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SECTION 7 – STORMWATER MANAGEMENT DESIGN CRITERIA

7.01 INTRODUCTION

.1 Scope:

(a) Stormwater management is the term traditionally used when referring to managing rainfall runoff based on using design storms and sizing drainage facilities. Rainwater management refers to rainfall runoff source control for frequently occurring events. In this section, the term stormwater management is used and is intended to include the scope of rainwater management. ***(REVISED JUNE 2026)***

(b) For Defined Terms refer to Section 2.01 []. ***(REVISED JUNE 2026)***

.2 Objectives:

(a) Overall – To provide flood protection, drainage, and minimize impacts on the environment. Achieve a balance between protecting property from flood hazards and protecting the environment in terms of both water quality and quantity. ***(REVISED JUNE 2026)***

(b) Major System – To safely convey the 1:100 Annual Exceedance Probability (AEP) or (1% AEP) storm event runoff with overland flow path and piped flow to suitable receiving bodies. ***(REVISED JUNE 2026)***

(c) Minor System – To safely contain the 1:5 AEP (20% AEP) storm runoff within the minor system. ***(REVISED JUNE 2026)***

(d) Rainwater Management Best Management Practices (BMP) – To mimic the conditions of a naturalized undeveloped land by reducing impervious area, retaining trees and tree canopy, and infiltrating frequent rain events. ***(REVISED JUNE 2026)***

(e) Downstream Environmental Protection – To ensure that the quality and quantity of flows do not adversely affect the groundwater or receiving waters (streams, creeks, ditches, lakes, wetlands, ocean). ***(REVISED JUNE 2026)***

(f) Protection of Environmentally Sensitive Areas (ESAs) – To protect ESAs, including leave strip areas from development impacts. Prioritize avoidance of negative impacts, restoration, and enhancement of Environmentally Sensitive Areas. ***(REVISED JUNE 2026)***

(g) Consideration for the Blue and Green Network of parks, watercourse, water bodies, greenways, and urban tree canopy to enhance habitat connectivity and ecosystem. ***(REVISED JUNE 2026)***

.3 City Authority and Bylaws: ***(REVISED JUNE 2026)***

(a) This manual should be used in accordance with the most recent version of other City policies and bylaws including, but not limited to: ***(REVISED JUNE 2026)***

(i) *Subdivision and Development Standards Bylaw* ***(REVISED JUNE 2026)***

(ii) *City Plan Official Community Plan* ***(REVISED JUNE 2026)***

(iii) Stormwater Management. Council Policy. ***(REVISED JUNE 2026)***

(iv) Ditch/Swale. Council Policy. ***(REVISED JUNE 2026)***

.4 Other Applicable Government Initiatives:

(a) In addition, this manual should be used in accordance with other commonly applicable government acts, regulations, policies, guidelines and documents. including, but not necessarily limited to the following: ***(REVISED JUNE 2026)***

(i) Federal *Fisheries Act*

(ii) *Riparian Areas Protection Act* and *Riparian Areas Protection Regulation* ***(REVISED JUNE 2026)***

(iii) *Water Sustainability Act* and *Water Sustainability Regulation* ***(REVISED JUNE 2026)***

(iv) Fish-Stream Crossing Guidebook, Ministry of Forests, Lands and Natural Resource Operations, Ministry of Environment ***(REVISED JUNE 2026)***

(v) Stormwater Planning: A Guidebook for British Columbia, Ministry of Water, Land and Air Protection ***(REVISED JUNE 2026)***

(vi) Requirements and Best Management Practices for Making Changes in and About a Stream in British Columbia, Government of British Columbia. ***(REVISED JUNE 2026)***

.5 Previous Design Criteria: ***(REVISED JUNE 2026)***

(a) The City's utility systems have been constructed over many years using design criteria and practices that were in place at the time. ***(REVISED JUNE 2026)***

(b) The current criteria is to be used when designing all new infrastructure and when assessing the adequacy of existing systems. ***(REVISED JUNE 2026)***

(c) When evaluating existing infrastructure and watercourses, where the existing system does not meet current criteria, the Professional of Record will provide a risk assessment and professional recommendations for consideration by the City Engineer. These will be evaluated on a case-by-case basis and upgraded as resources permit or by the developer if triggered by the proposed development. ***(REVISED JUNE 2026)***

(d) Pre-development is defined as a natural state: ***(REVISED JUNE 2026_redesignated)***

(i) Structures, parking areas, and manmade surfaces are not considered to be pre-development. ***(REVISED JUNE 2026)***

(ii) A forested area should be assumed. ***(REVISED JUNE 2026)***

(iii) However, if there is evidence that the lands natural state was something other than forested, such as a meadow or rock outcrop, the Qualified Registered Professional is responsible to document such evidence and submit to the City Engineer for approval.

(e) Post-development is the proposed development. ***(REVISED JUNE 2026)***

.6 Development Requirements (Responsibilities and Reporting): ***(REVISED JUNE 2026)***

(a) Applicants and their agent, a Professional of Record, are responsible for designing stormwater systems that align with the objectives in Section 7.01.2 [→]. ***(REVISED JUNE 2026)***

(b) Drainage works design must comply with Section 7.02 [→] - Summary of Stormwater and Environmental Protection Design Criteria and associated sections in this Manual.

(c) Construction activities must manage and minimize the impact to connected watercourses as set out in the Storm *Sewer Regulation and Fee Bylaw No. 7351* .

(d) The Professional of Record is responsible for ensuring all applicable guidelines, standards, bylaws, and other regulations and policies are met.

(e) Stormwater Management Plan shall be prepared for subdivision, multi-unit residential, commercial, industrial, and institutional developments, or as otherwise required by *Development* Approval *Information Bylaw No. 7346*. Submit as a report that includes: ***(REVISED JUNE 2026)***

i. A watershed location plan(s) showing: ***(NEW JUNE 2026)***

1. The watershed boundary and major system components, including labeled watercourses and Environmentally Sensitive Area (ESA) leave strips. Road network with key road names. ***(NEW JUNE 2026)***
2. Topography with low points marked, overland flow paths, and drainage routes. ***(NEW JUNE 2026)***
3. Identify outlet boundary conditions for the proposed development. Indicate the water level elevations at the outlet for the 20% AEP and the 1% AEP to establish the starting elevation of the downstream Hydraulic Grade Line (HGL). In some cases, the downstream water level elevation may be set by flood plain elevations typically associated with the 1:200 AEP (0.5% AEP) or an ocean tide level. ***(NEW JUNE 2026)***
4. At key junctions in the watershed, show the cumulative tributary areas, and if available the 1% AEP peak discharge. ***(NEW JUNE 2026)***
5. Prepare scaled plans using the City Geographical Information System (GIS) resources and the coordinate system in Section 1.42 []. List additional resources used for the base plan. ***(NEW JUNE 2026)***

ii. A tributary catchment area plan(s) based on boundary conditions from the watershed location plan, with these additional details:***(REVISED JUNE 2026)***

1. Drainage works for minor system and major system, with references to City GIS pipe and manhole ID numbers. ***(REVISED JUNE 2026)***
2. Existing topography and proposed grading contours for post-development, when available. ***(REVISED JUNE 2026)***
3. Street names and lot numbers. ***(REVISED JUNE 2026)***
4. A summary table of pipe and open channel analysis. ***(REVISED JUNE 2026)***

iii. A detailed plan of the proposed development, based on base plan from the tributary area, that includes: ***(REVISED JUNE 2026)***

1. Pre-development and post-development topography. ***(REVISED JUNE 2026)***
2. Sub-catchment areas to proposed drainage works. ***(REVISED JUNE 2026)***
3. Mitigative measures (retention, detention, water quality). ***(REVISED JUNE 2026)***
4. Label proposed areas, manholes, pipes and appurtenances in a logical way. ***(REVISED JUNE 2026)***
5. Overland flow routes clearly identified. ***(REVISED JUNE 2026)***
6. A summary table of pipe and open channel analysis. ***(REVISED JUNE 2026)***

iv. Methodology for analysis explaining the chosen hydrological and hydraulic and associated report presentation requirements, as per Section 7.03 Stormwater Runoff [→]. ***(REVISED JUNE 2026)***

v. Summary tables for the plans provides the following key design information: ***(REVISED JUNE 2026)***

1. Total and sub catchment areas.
2. Percent imperviousness values of the catchments. (***REVISED JUNE 2026)***
3. Hydraulic and Hydrologic design calculations for the pipe network, using either the Rational Method and Manning's Equation or computer modeling, to the plan limit boundary conditions as defined in Section 7.01.6 e (i) 3. ***(REVISED JUNE 2026)***
4. Clearly identify non-conforming conditions. These include, but are not limited to, minor system drainage works that exceed capacity during the 20% AEP event, as per Section 7.04 [→], and surcharge of the HGL in the major system and flooding as per Section 7.05 [→]. ***(REVISED JUNE 2026)***

vi. Water Quality - details on provisions address water quality leaving the site and entering the drainage system as per Section 7.14 [→], using the criteria in Section 7.02 [→]. ***(REVISED JUNE 2026)***

vii. Capture with Retention - details on provisions to address volume control as per Section 7.02 [→], through Rainwater Best Management Practices (BMP) as outlined in Section 7.13 [→]. ***(REVISED JUNE 2026)***

viii. Runoff Rate Control - details for peak discharge control as per Section 7.03.6 [→] and including design calculations for storage facilities including the required storage volume, design size and flow control considerations as per Section 7.12 [→]. ***(REVISED JUNE 2026)***

ix. Non-conforming conditions require approval by the City Engineer, as per Section 7.01.5(c) [→]. ***(NEW JUNE 2026)***

x. For systems which include works or facilities which require ongoing maintenance, a detailed operation and maintenance plan is required. ***(REVISED JUNE 2026)***

xi. Detailed design drawings, as per Section 1.05 [], for the proposed minor and major systems and rainwater management measures. The drawings should show the routing of flows and hydraulic grade lines under both the 1:5 AEP (20% AEP) and 1:100 AEP (1% AEP) design conditions. ***(REVISED JUNE 2026)***

xii. All Stormwater Management Plans, reports and drawings that are relied upon are to be authenticated by a Qualified Registered Professional licensed in British Columbia. ***(REVISED JUNE 2026)***

7.02 SUMMARY OF STORMWATER AND ENVIRONMENTAL PROTECTION DESIGN CRITERIA ***(REVISED JUNE 2026)***

.1 This section provides a summary of the design criteria to be used for the planning and design of stormwater management infrastructure. The planning and design for stormwater management infrastructure must meet the following criteria:

(a) A minor system conveyance capacity using the 1:5 AEP (20% AEP) rainfall event in Section 7.03.3 [→] and identified in Section 7.04 [→]. ***(REVISED JUNE 2026)***

(b) A major system conveyance capacity using the 1:100 AEP (1% AEP) rainfall event in Section 7.03.3 [→] and identified in Section 7.05 [→]. ***(REVISED JUNE 2026)***

(c) For areas draining to watercourses, provide rainwater capture with retention. This minimizes erosion, protects aquatic habitat and water quality. Depending on the habitat conditions, such as fish and wildlife, there may be other authorities having jurisdiction. Runoff rate control may be required to protect downstream infrastructure and natural assets. ***(REVISED JUNE 2026)***

(d) For areas draining directly to the ocean rainwater, capture with retention may not be required. However, runoff rate control may be required to protect downstream infrastructure. ***(REVISED JUNE 2026)***

(e) Capture with retention through Rainwater Best Management Practices (BMPs) to provide volume reduction and opportunities for infiltration, evaporation, reuse, or other approved method, as outlined in Section 7.13 [→]. ***(REVISED JUNE 2026)***

i. The target is to capture 31 mm of rainfall depth from impervious areas. In Nanaimo, 31 mm of rainfall represents the 85th percentile for rainfall events less than 24 hours duration. ***(REVISED JUNE 2026)***

ii. This captured water should drawdown from the BMP and recover within 12 to 36 hours to restore storage capacity. ***(NEW JUNE 2026)***

iii. If the site conditions do not permit infiltration or a constrained system is needed, then the maximum release rate permitted is 0.25 L/s/ha. ***(REVISED JUNE 2026_moved)***

(f) Provide water quality treatment for 36 mm of rainfall, which is 90% of the average annual rainfall onto impervious surfaces exposed to vehicle traffic as described in Section 7.14 – Water Quality [→]. The treatment performance is to remove 80% of Total Suspended Solids over 50 µm particle size. ***(REVISED JUNE 2026)***

(g) Control runoff rate using strategies like detention in storage facilities as per Section 7.12 [→], with the calculations for storage as per Section 7.03.6 [→]. ***(REVISED JUNE 2026)***

(h) Protect the downstream receiving watercourse from erosion. If the watercourse is located in an environmentally sensitive area (ESA) or is vulnerable to erosion, the City Engineer may require additional investigation to assess both the immediate connection point and potential downstream impacts, as per Section 7.01.5(c) [→]. ***(REVISED JUNE 2026)***

(i) Account for climate change in stormwater management designs as described in Section 7.15 - Climate Change [→].

7.03 STORMWATER RUNOFF

.1 Scope:

This section describes the rationale, methodology and parameters for determining the hydrologic variables such as stormwater runoff volume and rates in the design of drainage flow conveyance and storage facilities.

