SECTION 6 – SANITARY SEWER SYSTEM
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(REVISED MAY 2020)

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DESIGN CRITERIA

6.01 SCOPE

.1 All design and construction of sanitary sewers shall conform in general to these criteria and to the standard drawings and construction specifications. Changes may be authorized by the City of Nanaimo for specific projects. The following criteria shall be used in preparing construction drawings.

6.01A SEWAGE FLOWS

.1 Sanitary sewer systems shall be designed to accommodate peak sewage flows with an allowance for inflow and infiltration. The discharge of storm water into the sanitary sewer system will not be allowed.

.2 Design contributory populations shall be computed in accordance with the City of Nanaimo population predictions or with the planned development in the tributary area based on the Official Community Plan, whichever is the larger.

.3 In the absence of detailed design population information, the following minimum design population densities shall be used:

AREAS	POPULATION DENSITY
Single Family Dwellings	2.8 ppu or 36 pph
Low Density Multiple Family Dwellings	1.7 ppu or 48 pph
High Density Multiple Family Dwellings	1.7ppu or 120 pph
Industrial equivalent of	36 pph
Commercial equivalent of	90 pph (incl. parking)
Institutional equivalent of	50 pph (incl. parking, but not green space)

ppu = persons per unit
pph = persons per hectare

.4 Peak sewage flow shall be established by multiplying an average dry weather flow (ADWF) rate of 230 litres per capita per day by a peaking factor (PF) to obtain peak dry weather flow (PDWF). The peaking factor shall be based on the Harmon formula:

$PF = 1 + 14/(4+P^{0.5})$ ***(REVISED MAY 2020)***

Where P is the design contributory population, in thousands.

Where the service population exceeds 100, a sanitary sewer model approved by the City Engineer shall be used. ***(REVISED MAY 2020)***

.5 Peak Inflow and Infiltration (I&I):

(a) Peak inflow and infiltration (I&I) shall be calculated based on a minimum rate of 25,000 litres per hectare of design tributary area per day, or at rates approved by the City Engineer for the general tributary area, for I&I from a 1:25 year, 24 hour storm.

.6 Design sewage rates of flow shall be computed by adding peak sewage flow to peak inflow and infiltration.

.7 Sanitary sewage design calculations shall be prepared in a format in accordance with Appendix H1 – Sanitary Sewer Flow Analysis – Calculation Sheet.

6.02 SEWAGE CHARACTERISTICS

.1 Sewage quality criteria shall be as follows:

Sewage Quantity (AWDF) in the

Direct Service Area	Constituent	Normal Average	Maximum Short Duration
less than 50,000 L/d	BOD (Biological Oxygen Demand) 5 day 20°C	1000 mg/L	2000 mg/L
	TSS (Total Suspended Solids)	800 mg/L	2000 mg/L
	pH	4 – 10.5	3.5 – 11
	Temperature	79°C	95°C
50,000 to 450,000 L/d	BOD (Biological Oxygen Demand) 5 day 20°C	400 mg/L	1000 mg/L
	TSS (Total Suspended Solids)	300 mg/L	1000 mg/L
	pH	5 – 9.5	4 – 10.5
	Temperature	66°C	80°C
Over 450,000 L/d	BOD (Biological Oxygen Demand) 5 day 20°C	200 mg/L	500 mg/L
	TSS (Total Suspended Solids)	200 mg/L	500 mg/L
	pH	5.5 – 9.0	5 – 9.5
	Temperature	54°C	65°C

.2 Regulations governing the quality of wastes acceptable for admission to Regional District of Nanaimo facilities shall be followed.

.3 For industrial and commercial developments, flow sampling and pre-treatment may be required prior to discharge to City of Nanaimo facilities.

6.03 HYDRAULICS

.1 No gravity sewer shall be less than 200 mm in diameter except that in residential areas 150 mm diameter may be approved by the City Engineer in the final section of a gravity sewer, providing the pipe has the required capacity and extension in the future, is precluded by physical barriers or there is existing alternate pick-up of adjacent areas. Unless otherwise approved by the City Engineer downstream pipe diameter shall be greater than or equal to upstream pipe diameter.

.2 Except under special circumstances, gravity sewers shall be designed to achieve a minimum daily self-cleansing velocity of 0.75 m/s.

.3 A Mannings roughness co-efficient of 0.013 shall be used for design of gravity sewers and service connections.

.4 Design of gravity sewers to flow at less than 70% of diameter. For new development, replace existing mains that front the proposed developments or are within areas of proposed road works if the flow exceeds 50% of diameter or it does not meet the minimum pipe diameter requirement. ***(REVISED MAY 2020)***

.5 Service connections shall be 100 mm in diameter minimum. Service connections to other than single family dwellings shall be minimum 150 mm diameter in accordance with design flows and available grades. Water and sewer services in a common trench shall be in accordance with the requirements of the Ministry of Health.

.6 Minimum grade of gravity sewers are as required to obtain the minimum velocity of 0.75 m/s, except for terminal sewers which are to be as follows:

(a)	Sewers servicing less than 10 houses	1.0% minimum grade
(b)	Sewers servicing less than 25 houses	0.6% minimum grade

6.04 PIPING

.1 Depths:

(a) Depths of all gravity sewer mains and service connections shall be such that all basements in the area the sewer is intended to serve can be drained by gravity. Where properties cannot be serviced by a gravity connection, an explanation of the reasons shall be submitted to the City Engineer for approval. Pump stations from individual properties, shall have a gravity connection from the property line to the main sewer pipe.

(b) Minimum cover on gravity sewers shall be 1.5 m in travelled roads and 1.0m in untraveled areas. Unless otherwise approved by the City Engineer, the maximum cover depth over gravity sewers is 4.5 m.

(c) Minimum cover on service connections shall be 750 mm from finished grade.

(d) Where minimum cover cannot be provided, an explanation of the reasons and pipe loading calculations shall be submitted with the proposed method of pipe protection to the City Engineer for approval. Design services shall meet the minimum building elevation based on the lot topography in order to avoid excessively deep service inspection assemblies.

.2 Deflected Sewers: ***(REVISED MAY 2020)***

(a) Horizontal curves on sewers require approval from the City Engineer. ***(REVISED MAY 2020)***

(b) Horizontal curves will be considered where the configuration of the property lines requires curvature for a constant offset and where the design velocity exceeds 1 m per second. ***(REVISED MAY 2020)***

(c) Curvature will be achieved through joint deflection only, bending of the pipe barrel will not be permitted. Joint deflections shall not exceed 50% of the manufacturer's maximum recommended joint deflection. Radius of curvature shall be uniform throughout the curves. ***(REVISED MAY 2020)***

(d) Vertical curves may be approved by the City Engineer where excessive depths or rock cuts are to be avoided or where energy dissipation is required. ***(REVISED MAY 2020)***

(e) Only one vertical and/or horizontal curve shall be permitted between manholes.

.3 Location of Sewers:

(a) Wherever possible, sewers shall be located on the high side of the street centre line where only the high side is served by the sewers and on the low side of the street where both sides are served by the sewers. Normal sanitary sewer main offsets are shown in the standard drawings for roadways. Wherever possible, the sewer shall be located on the opposite side of the street centreline from the watermain and at a constant offset from the property line.

(b) Sanitary sewers and service connections shall be located not less than 3.0 m horizontally and 0.45 m vertically distant from all water pipes, unless otherwise approved by the Provincial Department of Health.

(c) Sanitary sewer mains may be installed in a common trench with storm sewers provided the minimum outside pipe separation is 300 mm.

(d) All lots shall be provided with a sanitary sewer service connection unless otherwise approved by the City Engineer. Service connections shall be located to the offsets as shown on Standard Drawing No. T-7.

.3A Utilities in Private Lands:

The following shall be considered in the design of utilities crossing private lands:

(a) The design of utilities shall avoid crossing private lands as much as possible. Low pressure sewer systems with a downstream connection to a gravity or pressure sewer in the public road fronting the property are preferred in place of gravity sewers crossing private lands. ***(REVISED MAY 2020)***
(b) Utilities following property boundaries across private lands shall generally be offset a minimum 2.0 m from the property boundary.
(c) Appurtenances such as manholes, valves, etc., shall not be located on property boundaries.
(d) Utilities shall not cross private parcels in such a manner that they render the property unusable. Special consideration must be given to ensure the location of the utility crossing minimizes the limitations on the future use of the property.
(e) For minimum widths of statutory right-of-way and working widths refer to Appendix D.
(f) For a sample statutory right-of-way condition sheet, refer to Appendix C, Standard Drawing No. RW-2.
(g) For an Easement Release and Inspection Form Following the Construction of the Utility, refer to Appendix C.

.4 Service Connection Lengths, Grade and Alignment:

(a) The maximum length of a sanitary sewer service connection as measured horizontally between the sanitary sewer and the property line shall be 30m. Sanitary Sewer services longer than 30 m shall require approval by the City Engineer. All inspection assemblies required for service connections in excess of 30 m in length shall be shown on the design drawings.
(b) Service connections shall be designed at a grade of not less than two percent (2%) unless otherwise directed by the Engineer.

.4A Number of Service Connections per Lot:

(a) Each lot shall be serviced by one only service connection for sanitary sewer.

.5 Selection of Pipe Material and Class:

(a) For determination of pipe material and class, the Engineer shall consider earth and live loading, depth of bury, soil conditions and design life of the installation. Pipe selection requires approval by the City Engineer.
(b) High Density Polyethylene (HDPE) pipe (Smooth Profile) is for special applications and shall only be considered in special situations where other types of pipe are not suitable.

6.04A MANHOLES

.1 Distances between manholes shall not exceed 120 m, unless otherwise approved by the City Engineer.

.2 Manholes shall be located at grade and alignment changes, at pipe size changes, at the upstream end of all gravity sewers, and at the junctions of all gravity sewers.

.3 Cleanouts may not be substituted for manholes at the upstream end of gravity sewers. Temporary cleanout structures may only be used at the discretion of the City Engineer where there is development phasing.

