SCHEDULE F

REGULATIONS, STANDARDS, AND SPECIFICATIONS FOR THE DESIGN AND INSTALLATION OF DRAINAGE SYSTEMS

This is Schedule F of the Corporation of the Village of Valemount Subdivision and Development Servicing Bylaw No. 450, 1998.

_____

Clerk

SCHEDULE F

REGULATIONS, STANDARDS, AND SPECIFICATIONS FOR THE DESIGN AND INSTALLATION OF DRAINAGE SYSTEMS

1.0 GENERAL

Where the provisions of Schedule A of this Bylaw require the construction of a storm drainage system, the Owner shall provide a storm drainage system including sewer mains, manholes, service connections, and all related appurtenances consistent with the standards and specifications contained in this Schedule.

1.01 Approval of Engineering Drawings Required Prior to Construction

Engineering drawings and design calculations which show detailed design of the necessary works shall be submitted to the Village Engineer for approval prior to the commencement of construction. The drawings shall show overland drainage systems, the alignment and size of pipes, proposed grades, distances between manholes, manhole invert elevations, existing ground line, proposed final ground line over the pipe, location of all service connections to the property line, all easements, pipe bedding requirements and all other details as may be required.

1.02 Where Storm Drainage Collection System Not Required

Where storm drainage facilities are not required at the time of development, the Corporation of the Village of Valemount may require rights-of-way to be provided by the Owner to allow for the eventual installation of these facilities. Such rights-of-way shall be registered in favour of the Corporation of the Village of Valemount at the Owner's expense. In this instance, the Owner will be required to provide for surface drainage as required by the Village Engineer, with all catch basins and other appurtenances designed to facilitate connection to the future storm sewer system.

1.03 Stormwater Drainage Plan

All drainage systems in the Corporation of the Village of Valemount shall be designed in accordance with the primary purpose to limit the effect of peak flows and volumes of runoff on private and public property, receiving streams, and watercourses. The Owner’s Engineer shall prepare a Stormwater Drainage Plan at a maximum 1:1000 scale, that will explicitly indicate existing and proposed drainage courses and drainage areas, together with estimated runoff flows and proposed drainage works.

1.04 Minor and Major Drainage Systems

The drainage system shall consist of two components, the minor and the major systems. The minor system will consist of underground conduits, open channels and watercourses designed to convey a 10 year return period flow for residential, industrial, commercial, institutional, and high density residential areas. The major system will consist of surface flood paths, roadways and watercourses designed to convey the 100 year return period flow. In special conditions where surface flood paths cannot be established, pipes and culverts of the minor system may be enlarged to accommodate the major system flow.

1.05 Adequate Drainage

All subdivisions shall be adequately drained throughout the year. Where the whole or part of any proposed subdivision is wet or subject to intermittent or periodic flooding, approval of the subdivision will be withheld until the Village Engineer is satisfied that appropriate steps have been taken to drain the land or otherwise remedy such wet or flooding conditions.

1.06 Existing and Natural Watercourses

Where a subdivision is traversed by a watercourse, drainage way or stream, a right-of-way shall be provided along such watercourse or its planned re-alignment of a width deemed necessary by the Village Engineer for construction, maintenance, conservation, and beautification purposes.

No natural drainage course shall be altered or diverted unless such alteration or diversion has been approved by the Corporation of the Village of Valemount and the Provincial Ministry of the Environment.

Storm water shall only be discharged from a subdivision to a drain, ditch, watercourse, stream or other waterway as may, in the opinion of the Village Engineer, be adequate to receive the discharge therefrom, or which has been declared a part of the Village drainage system.

1.07 Drainage Systems Through Private Property

Where it is necessary to construct a drainage system through privately-owned land, the Owner shall obtain or grant a right-of-way in favour of the Corporation of the Village of Valemount to guarantee the right of access, to the drain area facility in perpetuity.

2.0 DESIGN CRITERIA

2.01 Sizing of Systems

The system shall be of sufficient capacity to accommodate all tributary areas as defined by the Village. For drainage areas 20 hectares and smaller, the Rational formula shall be used,

Q = KCIA, where:

.1 Q = Flow in m^3/s;
.2 K = Constant to establish units of compatibility (.00278);
.3 C = Dimensionless runoff coefficient;
.4 I = Rainfall intensity in mm/hr; and
.5 A = Runoff area in hectares.

Rainfall intensities shall be calculated according to the following equation,

$I = A \times T^B$, where:

.1 T = the time of concentration in hours; and
.2 A and B are coefficients as specified in Table F.1.

