CITY OF VANCOUVER



ENGINEERING DESIGN MANUAL

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Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate, P.Eng
1	August 2024	Updates	Megan Pate, P.Eng
1.1	April 2026	Various Updates and Clarifications	Lon LaClaire, P.Eng, General Manager, Engineering Services

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INTRODUCTION



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INTRODUCTION

1.1 PREFACE

This is the first edition of the City of Vancouver's *Engineering Design Manual*. This manual is intended to be a comprehensive guide that documents the typical design processes and criteria to be used for projects conducted by and for the City of Vancouver. In accordance with the Engineers and Geoscientists BC's Bylaws (Standard for Checks) and the City's Professional Practice Management Plan, each design assignment should be completed in accordance with a design brief which will stipulate the unique specifications for the assignment, which may differ from this manual as prepared and amended by the City of Vancouver.

The scope of this manual is split into 10 chapters relating to various aspects of design in the City of Vancouver.

Chapter 1: Introduction

Chapter 2: Design Process & Coordination

Chapter 3: Water System

Chapter 4: Sanitary Sewer System

Chapter 5: Storm Drainage System

Chapter 6: Neighbourhood Energy

Chapter 7: Third-Party Utilities

Chapter 8: Streets & Transportation

Chapter 9: Streetscape & Urban Forest

Chapter 10: Traffic Signals & Electrical

This *Engineering Design Manual* is to be used in coordination with the other documents in the Engineering Standards Library which can be found on the City's website *City of Vancouver Standard Detail Drawings*.

1.2 PURPOSE

The purpose of this manual is to consolidate the City of Vancouver's design preferences and criteria into one comprehensive and cohesive document. It is to be used by any party designing city infrastructure including City staff, City officials, and design professionals such as consulting engineers and architects working on behalf of the City, Third-Party Utilities, or developers.

This manual provides general standard design criteria but cannot cover all specific situations. It is up to the designer to interpret these guidelines and apply them appropriately. The City is a design, build, operate, and maintain organization which does have in-house expertise that can assist with the interpretation and application of the standards / criteria in this manual.

This design manual is meant to provide guidance and processes for how design is typically conducted in the City of Vancouver; noting that use of accepted industry standards and specifications will likely still be required. The City reserves the right to review, provide comment on, and accept or reject designs whether they conform to the guidance within this document or not.

The City of Vancouver: (i) accepts no liability for any loss or damage which may be suffered by any person as a result of the use of this document; and (ii) makes no representation or warranty as to the appropriateness of the use of this document in any particular situation. This document is issued on the strict understanding that each user accepts full responsibility and liability for its use. It is the responsibility of designers to use sound professional judgment, knowledge and experience when using this document.

1.3 DESIGN PHILOSOPHY

The City of Vancouver aims to be one of the most sustainable and livable cities in the world today and in the future. The City's design philosophy is paramount to progressing towards and achieving these objectives. This section outlines the context, strategies, and vision that all projects designed in Vancouver must acknowledge and incorporate.

1.3.1 DESIGNING WITHIN CONTEXT

The City of Vancouver's mission is to create a great city of communities that cares about its people, environment, and opportunities to live, work, and prosper.

The City of Vancouver conducts itself based on these six values:

- **Responsiveness** - We are responsive to the needs of our citizens and our colleagues.
- **Excellence** - We strive for the best results.
- **Fairness** - We approach our work with unbiased judgement and sensitivity.
- **Integrity** - We are open and honest, and we honour our commitments.
- **Leadership** - We aspire to set examples that others will choose to follow.
- **Learning** - We are a learning workplace that grows through our experiences.

Consistency, continuity, cohesiveness, and quality are important aspects of design in the City of Vancouver. Historical, cultural, and aesthetical qualities of the surrounding area should be preserved and enriched. Design should align with the goals and vision of the community and future development plans. Community plans and zoning by-laws influence each design; all projects should strive to enhance the livability of the space and promote a vibrant community that is inclusive to all people.

Designers must integrate constructability, operations, and maintenance considerations during design development. Quality of infrastructure is highly important, and it is promoted and upheld by in-house expertise.

1.3.2 CITY OF RECONCILIATION

In July 2014, Vancouver was designated a City of Reconciliation and Council adopted the Reconciliation Framework. The Reconciliation Framework affirmed the City's ongoing commitment to working towards Reconciliation with xʷməθkʷəy̓əm (Musqueam Indian Band), Sḵwx̱wú7mesh Úxwumixw (Squamish Nation), səl̓ilwətaʔɬ (Tsleil-Waututh Nation), and urban Indigenous communities.

Our Reconciliation goals are to establish and maintain mutually respectful relationships between Indigenous and non-Indigenous peoples in the city and to respect the unique and on-going rights of the local First Nations. Despite the progress made to date, we know we have much more work to do and we recognize that Reconciliation is a continuous process, not a destination.

The *Engineering Design Manual* represents a compilation of many decades worth of technical expertise that was designed to guide community members. Much of this technical expertise is grounded in colonial considerations and expectations for design. As such, each project that we embark on needs to incorporate Reconciliation efforts and help expand the possibilities for infrastructure design.

According to Reconciliation Canada, "Reconciliation is an opportunity for all Canadians to renew relationships, based on a shared understanding of our histories and our cultures and walk a path together for a shared tomorrow. To 'reconcile' is to weave a stronger and more vibrant social fabric, supported by the unique and diverse strengths of Canadians and their communities." The City of Vancouver encourages all users of this manual to carefully consider how their designs are linked to Reconciliation efforts. Each of us must make concerted efforts to purposefully educate ourselves on the legacy and impacts of colonization and meaningfully engage with the local Indigenous communities on the projects we deliver. We can all do more to better understand Reconciliation and help create a healthier and more supportive city. We all have a role to play in advancing Reconciliation.

1.3.3 CITY STRATEGIES

The City of Vancouver has many strategies and goals that influence engineering design. Below is a list of some of the relevant City strategies:

Climate Emergency Action Plan - The Climate Emergency Plan builds on the previous Greenest City Action Plan. It focuses on cutting carbon pollution from our biggest local sources - burning fossil fuels in our vehicles and in our buildings. This plan means residents, businesses, and the City are doing their part to transition off fossil fuels and to make it easier to live a carbon-free life.

Transportation 2040 Plan - Transportation 2040 is a long-term strategic vision for the City that will help guide transportation, land use decisions, and public investments for the years ahead. It provides a blueprint for Vancouver to move forward, build upon past successes, and rise to meet new and emerging challenges. The plan sets long-term targets and includes both high-level policies and specific actions to achieve this vision.

Rain City Strategy – The Rain City Strategy was adopted to support the Climate Emergency Action Plan and Climate Change Adaptation Strategy through management of rainwater and runoff to prepare for climate change and severe weather; protect sensitive waterbodies; and reduce combined sewer overflows. These strategies are necessary to meet regulatory requirements and use City of Vancouver's rainfall as a resource rather than nuisance.

Resilient City - Vancouver has been selected as a member of 100 Resilient Cities. 100 Resilient Cities (100RC) is a program pioneered by The Rockefeller Foundation that helps a network of cities gain access to tools, funding, technical expertise, and other resources to build resilience to face 21st-century challenges. Natural and manmade shocks and stresses from urban growth will continue to hit the world's cities. 100RC is about preparing and acting to strengthen the City economically, environmentally, and socially.

Climate Change Adaptation Strategy - Council adopted the Climate Change Adaptation Strategy to ensure a vibrant, livable and resilient city in the face of climate change. The strategy supports the City preparing for the impacts of climate change such as increased intensity and duration of rainfall, sea level rise, and hotter, drier summers. The Coastal Flood Risk Assessment (CFRA) includes floodplain mapping to year 2100. Downscaled city climate projections are available from the City and renewed every 5 – 7 years.

Urban Forest Strategy – The City of Vancouver's urban forest provides a multitude of social, ecological and economic benefits. The Urban Forest Strategy's vision is to protect, plant, and manage trees to create a diverse, resilient, and beautiful urban forest on public and private land across the City. In 2025, the Park Board and City Council adopted a city-wide canopy cover target of 30% by 2050. The strategy will guide the management, protection and expansion of a diverse, resilient, and beautiful urban forest in the City of Vancouver to provide residents and workers a liveable city, and enhance habitat for birds, insects and urban wildlife. provide residents and workers a liveable city, and enhance habitat for birds, insects and urban wildlife. The urban forest should be robust, resilient, and well managed such that its beauty and benefits are safely enjoyed by people for present and future generations, and its habitats sustain ecosystems and wildlife.

Digital Strategy – Vancouver's Digital Strategy is a road map to enhance how you engage with and access the City through online, mobile, and social media channels; improve and expand the City's digital infrastructure; and support and strengthen Vancouver's digital economy.

Healthy City Strategy – Vancouver's Healthy City Strategy is a long-term, integrated plan for healthier people, healthier places, and a healthier planet. The Healthy City Strategy is comprised of 13 long-term goals for the well-being of the City and its people.

Zero Waste 2040 - Zero Waste 2040 is a long-term strategic plan with forward-looking policies to help stimulate, support, and allow Vancouver to become a zero waste community. The Plan supports sustainable resource use, a healthy economy, affordability, vibrant and inclusive neighbourhoods, and equal opportunity through the elimination of solid waste.

Vancouver Plan – The Vancouver Plan is a visionary long-range land use plan to guide growth and change over the next 30 years. It establishes a unified vision for the future land use of the city, with supportive policies that will help Vancouver become a more livable, affordable, and sustainable city with a strong economy where people and nature thrive. A city that is inclusive, diverse, and works for everyone. The three foundational principles at the centre of the Plan are: Reconciliation, Equity, and Resilience. It is the policy basis for the City-wide Official Development Plan.

1.3.4 RETROFIT VERSUS NEW CONSTRUCTION

Design in the City of Vancouver typically consists of retrofitting and modernizing existing infrastructure. Since the majority of the City has already been developed, it is less common that new streets are being designed where there was no street previously. New street design and construction is generally limited to new major developments.

Existing conditions can create challenges with design. There can be constraints and limitations that might not exist with new construction. The criteria outlined in this manual is generally for the ideal new street condition and therefore cannot always be fully achieved. When the opportunity exists, the criteria in this manual must be met at a minimum; however, if conditions do not practically allow for it, compromises may be made based on sound and reasonable judgement. If a condition cannot be met due to the existing conditions, it shall be well-justified and documented, and must be accepted by City Staff.

1.3.5 DESIGN FOR CURRENT AND FUTURE RESILIENCE

A resilient project is one built to withstand or recover quickly from natural and human-caused hazards and disasters and that also delivers co-benefits to people and systems in the absence of hazards and disasters. Vancouver is exposed to a range of hazards including but not limited to flooding, sea level rise, earthquakes, fires, hazardous materials incidents, and cyber-attacks.

Infrastructure needs to be designed to function well in today's climate and throughout the functional lifespan of the project when significantly different climate and social conditions may provide new limiting design considerations. Hazard and risk assessments that identify interdependencies within infrastructure systems, and evaluate the consequences of failure, can inform resilient design measures and response options to ensure the continuation of critical infrastructure services.

The City of Vancouver will continue to update and future-cast natural hazard mapping and associated standards, such as floodplain mapping, IDF curves, downscaled climate projections, cybersecurity resources and capabilities, and seismic hazards, in concert with the directions set out in the *Vancouver Citywide Official Development Land, Hazardous Lands and Risk Reduction Chapter*.

1.3.6 COMPLETE STREETS DESIGN

The City of Vancouver has developed a Complete Streets framework to deliver better streets for all users and promote sustainable transportation. The Complete Streets approach brings existing transportation policies together under a single holistic framework and helps prioritize corridor-length improvements informed by a street's function within the broader transportation network. Over the fullness of time, it is envisioned that every street will be designed following a Complete Streets philosophy.

From a transportation perspective, a Complete Streets approach considers the needs for people of all ages and abilities and for all modes of travel in planning and design. Safe and comfortable access for people walking, cycling, and using transit is an integral planning feature, ensuring that critical mobility and access functions are met. Complete Street design features allow all people to meet their daily needs and participate in public life regardless of their ability or mode of choice.

From a broader perspective, a Complete Streets approach considers the interplay between land use and transportation, providing the opportunity to achieve broader civic objectives. While allowing for the movement of people and goods, a broader Complete Street lens recognizes the importance of looking at streets holistically, bringing land use, green rainwater infrastructure, public space and transportation considerations seamlessly together.

In practice, not every street can be easily retrofitted, and arterials often serve multiple purposes, acting as key transit and / or truck routes, providing access for emergency services, customers, and deliveries, as well as accommodating local and regional motorized traffic.

Given these challenges, the City's immediate priority is not to make every street 'Complete', but to ensure that the broader street network provides for a full array of transportation choices that are safe and convenient. Since most of the City's arterials were designed decades ago to prioritize motorized traffic, retrofitting streets to be more 'Complete' often means ensuring the street is safe and comfortable for people of all ages and abilities to walk and cycle, and is accessible for persons with disabilities.

Key principles to consider when designing Complete Streets include:

- Improving **safety, comfort, and accessibility** for all modes, with a focus on walking, cycling and taking transit for people of all ages and abilities.
- Providing **direct and convenient access** to shops, services, and other destinations for all modes of transportation.
- Carefully **addressing impacts** to transit, emergency services, nearby streets, curbside management, and access to local businesses when reallocating road space.
- Enhancing overall **travel time reliability** on the street network for all modes, with emphasis on transit and goods movements.
- Incorporating **flexible design** approaches, where appropriate, to change usage and to facilitate special events at different times of day, week, or season.
- Considering **adaptable designs** where street infrastructure is likely to change over time, to make future space reallocation easier and less costly.
- Enabling **smart infrastructure** opportunities to support emerging green transportation technologies.
- Supporting a **lively city** that encourages a culture of walking and cycling, increased social interaction, and lingering within streets with vibrant public spaces.
- Encouraging **delightful and attractive** streets that contextually respond to surrounding land uses, providing opportunities for placemaking and art in various street elements.
- Exploring opportunities to improve **local ecology**, such as improving stormwater management and increasing the number, size, and health of street trees.
- Promote the use of green rainwater infrastructure systems to improve **urban livability**, stormwater runoff quality, and urban biodiversity.

1.3.7 ACCESSIBILITY

The *City* is committed to delivering a highly accessible and barrier-free pedestrian environment. *Engineering Services Department* staff have investigated, experimented, consulted, and been trained to explore the best techniques and practices to provide a seamless and socially inclusive public realm.

This manual provides specific information on standards the City is adhering to in efforts to create the best possible pedestrian environment that meets the needs of the largest range of users and to create an environment that provides opportunities to live, work, and prosper within our neighbourhoods. “Universal design is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design”- Ron Mace, founder and program director of The Center for Universal Design.

Things to consider when designing a pedestrian environment are the natural surroundings and the many possible users of the space including people who use wheelchairs, scooters, guide dogs, white canes, those who have hearing impairments, and those with learning disabilities. Materials, budgets, sustainability, maintenance, and new technologies are to be considered.

In designing for inclusion, accessibility, and barrier-free pedestrian environments, designers must look to the Seven Principles of Universal Design as follows:

- **Principle One: Equitable Use** - The design is useful and marketable to people with diverse abilities.
- **Principle Two: Flexibility in Use** - The design accommodates a wide range of individual preferences and abilities.
- **Principle Three: Simple and Intuitive Use** - Use of the design is easy to understand, regardless of the user’s experience, knowledge, language skills, or current concentration level.
- **Principle Four: Perceptible Information** - The design communicates necessary information effectively to the user, regardless of ambient conditions or the user’s sensory abilities.
- **Principle Five: Tolerance for Error** - The design minimizes hazards and the adverse consequences of accidental or unintended actions.
- **Principle Six: Low Physical Effort** - The design can be used efficiently and comfortably and with a minimum of fatigue.
- **Principle Seven: Size and Space for Approach and Use** - Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user’s body size, posture, or mobility.

1.3.8 UTILITIES AND UNDERGROUND INFRASTRUCTURE

The City of Vancouver’s utilities are fundamental public services, and their proper design is vital to ensure the health of the public and the environment. The design of utilities needs to consider long-term performance requirements and access and maintenance needs.

1.3.8.1 WATER SYSTEM

Vancouver purchases bulk, treated drinking water from Metro Vancouver, collected in the Capilano, Seymour, and Coquitlam reservoirs. Every day, Vancouver delivers nearly 300 million litres of clean, safe drinking water from Metro Vancouver’s reservoirs to homes and businesses. The design, construction, operation and maintenance of our drinking water system must support the City’s goals and objectives for drinking water and water resources:

- Deliver clean, safe and accessible drinking water to support daily needs and sufficient water supply for fire suppression.

- Enable and regulate efficient, equitable and sustainable use of drinking water.
- Upgrade and maintain aging water infrastructure to improve resiliency and reliability.
- Reduce the City of Vancouver's carbon footprint.
- Ensure the City is prepared for the impacts of climate change, and emergencies, including major disasters.

1.3.8.2 SANITARY SEWER AND STORM DRAINAGE SYSTEMS

Vancouver's sanitary sewer and storm drainage systems protect the public from wastewater by safely conveying flows. With infrastructure dating to the early 1900's, the City of Vancouver is working to improve and modernize its sewer infrastructure. The City of Vancouver is also actively working to protect the waterbodies in and around the City. As such, a prominent focus of sewer development is to fully separate the sewer system to eliminate combined sewer overflows. Developing and maintaining reliable and resilient sewer and drainage infrastructure throughout Vancouver is a key strategy to help fulfill the City's mission, values and objectives:

- Protect Vancouver's waterways and the environment.
- Fully separate the sanitary and storm sewer systems.
- Eliminate combined sewer overflows by 2050.
- Reduce the City of Vancouver's carbon footprint.
- Ensure the City is prepared for the impacts of climate change, and emergencies, including major disasters.

1.3.8.3 GREEN RAINWATER INFRASTRUCTURE

The Rain City Strategy calls for Green Rainwater Infrastructure to improve and protect Vancouver's water quality, proactively prepare for climate change impacts, and improve our resilience to rain and heat events, while supporting biodiversity and recreational water use. Green Rainwater Infrastructure systems can take many forms and use vegetation, soils, and engineered elements to mimic natural ecosystem processes to slow, clean, and absorb rainwater. They also include rainwater harvest and re-use systems at both the site and district-scale.

At a city scale, Green Rainwater Infrastructure is a distributed network of natural areas and engineered practices that contribute to cleaner water and air, habitat, flood protection, and cooler urban environments. From a citywide perspective, a core principle is a decentralized approach; small, widely applied Green Rainwater Infrastructure practices across a city collectively will have significant impacts. At a local scale, Green Rainwater Infrastructure practices are designed to reduce pollutant loads at the source and create alternate pathways for rainwater. The piped system, also known as the grey infrastructure, serves rainwater flows that cannot be readily accommodated through infiltration, evapotranspiration, and harvest and reuse.

Developing Green Rainwater Infrastructure throughout Vancouver is a key strategy to help fulfill the City's mission, values and objectives:

- Improve and protect Vancouver's water quality.
- Increase Vancouver's resilience through sustainable water management.

- Enhance Vancouver's livability by improving natural and urban ecosystems.
- Capture and treat 90% of Vancouver's annual average rainfall on both public and private property.

The Green Rainwater Infrastructure design guidance in the Engineering Design Manual primarily supports the design of small-scale GI in public spaces. Further resources for Green Rainwater Infrastructure can be found in the Metro Vancouver Source Control Guidelines, ***GI Sizing and Modelling Guide***, and Rain City Strategy. Site and building scale guidance can be found in the *Vancouver Building By-law*.

1.3.8.4 NEIGHBOURHOOD ENERGY

The Neighbourhood Energy Utility (NEU) is a City-owned District Energy System (DES) which captures waste heat from sewage and supplies low carbon heating and hot water to multiple buildings within the NEU service area (refer to Schedule A of *City of Vancouver Energy Utility System By-Law No. 9552*

DES's typically use low-carbon renewable energy sources to reduce the use of fossil fuels. They also eliminate the need for boilers in individual buildings, and provide environmentally-friendly, cost effective heat and hot water. In addition to the NEU, there are privately owned DES's within the City of Vancouver.

Expanding the NEU and supporting the development and decarbonization of privately owned DES's is a key strategy to meeting the Climate Emergency Action Plan and Renewable City Strategy goals to:

- Reduce the City of Vancouver's carbon footprint.
- Reduce our dependence on fossil fuels and increase access to local renewable energy.
- Keep energy affordable in the long term.
- Achieve 100% of our energy needs from renewable sources before 2050.

1.3.8.5 THIRD-PARTY UTILITIES

The City's effective management of underground utilities is essential to ensure the optimal use of City streets. The City needs to preserve space for future use, coordinate utility work to minimize disruptions, and use best practices for utility installations in order to minimize maintenance requirements and reduce life cycle costs. It is essential that the City manage all interests for street space with a balanced approach protecting the space for the present and future. In achieving this balance, the City strives to provide streets that safeguard the public and help fulfill the City's mission, values and objectives:

- Provide residents of City of Vancouver with access to utilities now and in the future.
- Safely operate utilities throughout the City of Vancouver.
- Reduce the City of Vancouver's carbon footprint.
- Ensure the City is prepared for emergencies, including major disasters.

1.4 REVISIONS TO THE MANUAL

The City's *Engineering Strategy and Standards* branch is responsible for maintaining the manual and issuing new editions. Minor revisions to the manual will consist of issued amendments. After multiple amendments are created or when warranted, a new edition of the manual will be issued.

For revisions, changes, errors and omissions, please contact the PMO at engineering.pmo@vancouver.ca.

1.5 REFERENCE DOCUMENTS

The City of Vancouver Engineering Design Manual outlines the preferred and recommended design requirements for City of Vancouver projects and is the principal reference for design requirements. The following reference documents may be used as secondary references:

- *ACI 522.1 Specification for Pervious Concrete Pavement*
- *ANSI/IES RP-8: Lighting Roadway and Parking Facilities*
- *ASME B31.1 Power Piping*
- *AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water*
- *Bridge Condition Index and Implementation Manual and User Guide*
- *British Columbia Commercial Transport Act*
- *British Columbia Commercial Transport Regulations*
- *British Columbia Dike Design and Construction Guide Best Management Practice for British Columbia*
- *British Columbia Ground Water Protection Regulation Handbook*
- *British Columbia Motor Vehicle Act*
- *British Columbia Motor Vehicle Act Regulations*
- *British Columbia Plumbing Code*
- *British Columbia Water Act*
- *BC MoTI Active Transportation Design Guidelines*
- *BC MoTI Bridge Standards and Procedures Manual*
- *BC MoTI Electrical and Traffic Engineering Manual*
- *BC MoTI Pedestrian Crossing Control Manual for British Columbia*
- *BC MoTI Standard Specifications for Highway Construction*
- *BC MOTI Traffic Control Manual for Work on Roadways*
- *CAN/CSA A23.1 Concrete Materials and Methods of Concrete Construction*
- *CAN/CSA A23.2 Methods of Test and Standard practices for Concrete*
- *CAN/CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code*
- *CAN/CSA C22.2 No. 211.2 Rigid PVC (Unplasticized) Conduit*
- *CAN/CSA C22.3 No. 1 Overhead Systems*
- *CAN/CSA Canadian Electrical Code with bulletins issued by Electrical Safety Branch of the Province of British Columbia and the City of Vancouver*
- *CAN/CSA S6 Canadian Highway Bridge Design Code*
- *CSA Group's Accessible Design for the Built Environment*
- *Canadian Urban Transit Association (CUTA) Guidelines*
- *Canada Fisheries Act*
- *City of Vancouver Boulevard Gardening Guidelines*
- *City of Vancouver Climate Change Adaption Strategy*
- *City of Vancouver Climate Emergency Action Plan*
- *City of Vancouver Complete Streets Policy Framework*
- *City of Vancouver Construction Specifications (Supplement to the MMCD)*
- *City of Vancouver Construction General Conditions (Supplement to the MMCD)*
- *City of Vancouver Design Guideline for AAA Cycling Routes*

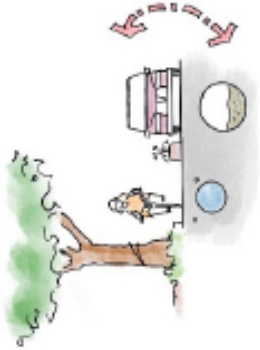
- *City of Vancouver Design Guidelines for Large Sidewalk Patios on City Property and Sample Drawings*
- *City of Vancouver Encroachment By-law No. 4243*
- *City of Vancouver Energy Utility System By-Law No. 9552*
- *City of Vancouver Engineering Design Reference for Shoreline Flood Protection Works*
- *City of Vancouver Equity Framework*
- *City of Vancouver Garbage & Recycling Storage Amenity Design Supplement*
- *City of Vancouver Graffiti By-law No. 7343*
- *City of Vancouver Green Rainwater Infrastructure Sizing and Modelling Guide*
- *City of Vancouver Green Rainwater Infrastructure Planting and Ecology Design Guideline*
- *City of Vancouver Greenest City Action Plan*
- *City of Vancouver Guidelines for Using Synchro Version 10*
- *City of Vancouver Marine and Coastal Structures Design Reference*
- *City of Vancouver Modular Concrete Block Retaining Wall*
- *City of Vancouver Noise Control By-law No. 6555*
- *City of Vancouver Parking and Loading Design Supplement*
- *City of Vancouver Parking By-law No. 6059*
- *City of Vancouver Parking Meter By-law No. 2952*
- *City of Vancouver Parklet Manual*
- *City of Vancouver Plaza Design Guidelines*
- *City of Vancouver Protection of Trees By-law No. 9958*
- *City of Vancouver Rain City Strategy*
- *City of Vancouver Recommended Guidelines for Universal Access to Public Docks in False Creek*
- *City of Vancouver Sewer and Watercourse By-law No. 8093*
- *City of Vancouver Sign Code Inventory*
- *City of Vancouver Streetscape Garbage & Recycling Enclosure Siting Manual*
- *City of Vancouver Traffic Signal Timing Guidelines*
- *City of Vancouver Standard Detail Drawings (Supplement to the MMCD)*
- *City of Vancouver Standardized C.I.P. Conventional Retaining Wall*
- *City of Vancouver Standardized C.I.P. L-Shape Retaining Wall*
- *City of Vancouver Standardized C.I.P. Zero PL Retaining Wall*
- *City of Vancouver Standardized Soil Bag Wall*
- *City of Vancouver Street and Traffic By-law No. 2849*
- *City of Vancouver Street Tree By-law No. 5985*
- *City of Vancouver Street Utilities By-law No. 10361*
- *City of Vancouver Streetscape Design Guidelines*
- *City of Vancouver Transportation 2040 Plan*
- *City of Vancouver Transportation Assessment and Management Study Guidelines for Consultants*
- *City of Vancouver Water Wise Landscape Guidelines*
- *City of Vancouver Water Works By-law No. 4848*
- *City of Vancouver Requirements and Standards for the Installation of Public Drinking Fountains*

- *City of Vancouver Vegetated Wire Face Retaining Wall*
- *City of Vancouver Zoning and Development By-law No. 3575*
- *CROW Design Manual for Bicycle Traffic (from the Netherlands)*
- *EGBC Professional Practice Guidelines and Practice Advisories*
- *Environmental Technology Verification (ETV) - Canada*
- *ICPI Permeable Interlocking Concrete Pavement*
- *IES DG-4 Design Guide for Roadway Lighting Maintenance*
- *IES DG-5 Recommended Lighting for Walkways and Class 1 Bikeways*
- *IES LM-79 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products*
- *IES LM-80 Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules*
- *IES TM-15 Luminaire Classification System for Outdoor Luminaires and Addendum A: Backlight, Uplight, and Glare (BUG) Ratings*
- *IES TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources*
- *ITDP Bikeshare Planning Guide*
- *ITE Traffic Detector Handbook*
- *ISO 14034: Environmental Management/Environmental Technology Verification (ETV)*
- *Master Municipal Construction Documents (MMCD) Platinum Edition*
- *MMCD Design Guideline Manual*
- *Metro Vancouver Stormwater Source Control Design Guidelines*
- *Manual on Uniform Traffic Control Devices*
- *MassDOT Separated Bike Lane Planning & Design Guide*
- *NACTO Bike Share Station Siting Guide*
- *NACTO Guidelines*
- *NACTO Transit Street Design Guide*
- *NAPA IS-115 Open-Graded Asphalt Friction Courses, Design, Construction & Maintenance*
- *NAPA IS-131 Porous Asphalt Pavements for Stormwater Management*
- *TAC Accessible Pedestrian Signals Guidelines*
- *TAC Bikeway Traffic Control Guidelines for Canada*
- *TAC Canadian Transit Handbook*
- *TAC Geometric Design Guide for Canadian Roads*
- *TAC Guide for the Design of Roadway Lighting*
- *TAC Guide to Bridge and Combination Barriers*
- *TAC Manual of Uniform Traffic Control Devices for Canada (MUTCD)*
- *TAC Pavement Design and Management Guide*
- *TAC Pedestrian Crossing Control Guide*
- *TAC Synthesis of Practices for Median Design*
- *Technology Assessment Protocol – Ecology (TAPE)*
- *TransLink Bus Infrastructure Design Guidelines*
- *TransLink Transit Passenger Facility Design Guidelines*
- *TransLink Transit Service Guidelines*
- *TransLink Universally Accessible Bus Stop Design Guidelines*
- *Transport Canada Grade Crossing Standards*

- *Transport Canada Grade Crossing Regulations*
- *Transport Canada Railway Relocation and Crossing Act*
- *Transport Canada Railway Safety Act*
- *Transport Canada RTD-10 Road/Railway Grade Crossing Technical Standards and Inspection, Testing and Maintenance Requirements*
- *UK London Area Travel Survey*
- *Vancouver Building By-Law*
- *Vélo Québec Planning and Design for Pedestrians and Cyclists*
- *Water Supply for Public Fire Protection – Fire Underwriters*
- *Survey UK London Area Travel Survey*

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DESIGN PROCESS & COORDINATION



2

Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Steve Brown, P.Eng, Director, Engineering Projects and Development Services

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DESIGN PROCESS & COORDINATION

2.1 INTRODUCTION

This chapter describes the general design process and coordination that must be considered for all design in the City of Vancouver.