.2 Catchment and Impervious Areas: ***(REVISED JUNE 2026)***

(a) Drainage catchments are governed by topography of the land and drainage works or watercourses that intercepts and conveys runoff. Drainage areas can refer to nested hydrologic units: ***(NEW JUNE 2026)***

i. Watersheds are the largest units, ranging from short creeks draining to the ocean, to systems of creeks, lakes, wetlands, and rivers. Watershed boundaries can be obtained from City GIS; however, the Professional of Record should verify boundaries. ***(NEW JUNE 2026)***

ii. Tributary catchment areas are upstream areas draining into a junction or confluence of drainage works or watercourses. ***(NEW JUNE 2026)***

iii. The drainage area for a proposed development may be within one or more tributary areas or even watersheds. Post-development design may alter drainage boundaries, and these changes should be considered in the design and analysis. ***(NEW JUNE 2026)***

iv. During extreme events such as flooding, drainage catchment boundaries may shift. ***(NEW JUNE 2026)***

(b) The impervious area is a key driver in stormwater runoff. Depending on the calculation method, it may be embedded within another parameter, such as the runoff coefficient in the Rational Method; or represented explicitly as in most hydrograph models. For larger drainage catchments, impervious area is often approximated using land use designations. ***(NEW JUNE 2026)***

i. Analysis of the existing storm system typically considers current impervious surfaces such as buildings, roads, and parking areas. These can be estimated using recent orthophotos. ***(NEW JUNE 2026)***

ii. Analysis for replacement will generally use ultimate land use and references the current Official Community Plan Bylaw No. 6500 and applicable Regional District Community Plans for areas outside the City. ***(NEW JUNE 2026)***

iii. Post- development site analysis uses the impervious area specified in the design, rather than zoning-based approximations. Pre- development conditions are assumed to reflect very low impervious conditions (treed), even if the development site is currently developed, as per Section 7.01.5(d) [→]. ***(NEW JUNE 2026)***

.3 Rainfall Data: ***(REVISED JUNE 2026)***

(a) IDF Curves:
Intensity-Duration-Frequency data has been compiled into the IDF Curves shown on Standard Drawing No. SW-25 [] for the applicable design annual exceedance probability (AEP) rainfall. The updated IDF curve takes climate change into account to planning horizon Year 2100. ***(REVISED JUNE 2026)***

(b) Rainfall Gauges:
The City has several rainfall gauges with historical rainfall data. This rainfall data is available for reference if desired and can be provided by the City; however, it is up to the Qualified Registered Professionals to verify the quality of the data and use the data for hydrological calculation. ***(REVISED JUNE 2026)***

(c) Design Storms:
The City has used various design storm hyetographs in hydrograph-based watershed studies. For consistency, it may be advisable to use the same design storm applied in the watershed study if seeking comparable values. However, any selected option should reflect the Intensity-Duration-Frequency (IDF) curves that include climate change projections to the Year 2100. Alternatively, AES design storms for durations of 1-hour, 2-hour, 6-hour, 12-hour, and 24-hour are suitable options. ***(NEW JUNE 2026)***

.4 Time of Concentration:

(a) Time of Concentration
is the time required for stormwater runoff to travel from the most remote point of the drainage catchment area to the point of interest and having the greatest impact on downstream flows. ***(REVISED JUNE 2026)***

(b) Method:
There are several methods available to calculate time of concentration such as the Upland Method, Kinematic Wave Equation, Kirby Equation, Kirpich Equation, and others. The Qualified Registered Professional is responsible to determine and document the most appropriate method of calculating the time of concentration. Overland flow path times in undeveloped areas may be estimated using the Upland Method of Estimating Time of Concentration as shown on Standard Drawing No. SW-26 [] if the slope and land use of the area is known. ***(REVISED JUNE 2026)***

(c) Minimum and Maximum Time of Concentration:
The minimum time of concentration for all calculations is 5 minutes. The maximum time of concentration is 10 minutes for the overland flow component into the stormwater system in fully developed areas. Time of concentration with large areas of land which will remain undeveloped is determined by one of the above mentioned methods. ***(REVISED JUNE 2026)***

.5 Rational Method:

(a) Application:
The use of the Rational Method for final design calculations is to be limited to the design of minor or major systems where detention storage and/or other runoff controls do not exist or are not required, and where the catchment is not larger than 20 hectares.

(b) Formula:

$$Q = C\ I\ A\ X\ 2.78$$

Where:
Q = storm runoff flow in litres/second
C = the coefficient to runoff
I = the rainfall intensity in mm per hour
A = contributing catchment area in hectares

(c) Coefficient of Runoff (C):
The choice of coefficient of runoff "C" is based on ground slope, type of ground or surface cover, soil conditions, size of drainage area and the land use of the properties within the drainage catchment areas. The following table provides a range of coefficient for land use conditions: ***(REVISED JUNE 2026)***

TYPE OF DEVELOPMENT	COEFFICIENT OF RUNOFF
Industrial	0.80 to 1.00
Commercial Business Areas, Multi-Unit Residential ***(REVISED JUNE 2026)***	0.65 to 0.90
Single Unit Residential and Low Density Multi-Unit Residential ***(REVISED JUNE 2026)***	0.50 to 0.80
Rural Areas, Parks, Golf Courses	0.25 to 0.55
Dense Forest ***(REVISED JUNE 2026)***	0.05 to 0.15
Light Forest ***(REVISED JUNE 2026)***	0.15 to 0.25

(d) Presentation:
Where the rational formula is used for the storm sewer design calculations, in a format in accordance with Appendix H2, Stormwater Management Flow Analysis – Calculation Sheet must submitted. ***(REVISED JUNE 2026)***

.6 Computer Simulation Methodology – Hydrograph-Based: ***(REVISED JUNE 2026)***

(a) Application:
For all stormwater calculations which include detention storage or other runoff controls and/or catchment greater than 20 hectares, a computer simulation model must be used. The model results should be calibrated and must be used for design and sizing of all pipes and storage facilities. ***(REVISED JUNE 2026)***

(b) Stormwater Modeling Software:
The City supports the use of any interface that supports the SWMM modeling engine for the creation of hydrologic and hydraulic computer models. The use of the other types of software requires the prior approval of the City Engineer. ***(REVISED JUNE 2026)***

(c) Hydrology Methods:
There are several hydrology methods available in modeling software. Infiltration methods such as Green Ampt or Horton's are encouraged for modeling urban watersheds; however, these methods require site specific information regarding the geotechnical conditions.

(d) Storage Analysis:
Comprehensive analysis of the storage should be completed by the Qualified Registered Professional including a review of all storm durations up to the 24 hour event to determine the governing storm duration. In the future, the City may require continuous modeling be completed for storage analysis. ***(REVISED JUNE 2026)***

(e) Procedure:
An analysis of the post-development conditions is to be done at key points of the major and minor system for various durations of the design return period storms. This process will identify the most critical event to be used when designing the system. It should be noted that the storm duration which generates a critical event for the conveyance system may be different than the storm duration which generates a critical event for the storage facility.

(f) Presentation:
A report is required to document the design rationale used to develop the model. The report is to be included in the Stormwater Management Plan. At a minimum, the report includes the following: ***(REVISED JUNE 2026)***

i. An executive summary.
ii. Type and version of the modeling software used.
iii. All hydraulic and hydrologic parameters and assumptions.
iv. Design storms used and/or continuous modeling data used.
v. Summary of peak flows for each element of the system for both the major system and minor system in a table. ***(REVISED JUNE 2026)***
vi. At storage or flow control facilities, the summary incoming and outgoing hydrographs and the stage discharge curve. ***(REVISED JUNE 2026)***
vii. Post- development hydrograph at the point where the flows leave the system being modeled and where the flows leave the proposed development.
viii. Pre- development major system and minor system calculations. ***(REVISED JUNE 2026)***
ix. Comparison of pre- and post- development flows and hydrographs at the point where the flows leave the proposed development.
x. Recommendations.
xi. Tables showing existing and future pipe information.
xii. Drawings showing hydraulic grade line (HGL) for design scenarios. ***(REVISED JUNE 2026)***
xiii. A digital copy of the model files.

.7 Runoff Rate Control: *(REVISED JUNE 2026)*

(a) Design Rainfall Events (AEPs) Inputs: *(NEW JUNE 2026)*

i. 1:2 AEP (50%) and 1:5 AEP (20%) for flow control device design (Section 7.03.3 [→]) *(NEW JUNE 2026)*

ii. 1:100 AEP (1%) for overflow sizing *(NEW JUNE 2026)*

(b) Methodology is to compare pre-development and post-development hydrographs to evaluate: *(NEW JUNE 2026)*

i. Peak flow rate *(NEW JUNE 2026)*

ii. Duration of peak flow *(NEW JUNE 2026)*

iii. Additional runoff volume *(NEW JUNE 2026)*

(c) Criteria *(NEW JUNE 2026)*

i. Post-development peak flow must not exceed pre-development peak flow *(NEW JUNE 2026)*

ii. Peak flow duration must be representative of pre-development conditions *(NEW JUNE 2026)*

iii. Additional runoff volume (difference between hydrographs) must be managed *(NEW JUNE 2026)*

(d) Outputs / Solutions *(NEW JUNE 2026)*

i. Storage facilities (Section 7.12 [→]) *(NEW JUNE 2026)*

ii. Rainwater BMPs (Section 7.13 [→]) *(NEW JUNE 2026)*

7.04 MINOR SYSTEM

.1 Components and Conveyance: *(REVISED JUNE 2026)*

(a) The minor system must be designed to convey the runoff from the 1:5 AEP (20% AEP) rainfall, as per Section 7.03.3 [→]. The minor system includes all drainage works that convey, detain, divert, and intercept the runoff including pipes, catch basins, manholes, swales, ditches, driveway culverts and other appurtenances. *(REVISED JUNE 2026)*

.2 Location:

(a) The minor system is typically located in road right-of-way. *(REVISED JUNE 2026)*

(b) Where the minor system is located in private property, the utility corridor must be preserved by statutory right-of-way and/or restrictive covenants for ease of access to repair or maintain the system. *(REVISED JUNE 2026)*

.3 Surcharge and Hydraulic Grade Line (HGL): *(NEW JUNE 2026)*

(a) Storm sewer pipes must be designed so that hydraulic grade line (HGL) is within the pipe during a 20% AEP rainfall event. The design must account for the HGL elevation at the connection into the existing storm system. *(NEW JUNE 2026)*

(b) Driveway culverts are designed initially assuming inlet control and sized with the headwater below the crown of the pipe and otherwise meet the criteria in Section 7.07 [→]. ***(NEW JUNE 2026)***

(c) Ditches may function as part of both the minor and major drainage systems and must be evaluated under both rainfall runoff conditions. A key design constraint is ensuring proper hydraulic interaction with culverts and service connections. Design for the 20% AEP rainfall does not permit surcharge in these connected systems. Ditches are designed as open channels and meet the design parameters in Section 7.08 [→]. The hydraulic grade line (HGL) corresponds to the water surface elevation during the design storm and should be contained within the channel. Design must also account for clogging risk by providing adequate inlet capacity, maintenance access, and, where applicable, redundancy to prevent localized flooding. ***(NEW JUNE 2026)***

(d) Swales may function as part of both the minor and major drainage systems and be evaluated under both rainfall runoff conditions. A primary performance target is containing and directing overland flow paths. Swales are designed as open channels and meet the minimum design parameters in Section 7.09 [→]. The hydraulic grade line (HGL) corresponding to the water surface elevation which should be contained within the channel. ***(NEW JUNE 2026)***

(e) Surcharging of storm sewer pipes and driveway culverts is permitted during a rainfall event greater than 20% to 1% AEP rainfall event, provided that the design complies with the performance requirements of the major system outlined in Section 7.05 [→]. ***(NEW JUNE 2026)***

(f) Non-conformance requires an assessment and approval by the City Engineer, as per Section 7.01.5(c) [→]. ***(NEW JUNE 2026)***

7.05 MAJOR SYSTEM

.1 Components and Conveyance: ***(REVISED JUNE 2026)***

(a) The major system shall be designed to safely convey the runoff from the 1:100 AEP (1% AEP) rainfall, as per Section 7.03.3 [→]. Sources of runoff include outflows from the minor system, overland flows, storage facilities, lakes, wetlands and watercourses. The major system includes all drainage work, but is not limited to road crossing culverts, swales, ditches, roadways, overland flow paths, and watercourses. ***(REVISED JUNE 2026)***

.2 Location of Overland Flow Paths: ***(REVISED JUNE 2026)***

(a) Generally, the major system overland flow paths are conveyed in public road right-of-way and adequate watercourses. Where adequate overland flow paths cannot be established, pipes and ditch culverts of the minor system may be increased to convey the major flows, subject to approval of the City Engineer. If the runoff from major flows is conveyed in a piped system, an alternate overland flow path shall be provided to ensure redundancy in the case of blockages or rainfall events that exceed the system capacity. ***(REVISED JUNE 2026)***

(b) When the major flow may be conveyed by a public roadway, the street must be designed to provide sufficient hydraulic capacity to handle the major flow. Planning for street layout, roadway grades and the drainage system must be coordinated to ensure the street functions as part of the major drainage system. ***(REVISED JUNE 2026)***

(c) When an overland flow path crosses private property, the flow route must be protected and preserved by restrictive covenants and/or statutory right-of-way to ensure access to repair or maintain the system. ***(REVISED JUNE 2026)***

(d) Overland flow paths through private property must be designed to minimize property damage and endangerment to public safety and have a suitable erosion protection. ***(REVISED JUNE 2026)***

(e) If no safe overland flow path exists, the Professional of Record shall notify the City Engineer and provide a risk assessment and recommendations as per Section 7.01.5(c) [→]. ***(REVISED JUNE 2026)***.

(f) Where surcharge from the minor system results in major system flow on the roadway, additional catch basins may be required to ensure the flow can be recaptured by the minor system, as per Section 7.06.12 [→]. ***(REVISED JUNE 2026)***

.3 Discharge to Existing Watercourses:

(a) The discharge to an existing watercourse must be designed in a way that protects the watercourse from erosion, as per Section 7.02 [→]. Typically, flow velocities exceeding 1.5 m/s require an energy dissipater to reduce flow velocity to an acceptable rate. For design refer to Section 7.11 [→], and for specifications refer to Section 7.33 [→]. ***(REVISED JUNE 2026)***

.4 Flooding:

(a) The major system routing may allow minor inconvenience, such as localized flooding of streets and green spaces (parks, boulevard, landscaped areas, naturally vegetated areas, etc.). However, major damage, such as damage to dwellings, significant erosion of private property, or damage to public facilities shall not occur as a result of the major storm. The Professional of Record must document non-conforming conditions as per Section 7.01.5(c) [→]. ***(REVISED JUNE 2026)***

(b) Full width cross-sections are to be provided showing the depth of the major flow along public streets, private property, ditches, and watercourses at typical and critical areas of the overland flow path. ***(REVISED JUNE 2026)***

(c) The major system shall be designed such that all habitable portions of buildings including basements are a minimum 0.3 m above the major flow hydraulic grade line. If buildings or service connections are found to be non-conforming, the Professional of Record must notify the City Engineer and may be required to provide a risk assessment and recommendations as per Section 7.01.5(c) [→]. ***(REVISED JUNE 2026)***

(d) Existing buildings constructed to a previous standard may not have this protection from the major system. As a result, if a lot is redeveloped, the new minimum habitable floor elevation on that lot may not be the same as previous minimum habitable floor elevation.

(e) The grading for new developments must ensure that the slope of the ground around structures has positive drainage away from structures.

