Engineer.

MC Liquid Asphalt MC-30, 70

2358.3 CONSTRUCTION REQUIREMENTS

A Restrictions
Bituminous prime coat shall not be applied at any time when the moisture content of the upper 80 mm (3 inches) of the base is more than 65 percent of optimum moisture, or when the weather or road surface conditions are otherwise unsuitable for proper construction.

When traffic is being maintained over the section of road under construction, not more than 50 percent of the traveled way shall be closed to traffic at any one time, and traffic movement in at least one direction shall be permitted at all times without pick up or tracking of the bituminous material.

B Equipment
The bituminous material shall be applied with a distributor meeting the requirements of 2321.3C1.

C Road Surface Preparations
At the time of applying the bituminous material, the subgrade shall be in acceptable condition, with all preparation and maintenance operations completed as required by other provisions of the Contract.

D Application of Bituminous Material
The bituminous material shall be applied in a uniform, continuous spread at the rate of 0.45 to 1.35 L per square meter (0.1-0.3 gallons) and in one or two applications, as directed by the Engineer.

Care shall be taken that the application of bituminous material at the junction of spreads is not in excess of the specified quantity. Excess bituminous material shall be squeegeed from the surface. Skipped areas and deficiencies shall be corrected.
The temperature of the bituminous material at the time of application shall be as approved by the Engineer, within the limits specified below.

<table>
<thead>
<tr>
<th>Material</th>
<th>Temperature</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC Liquid Asphalt</td>
<td>MC-30</td>
<td>29 to 63°C (85 to 145°F)</td>
</tr>
<tr>
<td></td>
<td>MC-70</td>
<td>49 to 82°C (120 to 180°F)</td>
</tr>
</tbody>
</table>

### 2358.4 METHOD OF MEASUREMENT

**A Bituminous Material**

Bituminous material for prime coat will be measured by volume at 15°C (60°F).

### 2358.5 BASIS OF PAYMENT

Payment for the accepted quantity of bituminous material used for prime coat at the Contract price per unit of measure will be compensation in full for all costs of furnishing and applying the material as specified, exclusive of those costs which are to be compensated for separately under other Contract items.

Payment for the prime coat will be made on the basis of the following schedule.

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2358.501</td>
<td>Bituminous Material for Prime Coat</td>
<td>liter (gallon)</td>
</tr>
</tbody>
</table>
2360.1

Plant Mixed Asphalt Pavement

2360.1 DESCRIPTION
This work consists of the construction of one or more pavement courses of hot plant mixed asphalt-aggregate mixture on the approved prepared foundation, base course or existing surface in accordance with the specifications and in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the Engineer. Mixture design will be either 2360 or 2350 (gyratory or Marshall) as described in the Special Provisions through the mixture designation.

A Mixture Designations
Mixture designations for asphalt mixtures contain the following information:

1. The first two letters indicate the mixture design type:
   - SP = Gyratory Mixture Design
   - LV = Marshall Mixture Design – Low Volume, 50 blow
   - MV = Marshall Mixture Design – Medium Volume, 50 blow
   - SM = Gyratory Mixture Design for Stone Matrix Asphalt (SMA)

2. The third and fourth letters indicate the course:
   - WE = Wearing and Shoulder Wearing Course
   - NW = Non-Wearing Course

3. The fifth letter or number indicates the maximum aggregate size*:
   - A or 4 = 12.5mm (½ inch), SP 9.5 mm (3/8 inch)**
   - B or 3 = 19.0mm (¾ inch), SP 12.5 mm (½ inch)**
   - C or 2 = 25.0mm (1 inch), SP 19.0 mm (¾ inch)**
   - 5 = 9.5mm (3/8 inch), 4.75 mm (#4) nominal size (Marshall design only)
   - E = See provision for SMA design

* Letter is used in gyratory designation; number is used in Marshall designation
** Nominal maximum aggregate size

4. For Gyratory Design:
The sixth digit indicates the Traffic Level (ESAL’s x 10⁶)
The requirements for gyratory mixtures in this specification are based on the 20-year design traffic level of the Project expressed in Equivalent Single Axle Loads (ESAL’s). The five traffic levels are shown below in Table 2360.1-A.
<table>
<thead>
<tr>
<th>Traffic Level</th>
<th>20 Year Design ESAL’s (1 x 10⁶ ESAL’s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2⁺</td>
<td>&lt;1</td>
</tr>
<tr>
<td>3⁺</td>
<td>1 to &lt; 3</td>
</tr>
<tr>
<td>4</td>
<td>3 to &lt; 10</td>
</tr>
<tr>
<td>5</td>
<td>10 to ≤ 30</td>
</tr>
<tr>
<td>6</td>
<td>SMA</td>
</tr>
</tbody>
</table>

1 – (AADT ≤ 2300)

2 – (2300 < AADT < 6000)

**For Marshall Design:**

The sixth and seventh digit indicate the Marshall design blows:

- 50 blow design for both LV and MV mixtures

(5) The last two digits indicate the air void requirement:

- 40 = 4.0% for SP and SM Wear mixtures
- 35 = 3.5% for MV Wear and Non-Wear
- 30 = 3.0% for LV Wear and Non-Wear and SP Non-Wear and Shoulder

(6) The letter at the end of the mixture designation identifies the asphalt binder grade:

- A = PG 52-34
- B = PG 58-28
- C = PG 58-34
- D = PG 58-40
- E = PG 64-28
- F = PG 64-34
- G = PG 64-40
- H = PG 70-28
- I = PG 70-34
- L = PG 64-22

Ex: Gyratory Mixture Designation -- SPWEB540E (Design Type, Lift, Agg Size, Traffic Level, Voids, Binder)

Ex: Marshall Mixture Designation – LVWE35030B (Mix Type, Lift, Agg Size, Marshall blows, Voids, Binder)

Ex: SMA Mixture Designation -- SMWEE640H (Design Type, Lift, Agg Size, Traffic Level, Voids, Binder)
2360.1

B Minimum Lift Thickness

Minimum paving lift thickness will be based on maximum aggregate size:

<table>
<thead>
<tr>
<th>Aggregate Size</th>
<th>Minimum Lift thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>A, 4*; B, 3*</td>
<td>40 mm (1 1/2 inch)</td>
</tr>
<tr>
<td>5*</td>
<td>20 mm (3/4 inch)</td>
</tr>
<tr>
<td>C, 2* (for non-wear only)</td>
<td>65 mm (2 1/2 inch)</td>
</tr>
</tbody>
</table>

*Marshall designation

2360.2 MATERIALS

A Aggregate

A1 General

The aggregate shall consist of sound, durable particles of gravel and sand, crushed stone and sand, or combinations thereof. It shall be free of objectionable matter such as metal, glass, wood, plastic, brick, rubber, and any other material having similar characteristics. Coarse aggregate shall be free from coatings of clay and silt to the satisfaction of the Engineer.

The Contractor shall not compensate for the lack of fines by adding soil materials such as clay, loam, or silt. Overburden shall not be blended into the asphalt aggregate.

Each different material (source, class, kind, or size) shall be fed at a uniform rate from its storage unit. An individual source, class, type, or size of material shall not be stockpile blended with another source, class, type or size of material.

A2 Classification

The aggregate shall conform to one of the following classifications. The class of aggregate to be used shall be the Contractor’s option unless otherwise specified in the Contract.

A2a Class A

Class A aggregate shall consist of crushed igneous bedrock (specifically; basalt, gabbro, granite, rhyolite, diorite and andesite) and rock from the Sioux Quartzite Formation. Other igneous or metamorphic rock may be used with specific approval of the Engineer. Class A materials may contain no more than 4.0% non-Class A aggregate. This recognizes the fact that some quarries may contain small pockets of non-Class A material within that source. Intentional blending or addition of non-Class A material is strictly prohibited!

A2b Class B

Class B aggregate shall consist of crushed rock from all other bedrock sources such as carbonate and metamorphic rocks. (gneiss or schist)
A2c  Class C

Class C aggregate shall consist of natural or partly crushed natural gravel obtained from a natural gravel deposit.

A2d  Class D

Class D aggregate shall consist of 100 percent crushed natural gravel. The crushed gravel shall be produced from material retained on a square mesh sieve having an opening at least twice as large as the Specification permits for the maximum size of the aggregate in the composite asphalt mixture. The amount of carryover (material finer than) the selected screen shall not exceed ten percent.

A2e  Class E

Class E aggregate shall consist of a mixture of any two or more of the above classes of approved aggregate (A, B, and D). The use of Class E aggregate, as well as the relative proportions of the different constituent aggregates, shall be subject to the approval of the Engineer. The relative proportions of the constituent aggregates shall be accurately controlled either by the use of a blending belt approved by the Engineer prior to production or by separately weighing each aggregate during batching operations.

A2f  Steel Slag

Steel slag may not exceed 25 percent of the mass of the total aggregate. Stockpiles will be accepted for use if the total expansion, determined by ASTM D4792, is less than 0.50%.

A2g  Taconite Tailings (TT)

Taconite tailings shall be obtained from ore that is mined westerly of a north-south line located east of Biwabik, Mn (R15W-R16W); except that taconite tailings from ore mined in southwestern Wisconsin will also be permitted for use.

Approved taconite tailing sources are on file with the Department Bituminous Engineer.

A2h  Scrap Asphalt Shingles

Scrap asphalt shingles may be included in both wear and non-wear courses to a maximum of 5 percent of the total weight of mixture. Only scrap asphalt shingles from manufacturing waste are suitable. The percentage of scrap shingles used will be considered part of the maximum allowable RAP percentage. Refer to Section 2360.2 G1 to select a virgin asphalt binder grade (use requirements for > 20% RAP, regardless of total RAP/shingle percentage). Scrap Shingle Specifications are on file in the Bituminous Office.

A2i  Crushed Concrete and Salvaged Aggregate

Crushed concrete is allowed as an aggregate source for up to 50 percent of the aggregate in non-wear mixtures. Crushed concrete is not allowed in wearing courses.
Salvaged aggregate is allowed as an aggregate source for up to 100 percent of the aggregate in wear and non-wear mixtures. All salvaged aggregate shall be stockpiled uniformly to limit variation in mixture properties. Salvaged aggregates shall meet quality and crushing requirements as specified herein.

A2j Sewage Sludge Ash (SSA)

Sewage sludge ash is allowed as an aggregate source in both wear and non-wear courses to a maximum of 5 percent of the total weight of mixture. Only SSA that meets the Tier II hazard evaluation criteria as approved by Mn/DOT’s Office of Environmental Services, Environmental Analysis Section, will be allowed for use in the mixture.

Approved waste incinerator ash sources are on file with the Department Bituminous Engineer.

A3 Recycled Asphaltic Pavement Materials (RAP)

The combined RAP and virgin aggregate shall meet the composite fine aggregate angularity or calculated crushed requirements (both coarse and fine aggregate) for the mixture being produced (calculated crushed allowed for Marshall design only). RAP containing any objectionable material, i.e., road tar, metal, glass, wood, plastic, brick, fabric, or any other objectionable material having similar characteristics will not be permitted for use in the asphalt pavement mixture.

Asphalt binder content in the RAP shall be determined according to Mn/DOT Lab Manual Method 1851 or 1852.

B Manufactured Crushed Fines (-4 material)

All Class A, B, D, and E material that passes the 4.75 mm (#4) screen will be considered as crushed fines.

Manufactured Crushed Fines (-4 material) from Class C Aggregate. Produce manufactured crushed fines (-4 material) from a gravel source by passing the gravel over a selected screen, 9.5 mm (3/8 inch) or larger, prior to mechanical crushing. The material which passes the 9.5 mm (3/8 inch) screen shall not be incorporated into the manufactured crushed fines but may be used as it qualifies for natural sand. The amount of carryover (material finer than) the selected screen shall not exceed ten percent.

The material retained on the 9.5 mm (3/8 inch) screen shall be crushed. The material that passes the 4.75 mm (#4) screen, after crushing, will be considered as 100% crushed fines. Material retained on the 4.75 mm (#4) screen after crushing will not be counted as +4 crushing until tested.

C Quality Requirements

C1 Los Angeles Rattler Test..........................................................AASHTO T96

The Los Angeles Rattler loss on the coarse aggregate fraction
(material retained on the 4.75 mm (#4) sieve shall not exceed 40 percent for any individual source used within the mix. An aggregate proportion which passes the 4.75 mm (#4) sieve and exceeds 40 percent LAR loss on the coarse aggregate fraction is prohibited from use in the mixture.

C2 Soundness (Magnesium Sulfate).......................AASHTO T104

The magnesium sulfate soundness loss at 5 cycles on the coarse aggregate fraction (material retained on the 4.75 mm (#4)) shall not exceed the following for any individual source used within the mix: *

a) No more than 14% loss on the 19 mm (¾ inch) to 12.5 mm (½ inch) and larger fractions.
b) No more than 18% loss on the 12.5 mm (½ inch) to 9.5 mm (3/8 inch) fraction.
c) No more than 23% loss on the 9.5 mm (3/8 inch) to 4.75 mm (#4) fraction.
d) No more than 18% for the composite loss. (Applies only if all three size fractions are tested).

* 1) If the composite requirement is met but one or more individual components do not, the source may be accepted if no individual component is more than 110% of the requirement for that component.

2) If each individual component requirement is met but the composite does not, the source may be accepted if the composite is no greater than 110% of the requirement.

An aggregate proportion which passes the 4.75 mm (#4) sieve and exceeds the requirements listed above on the coarse aggregate fraction is prohibited from use in the mixture.

C3 Spall Materials and Lumps ........... Mn/DOT Laboratory Manual

Spall is defined as shale, iron oxide, unsound cherts, pyrite, highly weathered and/or soft phyllite and argillite (may be scratched with a brass pencil), and other materials having similar characteristics.

Lumps are defined as loosely bonded aggregations and clayey masses. If the percent of lumps measured in the stockpile or cold feed exceed the values listed below, asphalt production shall cease and compliance shall be determined by dry batching. This procedure may be repeated at any time at the discretion of the Engineer.

Maximum limits for Spall and lumps, expressed as percentages by mass, are listed in Table 2360.3-B2a.
C4 Insoluble Residue Test

If Class B carbonate material is used in the mix, the minus 0.075 mm (#200) sieve size portion of the insoluble residue shall not exceed 10 percent.

D Aggregate Restrictions

Class B carbonate aggregate restrictions are specified in Table 2360.3-B2a.

E Gradation Requirement

The coarse and fine aggregate shall be combined in such proportions to produce an asphalt mixture meeting all of the requirements defined in this specification and shall conform to the gradation as defined in Table 2360.2-E. Gradation testing shall be conducted in accordance with AASHTO T-11 (-0.075 mm (#200) wash) and T-27.

### TABLE 2360.2-E

**AGGREGATE GRADATION BROAD BANDS**

(% passing of total washed gradation)

<table>
<thead>
<tr>
<th>Sieve Size (mm (inch))</th>
<th>A or 4*</th>
<th>B or 3*</th>
<th>C or 2*</th>
<th>5*</th>
<th>E (SMA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.0 (1&quot;)</td>
<td></td>
<td>100</td>
<td></td>
<td></td>
<td>See SMA Provisions</td>
</tr>
<tr>
<td>19.0(¾&quot;)</td>
<td>100¹</td>
<td>85-100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.5(½&quot;)</td>
<td>85-100</td>
<td>45-90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.5(3/8&quot;)</td>
<td>85-100</td>
<td>35-90</td>
<td>-</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>4.75 (#4)</td>
<td>25-90</td>
<td>20-80</td>
<td>20-75</td>
<td>65-95</td>
<td></td>
</tr>
<tr>
<td>2.36 (#8)</td>
<td>20-70</td>
<td>15-65</td>
<td>15-60</td>
<td>45-80</td>
<td></td>
</tr>
<tr>
<td>0.075 (#200)</td>
<td>2.0-7.0</td>
<td>2.0-7.0</td>
<td>2.0-7.0</td>
<td>2.0-7.0</td>
<td></td>
</tr>
</tbody>
</table>

*Marshall Designation

¹With the approval of the Engineer, the gradation broadband for the maximum aggregate size may be reduced to 97% passing for mixtures containing RAP, when the oversize material is suspected to come from the RAP source. The virgin material must remain 100% passing the maximum aggregate sieve size.

F Additives

An additive is any material added to an asphalt mixture or material, such as mineral filler, hydrated lime, asphalt additives, anti-strip, and similar products that do not have a specific pay item. When a Contract requires additives, compensation is included with the pay items for the appropriate mixture. If the Engineer directs the Contractor to incorporate additives, the compensation will be as Extra Work, at the unit price specified in the proposal. The Department will not compensate the Contractor for additives incorporated at the Contractor's option.
Additives will not be incorporated into the mixture without approval of the Department Bituminous Engineer. Anti-foaming agents shall be added to asphalt cement at the manufacturer's recommended dosage rate. Mineral filler and hydrated lime may be added in a quantity not to exceed 5 percent and 2 percent, respectively, of the total mass of the aggregate. The combination of mineral filler and hydrated lime shall not exceed 5 percent of the total mass of aggregate. The Engineer will approve or disapprove methods for addition of additives.

F1 Mineral Filler........................................................................ 3145
F2 Hydrated Lime...................................................................... 3145

Hydrated lime used in asphalt mixtures shall meet the requirements of ASTM C977 and have a maximum of eight percent unhydrated oxides (as received basis). The method of introducing and mixing the hydrated lime and aggregate shall be subject to approval by the Engineer prior to beginning mixture production.

F3 Liquid Anti-Stripping Additive

When a liquid anti-strip additive is added to the asphalt binder, blending shall be completed before the asphalt binder is mixed with the aggregate. Liquid anti-strip additives that alter the asphalt binder, such that it fails to meet the Performance Grade (PG) requirements, shall not be used. Liquid anti-strip may be added by the supplier at the refinery or by the Contractor at the plant site. The company/supplier adding the additive shall be responsible for testing the binder/additive blend to ensure compliance with the AASHTO M 320, Standard Specification for Performance Graded Asphalt Binder. No paving will be allowed until the asphalt binder/additive blend has been tested and results show that binder/additive blend properties meet the criteria in Section 2360.2G. The testing shall be done in accordance with a Mn/DOT approved Asphalt Binder QC Plan. Requirements for the Asphalt Binder QC Plan are on file in the Bituminous Office.

The following requirements for HMA mixture and asphalt binder must also be met when liquid anti-strip is added at the HMA plant site.

**Mixture Requirements at Design:**

1) The Contractor must design the mixture with the same asphalt binder that will be supplied to the plant site. (Both Laboratory Mixture Design (Option 1) and Modified Mixture Design (Option 2).

2) The Contractor must provide documentation with either design option that includes Tensile Strength Ratio results with the liquid anti-strip dosed at the optimal rate. Documentation must include verification the binder/additive
blend meets AASHTO M 320 at the optimal dose rate.

Contractor Production Testing Requirements for Asphalt Binder/Liquid Anti-Strip Blend:

1) The Contractor shall, on a daily basis, sample and test the asphalt binder/anti-strip blend. Testing of the blend can be by viscosity, penetration, or dynamic shear rheometer (DSR). When a polymer modified asphalt binder is specified, the Contractor shall use the DSR as the daily QC test.

2) The Contractor shall, on a weekly basis, send to the Engineer and Mn/DOT Chemical Laboratory Director a weekly QC report summarizing the results of the daily testing as required in number 1.

