SCHEDULE D

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

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

____

Clerk

SCHEDULE D

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

1.0 GENERAL

1.01 Water Distribution System to be Constructed by Owner

Where the provisions of Schedule A of this Bylaw require the construction of a water distribution system, the Owner shall provide a water distribution system and storage facilities including water mains, valves, hydrants, service connections, pump stations, reservoirs and pressure reducing stations consistent with the regulations, standards and specifications set out in this Schedule. All standards not specifically described in this schedule shall be in accordance with appropriate AWWA standards or as directed by the Village Engineer.

1.02 Approval of Engineering Drawings Required prior to Construction

Engineering drawings showing detailed design of the necessary works shall be submitted to the Village Engineer for approval. No construction shall commence until the engineering drawings have been approved by the Village Engineer. These drawings shall show alignment, size and depths of pipes, pipe bedding requirements, existing ground line and proposed final ground line over the pipe, location and detail of all fittings, valves and hydrants, location of all service connections, location, access to, size and details of any pump stations and reservoirs, all easements and all such other details as may be required. Where a water system is not yet available, rights-of-way may be required to be provided by the Owner to allow for the eventual installation of this facility. Such rights-of-way shall be registered in favour of the Corporation of the Village of Valemount at the Owner's expense.

2.0 DESIGN CRITERIA

2.01 Capacity of System and Sizing of Water Mains

Water distribution systems shall be designed to deliver water in adequate quantities at adequate pressures for both domestic use under peak consumption conditions and fire flows. Mains shall be sized to carry the peak hourly flow rate or the maximum daily flow rate plus the fire flow rate, whichever is the greater. Mains shall be sized using the Hazen-William formula with "C" equal to 120 and maximum flow velocity for peak hourly demand rate of 2.0 m per second. For fire flow, plus the maximum day rate, the flow velocity shall not exceed 3.0 m per second.

2.02 Domestic Demand Criteria

For residential areas, the daily domestic demand criteria for purposes of designing water distribution systems shall be assumed to be:

.1 Average day: 945 litres/day/capita;
.2 Maximum Day: 2360 litres/day/capita; and
.3 Peak Hour/Maximum day Consumption Ratio: 1.5.

For other than residential areas, the demand criteria shall be selected to suit the particular circumstances subject to the Approval of the Village Engineer.

2.03 Fire Flow Requirements

Water distribution systems shall also be designed to ensure that fire flows as required by the Insurers' Advisory Organization (IAO) are available for required durations. Fire flows shall not be less than 3640 litres per minute. The amount and duration of design fire flows shall be provided to the Village Engineer for his approval prior to final design of the water distribution system.

2.04 Design Pressures

Water systems shall be designed for pressures in the range of 245 kPa to 630 kPa, with 245 kPa measured under peak hourly conditions and 630 kPa measured under static conditions. The minimum pressure shall be measured or calculated at the main floor elevation of the highest proposed house and an allowance made for pressure loss in the service line to the house wall. Minimum residual pressure at any hydrant shall not be less than 140 kPa under maximum day domestic consumption plus fire conditions. Reservoir level shall be assumed at mid point for calculation of minimum pressures and full for calculation of maximum static pressures.

2.05 Minimum Pipe Size

The minimum pipe size for all water mains shall be 150 mm diameter, however the pipe size shall be capable of providing present and future domestic, and fire flows.

2.06 Location and Grade of Water Mains

Water mains shall be located in the road right-of-way as shown on the Standard Drawings unless otherwise approved by the Village Engineer. Where the location of the watermain is not practical there shall be a minimum lineal horizontal clearance of 1 metre between a water main and other existing or proposed underground services, except sanitary sewer mains. A minimum of 3.5 metre horizontal distance between a watermain and a sanitary sewer main shall be maintained. In special cases such as installations in rock or hardpan, the horizontal clearance may be reduced, with the approval of the Village Engineer, provided the invert of the water main is a minimum of 450 mm above the crown of the sanitary sewer and subject to any Provincial regulations. On side-hill streets, the main shall, where possible, be located on the cut side of the centre line of the street.

Water mains shall be normally designed to follow a straight alignment between intersections, at grades parallel to the road centreline.

Curved alignments may be accepted provided that the pipe alignment is at a parallel offset with an established boundary and the radius of curvature is not less than 60 m or twice the minimum radius of curvature recommended by the pipe manufacturer, whichever is the greater. The design drawings shall indicate where short lengths or field belled pipe lengths are required on curves.