.5 Roadway:

(a) Where the roadway functions as part of the major system, the following criteria must be considered: ***(REVISED JUNE 2026)***

i. For local streets, the maximum depth at the crown of the roadway is to be 50 mm. ***(REVISED JUNE 2026)***

ii. For mobility arterial, mobility collector, urban arterial and urban collector streets, a minimum of 3.0 m width of the roadway must be free from flooding. ***(REVISED JUNE 2026)***

iii. Care should be taken when designing intersections of roadway which are used to convey the major storm so that flows can pass over the cross street. ***(REVISED JUNE 2026)***

iv. Care should be taken when designing the grading at roadway curves and at locations where major flow path turns at intersections or at tee intersections. ***(REVISED JUNE 2026)***

v. Cul-de-sacs which are down slope from the street will not be accepted as part of the major system, unless approved by the City Engineer.

vi. Care should be taken when designing driveways which are downslope from streets which form part of the major system. ***(REVISED JUNE 2026)***

(b) The hydraulic capacity of a street section to convey water can be calculated by the Manning Equation, subject to the above conditions for major flows in a roadway. ***(REVISED JUNE 2026)***

.6 Surcharge and 1:100 AEP Hydraulic Grade Line (HGL): ***(NEW JUNE 2026)***

(a) Road crossing culverts are to be designed and sized so that the headwater remains below the road elevation for runoff from a 1:100 AEP (1% AEP) rainfall event. Where the headwater exceeds the diameter of the pipe, the surcharged condition must meet the criteria in Section 7.05.4. Culverts must also meet the criteria in Section 7.07 [→]. ***(NEW JUNE 2026)***

(b) Ditches function as part of the major drainage systems. A key design constraint is ensuring proper hydraulic interaction with culverts and service connections under major system flow conditions. Ditches are designed as open channels and must meet the design parameters in Section 7.08 [→]. The HGL will likely submerge minor system components such as driveway culverts; this is acceptable provided major system criteria are satisfied. Maintain a freeboard of 0.3 m for structures described in Section 7.05.5. Non-conformance with the design criteria must be reported to the City Engineer in accordance with Section 7.01.5(c) [→]. ***(NEW JUNE 2026)***

(c) Where stormwater storage facilities, culverts, or ditches are hydraulically connected to building service connections or other sensitive infrastructure, the risk assessment and professional recommendations, as per Section 7.01.5(c) [→], may include backwater prevention measures, such as backwater valves, which are subject to approval by the City Engineer. ***(NEW JUNE 2026)***

(d) Swales function as part of the major drainage systems. A primary performance target is containing and directing overland flow paths. Swales are designed as open channels and meet the minimum design parameters in Section 7.09 [→]. The hydraulic grade line (HGL) corresponding to the water surface elevation should be contained within the channel. Swales typically are not hydraulically connected to service connections; however, this must be verified by the Professional of Record. ***(NEW JUNE 2026)***

(e) Where the roadway functions as part of the major system and conveys major flows, the hydraulic grade line (HGL) must be evaluated against roadway criteria in Section 7.05.5 [→] to ensure compliance with allowable depths and widths. ***(NEW JUNE 2026)***

(f) Surcharging of storm sewer pipes and driveway culverts is permitted during a rainfall event where the hydraulic grade line (HGL) exceeds the minor system capacity for events greater than the 20% AEP up to the 1% AEP rainfall event. ***(NEW JUNE 2026)***

(g) Non-conformance requires an assessment and approval by the City Engineer, as per Section 7.01.5(c) [→]. ***(NEW JUNE 2026)***

7.06 PIPE DESIGN DETAILS

.1 Grades and Velocity of Stormwater in Pipes and Service Connections:

(a) The minimum design velocity for pipes must be 1.0 m/s. ***(REVISED JUNE 2026)***

(b) Where the pipe discharge velocity exceeds 1.5 m/s into an open ditch or watercourse, provision must be made for the installation of an energy dissipater to reduce flow velocity to the acceptable rate. For specifications, refer to Section 7.33 [→]. ***(REVISED JUNE 2026)***

(c) There are no maximum allowable velocities; however, where velocity exceeds 3.0 m/s or grades exceed 10%, the need for scour protection must be examined and anchor blocks are required as per Standard Drawing No. T-8 [] and Standard Drawing No. T-8A []. ***(REVISED JUNE 2026)***

(d) All 100 mm diameter service connections are to have a minimum grade of 2%.

.2 Pipe and Service Connection Sizes:

(a) Minimum pipe diameters must be 250 mm. In residential areas, 200 mm diameter pipe may be approved by the City Engineer for the final section of a lateral sewer if:

i. the pipe has the required capacity; and

ii. future extension is not possible due to physical barriers or there is an existing alternate drainage connection for adjacent areas. ***(REVISED JUNE 2026)***

(b) Unless otherwise approved by the City Engineer, downstream pipe diameter are to be greater than or equal to upstream pipe diameter. ***(REVISED JUNE 2026)***

(c) Residential service connections are a 100 mm diameter, or larger as required by site conditions. ***(REVISED JUNE 2026)***

(d) Commercial and Industrial service connections are a 150 mm diameter, or larger as required by site conditions. ***(REVISED JUNE 2026)***

(e) Service connections servicing lawn basins are a150 mm diameter, or larger as required by site conditions. ***(REVISED JUNE 2026)***

.3 Selection of Pipe Material and Class:

(a) The Professional of Record will consider earth and live loading, soil conditions, and design life of the installation for determining pipe material and class. Pipe materials and brands must be per the City's Approved Products List []. ***(REVISED JUNE 2026)***

.4 Pipe Friction Factors:

(a) Storm sewers are to be designed using the Manning Formula. The minimum 'n' value is 0.013 for all approved pipes. ***(REVISED JUNE 2026)***

.5 Pipe and Service Connection Depths:

(a) Minimum Cover:

i. Storm sewers are to have 1.5 m of cover in right-of-way. ***(REVISED JUNE 2026)***

ii. Storm sewers are to have 1.0 m of cover in untravelled areas.

iii. Service connections are to have 0.75 m of cover.

iv. Where minimum cover cannot be provided, an explanation of the reasons and pipe loading calculations must be submitted with the proposed method of pipe protection to the City Engineer for approval. ***(REVISED JUNE 2026)***

(b) Where practical, service connections must be deep enough for gravity flow from the lowest elevation of each lot serviced. Where it is not practical, or where servicing the low elevation of the lots would require utilities in private lands, the development must be graded to prevent overland flow from impacting neighboring structures. ***(REVISED JUNE 2026)***

(c) All existing foundation drains must be connected. For vacant lots, service connections must be deep enough to allow gravity flow from foundation drains for future building(s) constructed to the minimum basement floor elevation, as determined by the Professional of Record. ***(REVISED JUNE 2026)***

(d) Storm water sewers must be deep enough so that service connections for surface and foundation drainage from all lots in the upstream drainage catchment can drain to the storm -water system by gravity. ***(REVISED JUNE 2026)***

.6 Curved Pipes:

(a) Horizontal curves on sewers require approval from the City Engineer.

(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/s.

(c) 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.

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

(e) Only one vertical or horizontal curve is permitted between manholes.

.7 Location of Stormwater Mains and Service Connections:

(a) Stormwater mains offsets from all watermains must be in accordance with Section 5.10.3 or apply protective measures as per Section 5.10.4 and Standard Drawing T-5 []. Typical storm sewer main offsets are shown in the standard drawings for roadways in Section 8.0. ***(REVISED JUNE 2026)***

(b) If there is a significant elevation difference between the lots on opposite sides of the street, if possible, storm sewers are to be located on the low side of the street where both sides are served by the sewer. If only the high side of the street is serviced by the storm sewer, storm sewers are to be located on the high side of the street.

(c) All lots must be provided with a storm sewer service connection, unless otherwise approved by the City Engineer. Service connections are to be located to the offsets as shown on Standard Drawing No. T-7 [].

(d) Storm sewer mains may be installed in a common trench with sanitary sewers provided the minimum outside pipe separation is 300 mm.

.8 Utilities in Private Lands:

(a) The following must be considered in the design of utilities crossing private lands:

i. The design of utilities must avoid crossing private lands. Utilities in private lands require the approval of the City Engineer. Approval will only be granted where it is shown that all other options have been exhausted.

ii. Utilities following property boundaries across private lands must be offset a minimum 2.0 m from the property boundary. ***(REVISED JUNE 2026)***

iii. Appurtenances such as manholes, valves, etc., must be located entirely on one property, they cannot be located on property boundaries.

iv. Utilities cannot 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.

(b) For a sample statutory right-of-way condition sheet, refer to Appendix C, Standard Drawing No. RW-2.

(c) For an Easement Release and Inspection Form Following the Construction of the Utility, refer to Appendix C.

(d) For minimum widths of statutory right-of-way and working widths, refer to Appendix D.

.9 Service Connection Lengths:

(a) The maximum length of a storm sewer service connection measured horizontally between the storm sewer and the property line is 15 m. Storm sewer services longer than 15 m require approval by the City Engineer. The service alignment will be perpendicular to the main. All inspection assemblies required for service connections in excess of 15 m in length must be shown on the design drawings. ***(REVISED JUNE 2026)***

(b) For industrial, commercial, and multi- unit residential servicing, and/or where oil interceptors are required, manholes must be provided where the service connects with the main or at the property line regardless of the size of the service. ***(REVISED JUNE 2026)***

(c) All services 250 mm in diameter or larger require manholes where the service connects with the main or at the property line. In the case of closely spaced services, every other service manhole is to be located on the service line close to the property line. ***(REVISED JUNE 2026)***

.10 Number of Service Connections per Lot:

(a) Each lot must be serviced by one only service connection for storm drainage. Where the size of the lot or the topography makes one service connection impractical, additional service connections may be allowed subject to the approval of the City Engineer.

.11 Manholes:

(a) Distances between manholes must not exceed 120 m unless otherwise approved by the City Engineer. For pipes larger than 600 mm in diameter, manhole spacing may be increased to 180 m.

(b) Manholes must be located at grade and alignment changes, at lateral size changes, at the upstream end of all lateral sewers, and either at the junctions of all lateral sewers with the main or at property line for services 250 mm and larger.

(c) Cleanouts may only be used, if approved by the City Engineer, at the upstream end of lateral sewers in a temporary situation during a phased development where the future phase of the development will remove the cleanout.

(d) Outside drops must be provided for pipe sizes 375 mm or less where the difference in elevation between incoming and outgoing sewers exceed 600 mm. Drops less than 600 mm in elevation must be accommodated by manhole benching. Precast manhole barrels must be sized according to normal inside pipe diameter and depth as detailed below:

Minimum		
Pipe Size (Normal)	**Depth of Manhole (Top of Cover to Invert)**	**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 – 750 mm	All Depths	1350 mm
900 – 1050 mm	All Depths	1500 mm
Minimum barrel sizes are to be increased for manholes within multiple large pipes.		

(e) Where cast in place manholes are proposed, all design and construction details, require approval from the City Engineer. ***(REVISED JUNE 2026)***

(f) Manholes must be designed to incorporate a minimum pipe invert elevation difference or at least 25 mm, in addition to the normal grade of the storm sewer, wherever a horizontal deflection exceeding 45 degrees occurs. Smaller pipe sizes are to be crown to crown with larger pipe sizes when entering manholes. For super critical flows or large pipes (>600 mm diameter), the hydraulic losses through manholes must be calculated and the corresponding drop in inverts across the manhole must be included in the design where appropriate.

(g) Manholes are to be located to avoid any conflict with curb and gutter or sidewalks.

(h) A watertight manhole frame and cover are required for all sewer manholes where flooding can occur or in areas subject to vandalism (i.e. parks, undeveloped right-of-ways, etc.).

.12 Catch Basins:

(a) Catch basins are to be provided at regular intervals along streets, at street intersections, and at all low points in the street.

(b) Catch basins located in streets must be spaced to collect a maximum of 450 m² of pavement drainage where grades do not exceed 5%. On grades over 5% the maximum area collected can be reduced to 300 m².

(c) Double catch basins are required at all low points in roadways and downhill cul-de-sacs except where located along non-mountable curb which provides for installation of a single curb inlet, refer to the curb inlet standard drawing. ***(REVISED JUNE 2026)***

(d) Location requirements for the different catch basin types must conform to the following: ***(REVISED JUNE 2026)***

i. Curb inlet catch basins are to be used in locations along non-mountable curbed streets at all low points or in other areas where additional inlet capacity is required. ***(REVISED JUNE 2026)***

ii. Boulevard catch basins are to be used in boulevards and easements outside of the paved roadway. ***(REVISED JUNE 2026)***

iii. Lawn basins may be used for locations on private property where drainage is required to be contained and prevented from flowing onto other properties, unless otherwise approved by the City Engineer. ***(REVISED JUNE 2026)***

iv. Shallow catch basins may be used in locations where it is not possible to provide a catch basin with a stump.

(e) Where the street roadway functions as part of the major system, catch basins must be provided in sufficient number and at appropriate locations to ensure that major storm runoff from the overland flow path can enter the storm system. The inlet capacity of the catch basins is to be reviewed by the Professional of Record and approved by the City Engineer. ***(NEW JUNE 2026)***

(f) Catch Basin Leads:

i. Single basin leads have a minimum diameter of 200 mm.

ii. Double basin leads have a minimum diameter of 250 mm.

iii. Lawn basin leads have a minimum diameter of 150 mm.

iv. Leads over 30 m have a minimum diameter of 250 mm.

v. Double catch basin leads must be joined using a wye fitting before connecting to the main. (*REVISED JUNE 2026)*

vi. The desired grade for a catch basin leads is 2%. Where it is impractical to obtain 2%, a catch basin lead with a 1% grade is acceptable.

.13 Surcharge and Hydraulic Grade Line (HGL): *(REVISED JUNE 2026)*

(a) Compliance limits for the Hydraulic Grade Line (HGL) are specified in Section 7.04 – Minor System [→], while HGL, surcharge, and flooding criteria are outlined in Section 7.05 – Major System [→]. *(REVISED JUNE 2026)*

.14 Trench Dams:

(a) Where there is any possibility of groundwater concentration to other utility trenches, storm sewer connections and trench dams are as per Section 4.18 – Trench Dams. *(REVISED JUNE 2026)*

.15 Subsurface Drains:

(a) Subsurface drains will be used where a geotechnical evaluation shows a high groundwater table or an area which significant cuts into the existing ground may create the potential for a saturated condition. Subsurface drains located adjacent to roadways will be extended well below the roadway base. The material for subsurface drains will be clear round drain rock in an envelope of approved filter material. A minimum 150 mm PVC perforated pipe will be placed at the bottom of the trench. *(REVISED JUNE 2026)*

7.07 CULVERTS

.1 General:

(a) Generally, culverts must be sized to suit the drainage area and cannot be smaller than upstream culverts without prior approval of the City Engineer.