3) The Contractor shall, on a bi-weekly basis, test the binder/anti-strip blend to ensure compliance with the AASHTO M 320, Standard Specification for Performance Graded Asphalt Binder (minimum 1/project). Test results shall be sent to the Engineer and Mn/DOT Chemical Laboratory Director.

4) In addition to the sampling requirements listed above, the Contractor shall obtain asphalt binder/anti-strip blend field verification samples according to 2360.4 E12.

Liquid Anti-Strip Additive Metering System:

1) The metering system shall include a liquid anti-strip flow meter in addition to an anti-strip pump. The flow meter shall be connected to the liquid anti-strip supply to measure and display only the anti-strip being fed to the asphalt binder.

2) The meter readout shall be positioned for convenient observation.

3) There shall be a means provided for comparing the flow meter readout with the calculated output of the anti-strip pump. See number 7.

4) The system shall display in units of liters (gallons) to the nearest liter (gallon) or in units of metric tons (tons) to the nearest 0.001 metric tons (0.001 tons), the accumulated anti-strip quantity being delivered to the mixer unit.

5) The system shall be calibrated and adjusted to maintain an accuracy of ± one percent error.

6) Calibration shall be required for each plant set-up prior to production of mixture.

7) The Engineer may require, on a daily basis, the Contractor “stick” the anti-strip tank at the end of the days production to verify anti-strip usage quantities.

8) The system shall provide for a convenient method for sampling the binder/anti-strip after blending has occurred.
9) Alternative blending and metering systems must be pre-approved by the Engineer.

F4 Coating and Anti-Stripping Additive.......................... 3161

G  Asphalt Binder Material.................................AASHTO M 320

Asphalt binder material shall meet the requirements of PG asphalt binder testing tolerances, sampling rates, testing procedures, and acceptance criteria based on the most current Mn/DOT Technical Memorandum, titled "Inspection, Sampling, and Acceptance of Bituminous Materials." The PG asphalt binder cannot be modified with air blowing procedures unless the Department Bituminous Engineer approves it. The Contractor shall not use petroleum distillates such as fuel oil, diesel fuel or other fuels in the asphalt tanks. A statement shall be provided by the supplier for recommended laboratory mixing and compaction temperatures and field maximum mixing and compaction temperatures.

G1 Asphalt Binder Selection Criteria for All Mixtures with RAP

<table>
<thead>
<tr>
<th>Overlay</th>
<th>Specified PG Asphalt Binder Grade</th>
<th>Virgin Asphalt Binder Grade to be used with RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 20% RAP</td>
<td>&gt; 20% RAP</td>
</tr>
<tr>
<td>64-22</td>
<td>64-22</td>
<td>64-28</td>
</tr>
<tr>
<td>Other PG Grades</td>
<td>No grade adjustment</td>
<td>No grade adjustment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>New Construction *(1)</th>
<th>Specified PG Asphalt Binder Grade</th>
<th>Virgin Asphalt Binder Grade to be used with RAP</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤ 20% RAP</td>
<td>&gt; 20% RAP</td>
</tr>
<tr>
<td>52-34</td>
<td>52-34</td>
<td>Not allowed *</td>
</tr>
<tr>
<td>58-28</td>
<td>58-28</td>
<td>58-28</td>
</tr>
<tr>
<td>58-34</td>
<td>58-34</td>
<td>Not allowed *</td>
</tr>
<tr>
<td>64-28</td>
<td>64-28</td>
<td>64-28</td>
</tr>
<tr>
<td>64-34</td>
<td>64-34</td>
<td>Not allowed *</td>
</tr>
<tr>
<td>Other PG Grades</td>
<td>No grade adjustment</td>
<td>Not allowed *</td>
</tr>
</tbody>
</table>

* When approved by the Engineer, the virgin asphalt binder grade can be selected by using the blending chart procedure on file in the Bituminous Office. Mn/DOT may take production samples for information/verification of compliance with a specified asphalt binder grade.

(1) Includes cold inplace recycle, reclaiming, and reconstruction.
2360.3 MI XTURE DESIGN

A Mixture Design General

The asphalt mix may be designed using one of the following two Contractor trial mix design options. Review of mixture designs will be performed in the District Materials Laboratory lab where the Project is located. The addition of aggregates and materials not included in the original mixture submittal is prohibited.

It is the Contractor's responsibility to design a Marshall mixture in accordance with the most current AASHTO T-245, the Asphalt Institute's Mix Design Methods for Asphalt Concrete MS-2, and the Mn/DOT Laboratory Manual such that it meets the requirements of this specification.

For Marshall design, the design air void content of the mixture is dependent on the mixture type, regardless of the location in the pavement structure. Design air void content for LV and MV mixtures is 3.0% and 3.5%, respectively.

It is the Contractor's responsibility to design a gyratory mixture in accordance with the most current AASHTO T-312, the Asphalt Institute's Superpave Mix Design Manual SP-2 (2-hour short term aging period is used for volumetric), and the Mn/DOT Laboratory Manual such that it meets the requirements of this specification.

For gyratory design, the design air void content of the mixture at design shall be 4.0% at the design number of gyrations \(N_{\text{design}}\) for mixtures placed in the upper 100 mm \(\text{(4 inches)}\) of the finished surface. The design air void content of the mixture at design shall be 3.0% at the design number of gyrations \(N_{\text{design}}\) for mixtures placed at depths more than 100 mm \(\text{(4 inches)}\) from the surface and on all (wear and nonwear) shoulders that do not carry traffic. If less than 25% of a layer is within 100 mm \(\text{(4 inches)}\) of the surface, the layer may be considered to be below 100 mm \(\text{(4 inches)}\) for mix design purposes (non-wear).

| Location from surface \(\leq 100 \text{ mm} \text{(4 inches)}\) | Location from surface \(> 100 \text{ mm} \text{(4 inches)}\) | All Wear and Non-Wear
|---|---|---|
| Air Voids | 4.0% | 3.0% | 3.0%

* If less than 25% of a layer is within 100 mm \(\text{(4 inches)}\) of the surface, the layer may be considered to be below 100 mm \(\text{(4 inches)}\) for mix design purposes.

** Shoulders that do not carry traffic.

B Laboratory Mixture Design (Option 1)

Test results and documentation as described in Section 2360.3C shall be submitted with the materials described below for
consideration by the Department Bituminous Engineer or District Materials Engineer to verify compliance with these specifications and to issue a Mixture Design Report.

B1 Aggregate Sample

At least 15 working days prior to the start of asphalt production, the Contractor shall submit to the Department Bituminous Engineer or the District Materials Engineer a 35 kg (80 pound) sample of representative aggregate retained on the 4.75 mm sieve (#4) and a 15 kg (35 pound) sample of material passing the 4.75 mm sieve (#4) for quality testing. The Contractor shall provide 24 hour notice of intent to sample aggregates. These samples will be tested for quality of each source, class, type, and size of virgin and non-asphaltic salvage aggregate source used in the mix design. The Contractor shall retain a companion sample of equal size until a Mixture Design Report is issued. Quality requirements are defined in Section 2360.2C.

Aggregates that require the magnesium sulfate soundness test shall be submitted to the Department Bituminous Engineer or District Materials Engineer at least 30 calendar days prior to the start of asphalt production. Dispute resolution procedures for aggregate qualities are on file in the Bituminous Office.

B2 Mixture Sample

At least 7 working days prior to the start of asphalt production, the Contractor shall submit in writing a proposed Job Mix Formula (JMF) for each combination of aggregates to the Department Bituminous Engineer or District Materials Engineer for review. A Level II Quality Management mix designer must sign the proposed JMF. For each JMF submitted, the Contractor shall include test data to demonstrate conformance to mixture properties as specified in Table’s 2360.3-B2b and 2360.3-B2c. The proposed JMF shall be submitted on forms approved by the Department. In addition, the Contractor shall submit an uncompacted mixture sample plus briquettes compacted at the optimum asphalt content and required compactive effort conforming to the JMF for laboratory examination and evaluation. Mixture sample size and number of compacted briquettes are as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Gyratory Design</th>
<th>Marshall Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un-compacted Mixture Sample Size</td>
<td>30 kg (75 pounds)</td>
<td>18 kg (40 pounds)</td>
</tr>
<tr>
<td>Number of compacted briquettes</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Mixture Aggregate Requirements

The aggregate fractions shall be sized, graded, and combined in such proportions that the resulting mixture will meet the requirements listed in Section 2360.2-E and Table 2360.3-B2a shown below.

### TABLE 2360.3-B2A

<table>
<thead>
<tr>
<th>Aggregate Blend Property</th>
<th>Traffic Level 2 &amp; LV</th>
<th>Traffic Level 3 &amp; MV</th>
<th>Traffic Level 4</th>
<th>Traffic Level 5</th>
<th>SMA T. Level 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 year Design ESAL’s</td>
<td>&lt;1 million</td>
<td>1 - 3 million</td>
<td>3 - 10 million</td>
<td>10 - 30 million</td>
<td>See SMA Prov.</td>
</tr>
<tr>
<td>Coarse Aggregate Angularity (ASTM D5821) (one face / two face), % - Wear</td>
<td>30/- 30/-</td>
<td>55/- 55/-</td>
<td>85 / 80</td>
<td>60/-</td>
<td>95 / 90</td>
</tr>
<tr>
<td>Fine Aggregate Angularity (FAA) (AASHTO T304, Method A) % - Wear</td>
<td>40(2)</td>
<td>42(1)</td>
<td>44</td>
<td>45</td>
<td>-</td>
</tr>
<tr>
<td>% - Non-Wear</td>
<td>40(1)</td>
<td>40</td>
<td>40</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Flat and Elongated Particles, max(3) % by weight, (ASTM D 4791)</td>
<td>-</td>
<td>10 (3:1 ratio)</td>
<td>10 (3:1 ratio)</td>
<td>10 (3:1 ratio)</td>
<td>-</td>
</tr>
<tr>
<td>Clay Content(2) (AASHTO T 176)</td>
<td>-</td>
<td>-</td>
<td>45</td>
<td>45</td>
<td>-</td>
</tr>
<tr>
<td>Total Spall in fraction retained on the 4.75mm (#4) sieve</td>
<td>5.0</td>
<td>2.5</td>
<td>1.0</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Maximum Spall Content in Total Sample</td>
<td>5.0</td>
<td>5.0</td>
<td>1.0</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Maximum Percent Lumps in fraction retained on the 4.75mm (#4) sieve</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>-</td>
</tr>
<tr>
<td>Class B Carbonate Restrictions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum% -4.75mm (-#4) Final Lift / All other Lifts</td>
<td>100/100</td>
<td>100/100</td>
<td>80/80</td>
<td>50/80</td>
<td>-</td>
</tr>
<tr>
<td>Maximum% +4.75mm (+#4) Final Lift / All other Lifts</td>
<td>100/100</td>
<td>100/100</td>
<td>50/100</td>
<td>0/100</td>
<td>-</td>
</tr>
<tr>
<td>Gyratory</td>
<td>Max. allowable RAP percentage</td>
<td>30/40</td>
<td>30/30</td>
<td>30/30</td>
<td>30/30</td>
</tr>
<tr>
<td>Wear / Non Wear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marshall</td>
<td>Max. allowable RAP percentage</td>
<td>30/40</td>
<td>30/30</td>
<td>30/30</td>
<td>30/30</td>
</tr>
<tr>
<td>Wear / Non Wear</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) For Marshall design, the Contractor may determine –4 crushing.
by either FAA of uncompacted voids or calculation of crush from the composite blend. The choice must be made prior to start of production. Manufactured crushed fines requirement is 25%. RAP sand will be considered 50% crushed if the angularity index equals or exceeds 40, and 100% crushed if the angularity index equals or exceeds 45.

(2) Not applicable under Marshall design.

B2b Mixture Requirements
Mixture evaluation will be based on the trial mix tests and the corresponding requirements listed in Table 2360.3-B2b and Table 2360.3-B2c.

B2c VMA Criteria
The voids in mineral aggregate (VMA) of the mixture at design and during production shall meet the minimum criteria as shown in Table 2360.3-B2c at the specified compaction level. VMA shall be calculated according to the procedures outlined in Asphalt Institutes SP-2 or MS-2 manual. VMA is a design and acceptance/process control requirement.

B3 Tensile Strength Ratio Sample
Mixture or briquettes that represent the mixture at optimum asphalt content, shall be submitted at least 7 days prior to actual production for verification of moisture sensitivity retained tensile strength ratio (TSR). Material submitted for TSR verification may be tested for maximum specific gravity $G_{mm}$ compliance in addition to TSR results. Failure to meet the $G_{mm}$ tolerance will result in rejection of the submitted mix design. A new mix design submittal will be required and will be subject to provisions described in Section 2360.3C. One of the following options may be used to verify that the tensile strength ratio (TSR) meets the requirements in Table 2360.3-B2b.

Option A) The Contractor will batch material at the design proportions including optimum asphalt. Immediately (before curing) split the sample and allow samples to cool to room temperature. Submit 35 kg (77 pounds) of mixture to the District Materials Laboratory for curing and test verification. Both groups will use a two (2) hour cure time ($\pm$ 15 minutes) at 144°C (290°F) and follow procedures in ASTM D 4867-92, Mn/DOT modified as defined in the Mn/DOT Laboratory Manual.

Option B) The Contractor batches, cures (as indicated in option A), compacts, and submits briquettes and uncompacted mixture as specified below.
### TABLE 2360.3-B2B

**MIXTURE REQUIREMENTS**

<table>
<thead>
<tr>
<th>Traffic Level</th>
<th>Traffic Level 2</th>
<th>Traffic Level 3</th>
<th>Traffic Level 4</th>
<th>Traffic Level 5</th>
<th>SMA T. Level 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 year Design ESAL’s</td>
<td>≤ 1 million</td>
<td>1 - 3 million</td>
<td>3 - 10 million</td>
<td>10 – 30 million</td>
<td>See SMA Prov.</td>
</tr>
</tbody>
</table>

**Gyratory Mixture Requirements**

<table>
<thead>
<tr>
<th>Gyration for $N_{N_{initial}}$</th>
<th>Traffic Level 2</th>
<th>Traffic Level 3</th>
<th>Traffic Level 4</th>
<th>Traffic Level 5</th>
<th>SMA T. Level 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gyrations for $N_{N_{initial}}$</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>8</td>
<td>-</td>
</tr>
<tr>
<td>Gyrations for $N_{N_{design}}$</td>
<td>40</td>
<td>60</td>
<td>90</td>
<td>100</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Air Voids, % -- Wear</th>
<th>Traffic Level 2</th>
<th>Traffic Level 3</th>
<th>Traffic Level 4</th>
<th>Traffic Level 5</th>
<th>SMA T. Level 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Voids, % --非磨损 &amp; 全部</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>4.0</td>
<td>-</td>
</tr>
<tr>
<td>Air Voids, % --非磨损 &amp; 全部</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% $G_{mm}$ at $N_{N_{initial}}$ -- Wear</th>
<th>Traffic Level 2</th>
<th>Traffic Level 3</th>
<th>Traffic Level 4</th>
<th>Traffic Level 5</th>
<th>SMA T. Level 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>% $G_{mm}$ at $N_{N_{initial}}$ --非磨损 &amp; 全部</td>
<td>-</td>
<td>≤ 91.5</td>
<td>≤ 90.5</td>
<td>≤ 90.0</td>
<td>-</td>
</tr>
<tr>
<td>% $G_{mm}$ at $N_{N_{maximum}}$ -- Wear</td>
<td>≤ 98.0</td>
<td>≤ 98.0</td>
<td>≤ 98.0</td>
<td>≤ 98.0</td>
<td>-</td>
</tr>
<tr>
<td>% $G_{mm}$ at $N_{N_{maximum}}$ --非磨损 &amp; 全部</td>
<td>≤ 99.0</td>
<td>≤ 99.0</td>
<td>≤ 99.0</td>
<td>≤ 99.0</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tensile Strength Ratio $(1)$, min%</th>
<th>Traffic Level 2</th>
<th>Traffic Level 3</th>
<th>Traffic Level 4</th>
<th>Traffic Level 5</th>
<th>SMA T. Level 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fines/Effective Asphalt</td>
<td>75 $(2)$</td>
<td>75 $(2)$</td>
<td>80 $(3)$</td>
<td>80 $(3)$</td>
<td>-</td>
</tr>
<tr>
<td>VFA, % -- Wear</td>
<td>0.6 - 1.2</td>
<td>0.6 - 1.2</td>
<td>0.6 - 1.2</td>
<td>0.6 - 1.2</td>
<td>-</td>
</tr>
<tr>
<td>VFA, % --非磨损 &amp; 全部</td>
<td>65 - 78</td>
<td>65 - 78</td>
<td>65 - 78</td>
<td>65 - 78</td>
<td>-</td>
</tr>
<tr>
<td>Marshall Blows</td>
<td>50</td>
<td>50</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Marshall Tensile Strength Ratio $(4)$, min%</td>
<td>Traffic Level 2</td>
<td>Traffic Level 3</td>
<td>Traffic Level 4</td>
<td>Traffic Level 5</td>
<td>SMA T. Level 6</td>
</tr>
<tr>
<td>Stability, minimum N $(1B f)$</td>
<td>5000 $(1125)$</td>
<td>6000 $(1350)$</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

(1) See Section 2360.4 E9. Use 150 mm (6 inch) specimens for gyratory and 100 mm (4 inch) specimens for Marshall design.
(2) Mn/DOT Min = 65, (3) Mn/DOT Min = 70, (4) Mn/DOT Min = 60
**TABLE 2360.3-B2C**

VOIDS IN MINERAL AGGREGATE (VMA) MIXTURE REQUIREMENTS

<table>
<thead>
<tr>
<th>Gradation</th>
<th>Fine Mixture % Pass 2.36 mm (#8)</th>
<th>VMA Minimum</th>
<th>Coarse Mixture % Pass 2.36 mm (#8)</th>
<th>VMA Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A or 4*</td>
<td>&gt; 47</td>
<td>15.0**</td>
<td>≤ 47</td>
<td>14.5*</td>
</tr>
<tr>
<td>B or 3*</td>
<td>&gt; 39</td>
<td>14.0</td>
<td>≤ 39</td>
<td>13.5</td>
</tr>
<tr>
<td>C or 2*</td>
<td>&gt; 35</td>
<td>13.0</td>
<td>≤ 35</td>
<td>12.5</td>
</tr>
<tr>
<td>5*</td>
<td>-----</td>
<td>15.0**</td>
<td>-----</td>
<td>-----</td>
</tr>
<tr>
<td>E</td>
<td>See SMA Provisions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Marshall designation.
**For LV 4 and LV 5 mixes lower VMA requirements by 0.5%

**TABLE 2360.3-B3**

OPTION B MIXTURE REQUIREMENTS

<table>
<thead>
<tr>
<th>Item</th>
<th>Gyratory Design</th>
<th>Marshall Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Un-compacted Mixture Sample Size</td>
<td>8,200 g</td>
<td>8,200 g</td>
</tr>
<tr>
<td>Number of compacted briquettes(1)</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Compacted briquette air void content</td>
<td>6.5 – 7.5%</td>
<td>6.0 – 8.0%</td>
</tr>
</tbody>
</table>

(1) 150mm (6 inch) specimens for gyratory design
100mm (4 inch) specimens for Marshall design

B4 Aggregate Specific Gravity ...........................................................