.4 Minimum Drop in Invert Elevations Across Manholes: ***(REVISED MAY 2020)***

Alignment Change	Minimum Drop Across Manhole
Straight run	No drop required
Deflections up to 45 degrees	30 mm
Deflections 45 to 90 degrees	60 mm

(REVISED MAY 2020)

(a) Where the difference in elevation between incoming and outgoing sewers exceeds 600 mm, standard drops for pipe sizes 375 mm or less shall be used as shown in the Standard Drawings. Differences in elevation between 150 mm and 600 mm shall be avoided where possible. Inside drops into a diameter manhole may be permitted at the discretion of the City Engineer, only under exceptional circumstances. The inside drop manhole shall accommodate the incoming sewer without compromising workings space with the manhole. ***(REVISED MAY 2020)***

.5 Precast manhole barrels shall be sized according to nominal inside pipe diameter and depth as detailed below:

Pipe Size (Nominal)	Depth of Manhole (Top of Cover to Inv.)	Barrel Size (Inside Dia.)
150 – 375 mm	0 - 5.9 m	1050 mm
150 – 375 mm	6.0 - 9.0 m	1200 mm
150 – 600 mm	9.0 m or greater	1500 mm
400 – 600 mm	0.0 - 8.9 m	1200 mm
675 – 1050 mm	All Depths	1500 mm

.6 Where cast in place type manholes are proposed, design and construction details shall be submitted to the City Engineer for approval.

.7 Manholes shall be located to avoid and conflict with curb and gutter or sidewalks.

.8 A watertight manhole frame and cover shall be required for all sewer manholes located in areas where flooding can occur or in areas subject to vandalism (i.e. Parks, undeveloped rights-of-way, etc.).

.9 On trunk mains, as identified by City staff, manholes shall be designed to accommodate surcharging and shall include sealed lids fastened to the manhole. ***(REVISED MAY 2020)***

6.05 PUMPING STATIONS

.1 This section applies to all municipal owned and operated sanitary sewer pumping stations. Properties serviced by individual sewer pumps shall be connected to the municipal sewer system by a gravity service connection from the property line to the municipal sewer system. Non-municipal owned sewer pumps shall conform to the Provincial Health Branch requirements and the City of Nanaimo Building Bylaws.

.2 Sanitary sewer pumping stations shall be permitted only at locations where gravity connections from an existing or proposed trunk sewer, as identified by City staff, cannot be provided. Pump stations require approval from the City Engineer. The extent of the works and technical specifications shall be determined on a site specific basis at the discretion of the City Engineer. ***(REVISED MAY 2020)***

.3 Provisions for odour control are to be considered as part of pump station and force main design. ***(REVISED MAY 2020)***

6.06 FORCE MAINS

.1 All force mains shall be designed for a 1 m/s minimum velocity. If the sewage detention time at the minimum design ADWF, exceeds 12 hours, special consideration must be given for odour control. ***(REVISED MAY 2020)***

.2 Force mains shall be designed without high points unless otherwise approved by the City Engineer. If approved, an air-relief valve shall be provided at high points in the line.

.3 The top of the force main shall be below the hydraulic grade line at minimum pumping rate.

.4 Force mains shall be designed using a Hazen Williams roughness coefficient of 140 for PVC and HDPE pipe with minor losses accounted for separately with all fittings and valves. ***(REVISED MAY 2020)***

6.06A LOW PRESSURE SEWERS ***(REVISED MAY 2020)***

.1 General: ***(REVISED MAY 2020)***

(a) The City may consider low pressure sanitary sewer systems for areas which are beyond the reaches of the City gravity sewer system and not large enough to provide economic justification for a community sewage pump station, or where soil conditions or topography are not suitable for a gravity sewer system. A low pressure sanitary sewer system consists of on-site, privately owned and operated sewage pump unit with discharge pipes connected to either an inspection chamber at property, or City owned gravity sewer, or a City owned and operated low pressure sewage force main. ***(REVISED MAY 2020)***

(b) Systems in which private pump units discharge into a public gravity sewer or force main from a public community sewage pump station are not classified as low pressure sanitary sewer systems. Where specifically indicated herein, some of

the items included in this Low Pressure Sewers section are applicable to such other pumped systems. ***(REVISED MAY 2020)***

(c) Pump unit details design and all ancillary components designed within the private property shall be certified by the Consultant, and the intent of this Section is to provide design guidelines to the Consultant. ***(REVISED MAY 2020)***

.2 Restrictive Covenant: ***(REVISED MAY 2020)***

(a) The land title for each legal lot served by a private pump unit located on the subject lot shall include a restrictive covenant, filed by the property owner, requiring the property owner to install a pump unit and service connection pipe to the City service box. The required format of the restrictive covenant will be provided by the City at the Building Permit stage. ***(REVISED MAY 2020)***

(b) The ownership and the responsibility for the operation and maintenance of the pump chamber and the service pipe on private property is that of the property owner. Ownership and responsibility for the operation and maintenance of the service box and service pipe on City property or right-of-way is that of the City. ***(REVISED MAY 2020)***

(c) The portion of service connection pipe and service box to be located on public property or right-of-way will be completed by the City at the Bylaw Rate for this type of service. ***(REVISED MAY 2020)***

.3 Codes and Standards: ***(REVISED MAY 2020)***

Low pressure sewer systems and the components therefore will be designed and constructed in conformance with the following codes and standards: ***(REVISED MAY 2020)***

(a) Canadian and British Columbia Electrical Code. ***(REVISED MAY 2020)***

(b) British Columbia Public Health Act and Sewage System Regulation. ***(REVISED MAY 2020)***

(c) British Columbia Plumbing Code. ***(REVISED MAY 2020)***

(d) City of Nanaimo Manual of Engineering Standards and Specifications. ***(REVISED MAY 2020)***

(e) WorkSafeBC Regulations. ***(REVISED MAY 2020)***

.4 System Layout: ***(REVISED MAY 2020)***

(a) The preliminary layout of a proposed low pressure sewer system should be approved by the Engineer before detailed design proceeds. ***(REVISED MAY 2020)***

.5 Preliminary Design: ***(REVISED MAY 2020)***

(a) The following information is required as part of the preliminary design submission: (REVISED MAY 2020)

(i) Plan of the entire area to be served by the proposed system, including adjacent lands that cannot be serviced by a gravity sewer system or community sewerage pump station; ***(REVISED MAY 2020)***

(ii) Topographic plan; ***(REVISED MAY 2020)***
(iii) Report on soil conditions; ***(REVISED MAY 2020)***
(iv) Preliminary layout; ***(REVISED MAY 2020)***
(v) Area development sequence and timetable, and ***(REVISED MAY 2020)***
(vi) Pump unit power requirements. ***(REVISED MAY 2020)***

.6 Detailed Design: ***(REVISED MAY 2020)***

(a) At the detailed design stage, the following information will be submitted to the Engineer for review and approval: ***(REVISED MAY 2020)***

(i) Hydraulic Grade Line (HGL) for the City force main; ***(REVISED MAY 2020)***
(ii) Location and elevation of each pump unit, valve chamber and service connection; ***(REVISED MAY 2020)***
(iii) Pump head and capacity requirements, plus recommended manufacturer and model, pump curve, and power requirements; ***(REVISED MAY 2020)***
(iv) Pump chamber diameter, depth, operation levels and configuration (simplex or duplex); ***(REVISED MAY 2020)***
(v) Location and direction of flow of each lateral, branch and main, plus details of the system discharge point. Sewer system should be designed to minimize the length of runs and avoid abrupt changes in direction; ***(REVISED MAY 2020)***
(vi) Location and elevation of system high points, where high points are unavoidable; ***(REVISED MAY 2020)***
(vii) Maintenance flushing volumes and frequency for each run; ***(REVISED MAY 2020)***
(viii) Qualifications of supplier of pump unit package as indicated under pump unit general requirements, and; ***(REVISED MAY 2020)***
(ix) Sample of Operation and Maintenance manual to be provided with pump unit. ***(REVISED MAY 2020)***

.7 System Hydraulic Design: ***(REVISED MAY 2020)***

(a) System hydraulic design will include complete hydraulic data for each section of the City force main including flows, heads, velocities and maximum retention times. Submission of this information will include a table showing all of the data for each anticipated stage of the system development. ***(REVISED MAY 2020)***

.8 Design Flows and Hydraulics: ***(REVISED MAY 2020)***

(a) Design flows for sizing pressure sewers, including Service Connections and City Force Mains, will be determined on the basis of the velocity and head criteria as summarized in these guidelines, and using one of the following procedures, depending upon the land use. ***(REVISED MAY 2020)***

(i) Single Family Residential Areas. ***(REVISED MAY 2020)***

1. For single family residential areas, estimate the number of pump units operating simultaneously as provided in Table: Low Pressure Pumps Operating Simultaneously. ***(REVISED MAY 2020)***

Table: Low Pressure Pumps Operating Simultaneously *(REVISED MAY 2020)*

Number of Single Family Residential Pumps Connected	Number of Pumps Operating Simultaneously
1	1
2 to 3	2
4 to 9	3
10 to 18	4
19 to 30	5
31 to 50	6
51 to 80	7
81 to 113	8
114 to 149	9

(REVISED MAY 2020)

(ii) Multi-Family, Non-Residential and Mixed Areas: ***(REVISED MAY 2020)***

1. The following formula may be used for any development in which pump capacities exceed those for single-family residences. For the upstream end of the system, where there are only one or two connections, assume the connected pumps are operating. Other approved hydraulic calculations may also be acceptable if approved by the City. ***(REVISED MAY 2020)***

Q_{design} = CP+F ***(REVISED MAY 2020)***

Where:

Q = Design flow in liters per second (L/s)
C = Coefficient based on land-use and peaking factor; standard value = 0.008.
P = Population or equivalent
F = Factor based on minimum flows; standard value = 2.10

.9 Hydraulic Calculations: ***(REVISED MAY 2020)***

(a) Criteria for hydraulic design calculations include the following: ***(REVISED MAY 2020)***

(i) Pipe flow formula: Hazen Williams, with friction coefficient C=130. ***(REVISED MAY 2020)***
(ii) Minimum velocity: V = 0.6 m/s; and ***(REVISED MAY 2020)***

(iii) Maximum operating head (total dynamic head, TDH): compatible with pumps and not to exceed 35 m (343 kPa) unless otherwise approved by the Engineer. ***(REVISED MAY 2020)***

(b) System test pressures will be 2.0 times the maximum operating head and not less than 700 kPa. ***(REVISED MAY 2020)***