(b) Inlet and outlet structures must be appropriately designed with energy dissipation, scour protection, erosion control and overflow protection as needed. For additional design criteria, Section 7.11 - Inlet and Outlet Structures [→]. For specifications, refer to Section 7.32 [→] and Section 7.33 [→]. *(REVISED JUNE 2026)*

.2 Road Crossing Culverts: ***(REVISED JUNE 2026)***

(a) Road crossing culverts are part of the minor system and major system, refer to Section 7.04 [→] and Section 7.05 [→].***(REVISED JUNE 2026)***

(b) Road crossing culverts must be minimum 450 mm diameter regardless of hydraulic capacity. ***(REVISED JUNE 2026)***

(c) Road crossing culverts for watercourses that are, or may reasonably be expected to become, fish bearing, are designed to provide fish passage. Designs are to incorporate baffles and embedded fish gravel substrate (see Section 9.0) and, where practicable, utilize open-bottom culverts as the preferred option. ***(REVISED JUNE 2026)***

.3 Driveway Culverts:

(a) Driveway culverts are designed as part of the minor system as per Section 7.04 [→]. ***(REVISED JUNE 2026)***

(b) Driveway culverts must be minimum 300 mm diameter regardless of hydraulic capacity. ***(REVISED JUNE 2026)***

7.08 DITCHES (WITHIN ROAD RIGHT-OF-WAY)

.1 Ditches are used in road allowances right-of-way where there is no curb and gutter to direct minor flows as per Section 7.04 [→] and major flows as per Section 7.05 [→] ***(REVISED JUNE 2026)***

.2 Ditches are to be designed to promote groundwater infiltration. ***(REVISED JUNE 2026)***

.3 Ditches adjacent to travelled roadways must not exceed 1.9 m in depth. ***(REVISED JUNE 2026)***

.4 Ditches are to be trapezoidal in shape having maximum side slopes of 1.5H:1V and a minimum bottom width of 450 mm.

.5 The minimum grade of a ditch must be 0.5%. ***(REVISED JUNE 2026)***

.6 The maximum velocity in an unlined ditch is limited to 1.5 m/s. Higher velocities may be permitted where soil conditions are suitable or where erosion protection has been provided. Excessive velocities should be avoided by using a piped system instead of ditches.

.7 On steep slopes, grade control structures may be required.

7.09 SWALES (WITHIN ROAD RIGHT-OF-WAY) ***(REVISED JUNE 2026)***

.1 Swales are to be used in right-of-way where there is no curb and gutter to direct minor and major flows towards watercourses or the nearest piped system or on private property in conjunction with lot grading to protect properties from overland sheet flow. ***(REVISED JUNE 2026)***

.2 Swales are to be designed to promote groundwater infiltration. ***(REVISED JUNE 2026)***

.3 Swales have a minimum depth of 150 mm, and a minimum width of 1.5 m. ***(REVISED JUNE 2026)***

.4 The minimum grade of a swale must be 1.0%. ***(REVISED JUNE 2026)***

.5 Swales should not be used where the velocity exceeds 1.5 m/s or on an excessively steep slope. ***(REVISED JUNE 2026)***

7.10 OPEN CHANNELS (WITHIN PRIVATE PROPERTY AND EASEMENTS)

.1 The design of open channels as part of the major system or minor system are restricted to the following maximum velocities: ***(REVISED JUNE 2026)***

(a) Unlined channel: 1.5 m/s

(b) Suitably lined channel: 3 m/s

.2 If the mean velocity exceeds that permissible for the particular kind of soil or greater than 1.5 m/s, the channel must be suitably lined to protect it from erosion. ***(REVISED JUNE 2026)***

.3 The maximum depth of flow cannot exceed 300 mm with a freeboard of 150 mm. ***(REVISED JUNE 2026)***

.4 Side slopes on designed channels cannot exceed 3H:1V. ***(REVISED JUNE 2026)***

.5 Open channels are to be designed, where possible, to promote infiltration. ***(REVISED JUNE 2026)***

7.11 INLET AND OUTLET STRUCTURES

.1 Inlet and outlet structures are required on all storm sewer pipes and culverts. Headwater requirements as per criteria in Section 7.04 – Minor System [→] and Section 7.05 – Major System [→]. ***(REVISED JUNE 2026)***

.2 A trash rack is required as a part of all inlet structures to storm sewer pipes. Trash racks may be required on culverts at the discretion of the City Engineer. ***(REVISED JUNE 2026)***

.3 Trash rack hydraulic and structural design must allow for passage of design flows with 50% blockage of the trash rack with debris. ***(REVISED JUNE 2026)***

.4 A safety grillage is required as part of an outlet structure from storm sewer pipes greater than 450 mm in diameter or 3.0 m in length. Safety grillages may be required on culverts at the discretion of the City Engineer.

.5 Pipe leaving inlet structures, where the inlet elevation significantly higher than the storm sewer, are to have a maximum grade of 5% for minimum 2.0 m. After the 2.0 m, the pipe grade can be adjusted with a vertical curve to attain design depth. ***(REVISED JUNE 2026)***

.6 Cast in place concrete inlet and outlet structures must be designed by a structural professional engineer to suit the specific site and soil conditions. Standard drawings are to be used as a guide for specific design criteria. Approved prefabricated inlet and outlet structures may be used. The Professional of Record must ensure the structures are designed to suit the existing site and soil conditions. ***(REVISED JUNE 2026)***

.7 Sandbag headwalls cannot be used except for driveway crossings or hydrant access crossing.

.8 Outlets for storm systems where velocities may cause erosion in the receiving channel must include a method to dissipate the energy, designed by a Professional of Record. For specifications, refer to Section 7.33 [→]. ***(REVISED JUNE 2026)***

.9 All inlet and outlet structures must include provisions for safe maintenance access and must conform to WorkSafeBC requirements ***(REVISED JUNE 2026)***

7.12 STORAGE FACILITIES

.1 General:

(a) The design of permanent storage facilities forming part of the minor system are an integral part of the overall drainage basin plan. ***(REVISED JUNE 2026)***

(b) The design of permanent storage facilities must consider safety and economical maintenance of operations. Storage facilities should also, where possible, be designed as multiuse facilities that include recreational, environmental and aesthetic aspects. ***(REVISED JUNE 2026)***

(c) Storage facilities are to accommodate the entire future developed tributary area. ***(REVISED JUNE 2026)***

(d) Depending on the site specific characteristics, a combination of storage and other groundwater recharge facilities may be appropriate to effectively reduce the runoff from development sites. ***(REVISED JUNE 2026)***

.2 Ownership:

(a) Residential: ***(REVISED JUNE 2026)***
Large storage facilities servicing residential developments will be owned and maintained by the City. Storage facilities constructed as part of a Bare Land Strata residential development will be owned and operated by the Strata Corporation. ***(REVISED JUNE 2026)***

(b) Multi- Unit Residential, Commercial, Industrial, and Institutional: ***(REVISED JUNE 2026)***
Storage facilities required as part of a multi- unit, commercial, industrial, or institutional development will be owned and operated privately. Facilities may be underground or above ground including roof top or parking lots. ***(REVISED JUNE 2026)***

.3 Storage Facility Options:

(a) Constructed Wetland:
Constructed wetlands can be incorporated into the drainage system as a means to not only control runoff but to introduce habitat for wildlife and add a bio-filtration element to the facility that improves water quality. The use of constructed wetlands is strongly encouraged.

(b) Wet Pond:
A wet pond is a method where rainwater runoff is collected and stored for a significant amount of time. The water in the active storage portion of the pond is usually released after the storm has ended, while a permanent pool is maintained during dry periods. These may form a recreational or aesthetic facility centered on a permanent pool of water.

(c) Dry Pond:
Dry ponds are used as temporary water storage after a significant rainfall event. They are typically controlled so that frequent low flows are not detained in the dry pond. As the pond is dry for the majority of the time, dry ponds can be landscaped in a way that they can be used for other purposes.

(d) Underground Storage:
A variety of methods are available for storing rainwater underground to control flows. Underground storage that incorporates other functions is encouraged; storage tank for water re-use (landscape irrigation), groundwater recharge, and infiltration are possible options.

(e) Other Methods:
There are a variety of other ways to store rainwater onsite including rooftop storage, parking lot storage, infiltration swales, rain gardens and many others. The City is open to innovative ways to store and infiltrate rainwater subject to the approval of the City Engineer. ***(REVISED JUNE 2026)***

.4 General Design Guidelines:

(a) Storage facilities are site specific and require a geotechnical evaluation to address the groundwater table interaction, and the permeability and stability of the existing soils. ***(REVISED JUNE 2026)***

(b) Maximum grade for a dry detention pond are to be 4H:1V. ***(REVISED JUNE 2026)***

(c) Maximum grade for a wet detention pond are to be 7H:1V from the normal water level to a depth of 0.4 m; steeper side slopes may be considered with a risk assessment and mitigation. ***(REVISED JUNE 2026)***

(d) Storage facilities must be designed to accommodate the design storage volume. The crest of the surrounding berm must be at least 300 mm higher than the maximum water level expected during the 1% AEP overflow condition. ***(REVISED JUNE 2026)***

(e) Where practical, sub-surface drains are preferred to ensure that the storage facility can be completely drained. Where subsurface drains cannot be installed, the pond must be designed so that mobile pumping equipment may be installed and used to drain the pond. ***(REVISED JUNE 2026)***

(f) All existing and future foundation drains must drain by gravity to the storage facility inlet pipe above the design storage level. ***(REVISED JUNE 2026)***

(g) An overflow spillway must be provided to handle potential peak runoff from the major storm or a blockage to the outlet. Discharge must be to the major system downstream flow path, see Section 7.05 [→]. ***(REVISED JUNE 2026)***

(h) An 8.0 m buffer zone is to be provided along the top of wet ponds, dry ponds, and constructed wetlands with a minimum building set-back of 15 m from the top of the storage facility. To be verified by a Qualified Registered Professional, especially when there is connectivity to Environmental Sensitive Areas. ***(REVISED JUNE 2026)***.

(i) An access of at least 3.0 m wide is to be provided to all storage facilities for maintenance purposes. The access design must accommodate motor vehicles unless otherwise approved by the City Engineer. ***(REVISED JUNE 2026)***

(j) Storage facilities are to be appropriately landscaped and protected from erosion. ***(REVISED JUNE 2026)***

(k) The outlet control for storage facilities are to be designed for safe access and maintenance with a lock to prevent vandalism. ***(REVISED JUNE 2026)***

(l) The pond design will include a sediment removal process for control of heavy solids which may be washed to the pond during the construction period associated with the development of the contributing basin. Sediment basins will be provided at all inlet locations for continued use after completion of the subdivision development.

.5 Temporary Storage Facilities:

(a) Where land development occurs in advance of completed drainage basin facilities, temporary storage facilities may be utilized on an individual basis as approved by the City Engineer.

(b) The design of temporary storage facilities are to consider the following: ***(REVISED JUNE 2026)***

i. The temporary storage facility meets or exceeds the requirements of this section for permanent storage facilities unless otherwise noted.

ii. All storm drainage systems discharging to the temporary storage facility can be connected to the permanent drainage works when completed and the temporary facility is abandoned.

.6 Storage Facility Outlets:

(a) The outlet of the storage facility should be designed to control the outflow as calculated based on Runoff Rate Control in Section 7.03.7. ***(REVISED JUNE 2026)***

(b) The outlet structure for a storage pond must discharge to a point downstream which has the ability to safely and adequately accommodate the maximum discharge. ***(REVISED JUNE 2026)***

(c) Outlet structures must be freeflow and ungated. Controls such as orifices and weirs are the preferred method of controlling the outflow. Manual controls such as gates, valves, or stop logs are discouraged. A valve will be permitted in the drain of a storage pond. ***(REVISED JUNE 2026)***

(d) Outlet structures are to conform to Section 7.11 [→]. ***(REVISED JUNE 2026)***

(e) For outlets that are not submerged, a lattice type cover over the inlet end of the outlet is preferred. A limiting velocity of 1.0 m/s is required for the design of the lattice.

(f) Outlets must be designed to all appropriate WorkSafeBC requirements for entry and exit. ***(REVISED JUNE 2026)***

(g) Outlet structure must be designed to allow safe access for cleaning of the inlet side during peak runoff. ***(REVISED JUNE 2026)***

7.13 RAINWATER BEST MANAGEMENT PRACTICES

.1 Introduction:

The development of previously vegetated land significantly changes the hydrological characteristics of the land by removing vegetation, changing the topography of the land, increasing impervious surfaces, and changing drainage paths. Traditionally, the increases in stormwater runoff created by this development have been mitigated through detention storage to control peak runoff and by increasing the hydraulic capacity of the drainage system. Recently, there has been progress toward considering more than just the hydraulic aspects of rainwater runoff and include aspects that can mimic the natural hydrologic process, protect watershed health, and improve water quality. Some of the rainwater best management practices described in this section are an attempt to mimic the natural characteristics of a watershed. Many of them promote infiltration of rainwater into the ground and provide groundwater recharge benefits in addition to rainwater runoff control. Rainwater best management practices (BMP) may also be called rainwater BMPs, stormwater source controls, low impact development BMPs, or rainwater management methods. ***(REVISED JUNE 2026)***

The use of rainwater best management practices is required wherever technically feasible for new developments and re-developments which outlet into a watercourse. For developments that do not drain into a watercourse, but discharge directly into pipes, ditches, or overland flow paths which discharge directly into the ocean, rainwater best management practices may not be required for runoff volume control, but for water quality enhancement only. ***(REVISED JUNE 2026)***

.2 Types of Rainwater Best Management Practices:

The following are brief descriptions of various rainwater best management practices which can be applied:

(a) Infiltration Swales:

An infiltration swale is designed to accept flows from small areas of impervious surface and allow it to infiltrate into the soils below. The swale also allows larger flows to be conveyed to the minor or major drainage system and provides water quality treatment.

(b) Rain Gardens:

Rain gardens are designed to have an aesthetically pleasing appeal in addition to providing water quality treatment and infiltration into the ground. The plantings are carefully selected based on the expected soil moisture conditions. Generally, rain gardens have a drain rock reservoir and a perforated drain system to collect excess water.

(c) Absorbent Landscaping:

The majority of the City's undeveloped land contains landscapes which soak up the rainfall. Applying absorbent landscaping to development sites is an attempt to mimic this natural landscape. The minimum thickness for absorbent landscaping is 300 mm. ***(REVISED JUNE 2026)***

(d) Green Roof:

A green roof includes a layer of growing media which supports vegetation. The application of green roofs can significantly reduce the runoff increase caused by new building construction. Green roofs must be designed with the structural considerations of the building and must comply with the *BC Building Code*.

(e) Infiltration Trenches:

An infiltration trench allows rainwater runoff to soak away into the ground. Infiltration trenches are best suited for runoff which does not require treatment, such as roof runoff. For areas where runoff requires treatment, consider pairing an infiltration trench with a rain garden.

(f) Soak-Away Manholes:

Soak-away manholes are similar to infiltration trenches; they allow the rainwater runoff to infiltrate into the soil through perforations in the manhole. Soak-away manholes are best suited for runoff which does not require treatment. For areas where runoff requires treatment, consider pairing a soak-away manhole with a feature which provides an aspect of treatment, such as a rain garden or infiltration swale.

