SPECIFICATION AMENDMENTS and SUPPLEMENTAL SPECIFICATIONS FOR HIGHWAY AND BRIDGE CONSTRUCTION

(Supplemental to the Standard Specifications for Highway Construction, Edition 12, 2005, and the Specifications for Bridge Construction, 2005 manuals)

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1.1 PRIORITY LINE PAINTING FOR SITE OCCUPANCY

1.1.1 SITE OCCUPANCY

In accordance with Section 1.2.21.7, Completion of Line Painting and for the purposes of calculating Calendar Days for Site Occupancy, this project will be considered a Priority Line Painting project.

1.2 NON-PRIORITY LINE PAINTING FOR SITE OCCUPANCY

1.2.1 SITE OCCUPANCY

In accordance with Section 1.2.21.7, Completion of Line Painting and for the purposes of calculating Calendar Days for Site Occupancy, this project will be considered a Non-Priority Line Painting project.

1.3 CONSTRUCTION STAKING AND SURVEY BY CONTRACTOR

1.3.1 FOR ASPHALT CONCRETE PAVEMENT- EPS OR COMBINED GRANULAR BASE COURSE, ASPHALT CONCRETE PAVEMENT- EPS PROJECTS OR OTHER APPLICABLE PROJECTS WHERE MEASUREMENT OF EXCAVATION QUANTITIES AS DETAILED IN SPECIFICATION 2.3, GRADING IS NOT REQUIRED

1.3.1.1 **Insert the following at the beginning of Section 1.2.31, Stakes, Marks and Engineering Tests:**

The Consultant will indicate the beginning and end of the project and sufficient reference points and other information for horizontal and vertical control, to be used by the Contractor for his detailed layout. This information will include, if available, radii and lengths of curves, design superelevations, pavement widths, and centreline deflection points. The Contractor shall protect and shall not remove or destroy, or permit to be removed or destroyed, the stakes or marks set as reference points by the Consultant.

Subsequent to the initial reference points staking performed by the Consultant, the Contractor shall perform all layout, survey and construction staking necessary to meet specified requirements for any type of construction.

The Contractor's detailed survey layout for base course construction shall include a complete base-line displaying project stationing at 20 m intervals suitable for referencing test locations and for purposes of measurement for payment. For Asphalt Concrete Pavement overlay projects, the base-line shall display project stationing at 30 m intervals.

Layout for interim lane markings, including those for intersection treatments, shall be performed by the Contractor at his own cost.

The cost of all survey and construction staking performed by the Contractor shall be incidental to the Work and will not be paid for separately.

1.4 CONSTRUCTION STAKING AND SURVEY BY CONSULTANT

1.4.1 FOR PROJECTS WHERE MEASUREMENT OF EXCAVATION QUANTITIES AS DETAILED IN SPECIFICATION 2.3, GRADING IS NECESSARY

1.4.1.1 **Insert the following at the beginning of Section 1.2.31, Stakes, Marks and Engineering Tests:**

Stakes or marks will be set by the Consultant to define the location, alignment, elevation, and grade required for the Work. The Contractor shall give the Consultant ample notice of the time and place where the stakes or marks will be needed. The Contractor shall protect, and shall not remove or destroy or permit to be removed or destroyed, the stakes or marks placed on or about the Work by the Consultant.

The Contractor shall satisfy himself before commencing the Work as to the correctness and meaning of all stakes and marks.

Initially, the Consultant will provide complete baseline survey stakes at 20 m intervals which show offsets and metric station numbers or kilometre chainages that correspond to the control section. Additional baselines may be warranted depending on the complexity and terrain of the project. At least one baseline will note elevations above or below the shoulder grade. Work stakes will indicate backslope and/or sideslope cut and fills left and right of centerline.

Culvert locations will be staked by the Consultant noting the location of culvert ends, invert elevations, sizes and lengths.

Bridge fills will be staked by the Consultant in accordance with the applicable standard drawing(s).

The Contractor shall perform any further required survey to complete and prepare the roadway for final grade stakes.

When the Contractor determines that the roadway is sufficiently completed and prepared for final grading, he shall request that the Consultant provide final grade stakes. The Consultant will provide a maximum of two sets of final grade stakes.

Notwithstanding these provisions, layout for interim lane markings, including those for intersection treatment, shall be performed by the Contractor at his own cost.

1.5 AMENDMENT TO SPECIFICATION 1.2, GENERAL, RE: CONSTRUCTION STAKING AND SURVEY FOR BRIDGE STRUCTURES

1.5.1 THE FOLLOWING SUBSECTION HAS BEEN ADDED TO SECTION 1.2.31 'STAKES, MARKS AND ENGINEERING TESTS' OF SPECIFICATION 1.2 'GENERAL':

1.2.31.1 Construction Staking and Survey for Bridge Structures

The Consultant will provide accurate horizontal and vertical reference points for centreline of the structure. The Contractor shall protect, and shall not remove or destroy or permit to be removed or destroyed, the stakes or marks established by the Consultant.

The Contractor shall provide and be responsible for all other stakes and marks, and shall be fully responsible for the alignment, elevation and dimensions of each and every component of the structure.

The Contractor shall keep complete survey records for review purposes and make these records available to the Consultant. The Contractor shall provide such assistance as the Consultant may require for review purposes.

In the event any component(s) of the structure is found to be incorrectly located or constructed the Contractor shall, at his own expense, immediately take any action necessary to correct or replace the particular component(s) of the work in question including the supply of any and all additional material required, and the Contractor shall be responsible for any delay incurred thereby.

1.6 SUPPLY OF PLASTIC GUARDRAIL POSTS - CONTRACTOR'S OPTION

The Contractor has the option of supplying plastic guardrail posts in place of wooden posts except for the following locations:

- At any installation on Highway 2 between Edmonton and Calgary,
- On strong post system installations at bridge abutments or
- At any other installation specifically prohibited by the Consultant

1.6.1 IN SPECIFICATION 5.25, ADD A NEW SUB-SECTION AS FOLLOWS:

5.25.3.4 Plastic Guardrail Posts

Plastic Guardrail Posts shall be supplied in accordance with the Alberta Transportation Recognized Products List as shown on the Department's web pages and the following:

Plastic posts shall be stamped at the top of the post on a surface not used for rail attachment with:

- the identifying product number or code, and
- the year of manufacture.

These markings shall be legible throughout the normal service life of the post. The Contractor shall supply the Consultant with certification from the supplier that the plastic posts conform with the specifications.

1.6.2 IN SPECIFICATION 2.19, GUARDRAIL AND GUIDE POSTS, ADD THE FOLLOWING NEW SECTION:

2.19.4.6 Supplying and Installing Plastic Guardrail Posts

If the Contractor elects to install plastic posts instead of wooden posts, the Department will make a premium payment of $ 2.50 for each plastic guardrail post supplied and installed. This premium will be paid in addition to the unit price bid for the applicable supply and install guardrail bid item.

1.7 AMENDMENT TO SPECIFICATIONS 2.3 GRADING, 3.1, SUBGRADE PREPARATION AND ALL BASE COURSE SPECIFICATIONS REGARDING TOLERANCE FOR SURFACE FINISH

1.7.1 GENERAL

The finished surfaces constructed under this contract are subject to tolerances for elevation, slope and width. These tolerances shall apply to the following:

(i) the finished subgrade surface;
(ii) the finished surface of Granular Base Course, Cement Stabilized Base Course and Asphalt Stabilized Base Course; and
(iii) embankment sideslope and ditches.

All surfaces shall be built true to grade, cross-section and alignment with consistent, uniformly contoured surfaces. Furthermore, the finished roadway grade, alignment and widths shall tie neatly into fixed control points such as bridge abutments, railway crossings, grade intersections, etc. to the satisfaction of the Consultant.

1.7.2 TOLERANCES FOR ALL TYPES OF GRADING AND BASE COURSE WORK

The Contractor shall produce all finished surfaces to achieve or exceed the grade, slope and width tolerance limits as follows:

1.7.2.1 **Surface Tolerance at Base Line Stations**

The deviation of the finished surface from the corresponding design elevation will be determined by the Consultant at each station. The maximum allowable deviation from the design elevation at any point will be ± 30 mm for subgrade surfaces and ± 20 mm for base course surfaces.

Furthermore, the maximum difference in deviation between consecutive stations at the same offset, shall not be more than 30 mm for subgrade surfaces and 20 mm for any type of base course surface.

1.7.2.2 **Slope Tolerance Limits**

The Consultant will determine the roadway slope using the elevations at centerline and edge of shoulder at any location on the finished surface that he determines necessary. These measured slopes shall be considered Slope Reference Lines.

For projects consisting of combined Grading/Granular Base Course Work or Base Course Work only, the Slope Reference Line at any location on a finished surface shall not deviate from the design slope by more than 0.25%.

For projects consisting of Grading Work only, the Slope Reference Line at any location on a finished surface shall not deviate from the design slope by more than 0.5%.

Furthermore, for all types of Work, no point on the surface shall deviate in elevation by more than 15 mm from the Slope Reference Line as determined.

1.7.2.3 **Surface Width Tolerance Limits**

The finished surface, as measured from shoulder edge to shoulder edge, shall not be wider by more than 0.1 m or narrower by more than 0.05 m from the design width as determined by the Consultant.

1.7.2.4 **Road Side Slope Tolerance Limits**

At any location, no part of any finished side slope shall deviate from the design side slope by more than ±0.2 m/m.

1.7.2.5 **Road Ditch Width Tolerance Limits**

At any location, the ditch width shall not deviate by more than 0.2 m from the design or as approved by the Consultant.

The tolerance limits for Road Side Slope and Road Ditch Width only apply when the Contract calls for Grading Work.

1.7.3 MEASUREMENT

The Consultant will take as many measurements as he thinks necessary to establish compliance with this specification and may vary the general interval, particularly where the finished surface is evidently not plane between stations or across the travel lanes. The Department will make no charge for initial measurements. Where compliance with surface tolerance requirements is not initially achieved, reworking will be required. After the surfaces are reworked, the Consultant will determine if remeasuring to confirm compliance is required. If the Consultant performs remeasure and the surfaces are not in compliance, the Contractor will be charged an amount of $500.00 per occurrence and further reworking shall be required. An "occurrence" will be considered a day or portion of a day in which remeasuring to verify compliance is performed. If the Consultant performs remeasure and the reworked surfaces are in compliance, no charge will be made for the remeasure.

For Granular Base Course projects, no payment will be made for any granular material placed outside the specified tolerance limits for Surface Width and Road Side Slope, with the exception that for Grade Widening projects where there is a need to initially construct the granular base course to a width that will accommodate construction equipment, the Consultant and Contractor shall agree on the allowable tolerances for construction and payment purposes.

In any cases where granular base course material is placed outside the specified or allowable tolerances, as the case may be, such quantity will be determined by the Consultant.

1.8 HOT IN-PLACE RECYCLED ASPHALT CONCRETE PAVEMENT - EPS

1.8.1 GENERAL

This specification is to be used only for pavement to be processed using the Hot In-Place Recycling (HIR) technology and serves as a supplement to Specification 3.50, Asphalt Concrete Pavement - End Product Specification (EPS). Specification changes have been made recognizing the unique characteristics of mixes processed using this technology. In case of conflict between this special provision and Specification 3.50, this special provision shall govern. References to Asphalt Concrete Pavement in Specification 3.50, except where noted in this special provision, shall also apply to Hot In-Place Recycling.

1.8.2 HOT IN-PLACE RECYCLING (HIR)

Hot In-Place Recycling shall consist of heating the existing asphalt concrete pavement; milling the heated pavement; mixing the milled material; adding as directed, admix, or rejuvenating agent and spreading and compacting the resultant mixture, all in one continuous operation, to the depths, lines, grades and dimensions shown on the plans or as designated by the Consultant.

1.8.3 CHANGES TO SPECIFICATION 3.50

1.8.3.1 **In Section 3.50.1.2 Definitions make the following changes:**

1.8.3.1.1 Remove definition 3.50.1.2.1 Acceptance Limits (i) Density and Actual Asphalt Content and replace with:

(i) Density, Marshall Air Voids and Recovered Asphalt Penetration

Acceptance Limit for Density, Marshall Air Voids and Recovered Asphalt Penetration is the limiting value of the Sample Mean beyond which a Lot is accepted at full, increased or reduced payment as shown in Tables 6, 7 and 8.

1.8.3.1.2 In Section 3.50.1.2.1 Acceptance Limits remove (iii) Gradation.

1.8.3.1.3 Replace Section 3.50.1.2.5 Lot with the following:

A Lot is a portion of the Work being considered for acceptance and is generally considered to represent 3 lane□kilometres of production, but can vary in length, according to project specific requirements, within the limits of 1 lane.km to 4 lane□kilometres. The actual Lot size is to be chosen by the Consultant.

A change in any one of the following may require a new Lot designation:

(a) Mix design
(b) Pavement Density Requirement

1.8.3.1.4 In Section 3.50.1.2.6 Rejection Limit remove (i) Density and Asphalt Content and replace with:

(i) Density, Marshall Air Voids and Asphalt Penetration - Rejection Limit for density, Marshall air voids and asphalt penetration is the limiting value of the Sample Mean beyond which a Lot is rejected and not paid for as shown in Tables 6, 7 and 8.

1.8.3.1.5 In Section 3.50.1.2.6 Rejection Limit remove (iii) Gradation.

1.8.3.1.6 Add the following to Section 3.50.1.2 Definitions:

3.50.1.2.14 Admix

Aggregate, with sufficient asphalt cement added to produce a uniform completely coated mixture that is added during the recycling process to improve the engineering characteristics of the HIR mix.

3.50.1.2.15 Segment

For the purposes of acceptance sampling and testing for Pavement Density, a Lot is divided into 5 or more segments of approximately equal area.

1.8.3.2 **Remove the contents of Section 3.50.2.1 Asphalt and replace with:**

The Contractor shall supply asphalt material for pre-coating of the admix in accordance with Specification 5.7, Supply of Asphalt.

1.8.3.3 **Remove the first sentence of Section 3.50.2.2 Aggregate and replace with:**

The Contractor shall supply aggregate in accordance with Specification 3.2 Aggregate Production and Stockpiling according to the Admix Aggregate Requirements outlined in Table 2 HIR Mix Types and Characteristics

1.8.3.4 **Add the following Section to 3.50.2 MATERIALS**

3.50.2.5 Rejuvenating Agent

An asphalt rejuvenating agent or asphalt shall be provided and added by the Contractor, when required, to result in the recycled asphalt cement meeting the specified penetration criteria.

Only asphalt rejuvenating agents listed within the Department's Recognized Products List shall be used by the Contractor.

Any asphalt rejuvenating agent used by the Contractor shall meet the applicable manufacturer's specifications.

1.8.3.5 **In Section 3.50.3 ASPHALT MIX DESIGN AND JOB MIX FORMULA**

1.8.3.5.1 Replace Table 3.50.3.2 with Table 1

Table 1 HIR Mix Types and Characteristics

Mix Type (Note 4)	Recovered Asphalt Penetration (dmm) (Note 1)	Admix Aggregate Requirements		Air Voids (%) (Note 3) refer to Figure 1 for Box Boundaries	Marshall Stability	
		Plasticity Index (PI)	Maximum Passing 80 Fm Sieve (%) (Note 2)		Minimum (N)	Minimum % Retained
HR1	65 to 135	NP	10	A, B & C	8 000	70
HR1C	95 to 135	NP	10	B & C	8 000	70
HR2	65 to 160	NP	10	A, B, C & D	6 000	70
HR2C	115 to 160	NP	10	C & D	6 000	70

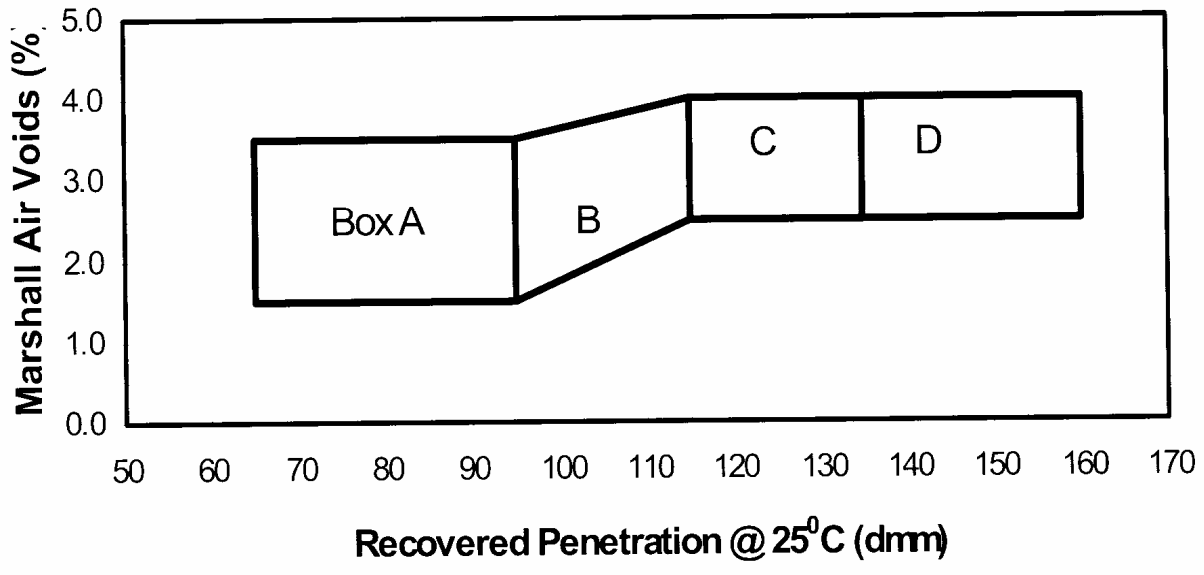
Note 1 Recovered Asphalt Penetration requirements are for the combined asphalt including any rejuvenating agent or virgin asphalt.

Note 2 If the admix is a manufactured fines aggregate the maximum limit for percent passing the 80 µm sieve shall be 13%.

Note 3 Air voids shall be determined on the basis of maximum specific gravities at each asphalt content. Marshall briquettes shall be formed using 75 blows per face at a compaction temperature of 130°C.

Note 4 HIR Mix Type shall be as listed in the special provisions.

Figure 1 HIR Design Air Voids and Design Recovered Asphalt Penetration



1.8.3.6 **In Section 3.50.3.3 Verification of Mix Design make the following changes:**

1.8.3.6.1 Remove items (i), (ii), (iii), (iv), (v) and (vi) and replace with the following:

(i) The aggregate type and amount of any admix added by weight of total mix.

(ii) The aggregate gradation of any admix used and the other aggregate characteristics for admix as specified in Table 2 HIR Mix Types and Characteristics.

(iii) The type of asphalt cement grade and percent asphalt content added to the admix.

(iv) Other aggregate characteristics of the admixture as specified in Table 1 HIR Mix Types and Characteristics.

(v) Test data of the existing pavement used in the preparation of the mix design, including sampling locations, aggregate gradations, asphalt contents and penetrations @25°C (100 g, 5 s) of the existing asphalt cement.

(vi) Identification of type and quantities of any asphalt rejuvenating agent required.

(vii) All Marshall mix design characteristics as specified in Table 1 HIR Mix Types and Characteristics including the aggregate gradation of the recycled mix including admix where applicable.

1.8.3.6.2 Add the following to the end of the fourth paragraph:

For HIR mix the Consultant may, at any time, require the Contractor to provide representative samples of each of the aggregate components or existing pavement material for verification purposes. A sufficient quantity of each component shall be provided to result in a 10 kg sample of recycled material and no individual component shall be less than 5 kg.

1.8.3.6.3 Add the following paragraph:

The addition rate of admix and rejuvenating agent for the approved mix design will then be the Job Mix Formula for the production of HIR mix.

1.8.3.7 **Remove the first three paragraphs of Section 3.50.3.4 Variation from Approved Job Mix Formula and add the following:**

After the Consultant has accepted the HIR mix design, the combined aggregate gradation in the accepted design shall become the Design Combined Aggregate Gradation. The difference between the Lot Average Gradation and the Design Combined Aggregate Gradation shall not exceed the amounts shown in Table 2. Deviations outside the permissible limits shown in Table 2 will be evaluated by the Consultant to determine if a new mix design is required.

Table 2 HIR GRADATION VARIATION

SIEVE DESIGNATION	MAXIMUM PERMISSIBLE VARIATION PERCENT BY WEIGHT PASSING
5000	±6
1250	±5
630	±4
315	±3.5
160	±3.0
80	±2.5

1.8.3.8 **In Table 3.50.4.2 Test Methods make the following changes:**

1.8.3.8.1 Add "ASTM D3203" under test method for Test Description No. 9. Voids Calculation, Asphalt Concrete Specimens.

1.8.3.8.2 Add the following:

18	Asphalt Recovery from Solution by the Abson Method	ASTM D1856
19	Standard Penetration Test for Asphalt	ASTM D5
20	Theoretical Maximum Specific Gravity, Asphalt Mix	ASTM D2041

1.8.3.9 **Add the following to Section 3.50.4.3 Quality Control Testing**

The quality control testing requirements for HIR shall be as outlined in Table 3 QUALITY CONTROL TESTING REQUIREMENTS - HOT IN-PLACE RECYCLING.

