SCHEDULE A
WORKS AND SERVICES REQUIREMENTS

SCHEDULE A - Works and Services Requirements

KEY SHEET

CODE	DESCRIPTION
WTR	Community water system. In subdivisions which are to be provided with a community water system, each Parcel being developed must be supplied by a water distribution system, including service connections and with adequate fire flow and protection, to be designed in accordance with the standards prescribed by the City.
WELL	Where a community water system is not available, a proven water supply located on each parcel is permitted.
SEP	On-site sewage disposal system.
SWR	Community sanitary sewer system.
DITCH	Drainage collection and disposal system by open ditches and culverts.
STM	Closed drainage collection and disposal system (i.e. a system other than open ditches).
SL	Street lighting throughout the subdivision.
SLI	Street lighting at street intersections only.
SW	Sidewalk (one or both sides of the roadway).
OH	Overhead electrical and communication wiring.
UG	Underground electrical and communication wiring.

Schedule A – Level of Service

	UTILITIES (refer to Key Sheet)					ROADS (refer to Standard dwgs)	
Zone	**Water**	**Sewer**	**Drain**	**Wiring**	**Lighting[(1)]**	**Roads**	**Sidewalks[(2)]**
R1/R1A	WTR	SWR	STM/DITCH	OH/UG	SL/SLI	R1-R7	0/1/2
R2	WTR	SWR	STM	OH/UG	SL	R1-R7	1/2
R1	WTR	SWR	STM/DITCH	OH/UG	SL/SLI	R1-R7	0/1/2
R3A	WTR	SWR	STM	OH/UG	SL	R1-R7	1/2
R3	WTR	SWR	STM	OH/UG	SL	R1-R7	1/2
R1B	WTR	SWR	STM	OH/UG	SL	R1-R7	1/2
R5	WTR	SWR	STM/DITCH	OH/UG	SL/SLI	R1-R6	0/1/2
R4/R4A	WTR/WELL	SWR/SEP	STM/DITCH	OH	SLI	R2/R4/R6	0/1
NC/CC	WTR	SWR	STM	UG	SL	R1/R3/R5/R7	1/2
HC	WTR	SWR	STM/DITCH	UG	SL	R1/R3/R5/R7	1/2
TC	WTR	SWR	STM	UG	SL	R1/R3/R5/R7	1/2
C6	WTR	SWR	STM	UG	SL	R1/R3/R5/R7	1/2
C7	WTR	SWR	STM	UG	SL	R1/R3/R5/R7	1/2
C9	WTR	SWR	STM/DITCH	UG	SL	R1/R3/R5/R7	1/2
I1-I4	WTR/WELL	SWR/SEP	STM/DITCH	OH/UG	SL/SLI	R1-R4	0/1
CU	WTR	SWR/SEP	STM/DITCH	OH/UG	SL/SLI	R1-R7	0/1
AUC	WTR	SWR	STM	UG	SL	R1/R3/R5/R7	1/2
LANDFILL	WELL	SEP	DITCH	U/G	SL	R1-R7	0/1
AIRPORT	WTR	SEP	DITCH	U/G	SL	R1-R7	0/1

Notes:
(1) Level of street lighting service requirements may be reduced by the Approving Officer (e.g. from SL to SLI) within a rural road cross-section.
(2) Level of sidewalk service requirements may be reduced by the Approving Officer (e.g. from 1 to 0) within a rural road cross-section.

SCHEDULE B
SUBMISSIONS AND APPROVALS

Schedule B - Submissions and Approvals

1. GENERAL

1.1 This section addresses submission and approval requirements with respect to pre-design reports, conceptual design drawings and Record Drawings. Typically, a subdivision will require a pre-design report including conceptual drawings, engineered drawings based on the approved pre-design report, and Record Drawings at Total Performance.

2. PRE-DESIGN REPORT SUBMISSION REQUIREMENTS

2.1 A pre-design report (4 copies) is required for all subdivisions of five parcels or more. The Approving Officer may also require a pre-design report for subdivisions of less than five parcels, where the Approving Officer deems it appropriate.

2.2 The pre-design report must be submitted bearing the seal and signature of a Consulting Engineer registered with the Association of Professional Engineers and Geoscientists of British Columbia.

2.3 The pre-design report must address at minimum the following:

2.3.1 General

(a) Impact statement regarding adjacent lands and where appropriate, soil stability, erosion control, or environmental issues.

(b) Pre-design requirements shall be extended beyond the development limits to a distance which enables the City to ensure that future extensions will meet the requirements and shall be not be less than 60 meters.

(c) The pre-design report shall assess how existing infrastructure will be affected by the demands placed on the proposed subdivision or development.

2.3.2 Existing Site Conditions

(a) The pre-design report shall provide information regarding the existing land use, the existing infrastructure (roadways, water, sanitary sewer, storm sewer, and utilities), and the geotechnical conditions.

2.3.3 Water System

(a) The pre-design report is to include an overall conceptual plan showing the proposed water system, pressure zones and how it connects to existing infrastructure. The Approving Officer may request additional information for

more complex water systems.

(b) The pre-design report shall analyze the proposed water system under Average Day Demand, Maximum Day Demand, Peak Hour Demand, Maximum Day Demand plus fire flow requirements. Calculations must be made in accordance with Schedule 3- Water Distribution.

(c) The water section of the pre-design report must also include all other pre-design requirements in Schedule 3- Water Distribution.

2.3.4 Sanitary Sewer System

(a) The pre-design report is to include an overall conceptual plan showing the proposed sanitary sewer system and how it connects to existing infrastructure.

(b) The pre-design report shall include the proposed sanitary sewer design calculations which will take into account the peak flow and infiltration flow, maximum and minimum velocities, pipe size and grade. Calculations must be made in accordance with Schedule 4- Sanitary Sewer.

2.3.5 Transportation System

(a) The pre-design report is to include an overall conceptual transportation network plan showing the proposed transportation network and how it connects to the existing network.

(b) The pre-design report shall also provide details that address the requirements of Schedule 1- Roads.

2.3.6 Utility Services

(a) The pre-design report shall provide details with respect to the general location of utilities, including hydro, gas, electrical, street lighting, telephone and cable television. The utility services shall be shown on an overall conceptual utility services plan.

3. CONCEPTUAL DESIGN DRAWINGS

3.1 Four (4) copies of the conceptual design drawings are to be submitted as part of the pre-design report. The conceptual drawing shall be prepared in accordance with Schedule 11- Engineering Drawing Submission, and the conceptual design drawings must include:

(a) An overall water system plan.
(b) An overall sanitary sewer system plan.
(c) An overall storm sewer system plan.

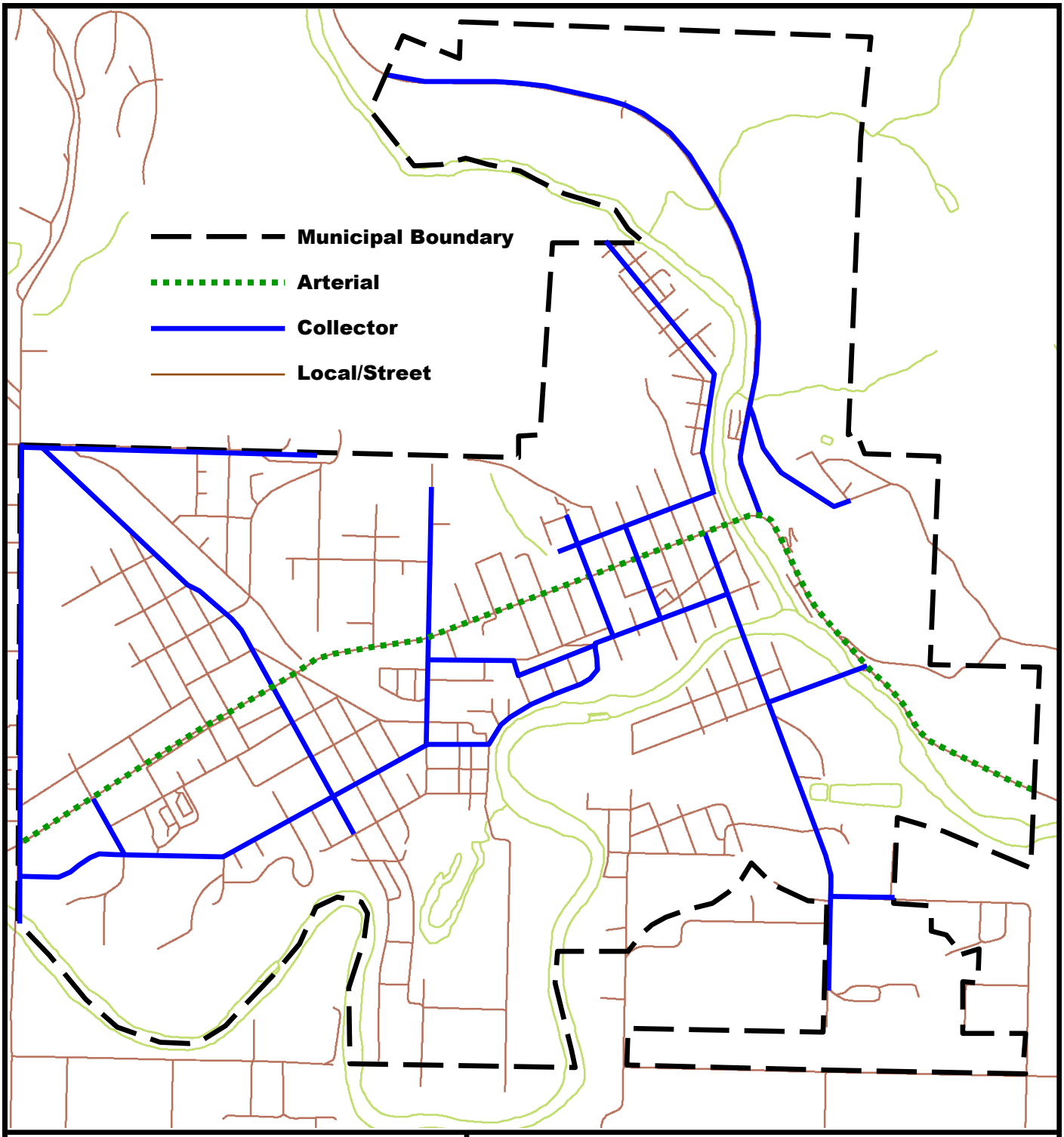
(d) An overall electrical system plan.
(e) An overall transportation network plan.
(f) An overall utility services plan.
(g) An overall site grading plan.

4. RECORD DRAWINGS

4.1 All Record Drawings being submitted for approval shall bear the seal and signature of a Consulting Engineer registered with the Association of Professional Engineers and Geoscientists of British Columbia.

4.2 The Record Drawings shall be prepared in accordance with Schedule 11-Engineering Drawing Submission.

SCHEDULE C
ROADWAY CLASSIFICATION



GRAND FORKS
– BC –

ROAD CLASSIFICATIONS

Scale: 1 cm = 225 m

Date: Sept. 23, 2014

Drawn by: D. Sheets

Drawing Number:

C

SCHEDULE D
HILLSIDE DEVELOPMENT DESIGN CRITERIA

Schedule D- Hillside Development Design Criteria

1. GENERAL

1.0 In steep slope areas where it is impossible to conform to the Design Criteria as set out in Schedules 1 to 11 of this bylaw, the Approving Officer may approve Subdivision or Development required works or services which vary the conventional design criteria required by Schedules 1- 11.

1.1 Before agreeing to vary any part of Schedule 1-11, the Approving Officer must be satisfied that the variance is warranted due to the topographical constraint involved and the varied criteria is presented and acceptable as good engineering practice, environmentally sound, and does not adversely affect transportation or public safety.

1.2 Steep slopes are defined as lands in their natural state that have a slope angle exceeding 20% or greater for a minimum horizontal distance of 10 meters, or adjacent areas where existing or potential sloughing or stability warrants concern. The definition applies to all properties which are 0.5 hectares or greater in size, and where 10% or greater of the parent property contains slope of more than 20%.

1.3 Subdivision and site design should respond to the unique circumstances of each site, avoiding significant disruption of the natural terrain (tree cover and natural vegetation) as much as possible. Creation of deep scars, highly visible cut and fill excavations, and the deposit of side casting material along sloped edges should be avoided.

1.4 Natural open space development is more appropriate for environmentally or geo-technically sensitive areas of the hillside. Public dedication of these lands is preferred, the Approving Officer may consider no-build/no disturb covenants or land trusts on these lands, where subdivision is to occur.

1.5 Development must take place on lands containing less than 30% natural grade, with the exception of small pockets of land along with more gentle slopes that a maximum of 10% of the terrain required for a building envelope can be altered.

1.6 Subdivision or developments in steep slope areas require a City Development Permit.

2. PRE-DESIGN REPORT

2.0 The Consulting Engineer is expected to use innovative design techniques that minimize impacts to future land owners, maintenance and sensitive steep slopes and natural drainage areas.

2.1 The Consulting Engineer is expected to minimize the total amount of cut and or fill and its environment and visual impact when designing and developing a site.

2.2 Detailed geotechnical, slope stability, hazard assessments and hydrogeological reports shall be required as part of the pre-design report and shall be submitted prior to approval of a Subdivision or Development. In addition to Schedules 1-11, the pre-design report for steep slope areas will also have to address specifically and provide recommendations for:

(a) A lot grading and drainage management plan that mitigates the potential impacts onsite and downstream. The drainage management plan shall include at a minimum the following:

i. Existing and proposed topography.
ii. Key cross sections showing cuts and fills related to building sites, roads, and retaining walls.
iii. Erosion and sedimentation control and protection.
iv. Pre and post development hydrogeological conditions.
v. Stormwater quality and treatment.
vi. Protection of natural drainage patterns or water course.
vii. Drainage control around future buildings and between upper and lower lots.
viii. Control and discharge of roof and footing drainage.

(b) Underground infrastructure pipe bedding, trench backfill and mechanical restraints.
(c) Roadwork structure, tack coat requirements and guard rail requirements.
(d) Driveway access concerns.
(e) Building code structural or foundation requirements.
(f) Restrictions on irrigation and removal of vegetation.
(g) Environmental impact assessment.
(h) Assessment of up-gradient and down-gradient conditions.
(i) A list of requirements on a lot by lot basis pertaining to covenants that may be required.
(j) Land Clearing and Tree Retention and Removal plans.
(k) Urban Wildfire Protection Plan.

2.3 Each Parcel created by Subdivision must have a buildable site with a building envelope, setbacks and driveways shown on the conceptual drawing required in Schedule B – Submissions and Approvals.

3. ROADS

3.1 Vertical Alignment

3.1.1 Engineered design grades shall be as per Table 10.0- Hillside Development

Standards Table of this section.

3.1.2 Alternate access routes must be incorporated to ensure emergency or maintenance vehicular access.

3.2 Horizontal Alignment

3.2.1 Only where surveyed topography determines that lesser radii must be used, the radii may be reduced as per Table 10.2 with approval from the Approving Officer with potentially the addition of speed reduction and warning signs. Designs providing reduced cul-de-sac radii or hammerhead configurations may also be considered.

3.2.2 The requirement for guard rail installation will be on the basis of warrant analysis as per the Transportation Association of Canada Geometric Design Guide for Canadian Roads.

3.3 Roadway Cross Sections

3.3.1 Roadway cross sections may be reduced in width as illustrated in Standard Drawings SD-HS1 and SD-HS2 and as shown in Table 10.0 of this section.

3.3.2 Roadway cross sections may be further reduced in width if parking is to be located on private lots or if special pull out parking areas are established in strategic positions.

3.3.3 Boulevard grades in excess of 2% may be designed to a point 1.0 m from the back of sidewalk or curb (where no sidewalk present) where on- street parking is provided and to a point 2.4 m back where parking is adjacent to the street, behind the curb, as long as it can be demonstrated that the depth of bury on underground utilities will not be negatively impacted and there is sufficient space for snow storage.

3.3.4 In areas where the boulevard grade exceeds 2% the Approving Officer may require the developer to undertake boulevard slope stabilization and planting.

3.3.5 In no case shall the grade from the property line to the back of sidewalk, back of curb or back of ditch be less than 1%.

3.3.6 The Approving Officer may consider alternative utility offsets within road section.

3.3.7 Level access and clearance of 1.3 m around fire hydrants, transformers, and vaults must be established.

3.4 Road Lane Grade Separation (Split-Road Section)

3.4.1 Cross-sectional separated grade (one way) lanes are a design option to minimize excessive cut/fill slopes, protection of large trees, improve property access or allowance for gravity sewer connections for down slope lots to the street.

3.4.2 Center median cross-section slopes shall be protected from erosion and designed to be maintenance free.

3.4.3 Utility offsets shall be established within the down slope road section with storm mains and sanitary mains in common trench.

3.5 Intersection Grades/Site Clearances

3.5.1 Through street maximum grade is 8%. The Approving Officer may consider increases due to topographic constraints.

3.5.2 Cut/fill slopes, vegetation planting, retaining wall structures and parking, shall be designed to protect all site distances.

4. STORM DRAINAGE

4.1 Catch basin grates on road grades exceeding 6% shall slope into (opposite) the downhill road grade to catch surface flows.

4.2 High side gutter elevation shall be 75 mm above the catch basin grate.

4.3 Ditching, swales or natural drainage courses exceeding 6% require a ditch cross section that will control erosion taking into account soil type, water flow and velocity.

4.4 Roof leaders and foundations drains shall be discharged to a closed drainage system.

5. WATER

5.1 Water system pressure zone boundaries should be designed to ensure fire fighting pressures in the high side of the lots.

6. UTILITY CORRIDORS

6.1 Side yard and rear yard utility corridors shall only be approved if they are included in a right-of-way that restricts the construction of permanent structures (excluding fences) and requires that the cost of removing and reconstructing fences and landscaping placed within the easement are the responsibility of the property owner.

6.2 The width of the underground utility corridor shall consider depth of bury, access, separation from private structures and long term operation and maintenance.

6.3 Utility service and transformer boxes, which need to be at road grade, would require suitable grading and retaining structures.

7. RETAINING WALLS/STAIRWAYS

7.1 Any retaining or landscape structure across a boulevard or median required to maintain surface utilities at road grade or to facilitate split road sections shall be designed to protect the location and depth of all underground utilities.

8. DRIVEWAY ACCESS

8.1 Reciprocal driveway access can be a design option for a maximum of 3 lots where the grade of the access is not greater than 14%.

8.2 Individual driveways should:

(a) Have a grade of not more than 20%. If this is not achievable, 2 readily accessible off-road parking stalls shall be provided on the property.

(b) On down slope driveways, the driveway grade for the first 3.5 m length from property line shall not be greater than 7%.

8.3 In areas with severe vertical curves, driveway locations may have to be restricted to maintain proper sight lines and stopping sight distance.

9. SITE RESTORATION

9.1 Disturbed area within the road right-of-way or on disturbed areas of the site that are not within formal landscaped areas or building envelopes shall be restored to a natural condition or to a condition that will prevent erosion prior to Substantial Performance being issued or final occupancy in the case of a Building Permit application.

9.2 Restoration practices shall be specifically tailored to address the type and degree of disturbance and the specific conditions of the site. The design shall be completed in accordance with Schedule 7- Landscaping, where possible.

10.0 HILLSIDE DEVELOPMENT STANDARDS TABLE

STREET TYPE	CONDITION[1]	DESIGN SPEED	MAX. GRADE	ROW WIDTH	PAVEMENT WIDTH (m)[2]	PARKING	CURB & GUTTER	SIDEWALK[3]	STREET TREES
LOCAL STREET									
Development fronts both sides	A	40	12	14	6.0	above curb both sides	rollover	1	optional
Development fronts one side	B	40	12	12	6.0	above curb both sides	rollover	1	optional
No Development fronting	C	40	12	10	6.0	none permitted	barrier	1	optional
COLLECTOR STREET									
Development fronts both sides	A	50	10 (7)	18	8.6	above curb both sides	rollover	2	2 sides
Development fronts one side	B	50	10 (7)	15	8.6	above curb both sides	rollover	1	2 sides
No Development fronting	C	50	10 (7)	14	8.6	none permitted	barrier	1	2 sides
HILLSIDE EMERGENCY VEHICLE ACCESS		**20**	**15**	**6.0**	**6.0**				

Footnotes:

1. Condition refers to Standard Drawings SD-HS1 and SD-HS2.
2. Pavement width measured from face of curb.
3. Sidewalks shall terminate at a destination or connect with another sidewalk or pathway. The numbers indicates whether sidewalk is required on either one or both sides of the street.
4. Sidewalks are not required on local streets in steep slope areas unless they are required to provide connectivity to schools, parks, commercial areas or lands beyond.
5. Roadway cross sections may be further reduced in width if parking is to be established at strategic locations.
6. Split road section lane widths require 3.0 m traveled lane plus 2.5 m parking or cycling width.
7. Collector Streets maximum grades may be increased to 12% where necessary due to topographic constraints. Where approved, grades exceeding 10% shall be topographically surveyed at the developer's expense, to verify final road grades, prior to final subdivision approval.

Table 10.2 - Alignment Design Criteria

1. Horizontal Curve Radii

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Roadway				
normal crown (-2%)	260m	165m	90m	45m
2% superelevation	205m	120m	65m	30m
4% superelevation	150m	80m	45m	22m
6% superelevation	120m	-	-	-
Through Intersections	200m	120m	70m	40m

2. Superelevation

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Maximum Superelevation	6%	4%	4%	4%
Maximum Superelevation at Intersection	4%	4%	4%	4%

3. Superelevation Transition Lengths

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Transition Lengths (2 /4-lane roadways)[1]				
normal crown to +2%	24m / 36m	22m / 34m	20m	20m
normal crown to +4%	38m / 54m	33m / 50m	30m	30m
normal crown to +6%	48m / 72m	-	-	-
Min Tangent Length between reversing				
2% superelevation (2 / 4-lane roadways)[2]	15m / 22m	13m / 20m	12m	12m
4% superelevation	28m / 42m	26m / 40m	24m	22m
6% superelevation	42m / 64m	-	-	-

1. Values for transition lengths include tangent runout applied at the same rate as superelevation runoff.
2. 60% of superelevation runoff occurs on the tangent approach and 40% on the curve, resulting in a minimum length of tangent between reversing curves of 120% of the superelevation runoff length.

4. Gradients

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Minimum Grade	0.5%	0.5%	0.5%	0.5%
Maximum Grades				
on horizontal tangents	8%[1]	10%[2]	12%	12%
on minimum radius horizontal curves[3]	8%	9%	10%	10%
Grades Through Intersections				
with design speed on major road	8%	8%	8%	-
approach distance for major road[4]	15 / 5 m[5]	5m	0m	-
with design speed on minor road	5%[6]	5%	6%	6%
approach distance for minor road[7]	20m	15m	5m	5m

1. Under special curcumstances, grades up to 10% may be permitted.
2. Under special circumstances, grades up to 12% may be permitted.
3. Applies where radius is less than 1.5 times minimum allowable radius.
4. Minimum distance back from the gutter line of the minor road that the specified grade may not be exceeded.
5. Distances for design road approach to intersection with collector road / local road.
6. 4% desirable.
7. Minimum distance back from the gutter line of the major road that the specified grade may not be exceeded.

Table 10.2 (continued) - Alignment Design Criteria

5. Vertical Curve K Values

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Minimum Crest	15	8	4	2
Minimum Sag	10	7	4	2
Crest / Sag on approach to stop condition	4	3	2	2
K values listed assume that new roadways will be illuminated				

6. Stopping Sight Distances

Criteria		60 km/h	50 km/h	40 km/h	30 km/h
Down grades:	12%	109m	78m	52m	34m
	9%	101m	73m	50m	32m
	6%	94m	69m	48m	31m
	3%	89m	66m	46m	30m
	0%	85m	63m	45m	30m
Up grades:	3%	81m	61m	44m	29m
	6%	78m	59m	42m	29m
	9%	76m	57m	41m	28m
	12%	73m	56m	40m	28m

7. Decision Sight Distance

Minimum decision sight distance for 60 km/h: 175m - 235m.

1. Note that decision sight distance applies only to multi-lane roads at intersections.

2. The range of values recognizes the variation in complexity that occurs at various sites. For less complex situations, values towards the lower end of the range are appropriate and for more complexity, values at the upper end are used.

SCHEDULE 1
ROADS

Table of Contents

1. ROADS

1.1 General

The Approving Officer shall consider the sufficiency and suitability of the proposed Road system, the arrangement, width, grade and location of all Roads in relation to existing and planned Roads, to topographical features, to public convenience and safety, and to the proposed uses of the land to be served by such Roads.

The arrangement of Roads in a Subdivision shall either:

(a) provide for the continuation or appropriate projection of existing Roads in surrounding areas; or

(b) where topographic or other conditions make continuation or projection of existing Roads impractical, provide an adequate and suitable roadway system having regard to the uses of the land to be served.

The dimensions, locations and standard of all Roads in a proposed Subdivision shall conform substantially to the Sustainable Community Plan.

Local residential Roads shall be aligned so that their use by through traffic will be discouraged.

Developments may require Frontage Roads, double Frontage Lots, deep Lots with rear service Lanes, or such other treatment as may be necessary in the public interest for the adequate protection of residential properties and to afford separation of through and local traffic.

The Approving Officer may require an independent Traffic Impact Study to determine the requirements or warrants for traffic control at accesses off major roads and deceleration and acceleration turning lanes to minimize impacts to safety and disruption to traffic.

The Consulting Engineer shall provide a report that includes all pertinent information related to the design, scheduling and Construction of the roadway.

1.2 Road Classification

The existing roadway classifications within the City are summarized in Tables 1.1 and 1.2, and are described as follows:

- **Arterial Roadway** – An arterial Road has the primary function of carrying through traffic from one area to another with as little interference as

possible from adjacent land uses. An arterial Road may provide direct access to property as a secondary function when alternate access is not available.

- **Collector Roadway**– A collector Road has the primary function of distributing traffic between arterial, other collector and local Roads within an area. A collector Road may also provide direct access to properties.
- **Local Roadway** – A local Road has the primary function of providing direct access to properties. Local Roads normally connect to other local Roads or to collector Roads.

Arterial, collector and local roadway classifications have been further divided into urban and rural classifications within this bylaw. Other Road network components include:

- **Lanes** – A Lane is a roadway with the primary function of providing land access, typically at the rear of abutting properties. Lanes are not intended to carry through traffic. For properties fronting collector or arterial Roads, rear Lanes can eliminate the need for front driveways.
- **Walkways and Pathways** – Walkways and pathways are paths which follow routes independent from motor vehicle roadways, sidewalks and bike Lanes.

The roadway classifications are summarized in Table 1.1.

Table 1.1: Roadway Classification

Roadway Classification	Minimum Right-of-Way Width (metres)
WALKWAYS AND PATHWAYS	
Walkway	3.0
Multi-Use Pathway	5.0
LANES	6.0
LOCAL ROADWAYS	
Urban	20.0
Rural	20.0
COLLECTOR ROADWAYS	
Urban	20.0
Rural	20.0
ARTERIAL ROADWAYS	
Rural	20.0
Urban	20.0 – 25.0

A map illustrating the City's roadway classification can be found in Schedule C.

1.3 Road Cross-Section Details

The standard roadway cross-sections shall be as shown on the Standard Drawings and detailed in Table 1.2.

Note that the objectives of the standard Road cross-sections as detailed in Table 1.2 and the Standard Drawings are the clear and intended goals on all roadways within the City of Grand Forks. It is recognized, however, that ambient conditions may require variance from these standards in existing and substantially Developed areas, where provisions to accommodate the required roadway modifications may not have been anticipated. A variance to these standards may be considered by the Approving Officer. Variances may also be considered for unique situations such as access Roads or steep hillside Roads.

Table 1.2: Roadway Cross-Section Details

Facility Classification	Right-of-way (metres)	Road Width (metres)	Lane Width (metres)	Parking	Shoulder	Curb Type	Sidewalks	Bicycle Facilities
WALKWAYS AND PATHWAYS								
Walkway	3.0	3.0	N/A	N/A	N/A	N/A	N/A	N/A
Multi-Use Pathway	5.0	4.0	N/A	N/A	0.5 m gravel	N/A	N/A	Shared
LANES								
Commercial	6.0	6.0	2 x 3.0	N/A	N/A	N/A	N/A	N/A
LOCAL ROADWAYS								
Urban	20.0	7.0	2 x 3.5	N/A(4)	N/A	Rollover	1.5 m(1) one side	N/A
Rural	20.0	6.0	2 x 3.0	Yes(2)	1.5 m gravel(3)	N/A	N/A	N/A
COLLECTOR ROADWAYS								
Urban	20.0	8.6	2 x 4.3	N/A(4)	N/A	Barrier	1.8 m one side	Shared
Rural	20.0	8.6	2 x 4.3	N/A(4)	1.5 m gravel(3)	N/A	N/A	Shared
ARTERIAL ROADWAYS								
Rural	20.0	8.5	1 x 5.20 1 x 4.30	N/A	N/A	Barrier	1.8 m one side Optional two sides	1-1.5 m (Uphill) 1-Shared (Downhill)
Urban	20.0 - 25.0	12.0	2 x 6.0	Shared	N/A	Barrier	1.8 m one side Optional two sides	Shared

(1)Except Cul-de-sacs or as determined by the Approving Officer
(2)Permitted, requires 1.0m paved shoulder
(3)Optional 1.0m paved with 0.5m gravel shoulder (one side)
(4)May be permitted with addition of 1.4m paved surface each side (site-specific conditions)

Where roadway cuts or fill sections extend beyond the right-of-way widths noted in Table 1.2, the right-of way shall be widened accordingly.

All rock cut, escarpments or retaining structures shall be equipped with protective railings or fencing.

1.4 Road Design Criteria

All Road classifications and designations for vertical and horizontal alignment elements shall be designed utilizing the designated design speeds contained in Table 1.3, and in compliance with the most current edition of the Transportation Association of Canada - Geometric Design Guide for Canadian Roads. Road design criteria to be referenced from this document include super elevation, centreline radius, maximum grade, vertical curvature and sight distance.

Table 1.3: Road Design Criteria

Facility Classification	Design Speed (km/h)
Concrete Walkway	N/A
Multi-Use Pathway	30
Lane	30
Local Roadway	30
Collector Roadway	50
Arterial Roadway	60

1.5 Vertical Alignment

The following shall be considered when establishing the vertical alignment of a roadway:

- The vertical alignment of Roads shall be set so the grades of the driveway to adjacent properties will conform to the Standard Drawings. Where it is impractical to meet these criteria, the Approving Officer may approve the use of private access Lanes.
- The draining grade around the outside curb of a Cul-de-sac shall be not less than 0.5% and not greater than 5.0%. Longitudinal gradients of Cul-de-sac bulbs shall not exceed 10.0%.
- When a Cul-de-sac is at the bottom of a hill, the longitudinal gradient of the first 50m of roadway uphill from the Cul-de-sac bulb shall not exceed 5.0%. The maximum longitudinal gradient for the rest of the hill shall not exceed 8.0%.
- When a Cul-de-sac is at the top of a hill, the longitudinal gradient for the roadway downhill from the Cul-de-sac shall not exceed 12.0%.
- All changes in gradient over 1.0% on arterial and collector Roads and over

2.0% on all other Road classifications shall be connected by vertical curves.

- Standard cross slopes (normal crown) shall be 2.0% on all Road classifications unless specified otherwise by the Approving Officer. Design Road elevations shall give due consideration to floodproofing requirements of adjacent properties. Full Road crossfall (reverse crown) may be considered in special circumstances, as a means of more closely matching property grade adversity on either side of the roadway.
- The length of a transition from a normal cross-sectioned Road to a section of Road where there is super-elevation or crossfall shall, in no case, be less than 70 m for a 50 km/h designed Road. In selecting the length of the transition, care and consideration shall be given to draining the entire pavement. Typically, if no horizontal spiral curve is used, 60% of the super- elevation is introduced prior to the beginning of the curve, and the balance is developed in the curve.
- Gutter elevations on curb returns and Cul-de-sacs shall be shown on the drawings at the beginning, one-quarter points and end of curb returns and at 7.50 m intervals around Cul-de-sacs.

1.6 Horizontal Alignment

The following shall be considered when establishing the horizontal alignment of a roadway:

- The horizontal centreline alignment of the Road shall be located on the centreline of the right-of-way, unless permitted otherwise by the Approving Officer.
- Typical locations of works and utilities in Roads are shown on the Standard Drawings.
- Centreline chainage stations shall be fully referenced and dimensioned from property lines.
- A horizontal curve shall be fully described showing internal angle, radius, tangent length and arc.
- If reversed curves are required in a roadway alignment, the Approving Officer may require that they be separated by means of tangents of sufficient length.
- Where angular deflections occur in a roadway alignment, the Approving Officer may require that the angle be replaced by a curve of suitable radius.

1.7 Cul-De-Sacs

Cul-de-sac bulbs shall be used to terminate “no exit” Roads as detailed in the Standard Drawings. The following shall apply:

- A maximum Cul-de-sac length of 150 m is allowed, unless a secondary

emergency vehicle access is provided at least halfway to the end of the Cul- de-sac, in which case the length specification is not prescribed. The right-of- way provided for a secondary emergency access should be a minimum of 6.0 m wide, and the maximum grade of a secondary emergency access should not exceed 15%. A pedestrian walkway may be integrated into the access, and non-emergency vehicle access should be restricted through the use of removable bollards or other devices.

- Cul-de-sac Roads, designed to be permanent, shall be provided at the closed end with an area designed to permit safe and adequate space for the turning of motor vehicles. The minimum radius of this “bulb” should be 14.6 m to the curb face, requiring a minimum right-of-way of 18 m radius. Alternative types of street turnarounds may be considered based on site specific conditions. The preferred end treatment is a Cul-de-sac bulb.

1.8 Curb Returns

- The minimum radius of curb return at intersections shall be 9.0 m for a local Road and 12 m for a collector or arterial Road. Curb returns located on Roads within industrial and commercial areas may require a larger radius to facilitate truck traffic and bus traffic, and will be as specified by the Approving Officer. The right-of-way geometry at curb returns shall be adjusted so as to provide a curvature parallel to the curb return or, alternatively, provided with 5.0 m corner cut.
- When a new Road with curbs intersects an existing Road without curbs, only half the curb returns shall be constructed unless the Road design for the uncurbed Road is available and will allow Construction of the full curb returns. Full curb returns shall be constructed at the intersection of two curbed Roads.

1.9 Intersections

- Intersections are to be designed as close to 90° as possible and in all cases located within a range of angles between 70° and 110°.
- The Maximum spacing between tee intersections is 60 m.
- The minimum spacing between four-legged intersections on arterial streets is as required to provide a minimum 40 m of left turn storage (at both intersections), 35 m of transition between storage Lanes and an allowance for turning movements.

1.10 Sidewalks, Walkways, Multi-Use Pathways, Bicycle Facilities and Wheelchair Ramps

- Concrete sidewalks shall be provided on Roads in or adjacent to Subdivisions or Developments in accordance with Table 3.2 and the Standard Drawings.
- The maximum grade for sidewalks shall not exceed the maximum Road

grades.

- Concrete walkways shall be provided for access through the Subdivision to schools, playgrounds, shopping centres, transit, beaches and other community facilities.
- Fencing for walkways located between Lots shall be provided.
- The maximum grade for walkways shall not exceed 15%. Where walkways exceed 15%, alternate walk routes shall be considered by the Approving Officer. Only where other acceptable walk routes are not acceptable, will the installation of concrete stairs be considered.
- Concrete walkways shall conform to the Standard Drawings.
- Multi-use pathways shall conform to the Standard Drawings.
- Wheelchair ramps shall be provided at all intersection curb returns as an integral part of the sidewalk or to link walkways, crosswalks and multi-use pathways. Reference Standard Drawings.
- Bicycle facilities shall be designed as specified in Table 1.2 and Table 1.3 and in accordance with the Transportation Association of Canada Geometric Design Guide.

1.11 Curb and Gutter

- Curb and gutters shall be provided as specified in Table 1.2 and the Standard Drawings.

1.12 Driveways / Crossovers

- Each property shall only have one driveway access per Road Frontage, unless a demonstrated need is agreed upon with, and approval for the additional driveway(s) is obtained from the Approving Officer.
- Driveway letdowns shall conform to the Standard Drawings. At the discretion of the Approving Officer, access to large parking areas shall be by curb returns rather than by a driveway letdown. The Approving Officer may require deceleration and acceleration Lanes for access off major Roads for safety reasons and to minimize disruption to traffic flows.
- Driveway access grades shall be designed to permit the appropriate vehicular access for the Zone, without “bottoming-out” or “hanging-up”. From edge of pavement or back of curb to property line, the driveway grade shall not exceed 5% for the first six (6) meters. For the next 10 m on private property, the maximum allowable driveway grade is 15% if accessing a local or collector Road. This maximum grade is limited to 10% if accessing an arterial Road. Maximum driveway grades within Lots shall not exceed 15%.
- Driveways shall be located a minimum of 1 m from transformers, junction boxers, hydrants, poles, street lights or street signs.
- Residential driveway access onto an arterial Road is not permitted unless alternate access is impractical. Wherever physically possible, alternate local Road or Lane access shall be dedicated to preclude residential

driveways accessing directly onto arterial Roads.

- Residential driveway accesses serving corner Lots shall be a minimum of 7 m from the Lot corner nearest the intersection.
- All residential driveway accesses shall have a minimum width of 3 m and a maximum width of 6.0 m.
- All reciprocal access driveways (for a maximum of three (3) single family residences) shall have a minimum width of 6 m, a maximum Road grade of 12%, and the minimum surface requirement shall be constructed with a hard surface in accordance with the City's Driveway Access Bylaw as amended or changed from time to time.
- Driveway accesses to commercial and industrial corner Lots shall be a minimum of 15 m from the property line of the adjoining Road.
- The maximum width of a driveway to a commercial or industrial property having only one access shall be 11 m. The maximum width of each driveway to a commercial or industrial property having more than one access shall be 9 m.

1.13 Transit Facilities

- The requirement for transit facilities shall be established by the Approving Officer.
- Transit bays shall be provided where required by the Approving Officer, and shall be in accordance with the "Pullouts" section of the Transportation Association of Canada Geometric Design Guide, as amended or replaced from time to time.
- Transit signs shall be in accordance with the Manual of Uniform Traffic Control Devices for Canada, 1998, as amended or replaced from time to time.

1.14 Regulatory and Information Signs

Road name signs and traffic signs for new or improved Roads shall be provided by the City of Grand Forks at the expense of the Owner.

