LLOYDMINSTER

MUNICIPAL DEVELOPMENT STANDARDS

SECTION 3 – ROADWAY SYSTEMS

October 2020

Planning & Engineering

TABLE OF CONTENTS

SECTION			PAGE
3	Roadway Systems		3-2
3.1	General		3-2
3.2	Traffic & Transportation		3-2
3.3	Road Classification and Geometric Standards		3-2
3.3.1		General	3-2
3.3.2		Arterial Road	3-2
3.3.3		Collector Road	3-2
3.3.4		Local Road	3-2
3.3.5		Angle Parking	3-3
3.4	Traffic Impact Assessment		3-3
3.5	Pavement Structures		3-3
3.6	Road Construction Requirements		3-3
3.6.1		General	3-3
3.6.2		Temporary Roads and Access	3-3
3.6.3		Dust Control, Street Cleaning and Snow Removal	3-3
3.6.4		Maintenance of Existing Facilities	3-4
3.6.5		Staged Construction	3-4
3.7	Materials		3-4
3.7.1		General	3-4
3.7.2		Concrete	3-4
3.7.2.1		Concrete Design	3-4
3.7.2.2		Deficiencies	3-4
3.7.3		Asphalt	3-5
3.7.3.1		Pavement Design	3-5
3.7.3.2		Deficiencies	3-5
3.8	Traffic Control Devices, Street Signs, And Pavement Markings		3-5
3.9	Roadway Illumination		3-5
3.10	Sound Abatement		3-6
3.11	Swales		3-6
3.12	Lanes		3-6
3.13	Cul-De-Sacs		3-6
3.14	Intersections		3-7
3.15	Walkway Systems		3-7
3.15.1		Urban Sidewalks	3-7
3.15.2		Trails	3-7
3.16	Roundabouts		3-7
3.17	Speed Controls for New Residential Neighbourhoods		3-8

3 ROADWAY SYSTEMS

3.1 General

Drawings relating to roadway design and construction are provided in section 1 (Roadways) and 2 (Concrete Work) of the Standard Drawings.

3.2 Traffic & Transportation

This section covers the transportation and traffic engineering aspects of roadway and walkway design in the City. It also covers those roads, lanes, curbs, gutters, walks, and trails to be built or re-built in the City.

These requirements and standards are the minimum basis for roadway and walkway facilities. Changes in the design values may be considered, provided that the changes are justified and added benefits are provided by the Developer to the City's satisfaction.

All designs must be consistent with the current version of the City of Lloydminster Transportation Master Plan and must ensure the safe and efficient movement of traffic and pedestrians. Sufficient access points to collectors must be provided subject to the approval of the City.

3.3 Road Classification and Geometric Standards

The classification and designation of roads and walks must be undertaken during the subdivision design stages, commencing with the Outline Plan, in order that roads and walks, utility, and right-of-way requirements can be coordinated, established and approved in the design stages of subdivision development.

3.3.1 General

Roads are classified in a functional hierarchy. The road classifications are local, collector, and arterial. The design standards for roads must be in accordance with the geometric design guidelines outlined in the latest edition of the "Geometric Design Guide for Canadian Roads" by the Transportation Association of Canada. Typical cross-sections are provided in Section 1 (Roadways) of the Standard Drawings. Table 3.1 in Appendix 3A provides a summary of the design standards.

3.3.2 Arterial Road

Arterial roads generally serve as line-haul facilities carrying traffic between activity centres - connecting with collectors, and other arterials, but not local streets. Arterial streets can be subdivided into two categories: undivided, which would carry up to 12,000 vehicles per day; and divided, which would carry more than 12,000 vehicles per day. On-street parking is not normally permitted on this type of roadway within the City.

3.3.3 Collector Road

A Collector road is intended to provide local access to frontage developments, or to channel traffic collected from several local streets or from an industrial area towards the arterial system. A collector road can connect with local roads, other collectors or with arterial roadways; however, their location should minimize the potential use as a short-cut between arterial roadways. Parallel parking may be allowed on these roads. No residential driveways are permitted to be constructed that access collector roadways, unless the roadway is expected to service less than 4000 vehicles per day under its ultimate design condition.

3.3.4 Local Road

A Local road is intended solely to provide access to individual properties. The amount of traffic on the road is generally low; however, the volume can be controlled if the maximum length is set at 600 m and speed control considerations as described in Section 3.17 are a part of the design. This road should only be permitted to connect with similar type facilities or with collector roads. All sites should provide sufficient on-site parking to meet demands. A local road may not service commercial bus routes, however school buses are permitted.

3.3.5 Angle Parking

Angle parking is not permitted, but may be considered in redevelopment areas where it is shown to be advantageous. Proposal of a non-standard road width to accommodate angle parking would follow the standards deviation process.