Water mains shall be designed with a rising grade wherever possible to minimize high points in the main. Where a high point is unavoidable, either a blow off, service or air release valve shall be installed at that point.

Where the water main network is weak, installation of supplementary mains of a minimum of 150 mm diameter to existing mains may be required at the discretion of the Village Engineer and may necessitate the provision of rights-of-way in favour of the Corporation of the Village of Valemount.

No gas main, electric or telephone duct or other utility line shall be installed in the same trench with water mains.

Where it is necessary for the water main to cross other underground services, the crossing shall be made at an angle greater than 20 degrees and the vertical clearance between services at the crossing point shall be not less than 200 mm except for sanitary sewers where the clearance shall be 450 mm between the exterior walls of the pipes.

The drawings shall indicate whether the water main passes over or under other underground services which it is crossing.

2.07 Spacing of Fire Hydrants

Fire hydrants shall be located, in general, at highway intersections and at maximum spacing of 150 metres in low density residential areas and 100 metres in high density residential, commercial and industrial areas. Additional hydrants may be required by the Village Engineer at schools, major multiple family developments, commercial buildings or other major developments consistent with the current fire flow requirements of the Canadian Underwriters' Association.

Where hydrants are located other than at intersections, they should be located on the projection of the property line dividing two lots. In selecting the location of a hydrant, the probable route of the fire engine shall be considered.

A hydrant shall not be located within 3 m of a utility pole, pad mounted transformer or light standard, within 1.5 m horizontally of underground service pipes or open ditches, or within 1 m of the curb line or back of sidewalk.

2.08 Line Valves

Line valves in residential areas shall be located at a maximum spacing of 250 m in a continuous line and shall generally be located so that not more than 2 hydrants or 50 dwelling units will be without adequate pressure in the event of any one water break. In commercial and industrial areas, line valves shall have a maximum spacing of 120 m and be located so that not more than one hydrant will be out of service during water system repairs.

Each tee shall have two line valves; each cross shall have three line valves. Each line valve shall be the same diameter as the pipe on each downstream branch of the tee or cross. At the discretion of the Village Engineer, line valves may be required on all branches of a wye or tee.

A line valve may be required on a new pipe line near each point of connection to existing mains.

2.09 Blow Offs

Permanent blow offs shall be installed at all permanent dead-ends and an adapter will be required for connecting a standard 63 mm fire hose for flushing the main, as shown on the Standard Drawings.

Temporary blow offs (usually a corporation stop) may be installed to facilitate chlorination and flushing of any part of the system. After flushing, the temporary blow off shall be removed as directed by the Village Engineer.

2.10 Air Relief Valves

Double acting air relief valves shall normally be installed at all summits in the mains.

2.11 Fittings and Appurtenances

Fittings and appurtenances with other than standard hub ends shall be so indicated on plan.

Where practical, all fittings shall be located in respect to each other so that flanges or standard pipe lengths can be used to connect them.

The centre-to-centre dimension between fittings near each other shall be shown on the final engineering drawing.

2.12 Service Connections

The diameter of water services shall be determined by the Design Engineer and is subject to approval of the Village Engineer, and in no case shall the diameter be less than 20 mm.

Water services shall be installed to the center of each lot in accordance with the Standard Drawings and shall be installed, whenever possible, in a common trench with the sanitary sewer service. Through areas of steep topography and roads the service location may be moved to 3.5 m from the lowest (elevation) lot line.

A water service shall be installed where required to provide a connection to each lot created by the subdivision and to any other existing or possible future lot which can be serviced from mains installed by or for the subdivision.

In general, 20 mm to 50 mm diameter service connections may be tapped into mains 150 mm diameter and greater with double strap service saddles. Multiple corporation stops shall be staggered and not less than 300 mm apart.

No tappings shall be made at an angle of greater than 30 degrees above the horizontal centreline plane of the pipe.

Where it is necessary to install service connections at less than 1 m centres in a 100 mm diameter main, the 100 mm diameter main, in all cases, shall be ductile iron.

The curb stop at the end of each service pipe shall be located 0.3 m in front of the street/property boundary line, and 3.0 metres from the lowest corner lot pin. Where such location will conflict with other services, the location may be revised with the approval of the Village Engineer.

2.13 Depth of Cover

The depth of the water main shall be sufficient to provide all services with a minimum cover of 2.5 m to the top of the service anywhere within the Right-of-Way. In no instance shall the minimum cover over the crown of the main be less than 2.5 m.