1.15 Appurtenances

- All proposed traffic islands, retaining walls, guard-rails, and permanent barricades shall be designed in accordance with good engineering practices.
- For all utility poles and tie-downs which require relocation prior to Road Construction, the utility shall confirm the feasibility of their re-location prior to completion of the engineering drawings.
- The top of escarpments, rock cuts and retaining walls constructed on or adjacent to proposed roadways shall be equipped with railings or handrails.

1.16 Pavement Structure

(a) General Requirements

Pavement structures shall be designed by a qualified Consulting Engineer in accordance with a commonly accepted design method (AASHTO, Asphalt Institute, etc.). The pavement shall be designed to provide a 20 year design life.

The parameters used for design shall be based on site specific information which shall include, but is not limited to the following:

1. Existing pavement surface conditions
2. Subsoil conditions
3. Groundwater & drainage conditions
4. Climate
5. Traffic Volumes

(b) Field and Laboratory Investigations

A subsurface exploration program shall be completed to a depth of at least 1.2 m below existing and proposed finished roadway surface grades. At least one exploratory borehole and/or test pit shall be made at intervals of no more than 150 m along the proposed horizontal alignment. In-situ testing shall be completed, representative soil samples collected, and laboratory testing carried out as necessary to determine the engineering properties and characteristics of the subgrade materials. The minimum laboratory testing requirements include natural moisture content determinations and grain-size analyses and/or Atterberg limit determinations as appropriate to characterize the site subsoils for design purposes.

Groundwater levels that may influence the roadway performance shall be determined at the time of the investigation and seasonal fluctuations should be estimated.

(c) Design Parameters

On the basis of the field and laboratory investigations, a soaked California Bearing Ratio (CBR) value shall be determined or estimated for use in design of the pavement structure. A Resilient Modulus may be approximated from the CBR value using the relationship:

MR (Mpa) = 10.3*CBR

The plasticity of the subgrade soils determined in the laboratory shall be

reported (swelling/shrinking potential).

The frost susceptibility of the soils within 850 mm of the finished paved surface shall be considered in the design.

(d) Minimum Pavement Design

In the absence of traffic volume data, the Roads shall be classified as follows with the associated Equivalent Single Axle Loads (ESAL) for the purposes of pavement structure design:

Table 1.4	
Road Classification	**Design Traffic (ESAL)**
Arterial	> 2.8×10^5
Collector	2.8×10^5
Industrial	5.6×10^5
Residential	2.8×10^4

In the event that the CBR value soaked CBR value is less than 3, the subgrade shall be enhanced to provide a CBR value of 3 to be used for the pavement structure design calculations.

Irrespective of calculated requirements, the following values for pavement structure component thicknesses are considered to be minimum requirements for all roadways where:

1. the subgrade CBR value is greater than or equal to 6 and,

2. the subgrade soils are not frost susceptible within 850 mm of the finished paved surface or groundwater is at least 1.5 m below the proposed subgrade surface:

Table 1.5			
Road Classification	Subbase (1) 75mm (minus)	Base (2) 19mm (minus)	Hot Mix Asphalt Surface Course (3) (mm)
Arterial	400	100	100 (2 lifts)
Collector	400	100	75 (2 lifts)
Industrial	400	100	100 (2 lifts)
Residential	300	100	50
Lanes	200	100	50
Multi-Use Pathways	150	75	50

(1) MMCD Crushed Granular Sub-base
(2) MMCD Granular Base
(3) MMCD Upper Course #1

Pavement structure designs shall be submitted to the Approving Officer in an acceptable report format.

(e) Construction Recommendations

Recommendations related to roadway Construction shall be provided by the Consulting Engineer. The recommendations shall address:

1. Subgrade preparation and enhancement
2. Long term drainage
3. Road structure materials requirements
4. Construction methods and procedures

(f) Where Works and Services are required on existing roadways, an applicable permit, as per the City of Grand Forks Traffic Regulation Bylaw No. 1956 as changed or amended from time to time, shall be obtained by the Consulting Engineer setting out the general conditions for Construction.

1.17 Emergency Access Routes

(a) Alternate access routes are required where the primary access road to the Subdivision or Development exceeds 10% and there is no alternate

access route.

(b) Maximum grade is 12.5%.
(c) Right-of-way width to be 6.0m.
(d) Road paved width to be 6.0m.
(e) Restrict non-emergency vehicles access through the use of removable restriction posts.
(f) Shared use with pedestrian trails is permitted.

1.18 Community Mailboxes

a) The Developer shall supply, install and locate the mail delivery equipment to Canada Post Specifications and to the satisfaction of the Approving Officer. All mail delivery equipment is to be accessible by persons with physical disabilities.

SCHEDULE 2
STORM DRAINAGE

Table of Contents

2. STORM DRAINAGE

2.1 General

Drainage systems shall be designed in accordance with the standards and specifications set out in this Schedule, and the provisions of this Bylaw. These standards are not intended to be a substitute for sound engineering knowledge and experience. Drainage designs shall be prepared under the direction of a Consulting Engineer with the appropriate experience and knowledge.

These standards are intended to cover only minimum requirements. Drainage designs shall conform to all pertinent City Bylaws, regulations, guidelines and policies as well as federal and provincial statutes and guidelines. These include but are not limited to the following:

- Local Government Act
- Fisheries Act
- Water Act
- Navigable Waters Protection Act
- Wildlife Act
- Heritage Act
- Riparian Areas Regulation
- Migratory Birds Convention Act
- Dyking Act
- Species At Risk Act
- Waste Management Act
- Land Development Guidelines for the Protection of Aquatic Habitat (Canada/BC)
- Stormwater Planning – A Guidebook for British Columbia (BC/Canada)
- British Columbia Approved Water Quality Guidelines 2006 (BC)Develop With Care: Environmental Guidelines for Urban and Rural Land Development in BC 2006 (BC) National Guide to Sustainable Municipal Infrastructure (Canada)

2.2 Storm Water Management

Stormwater management involves the planning and design necessary to mitigate the hydrological impacts of land Development or land use changes. Adverse hydrological impacts include such things as increased peak stormwater flows, erosion, sedimentation, flooding, reduced surface infiltration, reduced minimum groundwater levels and stream flows, water quality deterioration, and degradation of aquatic and wildlife habitats. Mitigation measures include but are not limited to the following:

- Appropriate sizing and routing of pipes and channels
- Major flow path routing and protectionDetention storage

- Sediment removal
- Biofiltration
- Landscaping
- Source control
- Erosion protection
- Groundwater infiltration
- Subsurface disposal
- Lot grading

2.3 Stormwater Management Plan

A Stormwater Management Plan is required for any Development larger than 0.4 ha. The stormwater management plan shall include the following:

- Catchment plan for the subject Site which includes all upstream lands that drain into or through the Site.
- Location, extent, and description of the existing and proposed land uses.
- Details indicating how the Stormwater Management Plan integrates with the City's Stormwater Master Plan, if applicable.
- Contours at 1.0m elevation intervals (existing and proposed).
- Alignment and limits of existing and proposed Watercourses and wetlands located in, or within 30 meters of, the subject Site, complete with environmental classifications and/or fish presence information, if available.
- Layout of existing and proposed drainage systems.
- Proposed point of stormwater discharge, and method of stormwater discharge, from the Site (e.g. Pipe connection to City main(s), open discharge to ditch or natural Watercourse).
- Existing and proposed major surface flow paths, including the location of low points on all Roads, Lanes, or walkways.
- Proposed Lot grading plan.
- Proposed source control and/or quality treatment facilities, including target level of treatment, if appropriate.
- Locations, sizes and hydraulic grade line (HGL) elevations of proposed conveyance and other management facilities for both minor and major systems.
- Indicate Maximum ponding depths for low points on Roads, lanes or walkways.
- Proposed minimum building elevations (MBE) and its relationship to the major flow path HGL.
- Construction erosion and sediment control plan.
- Pre and post-Development peak flow rates for both the minor and major systems
    - Velocities under design peak flow rate conditions for all open channels (ditches, swales, ravines, streams, etc…) both on and off site.
    - Downstream capacity for the system which the subject Site is proposed to discharge to.

- Pre-Development flows for all areas draining to and through the subject site.

2.4 Minor and Major Systems

Each drainage system usually consists of the following components:

(a) The Minor System

Pipes, gutters, catchbasins, driveway culverts, open channels, Watercourses, and stormwater management facilities designed to carry flows with the specified return frequency.

(b) The Major System

Surface flood paths, Roadways, Roadway culverts, swales, Watercourses, and stormwater management facilities designed to carry flows with the specified return frequency.

2.5 Runoff Analysis

Storm drainage systems shall be designed to accommodate the post-Development flows using the Rational Method or an approved hydrologic / hydraulic computer model. All calculations pertinent to the design of the drainage system shall be signed and sealed by the Consulting Engineer and submitted to the City.

For Developments where the total tributary area is 10 hectares or less, the Rational Method may be used to compute the peak runoffs. An approved hydrologic/hydraulic computer model shall be used for analyzing larger catchments and for the design of all storage facilities.

The extent of the tributary drainage areas of the storm drainage system under design shall be based on the natural contours of the land and be subject to the overall drainage plan established by the City through any Master Drainage Plan (MDP), Neighbourhood Concept Plan (NCP), or other area servicing plans established for the catchment in which the subject property is located.
It is the Consulting Engineer's responsibility to confirm the extent of the drainage area with the Approving Officer prior to final design.

2.6 Design Frequencies

In general, the design of stormwater management system components is required to accommodate a number of variable storm runoff rates and volumes generated by storms of certain recurrence intervals. The following storm return frequencies shall be used for the design of the drainage and stormwater

management system components:

Table 2.1

Drainage System Component	Hydraulic Variables	Hydrologic Design Basis
On-site Minor Disposal System (where proven to be appropriate).	Mean Annual Rainfall (MAR) volume, infiltration rates of native soils, groundwater levels.	On-site disposal features to retain 50% of the Mean Annual Rainfall (MAR)[1] volume.
Minor conveyance system as defined in Section 2.4(a)	Base and peak flow rates, flow depths, flow velocities, and durations.	1:10 year design storm
Storage facility.	Runoff volume, depth, freeboard, peak inflow rate, control discharge rate, time to empty, base flow rates.	Storage capacity to reduce the post-Development flow rates with return periods of up to 10 years. Attenuation of Post Development runoff with return periods up to 100 years may be required if inadequate downstream major flow paths exist. Runoff from commercial sites must be attenuated for all events with return periods of up to 100 years.
Major system as defined in Section 2.4(b).	Base and peak flow rates, depths, velocities, and durations.	1:100 year design storm with winter condition antecedent moisture condition. Sufficient freeboard above the maximum hydraulic grade line must be provided to protect buildings. Ponds to have an overflow point at a minimum 0.6m below the closest opening (i.e. adjacent doors, windows, etc).

Table 2.1 (continued)		
Drainage System Component	**Hydraulic Variables**	**Hydrologic Design Basis**
Culverts, bridges, and other crossing structures.	Peak flow rates, depth and freeboard, backwater effect, fish passage.	1:100 year design storm and/or with safe overflow to protect City infrastructure and private property. 1:200 year for natural streams with catchments exceeding 10 sq. km or for structures crossing arterial or collector Roads.
Water Quality Treatment Systems	Peak flow, base flow, pollutant load and type	Treatment of flows equivalent to 50% of the Mean Annual Rainfall (MAR) volume.

[1]The Mean Annual Rainfall is defined as the 2 year 24 hr rainfall volume, see section 2.10.4.

2.7 Site and Lot Grading

Developments shall incorporate site and Lot grading techniques in accordance with the following criteria:

(a) Each Lot shall be graded to drain to a City drainage system or to a natural drainage path independent of adjacent Lots. Minimum Lot grades to be 2%. Lot grading is to be uniform and consistent.
(b) Areas around buildings (or proposed building sites) shall be graded away from the (proposed) foundations to prevent flooding. Grading within 2m of the structure should have 10% slope or minimum 0.15m drop.
(c) Lots lower than adjacent Roadways shall be avoided where possible, otherwise an approved stormwater management technique shall be incorporated to direct the runoff to an existing or proposed drainage system. Proper flood proofing is required at the low points of Roadways.
(d) Existing or proposed buildings shall be sited above the hydraulic grade line of the Major System. The Minimum Building Elevations (MBE) shall be noted on the drawings.
(e) Lot grading shall not channelize flow for discharge into natural Watercourses. Where Lot grading directs runoff to natural drainage courses, measures shall be implemented to distribute rather than concentrate flows.
(f) Avoid drainage across adjacent Lots where practical. Side and rear yard swales shall be employed as necessary.

2.8 Minimum Building Elevations (MBE)

The MBE is defined as the elevation of the lowest floor slab in a building or the underside of the floor joists where the lowest floor is Constructed over a crawlspace. Crawlspace is defined as the space between a floor and the underlying ground

having a maximum height of 1.2m to the underside of the joists and not used for the storage of goods or equipment damageable by floodwater.

The MBE shall be established at least 0.6m above the service connection invert and 0.3m above the 100-year hydraulic grade line elevation. Accepted MBE's may not be revised without the permission of the Approving Officer.

For sites near a Watercourse for which a floodplain elevation has been established, the MBE is 0.3m above the 200-year return period instantaneous flood elevation.

2.9 Roof Drainage and Building Perimeter Foundation Drainage

Roof drainage shall be:

(a) discharged to the ground and dispersed via splash pads at the downspouts, provided that the site is graded away from the building and **not in steep slope areas**, or
(b) to an approved sub-surface soak-away system, or
(c) To an approved rain storage tank for on-site reuse

If site grading in accordance with Clause 2.7 is not possible, roof drainage may be discharged into the municipal drainage system, at the discretion of the Approving Officer, where the size of the proposed or existing drainage has been designed for, or can be shown to accommodate the anticipated flows.

Roof leaders and foundations drains shall not discharge at the top of bank of a natural Watercourse or other open channel.

Building perimeter foundation drains shall be discharged into the municipal drainage system where the size of the proposed and existing downstream storm sewer has been designed for, or can be shown to accommodate the anticipated flows.

Under no circumstances shall a building perimeter foundation drain be connected to a sanitary sewer.

2.10 Rational Method

The Rational Method calculates the peak flow using the formula:

$$Q = RAIN$$

Where: R = Runoff Coefficient
A = Drainage area in ha.
I = Rainfall intensity in mm/hr.
N = 0.00278
Q = Peak flow in m^3/s

2.10.1 Runoff Coefficients

Zone designations selected for design purposes shall be based on the highest and best use of the properties in the design catchment area based on the most current version of City's Zoning Bylaw and SCP. Future land designations, as defined in the SCP shall be used if such land use designations will result in a higher runoff coefficient.

Table 2.2 Runoff Coefficient Table

Land Use or Surface Characteristic	Coefficient	
	1:10 year	1:100 year
Business:		
A. Commercial	0.85	0.95
B. Neighbourhood Area	0.60	0.70
Residential:		
A. Single Family	0.35	0.40
B. Multi-Unit (detached)	0.45	0.50
C. Multi-Unit (attached)	0.55	0.65
D. ½ Lot or Larger	0.25	0.30
E. Apartments	0.60	0.70
Industrial:		
A. Light Areas	0.65	0.75
B. Heavy Areas	0.85	0.95
Parks, Cemeteries, and Playgrounds	0.20	0.25
Schools	0.45	0.50
Railroad Yard Areas	0.35	0.40

Table 2.2 Runoff Coefficient Table (cont'd)		
Streets: A. Paved B. Gravel	 0.90 0.40	 0.95 0.45
Drives, Walks & Roofs	0.90	0.95
Lawns: A. 50% - 75% Grass (Fair Condition) B. 75% or More Grass (Good Condition)	 0.20 0.15	 0.25 0.20
Land Use or Surface Characteristic	Coefficient	
	1:10 year	1:100 year
Undeveloped Surface [(1)] A. Flat (0-1%) B. Average (2-6% C. Steep (>6%)	 0.04 0.09 0.13	 0.09 0.14 0.18

[(1)] Undeveloped Surface Definition: Forest and agricultural land, open space

2.10.2 Time of Concentration

The time of concentration is the time required for runoff to flow from the most remote part of the catchment under consideration to the design location (inlet, pipe, channel, outfall, etc…). For both urban and rural areas, the time of concentration consists of the following formula:

$$Tc = Ti + Tt$$

Where: Tc = time of concentration (minutes)
Ti = inlet or overland flow time (minutes)
Tt = travel time in sewers, ditches, channels or Watercourses (minutes)

Inlet or Overland Flow Time (Ti)

i) Minimum inlet times for various Development conditions are given to ensure uniformity in runoff computations.

Table 2.3		
Lot Type	**Minimum Inlet time**	
	10 year	**100 year**
Single Family	15	10
Multi Family	10	5
Commercial/Industrial/Institutional	10	5

ii) The inlet time in rural areas shall be calculated using the Airport Method:

$$Ti = \frac{3.26(1.1 - C)\, L^{0.5}}{S^{0.33}}$$

Where: Ti = inlet (minutes), minimum time = 15 minutes
C = runoff coefficient
L = travel distance (m), maximum length = 300m
S = slope of travel path (%)

Travel Time (Tt)

The travel time in sewers, ditches, channels or Watercourses shall be estimated using the following formula:

$$Tt = \frac{C_t\, Ln}{12\, s^{0.5}}$$

C_t	=	Concentration coefficient depending on the type of flow
	=	0.5 for natural Watercourses or ditches
	=	1.4 for overland flow
	=	0.5 for storm sewer flow
L	=	Length of Watercourse, conduit or overland flow in metres, along the drainage path from the furthest point in the basin the outlet.
n	=	Channel friction factor
	=	0.050 Natural channels
	=	0.030 Excavated ditches
	=	0.016 Overland flow on smooth paving
	=	0.400 Overland flow on natural areas
	=	0.013 Concrete pipe
	=	0.011 PVC pipe
s	=	Basin slope in meter/meter

The above equation provides an approximate travel time which shall be corrected with the actual time of flow calculated from the hydraulic properties of the selected pipe/channel. A composite value for Ti shall be calculated in cases where the type of flow along the longest path varies or the slope changes.

2.10.3 Rainfall Intensity

The rainfall intensity for the Rational Method should be determined using the appropriate rainfall IDF curve with the duration equal to the Time of Concentration (Tc) calculated as indicated above.

2.10.4 Mean Annual Rainfall (MAR)

Statistically, the Mean Annual Rainfall (MAR) is defined to be the 24 hour rainfall volume with a return period of 2.33 years. For practical purposes, the 2 year 24 hour rainfall volume may be used.

2.10.5 Presentation of Rational Calculations

The Consulting Engineer shall be required to tabulate the Rational Method calculations in accordance with Table 2.5 for submission along with the appropriate plans and other relevant information.

2.11 Computer Modeling Method

2.11.1 Selection of Modeling Program

For basins larger than 10 hectares, hydrologic modeling software shall be used for runoff analyses. Hydrologic/Hydraulic software shall also be used for the design of all stormwater detention facilities. The Approving Officer shall maintain a list of currently approved software programs, and only these shall be used for design purposes.

2.11.2 Design Storms

Rainfall hyetographs for single-event design storms with durations 15 minutes to 24 hours and various return frequencies shall be developed using Atmospheric Environmental Services (AES) rainfall data and rainfall distribution curves from Grand Forks, if available, or a suitable substitute as approved by the Approving Officer.

Drainage and stormwater management facility sizing is sensitive to the duration of the design storm. Shorter duration storms tend to generate low volume, high peak flow runoff, especially from smaller catchments. Longer duration storms tend to generate high volume, low peak flow runoff, especially from larger catchments. The critical design storm for components of a stormwater management system may differ for each primary component in terms of duration, even though the return period is identical. Therefore, the Design must identify the critical storm used to size each primary drainage and stormwater management component, the critical storm being the storm with the duration which requires the largest component size necessary to meet the design objectives and servicing standards specified in this document.

Tabulated data are suitable for most hydrological studies. However, the simulation of large watersheds or complex drainage systems may require extended duration storms or continuous rainfall data. It is incumbent on the Consulting Engineer to obtain the appropriate rainfall data for the analysis.

City of Grand Forks
Subdivision and Development Servicing Bylaw No. 1970

Table 2.5
Storm Sewer Design – Rational Method

Project Location:	**Date:**
Reference No.:	**Calculated By:**
Storm Return Period:	**Sheet:** _____ of

			Tributary Area						Storm Sewer Design							
Location	**From MH**	**To MH**	**R**	**A**	**Sum A**	**Sum RA**	**Rainfall Intensity (mm/hr)**	**Storm Q (m^3/s)**	**L**	**S**	**Diam.**	**n**	**Velocity**	**Q cap**	**Tc**	**HGL**
				(ha.)	**(ha.)**				**(m)**	**(%)**	**(mm)**		**(m/s)**	**(m^3/s)**	**(min)**	**(m)**

Tabulated data are suitable for most hydrological studies. However, the simulation of large watersheds or complex drainage systems may require extended duration storms or continuous rainfall data. It is incumbent on the Consulting Engineer to obtain the appropriate rainfall data for the analysis.

2.11.3 Catchment Data

Data preparation for planning areas or proposed Development shall be based on the best available information as per the SCP, any Neighbourhood Concept Plan (NCP), Master Stormwater Plan, Subdivision proposals and other pertinent land use information.

In most cases, the Consulting Engineer shall determine both pre-Development and post-Development flows using the default methods of selected software, except when that is the Soils Conservation Service (SCS) curve number (CN) approach. The SCS CN method shall not be used. If sufficient information is known about the infiltration characteristics of the soils, either the Horton's or Green Ampt methods may be applied. Whichever method is selected, the parameters shall be reflective of the type of soils, ground cover and typical antecedent moisture condition (AMC).

Where information is not specifically available through applicable documents, future impervious fractions for common land uses, as shown in Table 2.7 shall be used for analysis. These are intended as a guide only. In areas of existing Development or where more detailed information is available, the Consulting Engineer shall verify that the values shown are representative of the true conditions.

Table 2.7
Common Impervious Fractions

Common Land Use	Total Impervious Fraction
Wood Lot	0.00
Agricultural	0.10
Sub-Urban Residential	0.35
Single Family Residential (700	0.45
Low Density Multi-Family Residential	0.65
Apartment	0.75
Commercial	0.90
Industrial	0.90
Institutional	0.80

2.11.4 Storm Events

In order to determine the critical storm event for designing drainage works, analysis shall be conducted using design storms with the appropriate return period and a range of durations. Developing design flows for both existing and proposed Development conditions may be required. The following guide shall be used to assess the level of effort. However, the specific requirements shall be confirmed with the Approving Officer.

Table 2.8

Infrastructure Component	Storm Return Period	Storm Duration Range
Minor conveyance system	1:10 year	0.5 to 24 hours to determine design peak flow rate.
Major conveyance system	1:100 year	0.5 to 24 hours to determine design peak flow rate.
On-site Retention (Infiltration) Systems	1:2 year	24 hours (MAR) to determine on-site retention volume.
Detention Storage Facilities	1:10 year 1:100 year (if necessary)	0.5 to 24 hours to determine maximum storage volume and peak overflow rate.

The storm duration which generates the critical peak runoff rate is not necessarily the event which results in the largest storage volume requirement for peak flow attenuation. The Consulting Engineer is required to review all design storm events and select the critical design values for each component of the drainage system.

2.11.5 Presentation of Modeling Results

To document the design rational used to Develop the hydrologic model and to standardize the presentation of model results, the design reports shall include appropriate sections which shall indicate the following:

- Type and version of modeling software used.
- Summary of all parameters and specific simulation assumptions used.
- Design storms used, to be clearly documented (return periods, duration, and depth)
- A summary of peak flows for each system component
- Inflow and outflow hydrographs for storage facilities.
- Predicted hydraulic grade lines throughout the drainage system under conditions governing the design.
- Volumetric runoff coefficient (runoff volume divided by rainfall volume) and unit peak flow (peak flow divided by area) summarized for each catchment.

The report documentation shall include:

- A plan showing sub-catchment areas, watershed boundary (including upstream catchments) and the drainage system.
- A plan identifying the specific land uses modeled for each Development condition analyzed.
- For detention ponds, stage-area and storage-discharge curves and the layout (including sizing) of pond control devices.
- The functional layout and sizing of any flow control/diversion structure and the tabular/graphical plots of inflow and outflow hydrographs.
- Tables summarizing the above described performance related parameters.
- Appropriate identification tables for cross-reference between plans and tables.

2.12 Minor System Design

2.12.1 Level of Service

The minor drainage system consists of pipes and appurtenances sized to convey peak runoff by gravity (non-surcharged) flow conditions for storms having the return period specified in Section 2.6.

2.12.2 Pipe and Channel Capacity

Apply the Manning Formula under free flow (non-surcharged) condition. The Manning formula is:

$$Q = \frac{A\, R^{0.667}\, S^{0.5}}{n}$$

Where: Q = flow capacity (m/s)

A = cross sectional area (m^2)

R = hydraulic radius (m)

S = slope of hydraulic grade line (m/m)

n = roughness coefficient

- 0.011 for PVC pipe
- 0.013 for concrete pipe
- 0.024 for corrugated metal pipe (CMP or CSP)

Indicate hydraulic grade line for both the 10-year and 100-year return period on the Design Drawings, along with the peak design flow rate and pipe capacity for each reach.

2.12.3 Flow Velocities

Minimum design velocity for pipes flowing full or half full: 0.6 m/s.

Where steep grades result in velocities exceeding 6 m/s, consider measures to prevent pipe erosion and movement.

Provide riprap bank protection and, if necessary, energy dissipation facilities where discharges are approved into a Watercourse. Avoid discharge perpendicular to stream flow.

2.12.4 Minimum Grades

Minimum grades of storm mains are required to obtain the minimum velocity of 0.6 m/s except for catchbasin leads and service connections, for which minimum grades are as indicated elsewhere in this schedule.

2.12.5 Minimum Pipe Diameter

- Storm Mains 250 mm
- Culverts:
  - Crossing Roads 600 mm
  - Crossing Driveways 450 mm
- Catchbasin Leads 200 mm for single catchbasin
  250 mm for double catchbasin
- Service Connections:
  - Residential 100 mm
  - Commercial/Industrial 150mm

Downstream pipe sizes are not to be reduced unless the proposed downstream pipe is 600mm diameter or larger and increased grade provides adequate capacity. Detailed hydraulic analysis is required. The maximum reduction is two pipe sizes.

2.12.6 Alignment

Except as noted in 2.12.7, horizontal and vertical alignments are to be straight lines between manholes.

2.12.7 Curved Sewers

Where permitted by the Approving Officer, horizontal and vertical curves may be formed using pipe joint deflections as follows:

- Constant radius throughout curve.
- Joint deflection not to exceed 75% of maximum recommended by pipe

manufacturer.
- Minimum design velocity = 0.9 m/s.
- Curve locations to be recorded at ¼ points and midpoint.
- Constant offset from property line or Road centerline.

Where permitted by the Approving Officer, mains larger than 600mm diameter may include deflections formed by mitred bends, with minimum 1.25m straight sections and maximum 45° mitres.

2.12.8 Manholes

(a) Locations:

Manholes are required at:

- Every change in grade, except as permitted for curved mains.
- Every change in direction, except as permitted for curved mains.
- Every change in pipe size.
- The downstream end of curved mains and mitred bends.
- Every pipe intersection except for 100mm and 150mm service connections and junctions with trunk mains 900mm and larger.
- 150m maximum spacing for mains smaller than 900mmØ.
- 250m maximum spacing for pipes 900mmØ and larger.
- Every future pipe intersection.
- The upstream end of every storm main.

Catchbasins leads shall discharge into a manhole and not directly into the main wherever possible.

Temporary clean-outs may be provided at terminal section of a main provided that:

- Future extension of the main is proposed or anticipated.
- The length of main to the downstream manhole does not exceed 45.0m.
- The depth of the main does not exceed 2.0m at the terminal point.
- Clean-outs are not to be considered a permanent structure.

Manhole rim elevations outside of paved Roadways shall be designed to be above the surrounding ground so that infiltration from ponding will not occur.

(b) Hydraulic Details:

- Crown elevations of inlet mains shall not be lower than the crown elevation of outlet mains.
- Minimum drop in invert elevations across manholes:
  - Straight run: 5mm drop

- Deflections up to 45 degrees: 25mm drop
- Deflections 45 to 90 degrees: 50mm drop

- Drop manhole and ramp structures shall generally be avoided by steepening inlet mains. Where necessary, provide drop structures as follows:

Invert Difference	Structure
- Up to 0.45	Inside Ramp
- 0.45 to 0.90m	Outside Ramp
- Greater than 0.90m	Outside Drop*

* Inside drop may be used if specifically permitted by the Approving Officer.

- Hydraulic losses shall be calculated for manholes with significant change of grade or alignment. For high velocity flows or large mains (>600mmØ), detailed analysis is required. For low velocities and smaller mains, use the following formula:

$$H_L = k \frac{V^2}{2g}$$

Where:
H^L = head loss (m)
V = outlet flow velocity (m/s)
g = gravitational acceleration (9.81 m/s^2)
k = head loss coefficient (1.0 for channeled 90° bends and tees, to 1.5 without channelized benching)

2.12.9 Depth and Cover

- Depth shall be defined as the distance from the finished ground surface to the top of the main.
- Mains shall be of sufficient depth to:
  - Permit gravity sewer service to the basements of properties adjacent to the Roadway of sewer right-of-way.
  - Prevent freezing.
  - Meet the minimum depth of cover requirements of 1.8m.
  - Clear other underground utilities.
  - Prevent damage from surface loading.
  - Allow for future extension of the minor system to service upstream tributary lands at ultimate Development, as defined by the Approving Officer.
- Maximum cover depth: 4.5m, except under special circumstances and with permission of Approving Officer.

2.12.10 Rights-of-Way (R.O.W.)

Right-of-way locations shall be selected to avoid environmentally sensitive areas such as Watercourses, wetlands and wildlife migration corridors and forested areas.

Rear yard mains are discouraged and shall only be permitted with the approval of the Approving Officer.

Where location of a municipal utility in a statutory right-of-way is permitted by the Approving Officer, the minimum right-of-way widths are as follows:

- Single Service:

  R.O.W. width = Twice the depth from surface to the crown of the main [4.5m minimum width].

- Two Services within the Same Trench:

  R.O.W. width = Twice the depth from surface to the crown of the deeper main [5.5m minimum width].

- Two or More Services Adjacent to one Another but in Separate Trenches:

  R.O.W. width = Cumulative widths for single services PLUS any difference to provide the required separation [6m minimum width].

- Where the service is within a Road allowance, and the distance from the property line to the centre of the service is less than one half of the width indicated above for a single service, the difference shall be provided as right-of-way on the adjacent property.

In all cases, the width of rights-of-way shall be sufficient to permit an open excavation with side slopes in accordance with the Worksafe BC regulations, without impacting on or endangering adjacent structures.

Where required, trunk and interceptor mains should have rights-of-way wide enough for future widening and/or twinning. The width of the right-of-way should be the required separation between pipe centerlines plus 2 times the depth of the crown of the deeper main.

The Consulting Engineer shall provide cross sections indicating the minimum safe distances to adjacent building footings based on a safe angle of repose from the limits of the excavation.

Where a utility is located within a right-of-way, and manholes, or other appurtenances which require maintenance are located within the right-of-way, provide Road access from a public Road. The maintenance access must be sufficiently wide and structurally adequate to support the maintenance vehicles for which the access is intended. Maximum allowable grade of the maintenance access is 12%.

2.12.11 Utility Separation

Requirements for separation of storm mains from water mains are as follows, unless otherwise indicated by the local public health authority:

(a) Horizontal Separation:

At least three (3) m horizontal separation shall be maintained between a water main and a storm main.

In special circumstances, specifically in rock or where the soils are determined to be impermeable, lesser separation than 3.0m may be permitted provided that:

- The storm main and water main are installed in separate trenches and the water main invert is at least 0.5m above the crown of the sanitary storm main and the joints are wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of AWWA Standards C217, and C214 or C209; or,
- The pipes are installed in the same trench with the water main located at one side on a bench of undisturbed soil at least 0.5 m above the crown of the storm main and the joints of the water main are wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of the AWWA Standards C217, and C214 or C209.

(b) Vertical Separation

Where a storm main crosses a water main, the main should be below the water main with a minimum clearance of 0.45 m and the joints of the water main, over a length extending 3 m either side of the storm main, are to be wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of the AWWA Standards C217, and C214 or C209.

Where it is not possible to obtain the vertical separation indicated above, and subject to public health considerations, the following details may be

used:

- The water pipe joints shall be wrapped as indicated above, and
- The storm main should be Constructed of pressure pipe such as high density polyethylene (HDPE) or PVC with fused joints and pressure tested to assure it is watertight.

(c) Storm mains in Common Trench

Sanitary and storm sewers may be installed in a common trench, provided that the design has taken into account:

- Interference with service connections,
- Stability of the benched portion of the trench,
- Conflict with manholes and appurtenances.

The horizontal clearance between mains shall be no less than 1.0 m and the horizontal clearance between manholes should be no less than 0.3 m.

2.12.12 Service Connections

Every legal Lot shall be provided with a separate service connection.

Unless otherwise permitted by the Approving Officer, connections are to serve the perimeter (foundation) drains of all buildings by gravity. The Minimum Building Elevation (MBE) shall be a minimum 0.6m above the 100 year hydraulic grade line by gravity. Building elevations should be established accordingly. At the discretion of the Approving Officer, a private pump and backflow prevention device may be requested by the property Owner, or required by City of Grand Forks, where the predicted major flow hydraulic grade line in the municipal system is higher than the foundation level. All pumping and backflow prevention devices shall be located on private property and remain solely the responsibility of the property Owner. A covenant shall be registered on the property for such pumped systems.

Service connections shall be provided to each Lot fronting the main. Service connections shall not be extended at an angle that exceeds 45° from perpendicular to the main, and in no case shall a service connection be placed so that it extends in front of any property other than the one being serviced. Each property is permitted only one service connection. In special circumstances, where servicing of all buildings on existing Industrial or Commercial properties is not feasible, two services may be allowed if permitted by the Approving Officer.

Connections to new mains shall be made using standard wye fittings. Connections to existing mains shall use wye saddles or, where permitted by the

Approving Officer, inserta-tees may be used. All services shall enter the main at a point just below the springline.

The standard size for single family residential service connections shall be 100 mm, for which the minimum grade from the main to the property line shall be 2.0%.

The minimum depth of a service at the property line shall be 1.5 m provided that gravity service to the Minimum Building Elevation is available.

Where rear yard mains are necessary due to steep topography, the minimum cover shall be 1.0 m provided that gravity service, to the Minimum Building Elevation is available.

2.12.13 Catchbasin Spacing

Catchbasins are required at regular intervals along Roadways, at intersections and at low points.

Catchbasin spacing is to provide sufficient inlet capacity to collect the entire minor flow or major flow, if required, into the piped system.

The capacity of a single catchbasin (in sump conditions) can be calculated using the orifice formula:

$Q = kCA\sqrt{2gh}$ Where: Q = inlet capacity (m^3/s)
k = clogging factor (0.6)
C = orifice coefficient (0.8)
A = open area
g = gravitational acceleration (9.81 m/s^2)
h – depth of ponding (m)

Space catchbasins to drain maximum paved areas of:

- 500 m² on Roads with grades up to 4%.
- 400 m² on Roads with grades greater than 4%.

Other spacing requirements and considerations:

- Prevent overflows to driveways, boulevards, sidewalks and private property.
- Avoid interference with crosswalks.
- Avoid low points in curb returns at intersections.
- Catchbasin leads to discharge into manholes. Minimum grade of catchbasin leads: 2.0%.

Lawn basins are required on boulevards and private properties where necessary to prevent ponding or flooding of sidewalks, boulevards, driveways, buildings and yards.

Double catchbasins shall be connected directly together with a minimum 250mm PVC lead with one lead extending to the manhole. Maximum lead length shall be 30 meters.

Double catchbasins shall be provided at all low points.

2.12.14 Pipe Joints

Use watertight joints except where storm mains are part of a subsurface disposal system.

2.12.15 Groundwater Infiltration

In low areas where groundwater concentration may cause surface ponding, reduced soil stability, or submergence of other utilities, provide screened and filtered manhole inlets or perforated sections of storm main.

2.12.16 Ditch Inlets

Ditch inlets to storm main shall include safety grillage for large pipes (>400mm), debris screens and sedimentation basins.

2.13 Major System Design

2.13.1 Surface Flow Routing

All surface flows shall have specially designed routes that are preserved and protected by right-of-ways and are accessible for maintenance. Design criteria include:

- HGL is to be at least 600mm below the MBE of adjacent buildings.
- Maximum flow depth on Roadways: 150mm.
- One lane, or a 3.5m width at the crown of each Road, is to be free from flooding.
- Where a Road is used as a major flow path, the Road grades are to be designed to accommodate the flow at intersections and driveways.
- Flooding is not permitted on private property except in flow channels in municipal rights-of-way.
- Overflow routes are required at all sags and low points in Roads and other surface flow routes.
- Major flood routes are required at down-slope Cul-de-sacs.

2.13.2 Surface Flow Capacity

Flow capacity of Road surfaces and swales shall be calculated using the Manning formula, which is presented in Section 2.12.2. Typical values of the Manning Roughness Coefficient "n" are:

- 0.018 for paved Roadway.
- 0.030 for grassed boulevards and swales.
- 0.040 to 0.10 for irregular or treed channels.

Design detail is to include consideration of flow velocities and the potential requirement for erosion control measures. Maximum allowable velocities for various soil types are listed in Table 2.9.

Table 2.9
Maximum Recommended Velocities In Earth And Grass Lined Channels

Earth – Soil Type	**Permissible Velocities M/Sec**		
Fine Sand (noncolloidal)	0.5		
Sandy Loam (noncolloidal)	0.5		
Silt Loam (noncolloidal)	0.6		
Ordinary Firm Loam	0.9		
Fine Gravel	1.2		
Stiff Clay (very Colloidal)	1.4		
Graded Loam to Cobbles (noncolloidal)	1.4		
Graded, Silt to Cobbles (colloidal)	1.7		
Alluvial Silts (noncolloidal)	0.9		
Alluvial Sites (colloidal)	1.4		
Coarse Gravel (noncolloidal)	1.8		
Cobbles and Shingles	1.7		
Shales and Hard Pans	1.8		
Grass Lined	**<0.5%**	**5 – 10%**	**>10%**
Erosion Resident Soils	1.2	0.9	0.7
Highly Erodible Soils	0.9	0.7	0.5

2.13.3 Piped System

Where permitted by the Approving Officer, the minor drainage system may be enlarged or supplemented to accommodate major flows. System details shall be

indicated in the Storm Water Management Plan. Design considerations include:

- Provision of adequate inlets to accommodate major flows, especially for debris-laden water.
- The requirement for surface overflow routes at potential surface ponding locations.
- Design in accordance with minor drainage system guidelines.
- Adequate capacity of the existing downstream storm main.