The following is a brief description of each section:

- The *Design Coordination* section outlines how the various aspects of design interact among one another. This section includes coordination of disciplines, clearances, rights-of-way, and external agencies.

The General Requirements section outlines general requirements including units, permitting, surveys, test holes, and estimates.

- The *Drawing Standards* section outlines the drawing requirements for submissions to the City of Vancouver.
- The *Design Process* section outlines the typical process from project initiation to record drawings including required deliverables.
- The *Development Design Review Process* section outlines the review process and requirements that all development drawings submitted to the City of Vancouver must undergo.
- The *Third-Party Utility Drawing Submissions* section outlines where requirements for Third-Party Utility submissions are documented.

2.2 DESIGN COORDINATION

A key factor in ensuring a smooth design process is the effective coordination between consultants, the City, and external agencies. This section outlines the methods and interactions that must occur when designing in the City of Vancouver, as well as specifying criteria to mitigate utility conflicts that may arise during design and construction.

2.2.1 INTERACTION BETWEEN DISCIPLINES

When designing in Vancouver, it is critical that the interaction between the various design disciplines is coordinated. Designers shall deliver a well thought-out and functional project which avoids conflicts between the disciplines, accounts for operations and maintenance requirements and considers possible future growth through development. The following are examples to consider:

- Street lighting and utility poles should not hinder the path of pedestrians or cyclists.
- Bus doors should not be blocked by above-ground utilities or street furniture.
- New and relocated water mains and utilities should not be located under curbs or within the Tree Protection Zone (See *City of Vancouver Construction Specifications* Section 31 11 41 – Shrub and Tree Preservation and *Section 33 50 01S – 3.4.1* for more information).
- Maintenance holes, valve boxes, and other utility surface obstructions, where possible, should not fall within the wheel path of vehicles or bicycles and should avoid being in the path of pedestrians.
- The space between pedestrian ramps and pedestrian push buttons is to be clear (i.e. no junction boxes, fire hydrants or waste receptacles, etc.) and the space must be hardscape.
- Civil, landscape and electrical designs are to be coordinated. For example, trees and landscaping must be coordinated with junction box and street light placement and sidewalk treatments.
- Vehicles and access for street cleaning (including bike lanes) and waste collection (including streetscape waste receptacles and residential/commercial waste containers) should be accommodated in the design.
- Not all conflicts can be avoided. When conflicts cannot be mitigated, the hierarchy of objectives is:
    - Safety.
    - Asset Health.
    - Public Realm.

2.2.2 PARTNERS AND EXTERNAL AGENCIES

When a design ties into or crosses infrastructure falling under the jurisdiction of another level of government or external agency, those impacted should be notified, the design coordinated, and their requirements met. Below are some common external governments or agencies that typically require coordination with City designs:

- BC Hydro.
- British Columbia Rapid Transit Corporation.
- Creative Energy (Formerly Central Heat Distribution Ltd).

- Coast Mountain Bus Company.
- Department of Fisheries and Oceans.
- Local First Nations (Musqueam, Squamish, Tsleil-Waututh).
- FortisBC.
- Greater Vancouver Sewerage and Drainage District.
- Greater Vancouver Water District.
- Metro Vancouver.
- Ministry of Environment.
- Ministry of Forests, Lands and Natural Resource Operations.
- Ministry of Transportation and Transit.
- Other Municipalities (Burnaby, Richmond, North Vancouver, and others).
- Neighbourhood/ District Energy Systems.
- Railway Companies (BNSF, CN, CP, Southern Railway, and others).
- Telephone, Cable and Communications (i.e. Telus, TeraSpan Networks, A2B Fibre Inc., Novus Entertainment Inc., MTS Allstream, Bell West, MK Telecom, Urban Networks Inc., Business Objects, Navigata, Rogers Communications, Shaw Communications Inc. etc.).
- TransLink.
- Vancouver Coastal Health.
- University of British Columbia (UBC).
- University Endowment Lands (UEL).
- WorkSafeBC.

2.2.3 STATUTORY RIGHTS-OF-WAY

The City of Vancouver secures statutory rights-of-way in order to install and maintain above and below ground infrastructure.

To provide adequate public realm, including sidewalks, statutory rights-of-way may be required in accordance with *Section 8.4.3*.

When an underground utility is within the road allowance (but located close to the property line), a right-of-way may be required to make up the difference if the extents of the utility horizontal clearance required extend past the property line. Rights-of-way must be wide enough to allow for safe excavation of side slopes and must not fall within the safe angle of repose of building and structural footings. They must also be wide enough to allow for maintenance and planned future widening or twinning. Rights-of-way must be aligned to create minimal impact, avoid environmentally-sensitive areas, and allow practical maintenance vehicle access.

The minimum right-of-way widths are provided in ***Table 2-1***.

Table 2-1: Right-of-Way Widths

Right-of-Way Type	Minimum Right-of-Way Width
Single utility	• 2x the depth to the invert. • Minimum 5m wide.
Two utilities in a common trench	• 2x the depth to the deeper invert. • Minimum 6.0m wide.

Rights-of-way are also required to provide an improved public realm and wider sidewalks. Where possible, the minimum clear width for sidewalks (as specified in *Section 8.4.3.1*) should be accommodated on City property. A wider preferred width may be provided through rights-of-way. A cold joint shall be designed for and installed at the property line to separate the asset for future maintenance and rehabilitation responsibilities. Where the minimum clearway width cannot be provided on City property, additional measures may be required to ensure sidewalk performance and durability.

2.2.4 SEWERS IN COMMON TRENCH

During sewer separation projects, sanitary and storm sewers may be installed in the same trench if the design meets the requirements shown in the *City of Vancouver Standard Detail Drawings G4.4, S16.1,* and *S16.2*.

2.2.5 UTILITY CLEARANCES AND UNDERGROUND INFRASTRUCTURE SEPARATION

Table 2-2 outlines required clearances and separations for utilities. All clearances listed are to be measured from outside pipe wall to outside pipe wall, unless specified differently below. Any exceptions to these clearances will require approval from the affected utility or utilities. The clearance requirements are provided by utility and asset type. All requirements in the table below must be met when designs include multiple assets and utilities.

Table 2-2: Utility and Asset Clearances

Utility and Asset	Clearance Requirement
Third-Party Utilities	• See *Section 7.2.3* to *Section 7.2.6*. • The minimum vertical clearance when crossing a utility is 0.3m. • The minimum horizontal clearance for all City's utilities is 0.3m, with stricter requirements provided in this table and in *Section 7.2.3* depending on the utility.
Underground Utilities from Curbs	• Underground utilities, excluding electrical conduits, shall have a minimum horizontal clearance of 0.5m from the closest edge of the curb or gutter.

Utility and Asset	Clearance Requirement
City Water Infrastructure including but not limited to water mains, service connections, water chambers, water valves, hydrants and hydrant leads	• Minimum 3.0m horizontal clearance between water mains and sewers (edge to edge). • Where new sewers are being constructed, the storm sewer should preferably be located nearest the water main rather than the sanitary whenever practical. • Minimum 0.45m vertical clearance above City sewers. • If minimum clearances to sewers cannot be met, refer to ***Figure 2-1***, ***Figure 2-2*** and ***Figure 2-3*** for mitigation measures. • Water mains and larger water services (100mm and greater) must have a minimum 3.0m clearance from Green Rainwater Infrastructure. • Minimum 2.0m clearance from trees. • Third-party utilities must have a minimum vertical clearance of 0.3m and a horizontal clearance of 1.0m from water mains. 90-degree crossings are preferred. • Water mains shall have a minimum horizontal clearance of 1.0m from the closest edge of the curb or gutter. • Minimum horizontal clearance of 1.0m from electrical infrastructure.
City Sewer Infrastructure including but not limited to sewer mains, maintenance holes, service connections, catchbasins and catchbasin leads	• See above for separation requirements from City water mains. • Minimum 1.5m horizontal clearance from all other utilities. • Minimum 0.3m horizontal clearance for sewers mains in common trench. • Minimum 0.3m vertical clearance at crossings. • For new sewer main construction, minimum 1.5m horizontal clearance from face of curb to wall of sewer main. • Preferred minimum 1.5m from Green Rainwater Infrastructure. • Minimum 2.0m clearance from trees.
City Neighbourhood Energy Piping	• Minimum 1.0m horizontal clearance wall-to-wall from all other utilities. • Minimum 0.3m vertical clearance wall-to-wall from all other utilities.

Utility and Asset	Clearance Requirement
City Electrical Infrastructure including streetlight and traffic signal pole bases, junction boxes, conduits, and vaults to utilities	• Utilities must have a minimum clearance of 0.3m from all pole bases, junction boxes, conduits and electrical vaults. • The minimum clearance between edge of tree trunk and conduits shall be 0.3m. • At intersections, 1.5m clearance from edge of pole bases is preferred to allow for future replacement of signal poles while keeping existing poles operational.
Structures	• New bridges and structures less than 6.0m wide above utilities must have a vertical clearance of 5.2m directly under the structure and a vertical clearance of 7.6m, 12.0m from the structure on either side. Structures over 6.0m wide to be reviewed individually. • All structures within 3.0m of sewers to be reviewed individually by the Sewers and Drainage Design Branch. • Min 3.0m horizontal clearance between edge of footing for structure to edge of underground utility.
Green Rainwater Infrastructure	• See *Section 5.7.3*.

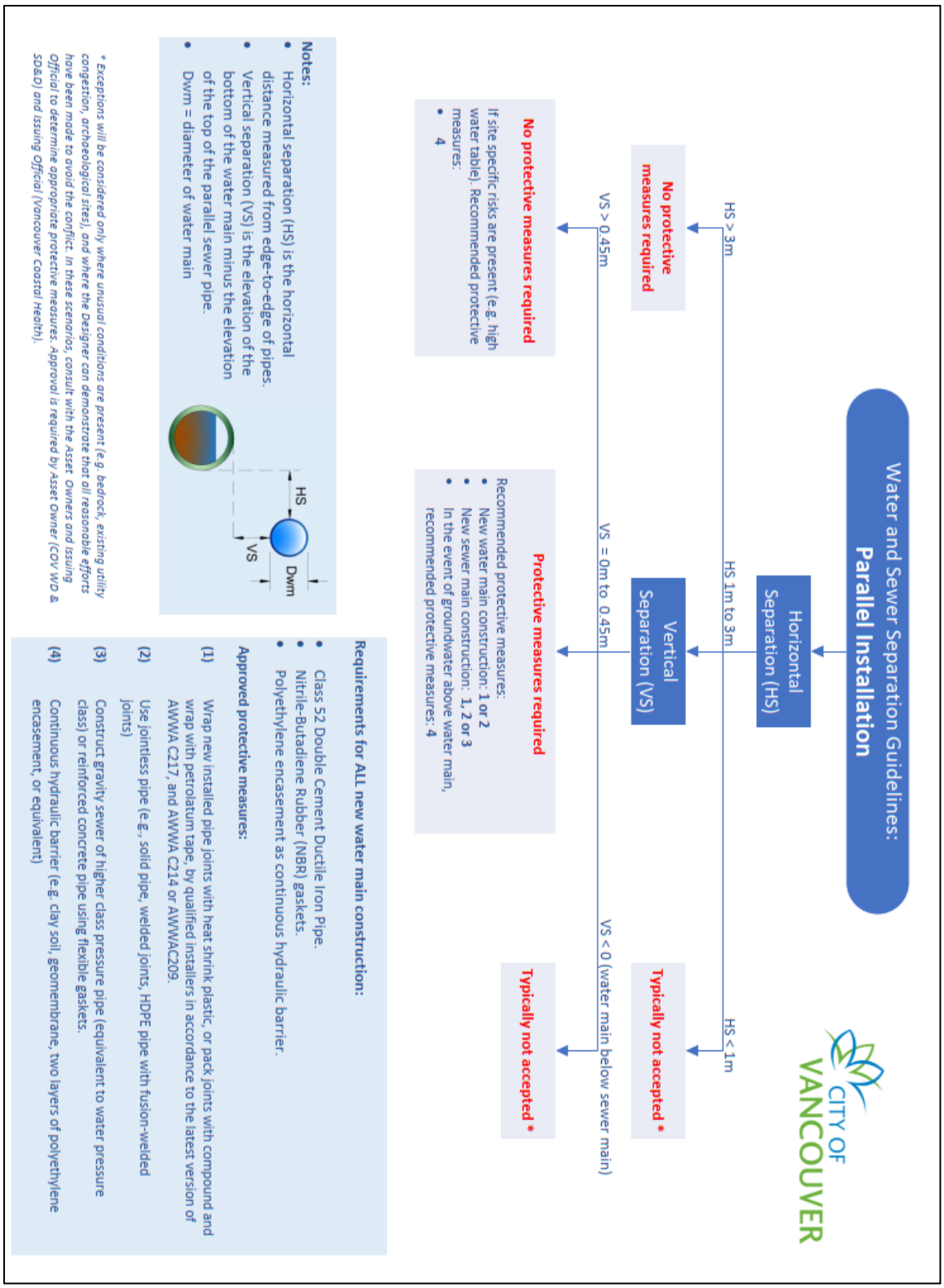


Figure 2-1 Water – Sewer Separation Flowchart for Parallel Installations

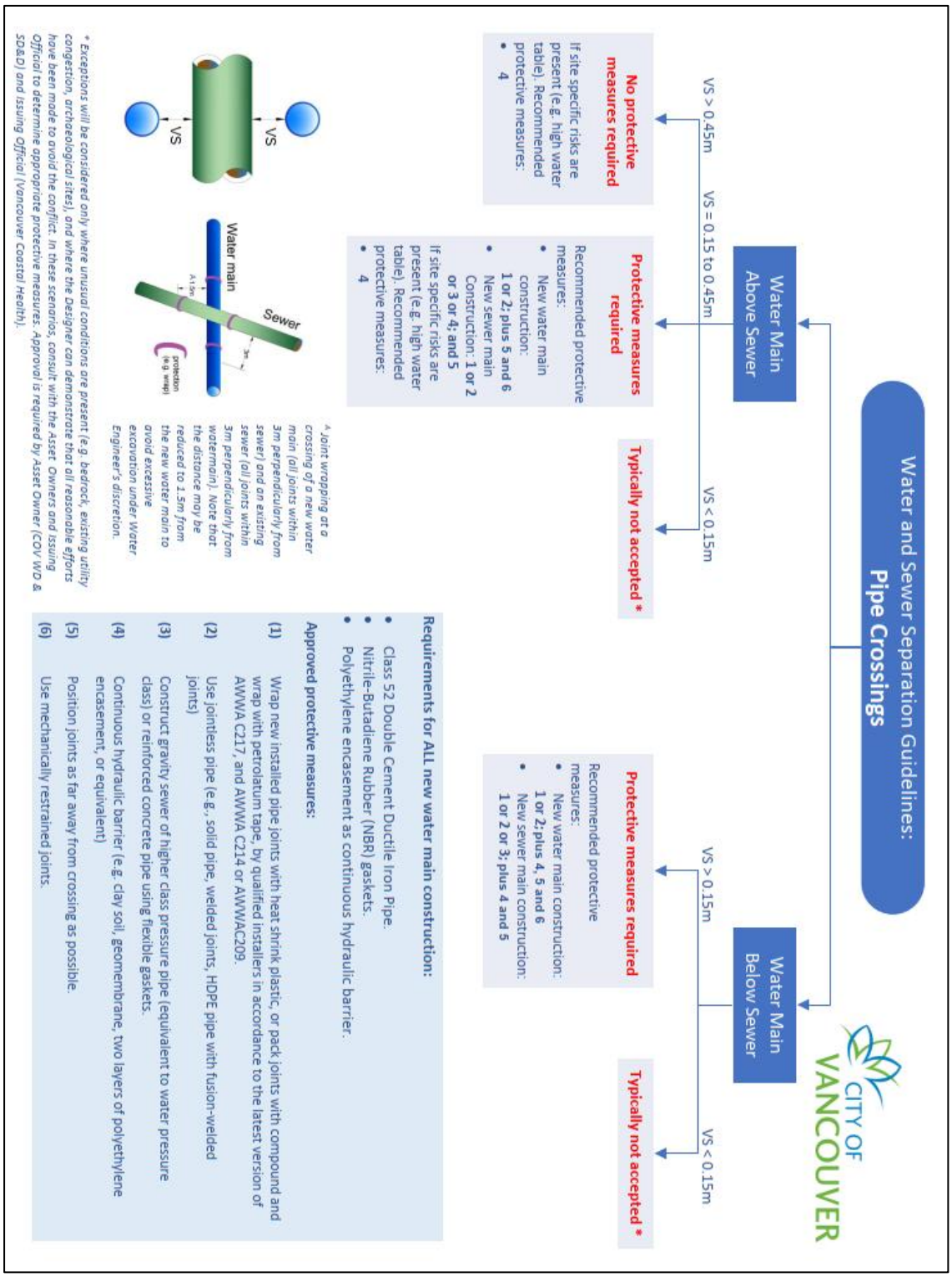


Figure 2-2 Water – Sewer Separation Flowchart for Crossing Installations

General Proactive Mitigation Methods:

All newly constructed ductile iron water main will generally use:

- Class 52 Double Cement Lined Ductile Iron Pipe – as per Design Guidelines 16.6.1.1 Table 16-5: Increase the pipe strength of water main; and
- Nitrile-Butadiene Rubber (NBR) gaskets – as per Design Guidelines 16.3.11.3: resistance to potential permeation issues; and
- Polyethylene encasement in the pipe system – as per Design Guidelines 16.6.1.1 Table 16-5, and 16.6.2.1 Table 6: continuous hydraulic barrier.

Parallel Installation (Separate Trenches)

- Horizontal Separation >3m (measured edge to edge)
  - Vertical separation >0.45m: water main at higher elevation
  - Vertical separation <0.45m: water main at higher elevation if possible
- Horizontal Separation = 1m to 3m
  - Water main >0.45m above sewer:
    - General proactive mitigation methods for new water main construction
  - Water main <0.45m above sewer:
    - General proactive mitigation methods; and
    - Wrap water main joints with heat shrink plastic, or pack water main joints with compound and wrap with petrolatum tape by qualified installers in accordance with the latest version of AWWA C217, and AWWA C214 or AWWA C209; or
    - Use jointless pipe (e.g. solid pipe, welded joints, HDPE pipe with fusion-welded joints); or
    - Construct gravity sewer of higher-class pressure pipe (equivalent to water pressure class) or reinforced concrete pipe using flexible gaskets

    In the event of
      - Groundwater level is above water main; or
      - The existing water main pipes is not polyethylene encased and joints are not wrapped
    - General proactive mitigation methods; and
    - Continuous hydraulic barrier (e.g. clay soil, geomembrane) or equivalent between pipes should be installed in trench
  - Water main crown below sewer crown: not typically accepted
- Horizontal Separation <1m: not typically accepted

Pipe Crossing

- Water main above sewer >0.45m: generally accepted, no additional mitigation
- Water main above sewer = 0.15m to 0.45m: additional mitigation required
  - For new water main construction:
    - Use jointless pipe (e.g. solid pipe, welded joints, HDPE pipe with fusion-welded joints); or
    - Use mechanically restrained joints; and
    - Wrap water main joints with heat shrink plastic or pack water main joints with compound and wrap with petrolatum tape in accordance with the latest version of AWWA C217, and AWWA C214 or AWWA C209; and
    - Position joints as far away from crossing as possible
  - For new sanitary sewers and stormwater infrastructure construction:
    - Construct gravity sewer of higher-class pressure pipe (equivalent to water pressure class) or reinforced concrete pipe using flexible gaskets; and
    - Position joints as far away from crossing as possible; or
    - Continuous hydraulic barrier extending 3 m to either side of crossing
- Water main below sewer >0.15m:
  - Same mitigation methods as "Water main above sewer = 0.15m to 0.45m"; and
  - Two layers of polyethylene encasement in the pipe system;
  - In the event of groundwater level is above water main, provide continuous hydraulic barrier extending 3 m to either side of crossing
- Water main below sewer <0.15m: not typically accepted

Figure 2-3 Water – Sewer Separation Requirements – Vancouver Coastal Health Requirements 2025

2.2.6 CLEARANCES FROM ABOVE GROUND INFRASTRUCTURE

Table 2-3 outlines required clearances and separations for above ground assets. All clearances listed are to be measured from outside edge to outside edge, unless specified differently below. Clearances in this section should be considered in coordination with the clearances in **Table 2-2**. There are many space demands in the public realm and at times, clearances below cannot be fully satisfied. Exceptions will require approval from the city.

Table 2-3: Above Ground Infrastructure Clearances

Asset	Clearance Requirement

Third-Party Utilities	• Third-party utilities should have the greater of: 2.0m setback from the beginning or end of the curb radius to the closest structure edge OR 3.0m setback from the adjoining street property line to the closest structure edge.
	• Vault Clearances:
	  ○ Minimum 1.0m clearance of vaults from street furniture.
	  ○ Vaults maintain twelve times the tree trunk diameter measured at 1.4m above ground.
	  ○ Minimum 1.0m clearance of vaults from residential and business entrance / walkways, and green rainwater infrastructure.
	• Aboveground equipment clearances:
	  ○ Minimum 1.7m clearance measured from the port of fire hydrants (Requirement from Fire Department). Refer to Standard Detail Drawing No. W4.1.
	  ○ Minimum 1.5m clearance from any above ground Water infrastructure (except fire hydrants).
	  ○ Minimum 1.0m clearance from poles, planters, green rainwater infrastructure, and street furniture.
	  ○ Minimum 1.0m clearance from all vehicle crossings.
	  ○ Minimum 1.0m clearance from pedestrian entrances to residential and commercial properties.
	  ○ Minimum 0.3m clearance from sidewalks and future sidewalks.
	  ○ Minimum 0.3m clearance from Green Rainwater Infrastructure.
	  ○ Maximum offset of 1.2m from the property line to the roadside face of the box.

Asset	Clearance Requirement
	○ Minimum clearance of 3.0m from a lane or street property line.
Street Furniture (Benches, Bus Shelters, Map Stands)	• Minimum 1.7m clearance measured from the port of fire hydrants (Requirement from Fire Department). Refer to Standard Detail Drawing No. W4.1. • Minimum 1.5m clearance from utility access points i.e. maintenance holes, junction boxes, and all above.ground water infrastructure (except fire hydrants), etc. • Minimum 1.0m clearance from catchbasins. • Minimum 1.0m clearance from building fire department connections. • Minimum 0.3m clearance from buildings unless noted otherwise. • Minimum 0.5m from the edge of a protected bike lane or bike path. • Minimum 1.0m clearance from any streetlight, traffic signal pole, kiosk/service cabinet, electrical or communication junction boxes, or third-party utility. • Minimum 0.5m clearance from Green Rainwater Infrastructure.
Waste Receptacles	The following list of requirements are absolute clearance requirements: • Minimum 1.5 m of clear space downstream of bus ID pole. • Minimum 1.5 m of horizontal clearance for locations that are not immediately adjacent to the curb and do not interfere with bus door clearance areas. • Minimum clearance of 1.7 m measured from the port of a fire hydrant (Requirement from Fire Department). Refer to Standard Detail Drawing No. W4.1. • Minimum clearance of 0.6 m from the edge of any waterworks chamber or maintenance hole. • Minimum horizontal clearance of 1 m in all directions and no visual obstructions upon approach of privately-owned high pressure water valve connections. • Minimum clearance from the back of an enclosure to the edge of a bike lane is 0.3 m. • Enclosure location should not obstruct a curb ramp or any driveway. • Enclosure location must not interfere with a permitted street vendor location and

Asset	Clearance Requirement
	access/egress to the permitted location (if on a sidewalk or plaza). • Enclosure location must not impede access/egress from buildings or other emergency exits (such as Skytrain/Canada Line etc.) • Enclosure should not be any closer to the curb than existing above-ground street infrastructure. • The enclosure location must not impede access to an automatic public toilet or its service panel. • The enclosure location must not prevent access to parklets, patios, or plazas. • For locations with surface not suitable for installation, location must be reviewed to verify whether it is in an archeologically sensitive area before concrete pad installation. In addition, the following are preferred clearance requirements: • The enclosure location should be at 0.3 m to 0.5 m from the curb face, with a preference for 0.5 m. • The sidewalk clearance should be 1.8 m to 2.4 m, with a preference for 2.4 m. • No part of the cart enclosure should be within the Sight Clearance Triangle. When the enclosure is located on the near side of a crosswalk, it should be located at least 4 m from the closest crosswalk line. • Enclosures should be located in a no parking zone. In the case where the enclosure is located within a parking spot, the edge of enclosure should be at minimum 1.0 m away from the parking meter and 0.5 m from the curb face. • Enclosure should be at least 1.0 m from any street light, traffic signal pole, or kiosk/service cabinet. Full siting requirements can be found in the “City of Vancouver Streetscape Garbage and Recycling Enclosure Siting Manual”.
Fire Hydrants	• Minimum 1.7m clearance measured from the port of fire hydrant to all above ground infrastructure (Requirement from Fire Department). Refer to Standard Detail Drawing No. W4.1. • Minimum 2.0m clearance from trees.
Bike Racks	• Minimum 1.8m from any other above-ground appurtenance including other bike racks when placed parallel to the curb.

Asset	Clearance Requirement
Trees	• Minimum clearance to intersections is 6.0m from stop bar or stop sign; designer to consider impact to sightlines and type of intersection control. • Minimum of 1.5m from traffic signal poles, electrical, communication or trolley poles. • Minimum of 1.8m to driveways and vehicle crossings. • Minimum clearance to buildings is 3.0m (spreading trees) and 2.0m (columnar trees). • Minimum of 1.5 m from catchbasins and valve boxes (except water valve boxes – see below other water infrastructure). • Minimum corner clearances (from extended property line) of 3.0m. • Parking meters must be clear of tree pit/surround. • Minimum clearance to water infrastructure is 2.0m. • Min 1.5m to 4.5m to lamp standards, depending on tree species and pole type. Verify with *City Engineer*, upon consultation with Urban Forestry, Vancouver Park Board.