2.14 Tie-ins to Existing Water Mains

Connection of a new pipe to an existing water main shall be undertaken by the Village, who will supply and install all materials to construct the connection. The cost of the connection will be charged to the Owner by the Village.

2.15 Reservoirs

Reservoirs, where required, shall be designed to suit the particular circumstances. In general, reservoir capacity shall be not less than:

Total Storage Requirement = A + B + C, where:

A = Fire Storage, based on minimum 3640 litres per minute fire flow;
B = Equalization Storage (25% of maximum day demand);
C = Emergency Storage (25% of A + B).

Reservoir design, at minimum, shall incorporate the following features:

.1 sufficient geotechnical data to prove the site suitable for reservoir construction;
.2 structures to be below ground and covered, unless specifically approved otherwise;
.3 material - reinforced concrete;
.4 2 cells, each containing one-half of total required volume and capable of being drained and filled independently;
.5 lockable access opening in roof for cleaning and maintenance - minimum dimension 1 m x 1 m to be located between overflow pipe and wall;
.6 ventilation pipes or openings;
.7 slope floor to sump;
.8 sub-drain under floor to collect and drain any leakage (connect to overflow pipe in a manhole);
.9 interior wall ladder from roof access to floor (no exterior ladder required);
.10 inlet, outlet pipe to be perforated and designed to disperse water throughout the reservoir;
.11 overflow drain to be provided and sized to transmit the maximum pump discharge. The overflow drain shall be connected to an acceptable point of discharge; and
.12 access roads; and
.13 telemetry alarm system.

Reservoir valve chamber design shall incorporate:

.1 sump in valve chamber floor, connected to overflow pipe;
.2 50 mm valved outlet off supply line within valve chamber for water supply for cleaning reservoir; and
.3 valves shall be OS & Y.

2.16 Pump Stations

Pump stations, where required, shall be designed to suit the particular circumstances. In general, pump stations shall be designed to meet maximum daily demands with the largest pump out of service with balanced storage on line. If equalization storage is not on line, pump station capacity must meet peak hour demand with the largest pump out of service.

Pump station design, at minimum, shall incorporate the following features:

.1 reinforced concrete, blockwork or brick construction, aesthetically pleasing;
.2 lockable access doorways sized so that the largest single piece of equipment may be safely removed and replaced. Lifting hooks or rails with pulley blocks as required;
.3 pumps to start and stop individually. Start and stop to be based on water levels in control reservoir. Automatic alternation of pump sequence;
.4 power failure protection with manual reset;
.5 high water override start plus alarm;
.6 high pressure (discharge) override start;
.7 low pressure (discharge) override start plus alarm;
.8 low pressure/no flow (suction) override start;
.9 alarms to be audible and visible;
.10 control valves to minimize starting and stopping surges;
.11 duplicate control cables (without splices) between pump stations and reservoirs;
.12 power factor correction as required by Power Authority;
.13 hour meters and amp meters on each pump;
.14 recording flow meter at each pump station;
.15 recording suction and discharge pressure gauges at each pump station;
.16 automatic heating, ventilating and dehumidifying systems;
.17 in-station lighting;
.18 drainage to be provided for all pump station;
.19 interconnection with the Village's alarm telemetry system;
.20 electrical phase loss protection;
.21 electrical drawing schematics for control panels;
.22 access roads; and
.23 pump manuals.

For each design submission to the Village, an extra set of drawings pertaining to the design of the pump station, keyplan, and a location plan shall be submitted for the maintenance department to review.

Before commencement of construction, the Owner shall provide five sealed sets of mechanical shop drawings and five sealed sets of electrical line diagrams for review by the Village Engineer. Two sealed copies of design calculations shall be provided for documentation. Before acceptance of the completed station, by the Village, the Owner shall provide 3 copies of an Operation and Maintenance Manual to the Village. The manual shall contain:

.1 cover page and table of contents;
.2 as constructed shop drawings;
.3 equipment layout drawings;
.4 electrical, control, and alarm wiring diagrams;
.5 operating instructions for all equipment;

.6 maintenance instructions for all equipment, including frequency of maintenance tasks;
.7 equipment data sheets;
.8 certified head/capacity curves for pumps;
.9 equipment part lists; and
.10 emergency operating procedures.

The maintenance manuals shall be hardbacked bound documents with the name of the facility embossed on the cover. Each section of the manual shall be identified by plastic covered tabbed dividers, with the section name identified on the tab.