2.13.4 Culverts

Culverts located in Watercourses or culverts crossing Roads shall be designed for the 1:100 year event (see Table 2.1 for conditions which require a 200 year design flow). Driveway culverts that form part of the minor system shall have capacity for the runoff from the 1:10 year storm. All culverts shall be sized with the design headwater not to exceed the top of the culvert. The Consulting Engineer shall determine whether the culvert will operate under the inlet or outlet control at design conditions.

The minimum depth of cover for culvert shall be 0.3m, subject to the correct pipe loading criteria.

The maximum length of a driveway culvert is 6.0 meters, unless otherwise permitted by the Approving Officer.

Inlet and outlet structures are required for all culverts, in accordance with Section 2.13.5) – Inlet and Outlet Structures.

2.13.5 Inlet and Outlet Structures

Provide inlet and outlet structures for all culverts larger than 450mm. Pipes larger than 1,200mm diameter and non-circular culverts require specially designed inlet and outlet structures.

Outlets having discharge velocities in Excess of 1 m/s require rip rap protection and/or energy dissipating structures for erosion control.

Hinged trash racks shall be required at the inlets of all pipes that are 450mm and larger. Grills may also be required at the inlets on smaller diameter storm sewers, at the discretion of the Approving Officer.

2.13.6 Ditches

Ditches shall only be provided if in accordance with the applicable Road classification and design standards. They may also be considered by the Approving Officer for special interim uses.

Ditches adjacent to Roads shall conform to the following criteria:

- Maximum depth: 1.0m
- Minimum bottom width: 0.5m
- Maximum side slope: 1.5(H):1(V)
- Minimum grade: 0.5%
- Maximum velocity (Unlined ditch) See Table 2.9

Where soil conditions are suitable or where erosion protection is provided, higher velocities may be permitted. If grades are excessive, erosion control structures or ditch enclosures may be required.

The minimum right-of-way width for a ditch through private property shall be 5m or the width of the ditch plus 3m, whichever is greater. The ditch shall be offset in the right-of-way to permit a 3m wide access for maintenance vehicles. Additional right-of-way may be required to facilitate the ditch Construction and access. The top of the ditch shall be a minimum 0.5m away from any property line.

2.14 Runoff Controls

2.14.1 Stormwater Storage Facilities

The application of infiltration features to retain frequent rainfall volumes on-site is encouraged. The application of such features shall be supported by a geotechnical evaluation which supports the long-term viability of stormwater disposal on-site (See Section 2.14.8 – Groundwater Recharge). Target design parameters are listed in Section 2.6 – Design Frequencies.

Peak flow attenuation shall be provided where post-Development stormwater runoff rates exceed the existing or pre-Development runoff rates, and the following conditions exist:

- The proposed Development site contributes directly or indirectly to a natural Watercourse or open channel that has a risk of increased erosion.
- The need for a storage facility has been identified in historical documents governing drainage for that catchment.
- The existing stormwater infrastructure downstream of the site does not have adequate capacity to accept additional flow and still meet the criteria herein. In this case, the Approving Officer will consider upgrading of the downstream deficiencies, at the Owner's cost, as an alternative to storage.

Stormwater detention shall be provided in accordance with the criteria herein:

(a) Capacity Requirements

The storage capacity requirement is determined by evaluating the

performance under a number of storm events as listed in Table 2.10. Sufficient live storage capacity shall be provided as follows:

- For the purpose of minor system performance and flood control, the storage facility shall be sized to limit the 1:10 year post Development flow to the 1:10 year pre-Development level with the outlet to have a graduated control structure based on a range of pre-Development flow rates (1, 2, 5, and 10 years).
- Storm events exceeding the 1:10 year level are generally considered an overflow condition and part of the major system. The facility shall be designed to permit the controlled overflow release of flows up to the peak 1:100 year level to an approved major flow path. If a sufficient major flow path does not exist, or if the proposed release rate will increase the risk of downstream impacts, then storage will be required to ensure that the post-Development 1:100 year flows do not exceed the 1:100 year pre-Development levels.
- In commercial areas, storage will be required to ensure that the post- Development 1:100 year flows do not exceed the 1:10 year pre- Development levels.

The performance of the storage facility shall be evaluated under the selection of storm events listed in Table 2.10. The facility shall be sized and designed for the criteria which results in the largest storage volume required. Storage facilities shall be designed and evaluated using approved modeling software as discussed in Section 2.11. This criteria is applicable to all service areas 0.4 hectares or greater.

(b) Small Lot Criteria

For service areas smaller than 0.4 hectares, the Approving Officer may waive the requirement for a detailed analysis of the storage facility, provided that on-site storage is provided in accordance with the criteria listed in Table 2.10.

Table 2.10
Small Lot Stormwater Detention Requirements

Land Use	Storage Rate	Maximum Allowable Release Rate
Single Family Residential	200 m^3/ha.	0.005 m^3/s/ha.
Townhouse/Apartment	250 m^3/ha.	0.005 m^3/s/ha.
Commercial/Industrial	300 m^3/ha.	0.005 m^3/s/ha.

1:100 year flows and volumes are to be determined by the Consulting Engineer as required to suit downstream constraints.

(c) Storage Alternatives

Further to 2.14.1, storage facilities shall be considered private systems and are to be located on private property with a registered protective covenant. Costs and long term operation and maintenance are the responsibility of the property Owner. These private systems shall not service more than a single Lot.

At the discretion of the Approving Officer, the City may agree to assume responsibility for the long term operation and maintenance of facilities that service multiple properties. In that case, the proposed facility and all connecting services shall be contained within a municipal right-of-way, and must be accessible by vehicle from a Road right-of-way.

The proposed stormwater detention alternatives shall be reviewed on a site specific basis. The Consulting Engineer shall consider storage methods listed in this section, and other methods of merit which the Consulting Engineer may determine appropriate. The number and location of the facilities shall consider the ultimate land use and servicing plan for the watershed. The proposed concept for all storage facilities shall be approved by the Approving Officer prior to detailed design. Typical control facilities include:

- Dry detention ponds, rain gardens, and swales
- Underground storage vessels
- Parking Lot surface detention

The Consulting Engineer shall consider the site and downstream conditions to determine the most suitable type of storage facility. All proposals shall address safety, long-term performance and maintenance issues.

(d) Geotechnical Considerations

On steep slopes, where stormwater detention or recharge is proposed, where discharge to a natural Watercourse or open channel is proposed, or as required by the Approving Officer, a geotechnical investigation shall be completed in order to address issues such as groundwater table, soil permeability, composition and stability. Such investigations shall be undertaken prior to the preparation of the final design of the facilities.

(e) Control Structures

A graduated spectrum of release rates from detention facilities shall be required using a control structure. Control structure design shall be subject to approval by the Approving Officer.

The outlet control for storage facilities shall be designed using standard orifice or weir equations:

Orifice Equation: $Q = C\ A\ (2\ g\ h)0.5$

Where Q = release rate (m^3/s)
C = coefficient (0.62 for sharp or square edge) A = area of orifice (m^2)
g = gravitational acceleration (9.81 m/s2)
h = net head on orifice (m)

Weir Equation: $Q = C\ L\ H1.5$

Where Q = release rate (m3/s)
C = weir coefficient (from published references) L = effective length of weir crest (m)
H = net head on weir crest (m)

Storage facilities shall include provisions for discharge rates greater than the design release rate. Rapid draw down of the facility may be necessary for emergency purposes or to restore the available storage to accommodate subsequent storm events.

Provisions to accommodate higher discharges shall involve over-sizing the fixed openings and sewers connected to control structure. Adjustable mechanisms such as slide gates or removable orifice plates can be used to regulate the design release rates. The extent of the over-sizing will depend on the capacity of the downstream drainage system.

Design of inlet/outlet structures shall consider flow energy dissipation and erosion control. Safety gates are required over all inlet/outlet openings larger than 450mm in diameter. Locks for access hatches are required to prevent unauthorized entrance to the structure.

(f) Provision for Water Level Measurement

A manhole accessible by maintenance vehicles shall be provided and shall be hydraulically linked to the storage facility. The invert of the manhole shall be set equivalent to the invert of the facility to allow quick and accurate measurement of the storage depth at any given time. The access for measuring depth may nor may not be the same facility as the control structure.

(g) Emergency Overflow

Whether the facility is sized to control the 1:100 year event or not, an emergency overflow spillway with the capacity for the peak 1:100 year flow rate shall be provided for all storage facilities. The spillway surface shall be finished with erosion resistant material such as concrete, asphalt, paving stone, or an approved equivalent. The design of the spillway and/or overflow shall consider the possibility of blockages in the outlet structure. The overflow shall provide safe discharge to an accepted major flow path.

(h) Operation and Maintenance Requirements

A minimum 4 meter wide all-weather vehicle access shall be Constructed from a public Road right-of-way to the control structure and other works requiring maintenance. The maximum grade on the access shall be 8%. The surface shall be finished with an erosion resistance material such as concrete, asphalt, paving stone, or approved equivalent. A maintenance access of the same type shall also be provided to a sediment sump or forebay at the inlet end of an open pond.

For facilities servicing multiple Lots, and where the City agrees to assume responsibility for operation and maintenance of the facility, six copies of the operation and maintenance manual shall be provided when the facility is completed and prior to ownership to the City. The manual shall include:

- Record Drawings of the Constructed facility.
- Brief description of the facility operation including design flows, design depths, and schematic diagrams of the inlet and outlet structures, connections, controls, valves, bypasses, overflows, etc.
- List of manufacturer's operation, service and repair instructions and parts lists (where applicable).
- Stage-storage-discharge relationship of all controls.
- General maintenance requirements and emergency procedures.

(i) Public Safety and Signage

All above ground storage facilities shall be designed to maximize public safety. Interior side slopes shall be 5:1 within the limits of the live storage volume. Side slopes above the live storage Zone may be a maximum of 3:1. The design of storage facilities shall include adequate provisions for installation of standard signage to warn of anticipated water level fluctuations, with demarcation of the expected maximum water levels for design conditions. If the permanent storage depth in a wet detention pond exceeds 1.0 meters, a safety barrier shall be provided in addition to signage. This barrier should be aesthetically pleasing and may be in the form of a chain and post fence, continuous planting of dense shrubs, etc.

(j) Performance Monitoring

Prior to final approval of all stormwater detention facilities, the Developerwner shall prepare and submit to the Owner a written monitoring program to be conducted by the Owner for a period of 12 months following Construction. Monitoring results are to be submitted to the City on a monthly basis for review. Adjustments to the control device shall be required as necessary prior to the expiry of the 1 year Maintenance Period.

2.14.2 Swales and Biofiltration Swales

The term biofiltration refers to a depressed flow conveyance / detention area that is surfaced with a relatively deep layer of highly permeable topsoil and vegetation (turf or ornamental landscaping) that absorbs and filters stormwater prior to discharge off-site.

Minimum depth of biofiltration swales shall be 150mm. Maximum depths shall be 300mm. Deeper swales may be considered provided side slopes do not exceed 3:1. Turf lined swales shall be lined with a minimum 200mm of top soil beneath the turf. Ornamentally landscaped swales to be lined with a minimum of 450mm of top soil, with consideration for ornamental rock placed in the invert to resist soil erosion.

Perforated underdrains may be added for enhanced groundwater recharge in areas where underlying native soils provide reasonable infiltration capacity. See Section 2.15.2 (Water Quality Protection) and Section 2.15.5 (Groundwater Recharge).

2.14.3 Erosion and Sediment Control

An erosion and sediment control plan shall be provided. The purpose of this plan is to prevent the release of silt, raw concrete, concrete leachate and other deleterious substances into any ditch, storm main, Watercourse or ravine. Construction materials, excavation wastes, overburden soils, or other deleterious substances shall be disposed of or placed in such a manner as to prevent their entry into any Watercourse, ravine, storm sewer system, or restrictive covenant area.

All siltation control devices shall be situated to allow for ready access for cleaning and maintenance. Siltation control structures shall be maintained throughout the course of Construction and to the end of the Maintenance Period (final acceptance). Changes in the design of the structure shall be required if the proposed structure is found to perform inadequately.

At minimum, the control plan shall provide the following:

(a) Section I: Narrative

- Project description: A brief description of the nature and purpose of the land- disturbing activity and the amount of grading involved.
- Existing site conditions: A description of the existing topography, vegetation, and drainage.
- Adjacent areas: A description of neighbouring areas, such as streams, lakes, residential areas, and Roads that might be affected by the land disturbance.
- Soils: A brief description of the soils on the site including erodibility and particle size distribution (texture).
- Critical areas: A description of areas within the Developed site that have potential for serious erosion or sediment problems.
- Erosion and sediment control measures: A description of the methods that will be used to control erosion and sediment on the site including, temporary erosion control, temporary sediment control measures, and whom will be responsible for implementation. Financial guarantees may be required to assure proper implementation.
- Permanent stabilization: A brief description of how the site will be stabilized after Construction is completed.
- Maintenance: A schedule of regular inspections and repairs of erosion and sediment control structure, and the person responsible for maintenance.

(b) Section II: Details

- Detailed drawings: Enlarged dimensioned drawings of such key facilities as sediment basin risers, energy dissipaters, waterway cross-sections, and sediment barriers.
- Seeding and mulching specifications: Seeding dates, seeding, fertilizing, and mulching rates in kilograms per hectare, and application procedures.
- Maintenance program: Inspection schedules, spare materials needed, stockpile locations, and instructions for sediment removal and disposal and for repair of damaged structures.

(c) Section III: Calculations

- Calculations and assumptions: Data for design storm used to size pipes and channels and sediment basins and traps (e.g., 10-year, 6-hour storm = 3.1 in.; i peak = 2.6 in./hr.), design particle size for sediment trap efficiencies, basin discharge rates, size and strength characteristics for filter fabric, wire mesh, fence posts, etc. and

other calculations necessary to support drainage, erosion, and sediment control systems.

- Attachments: The erosion control plan shall be accompanied by a grading plan.

2.15 Environmental Protection

2.15.1 Creek Setback Protection

An environmental assessment pursuant to applicable provincial and federal legislation shall be completed where the top of bank of an existing Watercourse is located within 30m of the property line of a proposed Development.

No new stormwater outfall is permitted into a natural Watercourse without approval from applicable provincial and federal authorities.

2.15.2 Water Quality Protection

Specific practices for the quality treatment of stormwater runoff shall be applied to the paved surfaces of all multi-family residential, industrial, commercial, public and institutional uses, or other areas that provide communal vehicle parking, or where there is a specific risk from other point source pollution.

Best Management Practices (BMP's) shall be implemented to protect water quality where indicated above, or where required by the Approving Officer. Also, runoff temperature shall be no greater than 15 deg C.

Table 2.11 summarizes potential BMP's and appropriate application. These shall be considered and implemented where practical. This list is not exhaustive and there may be alternatives which the Consulting Engineer may wish to propose for review by the Approving Officer.

Table 2.11	
Best Management Practice	**Typical Applications**
Coalescing plate Oil/Water separator or equivalent (mandatory for noted	Gas stations, automotive service facilities, auto recycling facility.
Engineered Treatment Unit	Parking Lots, light industrial and commercial sites. **Required** within 30m of the high water mark for the Kettle & Granby Rivers and within 30m of any Riparian Areas.
Biofiltration swales and rain gardens	All uses
Sump manholes and catchbasins with trash hoods	All uses
Covered containment area	All commercial, industrial or agricultural chemical handling and storage areas.
Infiltration and groundwater recharge	All uses
Constructed wetland / stormwater detention	All uses

The noted Best Management Practices are intended for water quality control and do not necessarily perform a function of runoff control. Treatment BMP's should be located upstream of any detention storage facilities. The target levels of treatment and the proposed type of treatment unit shall be provided by the Consulting Engineer to the City for approval. The Approving Officer may require different levels of treatment depending on specific site constraints.

2.15.3 Slope Stabilization

The implementation of stormwater management measures, combined with controls on Development adjacent to Watercourses, is intended to minimize the impact on the receiving Watercourses.

(a) Setbacks

Disturbance too close to a slope bank can destabilize the bank material and contribute to bank failures. In addition to the environmental restrictions to working within the streamside protection area of a natural Watercourse, no disruption to the native ground is permitted within a setback Zone established by a 4:1 slope measured from the bottom of the slope. Detailed site investigations by a qualified Geotechnical Consulting Engineer is required prior to the approval of any Development of disturbance within this setback Zone.

(b) Retention of Bank Vegetation

Existing vegetation along stream channel banks and within the established riparian setback shall be retained, and the disposal of debris within this setback is prohibited. The design shall consider the erection of temporary fencing and flagging during Construction which clearly identifies the working limits for the protection of the riparian setback.

(c) Storm Outfalls

The number of storm outfalls into natural Watercourses shall be minimized. Individual drains to natural Watercourses are not permitted unless specific approval has been granted by provincial and federal agencies as well as the Approving Officer.

2.15.4 Channel Erosion Protection

Where required and permitted by the approving authorities, bank protection shall be considered along existing and new open Watercourses to provide adequate erosion protection in the form of bank armoring, soil stabilization, flow deflection and other methods applicable for the specific site conditions. Some of the optional methods are summarized below. However, it is the Consulting Engineer's responsibility to assess the requirements for and suitable method of bank protection.

- Grass lined and natural channels: Most suitable for longitudinal gradients of 2% or less.
- Rip-Rap protection: The selection of rip-rap protection shall consider the flow velocities and scour of the underlying materials. The use of granular material or geotextiles shall provide a suitable barrier to prevent the migration of finer materials caused by either the flow in the main channel or by flows from the channel banks due to seepage.
- Bio-Engineering: Bio-engineering methods of bank protection shall be promoted wherever possible for the protection and stabilization of Watercourses. Bio-engineering solutions involve the use of live plants and vegetation to provide bank lining and cohesion of bank materials to resist scour. The plant materials used will require anchoring to ensure long-term stability. Bio-engineering solutions shall be compiled by the Consulting Engineer with demonstrated expertise in this area.

It is noted that any proposed works within the streamside protection area of an existing Watercourse falls under the jurisdiction of the Provincial or Federal governments, and as such, shall be subject to their approval.

2.15.5 Groundwater Recharge

The drainage characteristics of the surface soils in the City are variable from one location to another. These conditions may provide the opportunity to implement infiltration measures to reduce stormwater runoff. All Development proposals are encouraged to implement on-site mitigative measures for the purposes of groundwater recharge. For all commercial, institutional, multi-family residential and industrial Developments, the Consulting Engineer shall submit a report, prepared by a qualified hydrogeologist, which clearly identifies the specific opportunities and constraints for implementing shallow groundwater recharge systems on-site. At a minimum, this report shall present the following items:

- Description of site condition, size and location.
- Description of proposed Development and resulting design flows.
- Description of native soils and water table conditions on-site to a depth of 5 meters.
- Estimated infiltration rates for each strata of material within the 5 meter depth (complete with a description of seasonal variability.
- Recommendations for recharge methods suitable for the proposed Development.

Based on the opportunities identified in the above noted investigation, groundwater recharge systems may be approved, at the discretion of the Approving Officer, either in lieu of stormwater detention facilities, or to reduce stormwater detention requirements.

Requirements to incorporate recharge systems in the design shall be reviewed by the Approving Officer on a site specific basis. However, the Consulting Engineer is required to demonstrate that infiltration potentials are being maximized, within reasons:

(a) Pre-Treatment

Particularly in multi-family, commercial, institutional and industrial Developments, all groundwater recharge systems shall include pre-treatment measures to remove sediments, suspended solids and greases prior to entering the infiltration Zone. Biofiltration is the preferred approach.

(b) Overflow System

Recharge systems shall be designed with sufficient volume to maximize the opportunity for infiltration.

(c) Recharge Systems

Methods of groundwater recharge (infiltration) systems are discouraged, and will only be approved by the Approving Officer on a site specific basis. The proposed system shall satisfy long-term performance and maintenance issues in order to be approved. Typical systems supported by the City include the following:

- Drywells
- Rock pits
- Perforated drains
- Premanufactured modular infiltrator chambers (design as per manufacturer's recommendations).

SCHEDULE 3
WATER DISTRIBUTION

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3. WATER DISTRIBUTION

3.1 Water Distribution

Water distribution systems shall be designed in accordance with the standards and specifications set out in this Schedule, and the provisions of this bylaw.

3.2 Per Capita Demand

For residential areas, use the following per capita demands:

- Average annual daily demand (A): 720 litres per capita per Day (L/c/d)
- Maximum Day demand (D): 3,200 litres per capita per Day (L/c/d)
- Peak hour demand (H): 4,800 litres per capita per Day (L/c/d)

For other than residential areas, the demand criteria must be selected to suit the particular circumstances as approved by the City.

3.3 Fire Flows

(a) Fire flows should be determined in accordance with the requirements of the current edition of "Water Supply for Public Fire Protection – A Guide to Recommended Practice", published by Fire Underwriters Survey.

(b) Fire flows are also subject to the following minimum requirements:

Table 3.1

Developments (without sprinklers)	**Minimum Fire Flow**
Single Family Residential	60 L/s
Apartments, Townhouses	150 L/s
Commercial	180 L/s
Institutional	150 L/s
Industrial	205 L/s

3.4 Design Flows

(a) System design flows should be based on the ultimate population and fully Developed non-residential land as anticipated in the Sustainable Community Plan (OCP).

Equivalent populations for non-residential flows can be estimated using the established non-residential demands and the Maximum Day per capita demand.

(b) Total design flows (Q_{design}) are to be greater of the following:

Q_{design} = D+F	Maximum Day Demand for the population or equivalent population **plus** the Fire Flow, or
Q_{design} = H	Peak Hour Demand for the population or equivalent population

3.5 Water Pressure

Table 3.2	
Static Conditions - Maximum	860 kPa* (125psi)
Static Conditions – Minimum	380 kPa (55psi)
Peak Hour Conditions	310 kPa (45 psi)
Minimum Hydrant Residual (MDD + Fire Flow)	140 kPa (20psi)

*Where permitted by the Approving Officer, the maximum allowable pressure may be increased to 1,035 kPa for systems with multiple pressure Zones.

Where the maximum pressure exceeds 515 kPa, service connections must be individually protected by pressure reducing valves located in the buildings being served.

Determination of maximum and minimum pressures shall include consideration of final Lot grades relative to Road and street elevations.

3.6 Hydraulic Design

(a) Use a proven network analysis computer model based on the Hazen-Williams formula:

$$Q = \frac{CD^{2.63}S^{0.54}}{278780}$$

Where: Q = Rate of flow in L/s
D = Internal pipe diameter in mm
S = Slope of hydraulic grade line in m/m
C = Roughness coefficient= 120 for all pipes

(b) the maximum allowable design velocity under fire flow conditions should be 3.0 m/s, and

(c) 2.0 m/s under Peak Hour demand conditions.

3.7 Minimum Pipe Diameter

Table 3.3	
Distribution mains:	200mm
Fire hydrant connections:	150mm
Service connections:	19mm
With fire sprinklers:	50mm

Where permitted by the Approving Officer, distribution main minimum diameter may be reduced to 150mm provided that the main terminates in a short residential Cul-de-sac, has a length less than 80 m and serves no fire hydrants. The City may require water mains larger than 200mm diameter for main feeder lines.

3.8 Dead Ends

Watermains shall be looped wherever possible. Where dead ends are unavoidable, and where permitted by the Approving Officer, blow-offs or blow-downs shall be provided. Blow-off and blow-down sizes are:

- 50mm diameter for 150mm diameter watermains.
- 100mm diameter for 200mm diameter and larger watermains. Where practical, a hydrant may serve a secondary role as a blow-off.

3.9 Minimum Depth of Cover

Depth of cover shall be determined on the distance from finished ground surface to top of pipe. Watermains and services must be of sufficient depth to:

- Prevent freezing. Minimum 1.5m cover.
- Provide mechanical protection from external loads.
- Clear other underground utilities.

Provide special consideration for frost and mechanical protection in cases where minimum depths cannot be attained, e.g. at bridge crossings and in chambers.

3.10 Grade

Grades shall be straight lines between defined deflection points.

Where possible, the minimum grade of watermains shall be 0.1%. Grading shall be designed to minimize the number of high points.

When the grade of the main equals or exceeds 20%, provide anchorage, joint restraints, trench dams and trench drainage. Provide geotechnical engineering report where appropriate.

3.11 Corrosion Protection

Where there is a potential for encountering corrosive soils, a geotechnical corrosion analysis along the alignment of any proposed metallic watermain shall be conducted to determine the corrosiveness of the native soils. If the soils are determined to be corrosive, measures such as cathodic protection shall be included to prevent corrosion of the watermain and appurtenances.

3.12 Valves

In general, valves should be located as follows:

- In intersections either in a cluster at the pipe intersection or at projected property lines to avoid conflicts with curbs and sidewalks:
  - 4 valves at “X” intersection
  - 3 valves at “T” intersection
- Not more than 250m apart
- Not more than 2 hydrants isolated
- Not more than 50 service connections isolated.

Gate valves are required on all mains. Gate valves 400mm and larger to include a bypass.

3.13 Hydrants

Fire hydrants shall be located, in general, at street intersections and as follows:

- Note more than 150m apart nor more than 90m from a building.
- In accordance with “Water Supply for Public Fire Protection – A Guide to Recommended Practice” published by Fire Underwriters Survey.
- 2.0m back from curb or 0.5m back of sidewalk.
- Minimum 3.0m clear of any other utility structure.
- At property lines in mid-block locations.

3.14 Air Valves

Combination air valves shall be installed at the summits of all mains of 200mm diameter and larger, except as follows:

- Where the difference in elevation between the summit and valley is less than 600mm.
- Where it can be shown that air pockets will be carried by typical flows.
- Where active service connections are suitably located to dissipate entrapped air. Typical air valve sizes, subject to design analysis, are as follows:

Table 3.4

Watermain Size	Valve Size
200mm to 300mm	25mm
350mm to 600mm	50mm
Larger than 600mm	Special design

Air valves shall be vented to an appropriate above-grade location to eliminate any potential for cross connection in a flooded or contaminated chamber.

3.15 Thrust Restraint

Concrete thrust blocking and/or adequate joint restraining devices shall be provided at bends, tees, wyes, reducers, plugs, caps, valves, hydrants and blow-offs.

The restraint system shall take into account potential future excavations in the vicinity of the watermain. Design calculations shall be based on fitting type, water pressure and soil conditions.

3.16 Chambers

Chambers or manholes containing valves, blow-offs, meters, or other appurtenances shall allow adequate room for maintenance, including headroom and side room. Access openings shall be suitable for removing valves and equipment. The chamber shall be provided with a drain to storm main or to a ditch, complete with backflow prevention, to prevent flooding of the chamber. Rock pits may be considered, subject to suitable soil and groundwater conditions. A pumping system may be required for drainage.

Adequate venting shall be provided. The Approving Officer may require provision of forced ventilation, lighting, heating and dehumidification. Access and ventilation details shall comply with WorkSafe BC regulations.

Insulation to prevent freezing shall be provided where necessary.

3.17 Service Connections

Service connections size shall be calculated on the basis of the designated land use including sprinkler systems and/or on-site hydrants, where applicable. The minimum connection size shall be 19mm.

Each service shall have a shut-off located within 300mm of the property line on the public side. Each connection of 100mm diameter or larger requires a check valve at the property side of the shut-off.

All service connections shall have provisions for metering.

3.18 Alignment

Except as noted in 3.21, watermains shall have straight alignments, with uniform offsets between intersections.

Mains shall be located such that each property served has at least one side facing the watermain.

3.19 Rights-Of-Way (R.O.W)

Right-of-way locations should be selected to avoid environmentally sensitive areas such as Watercourses, wetlands and wildlife migration corridors and forested areas.

Where location of a municipal utility in a statutory right-of-way is permitted by the Approving Officer, the minimum right-of-way widths are as follows:

- Single service:

  R.O.W. width = twice the depth from surface to the crown of the pipe [4.5m minimum width]

- Two services within the same trench:

  R.O.W. width = twice the depth from surface to the crown of the deeper pipe [5.5m minimum width]

- Two or more services adjacent to one another but in separate trenches:

  R.O.W. width: cumulative widths for single services PLUS any difference to provide the required separation [6m minimum width]

- When the service is within a Road allowance, and the distance from the property line to the centre of the service is less than one half of the width

indicated above for a single service, the difference should be provided as right-of-way on the adjacent property.

In all cases, the width of rights-of-way shall be sufficient to permit an open excavation with side slopes in accordance with the WorkSafe BC regulations, without impacting on or endangering adjacent structures.

Where required, water mains should have rights-of-way wide enough for future widening and/or twinning. The width of the right-of-way should be the required separation between pipe centerlines plus 2 times the depth to the crown of the deeper pipe.

The Consulting Engineer shall provide cross sections indicating the minimum safe distances to adjacent building footings based on a safe angle of repose from the limits of the excavation.

Where a utility is located within a right-of-way, and valves, valve chambers, manholes, or other appurtenances which require maintenance are located within the right-of-way, provide Road access from a public Road. The maintenance access must be sufficiently wide and structurally adequate to support the maintenance vehicles for which the access is intended. Maximum allowable grade of the maintenance access is 12%.

3.20 Curved Watermains

Where permitted by the Approving Officer, horizontal curves may be formed by arcing the pipe barrel as follows:

- Radius and curvature not less than 60m.
- No deflection at pipe joints.
- Constant radius throughout curve.
- Curvature limited to half of maximum curvature specified by pipe manufacturer.
- Curve locations to be recorded at ¼ points and mid-point.
- Constant offset from property line or Road centerline.

3.21 Reservoirs

(a) Preliminary Design Requirement

In addition to the requirements of Schedule B – Submissions and Approvals, reservoir design shall include a preliminary design report which is to be accepted

by the Approving Officer before detailed design begins. Preliminary design shall cover the following issues:

- Selection of materials (concrete or steel)
- Operational Schematic
- Design standards
- Volume
- Shape
- Number of cells
- Geotechnical report on foundation conditions
- Aesthetics
- Water Quality and reservoir mixing

(b) Capacity

Reservoirs shall be designed to suit the particular circumstances. Reservoir capacity shall be calculated by the following formula:

Total Storage Volume = A + B + C

Where: A = Fire Storage (from Fire Underwriters Survey guide)
B = Equalization Storage (25% of Maximum Day Demand)
C = Emergency Storage (25% of A + B)

Subject to the results of a detailed engineering analysis, and approval of the local authority, the requirement for emergency storage (C) may be reduced or eliminated based on consideration of the following:

- Dependability of water source
- Reliability of supply system
- Presence of more than one supply source
- Whether the reservoir is part of a large system
- Presence of other reservoir(s) in system
- Availability of standby power

(c) Structural Design Codes

Design in accordance with the latest edition of the BC Building Code and, as applicable, the following specialty codes:

- American Concrete Institute (ACI) 350/350R: Code Requirements for Environmental Engineering Concrete Structures, and Commentary
- Portland Cement Association (PCA): Circular Concrete Tanks Without Prestressing
- ACI 350/350R: Seismic Design of Liquid Containing Concrete Structures, and Commentary

- American Waterworks Association (AWWA) D110: AWWA Standard for Wire and Standard-Wound Circular Prestressed-Concrete Water Tanks
- AWWA D115: AWWA Standard for Circular Prestressed Concrete Water Tanks with Circumferential Tendons
- AWWA D100: AWWA Standard for Welded Steel Tanks for Water Storage
- AWWA D103: AWWA Standard for Factory-Coated Bolted Steel Tanks for Water Storage

(d) Design Features

- Seismic Loading: Design for the following:
  - Watertight structure and fully operational mechanical equipment, following a 475-year return period earthquake.
  - Repairable damage and no uncontrolled release of water following a 2500-year return period earthquake.
- Two cells, each containing one-half of total required volume and capable of being drained and filled independently. A single cell reservoir may be considered under the following circumstances:
  - Total volume less than 4500 m^3.
  - Alternative storage available (another reservoir in system).
  - Alternative supply source available.
  - Alternative storage or supply source scheduled to be available within five years.
- Independent drain outlet at bottom, with consideration given to discharge route, capacity and any environmental concerns.
- Overflow drain sized to handle the maximum design inflow.
- Separate inlet and outlet pipes, located and oriented to provide circulation within the reservoir.
- Roof access hatch sized and located for safe and convenient access for personnel, parts, temporary ventilation facilities and cleaning equipment into each cell.
- Hatches: watertight aluminum, complete with hinges and related hardware, drains, locks and intrusion alarms.
- Ventilation pipes or openings sized to handle appropriate intake and exhaust air volumes for filling and draining the reservoir. Include security considerations.
- Reservoir floor to slope to drain sump in concrete structures and in steel structures where possible. Drain as low as possible in steel reservoirs.
- Drain sump in concrete reservoirs to be minimum 1,000mm x 1,000mm x 400mm; invert of drain pipe to be flush with sump floor; grating to be installed over sump.
- Zoned sub-drains under floor to collect, drain and allow monitoring of any leakage.

- Stairways or stainless steel or aluminum interior wall ladder from roof access to floor. All ladders and stairs to meet WorkSafe BC regulations, including attachment points for fall arrest equipment.
- Fall prevention railings.
- All pipework within the reservoir to be PVC, stainless steel, fiberglass or steel or ductile iron coated to AWWA standards.
- All metal parts within the reservoir including bolts, nuts, screws, anchors, ladders, etc. to be stainless steel.
- Pressure transducer or ultrasonic level controls for each cell.
- Sample lines for at least one sample per 1,000 m^3 volume within each cell.
- Washdown connection in each cell, complete with backflow preventer and 65mm diameter pipe.
- Convenient vehicular maintenance access conforming to Section 1 - Roads.
- Fencing, lighting, locks, ladder guards, alarms and other security facilities to minimize vandalism and prevent water contamination.
- Site finishing to suit location and surrounding land uses.

(e) Valve Chamber

Reservoir piping is to incorporate a valve chamber with the following design features:

- Chamber to include all valves associated with the reservoir operation
- Design in accordance with seismic codes noted above
- Entrance at grade large enough to permit safe removal of largest equipment
- Lifting beams and hoists where necessary to enable removal of equipment
- Space for safe and convenient operating and maintenance access to all valves, piping, equipment and instruction
- Interior and exterior of all steel piping to be coated to AWWA standards, or, alternatively, use stainless steel. Steel pipe in contact with potable water to use products that are NSF 61 certified.
- Floor drains and drainage system
- Located above 200-year flood level or 1.0 m above highest recorded flood elevation

Additional features, which may be required subject to system operations details, include the following:

- Sampling ports for inlet, outlet and reservoir water
- Flow measurement and recording

- Heat, light and ventilation WCB standards
- PLC-controlled inlet valve and level monitoring and control system
- Connection to SCADA system
- Uninterruptible power supply (UPS) for control system
- Chlorine residual analyzer for reservoir inlet and outlet
- Provision for re-chlorination facilities
- Four (4) copies of a comprehensive Operations and Maintenance Manual. Manual shall be hardbacked bound documents with the name of the facility embossed on the cover. Manuals shall contain a table of contents with each section identified by a plasticized, labeled divider.

3.22 Pump Stations

(a) Preliminary Design

In addition to the requirements of Schedule B – Submissions and Approvals, pump station design shall include a preliminary design report which is to be accepted by the Approving Officer before detailed design proceeds. The preliminary design shall follow a „systems based‟ approach which addresses the performance of the pump station and the supply and distribution network together. Preliminary designs shall include the following issues:

- Location
- Capacity
- Hydraulics (Pressure, NPSH, pump RPM, efficiencies)
- Water hammer analysis and mitigative measures.
- Number and type of pumps
- Preliminary piping layout
- Type and appearance of structure
- Foundation conditions
- Maintenance requirements and access
- Energy requirements (sustainability, energy efficiency)
- Standby power
- HVAC
- Aesthetics
- Noise
- Controls and monitoring, including process and instrumentation drawing and control narrative
- Life cycle costs
- Operations

(b) Capacity

Pumping capacity shall be designed to suit the particular circumstances.

In general, capacity should meet maximum Day demand with the largest pump out of service and balancing storage on line. If balancing storage is not on line, pumping capacity should meet peak hour demand with the largest pump out of service. Stand-by power should be provided to allow the greater of maximum Day demand plus fire flow or peak hour demand (D+F, or H) during a power outage.

(c) Design Features

- Structure, piping and mechanical systems designed in accordance with seismic codes for post-disaster structures.
- Located above 200-year flood level or 1.0m above highest recorded flood elevation.
- Reinforced concrete, blockwork or brick Construction designed to incorporate aesthetic considerations.
- Lockable access doorways sized for safe and convenient removal and replacement of the largest piece of equipment. Lifting hooks or rails with hoisting equipment as required.
- Adequate HVAC and lighting.
- Standby power, unless fire storage and balancing and/or emergency storage is available without pumping.
- Electric motors to be 600 volt, 3-phase, premium efficiency, with thermal protection. Lower voltage (208V, 3-phase), single phase may be considered, depending upon service voltage available from the power company.
- Electrical motors to be suitable for use with a Variable Frequency Drive (VFD).
- Motors 100 HP and above to have analog vibration recording and protection.
- Air relief discharge and pilot lines to be piped to floor drains.
- Housekeeping pads for MCCs.
- Hydraulically operated or motorized pump control valves with isolation valves, unless pumps have variable speed drives which control transient pressures.
- Totalizers.
- Spring return “Silent” check valves.
- High pressure and surge relief valves or VFDs with isolation valves, if warranted by system characteristics and transient analysis.
- Suction and discharge pressure gauges, with isolation valves, for each pump.
- Discharge pressure transducer for connection to SCADA.
- Mechanical pump seals.
- Water quality sampling ports.
- Interior and exterior of pipework coated to AWWA standards, or, alternatively, use stainless steel. Steel pipe in contact with potable water to use products that are NSF 61 certified.

- Pump system to be PLC-controlled and connected to SCADA system. PLC to conform to current City of Grand Forks standard.
- Hour meters and ammeters for each pump.
- Power factor correction, if required by power company.
- 120 V power outlet for small tools
- Noise attenuation to suit the location and local authority standards.
- Equipment to be CSA approved and have minimum one-year guarantee on parts and labour. All equipment must be tested prior to acceptance.
- Off-Road vehicle parking.
- Four (4) copies of a comprehensive Operating and Maintenance Manual. Manual shall be hardbacked bound documents with the name of the facility embossed on the cover. Manuals shall contain a table of contents with each section identified by a plasticized, labeled divider.

3.23 Pressure Reducing Valve (PRV) Stations

Prior to commencing detailed design of a PRV and in addition to the requirements of Schedule B – Submissions and Approvals, the Consulting Engineer shall submit a preliminary design report that addresses the design considerations of this bylaw.