................................. AASHTO T84 and T85, Mn/DOT Modified

The Contractor shall determine the specific gravity of all aggregate used in the mixture.

C Documentation

Each proposed JMF submitted for review under Section 2360.3B and 2360.3D shall include the following documentation and test results.

(1) The name(s) of the individual(s) responsible for the Quality Control of the mixture during production.
(2) The low projects number on which the mixture will be used.
(3) The percentage in units of 1 percent (except the 0.075 mm sieve (#200) in units of 0.1 percent) of aggregate passing each of the specified sieves for each aggregate to be incorporated into the mixture. The gradation of aggregate
from salvaged asphaltic material shall be derived from the material after the residual asphalt has been extracted.

(4) The source and description of the materials to be used. The aggregate pit or quarry source number. The proportion of each material (in percent of total aggregate).

(5) The composite gradation based on (3) and (4) above. Note: Include virgin composite gradation based on (4) and (5) above for mixtures containing RAP.

(6) The bulk (dry) and apparent specific gravities and water absorption (by % weight of dry aggregate) of both coarse and fine aggregate, for each product used in the mixture (including RAP). Use AASHTO T-84 and T-85 Mn/DOT modified as defined in the Mn/DOT Laboratory Manual. The tolerance allowed between the Contractor's and the Department's specific gravities are $G_{sb}$(individual) = 0.040 (+4 AND -4) and $G_{sb}$(combined) = 0.020.

(7) The composite gradation plotted on a FHWA 0.45 power chart. (Federal form PR-1115)

(8) For mixtures containing RAP include extracted asphalt binder content of the RAP with no retention factor included.

(9) The percentage (in units of 0.1 percent) and PG grade of asphalt binder material to be added, based upon the total mass of the mixture.

(10) When using laboratory mixture design Option 1 (2360.3B) or Option 2 (2360.3D), include the following:

(a) A minimum of three different asphalt binder contents (minimum 0.4 percent between each point), with at least one point at, one above and one below the optimum asphalt binder percentage.

(b) The maximum specific gravity at each asphalt binder content. The theoretical maximum specific gravity used for percent air voids determination shall be calculated based on the average of the effective specific gravities measured by a minimum of two maximum specific gravity tests at the asphalt contents above and below the expected optimum asphalt binder content.

(c) The test results for the individual and average bulk specific gravity, density, and heights, of at least two specimens at each asphalt binder content. For Marshall design include the test results for the individual and average bulk specific gravity, density, height, stability, and flow of at least three specimens at each asphalt binder content.

(d) The percent air voids in the mixture at each asphalt
(e) The percent Voids in Mineral Aggregate (VMA) at each asphalt binder content.
(f) The fines to Effective Asphalt (F/A) ratio calculated to the nearest 0.1 percent.
(g) TSR results at the optimum asphalt binder content.
(h) Graphs showing air voids, voids in the mineral aggregate, Gmb, Gmm and unit weight vs. percent asphalt binder content for each of the three asphalt binder contents submitted with trial mix.


If the Contractor chooses to use the add-material option to augment the submitted JMF, the Contractor shall provide samples of the aggregate for quality analysis in accordance with Section 2360.3B1. The Contractor shall provide mix design data for two additional design points per add-material. One point shall show a proportional adjustment to the submitted JMF that includes 5 percent, by mass, add-material at the JMF optimum asphalt percent. The second point shall show a proportional adjustment to the submitted JMF that includes 10 percent, by mass, add-material at the JMF optimum asphalt percent. The following information will be reported for each of these two points:
(a) The maximum specific gravity (average of two tests).
(b) The test results for the individual and average bulk specific gravity, density, and height of at least two specimens at the optimum asphalt binder content. For Marshall design include the test results for the individual and average bulk specific gravity, density, height, stability, and flow of at least three specimens at the optimum asphalt binder content.
(c) The percent air voids in the mixture for each point.
(d) The Fines to Effective Asphalt ratio calculated to the nearest 0.1 of a percent.
(e) Coarse and Fine Aggregate crushing counts

Up to two add-materials will be allowed per mix design submittal. Aggregate quality and mix characteristics are required for each proposed add-material and shall be submitted at the time of the original trial mix submittal. No mixture sample or briquettes are required for these two additional points.
Additional Documentation for:

Gyratory Design

(G1) The test results from the composite aggregate blend at the proposed JMF proportions indicating compliance with Coarse Aggregate Angularity and Fine Aggregate Angularity as shown in Table 2360.3-B2a.

(G2) The design traffic level and the initial, design, and maximum number of gyrations \(N_{\text{initial}}, N_{\text{design}},\) and \(N_{\text{maximum}}\).

(G3) The temperature ranges the mixture is intended to be discharged from the plant and compacted at the roadway shall be provided by the asphalt binder supplier. Temperatures to be included are, laboratory mixing and compaction temperature ranges and maximum field mixing and compaction temperatures.

(G4) Evidence that the completed mixture will conform to all specified physical requirements as follows:

- Design air Voids \(V_a\), VMA, VFA, TSR, F/Ae (Fines to effective asphalt ratio), Densification \%G_mm at \(N_{\text{initial}}, N_{\text{design}},\) and \(N_{\text{Maximum}}\).

(G5) Labeled gyratory densification tables and curves, generated from the gyratory compactor, for all points used in the mixture submittal.

Marshall Design

(M1) The test results from the composite aggregate blend at the proposed JMF proportions indicating compliance with fine aggregate angularity uncompacted voids as shown in Table 2360.3-B2a. Or calculated -4.75 mm (-#4) crushing from the composite blend of the proposed JMF. Selection of either FAA or -4.75 mm (-#4) crushing shall be made at the time of mix design submittal. This selection will dictate the choice of method used for determination of compliance and acceptance for the duration of time the Mixture Design Report is in force. RAP sand will be considered 50% crushed if the angularity index equals or exceeds 40, and 100% crushed if the angularity index equals or exceeds 45.

D Modified Mixture Design (Option 2)

Test results and documentation as described in Section 2360.3C shall be submitted to the Department Bituminous Engineer or the District Materials Engineer to verify compliance with mix design requirements and issue a Mix Design Report. Mixture submittal is not required. The Contractor may use this option if all of the following conditions are met:

a) The aggregates in the proposed Mix Design Report have been used, in part, in other Mix Design Reports. Additionally, the
aggregates must have been previously tested for and meet all applicable quality requirements in the current construction season.

b) The Level II mix designer submitting the mixture design must have a minimum of 2 years experience in mixture design.

c) The Contractor and his representatives cannot have violated the requirements of 1512 Unacceptable and Unauthorized Work relating to mixture design or mixture production within the last 12 month period.

D1 JMF Submittal
At least 2 working days prior to the start of asphalt production, the Contractor shall submit in writing a proposed Job Mix Formula (JMF) for each combination of aggregates to the Department Bituminous Engineer or District Materials Engineer for review. A Level II Quality Management mix designer must sign this proposed JMF. For each JMF submitted, the Contractor shall include documentation as outlined in Section 2360.3C to demonstrate conformance to mixture properties as specified in Table 2360.3-B2b and 2360.3-B2c. The proposed JMF shall be submitted on forms approved by the Department.

D2 Initial Production Test Verification
At the start of production, the testing frequency for the first 1,800 metric tons (2,000 tons) of each mix type shall be as specified in Table 2360.4-D.

All mixture placed on Mn/DOT projects shall meet the specified quality indicators and required field density. Failure to do so will result in reduced payment or removal and replacement with acceptable material.

The Department shall take a mix verification sample within the first four samples at the start of production of each mix type.

D3 Tensile Strength Ratio Sample
See Section 2360.4E9.

D4 Marshall Stability (Marshall Design Only)
On the first day of production, for each different mix design, at the same time the verification sample is obtained, an additional sample shall be obtained for Department evaluation of Marshall stability. This sample may be tested at the discretion of the District Materials Engineer. The Contractor is not required to test stability on production mixture.

If the Marshall stability fails to meet the minimum requirements as listed in Table 2360.3-B2c the Contractor shall stop production immediately. The Contractor will be required to submit a revised mix design, with bituminous mixture at optimum asphalt content, to
the District Materials Laboratory. If the mixture meets the minimum stability requirement production may be resumed. If the stability fails the second time, the Mix Design Report will be revoked. The Contractor will then be required to submit a new mix design according to Laboratory Mixture Design 2360.3B, Option 1. A new Mix Design Report will be issued upon successful verification of the new mixture design submittal.

E  Mixture Design Report

A Mixture Design Report consists of the JMF (Job Mix Formula). The JMF includes composite gradation, aggregate component proportions, asphalt binder content of the mixture, design air voids, Voids in Mineral Aggregate, and aggregate bulk specific gravity values. JMF limits will be shown for gradation control sieves, percent asphalt binder content, air voids, and VMA. Issuance of a Mixture Design Report confirms the mixture has been reviewed for and meets volumetric properties only. No guaranty or warranty, either expressed or implied, is made regarding placement and compaction of the mixture.

A Department reviewed Mixture Design Report is required for all paving except for small quantities of material provided under Section 2360.5H. All submitted materials must meet aggregate and mixture design requirements before a Mixture Design Report is issued. The Department will review two trial mix designs per mix type designated in the plan, per Contract at no cost to the Contractor. Additional mix designs will be verified at a cost of $2000 per design, payable to the Commissioner of Transportation.

For city, county, and other agency projects, the Contractor shall provide to the District Materials Laboratory a complete Project proposal including addenda, supplemental agreements, change orders, and any Plan sheets (including typical sections) that affect the mix design. The Department will not start the verification process without this information.

2360.4 MIXTURE QUALITY MANAGEMENT (Quality Control/Quality Assurance)

A  Quality Control (QC)

The Contractor shall provide and maintain a quality control program for HMA production. A quality control program is defined as all activities, including mix design, process control inspection, sampling and testing, and necessary adjustments in the process that are related to the production of a hot mix asphalt (HMA) pavement which meets the requirements of the specifications.

A1  Contractor Certified Plant HMA

A1a  Certification Procedure

The Contractor shall:
(1) Complete application form and request for plant inspection.
(2) Provide a site map of stockpile locations.
(3) Pass plant and testing facility inspection by having the Plant Inspector and Bituminous Plant Authorized Agent complete and sign the Asphalt Plant Inspection Report (TP 02142-02, TP 02143-02). By signing the Asphalt Plant Inspection Report, the HMA plant authorized agent agrees to calibrate and maintain all plant and laboratory equipment within allowable tolerances set forth in these specifications, Standard Specifications for Construction, and the Mn/DOT Bituminous Manual.
(4) Obtain a Mixture Design Report prior to production.

A1b Maintaining Certification
To maintain certification, the plant must produce, test, and document all certified plant asphalt mixtures in accordance with the above requirements on a continuous basis. Continuous basis means all asphalt mixtures supplied from a certified plant to any Department project with 2360 asphalt mixtures must be sampled and tested in accordance with 2360 requirements and the Schedule of Materials Control.

The Contractor shall assure the plant certification procedure is performed annually after winter suspension and before producing material for a Project. In addition, a first-day sampling and testing frequency rate as stated in Table 2360.4-D shall be followed.

The Contractor shall recertify a plant when it is moved to a new location or a previously occupied location.

A1c Revocation of Plant Certification
The Department Construction Engineer may revoke certification of an asphalt plant when requirements are not being met or records are falsified. The Department may revoke the Technician Certification for the individual involved.

The Department Bituminous Engineer and Department Contract Administrator will maintain a list of companies who have had their asphalt plant certification revoked.

B Quality Assurance (QA)
The Department will perform QA testing as part of the acceptance process. The Engineer is responsible for QA testing, records, and acceptance. The Engineer will accomplish the QA process by:
(1) Conducting Quality assurance and verification sampling and testing.
(2) Observing sampling and tests performed by the QC personnel.
(3) Taking additional samples at any time and any location during production.
(4) Monitoring the required QC summary sheets and control charts.
(5) Verifying calibration of laboratory testing equipment.
(6) Communicating Mn/DOT test results to the Contractor’s QC personnel in a timely manner.
(7) Ensuring Independent Assurance Sampling and testing requirements are met.

C Contractor's Quality Control

C1 Personnel Requirements

Along with the proposed mix design data, the Contractor shall submit to the Engineer an organizational chart listing the names and phone numbers of individuals and alternates responsible for mix design, process control administration, and inspection. The Contractor shall also post a current organizational chart and if required by the Engineer, post a daily roster of individuals performing QC testing in the Contractor’s test facility.

The Contractor’s quality control organization or private testing firm shall have Certified Technicians who have met the requirements on file with the Department’s Technical Certification program. Individuals performing process control testing must be certified as a Level I Bituminous Quality Management (QM) Tester. Individuals performing mix design calculations or mix design adjustments must be certified as Level II Bituminous QM Mix Designer. The Contractor shall have a Certified Level II Bituminous QM Mix Designer available to make any necessary process adjustments. The Contractor shall have a minimum of one person per paving operation certified as a Level II Bituminous Street Inspector.

C2 Laboratory Requirements

The Contractor shall furnish and maintain a laboratory at the plant site or other site as approved by the Engineer. The laboratory shall be furnished with the necessary equipment and supplies for performing Contractor quality control testing. The laboratory equipment shall meet the requirements listed in Section 400 of the Mn/DOT Bituminous Manual and these specifications, including having extraction capabilities. The laboratory shall be calibrated, and operational prior to the beginning of production. In addition to the requirements listed above, the laboratory shall be equipped with a telephone for use by the Contractor or the Engineer. A fax machine and copy machine shall be available for use by the Contractor or the Engineer at the laboratory site. The laboratory shall also include a computer and printer. The computer shall have the following minimum requirements: 1) Intel based with either Celeron or Pentium
IV processor with a minimum processor speed of 1.8 MHZ. 2) CD writer with CD/RW capability and a minimum write speed of 16x. 3) Windows 2000 or Windows XP with Microsoft Excel version 97 or newer. The printer must be able to print control charts.

The Engineer shall be allowed to inspect measuring and testing devices to confirm both calibration and condition. The Contractor shall calibrate and correlate all testing equipment in accordance with the latest version of the Mn/DOT Bituminous Manual.

**D Sampling and Testing**

The Contractor shall ensure that all QC samples are taken at random locations. Random number generation and determination of random sample location shall be consistent with the Mn/DOT Bituminous Manual Section 5-693.7 Table A or Section 5 of ASTM D3665. The Engineer may approve alternate methods of random number generation.

The tests for mixture properties shall be conducted on representative portions of the mix, quartered from a larger sample of mixture taken from behind the paver, or when approved by the Engineer, an alternate sampling location. The procedure for truck box sampling, an alternate sampling location, is on file in the Bituminous Office. When an alternate sampling location is approved and used by the Contractor, the daily verification sample must still be taken from behind the paver.

The Contractor shall obtain a sample of at least 25 kg (55 pounds). This sample may be either split in the field or transported to the test facility by a method to retain heat to facilitate sample quartering procedures. The Contractor shall store and retain mixture bulk samples and companion samples for the Department for a period of 7 working days. The Contractor shall maintain these split samples in containers labeled with companion numbers. The Contractor shall perform QC sampling and testing according to the following schedule.

Determine the planned tonnage for each mixture to be produced during the production day. Divide the planned production by 1000. Round the number to the next higher whole number. This number will be the number of production tests required for that mixture. Required production tests are listed in Table 2360.4-E. Split the planned production into even increments and select sample locations as described above. If actual tonnage exceeds planned tonnage additional tests may be required. During production, mixture volumetric property tests will not be required when mix production is less than 270 metric tons (300 tons). However, production tests will be required when the accumulative tonnage on successive days exceeds 270 metric tons (300 tons).
At the start of production, the testing frequency for the first 1800 metric tons (2,000 tons) of each mix type shall be as follows:

### TABLE 2360.4-D

<table>
<thead>
<tr>
<th>Production Test</th>
<th>Testing Rates</th>
<th>Test Reference</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Specific Gravity</td>
<td>1 test per 450 metric tons (500 tons)</td>
<td>AASHTO T312, T166 Mn/DOT modified</td>
<td>2360.4E2</td>
</tr>
<tr>
<td>Maximum Specific Gravity</td>
<td>1 test per 450 metric tons (500 tons)</td>
<td>AASHTO T209 Mn/DOT modified</td>
<td>2360.4E3</td>
</tr>
<tr>
<td>Air Voids (calculated)</td>
<td>1 test per 450 metric tons (500 tons)</td>
<td>AASHTO T269, T312</td>
<td>2360.4E4</td>
</tr>
<tr>
<td>Asphalt Content</td>
<td>1 test per 450 metric tons (500 tons)</td>
<td>Bit &amp; Lab Manual</td>
<td>2360.4E1</td>
</tr>
<tr>
<td>VMA (Calculated)</td>
<td>1 test per 450 metric tons (500 tons)</td>
<td>AIMS 2 &amp; SP 2</td>
<td>2360.4E5</td>
</tr>
<tr>
<td>Gradation</td>
<td>1 test per 900 metric tons (1000 tons)</td>
<td>AASHTO T11, T27, T30Mn/DOT modified</td>
<td>2360.4E6</td>
</tr>
<tr>
<td>Coarse Aggregate Angularity</td>
<td>1 test per 900 metric tons (1000 tons)</td>
<td>ASTM D5821</td>
<td>2360.4E7</td>
</tr>
<tr>
<td>Fine Aggregate Angularity (FAA)²</td>
<td>1 test per 900 metric tons (1000 tons)</td>
<td>AASHTO T304, Method A</td>
<td>2360.4E8</td>
</tr>
</tbody>
</table>

² Marshall design allows -4.75mm (-#4) manufactured crushed fines calculation per Mn/DOT Bituminous Manual

**E Production Tests**

When more than one Mn/DOT approved test procedure is available, the Contractor shall select, with the approval of the Engineer, one method at the beginning of the Project and use that method for the entire Project. The Contractor and Engineer may agree to change test procedures during the construction of the Project.
<table>
<thead>
<tr>
<th>Production Test</th>
<th>Sampling/Testing Rates</th>
<th>Test Reference</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk Specific Gravity</td>
<td>Divide the planned production by 1000. Round the number to the next higher whole number.</td>
<td>AASHTO T312, T245, T166 Mn/DOT mod</td>
<td>2360.4E2</td>
</tr>
<tr>
<td>Maximum Specific Gravity</td>
<td>&quot;</td>
<td>AASHTO T209 Mn/DOT modified</td>
<td>2360.4E3</td>
</tr>
<tr>
<td>Air Voids (calculated)</td>
<td>&quot;</td>
<td>AASHTO T269, T312</td>
<td>2360.4E4</td>
</tr>
<tr>
<td>Asphalt Content</td>
<td>&quot;</td>
<td>Bit &amp; Lab Manual</td>
<td>2360.4E1</td>
</tr>
<tr>
<td>VMA (Calculated)</td>
<td>&quot;</td>
<td>AI MS 2 &amp; SP 2</td>
<td>2360.4E5</td>
</tr>
<tr>
<td>Gradation</td>
<td>1 gradation per 1,800 metric tons (2,000 tons), or portion thereof (minimum of one per day)</td>
<td>AASHTO T11, T27, T30 Mn/DOT modified</td>
<td>2360.4E6</td>
</tr>
<tr>
<td>Coarse Aggregate Angularity</td>
<td>2 tests/day for a minimum of 2 days, then 1 per day if CAA is met. If CAA &gt;8% of requirement, 1 sample/day but test 1/week.</td>
<td>ASTM D5821</td>
<td>2360.4E7</td>
</tr>
<tr>
<td>Fine Aggregate Angularity (FAA)</td>
<td>2 tests/day for a minimum of 2 days, then 1 per day if FAA is met. If FAA &gt;5% of requirement, 1 sample/day but test 1/week.</td>
<td>AASHTO T304, Method A</td>
<td>2360.4E8</td>
</tr>
<tr>
<td>TSR</td>
<td>1st sample at 5,000 tons or by second day of production, then sample at every 18,000 metric tons (20,000 tons)</td>
<td>ASTM D4867 Mn/DOT modified</td>
<td>2360.4E9</td>
</tr>
<tr>
<td>Aggregate Specific Gravity</td>
<td>1 per 9,000 metric tons (10,000 tons)</td>
<td>AASHTO T84 &amp; T85, Mn/DOT modified</td>
<td>2360.4E10</td>
</tr>
<tr>
<td>Mixture Moisture Content</td>
<td>Daily unless exempted by Engineer</td>
<td>Mn/DOT 5-693-950</td>
<td>2360.4E11</td>
</tr>
<tr>
<td>Asphalt Binder</td>
<td>Sample 1st load (each grade) then 1 per 1,000,000 liter (250,000 gallon-sample size 1 quart.)</td>
<td>Mn/DOT 5-693-920</td>
<td>2360.4E12</td>
</tr>
</tbody>
</table>
(1) Marshall design allows -4.75mm (#4) manufactured crushed fines calculation per Mn/DOT Bituminous Manual

E1 Asphalt Binder Content
   (a) Spot Check (Virgin only) ............................................................. Mn/DOT Bituminous Manual
   (b) Incinerator Oven (1) ................................................................. Mn/DOT Laboratory Manual Method 1853
   (c) Chemical Extraction ................................................................. Mn/DOT Laboratory Manual Method 1851 or 1852
   (d) Meter Method (Virgin only) .................................................... Mn/DOT Bituminous Manual

(1) Incinerator Oven may not be used when the percentage of Class B material exceeds 50% within the composite blend, unless a correction factor is determined by the Contractor and approved by the District Materials Engineer.