2.17 Pressure Reducing Stations

Pressure reducing stations, where required, shall be designed to suit the particular circumstances. In general, each pressure reducing station shall have a separate pressure reducing valve and appurtenances for maximum daily demand and a separate pressure reducing valve and appurtenances for fire flows.

Pressure reducing station design, at minimum, shall incorporate the following features:

.1 access road to chamber;
.2 precast or cast in place buried concrete chamber suitable for H20 Highway loading;
.3 lockable access hatch (914 mm x 914 mm minimum);
.4 aluminium ladder and safety port;
.5 sump with sump pump assembly;
.6 fluorescent lighting, heating, venting and one electrical outlet;
.7 pressure reducing valves with downstream surge control;
.8 wye strainers;
.9 OS&Y isolating gate valves;
.10 victaulic couplings;
.11 pressure gauges;
.12 one 20 mm hose bib connection;
.13 pipe stands; and
.14 ceiling and wall of chamber to be painted with two coats of latex white paint;

For each design submission to the Village, three sets of drawings pertaining to the design of the pressure reducing station, key plan and a location plan shall be submitted.

2.18 Access

An all weather vehicular access shall be provided to all reservoirs and pump stations. The access roads shall conform to the following standards:

.1 minimum surface width - 6m;
.2 ditching along both sides to at least 100 mm below subgrade;
.3 300 mm pitrun gravel subbase; and

.4 50 mm crushed gravel base.

3.0 MATERIALS

3.01 Pipe

Pipe for water mains shall either be ductile iron or polyvinyl chloride (PVC).

.1 Ductile iron pipe shall conform with American Standard AWWA C150/A21.50 and C151/A21.51, Latest Edition. All pipes shall conform to AWWA C151, minimum pressure class 150, unless specified otherwise by the Village Engineer. Pipes shall be cement mortar lined, conforming with AWWA C104/A21.4, Latest Edition. Joints shall be mechanical or a rubber gasket bell and spigot to AWWA C111, A21.11, Latest Edition.

.2 PVC pipe shall conform with AWWA C-900 and CSA CAN3-B137.3 for mains 100 - 300 mm diameter and with AWWA C-905 and CSA CAN3-B137.3 for mains 350 mm to 600 mm diameter. Joints shall be wall thickened and sleeve reinforced bell and spigot ends with formed groove for elastomeric gasket seal conforming to ASTM D2122.

3.02 Fittings

Fittings shall be ductile iron for use with ductile iron or PVC pipes conforming to AWWA C110/A21.10 and shall be designed for a minimum pressure of 1720 kPa unless specified otherwise by the Village Engineer. Fittings shall be Terminal City only.

3.03 Buried Gate Valves

Buried gate valves shall conform to:

.1 AWWA C-500 iron body, bronze mounted wedge valves with non-rising stem, O-ring stem seal, suitable for 1 MPa minimum; or

.2 AWWA C-509 iron body, resilient seated valves with non-rising stem, O-ring stem seal, suitable for 1 MPa minimum.

Valves shall be equipped where a 50 mm square operating nut and tie-lugs where restraining is required. Valves to open counterclockwise.

3.04 Valve Boxes

Valve boxes shall be Nelson or Robar type with anchored flanges approximately 100 mm from the top of the box.

3.05 Hydrants

All hydrants shall be Terminal City compression type, complete with 2 - 63 mm ports and 114 mm pumper port. Threads shall conform to the British Columbia Fire Hose Thread specifications. Hydrants shall be painted red above the ground line. Drain outlets shall be provided. Depth of bury shall be a minimum of 2.5 metres. Hydrant extensions shall be installed as required to suit the final boulevard grade. Hydrants shall be equipped with a standard BC pentagon operating nut and shall open counterclockwise. Cap chains not required. Hydrant colour shall be red.

Hydrant lead pipe shall be a minimum of 150 mm diameter. At the discretion of the Village Engineer, a concrete wing wall shall be installed at hydrants adjacent to road cut slopes. In areas where road ditches exist, a culvert and a 3 metre wide gravelled pad across the ditch shall be provided for access to the hydrant.

3.06 Service Connection Pipe, Saddles, and Joints

All pipe for underground services 50 mm diameter and smaller shall be Polybutylene Municipal grade series 160 service pipe complete with stainless steel inserts conforming to AWWA C902. Pipe for services 100 mm and 150 mm diameter shall be the same as specified for watermain pipe.