Approval of the preliminary design report shall be obtained prior to the Consulting Engineer commencing detailed design.

(a) Preliminary Design Parameters

- Design flows:
  - Peak hour
  - Maximum Day plus fire
  - Continuous, emergency or fire flow operation
  - Location

- Chamber details:
  - Structure and access
  - Controls and monitoring
  - HVAC
  - Lighting

(b) Design Features

- Above ground building; minimum size: 3 m x 4 m x 2 m (inside dimensions).
- Sump drain to drainage system.
- Structure and piping in accordance with Chambers, Reservoirs, and Pump Stations sections.

- External bypass with closed valve.
- Parallel pressure reducing valves sized for peak hour and maximum Day plus fire flows.
- Isolating valves, accessible from surface.
- Air release valves.
- Off-street parking.
- Strainers upstream of each control valve complete with flushing capability equipped with Kamlock connector.
- Upstream and downstream pressure gauges.
- Water quality sampling ports, located to ensure external sampling.
- Magnetic flowmeter with SCADA connection.
- Interior and exterior pipework coated to AWWA standards, or, alternatively, use stainless steel. Steel pipe in contact with potable water to use products that are NSF 61 certified.
- Forced air ventilation plus heat and light, subject to local authority review.
- External kiosk and antenna, if electrical and electronic equipment is included.
- PLC-controlled with connection to SCADA system, if applicable, including:
  - Discharge and suction pressure transmitters
  - Flow transmitter
  - Uninterruptible power supply (UPS)
  - Operator interface panel
- Four (4) copies of a comprehensive Operating and Maintenance Manual. Manual shall be hardbacked bound documents with the name of the facility embossed on the cover. Manuals shall contain a table of contents with each section identified by a plasticized, labeled divider.

3.24 Water Meters

(a) The water distribution system shall be designed to incorporate water meters, to City specifications. Water meters are installed within the building of every detached residential dwelling, as well as one for each attached dwelling, commercial, industrial and institutional building.

(b) Irrigation service with a meter may be required by the City. The irrigation meter shall be installed within a meter chamber.

(c) Flow metering with electronic connection to the City SCADA system may be required, as determined by the City.

SCHEDULE 4
SANITARY SEWER

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4. SANITARY SEWER

4.1 Sanitary Sewer

Sanitary sewer systems shall be designed in accordance with the standards and specifications set out in this Schedule, and the provisions of this bylaw.

4.2 Per Capita Flow

(a) Sanitary sewer system design shall be based on an average daily dry weather flow (ADWF) of 360 litres per day per capita (L/d/c).

(b) For residential areas, the land use densities in Table 3.1 shall apply.

Table 3.1

	People/Gross Ha.	**People/Unit**
Single Family	24-30	3
Multi-family Low	85	2
Multi-family Medium	(3 storey) 120	2
Multi-family High	(4-12 storey) 320-960	2
Semi-detached	50	2
Mobile Home	45	2

4.3 Non-Residential Flows

(a) Average dry weather flows (ADWF) for non-residential areas shall be based on specific data related to the development or zoning. In the absence of such data, use the above residential per capita flow and the following equivalent population factors:

Table 3.2

Land Use	Equivalent Population/Hectare (gross)
Commercial:	75 people/ha
Institutional:	50people/ha
Industrial:	50 people/ha

4.4 Peaking Factor

(a) The peaking factor is the ratio of peak dry weather flow (PDWF) to the average dry weather flow (ADWF). Where possible, the peaking factor should be based on locally recorded flow data from similar developments. In the absence of such data, the peaking factor is to be calculated using the design residential population and non-residential equivalent population, with the following formula:

$PF = 6.75P^{-0.11}$ Where: PF = Peaking Factor

P = Population and equivalent.

4.5 Infiltration/Inflow

Design flows shall include an infiltration allowance to cover groundwater infiltration and system inflows as follows:

- Pipes not in water table: 5,000l/ha/d
- Pipes in water table: 8,000l/ha/d
- Old pipes: 10,000l/ha/d

4.6 Design Flow

(a) Peak design flows must be determined by applying the peaking factor to the average daily flow plus infiltration.

(b) Pipe sizes must be selected so that sewers flow $^{2}/_{3}$ to $^{3}/_{4}$ full at peak hour design flow.

4.7 Pipe Flow Formulas

(a) Gravity Sewers

Use Manning's formula:

$$Q = \frac{AR^{0.667}S^{0.5}}{n}$$

Where: Q = Design flow in m^3/s
A = Cross sectional area in m^2
R = Hydraulic radius (area/wetted perimeter) in m
S = Slope of hydraulic grade line in m/m
n = Roughness coefficient
→ concrete = 0.013
→ PVC = 0.011

(b) Sewage Force Mains

Use Hazen-Williams formula:

$$Q = \frac{CD^{2.63}S^{0.54}}{278780}$$

Where: Q = Rate of flow in L/s
D = Internal pipe dia. in mm
S = Slope of hydraulic grade line in m/m
C = Friction coefficient = 120

4.8 Flow Velocities

(a) Gravity Mains: The minimum velocity shall be 0.6 m/sec. There is no maximum velocity. However, consideration shall be given to scour problems and the dynamic loading on manholes where flow exceeds 3.0 m/sec.

(b) Force Mains: At the lowest pump delivery rate anticipated to occur at least once per day, a minimum cleansing velocity of 1.0 m/sec shall be maintained. Maximum velocity should not exceed 3.5 m/s.

4.9 Minimum Grades

(a) Gravity Mains: The grade of any sewer is governed by the minimum required velocity of 0.6 m/sec. However, the last section of a main that will not be extended in the future shall have a minimum grade of 1.0% where 150 mm diameter pipe is proposed. Notwithstanding the above, the minimum grade for all pipes must be 1.0% unless restricted by topography or other factors approved by the Approving Officer. There must be no change in grade between manholes.

Where the slope of the sewer main exceeds 20%, anchorage is recommended. Where the slope is 30% or greater, anchorage must be incorporated in the design.

(b) Forcemains: Forcemains shall be graded at a minimum of 0.5%. Grading shall be designed to minimize high points. Provide air release valves at high points.

4.10 Minimum Pipe Diameter

(a) Gravity Mains:

- For residential lands – 200 mm
- For commercial and industrial – 250 mm

Terminal pipe section, upstream of the last intersection of mains, and where no further extension is planned, shall be:

- For residential lands – 150 mm at a minimum 1.0% grade
- For commercial and industrial – 200 mm at a minimum 0.60% grade

(b) Forcemains: 100 mm

(c) Service Connection:

- Residential – 100mm
- Multi-family/commercial/institutional – 150mm

4.11 Alignment

Sewer mains must be designed to follow straight alignment between manholes unless approved by the Approving Officer. Where permitted, horizontal curves will require a constant offset and must be uniform throughout the curve. In no case shall the radius of curvature be less than 300 times the outside diameter of the pipe barrel. The design velocity must exceed 0.90m/s, the minimum grade must be 1.0% and curve midpoint and two ¼ points are to be located by survey and shown on the as-constructed drawings with an elevation and offset of the invert at each point.

Routing of the sewers must be approved by the Approving Officer.

4.12 Manholes

(a) Locations

Manholes are required at:

- Every change in grade, except as permitted for curved sewers
- Every change in direction, except as permitted for curved sewers
- Every change in pipe size
- Downstream end of curved sewers
- Every pipe intersection except for 100 mm and 150 mm service connections and junctions with trunk sewers 900 mm and larger
- 150 m maximum spacing
- Every future pipe intersection
- Upstream end of every sewer main
- Temporary clean-outs may be provided at terminal section of a main provided that:
  - Future extension of the main is proposed or anticipated.
  - The length of sewer to the downstream manhole does not exceed 45.0 m.
  - The depth of the pipe does not exceed 2.0 m at the terminal point.
  - Clean-outs are not to be considered a permanent structure.
  - Design of the anticipated extension is completed to the next manhole to ensure the works will not require realignment when extended.
- Sanitary manhole rim elevations outside of paved roadways shall be designed to be:
  - Above the adjacent storm manhole rim elevation
  - Above the surrounding ground so that infiltration from ponding will not occur.
  - The 100 year return runoff event.

4.13 Hydraulic Details

- Crown elevations of inlet sewers shall not be lower than crown elevation of

outlet sewer.

- Minimum drop in invert elevations across manholes:
  - Straight run: 5 mm drop
  - Deflections up to 45 degrees: 30 mm drop
  - Deflections 45 to 90 degrees: 60 mm drop
- Drop manhole and ramp structures shall be avoided where possible by steepening inlet sewers. Where necessary, provide drop structures as follows:

Invert Difference	Structure
Up to 0.45	Inside Ramp
0.45 to 0.90 m	Outside Ramp
Greater than 0.90 m	Outside Drop*

* Inside drop may be used if specifically permitted by the Approving Officer.

- The maximum deflection angle in a junction shall be 90°.
- Force main discharges shall be directed into the receiving manhole outflow pipe. Manhole benching shall be extended a minimum 200 mm above the force main crown. If a manhole drop cannot be avoided, an inside drop pipe is required.

4.14 Depth and Cover

- Depth shall be defined as the distance from the finished ground surface to the top of pipe.
- Sewers shall be of sufficient depth to
  - Permit gravity sewer service to the basements of properties adjacent to the roadway or sewer right-of-way
  - Prevent freezing
  - Meet the minimum depth requirements of 1.8 m
  - Clear other underground utilities
  - Prevent damage from surface loading
  - Allow for future extension of the sanitary sewer system to service upstream tributary lands at ultimate development, as defined by the Approving Officer.
- Maximum cover depth: 4.5 m, except under special circumstances and with permission of Approving Officer.

4.15 Rights-Of-Way (R.O.W)

Right-of-way locations shall be selected to avoid environmentally sensitive areas such as watercourses, wetlands and wildlife migration corridors and forested areas.

Rear yard sewers are discouraged and will only be allowed with the permission of the Approving Officer.

Where location of a municipal utility in a statutory right-of-way is permitted by the Approving Officer, the minimum right-of-way widths are as follows:

- Single service:

  R.O.W. width = twice the depth from surface to the crown of the pipe [4.5 m minimum width]

- Two services within the same trench:

  R.O.W. width = twice the depth from surface to the crown of the deeper pipe [5.5 m minimum width]

- Two or more services adjacent to one another but in separate trenches:

  R.O.W. width = cumulative widths for single services PLUS any difference to provide the required separation [6 m minimum width]

- When the service is within a road allowance, and the distance from the property line to the centre of the service is less than one half of the width indicated above for a single service, the difference shall be provided as right-of-way on the adjacent property.

In all cases, the width of rights-of-way shall be sufficient to permit an open excavation with side slopes in accordance with the WorkSafe BC regulations, without impacting on or endangering adjacent structures.

Where required, sanitary trunk and interceptor sewers shall have rights-of-way wide enough for future widening and/or twinning. The width of the right-of-way shall be the required separation between pipe centerlines plus 2 times the depth to the crown of the deeper sewer.

The Consulting Engineer shall provide cross sections indicating the minimum safe distances to adjacent building footings based on a safe angle of repose from the limits of the excavation.

Where a utility is located within a right-of-way, and valves, valve chambers, manholes, or other appurtenances which require maintenance are located within the right-of-way, provide road access from a public road. The maintenance access shall be sufficiently wide and structurally adequate to support the maintenance vehicles for which the access is intended. Maximum allowable grade of the maintenance access is 12%.

4.16 Utility Separation

Requirements for separation of sanitary sewers from water mains are as follows, unless otherwise indicated by the local public health authority.

(a) Horizontal Separation

At least three (3) m horizontal separation shall be maintained between a water main and a sanitary sewer.

In special circumstances, specifically in rock or where the soils are determined to be impermeable, lesser separation than 3.0 m may be permitted provided that:

- The sewer main and water main are installed in separate trenches and the water main invert is at least 0.5 above the crown of the sanitary sewer and the joints are wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of AWWA Standards C217, and C214 or C209; or,
- The pipes are installed in the same trench with the water main located at one side on a bench of undisturbed soil at least 0.5 m above the crown of the sanitary sewer and the joints of the water main are wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of the AWWA Standards C217, and C214 or C209.

(b) Vertical Separation

Where a sanitary sewer crosses a water main, the sewer shall be below the water main with a minimum clearance of 0.5 m and the joints of the water main, over a length extending 3 m either side of the sewer main, are to be wrapped with heat shrink plastic or packed with compound and wrapped with petrolatum tape in accordance with the latest version of the AWWA Standards C217, and C214 or C209.

Where it is not possible to obtain the vertical separation indicated above, and subject to local public health authority approval, the following details shall be used:

- The water pipe joints shall be wrapped as indicated above, and
- The sewer shall be constructed of pressure pipe such as high density polyethylene (HDPE) or PVC with fused joints and pressure tested to assure it is watertight.

(c) Sewers in Common Trench

Sanitary and storm sewers may be installed in a common trench, provided that the design has taken into account:

- Interference with service connections,
- Stability of the benched portion of the trench,
- Conflict with manholes and appurtenances.

The horizontal clearance between sewer pipes shall be no less than 1.0 m and the horizontal clearance between manholes shall be no less than 0.3 m.

4.17 Service Connections

Every legal lot and each unit of a residential duplex shall be provided with a separate service connection.

Unless otherwise permitted by the Approving Officer, connections are to serve all plumbing by gravity. Building elevations should be established accordingly. Pumped connections may be permitted if requested prior to sewer design and if appropriate covenants are provided.

Service connections shall be provided to each lot fronting the main. Service connections shall not be extended at an angle that exceeds 45° from perpendicular to the main, and in no case shall a service connection be placed so that it extends in front of any property other than the one being serviced.

Each property is permitted only one service connection. In special circumstances, where servicing of all buildings on existing industrial or commercial properties is not feasible, two services may be allowed, if permitted by the Approving Officer.

Connections to new mains shall be made using standard wye fittings. Connections to existing mains shall use wye saddles or, where permitted by the Approving Officer, inserta-tees may be used. All services shall enter the main at a point just below the springline.

The minimum grade from the main to the property line shall be 2.0%.

The minimum depth of a service at the property line must be 1.2 m provided that gravity service to the Minimum Building Elevation is available.

Where rear yard sewers are necessary, due to steep topography, the minimum cover must be 1.0 m provided that gravity service, to the Minimum Building Elevation, is available.

Service connections may be permitted into manholes provided that:

- the connection is not in an adverse direction to the flow in the sewer main;
- the connection enters the manhole so the service crown is no lower than the sewer main crown.

Inspection chambers are required for all service connections, except when the sewer main is in a right-of-way and the service is less than 2.5m long and ties into a manhole.

Control manholes are required for all industrial and light industrial connections.

Control manholes will be required for commercial connections at the discretion of the Approving Officer.

Service connections shall be installed at the lower (downstream) portion of the lot for larger lots or parcels of land at an offset of 3.0m from the property pin. For residential development, connections shall be as noted on the Standard Drawings.

The maximum length of any service connection is 30m, unless permitted otherwise by the Approving Officer.

4.18 Pump Stations

The use of pump stations shall be avoided where possible. Any proposed use of pump stations shall receive prior approval from the Approving Officer. Prior to commencing detailed design of a pump station, the Consulting Engineer shall submit a preliminary design report that addresses all pertinent design considerations.

The Applicant must provide three sealed sets of mechanical drawings and three sets of sealed electrical line diagrams for review by the Approving Officer. Two sealed copies of design calculations shall be provided for documentation.

Approval of the preliminary design report shall be obtained prior to the Consulting Engineer commencing detailed design. Larger capacity sewage lift stations or lift stations with special design criteria or siting requirements may require additional assessment and review of criteria.

(a) Preliminary Design Requirements

- System Layout: Select location(s) to minimize long-term total number of pump stations.
- Location: Within right-of-way adjacent to road, outside the required road dedication.
- Capacity: Dependent upon the development and catchment area. Designs must be designed to handle the ultimate flows of the designated catchment.
- Configuration: Gorman-Rupp pump or pre-approved equivalent.

Other basic criteria include:

- Construction dewatering requirements.
- Access for construction and maintenance.
- Aesthetics, noise, odour control and landscaping.
- Type of station and impact on neighbors.
- Waterhammer and/or column separation prevention measures.

- Security against vandalism and theft.
- Station uplift design must be based on minimum load level and maximum flood elevations.
- Proximity of receiving sewers, water mains, and power supply.
- Minimizing energy requirements.
- Type of controls:
  - PLC compatible with City of Grand Forks system
  - Ultrasonic and backup float controls
  - SCADA connection or capability
- Standby power or emergency storage.
- Soils. Sub-surface investigations must be undertaken prior to site approval.
- Convenience of operation and maintenance including service vehicle access.
- Safety for operators and public.
- Capital costs and operation and maintenance costs.
- Corrosion control.
- Vehicle loads adjacent to and/or on station structure.
- Davit and lifting arms for pumps and fall arrests.
- Station to be complete with an Uninterruptible Power Supply (UPS) to serve alarms and controls.

(b) Design Features

1) Pump stations shall be designed with a minimum of two pumps, capable of handling the maximum flow condition with any one pump off line.

Where the design flow exceeds the capacity of a single, commonly available pump, use three or more pumps with capacities such that there is always one pump available for standby.

2) Pump requirements:

- Capable of passing solids up to 75 mm in size.
- Maximum motor speed: 1750 RPM.
- Explosion proof.
- Operate on a 3 phase 600 volt electrical source. Lower voltage (208 V, 3-phase or single phase) may be considered depending upon service voltage available from the power company.
- Suitable for use with a variable speed drive.
- Easily removed for maintenance.
- Able to operate alternately and independently of each other.
- Able to meet maximum flow condition with one pump in failure mode.
- Sized so that each motor does not cycle more than six times in one hour under worst case operating conditions or as

recommended by pump manufacturer.
- Motor over temperature and leak detection system.

3) Minimum storage between the high level alarm and the start of overflow under the more critical of:

- Minimum 2 hour in wet well at average weather flow.
- Minimum 1 hour in wet well and influent pipes at peak wet weather flow.

4) Ball type check valves or swing check with outside lever and weight required on each pump discharge

5) Gate valves required outside pump station on influent line and a plug valve on each pump discharge line. The valves must be outside the station and be complete with square operating nut, riser, rock guard and nelson box.

6) Provision(s) must be made for standby pumping from an external source. An adaptor flange ("Kamlock") complete with a quick coupling and lockable cap will be required.

7) Minimum wet well size: 2440mm diameter, smaller sizes may be permitted by the Approving Officer.

8) Wet well bottom to be benched to direct solids to pump suction. Wet wells to be designed in accordance with the latest edition of the Hydraulic Institute Standards.

9) Pump station lids to be waterproof and provided with suitable locks. Covers may be either aluminum or fiberglass. Minimum 900 mm x 900 mm in size. Fasteners to be 316 stainless steel. Lids to be 200 mm to 300 mm above ground level.

10) The access hatch shall have:

- An aluminum 6.4mm tread plate
- A perimeter drain
- A perimeter sealing gasket
- A slam lock with an aluminum removable sealing plug and opening tool
- A flush lift handle
- A gas spring assist cylinder
- A 90 degree hold open arm
- A flush fitting padlock tang
- Hatch safety grate

11) The hatch shall be reinforced for 1465 kgs/m² (300 lbs./sq.ft.) or withstand a loading of H-20 where subject to vehicular traffic. All

fasteners to be made of 316 stainless steel.

12) Station access shall be by aluminum ladder. Ladder to be located to avoid interference with removal and installation of pumps. Ladder to be provided with extension and lock at least 600 mm above station lid. Fiberglass grating platform to be provided above high water level for wet well access. Access, ladder and platform to meet WorkSafe BC standards.

13) Wet well ventilation shall be designed to address odor control, and confined space entry to WorkSafe BC and NFPA Standard 820.

14) The entrance must be at ground level where feasible but, in no case, more than 300mm above ground. An explosion-proof light with a protective cover should be located in a suitable location in the station and the light should be activated by the entrance cover and shall be located 0.6m above 200-year flood level or 1.0 m above highest recorded flood elevation.

15) A removable lifting arm and davit socket shall be incorporated into the design of the pump station to facilitate the removal and installation of the pumps.

16) Metal stations shall be provided with impressed current cathodic protection.

17) Steel and fiberglass surfaces to receive minimum two coats of two-component white epoxy enamel. Concrete stations to be designed to prevent sulphide attack.

18) When a kiosk is used to house auxiliary equipment and control panels, kiosk to be weatherproof and adjacent to station. Kiosk to be located not less than 2.0 m and nor more than 3.0 m from station lid.

19) Kiosk to contain separate compartment for pump station ventilation fan.

20) Wiring in station and fan compartment to be explosion-proof, Class 1, Division 2. Electrical design and installation subject to approval by Provincial Safety Inspector.

21) Power and control cables to be continuous from within the pump station to within the kiosk. In no instance shall a cable be spliced.

22) Control kiosk to be designed to contain control and telemetry equipment on front panel and power equipment on rear panel. Concrete base to be minimum 75 mm above finished grade.

23) The control panel must incorporate a Crouse Hinds receptacle and a transfer switch for a standby power source. Underground electrical wiring is required. Pump stations to include automatic generator sets for standby power in case of power failure. Generator set enclosures to be weatherproof and to include noise control. For small pump stations, emergency storage may be considered in place of standby power. Emergency storage is to be based on 8 hours of average day flows plus infiltration.

24) Control panel to include hour meter and ammeter for each pump, switchable.

25) Pump control panel to incorporate operator interface (Panelmate or equivalent), and the panel must be complete with a lamp text button.

26) Unless otherwise permitted by the Approving Officer, all lifts stations must be equipped with telemetry connected to the City's telemetry system and City of Grand Forks SCADA.

27) Levels to be controlled by a level transmitter, plus emergency high and low level floats.

28) Station to include magnetic flow meter with local display and connections to SCADA.

29) A complete set of spare circuit cards are to be provided where modular card- type pump controllers are used.

30) 110V outlet for hand tools.

31) Noise levels for facilities must not exceed 65 dB at property line or 20 m away whichever is closer.

32) A 38 mm water connection with standpipe and cross-connection protection must be provided on-site for cleaning purposes.

33) Area around station and related equipment or building is to be graded, asphalted and fenced with security lighting. The fence must be made of black chain link. Size of area to be determined by maintenance requirements and clearance to structures with doors opened. Layout of structures and gates is to provide for clearances for pump removal by hoist truck with a 1.8m boom.

    Landscaping acceptable to the Approving Officer, and shall be provided to include irrigation.

34) Design in accordance with appropriate seismic standards.

35) Equipment to be CSA approved and have minimum one-year guarantee on parts and labour. All equipment must be tested prior to acceptance, with all pumps being factory tested prior to installation.

36) Provide four (4) copies of a comprehensive Operating and Maintenance Manual, in hardback bound format with name of facility embossed on cover. Manuals shall contain a table of contents with each section identified by a plasticized, labeled divider. The manual must contain:

- As constructed shop drawings;
- Equipment layout drawings;
- Electrical, control, and alarm wiring diagrams;
- Operating instructions for all equipment;
- Maintenance instructions for all equipment, including frequency of maintenance tasks;
- Equipment data sheets;
- Spare circuit cards for critical components;
- Certified head/capacity curves for pumps;
- Equipment parts list;
- Emergency operating procedures.

4.19 Corrosion and Odour Criteria

(a) Dissolved sulphide maximum limit at any point in the system is to be 0.5 mg/l. However, for new tie-ins to the City of Grand Forks system, the maximum limit is 0.3 mg/l.

(b) Odour Criteria:

- At 10 m from any gravity main, force main, manhole and lift station or other sewer facility (summer conditions, winds between 2-10 km/h), 1.0 odour units.
- Where sewer facilities are close to houses, parks or walkways, 0.0 odour units.

(c) Analysis for odour and sulphides is required.

(d) Wet well size, forcemain diameter and length, as well as other pertinent factors must be considered in optimizing system operations to avoid odours.

SCHEDULE 5
ELECTRICAL

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5. ELECTRICAL

5.1 General

The applicant shall furnish all supervision, labour and materials necessary to construct the works required under the Bylaw. The works shall be constructed in strict accordance with detailed plans and specifications approved by the Approving Officer.

Electrical power supply systems and street lighting shall be approved by the Approving Officer. Consulting Engineers retained by the Owner to design the works and services must consult with the Approving Officer to determine what existing information may be of assistance to them.

The electrical systems must be designed and installed at the Owner's expense, in accordance with the requirements of the appropriate utility company standards and in accordance with all applicable Municipal codes and regulations, Provincial Statutes, regulations and/or standards.

It is standard practice that electrical design plans are prepared prior to design co-ordination with other utility companies. Details of design such as vertical and horizontal location of service boxes, size and type of conduits and gas mains, kiosk dimensions and ducting and all wiring details shall be as per specifications and drawings provided by the Grand Forks Electrical Utility and the appropriate telephone, cable, other electrical and gas utilities.

All wiring for new development shall be installed underground unless alterations to design are approved by the Approving Officer. The power distribution system shall consist of primary distribution switchgear, primary duct and conductor, transformer, secondary service duct and all related items for a complete installation.

Where overhead distribution is permitted, pole and anchor locations must be approved by the Approving Officer and any other affected company. Care must be taken to avoid aerial trespass, or conflicts with all other utility infrastructure.
Plans and agreements for rights of way for anchors, pad-mounted transformers, etc., must be provided and registered in favor of the appropriate utility prior to construction.

Electrical systems must be provided to serve each lot within the subdivision. The location of all facilities and structures must be in accordance with the engineering drawings as approved by the City.

Electrical transformers, junction boxes, vaults and streetlights are normally set at the projection of a lot line.

Designs shall eliminate location conflicts with other utilities such as fire hydrants, valves or splice boxes.

5.2 Other Utility Services

Other utility ducts shall be installed in the same trench as power ducts where they run parallel on the same side of the street.

5.3 Street Lighting

Design of street lighting systems shall be prepared by the Consulting Engineer. A copy of the lighting calculations shall be submitted to the Approving Officer. The drawing is to note the types of refractors to be used. Street lighting shall be designed in accordance with the requirements of this Schedule, the MMCD Design Guideline Manual (2005 edition) and the provisions of this bylaw. The design must encourage the reduction of light pollution wherever possible and avoid excessive light pollution to residences.

5.3.1 Minimum Levels of Illumination

(a) The minimum level(s) of illumination in average lux shall be as follows:

Table 5.1 Zone			
Road	**Residential**	**Industrial**	**Commercial**
Arterial Roads	10.0	13.0	17
Collector Road	6.0	10.0	13.0
Local Roads	4.0	7.0	9.0
Walkways & Pathways	4.0		
Lanes	4.0	2.0	2.0

(b) At all major intersections involving arterial or collector Roads, the values noted in the above table shall be increased by fifty percent. The illumination of all major intersections shall be at least equal to the sum of the illumination values provided on the streets forming the intersection.

(c) The lowest lux value of any point on a Roadway shall not be less than one- third of the average value, with the exception of residential Roadways where it may be as low as one-fifth of the average value, using a maintenance factor of 0.75.

(d)

Table 5.2	
Road Classification	**Uniformity (Average: Minimum)**
Arterial	3 : 1
Collector	4 : 1
Local	5 : 1
Walkways and Pathways	6 : 1

5.3.2 Streetlight Pole Locations

(a) Generally, streetlight poles shall be designed as follows:

Table 5.3			
Road Type	**Pole Location/Spacing**	**Pole Type**	**Lamp Standard Height**
Arterial	Opposite or Staggered	Davit	9.1 M
Collector	Spaced on One Side	Davit	8.2 M
Local	Spaced on One Side of Roads & Lanes	Davit	8.2 M
Walkways & Pathways	Entrance & Exit Points	Davit or Post	7.6 M

(b) Streetlights in rural areas shall only be required at intersections.

5.3.3 Underground Ducts

Underground wiring for street lighting shall be designed in accordance with the requirements of the local power authority and shall conform to the rules and regulations of the Canadian Electrical Code (Part 1), the Provincial Electrical Inspection amendments and any municipal codes or bylaws and other authorities having jurisdiction shall be followed.

The standard off-set for the location of the underground streetlighting ducts in Road rights-of-way shall conform to the applicable Standard Drawing.

It is the Owner’s responsibility to ensure that the supply service to the street lighting system receives approval from the local power authority.

5.3.4 Lamp Standards

In designated Development Permit Areas, decorative lamp standards may be considered by the Approving Officer.

5.3.5 Luminaires

As determined by the Approving Officer and Grand Forks Electrical Utility department.

5.4 Construction

Construction shall conform with the intent of this bylaw and the current design and construction standards for the appropriate utility (gas, electric, cable or other utility).

SCHEDULE 6
RETAINING WALL SYSTEMS AND ALTERATIONS

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6. Retaining Wall Systems and Alterations

6.1 Conditions Requiring Retention

Retention of land shall be required in the following conditions:

(a) Where it is deemed necessary, by the Approving Officer to provide stability to existing or altered slopes or to control potential erosion.

(b) Where the slopes either existing or altered are steeper than their natural geological angle of repose or steeper than 2 horizontal to 1 vertical whether terraced or otherwise.

(c) Where it is deemed necessary to protect Works and Services or provide access to Works and Services.

(d) Where it is deemed necessary to retain other land or structures.

(e) Where it is deemed necessary to control surface drainage by altering the contours of the land.

6.2 Design and Inspection

(a) The design and inspection of any retention system or structure shall be prepared and carried out by the Consulting Engineer who shall be responsible to acquire geotechnical consultation and advice where conditions present the need for it.

(b) Consideration shall be given to the aesthetic appearance of retention structures. Where practical, retaining walls shall be rock gravity walls designed to be consistent with the natural surroundings of the area and not be dominating or fortress-like. The color pallet of the retaining wall must be submitted to the City for approval, preference will be given to earth tones. The following types of structures shall not be permitted as permanent structures:

i) LOCK BLOCKS (concrete blocks approximately 750mm x 750mm x 1,500mm) unless:
   - No more than one half of the top course of blocks are exposed with the top surface being flat without locking stubs; and
   - Ends of the system include sloping transition blocks where topography is sloping; and
   - Exposed faces and surfaces, including the top surfaces of such system, are faced or surfaced with either exposed aggregate or granite finish;
   - Precast Concrete constructed in accordance with CAN/CSA-

A23.1;
- Continuous reinforced concrete footings are installed;
- Geogrid reinforcing is installed between each horizontal row of blocks.

ii) GABION (wire baskets filled with rocks) except for in-stream or waterfront erosion protection, not more than two (2) baskets high, Drip Irrigated Vegetative Strip is required.

iii) WOOD CRIB (over one (1) metre high or terraced at a slope steeper than (2) horizontal to one (1) vertical).

(c) Guardrails or Fences

i) Guardrails or fences shall be required at the top of retention structure where the difference in elevation between adjacent levels exceeds 1 metre.

ii) Landscaping alternative may be used providing it is of a dense thorny type to discourage access to the top of the retention structure area and providing the difference in elevation between adjacent levels does not exceed 1.5 metres.

(d) Where the height of a retaining wall exceeds 1.5 m, the wall shall be stepped with a minimum horizontal distance of 1.0 m between walls. This requirement may be varied by the Approving Officer with the provision of additional detailed information and/or investigations, including but not limited to:

i) Structural,
ii) Geotechnical,
iii) Hydrogeological,
iv) Visual Impact with respect to:
- height and mass
- not significantly obstructing views of neighbouring properties
- maintaining the hillside aesthetic and minimizing the disruption of hillside contours
- not being dominating or fortress

v) Landscape Treatment, and
vi) Manufacturer Product Information.

6.3 Building Permits for Retention Structures

(a) Building Permits are required for all retention structures which are more than 1.5 m high and/or terraced at a slope steeper than 2 horizontal to 1 vertical.

(b) Building Permit Applications shall be accompanied by the following documentation signed and sealed by the Consulting Engineer.

i) Scaled structural, geotechnical and drainage details.
ii) Scaled site plan showing the location of the retention structures in

relation to any property lines. Rights-of-way or easements, tanks, other structures, underground works or services or natural features and confirmed by a Surveyor if deemed necessary.

iii) Letters of Assurance of Design and Field Review.

(c) Geological reports shall define hazards/risks, suggest remedial measures and shall show the locations of retaining structures on a scaled map.

6.4 Completion of Retention Works

(a) The Owner shall take all necessary measures, temporary and permanent to provide any necessary protection.

(b) All required retention works are required to be completed prior to:
- i) Substantial Performance of a subdivision, or
- ii) Occupancy of a building in a Development.

(c) In the event that an extension of time is necessary, the Owner shall provide to the City:
- i) A security deposit in an amount equal to the cost of the outstanding work, accompanied with
- ii) An agreed upon time schedule to complete the work.

(d) The Building Inspector may withhold occupancy of any Building Permit if the incomplete works present a safety hazard or are not secured by a deposit and accompanying schedule as described in 5.4(c) above.

(e) Retaining walls will not normally be permitted within utility rights-of-way.

SCHEDULE 7
LANDSCAPING

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7. LANDSCAPING

7.1 Objectives

These design standards are intended to promote water conservation, enhance the safety, aesthetics and sustainability of Public Lands and to ensure efficiency and effectiveness of maintenance and operations of these lands. Landscaping shall be designed in accordance with the requirements of this Schedule, and the provisions of this bylaw.

7.2 Related Standards

This standard shall be referenced to and integrated with, at minimum, the following:

- BC Landscape Standard, Current Edition.
- National Guide to Sustainable Municipal Infrastructure (Canada).
- Irrigation Association – Turf and Landscape Irrigation Best Management Practices.

7.3 Application of Standard

These standards apply to the following types of Public Lands:

- Parks and Public Open Spaces.
- Boulevards.
- Medians.
- Roundabouts, Traffic Circles and Cul-de-sac Islands.
- Recreation Corridors.
- Public Access Routes.
- Stormwater Management Facilities.
- Erosion Control.
- Trails.

7.4 Landscape Consultant

The Owner shall retain a Landscape Consultant to be directly supervised by a Landscape Architect or a Registered Irrigation Designer. All Landscape drawings and specifications shall be sealed by a professional Landscape Architect. Irrigation drawings and specifications shall be prepared by a Registered Irrigation Designer.

7.5 Landscape Plan

The Landscape Designer shall consider, at minimum, the following criteria:

- The functional relationship of the landscape design to existing and proposed land uses, utilities, flood patterns, drainage facilities, Roads, driveways and pedestrian facilities.
- Accessibility as it relates to pedestrians, cyclists and people with limited physical or visual abilities.
- Horticultural use of plant material, including plant suitability, survival rate, growth habit, size, disease resistance and water demand.
- Appearance of the proposed plant material and site landscape, including appropriateness, aesthetics, visual screening and site lines.
- Protection of existing trees.
- Protection of the natural environment and restoration or enhancement of natural habitat.
- Site drainage, water levels, ponding and overland flow.
- Minimization of the opportunity for crime and undesirable behaviour.
- Weed control.
- Erosion control.
- Fire hazard reduction.
- The estimated costs and efficiency of maintenance practices that will be required for the Public Land.
- Restoration of disturbed areas.

Preference shall be given to water conservation and sustainable landscape designs which:

- Use drought tolerant plants.
- Use native plants
- Irrigation systems, if required, being temporary and removed after planting is established.
- Adaptable to the changing climatic conditions of the Grand Forks area.

7.6 Boulevards

(a) Upon completion of the Works and Services required within the City's right-of- way, the Approving Officer may require the Owner to complete boulevard landscaping at any time.

(b) Boulevards within public road rights-of-way having an urban cross-section:

i. For boulevards of collector roads the landscape treatment shall include:

- Grass surface with street trees, if the land use of the adjacent property is commercial, industrial, institutional or multi-family, and including complete irrigation system provided and maintained by the Owner(s) of the adjacent property; or
- Grass surface with street trees, if the land use of the adjacent property is one, two-family residential or park and if the boulevard is accessible for maintenance (i.e., mowing, watering) from the adjacent property; or
- Exposed aggregate concrete surface with street trees in tree wells with structural soil. Provision of irrigation and tree grates shall be at the discretion of the Approving Officer.

ii. Underground utilities in boulevards shall be aligned and buried to provide a continuous 1.0m deep utility-free trench to accommodate tree planting, except as required for utility crossings, service connections, boxes and vaults.

7.7 Medians

- Landscape treatment shall generally include continuous exposed aggregate concrete surface with irrigated trees in concrete tree wells with structural soil or, where appropriate, with a central band of irrigated landscaping (i.e., groundcovers and/or low shrubs with regularly spaced trees) as lines of sight permit.

7.8 Roundabouts, Traffic Circles and Cul-de-sac Islands

The following guidelines are the minimum requirements for all landscape Works and Services in roundabouts, traffic circles and Cul-de-sac islands:

- The central area may, as lines of sight permit, feature a single specimen tree or a group of like trees with low groundcovers and/or shrub plantings.
- For landscaped roundabouts, traffic circles and Cul-de-sacs a complete and working automatic irrigation system shall be provided.
- Lighting of trees or public art in a traffic circle shall be provided as required by the Approving Officer.

7.9 Stormwater Management Facilities

(a) Wet Ponds

- Between the normal water level and the top of bank the side slopes shall be naturalized with low maintenance riparian plantings in 100mm minimum depth growing medium.
- Above the top of bank the ground surface shall be turf on 50mm depth smooth growing medium, with a maximum slope of 4 (horizontal) to 1 (vertical), except as required for vehicle access and pedestrian surfaces.

- Shrubs and trees shall be selected, planted and maintained to provide screening, habitat, shade and aesthetics as required.
- Irrigation system per 7.12.

(b) Dry Ponds

- The bottom of dry ponds and infiltration basins shall be turf on 50mm depth smooth growing medium or, if approved or required by the Approving Officer, hard-surfaced recreational surface.
- Side slopes with a 4 (horizontal) to 1 (vertical) or shallower slope shall have a turf surface on 50mm minimum depth smooth growing medium. Side slopes steeper than 4 (horizontal) to 1 (vertical) slope shall be naturalized with low maintenance riparian plantings in 100mm minimum depth growing medium.
- Above the design high water level the ground surface shall be turf on 50mm depth smooth growing medium, with a maximum slope of 4 (horizontal) to 1 (vertical), except as required for vehicle access and pedestrian surfaces.
- Shrubs and trees shall be selected, planted and maintained to provide screening, habitat, shade and aesthetics as required.
- Irrigation system per 7.12.

7.10 Erosion Control

Land proposed as Public Land where there is evidence of active or historic erosion that may have maintenance or liability implications for the City shall not be accepted by the City as Public Land.