Table 3
Quality Control Testing Requirements - Hot In-place Recycling

Test	Standard	Minimum Frequency
AGGREGATE PRODUCTION		See Specification 3.2
EQUIPMENT CALIBRATION	Determined by Contractor	Once per project or as required
SAMPLES		
1. Admix	ATT-38	(1)
2. HIR mix	ATT-38	One per lane·km
3. QA Cores for Pavement Density - Stratified Random Test Sites Chosen by the Consultant	ATT-56, ATT-5	Five per Lot
EQUIPMENT INSPECTION	Determined by Contractor (2)	Four per day

	Test	Standard	Minimum Frequency
TESTING WITH NO SPECIFIED MINIMUM FREQUENCIES			
1	Asphalt Content of Admix and HIR mix	AASHTO T-164, T287 or ATT-12 or ATT-74	(1)
2	Moisture Content of Admix and HIR mix	ATT-15	(1)
3.	Field Formed Marshall Briquettes	ATT-13	(1)
4.	Abson Extraction of HIR mix	ASTM D1856	(1)
5.	Standard Penetration of Recovered Asphalt	ASTM D5	(1)
TESTING WITH SPECIFIED MINIMUM FREQUENCIES			
1	Aggregate Extraction or Ignition Sieve Analysis of HIR mix.	ATT-26	One per HIR mix sample
OTHER RELATED TESTS			
1.	Density Immersion Method, Saturated Surface Dry	ATT-7	(1)
2.	Temperatures	ATT-30	(1)
3	Extraction Sieve Analysis of Admix	ATT-26	(1)
4.	Void Calculations, Cores or Formed Specimens	ASTM 3203 (3)	(1)
5.	Coring or Nuclear Density	ATT-5 or ATT-11 (3)	(1)
6	Percent Compaction, Asphalt Concrete Pavement	ATT-67 or ATT-11	(1)
7	Random Test Site Locations	ATT-56	As applicable
8.	Correction Factors, Nuclear Moisture-Density Measurement	ATT-48	(1)
9.	Thickness Measurement of Un-compacted Mat		Minimum of one per hour of production
10	Theoretical Maximum Specific Gravity of Bituminous Mixes	ASTM D2041	(1)

Notes:
(1) Minimum Frequency not specified.
(2) To include checks on the addition rate of any asphalt rejuvenating agent and/or admix used.
(3) Percent compaction and core air voids based upon the Lot Mean Maximum Specific Gravity (Gmm).
Air voids on Marshall formed specimens to be based upon corresponding individual Gmm tests.

1.8.3.10 **Make the following changes to Section 3.50.4.4 Acceptance Sampling and Testing**

1.8.3.10.1 Replace the third paragraph of Section 3.50.4.4.1 with the following:

The Contractor shall provide to the Consultant all quality assurance density cores within 24 hours of receiving the stratified random sample locations. Prior to obtaining the cores, the Consultant may provide the Contractor with new or different random sample locations. The Consultant may have the Contractor obtain quality assurance cores at any time throughout the project for any Lot. All cores provided to the Consultant shall be in their original condition. Core preparation or sawing shall be done by the Consultant.

All costs associated with pavement coring for quality control and quality assurance testing shall be the responsibility of the Contractor.

1.8.3.10.2 Add the following to Section 3.50.4.4.1 General

If the testing equipment malfunction, improper testing procedures or calculations were on the part of the Consultant, the Contractor shall be reimbursed $50 per location for obtaining cores.

1.8.3.10.3 In Section 3.50.4.4.2.1 Pavement Sampling for Density, Asphalt Content and Gradation change the title to Pavement Sampling for Density.

1.8.3.10.4 Delete the contents of 3.50.4.4.2.3 Asphalt Mix Sampling and replace with the following:

Sampling of the recycled asphalt mixture for the formation of Marshall briquettes, mix extraction, determination of the maximum specific gravity, air voids determination and penetration testing of the recovered asphalt will be done by the Consultant behind the paver as outlined in ATT-37 with the following changes:

For each mix sampling instance, an additional two split samples, of 5 000 g each, will be collected. One of the two split samples will be identified for recovered asphalt penetration testing while the remaining sample will be identified for possible appeal testing of the Lot maximum specific gravity that is used for the determination of the Lot average Marshall Air Voids.

1.8.3.10.5 Add the following as Section 3.50.4.4.2.5 Recovered Asphalt Penetration

From the group of split samples identified for penetration testing for each lot, one of the 5 000 g samples will be selected for penetration testing of the recovered asphalt. The remaining split samples identified for penetration testing, are to be saved for possible follow-up testing as outlined in the new Section 3.50.4.8.8, Recovered Asphalt Penetration as shown in this specification amendment.

The Consultant may not test every Lot for Recovered Asphalt Penetration if he is satisfied that the requirements for Recovered Asphalt Penetration is being achieved.

1.8.3.11 **Delete all of Section 3.50.4.6 Aggregate Gradation Requirements.**

1.8.3.12 **In Section 3.50.4.8 Appeal of Acceptance Test Results and Appeal Testing delete all reference to Asphalt Content and Gradation.**

1.8.3.13 **Rename Section 3.50.4.8.4 to be "Payment of Appeal Testing Costs for Smoothness and Marshall Air Voids" and add the following:**

Theoretical maximum specific gravity tests for determination of Lot Average Marshall Air Voids: $100 per test.

1.8.3.14 **Add the following as Section 3.50.4.8.7 Marshall Air Voids**

The Contractor may appeal the theoretical maximum specific gravity test results, used to determine the Marshall air voids, of any rejected or penalized lot only once. The appeal shall be for all the theoretical maximum specific gravity tests within the Lot, and there will be no appeal allowed for single tests within a Lot.

No appeal will be allowed for Marshall bulk specific gravity test results.

The following procedure will apply for an appeal:

(i) The Contractor shall serve notice of the appeal to the Consultant, in writing, within 48 hours of receipt of the QA test results.

(ii) The appeal testing will consist of retesting for theoretical maximum specific gravity the split mix samples obtained for the appealed lot.

(iii) The number of split samples shall correspond to the original number of quality assurance mix samples taken in the Lot.

(iv) The high and low test results from the old Lot will be rejected and all the remaining test results will be added to the results of the new tests. A new mean for the test results will be determined and used for calculating the new average Marshall air voids to be used for acceptance and unit price adjustment.

The new mean, thus determined, in all cases, will be binding on the Contractor and the Department.

1.8.3.15 **Add the following as Section 3.50.4.8.8, Recovered Asphalt Penetration**

If the original test result for the penetration of the abson recovered asphalt falls within the range for rejection or penalty, the Consultant will arrange to have the remaining penetration split samples from that Lot tested. The number of split samples shall correspond to the original number of quality assurance mix samples taken in the Lot, less one for the original penetration test.

A new mean including the original test result and subsequent test results will be used for calculating the new average penetration of recovered asphalt for acceptance and unit price adjustment.

The new mean, thus determined, in all cases, will be binding on the Contractor and the Department.

1.8.3.16 **Add the following to Section 3.50.5 CONSTRUCTION**

3.50.5.10 Hot In-Place Recycling

Equipment used for hot in-place recycling shall be specifically designed to heat and mill the existing pavement to a minimum depth of 50 mm, thoroughly mix the recycled material and uniformity spread the recycled material. Milling heads are to be used for removing the existing pavement material as opposed to the sole use of scarifier tines which shall not be allowed.

The recycling equipment shall be designed to heat the recycled material to within specified limits without scorching or localized over-heating of any of the recycled material.

The hot in-place recycling equipment shall be equipped with a mixing system capable of continued and consistent mixing. The mixing system must have sufficient capacity to thoroughly mix the recycled material including any admixture and/or rejuvenating agent into a homogeneous mass.

The hot in-place recycling equipment shall be equipped with a vibratory heated screed and strike-off device capable of distributing and placing the recycled mix to the depths and dimensions shown on the typical plans and sections. The temperature of recycled material behind the paver screed shall be greater than 110°C. At no time shall the recycled material be heated over an average material temperature of 150°C in order to avoid excessive oxidation and hardening of the recycled asphalt cement.

The recycler unit shall be equipped to enable admix to be metered into the material being processed at a controlled and uniform rate and in such a manner to ensure that all materials are uniformly mixed with the recycled material. All HIR material, with or without admix, shall be uniformly mixed and coated.

The recycler unit shall be equipped to enable a rejuvenating agent to be uniformly added to the heated and milled mixture. Such equipment shall provide for the following:

(i) Positive feed and shut-off, interlocked to the movement and processing rate of the recycler.

(ii) Control of the quantity to ±0.05 ℓ/m2 from the approved target application rate.

(iii) Measurement of the total volume used by means of a calibrated metering device capable of recording accumulated litres to an accuracy of ±2%.

(iv) Heating and maintaining the temperature to within ±5°C of the temperature recommended by the manufacturer of the rejuvenating agent used.

HIR equipment shall be operated in accordance with the manufacturer's recommendations and shall be calibrated prior to commencing production. The Contractor shall provide the Consultant with calibration data indicating that the hot in-place recycling equipment has been calibrated to produce a uniform mixture in accordance with the Job Mix Formula.

The HIR production has the potential to produce unlawful air emissions unless carried out carefully using the appropriate equipment. In this regard, the Contractor's attention is directed specifically to Section 1.2.51 of the specifications. The Contractor shall have no claim to any

exemption from the requirements of Alberta Environment, or to any payment for extra costs resulting from the need to comply with their requirements, by virtue of this Contract or for any other reason.

1.8.3.17 **Add the following to Section 3.50.5.2.1 General**

Pavement surfaces to be recycled shall be cleaned of all dirt, dust, and other objectionable matter. The existing asphalt surface shall be heated a minimum of 0.10 m wider on each side than the width being processed. The processing width shall be as shown on the plans or as determined by the Consultant.

For hot in-place processed material, the requirements for prime coat or tack coat do not apply.

1.8.3.18 **Add the following to Section 3.50.5.2.3 Transverse Pavement Joints:**

At locations where hot in-place recycling is used the preceding joint requirements do not apply, however the Contractor shall ensure that the transition between the treated and untreated surfaces is smooth with no irregularities.

1.8.3.19 **Make the following changes to Section 3.50.6.2.1 Acceptance at Full or Increased Payment:**

1.8.3.19.1 delete sections (ii) and (v)

1.8.3.19.2 add the following

(vi) the average Marshall Air Voids of the mix is within the applicable limits specified in Table 1 HIR Mix Type and Characteristics.

(vii) the average penetration of the recovered asphalt is within the limits shown within Table 6 indicating no price adjustment for the applicable HIR mix type.

1.8.3.20 **In the first paragraph of Section 3.50.6.3 End Product Rejection replace the words "actual asphalt content or aggregate gradation" with "Marshall air voids or penetration of recovered asphalt".**

1.8.3.21 **In Section 3.50.7 Measurement and Payment, replace Section 3.50.7.1 with the following:**

3.50.7.1 HIR Pavement

Accepted HIR Pavement will be measured in square metres as determined by the actual treatment width and length measured according to the established baseline survey and will be paid for at the unit price bid per square metre for "HIR Pavement - EPS" subject to the unit price adjustments and assessments hereinafter specified. This payment will be full compensation for all labour, equipment, tools and incidentals necessary to complete the work in accordance with the Special Provisions in the Contract and shall include heating, milling, mixing, laying and compacting the recycled asphalt mixture; supplying and adding admix; aggregate supply and processing; supplying and adding rejuvenating agent or virgin asphalt; interim lane markings; quality control testing including sampling of quality assurance cores and traffic accommodation.

1.8.3.22 **In Section 3.50.7.1.1 Pay For Acceptable Work make the following changes:**

1.8.3.22.1 Delete the first six paragraphs and replace with the following:

The following end product properties of "HIR Pavement - EPS" will be measured for acceptance in accordance with Section 3.50.4.4 Acceptance Sampling and Testing.

(i) Pavement Density
(ii) Marshall Air Voids
(ii) Penetration of Recovered Asphalt
(iv) Smoothness (top lift only)
(v) Segregation (top lift only)

For the Pavement Density, Marshall Air Voids and Penetration of Recovered Asphalt to be acceptable, they must be within the limits shown in Tables 4, 5 and 6.

For each Lot, the unit price adjustments for Pavement Density, Marshall Air Voids and Penetration of Recovered Asphalt will be the amounts shown in Tables 4, 5 and 6.

The unit price applicable to each Lot quantity of "HIR Pavement, - EPS" will be calculated as follows:

Lot Unit Price per Square Metre	=	Contract Unit Price per Square Metre	+	the sum of the unit price adjustment for PAd + PAr + PAv

where:

PAd = Unit Price Adjustment for Pavement Density (bonus or penalty)
PAr = Unit Price Adjustment for Penetration of Recovered Asphalt (penalty only)
PAv = Unit Price Adjustment for Marshall Air Voids (penalty only)

If the mean Pavement Density or the mean Marshall Air Voids or the mean Penetration of Recovered Asphalt is outside the acceptance limit, the Lot is rejected, and no payment will be made for the quantity of HIR in that Lot, until the defect has been remedied.

1.8.3.22.2 In the second last paragraph of 3.50.7.1.1 Pay For Acceptable Work delete the term "PAa and PAg" and replace with the terms "PAr and PAv".

1.8.3.23 **In section (ii) of 3.50.7.1.3 Payment For Work That had Been Rejected, But Was Made Acceptable delete the words "Asphalt Content and Gradation" and replace with "Marshall Air Voids and Penetration of Recovered Asphalt".**

Table 4
Unit Price Adjustment for Density - Hot In-Place Recycled Asphalt Concrete Pavement

% Lot Mean Maximum Specific Gravity	HIR Unit Price Adjustment	
	HIR ($/m2)	
Lot Average	Design Lift Thickness	
	40 mm	50 mm
$ 95.5	0.048	0.06
95.4	0.043	0.054
95.3	0.039	0.048
95.2	0.034	0.042
95.1	0.029	0.036
95.0	0.024	0.03
94.9	0.019	0.024
94.8	0.015	0.018
94.7	0.009	0.012
94.6	0.005	0.006
94.5	0	0
94.4	-0.009	-0.012
94.3	-0.019	-0.024
94.2	-0.029	-0.036
94.1	-0.039	-0.048
94.0	-0.048	-0.06
93.9	-0.057	-0.072
93.8	-0.066	-0.084
93.7	-0.077	-0.096
93.6	-0.086	-0.108
93.5	-0.096	-0.12
93.4	-0.106	-0.132
93.3	-0.115	-0.144
93.2	-0.125	-0.156
93.1	-0.134	-0.168
93.0	-0.144	-0.180
92.9	-0.154	-0.192
92.8	-0.163	-0.204
92.7	-0.173	-0.216
92.6	-0.182	-0.228
92.5	-0.191	-0.240
92.4	-0.211	-0.264
92.3	-0.229	-0.288
92.2	-0.250	-0.312
92.1	-0.268	-0.336
92.0	-0.288	-0.360
91.9	-0.307	-0.384
91.8	-0.327	-0.408

Table 4 Unit Price Adjustment for Density - Hot In-Place Recycled Asphalt Concrete Pavement		
% Lot Mean Maximum Specific Gravity	HIR Unit Price Adjustment HIR ($/m2)	
Lot Average	Design Lift Thickness	
	40 mm	50 mm
91.7	-0.345	-0.432
91.6	-0.365	-0.456
91.5	-0.384	-0.480

For lower lifts when the Lot average density is less than 90.0% and greater than 86.9%, payment will be 50% of the unit bid price.

For top lifts where the Lot average density is less than 90.0% and greater than 87.9%, payment will be 50% of the unit bid price.

For top lifts where the Lot average density is less than 88.0% and on lower lifts where the density is less than 87.0%, the Contractor shall remove and replace the mix, or on approval of the Consultant, reprocess using HIR equipment.

Table 5 Unit Price Adjustment for Marshall Air Voids - HIR		
Amount That Lot Average Air Voids (%) is	HIR Unit Price Adjustment - HIR ($/m2) Treatment Depth	
Below Lower Design Limit	**40 mm**	**50 mm**
0.1	-0.04	-0.05
0.2	-0.08	-0.10
0.3	-0.12	-0.15
0.4	-0.16	-0.20
0.5	-0.20	-0.25
0.6	-0.24	-0.30
0.7	-0.32	-0.40
0.8	-0.40	-0.50
0.9	-0.48	-0.60
1.0	-0.56	-0.70
Above Upper Design Limit	**40 mm**	**50 mm**
0.1	-0.04	-0.05
0.2	-0.08	-0.10
0.3	-0.12	-0.15
0.4	-0.16	-0.20
0.5	-0.20	-0.25
0.6	-0.32	-0.40
0.7	-0.44	-0.55
0.8	-0.56	-0.70
0.9	-0.68	-0.85
1.0	-0.80	-1.00

Note 1:

Lower and upper Air void design limits are determined from Figure 1 HIR Design Air Voids and Recovered Asphalt Penetration Limits according to the Design Recovered Asphalt Penetration.

For lower lifts when the Lot average Marshall air voids is greater than 1% above the upper design limit, payment will be at 50% of the unit bid price.

For top lifts when the Lot average Marshall air voids is greater than 1% above the upper design limit, the Contractor shall either overlay or remove and replace the previously placed mix or, on the approval of the Consultant, reprocess using HIR equipment.

For lower lifts where the Lot average Marshall air voids is greater than 1.0% below the lower design limit, payment will be at 50% of the unit bid price.

For top lift where the Lot average Marshall air voids is greater than 1.0% below the lower design limit, the Contractor shall remove and replace the mix or, on the approval of the Consultant, reprocess using HIR equipment.

Table 6
Unit Price Adjustment for Recovered Asphalt Penetration
Hot In-Place Recycled Pavement

Amount That Lot Average Recovered Penetration is (dmm @ 25 CE)		**HIR Unit Price Adjustment HIR ($/m2)**	
Below Lower Design Limit Shown in Table 1	**Above Upper Design Limit Shown in Table 1**	**Treatment Depth**	
		40 mm	**50 mm**
# 10	0	0.00	0.00
11	1 - 2	-0.06	-0.08
12	3 - 4	-0.08	-0.10
13	5 - 6	-0.10	-0.12
14	7 - 8	-0.11	-0.14
15	9 - 10	-0.13	-0.16
16	11 - 12	-0.17	-0.21
17	13 - 14	-0.21	-0.26
18	15 - 16	-0.25	-0.31
19	17 - 18	-0.29	-0.36
20	19 - 20	-0.33	-0.41
21	21 - 22	-0.38	-0.48
22	23 - 24	-0.44	-0.55
23	25 - 26	-0.50	-0.62
24	27 - 28	-0.55	-0.69
25	29 - 30	-0.61	-0.76

For any lifts when the Lot average recovered asphalt penetration is greater than 30 dmm above the upper specification limit, the Contractor shall remove and replace the previously placed mix.

For any lifts where the Lot average recovered asphalt penetration is greater than 25 dmm below the lower specification limit, payment will be at 50% of the unit bid price.

1.9 ACCEPTANCE TESTING FOR CONTRACTS WITH SMALL QUANTITIES (LESS THAN 1000 TONNES) OF ASPHALT CONCRETE PAVEMENT (ACP)

1.9.1 AMENDMENTS TO SPECIFICATION 3.50, ASPHALT CONCRETE PAVMENT - EPS:

1.9.1.1 **In section 3.50.1.2.5 Lot, items (i) and (ii) are deleted and replaced with the following; and item (iii) is renumbered to item (ii):**

(i) The entire quantity of ACP will normally be considered as one Lot, not withstanding the conditions outlined in item (ii).

1.9.1.2 **Table 3.50.4.3 Quality Control Testing Requirements - Managed QA Testing Projects, is replaced with the following table:**

Test	Standard	Minimum Frequency
AGGREGATE PRODUCTION		See Specification 3.2
ASPHALT MIX PLANT		
1. Calibration	ATT-17	Once per project or as required
2. Inspection	ATT-16	(1)
SAMPLES		
1 Asphalt Cement	ATT-42	See Specification 5.7
2 Tack, Prime and Fog Materials	ATT-42	See Specification 5.7
3 Cold Feed Aggregate	ATT-38	(1)
4 Mix	ATT-37	(1)
5 QA Cores for Pavement Density, Asphalt Content and Gradation obtained by the Contractor at Stratified Random Test Sites chosen by the Consultant	ATT-56 ATT-5	Five core locations per Lot.
TESTS		
1 Mix Asphalt Content	AASHTO T-164, T287 or ATT-12 or ATT-74	(1)
2 Correction Factors	ATT-12, Part III or ATT-74, Part II	As Required
3. Mix Moisture Content	ATT-15	(1)
4. Aggregate Sieve Analysis	ATT-26	(1)
5. Field Formed Marshall Briquettes	ATT-13	(1)
6. Density Immersion Method, Saturated Surface Dry	ATT-7	(1)
7. Void Calculations, Cores or Formed Specimens	ATT-36	(1)
8. Temperatures	ATT-30	(1)
9. Percent Compaction, Cores or Nuclear Density	ATT-67, ATT-5 or ATT-11	(1)
10 Random Test Site Locations	ATT-56	(1)
11 Correction Factors, Nuclear Moisture-Density Measurement	ATT-48	(1)

Notes: (1) Minimum Frequency not Specified.