Service connections to PVC pipe shall be made using bronze double strap saddles with either bronze or stainless steel fasteners tapped for AWWA thread. Saddles shall provide full support around the circumference of the pipe and shall provide a minimum bearing width of 50 mm measured along the axis of the pipe.

Joint fittings shall be compression type suitable for 1035 kPa working pressure.

3.07 Corporation Stops

Corporation stops shall be Mueller H15008 for 20 mm diameter through 50 mm diameter, or approved equal.

3.08 Curb Stop and Boxes

Curb stops shall be Mueller Mark II Oriseal H 15209 stop, or approved equal, for 20 mm diameter through 50 mm diameter. Service boxes shall be Mueller A726, or approved equal, for 20 mm diameter to 40 mm diameter and Mueller A728, or approved equal, for 40 mm diameter through 50 mm diameter.

3.09 Air Valves

Air valves shall be 50 mm Terminal City, Apco, or approved equal, double acting air valves or as approved by the Village Engineer.

3.10 Stops and Drains For Blow Offs

Stops and drains shall be minimum 50 mm Mueller A-10284 Mark II Oriseal, or approved equal.

3.11 Meter Chambers

Metering may be required at the discretion of the Village Engineer, at the Owner's expense. The location of meter chambers shall be approved by the Village Engineer. All meters and remote readout devices shall be easily accessible to the Village. Meter chambers or enclosures shall include:

.1 structures shall be watertight;
.2 drainage, ventilation and lighting;
.3 protection from freezing;
.4 adequate access and interior space for maintenance and equipment removal;
.5 minimum headroom of 2.0 m;
.6 piping primed and painted with a rust-inhibiting paint;
.7 remote readout device;
.8 meter bypass; and
.9 meter for domestic and irrigation use - bypass for fire flows.

3.12 Concrete

All concrete shall conform to CSA:A23.1M with a minimum 28-day compressive strength of 20 MPa for unshrinkable fill and thrust blocks, and 25 MPa for all other purposes. Concrete slump shall be in the range of 50 mm to 100 mm.

Cement shall be Portland cement conforming to CSA:A.5, and shall be normal type unless specified by the Village Engineer or dictated otherwise by soil conditions.

Admixtures shall not be included in the concrete mix without the approval of the Village Engineer.

3.13 Bedding Material

Bedding shall for all pipe bedding shall be sand or crushed rock free of clay lumps, organic and other deleterious material. Gradation shall conform to the gradation limits set out in Table D.1.

TABLE D.1
PIPE BEDDING GRADATION LIMITS

USBC Sieve Size	Percent by Weight Passing
19	100
12.5	75 - 100
4.75	40 - 80
2.36	25 - 65
0.300	5 - 25
0.075	0 - 8

Through areas of high groundwater and/or unstable soil conditions, crushed gravel or drain rock shall be installed to bed the pipe.

3.14 Backfill Material in Pipe Zone (Pipe Surround)

Backfill material in the pipe zone (pipe surround) shall be sand and crushed rock free of clay lumps, organic and deleterious material. Gradation shall conform to the gradation limits set out in Article 3.13.

3.15 Backfill Material Above Pipe Zone

<u>In Road Areas</u>

.1 Backfill material below the pavement structure for trenches in road areas may be native soil provided the native soil is free of organic or foreign matter and can be readily compacted to a minimum of 95% standard Proctor density in compliance with ASTM D-698. Native material is not acceptable if it is not competent enough to provide an adequate subgrade to support road sub-base, base and asphalt. Maximum particle size of backfill material not to exceed 200 mm.

If the native material is deemed unacceptable, it shall be disposed of and competent granular backfill material conforming to Clause 3.01 of Schedule B imported.

In Non-Road Surfaces:

.2 Backfill material for trenches and easements or other non-road areas may be native material excavated from the trench providing it is sufficiently free of frozen soil, roots or other objectionable material so as not to cause undue settlement. Maximum particle size of backfill material not to exceed 200 mm.

3.16 Encasement Pipe Filler Sand

To be well graded, clean sand, free from organic materials and conforming to the following gradation limits as set out in Table D.2.

TABLE D.2
ENCASEMENT PIPE FILLER SAND GRADATION LIMITS

USBC Sieve Size	Percent By Weight Passing
4.750 mm	100
2.360 mm	20 - 70
1.180 mm	13 - 50
0.850 mm	8 - 35
0.300 mm	5 - 25
0.150 mm	2 - 15
0.075 mm	0 - 8

3.17 Insulation

Fifty (50) mm Styrofoam SM insulation shall be installed over all watermains and service lines that are installed shallower than the specified 2.5 m depth of earth cover.