3.4 Traffic Impact Assessment

A traffic impact assessment (TIA) will be required whenever a proposed development will have a significant impact on the adjacent transportation system. If, in the opinion of the City, the development will have insignificant impact on the transportation system, a TIA may not be required. In general, a TIA will be required for developments generating more than 100 vehicle trips in the peak hour, as calculated using the latest edition of the Trip Generation Manual published by the Institute of Transportation Engineers. The TIA should adhere to the Lloydminster Traffic Impact Analysis Guidelines. Additional guidance may be obtained from the City.

3.5 Pavement Structures

In accordance with Section 2.2.1, a geotechnical investigation must be conducted for every new development. The recommendations of the geotechnical investigation report must be followed. Unless otherwise recommended by the geotechnical report, the pavement structure will include a minimum of 150 mm of subgrade preparation, a granular base of 300 mm in thickness and asphaltic concrete surface with a thickness of 120 mm. Proposed reductions to the minimum structure must be justified in the geotechnical report.

Pavement structure design will be based on a 20 year design life. Arterial pavement structure design must also be based on projected traffic loading. Bus loading on arterial and collector roads must be considered in the design of the pavement structure.

The pavement must be placed in two (2) separate lifts. The first lift must conform to the requirements for base course construction and should withstand the expected loads due to construction activity in the first two (2) years and must be placed prior to a Construction Completion Certificate being executed by the City. The second lift should be placed no more than thirty (30) days prior to the expiry of the two (2) year warranty period and must be placed prior to a Final Acceptance Certificate being executed by the City.

3.6 Road Construction Requirements

3.6.1 General

Good roadway industry construction practices and techniques must be employed. Roadway construction must be in accordance with the plans and design approved by the City, and the parameters identified in Appendices 3B and 3C. The work must be carried out at all times in an efficient manner with approved equipment and capable personnel. The City or an appointed representative must at all times have access to the site and will promptly be provided with all test results and all information necessary to assess the Contractor's performance.

3.6.2 Temporary Roads and Access

Plans for temporary roads, access, and detours must be approved by the City, as part of the Traffic Accommodation Strategy. All weather type construction will be required, and the Developer is responsible for all maintenance of temporary roads, access, and detours.

All signing, channelization, detours, closures, etc. must be in accordance with the Manual of Uniform Traffic Control Devices as published by the Transportation Association of Canada.

3.6.3 Dust Control, Street Cleaning and Snow Removal

The Developer will be responsible for dust control, and debris and mud removal from sidewalks, curb, gutter, and boulevards within the subdivision for the duration of the Warranty Period. The Developer will also be

responsible for ensuring silt and debris cannot enter into catch basins within the new development and areas directly adjacent to the new development in accordance with the Erosion and Sedimentation Control Plan, as described in Section 5.8. Some of these responsibilities are shared by the developers of the individual lots in the subdivision, as described in Section 11.9.1.

The City will be responsible for snow removal and street cleaning once the first lift of asphalt has been installed and a Construction Completion Certificate has been executed.

3.6.4 Maintenance of Existing Facilities

The Developer must ensure that existing infrastructure, such as sewer mains, watermains, roadways, and landscaped areas, are not disturbed or become inoperable as a result of actions by the Developer, their agents or Contractors. Existing infrastructure must not be exposed to loadings beyond design capacities. Existing infrastructure must continuously be maintained and cleaned by the Developer where their actions are cause for additional maintenance. Where the road surface or concrete have been disturbed, these areas should be restored to their original condition within two (2) weeks, but in any case must be restored no more than four (4) weeks from the time the subsurface work is completed. The existence and location of any underground utilities indicated on the plans that have been determined from the City's records are not guaranteed.

3.6.5 Staged Construction

Staged construction must meet the approval of the City. The Developer is responsible for all maintenance of partially completed works which have been opened for use. All partially completed works must be properly restored prior to commencing with the next stage of construction. The Developer is required to place a temporary turnaround on dead end streets to accommodate curbside collection and school buses.

3.7 Materials

3.7.1 General

Materials used in roadway construction must be from sources approved by the City. Manufactured goods must meet the standard manufacturer's specifications and the approved roadway specifications. Defective, rejected or substandard materials must not be used in the construction of roadways under any circumstances.

3.7.2 Concrete

3.7.2.1 Concrete Design

Concrete for roadways, including sidewalks, walkways and structures, must be to a C-2 exposure classification (CSA-A23.1), have a minimum compressive strength of 32 MPa in 28 days, be Type HS (unless specified differently) 5% to 8% air content, have a nominal maximum size coarse aggregate of 14.0-20.0 mm, a maximum water/cement ratio of 0.45, and use a curing compound. Slump must be 80 ±30 mm for hand placed concrete and 25 ±15 mm for extruded concrete. A concrete mix design must be submitted to the City for review a minimum of two (2) weeks prior to initial concrete placement.