.10 Pipe: ***(REVISED MAY 2020)***

(a) Minimum pipe sizes are as follows: ***(REVISED MAY 2020)***

(i) From pump unit to City low pressure force main: 38 mm ID; and ***(REVISED MAY 2020)***

(ii) City low pressure sewage force main: 50 mm Iron Pipe Size (IPS). Internal diameters will vary based on pipe wall thickness; the actual internal pipe diameter is to be used for hydraulic calculations. ***(REVISED MAY 2020)***

(b) Low pressure force mains shall be installed at a minimum depth of cover of 0.9 m when located within the City road right-of-way and 0.45 m on private property. The maximum depth shall not exceed 3.0 m unless approved by the Engineer. (REVISED MAY 2020)

(c) All joints on the force main shall be compatible with pipe material and fittings, and complete with appropriate thrust restraints. ***(REVISED MAY 2020)***

(d) The segment of force main between pump unit and City force main will include 150 mm wide Detectable Warning Tape placed above the Force Main at a depth of 150 mm below the ground surface. **(REVISED MAY 2020)**

.11 Cleanout and Pig Launching Manholes: ***(REVISED MAY 2020)***

(a) Cleanout and pig launching manholes are required on low pressure force mains at ends and at a maximum 300 m spacing. Details of the cleanouts are shown on the Standard Drawing No. S-18. ***(REVISED MAY 2020)***

.12 Air Valves: ***(REVISED MAY 2020)***

(a) Sewage air release valves may be required at system high points and major changes in grade (10% or greater) at the discretion of the City Engineer. Details of air valve assemblies are shown on the Standard Drawings. ***(REVISED MAY 2020)***

.13 Discharge: ***(REVISED MAY 2020)***

(a) Location and detail of low pressure sewer force main discharge will be subject to the Engineer's approval. Submerged outlets are not acceptable. Discharge details are shown on the Standard Drawings. ***(REVISED MAY 2020)***

(b) Refer to Standard Drawing No. S-17. ***(REVISED MAY 2020)***

(c) Refer to Standard Drawing No. S-19. ***(REVISED MAY 2020)***

.14 Service Connections: ***(REVISED MAY 2020)***

(a) Service connections to the City force main will include integral wye fittings oriented in the direction of flow. ***(REVISED MAY 2020)***

(b) Each service connection will include a valve chamber located on City property at the property line. Details of the valve chamber and fittings are shown on the Standard Drawings. Check valves will be bronze or stainless steel, full-ported, wye body ball check valves. ***(REVISED MAY 2020)***

(c) Refer to Standard Drawing No. S-16. ***(REVISED MAY 2020)***

.15 Pump Unit Requirements: ***(REVISED MAY 2020)***

(a) Pumps for low pressure systems will be submersible grinder pumps capable of discharging the design flow at the maximum operating head. Pump design flow will be the greater of PDWF or the flow required to achieve the minimum flow velocity. ***(REVISED MAY 2020)***

(b) General requirements include the following: ***(REVISED MAY 2020)***

(i) Pump unit package design, including the service connection, shall be sealed by the Consultant. ***(REVISED MAY 2020)***

(ii) All pump and control equipment will be certified by CSA, or an equivalent certification agency approved by the Engineer. ***(REVISED MAY 2020)***

(iii) Pump unit specifications are subject to approval by the Engineer. ***(REVISED MAY 2020)***

(iv) A building permit is required for a pump unit. ***(REVISED MAY 2020)***

(v) Duplex (two pump) units are required for multi-family and non-residential properties. ***(REVISED MAY 2020)***

(vi) The pump unit will be installed outside of the building in a location convenient for maintenance. The control/alarm panel will be located in close proximity to the chamber either outside or inside the building. ***(REVISED MAY 2020)***

(vii) Detailed, concise manufacturer's operating and maintenance instructions will be submitted to the City as part of the permitting application process. A copy of these instructions will be fastened to the inside of the control panel door. ***(REVISED MAY 2020)***

(viii) Pump unit suppliers will have documented experience and ability in design, supply and servicing of pump unit packages, including pump(s), chamber, piping and controls. ***(REVISED MAY 2020)***

(c) Grinder pumps will be either centrifugal or semi-positive displacement pumps. The grinder assembly will consist of hardened steel components designed to grind sewage solids into fine particles, which can pass easily through 32 mm diameter pump and piping passages. The electrical and control cable(s) from the pump shall have a minimum 30 m whip length. ***(REVISED MAY 2020)***

(d) Pump units discharging through 100 mm diameter or larger service connections into 150 mm diameter or larger low pressure force mains or gravity sewers may be solids-handling submersible centrifugal pumps. ***(REVISED MAY 2020)***

(e) Pump curves will be "steep" within the design operating range, where total head is below the maximum operating head, such that the reduction of capacity with increasing head does not exceed 0.03 l/s/m. ***(REVISED MAY 2020)***

(f) Pumps will be manufactured using durable, non-corrosive metallic components. ***(REVISED MAY 2020)***

.16 Pump Chamber Details: ***(REVISED MAY 2020)***

(a) Criteria for pump chamber design will include the following:

(i) Material and Construction: Fibreglass reinforced polyester (FRP) or high density polyethylene (HDPE) with smooth interior, bottom shaped to avoid solids build-up, walls and bottom or sufficient thickness or with exterior corrugations to withstand soil pressure, and base to include flange for concrete collar to prevent floatation; ***(REVISED MAY 2020)***

(ii) Chamber lid and connections (inlet, discharge, ventilation and electrical) will be factory installed and watertight. The lid will have structural capacity sufficient of the expected design load and will provide access to the full diameter of the tan; ***(REVISED MAY 2020)***

(iii) A minimum chamber diameter of 750 mm is required to provide for convenient operating and maintenance access; ***(REVISED MAY 2020)***

(iv) Depth to accommodate inlet and discharge pipe elevations and to provide sufficient operating and storage volumes; ***(REVISED MAY 2020)***

(v) Chamber volume between pump on and off level to be based on pup cycle times between 5 and 30 minutes, with preference for normal operating depth ranging from 150 mm to 200 mm. A typical operating volume for a single family residential unit is 200 litres; and ***(REVISED MAY 2020)***

(vi) Chamber volume for emergency storage (above normal pump on level) may be required based on the Engineer's review. Subject to approval by the Engineer, emergency storage or standby power may be required. ***(REVISED MAY 2020)***

.17 Piping Details: ***(REVISED MAY 2020)***

(a) Piping design criteria for the inside of the pump chamber is as follows: **(REVISED MAY 2020)**

(i) Pump chamber piping will be designed to accommodate easy pump removal and replacement. Unless an approved equivalent system is provided, pump chambers 1050 mm in diameter or greater, or with a depth of 1.8 m or greater, are to include a pump liftout coupling and slide rail system. ***(REVISED MAY 2020)***

(ii) Pump discharge piping is to include full ported check valve and ball valve. Where a slide rail system is not provided, a union is to be installed before the two valves, with the union, a check valve, and ball valve installed in that sequence in the direction of flow. ***(REVISED MAY 2020)***

(iii) An anti-siphon valve is required where a pump is located higher than any part of the low pressure system. ***(REVISED MAY 2020)***

.18 Pump Chamber Ventilation: ***(REVISED MAY 2020)***

(a) Each pump chamber is to include a vent pipe meeting the requirements of the BC Plumbing Code, and installed in accordance with the BC Plumbing Code. ***(REVISED MAY 2020)***

(b) Unless otherwise approved by the Engineer or Plumbing Inspector, the vent discharge is to be installed with a minimum of 450 mm cover below ground level, at a positive slope draining towards the pump chamber, to the building wall. At the building exterior, the vent should extend at least 1.8 m above ground, anchored to the building, and not within 3.0 m of doors or windows. ***(REVISED MAY 2020)***

(c) If approved by the Engineer or Plumbing Inspector, the vent discharge may be located either on the building exterior wall or attached to a post in a secure location if the pump chamber is remote from the building. ***(REVISED MAY 2020)***

.19 Electrical: ***(REVISED MAY 2020)***

(a) All materials and installation are to comply with the BC Electrical Code and City requirements. ***(REVISED MAY 2020)***

(b) Power supply will be from the building served by the pump unit. The following nominal service voltages will be acceptable:

(i) For residential installation: 120/208 V or 120/240 V, single-phase, and ***(REVISED MAY 2020)***

(ii) For industrial/commercial installations: as above, or 120/208 V, or 347/600 V, thee-phase. ***(REVISED MAY 2020)***

(c) Wiring from the building to the pump chamber will be underground and continuous, with no splices, whereby the installed length of wiring (horizontal plus vertical grade difference) between the control cabinet pump shall be less than the minimum whip length required for the pump. ***(REVISED MAY 2020)***

(d) Where a building electrical system includes emergency standby power, the pump unit power supply shall be connected to the emergency power. ***(REVISED MAY 2020)***

.20 Pump Chamber Classification: ***(REVISED MAY 2020)***

(a) Pump chambers for single-family and duplex residential service are not considered to be "hazardous locations" for electrical code purposes. ***(REVISED MAY 2020)***

(b) Pump chambers for multi-family and non-residential service are considered as Hazardous, Class 1 locations. Material and installation requirements for these locations are further classified as either Zone 1 or Zone 2, depending upon the standard of ventilation, as follows: ***(REVISED MAY 2020)***

(i) Zone 1: No mechanical (forced air) ventilation: ***(REVISED MAY 2020)***

- Motors must be "explosion-proof"; ***(REVISED MAY 2020)***

- Motors must have over-temperature protection, and ***(REVISED MAY 2020)***
- Float switches must have "intrinsic safe barriers". ***(REVISED MAY 2020)***

(ii) Zone 2: "Adequate" (forced air) ventilation: ***(REVISED MAY 2020)***

- 3 – phase submersible motors must remain fully submerged; ***(REVISED MAY 2020)***
- Single-phase submersible motors must remain fully submerged if they have no spark-producing devices. If they have spark-producing devices, these motors must be "explosion-proof", and ***(REVISED MAY 2020)***
- Float switches must have "intrinsic safe barriers". ***(REVISED MAY 2020)***

.21 Controls: ***(REVISED MAY 2020)***

(a) Pump controls will automatically start and stop the pump(s) and provide a high-level alarm. ***(REVISED MAY 2020)***