E2 Marshall Bulk Specific Gravity, \( G_{mb} \) (3 specimens) ................. AASHTO T166, Mn/DOT Modified, or
E2a Gyratory Bulk Specific Gravity, \( G_{mb} \) (2 specimens) ......................... AASHTO T312, T166, Mn/DOT Modified
E3 Maximum Specific Gravity, \( G_{mm} \) .............................................. AASHTO T209, Mn/DOT Modified
E4 Air Voids - Individual and Isolated (calculation) ............................ AASHTO T269, T312

Isolated air voids are calculated using the maximum mixture specific gravity and the corresponding bulk specific gravity from a single test. Individual air voids are calculated from the maximum specific gravity moving average and the bulk specific gravity from that single test.

For gyratory design, compaction shall be conducted to \( N_{\text{maximum}} \) and calculations for \( \%G_{\text{mmn}} \) at \( N_{\text{initial}} \) and \( N_{\text{design}} \) shall be determined by applying the calculated correction factor as described in the Asphalt Institute SP 2 manual.

Production control for \( \%G_{\text{mmn}} \) at \( N_{\text{initial}} \) and \( N_{\text{maximum}} \) shall not exceed the limit shown in Table 2360.3-B2b by more than 1.0 %. Mixture produced beyond these limits, as measured by the moving average of four tests, may result in a cancellation of the Mix Design Report. A new mix design and submittal that satisfies these specification criteria may be required.

E5 Voids Mineral Aggregate (VMA) (calculation) ............................. Asphalt Institute MS-2, SP-2
E6 Gradation - Blended Aggregate

According to AASHTO T-11, T-27, and T-30 (all Mn/DOT modified), testing to determine the blended aggregate gradation shall be determined every 1800 metric tons (2,000 tons), or portion thereof (minimum of one per day), on samples taken at the same time as the required mixture sample for a given increment.

All gradations require a - 0.075 mm (-#200) wash.

(a) Virgin Aggregate Mixtures - Drum or Screenless Plants
Belt Samples or extracted production samples.

(b) All Other Mixtures:
   1. Hot Bins - Drybatch (Optional)
   2. Incinerator Oven Mn/DOT Laboratory Manual Method 1853 (Optional) except samples that contain over 50% class B. (1)
   3. Extraction Mn/DOT Laboratory Manual Method 1851 or 1852 (Optional)

   (1) Incinerator Oven may not be used when the percentage of Class B material exceeds 50% within the composite blend, unless a correction factor is determined by the Contractor and approved by the District Materials Engineer.

E7 Coarse Aggregate Angularity

According to ASTM D5821, CAA test results shall meet the minimum percent fractured faces as shown in Table 2360.3-B2a. ASTM D-5821 shall be used to determine coarse aggregate angularity on the composite blend from aggregates used in production of hot mix asphalt. Mixtures that contain virgin aggregates may be tested from composite belt samples. Mixtures that contain RAP must be tested from extracted aggregates taken from standard production samples. The percentage of fractured faces of the composite aggregate blend less than 100% shall be tested at the following rates:

1. Perform two tests per day for each mixture blend for a minimum of two days and then one per day if the test samples meet CAA requirements.
2. If CAA crushing test results exceed 8 percent of the requirement, take one sample per day and perform one test per week.

CAA results must be reported on the test summary sheet. Mixture placed and represented by results below the minimum requirement, as shown in Table 2360.3-B2a, will be subject to reduced payment as outlined in Table 2360.4-L3. Tonnage subjected to reduced payment shall be calculated as the tons placed from the sample point of the failing test until the sampling point when the test result is back within specifications.
2360.4

E8 Fine Aggregate Angularity ....... ASTM C1252 Method A
FAA test results shall meet the minimum criteria shown in Table 2360.3-B2a. ASTM C1252 Method A shall be used to determine fine aggregate angularity on the composite blend from aggregates used in production of HMA. Mixtures that contain virgin aggregates may be tested from composite belt samples. Mixtures that contain RAP must be tested from extracted aggregates taken from standard production samples. The percentage of uncompacted voids from the composite aggregate blend shall be tested at the following rates.

(1) Perform two tests per day for each mixture blend for a minimum of two days and then one per day if the test samples meet FAA requirements.

(2) If FAA test results exceed 5 percent of the requirement, take one sample per day and perform one test per week.

FAA results must be reported on the test summary sheet. Mixture placed and represented by results below the minimums, as shown in Table 2360.3-B2a, will be subject to reduced payment as outlined in Table 2360.4-L3. Tonnage is subjected to reduced payment shall be calculated as the tons placed from the sample point of the failing test until the sampling point when the test result is back within specifications.

E8a - 4.75 mm (-#4) Manufactured Crushed Fines
...............(calculation) Mn/DOT Bituminous Manual

Under Marshall design, when the -4.75 mm (-#4) crushing is calculated, adjustments in target values from the composite blend must be made at the end of each days paving. If the target quantity (percent of -4.75 mm (-#4) to be crushed) changes due to mixture proportion or composite gradation change, a new target shall be established for the next days paving.

E9 Field Tensile Strength Ratio (TSR)
.................................ASTM D4867 Mn/DOT Modified

A TSR sample shall be obtained within the first 4,500 metric tons (5,000 tons) of HMA produced or by the second day of production, whichever comes first, to verify tensile strength ratio (TSR). These samples may be tested at the discretion of the District Materials Engineer. If the Materials Engineer requires the samples to be tested, both the Contractor and the Department will be required to test these samples within 72 hours after it is sampled. Sample size shall be 50 kg (110 pound) minimum and split in half to provide a sample for the Department and the Contractor. The Department companion of this split shall be labeled with the date, time, Project number and approximate cumulative tonnage to date. The Department companion shall be given to the Department Street Inspector or Plant Monitor immediately or delivered to the District Materials Engineer.
within 24 hours of sampling, as specified by the Engineer. Mixture samples shall be taken from behind the paver unless the Engineer approves an alternate sampling location. Specimen size shall be 100 mm (4 inch) for Marshall mix design and 150 mm (6 inch) for gyratory design. The Contractor may test the sample at a permanent lab site or a field lab site.

Additional HMA mixture samples for TSR evaluation shall be sampled at a rate of 1 per 18,000 metric tons (20,000 tons) increments for all mixtures produced on the Project. These samples may be tested at the discretion of the District Materials Engineer. If the Materials Engineer requires the samples to be tested, both the Contractor and the Department will be required to test these samples. Minimum acceptable TSR values for production are shown in Table 2360.4-E9. The Contractor shall stop production immediately if minimum TSR requirements are not met. The Contractor will not be allowed to resume production until anti-strip has been added to the asphalt binder. Determination of who is responsible for the cost of the anti-strip is based on Mn/DOT and Contractor TSR values as outlined in Tables 2360.4E9A, 2360.4E9B, and 2360.4E9C. When Mn/DOT is responsible for the cost of the anti-strip, payment will be made only for the cost of the anti-strip for mixtures placed on that project. Mn/DOT will not reimburse the Contractor for any delay costs associated with making changes related to this testing.

<table>
<thead>
<tr>
<th>TABLE 2360.4-E9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mixture Type -- Minimum TSR</strong></td>
</tr>
<tr>
<td>LV and MV</td>
</tr>
<tr>
<td>Contractor</td>
</tr>
<tr>
<td>70%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2360.4-E9A</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LV and MV Mixtures</strong></td>
</tr>
<tr>
<td><strong>Contractor TSR</strong></td>
</tr>
<tr>
<td>Mn/DOT TSR</td>
</tr>
<tr>
<td>&lt;60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TABLE 2360.4-E9B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gyratory Level 2-3</strong></td>
</tr>
<tr>
<td><strong>Contractor TSR</strong></td>
</tr>
<tr>
<td>Mn/DOT TSR</td>
</tr>
<tr>
<td>&lt;65</td>
</tr>
</tbody>
</table>
Another sample shall be taken and tested within the first 450 metric tons (500 tons) after production resumes. If the re-test fails to meet the minimum specified value the Contractor shall stop production immediately. Production cannot resume until the Contractor has discussed, with the Engineer, a proposal for resolving the problem. The Contractor shall not operate below the specified minimum TSR on a continuing basis. A continuing basis shall be defined as 2 or more successive tests failing the TSR requirements.

The following conditions will automatically require a sample to be taken and tested:

1. A proportion change of more than 10 percent (from the currently produced mixture) for a single stockpile aggregate.
2. The discretion of the Engineer.

Dispute resolution procedures for TSR are on file in the Bituminous Office.

E10 Aggregate Specific Gravity (Gsb) ............................AASHTO T84 and T85, Mn/DOT modified

Samples of all aggregate stockpiles shall be collected on each aggregate used in the production mixture, at a rate of one sample per 9,000 metric tons (10,000 tons) mixture produced. These samples shall be taken at random as directed by the Engineer. These representative stockpile samples shall be 40 kg (90 pounds) of each aggregate component. Each sample shall be split in half to provide a sample for the Department and the Contractor. The Department companion shall be labeled with date, time, Project number and approximate cumulative tonnage to date.

The Department companion shall be given to the Department Street Inspector or Plant Monitor immediately or delivered to the District Materials Engineer within 48 hours of sampling, as specified by the Engineer. These samples may be tested. Tested samples will be compared to the Contractor’s values on the Mix Design Report. If the results deviate beyond the tolerance specified in Table 2360.4-M, the dispute resolution procedure on file in the Bituminous Office will be utilized. Any mixture placed following notification of new specific gravity values will be based upon Department results unless proven incorrect. The Contractor shall be notified when new specific gravity values become available and what impact this will have on the calculated VMA.
E11 Moisture Content

Provide a mixture with a moisture content not greater than 0.3 percent. The moisture content in the mixture shall be measured behind the paver or alternate approved sampling method on file in the Bituminous Office. Sampling and testing shall be conducted by the Contractor on a daily basis unless exempted by the Engineer. Sampling and testing is suggested when rain on stockpiles exceed more than 5 mm (0.2 inch) in a 24 hour period. The sample shall be stored in an airtight container. Microwave testing is prohibited. HMA that exceeds 0.3% moisture content is unacceptable. The Contractor shall take appropriate action to remove excess water from the mixture. This action may include reducing the production rate, mixing stockpile aggregates prior to placement into the feed bins, and use of covered stockpiles.

E12 Asphalt Binder Samples

The Contractor shall sample the first shipment of each type of asphalt binder, then sample at a rate of one per 1,000,000 liters (250,000 gallons); sample size shall be 1.0 L (1 quart). All samples shall be taken in accordance with the Mn/DOT Bituminous Manual 5-693.920. Sampling shall be conducted by Contractor and monitored by the Inspector. Promptly submit the sample to the Department Materials Laboratory in Maplewood. The Contractor shall record sample information on Asphalt Sample Identification Card.

F Documentation (Records)

The Contractor shall maintain documentation, including test summary sheets and control charts, on an ongoing basis. The Contractor shall also maintain a file of gyratory specimen heights for all gyratory compacted samples and test worksheets. Reports, records, and diaries developed during the progress of construction activities for the Project, shall be filed as directed by the Engineer and will become the property of the Department. The Contractor shall:

1. Number test results in accordance with standard Department procedures and record on forms approved/supplied by the Department.

2. Facsimile all production test results on test summary sheets to the District Materials Laboratory and to other sites as requested by the Engineer, by 11 AM of the day following production.

2a. Include the following production test results and mixture information on the Department approved test summary sheet.
1. Percent passing on sieves listed in Table 2360.2-E.
2. Coarse and fine aggregate crushing.
3. Maximum specific gravity (G_mm).
4. Bulk specific gravity (G_mb).
5. Percent asphalt binder content (P_b).
6. Calculated production air voids (V_a). Gyratory design shall also include \( \%G_{\text{mm}} \) at \( N_{\text{initial}} \), \( \%G_{\text{mm}} \) at \( N_{\text{design}} \), and \( \%G_{\text{mm}} \) at \( N_{\text{maximum}} \).
7. Calculated voids in mineral aggregate (VMA).
8. Composite aggregate specific gravity (G_ab) reflecting current proportions.
9. Aggregate proportions in use at the time of sampling.
10. Tons where sampled.
11 Cumulative tons.
  11a. Tons Represented by Test.
12. Fines to effective asphalt ratio (F/A_e).
13. Signature Line for Mn/DOT and Contractor Representative.
14. Mixture Moisture Content.
15. Mn/DOT verification sample test result.

(2b) Submit copies of all failing test results to the Engineer on a daily basis.
(3) Provide the Engineer with asphalt manifests of BOL's on a daily basis.
(4) Provide a daily plant diary to include a description of QC actions taken (adjustment of cold feed percentages, changes in JMFs, etc.) include all changes or adjustments on the test summary sheets.
(5) Provide weekly truck scale spot checks.
(6) Provide a Department approved accounting system for all mixes and provide a daily and final Project summary of material quantities and types.
(6a) Provide a final hardcopy summary of all quality control test summary sheets and control charts at completion of bituminous operations on the Project to the Engineer. Because Certified Plant test data often represents test data for multiple projects, it may be necessary to make duplicate copies of the data for each project. The Contractor shall also submit a diskette of the quality control summary sheets, control charts and density worksheets to the Bituminous Engineer.

(7) Furnish an automated weigh scale and computer generated weigh ticket. The ticket shall indicate project number, mix designation (including binder grade), Mixture Design
(8) Charts and records for a mixture produced at one plant site shall be continued from contract to contract.

G Documentation (Control Charts)

The following data shall be recorded on the standardized control charts, all control charts and summary sheets shall be computer generated using software approved by the Engineer. Software is available from the Mn/DOT Bituminous Office website.

(1) Blended aggregate gradation, include sieves shown in Table 2360.2-E for specified mixture.
(2) Percent asphalt binder content (Pb).
(3) Maximum specific gravity (Gmm).
(4) Production air voids (Va).
(5) VMA.

Individual test results shall be plotted for each test point. A solid line shall connect individual points. The moving average for each test variable shall be plotted starting with the fourth test. A dashed line shall connect the moving average points. The Department's quality assurance and verification test results shall be plotted with asterisks. Specification JMF limits shall be indicated on the control charts using a dotted line. The Engineer may waive the plotting of control charts.

H JMF Limits

The production air voids and VMA are based upon the minimum specified requirements as shown in Tables 2360.3-B2b and 2360.3-B2c. Gradations and asphalt binder content limits are based upon the current Department reviewed Mixture Design Report. Gradation control sieves include each sieve shown in Table 2360.2-E. The mixture production targets are listed on the Mixture Design Report. JMF limits are the target plus or minus the limits shown in Table 2360.4-H. JMF limits are used as the criteria for acceptance of materials based on the moving average. A moving average is the average of the last four test results.

I JMF Bands

JMF Bands are defined as the area between the target, as identified on the Mixture Design Report, and the JMF limits.
TABLE 2360.4-H
JMF LIMITS (N=4)

<table>
<thead>
<tr>
<th>Item</th>
<th>JMF Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>VMA, %</td>
<td>- 0.3</td>
</tr>
<tr>
<td>Production Air Voids, %</td>
<td>± 1.0</td>
</tr>
<tr>
<td>Asphalt Binder Content, %</td>
<td>- 0.4</td>
</tr>
<tr>
<td>Sieve - % Passing*</td>
<td></td>
</tr>
<tr>
<td>25, 19, 12.5, 9.5, 4.75 mm (1 inch, ¾ inch, ½ inch, 3/8 inch, #4)</td>
<td>± 7</td>
</tr>
<tr>
<td>2.36 mm (#8)</td>
<td>± 6</td>
</tr>
<tr>
<td>0.075 mm (#200)</td>
<td>± 2.0</td>
</tr>
</tbody>
</table>

*JMF limits are not allowed outside the broadband requirements in Table 2360.2-E.

J MF Adjustment

The Contractor shall begin mixture production with the materials (gradation, asphalt content, and aggregate proportions) closely conforming to the reviewed Mixture Design Report. Closely conforming shall be defined as aggregate proportions within 5 percent of the design proportions (1) and other mixture parameters within the JMF limits in Table 2360.4-H. This requirement may be waived if the Contractor provides the District Materials Laboratory with prior documented production data showing how production affects the mixture properties or if the Contractor provides the District Materials Laboratory with a written justification or explanation of material changes since the original mixture submittal.

(1) The Contractor shall begin mixture production using all aggregate proportions included on the Mixture Design Report unless the aggregate proportion is shown as 0 percent.

If, during production, the Contractor determines from results of QC tests that adjustments to the mix design are necessary to achieve the specified properties, the following provisions shall apply. No adjustments are allowed using aggregates or materials not part of the original mix design.

The Contractor shall make a request for a JMF adjustment to the Department Bituminous Engineer or District Materials Engineer. The requested change will be reviewed for the Department by a Certified Level II Bituminous QM Mix Designer. If the request meets the design requirements in Tables 2360.3-B2a and 2360.3-B2b, a revised Mixture Design Report shall be issued. Each trial mixture design submittal as described in Section 2360.3A may have three JMF adjustments per mixture per project without charge. Additional JMF adjustments requested must be accompanied with a $500 fee per each additional JMF adjustment, payable to the Commissioner of
Transportation.