TABLE F.1
RAINFALL INTERPOLATING EQUATION COEFFICIENTS

Rainfall Frequency	A	B
10 Year Storm	18.4	-0.711
100 Year Storm	27.3	-0.739

For the minor system, the 10 year frequency curve shall be used. For the major system, and for special structures such as in the design of storm retention basins, underpass drainage or arterial roads, the 100 year rainfall curve shall be used.

The time of concentration, or inlet time, will vary with topography and the nature of the drainage areas, but will generally be fifteen minutes or greater for residential areas. Inlet times shall be determined by the Design Engineer.

Runoff coefficients for storm sewer design shall be assumed to be not less than the values specified in Table F.2.

TABLE F.2
RUNOFF COEFFICIENTS

Description of Area	Runoff Coefficient
Commercial	
• Downtown	0.82
• Neighbourhood	0.60
Industrial	
• Light area	0.65
• Heavy area	0.75
Residential	
• Suburban	0.30
• Single - family	0.40
• Multiunits - detached	0.55
• Multiunits - attached	0.65
• Apartment dwelling area	0.60
Parks, cemeteries	0.15
Playgrounds	0.25
Unimproved areas	0.15

Runoff coefficients other than those specified in this section shall be used only with the express written consent of the Village Engineer.

For tributary areas greater than 20 hectares, the method used by the Design Engineer to calculate storm flows shall be approved by the Village Engineer.

2.02 Design Grade

The minimum design grade shall be calculated by use of the Manning Formula such that a minimum velocity of 0.6 m/s shall be maintained during the design flow.

Pipes shall be designed to carry the required quantity when flowing 3/4 full for pipes sized 450 mm and smaller. Pipes sized 525 mm or larger shall be sized to carry the required quantity when flowing full.

2.03 Roughness Coefficients

Roughness coefficients for use with the Manning's Formula shall be as specified in Table F.3.

TABLE F.3
ROUGHNESS COEFFICIENTS

Pipe or Channel Material	Roughness Coefficient
Concrete Pipe	0.013
PVC Pipe	0.011
Corrugated Metal Pipe	
• Unpaved	0.024 - 0.033
• 25% paved	0.021 - 0.028
• 100% paved	0.013
Smooth Asphalt	0.012
Asphalt or Concrete Paving	0.014
Packed Clay	0.030
Light Turf	0.200
Dense Turf	0.350
Dense Shrubbery	0.400

Minimum velocity of pipes, flowing full, shall be 1.0 m per second.

There are no maximum allowable velocities except that the designer shall ensure that supercritical flow does not occur. Where grades exceed 15%, scour protection may be needed and anchor blocks will be required. These criteria may be modified by the Village Engineer to meet local conditions.

2.04 Minimum Pipe Size

Minimum pipe size shall be 250 mm for mains, 200 mm for catch basins leads, 100 mm for residential service connections, and 150 mm for non-residential service connections. The minimum pipe size for mains accepting flows from open ditches shall be 400 mm and suitable silt traps shall be provided.

2.05 Culverts

Where an open ditch system is required to cross a road, street or driveway, the ditch shall be enclosed by means of a culvert. All culverts shall be of sufficient size to properly drain all of the area naturally draining into the channel or ditch feeding into the culvert but shall be a minimum 300 mm diameter. Allowance shall be made for future flows as a result of full development of the upstream tributary area.

2.06 Location of Storm Mains

Storm sewer mains shall, wherever possible, be located in the road right-of-way as shown on the Standard Drawings. Where the location of the sewer main within the road right-of-way is not practical due to topography or other factors, the sewer main shall be located in a utility right-of-way registered in favour of the Corporation of the Village of Valemount and having a width of not less than 6.0 metres. The Village Engineer may require a utility right-of-way wider than 6.0 metres in the case where services in addition to storm sewer will be placed in the same right-of-way or where the depth of the sewer main requires a wider easement. There shall be a minimum clear lateral distance between the outside walls of storm sewers and sanitary sewers of 0.75 m.

2.07 Alignment of Storm Mains

Storm sewer mains shall generally be designed to follow a straight alignment between manholes. Curved alignments within rights-of-way shall be subject to the approval of the Village Engineer and provided that the pipe is set at a grade greater than the specified minimum and pipe alignment is at a parallel offset with an established boundary. In these cases, the radius of curvature shall be not less than 65 metres, or twice the minimum radius recommended by the pipe manufacturer, whichever is the greater.