(g) Pervious Paving: ***(REVISED JUNE 2026)***

Pervious paving allows rainfall to penetrate into the underlying soils through the paving. Care should be taken when designing pervious pavers to ensure materials used do not require special maintenance. Pervious paving should generally be restricted to low traffic areas. Where possible, other best management practices, such as rain gardens or infiltration swales are preferred to pervious paving as less maintenance is required and additional treatment benefits are realized. ***(REVISED JUNE 2026)***

(h) Deep Groundwater Recharge:
Deep groundwater recharge involves directly injecting stormwater into underground aquifers. Generally, injected stormwater must be treated to a high level for water quality prior to injection. Design for this practice may be highly complex and require specialist expertise and approval by the City Engineer.

(i) Retention:
Retention of rainwater runoff involves storage and release of rainwater at very low rates, to mimic natural groundwater interflow rates. ***(REVISED JUNE 2026)***

(j) Other Methods:
The BMPs listed above are some of the more common approaches to managing rainwater runoff in ways that mimic natural systems. Other methods may be accepted with approval by the City Engineer.

.3 Application:

(a) Refer to Section 7.02 for the Summary of Stormwater and Environmental Protection Design Criteria

(b) Residential: ***(REVISED JUNE 2026)***
Recent densification of residential zoning increases impervious coverage from roofs and driveways, resulting in higher runoff volumes to the storm system. For residential lots, the most practical rainwater best management practices (BMPs) include absorbent landscaping, pervious driveways and patios, and raingardens for localized infiltration. Where site constraints limit infiltration options, subsurface storage tanks with controlled release may be considered, subject to approval by the City Engineer. ***(REVISED JUNE 2026)***

(c) Multi-Unit Residential, Commercial, Industrial, and Institutional: ***(REVISED JUNE 2026)***
The use of rainwater best management practices to infiltrate and retain rainwater is required for multi- unit, commercial, industrial, and institutional developments in order to preserve the natural hydrologic condition as much as possible. ***(REVISED JUNE 2026)***

(d) Steep Slope Development:
Steep slope development, in Development Permit Area (DPA 6) and adjacent to Hazardous Slope (DPA 2) may not be suitable for some rainwater best management practices. Developments in these areas will require specific attention to methods of retention and detention so that post development stormwater management targets can be met. ***(REVISED JUNE 2026)***

(e) Areas which are underlain by shallow coal mines and Development Permit Area (DPA 4) may not be suitable for some rainwater best management practices. Developments in these areas will require specific attention to methods of retention and detention so that post development stormwater management targets can be met. ***(REVISED JUNE 2026)***

.4 Design:

(a) Detailed methodology for the design of rainwater best management practices can be found in Metro Vancouver's "Stormwater Source Control Design Guidelines 2023". An overview of some of the design considerations are listed below.

(b) Sizing Methods:
There are several ways to size and design rainwater best management practices. Programs capable of continuous modeling will be in accordance with Section 7.03.6(b) [→]. The Professional of Record (or Qualified Registered Professional) must document the chosen approach and clearly demonstrate that the design meets the performance targets in Section 7.02 [→].

(c) Soil Hydraulic Conductivity:
Hydraulic Conductivity rates are to be determined by a Qualified Registered Professional and be supported by site soil conductivity testing. ***(REVISED JUNE 2026***

Rainwater infiltration and groundwater recharge facilities are still encouraged on sites with moderate or low soil hydraulic conductivity, even when the facility cannot accommodate the full target infiltration volume. Retention type facilities may be investigated to make up the difference.

(d) Groundwater:
Seasonal groundwater levels are to be assessed when considering rainwater infiltration and groundwater recharge. ***(REVISED JUNE 2026)***

(e) Bedrock:
Rainwater infiltration and groundwater recharge facilities may not be practical in areas where there is bedrock close to the surface. It should be noted that certain types of bedrock are highly pervious (i.e. fractured sandstone) and suitable for infiltration. ***(REVISED JUNE 2026)***

(f) Drinking Water Wells:
The design of groundwater recharge facilities must be separated from drinking water wells and comply with all applicable provincial requirements for groundwater protection and minimum separation distances between wells and septic systems. ***(REVISED JUNE 2026)***

(g) Water Quality:
Water infiltrated into the ground must be uncontaminated. Sites that present a high risk of groundwater contamination must provide appropriate pre-treatment and spill control. Examples of these sites include: ***(REVISED JUNE 2026)***

i. Automobile Service Yards, and

ii. Industrial Chemical Storage Facilities.

(h) Contaminated Soils:
Sites with contaminated soils must be reviewed by a Qualified Registered Professional for suitability for rainwater infiltration into the ground. ***(REVISED JUNE 2026)***

(i) Steep Slopes and Unstable Soils:
Sites containing steep slopes, near steep slopes, or unstable soils must be reviewed by a Qualified Registered Professional for suitability for rainwater infiltration and groundwater recharge facilities, but generally these facilities are prohibited in such conditions as they can saturate soils and can exacerbate slope instability. Designers should refer to the City's Development Permit Areas (DPA), DPA 3 and DPA 5, for areas where there may be concerns for surface water control and/or subsurface infiltration. It is important that infiltrated water does not seep out of down slope areas, impacting other properties. If there is a reason for concern with the suitability of proposed on-site infiltration facilities, the City Engineer may request a peer review by a Qualified Registered Professional, with specific expertise in hydrogeology. ***(REVISED JUNE 2026)***

(j) Overflows:
Rainwater best management practices must be designed with an overflow into the minor or major drainage system. ***(REVISED JUNE 2026)***

(k) Maintenance:
The design must minimize the maintenance required in order for the facilities to properly operate. Regular maintenance which is required must be identified in the Stormwater Management Plan. ***(REVISED JUNE 2026)***

(l) Sediment Loads:
All rainwater management best practices, other than green roofs, must be designed in such a way that there is a simple procedure for removing sediment which does not require confined entry. Specific attention is needed during the construction period. Infiltration facilities are to be designed in a way which prevents sediment from entering the facility and plugging the water-soil interface. ***(REVISED JUNE 2026)***

7.14 WATER QUALITY

.1 Introduction:

(a) All stormwater management systems must be designed in a way that prevents harmful materials from entering the natural watercourses. Methods of controlling the water quality must be outlined in the Stormwater Management Plan Report. ***(REVISED JUNE 2026)***

.2 Treatment:

(a) High Risk Sites:
Sites which present a high risk of groundwater or receiving water contamination must provide appropriate treatment prior to water entering the stormwater system. Examples of these sites include: ***(REVISED JUNE 2026)***

i. Automobile Service Yards, and

ii. Industrial Chemical Storage Facilities.

These uses may require covered areas to separate them from stormwater contact and may require discharge to the sanitary sewer.

(b) Parking Areas:
All uncovered parking areas greater than 100 m² in size require treatment to remove oil, total suspended solids (TSS), and other contaminants. Remove 80% TSS over 50 µm particle size. Treatment can be achieved by draining the parking area to rainwater best management practices or by installing a mechanical method for removing the contaminants. Where possible, treatment using rainwater best management practices is preferred as they provide additional rainwater management benefits at the same time as water quality treatment. ***(REVISED JUNE 2026)***

(c) Design Requirements for Water Quality Treatment:
On sites where water quality treatment is required, including when mechanical treatment is selected (such as an oil water separator), the facilities must be designed to treat 90% of the total volume of stormwater runoff for a typical year which is equivalent to 36 mm of rainfall per square metre of impervious area. Maintenance manuals are to be provided for all mechanical treatment facilities. ***(REVISED JUNE 2026)***

(d) Sediment:
All stormwater management systems must be designed to minimize sediment discharges both during and after construction. Excess sediment is harmful to both the downstream aquatic environment and the functionality of conveyance and infiltration facilities. The systems must be designed with awareness of possible sediment sources and methods of intercepting and removing sediment before it clogs infrastructure and harms the downstream environment. ***(REVISED JUNE 2026)***

(e) Water Quality:
Treated water must meet ***British Columbia Approved Water Quality Guidelines*** as set out by the British Columbia Ministry of Environment and Climate Change Strategy. ***(REVISED JUNE 2026)***

7.15 CLIMATE CHANGE

.1 Rainfall Patterns:

(a) The City recognizes that climate change is altering historical rainfall patterns in Nanaimo. Rainfall is a key parameter in the design of storm systems. These changes introduce uncertainty in long-term infrastructure and development planning, which is addressed through a risk-based approach. ***(REVISED JUNE 2026)***

(b) Mitigation of rainfall uncertainty due to climate change is based on guidance from the Association of Professional Engineering and Geoscientists of BC [1] and current down scaled climate model projections from the Pacific Climate Impacts Consortium[2] Risk management is implemented through engineering design and stormwater management for frequent (minor rainfall) and extreme (major rainfall) events. The updates are reflected in the Intensity-Duration-Frequency (IDF) curves derived from rain gauge data, which have been updated to account for Climate Change to Year 2100 as shown in Standard Drawing No. SW-25 . Refer to Section 7.03.3 [→]. ***(REVISED JUNE 2026)***

7.20 SCOPE

.1 This specification refers to gravity sewer pipe and appurtenant fittings for storm sewers. Only those products approved by the City Engineer and listed in the City's Approved Products List [] will be accepted for installation. ***(REVISED JUNE 2026)***

.2 Refer to Section 4.0 - Excavation, Trenching and Backfill [] for related specifications.

7.21 MATERIALS TESTING

.1 If, in the opinion of the City Engineer, testing is required, the Professional of Record 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 Professional of Record. ***(REVISED JUNE 2026)***

.2 The Contractor, as directed by the Professional of Record, must supply specimens or samples for testing. ***(REVISED JUNE 2026)***

.3 The types of tests listed below may be required by the City Engineer unless in the opinion of the City Engineer other testing is required. ***(REVISED JUNE 2026)***

.4 Joints for storm sewer main pipe and fittings and service connection pipe and fittings must be capable of meeting the following exfiltration tests. The Professional of Record may require that these tests be carried out by the Contractor or their supplier prior to acceptance of pipe on the project. ***(REVISED JUNE 2026)***

(a) Pipes in Proper Alignment:

Not fewer than 3 or more than 5 pipes selected from stock by the Professional of Record are to be assembled according to standard installation instructions issued by the manufacturer. With ends bulkheaded and restrained against internal pressure, the section is subjected to 70 kPa hydrostatic pressure. Pressure must be maintained for a period of 24 hours. There must be no leakage at the joints. ***(REVISED JUNE 2026)***

(b) Pipes in Maximum Deflected Position:

At least 2 joints of the assembly are to be deflected to the maximum amount recommended by the manufacturer. 35 kPa internal hydrostatic pressure is then applied to the test section and maintained for a period of 24 hours. There must be no leakage at the joints. ***(REVISED JUNE 2026)***

(c) Pipes in Maximum Lateral Misalignment:

The test section is to 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 is then 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 a pipe with a laying length of more than 1.2 m must be loaded no more than the amount computed for a 1.2 m length. There must be no leakage at the stressed joint while under this load of 35 kPa internal hydrostatic pressure. ***(REVISED JUNE 2026)***

7.22A PIPING, FITTINGS AND SERVICES

.1 The size and type of pipe to be used are shown on the drawings.

.2 Concrete Pipe:

(a) Non-reinforced concrete pipe and fittings must conform to ASTM C14M Class 3 to a maximum diameter of 600 mm and designed with flexible rubber gaskets joints conforming to ASTM C443M. ***(REVISED JUNE 2026)***

(b) Reinforced circular concrete pipe and fittings must conform to ASTM C76M Class III or higher for all pipe greater than 600 mm diameter and are to be designed with flexible rubber gasket joints conforming to ASTM C443M. ***(REVISED JUNE 2026)***

(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 must be DR35. Pipe and fittings must have a minimum pipe stiffness of 320 kPa at 5.0% deflection when tested in accordance with ASTM D2412. ***(REVISED JUNE 2026)***

(b) Pipe and fittings must be manufactured to the following specifications: ***(REVISED JUNE 2026)***100 mm – 375 mm diameter to ASTM D3034 and CSA B182.2
450 mm – 675 mm diameter to ASTM F679 and CSA B182.2

(c) Pipe and fittings must include integral bell and spigot ends with stiffened wall section and a formed groove for a rubber gasket conforming to ASTM F477. ***(REVISED JUNE 2026)***

(d) All PVC storm pipe must be green in colour. ***(REVISED JUNE 2026)***

.4 Ductile Iron Pipe:

(a) Pipe and fittings must conform to ASTM A746 or as approved by the City Engineer. ***(REVISED JUNE 2026)***

.5 Polyvinyl Chloride (PVC) Service Pipe:

(a) All storm service inspection assemblies must be green in colour. ***(REVISED JUNE 2026)***

(b) Storm service connections of 100 mm diameter must be DR28 and conform to CSA B182.1. Pipe and fittings must have elastomeric seal joints, locked in gasket, and integral bell joint features. ***(REVISED JUNE 2026)***

(c) Storm service connections greater than 100 mm diameter are to be as specified for PVC (smooth profile) mainline pipe. ***(REVISED JUNE 2026)***

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

(a) Pipe must conform to AWWA C906. All pipes are to be certified by Canadian Standards Association – CSA B137.1. ***(REVISED JUNE 2026)***

(b) Minimum acceptable pipe class is DR26 with a hydrostatic design stress rating of 10 MPa. ***(REVISED JUNE 2026)***

(c) All pipe supplied must bear the pipe series designation and manufacturer's name. ***(REVISED JUNE 2026)***

(d) Fabricated HDPE mitred fittings must conform to AWWA C906 and certified by Canadian Standards Association – CSA B137.1. Mounded HDPE fittings to ASTM D3261 suitable for pressure rating specified and fusion to main pipe. Pipe deflection up to manufacturer's recommended minimum radius may be used in place of fabricated mitre bends and to form the required vertical and horizontal curves. Polyethylene fittings must have a pressure rating at least equal to that of the pipe being joined. ***(REVISED JUNE 2026)***

7.22B JOINTS

.1 Storm sewer main pipe and fittings and service connection pipe and fittings must be jointed with a rubber gasket or other pre-formed, factory-manufactured gasket or approved material, designed for use with the specified pipe. Solvent connected joints and fittings are not permitted. ***(REVISED JUNE 2026)***

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

(a) Joints must be by thermal butt-fusion constructed in accordance with the manufacturer's specifications. ***(REVISED JUNE 2026)***

(b) Flange joints can be used to join long sections of butt-jointed pipe or as shown on the construction drawings. ***(REVISED JUNE 2026)***

(c) Flanges for polyethylene pipe must be slip-on type installed in conjunction with stub ends supplied by the pipe manufacturer. The flanges must be Class 150 meeting ANSI B16.5 drilling dimensions. Flanges must be carbon steel. ***(REVISED JUNE 2026)***

(d) All flanged joints must be separated by a neoprene gasket bonded to one of the flange faces. Neoprene for flange gaskets are to be 3 mm thick with holes drilled for flange bolts and size equal to flange diameter. ***(REVISED JUNE 2026)***

(e) Bolts and nuts for flanges must be stainless steel complete with isolation washers. ***(REVISED JUNE 2026)***

(f) Refer to Section 7.46 - Fitting and Joint [→] installation. ***(REVISED JUNE 2026)***

7.23 SERVICE JUNCTIONS

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

(a) Service connections must be manufactured using a sanded PVC male end stub pipe with integral bell. ***(REVISED JUNE 2026)***

(b) Stub orientation may be at 45˚ or 90˚ to the centerline of the mainline pipe (either at 9 o'clock to 11 o'clock, or at 10 o'clock to 3 o'clock).