3.7.2.2 Deficiencies

Areas found to be deficient in compressive strength will be rejected. The cost of removing and replacing the deficient concrete surface and any associated costs due to additional testing requirements, must be borne by the Developer. The warranty period will not be considered to be complete until such time as testing and inspection demonstrates the replaced surface is not deficient.

The representative area will be considered to be deficient if it does not reach eighty (80) percent of the minimum compressive strength within 28 days. Compressive strength must be determined in accordance with CSA A23.2-9C.

3.7.3 Asphalt

3.7.3.1 Pavement Design

Roadways in all subdivision developments must be surfaced with asphaltic concrete pavement (hot mix asphalt). An asphalt mix design must be submitted to the City for review a minimum of fourteen (14) days prior to initial asphalt placement. Design parameters can be found in Appendix 3B.1.

3.7.3.2 Deficiencies

Areas found to be deficient in bitumen content, thickness or density will be rejected, unless other corrective actions are taken to the approval of the City. The cost of removing and replacing the deficient asphalt surface, and any associated costs due to additional testing requirements, must be borne by the Developer. The warranty period will not be considered to be complete until such time as testing and inspection demonstrates the replaced surface is not deficient. The collection of any additional cores must be witnessed by a representative of the City.

The representative area will be considered to be deficient if the deviation from the approved bitumen content, as identified in the approved mix design, is 0.5% or greater. If a deficiency in bitumen content is found, three (3) more cores must be taken from the same area and retested, and the average bitumen content of those three cores will represent the area. Bitumen content must be determined in accordance with ASTM D2172 or ASTM D6307-10.

The representative area will be considered to be deficient and rejected if the thickness deficiency is greater than 6.0 mm per lift, or 9.0 mm total. If a deficiency in thickness is found, three (3) more cores must be taken in the area, and the average thickness of those three cores will represent the area. Core thickness must be determined in accordance with ASTM D3549.

The cores will also be used to determine density. If any test fails to meet the minimum paving density for the type of paving as specified in Table 3.8 in Appendix 3C, three (3) more cores must be taken in the area, and the average density of those three cores will represent the area. The representative area will be considered to be deficient and rejected if the difference in percentage density is 2.0 or greater (e.g. if the required density is 97.0%, a density less than 95.0% would be rejected). Core density must be determined in accordance with ASTM D2726, ASTM D1188, or ASTM D6752.

3.8 Traffic Control Devices, Street Signs, And Pavement Markings

Traffic control devices, street signs and pavement markings must be installed by the Developer and must be in accordance with the latest edition of the Manual of Uniform Traffic Control Devices for Canada; see Section 1 (Roadways) of the Standard Drawings for typical road cross-sections.

Highly reflective engineering grade street name signs and traffic control high density signs, of a type and colour satisfactory to the City, must be mounted on an aluminum post in accordance with the City's Standards. Approved sign supports must be installed by the Developer as per the approved Traffic Control Devices and Street Sign plans. Stop signs are the only signs required to be Diamond grade reflective signs.

Pavement markings, including lane markings, stop lines and pedestrian crossings, must be provided by the Developer at their own expense. Pavement markings must be painted on the top course of asphaltic concrete surfaces both at the interim and Final Acceptance Certificate lift at the time of construction.

3.9 Roadway Illumination

The Developer must provide plans for street lights. Where a development connects with existing roadways, the tie-in point must be considered in the design. The frequency of street lights will be such as to provide the minimum lighting levels in conformance with the Transportation Association of Canada's *Guide for the Design of Roadway Lighting*.

Street lights must be placed at locations not interfering with proposed driveways and water and sewer services and in general will be located in line with the extension of common property lines between two lots. Wherever possible, street light cables will be installed underground. Cables crossing all roadways or driveways will be placed in direct-burial type rigid plastic pipe using one pipe per individual cable unless noted otherwise.

3.10 Sound Abatement

The Developer must utilize berms or elevated contoured embankments and noise attenuation fencing for sound abatement along arterial roadways, highways and/or railways as required by regulatory authorities and the City. Refer to Standard Drawings 9-209 – Noise Attenuation Fence, and 9-301 – Typical Berm.

Where a railway, arterial roadway, Secondary Highway or Primary Highway abuts or passes through a development area, the Developer must engage an independent consultant to conduct a noise study to forecast noise levels that would be experienced within the development area from the rail and/or roadway:

- Where the noise study predicts a 24 hour L_{eq} of 55 dBA or less measured or calculated at a distance of 5.0 m from the nearest dwelling facade adjacent to the rail and/or the roadway within the subdivision area, no further action by the Developer will be required; and
- Where the noise study predicts a 24 hour L_{eq} in excess of 55 dBA, the Developer must provide noise attenuation in a form that will reduce the noise level to 55 dBA or below.

The subdivision side of the embankment must be with gentle slopes no greater than 4:1. The right-of-way may require widening to suit.