If a JMF change is requested for the 0.075 mm (#200) sieve, the Fines to Effective Asphalt Ratio shall be determined on the moving average from the previous four gradation tests conducted during actual production. The adjusted JMF shall be within the mixture specification gradation design broadbands shown in Section 2360.2E. Should a redesign of the mixture become necessary, a new JMF shall be submitted. The JMF asphalt content may only be reduced if the production VMA meets or exceeds the minimum VMA requirement for the mixture being produced.

Adjustments will be made as a result of an interactive process between the Contractor, Engineer, and District Materials Engineer. Consecutive requests for JMF adjustments, without production data, are not allowed. The calculation of the moving average shall continue after the JMF has been approved.

J1 JMF Adjustment for Proportion Change > 10%

If a JMF adjustment is requested for a proportion change exceeding 10% (from the currently produced mixture) for a single stockpile aggregate, supporting production test data from a minimum of four tests run at an accelerated testing rate of 1 test per 450 metric tons (500 tons) must be included with the request for adjustment. In addition to the requirements listed above, acceptable verification and approval of the requested JMF will be based on individual and moving average test results. Individual test results must be within twice the requested JMF limits for percent asphalt binder, production air voids, and VMA. Individual gradation must be within twice the requested JMF bands. The moving average values must be within the control limits of Table 2360.4-H. The calculation of the moving average shall continue after the change in proportions.

If the mixture meets the specified quality indicators, the request for JMF adjustment will be signed by the District Materials Laboratory and considered effective from the point the proportion change was made. Failure to meet the quality indicators will result in reduced payment or removal and replacement with acceptable material. Consecutive requests for JMF adjustments without production data is not allowed.

K Corrective Action -- Percent Asphalt Binder Content, VMA, and Gradation and Production Air Voids

When the moving average values trend toward the JMF limits, the Contractor shall take corrective action. The corrective action taken shall be documented on summary sheets and, if applicable, a request for JMF adjustment shall be submitted to the District Materials Engineer for review and approval. All tests shall be part of the project files and shall be included in the moving average
calculations. The Contractor shall notify the Engineer whenever the moving average values exceed the JMF limits.

L. Failing Materials

The determination of price adjustments for failing materials will be based on the criteria outlined in this Section. Material acceptance is based on individual and moving average test results. Isolated test results are used for acceptance of air voids at the start of mixture production. Generally, individual test results which are more than twice the JMF bands are considered failing. Moving average test results are considered failing when they exceed the JMF limits.

If the moving average values exceed the JMF limits, the Contractor shall stop production and make adjustments. The Contractor shall restart production only after notifying the Engineer of the adjustments that have been made. Testing shall resume at the accelerated rates and for the tests listed in Table 2360.4-D for the next 1800 metric tons (2,000 tons) of mixture produced. The calculation of the moving average shall continue after the stop in production.

Mixture produced where the moving average of four exceeds the JMF limits shall be considered unsatisfactory and subject to requirements of Section 2360.4L4, L5, L6, and L7. Individual test failures are discussed in Section 2360.4L1, L2, and L3.

When the total production of a mixture type for the entire project requires less than four tests, a moving average will be established based on the tests taken. Acceptance of material will be consistent with the criteria outlined in Section 2360.4L and will be based on the following modifications to the JMF limits: For two tests, establish the new JMF limits by multiplying the JMF limits listed in Table 2360.4-H by 1.41; for three tests, establish the new JMF limits by multiplying the JMF limits listed in Table 2360.4-H by 1.15. For moving average gradation, the modified JMF limit cannot exceed the broadband requirements in Table 2360.2-E.

When the Contractor's testing data fails to meet specified tolerances as listed in Table 2360.4-M, quality assurance/verification data shall be used in place of the Contractor's data to determine the appropriate payment factor.

L1 Isolated Failures at Mixture Start-Up – Production Air Voids

At the start-up of mixture production, before a moving average of four can be established the first three (3) isolated test results for production air voids will be used for acceptance. Isolated production air voids are calculated by using the maximum mixture specific gravity and the corresponding bulk specific gravity from that single test. After four (4) samples have been tested and a moving average of four can be established, acceptance will be based on individual and
moving average production air voids.

If, at the start of production, any of the first three (3) isolated test results for production air voids exceeds twice the JMF bands from the target listed on the Mixture Design Report, the material is considered unsatisfactory or unacceptable. Reduced payment as outlined in Table 2360.4-L3 shall apply to all tonnage placed from the sample point of the failing test until the sample point when the isolated test result is back within twice the JMF bands. When the failure occurs at the first test, after the start of production, the tonnage subjected to reduce payment shall be calculated as described above and shall include the tonnage from the start of production.

When isolated air voids are less than 1.0% or greater than 7.0% the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. To better define the area to be removed and replaced the Engineer may require the Contractor to test inplace mixture. This may include testing mixture placed prior to the failing test result. Reduced payment will be 50 percent of the Contract bid price.

L2 Individual Failure at Mixture Start-Up – VMA

At the start-up of mixture production, before a moving average of four can be established, the first three (3) individual test results for VMA will be used for acceptance. After 4 samples have been tested and a moving average of four can be established, acceptance will be based on individual and moving average VMA.

If, at the start of production, any of the first three (3) individual VMA test results exceeds twice the JMF bands from the target listed on the Mixture Design Report, the material is considered unsatisfactory or unacceptable. Reduced payment as outlined in Table 2360.4-L3 shall apply to all tonnage placed from the sample point of the failing test until the sample point when the test results are back within twice the JMF limits. When the failure occurs at the first test, after the start of production, the tonnage subjected to reduce payment shall be calculated as described above and shall include the tonnage from the start of production.

L3 Individual Failure - Gradation, Percent Asphalt Binder, Production Air Voids, and VMA

If the individual gradation test exceeds twice the JMF bands from the target listed on the Mixture Design Report the material is considered unsatisfactory or unacceptable. Reduced payment as outlined in Table 2360.4-L3 shall apply to all tonnage represented by the individual test.
<table>
<thead>
<tr>
<th>Item</th>
<th>Pay Factor (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation</td>
<td>95 %</td>
</tr>
<tr>
<td>Coarse and Fine Aggregate Crushing</td>
<td>90 %</td>
</tr>
<tr>
<td>VMA</td>
<td>85 %</td>
</tr>
<tr>
<td>Asphalt Binder Content</td>
<td>85 %</td>
</tr>
<tr>
<td>Production Air Voids (individual(^{(2)}) and isolated(^{(3)}))</td>
<td>70 %</td>
</tr>
</tbody>
</table>

\(^{(1)} \) Lowest Pay Factor applies when there are multiple reductions on a single test.

\(^{(2)} \) Individual air voids are calculated using the moving average maximum specific gravity and the bulk specific gravity from that single test.

\(^{(3)} \) Isolated air voids are calculated from the maximum specific gravity and the bulk specific gravity from that single test. Isolated void test results are used for acceptance only for the first 3 tests after mixture production start-up.

If the individual tests for percent asphalt binder content, production air voids, or VMA exceeds twice the JMF bands from the target listed on the Mix Design Report the material is considered unsatisfactory or unacceptable. Reduced payment as outlined in Table 2360.4-L3 shall apply to all tonnage placed from the sample point of the failing test until the sample point when the test result is back within twice the JMF limits. When the failure occurs at the first test after the start of daily production, tonnage subjected to reduced payment shall be calculated as described above and shall include the tonnage from the start of production that day.

When individual air voids are less than 1.0% or greater than 7.0% the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. To better define the area to be removed and replaced the Engineer may require the Contractor to test inplace mixture. This may include testing mixture placed prior to the failing test result. Reduced payment will be 50 percent of the Contract bid price.
L4  Moving Average Failure at Mixture Start-Up – Production Air Voids

When a moving average failure occurs within any of the first 3 moving average results after mixture start-up (tests 4, 5, 6), the mixture will be considered acceptable if the individual air void, corresponding to the moving average failure is within the JMF limits. If the individual air void is not within the JMF limit, the mixture will be considered unacceptable and the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. The Engineer may waive the penalty if the isolated air void corresponding to the individual air void is within the JMF limit. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. Reduced payment will be 50 percent of the Contract bid price. Tonnage subjected to replacement or reduced payment shall be calculated as the tons placed from the sample point of the failing moving average result and corresponding individual air void beyond the JMF limit to the sampling point when the individual test result is back within the JMF limit.

L5  Moving Average Failure at Mixture Start-Up - VMA

When a moving average failure occurs within any of the first 3 moving average results after mixture start-up (tests 4, 5, 6), the mixture will be considered acceptable if the individual VMA, corresponding to the moving average failure is within the JMF limits. If the individual VMA is not within the JMF limit, the mixture will be considered unacceptable and the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. Reduced payment will be 75 percent of the Contract bid price. Tonnage subjected to replacement or reduced payment shall be calculated as the tons placed from the sample point of the failing moving average result and corresponding individual VMA beyond the JMF limit to the sampling point when the individual test result is back within the JMF limit.

L6  Moving Average Failure - Production Air Voids

A moving average production air void failure occurs when the individual production air void moving average of four exceeds the JMF limit. This mixture is considered unacceptable and the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. Reduced payment will be 50 percent of the Contract bid price. Tonnage subjected to replacement or reduced payment shall be calculated as the tons placed from the sample point of all individual test results beyond the JMF limits which contributed to the moving
average value that exceeded the JMF limit to the sampling point when the individual test result is back within the JMF limits. When the failure occurs at the first test after the start of daily production, tonnage subjected to reduced payment shall include the tonnage from the start of production that day.

**TABLE 2360.4-L6**

<table>
<thead>
<tr>
<th>Item</th>
<th>Pay Factor (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gradation</td>
<td>75 %(^{(3)})</td>
</tr>
<tr>
<td>Coarse and Fine Aggregate Crushing</td>
<td>NA (individual failures only)</td>
</tr>
<tr>
<td>VMA(^{(2)})</td>
<td>75 %</td>
</tr>
<tr>
<td>Asphalt Binder Content</td>
<td>75 %</td>
</tr>
<tr>
<td>Production Air Voids(^{(2)})</td>
<td>50 %</td>
</tr>
</tbody>
</table>

\(^{(1)}\) Lowest Pay Factor applies when there are multiple reductions on a single test.

\(^{(2)}\) See criteria for mixture production start-up.

\(^{(3)}\) Excluding the 0.075 mm (\#200) sieve, use 95% pay factor if failure is within ±1% of aggregate gradation broadband, Table 2360.2-E.

L7 Moving Average Failure - Percent Asphalt Binder Content, VMA, and Gradation

For mixture properties including asphalt binder content, VMA, and gradation, where the moving average of four exceeds the JMF limits, the mixture is considered unacceptable and the Engineer will decide whether the mixture is subject to removal and replacement or reduced payment. If the mixture is to be removed and replaced, the Contractor at his expense will perform the work. Reduced payment will be 75 percent of the Contract bid price. Tonnage subjected to replacement or reduced payment shall be calculated as the tons placed from the sample point of all individual test results beyond the JMF limits which contributed to the moving average value that exceeded the JMF limit, to the sampling point when the individual test result is back within the JMF limits. When the failure occurs at the first test after the start of daily production, tonnage subjected to reduced payment shall include the tonnage from the start of production that day.

L8 Coarse and Fine Aggregate Crushing Failure

If any test result for Coarse Aggregate Angularity, Fine Aggregate Angularity or -4.75mm (\#4) calculated crushing fail to meet minimum requirements in Table 2360.3-B2a, all material placed
is subject to reduced payment as outlined in Table 2360.4-L.3. Tonnage subjected to reduced payment shall be calculated as the tons placed from the sample point of the failing test until the sampling point when the test result is back within specifications. When the failure occurs at the first test after the start of daily production, tonnage subjected to reduced payment shall include the tonnage from the start of production that day.

M Quality Assurance

The Engineer will periodically witness the sampling and testing being performed by the Contractor. If the Engineer observes that the sampling and quality control tests are not being performed in accordance with the applicable test procedures, the Engineer may stop production until corrective action is taken. The Engineer will notify the Contractor of observed deficiencies promptly, both verbally and in writing.

The Engineer may obtain additional samples, at any time, to determine quality levels. These additional samples or verification samples are described in Section 2360.4N. For mixture, the Contractor shall test their portion immediately.

All testing and data analysis shall be performed by the Certified Level I Bituminous Quality Management (QM) Technician. Certification shall be in accordance with the Mn/DOT Technical Certification Program. The Department shall post a chart giving the names and telephone numbers for the personnel responsible for the Quality assurance program.

The Engineer shall calibrate and correlate all laboratory testing equipment in accordance with the latest version of the Mn/DOT Bituminous Manual.

N Verification Testing

A verification sample is a sample, which is sampled and tested by Mn/DOT to assure compliance of the Contractor’s Quality Control program. A verification companion is a companion sample, to Mn/DOT’s verification sample, provided to the Contractor. The Contractor is required to test and use this verification companion sample as part of the QC program. The verification companion sample will replace the next scheduled QC sample. It is recommended enough material be sampled to accommodate retesting should the samples fail to meet requirements as described below.
### TABLE 2360.4-M
ALLOWABLE DIFFERENCES (TOLERANCES) BETWEEN CONTRACTOR AND MN/DOT TEST RESULTS*

<table>
<thead>
<tr>
<th>Item</th>
<th>Allowable Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixture Bulk Specific Gravity ($G_{mb}$)</td>
<td>0.030</td>
</tr>
<tr>
<td>Mixture Maximum Specific Gravity ($G_{mm}$)</td>
<td>0.019</td>
</tr>
<tr>
<td>VMA (Calculated)</td>
<td>1.2</td>
</tr>
<tr>
<td>Fine Aggregate Angularity, uncompacted voids (U) %</td>
<td>1</td>
</tr>
<tr>
<td>Coarse Aggregate Angularity, % fractured faces (%P)</td>
<td>15</td>
</tr>
<tr>
<td>Aggregate Individual Bulk Specific Gravity (+4.75mm (+ #4))</td>
<td>0.040</td>
</tr>
<tr>
<td>Aggregate Individual Bulk Specific Gravity (-4.75mm (- #4))</td>
<td>0.040</td>
</tr>
<tr>
<td>Aggregate combined blend Specific Gravity ($G_{ab}$)</td>
<td>0.020</td>
</tr>
<tr>
<td>Tensile Strength Ratio (TSR) %</td>
<td>See Table 2360.3-B2b</td>
</tr>
</tbody>
</table>

#### Asphalt Binder Content

<table>
<thead>
<tr>
<th>Method</th>
<th>Allowable Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter Method, %</td>
<td>0.2</td>
</tr>
<tr>
<td>Spot Check Method, %</td>
<td>0.2</td>
</tr>
<tr>
<td>Chemical Extraction Methods, %</td>
<td>0.4</td>
</tr>
<tr>
<td>Incinerator Oven, %</td>
<td>0.3</td>
</tr>
<tr>
<td>Chemical vs. Meter, Spot Check, or Incinerator methods</td>
<td>0.4</td>
</tr>
<tr>
<td>Incinerator Oven vs. Spot Check</td>
<td>0.4</td>
</tr>
</tbody>
</table>

#### Gradation Sieve % passing

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Allowable Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.0, 19.0, 12.5, 9.5 mm (1 inch, ¾ inch, ½ inch, 3/8 inch)</td>
<td>6</td>
</tr>
<tr>
<td>4.75 mm (#4)</td>
<td>5</td>
</tr>
<tr>
<td>2.36 mm (#8)</td>
<td>4</td>
</tr>
<tr>
<td>0.075 mm (#200)</td>
<td>2.0</td>
</tr>
</tbody>
</table>

*Test tolerances listed are for single test comparisons.

Verification testing shall be performed on at least one set of production tests Section 2360.4E, excluding sections E9, E10, E11, and E12, on a daily basis per mix type. The verification companion sample will be used to verify the requirements of Tables 2360.2-E, 2360.3-B2a, 2360.3-B2b, and 2360.3-B2c and will be compared to the Verification sample for compliance with allowable tolerances as specified in Table 2360.4-M. These include the mixture properties of
2360.4

G\text{mm} (mixture max gravity), G\text{mb} (mixture bulk gravity), asphalt binder content, VMA (calculated), Coarse and Fine Aggregate crushing, and gradation. For Coarse and Fine Aggregate crushing that meets the requirements of Section 2360.4E7 and 2360.4E8 the one test per week shall be performed on a verification companion. These do not include the aggregate bulk specific gravity G\text{sb}, fines to effective asphalt, or the tensile strength ratio (TSR). Asphalt binder content and gradation must be determined by either extraction method 2360.4E1b or 2360.4E1c. Asphalt content from the verification test result must be used to determine VMA.

The Department’s verification test results will be available to the Contractor within 2 working days from the time the sample is delivered to the District Laboratory for G\text{mm} mixture max gravity, G\text{mb} mixture bulk gravity, air voids (calculated), asphalt binder content, VMA (calculated). Gradation and crushing results will be provided to the Contractor within 3 Mn/DOT working days. Once the verification test results are available, they will be included on the test summary sheet. These results and those from the Contractor’s verification companion will be compared for allowable tolerances as specified in Table 2360.4-M. If the tolerances are met, the verification process is complete.

If the tolerances between Department and Contractor are not met, retests of the material shall be conducted by the Department. If the retests fail to meet tolerances, the Department’s verification test results will be substituted for the Contractor’s results in the QC program and used for acceptance. Only those parameters out of tolerance will be substituted and, if applicable, volumetric properties will be recalculated (1).

When tolerances from the verification sample retests are not met, an investigation will begin immediately to determine the cause of the difference. Testing equipment, procedures, worksheets, gyratory specimen height sheets, and personnel will be reviewed to determine the source of the problem. The District Materials Engineer may also require a hot-cold comparison of mixture properties be performed. The procedure for hot-cold comparisons is as follows:

The hot-cold comparison sample will be split into three representative portions. The Engineer will observe the Contractor testing the sample. One part shall be compacted immediately while still hot (additional heating maybe required to raise the temperature of the sample to compaction temperature). The second and third part will be allowed to cool to air temperature. The Contractor will retain the second part and the third part will be transported to the District Materials Laboratory. On the same day and at approximately the same
time the Contractor and the District Materials Laboratory will heat their samples to compaction temperature and compact them. From this information a calibration factor will be developed to compare the specific gravity of the hot compacted samples to reheated compacted samples. Each test will involve a minimum of three Marshall specimens or two gyratory specimens. This test may be repeated at the discretion of the Contractor or the District Materials Engineer.

Note: Care must be taken when reheating samples for mixture properties analysis tests. Mix samples should be reheated to 70°C (160°F) to allow splitting of the sample into representative fractions for the various tests. Overheating of the mixture portions to be tested for maximum specific gravity (Rice Test) may result in additional asphalt being absorbed in the aggregate.

The Department will test the previously collected QA samples until they meet the tolerances or the remaining samples are all tested. Once these samples are tested, the department will test QA samples subsequent to the verification sample until tolerances are met. Acceptance will be based on QC data with substitution of Department test results for those parameters out of tolerance \(^{(1)}\). If reestablishment of test result tolerances is not achieved within 48 hours, the Contractor shall cease mixture production and placement until the problem is resolved.