(c) Field break-in and mortar patch joints are not permitted unless approved by the City Engineer. Refer to Section 7.48 - Service Connection Junction [→] installation. ***(REVISED JUNE 2026)***

.2 PVC Pipe (Smooth Profile):

(a) Service connections to PVC mainline pipe must be made with extrusion molded PVC or fabricated PVC fittings manufactured to ASTM D3034, CSA B182.1 and CSA B182.2. ***(REVISED JUNE 2026)***

(b) The use of saddles instead of manufactured wye fittings requires approval by the City Engineer. Where pipe saddles have been installed without approval, the City will require removal and reinstatement with an acceptable installation. ***(REVISED JUNE 2026)***

(c) Refer to Section 7.48 - Service Connection Junction [→] installation. ***(REVISED JUNE 2026)***

.3 PVC Pipe (Ribbed Profile):

(a) Ribbed pipe is only permitted when repairing an existing ribbed pipe section. ***(REVISED JUNE 2026)***

(b) Service connections to PVC mainline pipe must made with extrusion molded or fabricated PVC fittings manufactured to ASTM D3034, CSA B182.1 and CSA B182.2. ***(REVISED JUNE 2026)***

(c) For connections more than two pipe sizes smaller than the mainline, prefabricated service saddle connections may be approved.

(d) Refer to Section 7.48 - Service Connection Junction [→] installation. ***(REVISED JUNE 2026)***

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

(a) Service connections to HDPE mainline pipe must be made with manufactured fittings, electro-fused or heat-welded to the mainline pipe. Mechanical connections, if used, must be water-tight. ***(REVISED JUNE 2026)***

(b) Refer to Section 7.48 - Service Connection Junction [→] installation. ***(REVISED JUNE 2026)***

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

(a) Service connections to HDPE mainline pipe must be made with extrusion molded or fabricated fittings manufactured to CSA B182.1, B182.2 and B182.4. ***(REVISED JUNE 2026)***

(b) For service connections more than two pipe sizes smaller than the mainline, prefabricated service saddle connections may be approved.

(c) Refer to Section 7.48 - Service Connection Junction [→] installation. ***(REVISED JUNE 2026)***

7.24 PERFORATED DRAINS

.1 The granular material for perforated drains must be a clear round drain rock with 100% passing 40 mm and 0% passing 10 mm screens. ***(REVISED JUNE 2026)***

.2 Piping must be a minimum 150 mm diameter DR28 PVC perforated pipe with a minimum of 50 perforations 5 mm in diameter per linear metre of pipe for all pipe sizes. ***(REVISED JUNE 2026)***

.3 Perforations must be located in the bottom half of the pipe only. ***(REVISED JUNE 2026)***

.4 Filter fabric must be non-woven polyester fabric conforming to: ***(REVISED JUNE 2026)***

Tensile Strength (ASTM 1682)	250	N (minimum)
Bursting Strength (ASTM D-751)	865	kPa (minimum)
Permeability	$2x10^{-2}$	cm/s

7.25A PRECAST MANHOLE SECTIONS

.1 Unless otherwise approved, all manholes sections must be precast reinforced concrete conforming to ASTM C478. ***(REVISED JUNE 2026)***

.2 All precast sections must be complete with ladder rungs. ***(REVISED JUNE 2026)***

.3 0-ring rubber gaskets must conform to ASTM C443. ***(REVISED JUNE 2026)***

.4 Refer to Section 7.51 - Precast Manhole Sections [→] installation. ***(REVISED JUNE 2026)***

7.25B PRECAST MANHOLE BASES

.1 Precast manhole bases must be reinforced concrete in accordance with ASTM C478. ***(REVISED JUNE 2026)***

.2 All dimensions, specifications, and installations must conform to the requirements for cast in place manhole bases in accordance with Section 7.49 - Cast In Place Manhole Concrete Bases [→], Section 7.52 - Precast Manhole Bases [→] and the Standard Drawings. ***(REVISED JUNE 2026)***

.3 Pipe alignment, grade, and invert elevations in the precast manhole bases must conform to the construction drawings. ***(REVISED JUNE 2026)***

7.25C MANHOLE TOPS

.1 Manhole tops must be flat slab, precast concrete. Tops must be reinforced to meet CS600 loading requirements. Precast tops must conform to ASTM C478 with approved offset opening for frame and cover. ***(REVISED JUNE 2026)***

7.25D MANHOLE COVERS AND FRAMES

.1 Covers and frames must be cast iron and certified to meet CS600 loading requirements with the bearing faces of the cover to be frame machined for non-rocking fit. ***(REVISED JUNE 2026)***

.2 Patterns, dimensions and weights are to be in accordance with the Standard Drawings. Covers must have "CITY OF NANAIMO STORM DRAIN" permanently embossed on the covers. ***(REVISED JUNE 2026)***

.3 Standard manhole frame and cover are to conform to Standard Drawing No. SW-16 – Storm Manhole Cover [].***(REVISED JUNE 2026)***

.4 Utility chamber manhole frame and cover are to conform to Standard Drawing No. SW-17 – Utility Chamber Storm Manhole Frame, Ring and Cover []. ***(REVISED JUNE 2026)***

.5 A watertight manhole frame and cover, if required, are to conform to Standard Drawing No. SW-18 – Watertight Storm Manhole Frame and Cover []. ***(REVISED JUNE 2026)***

.6 Covers located in statutory right-of-way must be permanently embossed with the additional wording "DO NOT COVER". ***(REVISED JUNE 2026)***

.7 Refer to Section 7.54 - Frame and Cover [→] installation. ***(REVISED JUNE 2026)***

7.25E MANHOLE LADDER RUNGS ***(REVISED JUNE 2026)***

.1 Rungs must conform to ASTM C478 for concrete manhole rungs and ladders and must be a 19 mm diameter aluminum alloy conforming to CSA S157. ***(REVISED JUNE 2026)***

.2 Refer to Section 7.55 - Manhole Ladder Rungs [→] installation. ***(REVISED JUNE 2026)***

7.26 CONCRETE

.1 Concrete for cast in place are to conform to Section 11.0 - Cast In Place Concrete Works []. ***(REVISED JUNE 2026)***

7.27 PRECAST CONCRETE GRADE RINGS

.1 Precast concrete grade rings must conform to ASTM C478. ***(REVISED JUNE 2026)***

.2 For streets with steep grades, sloped concrete grade rings are to be used in conjunction with an adjustable manhole frame assembly. ***(REVISED JUNE 2026)***

7.28 TEMPORARY CLEANOUT FRAMES AND COVERS

.1 Temporary cleanout structures may only be used if approved by the City Engineer where there is development phasing. ***(REVISED JUNE 2026)***

7.29 PIPE AND FITTINGS FOR DROP MANHOLE STRUCTURES

.1 Pipe and fittings for drop manhole structures are specified under Section 7.22A - Piping, Fittings and Services [→] and Section 7.22B – Joints [→]. ***(REVISED JUNE 2026)***

.2 Refer to Section 7.56 for drop manhole structures [→] installation.

7.30 -NOT USED-

7.31A PRECAST CATCH BASIN BARRELS AND LEADS

.1 Catch basins barrels must be 600 mm or 750 mm diameter as noted on the standard drawings and must be reinforced concrete conforming to ASTM C478, Class III. ***(REVISED JUNE 2026)***

.2 Catch basin leads are to be of the same material as the main piping and used the same type of joints, gaskets, and fittings. ***(REVISED JUNE 2026)***

.3 Catch basin lead minimum sizes and desired grade as per Section 7.06.12 [→]. ***(REVISED JUNE 2026)***

7.31B CATCH BASIN CASTINGS

.1 Catch basin frame and grating are to be in accordance with Standard Drawings: ***(REVISED JUNE 2026)***

(a) SW-6 - Catch Basin Frame and Grate []
(b) SW-7 - Adjustable Catch Basin Frame and Hood []
(c) SW-8 - Boulevard Catch Basin Frame and Grate []

7.32 INLET AND OUTLET STRUCTURES

.1 Concrete inlet and outlet structures must be precast unless approved by the City Engineer. ***(REVISED JUNE 2026)***

.2 Cast in place concrete are to conform to Section 11.0 - Cast In Place Concrete Works []. ***(REVISED JUNE 2026)***

.3 The trash rack are to be pre-fabricated to match the pre-fabricated inlet or outlet structure. Custom built trash racks must be constructed with 20 mm diameter hot dipped galvanized bar. ***(REVISED JUNE 2026)***

7.33 ENERGY DISSIPATOR OUTLET STRUCTURES

.1 Energy dissipators must be pre-cast concrete integral to the outlet structure, unless approved by the City Engineer. The design must reduce runoff velocities to less than 1.5 m/s and disperse runoff evenly. ***(REVISED JUNE 2026)***

7.34 INLET AND OUTLET PROTECTIVE FENCING AND HANDRAILS

.1 Unless otherwise specified, protective fencing, and handrails including posts, pipe rails, and hardware are to be hot dip galvanized steel. Mesh must be 50 mm wire mesh, 9 gauge, hot dip galvanized, or plastic coated. ***(REVISED JUNE 2026)***

7.35A CULVERTS

.1 Concrete pipe are to conform to Section 7.22A - Piping, Fittings and Services, clause 7.22A.2 [→]. ***(REVISED JUNE 2026)***

.2 PVC pipe are to conform to Section 7.22A - Piping, Fittings and Services, clause 7.22A.3 [→]. ***(REVISED JUNE 2026)***

.3 Ribbed PVC pipe is permitted only for driveway culverts and must conform to CSA B1800. ***(REVISED JUNE 2026)***

7.35B CULVERT HEADWALLS

.1 Sacks are to be 0.25 kg burlap with approximate inside dimensions of 350 x 900 mm as measured when the sack is laid flat. ***(REVISED JUNE 2026)***

.2 All cast in place concrete are to conform to Section 11.0 - Cast In Place Concrete Works []. ***(REVISED JUNE 2026)***

.3 Reinforcing bars must be 15M intermediate grade steel conforming to CSA G30.18, Grade 400. ***(REVISED JUNE 2026)***

.4 Composite material headwalls may be used for culvert headwalls at the discretion and on approval of the City Engineer.

7.36A RIPRAP

.1 Riprap must be hard, dense, durable quarry stone, free from seams, cracks, or other structural defects, with a specific gravity of not less than 2.65. ***(REVISED JUNE 2026)***

.2 The gradation of rock sizes (mass in kg) for each class of riprap is to conform to the following table: ***(REVISED JUNE 2026)***

Class of Riprap (kg)	Nominal Thickness of Riprap (mm)	Rock Gradation (Percentage Larger than given rock mass, kg)			Approximate Average Dimension of Rock (mm)
		85%	50%	15%	
10	350	1.0	10	30	200
25	450	2.5	25	75	300
50	550	5.0	50	150	350
100	700	10	100	300	450
250	1000	25	250	750	600
500	1200	50	500	1500	800
1000	1500	100	1000	3000	1000
2000	2000	200	2000	6000	1200
4000	2500	400	4000 ***(REVISED JUNE 2026)***	12000	1500

Example: For Class 50 Riprap

85% of riprap stones are greater than 5.0 kg.
50% of riprap stones are greater than 50 kg.
15% of riprap stones are greater than 150 kg.

Based on Province of British Columbia Ministry of Transportation and Infrastructure. (2020). *Standard specifications for* highway *construction: Volume 1*. Table 205-C: Gradation and Intermediate Dimension of Rock by Class of Riprap ***(REVISED JUNE 2026)***

7.36B MANHOLE AND TEMPORARY CLEANOUT LID MARKERS

.1 Markers are required, where manhole and temporary cleanout lids are not located within developed right-of-way or residential properties, to indicate the location of the manholes and temporary cleanouts. These markers must 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 are to extend 1.0 m above the ground surface. The markers are to be located on site at a location, determined by the City 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. SW-20 – Storm Manhole and Temporary Cleanout Marker []. ***(REVISED JUNE 2026)***

7.37 SERVICE BOXES

.1 Service boxes for single storm sewer services are to be 300 mm x 500 mm concrete boxes complete with cast iron traffic cover marked “Storm” and concrete extension sections as required. ***(REVISED JUNE 2026)***

.2 Service boxes for twin storm sewer services are to be 425 mm x 750 mm concrete boxes complete with steel traffic cover marked “Storm” and concrete extension sections as required. ***(REVISED JUNE 2026)***

7.40 TRENCH EXCAVATION, BEDDING AND BACKFILL

.1 Refer to Section 4.0 - Excavation, Trenching and Backfill [] for installation requirements.