Traffic Signal and Street Light Poles	• See *7.2.8*.
	• Signal equipment/signage shall follow these offsets and guidelines from CMBC infrastructure:
	  ○ Minimum clearance of 0.3m above CMBC DC feeders.
	  ○ Minimum clearance of 0.3m above CMBC running wires.
	  ○ Minimum clearance of 1.0m below running wires brackets on poles.
	  ○ Clamp-on mast arms are to be installed above the trolley wires, at 6.4m (min) and 7.01 m (max) from the grade to the center of the mast arm.

2.3 GENERAL REQUIREMENTS

All projects within the City of Vancouver have a set of general requirements that must be met. This section outlines these requirements and provides general information regarding units, permits, cost estimates, mapping resources, surveys, and test holes.

2.3.1 UNITS

All designs must be provided in metric except where noted otherwise in this manual.

2.3.2 PERMITS

Permits that are required by either the City of Vancouver or external agencies must be applied for and obtained when required. The list of external agencies in *Section 2.2.22.2.2* typically require permits. Refer to the ***City of Vancouver Construction Specifications*** and the ***City of Vancouver Construction Supplemental General Conditions*** for the City of Vancouver permitting requirements and the list of typical permits.

2.3.3 COST ESTIMATES

Cost estimates are typically included with design submissions. Refer to *2.5* for an outline of the level of cost estimate that is required at each design stage.

2.3.4 VANMAP

The City of Vancouver maintains a web-based GIS database called VanMap. It can be used for gathering general mapping information and related data such as properties, zoning, utilities, public places, parks, and roads. Although it is useful for obtaining general information, it does not replace surveys and site visits and may not reflect the current condition since the environment is continually changing. The accuracy of the data is not guaranteed; therefore, any information provided by this system must be checked and validated.

2.3.5 SURVEYS

All designs intended for construction must be done based on a topographic survey with property lines “adjusted” by the surveyor. Surveys should be completed by a qualified and experienced surveyor.

2.3.5.1 TOPOGRAPHIC SURVEY STANDARDS

- The survey must be in ground metric coordinates based on the current City Survey Monument Network. Monuments used are to be clearly indicated.
- The current horizontal datum for the City of Vancouver is NAD83(CSRS). All surveys shall meet a minimum horizontal accuracy of 1 in 20,000.
- All elevations shall be based on the CGVD28 vertical reference datum. The vertical accuracy must be plus or minus 0.01m.

2.3.5.2 SUBMISSION REQUIREMENTS

- The finished survey must be submitted in an AutoCAD DWG format showing all the property lines and using the City of Vancouver layers and standards.
- Unedited digital raw survey files, in FBK format, showing all ties and checks.
- A point file is required (Point, N, E, Z, Description) in excel or text format.
- Clearly identify monuments used in the field, their location, elevation and vertical reference datum (CGVD28).
- Ask the City for current point codes. City point codes are suggested.
- Line / point connectivity must be provided. Use survey figures or 3D polylines only.
- Clearly identify all features and include a legend of all survey codes used.
- Title block, including surveyor name, organization, and date of survey and vertical datum (CGVD28).

2.3.5.3 REQUIRED DETAILS

The survey will include all (but is not limited to):

- Survey monument ties.
- Lead plugs.
- Iron pins.
- Gutter line at curb face.
- Back of curb.
- Front of walk.
- Back of walk.
- Catchbasins.
- Approx. center line of lanes.
- Pavement markings.
- Garages and driveways.
- Concrete pads.
- Points of intersection on the gutter line returns and 1.5m offset, quartered along curb returns.
- Entrance walks (i.e. walkways, doorways, stairs) to ensure accurate tie-ins.
- Top and bottom of retaining walls.
- Street fixed furniture (i.e. lamp standards, traffic lights, power poles, signposts, parking meters, benches, bicycle racks).
- Fire hydrants.
- Bus shelters.
- Kiosks.
- Traffic signs.
- Valves (i.e. water and gas).
- Maintenance holes (specify type. i.e. Sewer, Telecommunications, Hydro, GVRD).
- Trees (located to the roadside face and diameter noted), hedges and garden outlines.
- Shots along the property line.
- Ground points at first lane line or a car-width from the gutter.
- Any permanent structure, pad, or utility.

- Waste Receptacles.

If the data does not meet the minimum City of Vancouver survey standards specified in *2.3.5*, the field work could be rejected and the surveyor may be asked to complete the missing information.

2.3.5.4 SURVEY EXTENTS

- The survey shall extend at least 30m on either side of the project extents along all properties abutting City property.
- In lanes, the survey must extend across both sides of the lane.

2.3.5.5 SURVEY METHODOLOGY

- The City may accept innovative survey methods, and such alternative methodologies should be proposed, where appropriate, for approval. It is the responsibility of the surveyor to assess which survey method or combination of survey methods must be used for a particular survey.
- Survey traverses and networks must consist of closed figures or be confirmed by sufficient redundant measurements to verify the survey standards required by the Streets Division and other departments within City of Vancouver.
- The unedited digital survey raw data file must show:
    - Agreement between ties to a minimum of two different City of Vancouver Survey Monuments.
    - Enough redundant measurements to verify that the survey meets the City of Vancouver survey accuracy standards.
    - A backsight check recorded at the beginning and end of each setup.
    - All checks and measurements recorded.
- If level loops are used, the field notes must be supplied (PDF of field notes are acceptable).
- Two-point solutions are not acceptable under any circumstances.
- Pick up cross sections approximately every 10m. If the street is flat or in a curve, the cross sections should be approximately every 7.0m to ensure proper terrain representation.
- Pick up the back of the curb just beside the gutter shot.
- Pick up high / low points.
- Pick up approximate location of all longitudinal and cross-sectional grade breaks.
- Pick up the drops of the curb in all let downs (wheelchair ramps and driveways).
- Do not cross survey lines in the drawing.
- All 3D polylines should be connected point-to-point between surveyed points and should not be offset or trimmed.

2.3.5.6 SURVEY MONUMENTS

The City of Vancouver's survey control network consists of Provincial Integrated Survey Area monuments, as well as monuments installed and maintained by the City. In addition to these, the City in partnership with the Greater Vancouver Regional District, has installed High Precision Network (HPN) monuments that include a GPS reference network system, meeting First Order survey accuracy standards.

The City has also resurveyed 78 of the City's Standard Integrated Survey Area monuments to provide elevations to First Order survey accuracy. These monuments have been designated as Secondary Benchmarks. The City's existing control monuments are just as important, and are regularly used by the Engineering Services Department, British Columbia Land Surveyors and many others, in their daily operations to provide horizontal and vertical control.

Any work occurring at or near any integrated survey monument is required to notify the Land Survey Branch prior to construction to verify disturbance of any integrated survey monuments during construction.

Any monument that has been disturbed or removed will require replacement cost payment from the contractor as per *City of Vancouver Construction Specifications* unless otherwise instructed by the City Engineer. Any monument that has been disturbed or removed will be considered destroyed if:

- The grade of the road at the location of the monument is being lowered or raised, as a result of construction.
- The installation of any underground utility is occurring within a 2.0m radius from the monument. This will require the monument to be referenced and monitored by the City, to ensure no impact on its location has occurred.
- The installation of any aboveground equipment is occurring within a 2.0m radius from an HPN monument. Such installations may interfere with the GPS Reference Network System.

2.3.5.7 LEGAL SURVEY

In some cases, a legal survey by a registered B.C.L.S. may be required. The City will specify when a legal survey is required.

2.3.6 TEST HOLES AND MONITORING WELLS

The installation of test holes within the City street right-of-way for environmental or geotechnical investigations or utility locations can be arranged through the Utilities Management Branch.

The purpose of this section is to outline the requirements for the installation of test holes within the City street right-of-way. The City permits the completion of test holes for environmental and geotechnical testing purposes, and in its review considers location, existing utilities, pedestrian and vehicle volumes, as well as many other issues that may affect the proposed site. Upon approval of the application, the Utilities Management Branch will issue a Test Hole Permit, which grants access to the City street for drilling purposes. The following sections provide specific details regarding the test hole application approval process and installation standards.

2.3.6.1 PERMIT APPROVAL PROCESS

Applicants wishing to install test holes or monitoring wells within the street right-of-way are encouraged to use this document as a guideline when applying for a Test Hole Permit and Temporary Street Occupancy Permit (TO). This document outlines the requirements that must be met by an applicant, for the efficient review and timely approval of the permit.

Applicants are required to submit a GIS base plan drawing request to the Utilities Management Branch e-mail: covutilities@vancouver.ca. The request should describe the location of the proposed test hole site(s) by address, intersection, or a map clearly identifying the site.

All efforts should be made to locate test holes and monitoring-wells outside of tree protection zones and/or critical root zones of street trees. If a location in these zones still proves to be necessary, it must be reviewed by Urban Forestry with a standard condition for installation and removal. Both installation and removal must be monitored and documented by a certified arborist.

All applicants requesting a GIS base plan drawing must complete a City of Vancouver Data License Agreement. The Agreement only needs to be completed once and remains in effect for the provision of data for future requests, until otherwise advised by the City. The Agreement is available upon request from the Utilities Management Branch.

Once the applicant has completed and returned the Agreement, the Utilities Management Branch will provide a GIS base plan drawing containing all underground utilities at the proposed site. The applicant is to use the data supplied to produce an engineering drawing for permit approval. Please note that the Utilities Management Branch accepts drawings in PDF and as an AutoCAD editable file (DWG).

The following list of items must be submitted to streetutilities.permit@vancouver.ca, a minimum of ten working days before the proposed start date, by the applicant for permit approval:

- A letter detailing the issues pertaining to the proposed site. This will include the diameter of the test hole or bore hole, location, number of test holes per street, traffic concerns, overhead obstacles (i.e. this may prevent the set-up of a drill rig) and any additional site issues.
- A proposed construction schedule detailing the start and end dates for the work, including information regarding monitoring activities if a monitoring well is installed.
- A traffic management plan (if applicable), refer to *Section 2.3.6.8* for more information.
- A metric scaled drawing of the site, including but not limited to:
    - All existing underground utilities with their size and offset from the property lines.
    - All proposed test hole locations must be referenced to the property line as well as to the closest cross street, and each must be labelled (TH1, TH2, and so on, for test holes and MW1, MW2, and so on for monitoring holes) for identification.
    - Title Block.
    - North Arrow.
    - Scale.
    - Company Name.
    - Contact Information.
    - Legend.
    - Site Address.

- The proposed test hole location should consider the locations of existing utilities / assets and their clearance requirements, as described in Section 2.2.5. For monitoring wells installation, Notification of Likely or Actual Migration (NOM) is required. This is to ensure the City is being notified of likely or actual contamination within the City street right-of-way. A NOM is required to be submitted in accordance with BC MOE guidance documents.

The Utilities Management Branch will review applications to ensure all submission requirements have been met. For those applications that do not satisfy all requirements, applicants will be contacted and advised to make the appropriate revisions, and to resubmit the application. When the Utilities Management Branch is satisfied that all requirements have been met, the application will be approved. Staff will notify the applicant to:

- Make payment for the Test Hole Permit and Temporary Street Occupancy Permit (if applicable) a minimum five working days prior to the drilling start date.
- Obtain a valid BC One Call.
- Complete a Certificate of General Liability form that is current and covers a minimum of $2 million dollars. A form will be provided by the Utilities Management Branch.
- Prepare a notification letter required to be distributed to all property owners within a block of where the construction activities are taking place. Notification must be issued to all property owners a minimum of five working days prior to the start of work. Complete a test hole investigation report. A form will be provided by the Utilities Management Branch. The report must be completed and submitted electronically to the Contaminated Sites Team (CST): contaminated.sites@vancouver.ca within two months of completing the drilling investigation.

2.3.6.2 TEST HOLE PERMIT

The Test Hole Permit sets out the terms and conditions by which the City grants permission to an applicant for the installation of test holes within the City street right-of-way. The following sections detail the fees associated with issuing the permit including the plan review fee, and deposits for inspection, street restoration and sidewalk protection from damage caused by the drill rig. Payment of the total test hole permit fee must be paid a minimum of five working days prior to the drilling start date.

2.3.6.3 PLAN REVIEW FEE

All applicants wishing to install test holes within the City street right-of-way will be charged a plan review fee. The plan review fee covers the costs associated with Utilities Management Branch staff undertaking tasks involved in the application approval process. Please refer to the *City of Vancouver Street and Traffic By-law No. 2849* for current fees or send a request to Utilities Management Branch staff.

2.3.6.4 INSPECTION FEE

An inspection fee will be charged to all test hole installation projects. The Utilities Management Branch inspector will conduct at least two site inspections for all test hole installation projects where no monitoring wells are installed: one prior to drilling activities, and one following restoration to ensure the restoration work is acceptable. For those test holes to be outfitted with monitoring wells, the Utilities Management Branch inspector will conduct at least three site inspections: one prior to drilling activities, one following the installation of the monitoring well, another following the decommissioning (removal) of the monitoring well and restoration of the pavement to ensure the restoration work is acceptable. Please refer to the ***City of Vancouver Street and Traffic By-law No. 2849*** for current fees or send a request to Utilities Management Branch staff.

2.3.6.5 SURFACE RESTORATION

The ***City of Vancouver Construction Specifications*** provides standards, specifications and procedures for construction works on City streets. It specifies materials and methods for the restoration of works in a safe, proven and consistent manner. The temporary restoration of all test holes installed within the City streets must conform to ***City of Vancouver Construction Specifications****, Section 32 15 01S – Surface Restoration*.

The costs of permanent restoration and pavement degradation of each test hole, based on the type of street treatment, will be invoiced when the permit is issued. All fees are based on the current street restoration cut rates approved by the City's Council.

2.3.6.6 SIDEWALK DEPOSIT FOR DAMAGE CAUSED BY THE DRILL RIG

If a drill rig is to be placed on a City sidewalk, there will be an additional fee charged in the event that any sidewalk damage occurs. A $1000 deposit will be secured when the permit is issued and will be refunded if no damage has occurred.

2.3.6.7 UTILITY LOCATES

Applicants are required to contact BC One Call and obtain a valid ticket prior to commencing any excavation or drilling activities. In addition to the utility information provided by BC One Call, information regarding City water, storm and sanitary sewer service connections to properties is available by contacting the City. The applicant is responsible for identifying, locating, and designing around all nearby utilities.

2.3.6.8 TEMPORARY STREET OCCUPANCY PERMIT AND TRAFFIC MANAGEMENT PLAN

A Temporary Street Occupancy (TO) Permit may be required to remove parking to allow for work to be undertaken on a street. Before a TO Permit is issued, a Traffic Management Plan must be submitted to the City for review and approval. Detailed information and application instructions can be found at: https://vancouver.ca/streets-transportation/traffic-management-for-construction-and-special-events.aspx.

2.3.6.9 REMOVAL AND DECOMMISSIONING OF MONITORING WELLS

The applicant shall provide the Utilities Management Branch with the anticipated removal and decommission date of the monitoring well(s) at a permit application stage. If the applicant requires the monitoring well(s) to be in commission for longer than planned, the Utilities Management Branch shall be notified and advised of the new removal and decommission date. The applicant shall follow the requirements outlined in the *British Columbia Ground Water Protection Regulation Handbook* when removing and decommissioning the monitoring wells. The monitoring wells should be removed and decommissioned immediately after they are no longer required, and the damaged surface should be temporarily restored to the City's standards as outlined in *Section 32 15 01S – Surface Restoration of* ***City of Vancouver Construction Specifications***. Once the monitoring wells are properly removed and decommissioned, and the surface temporarily restored, the applicant shall notify the Utilities Management Branch within the next day to initiate site inspection.

2.4 DRAWING STANDARDS

The City of Vancouver has specific requirements for drawings depending on the project and the type of construction the project involves. This section outlines the general requirements for all drawings submitted to the City, as well as the specific requirements for different types of drawings.

2.4.1 GENERAL REQUIREMENTS

This section contains general arrangement for all drawings submitted to the City. All drawings submitted should meet these minimum standards, as well as the specific standards other section specify.

2.4.1.1 SUBMISSION FORMAT

A complete set of construction drawings shall consist of separate drawings of some or all of the following as determined by the City:

- Cover Sheet.
- Site Plan, General Notes, Legend, and Index.
- Key Plan.
- Streets / Transportation Geometrics and Planning Plan and Profile.
- Typical Sections.
- Road Cross Sections.
- Spot Elevation and Curb Return Grading Plans.
- Signage Plan.
- Pavement Markings Plan.
- Stormwater Management / Sanitary Catchment Plan.
- Storm / Sanitary Sewer Plan, Profile, and Details.
- Waterworks Plan and Profile and Details.
- PRV and Chambers.
- Lot Grading Plan.
- Miscellaneous Details.
- Street Lighting / Traffic Signal Design and Timing.
- Streetscape/ Landscape / Street Furniture.
- Third-Party Utilities.
- Land Acquisition.
- Pump Station (Refer to Wastewater Pump Station Guidelines).
- Forcemains Plan, Profile and Details.
- Structures.
- Construction Phasing, Temporary Works, and Staging Plan.
- Traffic Control Plan.
- Tree Protection Plan.
- Sediment Control Plan.
- Green Rainwater Infrastructure Plan.

2.4.1.2 SOFTWARE

The City of Vancouver's Contract Drawings and CADD Standards are based on the current version of Autodesk AutoCAD Civil 3D. All drawings submitted to the City of Vancouver must be in XML and eTransmit DWG format using AutoCAD.

2.4.1.3 PAGE LAYOUT

The following should apply to all drawing layouts:

- Standard full-scale drawings shall be ANSI D (22" x 34").
- Standard half-scale drawings shall be ANSI B (11" x 17").
- Drawings shall be prepared to be fully legible when reproduced at half size.
- Plan and profile drawings shall have the plan view at the top of the page with the corresponding profile on the bottom of the page with the stationing aligned to match in both views.
- North arrow shall be located in the top right or top left corner of the drawing.
- North arrow shall be pointing to the top or right of the drawing.
- The drawings shall be neat and legible with adequate clearance margins between the drawing information and the title block border meeting the City of Vancouver drafting standards.
- Drawing scale is to be clearly identified on all views and details on a drawing sheet.
- Reference to a survey benchmark is to be included on all plan view drawings.
- Legends should be utilized to both clarify any symbols and line types on the drawing and to reduce the extent of drawing annotation required.
- Limits of construction and match lines shall be clearly marked on the drawing.

2.4.1.4 TITLE BLOCK AND TEMPLATES

The drawing title block shall be the City of Vancouver Standard Title Block and shall include the project name, project location, type of drawing (i.e. Key Plan), engineer's name, consultant's name and logo, drawing scale, consultant file number, and the City of Vancouver drawing number and file number which will be provided by the City of Vancouver. A revision block must be included in each title block containing revision numbers, revision reasoning, date, and full initials of both designer and drafter.

The final 100% Design, Issued for Tender, Issued for Construction, and Record Drawing submissions shall bear the seal, date, and signature of the professional engineer registered in British Columbia who is responsible for the design and the firm's permit to practice number, if applicable. A digital seal is acceptable and all corresponding digital PDF versions must contain the seal.

2.4.1.5 SCALES

Horizontal scales are to be noted on each drawing with a scale bar. Vertical scales are to be noted if relevant and varying from horizontal scales. Drawings shall be according to the scales shown in ***Table 2-4*** unless otherwise approved:

Table 2-4: Drawing Scales

Drawing	Horizontal Scale	Vertical Scale
Site Plan, General Notes, Legend, and Index	1:10000	-
Key Plan	1:500 or 1:250	-
Streets / Transportation Plan and Profile	1:250	1:10 or 1:25
Typical Sections	1:100	-
Road Cross Sections	1:250	1:10 or 1:25
Spot Elevations	1:250	-
Signage and Pavement Markings	1:250	-
Waterworks Plan and Profile (typical)	1:500	1:50
Waterworks Plan and Profile (downtown)	1:250	1:25
Storm / Sanitary Plan and Profile (typical)	1:500	1:100
Storm / Sanitary Plan and Profile (downtown)	1:250	1:100
Stormwater Management / Sanitary Catchment Plan	1:1000	-
Green Rainwater Infrastructure Plan and Profile	Varies	Same as horizontal scale
Lot Grading Plans	1:250	-
Miscellaneous Details	Varies	Varies
Street Lighting Plan	1:500 or 1:250	-
Traffic Signal Plan	1:200	-
Traffic Signal Plan Details	1:100	-
Streetscape / Landscape / Street Furniture	1:250	-
Third-Party Utilities	Varies	1:100
Land Acquisition	1:500	-
Planting Plan	1:100	-
Tree Protection Plan	1:250	-

Notes:

1) Alternatives to the scales required above may be accepted where the City of Vancouver considers them to be appropriate or required.

2.4.1.6 DIMENSIONS

All drawings shall be in metric. Numerical values shown on the construction drawings shall be shown to two decimal places (0.01) unless accuracy warrants otherwise, and with the exception of all coordinates, which are to be in meters and indicated to the nearest three decimal places (0.001). The source and location of the datum shall be clearly noted on each drawing (Updated UTM NAD 83, Zone 10). The drawings must be in ground metric coordinates based on the current City Survey Monument Network and clearly indicate the monuments used.

2.4.1.7 NOTES

Notes and text shall locate and describe the proposed work in sufficient detail to facilitate construction. Text is to be orientated to best suit the layout of sheets which is typically horizontal or parallel to the main alignment. Text shall be minimum 1.8mm text height for full-sized drawings and minimum 0.9mm text height for half-size drawings. Standard City of Vancouver notes should be used when possible and be updated as required to suit specific situations.

Construction notes are to be boxed and located around the perimeter of the drawing and shall be tagged to the drawing feature.

2.4.1.8 COLOUR

All drawings are to be submitted in colour. Colours should be allocated with the understanding that different printers produce different tones. Differentiation should always be easily understood.

2.4.1.9 DRAWING CERTIFICATION

All final drawings must be signed, sealed, and dated by the professional engineer, or the registered landscape architect as appropriate, responsible for the design. This certification indicates that the engineer is in good standing with Engineers and Geoscientists British Columbia (EGBC) and that the drawings have been designed using sound engineering practices. By stamping the drawings, the engineer is also certifying that the design is generally in accordance with the *City of Vancouver Engineering Design Manual*, *City of Vancouver Construction Specifications*, *City of Vancouver Standard Detail Drawings* and the MMCD.

2.4.1.10 DELIVERABLES

Unless otherwise specified, expected deliverables for all design phases are:

- One submittal letter on the consultant's letterhead, signed by the consultant. As a minimum, the letter shall define what is being submitted, confirm appropriate QA/QC has been completed and provide general information on the project and its construction schedule.
- Three complete sets of full-size hardcopy drawings signed and sealed when appropriate, unless otherwise specified.

- One digital submission including one complete PDF version and an AutoCAD version. The AutoCAD version shall include models, surfaces, pipe networks, and all other design elements.

2.4.1.11 CITY REVIEW

The City of Vancouver must be provided with a minimum of 20 working days for review of any submission, unless otherwise agreed upon by the consulting engineer and the City. All reviews must be completed, and comments addressed to the City's satisfaction prior to construction.

2.4.2 KEY PLAN

The purposes of the key plan are to present the overall design, show the interaction between various design disciplines, and to check for conflicts among the various existing and proposed features. The following shall be shown in addition to the information required.

- All proposed underground and surface utilities and services (with offsets, size, and material type) including, but not limited to, the following:
    - Sanitary sewers, forcemains, storm sewers, water mains, and appurtenances.
    - Street light poles, conduit, service panels / kiosks, junction boxes, and appurtenances.
    - Hydro poles, underground wiring ducts, and appurtenances.
    - Communications poles, underground wiring ducts, fibre-optic cables, and appurtenances.
    - Gas mains and appurtenances.
    - Pump stations, PRV's, and operating kiosks.
- All existing and proposed roadworks and landscaping such as open spaces (plazas, greenspaces), street trees, and plantings.
- Stationing.
- Plan and profile drawing reference numbers.
- Survey control monuments.
- Traffic control devices, poles, conduits, signs, and painting.
- Routing of all major storm flows including the 100-year storm.

The key plan required for the new developments can reference Bulletin 2022-01-UMB "Key Plan Process and Requirements" for additional details.

2.4.3 GENERAL DRAWING INFORMATION

Each plan and profile drawing shall show, but not be limited to, the following information:

- Title block.
- Scale bar.
- Match lines with associated reference drawing number, and continuation notes where applicable.
- Benchmarks (including temporary benchmarks) noted in the legend with identification number, location and elevation, and survey monuments shown on the plan view.

- Existing topographic surface features (displayed at 50% transparency) including, but not limited to, the following:
    - Pavement, curbs, sidewalks, bicycle paths, and boulevards.
    - Ditches, watercourses, and culverts.
    - Bus stops, benches, public art, waste receptacles, and other street furniture.
    - Trees, vegetation, and landscape features.
    - Retaining walls, buildings and structures.
- All existing underground and surface utilities and services (displayed at 50% transparency) with offsets, size, and material type including, but not limited to, the following:
    - Sanitary sewers, storm sewers, water mains, fire hydrants, service connections and appurtenances.
    - Street light poles, conduit, and appurtenances.
    - Hydro poles, underground wiring ducts, and appurtenances.
    - Sign posts.
    - Communications poles, underground wiring ducts, fibre-optic cables, and appurtenances.
    - Gas mains and appurtenances.
    - Traffic control devices, poles, conduits, signs, sign posts, and painting.
    - Pump stations, PRV's, and operating kiosks.
    - Utility crossings with crossing pipe inverts.
- Legal property information including, but not limited to, the following:
    - All pertinent property lines, right-of-way and easement lines, and road allowances.
    - Lot numbers, existing legal plan numbers, street names, and addresses.
- Offsets for all mains and services referenced from property lines or rights-of-way as appropriate.
- Right-of-way and / or road centerline stationing to metric standards (0+000) and marked at 10m intervals with labels every 50m. Stationing shall be related geometrically to legal property lines or survey monuments. Stationing shall run left to right where possible.
- Stationing referenced to monuments / iron pins with coordinates.
- Horizontal plan views with alignments from west to east or from south to north across the drawing sheet.
- Profile elevations placed at both sides of the profile. Split profiles must show elevations on both sides of the break.
- Labels including the scale of the view.
- The work laid out in an orderly sequence (ex. intersections or pipe junctions not broken up between sheets where possible, and interchanges easily defined).
- Profile views lined up with plan views. Stationing of alignments (T.S., S.C., etc.) coinciding with plans.
- Existing ground lines on profiles.
- Limits of construction.
- Reference data for monuments used in survey.

2.4.4 SITE PLAN, GENERAL NOTES, AND INDEX

A small-scale Site Plan showing the project location in relation to major streets shall be provided. The drawing shall include the general notes and construction notes and an index which includes drawing titles, sheet numbers, and the current revision of each sheet. The drawing shall also include a legend indicating symbols and line types used in the drawing set. Line thicknesses shall distinguish between existing and proposed features with bold lines for proposed features.

2.4.5 STREETS / TRANSPORTATION

Streets / transportation drawings are separated into four distinct categories: plan & profile, typical sections & cross-sections, signage plans, and pavement marking plans. This section outlines the drawing requirements for each of these drawings.

2.4.5.1 STREETS / TRANSPORTATION PLAN AND PROFILE

The drawings will include plan view, profile view, and details. The following shall be shown in addition to the information required in *Section 2.4.2*:

- All proposed roadworks, complete with tie-in points and offsets from road centerline, including pavement extents, lane assignments, curbs (with types noted), sidewalks, bicycle facilities, poles, barriers, retaining walls, culverts, and roadside drainage ditches.
- Where there is an elevation difference of more than 0.3m from the design road centerline to an existing or suitable building site on the adjacent parcel, driveway grades and profiles shall be shown on the drawings.