\(^{(1)}\) If, through analysis of data, it is determined there is a bias in the test results, the Engineer will determine which results are appropriate and shall govern. Methods to analyze data for determination of bias are on file in the Bituminous Office.

2360.5 CONSTRUCTION REQUIREMENTS

A General
The following construction requirements provide for the construction of all courses. When construction is under traffic, the requirements of Mn/DOT 2221.3D will apply.

B Restrictions
In general, no work within the roadway will be permitted in the spring until seasonal load restrictions on roads in the vicinity have been removed. However, work within the roadbed may be permitted before that time if, in the opinion of the Engineer, it can be done without damage to the subgrade. HMA shall not be placed when, in the opinion of the Engineer, the weather or roadbed conditions are unfavorable.
No asphalt pavement wearing course (final wearing course if multiple wearing courses) shall be placed after October 15th in that part of the state north of an east-west line between Browns Valley and Holyoke, nor after November 1st south of that line. The Engineer may waive these restrictions when:

1. The asphalt mixture is not being placed on the traveled portion of the roadway, or
2. The roadway involved will not be open to traffic during the following winter, or
3. The Engineer directs in writing the mixture be placed.

The Contractor shall not use petroleum distillates such as kerosene and fuel oil to prevent adhesion of asphalt mixtures in pavement hoppers, truck beds, or on the contact surfaces of the compaction equipment. Anti-adhesive agent must meet the criteria for "Effect on Asphalt" as described in the most recent Asphalt Release Agent Report on file in Mn/DOT’s Office of Environmental Services and the Bituminous Office.

C Equipment
C1 Asphalt Mixing Plants
C1a Requirement for All Plants

The Contractor shall test and calibrate all scales according to Mn/DOT 1901, except as otherwise designated by the Contract.

C1a(1) Equipment for the Preparation of the Aggregate

Add mineral filler to the mixture using a storage silo equipped with a device to ensure a constant and uniform feed.

C1a(2) Equipment for the Preparation of Asphalt Material

Tanks for storage of asphalt material at the plant shall be equipped to heat the material and maintain the material at the required temperatures. The discharge end of the circulating line shall be below the surface of the asphalt material. Provide agitation for modified asphalt, when used, if recommended by the supplier.

An outage table or chart and measuring stick shall be provided for each storage or working tank. Tanks shall be equipped with provisions for taking of asphalt binder material samples. After delivery of asphalt binder material to the Project, the Contractor shall not heat the material above 175°C (350°F). For modified asphalt, the maximum storage temperature shall not exceed the recommendation of the asphalt supplier.

C1a(3) Asphalt Binder Control

When asphalt binder material is proportioned by volume, the plant shall be equipped with either a working tank or a metering system for determining asphalt binder content of the mixture.

The working tank shall have a capacity between 3,800 L (1,000 gallons) and 7,600 L (2,000 gallons). The working tank shall be
calibrated and supplied with a calibrated measuring stick. The tank may be connected to a mixing unit and used only during spot check operations, but it shall be available at all times. Any feedback shall be returned to the working tank during spot check operations.

The metering system shall consist of at least one approved asphalt binder flow meter in addition to the asphalt binder pump. The flow meter shall be connected to the asphalt binder supply to measure and display only the asphalt binder being fed to the mixer unit. The meter readout shall be positioned for convenient observation. Means shall be provided for comparing the flow meter readout with the calculated output of the asphalt binder pump. In addition, the system shall display in liters (gallons) or to the nearest 0.001 metric tons (0.001 tons), the accumulated asphalt binder quantity being delivered to the mixer unit. The system shall be calibrated and adjusted to maintain an accuracy of ± one percent error. This calibration shall be required for each plant set-up prior to production of mixture.

C1a(4) Dryer: The aggregate shall be free of unburned fuel.
C1a(5) Thermometric Equipment:
   The plant shall be equipped with a sufficient number of thermometric instruments to ensure temperature control of the aggregate and the asphalt binder material.
C1a(6) Pollution Controls
   C1a(6)(a) Pollution ................................................................. 1717
C1a(7) Surge and Storage Bins
   The plant may include facilities to store hot asphalt mixture for coordinating the rate of production with the paving operations. Storage of the hot mixture will be permitted for a period not to exceed 18 hours, provided the following requirements are met:
      (a) Hot mix storage facilities shall be designed and operated to prevent segregation of the mix, drainage of the asphalt from the mix, and to prevent excessive cooling or overheating of the mixture.
      (b) The temperature of the mixture at time of discharge from the storage facility shall be within a tolerance of 5°C (9°F) of the temperature when discharged from the silo or mixer.

C2 Placement and Hauling Equipment
   All equipment shall be serviced away from the paving site to prevent contamination of the mixture. Units that drip fuel, oil, or grease shall be removed from the paved surface until such leakage is corrected.
C2a Asphalt Pavers
   Asphalt pavers shall be self-contained, power-propelled units, with an operational vibratory screed, capable of spreading and
finishing courses of asphalt plant mix material in widths applicable to the specified typical sections and thicknesses, indicated in the Contract.

The screed or strike-off assembly shall produce a finished surface of the required evenness and texture without tearing, shoving, or gouging. For mainline paving, screed extensions and auger extensions are required if the paving width on either side of the paver is greater than the basic screed unless otherwise directed by the Engineer. Strike-off only extension assemblies are not allowed for mainline wearing course paving, unless directed by the Engineer.

Automatic screed control by means of an erected string line shall only be required when stated in the Contract.

All pavers shall be equipped with an approved automatic screed control. The automatic controls shall include a system of sensor-operated devices, which follow reference lines, or surfaces on one or both sides of the paver as required. The speed of the paver shall be adjusted to produce the best results.

All mixtures shall be spread without segregation to the cross sections shown in the plans. In general, leveling layers shall be spread by the method producing the best results as approved by the Engineer. The objective is to secure a smooth base of uniform grade and cross section so that subsequent courses will be uniform in thickness. The leveling layer may be spread with a properly equipped paver or, when approved by the Engineer, a motor grader equipped with a leveling device, or with other means for controlling the surface elevation of the leveling layer.

All mixtures shall be spread, to the fullest extent practicable, by an asphalt paver. When approved by the Engineer, mixtures may be spread by a motor grader in areas that are inaccessible to a paver such as on driveway entrances, irregular areas, short isolated areas or when the quantity of mixture makes it impractical to place with a paver.

On shoulder surfacing and uniform width widening, when the placement width is too narrow for a paver, the mixture in each course shall be spread with an approved mechanical device.

The placement of each course shall be completed over the full width of the section under construction on each day's run unless otherwise directed by the Engineer.

C2b Trucks

Trucks for hauling asphalt mixtures shall have tight, clean, and smooth beds. Mixture shall not be allowed to adhere to the truck beds. Adherence may be prevented by spraying the truck bed with an anti-adhesive agent in accordance with Section 2360.5B. Each truck shall be equipped with a cover of canvas or other suitable material to protect the mixture from weather. The cover shall extend at least
300 mm (1 foot) over the sides and be attached to tie-downs unless the truck is furnished with a mechanical or automated covering system, which prevents airflow underneath by stretching the cover tightly on the top of or inside the sideboards. The cover shall be used when directed by the Engineer.

C2c Motor Graders

Motor graders shall be self-propelled and have pneumatic-tires with a tread depth of 13 mm (½ inch) or less. They shall be equipped with a blade not less than 3 m (10 feet) in length and shall have a wheelbase of not less than 4.5 m (15 feet).

D Treatment of the Surface

D1 Tack Coat

An asphalt tack coat shall be applied to existing asphalt and concrete surfaces, and to the surface of each course or lift constructed, except for the final course or lift, according to Mn/DOT 2357. Emulsified asphalt tack coats shall be allowed to break, as indicated by a color change from brown to black, before a subsequent lift is placed.

The contact surfaces of all fixed structures and the edge of the in-place mixture in all courses at transverse joints and longitudinal joints shall be given a uniform but not excessive coating of liquid asphalt or emulsified asphalt before placing the adjoining mixture.

E Compaction Operations

After being spread, each course shall be compacted to the required density. The rollers shall, as practicable, be operated continuously so all areas are thoroughly compacted to the required density. When not operating, the rollers shall not stand on the uncompacted mixture or newly rolled pavement having a surface temperature exceeding 60°C (140°F). Rolling with steel-wheeled rollers shall be discontinued if it produces excessive crushing or pulverizing of the aggregate or displacement of the mixture.

To prevent adhesion of the mixture to the steel roller wheels, the contact surfaces of the wheels shall be kept properly moistened using water or a water solution containing small quantities of a detergent or other approved material.

To secure a true surface, variations such as depressions or high areas, which may develop during rolling operations, and lean, fat or segregated areas shall be corrected by removing and replacing the material in the defective area. All such corrections shall be accomplished as directed by the Engineer at no expense to the Department.

When mixtures are spread by a motor grader, pneumatic-tired rollers shall compact the mixture simultaneously with the spreading operation.
F  Construction Joints

Joints shall be thoroughly compacted to produce a neat, tightly bonded joint that meets surface tolerances. Both transverse and longitudinal joints are subject to density requirements as outlined in Section 2360.6 Pavement Density.

F1  Transverse Joints

A transverse joint (full paver width at right angles to the centerline) shall be constructed when mixture placement operations are suspended. The forward end of the freshly laid strip shall be thoroughly compacted by rolling before the mixture has cooled. When work is resumed, the end shall be cut vertically for the full depth of the layer unless a formed edge is constructed as approved by the Engineer.

F2  Longitudinal Joints

Longitudinal joints between strips shall be parallel to the centerline. In multiple lift construction, the longitudinal joints between strips in each lift shall be constructed not less than 150 mm (6 inches) measured transversely from the longitudinal joints in the previously placed lift. When the wearing course is constructed in an even number of strips, one longitudinal joint shall be on the centerline of the road. When it is constructed in an odd number of strips, the centerline of one strip shall be on the centerline of the road, provided that no joint is located in the wheel path area of a traffic lane. Longitudinal joints in multiple lift construction over Portland cement concrete pavements may be aligned directly over the concrete pavement longitudinal joints at the discretion of the Engineer.

At longitudinal joints formed by placing multiple strips, the adjoining surface being laid shall, after final compacting, be slightly higher (but not to exceed 3 mm (1/8 inch)) than the previously placed strip. When constructing a strip adjoining a previously placed strip or a concrete pavement, any fresh mixture that overlaps a previously placed strip or pavement shall be removed (to the longitudinal joint line) before any rolling is done.

G  Asphalt Mixture Production (FOB Department Trucks)

For asphalt mixture production, the Contractor shall, in addition to the asphalt mixture required on the Project, produce and deliver asphalt mixture to the Department. The mixture shall be the mixture being produced and shall be loaded on Department furnished trucks at the mixing plant at a time agreed on by the Engineer and Contractor. The Engineer will notify the Contractor of the total quantity of mixture desired not less than 2 weeks prior to completion of the wearing course construction. The Engineer will not accept the asphalt mixture if it is inappropriate for the Department's intended use.
H Small Quantity HMA Paving

Unless otherwise indicated in the Special Provisions, the following provision for a small quantity of asphalt mixture shall apply.

A Mixture Design Report is not required for planned project quantities less than 191,200 m$^2$ mm (9,000 square yard inches (4,500 square yards per 2 inch thickness, etc)) or 450 metric tons (500 tons). However, the Contractor shall verify in writing the asphalt mixture delivered to the project meets the requirements of Table 2360.3-B2a and Table 2360.3-B2b. The Department will obtain samples, as determined by the Engineer, to verify percent design air voids and gradation. These results will be used for material acceptance. Air voids will be subject to the requirements of Section 2360.4L.1b for isolated air voids and a gradation falling outside the requirements of Table 2360.2-E will be subject to payment as indicated in Table 2360.4-L.2b.

2360.6 PAVEMENT DENSITY

A General

All pavements will be compacted in accordance with the Maximum Density Method unless otherwise specified in the Contract special provisions or as noted in Section 2360.6C.

B Maximum Density Method

All courses or layers of plant mixed asphalt mixtures for which the Maximum Density Method is used shall be compacted to a density not less than the percentage shown in the Table of Required Density, Table 2360.6-B2, for the applicable mixture and course.

B1 Maximum Density Determination

The Density requirements listed in Table 2360.6-B2 are percent of maximum specific gravity (G$_{max}$) based on the individual lot. The Maximum specific gravity value used to calculate the percentage density for the lot shall be the average value obtained from the maximum gravity results from production tests taken during that days paving. If only one or two maximum specific gravity values were obtained that day, then the moving average value (at that test point) shall be used. If three or more maximum specific gravity values are obtained that day, then the average of those tests alone shall be used as indicated above.
B1a Pavement Density Determination

The density of each lot shall be expressed as a percentage of the maximum specific gravity (% Gmm) obtained by dividing the average bulk specific gravity for the lot by the maximum specific gravity multiplied by 100, (maximum specific gravity basis is the average Gmm of QC tests done on the day that the individual lot was paved as described above). Determination of the bulk specific gravity of the cores shall be in accordance with AASHTO T-166, Mn/DOT modified. For coarse graded mixtures the Engineer may require determination of bulk specific gravity of the cores be in accordance with ASTM D1188, Mn/DOT modified. ASTM D6752 Mn/DOT modified (Corelok) is also allowed for determination of bulk specific gravity of coarse graded mixtures. Selection of the test method to determine coarse graded mixture bulk specific gravity shall be agreed upon at the time of mix design submittal. Both the Contractor and Mn/DOT shall use the same test method to determine bulk specific gravity. The determination of coarse and fine graded mixtures will be based on the percentage of material passing the 2.365 mm sieve (#8) as defined in Table 2360.3-B2c.

Compaction operations shall be completed within 8 hours of mixture placement and before core samples are obtained for density determination. Only pneumatic tired or static steel rollers are permitted for any compactive effort performed between 6 and 8 hours after mixture placement.

Compacted mixtures represented by samples or tests having deficient densities shall not be re-rolled. The Contractor shall not operate below the specified minimum density on a continuing basis. A continual basis shall be defined as all lots in a day’s production failing to meet minimum density or more than 50% of lots on multiple days which fail to meet minimum density requirements. Production shall be stopped until the source of the problem is determined and corrective action is taken to bring the work into compliance with specified minimum required density.

B2 Required Density

Minimum density requirements for both gyratory (SP) and Marshall designed mixtures are listed in Table 2360.6-B2.

Unless otherwise indicated in the Plans or Special Provisions, shoulders wider than 1.8 meters (6 feet) paved shall be compacted by the Maximum Density Method. When shoulders are required to be compacted by the Maximum Density Method and are paved in a separate operation or have a different required minimum density than the driving lane, the lot tonnage placed on the shoulder shall be delineated in separate lots from the driving lanes for the day paving was conducted.
Unless otherwise indicated in the Plans or Special Provisions a narrow shoulder, 1.8 meter (6 feet) or less wide, that is paved in the same pass as a driving lane or that is paved separately will be compacted by the Ordinary Compaction Method. Mixture compacted under Ordinary Compaction is excluded from lot density requirements and that tonnage is also excluded from incentive/disincentive payment.

If the Plans or Special Provisions indicate a narrow shoulder is to be compacted by the Maximum Density Method, the minimum required density is listed in Table 2360.6-B2. If the minimum required density of the shoulder is different than the driving lane, the tonnage placed on the shoulder shall be delineated in separate lots from the driving lane.

Echelon paving (two pavers running next to each other in adjacent lanes) shall be considered separate operations.

### TABLE 2360.6-B2
**REQUIRED MINIMUM DENSITY**

<table>
<thead>
<tr>
<th>Location from surface*</th>
<th>SP Wear and All MV and LV Mixtures (1)(2)</th>
<th>SP Nonwear (1)(2)</th>
<th>SP Shoulders (1)(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 100 mm (4 inch)**</td>
<td>Designed at 3% voids</td>
<td>Designed at 4% voids</td>
<td></td>
</tr>
<tr>
<td>&gt; 100 mm (4 inch)**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* SP Mixtures only

** If less than 25% of a layer is within 100 mm (4 inches) of the surface, the layer may be considered to be below 100 mm (4 inches) for mix design purposes.

(1) Minimum reduced by one percent on the first lift constructed over PCC pavements.

(2) Minimum reduced by one percent for the first lift constructed on aggregate base (mainline and shoulder), reclaimed or cold inplace recycled base courses and first lift of an overlay on a roadway with a 6.35 metric ton (7 ton) or less spring load restriction (roadway includes shoulders).

B2a **Lots & Core Locations**

Divide the days production into equal lots as shown in Table 2360.6-B2a. The Engineer may require additional density lots be established to isolate areas affected by equipment malfunction/breakdown, heavy rain, or other factors that may affect the normal compaction operations. Obtain three cores in each lot. Two cores will be taken from random locations selected by the Engineer. The third core, a companion core, shall be taken within 0.3
TABLE 2360.6-B2A
LOT DETERMINATION

<table>
<thead>
<tr>
<th>Daily Production</th>
<th>Lots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metric (ton)</td>
<td>(English (Ton))</td>
</tr>
<tr>
<td>270* – 545</td>
<td>(300* – 600)</td>
</tr>
<tr>
<td>546 – 910</td>
<td>(601 – 1,000)</td>
</tr>
<tr>
<td>911 – 1,455</td>
<td>(1,001 – 1,600)</td>
</tr>
<tr>
<td>1,456 – 3,275</td>
<td>(1,601 – 3,600)</td>
</tr>
<tr>
<td>3,276 – 4,545</td>
<td>(3,601 – 5,000)</td>
</tr>
<tr>
<td>4,546 +</td>
<td>(5,001 +)</td>
</tr>
</tbody>
</table>

*When mix production is less than 270 metric tons (300 tons), establish 1st lot when accumulative tonnage exceeds 270 metric tons (300 tons).

meters (1 foot) longitudinally from either of the first two cores. The companion cores shall be given to the Department Street Inspector immediately upon completion of coring and sawing. The random locations will be determined by the Engineer using statistically derived stratified random number tables or other approved methods of random number generation. These will also be used for partial lots. Both transverse and longitudinal joints are subject to maximum density requirements. If the random core location falls on an unsupported joint, at the time of compaction, (the edge of the mat being placed does not butt up against another mat, pavement surface, etc.) cut the core with the outer edge of the core barrel 0.3 meters (1 foot) away (laterally) from the edge of the top of the mat (joint). If the random core location falls on a confined joint (edge of the mat being placed butts up against another mat, pavement surface, curb and gutter, or fixed face), cut with the outer edge of the core barrel 150 mm ± 12.5 mm (6 inches ± ½ inch) from the edge of the top of the mat (ex. center of 100 mm (4 inch) core barrel 200 mm ± 12.5 mm (8 ± ½ inches) from the edge of the top of the mat). Cores will not be taken within 300 mm (1 foot) of any unsupported edge. The Contractor shall be responsible for maintenance of traffic, coring, patching the core holes, and sawing the cores if necessary to the proper thickness prior to density testing.

B3 Core Testing

Cores will be taken and tested by the Contractor. Core locations will be determined and marked by the Engineer. The Contractor shall schedule the approximate time of testing during normal project work hours so that the Engineer may observe and record the saturated surface dry and immersed weight of the cores.

Density determination will be made by the end of the next working day after placement and compaction. If multiple layers are
placed in a single day, cores shall be sawn and separated for each layer, tested and reported by the end of the next working day.