3.18 Bolts and Nuts

Bolts and nuts to be Type 314 stainless steel.

4.0 WORKMANSHIP

4.01 Trench Excavation

Trenches shall be excavated to suit the cross-section shown on the Standard Drawings. Open trenches through existing paved surfaces will be allowed only with the prior express consent of the Village Engineer. When trenches through existing pavement are allowed, the pavement shall first be saw-cut by mechanical means in straight continuous lines parallel to the trench centreline.

If trenches are excavated wider than the specified widths, a higher class of pipe or special bedding may be required.

Rock excavation in trenches shall provide a minimum clearance of 150 mm below the pipe for pipes 600 mm in diameter or less, and 250 mm for pipes larger than 600 mm in diameter.

The top of the trench at ground level shall be kept to the minimum width consistent with the depth, natural angle of repose of the material and the regulations of the Workers' Compensation Board.

Excavation for chambers, fittings and other appurtenances shall be to the lines which will permit the assembly of these sections, and to permit adequate backfilling and compaction operations.

Where an existing structure or underground installation may be affected by the works, it is the responsibility of the Owner to inform the Village of such facility sufficiently in advance that the Village may make an inspection and specify the protective measures to be undertaken.

Where an unforeseen or other obstruction is encountered which interferes with the designed alignment or grade, the construction shall cease until such time as revised proposals are approved by the Village Engineer.

The attention of the Owner is directed to the provisions of the Workers' Compensation Board safety regulations. All municipal employees have been instructed not to enter excavations which are not properly braced or which otherwise do not conform with the requirement of the Board. It follows, therefore, that approvals cannot be given to installations not inspected because of unsafe working conditions.

Any over-excavation of the trench subgrade beyond the specified depth shall be backfilled with select material and compacted to 100% Standard Proctor density.

In rock excavation the depth of compacted bedding material below the pipe shall be a minimum of 150 mm for pipe of 600 mm diameter or less and 250 mm for pipe in excess of 600 mm diameter. This depth shall exist for the full wall-to-wall width of the trench.

Where the bottom of any excavation as uncovered is soft and is in the Design Engineer's opinion unfit to support the pipes or structures, a further depth shall be excavated and refilled to the correct shape, grade and elevation as directed by the Design Engineer.

When the bottom of a trench is found to consist of unstable material which, in the opinion of the Design Engineer, cannot be removed and replaced with bedding material, a pile foundation or other structural support in accordance with plans prepared by the Design Engineer shall be constructed.

In areas of clay or other impermeable soils, where over excavation of the trench subgrade is required, the over excavation shall continue to a point where ponding of water in the trench bottom will be avoided.

Open cut trenches shall be sheeted and braced as required by the Workers' Compensation Act, as may be necessary to protect life, property, or the work, unless the trench excavation is sufficiently wide at the top to be naturally stable. When close sheeting is required, it shall be driven so as to prevent the soil from entering the trench either from below or through such sheeting. A minimum distance or 150 mm from the closest point of the pipe to the sheeting shall be maintained.

When possible, vertical trench timber or sheeting shall be placed so that it does not extend below the level of the bottom of the excavation. Sheeting driven below the pipe grade shall not be removed unless the sheeting can be removed without causing settlement or lateral displacement of the pipe.

Unless otherwise indicated in the drawings or specifications, or unless approval to leave it in place is received from the Village Engineer, trench sheeting and bracing shall be removed when backfilling has been completed or has reached a level which will permit its safe removal without causing injury to persons or damage to the works. When sheeting and bracing is left in place, it shall be cut such that no sheeting remains closer than one metre to the established sub-base road grade or the existing ground surface, whichever is the lower.

Particular caution will be taken to ensure that pipe bedding is not disturbed such that settlement of the pipe results.

Timber supports or sheeting shall be left in place when its removal would endanger adjacent structures or result in a shifting of pipe bedding material and a displacement of the pipe. The Village Engineer may require the pipe to be bedded in concrete (Class A Bedding) when, in his opinion, the removal of sheeting would disturb the pipe bedding. Discharge from trench pumps, well points, or other dewatering aids, shall be located and controlled in such a manner as to not cause loss or damage to public or private property, nuisance on roads or walks, or injury to the public.

4.02 Pipe Class and Bedding Class

Notwithstanding other provisions of this Bylaw, the quality of the 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. For ductile iron pipe, the calculations shall follow the method shown in AWWA C-150, latest edition. For PVC pipe, the calculations shall follow the methods outlined in AWWA C-900 and C-905, latest edition.