7.40A PIPE ALIGNMENT AND GRADE

.1 The pipe must be laid on the alignment and grade in accordance with the construction drawings. Each pipe must be checked for line and grade during installation. Methods used to maintain pipe alignment and grade must be approved by the Profession of Record. ***(REVISED JUNE 2026)***

.2 Unless otherwise directed by the Engineer, tolerances for pipe alignment and grade must be: ***(REVISED JUNE 2026)***

Alignment	=	± 50 mm
Grade	=	± 10 mm

7.41 PIPE CUTTING

.1 Pipe cutting are to be done in the manner recommended by the pipe manufacturer employing tools designed for this purpose. ***(REVISED JUNE 2026)***

7.42 PIPE INSTALLATION

.1 Pipe must be installed in strict accordance with the manufacturer's recommended practice. Joint gaskets are required unless stated otherwise by the Professional of Record. ***(REVISED JUNE 2026)***

.2 Pipe must 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. ***(REVISED JUNE 2026)***

.3 The open end of the pipe in the trench must be suitably covered to prevent entrance of trench water and other material during periods when pipe is not being installed. ***(REVISED JUNE 2026)***

.4 Precautions are to be taken to ensure that displacement of the pipe in the trench does not occur through soil displacement or floatation due to the presence of trench water. Pipe that has been displaced must be removed from the trench and re-laid. ***(REVISED JUNE 2026)***

.5 Lifting holes in concrete pipe are to be plugged with prefabricated plugs in non-shrink grout, or other plugs recommended by the pipe manufacturer. ***(REVISED JUNE 2026)***

7.43 JOINTS AT RIGID STRUCTURES

.1 A flexible joint must be provided at locations where the pipe is held in a fixed position by a rigid support or structure. The distance from the support or structure depends on the diameter and type of pipe being installed and must 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 dresser couplings. ***(REVISED JUNE 2026)***

7.44 HORIZONTAL AND VERTICAL CURVES

.1 Pipe on horizontal and vertical curves must be laid true to the radius of the curve shown on the drawings. Variations in vertical curves and grades are permitted only within the allowable joint deflection specified in Section 7.06.6 [→], unless approved by the City Engineer. ***(REVISED JUNE 2026)***

7.45 DEFLECTION

.1 The amount of pipe deflection at joints and couplings must be the limit as specified in Section 7.06.6 [→]. ***(REVISED JUNE 2026)***

7.46 FITTINGS AND JOINTS

.1 Fittings are to be installed at the locations shown on the construction drawings or as directed by the Professional of Record. Fittings must be installed in accordance with the manufacturer's specifications. ***(REVISED JUNE 2026)***

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

(a) Pipes must be joined using the thermal butt fusion method. ***(REVISED JUNE 2026)***

(b) The contractor must make arrangements to have the pipe jointing be carried out by the pipe manufacturer or certified personnel familiar with the jointing technique, using equipment and methods specifically designed for the pipe diameter and material. ***(REVISED JUNE 2026)***

(c) Where required, flanged joints must be used to connect long pipe sections. ***(REVISED JUNE 2026)***

(i) Each joint must consist of a polyethylene stub end butt-fused to the end of pipe and a carbon steel slip-on flange. ***(REVISED JUNE 2026)***

(ii) Flanged joints and flange bolts must be stainless steeland include isolation washers. ***(REVISED JUNE 2026)***

(d) Refer to Section 7.22B [→] for Joint Specifications.

7.47 CONNECTIONS TO EXISTING PIPING AND APPURTENANCES

.1 All connections to existing piping, services, and appurtenances will made by City forces unless otherwise approved by the City Engineer. ***(REVISED JUNE 2026)***

.2 All connections to existing piping and services must utilize a manufactured rubber gasket bell and spigot joint or dresser coupling designed for the types of pipes to be connected. For connections to existing service connections refer to Standard Drawing No. SW-27 – Concrete Encasement for Connections to Existing Storm Services []. ***(REVISED JUNE 2026)***

.3 The use of field joints or rubber repair couplings require the approval of the City Engineer. ***(REVISED JUNE 2026)***

.4 Rubber repair couplings must have 4 stainless steel clamps complete with stainless steel clamps complete with stainless steel anti shear band. Only those products approved by the City Engineer will be accepted for installation.

.5 Slip couplers must be used on PVC pipes. Rubber repair couplings are not permitted on PVC pipes. ***(REVISED JUNE 2026)***

7.48 SERVICE CONNECTION JUNCTIONS

.1 Service connection junctions are to be installed at the locations shown on the construction drawings or as directed by the Professional of Record during construction. ***(REVISED JUNE 2026)***

.2 Where service connections are not installed with the main, install fittings to accommodate the future service connections and cap or plug the fittings. Install markers as per Section 7.61 – Service Connection Installation [→]. ***(REVISED JUNE 2026)***

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

(a) Field break-in and mortar patch joints are not be used unless approved by the City Engineer. If approved, the following will apply: ***(REVISED JUNE 2026)***

(i) Service connections must be manufactured using a sanded PVC male end stub pipe with integral bell. ***(REVISED JUNE 2026)***

(ii) Break into the pipe by coring to within 40 mm of the outside diameter of the service stub. All exposed reinforcing steel must be removed. ***(REVISED JUNE 2026)***

(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 is to be equivalent to the thickness of the concrete pipe wall and length of the stub's integral bell. ***(REVISED JUNE 2026)***

(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 and backfilling.

(vii) Installation must be inspected by the Professional of Record prior to backfilling. ***(REVISED JUNE 2026)***

(b) Refer to Section 7.23 - Service Junction [→] specifications. ***(REVISED JUNE 2026)***

.4 PVC Pipe (Smooth Profile):

(a) Service saddle connections cannot be used unless approved by the City Engineer. ***(REVISED JUNE 2026)***

(b) If approved, installation of service saddle connections must conform to the following: ***(REVISED JUNE 2026)***

(i) Drill hole into main line pipe to the exact outside diameter of the new connection.

(ii) The use of saddles instead of manufactured wye fittings requires approval by the City Engineer. Saddles must be rigid PVC material complete with rubber seating gasket. Saddles are to be attached to pipe with stainless steel banding straps. ***(REVISED JUNE 2026)***

(iii) Attach service saddle in accordance to the manufacturer's specifications.

(c) Refer to Section 7.23 - Service Junction [→] specifications. ***(REVISED JUNE 2026)***

.5 PVC Pipe (Ribbed Profile):

(a) Installation of service saddle connections are to conform to Section 7.48.4 [→]. ***(REVISED JUNE 2026)***

(b) Refer to Section 7.23 - Service Junction [→] specifications.

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

(a) Service connections to mainline pipe using manufactured fittings must be in strict accordance with manufacturer's instructions. ***(REVISED JUNE 2026)***

(b) Connection of HDPE service junctions to non-pressurized PVC service pipe must be made with flexible couplings. Flexible couplings must be manufactured from elastomeric PVC and be held in place with series 300 stainless steel worm gear clamps. ***(REVISED JUNE 2026)***

(c) Refer to Section 7.23 - Service Junction [→] specifications.

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

(a) Installation of service saddle connections are to conform to Section 7.48.4 [→]. ***(REVISED JUNE 2026)***

(b) Refer to 7.23 - Service Junction [→] specifications.

7.49 CAST IN PLACE MANHOLE CONCRETE BASES

.1 All water is to be removed from the excavation prior to placing base concrete. The base must be constructed such that the first section of a precast section can be set plumb with uniform bearing throughout its full circumference. ***(REVISED JUNE 2026)***

.2 If material in the bottom of the trench is unsuitable for support, the bottom may be overexcavated to firm base as determined by the Professional of Record and backfilled to the required grade with thoroughly compacted base gravel as specified for trench bottom stabilization under the applicable section included in Section 4.0 - Excavation, Trenching and Backfill []. ***(REVISED JUNE 2026)***

.3 Where overexcavation and backfill with base gravel is not practical, special structure support are to be provided as specified for trench bottom stabilization under the applicable section included in Section 4.0 - Excavation, Trenching and Backfill []. ***(REVISED JUNE 2026)***

.4 Concrete manhole bases must be constructed as shown on the drawings. Pipes and fittings through the manhole must 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 adaptor rings on all plastic pipe installed in the manhole base. ***(REVISED JUNE 2026)***

.5 Invert elevations of pipes at the manhole must 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 designed elevation. ***(REVISED JUNE 2026)***

.6 Variations in manhole inverts from established grade or elevations must be corrected. ***(REVISED JUNE 2026)***

.7 Manhole channeling must be constructed as shown on Standard Drawings or as shown on the construction drawings. Channeling must be constructed to have a minimum 0.3 m straight section before the change in direction within the manhole. ***(REVISED JUNE 2026)***

.8 The channels in the base of manholes must be shaped and finished to provide smooth passage for the stormwater in order to minimize head losses and deposits at bends and at junctions of channels. ***(REVISED JUNE 2026)***

.9 Channels must be accurately formed. The practice of forming channels roughly to shape and finishing with cement mortar will not be permitted. The channels are to be steel trowel finished. ***(REVISED JUNE 2026)***

.10 Benching in manholes must be sloped to drain. Broom finish to produce a non-skid surface. ***(REVISED JUNE 2026)***

SECTION 7 – STORMWATER MANAGEMENT INSTALLATION

7.50 -NOT USED-

7.51 PRECAST MANHOLE SECTIONS

.1 Precast manhole barrel sections must be placed plumb. ***(REVISED JUNE 2026)***

.2 Joints between the top riser and the cover slab must be made watertight with cement mortar. Prior to placing sections, the mating face are to be thoroughly soaked with water and a layer of cement mortar spread on the lower face. After sections are placed, excess mortar is removed and the joint made flush inside and out. ***(REVISED JUNE 2026)***

.3 Joints between precast manhole barrels must utilize o-ring gaskets and conform to the manufacturer's specifications. The inside surface of the precast barrel at the o-ring joints must be filled with cement grout to a smooth finish. ***(REVISED JUNE 2026)***

.4 Damaged o-ring manhole joints require removal and replacement of damaged manhole section. Mortar patching of damaged area, if approved by the Qualified Registered Professional, requires removal of the o-ring gasket and installation as per Section 7.51.2 [→]. ***(REVISED JUNE 2026)***

.5 Refer to Section 7.25A - Precast Manhole Section [→] specifications. ***(REVISED JUNE 2026)***

7.52 PRECAST MANHOLE BASES

.1 Installation of precast manhole bases are to conform to Section 7.49 - Cast In Place Manhole Concrete Bases [→]. ***(REVISED JUNE 2026)***

.2 Precast manhole bases must be placed on 150 mm thick base of 38 mm drain rock. ***(REVISED JUNE 2026)***

.3 Plastic and concrete pipes installed in the precast manhole base must utilize rubber manhole adaptor rings to seal the connection. ***(REVISED JUNE 2026)***

.4 Refer to 7.25B -Precast Manhole Section [→] specifications.

7.53 CONCRETE

.1 Cast in place concrete are to conform to Section 11.0 - Cast In Place Concrete Works []. ***(REVISED JUNE 2026)***

7.54 FRAMES AND COVERS

.1 Frames must be set on precast concrete grade rings to bring the cast iron manhole frame up to grade elevation shown on construction 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 must be laid in common bond with racked mortar joints and mortared inside and outside of the manhole. ***(REVISED JUNE 2026)***

(a) Fine grade elevation adjustments of frames are to be done with a minimum of 3, steel only, shims equally spaced. ***(REVISED JUNE 2026)***

.2 Manhole covers must be installed:

(a) for unpaved areas: Covers are to have a 1.5 m x 1.5 m, 50 mm thick asphalt apron. Covers must be set flush with the asphalt surround. ***(REVISED JUNE 2026)***

(b) for paved areas: Covers must be flush with pavement grade with a maximum allowed variance of 6 mm lower than finished pavement. Covers must not protrude above finished pavement. ***(REVISED JUNE 2026)***

(c) covers installed outside of the tolerances listed above require approval by the City Engineer. ***(REVISED JUNE 2026)***

.3 Steel manhole riser rings are permitted in easements only. ***(REVISED JUNE 2026***

.4 The inside surface of the manhole frame are to be painted green with an enamel rust paint in accordance with the manufacturer's specifications. ***(REVISED JUNE 2026***

.5 Refer to Section 7.25D [→] for Manhole Covers and Frames Specifications.

7.55 MANHOLE LADDER RUNG ***(REVISED JUNE 2026)***

.1 Manhole ladder rungs are to be installed in manhole sections by the manufacturer unless circumstance dictates otherwise in which case approval must be received from the City Engineer. ***(REVISED JUNE 2026)***

.2 The distance from the top of the manhole cover to the first manhole rung, must conform to WorkSafeBC requirements. ***(REVISED JUNE 2026)***

.3 All rungs must 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. ***(REVISED JUNE 2026)***

.4 Refer to Section 7.25E [→] for manhole rungs specifications. ***(REVISED JUNE 2026)***

7.56 DROP MANHOLE STRUCTURES

.1 Manhole drop structures must be constructed as shown on Standard Drawing No. SW-14 - Storm Drop Manhole []. ***(REVISED JUNE 2026)***

7.57 STUBS

.1 Blind stub sections for connection of future sewers and service connections to the manholes must be installed where shown on the construction drawings and as directed by the Professional of Record. Stubs are to be as long as the vertical depth from finish grade to the invert of each stub. Each stub must be plugged with a removable, watertight plug as shown on the construction drawings. Where stubs are installed, the bottom of the manhole must be channelled to the stub entrance. ***(REVISED JUNE 2026)***

7.58 – NOT USED- ***(REVISED JUNE 2026)***

7.59 - NOT USED-

7.60 PRECAST CATCH BASIN BARRELS AND LEADS

.1 Catch basins must be installed in accordance with the Standard Drawings. ***(REVISED JUNE 2026)***

.2 Catch basin leads must be installed to allow passage of video cameras and flushing equipment. Installation of mitred may be allowed to avoid pipe conflicts or insufficient bury. Mitre bends cannot exceed 45˚ and there must be a minimum 1.0 m separation between mitre bend hubs. ***(REVISED JUNE 2026)***

.3 Catch basin leads taken into manholes must be benched in the same manner as main line piping. ***(REVISED JUNE 2026)***

.4 Catch basin grates are to be set 20 mm below the gutter line. The concrete gutter and asphalt are to be shaped to form a dish around the inlet. ***(REVISED JUNE 2026)***

.5 Construction and finishing of catch basins are to be the same as for manholes as described in Section 7.54 - Frames and Covers [→]. ***(REVISED JUNE 2026)***

.6 Catch basin leads are to protrude 50 mm into the catch basin barrel and must be grouted inside and outside of the barrel in accordance with the Standard Drawings. ***(REVISED JUNE 2026)***

.7 There must be a 400 mm minimum clearance between the outside of the catch basin barrel and the trench wall to allow for compaction. ***(REVISED JUNE 2026)***

.8 Curb inlet catch basins are to be installed to be rigid once installed and the inlet hood remain flush with the top of the curb.

7.61 SERVICE CONNECTION INSTALLATION

.1 Location of Service Connections:

(a) Service connections are to be installed at the locations and depths as specified by the Professional of Record. Where the depth of the service connection exceeds 2.0 m, the service must be extended into the property the same distance as the depth of the service, up to a maximum distance of 4.0 m. This must be done during the installation of the service connection from the main to the property. ***(REVISED JUNE 2026)***

(b) At no time are two or more storm services be coupled into one lead crossing the street or right-of-way. Each service must have its own independent connection into the main sewer. ***(REVISED JUNE 2026)***

.2 Grade and Alignment of Service Connections:

(a) Trenches must be excavated so the 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 connections must be installed at grade of not less than 2% unless otherwise directed by the Engineer. Service pipe must be installed at a uniform grade between the terminus at the property line and the junction fitting at the sewer or upper end of a service drop. ***(REVISED JUNE 2026)***

.3 Storm Sewer Service Connection Installation:

(a) Pipe must be installed in strict accordance with the manufacturer's recommended practice. ***(REVISED JUNE 2026)***

(b) Pipe must 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. ***(REVISED JUNE 2026)***

(c) The Contractor must use methods for installing pipe in an auger hole or casing pipe as shown on the construction drawings. ***(REVISED JUNE 2026)***

(d) The trench must be excavated to provide a minimum cover of 0.75 m over the service connection pipe at property line. ***(REVISED JUNE 2026)***

(e) In rock, the trench is to be extended three 3.0 m into the property to facilitate future extension of the service connection.