(b) Level switches will be either pressure switches, if approved by the Engineer, or float switches. ***(REVISED MAY 2020)***

(c) Power and control wiring will be continuous from the pump unit and level switches to junction boxes located above grade on the exterior of the building. Where the pump chamber is classified as hazardous, a conduit seal will be provided between the junction box and the control cabinet. ***(REVISED MAY 2020)***

(d) Subject to approval by the Engineer, or Building Inspector, the control cabinet will be installed in one of the following locations: ***(REVISED MAY 2020)***

(i) On an exterior building wall closest to the pump chamber; ***(REVISED MAY 2020)***

(ii) Inside The building near an outside door which is close to the pump chamber; or ***(REVISED MAY 2020)***

(iii) On a post adjacent to the pump chamber if the chamber is located 25 m or more away from the building. ***(REVISED MAY 2020)***

(e) If located outdoors, the control cabinet will be lockable and weatherproof (EEMAC Type 3) and made from non-corrosive materials. Junction boxes will be non-corrosive Type 4x, or NEMA 4 painted steel enclosure. ***(REVISED MAY 2020)***

(f) The control panel shall include the following features: ***(REVISED MAY 2020)***

(i) Control voltage limited to maximum 120 VAC; ***(REVISED MAY 2020)***
(ii) "Power on" light; ***(REVISED MAY 2020)***
(iii) Float switch indication lights; ***(REVISED MAY 2020)***
(iv) Green "pump on" light; ***(REVISED MAY 2020)***
(v) Red "motor overload" light; ***(REVISED MAY 2020)***
(vi) Manual reset of fault conditions; ***(REVISED MAY 2020)***
(vii) High level alarm light ("red" and buzzer); ***(REVISED MAY 2020)***
(viii) Pump disconnect switch; ***(REVISED MAY 2020)***
(ix) Motor starter; ***(REVISED MAY 2020)***
(x) Hand-Off-Auto (HOA) selector switch; ***(REVISED MAY 2020)***

(xi) Control transformer, if required to suit voltage; ***(REVISED MAY 2020)***
(xii) Automatic alternator for multiple pump units; ***(REVISED MAY 2020)***
(xiii) Control fuse; ***(REVISED MAY 2020)***
(xiv) Terminal strip, and; ***(REVISED MAY 2020)***
(xv) Form "C" (SPD) alarm contact, rated minimum 3A, 120 VAC, wired to a set of isolated Terminal blocks. ***(REVISED MAY 2020)***

(g) The alarm circuit will include an alarm light and signal/buzzer with a test/silence switch. If the control cabinet is mounted outside, the alarm light will be located outside and the alarm signal will be transmitted to an alarm box installed inside the building. ***(REVISED MAY 2020)***

(h) In non-residential and multi-family installations, a remote alarm using telephone auto-dialer or other suitable technology should be considered. ***(REVISED MAY 2020)***

6.07 SIPHONS

.1 Where a siphon (i.e., inverted sewer, depressed sewer) is required to carry flow under an obstruction such as a stream, the following criteria shall be applied to the design:

(a) All siphons shall be multiple-pipe structures.
(b) A cleansing velocity of 0.6 to 0.9 m/s shall be reached at least once a day in the primary pipe even during the first years of operation.
(c) The total system shall be sized to accommodate the ultimate design peak flow.
(d) A 1200 mm diameter manhole shall be provided on both ends of the siphon.
(e) Each manhole on the siphon shall be provided with a suitable vent.
(f) There shall be no high points in the siphon between manholes.
(g) There shall be no acute bends in the siphon.
(h) There shall be no change of pipe diameter between manholes.
(i) The primary pipe shall be minimum 200 mm in diameter wherever possible.
(j) All siphons shall have a separate debris sump manhole upstream of the siphon. The debris sump shall be designed to allow easy access for maintenance and cleaning and shall be suitably vented.

6.20 SCOPE

.1 This specification refers to gravity sewer pipe and appurtenant fittings for sanitary sewers. Only those products approved by the City Engineer and listed in the City of Nanaimo Approved Products List will be accepted for installation.

.2 Refer to Section 4.0 –Excavation, Trenching and Backfill for related specifications. ***(REVISED MAY 2020)***

6.21 MATERIALS TESTING

.1 If, in the opinion of the Engineer, testing is required, the Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates inadequacies, additional testing may be required by the Engineer.

.2 The Contractor as directed by the Engineer shall supply specimens or samples for testing.

.3 The types of tests listed below may be required by the Engineer unless in the opinion of the Engineer other testing is required.

.4 Joints for sanitary sewer main pipe and fittings and service connection pipe and fittings shall be capable of meeting the following exfiltration tests. The Engineer may require that these tests be carried out by the Contractor or his supplier prior to acceptance of pipe on the project.

(a) Pipes in Proper Alignment:

Not fewer than 3, or more than 5, pipes selected from stock by the Engineer shall be assembled according to standard installation instructions issued by the manufacturer. With ends bulkheaded and restrained against internal pressure, the section shall be subjected to 70 kPa internal hydrostatic pressure. Pressure shall be maintained for a period of 24 hours. There shall be no leakage at the joints.

(b) Pipes in Maximum Deflected Position:

At least 2 of the joints of the assembly shall be deflected to a maximum amount recommended by the manufacturer. 35 kPa internal hydrostatic pressure shall then be applied to the test section and maintained for a period of 24 hours. Joints shall show no leakage.

(c) Pipes in Maximum Lateral Misalignment:

The test section shall be supported on blocks or otherwise so that one of the pipes is suspended freely between adjacent pipes and bears only on the jointing material. The suspended pipe shall then be loaded on the bell or coupling by a load equal to one-third of the ultimate 3-edge bearing strength required by the applicable ASTM specification, except that pipe having a laying length of more than 1.2 m shall be loaded no more than the amount computed for a 1.2 m length. While under this load, stressed joints shall show no leakage under 35 kPa internal hydrostatic pressure.

6.22 PIPING, FITTINGS AND SERVICES

.1 The sizes and types of pipe to be used are shown on the drawings.

.2 Concrete Pipe:

(a) Non-reinforced concrete pipe and fittings shall conform to ASTM C14M, Class 3, to a maximum diameter of 600 mm and shall be designed with flexible rubber gasket joints conforming to ASTM C443M.
(b) Reinforced circular concrete pipe and fittings shall conform to ASTM C76M, Class III or higher, for all pipe greater than 600 mm diameter and shall be designed with flexible rubber gasket joints conforming to ASTM C443M.
(c) Pipe with chips, cracks, porous concrete or any other defects which impair joint sealing or durability will not be accepted.

.3 Polyvinyl Chloride (PVC) Pipe (Smooth Profile):

(a) Pipe and fittings up to 675 mm diameter shall be DR35. Pipe and fittings shall have a minimum pipe stiffness of 320 kPa at 5.0% deflection when tested in accordance with ASTM D2412.
(b) Pipe and fittings shall be manufactured to the following specifications:

100 mm – 375 mm dia. to ASTM D3034 and CSA B182.2
450 mm – 675 mm dia. to ASTM F679 and CSA B182.2

(c) Pipe and fittings shall include integral bell and spigot ends with stiffened wall section and a formed groove for a rubber gasket conforming to ASTM F477.
(d) All PVC sanitary gravity main pipes shall be green in colour.

.4 Ductile Iron Pipe:

(a) Pipe and fittings shall conform to ASTM A746 or as approved by the City Engineer.

.5 Polyvinyl Chloride (PVC) Service Pipe:

(a) All sanitary service inspection assemblies shall be white in colour.

(b) Sanitary service connections of 100 mm diameter shall be DR28 and conform to CSA B182.1. Pipe and fittings shall have elastomeric seal joints, locked in gasket and integral bell joint features.
(c) Sanitary service connections greater than 100 mm diameter shall be as specified for PVC (smooth profile) mainline pipe.

.6 High Density Polyethylene (HDPE) Pipe (Smooth Profile):

(a) Pipe shall conform to AWWA C906. All pipes to be certified by Canadian Standards Association – CSA B137.1. ***(REVISED MAY 2020)***
(b) Minimum acceptance pipe class shall be DR26 with hydrostatic design stress of 10 MPa.
(c) All pipe shall bear the pipe series and manufacturer's name.
(d) Fabricated HDPE mitred fittings shall conform to AWWA C906 and certified by Canadian Standards Association – CSA B137.1. Moulded HDPE fittings shall conform to ASTM D3261 suitable for pressure rating specified and fusion to main pipe. Pipe deflected up to manufacturer's recommended minimum radius may be used in place of fabricated miter bends and to form the required vertical and horizontal curves. Polyethylene fittings shall have a pressure rating at least equal to that of the pipe being joined. ***(REVISED MAY 2020)***

6.22A FORCE MAINS

.1 The sizes and types of pipes to be used are shown on the drawings.

.2 Ductile Iron Pipe:

(a) Pipe shall conform to AWWA C150 and C151 and shall be cement mortar lined in accordance with AWWA C104.
(b) Joints shall be a mechanical type conforming to AWWA C111 or shall be rubber gasket, bell and spigot tyton joint.

.3 Polyvinyl Chloride (PVC) Pressure Pipe:

(a) Pipe shall be ULC approved and have cast iron pipe equivalent outside diameter.
(b) Pipe shall be manufactured and certified to the following specifications: ***(REVISED MAY 2020)***

100 mm – 900 mm dia. to AWWA C900 and CSA B137.3 ***(REVISED MAY 2020)***

(c) Pipe shall be compatible with mechanical and push-on joint fittings and valves without the use of special adapters.
(d) Pipe shall include push-on integrally thickened bell and spigot type joints conforming to ASTM D3139 with single elastomeric gasket conforming to ASTM F477.
(e) All PVC sanitary force main pipe shall be white in colour.

.4 High Density Polyethylene (HDPE) – Smooth Profile:

(a) High Density Polyethylene (HDPE) pipe shall conform to Section 6.22.6, except that the minimum acceptable pipe class shall be DR21.

6.22B LOW PRESSURE SEWERS *(REVISED MAY 2020)*

.1 Low pressure sewers are to follow the specifications identified for force mains as per Section 6.22A – Force Mains. ***(REVISED MAY 2020)***

6.23 JOINTS

.1 Sanitary sewer main pipe and fittings and service connections pipe and fittings shall be jointed with a rubber gasket or other preformed, factory-manufactured gasket or approved material designed for use with the specified pipe. Solvent connected joints and fittings will not be permitted.