For all pipe, a minimum Class B bedding, as defined by the Standard Drawings, is required. Pipe class and bedding class must be identified on all engineering drawings.

4.03 Pipe Alignment and Depth of Cover

Pipe shall be installed true to the alignment shown on the approved construction drawings and to a depth sufficient to provide a minimum cover of 2.5 m measured from the top of the installed pipe to the finished grade elevation over the pipe.

4.04 Pipe Installation

Prior to installing pipe, all standing water shall be drained or pumped from the trench. Pipe shall be carefully offloaded and lowered into the trench in a manner that will prevent damage to the pipe. The pipe shall be jointed in strict accordance with the manufacturer's recommended practice.

Uni-flange thrust restraints shall be installed on pipes installed on grades in excess of 20%.

4.05 Service Connections

Service connections shall be connected to the Corporation stop and a gooseneck formed in a horizontal plane as shown on the applicable Standard Drawing. Pipe shall be installed in a straight line between the gooseneck and the terminus of the service.

Compression joints shall be required for connecting service piping. Service tapping shall be spaced along the length of pipe and staggered around the circumference to avoid cracking of pipe between tappings. Minimum distance between two tappings and between the end of a pipe and the tapping shall be 300 mm. A marker stake shall be set with bottom flush with the end of the service and the top projecting a minimum 1,000 mm above the ground. Marker stakes shall be cut to an even 200 mm length, and depth from top of marker to water service shall be clearly marked on the stake. Marker stake tops shall be painted blue with yellow painted stencilled numbers and letters.

Service boxes shall be set flush with ground or road surface. A length of copper flattened on one end shall be installed on the private property side of the curb stop to prevent entrance of foreign material and this pipe shall extend 1,500 mm into private property.

4.06 Thrust Blocking

Concrete thrust blocking shall be provided at fittings and on hydrants as shown on Standard Drawing D-1. Concrete shall be placed between undisturbed ground and the fitting to be anchored such that the pipe and the fitting joints are accessible for repair. Bolts on flanged fittings shall be left free.

4.07 Valves, Fittings and Hydrants

Valves, fittings and hydrants shall be set plumb and directly on the centreline of the pipe. A valve box shall be provided for every valve. The valve box shall not transmit shock or strain to the valve and shall be centered and plumb over the nut of the valve. The 150 mm riser pipe must be placed in such a manner as to permit the use of long-handled angle wrenches through the box to tighten packing gland nuts. On valves 200 mm and over, a cast bell bottom fitting shall be used over the valve. A 1.5 metre radius asphalt apron shall be placed around all valves installed on gravel roads and gravel shoulders.

Hydrants shall be plumb and shall have their nozzles at right angles to the curb. Hydrants shall be set with ground flange above the ground at the elevation directed by the Village Engineer generally at 50 mm above finished ground, curb or sidewalk grade. When set in a permanent sidewalk or other solid structure, a suitable expansion joint material shall be placed around the hydrant to allow for movement between hydrant and structure. All hydrants shall be supplied with drains. Sufficient drain rock shall be placed to allow for proper hydrant drainage, generally a minimum of 0.5 cubic metres.

4.08 Blow-Offs

Blow-offs shall be installed as shown on the applicable Standard Drawing.

4.09 Granular Bedding and Backfill in Pipe Zone

The pipe zone is considered as being the depth of trench between the trench bottom and a level 300 mm above the top of the pipe.

The pipe zone backfill shall be hand placed and thoroughly compacted to a density of 95% Standard Proctor Density in layers not exceeding 150 mm using hand tampers.

4.10 Backfill Above Pipe Zone

In Road Areas

.1 In road areas trench backfill material shall be placed in layers not exceeding 300 mm in thickness and compacted by mechanical means to a minimum of 95% Standard Proctor density.

The water content of the material shall be controlled to achieve the required density.

In Non-Road Areas

.2 In easements and other non-roads areas, native trench material may be used for trench backfill above the pipe zone. Backfill shall be placed and compacted to 90% Standard Proctor Density.

4.11 Pipe Casings

Pipe casings shall be installed as shown on the Standard Drawing. The water pipe shall be blocked at each joint to ensure line and grade is maintained and the casing is to be sealed at both ends with joint filler with proper care taken to ensure that the pipe remains on line and grade and does not float. The annular space between the water pipe and the casing pipe shall be filled with sand as specified in Section 3.16.