1.9.1.3 **The following is added to section 3.50.4.4.2.1, Pavement Sampling for Density, Asphalt Content and Gradation:**

Samples for asphalt content and gradation may be obtained by the consultant using the Sampling Mix Behind Paver method described in ATT-37. If the number of mix samples is less than five and the test results on the loose mix samples indicates that the mix is in penalty or rejection for asphalt content or in rejection for gradation, then additional cores samples shall be taken by the Contractor at locations as determined by the Consultant in order to perform the minimum five tests per Lot.

Testing for pavement density may be waived at the discretion of the Consultant. Pavement sampling for density will consist of 5 cores taken by the Contractor at locations as determined by the Consultant. If field formed Marshall density values are not available for compaction comparison the Consultant will determine the average Maximum Specific Gravity (Test Method ASTM D2041) on the 5 core samples to use for compaction comparison. Price adjustments and acceptance criteria will then be based upon Table 3.53A Unit Price Adjustments for Density.

1.9.1.4 **All references to Table 3.50A shall mean Table 3.53A.**

1.9.1.5 **The following is added to section 3.50.4.4.2.2, Pavement Sampling for Smoothness:**

QA smoothness testing may be waived at the discretion of the Consultant. Acceptance and rejection criteria for smoothness, including lump sum sublot assessments, will not apply if the Consultant elects not to undertake smoothness testing. If the Consultant does undertake QA smoothness testing then all acceptance and rejection criteria will apply, including lump sum sublot assessments and penalties for bump or dip defects over 8 mm.

1.9.1.6 **In Section 3.50.4.4.2.3 Asphalt Mix Sampling, the word "will" is changed to "may".**

1.9.1.7 **The following changes are made to Section 3.50.4.7.3.2, Inspections By The Consultant:**

1.9.1.7.1 <u>The third sentence of the second paragraph of item (i) Inspections During Construction, is replaced with the following:</u>

During the inspection(s) of the top lift, the Consultant will identify and record any areas of slight, moderate and severe segregation and any areas of centre-of-paver streak.

1.9.1.7.2 <u>Item (ii) 'Inspection Following Construction' is deleted.</u>

1.9.1.8 **In Section 3.50.6.2.1 End Product Acceptance, the term "Lot Mean Marshall density" is replaced with the following:**

"Lot Mean Marshall density or the Lot Mean Maximum Specific Gravity".

1.9.1.9 **In Section 3.50.7.1.2 Segregation Payment Adjustments, the following text is deleted from the first sentence of the second paragraph:**

"either during construction or during the inspection conducted 2 weeks after the completion of paving work,"

1.10 SUPPLY OF AGGREGATE - CONTRACTOR'S SUPPLY WITH OPTION

The Contractor shall supply the aggregate for this Contract. The Contractor has the option of supplying aggregate from the source controlled by the Department identified in the special provisions or from other sources of his own choice. No other source controlled by the Department may be used for the gravel component of the aggregate. However, sources controlled by the Department may be used for the blend sand component of the aggregate subject to the approval of the Department.

1.11 SUPPLY OF AGGREGATE - CONTRACTOR'S SUPPLY WITH NO OPTION

The Contractor shall supply the aggregate for this Contract from sources of his own choice with the exception that the gravel component of the aggregate may not be obtained from a source controlled by the Department. However, sources controlled by the Department may be used for the blend sand component of the aggregate, subject to the approval of the Department.

1.12 SUPPLY OF AGGREGATE – DESIGNATED SOURCE

The Contractor shall supply the aggregate for this Contract from the source(s) identified in the Special Provisions. No other source may be used for the gravel component of the aggregate, except that other sources including those controlled by the Department may be used for the blend sand component of the aggregate, subject to the approval of the Department.

No payment will be made for aggregate extracted from sources controlled by the Department.

If blend sand is supplied from a source that is not controlled by the Department, the supply of aggregate will be considered incidental to the Work and no separate or additional payment will be made.

1.13 INTERIM SUPPLY OF MATERIALS

The Contractor will have the option of requesting interim payment for the supply of materials for those items identified in the Special Provisions. This specification will only apply when the supply of materials is considered incidental to the Work, and when interim supply of materials is not addressed in the applicable specification.

1.13.1 GENERAL

Interim payments for the supply of material will be made under the following conditions:

(i) The Contractor submits a written request for interim payment to the Consultant.

(ii) Supplied materials will be inventoried for more than 30 days before incorporation into the Work.

(iii) The supply, fabrication, inspection and testing of the supplied materials has been completed in accordance with the applicable specifications.

(iv) There are no separate payments specified for interim supply of materials in the applicable specification.

(v) The Contractor provides the Consultant with written consent of Surety to the interim payment, or with security in the form of an Irrevocable Letter of Credit in the amount of the total interim payment.

Interim payment will not imply acceptance of the materials by the Consultant.

1.13.2 INTERIM PAYMENT FOR SUPPLY OF MATERIALS

Interim payments will be based on actual Supplier invoices, or 50% of the applicable bid item incorporating the materials; whichever is less.

Interim payments for the supply of materials will be made monthly. Interim payment will be considered a portion of the unit price or lump sum price bid for the Work that incorporates the materials supplied. The interim payment will be deducted when payment is made under the applicable bid item or when all Work covered by applicable bid item has been completed.

1.14 ADJUSTMENT OF COMPLETION DATE AND LIQUIDATED DAMAGES FOR BRIDGE STRUCTURE WORK

The following changes are applicable to the bridge structure portion of the work only:

1.14.1 SECTION 1.2.19, ADJUSTMENT OF COMPLETION DATE:

1.14.1.1 **In the first paragraph of Clause 1.2.19(c)(vi), the words "roadway surface" are changed to "Bridge Structure".**

1.14.1.2 **The second sentence of the second paragraph of Clause 1.2.19(vi) is deleted.**

1.14.1.3 **The last two paragraphs of Section 1.2.19 starting with "If an adjustment to the..." are deleted.**

1.14.2 SECTION 1.2.20, FAILURE TO COMPLETE ON TIME:

1.14.2.1 **In clause 1.2.20(i)(a) - “$1,350.00" is replaced with “$800.00".**

1.14.2.2 **Item (b) of subsection 1.2.20(i) is deleted.**

1.15 DURATION OF WORK AND SITE OCCUPANCY FOR BRIDGE STRUCTURE CONSTRUCTION

1.15.1 THE FOLLOWING SHALL APPLY TO THE BRIDGE STRUCTURE PORTION OF THE WORK ONLY:

1.15.1.1 **Replace the Contents of Section 1.2.21 with the following:**

1.2.21.1 General

When the Contract contains a bid item for “Site Occupancy - Bridge Structures”, bidders shall indicate the number of Calendar Days required to complete the Bridge Structure Work under the “estimated quantity” column of the unit price schedule and extend that number of days times the unit price per day as shown, to get the total bid for “Site Occupancy - Bridge Structures”.

1.2.21.2 Calculation of Calendar Days for Site Occupancy

Calendar Days for Site Occupancy will be calculated as whole days. The assessment of Calendar Days for “Site Occupancy - Bridge Structures” will commence on the day of the first disturbance of the right-of-way for the bridge portion of the Work. Thereafter, every day will be counted as a Calendar Day for site occupancy with the exception of when:

- The Contractor is prohibited from working due to restrictions imposed by local bylaws after the contract has been awarded or as a result of directives from the Consultant or the Department.

- The Contractor is unable to work on the project, or works less than half of a normal working day for reasons of inclement weather or conditions resulting from inclement weather. A normal working day shall comprise the average duration worked by the Contractor on the proceeding 5 uninterrupted working days.

- The Contractor pre-schedules interruptions to continuous prosecution of the Work as a result of the desire to schedule certain phases of the Work at different times.

- The Contractor schedules employee time off subject to the conditions specified herein.

- The Contractor is working solely on preparing and installing temporary environmental measures as detailed in the department manual entitled "Environmental Construction Operations (ECO) Plan Framework.

1.2.21.3 Employee Time Off

The Contractor will be granted a maximum of eight non-charged days per thirty day period for the purpose of allowing employee time off, providing:

- The Consultant is given at least seven days notice.

- There is no construction ongoing which requires the presence of the Consultant.

- No more than five consecutive days are taken at one time.

The thirty day period will start at the commencement of work as defined above and any of the time-off days not taken in a specified thirty day period will not be permitted to be used in subsequent periods. When the estimated number of Calendar Days required to complete the project is less than thirty, the number of allowable days off for this purpose will be prorated.

1.2.21.4 Conclusion of Site Occupancy

Assessment of Calendar Days for Site Occupancy will cease entirely only once the entire Work has been completed and in the opinion of the Consultant, the project is ready for the construction completion inspection as detailed in Section 1.2.53, Construction Completion and Acceptance. Calendar Days for Site Occupancy will not be assessed during the completion of any deficiencies identified in the construction completion inspection.

1.2.21.5 Statements, Extensions and General

The Consultant will, on a weekly basis, prepare a statement for the Contractor showing the number of Calendar Days for Site Occupancy worked on the contract during that week. In the event that the Contractor disagrees with the number of Calendar Days for Site Occupancy shown on the statement, he shall within one week of the date of such statement, notify the Consultant in writing of reasons for the disagreement, otherwise the number of Calendar Days for Site Occupancy shown on the statement shall be considered final.

An increase in the number of Calendar Days for Site Occupancy to complete the Work will be considered for an increase in quantities, late delivery of Department supplied materials, design changes to the project, or any other reason which in the opinion of the Consultant is outside the control of the Contractor, or could not have been reasonably foreseen by the Contractor.

If the Contractor believes there is an entitlement to an extension of the number of Calendar Days for Site Occupancy required to complete the Work, he shall, prior to the completion of the Work, submit a written request to the Consultant setting out the reasons for the request, justifying the number of additional days required.

This provision for Duration of Work in no way negates or mitigates the conditions of Sections 1.2.19, Adjustment of Contract Completion Date, 1.2.20, Failure to Complete on Time or Section 1.2.14, Commencement and Scheduling of Work.

1.2.21.6 Payment

Payment for “Site Occupancy - Bridge Structures” will be made as follows:

If the Contractor completes the bridge structure work in the exact number of calendar days entered in the “Site Occupancy - Bridge Structures” bid item, no payment will be made.

If the Contractor completes the bridge structure work in fewer Calendar Days for Site Occupancy than the number entered in the “Site Occupancy” bid item, a payment equal to the unit price per day as shown, multiplied by the difference between the estimated and actual number of Calendar Days for Site Occupancy will be made.

If the Contractor completes the bridge structure work in more than the number of Calendar Days for Site Occupancy entered in the “Site Occupancy - Bridges Structures” bid item, an assessment equal to the unit price per day as shown, multiplied by the difference between the estimated and actual number of Calendar Days for Site Occupancy will be made and charged to the Contractor. This assessment will be deducted from any monies due the Contractor.

1.16 LANE CLOSURE FOR BRIDGE STRUCTURES

1.16.1 GENERAL

In addition to the requirements of Section 1.2.21, Duration of Work and Site Occupancy, this contract contains a bid item for "Lane Closure - Bridge Structures".

Bidders shall indicate the number of Calendar Days during which travel lane widths will be restricted or lanes will be closed, under the “estimated quantity” column of the unit price schedule and extend that number of days times the unit price per day as shown, to get the total bid for “Lane Closure - Bridge Structures".

1.16.1.1 **Calculation of Calendar Days**

Calendar Days will be calculated as whole days. The assessment of Calendar Days will commence on the first day that the clear roadway is restricted in width and/or a travel lane is closed. Thereafter, every day will be counted as a Calendar Day with the exception of when:

- the Contractor is prohibited from working due to restrictions imposed by local bylaws after the Contract has been awarded or as a result of directives from the Consultant or the Department.

1.16.1.2 **Conclusion of Lane Closure**

Assessment of Calendar Days will cease entirely once the roadway is open to unimpeded flow of traffic with all the following conditions:

- continuous smooth, paved intact travel surface
- curb to curb unobstructed clear roadway width
- traffic control removed and traffic fully restored

1.16.1.3 **Extensions**

An increase in the number of Calendar Days for Lane Closure - Bridge Structures will be considered for an increase in quantities, late delivery of Department supplied materials, design changes to the project, or any other reason which in the opinion of the Department is outside the control of the Contractor, or could not have been reasonably foreseen by the Contractor.

If the Contractor believes there is an entitlement to an extension of the number of Calendar Days for Lane Closure - Bridge Structures, he shall, prior to the completion of the Work, submit a written request to the Consultant setting out the reasons for the request, justifying the number of additional days required.

1.16.1.4 **Payment**

Payment for Lane Closure - Bridge Structures will be made as follows:

If the Contractor restricts the roadway width or closes a travel lane for the exact number of Calendar Days bid for "Lane Closure - Bridge Structures", no payment will be made.

If the Contractor restricts the roadway width or closes a travel lane for fewer Calendar Days than the number bid for "Lane Closure - Bridge Structures", a payment equal to the unit price per day as shown, multiplied by the difference between the estimated and actual number of Calendar Days will be made.

If the Contractor restricts the roadway width or closes a travel lane for more than the number of Calendar Days entered in the "Lane Closure - Bridge Structures" bid item, an assessment equal to the unit price per day as shown, multiplied by the difference between the estimated and actual number of Calendar Days will be made. This assessment will be deducted from any monies due the Contractor.

1.17 SITE OFFICES FOR BRIDGE STRUCTURE CONSTRUCTION

1.17.1 SECTION 1.2.16, SITE OFFICES FOR BRIDGE STRUCTURE CONSTRUCTION

For this project, delete Section 1.2.16, “Site Offices for Bridge Structure Construction” in its entirety.

1.18 AMENDMENT TO SPECIFICATION 1.2.10 "GENERAL", RE: COURSE OF CONSTRUCTION INSURANCE

1.18.1 FOR THIS PROJECT COURSE OF CONSTRUCTION INSURANCE IS OPTIONAL.

1.18.2 ADD THE FOLLOWING PARAGRAPH AS THE SECOND PARAGRAPH OF SECTION 1.2.10 (IV)

Notwithstanding the optional status of Course of Construction insurance, and further to General Specification 1.2.46 "Damage to Work", the Contractor shall be solely responsible for damage to the bridge structure, bridge culvert, or building structure caused by the negligence of the Contractor, his employees, agents or sub-contractors.

Supplemental Specifications

SUPPLEMENTAL SPECIFICATIONS		
	2.26	Traffic Signals
	3.26	Micro-Surfacing
	3.40	Cutting of Pavement
	5.31	Geotextile
	6.05	Permanent Environmental Protection Devices
	6.10	Gabion and Gabion Mattress

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2.26 TRAFFIC SIGNALS

2.26.1 GENERAL

This work shall consist of the supply and installation of traffic signals and all associated electrical work in accordance with these specifications, and in conformity with the dimensions, details and requirements shown on the plans and drawings, at locations as indicated and as established by the Consultant. In cases of conflict with existing underground utilities, the Contractor shall contact the Consultant for approval of revisions prior to completing the Work.

The electrical installation shall be in accordance with the current edition of the Canadian Electrical Code, the Electrical Protection Act, the regulations of the Electrical Inspection Department having jurisdiction, and as determined by the Consultant. Any work, even if not shown or specified, which is obviously necessary or reasonably implied to complete the work, shall be done as if it were both shown and specified.

All electrical installation work shall be performed by qualified tradesmen experienced in such work. .

Cabinet bench testing, cabinet wiring, termination of cables, testing of signals, and activation of signals shall only be performed by personnel possessing the following qualifications:

- Journeyman Power Systems Electrician, or a Journeyman Power Lineman, or a Journeyman Electrician certificate;
- Successfully completed Traffic Signals Level I and Level II courses offered by IMSA;
- Five years experience with traffic signal installation, maintenance and troubleshooting.

The Contractor shall obtain all permits and approvals and pay all related fees required for the work and submit a copy of all permits and associated documents to the Consultant. After completion of the work, the Contractor shall provide the Consultant a "Certificate of Final Inspection and Approval" from the electrical inspection authority. The Contractor shall be responsible for all costs associated with the testing inspection done by the electrical inspecting authority.

At locations where new power supply or power supply modifications are needed, application to the power company will be carried out by the Consultant. A specific service point for the power requirements will be provided by the power company and will be as indicated on the Drawings. The Contractor shall provide all facilities to the service point. The power company shall make the final connection.

2.26.2 ABBREVIATIONS AND DEFINITIONS

Wherever in these Specifications the following abbreviations are used, the intent and meaning shall be as follows:

AISC:	American Institute of Steel Construction
ASA:	American Standards Association
ATSSA:	American Traffic Safety Services Association
CEMA:	Canadian Electrical Manufacturers Association
CSA:	The Canadian Standards Association
IMSA:	International Municipal Signal Association
NEMA:	National Electrical Manufacturers Association
EEMAC:	Electrical and Electronic Manufacturer's Association of Canada

Reference to regulations and standards in all cases shall mean the latest amendment or revision current at the closing date of the tender.

2.26.3 MATERIALS

2.26.3.1 **General**

The Contractor shall supply all materials required for the installation of traffic signals including associated electrical components.

All material supplied shall be new and CSA approved, unless otherwise approved by the local inspection authority. The Contractor shall obtain approval of the local inspection authority and shall bear all inspection charges levied and any modification costs required for any materials not CSA approved.

Material shall also comply with the plans, drawings and as required by the "Canadian Electrical Code". Where there is lack of specification in the plans and drawings, the materials shall comply with the special provisions, standard specifications, or as specified by the Consultant.

When the work necessitates the removal, salvage and reinstallation of existing structures, only materials from the existing installations shall be used. Contractor stockpiles of used material from other sources will not be acceptable.

2.26.3.2 **Wire and Cable**

2.26.3.2.1 General

Wire shall be stranded copper RWU90 cross-link conforming to CSA C22.2 No.38, 'Thermoset Insulated Wires and Cables' or equivalent, unless otherwise specified below or specified in the design drawings. Wire and cable shall meet CSA standards for installation in wet environments.

2.26.3.2.2 Signal Control Cable

Signal control cable shall be 600 volt rated, consisting of #14 AWG solid copper conductors, individually polyethylene insulated, covered with a black polyvinyl chloride outer jacket, conforming to IMSA Spec. No. 19-1. Signal cable for exposed installations shall conform to IMSA Spec. No. 20-1. The Contractor shall follow the Plans and Standard Drawing TCS-F-101 for selecting the type and quantity of signal control cables (7 or 16 conductor cable) for the work.

2.26.3.2.3 Loop Detector Wire

Loop detector wire shall be 600 volt rated #14 or #16 XHHW stranded copper conductor or equivalent with cross-linked polyethylene insulation conforming to IMSA Spec. No. 51-3.

2.26.3.2.3.1 Loop Detector Lead-In Cable

Loop detector lead-in cable shall be 600 volt rated, composed of two #16 AWG stranded tinned copper conductors individually insulated with polyethylene material, twisted together, and shielded with aluminum backed mylar. The cable shall conform to IMSA Spec. No. 50-2.

2.26.3.2.3.2 Microwave Detector Lead-In Cable

Microwave detector lead-in cable shall be 600 volt rated, unshielded, and composed of four #16 AWG stranded bare copper conductors. Belden 27338A or an equivalent cable are acceptable.

2.26.3.2.3.3 Communication Cable

Traffic signal communication cable shall consist of 4 twisted pairs of #16 AWG stranded copper polyethylene insulated conductor with electrical shielding and a polyvinyl chloride jacket, and shall conform with IMSA Spec. No. 19-2.

2.26.3.2.3.4 Advance Warning Cable

Advance warning signal cable shall be 600 volt rated, unshielded, composed of three #10 AWG RW90 cross-link conductor, suitable for installation in wet environments.

2.26.3.2.3.5 Streetlight Cable

The cable feeding streetlights on combination traffic poles shall be 600 volt rated, polyvinyl chloride jacketed, comprised of two #10 insulated conductors with a concentric neutral. USEB90 or equivalent cable is acceptable.

2.26.3.2.3.6 Power Supply

Power supply conductor shall be #8 AWG RWU90 cross-link.

2.26.3.3 **Grounding and Bonding**

2.26.3.3.1 General

Grounding and bonding materials shall conform to CSA C22.2 No.41, 'Grounding and Bonding Equipment'.

2.26.3.3.2 Ground and Bond Conductors

Ground and bond conductors shall be stranded copper RWU90 cross-link, insulation color green, and shall conform to CSA C22.2 No.38-M, type RWU90 cross-link.

2.26.3.3.3 Ground/Lightning Electrodes

Ground/Lightning Electrodes shall be copperclad steel rods, 21mm diameter by 3.0m in length.

2.26.3.3.4 Ground/Lightning Electrode Connectors

Moulded type connectors shall be used on all wire-to-rod connections. Moulded connectors shall consist of metallic alloys and fusible powder mixtures held in place by a suitable mould and connected using an exothermic type welding process.

2.26.3.4 **Conduits**

2.26.3.4.1 General

Supply and Installation of conduits shall be in accordance with Specification 2.7, Underground Electrical Conduits, and as specified herein.