.2 High Density Polyethylene (HDPE) Pipe (Smooth Profile) Joints:

(a) Joints shall be by thermal butt-fusion and constructed in accordance with the manufacturer's specifications.
(b) Flange joints shall be used to join long sections of butt-jointed pipe or as shown on the construction drawings.
(c) Flanges for polyethylene pipe shall be slip-on type installed in conjunction with stub ends supplied by the pipe manufacturer. The flanges shall be Class 150 meeting ANSI B16.5 drilling dimensions. Flanges shall be carbon steel.
(d) All flanged joints shall be separated by a full face neoprene gasket bonded to one of the flange faces. Neoprene for flange gaskets shall be 3 mm thick with holes drilled for flange bolts and size equal to flange diameter. ***(REVISED MAY 2020)***
(e) Flanged joints and flange bolts shall be stainless steel, complete with isolation washers.
(f) Refer to Section 6.46 for fitting and joint installation.

6.24 SERVICE CONNECTION JUNCTIONS ***(REVISED MAY 2020)***

.1 Concrete Pipe (non-reinforced and reinforced):

(a) Service connections shall be manufactured using a sanded PVC male end stub pipe with integral bell.
(b) Stub orientation shall be at 45° to the centreline of the mainline pipe for pipe diameter less than 1050 mm (between 1 o'clock and 2 o'clock or 10 o'clock and 11 o'clock orientation).
(c) Stub orientation may be at 90° to the centreline of the mainline pipe for pipe diameters of 1050 mm or larger (at 3 o'clock and 9 o'clock orientation).
(d) Field break-in and mortar patch joints shall not be used unless approved by the City Engineer. Refer to Section 6.48 for service connection junction installation.

.2 PVC Pipe (Smooth Profile):

(a) Service connections to PVC mainline pipe shall be made with extrusion molded PVC or fabricated PVC fittings manufactured to ASTM D3034, CSA B182.1 and CSA B182.2.
(b) The use of saddles instead of manufactured wye fittings shall require approval by the City Engineer. Refer to Section 6.48 for service connection junction installation.
(c) For connections more than two pipe sizes smaller than the mainline, prefabricated service saddle connections may be approved. ***(REVISED MAY 2020)***

.3 PVC Pipe (Ribbed Profile):

(a) Ribbed pipe shall only be used if repairing an existing ribbed pipe section.
(b) Service connections to ribbed PVC mainline pipe shall be made with extrusion molded or fabricated PVC fittings manufactured to ASTM D3034, CSA B182.1 and CSA B182.2. ***(REVISED MAY 2020)***
(c) For connections more than two pipe sizes smaller than the mainline, prefabricated service saddle connections may be approved.

.4 High Density Polyethylene (HDPE) Pipe (Smooth Profile):

(a) Service connections to HDPE mainline pipe shall be made with manufactured fittings, electro-fused, or heat welded to the main. Mechanical connections, if used, shall be water-tight.
(b) Refer to Section 6.48 for service connection junction installation.

.5 High Density Polyethylene (HDPE) Pipe (Open Profile):

(a) Service connections to HDPE mainline pipe shall be made with extrusion molded or fabricated fittings manufactured to CSA B182.1, B182.2 and B182.4.
(b) For service connections more than two pipe sizes smaller than the mainline, prefabricated service saddle connections may be approved.
(c) Refer to Section 6.48 for service connection junction installation.

6.25 PRECAST MANHOLE SECTIONS

.1 Unless otherwise approved, all manhole sections shall be precast reinforced concrete in accordance with ASTM C478.

.2 All precast sections shall be complete with ladder rungs.

.3 O-ring rubber gaskets shall conform to ASTM C443.

.4 Refer to Section 6.51 for precast manhole sections installation.

6.25A PRECAST MANHOLE BASES

.1 Precast manhole bases shall be reinforced concrete in accordance with ASTM C478. ***(REVISED MAY 2020)***

.2 All dimensions, specifications and installations shall conform to the requirements for cast in place manhole bases in accordance with Section 6.49 – Cast In Place Manhole Concrete Bases, Section 6.49A – Precast Manhole Bases and the Standard Drawings.

.3 Pipe alignment, grade and invert elevations in the precast manhole bases shall conform to the construction drawings.

6.26 MANHOLE TOPS

.1 Manhole tops shall be flat slab, precast concrete. Tops shall be reinforced to meet H-20 loading conditions. Precast tops shall conform to ASTM C478 with approved offset opening for frame and cover. ***(REVISED MAY 2020)***

6.27 MANHOLE COVERS AND FRAMES

.1 Covers and frames shall be cast iron and certified to meet H-20 loading requirements with the bearing faces of the cover to be frame machined for a non-rocking fit. ***(REVISED MAY 2020)***

.2 Patterns, dimensions and weights shall be in accordance with the Standard Drawings. Covers shall have “CITY OF NANAIMO SANITARY SEWER” permanently embossed on the cover.

.3 Standard manhole frame and cover shall conform to Standard Drawing No. S-9 – Sanitary Manhole Cover and Frame.

.4 Utility chamber manhole frame and cover shall conform to Standard Drawing No. S-10.

.5 A watertight manhole frame and cover, if required shall conform to Standard Drawing No.S-15 – Watertight Sanitary Manhole Frame and Cover.

.6 Covers located in statutory rights-of-way shall be permanently embossed with the additional wording “DO NOT COVER”.

.7 Refer to Section 6.53 for frames and covers installation.

6.28 MANHOLE STEPS

.1 Steps shall conform to ASTM C478 for manhole steps and ladders and shall be:
19 mm diameter aluminum allow conforming to CSA S157.

.2 Refer to Section 6.54 for manhole steps installation.

6.29 -NOT USED-

6.30 CONCRETE

.1 Concrete for cast in place manhole bases shall conform to Section 11.0 – Cast In Place Concrete Works. ***(REVISED MAY 2020)***

6.31 PRECAST CONCRETE GRADE RING

.1 Precast concrete grade rings conforming to ASTM C478 shall be used.

.2 For roads with steep grades, concrete grade rings are to be used in conjunction with an adjustable manhole frame assembly. ***(REVISED MAY 2020)***

6.32 TEMPORARY CLEANOUT FRAMES AND COVERS

.1 Temporary cleanout structures may only be used at the discretion of the City Engineer where there is development phasing.

.2 Temporary cleanout frames and covers shall be as specified for sanitary manhole frames and covers.

6.33 PIPE AND FITTINGS FOR DROP MANHOLE STRUCTURES

.1 Pipe and fittings for drop manhole structures shall be as specified under Section 6.22 – Piping, Fittings and Services and Section 6.23 – Joints.

.2 Refer to Section 6.55 for drop manhole structure installation.

6.34 -NOT USED-

6.35 MANHOLE AND TEMPORARY CLEANOUT LID MARKERS

.1 Markers are required, where manhole and temporary cleanout lids are not located within developed road rights-of-way or residential properties, to indicate the location of the manholes and temporary cleanouts. These markers shall be constructed of 50 mm galvanized steel pipe painted with a minimum of two coats of yellow exterior duty paint applied in accordance with the manufacturer's recommendations and set in a concrete base. The markers shall extend one (1) metre above the ground surface. The markers shall be located on site at a location determined by the Engineer opposite the manhole or temporary cleanout lid and the distance to the lid is to be marked in black figures on a flattened upper portion of the marker. See Standard Drawing No. S-14.

6.36 SERVICE BOXES

.1 Service boxes for single sanitary sewer services shall be 300 x 500 mm concrete boxes complete with cast iron traffic cover marked "Sewer" and concrete extension sections as required.

.2 Service boxes for twin sanitary sewer services shall be 425 x 750 mm concrete boxes complete with steel traffic cover marked “Sewer” and concrete extension sections as required.

6.37 PUMPING STATIONS

.1 The specifications shall be determined on a site specific basis at the discretion of the City Engineer.

6.40 TRENCH EXCAVATION, BEDDING AND BACKFILL

.1 Refer to Section 4.0 –Excavation, Trenching and Backfill for installation requirements. ***(REVISED MAY 2020)***

6.40A PIPE ALIGNMENT AND GRADE

.1 The pipe shall be laid on the alignment and grade in accordance with the construction drawings. Methods to maintain pipe alignment and grade must be approved by the Engineer. Each pipe shall be check for line and grade as it is installed.

.2 Unless otherwise direct for the Engineer, tolerances for pipe alignment and grade shall be:

Alignment	=	± 50 mm
Grade	=	± 10 mm

6.41 PIPE CUTTING

.1 Pipe cutting shall be done in the manner recommended by the pipe manufacturer employing tools designed for this purpose.

6.42 PIPE INSTALLATION

.1 Pipe shall be installed in strict accordance with the manufacturer's recommended practice.

.2 Pipe shall be checked before being lowered into the trench to ensure that no foreign material, manufacturer's defects, or cracks exist that might prevent the proper jointing of the pipe or its operation.

.3 The open end of the pipe in the trench shall be suitably covered to prevent entrance of trench water and other material during periods when pipe is not being installed.

.4 Precautions shall be taken to ensure that displacement of the pipe in the trench does not occur though soil displacement or floatation doe to the presence of trench water. Pipe that has been displaced shall be removed from the trench and re-laid.

.5 Lifting holes in concrete pipe shall be plugged with prefabricated plugs in non-shrink grout, or other plugs recommended by the pipe manufacturer.

.6 The contractor shall use methods for installing pipe in an auger hole or casing pipe as described on the construction drawings.

6.42A FORCE MAIN INSTALLATION

.1 Force mains shall be installed according to installation requirements in Section 6.42 – Pipe Installation.

.2 Thrust blocking to be installed in accordance with Section 5.47 – Pipe Restraint.