Noise attenuation fencing as described in Section 8.1.4.1 must be used. Alternative sound barrier fences may also be accepted by the City upon approval of submitted designs.

3.11 Swales

Swales will not be permitted in the roadways of new developments.

3.12 Lanes

In general, the following design standards should be followed:

- Minimum 6.0 m of right-of-way;
- Residential lanes must be paved and have minimum width of 4.5 m, with centreline swale and 2.5% cross-fall. Commercial/industrial lanes must be paved and be a minimum of 6.0 m wide or the width of the right-of-way;
- Where lane traffic is expected to be high, such as for certain commercial developments, a wider surface width and right-of-way may be required, as determined by the City;
- Road structure must be as per the recommendations of the geotechnical investigation;
- Where possible, lanes must have at least two points of access. "Dead-end" lanes, where justification has been provided that a second point of access is not feasible, must be terminated with a means to turn around;
- Lanes are to be designed such that any one point is not more than 175 m from a connection to a roadway. The lane layout should not encourage possible short cutting between streets;
- Maximum lane grade is 6.0%; and
- Minimum lane grade is 0.8%.

3.13 Cul-De-Sacs

In residential subdivisions, all dead-end roads must be provided with a cul-de-sac or turnaround consistent with the requirements outlined in Standard Drawing 1-106 and the Transportation Association of Canada manual. The length of dead end roads that service residential lots must be no greater than 150 m, as measured from the centreline of the intersecting street to the centre of the bulb. Cul-de-sac bulbs in residential areas must have a minimum radius of 12.5

m from the centre to the face of curb. Bulb road surfaces must be crossfall sloped for drainage, at a minimum grade of 1.0% and a maximum grade of 3.0% outward from the centre of the bulb. The bulb must have a minimum gutter grade of 0.8%.

Islands may be provided in cul-de-sacs, upon approval of the City. The design of cul-de-sacs including islands must be shown to allow the minimum turning movements of passenger (P) and garbage collection (HSU) vehicles and have sufficient width to allow for movement around passenger vehicles parked curbside. Islands must be complete with curb and gutter.

3.14 Intersections

The design of intersections must conform to the following:

- The minimum angle of intersection between two roadways is 75°;
- Curb returns must have a radius of 12.0 m minimum in residential areas (7.0 m if parking is allowed in the curb lane of both roadways) and in industrial areas a radius of 15.0 m minimum;
- Gutter grades are a minimum of 0.8% around curb returns; and
- Roadways connecting at an intersection must have a maximum grade 2.0% for 30.0 m approaching the intersection.

3.15 Walkway Systems

3.15.1 Urban Sidewalks

Concrete sidewalks measuring 1.5 m in width will be required in the following instances:

- On both sides of Collector roads;
- On both sides of residential road layouts;
- On both sides of cul-de-sacs;
- Where there is a possibility of a requirement to provide continuity of sidewalk to future development; and
- Where linkage is required to maintain the continuity of a pedestrian network.

Refer to the Standard Drawings in Section 1 (Roadways) for typical layouts and Standard Drawings 2-105, 2-106 and 2-107 for dimensions.

Curb ramps must be provided on sidewalks at all roadway intersections and at all pedestrian crossings in accordance with Standard Drawing 2-200.

3.15.2 Trails

Pedestrian or multi-use trails must be 3.0 m wide and designed in accordance with Standard Drawing 9-100. Trails may be installed on one side of a collector or industrial/commercial roadway in place of the sidewalk and must be placed on one side of an arterial roadway.

3.16 Roundabouts

It is recommended that roundabout designs be developed in accordance with the most recent version of The Transportation Association of Canada's *Canadian Roundabout Design Guide*. At a minimum, the following information must be included with the design drawings where applicable:

- All radii and grades for the inner circle and all outside radii;
- Curve tables;
- Dimension of the length of splitter islands;
- Dimension of the inscribed circle diameter;
- Dimension of the centre island diameter;
- Dimension of the entry and exit widths;

- Indicate entry angles;
- Dimension of the circulatory roadway width;
- Location and extent of the truck apron;
- Stopping sight distance showing sight lines for features in the centre and at each leg, showing vehicles and pedestrians; and
- Signage and pavement markings.

A roundabout landscape plan (following the requirements for landscaping drawings described in Section 2.3.4.9) must be submitted to the City for review and approval. Roundabout landscaping features must be designed such that they follow the approaches of the above noted NCHRP document with the addition of the following considerations:

- Only approved species of vegetation are to be used for plantings, see Section 8.1.2;
- The use of gravel and public furniture is to be avoided for use as landscape features;
- Truck aprons, if used, must use red coloured concrete, to differentiate it from walkways;
- Splitter islands are to be filled with concrete, which can be stamped or coloured for aesthetics;
- All concrete flatwork within the central island must be coloured for visibility; and
- Landscaping features must not interfere with access to utilities or ability to perform maintenance on utilities that may pass through the roundabout.