The Owner shall be responsible for undertaking erosion control and restoration works on proposed Public Land as necessary for the long-term prevention and control of erosion.

At the discretion of the Approving Officer, the Owner may be required to prepare and submit an erosion control plan covering some or all of the proposed Public Land.

The Owner is responsible for preventing and controlling erosion, and for restoring sites impacted by erosion, for the term of the Maintenance Period.

7.11 Fire Management

At the discretion of the Approving Officer, the Owner may be required to prepare and submit a Fuel Management Plan covering some or all of the proposed Public Land.

The Fuel Management Plan shall be prepared by a Forester and shall follow industry standards such as the FireSmart Guidelines endorsed by the BC

Ministry of Forests. The Fuel Management Plan shall include but is not limited to the following aspects:

- Map(s) showing existing and proposed vegetation, structures, trails, access points, and firebreaks on Public Lands and vegetated land adjacent to the site, including an assessment of the fuel hazard in these areas.
- Priority zones, per the FireSmart Guidelines, around all existing or planned structures. Fuel modification prescriptions for these Zones shall be developed based upon proximity to structures and target stand conditions.
- Establishment of strategic firebreaks adjacent to structures and hazardous fuel types, which may also serve as recreational trails. Breaks shall be a minimum of 1.5m wide with a 100mm minimum gravel base.
- Deciduous trees shall be retained where possible.
- Access points shall be provided between lots to provide access to Public Land containing natural vegetation from the roadway as required for land maintenance and fire hazard management.
- Access points shall enable access for emergency and maintenance vehicles. Hydrants shall be located in the Road dedication adjacent to the access point.

7.12 Irrigation

An irrigation system shall be designed, installed, operated and maintained to provide sufficient application of water to maintain the plants and grass of the landscape works and services in a healthy and growing condition for the irrigation of Public Land to be maintained by the Owner(s). If an irrigation system is not required at the time of Construction, but will be required in the future, sufficient design, servicing and Construction shall be performed to enable the irrigation system to be readily installed, connected and operated in future.

Where Public Land is to be maintained by the City, an irrigation system shall be designed to be compatible with the City of Grand Forks's SCADA operated irrigation system, operated and maintained until the end of the Maintenance Period. One (1) metered water service and one (1) metered electrical service (120 volts, 60 amps) shall be provided for each park, open space, drainage facility, boulevard, median, roundabout, traffic circle and Cul-de-sac island at a location acceptable to the Approving Officer. The service shall include the establishment of water and electrical service accounts, testing and certification of the backflow prevention device, a plumbing permit, an electrical permit, and all materials, labour, fees and utility costs necessary to provide the service until the end of the Maintenance Period.

7.13 Landscaping Security

Landscaping security may be required to ensure that remediation or restoration of landscaping occurs where it is required and to ensure landscaping is adaptable for changing conditions.

SCHEDULE 8
QUALITY CONTROL AND ASSURANCE

Table of Contents

8. QUALITY CONTROL AND ASSURANCE

This Schedule sets out the City's minimum standards for quality in design, quality in Construction and quality in record-keeping for the Works and Services to be designed and constructed in accordance with this bylaw.

Minimum design standards are set out in Schedules 1 to 7.

8.1 Engineering Requirements

(a) The Owner shall demonstrate to the satisfaction of the Approving Officer that the Owner has retained or shall retain the services of a Consulting Engineer to undertake the design, inspection, testing and record-keeping for the Works and Services.

(b) The Owner shall complete and provide the Approving Officer with the following information in the Owner/Consulting Engineering confirmation letter to demonstrate that the Consulting Engineer is qualified to undertake the Works and Services and more particularly, has successfully undertaken projects similar in scope, nature and value to the Works and Services:

- The name and address of the Consulting Engineer and a summary of the projects that the Consulting Engineer has undertaken that are similar in scope, nature and value to the Works and Services.
- The names of the individuals assigned to various aspects of the project by the Consulting Engineer together with a summary of the projects that the individual engineers have undertaken that are similar in scope, nature and value to the Works and Services.
- The names and the curriculum vitae for the person(s) that the Consulting Engineer proposes/has retained to undertake the inspections and testing on its behalf during the Construction of the Works and Services together with a summary of the projects that the person(s) has completed that are similar in scope, nature and value to the Works and Services.
- The names and addresses of all sub-consultants that the Consulting Engineer has/proposes to retain and a summary of the projects that the sub-consultants have completed that are similar in scope, nature and value to the Works and Services.
- The Owner shall ensure the Consulting Engineer designs all Works and Services in accordance with this bylaw.
- The Owner shall also confirm that the Consulting Engineer will provide the Design, Construction and Record-keeping Quality Control and Assurance Plans described herein. A copy of the agreement shall be filed with the Approving Officer.

8.2 Construction Requirements

(a) The Owner shall demonstrate that to the satisfaction of the Approving Officer that the Owner has or shall retain the services of one or more qualified Contractors to undertake the Construction of the Works and Services. The Owner shall provide the City with the name and address of its Contractor(s) together with a summary of the projects that the Contractor(s) has undertaken that are similar in scope, nature and value to the Works prior to awarding the contract(s) to the Contractor.

In the case where the Contractor has not performed similar Works and Services in the City of Grand Forks, the Approving Officer may require that the Owner provide a list of projects and references from other municipalities that demonstrates that the Contractor(s) is qualified to undertake the Works and Services.

(b) The Owner shall ensure that its Contractor(s) constructs the Works and Services in accordance with the design, drawings, plans and specifications approved for Construction by the Approving Officer.

(c) The Owner shall provide to the satisfaction of the Approving Officer a Construction Schedule indicating the planned start and completion dates of major activities of the work.

8.3 Quality Control and Assurance Plans

(a) Design Quality Control and Assurance Plan

- The Owner shall submit or cause the Consulting Engineer to submit a Design Quality Control and Assurance Plan to the City for approval coincident with submission of the first Design Drawings.
- The Owner's proposed Design Quality Control and Assurance Plan shall detail the procedures that will be used to ensure and verify that the design for the Works and Services, including all plans, drawings and specifications, shall be completed in accordance with the minimum design standards set out in this bylaw.
- In the case of design items related to pump stations, structures, structural fills, geotechnical or hydro-geotechnical items or any item not described in Schedule 1 to 7, the Design Quality Control and Assurance Plan shall show such specialist and/or sub-consultants with suitable experience in these works.

(b) Construction Quality Control and Assurance Plan

- The Owner shall submit or cause the Consulting Engineer to submit a Construction Quality Control and Assurance Plan to the Approving Officer coincident with submission of the first Design Drawing to the

City.

- The Owner's proposed Construction Quality Control and Assurance Plan must detail the procedures that will be used to ensure and verify that the Works and Services shall be constructed in accordance with the Consulting Engineer's design, plans, drawings and specifications. The Construction Quality Control and Assurance Plan must include:
  - A proposed Construction Schedule showing milestone dates and the dates of Provisional and Final Performance of the Works and Services.
  - The nature and frequency (periodic or full-time resident) of the proposed site inspections during Construction to ensure that all Works and Services constructed satisfy the intent of the design and conform to the drawings, plans and specifications.
  - The nature and frequency of the proposed field and laboratory testing requirements for the Works and Services including what materials and equipment are to be tested, what types of tests will be performed and when these tests are to take place.
  - Such information as the Approving Officer may stipulate from time to time.

(c) Record-keeping Quality Control and Assurance Plan

- The Owner shall submit or cause its Consulting Engineer to submit a Recordkeeping Quality Control and Assurance Plan to the Approving Officer coincident with submission of the first Design Drawings.
- The Owner's proposed Record-keeping Quality Control and Assurance Plan shall detail the procedures that will be used to ensure and verify that proper records will be kept and maintained throughout the design, Construction and warranty phases of the Works and Services. The Record-keeping Quality and Assurance Control Plan shall ensure that the following records are kept as a minimum:
  - Quality Manual and Standards.
  - Details of any field design or Construction changes to the drawings, plans and specifications to which changes are approved in writing by the City.
  - Deficiency Identification Forms (Items of the Works that are either not supplied or Constructed in accordance with the design (drawings, plans and specifications) or that require remedial or corrective action).
  - Deficiency Disposition/Verification Forms (List of the foregoing Items of the Works that have been corrected).
  - Inspection and Test Records.
  - Field measurement records of completed Works and Services that have been used by the Consulting Engineer to accurately prepare reproducible as-built drawings that are filed with the City.
- Notwithstanding the generality of the foregoing, the Owner shall ensure that its Consulting Engineer provides the City with the following at the

times and in the manner set out below:

- Certification prior to paving that it has inspected those items of the Works and Services that are below areas to be paved such as Roads, walkways, driveways and parking lots, and that same comply with the design (drawings, plans and specifications). Such certification shall be accompanied by all test and inspection reports and by video tapes and reports on pipe lines.
- The Owner shall ensure that the Construction of any Works and Services required within the City's right-of-way will be paved within 2 weeks of completion of any trench backfill or finish grading of base gravels.
- Certification prior to acceptance by the City that surface works including paving, drainage, curbs and gutters, sidewalks, street lights, etc. have been Constructed in accordance with the design (drawings, plans and specifications).

(d) Record Drawing Deficiency Holdback

- Pursuant to Section 7-9 of the Bylaw, the Owner shall provide security in the amount of $2,500 per drawing sheet (based on approved drawings) for provision of approved Record Drawings, service cards, inspection reports and videos, and all testing results and certifications.

SCHEDULE 9
SUPPLEMENTAL SPECIFICATIONS TO MASTER MUNICIPAL CONSTRUCTION DOCUMENT

DESIGN STANDARDS

9. SUPPLEMENTAL SPECIFICATIONS

This schedule contains supplemental specifications to be applied in conjunction with the Specifications portion of Volume II of the Master Municipal Construction Document (MMCD), printed 2009, both of which shall apply to all Works and Services Constructed within the City of Grand Forks.

Supplemental Specifications contained within this Schedule supplement or supersede the Master Municipal Construction Document (MMCD). Where the City of Grand Forks Supplemental Specifications are in conflict with the MMCD, the City of Grand Forks Supplemental Specifications shall take precedence.

Section number and clause numbers in the City of Grand Forks Supplemental Specifications coincide with the MMCD numbering protocol.

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CITY OF GRAND FORKS **SECTION: S26 56 01**
SUPPLEMENTAL SPECIFICATIONS **PAGE: 1 OF 1**

ROADWAY LIGHTING

2.0 PRODUCTS

2.19 Photocells

Add 2.19.1 as follows:

2.19.1 Photocell units shall be rated at one thousand (1,000) volt amperes 120 or 240 volt operation and shall have a built in surge protection and lighting arrestor.

Each photo cell unit shall have a twist lock base for mounting on the luminaire.

END OF SECTION

AGGREGATES AND GRANULAR MATERIALS

2.8 Select Granular Sub-base

.1 **Delete 2.8.1 and replace with:**

To be well graded granular material, substantially free from lumps and organic matter, screened if required to conform to the following gradations:

Sieve Size (mm)	Percent Passing
150	100
100	85 – 100
50	65 – 100
19	40 – 100
4.75	20 – 70
0.150	0 – 20
0.075	0 – 8

.2 **Add 2.8.2 as follows:**

Maximum aggregate particle size to be no more than 50% of total thickness of sub-base layer.

2.10 Granular Base

.1 **Delete 2.10.1 and replace with the following:**

To be 19 mm crushed gravel conforming to the following gradations:

Sieve Size (mm)	Percent Passing
25	100
19	80 100
9.5	60 – 90
4.75	35 – 70
2.36	25– 50
1.18	15 – 35
0.300	5 – 20
0.075	2 – 8

2.11 Recycled Aggregate Material

.2 **Add 2.11.2 as follows:**

Material retained on the 4.75mm sieve to be not more than 20% recycled material. Minimum size of processed recycled material is to be retained on the 4.75mm sieve.

AGGREGATES AND GRANULAR MATERIALS

.3 **Add 2.11.3 as follows:**

Recycled material and granular sub-base material is to be mechanically blended to produce a homogeneous mixture prior to delivery to site. Blending on-site will not be permitted.

.4 **Add 2.11.4 as follows:**

Acceptable recycled material to be used in sub-base material only.

END OF SECTION

EXCAVATING, TRENCHING AND BACKFILLING

3.0 EXECUTION

3.6 Surface Restoration

.7 Permanent Pavement Restoration:

.5 Modify 3.6.7.5 to read as follows:

Restore pavement width to minimum full lane width (for a multi Lane roadway) or to centreline of the roadway for a 2 Lane roadway as detailed on Standard Detail Drawing G5. Where the trench edge extends past the centreline or Lane edge, it should be extended to the far edge of that travel Lane. In the case of two longitudinal trenches in the roadway, the existing asphalt shall be removed and the entire area paved in conjunction with the paving of the two trenches. This surface restoration is to be completed within 48 hours of the base gravel being approved for paving.

If thickness of existing pavement permits, grind 35mm depth along edge of pavement. Dry if necessary and paint clean, dry edge with asphalt emulsion (tack coat). All longitudinal trenches must be paved with a paving machine.

END OF SECTION

CITY OF GRAND FORKS **SECTION: S31 23 23**
SUPPLEMENTAL SPECIFICATION **PAGE: 1 OF 1**

CONTROLLED DENSITY FILL

2.0 PRODUCTS

2.2 Mixes

.1 Modify 2.2.1 to read as follows:

RHEOCELL® RHEOFILL admixture.

.2 Modify 2.2.1 and 2.2.2 to read as follows:

Controlled density fill mix:

.1 Cement – 30 kg
.2 Fly ash – 89 kg
.3 Sand – 1,364 kg
.4 RHEOFILL – 1.4 bags
.5 Water – 124 to 178 kg
.6 Target comprehensive strength 0.5 MPa to 0.7 MPa.

END OF SECTION

CITY OF GRAND FORKS
SUPPLEMENTARY SPECIFICATIONS

HOT-MIX ASPHALT CONCRETE PAVING

2.1 Materials

.1 Delete 2.1.1 and replace with the following:

Asphalt cement to CGSB-16-3-M90, Grade 80-100, Class A.

2.2 Mix Design

Delete 2.2 and replace with the following:

.1 The Contractor, at their cost, must retain an independent testing consultant to perform trial mix designs and to submit the job mix formula. The trial mix design must be performed in accordance with ASTM D1559 (75 blows per face) and must include five (5) separate trial values of asphalt content. Contractor must pay for trial mix designs and submissions.

.2 Mixes for Construction of asphalt base course may contain up to 20% of RAP, provided that the properties of RAP material are considered in the trial mix design. Submissions for RAP mixes must contain all data relevant to RAP utilized in the mix design.

.3 Include the following data with the trial mix design submission:

- .1 Aggregate bulk specific gravity and water absorption.
- .2 Sand equivalent values.
- .3 Asphalt cement properties including mixing and compaction temperatures, based on temperature viscosity properties of asphalt cement.
- .4 Aggregate gradations and blending proportions.
- .5 Maximum theoretical density of trial mixes.
- .6 Asphalt absorption values.
- .7 Mix physical requirements to meet Table 2.2.3.
- .8 Do not change job-mix without prior approval to Contract Administrator. Should change in material source be proposed, new job-mix formula to be submitted to Contract Administrator for review and approval.

Table 2.2.3 - Specified Physical Requirements of Hot Mix Asphalt		
Property	**Mix Type**	
	Lower Course(1)	**Surface Course**
Stability @ 60°C, kN (min)	8.0	9.0
Flow Index, 0.25mm units	8 – 14	8 – 14
Voids in Mineral Aggregate % (min)	12.0	14.0
Air Voids, % (2)	3 – 6	3 – 5
Index of Retained Stability after Immersion in Water for 24 hrs @ 60°C, % (min)	75	85

Notes:
1) If lower course mix is used in staged Construction, i.e. exposed for at least one winter, specified properties for surface course mix must apply.
2) Percent air voids in compacted trail mixes must be determined in accordance with ASTM D3203, with asphalt cement absorbed into the aggregate compensated for in the calculation.

3.1 Plant and Mixing Requirements

.3 **Delete 3.1.1.3 and replace with the following:**

Before mixing, dry aggregates to a moisture content not greater than 1% by mass or to a lesser moisture content if required to meet mix design requirements.

.9 .4 **Add 3.1.1.9.4 as follows:**

RAP must not be fed through the aggregate dryer system.

.11 .3 **Add 3.1.1.11.3 as follows:**

Mixing period and temperature to produce a uniform mixture in which particulates are thoroughly coated, and moisture content of material as it leaves mixer to be less than 0.2%.

.1 **Delete 3.1.4.1 and replace with the following:**

Permissible variation in aggregate gradation from job mix (percent of total mass):

.1	4.75mm sieve and larger	± 4.5
.2	2.36 and 1.18mm sieve	± 4.0
.3	0.600mm sieve	± 3.5
.4	0.300mm sieve	± 2.5
.5	0.150mm sieve	± 1.5
.6	0.075mm sieve	± 1.0

3.2 Equipment

.1 **Delete 3.2.1 and replace with the following:**

Pavers: must be capable of placing a standard mat width not less than 3m and must be capable of paving wider widths in 150mm and 300mm increments by means of equipment supplied by the manufacturer of the equipment. The screed must include a tamping bar or strike-off device.

Control of the screed must be by automatic sensing devices. Longitudinal control must be by a sensor that follows a string-line, ski or other reference. The grade sensor must be movable and mounts provided so that grade control can be established on either side of the paver. A slope control sensor must be provided to maintain the proper transverse slope of the screed.

3.6.2 Compaction

.1 Delete 3.6.2.1 and replace as follows:

Provide sufficient compaction equipment to ensure that the compaction rate meets or exceeds the placement rate and to ensure that specified density is achieved before the temperature of the mat falls below 100°C.

3.7 Joints

.7 **Add 3.7.7 as follows:**

When placing final pavement layer against concrete curbing, compacted pavement must meet the gutter at the same elevation or a maximum of 10mm above and along the entire lip of the gutter.

HOT-MIX ASPHALT CONCRETE PAVING

4.1 COMPLIANCE WITH SPECIFICATIONS AND PAYMENT ADJUSTMENT FOR NON-COMPLIANCE

4.2 Hot Mix Asphalt Concrete

.1 A Marshall analysis will be performed from a sample obtained at the paving site on a frequency of one analysis per Day, with at least one analysis required per project or 700 tonnes of asphalt.

.2 When analysis identifies non-conformance with specified properties, the Contractor must immediately initiate remedial measures, and submit, at its expense, evidence that compliance exists with the approved mix design. Failure to do so will result in suspension of plant mixing operations.

4.3 Aggregate Gradation

.1 When the aggregate fails to comply with tolerances set forth in Section 3.1.4.1 of this specification, the Contract Administrator will initiate the following action:

.1 When two (2) consecutive gradation analyses identify non-compliance with the specified tolerances, the Contractor must be served notice and a third test will be initiated.

.2 If continued non-compliance is indicated from the third test, the Contractor must suspend production. It must not commence Construction again until it has demonstrated that corrective action has been taken and that the aggregate gradation is within the specified tolerance limits.

4.4 Asphalt Cement

.1 Payment adjusted for non-compliance with the tolerance specified:

Table 4.3.1

Asphalt Content Deviation from Design %	Payment Adjustment Factor
0.30 or less	0.00
0.31 to 0.40	0.20
0.41 to 0.50	0.75
0.50 or greater	Remove and replace

.2 Adjustment for asphalt cement content non-compliance to the amount payable for Hot Mix Asphalt Paving equals the unit bid price times the payment adjustment factor times the quantity to which the factor is to be applied, i.e.:

$$A_c = P\ (F_c)\ (Q_n)$$

Where:

A_c = Adjustment for asphalt cement content non-compliance
P = Unit bid price
F_c = Payment Adjustment Factor for Asphalt Cement Content non-compliance
Q_n = Asphalt measured for payment which was produced during the production period to which a test applies

4.5 Pavement Thickness

.1 Pavement of any type found to be deficient in thickness by more than 10mm must be removed and replaced by pavement, of specified thickness, at the Contractor's expense.

.2 Pavement of any type found to be deficient by less than 10% of its specified compacted thickness will not be subject to payment adjustment for thickness non-compliance.

.3 Pavement of any type found to be deficient in thickness by more than10% of its specified thickness but not more than 10mm shall give rise to an adjustment in the amount to be paid to the Contractor. The adjustment shall be subtracted from the amount otherwise payable to the Contractor, and the amount of the adjustment will be paid to the City. The adjustment shall be calculated as follows:

$$A_t = \frac{T_d \times P \times Q_t}{T_s}$$

Where:

A_t = Adjustment for thickness deficiency
T_d = Deficiency in thickness measured in mm and being greater than 10% of specified thickness but not greater than 10mm
T_s = Specified thickness in mm
Q_t = Asphalt measured for payment lying within a unit of work area defined in 5.2.2, where the thickness deficiency has been identified
P = Unit Bid Price

Note: No allowance will be made for the tolerance provided for in Section 4.4.2.

The adjusted price will be applied to all asphalt measured for payment which lies within a unit of work area defined in 5.2.2 where the thickness deficiency had been identified, or to such less area as may be defined in accordance with the provisions of 5.2.2.

4.6 Density

.1 The minimum specified density for acceptance, without payment adjustment, must be 97% of the 75 blow Marshall density as most recently determined by the appointed testing agency.

.2 Payment adjustment for density non-compliance will be as follows:

Table 4.5.2

Density (% of 75 Blow Marshall)	Payment Adjustment Factor
97 and greater	0.0
95.0 to 96.9	As per Density Payment Adjustment Factor Chart (see Standard Drawing SS-R24)
Less than 95.0	No Payment (subject to removal and replacement after review by the Engineer)

Adjustment for density specification non-compliance shall be determined as follows:

$$A_D = P\ (F_D)\ (Q_{nD})$$

Where:

A_D = Adjustment for density non-compliance
P = Unit Bid Price for Hot Mix Asphalt Cement paving
F_D = Payment Adjustment Factor for density non-compliance
Q_{nD} = Asphalt measured for payment within a unit of test area as defined in 5.3

4.7 Adjusted Payments

.1 The total adjustment arising from pavement deficiencies identified in the foregoing shall be determined as follows:

$$A_r = A_c + A_t + A_D$$

Where:

A_r = Total Adjustment
A_c = Adjustment for asphalt cement content non-compliance
A_t = Adjustment for thickness deficiency
A_D = Adjustment for density non-compliance

The total adjustment (A_r) shall be paid to the City.

5.1 TESTING FREQUENCY AND PROCEDURES

5.2 Aggregate Gradation and Asphalt Cement Content

.1 One test per production period as defined in Section 4.1.1. Asphalt content shall be determined in accordance with ASTM D2172 or D6307. Gradation analysis of extracted aggregate shall be performed in accordance with ASTM C136 and C117.

5.3 Thickness

.1 The actual pavement thickness, for each unit of work area, will be determined on the basis of the average thickness of three (3) cores. The cores shall be spaced at intervals of 150m of paved Lane width or less. If the deficiency of any individual core exceeds 10mm, three (3) additional cores may be extracted in proximity to the location of the core of excessive deficiency, to identify the extremities of the pavement area to be removed and replaced. The Contractor will initiate and pay for such additional coring.

.2 A unit of work area is defined as 1,500 m² or fraction thereof, representing pavement placed in an individual placement day.

.3 Sampling and testing for thickness determination shall be in accordance with ASTM D3549.

5.4 Density

.1 Density of compacted pavement shall be determined on the basis of tests on core samples taken at a maximum interval of 150m of paved Lane width. A test area shall be that area lying between longitudinal joints and between transverse lines located midway between test cores or between such transverse lines and the beginning or end of placement.

HOT-MIX ASPHALT CONCRETE PAVING

.2 With prior approval of the Contract Administrator, the in situ density of a compacted layer of pavement may also be determined by nuclear methods in accordance with ASTM D2950. Spacing of tests shall be as stated above, and tests shall be taken in the vicinity of the core samples extracted for testing of the thickness of the pavement layer. In a situation where the in situ density of the lift does not meet specification, according to D2950, then the density of the extracted cores shall be determined and will take precedent over the in situ density. Where the specified compaction has not been met, as confirmed by the direct measurement of the core, then an additional three cores shall be taken in the immediate area and the average of the three cores shall be used.

END OF SECTION

CITY OF GRAND FORKS **SECTION: S32 07 24**
SUPPLEMENTARY SPECIFICATIONS **PAGE: 1 OF 1**

TRAFFIC SIGNS

1.1 GENERAL

.1 Section SS 02578 refers to those portions of the work that are unique to the supply and installation of traffic signs. This section must be referenced to and interpreted simultaneously with all other sections pertinent to the works described herein.

1.2 Related Work

.1	Painted Pavement Markings	Section 32 17 23
.2	Cast-In-Place Concrete	Section 03 30 53
.3	Precast Concrete	Section 03 40 01

2.1 PRODUCTS

2.2 Materials

.1 Signs shall be mounted on sheet aluminum, 0.018" minimum, alloy 5052-H38.

.2 Sign posts shall be Telespar 50mm square perforated galvanized tubing with a 57mm square perforated galvanized tubing break away base set in concrete.

.3 Concrete shall be 32 mpa compressive strength

3.1 EXECUTION

3.2 General

.1 Layout and confirm the locations of all signs with the Contract Administrator prior to installation

.2 Install signs, posts and concrete bases in accordance with Contract Documents.

END OF SECTION

CITY OF GRAND FORKS **S33 11 01**
SUPPLEMENTARY SPECIFICATIONS **PAGE 1 OF 2**

WATERWORKS

2.0 PRODUCTS

2.2.1 Mainline Pipe, Joints and Fittings

.3 **Add 2.2.1.3 as Follows:**

Wrap: Ductile iron pipe to be installed with a polyethylene encasement conforming to AWWA C104.

2.3.2 Valves and Valve Boxes

.7 **Delete 2.3.2.7.**

2.5 Service Connections, Pipe, Joints and Fittings

.1 Delete 2.5.1 and replace with the following:

Pipe diameter 19mm to 50mm to be Type K annealed copper, to ASTM B88M, and pipe diameter 25mm to 50mm may be Pressure Class 160 Polyethylene tubing, certified to CSA B137.1.

2.6 Hydrants

.2 **Delete 2.6.2 and replace with the following:**

Colour: All hydrants are to be painted red in accordance with the standard drawings.

3.6 Pipe Installation

.1 **Delete 3.6.1 and replace with the following:**

Handle pipe in accordance with pipe manufacturer's recommendations. Do not use chains or cables passed through pipe bore so that weight of pipe bears on pipe ends. Unless approved by the Owner, all pipe to be delivered from manufacturer with weatherproof plugs/bagging to prevent contamination while being delivered and during storage. Pipe to remain this way until placed into trench and installed.

3.12 Hydrants

.6 **Delete 3.12.6 and replace with the following:**

For hydrants not in service, place an orange bag over the entire hydrant, secured at the bottom with tape and labeled in black "Not In Service". Remove bag once the watermain has been accepted by the City.

WATERWORKS

3.17 General Procedure Flushing, Testing and Disinfection

.2 **Delete 3.17.2 and replace with the following:**

Perform all tests in presence of Contract Administrator or a designated representative. Notify the Contract Administrator 24 hours in advance of proposed test. Upon satisfactory completion of the testing and disinfection, and prior to allowing the main to be used for active service, the Contract Administrator shall provide the Owner with written certification that the flushing, testing and disinfection has been performed in accordance with AWWA, MMCD, and City of Grand Forks requirements, and has been substantiated with Total and Fecal Coliform results of zero colonies per 100 ml.

3.20 Disinfection, General

.2 **Delete 3.20.2 and replace with the following:**

Disinfect and flush pipes and appurtenances in accordance with Section 3.21 of AWWA C651.

3.23 Connections to Existing Mains

.1 **Delete 3.23.1 and replace with the following:**

Contractor to complete tie-ins for the City water system in the presence of City Personnel and after appropriate City approvals are obtained. For watermains, the City Engineering Technologist, or designate, must approve the successful pressure testing, chlorination and flushing prior to authorizing the Contractor to proceed with the tie-in. The Contractor will coordinate with City staff to open and close existing water valves.

Add 3.23.2 to 3.23.5 as follows:

.2 The Contractor will be responsible for notifying all affected parties as per the requirements of Section 01 58 01, 1.2.2 Public Notice.

.3 The City of Grand Forks Public Works staff will be responsible for opening and closing any existing mainline water valves.

.4 Proposed works required for tie-ins shall be disinfected by swabbing in accordance with AWWA C-651 followed by line flushing immediately after installation work is complete and placed back into service.

.5 All pipes, fittings, couplings, miscellaneous materials and sufficient equipment and labour shall be made available at the tie-ins to ensure the tie-in can be completed within the maximum duration of water service disruption permitted.

END OF SECTION

CITY OF GRAND FORKS
SUPPLEMENTAL SPECIFICATIONS

SECTION: S33 44 01
PAGE: 1 OF 2

MANHOLES AND CATCHBASINS

2.1 PRODUCTS

2.2 Materials

.7

.1 Modify 2.1.7.1 to read as follows:

Frame and cover must conform to ASTM A48 and be designed to withstand, in an adjusted position, H20 loading, with a 2:1 safety factor prior to the addition of concrete support.

.3 Add 2.1.7.3 as follows:

Cover to be marked “SANITARY” or “STORM” to suit.

.4 Add 2.1.7.4 as follows:

Cover to be marked “Grand Forks Sanitary” where specified on Contract Drawings.

.5 Add 2.1.7.5 as follows:

Frame to be adjustable to within 5mm of design elevation and grade.

.6 Add 2.1.7.6 as follows:

Frame to be designed to eliminate any point loading on the concrete riser ring.

.7 Add 2.1.7.7 as follows:

Support ring must be designed to provide proper alignment of frame and cover over manhole opening.

.8 Add 2.1.7.8 as follows:

Frame to be designed so as to provide a minimum 25mm gap between support ring and adjustable frame base for proper placement of concrete and to eliminate concrete sloughing into the manhole.

.9 Add 2.1.7.9 as follows:

All components to be reusable.

MANHOLES AND CATCHBASINS

.11 Delete 2.1.11 and replace with the following:
Catchbasin leads to be minimum 200mm diameter and PVC DR 35 unless noted otherwise on the Contract Drawings.

.15 Mortar

.3 Add 2.1.15.3 as follows:

Support concrete to be non-shrink type, minimum 20 MPa @ 28 days, maximum 10mmØ aggregate.

.16 Adjusting rings: to ASTM C478

.3 Add 2.1.16.3 as follows:

Steel riser rings welded to the top of existing manhole frames is not permitted.

3.0 EXECUTION

3.3 Manhole Installation

.9

.1 Add 3.3.9.1 as follows:

„Conseal" continuous joint sealer is permitted.

.19 Add 3.3.19 as follows:

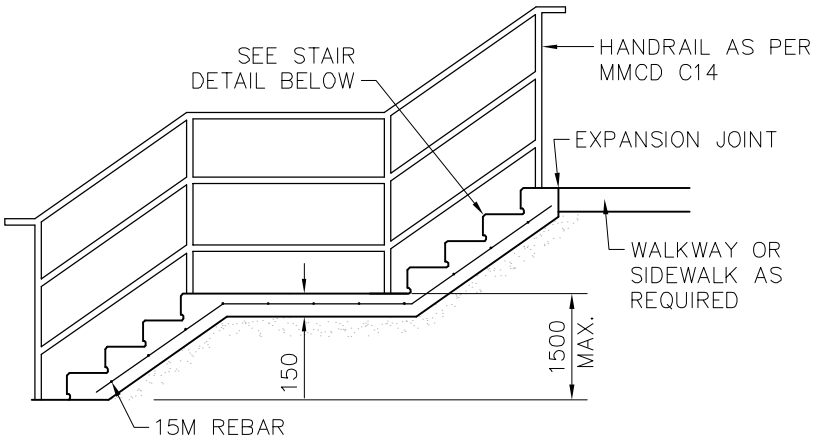
Where manholes are to be installed in new or re-constructed roadways that require two lifts of asphalt, interim adjustment of manhole frames and covers is to occur after lower course asphalt is in place when lower course asphalt is intended for traffic use. Final adjustment of manhole frames and covers is to occur after the surface course asphalt is in place.

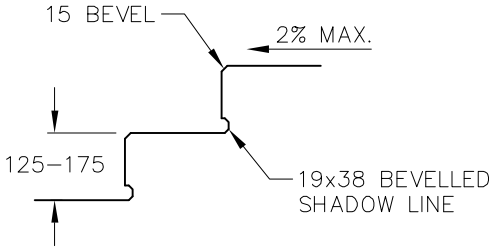
END OF SECTION

SCHEDULE 10
STANDARD DRAWINGS

10. STANDARD DRAWINGS

SD-C1	Reinforced Concrete Stairs
SD-R1	Arterial Cross-Section - Rural
SD-R2	Arterial Cross-Section - Urban
SD-R3	Collector Cross-Section - Urban
SD-R4	Collector Cross-Section - Rural
SD-R5	Local Cross-Section - Urban
SD-R6	Local Cross-Section - Rural
SD-R7	*Lane* Cross-Sections
SD-R8	Walkway and Multi-Use Pathway
SD-R9	Tree Planting Detail – Softscape
SD-R10	Tree Planting Detail - Hardscape
SD-S1	Drainage Drywell
SD-S2	Drainage Drywell Installation
SD-S3	Catch Basin Trapping Hood
SD-S4	Manhole Frame and Cover
SD-S5	Lot Servicing Locations
SD-HS1	Hillsides – Local
SD-HS2	Hillsides – Collector
SD-HS3	Plan View of Parking Pullout Areas for Hillsides

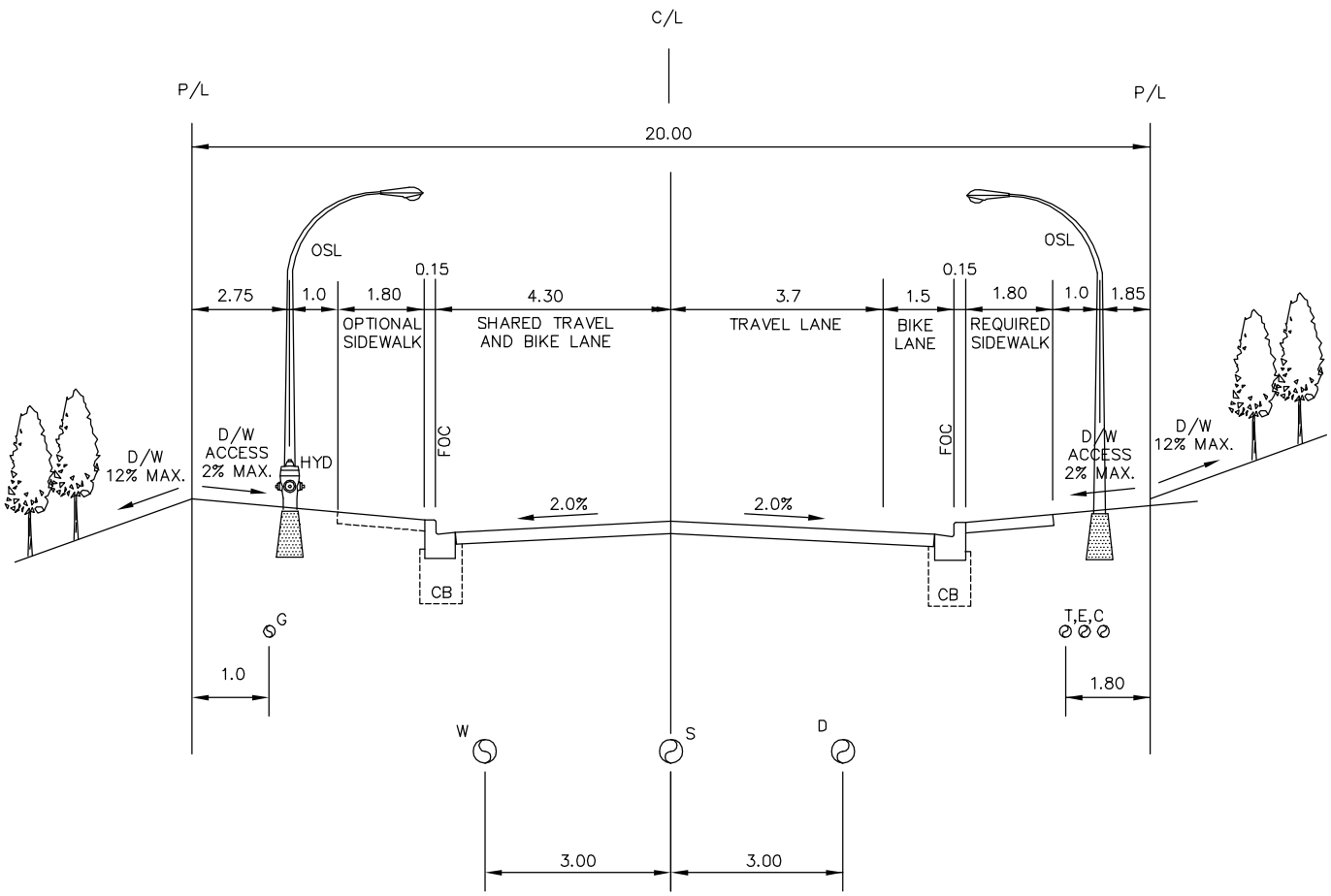




STAIR DETAIL

NOTE:
1. TREAD TO RISER RATIO SHALL BE (TREAD WIDTH+(2x RISER HEIGHT))=650–675mm

GRAND FORKS – BC –	SCALE: NTS	TITLE: REINFORCED CONCRETE STAIRS	
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014		
	APPROVED BY: –	SECTION: – –	REVISION No. – / DWG.No. SD–C1



LEGEND

C – CABLEVISION
T – TELEPHONE
G – GAS
E – ELECTRICAL
W – WATER
S – SANITARY SEWER
D – STORM SEWER

HYD – HYDRANT
P/L – PROPERTY LINE
C/L – CENTER LINE
R/W – RIGHT–OF–WAY
SWK – SIDEWALK
C – CURB
FOC – FACE OF CURB
CB – CATCH BASIN
OSL – STREET LIGHT

NOTES:

1) HYDRANT VALVES ON TEE.
2) WATER SERVICE VALVES 0.3 FROM P/L.
3) STREET LIGHTS ON BOTH SIDES ALTERNATING.
4) 1.5m BIKELANE ON THE UPHILL SLOPE (OPTIONAL)