(f) The trench bottom must be graded to form a continuous support along the service pipe. All rocks or projections which might prove detrimental to the pipe must be removed. ***(REVISED JUNE 2026)***

(g) Joints must be made using the specified couplings. No glued joints. ***(REVISED JUNE 2026)***

(h) At the terminus of each sewer service approved watertight caps suitably supported by sandbags are to be installed to prevent leakage. ***(REVISED JUNE 2026)***

(i) A 38 mm x 89 mm pressure treated wood marker stake must be placed at the service terminus as shown on the drawings to facilitate future location of the service pipe. This stake must extend in locations where the extension of the stake above ground surface would prove hazardous, in which case the stake must be cut off flush with the ground surface. The stake must be marked in an approved manner to show the depth of the service pipe invert below the top of the stake. The stakes must be painted green to visually identify the storm sewer service connections. The Professional of Record will take invert elevations of the service connection assembly prior to placement of the cap by the Contractor. ***(REVISED JUNE 2026)***

(j) Inspection assemblies must be installed as shown on the standard drawings. ***(REVISED JUNE 2026)***

(k) The service box must be installed plumb with the lid 25 mm above finished grade in unpaved areas and 0 - 6 mm below finished grade in paved areas. ***(REVISED JUNE 2026)***

.4 Riser Service Connections:

(a) Riser service connections must be installed as shown on Standard Drawings No. SW-21 - General Storm Service Connection Detail, Riser and Non Riser Types [] or Standard Drawing No. SW-22 - Commercial Areas Storm Service Connection Detail, Riser and Non Riser Types [] in locations shown on the construction drawings. ***(REVISED JUNE 2026)***

7.62 NOTIFICATION TO THE CITY OF NANAIMO

.1 The City Works Inspector must be given 48 hours notice of all tests. ***(REVISED JUNE 2026)***

7.62A CLEANING AND FLUSHING

.1 The pipes must be cleaned upon completion of the sewer pipe installation and one month prior to the end of the maintenance period to the satisfaction of the Professional of Record and the Inspector. Cleaning must be completed by power flushing with water to remove all foreign matter. ***(REVISED JUNE 2026)***

.2 Ensure that snow chains are installed at the downstream manhole so that no foreign material passes beyond downstream manhole. Flow through the system must remain unimpeded at all times while snow chains are installed. ***(REVISED JUNE 2026)***

.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 Professional of Record, the Inspector, or by the City CCTV contract administrator. ***(REVISED JUNE 2026)***

.4 Manholes must be cleaned after the upstream section of pipe has been successfully cleaned and approved by the Professional of Record, the Inspector, or by the City CCTV contract administrator. ***(REVISED JUNE 2026)***

.5 Pipes must be cleaned in the direction of flow and cannot be flushed in a backflush direction unless approved by the Professional of Record, by the Inspector, or by the City CCTV contract administrator. ***(REVISED JUNE 2026)***

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

.7 Dispose of the debris at approved dump site such as the Regional District of Nanaimo's landfill or by the CCTV contract administrator's approved alternative. ***(REVISED JUNE 2026)***

.8 Decanting of liquid waste accumulated during debris removal is permitted at a controlled release rate, to a maximum of 8 L/s, at a location approved by the City CCTV contract administrator. ***(REVISED JUNE 2026)***

.9 Timeframe between cleaning and video inspection of pipeline cannot exceed 24 hours unless approved by the City Engineer. ***(REVISED JUNE 2026)***

.10 Ensure all environmental mitigation is in accordance Provincial and Federal Regulations. ***(REVISED JUNE 2026)***

7.63 VIDEO INSPECTING MAINS

.1 All pipe video inspection including methods of cleaning, equipment and rates of camera travel, are to be in accordance with the UK Water Research Centre's (WRc), Sewage Rehabilitation Manual, most current edition. ***(REVISED JUNE 2026)***

.2 The contractor must 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 Professional of Record and the Inspector. ***(REVISED JUNE 2026)***

.3 For gravity sewers and service connections, the contractor must arrange for video inspection to check alignment, grade, and condition of the main sewer pipe including catch basin leads. Where a new sewer pipe crosses an existing sewer pipe, the contractor must also arrange for a video inspection of the existing sewer pipe at the location of the crossing. ***(REVISED JUNE 2026)***

(a) Illumination depth of field must be no less than 3 joints for standard joint and spigot pipe types to allow for pipe deflection assessments (9.0 m). No dark/opaque circle are to be visible in the middle of this depth of field viewing area. ***(REVISED JUNE 2026)***

(b) Eliminate steaming and fogging encountered during the inspection survey by introducing forced air flow by means of a fan.

(c) Camera lens to remain free of grease or other deleterious matter to ensure optimal clarity.

(d) Plan and tilt view each service connection (junction) such that the camera looks down the centerline of the service, pause for a minimum of five (5) seconds and note condition of the joint and/or pipe/service interface.

(e) Camera guides (Skids) should not be visible at either side of the pipe during normal camera travel or during Pan & Tilt operation. Configuration or camera/guides must be altered to alleviate this problem. ***(REVISED JUNE 2026)***

(f) CCTV push camera work must be video captured (complete with skids for centering) from the main wye pulling back to entrance point to avoid an invert only view. ***(REVISED JUNE 2026)***

(g) A winch line must be provided to support camera travel in steep, slippery, or relined pipe sections. ***(REVISED JUNE 2026)***

(h) Position camera lens centrally in the pipeline with a positioning tolerance of ±10% off the vertical centerline axis of the pipeline. For elliptical pipe the camera to be positioned 2/3 the height of 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 cannot exceeding 310 mm: and

(iii) 0.20 m/s for diameters exceeding 310 mm

.4 The inspection must include the preparation of: ***(REVISED JUNE 2026)***

(a) an HDSD 32 GB Class 10 regular card. Picture size: NTSC 640X480 pixels, aspect ratio 4:3, 29.97 frames per second @ 8 megabits per second capture rate. Individual MPEG4 video files cannot exceed 1.7GB in size. ***(REVISED JUNE 2026)***

(b) a Microsoft Access database CD of the Header and Observation codes as specified by the City. ***(REVISED JUNE 2026)***

(c) a pipe condition assessment paper report.

(d) All submitted to the Professional of Record. ***(REVISED JUNE 2026)***

.5 The Professional of Record must review the pipe condition report and provide certification that the condition of the installed pipe is accurately recorded and the pipe installation meets this manual . ***(REVISED JUNE 2026)***

.6 The pipe condition report and certification are the property of the City. ***(REVISED JUNE 2026)***

.7 Variations in line of grade of pipe, from that established by the Professional of Record prior to installation, and any jointing, pipe cleaning, or other deficiencies discovered during the inspection, must be rectified. Re-inspection of the pipe may be required by the Professional of Record at the Contractor's expense. ***(REVISED JUNE 2026)***

.8 During the test, manhole construction and invert elevations must be checked and any variations from the established grade, drawing, or specifications, must be rectified. ***(REVISED JUNE 2026)***

.9 Video inspection and pipe condition coding must be undertaken only by personnel with current Canadian certification by a City approved agency. ***(REVISED JUNE 2026)***

7.63A SMOKE TESTING

.1 The Professional of Record must arrange for smoke testing of all installed storm mains in the presence of the City Inspector. ***(REVISED JUNE 2026)***

.2 The Professional of Record must provide as-built service location information to the City Inspector prior to smoke testing. ***(REVISED JUNE 2026)***

.3 Cross-connections noted during the smoke testing must be corrected and the record drawing information revised. ***(REVISED JUNE 2026)***

7.64 DRAINAGE DITCH CONSTRUCTION

.1 Drainage ditches are to be excavated to the line and grade shown on the construction drawings or as otherwise determined by the Professional of Record. ***(REVISED JUNE 2026)***

7.65 CULVERT INSTALLATION

.1 Trenches for culvert installation must be excavated to the required depth and grade, then backfilled in accordance with the requirements for storm mainlines. ***(REVISED JUNE 2026)***

.2 Concrete Pipe:
(a) Install pipe in accordance with Section 7.42 - Pipe Installation [→].

.3 Polyvinyl Chloride (PVC) Pipe:
(a) Install pipe in accordance with Section 7.42 - Pipe Installation [→].

7.66 CULVERT HEADWALLS

.1 Culvert headwalls must be constructed as shown on the Standard Drawings. ***(REVISED JUNE 2026)***

.2 "Wet-mix" Sandbags:

(a) The sandbag sacks are to be wetted and filled with wet premixed concrete and folded at the top to retain the concrete at the time of placing.

(b) Immediately after being filled with concrete, sacks are to be placed and lightly tamped to conform with the slope, culvert pipe, and adjacent sacks in-place. ***(REVISED JUNE 2026)***

(c) Sacked concrete are to be laid in courses such that joints in succeeding courses are staggered. Courses are to be a minimum of ten per vertical metre. Dirt and debris are to be removed from the top of sacks before the next course is laid thereon. ***(REVISED JUNE 2026)***

(d) Prior to sacked concrete setting, courses of bags are to be tied by driving a 15M reinforcing bar vertically from top to bottom through each course so that displacement cannot occur after the final set of concrete. Top of reinforcing bar must be bent over on top. ***(REVISED JUNE 2026)***

.3 Headwalls must be protected from heavy rainfall and from contacting water for a period of at least 24 hours after placing. ***(REVISED JUNE 2026)***

.4 Composite culvert headwalls must be installed as per manufacturer's recommendations and Professional of Record approved design drawings. ***(REVISED JUNE 2026)***

7.67 PERFORATED DRAINS

.1 Excavate trench to the lines and grades as shown on the construction drawings.

.2 Place sufficient filter fabric in the trench to provide a minimum 300 mm overlap after the drain rock is placed.

.3 Place a 150 mm thick layer of drain rock and install the perforated pipe. Perforations must be installed on the bottom half of the pipe. ***(REVISED JUNE 2026)***

.4 Place drain rock to within 150 mm of finished surface and surround with filter fabric.

.5 Place remaining 150 mm of drain rock or, if specified, topsoil to finish grade. ***(REVISED JUNE 2026)***

.6 Install all manholes as per Section 7.0 - Stormwater Management.

7.68 INLET AND OUTLET STRUCTURES

.1 Inlet and outlet structures must be installed in accordance with Standard Drawings. ***(REVISED JUNE 2026)***

.2 Excavate to the lines and grades as shown on the construction drawings. If subgrade is unsuitable for support as determined by the Professional of Record, the bottom must be excavated and backfilled to the required grade with road base gravel compacted to 95% modified proctor or drain rock. ***(REVISED JUNE 2026)***

.3 Structure must be placed on a minimum of 100 mm (compacted thickness) of road base gravel compacted to 95% modified proctor. Where groundwater is present, drainrock may be substituted for road base gravel if approved by the Professional of Record. ***(REVISED JUNE 2026)***

.4 Cast in place concrete are to conform to Section 11.0 - Cast In Place Concrete Works []. ***(REVISED JUNE 2026)***

7.69 RIPRAP

.1 Areas to receive riprap must be trimmed to a uniform surface, to the grades shown on the drawings. Before rock placement commences, loose materials must be removed and minor pot holes and hollows filled in with select granular sub-base, well tamped in. ***(REVISED JUNE 2026)***

.2 Geotextile material and placement, where required, must be as shown on the drawings. ***(REVISED JUNE 2026)***

.3 At the toe of sloped riprap, larger rocks must be placed regularly enough to form a firm foundation, 50% thicker than the required nominal thickness. ***(REVISED JUNE 2026)***

.4 Other large rocks are to be regularly spaced. Smaller rocks are to be well positioned to form an interlocking, even surface. ***(REVISED JUNE 2026)***

7.70 PIPE VIDEO AND MANHOLE CONDITION REPORT FORMAT

.1 Reference plans must accompany reports with manholes labeled and inspected sections highlighted. Manhole and pipe numbering must conform to the construction drawings, or if available, City pipe and manhole numbers. Reports are to be submitted in both digital and hardcopy formats. ***(REVISED JUNE 2026)***

.2 All sewer defects must be photographed and included with the report and referenced by numbers accordingly. ***(REVISED JUNE 2026)***

.3 The video pipe condition rating report format are to be in accordance with the UK Water Research Centre's (WRc), Sewerage Rehabilitation Manual, most current edition. Structural defects must be properly weighted with the appropriate scores assigned to them as shown in the following table: ***(REVISED JUNE 2026)***

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

.4 Every video inspected sewer will be assigned a composite grade based on the sum of its defect point scores as per the following table:

WRc - SEWER RATING COMPOSITE GRADE

COMPOSITE GRADE	PEAK SCORE RANGE (SUM OF THE SCORES FROM THE ABOVE TABLE)	TYPICAL DEFECT DESCRIPTION
1 (least defective)	1 to 9	No observable structural defects
	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%.

.5 The following additional information must be included for each sewer section as the CCTV Title Page: ***(REVISED JUNE 2026)***

(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 (Street Name or RW No.). ***(REVISED JUNE 2026)***
(i) Distance from the manhole rim to pipe invert.
(j) Length of Capture.
(k) Total of Captured CCTV.
(l) Current weather information.

.6 All pipe video inspections must include an annotated map with the following information: ***(REVISED JUNE 2026)***

(a) Manhole and catch basin locations with labels.
(b) City of Nanaimo drawing numbers.
(c) Manhole I.D. numbers (as per the City GIS numbering system). ***(REVISED JUNE 2026)***
(d) Catch basin I.D. numbers (as per the City GIS numbering system). ***(REVISED JUNE 2026)***

.7 Computer database file to contain identical survey report information as the printed report exclusive of photographs. Index numbers and distance of survey information are numerically increase. For an individual survey, whether the information is sorted by index or distance, the result will be in the same order. ***(REVISED JUNE 2026)***

.8 All pipe video inspections operators must be thoroughly trained with current Canadian certification by a City approved agency. ***(REVISED JUNE 2026)***

.9 Manhole video inspection is not required. Manholes must be rated as per the following table, and form part of the video inspection report. ***(REVISED JUNE 2026)***

MANHOLE RATING SYSTEM ***(REVISED JUNE 2026)***

INTERNAL CONDITION GRADE	TYPICAL DEFECT DESCRIPTION
1 (least defective)	-No observable structural defects. -No observable signs of 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.