The Contractor will cut pavement samples from the completed work with power equipment, and restore the surface by the end of the next working day with new, well compacted mixture without additional compensation. Failure to restore the surface within 24 hours of coring shall subject the Contractor to a fine of $100 per working day, per lot, until the core holes are restored. Cores shall be cut using a 100 mm (4 inch) minimum outer diameter coring device. All samples shall be marked with the lot number and core number or letter. The cores shall be transported to the laboratory as soon as possible to prevent damage due to improper handling or exposure to heat. These companion cores may be tested by the Inspector on Department scales or transported to the Department’s Field Laboratory or District Materials Laboratory.

Measure each core three times for thickness prior to saw cutting, report the average lift thickness on the core sheet. The average thickness will contribute to thickness compliance as described in Section 2360.7A.

If the Department companion core test result for bulk specific gravity \( G_{mb} \) deviates beyond the allowable tolerance of 0.030, substitute Department companion result for Contractor’s core result and then average the Department result with the non-companion result for the lot density acceptance. If, through analysis of data, it is determined there is a bias in the test results, the Engineer will determine which results are appropriate and shall govern.

If the \( G_{mb} \) tolerance fails in more than 2 lots in a day of either consistently high or low differences between the companion cores then an investigation to determine the source of errors shall be conducted. Companion cores samples shall be increased to two per lot and tested until investigation is complete and tolerances are met.

The Engineer may allow recoring of a sample only when the core has been damaged through no fault of the Contractor, either during the coring process or in transit to the laboratory.

B4 Maximum Density Acceptance and Payment Schedule

The density of compacted mixture shall be accepted by pavement cores on a lot basis.

The Contractor’s cores will be used for acceptance if the determined bulk specific gravity \( G_{mb} \) from AASHTO T-166, Mn/DOT modified or ASTM D1188 is within ± 0.030 of the state companion \( G_{mb} \) value. Payment for lot densities of compacted mixture shall be determined from Table 2360.6-B4 or 2360.6-B4A. Incentive and disincentive payments are for both wearing and non-wearing courses.
When the density requirement has been reduced by one percent, per Table 2360.6-B2, footnote 1 & 2, payment adjustments for lot densities will be made as specified in Table 2360.6-B4A. Incentive payments are excluded when the minimum density has been reduced. However, at the Contractors request and with approval of the Engineer, the reduced density requirement may be waived and density evaluated under Table 2360.6-B4, including incentives, for first lift constructed on aggregate base, reclaimed or cold inplace recycled base courses and first lift of an overlay on a roadway with a 6.35 metric ton (7 ton) or less spring load restriction (reduced density shall not be waived for the first lift constructed on PCC pavements). The request and approval shall be made after the first days paving and before the third days paving begins. Once the request has been approved, evaluation of density will be in accordance with Table 2360.6-B2 (excluding footnote 2) and Table 2360.6-B4, and will remain in effect for the duration of mixture placement on that lift. The Contractor will also be responsible for compliance with any construction requirements on subsequent lifts.

TABLE 2360.6-B4
PAYMENT SCHEDULE FOR MAXIMUM DENSITY

<table>
<thead>
<tr>
<th>Percent of Max Specific Gravity (2)</th>
<th>Percent of Max Specific Gravity (2)</th>
<th>% Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Wear (≤100 mm (4 inches) from Surface)</td>
<td>SP Non-Wear (&gt;100 mm (4 inches) from Surface)</td>
<td></td>
</tr>
<tr>
<td>All MV &amp; LV, SP Shld (4% Void)</td>
<td>SP Shoulders (3% Void)</td>
<td></td>
</tr>
<tr>
<td>93.6 and above</td>
<td>94.6 and above</td>
<td>104 (3)</td>
</tr>
<tr>
<td>93.1 - 93.5</td>
<td>94.1 - 94.5</td>
<td>102 (3)</td>
</tr>
<tr>
<td>92.0 - 93.0</td>
<td>93.0 - 94.0</td>
<td>100</td>
</tr>
<tr>
<td>91.0 - 91.9</td>
<td>92.0 - 92.9</td>
<td>98</td>
</tr>
<tr>
<td>90.5 - 90.9</td>
<td>91.5 - 91.9</td>
<td>95</td>
</tr>
<tr>
<td>90.0 - 90.4</td>
<td>91.0 - 91.4</td>
<td>91</td>
</tr>
<tr>
<td>89.5 - 90.4</td>
<td>90.5 - 90.9</td>
<td>85</td>
</tr>
<tr>
<td>89.0 - 89.4</td>
<td>90.0 - 90.4</td>
<td>70</td>
</tr>
<tr>
<td>Less than 89.0 (4)</td>
<td>Less than 90.0</td>
<td>**</td>
</tr>
</tbody>
</table>
### TABLE 2360.6-B4A (1)

#### 1% REDUCED TABLE

<table>
<thead>
<tr>
<th>Percent of Max Specific Gravity (2)</th>
<th>Percent of Max Specific Gravity (2)</th>
<th>% Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP Wear (≤100 mm (4 inches) from Surface)</td>
<td>All MV &amp; LV, SP Shld (4% Void)</td>
<td>SP Non-Wear (&gt;100 mm (4 inches) from Surface)</td>
</tr>
<tr>
<td>91.0 and above</td>
<td>92.0 and above</td>
<td>91.0 - 91.9</td>
</tr>
<tr>
<td>90.0 - 90.9</td>
<td>90.5 - 90.9</td>
<td>90.0 - 90.4</td>
</tr>
<tr>
<td>89.7 - 89.9</td>
<td>89.5 –89.9</td>
<td>89.0 - 89.1</td>
</tr>
<tr>
<td>89.4 - 89.6</td>
<td>Less than 89.0</td>
<td>Less than 89.0</td>
</tr>
<tr>
<td>89.2 - 89.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>89.0 - 89.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 89.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Minimum reduced by one percent for the first lift constructed on aggregate base (mainline and shoulder), reclaimed or cold in-place recycled base courses and first lift of an overlay on a roadway with a 6.35 metric ton (7 ton) or less spring load restriction (roadway includes shoulders).

Minimum reduced by one percent on the first lift constructed on PCC pavements (reduced density cannot be waived).

(2) In calculating the percent of maximum specific gravity, report to the nearest tenth.

(3) The payment in this portion of the specification shall apply only if the day’s weighted average individual production air voids are within - 0.5 percent of the target air void value. The weighted average air voids shall be based on all the mixture production tests (2360.4e) for the corresponding day and shall be weighted by the tons the corresponding test represents.

(4) The HMA material represented by the lot shall be paid at a 70% pay factor, unless a single core density is less than 87.0% of the maximum specific gravity (Gmm). If a single core density is less than 87.0% of Gmm, the material shall be removed and replaced by the Contractor at their expense with mixture that meets the density requirements; or the Engineer may permit the unacceptable material to remain in place with a 50% pay factor. The limits of the area to be removed will be determined by additional core samples. These additional core samples shall be taken at the same offset from centerline as the original core; unless the original low density core was taken within 0.45 m (1 ½ feet) of an edge of the paver pass. In that case, the additional cores shall be taken 0.45 m
(1 ½ feet) from the edge of the paver pass. The densities shall be determined at 15 m (50 foot) intervals, both ahead and back of the point of unacceptable core density (less than 87.0% of Gmm), until a point of acceptable core density (87.0% of Gmm or greater) is found. If the incremental core density testing extends into a previously accepted lot, removal of the unacceptable material will be required; however, the results of these tests shall not be used to recalculate the previously accepted lot density. All costs incurred from additional coring and testing, resulting from unacceptable core density, will be paid by the Contractor. The unacceptable pavement area is to be computed as the product of the longitudinal limits so determined by the 15 m (50 foot) cores and the full width of the paver pass, laying in the traffic lane or lanes. Shoulders shall be exempt from this calculation unless density failure occurred in the shoulder area.

After the unacceptable material (core density less than 87.0% of Gmm) has been removed and replaced, the density of the replacement material will be determined by the average of two cores. Payment for the replacement material will be in accordance with Tables 2360.6-B4 or 2360.6-B4A, whichever applies. There will be no payment for the material removed. The remainder of the original lot shall have a 70% pay factor.

C Ordinary Compaction Method

Ordinary compaction shall be used for layers identified in the typical sections with a minimum planned thickness of less than 40 mm (1 ½ inches), thin lift leveling, wedging layers, patching layers, driveways, areas which cannot be compacted with standard highway construction equipment. Unless otherwise indicated in the Plans or Special Provisions recreational trails shall also be compacted by ordinary compaction. The ordinary compaction method shall not be used on mainline, ramp, or loop paving, unless otherwise designated in the plans or special provisions. When density is evaluated by the ordinary compaction method a control strip shall be used to establish a rolling pattern. This shall be used by the Contractor for the compaction of the asphalt mixture for the layer on which the control strip is constructed, or until a new control strip is constructed. The control strip requirement may be waived by the Engineer in small, localized areas or other areas not conducive to its establishment.

A control strip shall be constructed at the beginning of the work on each lift of each course. Each control strip shall have an area of at
least 330 m² (395 square yards) and shall be of the same thickness as
the lift it represents. The subgrade or pavement course upon which a
control strip is to be constructed shall have the prior approval of the
Engineer. The control strips shall remain in place and become part of
the completed work.

The materials used in the construction of the control strips shall
conform to the specified requirements for the course. The materials
used in the control strip shall be from the same source and of the
same type as the materials used in the remainder of the course that
the control strip represents.

The equipment used in the construction of the control strips shall
be approved by the Engineer and shall be the same type and mass
used on the remainder of the pavement course represented by the
control strip. A minimum of two rollers shall be required. A rolling
pattern shall be established for each roller. A pneumatic-tired roller
shall be available for compaction operations within 24 hours after
request by the Engineer. The final rolling shall be performed with a
tandem steel-wheeled roller. Areas that are inaccessible to the
conventional type rolling equipment shall be compacted to the
required density by using trench rollers or mechanical tampers.

Construction of the control strips will be as directed by the
Engineer. Compaction shall commence as soon as possible after the
mixture has been spread to the desired thickness and shall continue
until no appreciable increase in density can be obtained by additional
roller’s coverages. Densities will be determined by means of a
portable nuclear testing device or suitable approved alternate and a
growth curve shall be developed to determine the optimum rolling
pattern. The Contractor shall furnish documentation of the growth
curve to the Engineer.

To determine when no appreciable increase in density can be
obtained, two test points shall be established in the control strip on a
random basis and the density at each point shall be measured by a
portable nuclear device or suitable approved alternate after each
roller pass. Rolling shall be suspended when testing shows either a
decline of more than 2% of the maximum specific gravity or when
additional roller passes fail to increase the density.

After said testing is accomplished, rolling on the remainder of
that course shall be done in accordance with the pattern developed in
the test strip for that roller. A separate rolling pattern and time
interval shall be established for each roller.

A new control strip shall be ordered by the Engineer when:
(a) A change in the JMF is made, or
(b) A change in the source of material is made or a change in the
material from the same source is observed.
A new control strip may be ordered by the Engineer or requested by the Contractor when:

(a) Ten days of production have been accepted without construction of a new control strip, or
(b) There are other reasons to believe that a control strip density is not representative of the HMA mixture being placed.

The nuclear testing device shall be furnished and operated by the Contractor. The furnishing of the testing device and the operator will be considered incidental to the furnishing and placement of the HMA mixture and shall not be compensated for separately. The device shall be calibrated according to procedures described in the Mn/DOT Bituminous Manual.

Each course shall be uniformly compacted until there is no further evidence of consolidation and all roller marks are eliminated. When this method is employed, and the quantity of mixture placed by the paver exceeds 100 metric tons (110 tons) per hour, at least two rollers are required for compacting the mixture placed by each paver.

C1 Rollers

The following requirements for rollers apply only when compaction is obtained by the ordinary compaction method.

C2 Steel-Wheeled Rollers

Steel-wheeled rollers shall be self-propelled and have a minimum total mass of 7.3 metric tons (8 tons), or as otherwise specified in the Contract. When vibratory rollers are used, they shall produce 45 kN/m (3,085 lbf per foot) of width. The frequency should be at least 2400 vpm and amplitude setting low. The roller shall be capable of reversing without backlash and shall be equipped with spray attachments for moistening all rollers on both sets of wheels.

C3 Pneumatic-Tired Rollers

The pneumatic-tired roller shall have a compacting width of 1.5 m (5 feet) or more. It shall be so constructed that the gross wheel load force shall be a minimum of 13 kN (3,000 pounds) per wheel for LV and MV mixtures and SP Level 2-3 mixtures and 22 kN (5,000 pounds) per wheel for SP Level 4-6 mixtures and can be varied as directed by the Engineer. The tire arrangement shall be such that full compaction will be obtained over the full width with each pass of the roller.

The roller may be self-propelled or provided with suitable tractive equipment, unless otherwise specified in the Contract. If more than one roller is propelled by a single tractive unit, then that combination will be counted as a single roller unit.

C4 Trench Rollers

Trench rollers shall be self-propelled and have a mass of not less than 4,400 kg per meter (2,960 pounds per foot) of width.
C5 Mixture Temperature Controls

If compaction is obtained by the ordinary compaction method, the minimum laydown temperature in all courses (as measured behind the paver or spreading machine) of the asphalt mixture shall be in accordance with the temperature requirements of Table 2360.6-C5. Unless directed by the Engineer in writing, no paving is allowed under the Ordinary Compaction Method when the air temperature is below 0°C (32°F).

**TABLE 2360.6-C5 Mixture Temperature Control**

<table>
<thead>
<tr>
<th>Air Temperature °C (°F)</th>
<th>Compacted Mat Thickness, mm (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 mm (1 inch)</td>
<td>40 mm (1 ½ inch)</td>
</tr>
<tr>
<td>50 mm (2 inch)</td>
<td>≥75 mm (3 inch)</td>
</tr>
<tr>
<td>+0-5 (32-40)</td>
<td>129 (265)</td>
</tr>
<tr>
<td>+11-15 (51-60)</td>
<td>127 (260)</td>
</tr>
<tr>
<td>+16-21 (61-70)</td>
<td>121 (250)</td>
</tr>
<tr>
<td>+22-27 (71-80)</td>
<td>118 (245)</td>
</tr>
<tr>
<td>+28-32 (81-90)</td>
<td>113 (235)</td>
</tr>
<tr>
<td>+33 (91+)</td>
<td>110 (230)</td>
</tr>
</tbody>
</table>

(A) Based on approved or specified compacted lift thickness.
(B) A minimum of one pneumatic-tire roller shall be used for intermediate rolling unless otherwise directed by the Engineer. The Engineer may specify or modify in writing (with concurrence from the Department Bituminous Engineer) a minimum laydown temperature.

2360.7 THICKNESS AND SURFACE SMOOTHNESS REQUIREMENTS

A Thickness

After compaction the thickness of each lift shall be within a tolerance of 6 mm (¼ inch) of the thickness shown in the Plans, except that, if automatic grade controls are used, this thickness requirement will not apply to the first lift placed. This thickness requirement will not apply to a leveling lift whether or not automatic grade controls are required. The Engineer may require removal and
replacement, at the Contractor’s expense, of any part of any lift that is constructed to less than the minimum required thickness.

Cores taken for density determination shall be measured for thickness also. Each core shall be measured 3 times for thickness prior to sawing. Report the average of these three measurements. Each lot’s average core thickness shall be documented and submitted to the Engineer. If the average of the two Contractor cores exceed the specified tolerance, an additional two cores may be taken in the lot in question. The average of all core thickness measurements per day per lift will be used to determine daily compliance with thickness specifications.

On that portion of any lift constructed to more than the maximum permissible thickness, the materials used in the excess mixture above that required to construct that portion of the lift to the Plan thickness plus 6 mm (¼ inch) may be excluded from the pay quantities and at the discretion of the Engineer and at the Contractor’s expense may be required to be removed and replaced.

B Surface Requirements

After compaction, the finished surface of each lift shall be reasonably free of segregated, open and torn sections, and shall be smooth and true to the grade and cross section shown on the Plans with the following tolerances:

1. Where a leveling lift is specified, it shall be constructed to within a tolerance of 15 mm (½ inch) of the elevations and grades established by the Engineer. This requirement shall also apply to the first lift placed other than leveling when automatic controls are used.

2. The surface of the final two lifts placed shall show no variation greater than 6 mm (¼ inch) from the edge of a 3 m (10 foot) straightedge laid parallel to or at right angles to the centerline. Shouldersurfacing and surfacing on temporary connections and bypasses shall show no variations greater than 6 mm (¼ inch) from the edge of a 3 m (10 foot) straightedge laid parallel to the centerline.

3. After final compaction, all final lift asphalt wearing surfaces adjacent to concrete pavements shall be slightly higher (but not to exceed 6 mm (¼ inch) than the concrete surface. After final compaction, all asphalt surfaces adjacent to gutters, manholes, pavement headers, or other fixed structures shall be slightly higher (but not to exceed 6 mm (¼ inch) than the surface of the structure.

4. Transverse joints (construction joints), at the beginning and end of a project, at paving exceptions, or caused by suspension of daily paving operations, shall show no
variation greater than 6 mm (¼ inch) from the edge of a 3 m (10 foot) straightedge centered longitudinally across the transverse joint. The Engineer may require correction by diamond grinding when material is placed outside the above described limitations.

(5) The transverse slope of the surface of each lift, exclusive of the shoulder wearing lift, shall not vary from the slope shown in the Plans by more than 0.4 percent.

(6) The distance between the edge of each lift and the established centerline shall be no less than the Plan distance nor more than 75 mm (3 inches) greater than the Plan distance. In addition, the edge alignment of the wearing lift on tangent sections and on curve sections of 3 degrees or less shall not deviate from the established alignment by more than 25 mm (1 inch) in any 7.5 m (25 foot) section.

(7) The finished surface of each lift shall be reasonably free of segregated and open and torn sections.

Any material placed outside the above described limitations shall be removed and replaced after being cut or sawed at no expense to the Department or with the approval of the Engineer, allowed to remain in place at a reduced cost calculated at $12 per square meter ($10 per square yard).

C Pavement Smoothness

C1 General

Pavement smoothness will be evaluated on the final mainline pavement surface using a California type profilograph or Inertial Profiler (IP) with a 5 mm (0.2 inch) blanking band. Unless otherwise authorized by the Engineer, all smoothness testing shall be performed in the presence of the Engineer. The Engineer and the Contractor shall mutually agree upon scheduling of smoothness testing so that testing can be observed. Any testing performed without the Engineer’s presence, unless otherwise authorized, may be ordered retested at the Contractors expense. The following table shows pavement surfaces, which are excluded from profilograph testing, but subject to Section 2360.7B surface requirements.