Plan view to include:

- Stations of the beginning of curve and end of curve of the road centerline and curb return horizontal curves with the curve information including delta angle, radius, tangent length and arc length.
- Property acquisitions required for the design.
- Details of intersections with spot elevations at all critical points.
- Catchbasin locations with station, offset, and rim elevation (using leaders, not in a table).
- Spot elevation plan with spot elevations every 10m or 20m (corresponding with cross section spacing) on all gutter lines, back of walk, crown, and other relevant locations including beginning of curve, ¼ point, ½ point, ¾ point, end of curve, grade breaks, high points, and low points.
- Proposed street furniture and features such as trees, traffic devices / signals, street lighting poles, concrete barriers, guardrails, handrails, and integrated survey control monuments.
- Details of any pedestrian / bicycle refuge area, pedestrian crossing, wheelchair curb ramps, tactile pavers, paint markings, and other surface features.
- Toes of cut and fill labeled C or F.
- Design speed and design vehicles noted.
- Vehicle restriction, greenway related signage, retaining walls, special paving treatment, swales, and special features within greenway.
- Existing and proposed retaining wall alignments, layouts, and construction detailing (on structural drawings).

- Additional design details as required. All transit vehicle, truck, and motor vehicle facilities.
- Existing and proposed transit stops for all impacted routes.
- Existing and proposed structure locations, dimensions and elevations.
- Construction notes including:
- Identification of surcharge and preload areas.

Identification of access details, drainage structures, roadside barriers or flares, clearing and grubbing limits, critical dimensions, utility conflicts, objects/items to be removed or relocated, and fencing limits of construction. Detours shown, if applicable (may be separate drawings).

Profile view to include:

- Existing ground, proposed road centerline, gutter line, intermediate curb, front of walk, and property line profiles along the pavement centerline with elevations at 10m intervals and grades.
- Crown or superelevation information.
- Stations and elevations of beginning of vertical curve, end of vertical curve, and vertical point of intersection.
- Vertical curve and grade information including the length of curve, sag or crest K value, and percent.
- Elevation and station of low and high spots of vertical curves.
- Centerline of any intersecting roads.
- Curb return profiles (shown on separate sheets) extending 10m past either side of curve. Alignments to follow gutter line and not edge of gutter. Curb types to be clearly shown on profiles and plans.
- Impacted utilities at the discretion of the consultant.
- Additional design details as required.

2.4.5.2 TYPICAL SECTIONS AND ROAD CROSS-SECTIONS

Where road cross-sections are required, they may be provided on separate sheets. The following information is to be shown:

- Road cross-sections are required at 20m intervals and additionally at all critical locations including driveway crossings, BC, EC, and crosswalks as required. Sections are required at 10m intervals on curved roads and through intersections. Additional sections may be required where excessive cut or fill is required.
- Cross-sections shall include design road cross-section within the right-of-way and existing ground cross-section extending into the adjacent properties as required.
- Where only a half road is being constructed, full-width design cross-sections shall be provided as required to ensure the design suits the future development of adjacent properties. All future works to meet City of Vancouver drafting standards.
- Crossfall or superelevation information is to be shown.
- Proposed elevations of the road centerline, the curb and gutter (or edge of pavement), and property lines are to be noted on the cross-sections.

- A typical cross-section is required for each varying road arrangement showing details of right-of-way width, road structure, pavement width, centerline, lane arrangement, sidewalks and curbs, barriers, retaining walls, side and back slopes, roadside ditches, surface treatments, proposed and existing underground or above ground utilities including related offsets, cross falls, dimensions, and any other applicable features.
- Impacted utilities at the discretion of the consultant.

2.4.5.3 SIGNAGE PLAN

The Sign Plan Drawing shall detail all installation, relocation, removal and existing and/or new regulatory and warning signage. The design shall conform to the current edition of the MUTCD and Section 8.10 of this Manual. The standards for line types, and dimensions should be consistent with the most current Transportation AutoCAD Template file. To improve legibility, the Sign Plan Drawing should be a standalone page separate from other disciplines. The following information shall be considered:

Base Plan - The base plan of the drawing should show:

- The topographic survey and the existing geometric and pavement markings in greyscale with slightly increased transparency so all proposed geometric, pavement markings and signage shown in colour stand out.
- Curbs and pavement markings, sidewalks, trees, poles, driveways, fire hydrants, gas and water valves, catch basins, manholes, survey monuments and all other aspects elements of the roadway. The inclusion of these features ensures there are no conflicts in the installation.
- Dimensioned location and type of new, existing, proposed, and those proposed to be removed, relocated and/or modified signs displayed with AutoCAD blocks.

Sign Boxes - Each sign is graphically shown in an outlined rectangular box with the following information:



- Line 1: Sign Code.
    - Note: The Sign Code should mirror the City of Vancouver Sign Code Inventory. Where applicable, always specify the directional arrow(s) with a dash and/or lesser than symbol(s): <->, <- , or ->
- Line 2: Support Type (If it's a new support add "NEW" or 'EXISTING).
    - Note: If support is a Pole, the Pole Number (XX/XX) shall be included. Examples of supports are:
        - Mast Arm Pole XX/XX
        - Pole XX/XX
        - Saddle Mount: Sign On Concrete Barrier

    - Post & Sleeve: Sleeve in Concrete only
    - Post & Base: in Softscape or Asphalt
    - New Long Post & Ex Sleeve: Can retain existing Sleeve & upgrade Post length
    - New Long Post & Base: Cannot keep Base and upgrade Post as it is attached to the Post. Therefore, for a longer Post, the Post & Base must be removed & a New Long Post & Base must be proposed.
- Signs on roller curbs or tip of medians with increase probability of being hit are installed on PVC posts.
- Line 3: Direction of traffic for New Installs, Removals, and Relocations (If existing, only include direction for non-curb side regulation signs ie. Object Markers, left turn restrictions, lane designation etc.

Leaders

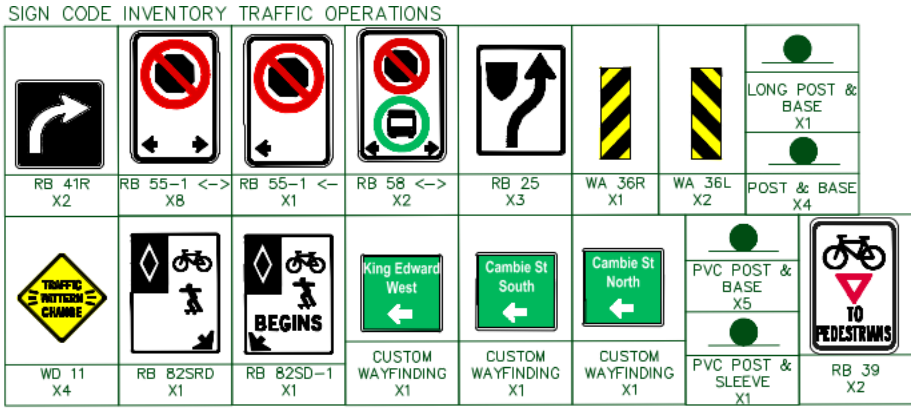
- A leader connects the sign box to the location of the support symbol in the drawing.

Aesthetics and Legibility

- Ensure the drawing is legible in printed format.
- Existing signs to be shown in greyscale. New, removed, relocated, and modified signs are to be shown in colour. Installed signs to be outlined with a green box, removed signs to be outlined with a red box, and relocated signs to be outlined with a blue box with leaders and text in corresponding colour to be shown.
- Sign supports shall be orientated to indicate the direction the sign is to be installed and viewed from. Sign images are to be orientated right side up on the page. The sign box should indicate the direction of travel for all new signage. Signage that is existing or to be removed shall have the direction of travel for all signs other than parking/curb regulation signs.

Sign Code Inventory

Signs should be on the appropriate layer and a code must be provided for all signs, as well as the quantity of each sign installed. Refer to City of Vancouver's Additional Documents section for Sign Code Inventory labels. If a post & base/sleeve is required, ensure you state those supports in the inventory as well. Traffic Ops and Electrical Ops are to have their own table:



Refer to *Additional Documents Section* for a Sample Traffic Signage Plan drafted to City of Vancouver standards.

2.4.5.4 PAVEMENT MARKINGS PLAN

The Pavement Markings Plan shall detail all eradications, alterations, additions, and new line painting. The design shall conform to the *MUTCD*. The standards for line types, and dimensions, should be consistent with the most current Transportation AutoCAD Template file. The following information shall be shown:

- Dimensions, lengths, and colour of proposed lane or curb markings, medians, and crosswalks and paint colour for special treatment areas.
- Lane widths, median radii, and taper ratios.
- Curbs, sidewalks, signage, trees, poles, driveways, and all other aspects of the roadway to assist with installation. For drawing clarity, remove unnecessary information that clutters the drawing.
- This plan is to be in colour (not black and white).

2.4.6 STORMWATER / SANITARY CATCHMENT PLAN

The drawings will include plan views and details. No profiles are required. The drawings shall show, but not be limited to, the following:

- Catchment boundaries with catchment number and area in hectares.
- Existing sewers and maintenance holes.
- Proposed sewers and maintenance holes.
- Any detention facilities.

- Accumulated flows and pipe capacity for each section between maintenance holes with provision for upstream development potential where applicable.
- Design storms used.
- Major flow path.
- Flow and pipe capacity calculation table (see *Sections 4.3.1* and *5.2.2.5)*.
- A legend noting all items proposed in the Stormwater / Sanitary Catchment Plan.
- Applicable general notes should also be included.

2.4.7 STORM / SANITARY / FORCEMAIN SEWER PLAN AND PROFILE

The drawings will include plan view, profile view, and details. The drawings will follow standards outlined in the City of Vancouver Sewers and Drainage Design CADD Standards. The following shall be shown in addition to the information required in *Section 2.4.2*:

- Show all proposed storm and sanitary works including maintenance holes, drop structures, cleanouts, catchbasins, inlet / outlet structures, pipe work, overland drainage, ditches, culverts, inspection chambers, services, bypass chambers, valve chambers, valve locations, and fittings. Drawings to be complete with offsets for mains (from the same property lines, coordinates on curves), rim elevations, stations related to the road centerline, pipe inverts at maintenance holes and pipe grade breaks, and hydraulic grade lines if outside the pipe.
- When possible, show storm and sanitary drawings on the same drawings using centerline stationing. Common trench sewers and sewer separations are required to be shown on the same drawing. Forcemain drawings shall be provided on its own dedicated drawings.
- For any detention ponds, show all pipes with size, inverts, and location; capacity; high water elevation; base elevation; control device particulars; location, size, and elevation of all maintenance holes and catchbasins; and any other design elements.
- Show any watercourse diversion information.
- The design flow rate, storm duration, and return period shall be noted on each storm drawing.
- All non-standard connections to be noted.
- Materials, types, sizes, inverts, and flow directions to be shown for all proposed and existing culverts.

Plan view to include:

- Directional flow arrows incorporated into all pipeline types.
- Proposed inverts and offset locations to property line for all service connections and mains.
- Offset distance to include prefix “SAN” for sanitary and “STM” for storm, (i.e. SAN 2.4m or STM 3.0m).
- Location of existing buildings on properties serviced by storm and sanitary sewers.
- Basement elevations for existing buildings at the discretion of the City.
- Catchbasin rim elevation and grate direction. “CB-R (rim elev) Sta x+xxx.xx” for a right grate, “CB-L (rim elev) Sta x+xxx.xx” for a left grate
- All existing utilities in the vicinity and their offset.

Profiles must be shown for all storm mains, sanitary mains, forcemains, sanitary services (for pipes greater than 100mm diameter), and storm services (for pipes greater than 150mm diameter) except where the installation of connections from an existing main is the only work performed. Profile view to include:

- Existing and finished ground profiles of the proposed sewer.
- Invert profiles of the proposed and existing pipes and service connections.
- Size, type, material, and class of pipe.
- Detailed fitting labels.
- Stationing bar, stationing at MHs and key profile locations (bends, fittings, caps, etc).
- Maintenance holes with diameters and rim elevation shown.
- Distance between maintenance holes with proposed grade of pipe.
- Chambers with dimensions shown, and offsets from edge of chamber to adjacent utilities.
- Existing and proposed pipe crossings including crossing pipe inverts, and horizontal and vertical separation between proposed and existing utilities.
- All infrastructure crossings and tie-ins.
- Utility protection provisions.
- CCTV bar between plan and profile showing wye locations.
- If flow calculations were performed using a hydraulic model, add design flow (Q_D) in cms and pipe capacity (Q_F) in cms.
- Areas of expected poor soil conditions.
- Additional design details as required.

2.4.8 WATERWORKS PLAN AND PROFILE

The drawings will include plan view, profile view, and details. The following shall be shown in addition to the information required in *Section 2.4.2*:

Plan view to include:

- All proposed waterworks including size, type, and class of pipe, hydrants, valves, services, joint restraints, fittings, and all related appurtenances.
- Stations and offsets for all mains, conduits, chambers, hydrants, tees, bends, line valves, air release valves, blow-offs, and horizontal pipe deflections. Offsets to be from the same property lines. Coordinates to be used on curves. Stations to relate to the road centerline.
- Size of each connection and meter chamber details if applicable indicated on the drawing.
- Locations of proposed service connections and fire hydrants including an offset distance from Property Line/Lot Line.
- List of materials for all elements such as pipes, fittings, polybags.
- Special fittings, coating, corrosion protection systems and other elements detailed on the drawings.
- Tie-in schematics and details.
- Utility protection provisions.
- Details in areas such as tee and cross intersections where dimensioning and other information cannot be adequately conveyed at the main drawing scale.
- Extent of work required in making the connection to existing water mains contained in a detail drawing view.

- Joint restraints or thrust blocks that are sized, shaded, labeled, and dimensioned from adjacent fitting showing the length of pipe requiring restraint.
- Limits of polyethylene encasement or joint encasement.
- Any water main protection details.
- Areas of expected poor soil conditions.
- Additional design details as required.

Profile views are required and will include:

- Existing ground profile; finished ground or road profile; pipe size, material, and class; and pipe invert and obvert profiles along the centerline of the proposed water main and water service connections >=100mm.
- All pertinent service crossings with clearances labelled (ex. sewer mains, gas mains, and duct banks).
- Station and offset from centerline at each deflection or fitting if the proposed water main alignment or profile varies from the road centerline, where applicable.
- The slope of the segment of main.
- Additional design details as required.

2.4.9 LOT GRADING PLANS

The drawings will include plan views and details. No profiles are required. The lot grading plan shall show, but not be limited to, the following:

- Existing storm sewers, maintenance holes, and connections.
- Proposed storm sewers, maintenance holes, and connections.
- Contours at 1.0m intervals with labels at 5.0m intervals showing existing and proposed grades extending a minimum of 20m beyond the project site.
- The proposed building envelope.
- Arrows identifying the positions of the major flow hydraulic grade lines within the Development as follows:
    - Above ground (solid flow arrow).
    - Surcharged (hatched flow arrow).
    - In pipe (hollow flow arrow).
- Existing elevations at all property lines (un-circled).
- Proposed elevations at all property lines (circled).
- Fill over 0.45m (shaded) and fill over 1.0m (hatched).
- Overland flow arrows.
- Lawnbasins and catchbasins, leads, and rim elevations.
- Swales (at time of subdivision development and at building construction).
- Proposed green rainwater infrastructure.
- On-site infiltration systems.
- Storm sewer invert elevation at property line for all lots.
- Retained trees.
- All proposed controls to prevent the release of sediment into any ditch, storm sewer, watercourse or ravine.

2.4.10 MISCELLANEOUS DETAILS

Standard details such as maintenance holes, catchbasins, and hydrants, that are shown and described in the ***City of Vancouver Standard Detail Drawings*** do not need to be shown in detail on the drawings. Instead, the Standard Detail Drawing number shall be referenced on the drawings. Standard symbols for the various utilities shall be used and may be shown in a legend on the drawings.

The following shall apply to detail sheets:

- Where there is not sufficient room on the plan and profile drawings, design details for the particular drawing may be provided on a separate sheet.
- Scales shall be determined by the designer to suit the design detail. Scales shall be noted on the detail drawing, unless it is not to scale, in which case it shall be noted as such.
- The detail shall reference the parent drawings it pertains to and the parent drawings shall reference the detail.
- A north arrow shall be added to all details that deviate from the page layout north arrow.
- Green Rainwater Infrastructure details with variable dimensions should be illustrated on drawings and include the dimensions and grades specific to the GRI system. GI components are outlined in the GI standard detail drawings.

2.4.11 ELECTRICAL/STREET LIGHTING PLAN

The drawings will include plan views and details. A pole profile showing pole base, pole type and elevation, luminaire arm length, receptacle, street and pedestrian luminaire, banners, and flower baskets is required. The following shall be shown in addition to the information required in *Section 2.4.2*:

- Plan drawings at a scale of 1:250 showing pole locations, conduit and service equipment. Poles and service equipment shall be located by offset and dimension from closest property lines. Conduit shall be located by offset from the property line. All utilities offsets from property lines must be shown.
- Details should be scaled at 1:50. The width of the trench shall be shown and offsets to the nearby utilities.
- Electrical diagram including details related to existing and proposed lighting, including but not limited to power supply, service voltage levels, circuit numbers, conductors size, luminaire types, etc.
- Legend and notes.
- Completed Lighting Design Criteria Tables (See *Section 10.3.3*) for each street, cycle path, walkway, mid-block crosswalk, intersection or roundabout.
- A table bill of materials with City products listed by manufacturer, make, and model number.
- Trench cross sections and trench profile.
- Service kiosk, cabinet, pedestal or panel schematic diagram.
- Voltage drop and short circuit calculations in AGi format to be submitted prior to issuing drawings at Conceptual design stage.
- Additional design details as required.

2.4.12 TRAFFIC SIGNAL PLAN

The drawings will include plan views, details and elevations. The traffic signal design drawings shall show, but not be limited to, the following:

- Plan drawings at a scale of 1:200 (ideal) showing pole locations (pole bases to shown to scale) and City pole asset number, signal heads, pushbuttons, audible/APS, luminaires, junction boxes and vaults, conduit, conductors and cables, cameras, detection type, signal controller cabinet, BC Hydro service equipment and location including BC Hydro pole ID, underground utilities, all pavement markings, curbs and ramps, trees property lines and any other elements of significance. Poles and service equipment shall be located by station and offset. Conduit shall be located by offset from the property line.
- Elevations of each roadway approach, including poles, signal heads, pushbuttons and signage. Also showing any additional equipment to be mounted on signal poles or arms.
- Legend and notes.
- Details including signal phasing diagram, pole elevations with references to roadway pavement markings, curbs and signage, detector loop table and single line diagrams and bill of materials with City approved and current stand product. Kiosk base plan detail for non-City standard service kiosk/cabinets.
- The proposed installation details and all related existing signal, lighting, and electrical information.
- Trench cross-section details.
- A table with City products listed by manufacturer, make, and model number (including any approved alternates), as per current City Signal Approved Product List.
- Additional design details as required.

2.4.13 STREETSCAPE/ LANDSCAPE / STREET FURNITURE / URBAN FOREST

All landscape related construction drawings and inspections required under this section shall be undertaken by a Landscape Architect registered with the British Columbia Society of Landscape Architects (BCSLA). The following information shall be shown in addition to the information required in *Section 2.4.2:*

- Overall open space (plaza, greenspace) design, plantings, street furniture.
- Clearly identified building footprints and overhead canopies.
- Sight distance triangles at intersections.
- Extent of proposed standard and decorative paving with details of paving structures.
- Walkway pavement elevations and layouts.
- Interface / relationship details and sections between different paving types.
- Location and type of proposed furnishing products, including street furniture, and shared micromobility stations.
- Drinking water fountains and associated utility boxes.
- Junction box locations.
- Proposed slopes with slope direction arrow and slope ratio, contours, and top and bottom of slope lines with elevations.
- Proposed boulevard locations, offsets, widths, surface treatments and materials, root protection zones, and planting shown.

- Cross section and details showing the relationship between landscape elements.
- Existing vegetation including size and type.
- Proposed tree locations with correct botanical name and showing trunk center.
- The location of plant material (with correct botanical name) with respect to curb, sidewalk, underground utilities, overhead utilities, driveway locations, mailbox locations, and streetlights.
- Plant labels and an associated plant list which indicates quantity, scientific name, common name, plant size, condition (e.g. container or B&B), spacing, and comments.
- Location of all shrubs, groundcover beds, and grass areas. Proposed grass areas shall be defined as sod or seed.
- Typical tree, shrub and groundcover cross-section planting details, including soil volume.
- Existing and proposed ground elevations at property lines.
- A typical right-of-way cross-section drawing indicating the relationship of all plantings to overhead, above-ground and below-ground utilities, pavement, and other structures referenced and shown on the landscape plan or, if there is insufficient room, on a details and cross-section sheet.
- Lawn basin and catchbasin rim elevations and proposed curb cuts.
- Proposed fencing layouts and construction detailing.
- Proposed tree pit details for trees planted in sodded boulevards. Trees planted within paved walkways shall conform to the current City of Vancouver standards.
- Structural soil details.
- Inspection and warranty requirements text block:
    - **Street and Public trees shall be installed between September 15th and April 15th, weather permitting. The two-year warranty will begin following a Park Board - Urban Forestry inspection and certification of trees prior to April 30th or after September 15th each calendar year.**
    - **If trees are planted outside of this window, the applicant/property owner will be responsible for delivering an enhanced watering program throughout the summer.**
    - **Tree Planting must comply with the Tree Planting and Watering Requirements Section.**
    - **Notify Park Board -Urban Forestry prior-to tree planting.**

2.4.14 LAND ACQUISITION

Where the proposed construction of capital works is over private lands and requires a right-of-way, a separate land acquisition drawing will be prepared for every lot affected.

- The drawing will be on an ANSI B (11” x 17”) or ANSI A (8½” x 11”) sheet.
- The drawing shall include the legal lot information, adjoining properties and street names, and a north arrow.
- The civic address and registered owners will be listed in the bottom right-hand corner above the title block.
- The plan will show the area of the proposed new right-of-way and of the total lot through which the right of way will go.
- The drawing will show the total acquisition area and hatching.
- The drawing will show a dimension perpendicular to the adjacent lot line and any other dimensions required to clarify the extent of the proposed right-of-way.

- The sketch is an attachment required with every right-to-enter form and condition sheet signed by the owner.
- The drawing will show survey monument locations.

2.4.15 SHARED MICROMOBILITY

At minimum, all drawings must show:

- A site plan overlaid with all relevant information and features that may impact the site including, but not limited to:
    - Curb and property lines.
    - Traffic and bike lane lines.
    - Above and below ground structures.
    - Utilities and utility access points.
    - Infrastructure.
    - Street furniture.
    - Trees.
    - Street regulation and other signposts.
    - Parking meters.
- Dimensions of critical clearances to nearby fixed objects, utility access points (maintenance holes, valve covers, etc.), and above ground access points (building exits, fire department Siamese connections, etc.).
- Consideration of access requirements for operation or maintenance of nearby elements or utilities.
- Any other relevant information requested by the City Engineer.

2.4.16 GREEN RAINWATER INFRASTRUCTURE

The guidance within this section describes the content that should be included within Green Rainwater Infrastructure (GI) drawing sets. Please note that all information described here may not be required for every project. Requirements should be established on a project-by-project basis. The following drawings may be included within a GI drawing set.

- Plan and Profile
- Utility Coordination Plan
- Grading Plan
- Site Plan
- Planting Plan
- GI Details

Green Rainwater Infrastructure drawings will include plan views, profile views, and section views, with information distributed between the relevant drawings. The following information shall be shown in addition to the information required in *Section 2.4.2*:

- All proposed roadworks, complete with tie-in points and offsets from road centerline, including pavement, curbs (with types noted), sidewalks, poles, barriers, retaining walls, culverts, and roadside drainage ditches.

- Sections should be provided to illustrate changes in layer depths, layer composition, and utility crossings.

Plan views to include:

- Green Rainwater Infrastructure system boundaries and Green Rainwater Infrastructure features.
- All third-party and City operated utilities shall be shown, along with any existing and proposed street furniture and/or features.
- All surrounding utilities shall be labelled with the width of the utility along with their invert elevations at the GRI system boundary.
- Catchbasin locations with station, offset, and rim elevation (using leaders or in a table).
- Proposed GI features such as inlets, perforated pipes, catchbasins, sediment pads and basins, object markers, moisture sensors, monitoring wells, pipe cleanouts, educational signage, and major system flow paths.
- All surface features connected to surrounding utilities (hydrants, valve boxes, MH covers, etc.) should be shown and labelled along with any relevant setbacks to the surface features.
- GRI system grades at all key locations with corresponding abbreviations, including but not limited to the following (inlet elevations, spillover elevations, catchbasins (CB RIM), top of weir wall (TW), sediment basins, top of curb (TC), bottom of curb (BC), top of soil (TS).
- Retained, removed, and new trees.
- Additional design details as required.

Profile views and sections to include:

- Profiles should be drawn along the major system flow path of the proposed GRI system.
- Existing ground, proposed road centerline, gutter line, intermediate curb, front of walk, and property line profiles along the pavement centerline with elevations at 10m intervals.
- Surface grades should be provided at all proposed inlets, outlets and drains of the proposed system.
- Elevations and dimensions should be provided to show the depth of all layers/media within the GRI system.
- Extent of all curb types, transitions, and curb cuts.
- All utility conflicts, protection measures, setbacks, and excavation offsets.
- Storm sewer connection and underdrain invert elevations.
- Excavation depths and fill details including material, depth, subgrade, and compaction requirements.
- Extent of all geotextiles, geogrids, and liners.
- Green Rainwater Infrastructure Sections shall include design road cross-section within the right-of-way and existing ground cross-section extending into the adjacent properties as required.
- Proposed elevations of the road centerline, the curb and gutter (or edge of pavement), and property lines are to be noted on the cross-sections.
- Additional design details as required.

2.5 DESIGN PROCESS

The design process is to be undertaken in coordination with appropriate project management practices. This section details the expected design process from project initiation to record drawings, including the expected submissions at each stage of the design process.

2.5.1 PROJECT INITIATION AND SCOPE

Project initiation is the first part of the design process. The needs, priorities, and motivations for the project are determined to help decide upon project scope and plans. This phase typically includes some or all of the following: public consultation, a public open house, information sessions, initiation meeting with City asset owners, Council approval, design brief, survey, and site investigation. This step is typically completed by City staff following the Engineering Project Management Framework using associated templates.

2.5.2 DESIGN DEVELOPMENT MATRIX

Table 2-5 outlines the specific objectives of each submission. Note that the City will inform a consultant if a requirement listed in the table is not needed or if additional submissions are required due to project complexity. Detailed submission requirements can be found at *City of Vancouver Design Submission Reference*.

Table 2-5: Design Submission Summary Table

Design Level	Progress	Submission Objectives
Functional/Conceptual Design Submission	25%-30%	• Provides sufficient detail to show how functional requirements will be met, including design criteria compliance or justification and mitigation for areas of non-compliance. • Identifies conflicts and constraints, site challenges. • Submission includes design brief, reports, identification of necessary site investigations, calculations & analyses, permits, stakeholder plan, as required. • Detailed design to be advanced upon City of Vancouver approval. • If a project is particularly complex and / or challenging, an interdisciplinary design review process and presentations / workshops in advance of formal submissions will be required, particularly to discuss and evaluate options for the project, including practical opportunities to innovate or provide added value.

Design Level	Progress	Submission Objectives
Detailed Design Submission	50%-75%	• Advances the preferred functional / conceptual option to provide sufficient detail to develop comprehensive engineering drawings and specifications. • Identifies conflicts between assets with recommendations for resolution and City approval. • Incorporates opportunities to optimize the design, such as to share facilities or trenches and evaluate other innovative solutions to provide value. • This submission will generate the bulk of the design comments, following which the design will be advanced to further design development to consider final detailing and construction notes. • Submission includes detailed design drawing package, updated design brief, updated reports, summary of site investigations, updated calculations & analyses, updated permits, updated stakeholder plan, as required.
	90%	• Detailed Design nearly complete. • Constructability fully considered. • Incorporates the comments from the previous submission including all details, construction notes, updated design brief and necessary reports. • Deliverables may be merged with previous submission for non-complex projects, at discretion of City Project Manager.
Pre-tender Submission	100%	• Final detailed design submission and fully coordinated design package incorporating all comments and include minor changes from the previous submission. The drawings should be signed, sealed, representing the final approved design. • Includes quantity take-offs, bill of materials and final specifications. • List of construction related line items in pricing schedule including tie-ins, temporary water servicing, temporary pipe support, and reserve items. • Identification of any regulatory permits that may be required prior to construction.