6.42B LOW PRESSURE SEWERS INSTALLATION ***(REVISED MAY 2020)***

.1 Low pressure sewers shall be installed according to requirements in Section 6.42 – Pipe Installation. ***(REVISED MAY 2020)***

6.43 JOINTS AT RIGID STRUCTURES

.1 A flexible joint shall be provided at locations where the pipe is held in fixed position by a rigid support or structure. The distance from the support or structure shall depend on the diameter and type of pipe being installed and shall be in accordance with the pipe manufacturer's recommended practice. The purpose of the flexible joint is to prevent pipe failure due to uneven support under the pipe. Approved flexible joints include rubber gasket bell and spigot connections and couplings. ***(REVISED MAY 2020)***

6.44 HORIZONTAL AND VERTICAL CURVES

.1 Pipe on horizontal and vertical curves shall be laid true to the curve of the radius shown on the drawings. For acceptable curvature, refer to Section 6.04.2. Horizontal and vertical curves are only permitted where approved by the City Engineer. ***(REVISED MAY 2020)***

6.45 DEFLECTION

.1 The amount of pipe deflection at joints and couplings shall be the limit as specified in Section 6.04.2. ***(REVISED MAY 2020)***

6.46 FITTINGS AND JOINTS

.1 Fittings shall be installed at the locations shown on the construction drawings or as directed by the Engineer. Fittings shall be installed in accordance with the manufacturer's specifications.

.2 High Density Polyethylene (HDPE) Pipe (Smooth Profile):

(a) Pipe shall be joined by the thermal butt fusion method.
(b) The contractor shall make arrangements to have the pipe jointing carried out by the pipe manufacturer or certified personnel, familiar with the jointing technique, using equipment and techniques specifically designed for the pipe diameter and material being jointed.
(c) Where required, flanged joints shall be used for connecting long pipe sections.
(d) The joint shall consist of a polyethylene stub end butt fused to the end of pipe and a carbon steel slip-on flange.
(e) Refer to Section 6.23 for joint specifications.

.3 Sewage Force Mains:

(a) Install thrust blocking in accordance with Section 5.47 – Pipe Restraint.

6.47 CONNECTIONS TO EXISTING PIPING AND APPURTENANCES

.1 All connections to existing piping, services, and appurtenances shall be made by City of Nanaimo forces unless otherwise authorized by the City Engineer.

.2 All connections to existing piping and services shall utilize a manufactured rubber gasket bell and spigot joint or coupling designed for the types of pipes to be connected. ***(REVISED MAY 2020)***

.3 The use of field joints or rubber repair couplings shall require the approval of the Engineer.

.4 Rubber repair couplings must have 4 stainless steel clamps with stainless steel anti shear band encased in concrete. Only those products approved by the City Engineer will be accepted for installation. ***(REVISED MAY 2020)***

.5 Slip coupler shall be used on PVC pipes. Rubber repair couplings are not to be used on PVC pipes.

6.48 SERVICE CONNECTION JUNCTIONS

.1 Locations of service connection junctions to the sewer shall be installed as shown on the construction drawings or as directed by the Engineer during construction.

.2 Where service connections are not constructed in conjunction with the mains, fittings shall be provided with approved caps or plugs and markers as specified in Section 6.59 – Service Connection Installation, clause 6.59.3(i). Caps or plugs for sanitary sewers shall be watertight and suitably blocked to withstand test pressures.

.3 Concrete Pipe (Reinforced and Non-reinforced):

(a) Field break-in and mortar patch joints shall not be used unless approved by the City Engineer. If approved, the following shall apply:

(i) Service connections shall be manufactured using a sanded PVC male end stub pipe with integral bell.
(ii) Break into the pipe by coring to within 40 mm of outside diameter of the service stub. All exposed reinforcing steel shall be removed.
(iii) Insert the stub into the core ensuring that no portion of the service stub protrudes past the inside of the concrete pipe wall, and the stub length shall be equivalent to the thickness of the concrete pipe wall and the length of the stub's integral bell.
(iv) Prepare non-shrink, fast setting cementitious grout with a 3:1 sand/cement mix to a "dry pack" consistency. Pack grout tightly into the void between the stub and the pipe and mound around the stub for lateral support.

(v) Hand finish interior and exterior grout surfaces to a smooth finish.
(vi) In order to prevent damage to the field joint, allow sufficient time for grout to develop strength prior to installation of connecting pipe or backfilling.
(vii) Installation shall be inspected by the Engineer prior to backfilling.

(b) Refer to Section 6.24 for service junction specifications.

.4 PVC Pipe (smooth profile):

(a) Service saddle connections shall not be used unless approved by the City Engineer.
(b) If approved, installation of service saddle connections shall conform to the following:

(i) Drill hole into mainline pipe to the exact dimension of the new connection.
(ii) The use of saddles instead of manufactured wye fittings shall require approval by the City Engineer. Saddles shall be cast iron with alignment rings complete with stainless steel bands.
(iii) Attach service saddle in accordance with the manufacturer's specifications.

(c) Refer to Section 6.24 for service junction specifications.

.5 PVC Pipe (ribbed profile):

(a) Installation of service saddle connections shall conform to Section 6.48.4.

.6 High Density Polyethylene (HDPE) Pipe (Smooth Profile):

(a) Service connections to mainline pipe using manufactured fittings shall be in strict accordance with manufacturer's instructions.
(b) Connection of HDPE service junctions to non-pressurized PVC service pipe shall be with flexible couplings. Flexible couplings shall be manufactured from elastomeric PVC, and be held in place with series 300 stainless steel worm gear clamps.
(c) Refer to Section 6.24 for service junction specifications.

.7 High Density Polyethylene (HDPE) Pipe (Open Profile):

(a) Installation of service saddle connections shall conform to Section 6.48.4.
(b) Refer to Section 6.24 for service junction specifications.

6.49 CAST IN PLACE MANHOLE CONCRETE BASES

.1 All water shall be removed from the excavation prior to placing base concrete. The base shall be constructed such that the first section of a precast section can be set plumb with uniform bearing throughout its full circumference.

.2 If material in the bottom of the trench is unsuitable for support, the bottom shall be over excavated to firm base as determined by the Engineer and backfilled to the required grade with thoroughly compacted base gravel as specified for trench bottom stabilization under the applicable item included in Section 4.0 –Excavation, Trenching and Backfill. ***(REVISED MAY 2020)***

.3 Where over excavation and backfill with base gravel is not practical, special structural support shall be provided as specified for trench bottom stabilization under the applicable item included in Section 4.0 –Excavation, Trenching and Backfill. ***(REVISED MAY 2020)***

.4 Concrete manhole bases shall be constructed as shown on the drawings. Pipes and fittings through the manhole shall be supported on concrete blocks and the concrete base poured around the pipe to a depth of at least 150 mm below the bottom of the pipe and up to the springline of the pipe. Install rubber manhole adapter rings on all plastic pipe installed in the manhole base.

.5 Invert elevations of pipes at the manhole shall be checked by the Contractor prior to and following placement of base concrete around the pipe to ensure that all pipes are installed at the design elevation.

.6 Variations in manhole inverts from established grade or elevation shall be corrected.

.7 Manhole channeling shall be constructed as shown on Standard Drawing No. S-1 or as shown on the construction drawings. Channeling shall be constructed to have a minimum 0.3 m straight section before the change in direction within the manhole.

.8 The channels in the base of manholes shall be shaped and finished to provide smooth passage for the sewage in order to minimize head losses and deposits at bends and at junctions of channels.

.9 Channels shall be accurately formed. The practice of forming channels roughly to shape and finishing with cement mortar will not be permitted. The channels shall be steel trowel finished.

.10 Benching in manholes shall be sloped to drain. While the concrete cures, the concrete benching shall be given at broom finish to produce a non-skid surface. ***(REVISED MAY 2020)***

6.49A PRECAST MANHOLE BASES

.1 Installation of precast manhole bases shall conform to Section 6.49 – Cast In Place Manhole Concrete Bases.

.2 Precast manhole bases shall be placed on 150 mm thick base of 38 mm drainrock.

.3 Plastic and concrete pipes installed in the precast manhole base shall utilize rubber manhole adapter rings to seal the connection.

.4 Refer to Section 6.25A for precast manhole bases specifications.

6.50 -NOT USED-

6.51 PRECAST MANHOLE SECTIONS

.1 Precast manhole barrel sections shall be placed plumb.

.2 Joints between the top riser and the cover slab shall be made watertight with cement mortar. Prior to placing sections, the mating faces shall be thoroughly soaked with water and a layer of cement mortar shall be spread on the lower face. After sections are placed, excess mortar which has been squeezed out shall be removed and the joint made flush inside and out.

.3 Joints between precast manhole barrels must utilize O-ring gaskets and shall conform to the manufacturer's specifications. The inside surface of the precast barrel at the O-ring joints shall be filled with cement grout to a smooth finish.

.4 Damaged O-ring manhole joints require removal and replacement of damaged manhole section. Mortar patching of damaged area if approved by the Engineer, shall require the removal of the O-ring gasket and installation as per Section 6.51.2.

.5 Refer to Section 6.25 for precast manhole sections specifications.

6.52 CONCRETE

.1 Cast In Place concrete work shall conform to Section 11.0 – Cast In Place Concrete Works. ***(REVISED MAY 2020)***

6.53 FRAMES AND COVERS

.1 Frames shall be set on precast concrete grade rings to bring the cast iron manhole frame up to grade as shown on the Standard Drawings. Contractor to install concrete grade rings to a minimum of 50 mm thick and to a maximum of 100 mm thick. The concrete grade rings shall be laid in common bond with raked mortar joints and shall be mortared inside and outside of the manhole.

(a) Fine grade elevation adjustments of frames shall be done with adjustable height manhole frame, or a minimum of 3 steel shims equally spaced. ***(REVISED MAY 2020)***

.2 Manhole covers shall be installed:

(a) for unpaved areas, covers shall have a 1.5 m x 1.5 m, 50 mm thick asphalt apron. Covers shall be set flush with the asphalt surround.

(b) for paved areas, covers shall be flush with pavement grade with a maximum allowed variance of 6 mm when measured with a 3 m straight edge in any direction. ***(REVISED MAY 2020)***

.3 Steel manhole riser rings shall be used in easements only.

.4 The inside surface of the manhole frame shall be painted yellow with an enamel rust paint in accordance with the manufacturer's specifications.

.5 Refer to Section 6.27 for manhole covers and frames specifications.

6.54 MANHOLE STEPS

.1 Manhole steps shall be installed in manhole sections by the manufacturer unless circumstance dictates otherwise in which case approval must be received from the Engineer.

.2 The distance from the top of the manhole cover, to the first manhole step, shall conform to WorkSafeBC requirements.