2.26.3.4.2 Fittings for DB2 Conduits

Only factory bends are acceptable for Type DB2 PVC conduits. Field fabrication of couplings, adapters, bends, and fittings for DB2 conduits will not be accepted.

2.26.3.4.3 Trench Marker Tape

Trench marker tape shall be 250mm wide yellow plastic tape, labeled "CAUTION - ELECTRICAL WIRE BURIED BELOW" at minimum 0.5m intervals.

2.26.3.5 **Junction Boxes**

Junction boxes shall be precast of non-ferrous metal or approved plastic material and shall be of suitable sizes. The boxes shall have a removable metal cover equipped with cap screws and threaded holes in the cover to facilitate removal of the cover after sealing. The metal cover shall be grounded.

2.26.3.6 **Foundations**

2.26.3.6.1 General

The Contractor shall supply portland cement concrete required for foundations in accordance with Specification 5.5, Supply of Portland Cement Concrete, and as specified herein.

2.26.3.6.2 Precast Cabinet Base

Precast concrete base for Type "M1" signal control cabinet and the power supply cabinet shall be constructed in accordance with Standard Drawing TEB 4.39.

2.26.3.6.3 Precast Pole Base

Concrete for the precast pole bases shall have minimum 28-day strength of 30 MPa concrete in accordance with CAN3-A23.1-M90. Concrete shall be Type 50, Class C. The Contractor shall supply galvanized steel anchor bolts with nuts, washers and nut covers.

Precast pole bases for pedestal poles shall be constructed in accordance with Standard Drawing TCS-F-301.

Precast pole base for traffic poles with an arm span of 9 metres or less shall be constructed in accordance with Standard Drawing TCS-F-305.

Concrete bases for advance warning signal poles or traffic poles with an arm span greater than 9 metres must be cast-in-place.

2.26.3.6.4 Cast-In-Place Pole Base

Cast-in-place pole bases shall be constructed of concrete using Type 50 sulphate resistant cement to give minimum compressive cylinder strength of 30 MPa in 28-days for Class C exposure with 20mm nominal size coarse aggregate, slump at point at time of discharge maximum 100mm and minimum 50mm. Air content shall be between 4% and 7%. Maximum water cement ratio shall be 0.45 by mass.

Cast-in-place concrete pole bases for pedestal poles shall be constructed in accordance with Standard Drawing TCS-F-301.1.

Cast-in-place concrete pole bases for advance warning signal poles with an arm span up to 9m and for traffic poles with an arm span up to 11m shall be constructed in accordance with Standard Drawing TCS-F-305.1.

Cast-in-place concrete pole bases for advance warning signal poles with an arm span up to 11m and for traffic poles with an arm span up to 15m shall be constructed in accordance with Standard Drawing TCS-F-310.

The Contractor shall submit the concrete truck tickets to the Consultant to demonstrate that the correct type of concrete is used.

2.26.3.6.5 Galvanized Steel Helix Pedestal Pole Base

Shop drawings for the galvanized steel helix pedestal pole bases shall be submitted by the Contractor to the Consultant for approval within 4 weeks after award of the Contract. Steel helix pedestal pole bases shall be fabricated to fit a bolt circle diameter (B.C.D.) of 280mm and for four 25mm anchor bolts. The steel helix pole base shall be designed to support a loading which corresponds to a 5m tall pedestal pole with 2 four-section signal head unit side-mounted at the upper section of the pole. Additional loadings are a 60cm x 75cm sign and a 60cm x 60cm sign mounted below the four-section signal heads.

2.26.3.6.6 Galvanized Steel Rotatable Base

Rotatable bases for traffic poles and advance warning signal poles shall be hot dip galvanized in accordance with CSA standard G164-M. Shop drawings for the rotatable pole base shall be submitted by the Contractor to the Consultant for approval within 4 weeks after award of the Contract.

Rotatable pole bases shall be fabricated to fit a B.C.D. of 400 mm and for four 35mm anchor bolts. The maximum height for the rotatable pole base shall be 800mm. A centre hole with a minimum diameter of 150mm shall be provided through the base. The rotatable base shall be designed so that a maximum rotating angle of 90 degrees is allowed. This can be achieved by fabricating a stop-end anchor at the underside of the top plate and on the side of the main rotatable base exterior wall tubing. A 40mm diameter hole should be provided on both stop-end anchors to allow the top plate to be locked in place after it is rotated.

The rotatable base shall be designed to support the loading outlined in Section 2.26.3.7, Signal Supports, based on the following arm mounting heights with the rotatable base attached: traffic sign poles - 6.7m above top of concrete pole base; traffic signal poles - 6.5m above top of concrete pole base.

Loading calculation shall be based on a wind speed of 160 km/h and a 12.7mm layer of ice load on one side of the structure / sign surfaces.

Welding for the rotatable base shall be done by a CWB certified company. All welding shall conform to CSA Standard W59 and shall be performed by welders or welding operators qualified under CSA Standard W47.1. SMAW process shall use E48018 or E48018-1 classification electrode. FMAW process shall use E480XT-X classification electrode. GMAW process shall use E480S-X classification electrode. All welding shall be completed prior to galvanizing. Welding activities shall not be permitted in the field without adequate protection from public viewing.

2.26.3.7 Signal Supports

2.26.3.7.1 General

The pole support structures shall be continuously tapered of polygonal cross sections presenting good visual appearance. With the anchor base mounted in a horizontal plane, the upright pole section shall be in a true vertical position. All materials used shall conform to the latest edition of C.S.A Standard G40.21M 300W, ASTM Standard A570 Grade D or ASTM Standard A36 as a minimum requirement. Silicon content of the steel shall be less than 0.04% for the shafts, whereas for base plates the silicon content shall be either less than 0.04% or between 0.15 to 0.25%.

Only new materials shall be used in its construction.

2.26.3.7.2 Shop Drawings

The Contractor shall submit to the Consultant shop drawings in triplicate (3 copies) for review prior to any fabrication. Shop drawings shall be complete and shall include all information such as material specifications, weld sizes, welding procedures, design criteria, and design loading. Shop drawings shall be stamped and signed by a Professional Engineer.

Review of shop drawings by the Consultant will be for general arrangement only and in no case will the Contractor be relieved of the responsibility for completeness or adequacy of fabrication materials and procedures for the structures. Any costs resulting from changes made necessary by errors in fabrication, or due to failure to have shop drawings so accepted shall be the responsibility of the Contractor. Work shall not commence until all shop drawings have been reviewed and accepted by the Consultant.

The Contractor shall maintain a set of drawings on the site at all times and record any changes approved by the Consultant that may occur and on the set mark "AS-BUILT". These drawings shall be submitted to the Consultant upon completion of the project.

2.26.3.7.3 Structural Design Criteria

2.26.3.7.3.1 General

The mast arm mounting height for advance warning signal poles or pedestrian corridor poles shall be 6.7 m above the base plate. The mast arm mounting height for traffic shall be 6.5 m above base plate. The arm reach of signal / overhead sign pole mast arm shall follow the Pole Schedule on the Drawings. In situations where rotatable bases are needed, the signal supports shall be fabricated so that shorter pole shafts will be used to achieve the same mast arm mounting heights as specified above.

2.26.3.7.3.2 Live Loads

The wind drag coefficient of the latest National Building Code of Canada for either octagonal section or round section shafts and where other cross sectional shapes are employed shall be utilized in the design. All safety factors shall be in accordance with A.I.S.C. Steel Construction Manual for wind and seismic stresses, or a minimum of 1.25:1 based on the published yield strength of the material.

The structural design criteria shall be for wind velocities up to and including 160 km/h upon the total effective area of the signal structures and fittings. The loading shall include ice load based on 12.7 mm ice thickness on all faces of structure members and on one face of the sign load.

2.26.3.7.3.3 Dead Loads

For Pedestal Poles

1. Two four-section signal heads mounted back to back on the pole. Each signal head has a weight of 20 kg, and
2. Any combination of signal heads or signs of which the projected area is not to exceed 2.0 square metres.

For Combination Cantilever Signal Poles

1. Three traffic signal heads each with maximum projected area of one square metre and weight of 20 kg each on the mast arm. The three signals on the traffic arm are to be located 0.5m, 3.8m, and 7.5m inward from the end of the arm, and
2. Three 75cm x 75cm aluminum signs mounted at 0.2m, 3.5m, and 7.2m inward from the end of the arm, and
3. Two pedestrian signals with a maximum projected area of one square metre and weight of 20 kg, to be mounted on the pole shaft along with a side mounted traffic signal with weight of 20 kg and projected area of one square metre.
4. A streetlight extension section 5.7m in height (total structure height of combination pole shall be 12.2m) and reaching 1.8m towards the road.
5. Pole shafts for signal poles with arm span of 11m or less shall be designed to support the loading of an 11m arm with the above-mentioned loadings.
6. Pole shafts for signal poles with arm span of 15m or less shall be designed to support the loading of a 15m arm with the above mentioned loadings.

For Cantilever Sign Poles

1. One sign 1.8m x 2.4m in dimensions on 20mm thick marine plywood c/w high intensity retro-reflective sheeting for the sign face (weight - 65 kg), and
2. Two 20cm diameter amber beacons (weight - 10 kg), and
3. Angle irons to mount sign (weight - 45 kg).
4. Pole shafts for sign poles with arm span of 9m or less shall be designed to support the loading of a 9m arm with the above-mentioned loadings.
5. Pole shafts for sign poles with arm span of 11m or less shall be designed to support the loading of an 11m arm with the above mentioned loadings.

2.26.3.7.4 Pole Setting Features (Anchorage)

The design may be such that the vertical shaft is inserted into the base plate and attached with two circumferential welds.

The signal / sign pole shall meet the following requirements:

1. Each base plate shall have 4 bolt holes equally spaced around the bolt circle. The rectangular centres of the two bolt holes shall be parallel with the neutral plane of the pole shaft. The bolt holes shall be elongated so that it can be fitted onto pole bases with B.C.D. of either 395mm (15.5") or 405mm (16"). Width of bolt hole slot shall be 45mm (1¾") plus/minus 1.6mm (1/16")
2. The base plate shall be designed for accommodating a single nut cover. Nut covers shall be attached to the poles by means of brass cap screws or other approved methods.
3. The pedestal pole shall be 120mm across flats at the top with a 115mm O.D. x 100mm long tenon. The pole shall come with an end cap.

4. B.C.D. dimensions and anchor bolt sizes shall meet the requirements outlined on Standard Drawings TCS-F-301, 301.1, 305, 305.1, and 310.

2.26.3.7.5 Mast Arm Attachment Features

The mast arm shall be designed to meet structural design criteria. The steel plates (flange) shall have 8 bolt holes equally spaced. A 100mm (4") diameter hole in flange and pole shaft shall be provided for electrical cable access, and centered in the flange. The 8 bolt holes in the flange shall be 28.5mm (1 1/8") in diameter. The 8 bolts supplied shall include washers and nuts sized to meet design criteria.

2.26.3.7.6 Surface Finish

The surface finish for the traffic / sign poles shall be hot dip galvanized and shall meet all the requirements outlined in CSA Standard G164-M. Pole refinishing materials shall be a cold galvanizing compound such as "Galvicon" or approved equivalent.

Where two or more galvanized sections will be placed in close proximity; the finished appearance each section shall be similar to the adjacent galvanized section(s). The Consultant will determine the suitability of repair methods.

2.26.3.7.7 Workmanship and Fabrication

Fabrication and workmanship shall be in accordance with the latest edition of CSA Specification S16, and all workmanship shall be equal to the best practice in modern construction steel shops. The structure inside and outside shall be clear of any obstructions which will hamper the wiring of the traffic signal after erection.

Welding shall be undertaken only by a fabricator fully approved by the Canadian Welding Bureau to the requirements of C.S.A. Standard W47. Any circumferential welds shall develop 100% penetration of the material thickness. All welds shall be cleared of all slags and spatter. If future welding is done after cleaning, the weld metal and adjacent areas shall be cleaned and all spatter removed.

2.26.3.7.8 Electrical Connections

Each pole shall include provision for electrical constructions in the form of hand holes of adequate size positioned 0.5m above the base plate and at the mast arm mounting level. The hand holes shall be adequately reinforced with a collar with covers secured in place by a 9.5mm (3/8") galvanized standard N.C. Hex bolt with anti-tampering cup washer.

Each pole shall be provided with 9.5mm x 38.1mm (3/8" x 1 1/2") N.C. galvanized bolt which shall be welded to the inside of the pole directly opposite the bottom hand hole. This stud shall be fitted with grounding lug, two washers, and a brass nut suitable for connecting the ground wire.

Wire access on the pole section: Four (4) only, 25mm (1") with 1360 kg (3,000 lbs) couplings complete with square recessed head plugs and spaced 90 degrees to each other at 3 m above the base plate shall be provided. Recessed head plugs must have a lubricant on the threads to allow easy removal.

Wire access on the mast arm section: Three or four 25mm (1") diameter rubber grommets shall be provided at the following locations on the mast arm: 0.5m from the end, and every 3.7m, thereafter.

2.26.3.7.9 Inspection and Testing

The Contractor shall obtain an independent testing firm to carry out ultrasonic testing on welds. Weld testing reports for all poles shall be submitted to the Consultant for review before the poles are shipped to the work site. Costs associated with testing shall be the responsibility of the Contractor.

Should such tests show the pole structures are not in accordance with the specifications, they shall be repaired or replaced by the Contractor at his own expense. The Consultant reserves the right to reject any portion of the shipment of pole structures that does not comply with the drawings and specifications,

In particular:

a) Pole structures which do not comply with the physical dimensions or B.C.D. specified on the Contract Drawing shall be rejected.
b) Pole structures which do not pass visual inspection at delivery shall be rejected.
c) Pole structures which have been damaged during delivery shall be rejected. The Contractor shall replace or repair rejected structures at his own expense.

2.26.3.7.10 Pole Identifications

Each structure supplied shall be fully identified by permanent markings on the walls of the structure (arm and trunk). The permanent markings are to be stamped or welded on the structures and shall include the following information:

- Name of manufacturer
- Year of manufacturing
- Type of pole
- Dimension / span / height of pole

2.26.3.8 **Luminaries and Photocells**

Luminaries shall be High Pressure Sodium complete with polycarbonate refractors and have integral 120/240 VAC regulated output constant wattage iso-lead (CWI) high power factor ballasts.

Photocell units shall be cadmium sulphide thermal delay type with built in surge and lightning protection. The photocell shall be load rated at a minimum of 1000 volt-amp.

2.26.3.9 **Pole Mounted Traffic Control Fixtures**

2.26.3.9.1 Traffic and Pedestrian Signal Heads and Accessories

Traffic and pedestrian signal heads optical system shall conform to the Institute of Transportation Engineer specifications, the American Standards Association (ASA) specifications, and the specifications contained herein. The traffic and pedestrian signal heads shall be polycarbonate in design unless otherwise indicated. The fixture body of the traffic and pedestrian signals shall be traffic yellow. The doors and visors shall be dull black. Refer to Standard Drawings TCS-F-501, 505, 510, 515, 520 and 525 for mounting hardware requirements for traffic control fixtures on signal poles.

2.26.3.9.1.1 General

All wiring and terminal blocks shall meet the requirements of Section 13.02 of the ITE Vehicle Traffic Signal Heads (VTCSH) standard. Two secured, colour coded, 914 mm (36 in) long 600 V, 20 AWG minimum, jacketed wires, conforming to the National Electrical Code, rated for service at +105oC, are to be provided for electrical connection.

2.26.3.9.1.2 Voltage Range

LED signal modules shall operate from a 60±3 cycle AC line power over a voltage range from 80 VAC RMS to 135 VAC RMS. The current draw shall be sufficient to ensure compatibility and proper triggering and operation of load current switches and conflict monitors in signal controller units the procuring agency has in use.

Nominal operating voltage for all measurements shall be 120±3 volts RMS.

Fluctuations in line voltage over the range of 80VAC to 135VAC shall not affect luminous intensity by more than ±10 percent.

The LED circuitry shall prevent flicker at less than 100 Hz over the voltage range.

It must be ensured that the product will not show illumination for input voltages below 45 volts.

2.26.3.9.1.3 Transient Voltage Protection

The signal module on-board circuitry shall include voltage surge protection to withstand high-repetition noise transients and low-repetition, high-energy transients as stated in Section 2.1.6, of NEMA Standard TS-2, 1992.

2.26.3.9.1.4 LED Drive Circuitry

The individual LED light sources shall be wired so that a catastrophic failure of one LED light source shall result in the loss of not more than 20 percent of the signal module light output.

2.26.3.9.1.5 Electronic Noise

The LED signal and associated on-board circuitry shall meet Federal Communications Commission (FCC) Title 47, SubPart B, Section 15 regulations concerning the emission of electronic noise.

2.26.3.9.1.6 Power Factor (PF) and AC Harmonics

LED signal modules shall provide a power factor of 0.90 or greater when operated at nominal operating voltage, and 25oC (77oF).

Total harmonic distortion induced into an AC power line by an LED signal module, operated at nominal operating voltage, with a power consumption equal to or greater than 15 watts at 25oC (77oF) shall not exceed 20 percent. Total harmonic distortion induced into an AC power line by an LED signal module, operated at nominal operating voltage, with a power consumption less than 15 watts at 25oC (77oF) shall not exceed 40 percent.

2.26.3.9.2 Traffic Signal Head

All traffic signal heads shall be 300 mm in diameter with Standard Full Matte Black Visors (tunnel visors). The signals shall come with 300 mm signal backboards and all mounting hardware. Backboards, doors, and visors shall be flat black. The design of the traffic signal head shall be such that the reflector assembly is hinged separately from the door assembly. The signal head shall be secured by a minimum of 2 latching bolts for the door assembly.

2.26.3.9.3 Pedestrian Signal Head

All pedestrian signal heads shall be of the standardized square head of 300 mm size or as specified, and shall be designed to retain optical efficiency.

The background of all message and indication type lenses shall be an opaque grey ceramic, fired directly on the lens. The lens shall be made of impact resistant polycarbonate.

WALK and DON'T WALK message shall be symbolized to the standards outlined in the Manual of Uniform Traffic Control Devices for Canada.

Standard cowl/cutaway style visors shall be included. The colour shall be flat black.

2.26.3.9.4 Pedestrian Pushbutton and Sign

Pushbutton and pushbutton housing shall be cast using aluminum alloy. The pushbutton shall be controlled by low voltage relay switching, operating from 24 VAC supply from the controller cabinet.

Pushbuttons shall have an isolator / LED latch module to enable a LED indicator light to come on once pressed. Each pushbutton requires a switch circuit module to operate the 3 volt LED. A 4-channel isolator/latch module is needed to operate up to 4 pushbuttons, for a total of 16 pushbuttons per isolator/latch module. Each pedestrian movement at the intersection requires at least one unlatch module. An intersection with 2 pedestrian movements will require 2 unlatch modules.

2.26.3.9.5 Microwave Detectors

Microwave detectors shall be controlled by a microprocessor. They shall be designed to allow a minimum detection range of 50 m and to trigger the operation of a traffic controller.

The microwave detector shall only respond to motion in one direction (approach or depart only - selectable). The detector shall generate a microwave beam aim to cover the same area normally covered by a loop detector system. The microwave detector shall have an operating voltage of 24 VAC.

2.26.3.9.6 Special Crosswalk

Special crosswalk sign shall consist of a 75cm x 240cm sign with RA-102 sign message and the following colour scheme - White Background, Black Border, Black Message/Symbol. The sign board material shall comply with the requirements in Specification 5.18, Supply of Permanent Highway Signing. Two 200mm amber beacons shall be mounted on the sign. Mounting hardware for the special crosswalk sign shall be provided in accordance with Standard Drawing TCS-F-520.

2.26.3.9.7 Advance Warning Signal

Advance warning signal sign shall consist of a 150cm x 240cm sign with WB-5 sign message and colour scheme. The sign board material shall comply with the requirements of Specification 5.18, Supply of Permanent Highway Signing. Two 200mm amber beacons shall be mounted on the sign. Mounting hardware for the advance warning signal sign shall be provided in accordance with Standard Drawing TCS-F-525.

2.26.3.10 **Traffic Signal Controller Unit and Cabinet**

2.26.3.10.1 General

This Specification is applicable for TS2 Type 2 Traffic Signal Control Cabinet for application in Alberta. TS2 Type 1 Cabinet is also accepted as an alternative. TS2 Type 1 Cabinets, if used, shall comply with the requirements of NEMA TS2-1998.

The Contractor shall demonstrate to the Consultant, in the Contractor's own signal shop, the ability of the controller cabinet to provide the expected traffic operations as specified on the Drawings.

2.26.3.10.2 Manufacturer's Identification

The manufacturers' identification shall be on all major equipment supplied with this specification including the cabinet assemblies. The date on which the controller cabinet is manufactured shall also be marked on the inside cabinet door.

2.26.3.10.3 Software Changes and Updates

All applicable software changes and updates shall be supplied and installed in the equipment at no extra cost to the Department for the duration of the warranty period.