Design Level	Progress	Submission Objectives
Issue for Tender Design Package	-	• Design package used for soliciting tenders. • Complete schedule of pay items. • Identification of any regulatory permits that may be required prior to construction.
Issue for Construction Design Package	-	• Sealed design package approved for construction, incorporating any clarifications resulting from the procurement process.
Record Drawing and Package Submission	-	• Submission that reflects as-constructed conditions for record keeping, including all inspection & deficiency reports in accordance with the Inspection & Testing Plan.

2.5.3 CONSTRUCTION COST ESTIMATES

With each submission to the City, a design brief is to be provided including a construction cost estimate. The cost estimates required are defined in ***Table 2-6***, in order of increasing level of design detail and cost certainty and decreasing contingency.

Accuracy is defined as the expected reliability of the estimate and is dependent on how much information is known vs unknown. This includes how much design is complete, how much site information is known and the level of detail in quantities, geotechnical information, permitting status, etc.

Contingency is a dollar amount included in the estimate to account for known-unknowns such as incomplete design details, expected minor changes in quantities, construction uncertainties and pricing variability. The table below is based upon Association for the Advancement of Cost Engineering (AACE) International and provided for guidance only.

Table 2-6: Construction Cost Estimates

Class of Estimate	Project Stage	Accuracy	Typical Contingency*
D	Planning	+/- 50%	30%-50%%
C	Functional/Conceptual Design	+/- 25-40%	20%-30%
B	Detailed Design	+/- 15-25%	10%-20%
A	Final Design/Pre-tender Submission 100%	+/- 10-15%	5%-10%

2.5.4 FUNCTIONAL / CONCEPTUAL DESIGN

The functional / conceptual design submission represents approximately 30% of the design effort and shall be of sufficient detail to show how the project's functional and technical requirements will be met, indicate the consultant's approach to the design solution, show compliance with design criteria, and provide justification for any noncompliance.

Functional / conceptual design submissions typically present various options for a project. The consultant is not to proceed to the detailed design stage until the functional/conceptual design, street geometry, utility alignments, and design report have been reviewed and accepted by the City of Vancouver. Refer to the *City of Vancouver – Design Submission Checklist*.

2.5.5 INITIAL DETAILED DESIGN SUBMISSION

The initial detailed design submission is the first submission of the detailed design. It should reflect the City's preferred functional / conceptual option with any requested conceptual changes to that option addressed. It may not contain all details; however, the majority of the design should be provided, including any design reports including site investigation reports previously identified. This is the submission where the bulk of the major design comments will be generated. The consultant is not to proceed until all comments from this initial detailed design stage addressed and accepted by the City of Vancouver. Refer to the *City of Vancouver – Design Submission Checklist*.

2.5.6 DETAILED DESIGN PROGRESS SUBMISSION

The detailed design progress submission should contain all planned details, including those related to constructability and phasing, if applicable. Future stages will only be a refinement of the information provided in this stage. The consultant is not to proceed to the pre-tender/100% design stage until all comments from this stage addressed and accepted by the City of Vancouver. Refer to the *City of Vancouver – Design Submission Checklist*.

2.5.7 PRE-TENDER/100% DESIGN SUBMISSION

The 100% detailed design submission is the final design submission. It should address all previous comments and include any minor changes. The drawings should be signed and sealed and represent the finalized approved design. Construction notes should reflect any additional temporary works required to construct the permanent works (including by-pass phasing, temporary support of utilities, and temporary water servicing). Refer to the *City of Vancouver – Design Submission Checklist*.

2.5.8 ISSUED FOR TENDER SUBMISSION

The Issued for Tender submission should contain the final design from the pretender/100% design submission and be repackaged to reflect an "Issued for Tender" status. The intent is to use this submission for soliciting tenders. Refer to the *City of Vancouver – Design Submission Checklist*.

2.5.9 ISSUED FOR CONSTRUCTION SUBMISSION

The Issued for Construction submission should contain the design from the Issued for Tender submission and be repackaged to reflect an "Issued for Construction" status. The intent is to provide this package to the contractor as an approved design to construct the works. The Issued for Construction set shall be updated to reflect any issues and comments raised during the tender process and changes made through addenda. Refer to the *City of Vancouver – Design Submission Checklist*.

The City's Quality Management System requirements (such as RFIs, COs, and CCOs) apply during construction.

2.5.10 RECORD DRAWING SUBMISSION

Record Drawings shall be corrected upon completion of construction to note all works installed, removed, or abandoned during construction. Record Drawings are to reflect as-built conditions for permanent records. Refer to the *City of Vancouver – Design Submission Checklist*.

All dimensions, elevations, and inverts shown shall reflect the as-built conditions of the construction and all references to "Proposed" shall be removed. Material changes shall be clearly shown. The record drawings should include revisions or clarifications made as part of RFI's, site instructions, change orders, and all inspection and testing results. Record Drawings shall be to scale in accordance with the as-built dimensions shown. The revision table shall be completed indicating the drawings are Record Drawings. Refer to the *City of Vancouver Construction Specifications* for additional record drawing requirements for specific City assets.

2.5.11 DESIGN BRIEFS

A Design Brief shall be included at each submission stage and will include sections for each design discipline (ex. Streets/Transportation, Waterworks, Electrical). Each section shall outline the scope, purpose, methodology, design criteria, design calculations, any outstanding issues or potential problems, any conflicts, any deviations from standards or design criteria and reasoning, and any other pertinent information. The City may also require other specific documents to be included in the design brief; some examples of these documents are:

- Traffic modeling results.
- Safety reviews, such as of existing traffic collision data and expected changes to safety performance.
- Field review forms.
- Water and sewer modeling results, complete with assumptions.
- Fire hydrant spacing, thrust restraint calculations.
- Green Rainwater Infrastructure sizing sheets/ performance summary.
- Street lighting calculations.
- A coordination letter.

The Design Brief will be prepared and submitted with the first submission and then updated throughout the submission process until the 100% submission at which point it will become the Final Design Brief. At the time of the record drawing submission, the Final Design Brief will be updated to form the Record Design Brief. Refer to the *City of Vancouver – Design Submission Details Reference*.

2.6 DEVELOPMENT DESIGN REVIEW PROCESS

The City requires a formal review of all development submissions. The *Development & Major Projects Branch* is responsible for the drawing review and approval process for major land development projects. The *Development & Major Projects Branch* staff circulates the drawings to the various departments and compiles comments. The following section provides the process for drawing review and approval during a development project. Two design scenarios are considered:

1) Works for which the City has an approved geometric design.
2) Works for which the geometric design will be done by the developer's engineer.

2.6.1 DRAWING CIRCULATION

During the review process, development drawing submissions shall be circulated to the following departments by *Development & Major Projects Branch* staff:

- *The Transportation Planning Branch coordinates the review by the Transportation Division, including* the *Transportation Planning Branch*, the *Transportation Design Branch*, the *Traffic & Data Management Branch*, and the *Street Activities Branch*.
- *Streets Design Branch* will review the overall street design, including grades and materials.
- *Waterworks Design Branch* will review proposed water works, including tie-ins, modifications to existing system, and crossings.
- *Electrical Design Branch will review the off-site electrical design including but not limited to street lighting design and any signal works.*
- *Traffic & Data Management Branch will review any signal, paint & geometric, and signage works.*
- *Sewers and Drainage Design Branch* will review sanitary and storm works, as well as tie-ins, forcemain, pump stations or modifications to existing sewer assets.
- *Streets Design Branch - Structures* will review if there are works proposed near bridge abutments or other structural assets.
- *Utilities Management Branch* will review utility alignments.
- *City of Vancouver Civic Engagement & Communications* will review communication requirements.
- *Street Activities Branch* will review public realm and streetscape designs.
- As required, the *Planning, Urban Design, and Sustainability Department* will review public realm as to how it meets previous policy or rezoning guidelines.
- The *Vancouver Board of Parks and Recreation (Vancouver Park Board) Urban Forestry department* is responsible for the care and custody of all street and park trees, noting that placement of those trees must be approved by Vancouver Park Board – Urban Forestry, via the *Streets Design Branch* or their designate.
- *Solid Waste Services Branch* will review streetscape waste receptacle, waste container storage and collection, and other zero waste related designs.
- Green Infrastructure Branch will review Green Rainwater Infrastructure features and will confirm utility alignments with Utilities Management Branch, curb alignments with Streets Design Branch, and sewer connections and drainage areas with Sewers and Drainage Design Branch.

Notes to the drawing circulation is completed by the *Development & Major Projects Branch* and the *Streets Design Branch* project coordinators. Minor projects are sites that were not part of a policy plan.

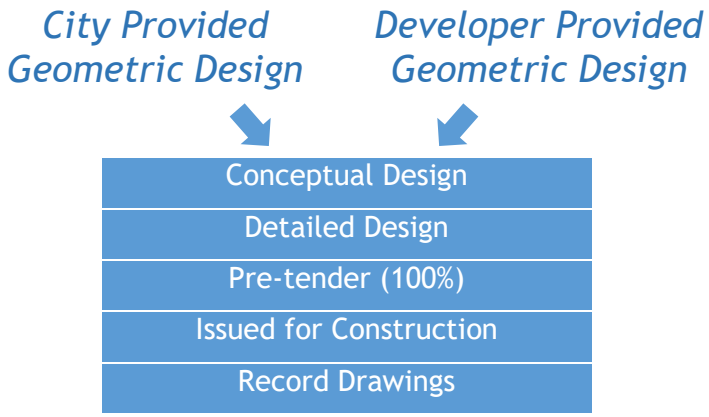
2.6.2 REVIEW PROCESS DESIGN

The review process is required to confirm that all drawings have been designed as per design submission requirements outlined in *Sections 2.4* and *2.5*. The review process depends on whether the City or the Developer completes the offsite geometric design. The Project Coordinator in the *Development and Major Projects Branch* will identify the option that is selected for the development based on site context and complexity.

In either case, the geometric design or geometric design criteria will be shared with the developer's engineer in a pre-design meeting which will also include a review of development infrastructure conditions in the Services Agreement. *Planning, Urban Design and Sustainability Department* will be included in this discussion as required.

Design submissions for the stages listed below will be shared with the city for review, comments and approval. The City's project coordinator may use discretion in varying the number of submissions required to be submitted for review and approval. Each submission will be accompanied by a submission checklist. Upon verification that a submission is complete (drawings and design rationale) the City review process requires four to six weeks for *Development & Major Projects Branch* to review and compile comments and circulate to branches for review. All submissions subsequent to the initial submission to include a tracker describing how each comment was addressed.

Drawings are approved upon receipt of a City issued Letter of Approval.



*Design Submissions, as defined in ***Table 2-5***: Design Submission Summary Table and *City of Vancouver Design Submission Reference Checklist*

2.6.3 ADDITIONAL CONSIDERATIONS

All City comments will be managed and provided to the developer's consultant by the *Development & Major Projects Branch*. Any correspondence between the engineering branches and the developer's engineer is to include the *Development & Major Projects Branch*.

As required, the *Planning, Urban Design, and Sustainability Department* is to be included in discussions about street materials and landscaping (generally for public plazas or walkways).

The *Vancouver Park Board* is to be included in discussions about street trees and streets adjacent to parks. Include an arborist report if required as per *Section 2.6.3.1*.

2.6.3.1 ARBORIST REPORT

An arborist report is required to assess the impacts of design and construction on both private and public trees as part of the application for any proposed development.

The arborist report must be prepared by a certified arborist or approved equivalent who is also a holder of a degree in Urban Forestry, Forestry, Landscape Architecture, Biology, or a related professional study. The development permit applicant submits the arborist report. All arborist reports impacting street trees shall be reviewed by both Urban Forestry and impacted engineering branches.

An arborist or landscape architect report shall contain:

- A tree protection plan, upon request, or whenever site work could impact public trees, should address the recommended protocols and practices in the *City of Vancouver Construction Specifications* and *Chapter 9: Streetscape & Urban Forest*.
- A description of the proposed development project, intensity and extent of impact to the public realm.
- Site conditions or proposed uses outside the norm that are likely to challenge tree growth.
- Rationale for species selection.
- A qualitative description of the below ground soil resources available to the trees.
- A table showing the quantity of good quality soil resources available per new street tree.
- Landscape plans should contain a warranty statement, for a period of two years from the date of planting. It should provide notation that the project manager or their designate must contact the Vancouver Park Board in advance of the trees being brought to site, so that an inspection may be made prior to installation.
- A Certified Consulting Arborist (ISA) or Landscape Architect (BCLSA) statement demonstrating that species, diversity, and minimum soil volumes are in compliance with tables. Rationale for requests for variance from tables to be included when appropriate.
- A Certified Consulting Arborist (ISA) or Landscape Architect (BCLSA) statement that existing public trees will not be impacted, or that an adequate public tree protection plan has been submitted.
- Inspection and warranty requirements. See *Section 2.4.13*. text block:
    - **Street and Public trees shall be installed between September 15th and April 15th, weather permitting. The two-year warranty will begin following a Park Board - Urban Forestry inspection and certification of trees prior to April 30th or after September 15th each calendar year.**
    - **If trees are planted outside of this window, the applicant/property owner will be responsible for delivering an enhanced watering program throughout the summer.**
    - **Tree Planting must comply with the Tree Planting and Watering Requirements Section.**
    - **Notify Park Board -Urban Forestry prior-to tree planting.**

2.7 THIRD-PARTY UTILITY DRAWING SUBMISSIONS

Third parties constructing, maintaining and operating utilities within the City of Vancouver are required to meet the requirements of the Utilities Management Branch. Chapter 7 of this manual is dedicated to third-party utility design and submission requirements, specifically:

- Refer to *Section 7.5* for Utility Drawing Submissions.
- Refer to *Section 7.6* for External Utility Electronic Submission Standards.
- Refer to *Section 7.4.11* for Attachments to City Structures.

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WATER SYSTEM



3

Approval Table

Version	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Mark Schwark, P.Eng, Director, Water and Utilities Management

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WATER SYSTEM

3.1 INTRODUCTION

Vancouver maintains and operates a complex water system which primarily consists of potable water transmission and distribution mains as well as an earthquake-resilient salt-water dedicated fire protection system.

The following is a brief description of each section:

- The *Demands and Flows* section outlines the analysis required to determine how much demand is placed on the water mains being designed or studied.
- The *Hydraulic Analysis* section outlines the process to determine the capacities of the water mains and services.
- The *Design of Water System Components* section discusses the specific requirements to design various components such as mains, valves, and hydrants.
- The Seismic Design Standards section outlines the seismic design of water mains.
- The Service Connections section outlines the requirements relating to service connections.
- The Thrust and Restraint Design section outlines the requirements relating to thrust restraint.

Refer to *Chapter 2: Design Process & Coordination* for specific submission requirements.

3.2 DEMANDS AND FLOWS

In order to determine the proper sizing and configuration of water distribution systems, the flow requirements must be determined. This section outlines the requirements for determining the design flows based on population estimates, per capita usage, fire flows, and building specific requirements.

3.2.1 DESIGN FLOWS

System design flows should be at a minimum based on the ultimate population and fully developed non-residential land as anticipated in the City of Vancouver Community Plans.

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

Total design flows, Q_{des}, are to be the greater of the following:

$$Q_{des} = D + F$$

or

$$Q_{des} = H$$

Where:

Q_{des} = Design Flow (L/s)

D = Maximum Day Demand for the Population or Equivalent Population (L/s)

F = Fire Flow (L/s)

H = Peak Hour Demand for the Population or Equivalent Population (L/s)

3.2.2 POPULATION ESTIMATES AND EQUIVALENTS

Commercial, industrial, and institutional demands should be determined using specific data related to the development or zoning.

If detailed population information is not accessible, the design population, P, is determined by using the following equation:

$$P = \frac{A_{lot} \times FSR}{D}$$

Where:

P = Design Population (people)

A_{lot} = Lot Area (m^2)

FSR = Maximum Allowable Floor Space Ratio from the *City of Vancouver Zoning and Development By-law No. 3575*

D = Density (m^2/person) from ***Table 3-1***:

Table 3-1: Development Densities

Development Type	Density, D (m^2/person)
Single-Family / Duplex / Triplex / Quadplex	55
Townhouse Complexes / Condos / Apartments	35
Commercial	23
Institutions / Schools / Stadiums / Hospitals	Case-by-case
Industrial	Case-by-case

Notes:

1) In absence of site-specific information, use Industrial: 105pp/property and Institutional: 65pp/property.

3.2.3 PER CAPITA DEMANDS

In the absence of reliable water consumption records, use the per capita demand of 320 L/cap/day. Peaking Factors to be used are Maximum Day Demand: 1.6 and Peak Hour Demand: 2.1.

3.2.4 FIRE FLOWS

Fire flows shall be determined in accordance with the requirements of the current edition of *Water Supply for Public Fire Protection*, published by Fire Underwriters Survey.

Fire flows are also subject to the minimum requirements in ***Table 3-2***:

Table 3-2: Minimum Fire Flows

Developments	Minimum Fire Flow (L/s)
Single Detached House	115
Single Detached House with Laneway, Duplex, or Multiplex up to 6 Units	140
Multi-Family	200
Commercial	220
Industrial	220
Historical Area (HA Zoning)	265

3.3 HYDRAULIC ANALYSIS

For the design of water mains, the criteria in ***Table 3-3*** must be satisfied:

Table 3-3: Overall Criteria for Water Main Design

Specification	Criteria
Design Velocity- Peak Hour Demand	V < 3.5m/s
Design Velocity- Average Day Demand	V < 1.8m/s
Hydraulic Grade	S < 0.005m/m
Minimum Domestic Use Pressure - Peak Hour Demand	275kPa (40psi) < p_D
Maximum Domestic Use Pressure	p < 1035kPa (150psi)
Fire Flow Residual Pressure	207kPa (30psi) < p_F

This section outlines the design process and factors to determine water distribution within the City.

3.3.1 FORMULAE AND COEFFICIENTS

The City uses the following formulas and coefficients for the determination of flow rate, head loss, and friction factors.

3.3.1.1 HAZEN-WILLIAMS EQUATION

The Hazen-Williams Equation is the following:

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

Where:

Q = Flow Rate (L/s)

C = Hazen-Williams Roughness Coefficient as per ***Table 3-4***

D = Internal Pipe Diameter (mm)

s = Slope of Hydraulic Grade Line (m/m)

Table 3-4: Hazen-Williams Roughness Coefficients

Material	Lining	C Factor	
		Minimum	Maximum
Concrete		110	140
Copper		130	140
Ductile Iron	Cement	120	140
HDPE		135	150
PVC		135	150
Steel		130	140

3.3.1.2 DARCY-WEISBACH EQUATION

The Darcy-Weisbach Equation is the following:

$$h_f = \frac{fLV^2}{2gD}$$

Where:

h_f = Friction Head Loss (m)

f = Friction Factor (from Moody Diagram or Colebrook Equation)

n = Manning's Roughness Coefficient

L = Length of Pipe (m)

V = Flow Velocity (m/s)

D = Internal Pipe Diameter (m)

g = Acceleration due to Gravity (m/s^2)

3.3.1.3 COLEBROOK EQUATION

The Colebrook Equation provides an iterative solution to friction factor and is calculated by the following formula:

$$\frac{1}{\sqrt{f}} = -2\log\left(\frac{e}{3.7D} + \frac{2.51}{R\sqrt{f}}\right)$$

Where:

f = Friction Factor

e = Magnitude of Wall Roughness (m)

D = Internal Pipe Diameter (m)

R = Reynolds Number

3.3.2 PRESSURE REQUIREMENTS

Pressure requirements within the City of Vancouver are separated by domestic use and fire flow.

3.3.2.1 DOMESTIC USE PRESSURES

Table 3-5 outlines the minimum domestic use pressure requirements:

Table 3-5: Minimum Domestic Use Pressures

Property	Pressure
Minimum Peak Hour	275kPa (40psi)
Normal Maximum	1035kPa (150psi)

3.3.2.2 FIRE FLOW PRESSURES

The minimum allowable pressure anywhere within the system under fire flow conditions (Maximum Day Demand and Fire Flow) is 207kPa (30psi).

3.3.3 COMPUTER MODELLING

Contact the Waterworks Design Branch for more information.

3.4 DESIGN OF WATER SYSTEM COMPONENTS

This section outlines the design requirements for pipes and appurtenances in the water distribution system within the City of Vancouver.

3.4.1 GENERAL CONSIDERATIONS

Water System Components shall be designed with consideration of the requirements outlined in *Chapter 2: Design Process & Coordination*.

3.4.2 TRANSMISSION AND DISTRIBUTION WATER MAINS

3.4.2.1 MAIN CLASSIFICATION

Transmission Mains are classified as mains that are larger than 300mm diameter. These mains primarily serve as links from the Metro Vancouver supply mains to the City's distribution main system.

Distribution Mains are classified as mains that are 300mm diameter and smaller. These mains distribute potable water for fire protection and domestic uses.

3.4.2.2 SIZE AND MATERIALS

The pipe outlined in ***Table 3-6*** is preferred for water mains:

Table 3-6: Water Main Pipe Materials

Pipe	Preferred Material	Min. Size (mm)
Small Diameter Service Connections (<100mm)	Copper	25
Large Diameter Service Connections (>= 100mm)	Ductile Iron	100
Fire Hydrant Connections	Ductile Iron	150
Distribution Mains	Ductile Iron	200

The preferred fittings shall be ductile. The use of compact fittings shall be approved by the City Engineer. Refer to ***City of Vancouver Construction Specifications*** for material requirements.

For looped distribution mains with lengths less than 500m in residential subdivisions, the minimum diameter may be reduced upon approval by the City Engineer, providing that the fire flow requirements can be met.

Distribution main minimum diameters may be reduced to 100mm upon approval by the City Engineer, providing that the main terminates in a short residential cul-de-sac, has a length less than 80m, and serves no fire hydrants.

The engineer of record remains responsible for calculating and confirming pipe sizing despite stated minimums in ***Table 3-6***. Refer to *City of Vancouver Construction Specifications* for material and installation requirements.

3.4.2.3 ALIGNMENT

Water mains are aligned relative to property lines, avoiding existing utilities, trees, poles, curbs, and placed if possible under pavement or in either boulevard or under sidewalk respectively, in descending order of merit. The offset of the water main from the property is not a fixed standard but is determined as to best suit the project site, wherever possible. The design shall meet the offsets required by the City of Vancouver as specified in *Section 2.2.5*.

Water main alignments on straight roads should have uniform offsets from property line between intersections wherever possible. If curved alignments are required, they are to remain parallel to property lines. Maximum design joint deflections should be half of the manufacturers recommended deflection angle.

Mains should be located such that every property served has at least one side fronting the water main. When water mains are located within a statutory right-of-way, access must remain available for maintenance vehicles and equipment.

Clearance from sewers is as indicated in *Section 2.2.5*.

3.4.2.4 LOOPING

Water mains are to be looped wherever possible.

Where practical, and approved by the City Engineer, a hydrant may serve a secondary role as a blowoff. Dead end water mains should be sized following the last hydrant to minimize the potential for stagnation. For blowoffs that are not hydrants, refer to *Section 3.4.8*.

3.4.2.5 BACKFILL AND MATERIALS

All backfill and water main-related materials such as bedding and concrete shall be in accordance with the *City of Vancouver Standard Detail Drawings G4.2* and *G4.3* and the *City of Vancouver Construction Specifications*.

3.4.2.6 DEPTH

All water main pipes must have a minimum cover of 0.9m to finished grade for all road classifications. For water main pipes with a diameter less than 300mm situated in local or residential roads, the minimum cover requirement can be reduced to 0.75m. The depth must not exceed 1.5m unless approved by the City Engineer. The depth of water main should be designed to minimize the use of trench shoring during construction.

Water mains and services must be of sufficient depth to:

- Prevent freezing - soil type and groundwater levels should be considered.
- Provide adequate clearance to other underground utilities as per *Section 2.2.5*.
- Provide protection from external loads.

Specialized designs are required to provide frost and external load protection in cases where minimum depths cannot be attained, e.g. at bridge crossings and in chambers.

3.4.2.7 GRADE

Water main grades are to be straight lines between defined deflection points. Wherever possible, the minimum grade of water mains is to be 0.1%. Grading should be designed to minimize the number of high points; see *Section 3.4.5* for more information on high points.

When the slope equals or exceeds 10%, joint restraints are required.

3.4.2.8 CORROSION PROTECTION

Native soil conditions within the City of Vancouver have a high potential for encountering corrosive soils. Due to these native soil conditions, corrosion protection measures in accordance with AWWA standards are required to protect metallic pipes and appurtenances. A 10-point test must be completed to determine soil corrosion properties.

Corrosion protection measures are as follows:

- All water mains and service connections equal to or greater than 100mm diameter are to be encased in polyethylene prior to backfilling regardless of potential for corrosion.
- Denso tape is to be applied to all rodding and bolts prior to backfilling.
- Existing cathodic protection systems are to be maintained in accordance with the *City of Vancouver Standard Detail Drawings W100.1* to *W120.2*.

If a special corrosion protection method is proposed, a geotechnical report or recommendation is required for review and approval.

3.4.3 DEDICATED FIRE PROTECTION SYSTEM

The City of Vancouver has a Dedicated Fire Protection System installed throughout the Downtown and Kitsilano areas which utilizes False Creek as a reservoir. The system is comprised of pump stations within False Creek, a Coal Tar Enamel Lined Steel Pipe network, and a series of high capacity fire hydrants. Any modifications to the Dedicated Fire Protection System will require specialty designs not covered in this design manual.

3.4.4 ISOLATING VALVES

Isolating valves shall meet the requirements outlined in ***Table 3-7***:

Table 3-7: Isolating Valve Types and Sizes

Main Size	Valve Type
Up to and including 300mm	Resilient Seat Gate Valve
350mm to 450mm	Resilient Seat Gate Valve Reduced by up to 2 sizes
Larger than 450mm	Butterfly Valve

3.4.4.1 DISTRIBUTION MAIN VALVE SPACING AND CONFIGURATION

Distribution mains valves at a street intersection are to be placed in line with projected property lines at a street intersection. Refer to *City of Vancouver Standard Detail Drawings W3.2*.

In general, valves for distribution mains should be located so that:

- No more than one hydrant is isolated.
- No more than 220m apart.
- No more than one of two interconnected services (100mm diameter and larger) to a single building is isolated, see *City of Vancouver Standard Detail Drawings W2a.4*.

3.4.4.2 TRANSMISSION MAIN VALVE SPACING AND CONFIGURATION

Valves should be located no more than 600m apart.

3.4.5 AIR VALVES

Combination air valves should be installed at high points of all mains of 200mm diameter and larger, except as follows:

- Where the difference in elevation between the high and low points is less than 600mm.
- Where it can be shown that air pockets will be carried by typical flows.

Air valves must be vented to an appropriate above-grade location to eliminate any potential for cross connection in a flooded or contaminated chamber. Above ground infrastructure must be integrated into public realm so as to not interfere with pedestrian flow, pedestrian facilities, bicyclists, motorists, or other infrastructure.

Typical air valve sizes, subject to design analysis based on manufacturers recommendations, are as shown in ***Table 3-8***:

Table 3-8: Air Valve Sizes

Water main Size	Valve Size
200mm to 300mm	25mm
350mm to 600mm	50mm
Larger than 600mm	Special Design

3.4.6 FIRE HYDRANTS

Hydrant placement and spacing shall meet fire protection requirements and satisfy the following minimum requirements:

- Placement of new fire hydrants shall meet the intent of the latest version of the *Vancouver Building By-Law*
- A sufficient number of fire hydrants shall be provided within 300m (measured along City streets) of a building's principal entrance to deliver the building's design fire flow.