Standard Drawings 1-500 and 1-501 show an example of a typical roundabout cross-section, and the landscaping zones, respectively.

3.17 Speed Controls for New Residential Neighbourhoods

On residential collector and local roads, include speed (traffic calming) control measures for road segments longer than 300 m. Speed controls aim for vehicle speeds in the order of 30 km/h. These speed controls consist of:

- A design condition requiring yielding the right of way;
- A tight horizontal curve defined as follows:
    - Delta from 30 to 40 degrees, centreline radius of 30 m or less;
    - Delta from 41 to 50 degrees, centreline radius of 35 m or less;
    - Delta greater than 51 degrees, radius of 45 m or less;
- Traffic calming devices with significant horizontal or vertical deflection, including but not limited to:
    - A raised crosswalk or bump-outs at a pedestrian or bicycle crossing;
    - A roundabout; or
    - A raised intersection.

This page intentionally left blank.

TABLE OF CONTENTS

SECTION		PAGE
Appendix 3A - Road Classifications		3A-2
Appendix 3B - Concrete Specifications		3B-1
3B.1	Placing	3B-1
3B.2	Temperature	3B-1
3B.3	Testing	3B-1
3B.4	Finishing	3B-1
Appendix 3C - Asphalt Specifications		3C-1
3C.1	Pavement Design	3C-1
3C.1.1	Aggregates	3C-1
3C.1.2	Mineral Filler	3C-2
3C.1.3	Bituminous Binder	3C-2
3C.1.4	Asphalt Mix	3C-3
3C.2	Road Base and Subgrade Preparation	3C-4
3C.3	Asphalt Placement	3C-4
3C.4	Testing and Inspection	3C-5

Appendix 3A - ROAD CLASSIFICATIONS

Table 3.1 provides a summary of the City's design standards for the various classifications of roads.

Table 3.1 – Road Classification and Geometric Guidelines

CLASSIFICATION	URBAN						RURAL	
	Arterial		Collector		Local		Collector	Local
	Divided	Undivided	Residential	Ind/Comm (Note 2)	Residential	Ind/Comm (Note 2)	Industrial (Note 2)	
TAC Designation	UAD	UAU	UCU	UCU	ULU	ULU	RCU	RLU
Parking	No	No	Permitted	Permitted	Permitted	Permitted	No	No
Service	Through Traffic		Through Traffic & Access		Access Only		Through & Access	Access Only
Average Daily Volume	12000-30000	5000-12000	1000-5000	1000-5000	Up to 1000		1000-5000	Up to 1000
Truck Traffic	5	5	5	10	1		5	10
No. of Housing Units	-	-	More than 100	-	Less than 100		-	Less than 100
Flow Characteristics	Uninterrupted except traffic/pedestrian signals		Interrupted flow		Interrupted flow		Interrupted flow	
ESALS	(Note 3)		$1.35x10^6$	$2.70x10^6$	$9.00x10^4$	$8.60x10^5$	$1.35x10^6$	$8.60x10^5$
Design Speed (km/h)	80	70	60	60	50	50	80	60
Posted Speed (km/h)	60-70	60	50	50	50	50	70	50
Road Width (m) (Note 1)	7.4 per direction	14.8	12(7)	12	11	12	8	8
Travel Lanes (m)	4 @ 3.7	4 @ 3.7	2 @ 3.6	2 @ 3.7	N/A	N/A	N/A	N/A
Parking Lanes (parallel)	N/A	N/A	2 @ 2.4	2 @ 3.0	N/A	Optional	N/A	N/A
Transit Service (Note 5)	Restricted		Permitted		Prohibited		Permitted	Restricted
Curb & Gutter (mm)	510	510	400	400	600	400	N/A	N/A
Curb Type	Standard		Standard with driveway cut		Rolled Face	Standard with driveway cut	N/A	N/A
Curb Return Radii (m)	Site specific; design to be approved by the City		15	15	12	15	N/A	N/A
Curb Cut Dimensions (m)	Site specific; design to be approved by the City		10 x 10	10 x 10	5 x 5	10 x 10	10 x 10	10 x 10
Radii (m) for Cul-de-Sac (Note 1)	Restricted		13.5 (Note 4)	17	13.5 (Note 4)	17	17.0 to EP	
Sidewalk	Separate - Both Sides		Separate - Both Sides		Mono - Both Sides	Separate - Both Sides	Optional	
Sidewalk Width (m)	1.5 Conc and 3.0 ACP		1.5 Conc or 3.0 ACP	1.5 Conc or 3.0 ACP	1.25 Conc	1.5 Conc or 3.0 ACP	3.0 ACP	3.0 ACP
Right-of-Way Width (m)	59	52	24	24	18	24	30 Minimum	30 Minimum
Max./Min. Gradient (%)	3/0.5	5/0.5	6/0.5	8/0.5	8/0.5	6/0.5	8-10/0	10-13/0
Min Stop Sight Dist. (m)	140	110	85	85	65	65	140	85
K. Crest (m)	36	23	13	13	7	7	35	15
K. Sag (m)	16	12	9	18	6	12	35	18
Crossfall (%)	2.5 - 4	2.5 - 4	2.5 - 4	2.5 - 4	2.5 - 4	2.5 - 4	2.5 - 4	2.5 - 4