2.26.3.10.4 Traffic Signal Cabinet Configurations

Traffic signal controller cabinets shall be configured to provide a minimum of 8-phase signal operations, with the following minimum configuration:

Controller Unit
- TS2 - Type 2 - Type A2 (TS2 Type 1 is an acceptable alternative)

MMU
- Type 12

Terminal and Facilities
- 16 Channel Detector Rack (Rack mounted. Shelf-mounted detector shall not be used)
- 8 veh / 4 Ped Test Switch Panel
- Police Panel on Main Door

Auxiliary Devices
- 12 Load Switches
- 1 - 2 cct Solid State Flasher
- 4 Flash Transfer Relays
- As per Detector Schedule on Contract Drawings

Cabinet
- Type M1 (82cm x 46 cm x 152 cm) with Corbin No. 2 Key (2 sets of keys)
- Bus Interface Unit
- 1 for Detector Rack, Controller, and MMU SDLC Interface

2.26.3.10.5 NEMA TS 2-1998 Exceptions

2.26.3.10.5.1 Controller Unit (CU)

The controller supplied by the Contractor shall be one of the Controllers listed on the Alberta Transportation Products List. Other Controllers configured for Dual Ring operations and conforming to the applicable standards of the National Electrical Manufacturers' Association (NEMA) TS 2-1998 edition for Type 2 configuration Type A2 - Controller Units in all material respects will be allowed with the prior approval of the Consultant.

2.26.3.10.5.2 Malfunction Management Unit (MMU)

The MMU shall be capable of operation in a cabinet designed to TS 1 specification with no loss of TS 1 functionality.

If a TS-1 type controller is used, all electrical connections with the monitor shall be through approved quick disconnect MS type connectors and harnesses such that it is directly pin plug interchangeable with other conflict monitors of like manufacture and NEMA series. If a TS-2 type controller is used, communication with the MMU shall be either as above or via a serial data bus.

MMU shall be provided complete with a "Programming Card".

2.26.3.10.5.3 Terminal and Facilities (TF)

The TF interface shall be as defined for TS 2 - Type 2 Controller Units and the use of a BIU for communication with the MMU and vehicle detectors.

AC Neutral Bus shall have minimum 14 positions. Earth Ground (Bond) Bus shall have minimum 14 positions. Main Breaker shall be 40 amp for the traffic signal equipment. Auxiliary Breaker shall be 15 amp for auxiliary equipment. As an integral part of the power assembly a ground fault equipment receptacle, controller ON/OFF switch and cabinet light switch shall be provided. The power distribution assembly shall be integral to the entire load bay assembly and shall be located in the center of the panel. All components of the power panel shall be protected by a front panel that isolates and protects all parts of the power assembly. This panel shall be clearly marked as to the functions for both the power assembly and output load bay.

Where any harnesses are exposed to damage or handled frequently, the harness shall be covered by a protective nylon cover. Changing flash programming, from red to amber flash, shall be accomplished by easily moving jumpers on a separate terminal block located on the front of the load bay or by means of toggle switches from a control panel. All wires used in the cabinet shall be of the low temperature type and be rated for -40 degrees C to +105 degrees C. A bracket shall be used to support all load switches and flashers and prevent them from vibrating out of position.

A small recessed police panel with a separate access door shall be contained within the front of the cabinet, with the following switches: "Signal AUTO/FLASH", "Signal AUTO/MANUAL".

A maintenance panel located on the inside of the front door, with the following switches: "Signal ON/OFF", "Signal AUTO/FLASH", "Signal AUTO/MANUAL".

2.26.3.10.5.4 Auxiliary Devices

Auxiliary Devices including: Load Switches; Solid State Flashers; Flash Transfer Relays; and Inductive Loop Detector Units.

No Exceptions to be noted.

2.26.3.10.5.5 Cabinet

The cabinet shall be a Canadian Electrical Manufacturer Association (CEMA) Type 3 enclosure, fabricated from sheet aluminum with a thickness of 3.18 mm (0.125 inches), type 5052 - H32 or equivalent. It shall provide weather and dust protection, with adequate strength to withstand reasonable vandalism protection to the control equipment.

The interior and exterior of the cabinet shall be properly cleaned and prepared for coating. The coating shall be a high quality ultra violet ray stable polyester powder paint (ASA 61 Grey), applied with a minimum thickness of 3 mil.

The cabinet shall include two (2) shelves with strong supports for placement of supplied signal controller and auxiliary equipment.

The main door of the cabinet shall include a police door. Both the main door and the police door shall be supported by continuous hinge. Included in the main door shall be ventilation louvers and an air filter (that fits tightly to the door) c/w sheet metal removable winter frost cover.

The cabinet shall be designed for base mounting on a Standard M or M1 signal cabinet concrete foundation.

The cabinet shall be equipped with a separately fused electric exhaust fan assembly for summer operations. The fan shall be thermostatically controlled and manually adjustable to turn on between +20oC and +65oC in increments of 10oC or less. The cabinet shall also be equipped with a separately fused 350 watt finned (Fast Heat RV0200D1 or equal) heater assembly for winter operations. The heater shall be thermostatically controlled and manually adjustable to turn on between -20oC and +10oC in increments of 10oC or less. The thermostats for the heater and exhaust fan shall be calibrated, labeled and installed on an easily accessible separate panel in the cabinet.

The cabinet shall be equipped with a switch and a fused lamp to illuminate the inside of the cabinet. Lamp shall be incandescent type.

2.26.3.10.5.6 Bus Interface Unit (BIU)

No Exceptions to be noted.

2.26.3.10.5.7 Documentation

Two sets of the following documentation shall be supplied:
- operation manual for the controller and MMU
- detailed controller programming chart
- cabinet wiring diagram
- MMU programming schematic
- any logic wiring diagrams that are applicable

One set of the documentation shall be placed in the controller cabinet inside a durable print pouch, which hangs in a convenient location not interfering with other equipment. The other set of the documentation shall be supplied to the Consultant directly.

2.26.3.11 Pedestrian Actuated Flashing Signal Control Unit

2.26.3.11.1 Control Unit Cabinet

The units shall be housed in a cast aluminum weatherproof cabinet. The cabinet shall be latched by a standard traffic control lock (2 sets of keys to be supplied). It shall be supplied with mounting brackets capable of being used for mounting the cabinet on any size of conventional type of traffic pole.

2.26.3.11.2 Inspection and Testing

Approval from the electrical inspection authority must be obtained by the Contractor before the unit is installed in the field for full operations.

2.26.3.11.3 Manufacturer's Identification

The manufacturer's identification shall be on all major equipment supplied with this specification including the control unit assemblies.

2.26.3.11.4 Instruction and Wiring Diagrams

The Control Unit shall be supplied with complete installation instructions including a complete chart for field connections. Installation hardware and instruction, including limits of operation, along with service manual shall be provided. Two set of the documentation shall be supplied. One set of the documentation shall be placed in the controller cabinet inside a durable print pouch, which hangs in a convenient location not interfering with other equipment. The other set of the documentation shall be supplied to the Consultant directly.

2.26.3.11.5 Functional Specifications

The pedestrian actuated flashing signal control unit shall function as follows:

Upon actuation of the crosswalk sign / signals by a pedestrian pushbutton, the pedestrian indicator lights will come on approximately 5 seconds (adjustable in increments of one second from 0 - 180 seconds) after the crosswalk sign / signals starts operating and will terminate 10 seconds (adjustable in increments of one second from 0 - 180 seconds) before the crosswalk sign / signals stop.

The timer relays shall disengage the flash conditions of the crosswalk signals and indicator lights after all of the preset time periods and rest itself automatically. Successive pushbutton actuation shall not cause extension of the timer relays.

Standard Drawing TCS-F-701 illustrates a typical wiring scheme and a functional scheme for the pedestrian actuated flashing signal control unit. Other design methods and wiring configurations are acceptable as long as the functional requirements are produced by the Control Unit.

2.26.3.11.5.1 Reset Timers

Rest timers shall be capable of performing a single timed interval for a preset time when initiated by an external signal (pedestrian pushbutton). The reset timers shall function as follows:

a) Crosswalk Signals Flash Time - sets the length of crosswalk signals flash time
b) Pedestrian Indicator Lights Start Time - sets the start time for the indicator lights flashing (delay start in relation to crosswalk signals)
c) Pedestrian Indicator Lights Flash Time - sets the length of indicator flash time.

2.26.3.11.6 Wiring

The units shall be wired in such a manner as to be able to accept #14 awg wires for the signal lamp connections, #8 awg wires for the a.c. feed connections, and #14 awg wires for the pedestrian pushbutton connections. These connections shall be made at a suitable termination strip. All 116 VAC connections shall be fused.

2.26.3.11.7 Flasher

The flasher used to generate alternate power on and off cycles between the two output terminals shall be of the Solid-State type. It shall be a plug in module easily replaceable without any tools. It shall be supplied with a radio interference suppressor and two 116 VAC power outputs. The output alternating rate shall be adjustable from 60 to 120 cycles per minute. The outputs shall be capable of handling at least 10 amps of current draw.

2.26.3.11.8 Timer

The timers used to time the preset time periods shall be adjustable from 0 to 180 seconds in one second intervals.

2.26.3.11.9 Pushbutton Field Circuit

The field circuit to be used for the pedestrian pushbuttons shall not exceed 12 volts A.C. or D.C.

2.26.3.11.10 Service Entrance

The unit supplied shall be approved for service entrance by the electrical inspection authority.

2.26.3.12 **Detector Loops**

2.26.3.12.1 Loop Detector Conductor

In-road loop detectors shall be insulated single conductor No. 14 or No.16 RW90 XLPE stranded copper conductors.

2.26.3.12.2 Lead-In Cable

Lead-in cable shall be similar to Beldon 8720 shielded audio broadcast cable, consisting of two continuous unspliced #14 or #16 stranded tinned copper conductors. Exterior insulation shall be polyethylene or other material suitable for direct burial in wet ground conditions.

2.26.3.12.3 Loop Sealant

Loop sealant shall be "3M" detector loop sealant or equivalent.

2.26.3.13 **Power Supply**

The Contractor shall supply and install a power supply cabinet to house a loadcentre and an externally mounted power supply meter socket. The enclosure shall be CSA approved and consist of a CEMA 3 enclosure complete with a vandal resistant padlocked door, with ASA 61 gray enamel finish over rust resistant primer. The loadcenter shall include a 60 ampere main breaker, and an eight position branch circuit panel to service the traffic control cabinet, street lighting on the combination traffic poles, median flashers, etc.

Shop drawings shall be submitted for the Consultant's review prior to fabricating the cabinet.

2.26.4 CONSTRUCTION

2.26.4.1 **Wire, Cable and Grounding/Bonding**

2.26.4.1.1 Wire and Cable

All installations of wire and cable shall comply with the Canadian Electric Code and the Alberta Electric and Utility Code.

Cable runs must be separated by function. Traffic signal cables and any other 120V wires and cables shall be grouped together into one or more conduits with a #8 AWG bonding conductor. If spare conduits are available, low voltage detector cables should be grouped together in separate conduit(s). Communication cable shall be run in a conduit and junction box system that is completely separate from the system for 120V wires/cables.

Routing of bonding conductor, signal cable, and streetlight cable shall be carried out in accordance with Standard Drawing TCS-F-105, and as per the Conduit Schedule on the Drawings. Where wires and cable pass through junction boxes, there shall be a minimum 300mm of slack left in each junction box, and also in pole handholes. Wire and cable shall be run continuous from the controller cabinet to the pole handhole - no splices are permitted underground in conduit or in junction boxes. In the case of detector loop wiring, splices between the loop conductors and the lead-in cable shall be made in the junction box in accordance with the installation procedures and requirements outlined in Section 8.3.7, Detector Loops.

Wires and cables shall be labeled at each junction box and at the traffic cabinet with tags of a permanent nature. Labeling shall identify the purpose/destination of the cable using the following convention:

Cable Labeling Requirements:

Traffic signal cable	Pole ID - TS (e.g. Pole A - TS)
Streetlight cable	Pole ID - SL (e.g. Pole A - SL)
Microwave cable	Pole ID - MWD No. (e.g. Pole A - MWD2)
Loop Lead-In Cable	Loop No. - Traffic Movement (e.g. Loop 3-EBLT) (LT - Left Turn, RT - Right Turn, TH - Through) (Loop No. denotes signal phasing)

2.26.4.1.1.1 Signal Control Cable

Standard colour coding for the IMSA signal control cable is shown on Standard Drawing TCS-F-101. The size and number of signal cables pulled to each traffic pole shall be as per the Conduit Schedule on the Drawings.

2.26.4.1.1.2 Traffic Signal Poles

Each traffic signal and pedestrian head shall be separately wired to the base of the pole utilizing a #14 AWG stranded signal cable and a #14 AWG fixture bonding conductor. All common connections shall be made accessible from the handhole at the base of the pole. Cable and wires from the mast arm hanger to cable entrances shall be bundled / taped together.

Where the Contractor is required to drill and tap the steel poles for wire outlets, rubber grommets shall be used to prevent abrasion to the signal cables. If requested by the Consultant, the Contractor shall drill additional cable entrances on the steel poles for future signal head mounting locations. The drilled holes shall be touched up with a cold galvanizing compound and plugged to minimize entrance of moisture.

2.26.4.1.1.3 Traffic Cabinet

Field wiring shall be dressed and routed in corners of the cabinet to the various terminal boards or blocks, secured by plastic locking cable ties, lacing or preformed plastic spiral wrapping harness and fanned out neatly from the harness to each terminal.

Individual leads shall be long enough to permit re-routing to different terminals at a later date should this be required or as specified on the Drawings. All conductors shall be stripped such that the amount of exposed conductor protruding from the terminal block does not exceed 3mm.

2.26.4.1.1.4 Splices

Splices in both aerial and underground cable must be electrically sound and waterproof. Splices shall be located in pole handholes. Splices are not permitted in conduit runs or within signal fixtures or within a pole base if not readily accessible through a handhole. No splices or joints of cable shall be drawn inside conduit.

2.26.4.1.2 Grounding

2.26.4.1.2.1 Service Ground

The intersection service ground will be connected to the power supply cabinet, and NOT to the traffic cabinet. The service ground shall consist of a minimum three 21mm diameter x 3.0m long copperclad ground rods on a #6 AWG bare copper ground conductor. The three ground electrodes shall be spaced 3.0 metres apart, forming an equilateral triangle (3m x 3m x 3m), and located at least 5.5 metres from either the traffic controller or the power supply cabinets. The service ground shall be bonded to the neutral side of the main power disconnect breaker with one #6 AWG conductor in a single circuit.

2.26.4.1.2.2 Fixture Bond

A #8 AWG insulated bonding conductor shall be installed throughout all conduits containing live 120 AC conductors and shall connect all poles, pole fixtures, luminaries, steel junction box lids, and metal conduit to the grounded or neutral side of the AC power supply.

2.26.4.1.2.3 Lightning Attenuation

The Contractor shall install a 21mm diameter x 3.0m long copperclad lightning electrode in the junction box adjacent to all main traffic poles (i.e. cantilever poles, cantilever combination poles, and signal bridges. Pedestal poles, in most cases, can be installed without lighting electrodes located immediately adjacent to them), and connect the lightning electrode to the pole bonding stud with a #6 AWG conductor.

2.26.4.2 **Conduits and Junction Boxes**

2.26.4.2.1 Conduits

Refer to Section 2.7 of the Standard Specifications, Underground Electrical Conduits, for general requirements related to conduit installations. Additional requirements related to conduit works in a traffic signals project are provided in this Section.

The Contractor shall install the conduits in accordance with the size, quantity, location, and installation method as specified on the Conduit Schedule and Underground Installations plan on the Drawings. If the installation method is not specified on the Drawings, approval from the Consultant shall be obtained prior to conduit installation. Any deviation from the design on the Drawings shall be pre-approved by the Consultant.

For traffic signal work, all underground conduit that runs underneath a roadway surface shall typically be installed at a minimum depth of 1.2m. Where it is necessary for conduits to cross over other conduits, a minimum separation of 150mm shall be provided between the crossing conduits. Where it is necessary for conduits to cross over utilities, a minimum separation of 300mm shall be maintained. Where local authorities have different separation requirements from their underground utilities, the more stringent (i.e. farther apart) requirements will govern unless otherwise authorized by the Consultant, the Owner, or representative of the local authority. Where conduits are installed prior to placing roadbed granular materials, the conduits shall be protected with a minimum cover of 300mm of compacted materials.

All conduits shall be installed free from dents and bruises and, as soon as installed, shall have the ends plugged to prevent the entrance of dirt or moisture. All conduits shall be thoroughly cleaned out before installation of conductors. All unused conduits shall be capped. Multiple bends in opposing directions are not permitted.

Conduit entrances into junction boxes designated for fibre optic cable installation shall be installed so that conduit designated for communication is capable of accommodating a minimum of 230mm bend radius and a minimum of 300mm clearance from the top of the cable bend to the top of the junction box.

The Contractor shall demonstrate to the Consultant the conditions of conduit connections by using an air compressor to blow a suitably sized Styrofoam ball through the conduit system.

The Contractor shall use a red pen to record the location, alignment, quantity, size, installed depth, and installation method of all conduits on the Drawings provided by the Consultant. Any deviation from the Drawings shall be clearly marked.

2.26.4.2.2 Junction Boxes

The Contractor shall install junction boxes in accordance with the size and location as specified on the Underground Installations plan on the Drawings. Any deviation from the design on the Drawings shall be pre-approved by the Consultant. Field location of all junction boxes shall be approved by the Consultant.

Junction boxes shall be rested on a 100mm layer of compacted gravel. The cover of the junction boxes shall be level with the surrounding surface. Ground surface adjacent to a junction box should provide slope to direct surface runoff away from the junction box.

The Contractor shall use a red pen to record the location, quantity, and size of all junction boxes on the Drawings provided by the Consultant. Any deviation from the Drawings shall be clearly marked.

2.26.4.2.3 Backfilling

Conduits installed by trench excavation must be backfilled with a trench marker tape placed 300mm below ground level, or provide at least 300mm separation above the installed conduit. The Consultant shall be notified prior to backfilling over any electrical conduits. Trenches shall not be excessively wet and shall not contain pools of water during backfilling.

2.26.4.3 **Foundations**

The locations of the traffic pole bases and cabinet bases shall be as specified on the Drawings, and will be subject to field confirmation by the Consultant. If obstructions or other existing conditions cause problems with the placement of the traffic pole bases or cabinet bases, the Consultant may direct that a different location be used. Any deviation from the design on the Drawings must be pre-approved by the Consultant.

The Contractor shall use a red pen to record the approved as-built location, quantity and size of all pole bases on the Drawings.

2.26.4.3.1 Precast Cabinet Base and Pole Base

Excavation required for the installation of the precast cabinet base and the precast pole bases shall be performed in such a manner as to avoid any unnecessary damage to streets, sidewalks, landscaping and other improvements. Excavation shall not be performed until immediately before installation of the precast concrete bases. At the end of each working period, all excavations shall be barricaded or covered, or both, to provide safe passage for pedestrian and vehicular traffic.

The precast cabinet bases shall be installed with the top of the base mounted at 600mm above the surrounding ground surface. The controller cabinet base shall be placed on a minimum 100mm layer of compacted granular material.

Precast concrete pole bases shall rest directly and solidly on the bottom of the hole. The top of the pole bases shall be up to 25mm above the existing or new curb and sidewalk, or up to 100mm above finished grade where there is no curb or sidewalk, except in sloped areas where they shall be up to 300mm above finished grade or as per requirements shown on the Drawings.

A 900mm diameter hole shall be excavated either by auger or hydrovac for precast concrete pole bases for cantilever or cantilever combination poles. A 600mm diameter hole shall be excavated for precast pole bases for pedestal poles. The Contractor shall thoroughly compact the bottom of the hole. Unsuitable material at the bottom of the holes shall be replaced with granular material. All surplus excavated materials shall be properly disposed of within 48 hours by the Contractor.

Excavated material from augering the foundation holes shall not be used for backfilling around a precasted concrete pole base. Lean mix concrete with a minimum 15 MPa 28 day compressive strength shall be used for backfilling. Alternatively, cold mix asphalt can be used, with compaction, for backfilling.

Allowable tolerances for precast concrete cabinet bases and pole bases are as follows:

Tolerance Limits:

Cabinet Bases:	Horizontal location (base centre)	+/- 100 mm
	Vertical location (top of base)	+/- 50 mm
Pole Bases:	Horizontal location (pole base centre)	+/- 50 mm
	Vertical location (top of pole base)	+/- 25 mm
Anchor Bolts:	Horizontal location (relative to centre of pole base)	+/- 25 mm
	Bolt circle diameter (B.C.D.)	+/- 10 mm
	Vertical location (from top of pole base)	+/- 15 mm

Situations where more stringent tolerance limits are required will be indicated in the Special Provisions or on the Drawings. The more stringent tolerance limits shall be adhered to.

2.26.4.3.2 Cast-In-Place Pole Base

The Contractor shall install casing for pole bases as per dimensions specified on the Pole Schedule on the Drawings.

Steel cage for the cast-in-place pole base must be constructed as per the reinforcement quantities, lengths and dimensions as per Standard Drawings TCS-F-301.1, 305.1, and 310. The anchor rods for the signal supports shall be physically bonded to the steel cage by either spot welds or reinforcements ties. The anchor rod assembly shall be centred on the pole base. The Contractor shall use 50mm concrete spacer blocks at the perimeter of the steel cage assembly and the sonar tube shall be erected to plumb. If the sonar tube is not positioned to plumb, it must be extracted and the drill hole or hydrovac hole be enlarged so that the sonar tube can be positioned vertically.