- Each hydrant's available flow rate is determined by the City's water model using a minimum residual pressure of 30psi.
- The maximum flow rate of a City hydrant is 95L/s. Each hydrant's achievable flow rate may be lower.
- Contact the Waterworks Design Branch for modelled system flow rates and assistance on determining adequate number of hydrants.
- Where streets are divided with concrete median barriers (e.g. streets with precast concrete barriers or cast-in-place retaining walls) that cannot be crossed by fire hose lines, hydrant placement shall be considered on each side of the street independently.

Fire hydrants shall be located in general at street intersections and in accordance with the following:

- Preferred locations for fire hydrants are shown in the *City of Vancouver Standard Detail Drawing W4.1*.
- Hydrants shall be placed on the side of the intersection that provides the shortest hydrant lead length where possible.
- Maximum setback of a fire hydrant from the face of curb adjacent to the vehicle travel lane shall be 7m.
- Midblock hydrants shall be placed in line with lot lines unless approved by the City Engineer.
- Hydrants shall have a minimum 2.0m clearance of any street tree.

Hydrants must be integrated into public realm to not interfere with pedestrian flow, pedestrian facilities, cyclists, motorists, or other infrastructure.

3.4.7 MAINTENANCE HOLES, COVERS, AND FRAMES

Chambers or maintenance holes containing valves, blow-offs, meters, or other appurtenances shall provide sufficient room for maintenance, including headroom and side room. When installing new water mains, care should be taken when placing new valve box covers to avoid sidewalks, and curb ramps where possible. Access openings are to be suitable for removing valves and equipment. The chamber is to be provided with a drain to a storm sewer or channel, complete with backflow prevention, to prevent flooding of the chamber. Rock pits may be considered subject to suitable soil and groundwater conditions. A pumping system may be required for drainage. Insulation to prevent freezing is required when cover is less than minimums outlined in *Section 3.4.2.6*.

Adequate venting should be provided. The City and WorkSafeBC may require provision of forced ventilation, lighting, heating, and dehumidification. Access and ventilation details must comply with WorkSafeBC requirements. The choice of lid should eliminate the need for confined space entry when possible.

Chambers, covers, frames and lids are to be designed for H20 loading or *CAN/CSA S6 Canadian Highway Bridge Design Code*. Chambers must also be designed for hydraulic thrust on the end walls imposed by the main.

3.4.8 BLOWOFFS

All mains 400mm and smaller should be designed so that they can be flushed. Blow offs are required at all terminal ends of the main to allow for flushing. Blowoffs should be designed to allow a flushing velocity of 0.8m/s.

Typical arrangements of blowoffs are shown in the *City of Vancouver Standard Detail Drawings W8.1* and *W8.2*.

3.4.9 PRESSURE REDUCING VALVES

Pressure reducing valves are to be required and designed on a case-by-case basis depending on project conditions. Contact the City for additional information.

3.4.10 BACKFLOW PREVENTERS

Backflow preventers for temporary construction water services are to be required and designed on a case-by-case basis depending on project conditions and shall be approved by the City Engineer. Typical arrangements of backflow preventers for temporary construction water services are shown in the *City of Vancouver Standard Detail Drawings W18.1*.

3.4.11 DRINKING FOUNTAINS

The City requires freeze resistant drinking fountains with underground freeze-proof plumbing assemblies that can operate year round. Drinking fountain drainage systems shall be approved by the City Engineer. Refer to the *City of Vancouver Standard Detail Drawings W20.2* and *W20.3* for typical drainage details.

Drinking fountains are to be positioned as follows:

- Located within 10m of a City water main.
- Directly tied-in to the City water main. Tie-ins to private-side plumbing will not be accepted.

Drinking fountains must be located on a concrete pad or other approved hard surface as shown in the *City of Vancouver Standard Detail Drawings W20.1*. The concrete pad surrounding the fountain must be level with the adjacent grades. No steps or drop offs from the concrete pad are permitted.

In addition, the following drinking fountain clearances must be met:

- 1.0m from the edge of sidewalk.
- Minimum 1.2m clearance in front of the fountain to ensure wheelchair accessibility.
- Minimum 1.7m clearance from fire hydrants.
- A distance of 6 times the tree trunk diameter measured at 1.2m above ground is required between a fountain and an adjacent tree.

3.4.12 TRENCHLESS TECHNOLOGIES

Table 3-9 outlines the trenchless methods familiar to the City of Vancouver for water main installations and rehabilitations:

Table 3-9: Trenchless Technologies for Water Main Installations

New Installation Methods	Rehabilitation Methods
Pipe Jacking	Pipe Bursting
Horizontal Directional Drilling	Cured in Place (Pressure)

The design engineer must be experienced in the design of the proposed trenchless method and shall be responsible for recommending design criteria and specifications for the proposed method. All trenchless technologies proposed shall by approved by the Water Design Branch.

For casing pipe details, refer to *City of Vancouver Standard Detail Drawings G6.1* and *G6.2*.

3.4.13 WET TAPPING

Tees are the preferred option for a connection to an existing water main. Wet tapping is only acceptable if there is a significant benefit and must be approved by the City Engineer. Wet tapping can be performed only when a tee connection is required and the branch is a minimum of one pipe size smaller than the mainline.

3.4.14 BRIDGE CROSSINGS

When bridge crossings are required, designs should pay particular attention to:

- Joints and restraints.
- Pipe supports and hangers.
- Vertical and lateral structural bracing.
- Expansion and contraction couplings.
- Abutments.
- Corrosion protection.
- Air release.
- Seismic conditions.
- Freezing conditions.
- Structural adequacy of the bridge.
- Vandalism.
- Exposure to traffic/vehicle damage.

3.4.15 FLEXIBLE EXPANSION JOINTS

Flexible expansion joints should be provided when connecting to structures or where permanent grade change is likely due to settlement or residual ground movement such as at preload locations.

3.5 SEISMIC DESIGN STANDARDS

The choice of replacement strategy and pipe material is based on a risk assessment driven by the criticality of the pipeline, the susceptibility of the contextual ground conditions for wave propagation, and potential for Permanent Ground Deformation (PGD).

Awareness and avoidance are the best approaches to protect the water system from risks associated with ground deformation. Strategies include:

- Limiting the number of non-resilient, unlikely to function post seismic activity, feeds in a neighborhood susceptible to ground acceleration.
- Locating feeds to occur outside of liquefaction zones.
- Tunneling under the liquefiable layer.

System mitigation strategies include:

- Provide valves around liquefiable soil areas to allow isolation from the rest of the system.
- Provide connections on either side of liquefiable soil areas to allow quick installation of temporary piping.

Another approach would be to reduce liquefaction susceptibility by installing gravel columns, grouting, or limiting lateral spread by installing earth-retaining structures, as recommended by a geotechnical engineer.

Pipe structural mitigation strategies include:

- Incorporation of expansion sleeves at valve locations to relieve pipe strain.
- Minimizing connections to buildings, tees, crosses and bends to provide additional flexibility.
- Wrap pipe in polyethylene to reduce pipe-soil friction.

3.5.1 REMOTE TELEMETRY AND SUPERVISORY CONTROL (SCADA SYSTEMS)

Using SCADA systems to remotely monitor and control valves (including pressure reducing valves) can provide quick isolation of neighbourhoods or pressure zones that are expected to be heavily damaged in an earthquake.

3.5.2 RESIDENTIAL SERVICE LINES (UP TO 50MM IN DIAMETER)

The City of Vancouver manages approximately 80,000 single / dual family property service connections. The vast majority are copper (20mm - 40mm). The best performance for small diameter service pipes, based on direct experience in other earthquake prone areas, is provided by high-density polyethylene (HDPE) and copper. Both materials are ductile and can accommodate moderate levels of permanent ground deformation (PGD).

Copper is the material of choice of Vancouver for the following reasons. Copper pipe is traceable (via EM scope) which is very important in a dense urban environment. Copper pipe also has the advantage as it can be replaced or renewed via “pulling”, a trenchless methodology that significantly reduces the cost and public disruption through limiting the amount of associated roadway repair.

3.5.3 SEISMIC PIPE MATERIAL SELECTION STANDARD

City of Vancouver Waterworks Standard for small service connections: Copper

Seismic Pipe Material Selection Standard Transmission (>300mm diameter), and Distribution, Hydrant Lead and Large Service Connections (100mm to 300mm diameter).

For ground acceleration < 40% x gravity and non-liquefiable soils, modern bell-and-spigot joints with nitrile elastomeric gaskets are adequate to accommodate pipe strain by induced wave passage.

- Ductile Iron bell and spigot joint – due to proven performance and compatibility of maintenance and with cache of repair couplings on hand (vast majority of existing pipe network is iron based).

For ground acceleration 40% x gravity or greater and non-liquefiable soils and where permanent ground deformation (PGD) < 5.0cm:

- Polyethylene encased restrained joint ductile iron pipe – due to proven performance and compatibility of maintenance and with cache of repair couplings on hand (vast majority of existing pipe network is iron based).

For PGD > 5.0cm

- Polyethylene encased restrained joint ductile iron pipe with expansion sleeves at a regular frequency (minimum 1% elongation and compression) at line valves, tees, and crosses – due to proven performance and compatibility of maintenance and with cache of repair couplings on hand (vast majority of existing pipe network is iron based).

3.5.4 WATER SYSTEMS EXPANSION – LARGE DEVELOPMENTS, NEIGHBOURHOOD PLANS, COMMUNITY PLANS

For newly rezoned large developments, newly design neighbourhoods, or community plans that require water system expansion, particularly in areas with or adjacent to non-optimal soil conditions, the seismic design standards outlined in *Section* 3.5 must be applied.

3.6 SERVICE CONNECTIONS

Service connections tie private property into the City's water distribution system, with the service being operated and maintained by the City within the public right-of-way. As a result, it's important to maintain the service connections to maintain the system as a whole. This section outlines the location, type, installation, and maintenance of water main service connections in the City of Vancouver.

3.6.1 LOCATION OF SERVICES

The location of a service pipe shall be at the discretion of the City Engineer; however, the location requested by the customer will usually be approved providing the service pipe meets the following requirements:

- Comply with utility clearances and separation requirements outlined under *Section 2.2.5*.
- Is not in line with an existing or future vehicular crossing.
- Is not taken off a transmission main (pipe greater than 300mm in diameter).
- Is 3.0m (minimum) clear of an existing or future sewer connection for large diameter non-copper services.
- Clears a lamp standard base or other obstruction by 1.5m.
- Remains outside of a tree's drip line where possible.
- Is not located in line with any building entry walk.
- Can be installed at 90˚ to the property line.

The amount of cover over the private service pipe and the City's service pipe is dependent upon the depth of the City's water main and any existing utilities already in the ground. The service depth is usually between 0.75m and 1.5m.

Only one metered service connection is allowed per property unless approved by the City Engineer. If permitted, the fee for the second service will be according to size as indicated in the *City of Vancouver Water Works By-law No. 4848*.

3.6.2 SERVICE TYPES AND WATER METERS

The following defines the various service types:

- Domestic Service (Residential): A service which has a meter in the line and whose water is used exclusively for domestic purposes. The meter is located on the City side of the property line.
- Domestic Service (Non-residential): A service which has a meter in the line and whose water is used exclusively for domestic purposes. The meter can be located on the City side of the property line or on private property.
- Combined Service Twin: A service which branches on City property to provide two service connections, one of which is a metered line and the other of which is a fire line.
- Combined Service Dual: A service which branches on private property to provide two service connections, one of which is a metered line and the other of which is a fire line.

- Combined Service Interconnected: Two combined services which come off either separate water mains or, come off the same water main but have a line valve between them, and connect together on private side. The two services are intended to reduce the likelihood of interrupted service due to water main failure or maintenance.

An interconnected servicing system may be required by the City Engineer in the case of each of the following:

- Multi-family residential building which exceeds 30 units.
- Commercial / retail, industrial or office building which exceeds 40,000ft^2 (3,716m^2).
- Mixed use building which exceeds 40,000ft^2 (3,716m^2) or 30 dwelling units.

3.6.3 CUSTOMER CONNECTION TO CITY SERVICE

Customer connection to City service pipe shall be Tyton, mechanical joint, dresser or similar rubber joint flexible connector, without electrical bonding strap and without restraining lugs or screws.

Customer piping shall be restrained from movement independently of the City service pipe. The design of an adequate restraining mechanism on private side is the sole responsibility of the customer.

3.6.4 SERVICE RENEWALS

These guidelines have been developed to clearly identify the action that is to be taken when a water service is reviewed as a result of a leak, prior to paving a project, or as part of a water main replacement project.

3.6.4.1 PHILOSOPHY

Service renewal philosophy is based on factors that include age, length of service pipe, location on arterial/collectors or local streets, as well as failure history. Recommendations for service pipe replacement are as follows:

- Replace any service pipe that leaks on a local street due to corrosion, except those which serve properties for which a development permit has been filed.
- Repair any service pipe that leaks on an arterial/collector street, with the exception of those pipes which should be replaced because the renewal cost is less than 80% of the average renewal cost, or those pipes that have previous leak history.
- Repair any pipe without previous leak history that leaks due to substandard installation or damage caused by construction activities.

Refer to *Section 3.6.5* for the decision tree relating to service pipe replacement.

3.6.4.2 REPLACEMENT SIZE SELECTION

When services are renewed at the City's expense, typically the existing service is to be replaced with the same service size. Current replacement methods such as service pulling and directional drilling minimize replacement costs.

Only redevelopment of a site would necessitate the installation of a larger service. The developer of the site is required to renew the service at their own expense. The new service size is based on the new development's firefighting or operational requirements. Generally, the size is determined by firefighting demands.

3.6.4.3 RENEWALS AS PART OF WATER MAIN REPLACEMENT

The cost-of-service replacement is lower during this type of work. All older services and services with failure histories shall be replaced. Refer to *Section 3.6.5* for more information.

3.6.4.4 PLANNED SERVICE REPLACEMENT

When a capital program is in place to proactively replace aging water services independently of water main construction, this work is often coordinated with large paving projects in order to maximize the cost efficiency of the overall project.

Small services are to be renewed and prioritized based on the following criteria:

- Any non-copper material services are automatically replaced when encountered. The vast majority of these services have been replaced, but poor records may hide some of these services.
- Older services and services with leak history located on streets scheduled for resurfacing (coordinated with the Streets Division).
- Older services or services with leak history located on streets not scheduled for resurfacing or water main replacement. In the situations where the information is unclear the service should be left in place unless it has a leak record.

Services under concrete roads should not be replaced based on the last criterion due to high restoration costs.

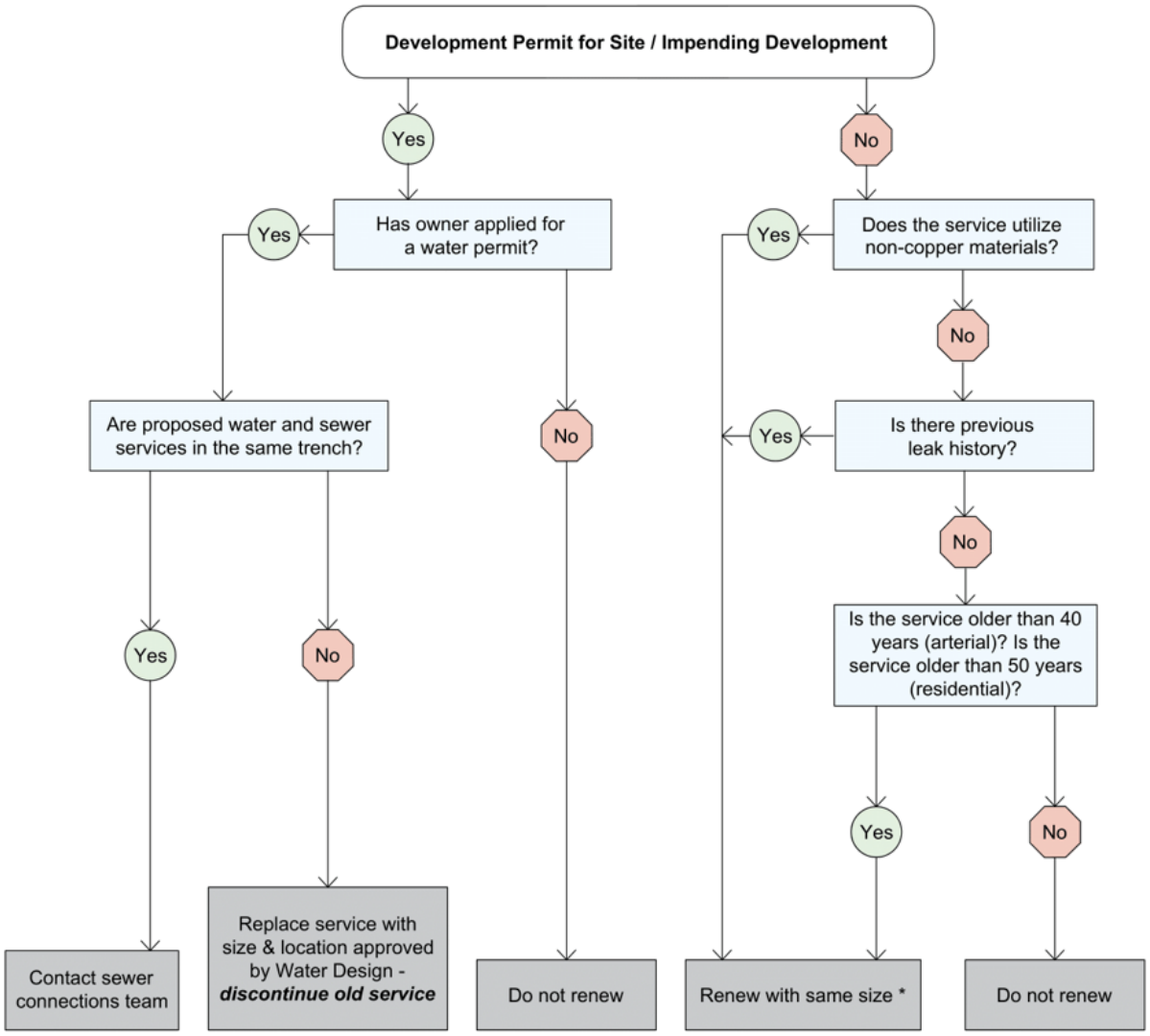
3.6.4.5 REPLACEMENT OF LARGE SERVICES

Services larger than 50mm are typically cast or ductile iron. These services have a service life common to that of cast or ductile iron water mains. Replacement of the service prior to water main replacement may be warranted if there is previous failure history or other indications that the pipe will likely fail again. Typically, these decisions are made on a case-by-case basis using the decision tree in *Section 3.6.5* as reference.

3.6.5 DECISION TREES

Water main service connections require case-specific judgement to determine the best course of action. The City of Vancouver requires the following decision trees be adhered to in order to install, change, or repair various sizes of services in the City. The decision trees are intended for internal City of Vancouver use only.

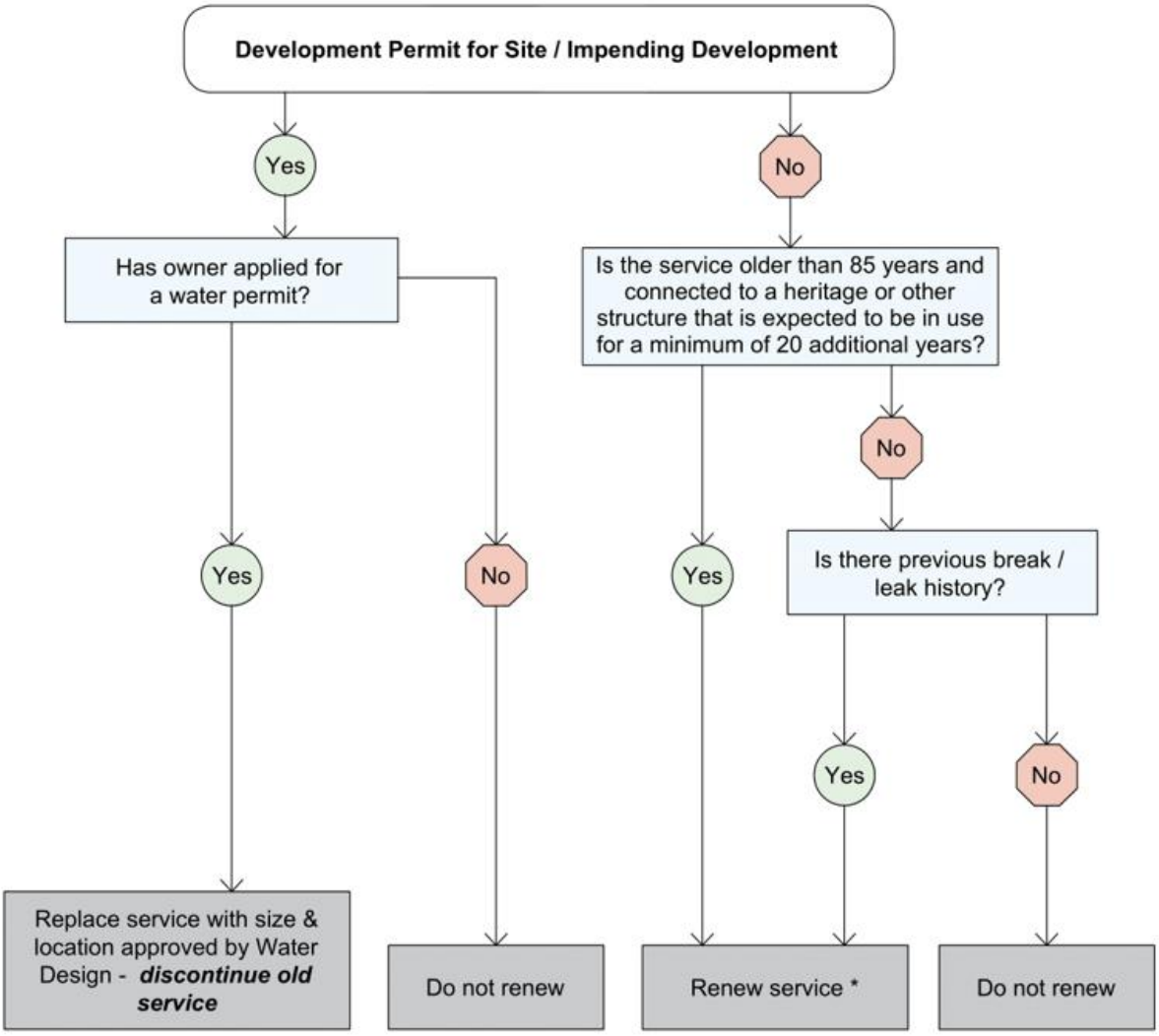
3.6.5.1 SMALL SERVICE REPLACEMENT AS PART OF A WATER MAIN REPLACEMENT PROJECT



* If renewal service work is expected to have significant impact (cost or major removal work such as tree or retaining wall), consult the Water Engineer prior to proceeding.

Figure 3-1: Should a Small Service be Replaced as Part of a Water Main Replacement Project?

3.6.5.2 LARGE SERVICE REPLACEMENT AS PART OF A WATER MAIN REPLACEMENT PROJECT



* If renewal service work is expected to have significant impact (cost or major removal work such as tree or retaining wall), consult the Water Engineer prior to proceeding.

Figure 3-2: Should a Large Service be Replaced as Part of a Water Main Replacement Project?

3.7 THRUST AND RESTRAINT DESIGN

This section identifies recommended methods of restraint for bell and spigot ductile iron piping to be installed in the City's water main distribution network. This section is written for distribution piping from 100mm to 300mm diameter but may be applied to larger diameter piping at the discretion of the City Engineer.

3.7.1 FULLY-RESTRAINED PIPING

In most instances, fully-restrained piping will not be required. The City Engineer may require fully restrained piping if one or more of the following conditions apply:

- The water main is located in an area which has been identified as having a risk of soil liquefaction in an earthquake.
- The water main is located in saturated soil conditions (bog or marsh where no soil bearing capacity is available).
- The water main has been designated as a seismically-important water main. Refer to *Section 3.5* for seismic design standards.
- The pipe is located downtown, under an arterial/collector road, or within the hardened grid.

3.7.2 PARTIALLY-RESTRAINED PIPING

Partially-restrained piping refers to ductile iron pipe that is only restrained at bends and other fittings to counteract local thrust forces developed at these locations. In all cases, the method and required restrained length to counter thrust forces shall be clearly indicated on design drawings. As well, soil type used in calculating restraint requirements shall be shown.

The Waterworks Design Branch on behalf of the City Engineer will select one of two methods for partially-restrained piping at horizontal and vertical fittings:

- Use of wedge-action restraints to transfer thrust along the pipeline and to soil by bearing friction. Wedge-action restraints are the preferred method of restraint.
- Concrete thrust blocking to transfer thrust to bearing soil when wedge-action restraints cannot be used.

3.7.3 CONCRETE THRUST AND GRAVITY BLOCKING

Concrete thrust blocks shall be sized and installed according to requirements as shown on the *City of Vancouver Standard Detail Drawings W1.1* to *W1.3*. Gravity blocks design must be prepared under the direction of a professional engineer.

3.7.4 USE OF WEDGE-ACTION RESTRAINTS

3.7.4.1 APPROVED MAKES

Wedge-action restraints and restraint harnesses shall be of approved design as specified in the *City of Vancouver Construction Specifications*.

3.7.4.2 LIMITATIONS TO USE

Due to the physical properties of the pipe, wedge-action restraints shall not be used when connecting to cast iron or steel pipes.

3.7.4.3 CALCULATION OF RESTRAINED LENGTH

Restrained length shall be calculated using applicable trench type (generally trench type 5), depth of bury, material type, and soil type.

The restrained length shall be calculated according to an approved restrained length calculation program. Approved restrained length calculation programs are:

- EBAA Iron Inc. *Restrained Length Calculation Program*
- Uni-Flange *Pipe Thrust Restraint Program* (from Ford Meter Box Co.)

For horizontal offsets, combined horizontal offsets, and combined vertical offsets, only the following program should be used:

- DIPRA's *Thrust Restraint Design for Ductile Iron Pipe*

Where fittings are located within the restrained length of neighbouring fittings, the City Engineer may require additional thrust restraint.

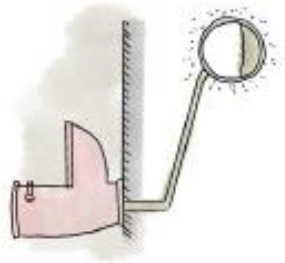
Restrained lengths shall be shown on drawings and record drawings. During construction, if a change in soil type is observed or if there is a change in material, the design engineer shall be notified, and the restrained length shall be recalculated using the new criteria.

3.7.5 USE OF TIE RODS

Corten tie rods shall only be used when other methods of restraint are not practical. See the ***City of Vancouver Construction Specifications*** for further details.

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SANITARY SEWER



4

Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Amy Sidwell, P.Eng, Director, Sewers and Drainage

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SANITARY SEWER SYSTEM

4.1 INTRODUCTION

The City of Vancouver updates, operates, and maintains a sanitary sewer network to convey liquid wastewater from residences, commercial buildings, institutions, industrial establishments, and unavoidable inflow and infiltration from surface storm water that finds its way into the sanitary system. All discharges to the public sewer shall comply with regulations contained in the *City of Vancouver Sewer and Watercourse By-law No. 8093* governing the admission of wastes into sewers. Metro Vancouver, the regional authority, owns, operates and maintains the treatment facilities and interceptors for Vancouver sanitary sewage.

The sanitary system is not intended to be the primary conveyance for stormwater and groundwater. Vancouver is in the process of separating combined storm and sanitary sewers into two isolated systems. The sewer system consists of local sewers and trunk sewers.

The following is a brief description of each section:

- The *Demands and Flows* section outlines the analysis required to determine flow demand placed on the sanitary sewers being designed or studied.
- The *Hydraulic Analysis* section outlines the process to determine the flow capacities of the sanitary sewers.
- The *Design of Sanitary Sewer Components* section discusses the specific requirements to design various components such as sanitary sewers, maintenance holes, and fittings.
- The Seismic Design Standards section outlines the requirements for seismic design of sanitary sewer components.
- The Service Connections section outlines the requirements relating to service connections.