2.08 Depth of Cover

The minimum depth of storm sewer mains shall be sufficient to provide all service connection piping with a minimum cover of 1.5 m to the top of the service, anywhere within the finished right-of-way. In no instance shall the cover over the crown of the main be less than 1.5 m.

2.09 Manholes

Manholes shall be installed at a maximum spacing of 120 metres and in the following locations:

.1 All changes in grade;
.2 All changes in alignment, including non-curvilinear sewers;
.3 All changes in pipe size;
.4 All pipe junctions; and
.5 All intersections.

Where, in the opinion of the Village Engineer, the grades of sewer pipes are sufficient to provide proper cleaning, the maximum spacing of manholes may be increased to 150 metres.

'GU' liners shall be installed in all manholes in accordance with the details as shown on the Standard Drawings. In cases where these details will not suffice, a detailed design drawing must be approved by the Village Engineer.

The relative elevations of storm sewers entering and leaving a manhole are to be such as to ensure that the manhole does not substantially reduce the hydraulic capacity of the system. Minimum fall through the manhole shall be 30 mm.

There shall be no change in the grades of pipe between manholes.

2.10 Catchbasins

Catchbasins shall be constructed as shown on the applicable Standard Drawings.

Catchbasins shall be located at a maximum spacing of 75 m along the drainage path, at all intersections, at all low points, or spaced at intervals such that not more than 10% of the gutter flow reaching each inlet will pass on to the next inlet downstream, provided this carry-over is not objectionable to pedestrian or vehicle traffic and the inlet is not in a sump. Catch basins shall be located at intervals such that surface drainage does not exceed gutter or flow channel capacities, to eliminate overflow to driveways, boulevard, margins, sidewalks, or private property.

2.11 Catchbasin Leads

Catch basin leads shall discharge into a manhole and not directly into the storm sewer pipe wherever possible.

Catch basin leads shall have a minimum cover of 0.7 m.

2.12 Service Connections

Storm sewer service connections shall only be used for foundation perimeter drains and roof drains unless otherwise approved by the Village Engineer.

The diameter of storm sewer service connections shall be determined by the Design Engineer, but shall be 100 mm diameter minimum for a single family residential service and in no case shall a non-residential service connection be less than 150 mm.

Service connections shall be made with an approved branch wye and be installed in a straight line and at a uniform grade from the terminus at the property line to the 45 degree long radius bend at the main. An approved wye saddle may be used to connect a 100m diameter service to an existing main. The minimum pipe grade for sewer service pipes shall be:

.1 2% for 100 mm service pipe; and

.2 1% for 150 mm service pipe.

For services 150 mm and larger, a manhole shall be installed at the intersection of the main and service.

Sewer services shall be installed 4.0 metres from the lot corner in accordance with the Standard Drawings and shall be installed, wherever possible, in common trench with the water and sanitary sewer services.

A cleanout shall be installed 300 mm from the property line on all services.

2.13 Pipe Class and Bedding Class

The quality of pipe and bedding shall be so selected such that the installation will adequately support the loads to be placed on it during construction and in operation. Pipe class and bedding class must be identified on all engineering drawings. Pipe shall have at least Class B bedding, as defined by the Standard Drawings.

For concrete pipe, the calculations shall follow the method shown in the latest edition of the *Water Pollution Control Federation Manual of Practice No. 9.* A safety factor of 1.5 shall be used for concrete pipe and the bedding classifications shall be as identified on the Standard Drawing.

For PVC pipe, the calculations shall follow the methods outlined in the latest edition of the Uni-Bell Plastic Pipe Association publication *Handbook of PVC Pipe - Design and Construction.*

For CSP pipe, the calculations shall follow the methods outlined in the latest edition of the American Iron and Steel Institute publication *Handbook of Steel Drainage & Road Construction Products.*

2.14 Major Flow Routing

All overland flows in excess of 0.05 cu.m./sec shall have specifically designed flow routes, that are protected and preserved by restrictive covenants or rights-of-way. The major flow routing shall normally be provided along roads and in natural watercourses. In some cases, the major flow may also be carried alongside the road in grassed swales, across country in rights-of-way and along public walkways.

In special circumstances, or where desired to enable lower building elevations, the pipes and culverts, which form a part of the minor system, may be enlarged or supplemented to accommodate the major flow. All habitable areas of buildings shall be above the major flow hydraulic grade line, except where specific flood prevention measures have been taken and which are acceptable to the Village Engineer.