The anchor rod shall be positioned so that the erected mast arm on the signal support shall be perpendicular to the approaching travel lanes, unless specified otherwise on the Drawings. Before the concrete is poured, the steel cage and the sonar tube must be ready and in position, and the anchor rod assembly must be secured to the steel cage and wrapped to protect the anchor bolt assembly from the concrete pour.

A 25mm chamfer shall be provided by using preformed formwork around the inside ring of the sonar tube for the purpose of establishing the top level of the pole base, provide a reference point for finishing the top of pole base, and to form a 25mm chamfer around the perimeter of the top of the finished pole base. The length of anchor rod protruding from the top of the pole base shall be as per Standard Drawings TCS-F-301.1, 305.1, and 310.

Place concrete in accordance with CAN3-A23.1. Use Hot Weather Concrete protection procedures when air temperature is at or above 25 degrees Celsius. Use Cold Weather Concrete protection procedures when air temperature is at or below 5 degrees Celsius. Concrete shall not be placed on frozen subgrade or subbase. Water shall not be added to the concrete after the concrete truck arrives at the work site.

Obtain approval from the Consultant before placing concrete. Steel cage for pole base shall be checked before concreting for cleanliness, secure connection to anchor bolts, and a minimum 50mm cover between steel cage and the sonar tube casing or the drilled hole. Copies of the concrete tickets shall be submitted to the Consultant after concreting as a record of the type of concrete used and the ambient conditions during concreting.

Ensure pile casing and anchor bolts are not disturbed during concrete placement. The allowable tolerances for the cast-in-place concrete pole bases are as follows:

Tolerance Limits:

Pole Bases:	Horizontal location (pole base centre)	+/- 50 mm
	Vertical location (top of pole base)	+/- 25 mm
	Vertical plumb (side of pole base)	+/- 5 degrees
Anchor Bolts:	Horizontal location (relative to centre of pole base)	+/- 25 mm
	Orientation of the anchor bolt	+/- 10 degrees
	Vertical location (from top of pole base)	+/- 15 mm

The above tolerances shall be measured and checked by the Consultant after the concrete is set and the concrete form tube casing is stripped from the pole base.

Situations where more stringent tolerance limits are required will be indicated in the Special Provisions or on the Drawings. The more stringent tolerance limits shall be adhered to.

2.26.4.3.3 Galvanized Steel Helix Pole Base

The allowable tolerances for the helix pole bases are as follows:

Tolerance Limits:

Pole Bases:	Horizontal location (pole base centre)	+/- 50 mm
	Vertical location (top of pole base)	+/- 25 mm
Anchor Bolts:	Horizontal location (relative to centre of pole base)	+/- 25 mm
	Bolt circle diameter (B.C.D.)	+/- 10 mm
	Vertical location (from top of pole base)	+/- 15 mm

Situations where more stringent tolerance limits are required will be indicated in the Special Provisions or on the Drawings. The more stringent tolerance limits shall be adhered to.

2.26.4.3.4 Salvaged Pole Base

Precast pole base to be salvaged shall be cleaned by the Contractor prior to delivery to the destination specified on the Drawings or by the Consultant.

2.26.4.4 **Signal Supports**

2.26.4.4.1 Refinishing Poles

Any spots where the galvanizing of the signal poles is damaged due to drilling, tapping, reaming, welding or surface damage during transportation and erection shall be refinished with an approved cold galvanizing compound. The application of the cold galvanizing compound shall be in accordance with the following:

a) The surface preparation and application of the compound shall be performed under the supervision or authorization of the Consultant. Any unsupervised or unauthorized application shall be completely removed and redone under proper supervision at the Contractor's expense.
b) The surface must be mechanically cleaned with a wire brush or grinder and chemically cleaned to remove all welding flux, grease, oil, rust, scale and other dirt.
c) The surface shall be absolutely dry and the ambient temperature shall be over 10oC.
d) The cold galvanizing compound shall be thoroughly stirred before using until it has a completely uniform appearance. No thinning agent shall be added unless the Contractor is instructed to do so by the Consultant.
e) A single brush coat shall be applied. This coat shall be as thick as possible without causing runs in the finished surface.
f) The brush shall be dipped to the bottom of the can each time. Periodic stirring of the can during painting is required.
g) Complete drying time can be as long as 48 hours so the application shall be timed so that the treated surface is not subject to damage or abrasion to other work within 48 hours of the time of application.

2.26.4.4.2 Signal / Sign Poles

The signal / sign poles shall be plumbed by the Contractor so that they are vertical when viewed from all directions. The plumb will be checked by the Consultant and the Contractor shall make any adjustments which are necessary by installing levelling shims as required around the anchor bolts. If requested by the Consultant, the Contractor shall grout underneath the shimmed pole base plate with a flowable and expansive high-strength grout compound, such as Sika 232, designed for such purposes. The Contractor shall obtain approval from the Consultant prior to using a selected grout compound.

The signal poles shall be oriented so that the mast arms are perpendicular to the approaching travel lanes, unless specified otherwise on the Drawings. Where practical, the signal poles shall be positioned with the handhole in the back of the pole or, if not possible, on the downstream traffic side of the pole.

Flange connections between all signal pole pieces shall be secured by means of bolts, washers and double nuts on each bolt in accordance with the torque recommended on the support structure shop drawings.

2.26.4.5 Pole Mounted Traffic Control Fixtures

The Contractor shall install traffic signal heads and other traffic control fixtures including signs, microwave detectors, and pushbuttons on the signal support as per the Pole Schedule on the Drawings. The Contractor shall be required to drill and tap the steel poles as required. All drill holes shall be further protected by a rubber grommet.

Standard mounting height and location of the pole mounted traffic signals, pedestrian signals, and pushbuttons shall be in accordance with Standard Drawing TCS-F-501.

Standard mounting hardware arrangement for traffic and pedestrian signals on pedestal poles shall be in accordance with Standard Drawing TCS-F-505.

Standard mounting hardware arrangement for traffic and pedestrian signals on the side of the signal pole (such as secondary heads) shall be in accordance with Standard Drawing TCS-F-510.

Standard mounting hardware arrangement for traffic signals, either horizontally or vertically, on the mast arm of a cantilever or combination pole shall be in accordance with Standard Drawing TCS-F-515. A minimum vertical clearance of 5.8m shall be provided between the bottom of the fixtures on the mast arm and the final pavement surface. This vertical clearance requirement is also applicable to large overhead signs such as special crosswalk sign and advance warning signal sign. The location and position of all pole mounted fixtures including traffic signal heads and pedestrian signal heads, pushbuttons, signs, and microwave detectors shall be checked with the Consultant in the field prior to final mounting.

All conductors from mast hangers to cable entrances shall be taped together.

The Contractor shall completely covered the signal heads, pedestrian signal heads, pushbuttons, and all signs that provide conflicting messages to the current traffic operating arrangements, from the time they are installed until the system is turned on for full operation.

Installation of microwave detectors shall include aiming and positioning of the detector to provide a desirable detection zone as per the Drawings or instruction of the Consultant.

The following items shall be inspected by the Consultant after all traffic control fixtures are mounted and secured on the support structures:

- Position and quantity of overhead signs, signal heads and other traffic control fixtures shall be checked for compliance with the Above Ground Installation Plan and Pole Schedule on the Drawings.
- Alignment of signal head and overhead signs to travel lane shall be checked with reference to the Above Ground Installation Plan on the Drawings.
- Type and detailed configuration of signal head mounting hardware shall be checked for compliance with the Above Ground Installation Plan and Pole Schedule on the Drawings, Standard Drawings TCS-F-501, 505, 515, 520, and 525.
- Alignment of pedestrian signal heads shall be checked for visibility from pushbutton location across the street.
- Mark on traffic signal head lens covers shall be checked for signal lenses alignment.
- Type of light bulb used shall be checked for compliance with Section 8.2.5.
- Vertical clearance for traffic control fixtures mounted on the mast arm shall be checked if the 5.8m minimum value is provided.
- All exposed cables shall be checked for presence of jacket insulation
- All unused signal cable wires shall be checked to ensure that they are taped off or grounded.

2.26.4.6 Traffic Signal Controller Unit and Cabinet

2.26.4.6.1 Controller Timing Programming

The Contractor is responsible for programming the controller, verifying proper/expected operation through testing, and final turn-on verification of the provided timings. The Consultant shall supply the Contractor the signal timing plans, in a generic format, for the traffic controller. The timings shall be provided to the Contractor at least 4 weeks before the expected traffic signal start-up date so that the Contractor can arrange for proper bench testing of the controller cabinet.

2.26.4.6.2 Bench Testing

Cabinets shall be pre-wired at the Contractor's shop to simulate all field operations as per the traffic signal design on the Drawings. The cabinet shall be configured to operate as per the designs provided, including timing, phasing and any additional control logic. When full compliance with the designs has been confirmed, the cabinet shall be bench tested for a period of 48 hours to verify proper operation. All timing plans and time-of-day plans must be tested. Prior to and after all bench testing, a full MMU test must be performed.

At the end of the bench testing process, the Contractor shall arrange for an inspection by y the Consultant. The Contractor shall demonstrate to the Consultant during this inspection that the Controller Cabinet is wired and operating as per the design illustrated on the Drawings, using the preliminary traffic signal timings provided by the Consultant.

The following reports shall be submitted to the Consultant at the time of the inspection at the Contractor's shop:

- A printed report of the conflict monitor test results
- Bench test and flash test reports
- A copy of the controller cabinet wiring drawing

2.26.4.6.3 Delivery to the Field

The Contractor shall be fully responsible for all costs associated with the delivery of the controller cabinet and associated control equipment to the site.
All equipment shall be delivered to the site free from any scratches or dents. Equipment will be rejected if noted that it has signs of any damage at time of "Construction Completion Inspection".

2.26.4.6.4 Field Wiring

Field wiring shall be terminated as indicated on the cabinet wiring drawing and shall be dressed and routed in corners of the cabinet to the various terminal boards or blocks, secured by lacing, cable ties, or preformed plastic spiral wrapping harness and fanned out neatly from the harness to each terminal. Individual leads shall be long enough to permit re-routing to different terminals at a later date should this be required or specified on the Drawings.

Wires and cables entering the traffic cabinet shall be labeled with tags of a permanent nature. Labeling shall identify the purpose of the cable (i.e.: Pole A-TS for traffic signal cable to Pole A). Refer to Section 2.26.4.1, Wire, Cable and Grounding / Bonding for cable labeling requirements. Colour coding of the traffic signal cable and conductors shall be in accordance with the requirements outlined in Section 2.26.4.1, Wire, Cable and Grounding / Bonding. The load switches and detector racks shall be labeled with a thick, black permanent marker the corresponding signal phasing the component is serving.

Any field modification to the wiring of the cabinet must be documented by marking up the controller cabinet wiring diagram. A copy of the marked-up drawing shall be submitted to the Consultant for records as part of the record drawing package.

The following items will be tested by the Consultant as part of the Construction Completion Inspection of the Controller Cabinet Installation:

- Check for number of conduits entering the cabinet
- Check ground connection

- Check signal timing values
- Check signal phasing and detector phasing are as per Phasing Diagram and Above Ground Installations Plan on the Drawings, and as per the Wiring Diagram accompanying the Controller Cabinet.
- Cleanliness
- Labeling of cables and auxiliary components in the controller cabinet such as load switches, and detector amplifiers.

2.26.4.6.5 Cabinet Sealing

The bottom of the controller cabinet contact with the concrete pedestal shall be sealed with a silicon base compound to prevent infiltration of dust and moisture.

2.26.4.7 **Detector Loops**

The Contractor is responsible for roadway cutting and patching for detector loop installation at locations indicated on the Underground Installation plan on the Drawings.

2.26.4.7.1 Wire Loop Assembly

Diamond detector loops shall be installed as per the dimensions and methods as shown on Standard Drawing TCS-F-801.

Rectangular detector loops shall be installed as per the dimensions and methods as shown on Standard Drawing TCS-F-805.

Quad detector loops shall be installed as per the dimensions and methods as shown on Standard Drawing TCS-F-810.

For total lead-in length is more than 100m, the number of windings should be increased by one.

When multiple loops are used, they should always be connected in series for maximum efficiency and greater reliability.

Conductor feeder pairs from loop to junction box shall be taped together every 0.3 m and twisted to provide a minimum of 15 turns per metre.

Adjacent loops serving a similar purpose shall be wired to provide current flow in the same direction (all clockwise or counter-clockwise). Adjacent loops serving separate traffic phases shall be wired to provide current flow in different directions (one clockwise and once counter-clockwise).

2.26.4.7.2 Pavement Slot Cutting

The locations of the detector loops shall be marked on the pavement as per the Drawings.

To minimize cross-talking between detector loops, the home runs of the detector conductor towards the roadside shall be located a minimum of 300 mm apart. At roadside where the home run enters the loop conduit connecting to the junction box, a minimum of 75 mm separation should be provided between home run slots. Maintain minimum 300 mm separation between loop conduits.

The depth of the saw cut and the saw cut width shall meet the requirements outlined on Standard Drawings TCS-F-801, 805, and 810. Saw cut shall be straight and be overlapped at corners to ensure that the full depth is cut. Diagonal saw cut of 45 degrees shall be used in all 90 degree corners of the detector loop.

2.26.4.7.3 Loop Installation

Remove all jagged edges and protrusions along the slot. The saw cut slots shall be cleaned by flushing with water and dried by blowing with oil free compressed air.

Place a small amount (5 to 10 mm) of loop sealant as a base. Carefully lay loop wire in the slot avoiding any kinking or stretching of the insulation and seat each turn using a blunt tool such as a wooden paint stirrer, but not a screwdriver or other such sharp object. Hold wire in place (minimum 35 mm below the surface of the roadway) with a backer rod. Push backer rod tight against conductors.

One continuous, unbroken length of wire shall be used to form a loop of the number of windings required from the loop to the junction box in accordance to Standard Drawings TCS-F-801, 805, and 810. Conduit connection at the roadside shall be installed in accordance with Standard Drawings TCS-F-815 and 815.1. Seal both ends of the flexible conduit with electrical cable sealant compound to prevent water from entering the conduit.

2.26.4.7.4 Sealing of Pavement Slot Cuts

Install detector loops and seal pavement slot cuts in the same day. Immediately prior to the application of loop sealant, saw cut slots must be thoroughly blown dried by using a high pressure air compressor.

Apply sealant in accordance with manufacturer's instructions. Apply the sealant in multiple (minimum 2) passes to prevent loop wire insulation damage and allowed to set prior to allowing vehicles to cross the loop.

Ensure that sealant completely surrounds detector loops and all hold down materials. Air bubbles which will leave voids must be removed and excess material smoothed out. Ensure that the slot is completely filled with sealant to 2 mm below the surface of the pavement. Any excess sealant or spillage shall be removed. The sealant shall be covered with dry cement powder or fine sand.

2.26.4.7.5 Splice between Loop Conductor and Lead-In Cable

Splices into the lead-in cable at the junction box shall be twisted, soldered and sealed using heat shrink connectors as per Standard Drawing TCS-F-820. All pair splices shall be sealed separately. Coil 1.0m of the lead-in cable in the junction box. No other splices to the lead-in cable are allowed. The splicing arrangement shall be done in accordance with the Detector Schedule on the Drawings. Lead-in cable run back to the controller cabinet shall be installed in accordance with the Conduit Schedule on the Drawings. Lead-in cable shall be grounded at the controller cabinet only. At the twisted feeder cable end, the ground wire of the lead-in cable shall be cut off flush and not connected to the ground.

2.26.4.7.6 Identification

Shielded cables shall be identified by labeling mechanically using identification tags by loop numbers and signal phases. Labeling shall be done with indelible marking pen. Label the shielded cables at the junction box and at the controller cabinet.

2.26.4.7.7 Tests

All splices shall be carefully made to ensure constant low resistance and be insulated in such a manner that, under the prevailing environmental conditions, the installation maintains resistance to ground of not less than 10 megohms. To ensure that the loop installation is correct, a continuity check on the loop wiring and a resistance check on the loop to ground using a "megger" or other suitable insulation tester shall be performed.

All tests shall be performed by the Contractor in the presence of the Consultant. The Contractor shall arrange for a field inspection by the Consultant. A minimum of two (2) business day notice is required to arrange for the inspection. Replace any loop or lead-in cable that fails the tests. Repeat test after completion of detector loop installation.

2.26.4.8 **Power Supply Cabinet**

2.26.4.8.1 Power Supply Cabinet

The power supply cabinet shall be pole mounted or concrete base mounted as indicated on the Drawings. When mounted on a pole, the power supply cabinet shall be mounted securely using stainless steel straps. Rigid PVC conduit and fittings shall be installed on the pole using PVC conduit straps and galvanized lag screws at 1.5 m maximum centers. When mounted on a concrete base, the bottom of the power supply cabinet that is in contact with the concrete base shall be sealed with proper weatherproof compound to prevent infiltration of dust and moisture.

The power supply cabinet shall be installed at least 11 m away from the traffic controller cabinet.

2.26.4.8.2 Grounding and Bonding

2.26.4.8.2.1 Service Ground

When a power supply cabinet is included on the Drawings, the intersection service ground will be connected to the power supply cabinet and shall consist of a minimum three 20 mm diameter x 3.0 m long copperclad ground electrodes, spaced 3.0 m apart on a #6 AWG bare copper ground conductor, and arranged in a equilateral triangle formation. The service ground shall be bonded to the neutral side of the main power disconnect breaker with one continuous #6 AWG conductor. The intersection service ground electrodes shall be installed at a minimum of 5.5 m from both the traffic control cabinet and the power supply cabinet.

2.26.4.8.2.2 Bonding

A #8 AWG green bonding conductor shall be installed from the power supply service cabinet to the traffic control cabinet and to each traffic signal pole and street light pole supplied by the power supply service cabinet.

Where bonding conductors are spliced in a junction box, a copper split bolt connector shall be used to join the associated conductors together.

From each pole fixture, a bonding conductor shall be installed to the bonding stud at the base of each pole.

Lightning electrodes are to be connected to the bonding stud at the base of each pole.

2.26.5 SIGNALS COMPLETION

A Signals Completion Inspection is required to demonstrate and determine that all parts of the traffic signal system function as per design prior to the signal actually being turned on for public traffic.

When the Contractor has finished all necessary wiring, obtained approval from the electrical inspection authority, entered into the traffic controller the traffic signal timings provided by the Consultant, and is confident that the signal system will operate satisfactorily; he shall inform the Consultant and request for a Signals Completion Inspection of the signal system. The Contractor shall submit a set of as-built drawings to the Consultant as part of the Signals Completion Inspection. The as-built drawings shall indicate (in red) the location and accurate alignments of all junction boxes, conduits, poles, detector loops, and other equipment or fixtures installed, as well as all changes, additions, deletions, or any other modifications made to the original design. A minimum of two (2) business days notice is required for scheduling the inspection.

In preparing for Signals Completion Inspection, the Contractor shall carry his own inspection to verify that all materials and equipment are in place and secure, and the traffic signal equipment and detectors are functioning. The results of such tests shall conform to the requirements of the Canadian Electrical Code and shall be to the satisfaction of the electrical inspection authority and the Consultant.

(a) If the Consultant decides that the results of the Signals Completion Inspection are unsatisfactory, a subsequent Signals Completion Inspection shall be arranged. The signal heads shall be either bagged or turned down if the traffic signal is not ready to go into a flashing mode.

(b) If the test results are satisfactory to the Consultant, the signal system will be left in a flashing mode. A date for Signal-Turn-On, usually 3 to 7 days later, will be selected jointly by the Consultant and the Owner for switching the traffic signal from a flashing mode to a fully operational mode. The Consultant may identify a list of deficiencies which must be rectified by the Contractor prior to the Signal-Turn-On Date.

(c) During both Signals Completion Inspection and Signal-Turn-On, the Contractor shall ensure that a qualified representative of the company, familiar with the equipment installed, is on site until it has been demonstrated that all equipment functions as intended on the Drawings and in the Specifications, and to the satisfaction of the Consultant.

A Signals Completion Certificate will be issued to the Contractor if the traffic signal system has been operating satisfactorily for a pre-specified burn-in period after Signal-Turn-On. For traffic signal installations located near an urban centre or is close to a local Alberta Transportation Maintenance Contract Inspector (MCI) office, a 7-day burn-in period is required. For traffic signal installations located outside an urban centre, or more than 100 km from a local Alberta Transportation MCI office, a 14-day burn-in period is required.

2.26.6 WARRANTY

Notwithstanding General Specification 1.2.53 “Construction Completion and Acceptance”, the warranty period will commence on the day following the successful completion of the burn-in period, or upon issuance of the Construction Completion Certificate; whichever date is later.

2.26.7 MEASUREMENT AND PAYMENT

Payment for a complete and operating traffic control system and all the Work described herein will be made at the lump sum price bid per intersection for "Traffic Signal System - Supply and Install". The lump sum price will be considered full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

Payment for supply and installation of underground conduit will be made in accordance with Specification 2.7, Underground Electrical Conduit.