GRAND FORKS – BC –

NTS

DATE DRAWN: | LATEST REVISION DATE: SEPT. 2014

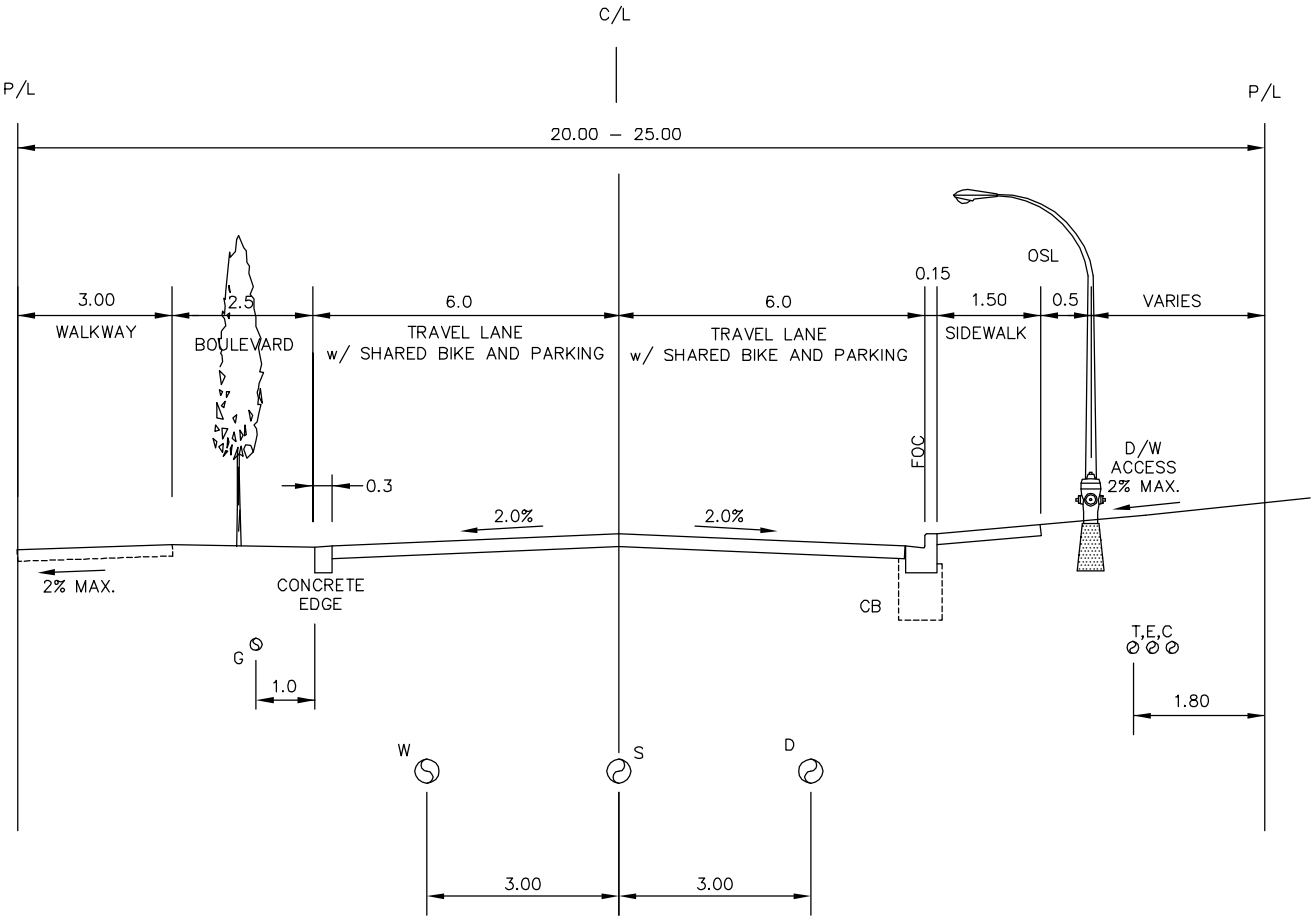
APPROVED BY: –

RURAL
ARTERIAL CROSS–SECTION

SECTION: – –

REVISION No. –

DWG.No. SD–R1



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NOTES:

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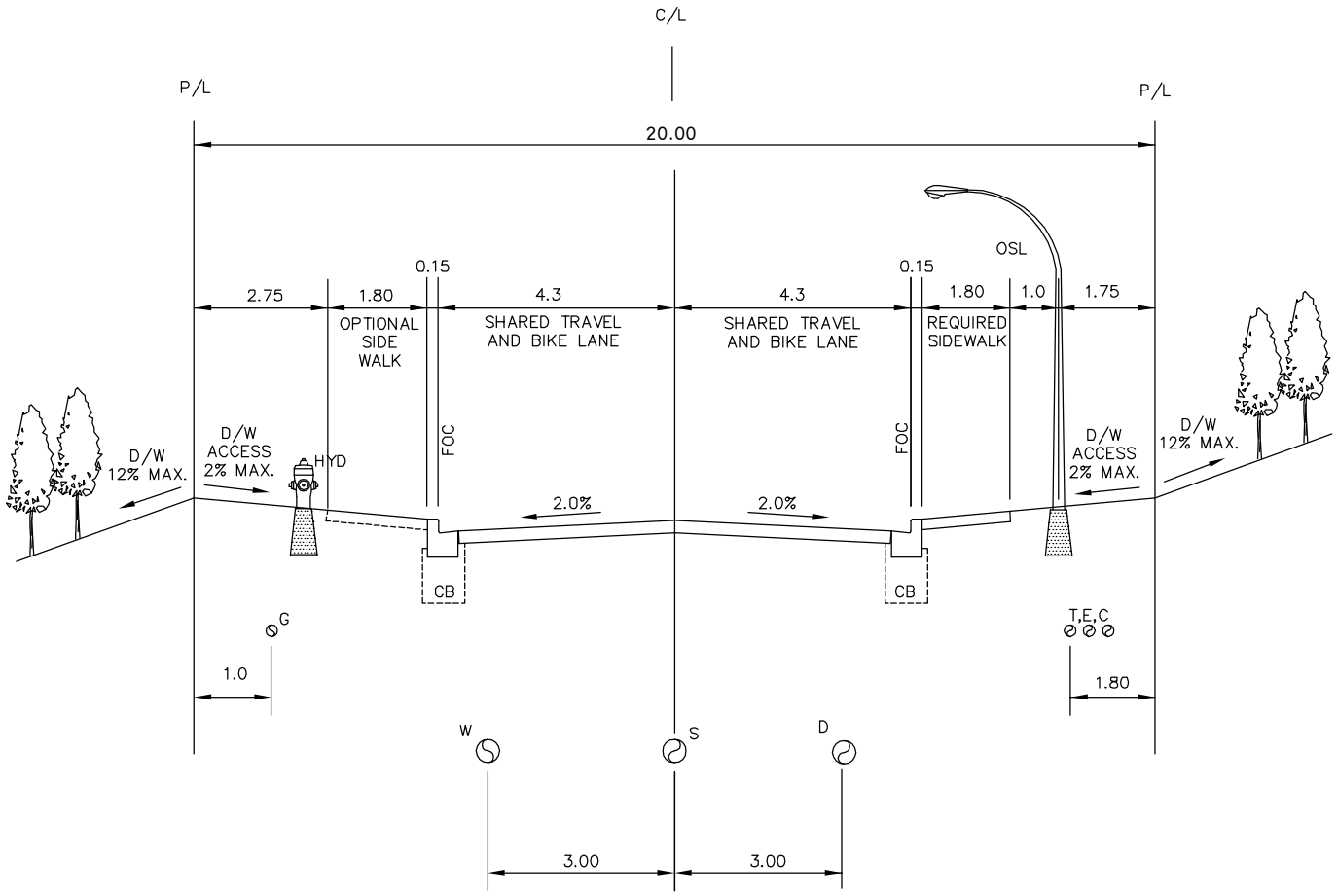
3) STREET LIGHTS ON BOTH SIDES ALTERNATING.

GRAND FORKS – BC –

NTS		URBAN CROSS–SECTION
DATE DRAWN:	LATEST REVISION DATE: SEPT. 2014	
APPROVED BY: –		
SECTION: – –	REVISION No. –	DWG.No. SD–R2



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FOC – FACE OF CURB
CB – CATCH BASIN
OSL – STREET LIGHT

NOTES:

1) HYDRANT VALVES ON TEE.
2) WATER SERVICE VALVES 0.3 FROM P/L.
3) FOR OFF–STREET PARKING OPPORTUNITIES, INCREASE ASPHALT WIDTH BY 1.4m EACH SIDE

GRAND FORKS – BC –

NTS

DATE DRAWN: | LATEST REVISION DATE: SEPT. 2014

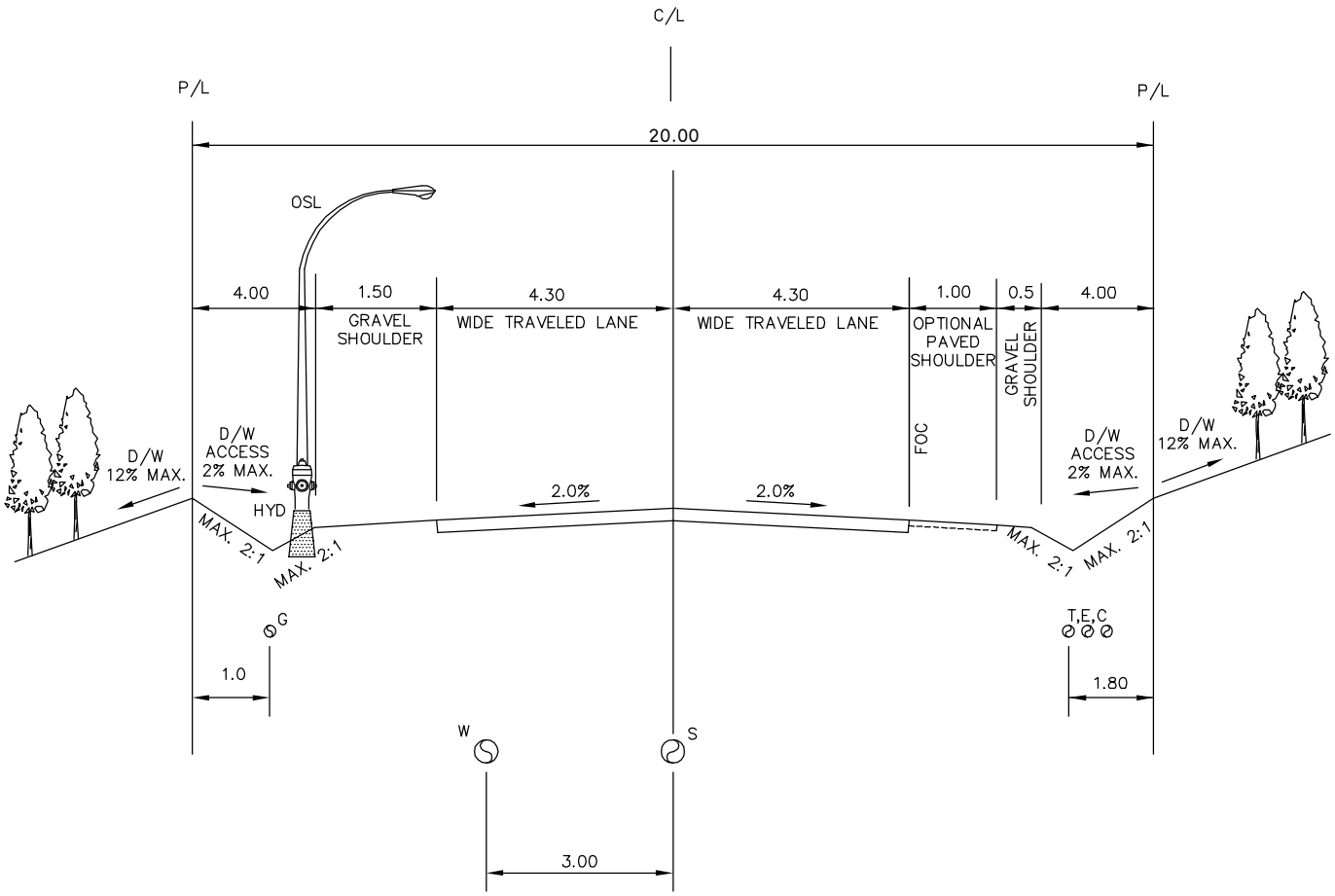
APPROVED BY: –

COLLECTOR CROSS–SECTION URBAN

SECTION: – –

REVISION No. –

DWG.No. SD–R3



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OSL – STREET LIGHT

NOTES:

1) HYDRANT VALVES ON TEE.
2) WATER SERVICE VALVES 0.3 FROM P/L.
3) DRAINAGE TREATMENT VARIES DEPENDING ON SITE SPECIFIC GROUND CONDITIONS.
4) FOR OFF–STREET PARKING OPPORTUNITIES INCREASE ASPHALT WIDTH BY 1.4m EACHSIDE

GRAND FORKS – BC –

NTS

DATE DRAWN:

LATEST REVISION DATE: SEPT. 2014

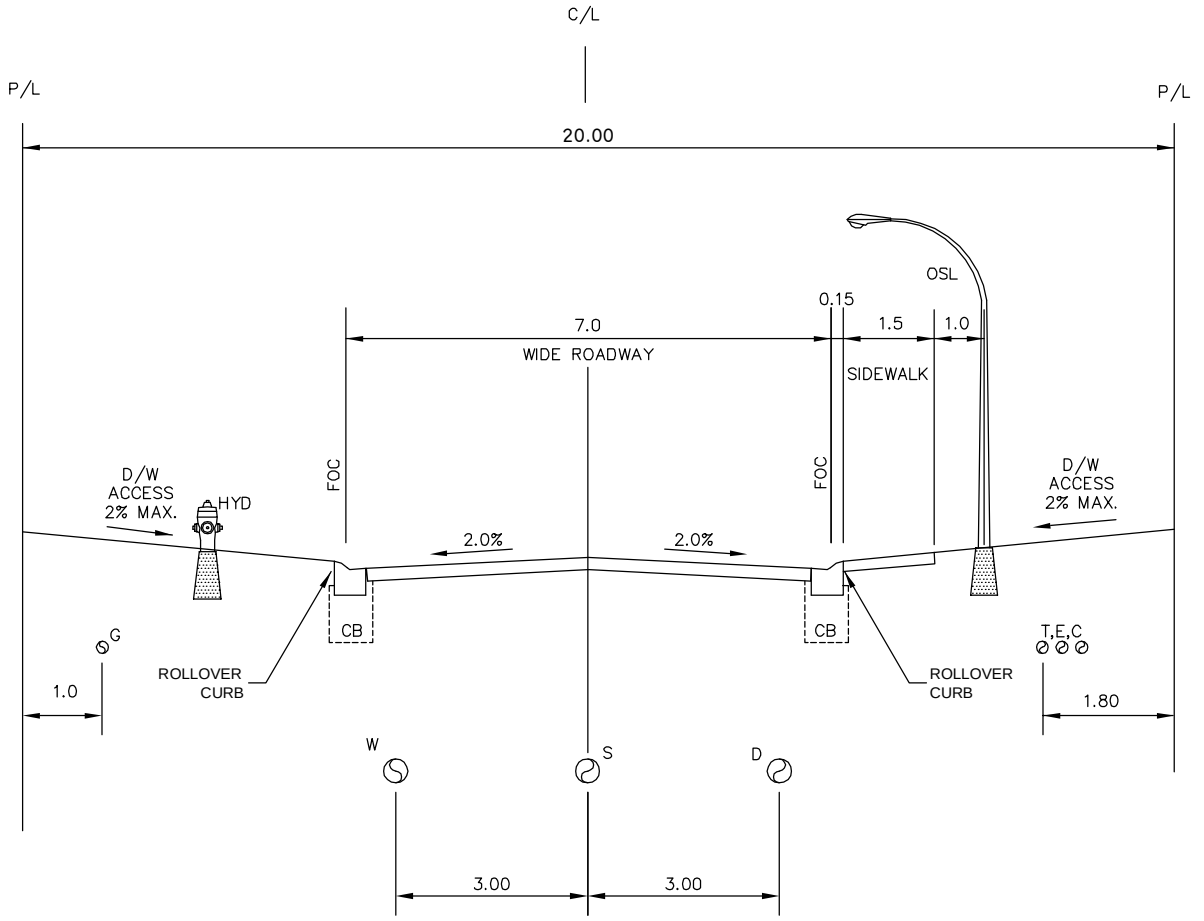
APPROVED BY: –

COLLECTOR CROSS–SECTION RURAL

SECTION: – –

REVISION No. –

DWG.No. SD–R4



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SWK – SIDEWALK
C – CURB
FOC – FACE OF CURB
CB – CATCH BASIN
OSL – STREET LIGHT

NOTES:

1) HYDRANT VALVES ON TEE.
2) WATER SERVICE VALVES 0.3 FROM P/L.
3) RIGHT OF WAY MAY BE REDUCED TO 15.0m DEPENDING ON GEOTECHNICAL CONSIDERATIONS, SLOPE ANALYSIS, OR CUL–DE–SAC DESIGN.
4) PARKING ADD 1.4m PAVED SURFACE EACH SIDE

GRAND FORKS – BC –

NTS

DATE DRAWN: | LATEST REVISION DATE: SEPT. 2014

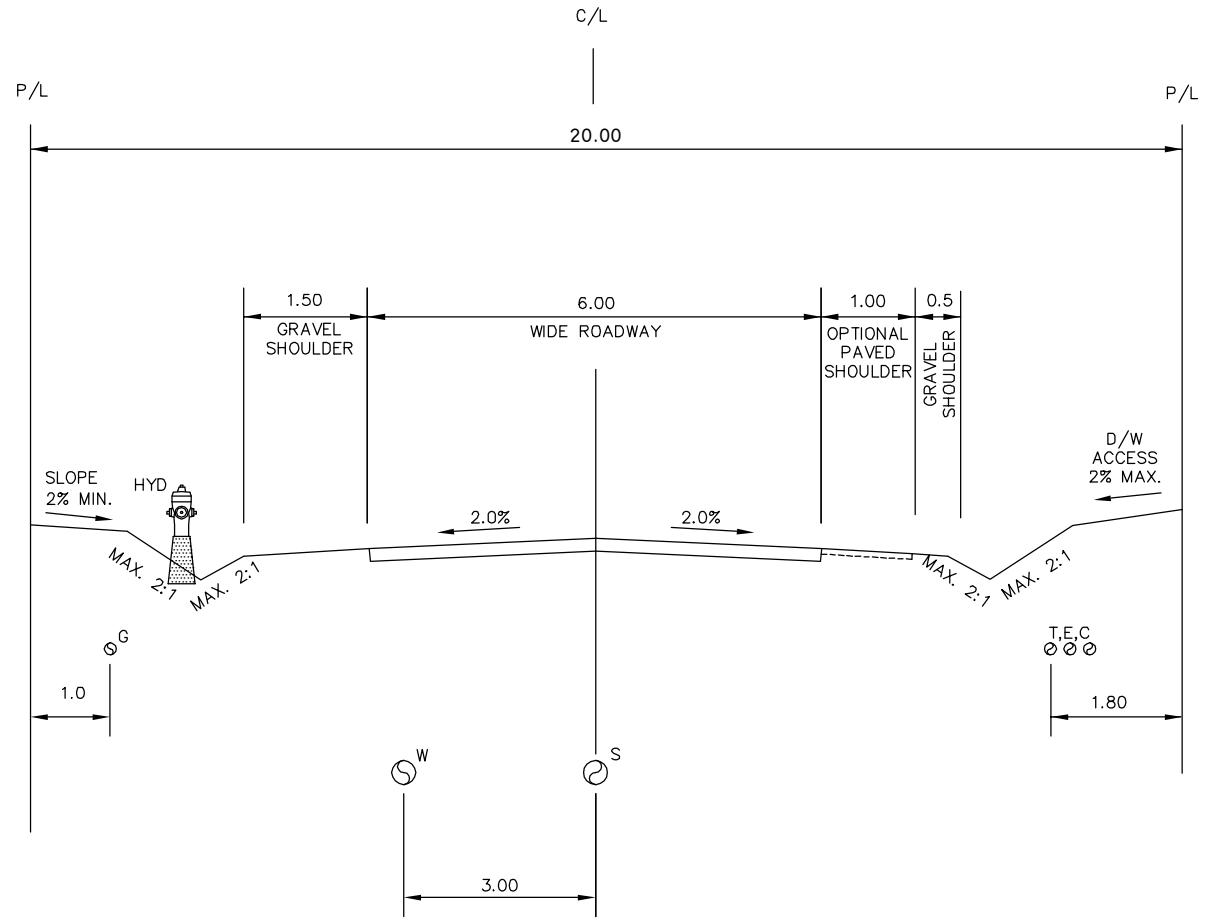
APPROVED BY: –

LOCAL CROSS–SECTION URBAN

SECTION: – –

REVISION No. –

DWG.No. SD–R5



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NOTES:

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2) WATER SERVICE VALVES 0.3 FROM P/L.
3) DRAINAGE TREATMENT VARIES DEPENDING ON SITE SPECIFIC GROUND CONDITIONS.
4) RIGHT OF WAY MAY BE REDUCED TO 15.0m DEPENDING ON GEOTECHNICAL CONSIDERATIONS, SLOPE ANALYSIS, OR CUL–DE–SAC DESIGN.

GRAND FORKS – BC –

NTS

DATE DRAWN: | LATEST REVISION DATE: SEPT. 2014

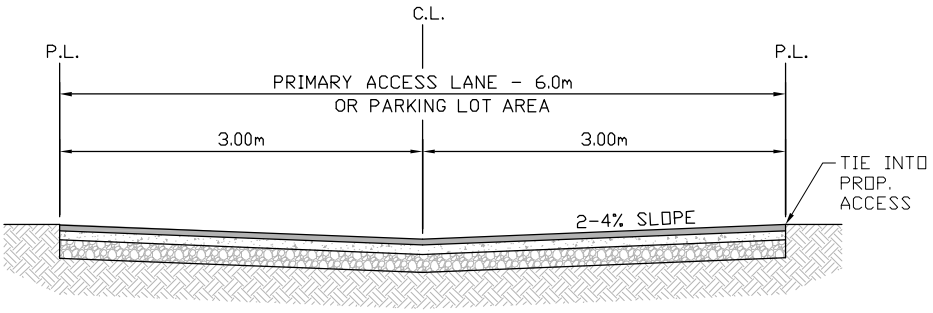
APPROVED BY: –

LOCAL CROSS–SECTION RURAL

SECTION: – –

REVISION No. –

DWG.No. SD–R6

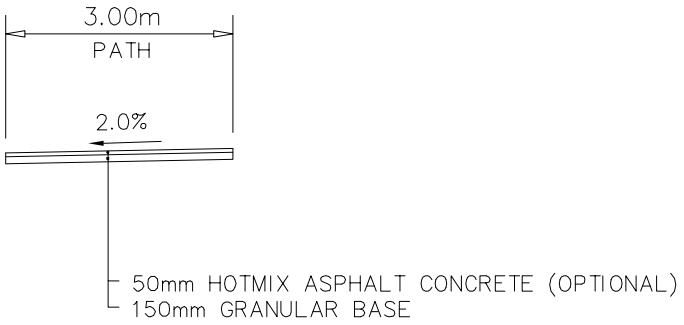


COMMERCIAL/MULTI-FAMILY PRIMARY ACCESS LANE OR PARKING LOT

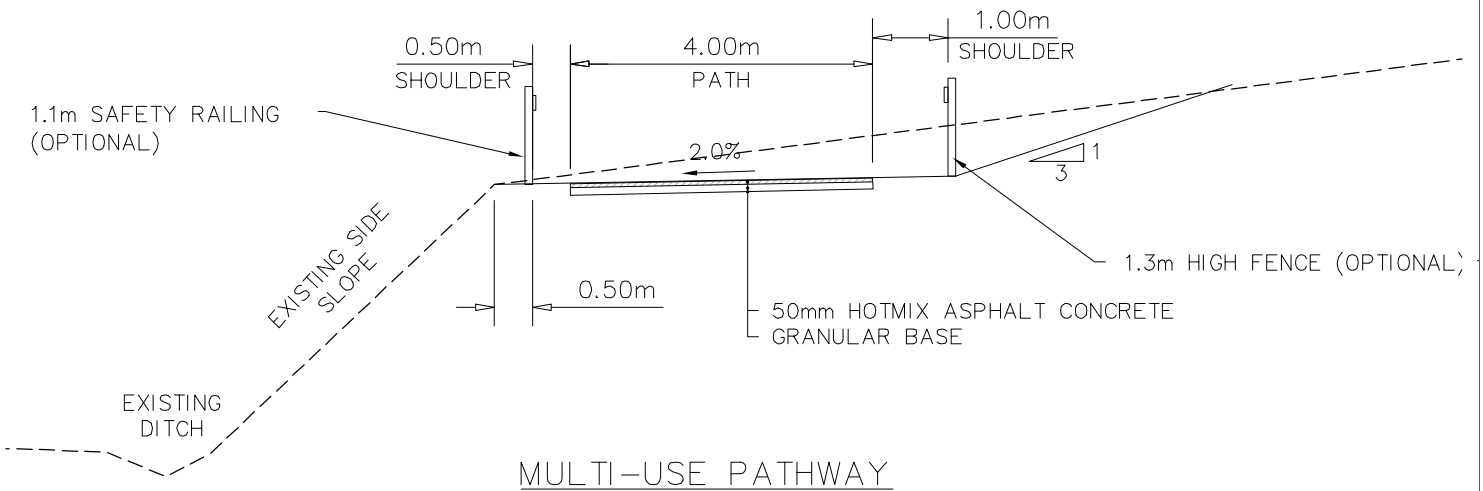
OR

RESIDENTIAL, EMERGENCY AND PRIVATE ACCESS ROADS

GRAND FORKS - BC -	NTS	LANE CROSS-SECTIONS	
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014		
	APPROVED BY: -	SECTION: - -	REVISION No. - / DWG.No. SD-R7



WALKWAY

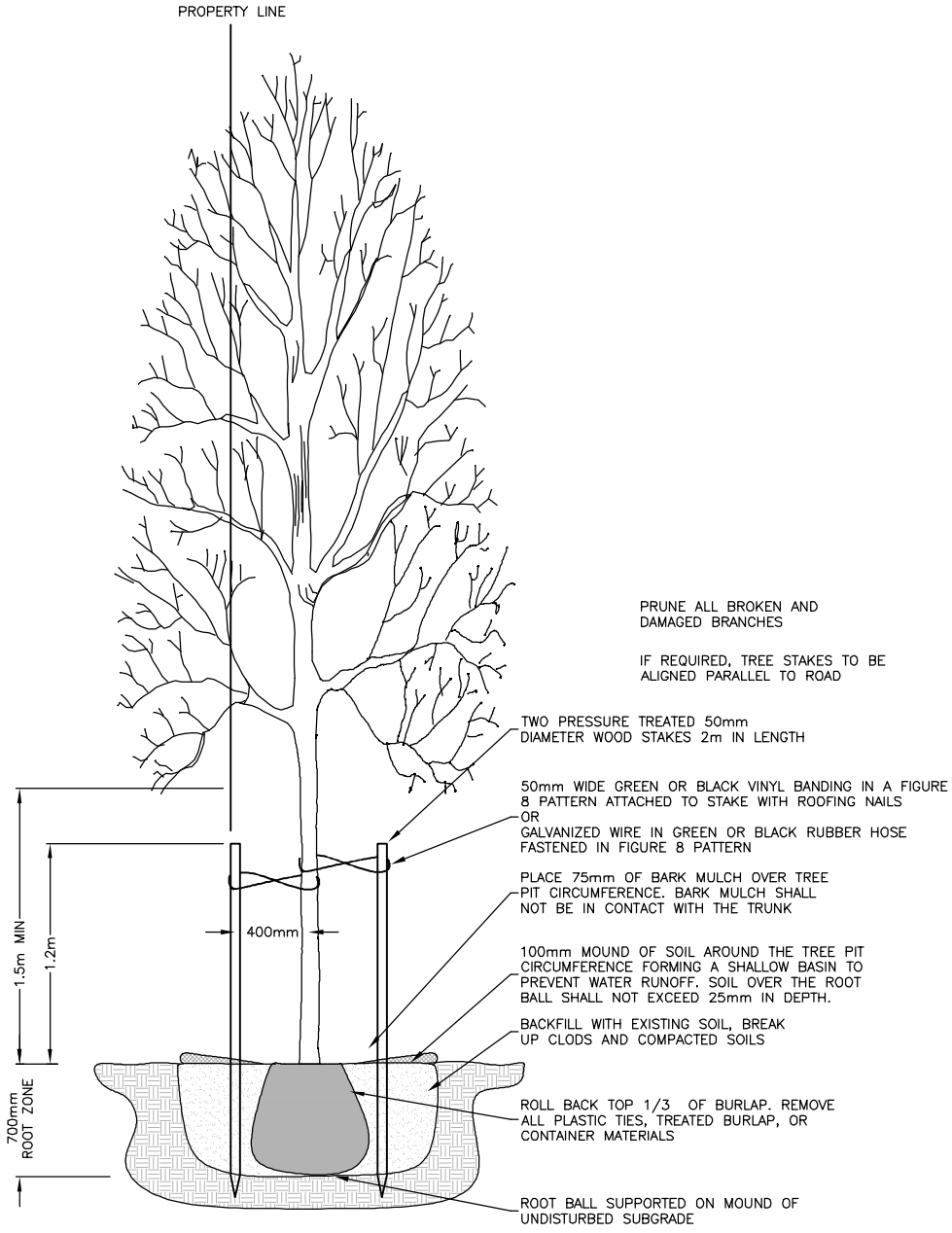


MULTI-USE PATHWAY

*NOTE: ACTUAL PATHWAY STRUCTURE TO BE DETERMINED BY A GEOTECHNICAL ENGINEER

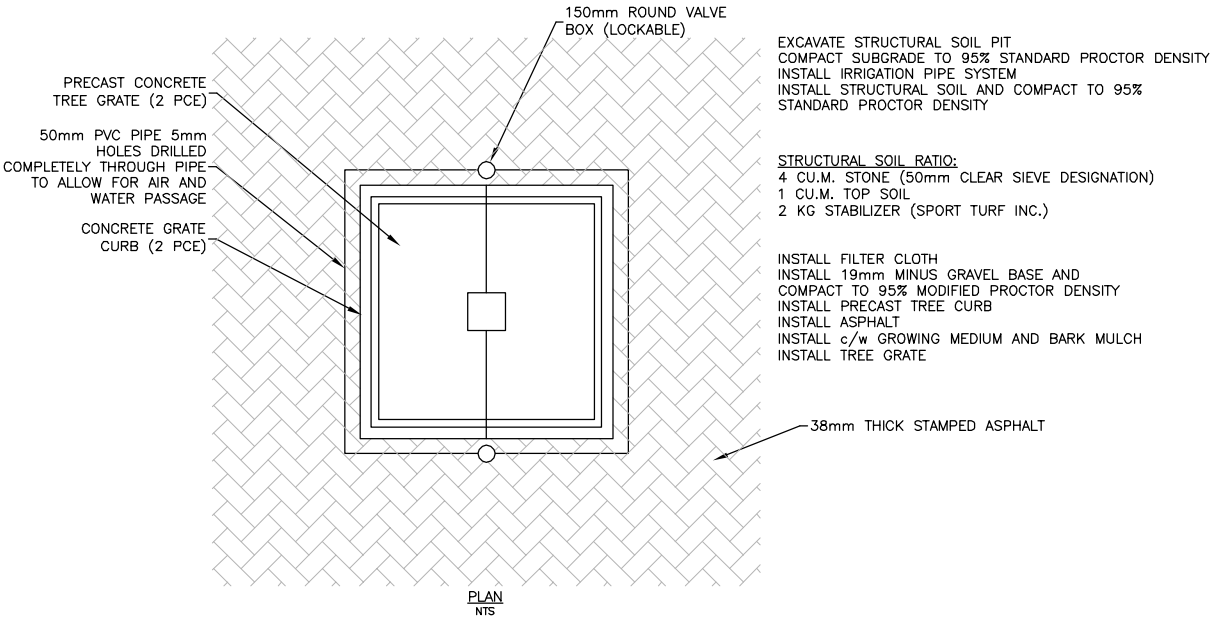
NOTE: DESIGN MAY BE MODIFIED PENDING CITY APPROVAL

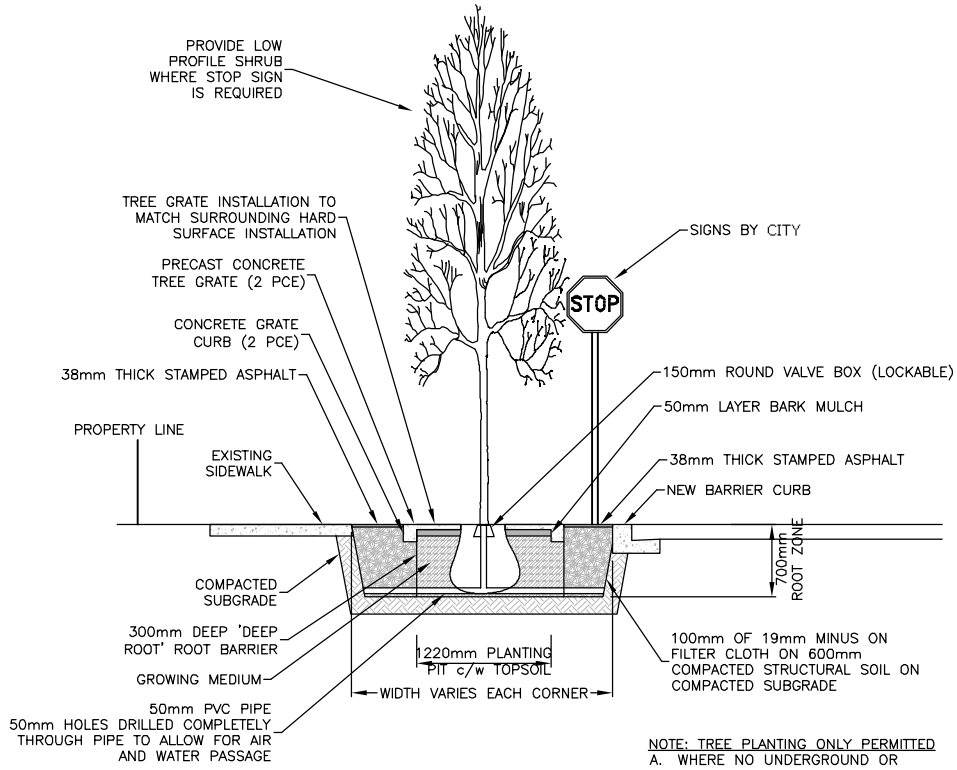
GRAND FORKS – BC –	SCALE: 1:100	TITLE: WALKWAY & MULTI-USE PATHWAY
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014	
	APPROVED BY: –	SECTION: – / REVISION No. – / DWG.No. SD-R8



ALL PLANTING PITS SHOULD BE EXCAVATED BY HAND AS UNDERGROUND SERVICES MAY EXIST NEAR STREET TREE LOCATIONS

GRAND FORKS – BC –	SCALE: NTS	TITLE: TREE PLANTING DETAIL – SOFTSCAPE
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014	
	APPROVED BY:	SECTION: / REVISION No. – / DWG.No. SD–R9

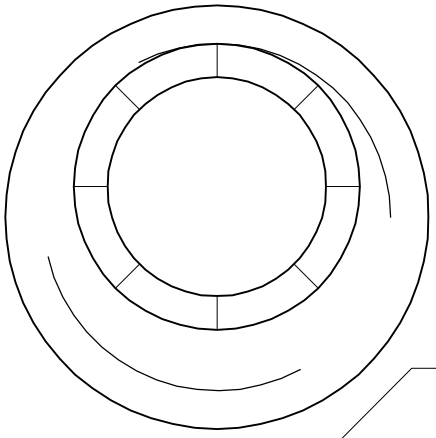


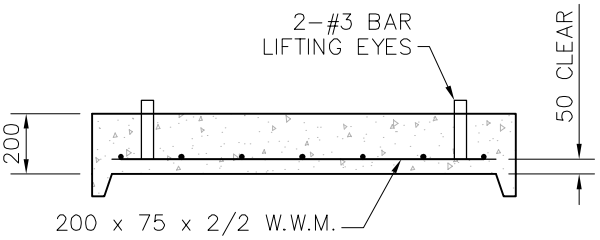


SECTION THROUGH PLANTER
NTS

NOTE: TREE PLANTING ONLY PERMITTED
A. WHERE NO UNDERGROUND OR OVERHEAD UTILITY CONFLICTS EXIST
B. NO TRAFFIC OR PEDESTRIAN SIGHT CLEARANCE CONFLICTS EXIST

GRAND FORKS – BC –	SCALE: NTS	TITLE: TREE PLANTING DETAIL – HARDSCAPE
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014	
	APPROVED BY:	SECTION: / REVISION No. – / DWG.No. SD–R10



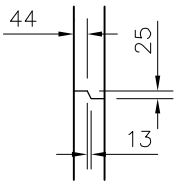


CONCRETE LID DETAIL

MANHOLE FRAME AND COVER
SEE STD. DRAWING

MIN. 100 BRICK
OR CONCRETE

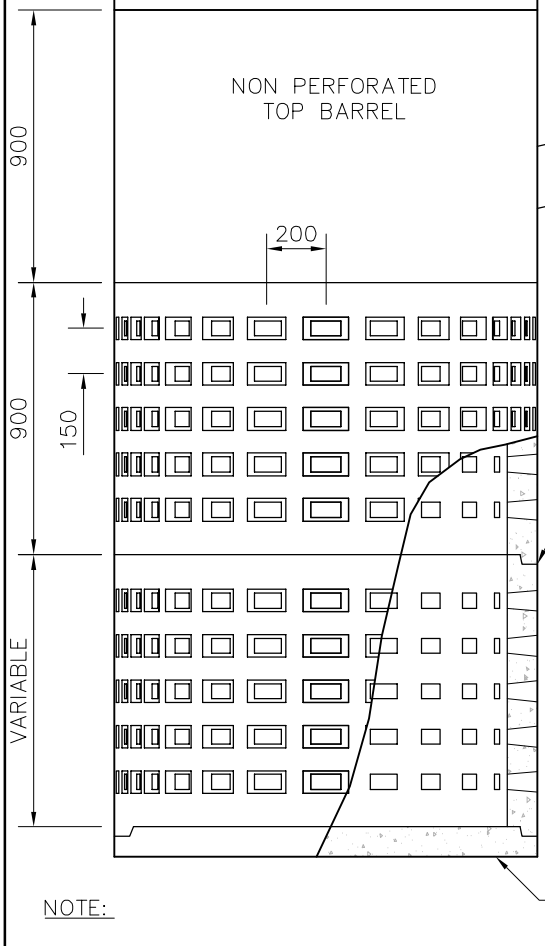
CONCRETE LID
SEE DETAIL THIS DRAWING



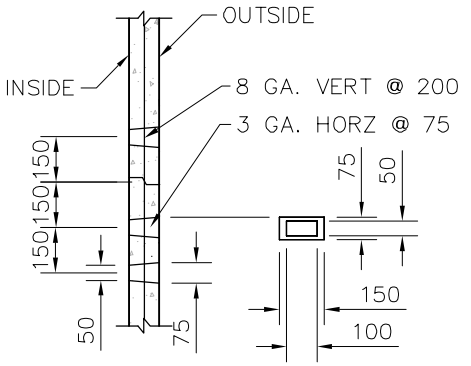
CONCRETE LID DETAIL

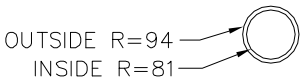
NON PERFORATED
TOP BARREL

200 DIA. INLET



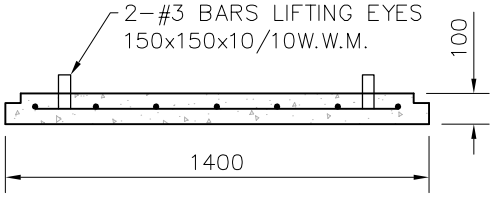
PRECAST SECTIONS
1200 LD. x 100 WALLS
100–75x150 HOLES
SPACED VERT. 150
HORIZ. 200