NOTES:
1. Road width dimension is edge of pavement (EP) to edge of pavement (EP).
2. Industrial applies to light industrial. For heavy industrial application, provide suitable design.
3. ESALS for arterial roadways are to be determined by engineering analysis by the developer's engineer and approved by the City.
4. Parking restrictions shall be applied on all residential cul-de-sacs from 7:30 AM to 4:30 PM on the scheduled garbage pick-up day in the subject area.
5. Minimum grade on all linear curb and gutters is to be 0.5%. Minimum grade on all curved curb and gutters, including curb returns and cul-de-sacs is to be 0.8%.
6. Major collectors connect to arterial roads and minor collectors connect to major collectors. Local roads connect to minor collectors.
7. Collector details to be reviewed and approved by the City.

This page intentionally left blank.

Appendix 3B - CONCRETE SPECIFICATIONS

3B.1 Placing

The top 150 mm of subgrade under separate walk or trails must be compacted to a Standard Proctor Density of 100% at ±2% of optimum moisture content. The granular base must be compacted to a Standard Proctor Density of 100% at ±2% of optimum moisture content.

The vertical height of free fall of concrete will not exceed 1 m, otherwise chutes or tremies will be used. During placement, concrete will be sufficiently tamped and vibrated with suitable equipment to ensure a close bond with the reinforcement, eliminate entrapped air voids, and ensure a homogeneous structure with adequate consolidation.

3B.2 Temperature

In hot weather conditions where the air temperature is at or above 27°C, the concrete temperature must not exceed 30°C. In cold weather conditions where the air temperature is at or below 5°C, the concrete must be delivered at a temperature between 15°C and 32°C. The temperature of the placed concrete must be maintained at a minimum of 10°C for 3 days by use of insulation or hoarding and heating.

When the mean air temperature is below 5°C, suitable means must be provided for maintaining the concrete at a temperature of at least 10°C for 7 days following placement of the concrete. Concrete will not be placed on frozen sub-grade.

3B.3 Testing

Slump, air content, and compressive strength tests for the concrete will be taken at least once every 50 m^3 placed for each class of concrete, with at least one test for each day of placing concrete. At a minimum, a total of four (4) concrete cylinder samples must be taken for compressive strength testing at 7 days, two (2) at 28 days, and a hold cylinder for further testing, if required. If the ambient air temperature during the first 24 hours after the cylinder is cast is expected to be outside the range of 15-25°C, an additional 7 day field cure cylinder must be cast. The concrete sample must be taken at the point of discharge into the structure. Testing must be conducted by an independent certified quality assurance laboratory.

3B.4 Finishing

Working of the surface during finishing will be the minimum amount necessary to produce the specified finish, with no exposed aggregate or entrapped air, or addition of water. The brush finish will be done with an approved nylon bristle brush or broom lengthwise along the curb and gutter, and transversely across the sidewalk to create grooves no deeper than 3mm. There is to be no excess water on the concrete surface. The surface of the concrete will be protected from the sun and air by an approved membrane curing material.

The contractor's name and year of construction must be stamped on the top of curb in each block or at 200m intervals, whichever is less as well as on the walk at each end of the block at an extension of property line. CC stamps will be placed perpendicular to the location of the CC, as shown in Standard Drawing 2-204.

Appendix 3C - ASPHALT SPECIFICATIONS

3C.1 Pavement Design

The pavement structure will be designed to carry the anticipated loadings and traffic capacity for a 20 year life. A mix design including a job mix formula must be submitted to The City for each asphalt mix type a minimum of ten (10) working days prior to the initial placement of asphalt. The asphaltic concrete must consist of aggregate (or as an alternative, recycled asphalt), mineral filler, bituminous binder and an anti-stripping agent. The asphalt must be laid and compacted to the specified thickness, conforming to the approved lines, grades and typical cross-sections.

Five (5) types of asphalt mixes may be used for surfacing depending on the classification of road:

- B – typically used as an asphalt cemented base;
- S1 – typically used on local residential roadways and collectors (0-3 million EASLs on a 20 year design);
- S2 – typically used on collectors, arterials and industrial roadways (3-6 million EASLs on a 20 year design);
- HWY1 – typically used on highways (>6 million EASLs on a 20 year design); and
- Ultra-thin – typically used as an overlay on arterial roads.