Refer to *Chapter 2: Design Process & Coordination* for specific submission requirements.

4.2 DEMANDS AND FLOWS

To determine the proper sizing and configuration of sanitary sewer systems, the flow requirements must be determined. This section outlines the requirements for determining the design flows based on population, peaking factors, and inflow and infiltration. Alternative criteria may be used at the discretion of the City Engineer.

4.2.1 DEFINITIONS

ADWF = Average Dry Weather Flow = Average flow during dry conditions (no infiltration)

PDWF = Peak Dry Weather Flow = Peak flow during dry conditions (no infiltration)

PWWF = Peak Wet Weather Flow = Peak flow during wet conditions (considers infiltration)

4.2.2 DESIGN FLOW

The Design Flow of sewage is determined by estimating the present and probable future quantities of domestic sewage, commercial and industrial wastes, and infiltration. Generally, the City requires new sanitary sewers to have capacity for a projected 100-year period.

4.2.2.1 POPULATIONS

If detailed population information is not accessible, the design population, P, is determined by using the equation below:

$$P = \frac{10{,}000 \times A_{lot} \times FSR}{D}$$

Where:

P = Design Population (people)

A_{lot} = Lot Area (ha)

FSR = Maximum Allowable Floor Space Ratio from the *City of Vancouver Zoning and Development By-law No. 3575* or as provided by the City to reflect future land use.

D = Density (m^2/person) from ***Table 4-1***:

Table 4-1: Development Densities

Development Type	Density, D (m^2/person)
Single-Family / Duplex / Triplex / Quadplex	55
Townhouse Complexes / Condos / Apartments	35
Commercial	23
Industrial	Case-by-case
Institutions / Schools / Stadiums / Hospitals	Case-by-case

4.2.2.2 AVERAGE DRY WEATHER FLOW

The Average Dry Weather Flow, ADWF, is determined by the following equation:

$$\mathrm{ADWF} = \frac{\mathrm{P} \times \text{Per Capita Flow}}{86400}$$

Where:

ADWF = Average Dry Weather Flow (L/s)

P = Design Population

Per Capita Flow (L/person/day) as per the following, unless otherwise directed by the City Engineer:

- Residential Areas: 455L/person/day
- Commercial, Institutional, and Industrial Areas: 225L/person/day

In limited or confined industrial and commercial areas, other methods may be used, as approved by the City Engineer.

4.2.2.3 PEAKING FACTOR

The Harmon Formula is used to determine the peaking factor which is given by:

$$\mathrm{PF} = 1 + \frac{14}{4 + (\mathrm{P}/1000)^{0.5}}$$

Where:

PF = Peaking Factor

P = Cumulative Equivalent Population (residential population + 0.5 x commercial population)

If flow data is recorded for similar developments, the peaking factor used should be the larger of the recorded data or the Harmon Formula.

4.2.2.4 INFLOW INFILTRATION (I&I)

The Infiltration Flow, $\mathrm{Q_{I\&I}}$, is used as an allowance in new branch sewers to account for any infiltration and inflow that makes its way into the sanitary sewer. To determine the infiltration flow, the following formula is used:

$$\mathrm{Q_{I\&I}} = (0.13\,\mathrm{L/s/ha}) \times \mathrm{A}$$

Where:

$\mathrm{Q_{I\&I}}$ = Inflow and Infiltration (L/s)

A = Gross Area (ha)

For design of sewers within existing systems, conveying significant upstream catchment flows, monitored I&I values should be used.

4.3 HYDRAULIC ANALYSIS

This section outlines the design process and factors determining sanitary sewer pipe flow within the City of Vancouver. For the design of sanitary sewers, the equations in ***Table 4-2*** must be satisfied:

Table 4-2: Hydraulic Design Requirements

Population	Maximum Flow Depth
5000 and less	$y = 50\% \times D$
Greater than 5000	$y = 70\% \times D$

Where:

y = Maximum Allowable Flow Depth (m)

D = Diameter of Pipe (m)

Refer to ***Figure 4-1*** for pipe flow properties.

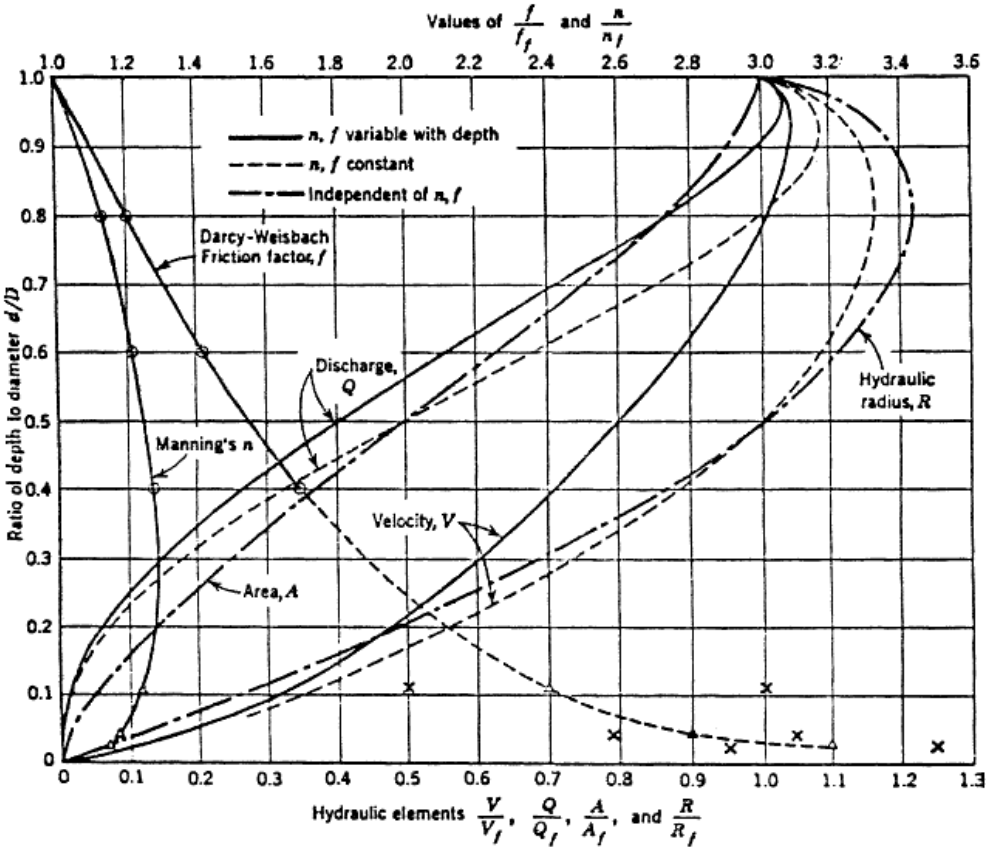


Figure 4-1: Hydraulic Elements Graph for Circular Sewers

From WPCF Manual of Practice No. 9 "Design and Construction of Sanitary and Storm Sewers" 1969 Ed.

Note that other methods may be used as approved by the City Engineer.

4.3.1 MANNING'S FORMULA

Pipe flow rates of unpressurized sanitary sewer pipes are calculated using Manning's Formula which is defined as:

$$Q = \frac{1000}{n} R^{2/3} s^{1/2} A$$

Where:

Q = Flow Rate (L/s)
n = Manning's Roughness Coefficient = 0.013 for all smooth pipes (ex. PVC, Concrete, Clay)
R = Hydraulic Radius (m) = Cross-Sectional Flow Area (m^2) / Wetted Perimeter (m)
s = Slope of Hydraulic Grade Line (m/m)
A = Cross-Sectional Flow Area (m^2)

4.3.2 HAZEN-WILLIAM'S FORMULA

Pipe flow rates of pressurized force mains are calculated using Hazen-Williams Formula which is defined as:

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

Where:

Q = Flow Rate (L/s)
D = Internal pipe diameter (mm)
s = Slope of hydraulic grade line (m/m)
C = Roughness Coefficient = 120 for all pipes

4.4 DESIGN OF SANITARY SEWER COMPONENTS

This section outlines the design requirements for pipes, maintenance holes, pump stations, and related appurtenances in the sanitary sewer system within the City of Vancouver.

4.4.1 GENERAL CONSIDERATIONS

Sanitary sewers shall be designed with consideration of the requirements outlined in *Chapter 2: Design Process & Coordination*.

Gravity sewers, pump stations, and forcemains are sub-systems of the broader sanitary sewer system. These sub-systems must work together for the sanitary sewer system to function efficiently. The design of each of these sub systems must consider the hydraulic functioning and maintenance considerations of each of the other sub-systems. The designer shall consider the integration of each of these systems through the design process. City pump station and forcemain staff shall participate in design processes for gravity sewer systems in close proximity to City pump stations.

4.4.2 SANITARY SEWERS

This section outlines the size, material, alignment, and other design criteria related to the installation of the sanitary sewer system in the City of Vancouver.

4.4.2.1 SIZE AND MATERIAL

The pipe outlined in ***Table 4-3*** is permitted for gravity sewer mains:

Table 4-3: Gravity Main Size and Materials

Pipe	Size (mm)	Standard
Non-Reinforced Concrete Cl. 3	200 – 600	*ASTM C14 / C443*
PVC SDR35	200 – 375	*ASTM D3034 / D2412*
PVC C900 (for low-cover situations)	200 – 375	*AWWA C900*
HDPE DR21	200 – 375	*ASTM D3035 / D3350*
Reinforced Concrete Cl. III, IV, and V	300 – 3050	*ASTM C76 / C443*

Sanitary gravity mains shall not be less than 200mm in diameter unless in a residential area where it cannot be extended. In no case shall it be less than 150mm in diameter.

Downstream pipe size reduction may only be used in special circumstances with City Engineer approval. A downstream pipe must not be reduced in size unless:

- It has increased slope to provide sufficient capacity.
- It is greater than or equal to 525mm.
- It is not reduced by more than two pipe sizes.
- A detailed hydraulic analysis has been done.

The engineer of record is responsible for the selection of materials and shall consider local conditions such as character of industrial wastes, soil characteristics, heavy external loadings, depth of cover, abrasions, and similar problems. Pipe material and class shall be selected by the engineer of record. Signed and sealed structural calculations for the selected material shall be provided to the City. Refer to the *City of Vancouver Construction Specifications* for further requirements.

4.4.2.2 ALIGNMENT

Whenever possible, sewers should be located based on the elevations of the adjacent properties. In cases where only one side of the street is serviced by a sewer, the sewer shall be located on the higher elevation side. In cases where both sides of the street are serviced by a sewer, the sewer shall be located on the lower elevation side. Wherever possible, the sewer shall be at a constant offset from the property line.

The following must also be considered when selecting the sewer alignment (in no particular order):

- Minimize crossing conflicts.
- Meet clearance and separation requirements in *Section 2.2.5*.
- The minimum edge to edge clearance between sewer maintenance holes is 0.15m.
- The minimum edge to edge clearance between a sewer maintenance hole and a sewer pipe is 0.15m.
- Minimize construction, public, and traffic impacts.
- Minimize construction costs.
- Maximize maintenance access.
- Consider long-term plans for separated and traditional sewer routing.
- Avoid trees and other surface features such as, but not limited to, traffic circles, bulges, landscaping, gate valves, gutters, catchbasins, retaining walls, trees, concrete curbs, sidewalks, or ramps.

4.4.2.3 DEPTH

The minimum depth of cover is 1.0m. The sanitary sewer must also be sufficiently deep to:

- Service basements by gravity that were previously serviced by gravity (existing pumped connections are not required to be converted to gravity connections).
- Allow for tie-ins of other mains and services.
- Structurally withstand surface loading.
- Avoid conflicts with other utilities.
- Prevent freezing.
- Accommodate future sewer separations and consider long-term plans for separated sewer routing.

The sewer shall be sufficiently shallow that it allows for the pump station to efficiently maintain wet well sewage levels without surcharging the sewers.

Generally, the maximum depth of cover is such that the trench depth will not exceed 6.0m; depths greater than 6.0m or trenches excavated in poor soil conditions require trenches designed by a professional engineer.

4.4.2.4 VELOCITY AND SLOPE

Sanitary mains shall be designed with a pipe slope which provides the minimum velocity at maximum flows as follows:

- Preferred minimum velocity: 0.76m/s
- Absolute minimum velocity: 0.61m/s

The pipe slope shall not be less than 0.5%. If the sewer services a design population of less than 25, the minimum slope is 0.6%.

Provisions shall be made for energy dissipation and movement when the velocity of the design flow exceeds 4.6m/s or as specified by the pipe manufacturer.

When lateral forces are excessive to unseat pipe joints, anchors will be required (i.e. steep slopes).

4.4.2.5 CURVED SEWERS

Horizontal and vertical curves will be permitted under special circumstances. Vertical curves may be required where excessive rock cuts are to be avoided and where energy dissipation is required. The following criteria applies to curved sewers:

- The rate of curvature must be uniform throughout the curve.
- Only one curve (horizontal or vertical) is allowed between consecutive maintenance holes.
- Curves must be formed through joint deflection or bends and not by bending of the pipe.
- The joint deflection must not be greater than 50% of the recommended maximum by the pipe manufacturer.
- The radius must also meet the minimum requirements in ***Table 4-4***.
- Horizontal curves require tracing wire above the alignment and are to terminate at upstream and downstream maintenance holes. Warning ribbon is to be placed 1.0m above the top of the curved sewer.

Table 4-4: Minimum Curved Sewer Radii

Pipe Type	Pipe Size (mm)	Laying Length (m)	Minimum Radius (m)	Max Deflection[1]
Concrete Pipe	300	2.5	41	3˚31’
	375	2.5	50	2˚53’
	450	2.5	58	2˚27’
	525	2.5	67	2˚6’
	600	2.5	80	1˚47’
	675	2.5	89	1˚37’
	750	2.5	98	1˚28’
	900	2.5	116	1˚17’
	1050	2.5	113	1˚4’
PVC	150	-	46	Per Manufacturer’s Guidelines
	200	-	61	
	250	-	77	
	300	-	92	
	375	-	107	

Notes:
1) In no case shall the deflection be greater than 50% of the manufacturer’s recommended maximum deflection

4.4.2.6 BACKFILL AND MATERIALS

All backfill and sewer-related materials such as pipe bedding and concrete shall be in accordance with the *City of Vancouver Standard Detail Drawings* and the ***City of Vancouver Construction Specifications***.

4.4.2.7 STRUCTURAL DESIGN

The design engineer must ensure that the pipe is sufficiently designed to withstand loading that will be applied to it without deflection or damage as per manufacture specifications. The signed and sealed calculations shall be completed using the manufacturers recommendations and submitted to the City.

Concrete Pipe Strength Calculation

$D_{0.3}$ is to be used when calculating the design strength of concrete pipes, where $D_{0.3}$ is the minimum load required to produce a 0.3mm crack in a concrete pipe.

$$\text{Minimum Load (N)} = \text{Strength Class } D_{0.3}\left(\frac{\frac{N}{m}}{mm}\right) \text{ x Length of Pipe (m) x Inside Diameter (mm)}$$

4.4.2.8 ODOUR MITIGATION

To reduce the effect of odour caused by the presence of Hydrogen Sulphide (H_2S), sewers should be designed with the following considerations:

- Steeper sewers should be used when possible since shallower slopes cause higher odours.
- Larger pipe sizes reduce the depth of flow which results in lower odours.
- Maintenance hole drop structures should be avoided since they create turbulence which releases odours.

4.4.3 MAINTENANCE HOLES

4.4.3.1 LOCATIONS

Maintenance holes must be placed at the following locations:

- At terminal ends.
- At all grade changes.
- At all size changes.
- At all alignment changes.
- At all sewer intersections.
- At a spacing of not more than 183m pipe length.
- At the downstream end of a curved sewer.
- At service connections outlined in *Section 4.6*.

4.4.3.2 LOADING

The BC CL-625 vehicle shall be used for loading designs, recognizing that the BC design vehicle includes higher axle load ratings than the CAN/CSA design vehicle.

4.4.3.3 SIZE AND BENCHING

Maintenance holes require a minimum of one 300mm wide bench. ***Table 4-5*** shows minimum sizes of standard maintenance holes based on the largest pipe diameter entering the maintenance hole. The angles, elevation and the number of incoming pipes must also be considered to ensure safe entry and structural integrity of the maintenance hole.

Table 4-5: Minimum Maintenance Hole Sizes

Pipe Diameter (mm)	Minimum Maintenance Hole Barrel Diameter for Pre-cast Base(mm)	Minimum Maintenance Hole Barrel Diameter for Cast-in-Place Base (mm)
150-450	1050	1050
525-600	1200	1200
675-750	1350	1350
900	1500	1500
1050	1800	1500
1200	1800 or Tee	1500 or Tee
1350-1500	2100 or Tee	1800 or Tee
1650-1800	2400 or Tee	2100 or Tee
2100	2750 or Tee	2400 or Tee
2400	3100 or Tee	2750 or Tee
2750	n/a	3100 or Tee

Precast tee maintenance holes can be used for 1200mm and larger pipe; in straight-through maintenance holes only. All junction maintenance holes to be installed with non-tee maintenance holes. Precast riser (tee) maintenance hole barrels are to be 1050mm diameter.

It is generally preferred to use a larger concentric maintenance hole with two benches (one on either side) instead of a smaller offset maintenance hole with one bench; however, in certain site conditions, the one-bench arrangement may be beneficial over the two-bench arrangement.

4.4.3.4 INLET AND OUTLET ELEVATIONS

The drop from the inlet invert elevation to the outlet invert elevation in the maintenance hole must meet the requirements in ***Table 4-6***.

Table 4-6: Minimum Maintenance Hole Drops

Alignment Deflection	Minimum Drop (mm)
0˚	10
≤ 45˚	30
45˚ - 90˚	50

The crown of the inlet pipe is to be the same elevation or higher than the crown of the outlet pipe.

4.4.3.5 DROP STRUCTURES

Drop structures should be avoided by adjusting the grade of the sewer, but where this cannot be achieved, provide drop structures according to ***Table 4-7***.

Table 4-7: Maintenance Hole Drop Structures

Difference in Invert (m)	Drop Type
≤ 0.25	Accommodated in Benching
0.26 – 0.6	Outside Open Ramp (for all pipes sizes)
≥ 0.61	Outside Closed Ramp for 200mm to 375mm Pipe Outside Open Ramp for ≥450mm Pipe(1)
≥ 0.9	Inside Drop (minimum 1200mm maintenance hole - upon special approval)

Notes:
1) When invert difference provides enough space to install fittings, outside closed ramp can be used

The types of drop structures are listed in order of the City's preference. The Engineer of Record shall select the most suitable drop structure in their design drawings for the City Engineer's approval.

1) Closed ramp (*City of Vancouver Standard Detail Drawings S3.1*), outside drop (*MMCD* Standard Drawing S3), or outside ramp (*MMCD* Standard Drawing S3)
2) Inside ramp (*MMCD* Standard Drawing S3)
3) Open ramp (*City of Vancouver Standard Detail Drawings* S3.1)
4) Inside drops. Not a preferred option but if the Engineer of Record determines it is necessary, design shall be submitted to the City Engineer complete with one cross fitting at the top of the drop structure. The minimum clearance between the cross and inside wall of the maintenance hole shall be 0.9m.

4.4.3.6 MAINTENANCE HOLE COVERS

For safety reasons, all new maintenance hole covers in playgrounds, schoolyards, and other areas that pose a safety hazard shall be buried 150mm below grade and secured using one of the following methods:

- Bolt-down cover and frame.
- Locking pin system.

Watertight maintenance hole covers are to be used when:

- The maintenance hole covers may be flooded by street runoff.
- The top of the maintenance hole is below the 10-year hydraulic grade line elevation.
- The elevation of the top of the maintenance hole is below 3.3m geodetic in the Fraser River floodplain, or 3.8m in the False Creek floodplain.

4.4.4 FITTINGS, COUPLINGS, AND CASTINGS

All fittings, couplings, castings, and appurtenances shall be in accordance with the *City of Vancouver Construction Specifications*.

4.4.5 TRENCHLESS TECHNOLOGIES

The use of trenchless technologies in the City of Vancouver as a means of installing or rehabilitating underground sewer infrastructure must be approved by the Sewers and Drainage Design Branch prior to construction. The design engineer and the contractor must be experienced in the proposed trenchless method.

4.4.6 AERIAL PIPE BRIDGES AND INVERTED SIPHONS

Pipe bridges and inverted siphons must be approved before proceeding with design. The following requirements apply:

- Low points require blowdowns.
- High points require blowoffs and air releases.
- Pigging and flushing ports are required.
- Access points are required.
- The design must be able to withstand the operating pressures.
- The minimum velocity for siphons is 0.9m/s (multiple siphons of varying invert may be required).
- Maintenance holes are required at both ends.
- Head losses must be considered.
- Any such "special structures" which require periodic inspection or maintenance need to be considered for addition to the Sewers Operations Branch Maintenance Manual as well as proper categorization into the Asset & Work Management system - Hansen.

4.4.7 PUMP STATIONS

Sanitary sewer pump stations are to be avoided where possible. Pump stations are acceptable as an alternative to gravity sewers only in certain cases as directed by the City Engineer or where no other feasible alternative can be designed. Please refer to the latest version of the City's Wastewater Pump Station Guidelines.

4.4.8 FORCEMAINS

4.4.8.1 SIZE AND MATERIAL

The minimum size for mains discharging raw sewage shall be 100mm diameter unless the entire system is designed as a pressure sewer system with multiple pump installations. The pipe outlined in

Table 4-8 is permitted for force mains:

Table 4-8: Force Main Size and Materials

Pipe	Size (mm)	Standard
PVC Schedule 40	75 – 100	*ASTM D1784 / D2241 / D2466*
PVC DR18	100 - 300	*AWWA C900 / M23*
*Ductile Iron Cl. 52	100 - 600	*AWWA C151 / C111*
HDPE (PE4710) DR11	75-600	*AWWA C906 / M55*

*Use of cement-mortar lined ductile iron pipe is not permitted for sewage forcemains or inverted siphons.

The selection of force main materials shall consider local conditions such as character of industrial wastes, soil characteristics, heavy external loadings, abrasions, and similar problems.

All force mains shall be designed to prevent damage from superimposed loads or from water hammer or column separation phenomena.

Installation of forcemains shall be per G4.2 and G4.3.

4.4.8.2 VELOCITY AND SLOPE

At the lowest pump delivery rate anticipated to occur at least once per day, a cleansing velocity of at least 1.2m/s should be maintained to scour air and solids. The Designer shall determine if a higher cleansing velocity is required based on an evaluation of project specific considerations. The maximum velocity must not exceed 2.5m/s. At the City Engineer's discretion, a maximum velocity of 3.5m/s may be accepted for infrequent conditions where there are significant RDII related flows.

Force mains shall be sloped upwards in the direction of flow or be installed level. Where a continuous upward slope cannot be maintained for the full forcemain alignment due to topography or other conflicts, additional requirements for forcemain air management and maintenance shall be discussed with the City.

4.4.8.3 VALVES

A resilient seat gate valve must be installed in the force main adjacent to the station. Shut-off valves shall be resilient seat gate valves complete with 50mm square nut operator. The valve shall be suitable for buried service.

A telescopic valve box with sewers lid shall be installed over the valve for access to the valve operator.

4.4.8.4 AIR VALVES

The use of air valves shall be discussed with the City.

4.4.8.5 CLEAN-OUT INFRASTRUCTURE

New and replacement force mains may require clean-out infrastructure and requirements shall be discussed with the City.

4.4.8.6 TERMINATION MAINTENANCE HOLES

Force mains shall terminate in a maintenance hole which shall be connected to the gravity sewer system. The base of this maintenance hole shall be designed to avoid turbulence from the discharge of the force main.

4.4.8.7 SEISMIC DESIGN STANDARDS

The choice of replacement strategy and pipe material is based on a risk assessment driven by the criticality of the pipeline, the susceptibility of the contextual ground conditions for wave propagation, and potential for Permanent Ground Deformation (PGD).

Refer to *Section 3.5.3* for material selection standards depending on anticipated ground acceleration.

All sewage forcemain joints shall be fully restrained.

Where differential movement could occur between the sewage forcemain and adjoining structures or appurtenances, flexible connections shall be incorporated to handle longitudinal and transverse movement (at discharge maintenance holes, chambers, pump stations, etc.).

4.5 SEISMIC DESIGN STANDARDS

The choice of replacement strategy and pipe material is based on a risk assessment driven by the criticality of the pipeline, the susceptibility of the contextual ground conditions for wave propagation, and potential for Permanent Ground Deformation. A professional geotechnical engineer shall be retained to perform investigation, review and design for areas with seismic concern or weak ground condition. The City reserves the rights to request for a professional geotechnical engineer to review and design for a project if the project site is deemed to be high risk for seismic activities and has known poor ground conditions.

Awareness and avoidance of these adverse conditions is the best approach to protect the system from risk associated with ground deformation. Strategies include:

- Limiting the number of non-restrained mains in a neighborhood susceptible to ground acceleration.
- Adding weight to maintenance holes to reduce buoyancy.
- Locating mains to occur outside of liquefaction zone.

See *Section 4.4.8* for seismic design standards for sewage forcemains.

4.6 SERVICE CONNECTIONS

Services must meet the most current edition of the *City of Vancouver Sewer and Watercourse By-law No. 8093*, the ***City of Vancouver Construction Specifications*** and the *City of Vancouver Standard Detail Drawings S7.1 to S7.4*.

4.6.1 LOCATION

Unless specifically exempted, all developed sites shall be provided with a connection. The storm service shall be to the right of the sanitary service when looking at the property from the street.

Service connections shall not exceed 30m in length as measured horizontally between the lateral sewer and the property line. If the service must be longer than 30m, a maintenance hole must be placed such that the longest section of service does not exceed 30m.

4.6.2 SIZE AND MATERIAL

All one- and two-family dwellings shall be provided with a 100mm diameter service. All other dwelling sanitary services shall be sized to accommodate peak flows and in accordance with the standards set in the *City of Vancouver Sewer and Watercourse By-law No. 8093*. No gravity sanitary service connection shall be less than 100mm in diameter.

The pipe outlined in ***Table 4-9*** is permitted for service connections:

Table 4-9: Service Size and Materials

Pipe	Size (mm)	Standard
PVC SDR28	100 - 150	*ASTM B182.1 / D2412*
PVC SDR35	200 - 375	*ASTM D3034 / D2412*
PVC Cl.50 DR18 (Force mains)	150 - 300	*AWWA C900 / M23*
Concrete Cl IV RC	450+	*ASTM C76*

4.6.3 DEPTH

The preferred connection depth to invert at the property line shall be 1.5m below the centerline of the street or lane. The sanitary connection must be installed at the same elevation as the storm connection at the property line.

Exceptions are occasionally approved with the following conditions:

- The new connection by itself shall not preclude raising of the main sewer in the future.
- The new connection depth shall not significantly increase the potential for flooding the new building.
- Where the property has not already been provided with a connection at the City's expense.

In no case shall the connection have less than 1.0m cover or greater than 2.4m depth at the property line.

4.6.4 VELOCITY AND SLOPE

Service connections shall be designed with a slope which provides the minimum velocity at maximum flows as follows:

- Preferred minimum velocity: 0.92m/s
- Absolute minimum velocity: 0.76m/s

The service slope shall not be less than 2%. Service slopes less than 2% to be approved by the City Engineer.

4.6.5 TIE-IN REQUIREMENTS

See *City of Vancouver Standard Detail Drawings S7.1* and *S7.2* for tie-in requirements for service connections to the main.

4.6.6 INSPECTION CHAMBERS

Inspection chambers are required on all new services and are to be located at 0.3m outside of property line. The lid for the sanitary inspection chamber is to be red.