Costs associated with Signal-Turn-On and the Burn-In Period will be considered incidental to the Work and no separate or additional payment will be made.

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3.26 MICRO-SURFACING

3.26.1 GENERAL

Micro-Surfacing is a slurry seal type of application which is placed on a prepared pavement at locations and conforming to the lines and dimensions specified or as designated by the Consultant. The micro-surfacing treatment is intended to provide a smooth, durable, skid resistant surface. Application can be for rut filling and/or surfacing the entire travel lane. The micro-surfacing mixture shall consist of a cationic polymer modified asphalt, mineral aggregate, mineral filler, field control additive and water.

3.26.2 MATERIALS

3.26.2.1 **Aggregate**

The Contractor shall produce aggregate that is 100% manufactured and is evaluated as being fully compatible with the emulsion. The Contractor shall supply aggregate materials in accordance with Specification 5.2, Supply of Aggregate and haul aggregate materials in accordance with Specification 4.5, Hauling.

The aggregate gradation, including mineral filler, shall be within the following limits for the type as specified:

Sieve Size (µm)	Percent Passing
10000	100
5000	70 – 90
2500	45 – 70
1250	28 – 50
630	19 – 34
315	12 – 25
160	7 – 18
80	5 – 15

The Contractor shall split aggregates for the micro-surfacing into coarse and fine fraction prior to crushing of the coarse fraction. The crushed coarse and the fine fraction shall be stockpiled separately.

The Contractor shall select a screen size at which splitting will take place. Splitting of aggregates shall be controlled such that the coarse aggregate fraction, before crushing, shall contain no more than 5% passing the 5 000 sieve.

The aggregate quality shall meet the following requirements:

Plasticity Index	AASHTO T90	Non - Plastic
LA Abrasion Loss	AASHTO T96	30% maximum
Sand Equivalent	AASHTO T176	65% minimum

3.26.2.2 **Mineral Filler**

The Contractor shall supply the mineral filler which shall be introduced into the mineral aggregate. Mineral filler may be any recognized brand of non air-entrained portland cement, hydrated lime or any other approved mineral filler that is free of lumps. The amount and type of mineral filler needed will be determined by the laboratory mix design and will be considered as part of the material gradation requirement. An increase or decrease of less than 1% may be permitted in the field for improving the mix consistency or set times.

3.26.2.3 **Field Control Additive**

The Contractor shall supply a field control additive and apply it as required to effectively maintain the quick-set characteristics of the mix and prevent premature breaking of the material in the spreader box. Additives must be included as part of the mix design and be compatible with the other components of the mix.

3.26.2.4 **Water**

The Contractor shall supply suitable water, free from soluble salts and any other harmful contaminants, for mixing of the micro-surfacing material and pre-wetting of the existing pavement

3.26.2.5 **Asphalt**

The emulsified asphalt shall be a quick-traffic polymer modified asphalt emulsion conforming to the requirements of AASHTO M208 for CSS-1h with the following changes.

i) The cement mixing test shall be waived for this emulsion.

ii) The Residue after Distillation shall be tested in accordance with ASTM D244 except that the test temperature shall be a maximum of 210 ºC and shall be maintained at 205 ºC ± 5 ºC for 20 minutes.

iii) The Residue after Distillation shall be a minimum of 62%.

The Residue after Distillation shall also meet the following requirements:

TEST METHOD	TESTS ON RESIDUE	SPECIFICATION
AASHTO T53	Softening Point	57 ºC minimum
AASHTO T49	Penetration at 25 ºC	40 - 90 dmm
ASTM 2170	Kinematic Viscosity @ 135 ºC	650 cST/sec minimum

The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process.

The addition rate of polymer modifier shall be a minimum of 3% polymer solids by mass of asphalt residue.

3.26.3 MIX DESIGN

Test procedures contained in this Specification are based upon the publication prepared by the International Slurry Seal Surfacing Association (ISSA) titled "Recommended Performance Guidelines for Micro-Surfacing A143 (Revised) May 2003".

The Contractor shall supply the mix design, and all components of the mix. The Contractor shall submit a mix design, signed and stamped by a Professional Engineer, to the Consultant a minimum of 5 working days prior to the placement of any micro-surfacing material. The mix design shall be prepared by a testing laboratory that has prior experience in the design of micro-surfacing mixes using ISSA test methods and design procedures. No micro-surfacing material shall be placed prior to the Consultant reviewing and accepting the submitted mix design.

Compatibility of the aggregate, polymer-modified emulsion, mineral filler and other additives shall be verified by the mix design. All component materials used in the mix design shall be representative of the materials proposed by the Contractor for use on this project. The mix design shall list the characteristics and proportions of all materials used in the micro-surfacing formulation.

The micro-surfacing mix design submission shall contain test results for all aggregate and mixture properties as herein specified.

The micro-surfacing material shall meet the following mix design requirements.

ISSA TEST NO.	DESCRIPTION	SPECIFICATION
ISSA TB-139	Wet Cohesion @30 minutes minimum (Set) @60 minutes minimum (Traffic)	12 kg-cm minimum 20 kg-cm minimum or near spin
ISSA TB109	Excess Asphalt by LWT Sand Adhesion	538 g/m^2
ISSA TB-114	Wet Stripping	Pass (90% minimum)
ISSA TB-100	Wet-Track Abrasion Loss One-hour Soak Six-day Soak	 538 g/m^2 maximum 807 g/m^2 maximum
ISSA TB-147	Lateral Displacement Specific Gravity after 1,000 cycles of 11.34 kg	5% maximum 2.10 maximum
ISSA TB-144	Classification Compatibility	11 grade points minimum (AAA, BAA)
ISSA TB-113	Mix Time @ 25 ºC	Controllable to 120 s minimum

The mix design proportions shall be within the following limits:

Residual asphalt: 6 to 11.5% by dry weight of aggregate.
Mineral filler: 0.0 to 3.0% by dry weight of aggregate.

The micro-surfacing material shall be designed to accommodate traffic without damage within one hour of placement.

3.26.3.1 **Testing**

Quality control and quality control testing are the responsibility of the Contractor throughout every stage of the work, from production of aggregates to the final accepted product. Tests that may be performed by the Consultant to determine compliance with specifications will be quality assurance tests and will not be considered as quality control tests.

The Contractor shall provide and maintain equipment and qualified personnel to perform all testing necessary to determine and monitor the characteristics of the materials produced and incorporated in the micro-surfacing.

The Contractor shall provide safe and convenient means for accurately and representatively sampling each aggregate stream being produced during all screening, splitting and crushing processes.

The Consultant may inspect the aggregate production process and test and monitor the quality of the material being produced by the Contractor at any time and as often as he deems necessary. Such inspection or testing shall not in any way relieve the Contractor of the responsibility for producing aggregates that meet the specifications in all respects.

Quality control testing and monitoring shall be completed by the Contractor according to the requirements outlined in the following Table, and shall be reported to the Consultant within one working day of the completion of each test.

Quality Control Testing Requirements for Micro-Surfacing Projects

TEST	STANDARD	MINIMUM FREQUENCY
Aggregate Production		
Sieve Analysis	ATT-26	One per 500 tonnes or a minimum of two per project, whichever is greater.
Determining Pit-Run Contamination of the uncrushed coarse fraction	ATT-25, Part II	One per 12 hours of plant production.
Sampling		
Asphalt Cement - provide to Consultant for Quality Assurance testing.	ATT-42	One per day.
Equipment		
Calibration	Note 1	Once per project
Inspection	Note 2	Daily – Provide to consultant the day following application.

Note 1 - Machine Calibration. Each mixing unit to be used in performance of the work shall be calibrated in the presence of the Consultant prior to construction. The calibration shall be documented and shall include the individual calibration of aggregate, mineral filler, and emulsified asphalt at various settings, which can be related to the machine proportioning devices to verify the application rate and mix design compliance.

Note 2 – Daily Inspection Report. The Contractor shall maintain a daily inspection report documenting the following information:

- Highway, Control Section
- Date
- Calibration Control Settings as applicable.
- Beginning and End Stations
- Total Area of Application – square metres
- Counter Readings (Beginning, Ending and Total)
- Quantities of Component materials used.
- Quantity weight of micro-surfacing applied.
- Target application rate of the micro-surfacing (kg/m^2)
- Bulk daily application rate of micro-surfacing (kg/m^2).
- Results of three random checks for the micro-surfacing application rates using the equipment counters.

3.26.4 EQUIPMENT

3.26.4.1 **General**

The Contractor shall provide all equipment, tools, machines, and incidentals necessary to complete the Work. All equipment shall be maintained in a clean and satisfactory working condition at all times to ensure a high quality product.

3.26.4.2 **Mixing Equipment**

The Contractor shall provide a self-propelled micro-surfacing mixing machine specifically designed and manufactured to lay micro-surfacing. The equipment shall be able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, field control additive, and water to a revolving multi-blade twin shafted mixer and discharge the mixed product on a continuous flow basis. The machine shall be equipped to allow the operator to have full control of the forward and reverse speed during application of the micro-surfacing material.

3.26.4.3 **Proportioning Device**

The Contractor shall provide proportioning devices that are properly marked for the individual volume or weight proportioning of each raw material to be added to the mix. These proportioning devices can be revolution counters or similar devices and are to be used in the material calibration for determining the mix design dial and gate settings and calculating the materials output at any time.

3.26.4.4 **Spreading Equipment**

A mechanical spreader box shall be attached to the paver or slurry machine. The spreader box shall be equipped with rotating paddle shafts to agitate and spread the material throughout the box and be capable of uniformly spreading the micro-surfacing mixture. A front seal shall be provided to ensure no loss of the mixture at the road contact point. The rear seal shall act as the final strike off and shall be adjustable.

Spreading equipment shall be capable of spreading the mixture to fill cracks and minor surface irregularities, and shall leave a uniform application of hi-friction material on the surface. The spreader box and rear strike off shall be so designed and operated that a free flow of material to the rear strike off is achieved.

The spreader box shall have suitable means provided to side shift the box to compensate for any change in longitudinal alignment. All excess material shall be removed from the job site prior to opening the road.

3.26.4.5 **Auxiliary Equipment**

Surface cleaning equipment, hand tools, and any support equipment shall be provided by the Contractor as necessary to perform the work.

3.26.4.6 **Sampling Requirements**

The Contractor may have to arrange to have suitable sampling facilities in order for the Consultant to obtain representative field samples of the micro-surfacing mixture and each of the component materials.

3.26.5 CONSTRUCTION

3.26.5.1 **General**

The micro-surfacing mixture shall be homogeneous during and following mixing and spreading. The micro-surfacing mixture shall be of the desired consistency when exiting the mixer and no additional materials shall be added. A sufficient amount of material shall be carried in all parts of the spreader box at all times so that complete coverage is obtained. Overloading of the spreader box shall be avoided. No lumping, balling, or unmixed aggregate will be permitted. The material shall not have segregation of the emulsion and aggregate fines from the coarser aggregate.

No streaks, such as those caused by oversize aggregate shall be left in the finished surface. If excessive streaking or drag develops, the operation will be stopped until the Contractor proves to the Consultant that the situation has been corrected.

A summary of the quantity and application rate of micro-surfacing placed and a list of quantities used for each of the components shall be submitted daily to the Consultant.

The application rate for the surface pass shall be 11.0 – 16.3 kg/m^2, or as directed by the Consultant.

No excessive buildup, uncovered areas, or unsightly appearances will be permitted.

3.26.5.2 **Seasonal and Weather Limitations**

The placement of micro-surfacing shall be limited to the period from June 1 to September 15. Micro-surfacing shall not be placed when, in the opinion of the Consultant, damage to the finished product may occur for any reason.

The micro-surfacing shall be placed only when the atmospheric temperature is at least 10ºC and rising and the weather is free of fog or precipitation and there is no forecast of temperatures below 0ºC within 24 hours from the time of application.

3.26.5.3 **Surface Preparation**

The area to be surfaced shall be thoroughly cleaned of loose aggregate and soil, particularly soil that is bound to the surface.

The surface shall be pre-wetted by fogging, with water, ahead of the spreader box when required by local conditions. The rate of application of the fog spray shall be adjusted during the day to suit temperatures, surface texture, humidity, and dryness of the pavement.

3.26.5.4 **Traffic**

The modified emulsified asphalt shall be formulated so that the material will cure sufficiently such that rolling traffic can be allowed on the surface within one hour of placing with no damage to the surface. Areas with rut fills deeper than 25 mm and fills in areas where hard, sharp turning or braking occurs may require up to one additional hour of cure time as directed by the Consultant.

The Contractor shall ensure that all lanes of travel remain open for traffic every night.

Adequate traffic control warning devices shall be used to control the movement of traffic in and around the construction site in accordance with the Specifications. Proper lane delineation, subject to the approval of the Consultant, shall be used by the Contractor to protect the micro-surfacing from traffic until the new surface will support traffic without damage. All traffic control signs and devices shall be in accordance with Specification 7.1 "Temporary Construction Signing".

The Contractor shall suspend his operations during periods of high traffic volumes as directed by the Consultant.

3.26.5.5 **Evaluation Section**

The Contractor shall mix a trial batch using the mix design submitted. Unless otherwise specified, the Contractor may construct his evaluation section of micro-surfacing at any location chosen by the Contractor. The evaluation section shall be between 100 metres and 200 metres in length. No further micro-surfacing will be permitted until the evaluation section has been inspected and accepted by the Consultant.

The Consultant will inspect the evaluation section one hour after placement. If the evaluation section does not meet the specified acceptance criteria, the Contractor shall repeat the trial batch and evaluation process until an acceptable evaluation section is constructed as determined by the Consultant.

The Consultant may stop operations at any time during the evaluation procedure and may require the Contractor to submit a new mix design.

All section(s) of unacceptable trial batch material placed on the highway surface shall be receive a second layer of micro-surfacing in accordance with the Specifications.

3.26.5.6 **Hand Work**

Small areas of non-uniform application shall be spot repaired using hand squeegees to provide complete and uniform coverage. Care shall be exercised to prevent an unsightly appearance from the handwork. A finish equivalent to or better than that applied by the spreader box will be required.

3.26.5.7 **Width of Application**

The micro-surfacing shall be applied between the painted edge lines of the highway. The Contractor shall apply the micro-surfacing neatly up to the painted edge lines but shall not cover any part of the painted edge lines. All median cross-overs will receive micro-surfacing treatment as directed by the Consultant.

3.26.5.8 **Roadway Lines and Pavement Message Markings**

The Contractor shall reference and record the location and configuration of all existing roadway lines and message markings to ensure that they are re-established correctly. Where applicable the Contractor shall preserve all permanent type of markings unless directed otherwise by the Consultant.

The Contractor shall paint all roadway lines and pavement messages for the areas receiving micro-surfacing in accordance with Specifications 7.2, Painted Roadway Lines and 7.3, Painted Pavement Messages.

All painted roadway lines and painted pavement messages applied to the micro-surfacing shall be applied twice at the full application rate for each application. On two lane highways the second application will be from the opposite direction of the initial application.

The Contractor shall re-paint all edge lines upon completion of the micro-surfacing construction. All edge lines shall be painted completely off the newly constructed micro-surface and will require only one paint application.

In all cases, the roadway shall not be posted at gazetted highway speeds until all work including line painting has been completed. The maximum length of roadway posted at less than gazetted highway speeds shall not exceed 30 km.

The Contractor shall notify the Consultant of the date and time at which painting is to be undertaken at least three days prior to the scheduled start of painting operations,. The Consultant will inspect the project jointly with the Contractor and any painting Sub-Contractor prior to the painting operations to assess the surface condition of the roadway and all requirements for painting as outlined in Section 1.2.30, "Preservation of Traffic Markings" of the Standard Specifications For Highway Construction. The scheduling of the site inspection shall be the responsibility of the Contractor. Any painting performed prior to the joint meeting will be considered unauthorized work and may not be paid for.

3.26.6 ACCEPTANCE CRITERIA

Requirements for the acceptance of the completed micro-surfacing include the following:

(i) Materials shall meet all specified requirements;

(ii) The finished micro-surfacing shall have a uniform texture free from excessive scratch marks, tears or other surface irregularities. Tear marks in any 12 square metre area per lane are considered excessive if there are:

a) four or more marks 12 mm wide and 100 mm long.
b) any marks 25 mm wide and 25 mm long.

(iii) There shall be no longitudinal ripples, raking, wash-boarding, chatter, or other irregularities that will affect the ride quality;

(iv) The edges of the micro-surfacing shall be finished uniformly, with a neat appearance along the roadway centreline, lane lines, shoulder, pavement edge and curb lines;

(v) The finished surface shall have a uniform, even texture;

(vi) No over-rich or bleeding areas shall be evident;

(vii) No loose chips shall be evident; and

(viii) All existing pavement markings have been preserved or replaced in accordance with Specifications 7.2, Painted Roadway Lines and 7.3, Painted Pavement Messages.

Work that does not meet the foregoing requirements shall be repaired or reconstructed to the satisfaction of the Consultant.

3.26.7 MEASUREMENT AND PAYMENT

3.26.7.1 **General**

Payments will be full compensation for designing the mix, surface preparation, processing, hauling and placing the mixture, traffic control and quality control, supplying and processing of all material including but not limited to; aggregate, emulsified asphalt binder, water, mineral filler and field additives.

Contrary to Specifications 5.20, Supply of Line Painting Materials; 7.2, Painted Roadway Lines and 7.3, Painted Pavement Messages, no separate payment will be made for the supply of painting materials, nor for replacing the lines and pavement message markings. The cost of this Work will be considered incidental to the Work and no separate or additional payment will be made.

3.26.7.2 **Trial Batches**

Payment for trial batches will be in accordance with the following:

- When trial batches of micro-surfacing are placed in a location outside the project limits, all costs associated with the trial batch will be considered incidental to the Work and no separate or additional payment will be made;

- When trial batches are placed in a location within the project limits, trial batches that meet the specified acceptance criteria will be paid at the applicable price. If the trial batch fails to meet the specified acceptance criteria, no payment will be made for the unacceptable trial batch.

Micro-surfacing for the repair of unacceptable trial batches placed at locations within the project limits will be paid at the applicable unit price bid.

3.26.7.3 **Micro-Surfacing**

Measurement of Micro-Surfacing will be based on the estimated quantities as shown in the unit price schedule unless otherwise specified. A variance in these quantities will only be considered when the scope of the Work has been modified by the Department. The Department reserves the right to measure the Work actually constructed to confirm compliance with the design. Any such measurement will be the basis for the final payment. No allowances will be made for additional quantities that may result from ruts or an otherwise irregular surface cross-section.

Payment for the Work will be made at the unit price bid per square metre for "Micro-Surfacing". The price bid will be considered full compensation for supplying the aggregate and asphalt, and all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

3.26.7.4 **Rut Repair by Micro-Surfacing**

When micro-surfacing is used solely for rut filling, measurement and payment will be based on one of the following methods as specified:

- By the weight of aggregate and asphalt emulsion used to produce the final product. Payment will be made at the unit price bid per tonne for aggregate and the unit price bid per tonne for asphalt emulsion.

- By unit rate. Payment will be made at the unit price bid per linear metre of individual wheel path.

The price bid will be considered full compensation for supplying the aggregate and asphalt, and all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

3.26.7.5 **Supply of Aggregate**

Contrary to Specification 5.2 Supply of Aggregate, no separate payment will be made for supplying aggregate for micro-surfacing. However, if the Contractor supplies aggregate from a Crown source on undeeded land, operated primarily under lease or licence and for which the Department does not have a reservation, the Department will deduct $0.48 per tonne from the total payments made under the Contract. The tonnage will be determined by summing the aggregate quantities reported on the Contractor’s Daily Inspection Report or other means as determined by the Consultant.

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3.40 CUTTING OF PAVEMENT

3.40.1 GENERAL

This specification covers the cutting of existing concrete curbs, sidewalks, driveways, asphalt concrete pavement, and base course materials where new surfacing materials are to be placed abutting the existing structure. The location of pavement cuts will be shown on the drawings, or as specified in the Special Provisions.

3.40.2 CONSTRUCTION

Wherever specified, the Contractor shall cut concrete curbs, sidewalks, driveways, and existing pavement to the full thickness of the structure so that a smooth vertical edge results, against which new materials can be effectively placed and compacted. Rough, jagged edges will not be acceptable.

Unless otherwise specified in the Special Provisions, the Contractor may utilize any cutting methodology, provided the methods and equipment result in a clean and straight vertical cut. All proposed methods and equipment employed by the Contractor shall be reviewed and accepted by the Consultant prior to the start of Work.

When trench excavation across an existing structure is required, the Contractor shall cut the existing pavement on both sides of the trench to the full depth of the structure. The trench cuts shall result in a trench that is no wider than necessary to permit satisfactory installation of the works, and to thoroughly compaction the backfill material.

When the Contractor cuts a trench across existing curb, sidewalk, driveway or roadway, the Contractor shall the backfill the trench with similar or better materials than those excavated. The backfill work shall be performed in accordance with the applicable sections of the Specifications.

All concrete, asphalt concrete pavement, and base course material that is cut-away shall be excavated, loaded, hauled and disposed of at a suitable disposal site provided by the Contractor. Alternatively, if the cut-away debris is sufficiently broken-down such that no piece is larger than 150mm in any dimension, the Contractor may incorporate the debris in the highway embankment, where such work exists.