3C.1.1 Aggregates

The aggregates in the mix must meet the gradation specified in Table 3.2 when tested to ASTM C-136 and C-117, within the tolerances identified in Table 3.3.

Table 3.2 – ACP Aggregate Gradation

Sieve Designation (mm)	Asphalt Mix Type (% Passing)			
	B	S1	S2, HWY1	Ultra-thin
20	100	–	–	–
16	84 – 94	–	100	–
12.5	–	100	80 – 92	100
10	63 – 86	83 – 92	70 – 84	98 – 100
5	–	55 – 70	50 – 65	85 – 95
2.5	20-43	–	–	–
1.25	–	26 – 45	26 – 45	38 – 48
0.630	14 – 34	18 – 38	18 – 38	25 – 35
0.315	9 – 26	12 – 30	12 – 30	12 – 23
0.160	5 – 18	8 – 20	8 – 20	6 – 15
0.080	2 – 10	4 – 8	4 – 8	4 – 8

Physical properties for the aggregate must meet the requirements in Table 3.4.

Table 3.4 – Physical Properties of ACP Aggregate

Requirement	Asphalt Mix Type				
	B	S1	S2	HWY1	Ultra-thin
Los Angeles Abrasion (% loss) (ASTM C131)	35 max.	32 max.	32 max.	32 max.	30 max.
Organic Content (% Passing 5.0 mm)	1.0 max.	1.0 max.	1.0 max.	1.0 max.	1.0 max.
Crush Count – 1 Face (% Retained 5.0 mm Sieve)	–	–	–	95 min.	–
Crush Count – 2 Faces (% Retained 5.0 mm Sieve)	60 min.	70 min.	70 min.	85 min.	80 min.
Manufactured Fines (% Passing 5.0mm Sieve)	60 min.	–	–	75 – 85	70 min.

3C.1.2 Mineral Filler

Mineral filler may consist of Portland cement, pozzolan, commercially ground stone dust, or other mineral dust approved by the City. Mineral filler will have a plasticity index of zero, and when tested by means of laboratory sieves it will meet the gradation in Table 3.5.

Table 3.5 – Mineral Filler Gradation

Sieve Designation (mm)	% Passing
0.4	100
0.16	not less than 90
0.08	not less than 70
0.045	not less than 62

Mineral filler is to be dry and free flowing when added to the aggregate.

3C.1.3 Bituminous Binder

The bituminous binder must be of uniform character, free of water, and must not foam when heated to 175 degrees Celsius. Solvents used in the manufacture of cut-back asphalts must be derived from petroleum oils. Emulsifiers used to stabilize asphalt emulsions must not be harmful to the performance of the asphalt in service. Bituminous binder must meet the specifications in Table 3.6.

Table 3.6 – Bituminous Binder Specifications

Asphaltic Cement	AASHTO Test Method	ASTM Test Method	Specification
Absolute Viscosity at 60 º C, 30 cm vacuum, poises	N/A	D2171	500+
Penetration, 25 º C, 100g, 5 sec.	T49	D5	150 - 200A
Flash Point (Cleveland Open Cup, º C)	T48	D92	205+
Thin Film Oven Test	T179	D1754	4.0 maximum
Penetration after test, 25 º C, 100 g 5 sec., % of original	T49	D5	40+
Ductility at 25 º C	T51		100 maximum
Solubility in Trichloroethylene	T44	D2042	99.5+

3C.1.4 Asphalt Mix

Asphalt mixes must consist of a homogeneous mixture of asphalt mix aggregate and asphalt cement mixed in a central plant. Marshall mix designs are to be completed in accordance with the latest edition of the Asphalt Institute Manual Series No. 2 (MS-2), ASTM D6926, D6927 and D5581, and ASSHTO T-245. Anti-stripping must be added to achieve a stripping potential of less than five percent (5%) as determined by the Saskatchewan Ministry of Highways and Infrastructure Stripping Potential Test. Physical properties for the mix must meet the design requirements in Table 3.7.

Table 3.7 – Asphalt Mix Design Physical Properties

Property	Asphalt Mix Type				
	B	S1	S2	HWY1	Ultra-thin
Maximum size of Aggregate (mm)	20	12.5	16	16	10
Marshall (blows per face)	75	75	75	75	75
Marshall Stability (KN) At 60 degrees Celsius (1)	8	6	8	12	11
Minimum Retained Stability (%)	70	70	70	75	75
Marshall Flow Index (mm) (1)	2-4	2-4	2-4	2-3.5	2-5
Air Voids in Mixture (%) (2)	3.5-5.5	3-5	3-5	3-5	3-5
Voids in Mineral Aggregate (%) (2)	13-15	13-15	13-15	13-15	–
Voids Filled with Asphalt (%) (2)	-	65-75	65-75	65-75	75-85
Min. Film thickness (µm) (3)	6	6	6	6	8

Notes:

(1) Marshall Stability and Flow Index will be determined according to ASTM Designation D6927 with the exception that briquettes must be fan cooled. A mechanical compactor, calibrated by a certified hand hammer, must be used to prepare briquettes.