OPTIONAL HOLE SHAPE

SECTION–BARREL



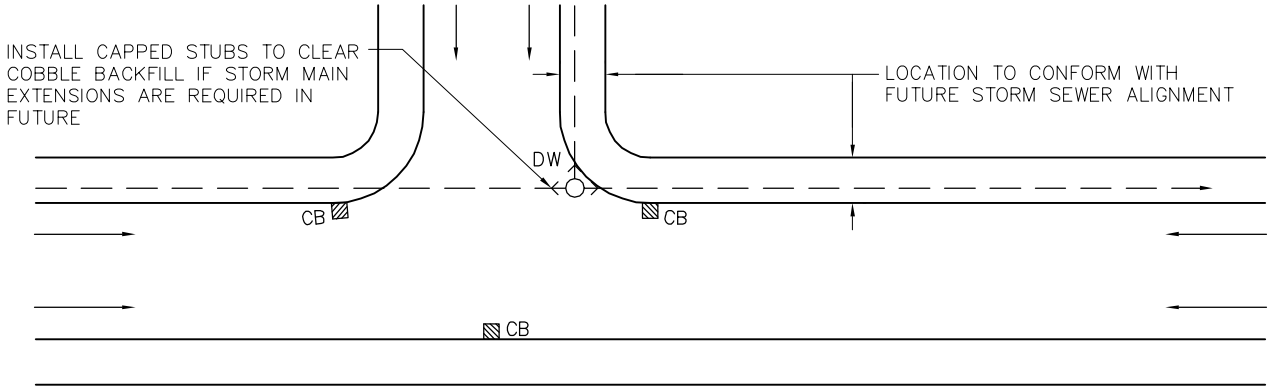
BOTTOM SLAB DETAIL

BOTTOM SLAB
SEE DETAIL

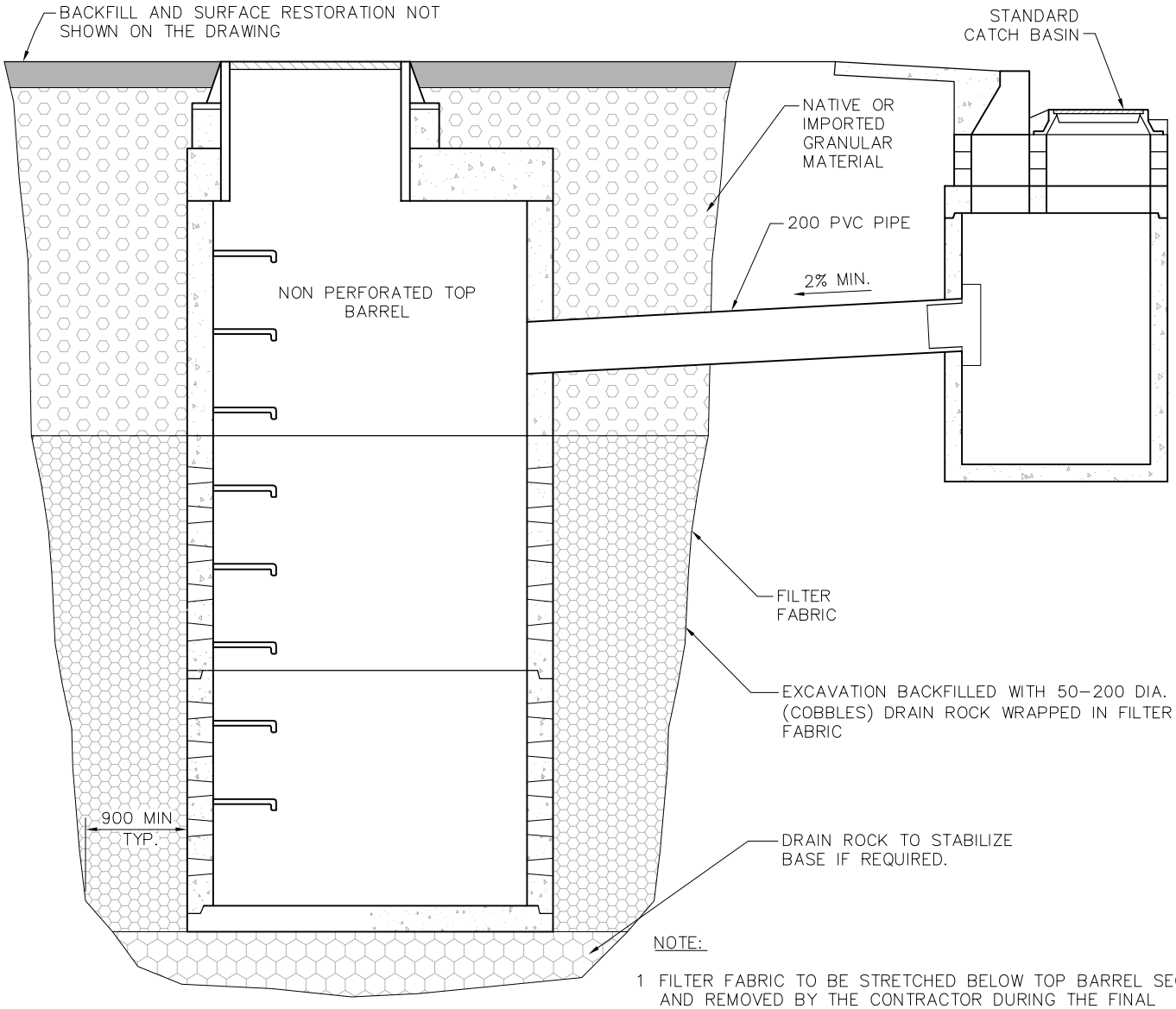
NOTE:

1. LADDER RUNGS ARE REQUIRED.
2. SEE MANHOLE STD. DWG FOR DETAILS.
3. SEE DRAINAGE DRYWELL INSTALLATION SD–S2.
4. DEPTH TO BE SPECIFIED WILL VARY DEPENDING UPON DRAINAGE REQUIREMENTS AND GROUND CONDITIONS. DEPTH TO WATER TABLE MUST BE SHOWN IF LESS THAN 3.6m.

GRAND FORKS – BC –	SCALE: 1:25	TITLE: DRAINAGE DRYWELL
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014	
	APPROVED BY: –	SECTION: – – / REVISION No. – / DWG.No. SD–S1



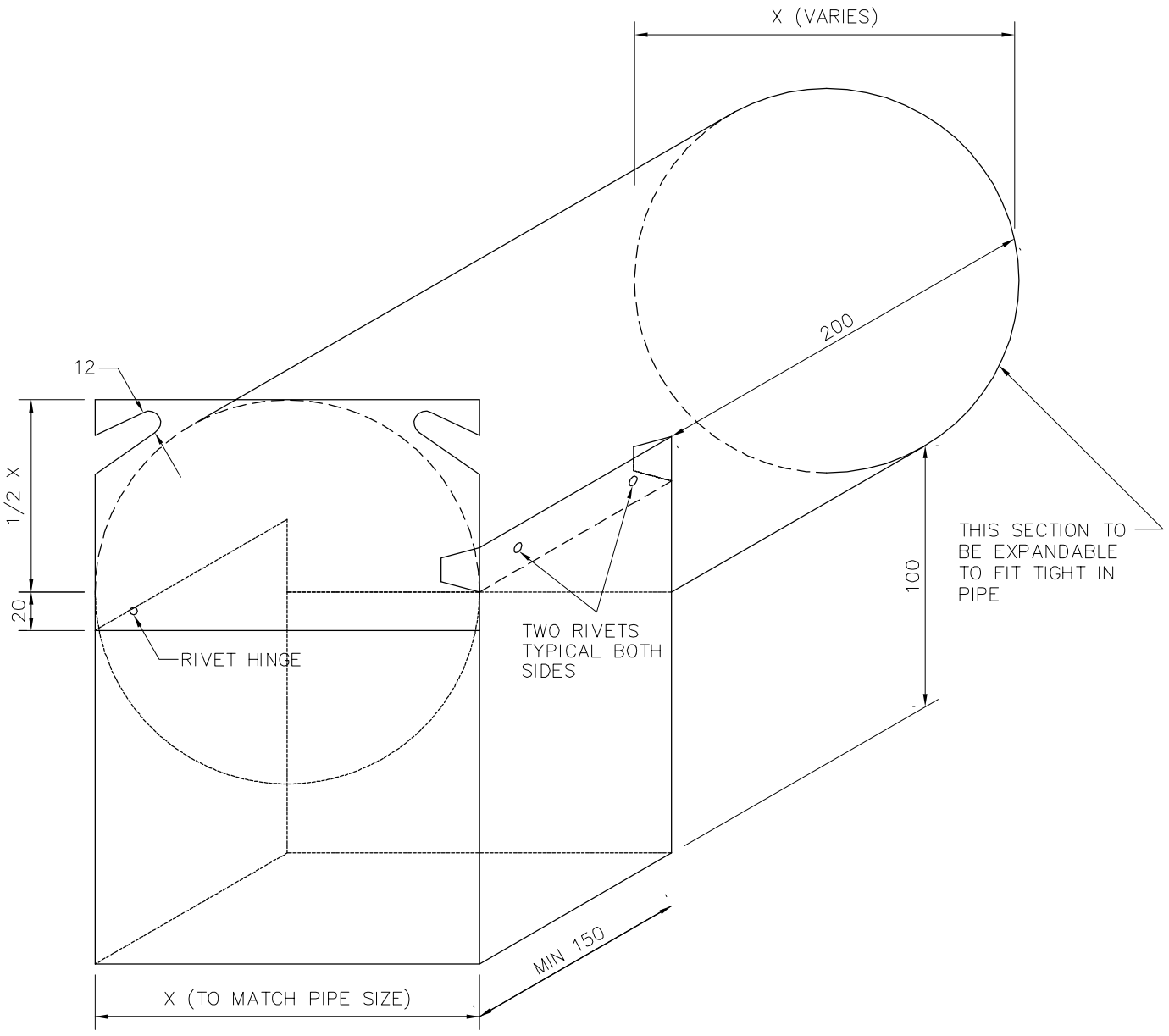
TYPICAL INSTALLATION



NOTE:

1. FILTER FABRIC TO BE STRETCHED BELOW TOP BARREL SECTION AND REMOVED BY THE CONTRACTOR DURING THE FINAL INSPECTION.
2. DEPTH TO BE SPECIFIED WILL VARY DEPENDING UPON DRAINAGE REQUIREMENTS AND GROUND CONDITIONS. DEPTH TO WATER TABLE MUST BE SHOWN IF LESS THAN 3.6m.

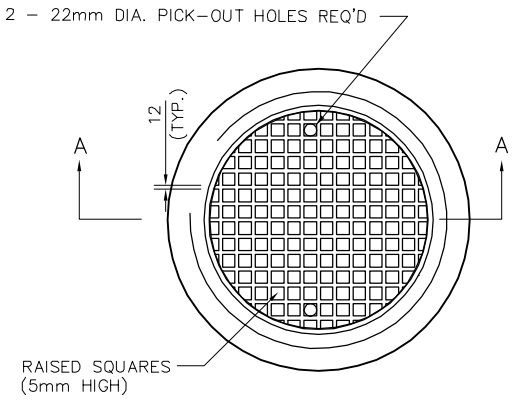
GRAND FORKS – BC –	SCALE: N.T.S.	TITLE: DRAINAGE DRYWELL INSTALLATION
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014	
	APPROVED BY: –	SECTION: – – / REVISION No. – / DWG.No. SD-S2



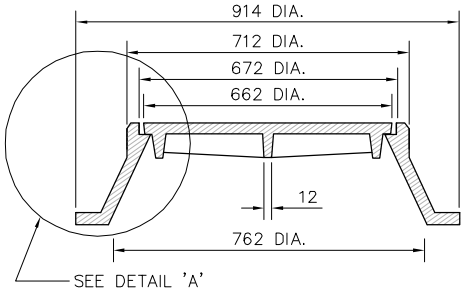
NOTES:

1. SEWER TRAPS SHALL BE MANUFACTURED FROM 16 GAUGE ALUMINUM.
2. BLIND RIVETS ONLY SHALL BE USED. RIVETS SHALL BE ALUMINUM EQUAL TO POP #AD64ABS.

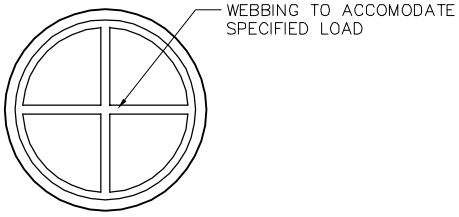
GRAND FORKS – BC –	SCALE: N.T.S.	TITLE: CATCH BASIN TRAPPING HOOD	
	DATE DRAWN:	LATEST REVISION DATE: SEPT. 2014	
	APPROVED BY: –	SECTION: – –	REVISION No. –
			DWG.No. SD–S3



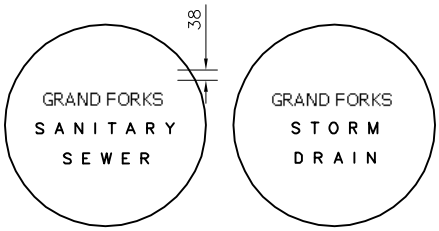
PLAN



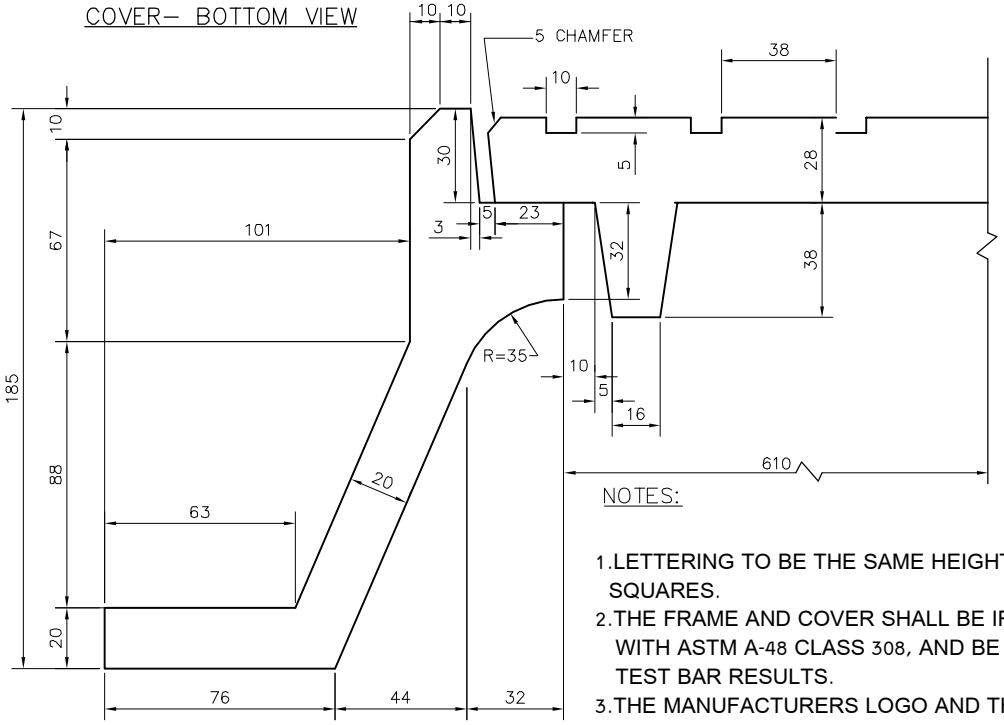
SECTION 'A–A'



COVER– BOTTOM VIEW



STANDARD LETTERING ON COVER

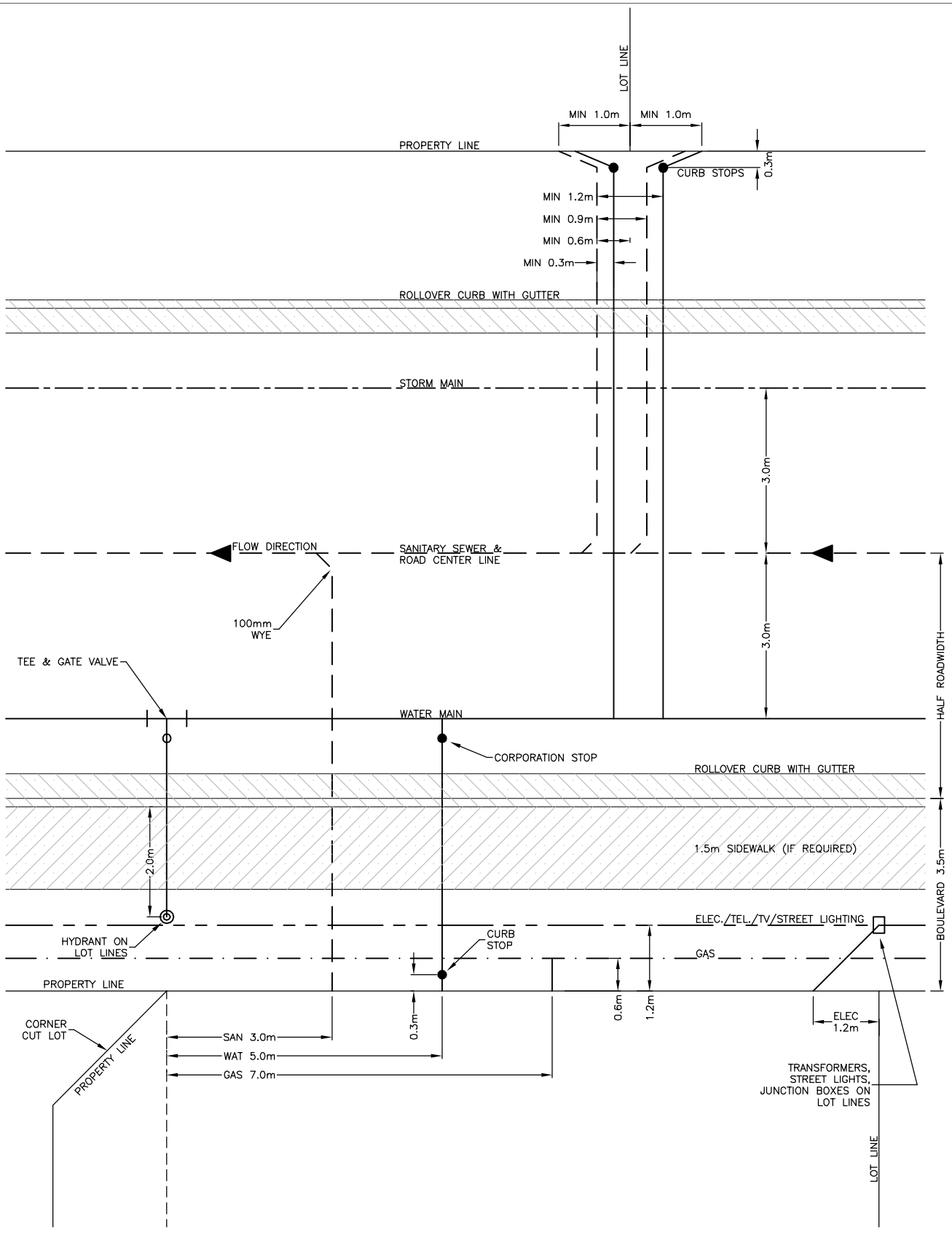


DETAIL 'A'

NOTES:

1. LETTERING TO BE THE SAME HEIGHT AS THE RAISED SQUARES.
2. THE FRAME AND COVER SHALL BE IRON IN ACCORDANCE WITH ASTM A-48 CLASS 308, AND BE ACCOMPANIED BY TEST BAR RESULTS.
3. THE MANUFACTURERS LOGO AND THE HEAT SERIES NUMBER SHALL BE CAST INTO THE FRAME AND COVER.
4. COVER AND FRAME TO BE ABLE TO WITHSTAND 175KN (40, 000 lbs) LOAD APPLIED AT THE CENTRE OF THE COVER ON A 50mm THICK 250 X 250 RUBBER PAD.
5. THE CONTACT SURFACES BETWEEN THE FRAME AND THE COVER ARE TO BE MACHINED SMOOTH.

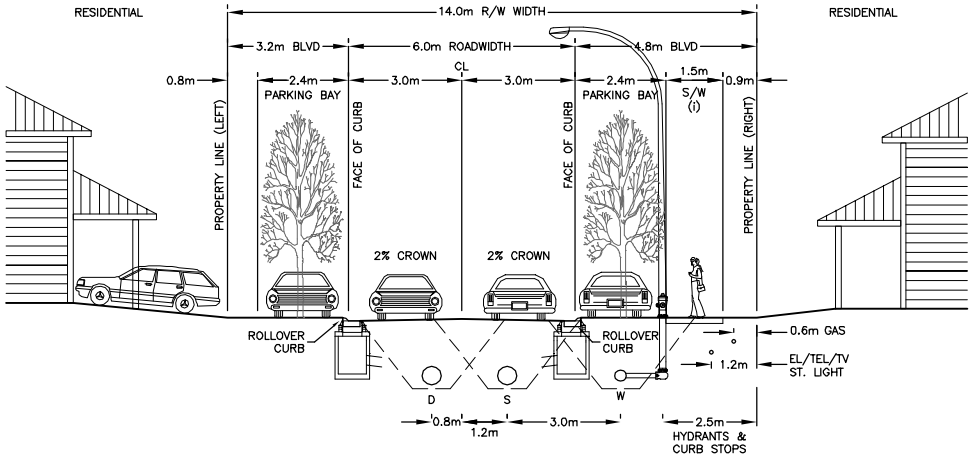
GRAND FORKS – BC –	SCALE: 1: 2.5	TITLE: MANHOLE FRAME AND COVER
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014	
	APPROVED BY: –	SECTION: – – / REVISION No. – / DWG.No. SD–S4



GRAND FORKS – BC –

SCALE: NTS		TITLE: LOT SERVICING LOCATIONS
DATE DRAWN:	LATEST REVISION DATE: SEPT. 2014	
APPROVED BY:		
SECTION:	REVISION No. –	DWG.No. SD–S5

Ⓐ



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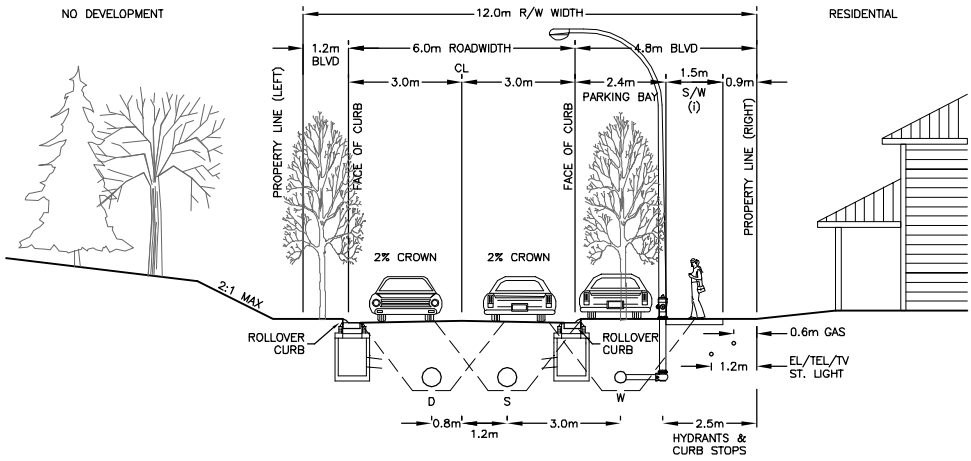

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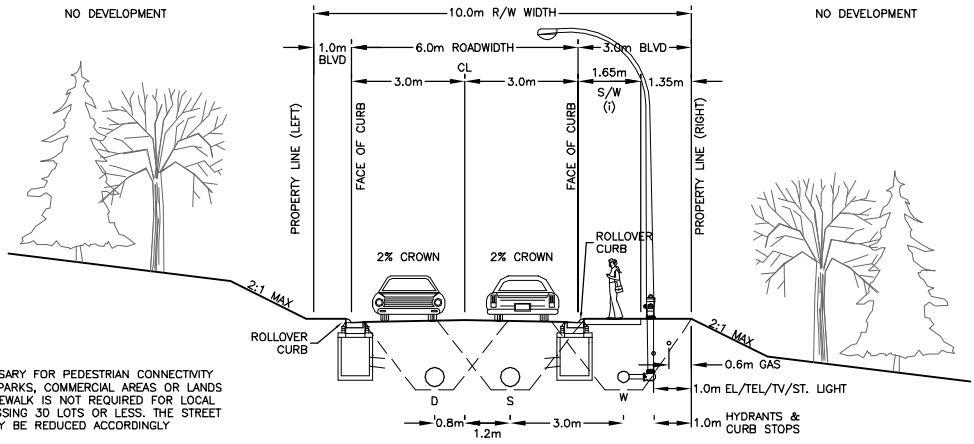
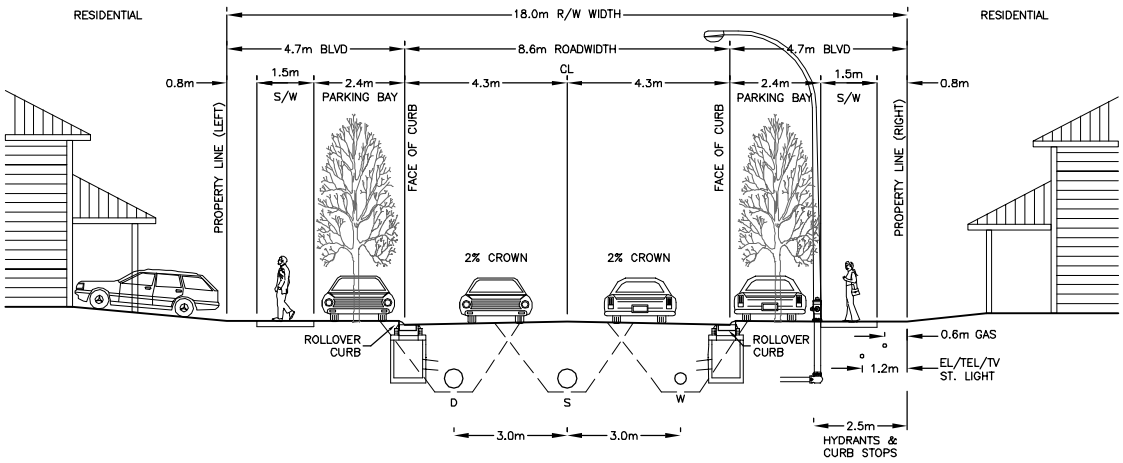


(i) – UNLESS NECESSARY FOR PEDESTRIAN CONNECTIVITY TO SCHOOLS, PARKS, COMMERCIAL AREAS OR LANDS BEYOND, A SIDEWALK IS NOT REQUIRED FOR LOCAL STREETS ACCESSING 30 LOTS OR LESS. THE STREET ROW WIDTH MAY BE REDUCED ACCORDINGLY

GRAND FORKS – BC –	SCALE: NTS	TITLE: HILLSIDES – LOCAL
	DATE DRAWN: / LATEST REVISION DATE: SEPT. 2014	
	APPROVED BY:	SECTION: / REVISION No. – / DWG.No. SD-HS1

Ⓐ



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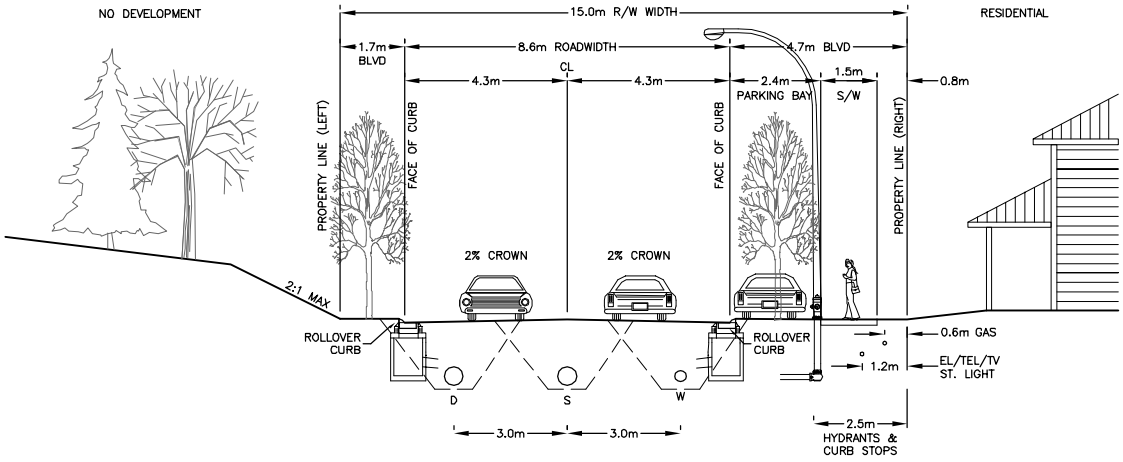
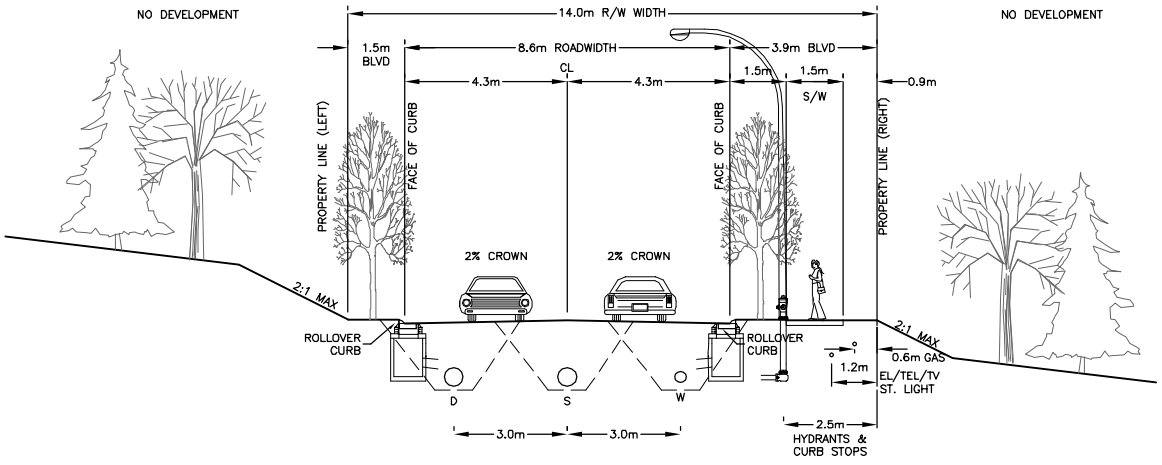
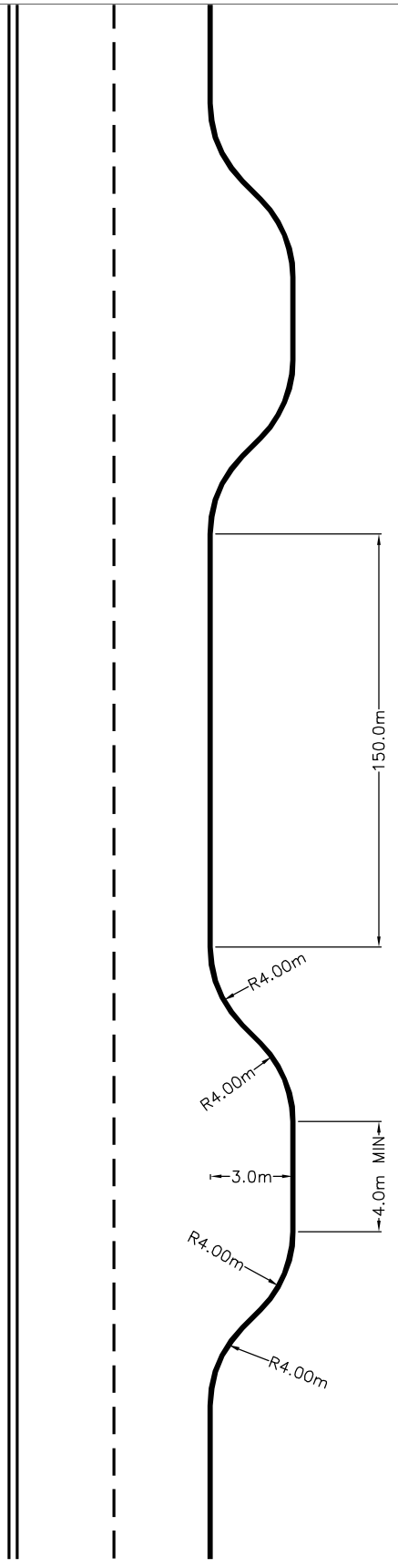


Ⓒ



GRAND FORKS – BC –

SCALE: NTS		TITLE: HILLSIDES – COLLECTOR
DATE DRAWN:	LATEST REVISION DATE: SEPT. 2014	
APPROVED BY:		
SECTION:	REVISION No. –	DWG.No. SD–HS2



GRAND FORKS – BC –

SCALE: NTS		TITLE: PLAN VIEW OF PARKING PULLOUT AREAS FOR HILLSIDES
DATE DRAWN:	LATEST REVISION DATE: SEPT. 2014	
APPROVED BY:		
SECTION:	REVISION No. –	DWG.No. SD–HS3

SCHEDULE 11
ENGINEERING DRAWING SUBMISSIONS

11. ENGINEERING DRAWING SUBMISSIONS

TABLE OF CONTENTS

11.0 ENGINEERING DRAWING SUBMISSION

11.1. General

11.1.1. Introduction

This Policy outlines the minimum standards and requirements for Design and Record Drawing submissions for engineering work(s).

Where a standard drawing exists, it shall be sufficient to refer to the appropriate drawing by reference number and date of issue. Where a standard drawing does not exist, or is unsuitable for a particular case, detail drawings shall be prepared to accurately portray the various elements of the installation.

Where no standard is defined in this Policy for the preparation of a drawing to portray a particular service, structure, or other item, instructions and requirements may be obtained by discussion with City staff.

11.1.2. General Requirements

Drawings shall clearly show existing and proposed locations of all utilities using offsets from property lines or boundaries of rights-of-way.

All drawings shall be signed and sealed be a Professional Engineer registered in the Province of British Columbia.

Elevations shall be referred to geodetic datum. Horizontal coordinates shall be referenced to UTM coordinate system NAD83.

The Owner shall also submit to the City a complete set of spatial data associated with the electronic drawings of the Subdivision or Development in ESRI Shape-file format. The spatial reference of the shape-files (i.e., the projection files) shall be in UTM 11N coordinate system NAD83. The data-type of the shape-files shall be in points, lines or polygons as indicated below. Each feature (for example, water lines) shall be in a separate shape-file. All features shall be in correct spatial relationship to each other for mapping purpose.

Description	Data-type
Properties lot-lines of the subdivision or development:	Lines
Sewer Pipes	Lines
Sewer Structures (manhole, cap etc.)	Points
Water Lines	Lines

Description	Data-type
Water Structure (curbstop, hydrant, valve etc.)	Points
Storm Lines	Lines
Storm Points (Storm man-hole etc.)	Points
Street Lamps	Points
Statuary Right of Way	Polygons

11.1.3. Abbreviations

UTM	Universal Transverse Mercator
NAD83	1983 North American Datum
BOC	Back of Curb
EC	End of Curve
BC	Beginning of Curve
PI	Point of Intersection

11.2. Drafting Standards

11.2.1. Sheet Layout

Drawing sheet layout(s) shall conform to and include the following:

(a) Sheet size to be ANSI D 558.8x863.6mm (22x34in).

(b) A north arrow shall be placed close to the top right side of each plan view on the sheet. Where feasible, the north arrow shall point to the top of the page.

(c) A title block which describes the contents of the drawing (eg. Key plan, road, etc) and shall clearly indicate the location of the works by road name(s) and/or legal description.

(d) Drawing scale, date, revision history block, and a detailed legend shall also be included on each sheet layout.

11.2.2. Dimensions and Units

The following conventions must be used:

(a) Dimensions and units must be shown in metric. No imperial units are permitted.

(b) All distances, elevations, and coordinates shall be given in meters to accuracy of 3 decimal places.

(c) Grades shall be given as a percentage to accuracy of 2 decimal places.

(d) Areas shall be in square meters rounded to the nearest square meter.

(e) All pipe sizes shall be given in millimeters as per ASTM specifications using:

1" = 25mm

(f) Existing imperial dimensions, except for pipe sizes, are to be soft converted using the factors:

1 inch = 25.4 millimeters
1 foot = 0.3048 meters.

11.2.3. Lettering

(a) Lettering is to be an open style of Vertical Gothic (eg. Leroy or AutoCAD – „romans").

(b) All lettering to maintain a 1:10 ratio between plotted text height and plotted pen thickness.

(c) The minimum plotted text height shall be 1.5mm.

(d) The maximum plotted text height shall be 5.0mm.

(e) The standard lettering height is 2.0mm.

11.2.4. Scales

The following scales shall be normally used:

(a) Location and Key plans	-	1:1000; 1:2500; 1:5000; 1:10000
(b) Composite Plans	-	1:500; 1:1000; 1:2500
(c) Plan/Profile Drawings	-	Horizontal 1:500 or 1:250 Vertical 1:50 or 1:25
(d) Cross Sections	-	Horizontal 1:100 Vertical 1:50
(e) Details	-	1:100; 1:20; 1:10

11.3. Drawing Standards (digital)

11.3.1. General Requirements

The Owner will be required to submit to the City a complete set of electronic drawings of the Subdivision or Development in AutoCAD DWG, ESRI Shape-file format and PDF format upon completion of the proposed works.