A length of 6 mm polypropylene rope shall be laid alongside the carrier pipe inside the casing to assist future retrieval.

4.12 Asphalt Restoration

If the edges of the cut asphalt become ragged as a result of the construction operation, the asphalt shall be re-cut to form a straight line prior to placing new pavement. The edges of the existing asphalt shall be thoroughly clean and coated with an approved bituminous bonding agent prior to placing the new hot asphalt mix. The finished grade of the asphalt surface shall conform with that of the existing surface such that no rises, depressions or ridges result from the repaving process.

4.13 Leakage Tests

Following final trench backfilling, leakage tests shall be performed on all installed piping according to AWWA C600, Latest Edition. Tests shall be conducted in the presence of the Village Engineer with 24 hour notice provided to the Village in advance of the test. A leakage test shall be conducted after all mains and service connections have been completely installed and backfilled. The Owner shall furnish all necessary apparatus, test water and labour to conduct test. Leakage tests shall be performed in the following manner:

The section to be tested shall be filled with water and all air expelled from the piping. It is recommended that the test section be filled with water for at least 24 hours prior to testing. By pumping water into the test section, the pressure within the piping shall be increased to the pressure rating of the main or at least 1 1/2 times the operating pressure at the point of testing, whichever is greater. This pressure shall be maintained constantly in the pipe within ± 35 kPa throughout the duration of the test, by the addition of make-up water. The duration of the test shall be a minimum of 2 hours. Hydrant leads shall be shut off at the hydrant such that the hydrant is placed under test. The quantity of water pumped into the test section to maintain the specified pressure over the period of the test shall be considered to be the leakage. Piping will not be accepted until the leakage is less than the maximum allowable leakage determined from the following formula,

$$L = \frac{NDP^{1/2}}{131{,}000} \text{, where:}$$

L	=	the allowable leakage in L/hr;
N	=	the number of joints in the test section;
D	=	the nominal diameter of the pipe in mm; and
P	=	the average test pressure during the leakage test, in kPa, not to vary more than ± 35 kPa.

Should any test disclose leakage greater than that specified above, the source of the leakage shall be located and the defect repaired or the necessary replacement made and the section retested until a satisfactory test is obtained. All repairs to the work shall be made with new material equivalent to that requiring repair or replacement. The use of repair and maintenance aids such as clamps will not be permitted.

Leakage tests shall be carried out between valved sections of the installation such that every valve in the system is tested for leakage in the shut-off position.

4.14 Flushing

The pipe shall be cleaned of dirt and other foreign materials. The pipe shall be flushed at water velocities of 1 m/s or as high a velocity as can be obtained from the available water source. Flushing time shall be at least five times the time required to travel the main at 1.5 m/s velocity. Flushing shall continue for the required time or until 10 minutes after the water has cleared, whichever is greater.

4.15 Chlorination

On completion of the flushing operation, main pipes and services shall be chlorinated. Chlorination procedures shall conform to AWWA C651, Latest Edition. No pills, powders or solids shall be placed in the main during installation or for chlorination purposes. Chlorination shall be applied by the continuous feed method.

After preliminary flushing, the chlorine solution shall be injected at a measured rate such as to fill the main with a 25 mg/L available chlorine solution.

All appurtenances shall be operated in this solution to disinfect them. All measures shall be taken to prevent the disinfectant solution from flowing into existing water supply system. The disinfecting solution shall remain in the main for 24 hours and shall have no less residual than 10 mg/l at the end of that period. Following disinfection of lines to the required standard, the line shall have a final flushing to completely purge all disinfecting solution. Any water with residual greater than 2.5 mg/L shall be diluted prior to discharging to an open ditch. Flushing shall continue for 15 minutes after a concentration of 1 mg/L is reached. Water with a chlorine concentration greater than 1 mg/L shall not be discharged to a recognized water course without the approval of the Ministry of Environment. A log of all test results and disinfection procedures shall be submitted to the Village Engineer. On completion of chlorination, the entire piping system shall be thoroughly flushed, filled with water and left in a condition ready for use.

4.16 Materials Testing

The Village shall be provided with copies of all sieve and compaction test results pertaining to bedding, backfill, and road restoration.

4.17 As Constructed Drawings

Prior to final acceptance, the Owner shall deposit with the Village one computer diskette (3½") in AutoCAD (latest version) format and one set of original as-constructed mylar drawings showing all the information requested by this schedule and conforming to the criteria set out in Schedule I.