(2) The percentage of air voids and percentage of voids filled with asphalt will be determined in accordance with ASTM D3203 with ASTM C127 and C128.

(3) The minimum bitumen content by dry mass of aggregate is 6.3% for Type Ultra-thin mixes

(4) Temperature: Mix temperature at point of plant discharge must not vary from that specified in the job mix formula by more than 10 degrees Celsius.

(5) Moisture in mix: Maximum permissible moisture at point of plant discharge is 0.2% by weight of mix.

3C.2 Road Base and Subgrade Preparation

Subgrades under roadway structure must be constructed of suitable soils free from organic and frost susceptible materials. Areas excavated to subgrade elevations will be scarified to a minimum depth of 150 mm below the surface and compacted to a Standard Proctor Density of 100% at ±2% of optimum moisture content. The cut will conform to the lines, grades, and dimensions required.

Granular base course materials must consist of crushed stone or gravel consisting of hard, durable, angular particles, free from clay lumps, cementation, organic material, frozen material, and other deleterious matter. Gradations must be within the limits specified when tested to ASTM C136 and ASTM C117 and have a smooth curve without sharp breaks when plotted on a semi-log chart. Granular base course gradation must conform to Table 3.8.

The subgrade must be inspected prior to placement of the granular base, and the granular base prior to the application of the prime coat, following the procedure in Section 9.4.

Table 3.8 – Granular Base Gradation

Sieve Designation (mm)	Percent Passing			
	Type I Base (20mm)	Type II Base (25mm)	Type III Subbase (40mm)	Type IV Subbase (63mm)
63				100
40			100	
25		100	70 – 94	
20	100	82 – 97		
16	84 – 94	70 – 94	55 – 85	
10	63 – 86	52 – 79	44 – 74	
5	40 – 67	35 – 64	32 – 62	25 – 50
1.25	20 – 43	18 – 43	17 – 43	
0.630	14 – 34	12 – 34	12 – 34	
0.315	9 – 26	8 – 26	8 – 26	
0.160	5 – 18	5 – 18	5 – 18	
0.080	2 – 10	2 – 10	2 – 10	0 – 10
Minimum Fracture by Weight	60% (+5mm, 2 Faces)	60% (+5mm, 2 Faces)	50% (+5mm, 2 Faces)	20% (+5mm, 1 Face)
Maximum Plasticity Index	6	6	6	None

Granular road base materials must be uniformly compacted to a Standard Proctor Density of 100% at ±2% of optimum moisture content. Standard Proctor Densities greater than 102% will be rejected.

3C.3 Asphalt Placement

The asphalt surface must not be laid prior to the granular base course meeting the required testing, see Section 9.2 and Section 9.4.

Prior to asphalt placement the road surface will be dry and clean of all loose or foreign materials. A tack or prime coat must be applied to all horizontal and vertical surfaces prior to paving. The tack or prime coat will be thoroughly cured prior to placing the surface course.

The asphalt mixture must not be placed unless the ambient air temperature is at least 5 degrees Celsius and rising except in specific situations where, in the opinion of the City, conditions warrant the risk involved.

Asphalt materials, mixing, spreading and rolling must conform to good industry practice, to produce a tightly knit surface free from checking, segregation, and roller marks. The required densities are listed in Table 3.9. The minimum and maximum thicknesses of asphalt lifts are listed in Table 3.10.

Table 3.9 – Minimum Paving Densities

Minimum Density	Type of Paving
98%	New paving and all stages in staged paving
97%	Lane paving.
97%	Rehabilitation overlay more than 40 mm thick.
96%	Rehabilitation overlay 40 mm thick or less.
96%	Paved trails
94%*	Ultra-thin overlay

*Ultra-thin overlays must not be compacted beyond a density of 94.5%

Table 3.10 – Paving Lift Thicknesses

Mix Type	Minimum (mm)	Maximum (mm)
B, S2, HWY1	40	75
S1	35	75
Ultra-thin	20	35

3C.4 Testing and Inspection

Asphalt must be tested with a minimum of two sets of tests by a certified third party quality assurance company for every 1000 m^2 of asphalt pavement placed. Core holes must be filled with hot mix asphalt, thoroughly compacted, and have a slurry seal patch applied. Samples must be taken as per ASTM D979. The minimum tests to be completed are as follows:

- Sieve Analysis;
- Bulk Specific Gravity;
- Marshall Stability;
- Bitumen Content;
- % Voids in Mineral Aggregate;
- Air Voids; and
- Core Densities and Thickness (1 core per 1000m^2).