C1 A Smoothness Requirements

Pavement smoothness requirements will be evaluated by Table 2360.7-C6A, 2360.7-C6B, or 2360.7-C6C. The pavement smoothness table will be identified in the Special Provisions of the proposal.
### TABLE 2360.7-C1

**PROFILOGRAPH TESTING EXCLUSIONS**

<table>
<thead>
<tr>
<th>Pavement Surfaces Excluded From Profilograph Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ramps, Loops, Climbing Lanes</td>
</tr>
<tr>
<td>Side Streets, Side Connections</td>
</tr>
<tr>
<td>Turn Lanes, Storage Lanes, Crossovers, Bypass Lanes</td>
</tr>
<tr>
<td>Shoulders</td>
</tr>
<tr>
<td>Acceleration, Deceleration Lanes</td>
</tr>
<tr>
<td>Intersections constructed under traffic – Begin and end the exclusion 30.5 m (100 feet) from the intersection radius</td>
</tr>
<tr>
<td>Sections less than 15.24 m (50 feet) in length</td>
</tr>
<tr>
<td>Projects less than 300 m (1000 feet) in length</td>
</tr>
<tr>
<td>Mainline paving where the normally posted regulatory speed is less than or equal to 70 km/hr (45 miles per hour) -- Begin the exclusion at the sign</td>
</tr>
<tr>
<td>Single lift overlays over concrete.</td>
</tr>
<tr>
<td>Horizontal Curves with a radius less than 289.6 m (950 feet).</td>
</tr>
<tr>
<td>Horizontal Curves with a degree of curvature greater than or equal to 6°.</td>
</tr>
<tr>
<td>Vertical Curves – Absolute value of grade change is 2 % or more and curve length is 91.4 m (300 feet) or less.</td>
</tr>
<tr>
<td>Vertical Curves – Absolute value of grade change is 3 % or more and curve length is 121.9 m (400 feet) or less.</td>
</tr>
<tr>
<td>Vertical Curves – Absolute value of grade change is 4 % or more and curve length is 182.8 m (600 feet) or less.</td>
</tr>
<tr>
<td>Vertical Curves – Absolute value of grade change is 8 % or more and curve length is 213.4 m (700 feet) or less.</td>
</tr>
<tr>
<td>Note: Begin and end the exclusion at the PC (PVC) and PT (PVT), respectively</td>
</tr>
</tbody>
</table>

**C2 Measurement**

Smoothness will be measured with a 7.62 m (25 foot) California type profilograph or an Inertial Profiler (IP), which produces a profilogram (profile trace of the surface tested). Either type of device must be certified according to the procedure on file in the Bituminous Office. One pass will be made in each lane, 2.74 m (9 feet) from centerline. The profilograph or IP shall be in the direction the traffic will be moving. Each lane will be tested and evaluated separately. The Engineer will determine the length in kilometers (miles) for each mainline traffic lane. The profilograph will be operated at a speed no greater than a normal walk, no greater than 6 km/hr (4 miles per hour). Motive power may be provided manually or by the use of a
propulsion unit approved by the Engineer. The IP will be operated at the optimum speed as defined by the manufacturer.

C3 Profilograph Testing

The Contractor will furnish a properly calibrated, documented, and certified 7.62 m (25 foot) California type profilograph or IP. The profilograph or IP shall be equipped with automatic data reduction capabilities unless otherwise authorized by the Engineer. Certification documentation shall be provided to the Engineer on the first day the profilograph or IP is used on the project. User selected profilograph or IP settings are on file in the Bituminous Office. The Contractor will furnish a competent operator, trained in the operation and evaluation of the 7.62 m (25 foot) California profilograph or IP.

All objects and foreign material on the pavement surface will be removed by the Contractor prior to testing. The pavement surface will be divided into sections which represent continuous placement. A section will terminate or begin 15.24 m (50 feet) before or after a bridge approach panel, bridge surface, manhole or similar interruption. These 15.24 m (50 foot) sections, including the transverse joint, will be evaluated under Section 2360.7B, Surface Requirements. A day’s work joint will be included in the trace with no special consideration. A section will be separated into segments of 0.1 km (0.1 mile). A segment will be in only one traffic lane.

A profilogram will be made for each segment of 15.24 m (50 feet) or more. The profilogram will include the 7.62 m (25 foot) at the ends of the section only when the Contractor is responsible for the adjoining surface.

End of run areas not included in the profilograph trace and any sections of pavement less than 15.24 m (50 feet) in length shall be checked longitudinally with a 3.028 m (10 foot) straight edge and the surface shall not deviate from a straight line by more than 6 mm in 3.028 m (½ inch in 10 feet). Transverse joints shall be evaluated by centering the straightedge longitudinally across the transverse joint.

The profile trace and index for each segment of pavement must be furnished to the Engineer within 48 hours after each day’s run. Identification of all bumps and dips, with signature of the Operator shall be included with the submitted trace.

The Contractor will submit a final evaluation generated from approved software, to the Engineer within five days after all mainline pavement placement. Software is available from the Mn/DOT Bituminous Office website. The evaluation submitted shall be in tabular form, with each 0.1 km (0.1 mile) segment occupying a row. Each row shall include the beginning and ending station for the segment, the length of the segment, the profile index for the segment, the profile index incentive/disincentive in dollars for the segment,
and the deductions for bumps in dollars for the segment. Each continuous run will occupy a separate table and each table will have a header that includes the following: the project number, the roadway number or designation, the specified ride table, a lane designation, the mix type of the final lift, the PG binder of the final lift, the date of the profilograph run, and the beginning and ending station of the continuous run. Each table will have a summary at the bottom that includes the following: a subtotal for the profile index incentive/disincentive, a subtotal for the bump deductions, and a total for incentive/disincentive for both profile index and bumps.

The Contractor will be responsible for all traffic control associated with the smoothness testing.

Any portion of the project may be retested if the Engineer determines that the Contractor's test results are in question. If results are found to be inaccurate, the Contractor will be charged at a rate of $155.34 per lane km ($250 per lane mile) that is retested, with a minimum charge of $500.00. If the results are found to be accurate, the Department will be paying the Contractor at a rate of $155.34 per lane km ($250 per lane mile) that is retested, with a minimum charge of $500.00.

C4 Profile Index

The profilograph or IP shall be equipped with automatic data reduction capabilities for determining the profile index (PI) unless otherwise authorized by the Engineer. The profilograph trace will be evaluated for the profile index (PI) and bumps in accordance with California Method 526 on file with the Department Bituminous Engineer. The original trace shall be provided to the Engineer.

A profile index shall be calculated for each segment. If an IP is used the corresponding International Roughness Index (IRI) for each segment shall be submitted to the Bituminous Office. The index will be determined by summing the vertical deviations outside either a 5 mm (0.2 inch) blanking band or outside a zero blanking band depending on the number of lifts in the construction. The units of this index are mm per km (inch per mile). When there is a segment of 76.2 m (250 feet) or less in length, the profilograph or IP measurements for that segment shall be added to and included in the evaluation of the adjacent section to that segment.

Bumps and dips equal to or exceeding 10.2 mm in a 7.62 m (0.4 inch in a 25 foot) span shall be identified separately. When the profile trace shows a successive, uninterrupted bump, dip; or dip, bump combination (up to a maximum of 3 alternating trace deviations that relate to one bump or dip on the roadway), identify and evaluate these occurrences as one event.
C5 Surface Correction

All areas represented by deviations of 28 mm (1.1 inch) or more, as measured by the 7.62 m (25 foot) profilograph or IP, will be corrected by the Contractor.

The Contractor may elect to correct pavement segments having no more than two events or two individual bumps or dips with a vertical deviation of 10.2 to 25 mm (0.4 to 1.0 inch) in a 7.62 m (25 foot) span. Correction of segments with more than two events or two individual bumps or dips, as defined above, will be allowed only when approved by the Engineer. The Contractor will be assessed a penalty for dips or bumps of 10.2 to 25 mm (0.4 to 1.0 inch) that are not corrected. Bumps and dips not corrected will also be included in the evaluation for the segment smoothness. Corrected dips or bumps will be considered satisfactory when the profilogram shows the dips or bumps are less than 10.2 mm in a 7.62 m (0.4 inch in a 25 foot) span.

Bump, dip, and smoothness correction work shall be for the entire traffic lane width. Pavement cross slope shall be maintained through corrective areas.

Corrective work shall be made by diamond grinding unless other methods are approved by the Engineer. Other methods may include; overlaying the area, or replacing the area by milling and inlaying. Any corrective actions by milling and inlay or overlay shall meet the specifications for ride quality over the entire length of the correction, including the first and last 15 m (50 feet). Bumps or dips in excess of 10.2 mm (0.4 inches) at transverse joints at areas of corrective actions utilizing overlay or milling and inlay, shall be removed by diamond grinding. The Contractor shall notify the Engineer prior to commencement of the corrective action. If the surface is corrected by overlay, inlay or replacement, the surface correction shall begin and end with a transverse saw cut.

If the smoothness evaluation indicates that corrective work is necessary for more than 50% of a segment, surface correction will be limited to mill and inlay (40 mm (1 ½ inch) min).

All corrective work shall be subject to the approval of the Engineer. After all required correction work is completed, a final profile index shall be determined. Corrective work and re-evaluation will be at the Contractor’s expense.

C6 Payment

The cost of certified smoothness testing and associated traffic control will be incidental to the cost of the Wear Course Mixture.
The Contractor may receive an incentive payment or be assessed a penalty based on the number of segments and the initial profile index. The total ride incentive shall not exceed 10% of the total mix price for pavement smoothness evaluated under Table 2360.7-C6A, 5% of the total mix price for pavement smoothness evaluated under Table 2360.7-C6B, or 5% of the total mix price for pavement smoothness evaluated under Table 2360.7-C6C. The maximum allowable net incentive (total incentive minus disincentive) payment shall be calculated by multiplying the total tons paved by the mixture price by the appropriate incentive cap. Pay adjustments for incentives will only be based on the initial Profile Index before any corrective work has been performed. Pavement that contains corrective action for profile or bumps is not eligible for incentive pay. These payments or assessments will be based on the following schedules.

The Contractor will not receive a net incentive payment for ride if more than 25% of all density lots for the project fail to meet minimum density requirements.

For each traffic lane, a penalty will be assessed for each bump or dip of 10.2 to 25 mm (0.4 to 1.0 inch) that is not corrected. Penalties, based on the table the profile index is evaluated under, are as follows:

Table 2360.7-C6A: $900
Table 2360.7-C6B: $675
Table 2360.7-C6C: $450

Bumps or dips resulting from a construction joint will be assessed a $900 penalty, regardless of the table used for evaluation of pavement smoothness.

The Engineer may, at his discretion, assess a penalty in lieu of requiring the Contractor to take corrective action when the profile index for a segment indicates corrective action is necessary. Penalties, based on the table the profile index is evaluated under, are as follows:

Table 2360.7-C6A: $560 per 0.1 km
Table 2360.7-C6B: $420 per 0.1 km
Table 2360.7-C6C: $280 per 0.1 km
### TABLE 2360.7-C6A *
INITIAL PROFILE INDEX FOR 5MM (0.2 INCH) BLANKING BAND

<table>
<thead>
<tr>
<th>mm per km per 0.1 km segment</th>
<th>(Inches per mile) (per 0.1 mile segment)</th>
<th>Dollars per Segment (Metric)</th>
<th>Dollars per Segment (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0- 13.4</td>
<td>(0.0 – 0.8)</td>
<td>210</td>
<td>(335)</td>
</tr>
<tr>
<td>13.5 – 25.3</td>
<td>(0.9 – 1.6)</td>
<td>145</td>
<td>(225)</td>
</tr>
<tr>
<td>25.4 – 38.7</td>
<td>(1.7 – 2.4)</td>
<td>80</td>
<td>(115)</td>
</tr>
<tr>
<td>38.8 – 78.9</td>
<td>(2.5 – 5.0)</td>
<td>0</td>
<td>(0)</td>
</tr>
<tr>
<td>79.0 – 92.3</td>
<td>(5.1 – 5.8)</td>
<td>(80)</td>
<td>(115)</td>
</tr>
<tr>
<td>92.4 - 105.7</td>
<td>(5.9 – 6.7)</td>
<td>(145)</td>
<td>(225)</td>
</tr>
<tr>
<td>105.8 - 118.3</td>
<td>(6.8 – 7.5)</td>
<td>(210)</td>
<td>(335)</td>
</tr>
<tr>
<td>Over 118.3</td>
<td>(Over 7.5)</td>
<td>Corrective Action</td>
<td>Corrective Action</td>
</tr>
</tbody>
</table>

* Typically, 3-lift minimum construction

### TABLE 2360.7-C6B *
INITIAL PROFILE INDEX FOR 5MM (0.2 INCH) BLANKING BAND

<table>
<thead>
<tr>
<th>mm per km per 0.1 km segment</th>
<th>(Inches per mile) (per 0.1 mile segment)</th>
<th>Dollars per Segment (Metric)</th>
<th>Dollars per Segment (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 15.8</td>
<td>(0.0 – 1.0)</td>
<td>145</td>
<td>(225)</td>
</tr>
<tr>
<td>15.9 - 31.6</td>
<td>(1.1 – 2.0)</td>
<td>100</td>
<td>(150)</td>
</tr>
<tr>
<td>31.7 - 47.3</td>
<td>(2.1 – 3.0)</td>
<td>55</td>
<td>(75)</td>
</tr>
<tr>
<td>47.4 - 110.5</td>
<td>(3.1 – 7.0)</td>
<td>0</td>
<td>(0)</td>
</tr>
<tr>
<td>110.6 - 126.3</td>
<td>(7.1 – 8.0)</td>
<td>(55)</td>
<td>(175)</td>
</tr>
<tr>
<td>126.4 - 142.0</td>
<td>(8.1 – 9.0)</td>
<td>(100)</td>
<td>(150)</td>
</tr>
<tr>
<td>142.1 - 157.8</td>
<td>(9.1 – 10.0)</td>
<td>(145)</td>
<td>(225)</td>
</tr>
<tr>
<td>Over 157.8</td>
<td>(Over 10.0)</td>
<td>Corrective Action</td>
<td>Corrective Action</td>
</tr>
</tbody>
</table>

* Typically, 2-lift construction
TABLE 2360.7-C6C *
INITIAL PROFILE INDEX FOR 5MM (0.2 INCH) BLANKING BAND

<table>
<thead>
<tr>
<th>mm per km per 0.1 km segment</th>
<th>(Inches per mile) per 0.1 mile segment</th>
<th>Dollars per Segment (Metric)</th>
<th>Dollars per Segment (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 31.6</td>
<td>(0.0 - 2.0)</td>
<td>95</td>
<td>(150)</td>
</tr>
<tr>
<td>31.7 - 47.4</td>
<td>(2.1 - 3.0)</td>
<td>65</td>
<td>(100)</td>
</tr>
<tr>
<td>47.5 - 79.0</td>
<td>(3.1 - 5.0)</td>
<td>35</td>
<td>(50)</td>
</tr>
<tr>
<td>79.1 - 158.0</td>
<td>(5.1 - 10.0)</td>
<td>0</td>
<td>(0)</td>
</tr>
<tr>
<td>158.1 - 189.6</td>
<td>(10.1 - 12.0)</td>
<td>(35)</td>
<td>(50)</td>
</tr>
<tr>
<td>189.7 - 221.2</td>
<td>(12.1 - 14.0)</td>
<td>(65)</td>
<td>(100)</td>
</tr>
<tr>
<td>221.3 - 252.8</td>
<td>(14.1-16.0)</td>
<td>(95)</td>
<td>(150)</td>
</tr>
<tr>
<td>Over (252.8)</td>
<td>(Over 16.0)</td>
<td>Corrective Action</td>
<td>Corrective Action</td>
</tr>
</tbody>
</table>

*Typically, single lift construction

2360.8 METHOD OF MEASUREMENT
A Asphalt Mixture
Asphalt mixture of each type will be measured separately by mass, based on the total quantity of material hauled from the mixing plant, with no deductions being made for the asphalt materials.
B Blank
C Asphalt Mixtures Measured by the Square Meter (Square Yard) per Specified (mm (inch)) and for Mixtures Measured by the (Square Yard inch)
Asphalt mixture of each type and for each specific lift will be measured separately by area and by thickness on the basis of actual final dimensions placed. The constructed thickness shall meet tolerances set forth in Sections 2360.7A.

2360.9 BASIS OF PAYMENT
Payment for the accepted quantities of asphalt mixture used in each course at the Contract prices per unit of material shall be compensation in full for all costs of constructing the asphalt surfacing as specified, including the costs of furnishing and incorporating any asphalt binder, mineral filler, hydrated lime, or anti-stripping additives that may be permitted or required.
If the production lab density at the design gyrations at the recommended or established asphalt content is in excess of 2565 kg/m³ (160 pounds per cubic foot), payment for mixture will be calculated at the following percent of the Contracted unit price.

\[
\text{% Payment} = 100 - \left( \frac{100 \times (\text{production density at design gyrations} - 2565)}{2565} \right)
\]

\[
\text{% Payment} = 100 - \left( \frac{100 \times (\text{production density at design gyrations} - 160)}{160} \right)
\]

In the absence of Contract items covering shoulder surfacing and other special construction, the accepted quantities of material used for these purposes will be included for payment with the wearing course materials.

The Contractor is responsible to complete yield checks and monitor thickness determinations so that the constructed dimensions correspond with the required Plan dimensions throughout the entire length of the Project. The tolerances for lift thickness shown in 2360.7A and B, Thickness and Surface Smoothness Requirement is for occasional variations and not for continuous over-running or under-running, unless ordered or Authorized by the Engineer.

Payment for the item of asphalt mixture production at the Contract unit price of mixture produced shall be compensation in full for all costs of producing the mixture and loading it on board the Department's trucks at the mixing plant. The provisions of Mn/DOT 1903 are modified to the extent that the Department will not make a price adjustment in the event of increased or decreased quantities of asphalt mixture items. Payment for plant mixed asphalt surface will be made on the basis of the following schedule:

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>2350.501</td>
<td>Type (1)(2) Wearing Course Mixture ((4))</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2350.502</td>
<td>Type (1)(2) Non Wearing Course Mixture ((4))</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2350.503</td>
<td>Type (1)(2)(3) Course Mixture ((4)), (5) mm (inch) thick</td>
<td>square meter (square yard)</td>
</tr>
<tr>
<td>2350.504</td>
<td>Type (1)(2)(3) Course Mixture ((4))</td>
<td>(square yard inch)</td>
</tr>
<tr>
<td>2350.505</td>
<td>Type (1)(2) Bituminous Mixture for Specified Purpose</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2350.506</td>
<td>Type (1)(2) Bituminous Mixture Production</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2360.501</td>
<td>Type (1)(6) Wearing Course Mixture ((8),(4))</td>
<td>metric ton (ton)</td>
</tr>
<tr>
<td>2360.502</td>
<td>Type (1)(6) Non Wearing Course Mixture ((8),(4))</td>
<td>metric ton (ton)</td>
</tr>
</tbody>
</table>
2360.503 Type (1) (6) (7) Course Mixture ((8),(4))
(5) mm (inch) thick ............ square meter (square yard)

2360.504 Type (1) (6) (7) Course Mixture ((8),(4))
.............................................. (square yard inch)

2360.505 Type (1) (6) Bituminous Mixture for
Specified Purpose ............................ metric ton (ton)

2360.506 Type (1) (6) Bituminous Mixture Production
.............................................. metric ton (ton)

(1) Mixture Design Type (LV, MV, SP or SM as appropriate).
(2) Aggregate size designation, as per Table 2360.2-E.
(3) "Wearing" or "Non Wearing" as appropriate.
(4) AC binder grade designation.
(5) Specified lift thickness.
(6) Aggregate Size Designation, 9.5, 12.5 or 19 as appropriate.
(7) "Wearing" or "Non Wearing" as appropriate.
(8) Traffic Level as per Table 2360-1-A.