The proportion of flow to be carried along the major routing shall be the total major flow less the flow carried in the minor system.

Where the road is used to accommodate major flow, it shall be formed, graded and sufficiently depressed below the surrounding property lines to provide adequate hydraulic capacity. On arterial roads, the 100 year hydraulic grade shall not be higher than centreline of the pavement with the maximum flow depth not to exceed 300 mm. On collector and local roads, the entire roadway may be used as a major flood path with the maximum flow depth not to exceed 300 mm.

Where roadways used for major flows intersect, care shall be taken to lower the intersection to allow flows to pass over the cross street. Where major flow routes turn at intersections, similar care in the road grading design is required.

In areas where surface major flow routes cannot be provided, a pipe system will be designed to accommodate the required major flow, and sufficient inlet capacity will be provided to accommodate introduction of the major flow into a piped system.

Major flow routing over 0.05 cu.m./s shall be shown on the engineering drawings and sufficient design shall be carried out to provide assurance to the Village Engineer that no property damage or endangering of public safety will occur under major flow conditions. The Design Engineer shall provide the Village Engineer with the depth of flow along the major flow route and shall show on the Design Drawings the hydraulic grade line above the design curb and gutter or above the finished surface of other drainage courses. The discharge point from the development for the major flow route shall be coordinated with the downstream routing to outfalls as determined by the Village of Valemount. Where major flow outfalls to a receiving watercourse, the velocity shall not exceed 1.5 m/s, or energy dissipaters shall be provided to minimize erosion.

The use of catchbasin inlet control devices to separate major and minor hydraulic grade lines may be allowed, subject to the satisfaction of the Village Engineer regarding the suitability of such control devices. Where catchbasin inlet control devices are used, building elevations may be controlled by the hydraulic grade line occurring in the minor system.

2.15 Drainage Drywells

Where drainage drywells are used as a means for disposal, drainage drywell wall surface areas shall be sized using Darcy's empirical law,

Q = A K i, where:

.1 Q = rate of flow in m^3/s;
.2 A = cross-sectional area of soil through which flow takes place in m^2;
.3 K = coefficient of permeability in m/s; and
.4 i = hydraulic gradient over a given flow distance.

Typical values for the Coefficient of Permeability, K, are presented in Table F.4.

TABLE F.4
TYPICAL VALUES OF COEFFICIENT OF PERMEABILITY

Typical Soil	Relative Permeability	Typical Value of K, m/s
Coarse Gravel	High Permeability	over 10^{-3}
Sand, Fine Sand	Medium Permeability	10^{-3} to 10^{-5}
Silty Sand, Dirty Sand	Low Permeability	10^{-5} to 10^{-7}
Silt	Very Low Permeability	10^{-7} to 10^{-9}
Clay	Practically Impervious	Less Than 10^{-9}

Upon determination of permeability factor, a safety factor of 2 shall be applied.

Drainage drywells shall, unless otherwise approved by the Village Engineer, or Public Works Superintendent, be located in the road boulevard or in other lands dedicated to the Village for the purpose of drainage disposal.

The depth of the drywell will vary in accordance with the requirements derived from Darcy's empirical law.

Drainage drywells shall be constructed as shown on the applicable Standard Drawings.

3.0 MATERIALS

3.1 Pipe and Fittings

.1 Pipe for gravity sanitary sewer mains and for services of 200 mm in diameter and larger may be any of the following:

.1 reinforced concrete pipe conforming to ASTM C76. Pipe strength (Class III min.) shall be specified for the trench conditions under which the pipe will be installed and operated. Joints shall conform to ASTM C443; or

.2 polyvinylchloride pipe up to 375 mm in diameter, S.D.R. 35, conforming to ASTM D3034 and CSA B182.2, stiffness (F/Y) of 320 kPa at 5% deflection conforming to ASTM D2412, complete with approved rubber gasket joints. Maximum pipe length shall be 4 metres.

.2 Pipe for sanitary sewer connections of 100 mm and 150 mm diameter and for 150 mm diameter sewer mains shall correspond in material to that used for the main sewer and shall be one of the following:

.1 non-reinforced concrete pipe conforming to ASTM C-14, Class III. Joints shall conform to ASTM C-443; or

.2 Polyvinylchloride pipe, S.D.R. 28, conforming to ASTM D3034 and CSA B182.1, complete with rubber gasket joints. Maximum pipe length shall be 4 metres.

Sewer fittings shall correspond with the respective main and service pipes and shall conform with consistent specifications for main pipe.