All drawing objects color and linetype properties shall be set to "bylayer".

All drawings must be purged and audited of all unnecessary information prior to submission to the City.

11.3.2. Drawing Conventions

11.3.2.1. Layer Names

The City uses the following convention for naming AutoCAD layers:

<Classification>-<Phase>-<Feature type>-<Description> (Optional)

The available classifications are defined in Table 3.2.1a; phases are defined in Table 3.2.1b; feature types are defined in Table 3.2.1.c. The description is optional.

For example, walk could be used to describe a "Feature type" of a proposed sidewalk as in ROAD-P-WALK-CONCRETE where P signifies Proposed, or ROAD-P-WALK-TEXT would describe text associated with the proposed sidewalk.

Table 11.3.2-a

CLASSIFICATION	DESCRIPTION
ALGN	Alignments
LEGL	Legal Information
MISC	Miscellaneous (Landscape, Hatches, etc)
ROAD	Roads
SANI	Sanitary Sewer
STRM	Storm Sewer
STRL	Structural and Hard Surface Features
PNTS	Survey Points Information
TITL	Title Block information
UTIL	Shallow Utilities (Gas, Tel and Cable)
WATR	Water System

Some common layer examples are:

SANI-P-MH-1050mm
ROAD-E-EDGE-ASPHALT
WATR-A-PIPE-250mm

If required layer names may be suffixed as in Table 3.2.1b to signify either as constructed, existing, proposed, or future works.

Table 11.3.2-b

PHASE SUFFIX	DESCRIPTION	RANGE
A	As Constructed	Varies
E	Existing Features	8
P	Proposed Works	Varies
F	Future works	Varies

Table 3.2.1c has some example of Feature Type classification

Table 3.2.1-c

TYPE	DESCRIPTION
TEXT	Text
DWY	Driveway
HYD	Hydrant
WV	Water Valve
MH	Manhole
PIPE	Water, Storm or Sanitary main

11.3.2.2. Special Layers

Exceptions to the layer naming convention described above are described in Table 3.2.2a

Table 11.3.2-c

LAYER CATEGORY	CATEGORY DESCRIPTION	COLOUR PEN #	PLOT STATE
-VP	Viewports	30	No Plot
-IMAGE	Images	7	
-XCLIP	Xref clip boundary	7	No Plot
-XREF	External References	7	

11.3.2.3. Lineweight Conventions

Layers line weight is set by a Color-dependent plot style tables (CTB) as specified in Table 3.2.3a. The City will provide upon request, a digital copy of the CTB files for full size and half size line weights.

Table 3.2.3-a

CTB PEN SETTINGS			
PLOT STYLES	LAYER COLOR	LINEWEIGHT	PLOT COLOR
Color 1		0.25	Black
Color 2		0.50	Black
Color 3		0.13	Black
Color 4		0.35	Black
Color 5		0.70	Black
Color 6		0.35	Black
Color 7		0.35	Black
Color 8		0.18	Black
Color 9		0.35	Black
Color 10		0.70	Black
Color 11		0.50	Black

CTB PEN SETTINGS			
Color 13		0.35	Black
Color 20		0.25	Object Color
Color 30		Object Lineweight	Black
Color 35		Object Lineweight	Black
Color 84		0.25	Object Color
Color 85		0.18	Black
Color 90		Object Lineweight	Object Color
Color 94		0.18	Black
Color 150		0.18	Black
Color 170		Object Lineweight	Black
Color 190		0.18	Black
Color 253	Screening 40	Object Lineweight	Black
Color 254	Screening 20	Object Lineweight	Black

11.3.2.4. Layer list, Linetypes and Layer Color

LAYER NAMES	LAYER DESCRIPTION	LAYER COLOR	LINE TYPE	PLOT STATE
0		7 - White	Continuous	No Plot
DEFPOINTS		7 - White	Continuous	No Plot
VP-XREF				
-IMAGE	images	7 - White	Continuous	
-VP	All view ports in paper space	30 - Orange	Continuous	No Plot
-XCLIP	Xref clip boundary	7 - White	Continuous	No Plot
-XREF	Xrefs layer	7 - White	Continuous	
ALIGNMENT				
ALGN	alignment objects	3 - Green	CENTER	
ALGN-P-GUT	alignment for gutterline	1 - Red	CENTER	
ALGN-LABEL	alignment labels	7 - White	Continuous	
ALGN-LABEL-CURVE	alignment label for curves	2 - Yellow	Continuous	
ALGN-LABEL-GEOM	alignment label for geometries	7 - White	Continuous	
ALGN-P-ETW	alignment Edge of Travel Way	13 - Dark Pink	CENTER	
ALGN-P-EPS	alignment Edge of Paved Shoulder	13 - Dark Pink	CENTER	
ALGN-P-ROW	alignment Right of Way	4 - Cyan	CENTER	
ALGN-TABLE	alignment Table	7 - White	Continuous	
LEGAL				
LEGL-E-BLOCKLINE	non-cogo exterior lot lines	8 - Grey	Continuous	
LEGL-E-COGOBLOCKLINE	coordinate geometry exterior lot lines	8 - Grey	Continuous	
LEGL-E-COGOPROPLINE	coordinate geometry interior lot lines	8 - Grey	Continuous	
LEGL-E-EASE	registered easement lines	8 - Grey	DASHED	
LEGL-E-EASE-TEXT	easement text	8 - Grey	Continuous	
LEGL-E-LOTTEXT	legal lot text	9 - Grey	Continuous	
LEGL-E-LPUG	lead plug	10 - Grey	Continuous	

LAYER NAMES	LAYER DESCRIPTION	LAYER COLOR	LINE TYPE	PLOT STATE
LEGL-E-PLANTEXT	legal plan text	11 - Grey	Continuous	
LEGL-E-PROPLINE	interior lot lines	12 - Grey	Continuous	
LEGL-E-ROADTEXT	existing road name text	13 - Grey	Continuous	
LEGL-E-STR_NUM	street number (address)	14 - Grey	Continuous	
LEGL-E-SUR-MON	survey monuments	15 - Grey	Continuous	
LEGL-E-WATERBOUDARY	lake boundary and creeks	16 - Grey	Continuous	
LEGL-E-WATERTEXT	lake boundary and creek text	17 - Grey	Continuous	
LEGL-P-EASE	proposed easement	4 - Cyan	DASHED	
LEGL-P-EASE-TEXT	proposed easement text	11 - Pink	Continuous	
LEGL-P-LOT	proposed lots	2 - Yellow	Continuous	
LEGL-P-LOT-DIM	proposed lot dimension	7 - White	Continuous	
LEGL-P-LOT-FILL	proposed lot fill	253 - Grey	Continuous	
LEGL-P-LOT-LINE	proposed lot line	2 - Yellow	Continuous	
LEGL-P-NO-PLOT	No plot lots	30 - Orange	Continuous	No Plot
LEGL-P-ROADTEXT	proposed road text - plan\profile	5 - Blue	Continuous	
LEGL-P-SROW	proposed Right of Way	4 - Cyan	Continuous	
LEGL-P-TABLE	proposed legal table	7 - White	Continuous	
LEGL-P-TEXT	proposed legal text	7 - White	Continuous	
MISCELLANEOUS				
MISC-E-HATCHLINES	lines used to create an existing hatch boundary	8 - Grey	Continuous	
MISC-E-NOTES	existing general notes	8 - Grey	Continuous	
MISC-NARROW	North arrow	8 - Grey	Continuous	
MISC-MATCHLINE	Alignment matchline	2 - Yellow	Continuous	
MISC-MATCHLINE-TEXT	Matchline text	11 - Pink	Continuous	
MISC-P-TEMP	Temporary layer	2 - Yellow	Continuous	No Plot
MISC-P-NOTES	Proposed notes	11 - Pink	Continuous	
MISC-P-TEXT	Proposed text	11 - Pink	Continuous	
MISC-P-VIEWFRAME	Viewframe object	7 - White	Continuous	
MISC-P-VIEWFRAME-BORDER	Viewframe border	5 - Blue	Continuous	
MISC-P-VIEWFRAME-TEXT	Viewframe text	7 - White	Continuous	
MISC-P-DETAIL	all detail objects and text	7 - White	Continuous	
MISC-P-HATCHLINES	lines used to create a hatch boundary	1 - Red	Continuous	
MISC-P-NOTES	proposed general notes	7 - White	Continuous	
MISC-P-TYP-X	typical road section	7 - White	Continuous	
POINTS				
PNTS-ALL POINTS	survey points	8 - Grey	Continuous	
PNTS-E-CTRL	survey points	8 - Grey	Continuous	
PNTS-E-ELEC	survey points (elec boxes, power poles, etc.)	8 - Grey	Continuous	
PNTS-E-ELEC-GUY WIRE	survey points	8 - Grey	Continuous	
PNTS-E-ELEC-LARGE ELEC BOX	survey points	8 - Grey	Continuous	
PNTS-E-LEGL-IP	survey points	8 - Grey	Continuous	
PNTS-E-LEGL-LEFT PROPERTY LINE	survey points	8 - Grey	Continuous	
PNTS-E-LEGL-RIGHT	survey points	8 - Grey	Continuous	

LAYER NAMES	LAYER DESCRIPTION	LAYER COLOR	LINE TYPE	PLOT STATE
PROPERTY LINE				
PNTS-E-LOT-CORNER	existing lot corner	1 - Red	Continuous	
PNTS-E-RAIL	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-ASPHALT DRIVEWAY	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-ASPHALT FLARE	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-ASPHALT LANE	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-ASPHALT SIDEWALK	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-BACK OF WALK	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-CARPORT	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-CL	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-CONCRETE DRIVEWAY	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-CROWN	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-EXTENDED EDGE OF ASPHALT	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-FACE OF CURB	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-FACE OF WALK	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-GRAVEL DRIVEWAY	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-GRAVEL LANE	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-LEFT EDGE OF ASPHALT	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-LEFT GUTTER	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-LIP OF EA	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-LIP OF GUTTER	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-PAINT LINES	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-RIGHT EDGE OF ASPHALT	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-RIGHT GUTTER	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-SIGNS	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-TOP OF CURB	survey points	8 - Grey	Continuous	
PNTS-E-ROAD-TOP OF WALK	survey points	8 - Grey	Continuous	
PNTS-E-SANI-IC	survey points	94 - Green	Continuous	
PNTS-E-SANI-MH	survey points	94 - Green	Continuous	
PNTS-E-SITE-BOTTOM OF BANK	survey points	8 - Grey	Continuous	
PNTS-E-SITE-BOW	existing bottom retaining wall	8 - Grey	Continuous	
PNTS-E-SITE-CONCRETE PAD	survey points	8 - Grey	Continuous	
PNTS-E-SITE-GROUND	survey points	8 - Grey	Continuous	

LAYER NAMES	LAYER DESCRIPTION	LAYER COLOR	LINE TYPE	PLOT STATE
PNTS-E-SITE-SITEFEATURES-OFF	survey points	8 - Grey	Continuous	
PNTS-E-SITE-SITEFEATURES-ON	survey points	8 - Grey	Continuous	
PNTS-E-SITE-TOP OF BANK	survey points	8 - Grey	Continuous	
PNTS-E-SITE-TOW	existing top retaining wall	8 - Grey	Continuous	
PNTS-E-SITE-TREES	survey points	8 - Grey	Continuous	
PNTS-E-STRM-CB	survey points	190 - Purple	Continuous	
PNTS-E-STRM-DITCH	survey points	8 - Grey	Continuous	
PNTS-E-STRM-MH	survey points	190 - Purple	Continuous	
PNTS-E-STRM-SWALE	survey points	8 - Grey	Continuous	
PNTS-E-SURF-TIN POINTS	survey points	8 - Grey	Continuous	
PNTS-E-UTIL-INVERTS	survey points	8 - Grey	Continuous	
PNTS-E-WATR	survey points	150 - Blue	Continuous	
PNTS-E-WATR-STEM	survey points	8 - Grey	Continuous	
PNTS-E-WATR-VALVE	survey points	150 - Blue	Continuous	
PNTS-LABEL	all point labels layer - need for style creation	7 - White	Continuous	
PNTS-P-ALGN	alignment points	2 - Yellow	Continuous	
PNTS-P-LOT-CORNER	proposed lot corner	2 - Yellow	Continuous	
PNTS-P-MINUS	cut-fill points	20 - Red	Continuous	
PNTS-P-PLUS	cut-fill points	84 - Green	Continuous	
PNTS-P-ROAD-CL	road CL points	2 - Yellow	Continuous	
PNTS-P-SITE-BOW	proposed bottom retaining wall	2 - Yellow	Continuous	
PNTS-P-SITE-TOW	proposed top of retaining wall	2 - Yellow	Continuous	
PNTS-TABLE	survey points	7 - White	Continuous	
ROAD				
ROAD-E-ASPH	existing asphalt	8 - Grey	Continuous	
ROAD-E-CURB	existing curb	8 - Grey	Continuous	
ROAD-E-DWY	existing driveway	8 - Grey	Continuous	
ROAD-E-GUT	existing gutter	8 - Grey	Continuous	
ROAD-E-LANE	existing lane	8 - Grey	Continuous	
ROAD-E-NAME	existing road name	11 - Pink	Continuous	
ROAD-E-SW	existing sidewalk	8 - Grey	Continuous	
ROAD-E-WLINE	crosswalk, stop and white lines, bike lanes, etc.	254- Grey	Continuous	
ROAD-E-YLINE	yellow lines	253- Grey	Continuous	
ROAD-P-ASPH	proposed asphalt	3 - Green	Continuous	
ROAD-P-GUT	proposed gutter line	7 - White	Continuous	
ROAD-P-NAME	proposed road name	11 - Pink	Continuous	
ROAD-P-SIGNS	proposed signs	170 - Blue	Continuous	
ROAD-P-SW	proposed sidewalk	4 - Cyan	Continuous	
ROAD-P-TEXT	proposed road text	11 - Pink	Continuous	
SANITARY				
SANI-A-MH	asbuilt sanitary manholes - plan\profile	11 - Pink	Continuous	
SANI-A-PIPE	asbuilt sanitary mains - plan\profile	10 - Red	Continuous	
SANI-A-SERV	asbuilt sanitary service - plan\profile	7 - White	Continuous	

LAYER NAMES	LAYER DESCRIPTION	LAYER COLOR	LINE TYPE	PLOT STATE
SANI-A-TEXT	asbuilt sanitary text - plan\profile	11 - Pink	Continuous	
SANI-E-FM	sanitary forced main	94 - Green	Dashed	
SANI-E-MH	existing sanitary manholes - plan	94 - Green	Continuous	
SANI-E-MH-PROF	existing sanitary manholes - prof	94 - Green	Continuous	
SANI-E-PIPE	existing sanitary mains - plan	94 - Green	SAN	
SANI-E-PIPE-PROF	existing sanitary mains - prof	94 - Green	SAN	
SANI-E-SEC	existing sanitary section	94 - Green	Continuous	
SANI-E-SERV	existing sanitary service connection - plan	94 - Green	Continuous	
SANI-E-SERV-PROF	existing sanitary service connection - prof	94 - Green	Continuous	
SANI-E-TEXT	existing sanitary text - plan	94 - Green	Continuous	
SANI-E-TEXT-PROF	existing sanitary text - prof	94 - Green	Continuous	
SANI-F-MH	future sanitary manholes - plan	94 - Green	Continuous	
SANI-F-MH-PROF	future sanitary manholes - prof	94 - Green	Continuous	
SANI-F-PIPE	future sanitary pipe - plan	94 - Green	SAN	
SANI-F-PIPE-PROF	future sanitary pipe - prof	94 - Green	SAN	
SANI-F-SEC	future sanitary section	94 - Green	Continuous	
SANI-F-TEXT	future sanitary text - plan	94 - Green	Continuous	
SANI-F-TEXT-PROF	future sanitary text - prof	94 - Green	Continuous	
SANI-P-IC	proposed sanitary inspection chamber - plan	11 - Pink	Continuous	
SANI-P-IC-PROF	proposed sanitary inspection chamber - prof	11 - Pink	Continuous	
SANI-P-MH	proposed sanitary manhole - plan	11 - Pink	Continuous	
SANI-P-MH-PROF	proposed sanitary manhole - prof	10 - Red	Continuous	
SANI-P-PIPE	proposed sanitary mains - plan	10 - Red	SAN	
SANI-P-PIPE-PROF	proposed sanitary mains - prof	10 - Red	SAN	
SANI-P-SEC	proposed sanitary section	10 - Red	Continuous	
SANI-P-SERV	proposed sanitary service - plan	7 - White	Continuous	
SANI-P-SERV-PROF	proposed sanitary service - prof	7 - White	Continuous	
SANI-P-SERV-TEXT	proposed sanitary service text	11 - Pink	Continuous	
SANI-P-TEXT	proposed sanitary text - plan	11 - Pink	Continuous	
SANI-P-TEXT-PROF	proposed sanitary text - prof	11 - Pink	Continuous	
SHALLOWS UTILITIES				
UTIL-E-ELEC	existing electrical conduit	8 - Grey	ELECTRICAL	
UTIL-E-GAS	existing gas conduit	8 - Grey	GAS	
UTIL-E-GAS-TEXT	existing gas conduit text	8 - Grey	Continuous	
UTIL-E-HTC	existing HTC conduit	8 - Grey	TEL	
UTIL-E-HTC-TEXT	existing HTC conduit text	8 - Grey	Continuous	
UTIL-E-LAMP	existing lamp	8 - Grey	Continuous	
UTIL-E-LAMP-TEXT	existing lamp-text	8 - Grey	Continuous	
UTIL-E-TRAF	existing traffic conduit	8 - Grey	ELEC	
UTIL-P-ELEC	proposed electrical conduit	7 - White	ELECTRICAL	
UTIL-P-GAS	proposed gas conduit	2 - Yellow	GAS	
UTIL-P-GAS-TEXT	proposed gas conduit text	11 - Pink	Continuous	
UTIL-P-HTC	proposed HTC conduit	6 - Magenta	TEL	
UTIL-P-HTC-TEXT	proposed HTC conduit text	11 - Pink	Continuous	
UTIL-P-LAMP	proposed lamp	7 - White	Continuous	
UTIL-P-LAMP-TEXT	proposed lamp-text	11 - Pink	Continuous	

LAYER NAMES	LAYER DESCRIPTION	LAYER COLOR	LINE TYPE	PLOT STATE
STORM				
STRM-A-CB	asbuilt storm catch basins	11 - Pink	Continuous	
STRM-A-DW	asbuilt storm drywell	11 - Pink	Continuous	
STRM-A-LEAD	asbuilt storm leads	10 - Red	Continuous	
STRM-A-MH	asbuilt storm manholes - plan\profile	11 - Pink	Continuous	
STRM-A-PIPE	as built storm pipe	10 - Red	STORM	
STRM-A-TEXT	asbuilt storm text - plan\profile	11 - Pink	Continuous	
STRM-E-CB	existing catch basin - plan	190 - Purple	Continuous	
STRM-E-CB-PROF	existing catch basin - prof	190 - Purple	Continuous	
STRM-E-DW	existing storm drywell - plan	190 - Purple	Continuous	
STRM-E-DW-PROF	existing storm drywell - prof	190 - Purple	Continuous	
STRM-E-LEAD	existing storm lead	190 - Purple	Continuous	
STRM-E-MH	existing storm manholes - plan	190 - Purple	Continuous	
STRM-E-MH-PROF	existing storm manholes - prof	190 - Purple	Continuous	
STRM-E-PIPE	existing storm mains - plan	190 - Purple	STORM	
STRM-E-PIPE-PROF	existing storm mains - prof	190 - Purple	STORM	
STRM-E-TEXT	existing storm text - plan	190 - Purple	Continuous	
STRM-E-TEXT-PROF	existing storm text - prof	190 - Purple	Continuous	
STRM-F-CB	future storm catch basin - plan	190 - Purple	Continuous	
STRM-F-CB-PROF	future storm catch basin - prof	190 - Purple	Continuous	
STRM-F-DW	future storm drywell - plan	190 - Purple	Continuous	
STRM-F-DW-PROF	future storm drywell - prof	190 - Purple	Continuous	
STRM-F-LEAD	future storm lead	190 - Purple	Continuous	
STRM-F-MH	future storm manhole - plan	190 - Purple	Continuous	
STRM-F-MH-PROF	future storm manhole - prof	190 - Purple	Continuous	
STRM-F-PIPE	future storm main - plan	190 - Purple	STORM	
STRM-F-PIPE-PROF	future storm main - prof	190 - Purple	STORM	
STRM-F-SEC	future storm section	190 - Purple	Continuous	
STRM-F-TEXT	future storm text - plan	190 - Purple	Continuous	
STRM-F-TEXT-PROF	future storm text - prof	190 - Purple	Continuous	
STRM-P-CB	proposed catch basin - plan	11 - Pink	Continuous	
STRM-P-CB-PROF	proposed catch basin - prof	10 - Red	Continuous	
STRM-P-DW	proposed drywell - plan	11 - Pink	Continuous	
STRM-P-DW-PROF	proposed drywell - prof	10 - Red	Continuous	
STRM-P-LEAD	proposed storm lead	10 - Red	Continuous	
STRM-P-MH	proposed storm manhole - plan	11 - Pink	Continuous	
STRM-P-MH-PROF	proposed storm manhole - prof	10 - Red	Continuous	
STRM-P-PIPE	proposed storm mains - plan	10 - Red	STORM	
STRM-P-PIPE-PROF	proposed storm mains - prof	10 - Red	STORM	
STRM-P-SERV	proposed storm service - plan	6 - Magenta	Continuous	
STRM-P-SERV-PROF	proposed storm service - prof	6 - Magenta	Continuous	
STRM-P-SERV-TEXT	proposed storm service text	11 - Pink	Continuous	
STRM-P-TEXT	proposed storm main text - plan	11 - Pink	Continuous	
STRM-P-TEXT-PROF	proposed storm main text - prof	11 - Pink	Continuous	
TITLE BLOCK				
TITL-BLOCK	title block	7 - White	Continuous	
TITL-BLOCKTEXT	title block text	7 - White	Continuous	

LAYER NAMES	LAYER DESCRIPTION	LAYER COLOR	LINE TYPE	PLOT STATE
TITL-BORDER	title block border	5 - Blue	Continuous	
TITL-JOBDESC	text in titleblock	7 - White	Continuous	
TITL-JOBNUMBER	text in titleblock	5 - Blue	Continuous	
TITL-LEGEND	titleblock legend	7 - White	Continuous	
TITL-MAGRID	major grid on titleblock	7 - White	Continuous	
TITL-MIGRID	minor grid on titleblock	3 - Green	Continuous	
TITL-NARROW	north arrow	8 - Grey	Continuous	
TITL-PAVE-LEGEND	pave legend in title block	7 - White	Continuous	
TITL-RDLEGEND	road legend in titleblock	7 - White	Continuous	
WATER				
WATR-A-HYD	asbuilt hydrant	11 - Pink	Continuous	
WATR-A-PIPE	asbuilt water mains - plan\profile	10 - Red	Water	
WATR-A-SERVICE	asbuilt water service	7 - White	Continuous	
WATR-A-TEXT	asbuilt water main text - plan\profile	11 - Pink	Continuous	
WATR-A-VALVE	asbuilt water valve	11 - Pink	Continuous	
WATR-E-BO	existing water blow-off	150 - Blue	Continuous	
WATR-E-HYD	existing water hydrant	150 - Blue	Continuous	
WATR-E-PIPE	existing water mains - plan	150 - Blue	Water	
WATR-E-PIPE-PROF	existing water mains - prof	150 - Blue	Water	
WATR-E-SERV	existing water service	150 - Blue	Continuous	
WATR-E-TEXT	existing water main text - plan	150 - Blue	Continuous	
WATR-E-TEXT-PROF	existing water main text - prof	150 - Blue	Continuous	
WATR-E-VALVE	existing water valve	150 - Blue	Continuous	
WATR-F-BO	future water blow-off	150 - Blue	Continuous	
WATR-F-HYD	future water hydrant	150 - Blue	Continuous	
WATR-F-PIPE	future water main - plan	150 - Blue	Water	
WATR-F-PIPE-PROF	future water main - prof	150 - Blue	Water	
WATR-F-SERV	future water service	150 - Blue	Continuous	
WATR-F-TEXT	future water text - plan	150 - Blue	Continuous	
WATR-F-TEXT-PROF	future water text - prof	150 - Blue	Continuous	
WATR-F-VALVE	future water valve	150 - Blue	Continuous	
WATR-P-BO	proposed water blow-off	10 - Red	Continuous	
WATR-P-HYD	proposed hydrant	11 - Pink	Continuous	
WATR-P-PIPE	proposed water mains - plan	10 - Red	Water	
WATR-P-PIPE-PROF	proposed water mains - prof	10 - Red	Water	
WATR-P-SERV	proposed water service - plan	7 - White	Continuous	
WATR-P-SERV-PROF	proposed water service - prof	7 - White	Continuous	
WATR-P-TEXT	proposed water main text - plan	11 - Pink	Continuous	
WATR-P-TEXT-PROF	proposed water main text - prof	11 - Pink	Continuous	
WATR-P-VALVE	proposed water valve	11 - Pink	Continuous	

11.4. Required Drawings

11.4.1. Cover Sheet (Title Page)

In addition to any other requirements presented in this policy, the cover sheet shall show the following information:

(a) Name of Development or Project.
(b) Name and address of Owner and Consulting Engineer.
(c) Site location plan of Development or project.
(d) Legal description of subject properties.
(e) File numbers of approving authorities, (i.e. City and/or Ministry).
(f) Complete drawing index of all sheets belonging to the set.

Note: The standards defined Sections 2.1(c), 2.1(d), and 2.3 do NOT apply to the cover sheet.

11.4.2. Key Plan(s)

In addition to any other requirements presented in this policy, Key Plans shall show the following information:

(a) Lot numbers, plan numbers, and road names of the subject Development and adjoining properties.
(b) Cross reference of the drawings by outlining the area contained in each drawing and referencing that drawing by drawing number.
(c) General Construction notes.

11.4.3. Building Envelope Plan (if applicable)

In addition to any other requirements presented in this policy, Building Envelope Plan shall show the following information:

(a) Overall plan of current phase
(b) Lot numbers
(c) Roads, curbs, gutters and sidewalks
(d) Rights of way and easements
(e) Offset lines from all property boundaries indicating required building setbacks
(f) 10 meter by 10 meter square on each parcel indicating the required minimum building envelope
(g) Notes that indicate the required setbacks from all property boundaries pursuant to the Zoning Bylaw

11.4.4. Composite Plan(s) (as required)

In addition to any other requirements presented in this policy, Composite Plans shall show the following information:

(a) All existing and proposed utilities, roads, walkways, and sidewalks.

(b) All rights of way and easements including widths.

(c) Control monuments with identification number.

(d) All legal information, including bearings, dimensions, Lot numbers, block numbers, legal plan numbers, and street names. All lots must be numbered.

(e) Show legal Lot line dimensions.

(f) All roadway dimensions including width of right of way, BOC to BOC and BOC to edge of right of way.

(g) Area of each parcel.

11.4.5. Plan / Profile Drawings

In addition to any other requirements of this policy, Plan/Profile drawings shall show the following information:

11.4.5.1. General

(a) Both plan and profile stationing must be tied to a property line or Road boundary.

(b) The profile shall be shown at true centerline length and projected below the plan in as close a horizontal relationship as possible.

(c) The top half of a Plan/Profile sheet shall show the plan view and shall show the legal layout with legal descriptions of all properties, the location of all sidewalks, catch basins, underground utilities such as sewer, water, telephone, television power, manholes, valves, hydrants, and all survey monuments, etc.

(d) Drawings shall also show existing dwellings, fences, trees, hedges, unusual ground features, existing Roads and driveways including the type such as asphalt, concrete or gravel.

(e) Plan/Profile drawings for various services may be combined on one plan (must be clear and readable) in the following manner:

- Roads & Storm Drains
- Sanitary Sewers & Water

11.4.5.2. Road Plan/Profile Drawings (may be combined with Storm Drains)

Road **plan** views shall show the following information:

(a) Drawings shall show width of Road, width of shoulders, and the offset of curb from property line.
(b) Chainages of the B.C. and E.C. of horizontal curves shall be shown together with the delta angle, centerline radius, tangent length, and centerline arc length. Curb radii are not required if the centerline radius and road width are shown, except on curb returns at intersections and at the end of Cul-de-sacs.
(c) Quarter point gutter elevations for Cul-de-sac.
(d) Catchbasin rim elevations.

Road **profiles** views shall show the following information:

(a) The design gutter and/or centerline grade (%).
(b) Vertical curve chainage and elevations of B.C., E.C. and P.I.; the external value, e; the length of vertical curve; the chainage and elevation of the low spot of sag curves; and, K value of vertical curvature (crest on sag).
(c) Existing ground elevation along the centerline of proposed roadway and/or the edge of existing asphalt.

11.4.5.3. Water Plan/Profile Drawings (may be combined with Sanitary Sewer and Storm Mains)

Water **plan** views shall show the following information:

(a) Offset of pipelines from property lines.
(b) Length and size of pipe.
(c) Offset of connections from property lines.
(d) The locations of manholes, hydrants, valves, services, end-of-main, or other appurtenances referenced to nearest property line.
(e) Information on any curves or pipe deflections.
(f) Easements (existing and/or required).
(g) Location and connection details for all values and fittings.

Water **profiles** views shall show the following information:

(a) Surface profiles (existing and design, if applicable) over proposed main.
(b) Length, size, grade, type, and material of pipe.

(c) Profiles of invert and crown of pipes.

(d) Location, type and invert elevation of all crossing utilities.

(e) Stationing of all valves, fittings and appurtenances.

(f) Anchor block locations.

11.4.5.4. Storm Drains and Sanitary Sewer Plan/Profile Drawings

Storm & Sanitary **plan** views shall show the following information:

(a) The drawings shall show the structural details of all manholes and chambers, etc. not covered by standard drawings. Where the sanitary sewers and storm drains or other utilities are to be installed in a common trench, a typical cross-section showing vertical and horizontal distances between pipes and classes of pipe and bedding shall be shown.

(b) Offset of pipelines from property lines.

(c) The size of pipe.

(d) Offset of connections from property lines.

(e) The locations of manholes, clean-outs and services relating to property lines.

(f) Information on any curves or pipe deflections.

(g) Easements (existing and/or required).

(h) Future curb & gutter lines (if applicable).

(i) Manhole identification numbers.

(j) Inverts of service connections at property line (if applicable).

(k) For storm drainage, features such as ditches, culverts, streams, channels, etc.

Storm & Sanitary **profiles** views shall show the following information:

(a) Surface profiles (existing and design, if applicable) over proposed main.

(b) Length, size, grade, type, and material of pipe.

(c) Profiles of invert and crown of pipes.

(d) Location, type and invert elevation of all crossing utilities.

(e) Invert elevations of manholes.

(f) Alignment station of manhole.

(g) Manhole identification number.

(h) Rim elevations of proposed or adjusted manholes.

11.4.6. Grading Plan(s)

In addition to any other requirements presented in this policy, grading plans shall show the following information:

11.4.6.1. General

(a) Pre-Development contour lines. The topographic information shall extend a minimum 30.0m outside the Development site;

(b) proposed contours, slopes, grades, and spot elevations;

(c) the minor (10 year return) storm sewer system with the flows noted per section and the accumulated flows from all upstream sections. Provision must be made for upstream Development potential where applicable;

(d) the major (100 year return) system. The Consulting Engineer shall note wherever the major system is not in the pipe or the roadway, showing the routing and flows for the 100 year return storm;

(e) all swales proposed to affect the submitted Storm Water Management Plan;

(f) how the Development proposal will affect adjacent lands, attempts should be made to "meet" existing elevations along the Development boundary;

(g) a legend noting all items proposed in the Storm Water Management Plan. Applicable "General Notes" should also be included.

11.4.6.2. Lot Grading

(a) all existing corner Lot elevations (uncircled);

(b) all proposed corner Lot elevations (circled);

(c) the proposed building envelope with the Minimum Basement Elevation (MBE) noted;

(d) the slope of the lot (directional arrow), noting a minimum 2% grade on the lots;

11.4.7. Landscape Plan(s)

In addition to any other requirements presented in this policy, Landscape plans shall show the following information:

(a) extent of proposed landscape Works and Services;

(b) existing and proposed property information, including lot lines, easements, legal descriptions, addresses and dimensions;

(c) existing and proposed contours, slopes, grades and spot elevations for landscaped areas (if not already shown on grading plan);

(d) existing and proposed buildings, structures, Roads, curbs, sidewalks, walls, fences, signs, site features and other appurtenances;

(e) existing vegetation proposed to be removed, relocated or retained;

(f) areas of proposed preservation, naturalization, restoration, lawn and landscaping, including soil types, depths and amendments;

(g) proposed plant species name (botanical and common), size and planting condition;

(h) existing and proposed irrigation systems; and

(i) Construction details and specifications as required.

11.4.8. Storm Water Management Plan (SMP)

In addition to any other requirements presented in this policy, Storm Water Management plans shall show the following information:

(a) Site and surrounding area (400 m minimum outside Development) showing roads and major features. A small location plan of the watershed is also to be included.

(b) Contours of existing ground (1.0 m intervals where slope <20%, 2.0 m >20%) for the site and surrounding area mentioned above.

(c) Major flood routing (1:100 year); show as arrows and indicate if in pipe or on surface show an "open" arrow for surface routes and the same arrow "shaded" for routes in pipes).

(d) Detention pond details, if applicable.

(e) Area, in hectares, of Development and the total area of drainage basin.

(f) Directional arrows of flow within the site and on surrounding areas.

(g) Sub-catchment boundaries, coefficients and areas.

(h) Pipe system including size, grade, and minor and major flows (a table may be utilized).

(i) The subject Development is to be highlighted.

11.4.9. Erosion and Sediment Control Plan(s)

This plan is to detail methods and procedures that will be used to prevent or minimize soil displacement and transport of sediment from the Development site. This is to include methods to prevent or minimize soil transport onto adjacent properties or onto existing roads adjacent to the site (i.e. tracking from vehicles). Preventative methods of soil displacement on the site are to be detailed. In addition to any other requirements presented in this policy, the drawing shall show the following:

(a) Existing contours of the site at an interval sufficient to determine drainage patterns.

(b) Final contours if the existing contours are significantly changed.

(c) Final drainage patterns/boundaries.

(d) Existing vegetation such as significant trees, shrubs, grass, and unique vegetation.

(e) Limits of clearing and grading.

(f) Erosion and sediment control measures (temporary and permanent) including locations, names and details, in accordance with "Land Development Guidelines for the Protection of Aquatic Habitat".

(g) Storm Drainage systems including drain inlets, outlets, pipes, and other permanent drainage facilities (swales, waterways, etc.).

The plan must have a narrative section describing the land, the disturbing activity and details of the methods used for controlling erosion and sedimentation. Include a description of the procedures for Construction and maintenance of the control measures and note the persons involved in maintenance and provide a maintenance schedule that is to be followed. Where the land area to be subdivided is less than 10 hectares, this plan may be combined with the Stormwater Management Plan.

11.4.10. Street Lighting Plan(s)

A plan view of the street lighting shall be provided. There shall be General Notes included on the Plan noting reference(s) to the Municipal Standards and Specifications and the appropriate design criteria.

11.4.11. Street Sign, Paint Marking, and Traffic Control Device Plans

A drawing identifying signs, markings, and required control devices is required. Detailed drawings may be required for traffic control devices.

11.4.12. Traffic Management Plan(s)

Detail routes for construction traffic and traffic controls for traffic on existing roads affected by construction is required.

11.4.13. Road Cross Section Plan(s)

Shall be scaled at 1:100 horizontal and 1:50 vertical and shall note the existing ground elevation, the proposed elevations of the road centerline, the curb and gutter (or road edge) and property lines. Cross-sections are required at 20.0 m intervals.

11.4.14. Construction Details

Show all details for Construction including those which are not covered by, or specifically detailed in the provisions of this bylaw. Where there is a Standard Drawing, it is expected the drawings will refer to the Standard Drawing Number.

11.4.15. Electrical, Gas, and Communication Utilities

For electrical and telecommunication servicing the plans shall show location and depth of services, pipe dimension and type, wire size and type and all other specifications of related equipment including but not limited to: pull boxes, junction boxes & transformers.

Gas utilities as per appropriate authority (Individual utilities may provide separate drawings).

11.5. Drawing Submissions

11.5.1. Design Submissions

3 paper copies of all Design Drawings are required for design submissions.

11.5.2. Record Drawings

Record Drawings must be submitted after the completion of the Works and Services. Record Drawings must be delivered in paper format for review and approval by the City. The Record Drawings shall include all drawing sheets submitted for the "Certificate to Proceed with Construction" unless specifically exempted by the Approving Officer.

The Owner shall submit to the City a complete set of electronic drawings of the Subdivision or Development in DWG format compatible with the current version of AutoCAD in addition to a Digital Hard copy in Adobe PDF format in accordance with Sections 5.3 and 5.4 of this policy. The complete electronic set shall only be submitted after acceptance of the draft paper Record Drawings by the Approving Officer.

11.5.3. Electronic Drawings

11.5.3.1. General Requirements

The Owner shall submit to the City a complete set of electronic drawings of the Subdivision or Development in AutoCAD DWG format.

The electronic drawing shall be prepared in accordance with Section 2.0 and the conventions prescribed in Section 3.0.

All external files associated with the electronic drawing (e.g. special fonts, line types, and/or images) shall also be supplied with the electronic drawing submission.

No drawing shall be submitted that contains any external references (xrefs). All externally referenced drawings shall be bound prior to submittal.

11.5.4. Digital Hard Copies

A digital hard copy is any digital file that is reproducible without the ability to modify the drawings contents or appearance.

11.5.4.1. General Requirements

Adobe's Portable Document Format (*.pdf) is the preferred file type. However alternatives will be considered. Alternative formats might be Autodesk's Drawing Web Format (*.dwf) or scanned tif or jpg images.

Drawing sets submitted as a digital hard copy shall be electronically sealed by the Owner's Engineer.

11.5.4.2. Device / Document Settings for Plotting Adobe Portable Document Format

Ensure all text is legible and the shading and hatching ordered so as not to block or hide other line work and/or text.

The following settings shall be used when plotting the drawings to Adobe PDF:

- paper size to be ANSI D 558.8 x 863.6 mm
- layout to be "landscape"
- graphic print quality to be no less than "600 dpi"