.3 All steps shall be complete with approved polyethylene anchor insulating sleeves and installed in 25 mm to 26 mm diameter precast or drilled holes in a manhole section.

.4 Refer to Section 6.28 for manhole steps specifications.

6.55 DROP MANHOLE STRUCTURES

.1 Drop manhole structures shall be constructed as shown on Standard Drawing No.S-3.

6.56 STUBS

.1 Blind stub sections for connection of future sewers and service connections to the manholes shall be installed where shown on the construction drawings and as directed by the Engineer. Stubs shall be as long as the vertical depth from finish grade to the invert of each stub. Each stub shall be plugged with a removable, watertight plug as shown on the construction drawings. Where stubs are installed, the bottom of the manhole shall be channeled to the stub entrance.

6.57 TEMPORARY CLEANOUTS

.1 Temporary cleanouts shall be constructed as shown on Standard Drawing No.S-12.

6.58 -NOT USED-

6.58A PUMPING STATIONS

.1 Pump stations shall be constructed in accordance with the approved construction drawings. The installation requirements shall be determined on a site specific basis at the discretion of the City Engineer. ***(REVISED MAY 2020)***

6.59 SERVICE CONNECTIONS INSTALLATION

.1 Location of Service Connections:

(a) Service connections are to be installed at the locations and depths as specified by the Engineer. For new connections, where the depth of the service connection

exceeds 2 m, the service shall be extended into the property the same distance as the depth of the service, up to a maximum distance of 4 m. This shall be done during the installation of the service connection from the main to the property.

(b) At no time shall two or more sanitary services be coupled into one lead crossing the street or right-of-way. Each service shall have its own independent connection into the main sewer.

.2 Grade and Alignment of Service Connections:

(a) Trenches shall be excavated so that pipe can be installed in a direct line from the service connection fitting at the sewer or from a manhole to the terminus of the service. Service pipe shall be installed at a uniform grade between the terminus at the property line and the junction fitting (or upper end of a service drop) at the sewer.

.3 Sanitary Sewer Service Connection Installation:

(a) Pipe shall be installed in strict accordance with the manufacturer's recommended practice.

(b) Pipe shall be checked before being lowered into the trench to ensure that no foreign material, manufacturer's defects, or cracks exist that might prevent the proper jointing of the pipe or its operation.

(c) The Contractor shall use methods for installing pipe in an auger hole or casing pipe as described in Section 4.0 –Excavation, Trenching and Backfill. ***(REVISED MAY 2020)***

(d) The trench shall be excavated to provide a minimum cover of 0.75 m over the service connection pipe at property line.

(e) In rock, the trench is to be extended 3 m into the property to facilitate future extension of the service connection.

(f) The trench bottom shall be graded to form a continuous support along the service pipe. All rocks or projections which might prove detrimental to the pipe shall be removed.

(g) Joints shall be made using the specified couplings. Glued joints shall not be made.

(h) Approved watertight caps suitably supported by sandbags to prevent leakage shall be installed on sewer services at the terminus of each service.

(i) A 38 mm x 89 mm pressure treated wood marker stake shall be placed at the service terminus as shown on the drawings to facilitate future location of the service pipe. This stake shall extend from a point approximately 600 mm above ground to the cap except in locations where the extension of the stake above ground surface would prove hazardous, in which case the stake shall be cut off flush with the ground surface. The stake shall be marked in an approved manner to show the depth of the service pipe invert below the top of the stake. The stake shall be unpainted to visually identify the sanitary sewer service connections. The Engineer will record the invert elevation of the service connection assembly prior to placement of the cap by the Contractor. ***(REVISED MAY 2020)***

(j) Inspection assemblies shall be installed as shown on the Standard Drawings.

(k) The service box shall be installed plumb with the lid 25 mm above finished grade in unpaved areas, and 0 – 6 mm below finished grade in paved areas.

.4 Riser Service Connections:

(a) Riser service connections shall be installed as shown on Standard Drawing No.'s S-5 or S-7 in locations shown on the construction drawings.

6.60 CLEANING AND FLUSHING

.1 The pipes shall be cleaned upon completion of the sewer pipe installation and within one month prior to the end of the maintenance period to the satisfaction of the Engineer and the City of Nanaimo Inspector. Cleaning shall be completed by power flushing with water to remove all foreign matter. ***(REVISED MAY 2020)***

.2 Ensure that snow chains are installed at the downstream manhole so that no foreign material passes beyond downstream manhole. Flow through the system shall remain unimpeded at all times while snow chains are installed.

.3 Begin cleaning from the upstream pipe in the system and proceed downstream. Under no circumstances is the pipe cleaning process to proceed downstream until all contributing upstream pipes have been successfully cleaned and approved by the Engineer, the City of Nanaimo Inspector, or by the City of Nanaimo CCTV contract administrator. ***(REVISED MAY 2020)***

.4 Manholes shall be cleaned after the upstream section of pipe has been successfully cleaned and approved by the Engineer, the City of Nanaimo Inspector or by the City of Nanaimo CCTV contract administrator. ***(REVISED MAY 2020)***

.5 Pipes shall be cleaned in the direction of the flow and shall not be flushed in a backflush direction unless approved by the City Engineer, by the City of Nanaimo Inspector or by the City of Nanaimo CCTV contract administrator. ***(REVISED MAY 2020)***

.6 Under no circumstances shall debris pass beyond the downstream manhole. Active vactoring shall remove all debris at the snow chains installed at the downstream manhole.

.7 Dispose of debris at approved dump site such as the Regional District of Nanaimo's landfill or by the CCTV contract administrator's approved alternative.

.8 Decanting of liquid waste accumulated during debris removal is permitted at a controlled release rate, to a maximum of 8 litres per second, at a location approved by the City of Nanaimo CCTV contract administrator.

.9 Timeframe between cleaning and video inspection of pipeline shall not exceed 24 hours unless approved by the City Engineer.

6.61 NOTIFICATION TO CITY OF NANAIMO

.1 The City of Nanaimo shall be given 48 hours' notice of all tests. ***(REVISED MAY 2020)***

6.62 LEAKAGE TESTING OF GRAVITY SEWERS

.1 Leakage tests shall be performed by the Contractor on all sanitary sewers and sewer service connections, manholes and appurtenances.

.2 Type of Test:

(a) Tests on gravity sewers and manholes shall be either exfiltration of infiltration water tests as directed by the Engineer. Manholes shall be tested separately from gravity sewers.
(b) In lieu of leakage testing with water, the Engineer may permit testing with low pressure compressed air.
(c) Testing shall only be carried out after all underground work is complete, including hydro/tel/cable. ***(REVISED MAY 2020)***
(d) Copies of all test results must be forwarded to the City of Nanaimo Inspector. ***(REVISED MAY 2020)***

.3 Testing Equipment:

(a) The Contractor shall furnish all necessary testing equipment, including suitable removable watertight plugs and test balls, and shall perform the tests in a manner satisfactory to the Engineer. Testing equipment must provide readily observable and reasonably accurate measurements of leakage under the specified conditions. The Contractor must comply with all WorkSafeBC regulations covering the use of air testing, and ensure that safe working practices are used in the application of the test.

.4 Water Exfiltration Test:

(a) On an exfiltration test, the test section shall be sealed at its lower extremity by means of a watertight plug. The test section shall be filled with water to the greater of, the maximum hydraulic grade line of the pipe, or such that a minimum hydrostatic head of 600 mm is placed on the pipe at its upper extremity. The head of the water on the pipe shall be taken as the distance from the top of the pipe being tested to water surface at the point of measurement. The test pressure shall be maintained above the 600 mm minimum head for a period of not less than one hour, and unless excess exfiltration requires further testing, not greater than 8 hours. Pressures in excess of 3 m water head are not recommended. Damage resulting to pipe as a result of testing shall be repaired by the Contractor at no cost to the owner. ***(REVISED MAY 2020)***
(b) Manholes shall be tested independent of the sewer pipe for leakage by filling the chamber to the underside of the roof slab with water. The test duration shall be a minimum of three hours. No leakage shall be permitted in manholes.
(c) In areas where the groundwater table is above the sewer invert level, the test shall be increased by a height equal to the distance from the sewer invert level to the water table elevations.
(d) Exfiltration test sections shall normally have a manhole at both extremities. If, however, sewer grades are such that a test section cannot be terminated at a

manhole without placing excess pressure on the pipe or joints, apparatus shall be provided to enable testing without having manholes at the upper and lower ends of a test section.

(e) Gravity sewers, service connections and appurtenant structures thereon shall be constructed such that leakage, as evidences by exfiltration tests, is less than that calculated using the following formula:

$$\text{Allowable leakage in litres} = \frac{HDL}{5200}$$

where H = duration of test in hours,
D = inside diameter of the pipe in millimetres, and
L = length of pipe in the test section in metres

(f) The above leakage limit will constitute the total maximum allowable leakage of any test section of gravity sewer. Where service connections exist along the test section, the allowable leakage from service pipe calculated by the used of the formula in Section 6.62.4 (e) will be added to that of the main sewer to arrive at the total allowable leakage unless the elevation of the service connection pipe is greater than the maximum water elevation. No additional leakage allowance will be made for the manholes existing along the test section.

(g) The maximum allowable leakage for an exfiltration test will be that calculated by the formula in Section 6.62.4 (e) regardless of the test head of water employed. Where a section of sewer is found to have leakage exceeding the allowable limit, replacement or repairs shall be made to reduce the amount or leakage to or below the allowable limit. Repaired sections shall be retested until they meet the allowable limit.

(h) All point sources of leakage exceeding 1.2 litres per minute (from poor joints, improper connections, etc.) shall be made watertight by the Contractor to the satisfaction of the Engineer.

(i) The Contractor shall dispose of the water used for testing in a manner approved by the Engineer.

.5 Water Infiltration Tests:

In areas of high groundwater table, the Contractor shall, if instructed by the Engineer, measure the amount of infiltration into the sewer over a period of 8 hours. The infiltration rate shall not exceed the leakage as calculated for exfiltration testing.

.6 Air Test:

(a) Air test shall not be used with concrete sewers.

(b) On an air test, the section to be tested shall be plugged at each end and all service laterals, stubs and fittings properly capped or plugged.