3.40.3 MEASUREMENT AND PAYMENT

Cutting of pavement will be measured in lineal metres of structure cut. No allowance will be made based on the depth of cut, or the type of material cut.

Payment for this Work will be made at the unit price bid for "Cutting of Pavement". The price bid will be considered full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

The removal and disposal of excavated material will be considered incidental to the Work and no separate or additional payment will be made.

When the Contractor cuts a trench across existing surfaces, the backfill of the trench with similar or better material will be considered incidental to the Work and no separate or additional payment will be made.

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5.31 GEOTEXTILE

5.31.1 GENERAL

The Work includes the supply and installation of both non-woven and woven geotextile at locations shown on the drawings, stated in the Special Provisions or as directed by the Consultant.

5.31.2 MATERIALS

5.31.2.1 Non-Woven Geotextile

Non-woven geotextile include:

- continuous monofilaments or staple fibers.
- random fibers that are physically entangled by punching with needles.
- random fibers that are pressed and melted together at the contact points.

The non-woven geotextile fabric shall meet the following requirements:

Property	ASTM Test	Material Specification [1] Average Roll Value		
		Type A [(2)]	Type B [(3)]	Type C [(4)]
Grab Tensile Strength (N)	D4632	400 min	650 min	875 min
Grab Tensile Elongation (%)	D4632	50 % min	50 % min	50 % min
Mullen Burst (MPa)	D3786	1.2 min	2.1 min	2.7 min
Puncture (N)	D4833	240 min	275 min	550 min
Trapezoid Tear (N)	D4533	180 min	250 min	350 min
Ultraviolet Stability (% Retained Strength)	D4355	70 % @ 150 hr.	70 % @ 150 hr	70 % @ 150 hr
Apparent Opening Size (mm)	D4751	0.2 max	0.2 max	0.2 max
Permittivity (per sec)	D4491	2.1 min	1.5 min	1.2 min
Flow Rate (l/sec/m$^{2)}$	D4491	102 min	102 min	102 min
Minimum fabric lap shall be 300 mm				

Note 1: All numeric values except A.O.S. represent minimum average roll value as measured in the weaker principal direction;
2: Typically used with perforated pipe and similar applications;
3: Typically used in medium duty situations such as under Class 1M, 1 & 2 riprap;
4: Typically used in heavy duty applications such as under Class 3 riprap.

5.31.2.2 Woven Geotextile

Woven Geotextiles consist of continuous monofilaments, staple fibres, multi-filament yearns, or slit films that are woven into a fabric.

Woven geotextiles shall have the following material properties:

Property	ASTM Test	Material Specification [1] Average Roll Value		
		Class 1	Class 2	Class 3
Elongation (%)	D 4632	<50 min	<50 min	<50 min
Grab Strength (N)	D 4632	1 400 min.	1 100 min.	800 min.
Sewn seam strength (N)	D 4632	1 260 min.	990 min.	720 min.
Tear Strength (N)	D 4533	500 min. [2]	400 min. [2]	250 min.
Puncture Strength (N)	D 4833	500 min.	400 min.	300 min.
Permittivity (per sec)	D 4491	0.05 min. [3]	0.02 min. [3]	0.02 min. [3]
Apparent Opening Size (mm)	D 4751	0.43 max.	0.60 max.	0.60 max.
Ultraviolet stability (% retained strength)	D 4355	50% after 500 hrs of exposure	50% after 500 hrs of exposure	50% after 500 hrs of exposure

Note 1: All numeric values except A.O.S. represent minimum average roll value as measured in the weaker principal direction

Note 2: For woven monofilament geotextiles, the required minimum average roll value for tear strength is 250 N.

Note 3: Default value. Permittivity of the geotextile should be greater than that of the soil. The Consultant may also require the permeability of the geotextile to be greater than that of the soil.

5.31.3 CONSTRUCTION

Unless otherwise directed in the applicable specification, the placement of geotextile shall be in accordance with the following:

- The surface to receive the geotextile shall be prepared to a relatively smooth condition free of obstructions, depressions, debris, and soft or low density pockets of material. The geotextile fabric shall be installed free from tensile stresses, folds, wrinkles, or creases.

- If more than one width of geotextile fabric is used, the Contractor shall either overlap the joints by a minimum of 400 mm with no stitching, or overlap the joint by 200 mm and provide two rows of stitching at each joint.

- The geotextile fabric shall be protected all times during construction. Wheeled or tracked vehicles shall not be allowed to travel directly on the geotextile fabric. Any geotextile fabric damaged during installation or during placement of granular material shall be replaced by the Contractor at his own expense.

5.31.4 MEASUREMENT AND PAYMENT

Supply and installation of geotextile will not be paid separately when the applicable specification states that the cost of supplying and installing geotextile is considered incidental to the Work, or included in the unit price bid for the Work for which the geotextile is being utilized.

In Contracts where the specification states the supply and installation of geotextile will be paid separately, geotextile will be measured in square metres of ground covered, excluding the area associated with laps or stitching.

Payment for:

- "Non-Woven Geotextile, Supply and Install" for the type specified;
- "Geotextile for Stabilization, Supply and Install" for the class specified ;
- "Geotextile for Materials Separation, Supply and Install" for the class specified;

will be made at the unit price bid per square metre". The price bid will be considered full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

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6.5 PERMANENT ENVIRONMENTAL PROTECTION DEVICES

6.5.1 GENERAL

This specification covers the installation of permanent environmental protection devices, as defined in Section 1.2.51.5 “General”, including silt fences, synthetic permeable barriers, erosion control soil covering, rock check dams and straw bale barriers.

The Work shall be in accordance with the Best Management Practices for the various structures as shown in the Design Guidelines for Erosion and Sediment Control for Highways, and as specified herein.

The location, spacing, and the estimated quantities of permanent environmental protection devices will be provided in the Special Provisions or will be as shown on the Contract Drawings.

6.5.2 ABBREVIATIONS AND DEFINITIONS

B.M.P. ..... Best Management Practice
E.C.B. ..... Erosion Control Barrier (Silt Fence)
R.E.C.P. . ..... Rolled Erosion Control Products
R.C.D. ..... Rock Check Dam
S.B.B. ..... Straw Bale Barrier
S.B.C.D ..... Straw Bale Check Dam
S.P.B. ..... Synthetic Permeable (Ditch) Barrier

6.5.3 MATERIALS

6.5.3.1 **Commercially Available Products**

Silt fences, synthetic permeable barriers and rolled erosion control products supplied by the Contractor shall be one of the Proven Products from the Alberta Infrastructure and Transportation Products List found on the Department’s web page. Alternative products that meet or exceed the material and performance properties shown on the Products List will be accepted subject to the Consultant’s review.

6.5.3.2 **Pins**

Pins shall be made, in either a T or U shape, from 4 mm diameter (minimum) ungalvanized wire. T-shaped pins shall be made from a single length of wire to a height of 200mm after bending. The bar of the T shall be 100 mm wide and the free end of the wire shall be bent downward approximately 20 mm. U-shaped pins shall have 200 mm long parallel legs spaced 25mm apart at the crown.

The Contractor shall have the option of supplying biodegradable plastic or wooden pins, compatible with the proven product, as an alternative to ungalvanized wire pins.

For synthetic permeable barriers, the pins shall be in accordance with manufacturer’s recommendations.

6.5.3.3 **Rock**

Rock shall meet the requirements of Class 1M Riprap in accordance with Specification 2.5 “Riprap”.

6.5.3.4 **Stakes**

Stakes used for silt fence and straw bale check dams and barriers shall be new, construction grade or better spruce wood cut from sound timber, and shall be free from any form of decay. The stake dimensions shall be in accordance with best management practice. Broken or split ended stakes will not be acceptable. Stakes cut from other types of wood may be used subject to the prior approval of the Consultant.

6.5.3.5 **Straw Bales**

Straw bales shall be less than 1-year old and shall show no signs of weathering. Bales shall be comprised of weed-free cereal crop straw such as wheat, oats, rye, or barley. Straw bales shall be machine-made, tightly compacted and bound with two rows of wire or synthetic string, and shall be rectangular in plan and cross-section.

6.5.4 CONSTRUCTION

6.5.4.1 **Erosion Control Barrier (Silt Fence)**

Silt fence barriers shall be constructed as early as practicable to maximize the entrapment of silt, and shall be placed along the contour of the fill slopes at the elevation specified or as directed by the Consultant. The terminal ends of the barrier shall be at a marginally higher elevation to prevent water from bypassing them.

The geotextile used in the fence construction shall be self-edged at the top and shall be buried at the lower end in a shallow trench on the upstream side of the fence line as shown in the B.M.P..

6.5.4.2 **Rolled Erosion Control Products**

Soil covering shall be placed immediately following seeding and fertilizing operations. The Contractor shall ensure that the ground surface is free from stones, or other debris, which would interfere with the uniform contact of the covering within the soil.

Soil coverings shall be unrolled in the direction of expected water flow and shall be applied without stretching so that they loosely, but smoothly, contact the soil surface. The top end of any ditch or slope installation shall be stapled and buried in a narrow trench that is at least 150 mm deep. The soil backfill in the trench shall be firmly tamped in place.

Longitudinal laps in covering installation shall be achieved by excavating a check slot of 150 mm minimum depth, at the location of the lap, and burying the upper end of the downslope blanket in the slot. The upslope covering shall then overlap the downslope one by a minimum of 150 mm. Coverings lying side by side shall be lapped a minimum of 100 mm.

Additional check slots shall be provided at a spacing of 15 m along slopes and 10 m along ditches measured parallel to the ground slope. The covering shall be folded to contact the cross-section of the slot and stapled in place. The trench shall then be firmly tamped.

Pinning of R.E.C.P. shall be as shown in the B.M.P.. A common row of pins shall be used for all laps.

6.5.4.3 **Rock Check Dams**

The rock check dam shall be constructed in a 0.15m deep key trench as shown in the B.M.P..

Typically, the weir crest shall be 0.5 metre above the ditch bed elevation unless otherwise directed by the Consultant.

6.5.4.4 **Straw Bale Check Dams and Barriers**

Straw Bale Check Dams and Straw Bale Barriers shall be constructed in accordance with B.M.P. No. 11 and No. 12.

Bales shall be placed in an open trench excavated in the ditch to accommodate the dimensions of the barrier as shown on the B.M.P drawing. The bales shall butt tightly against each other and shall be pinned to the ground with wooden stakes as shown in the B.M.P.. The joint between bales shall be caulked using loosing straw.

At the junctions where the sideslopes and backslope meet the ditch bottom, one end face of the bales meeting at these junctions shall be distorted, or otherwise modified, so as to permit a snug fit with the adjacent bale. The joint at these junctions shall also be caulked with loose straw.

6.5.4.5 **Synthetic Permeable (Ditch) Barrier**

The Contractor shall integrate barrier installation with the installation of erosion control soil covering within ditch areas.

Synthetic permeable barriers shall be shall be installed in accordance with manufacturer's recommendations unless otherwise specified in the B.M.P. No. 10.

6.5.5 MAINTENANCE

All permanent environmental protection devices shall be maintained by the Contractor until the issuance of the Construction Completion Certificate. At no time shall silt or debris build-up be allowed to exceed more than one-half of the above ground vertical height of the structure.

Damage to the permanent environmental protection devices, for whatever reason, shall be immediately repaired by the Contractor to the satisfaction of the Consultant.

The Contractor shall assume ownership of all silt and debris trapped by the permanent environmental protection devices and shall dispose of this material to the satisfaction of the Consultant.

6.5.6 MEASUREMENT AND PAYMENT

6.5.6.1 **Excavation and Backfilling**

Excavation and backfilling required for the installation of the permanent environmental protection devices will be considered incidental to the Work and no separate or additional payment will be made.

6.5.6.2 **Erosion Control Barrier (Silt Fence)**

Erosion control barrier will be measured in metres based on the length of the structure in-place.

Payment will be made at the unit price bid for "Erosion Control Barrier (Silt Fence)" and will be full compensation for all materials, equipment, labour, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

6.5.6.3 **Rolled Erosion Control Products**

Erosion control soil covering will be measured in square metres, based on the surface area of the ground covered by the installation. No allowances will be made for the burying or lapping of material.

Payment will be made at the unit price bid per square metre for "Erosion Control Soil Covering", for the type installed. This payment will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

6.5.6.4 **Rock Check Dams**

Rock Check Dams will be measured by the volume of rocks present in each structure calculated to the nearest 0.1 cubic metre in-place.

Payment will be made at the bid price per cubic metre for "Rock Check Dam". This payment will be full compensation for supplying the riprap, and all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

6.5.6.5 **Straw Bale Check Dams and Barriers**

Each row of bales in the structure will be measured in lineal metres. If the structure contains multiple rows of bales, the length paid will be the sum of the lengths of each row.

Payment shall be made at the unit bid price per metre for "Straw Bale Check Dam" or Straw Bale Barrier as applicable. This payment will be full compensation for all labour, materials, equipment, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

6.5.6.6 **Synthetic Permeable (Ditch) Barrier**

Each of the single rows of permeable ditch barriers will be measured to the nearest metre. The quantity paid for will be the sum of the lengths of barriers in each row.

Payment will be made at the unit price bid for "Synthetic Permeable Ditch Barrier", and will be full compensation for the supply of all materials, equipment, labour, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

Erosion control soil covering will be measured and paid at the applicable unit price bid.

6.5.6.7 **Maintenance**

Maintaining permanent environmental protection devices will be considered incidental to the Work and no separate or additional payment will be made. The removal and disposal of silt and debris trapped by the permanent environmental protection devices will be paid as Extra Work.

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6.10 GABIONS AND GABION MATTRESSES

6.10.1 GENERAL

This Specification covers the preparation of the ground surface to receive gabions, the placement of geotextile and the construction of the gabion structures in place, complete with rock filling in accordance with these specifications at locations specified on the drawings or described in the Special Provisions and in accordance with B.M.P. No. 2a-c of the Design Guidelines for Erosion and Sediment Control for Highways..

6.10.2 MATERIALS

All materials shall be supplied by the Contractor.

6.10.2.1 **Geotextile**

When specified, geotextile fabric shall be Type 'B' non-woven, in accordance with Specification 5.31 "Geotextile".

6.10.2.2 **Rock**

Rock used for gabion structures shall consist of clean, sound durable stones that are resistant to weathering and water action. Shale or other soft rock may not be used.

The stones shall be angular in shape with a height and width dimension of at least one third the length. The gradation of the mixture shall be such that at least 80 percent (by weight) of the stones, have a minimum dimension of at least 100 mm. The maximum dimension of a stone shall be the lesser of 300 mm or the gabion structure thickness.

6.10.2.3 **Gabions and Gabion Mattress**

The gabion materials supplied shall be of the Proven Products on the Alberta Infrastructure and Transportation Products list. Albertnative products meeting the properties listed below will be accepted pending review and acceptance by the Consultant

Gabion units shall be manufactured from wire in accordance with Federal Specification QQ-W-461G, "Wire Steel, Carbon (Round, Bare and Coated)" and shall be soft tempered. Additional requirements of the wire for gabion units are given in Table 1.

Table 1
Wire Requirements for Gabion Units

Property [1]	**Type**		
	Galvanized Basket	**Galvanized and PVC Coated Basket**	**Galvanized and PVC Coated Mattress**
Netting Wire dia. (mm)	2.90	2.65	2.20
Self-edge Wire dia. (mm)	3.85	3.40	2.65
Binding Wire dia. (mm) [2]	2.20	2.20	2.20
Zinc coating (gm/m2)	245	245	245
PVC coating (mm)	--	0.42	0.42

Note (1): The allowable tolerance on all properties is ± 3%
Note (2): Galvanized clips with a wire diameter of 2.90 mm may be used with galvanized baskets.

Mattresses and baskets shall be cubical in shape and shall be assembled from independent rectangular faces laced or clipped together. Each face shall be a non-raveling wire mesh woven with a double twist into regular hexagonal openings measuring approximately 75 mm X 100 mm. The edges of each face shall be self-edged by weaving the mesh around a reinforcing wire in a manner designed to prevent slippage. The self-edging shall be secure at all points so that joints formed by tying adjacent faces along the self-edges shall be at least as strong as the internal mesh.

Gabion basket and mattress shall be supplied, complete with diaphragms and dividers from among the various sizes listed in Tables 2 and 3.

Table 2
Gabion Basket Sizes and Dimensions

Dimensions and Volumes					
Size No.	**Number of Diaphragms**	**Length (m)**	**Width (m)**	**Depth (m)**	**Capacity (m3)**
1	1	2	1	0.3	0.6
2	1	2	1	0.5	1
3	1	2	1	1	2
4	2	3	1	0.3	0.9
5	2	3	1	0.5	1.5
6	2	3	1	1	3
7	3	4	1	0.3	1.2
8	3	4	1	0.5	2
9	3	4	1	1	4

Table 3
Gabion Mattress Sizes and Dimensions

Dimensions and Areas						
Size No.	**No. of Dividers**	**No. of Diaphragm**	**Length (m)**	**Width (m)**	**Depth (mm)**	**Plan Area (m2)**
10	1	18	30	2	230	60
11	2	27	30	3	230	90

6.10.3 CONSTRUCTION

All stumps, roots, debris and rocks shall be removed and disposed of as directed by the Consultant, prior to placing gabions. Excavation to accommodate gabion installation shall be carried out to the lines and levels as specified on the plans or as directed by the Consultant.

Geotextile shall be laid free from wrinkles onto the prepared ground surface. Laps in geotextile shall be a minimum of 500 mm with the upslope portion on top. The edges of the geotextile shall be neatly trimmed or buried in the ground whichever is specified.

Individual gabion units shall form the component parts of a gabion structure.

Gabion cages shall be assembled by tying the appropriate faces together along the selfedges with binding wire. The binding wire shall be tightly looped around every other mesh opening to form a spiral with single and double loops alternating. Diaphragms and dividers shall be affixed in position by similarly binding them to the mesh of the assembled cage. Free ends of binding wire shall not be made to project from exposed faces of gabion structures.

When assembled, gabion baskets shall be divided by the diaphragms into compartments having a plan dimension of one metre square. Gabion mattress shall be separated lengthwise by the dividers into 1 m wide strips. The diaphragms shall further subdivide the mattress into compartments that have a plan dimension of 1m x 3m.

Gabion units, grouped together to form a gabion structure, shall be securely bound to each other along all contacting selfedges in the same manner as the faces are bound in the assembly of the cages.

Irregular shapes in any structure shall be achieved by overlapping and bending the rectangular components. Cutting of the mesh shall be minimized to avoid damage to the galvanized wire.

Rocks shall be infilled in the assembled cage units either by machine or by hand. When machine is used, minor rock repositioning shall be done by hand to fill the voids between larger rocks and thereby achieve a dense structure. Rocks along visible faces shall be selected and placed by hand from among the larger sizes with a flat face toward the exterior to produce a semblance of a masonry structure and a neat and workmanlike appearance.

Undue distortion in gabion units shall be avoided. Rock filing shall be carried out in stages with the difference in rock level between any two adjacent compartments limited to 250 mm. Further, distortion of gabion baskets shall also be prevented by tying with binding wire, the opposite faces of a compartment at the surface level of the rocks when the depth of fill has reached designated levels. These levels shall be 300 mm and 600 mm for 1.0 m deep baskets and 250 mm for 0.5 m deep baskets. Cross ties are not required for 0.3 m deep baskets.

The exposed faces of a gabion structure shall be maintained true to vertical and horizontal alignment by stretching taut with a standard fence stretcher, or other approved method, before placing rocks within the baskets. No such stretching is required for gabion mattress installation.

Following the filling of each gabion unit, the lid shall be affixed in position so that the selfedges coincide with the perimeter of the filled gabion unit. The selfedges shall then be laced together in the same manner as described above.

6.10.4 MEASUREMENT AND PAYMENT

6.10.4.1 **Excavation**

Where excavation for gabions does not overlap with excavation for other work, excavation will be classified and paid as "Channel Excavation" in accordance with Specification 2.3 “Grading”.

Where the excavation for gabion overlaps excavation for other work, only the excavation for other work will be measured and paid, as if no separate excavation for gabions took place.

The removal and disposal of debris, stumps, roots, etc. will be considered incidental to the Work and no separate or additional payment will be made.

6.10.4.2 **Geotextile**

Geotextile will be measured by the square metre, based on the surface area covered by the material, with no allowance made for laps. Payment will be at the price bid for "Geotextile Installation - Gabions". This payment shall be compensation in full for the supply of all materials, equipment, labour, tools and incidentals necessary to complete the work.

6.10.4.3 **Gabion**

Gabion baskets will be measured in cubic metres based on the nominal dimensions of the baskets installed.

Payment for gabion baskets will be made at the price bid per cubic metre for "Gabion Basket". This payment shall be compensation in full for the supply of all materials including rock, and all equipment, labour, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.

6.10.4.4 **Gabion Mattress**

Gabion mattress will be measured in square metres based on surface area of the mattress in place.

Payment for gabion mattress will be made at the price bid per square metre for "Gabion Mattress". This payment shall be compensation in full for the supply of all materials including rock, and all equipment, labour, tools and incidentals necessary to complete the Work to the satisfaction of the Consultant.