.3 Pipes and fitting for sanitary sewer force mains shall be as approved for watermains in accordance with Schedule D, Sections 3.01 and 3.02.

.4 Other types of pipe may be used only with the written consent of the Village Engineer.

3.02 Pipe and Fitting Joints

Sewer pipe and fittings shall be jointed with a rubber gasket or other preformed, factory-manufactured gasket or approved material.

3.03 Service Junctions

Connection of services to the sewer shall be made using wye or service saddle fittings. The type of joint of the service connection pipe to the sewer main shall conform with the type of joints on the sewer main.

Service wye saddle shall only be used to connect a 100 mm diameter service to an existing main. Where service saddles are used, they shall be equipped with steel straps. Service saddles shall only be used with the approval of the Village Engineer.

3.04 Manholes

Precast concrete manhole sections shall conform to ASTM C478 and shall be minimum 1050 mm diameter with 115 mm wall thickness for mains less than 450 mm diameter; for mains greater than 450 mm diameter, the precast manhole sections shall conform to the diameters specified on the Standard Drawings. Concrete for cast-in-place manholes shall have a minimum compressive strength of 20 MPa at 28 days.

Concrete for cast-in-place manhole bases and benching shall have a minimum compressive strength of 20 MPa at 28 days.

Precast manhole bases of a design and construction quality acceptable to the Village Engineer will be accepted in lieu of cast in place bases.

Cover slabs may be precast or cast-in-place concrete reinforced to withstand H-20 loading conditions.

Manhole rungs shall be 20 mm diameter steel, hot dipped galvanized after bending, or an approved aluminum alternate, at 300 mm o.c., cast into the wall of the manhole section, or set in 30 mm holes filled with epoxy cement. Rungs shall protrude 125 to 150 mm from the manhole wall. If precast manhole barrels are used having inset wire lifting lugs, the lugs shall be galvanized.

3.05 Manholes Frames and Covers

Covers and frames shall be cast iron of an approved pattern to withstand H20 loading. The cover shall have a weight of 66 kg and the frame shall be of the round base pattern having a weight of 84 kg. Bearing faces of the cover to frame shall be machined for a non-rocking pit. The cover shall have 2 - 22 mm diameter lifting holes. The lid shall be embossed with "Sanitary Sewer".

3.06 Pipe

CSP shall be used for culverts only and shall consist of galvanized corrugated steel pipe designed to carry H-20 loading in accordance with the *American Iron and Steel Institute* "Handbook of Steel Drainage and Highway Construction Products", latest edition.

3.07 Drainage Drywells

Drywells shall be 1,200 mm diameter and shall be as per Article 3.04 and the Standard Drawings. Drywells shall have 75 mm x 150 mm holes through the walls spaced vertically 150 mm on centre and horizontally 200 mm on centre.

3.08 Pipe and Fitting Joints

Under certain approved conditions, storm sewer mains may be installed without gaskets or grouting to facilitate infiltration of ground water.

Suitable precautions such as shimming must be taken on these installations to ensure pipe to pipe alignment with no projecting inside edges or pipe misalignment.

3.09 Catch Basins

Catch basin barrels shall be pre-cast concrete conforming to ASTM C478. All catch basin barrels shall be 900 mm in diameter. Concrete cover slabs shall be designed to withstand H-20 loading conditions. Catch basins shall be fitted with "Sur-Trap" trapping hoods, or equivalent.

Cast iron frames, grates and side inlets shall be Dobney Foundry or as approved by the Village Engineer.

3.10 Headwalls

Headwalls for storm sewer inlets and outlets shall be designed by the Design Engineer and subject to the approval of the Village Engineer. As a minimum, the design shall include reinforced concrete slab, wingwalls and headwall, 30 MPa concrete at 28 days, 38 mm diameter galvanized pipe handrail, hinged and galvanized trash grate.

4.0 WORKMANSHIP

Storm sewer systems shall be installed in the manner described in Schedule E of this Bylaw except as modified herein.

4.01 Testing

Lamping

The storm sewer system shall be lamped as specified in Section 4.14 of Schedule E of this Bylaw and may be tested for leakage to Section 4.15 of Schedule E of this Bylaw at the discretion of the Village Engineer.

Materials Testing

As per Schedule E, Section 4.16.

Video Inspection Tests

As per Schedule E, Section 4.17, at the discretion of the Village Engineer.

4.02 Head Walls and Aprons

Cleaning and flushing as per Schedule E, Section 4.11 of this Bylaw.