(c) Air shall be supplied to the test section slowly, filling the line to a constant pressure of 24.0 kilopascal (kPa). The air pressure inside the pipe shall not exceed 28 kPa except in the case where the groundwater level is above the sewer line being tested. In the event of the groundwater level being above the invert, the

air test pressure must be increased by 1.0 kPa for each 100 mm of groundwater above the invert.

(d) The air supply is throttled to maintain the internal pressure above 20 kPa for a minimum of 5 minutes to stabilize the temperature in the pipe. After stabilization, the air pressure is adjusted to 24.0 kPa and the air supply shut off or disconnected. Timing commences and the time required for the line pressure to drop to 20.5 kPa is noted.

(e) If the time required to drop from 24.0 to 20.5 kPa is greater than allowable, the test section shall have passed.

(f) For the air test the minimum time allowable is calculated from the following tables:

Time Requirements for Air Testing

(Millimetres)	Min	Sec.
100	2	32
150	3	50
200	5	6
250	6	22
300	7	39
375	9	35
450	11	34
525	13	30
600	15	24

(g) Where multi pipe sizes are to undergo the air test, the average size shall be used.

6.63 TESTING OF FORCE MAINS

.1 Sewage force mains shall be tested in accordance with Section 5.61 – Pressure and Leakage Testing.

6.64 VIDEO INSPECTING MAINS AND SERVICE CONNECTIONS

.1 All pipe video inspection including methods of cleaning, equipment and rates of camera travel, shall be in accordance with the UK Water Research Centre's (WRc), Sewage Rehabilitation Manual, most current edition.

.2 The contractor shall arrange for a video inspection upon completion of the sewer pipe installation and within one month prior to the end of the maintenance period to the satisfaction of the Engineer and the City of Nanaimo Inspector. ***(REVISED MAY 2020)***

.3 For gravity sewers and service connections, the contractor shall arrange for video inspection to check alignment, grade, and condition of the main sewer pipe including service connection leads. Where a new sewer pipe crosses an existing sewer pipe, the contractor shall also arrange for a video inspection of the existing sewer pipe at the location of the crossing. ***(REVISED MAY 2020)***

(a) Illumination depth of field shall be no less than 3 joints for standard joint and spigot pipe types to allow for pipe deflection assessments (9 m). No dark/opaque circle shall be visible in the middle of this depth of field viewing area.
(b) Eliminate steaming and fogging encountered during the inspection survey by introducing forced air flow by means of fan.
(c) Camera lens to remain free of grease or other deleterious matter to ensure optimal clarity.
(d) Pan and tilt view of each service connection (junction) such that the camera looks down the centreline of the service, pause for a minimum of five (5) seconds and note the condition of the joint and/or pipe/service interface.
(e) Camera guides (Skids) shall not be visible at either side of the pipe during normal camera travel or during Pan & Tilt operation. Configuration of camera/guides shall be altered to alleviate this problem.
(f) CCTV push camera work shall be video captured (complete with skids for centering) from the main wye pulling back to entrance point to avoid an invert only view.
(g) A winch line shall be provided to support camera travel in steep, slippery or relined pipe sections.
(h) Position camera lens centrally in the pipeline with a positioning tolerance of ±10% off the vertical centreline axis of the pipeline. For elliptical pipe the camera to be positioned 2/3 the height of the pipe measured from the invert.
(i) Position camera lens looking along the longitudinal axis of pipeline except when viewing service connections or panning defects.
(j) Instantaneous travelling speed of the camera in the pipeline to be as follows:

(i) 0.1 m/s for pipeline of diameter less than 200 mm.
(ii) 0.15 m/s for diameters 200 mm and larger but not exceeding 310mm: and
(iii) 0.20 m/s for diameters exceeding 310 mm.

.4 The inspection shall include the preparation of:

(a) an HDSD 32 GB Class 10 regular card. Picture size: NTSC ***(REVISED MAY 2020)*** 640x480 pixels, aspect ratio 4:3, 29.97 frames per second @ 8 megabits per second capture rate. Individual MPEG4 video files shall not exceed 1.7 GB in size. ***(REVISED MAY 2020)***
(b) a Microsoft Access database CD of the Header and Observation codes as specified by City Engineer.
(c) a pipe condition assessment paper report.

All submitted to the Engineer.

.5 The Engineer shall review the pipe condition report and provide certification that the condition of the installed pipe is accurately recorded and the pipe installation meets the City of Nanaimo Standards and Specifications. ***(REVISED MAY 2020)***

.6 The pipe condition report and certification shall become the property of the City of Nanaimo. ***(REVISED MAY 2020)***

.7 Variations in line or grade of pipe, from that established by the Engineer prior to installation, and any jointing, pipe cleaning, or other deficiencies discovered during the inspection, shall be rectified. Reinspection of the pipe may be required by the Engineer at the Contractor's expense.

.8 During this test, manhole construction and invert elevations shall be checked and any variations from the established grade, drawings, or specifications, shall be rectified.

.9 Video inspection and pipe condition coding shall be undertaken only by personnel with current Canadian certification by a City approved agency.

6.65 SMOKE TESTING

.1 The Engineer shall arrange for smoke testing of all installed gravity sanitary mains in the presence of the City of Nanaimo Inspector. ***(REVISED MAY 2020)***

.2 The Engineer shall provide as-built service location information to the City of Nanaimo Inspector prior to smoke testing. ***(REVISED MAY 2020)***

.3 Cross-connections noted during the smoke testing shall be corrected and the as-built service location information revised.

6.66 TESTING OF PUMPING STATIONS

.1 Wet well chambers shall be tested for exfiltration by filling the chamber to the underside of the roof slab with water. The test duration shall be a minimum of three hours. No leakage shall be permitted.

.2 In areas of high groundwater tables, the Engineer may require an infiltration test. No leakage shall be permitted.

.3 Pumping stations shall be tested using water. Station shall be tested through its operating range to confirm float operation, pumps, controls, alarms, backup power, manual operation and operation with the City of Nanaimo's portable power unit.

.4 A noise level test shall be required to confirm pumping station and standby power are within specified acceptable limits.

6.67 PIPE VIDEO AND MANHOLE CONDITION REPORT FORMAT

.1 Reference plans shall accompany reports with manholes labeled and inspected sections highlighted. Manhole and pipe numbering shall conform to the construction drawings, or if available, City of Nanaimo pipe and manhole numbers. Reports shall be submitted in both digital and hardcopy formats. ***(REVISED MAY 2020)***

.2 All sewer defects shall be photographed and included with the report and referenced by numbers accordingly.

.3 The video pipe condition rating report format shall be in accordance with the UK Water Research Centre's (WRc), Sewerage Rehabilitation Manual, most current edition.

Structural defects shall be properly weighted with the appropriate scores assigned to them as shown in the following table:

	WRc GRADING SYSTEM	
DEFECT CODE NO.	TYPE OF DEFECTS	POINT SCORES
1	Open Joints	1 to 2
2	Displaced Joints	1 to 2
3	Cracks	10 to 40
4	Fracture	40 to 80
5	Broken	80
6	Hole	80 to 165
7	Collapsed	165
8	Spalling	5 to 120
9	Wear	5 to 120
10	Deformation	20 to 165

Every video inspected sewer will be assigned a composite grade based on the sum of its defect point scores, as per the following table: ***(REVISED MAY 2020)***

WRc – SEWER RATING COMPOSITE GRADE *(REVISED MAY 2020)*		
COMPOSITE GRADE ***(REVISED MAY 2020)***	PEAK SCORE RANGE (SUM OF THE SCORES FROM THE ABOVE TABLE)	TYPICAL DEFECT DESCRIPTION
1 (least defective)	1 to 9	No observable structural defects
2	10 to 39	Circumferential crack. Moderate joint defects, i.e. open joint (medium) or joint displaced (medium), spalling slight and wear slight.
3	40 to 79	Fracture with deformation <5%. Longitudinal cracking or multiple cracking. Minor loss of level. More severe joint defects, i.e. open joint (large) or joint displaced (large). Spalling medium. Wear medium.
4	80 to 164	Broken, deformation up to 10% and broken fracture with deformation 5 - 10%. Multiple fractures. Serious loss of level. Spalling large. Wear large.
5 (most defective)	165+	Already collapsed. Deformation >10% and broken. Extensive areas of fabric missing. Fracture with deformation >10%.

The following additional information shall be included for each sewer section as the CCTV Title Page:

(a) Date of survey.
(b) Contractor Project Index No. (i.e. Tape No. V2-1234)
(c) Survey No.
(d) Start MH No.
(e) Finish MH No.
(f) Line ID No.
(g) Direction of Camera Travel.
(h) Street Location (Road Name or RW No.).
(i) Distance from manhole rim to pipe invert.
(j) Length of Capture.
(k) Total of Captured CCTV.
(l) Current weather information.

.4 All pipe video inspections shall include an annotated map with the following information:

(a) Manhole and catch basin locations with labels.
(b) City of Nanaimo drawing numbers.
(c) Manhole ID numbers (as per the City of Nanaimo GIS numbering system).
(d) Catch basin ID numbers (as per the City of Nanaimo GIS numbering system).

.5 Computer database file to contain identical survey report information as the printed report exclusive of photographs. Index numbers and distance of survey information shall numerically increase. For an individual survey, whether the information is sorted by index or distance, the result will be in the same order.

.6 All pipe video inspection operators shall be thoroughly trained with current Canadian certification by a City approved agency.

.7 Manhole video inspection is not required. Manholes shall be rate as per the following table and form part of the video inspection report.

MANHOLE RATING SYSTEM	
INTERNAL CONDITION GRADE	TYPICAL DEFECT DESCRIPTION
1 (least defective)	-no observable structural defects -no observable signs on infiltration
2	-minor cracks, chips, spalling. -signs of minor staining, but no infiltration
3	-fractures, medium spalling, defective pipe/MH joints -some staining, mineral build-up and seeding infiltration. Possible infiltration through manhole cover.
4	-broken manhole wall, channel or riser assembly, multiple fractures, medium wear -moderate staining, mineral build-up and running infiltration -infiltration through manhole cover -manhole frame and cover cracks or broken
5 (most defective)	-failure in manhole wall, channel or riser assembly, multiple fractures with deformation, large wear -heavy staining, mineral build-up and gushing infiltration -surface ponding and infiltration through manhole cover -manhole frame and cover cracks or broken