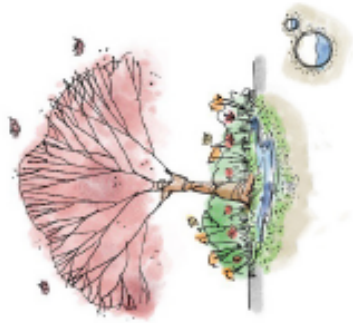
4.6.7 MINIMUM BUILDING ELEVATION (MBE)

In addition to all other requirements as set by this document and the *Vancouver Building By-Law*

, when possible the Minimum Building Elevation should be set such that the building's sanitary plumbing can be serviced by gravity.

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STORM DRAINAGE SYSTEM



5

Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Amy Sidwell, P.Eng, Director, Sewers and Drainage

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STORM DRAINAGE SYSTEM

5.1 INTRODUCTION

Vancouver's storm drainage system consists of storm sewers and green stormwater infrastructure to convey and manage stormwater. The storm system is not intended to include any sanitary wastewater. Vancouver is in the process of separating combined storm and sanitary sewers into two isolated systems. Vancouver's storm drainage and Green Rainwater Infrastructure are important components in the City's strategic plan to mitigate the effects of climate change and include built infrastructure into the natural water cycle of Vancouver. Another important aspect of storm infrastructure is seismic resiliency and adapting materials and construction techniques to site conditions to make Vancouver a more resilient city.

The following is a brief description of each section:

- The *Demands and Flows* section outlines the analysis required to determine flow demand placed on the drainage system being designed or studied.
- The *Hydraulic Analysis* section outlines the process to determine the flow capacities of the storm drainage system.
- The *Design of Storm Drainage Components* section discusses the specific requirements to design various components such as storm sewers, maintenance holes, and culverts.
- The *Seismic Design* section outlines the requirements for seismic design of storm drainage components.
- The *Service Connections* section outlines the requirements relating to service connections.
- The *Green Rainwater Infrastructure and Integrated Rainwater Management* section gives an overview of the City of Vancouver's criteria for green stormwater infrastructure.

Refer to *Chapter 2: Design Process & Coordination* for specific submission requirements.

5.2 DEMANDS AND FLOWS

To determine the proper sizing and configuration of storm drainage systems, the flow requirements must be determined. This section outlines the requirements for determining the design flows based on return periods and using either the Rational or Hydrograph method of flow analysis. Alternative criteria may be used at the discretion of the City Engineer.

5.2.1 DESIGN FLOW

The City of Vancouver's drainage system and design storms consist of the following:

- The Minor System: consists of gutters, catchbasins, ditches, pipes, driveway culverts, watercourses, and stormwater management facilities designed to carry flows with the following minimum return periods (note: design storms may differ from industry standard):

5-Year Return Period	Residential, minor system components not listed in the 10 and 25-year return periods below.
10-Year Return Period	Business, commercial, industrial, downtown core (west of Main Street includes all of the West End peninsula), and the False Creek Comprehensive Development District.
25-Year Return Period	All trunk sewers (sewers with a tributary area greater than 40ha).

- The Major System: consists of roadways, culverts, open channels, surface flood paths, watercourses, and stormwater management facilities designed to carry flows with the following minimum return period (note: design storm may differ from industry standard):

100-Year Return Period	All major system components.

The storm system must be designed using one of the following two methods:

≤ 20ha	The Rational Method as outlined in *Section 5.2.2; or optionally the Hydrograph Method as outlined in Section 5.2.3*
> 20ha	The Hydrograph Method as outline in *Section 5.2.3*

5.2.2 RATIONAL METHOD

The Design Flow, Q_{des}, for drainage areas less than or equal to 20ha is calculated using the Rational Method which is defined as:

$$Q_{des} = \frac{CIA}{360}$$

Where:

Q_{des} = Design Flow (m^3/s)

C = Runoff Coefficient as per *Section 5.2.2.1*

I = Rainfall Intensity (mm/hr) as per *Section 5.2.2.2*

A = Tributary Drainage Area (ha) as per *Section 5.2.2.3*

5.2.2.1 RUNOFF COEFFICIENT

The runoff coefficient, C, is based on ground slope, type of cover and ground surface which is associated with land use and development type. It is up to the designer to select an appropriate runoff coefficient that is representative of the catchment area considering infiltration and depression storage potential. The runoff coefficient for design of new infrastructure must account for future development outlined in community plans and / or over a 100-year period.

Table 5-1 provides general coefficients for typical development types:

Table 5-1: Runoff Coefficients

Land Use or Type of Development	Runoff Coefficient, C (up to 10 year event)
Parks & Greenspace	0.30
One and Two Family Dwelling	0.70
Multiple Family Dwelling (3+ Units)	0.85
Local Commercial	0.95
Central Business District	0.95
Industrial	0.90
Institutional	0.70 to 0.95 (depending on site characteristics)

Note: Apply the following multipliers to runoff coefficients for events greater than the 10 year, up to a maximum C-value of 0.95:

25 year event – multiply by 1.1

50 year event – multiply by 1.15

100 year event – multiply by 1.2

It is generally preferable to develop a composite runoff based on the percentages of different types of surfaces in the drainage area. This procedure is often applied to typical sample blocks as a guide to selection of reasonable values of the coefficient for an entire area.

Table 5-2 provides suggested coefficients for various surface types:

Table 5-2: Surface Type Runoff Coefficients

Character of Surface	[2]Runoff Coefficient, C (up to 10 year event)
Flat (<2%) Lawns, Sandy Soil	0.08
Average (2-7%) Lawns, Sandy Soil	0.13
Steep (>7%) Lawns, Sandy Soil	0.18
Flat (<2%) Lawns, Heavy Soil	0.18
Average (2-7%) Lawns, Heavy Soil	0.23
Steep (>7%) Lawns, Heavy Soil	0.30
Roofs, Pavement, & Concrete	0.95
Gravel, various compaction (Roads, Shoulders, Walkways & Driveways)	0.60 to 0.80
[1]Green Roof (>150-250mm thickness, roof pitch up to 5˚)	0.30 (min.)
[1]Green Roof (>100-150mm thickness, roof pitch up to 5˚)	0.40 (min.)
[1]Green Roof (>60-100mm thickness, roof pitch up to 5˚)	0.50 (min.)
Open Water (including water features)	1.0

Notes:

1) Green roof suppliers may provide alternate values for their products with justifications.
2) Runoff coefficient table is a guideline and is not an exhaustive list of all land cover types. Design engineers may apply their judgment where the table does not capture the required surface types
3) Apply the following multipliers to runoff coefficients for events greater than the 10 year, up to a maximum C-value of 0.95:
   - 25 year event – multiply by 1.1
   - 50 year event – multiply by 1.15
   - 100 year event – multiply by 1.2

Further details related to green rainwater infrastructure sizing and design are provided in Section *5.7.1.*

5.2.2.2 RAINFALL INTENSITY

The rainfall intensity, I, is calculated using the City of Vancouver Intensity Duration Frequency (IDF) curves and the IDF Equation which is defined as:

$$I = A * T^B$$

Where:

T = Time (hours)

A,B = Coefficients from ***Table 5-3***

I= Rainfall Intensity (mm/hr)

There are three IDF curves used by the City of Vancouver: 2018, 2050, and 2100. These curves are provided below as well as a description of when each curve is to be used.

2018 IDF

The 2018 IDF curve, ***Figure 5-1***, and coefficients in ***Table 5-3***, are to be used for determining pre-development flow estimates.

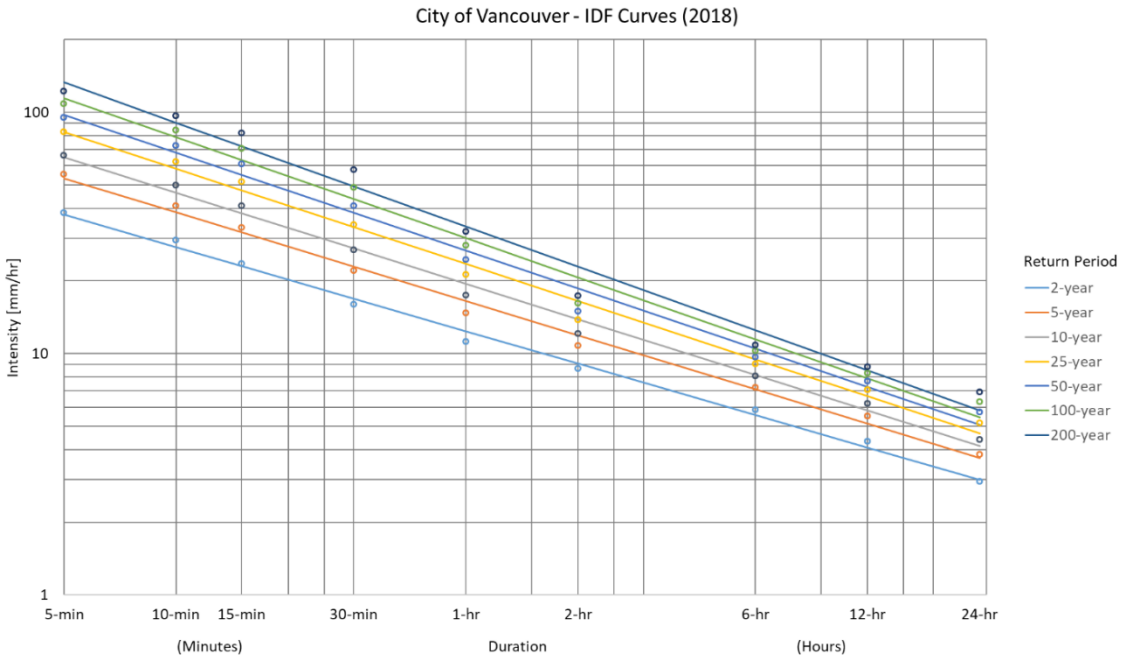


Figure 5-1: 2018 IDF Curve

Table 5-3: 2018 IDF Equation Coefficients

Recurrence Interval	Probability	A	B
1 in 2 year	50%	12.386	-0.447
1 in 5 year	20%	16.517	-0.471
1 in 10 year	10%	19.449	-0.486
1 in 25 year	4%	23.487	-0.508
1 in 50 year	2%	26.673	-0.522
1 in 100 year	1%	30.043	-0.537
1 in 200 year	0.5%	33.646	-0.553

2050 IDF (RCP 8.5 Moderate Projection)

The 2050 IDF (RCP 8.5 Moderate Projection) curve, ***Figure 5-2***, and coefficients in ***Table 5-4***, are to be used for storm inflow component of sanitary sewer design in a “combined connection to sanitary sewer area”.

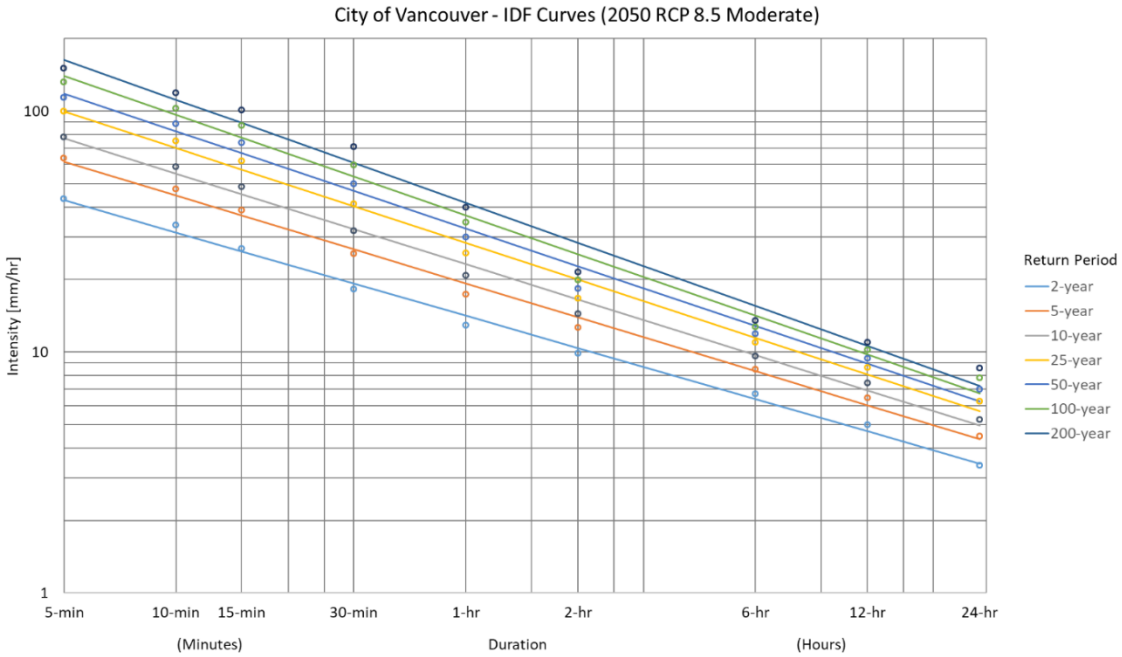


Figure 5-2: 2050 IDF (RCP 8.5 Moderate Projection) Curve

Table 5-4: 2050 IDF (RCP 8.5 Moderation Projection) Equation Coefficients

Recurrence Interval	Probability	A	B
1 in 2 year	50%	14.138	-0.445
1 in 5 year	20%	19.285	-0.469
1 in 10 year	10%	23.116	-0.484
1 in 25 year	4%	28.368	-0.506
1 in 50 year	2%	32.502	-0.520
1 in 100 year	1%	36.913	-0.535
1 in 200 year	0.5%	41.579	-0.550

2100 IDF (RCP 8.5 Moderate Projection)

The 2100 IDF (RCP 8.5 Moderate Projection) curve, ***Figure 5-3***, and coefficients in ***Table 5-5***, are to be used for storm sewer design and on-site storm water management post-development estimates.

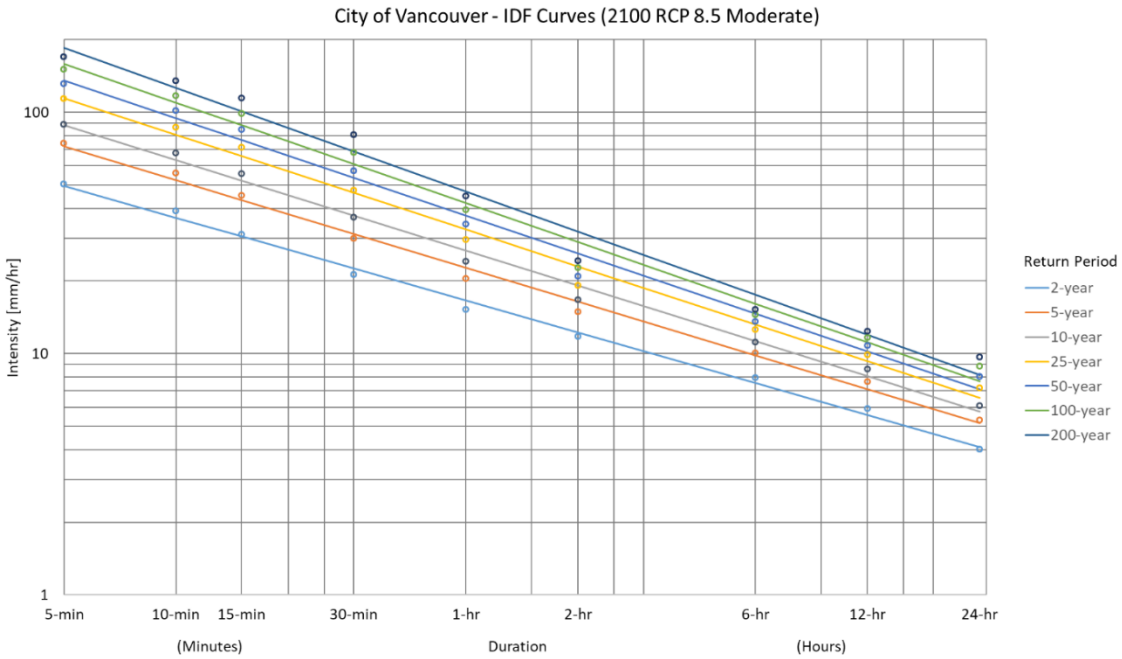


Figure 5-3: 2100 IDF (RCP 8.5 Moderate Projection) Curve

Table 5-5: 2100 IDF Equation Coefficients

Recurrence Interval	Probability	A	B
1 in 2 year	50%	16.607	-0.440
1 in 5 year	20%	22.698	-0.466
1 in 10 year	10%	26.651	-0.482
1 in 25 year	4%	32.615	-0.506
1 in 50 year	2%	37.252	-0.520
1 in 100 year	1%	42.014	-0.535
1 in 200 year	0.5%	46.968	-0.551

5.2.2.3 TRIBUTARY DRAINAGE AREA

The designer must determine the tributary drainage area, A, based on the applicable existing and proposed surface contours and/or site servicing locations as appropriate. The cumulative tributary drainage areas must be considered for catchments with multiple subcatchments.

5.2.2.4 TIME OF CONCENTRATION

The time of concentration, t_c, is a sum of the inlet time and travel time in the pipe or channel to the point of interest as shown in the formula below:

$$t_c = t_i + t_t$$

Where:

t_c = Time of Concentration (min)

t_i = Inlet Time (min)

t_t = Travel Time in Pipe or Channel (min) = Length (m) / Velocity (m/min)

The inlet time for developed areas is based on ***Table 5-6***:

Table 5-6: Inlet Times

Return Period	Typical Inlet Time, t_i
5-year Storm or below	10 minutes
10-year Storm or above	5 minutes

The inlet time for undeveloped areas may be based on the Kerby Formula which is defined as:

$$T_i = 1.45 \left[\frac{NL}{\sqrt{s}}\right]^{0.467}$$

Where:

T_i = Inlet Time (min)

L = Overland Flow Length to Furthest Point (m) (with L<370m)

s = Slope of Overland Flow Terrain (m/m)

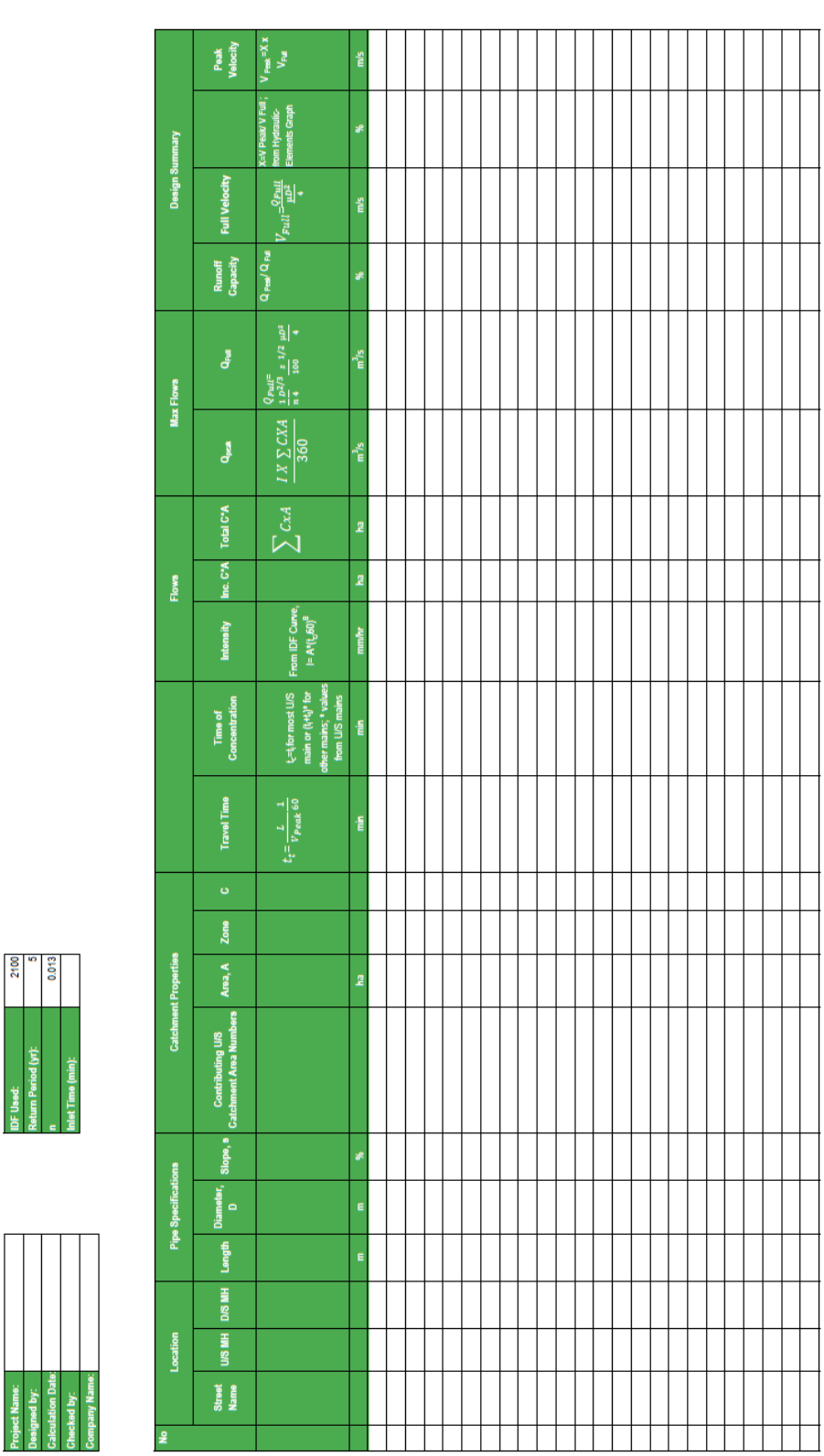
N = Kerby Coefficient from ***Table 5-7***

Table 5-7: Kerby Coefficients

Surface Type	N
Smooth impervious surface	0.02
Smooth bare packed soil	0.10
Poor grass, cultivated row crops, or moderately rough bare surfaces	0.20
Pasture or average grass	0.40
Deciduous timberland	0.60
Coniferous timberland, deciduous timberland with deep frost, litter, or dense grass	0.80

5.2.2.5 CALCULATIONS SHEET

Rational Method calculations shall be presented on the form outlined in ***Figure 5-4***:



Project Name:	
Designed by:	
Calculation Date:	
Checked by:	
Company Name:	

IDF Used:	2100
Return Period (yr):	5
n	0.013
Inlet Time (min):	

No	Location			Pipe Specifications			Catchment Properties				Flows				Max Flows		Design Summary			
	Street Name	US MH	DS MH	Length	Diameter, D	Slope, s	Contributing US Catchment Area Numbers	Area, A	Zone	C	Travel Time	Time of Concentration	Intensity	Inc. C*A	Total C*A	Q_{peak}	Q_{full}	Runoff Q-capacity	Full Velocity		Peak Velocity
											$t_t = \frac{L}{V_{Peak}} \frac{1}{60}$	t_c = t for most US main or (t+t_t) for other mains; * values from US mains	From IDF Curve, $I = A'(t_c60)^B$		$\sum C \times A$	$\frac{I \times \sum C \times A}{360}$	$Q_{Full} = \frac{1}{n} R^{2/3} \frac{s}{100}^{1/2} \frac{\mu D^2}{4}$	Q_{Peak} / Q_{Full}	$V_{Full} = \frac{Q_{Full}}{\frac{\mu D^2}{4}}$	X=V Peak/V Full ; from Hydraulic Elements Graph	$V_{Peak} = X \times V_{Full}$
				m	m	%	ha				min	min	mm/hr	ha	ha	m^3/s	m^3/s	%	m/s	%	m/s

Figure 5-4: Rational Method Calculations Form

5.2.3 HYDROGRAPH METHOD

The Hydrograph Method can be used to determine the demands and flows for catchment areas of any size, or areas that involve complex hydrology or hydraulics that are beyond the capability of the Rational Method. The City may request the Hydrograph Method or modelling for areas where they are deemed necessary.

The number of pipes modelled and size of subcatchments shall be determined by the complexity and scale of the project. Upstream and downstream boundary conditions, as applicable, are to be agreed upon by the City Engineer. The downstream boundary of the catchment shall be defined by the Metro Vancouver Trunk or as agreed upon by the City Engineer.

5.2.3.1 MODELLING SOFTWARE

Acceptable modelling software for the Hydrograph Method are to be approved by the City Engineer but may include PCSWMM, InfoWorks ICM, or alternates.

For InfoWorks ICM models, see the ***City of Vancouver InfoWorks ICM Modelling Standards & Guidelines (2023)*** document for additional requirements. For PCSWMM models, see the City of Vancouver Sewers & Drainage Design Branch PCSWMM modelling guides. For PCSWMM system assessment models, see the City of Vancouver PCSWMM modelling guidelines (date).

5.2.3.2 REPORTING

A modelling report must be prepared and submitted which outlines the following:

- Modelling software name and version.
- Inputs, parameters, and assumptions.
- Design storm data used.
- Hydrographs for pre- and post-development, and other relevant scenarios.
- Pipe profile indicating the hydraulic grade line (HGL), maintenance hole data (IDs, rim and invert elevations), pipe data (length, diameter, peak flow rates), and approximate ground profile.
- Plan(s) or map(s) which shows subcatchment boundaries, system network, junction IDs, boundary condition locations, tributary area, land use and/or zoning, areas, slopes, contours, imperviousness, flow paths, and existing and proposed storm drainage facilities.
- Results provided for existing, proposed and ultimate conditions, and other relevant scenarios, as applicable.

5.2.3.3 DESIGN STORMS

Table 5-8 indicates the design storms to be used for the 2, 5, 10, 25, 100, and 200-year storms in the City of Vancouver. The consultant / designer is to utilize the most conservative applicable event for design purposes. Where an event duration is not specified, it is not typically used in the City. Should an unspecified duration be required, the consultant / designer can propose a suitable distribution for approval by the City.

Table 5-8: Design Storm Distribution

AES 1-hr BC Coast[1]			AES 2-hr BC Coast[1]			SCS 24-hr Type 1A[2]		
Time	Absolute	Cumulative	Time	Absolute	Cumulative	Time	Absolute	Cumulative
0:00	0.000	0.000	0:00	0.000	0.000	0:00	0.00000	0.00000
0:05	0.010	0.010	0:05	0.005	0.005	0:05	0.00220	0.00220
0:10	0.030	0.040	0:10	0.005	0.010	0:10	0.00175	0.00395
0:15	0.060	0.100	0:15	0.015	0.025	0:15	0.00168	0.00563
0:20	0.100	0.200	0:20	0.015	0.040	0:20	0.00162	0.00725
0:25	0.150	0.350	0:25	0.030	0.070	0:25	0.00155	0.00880
0:30	0.210	0.560	0:30	0.030	0.100	0:30	0.00150	0.01030
0:35	0.160	0.720	0:35	0.050	0.150	0:35	0.00150	0.01180
0:40	0.120	0.840	0:40	0.050	0.200	0:40	0.00158	0.01338
0:45	0.080	0.920	0:45	0.075	0.275	0:45	0.00165	0.01503
0:50	0.050	0.970	0:50	0.075	0.350	0:50	0.00172	0.01675
0:55	0.020	0.990	0:55	0.105	0.455	0:55	0.00178	0.01853
1:00	0.010	1.000	1:00	0.105	0.560	1:00	0.00193	0.02047
			1:05	0.080	0.640	1:05	0.00233	0.02280
			1:10	0.080	0.720	1:10	0.00242	0.02522
			1:15	0.060	0.780	1:15	0.00248	0.02770
			1:20	0.060	0.840	1:20	0.00255	0.03025
			1:25	0.040	0.880	1:25	0.00262	0.03287
			1:30	0.040	0.920	1:30	0.00263	0.03550
			1:35	0.025	0.945	1:35	0.00250	0.03800
			1:40	0.025	0.970	1:40	0.00250	0.04050
			1:45	0.010	0.980	1:45	0.00243	0.04293
			1:50	0.010	0.990	1:50	0.00252	0.04545
			1:55	0.005	0.995	1:55	0.00255	0.04800
			2:00	0.005	1.000	2:00	0.00252	0.05052
						2:05	0.00258	0.05310
						2:10	0.00267	0.05577
						2:15	0.00267	0.05843
						2:20	0.00272	0.06115
						2:25	0.00272	0.06387
						2:30	0.00267	0.06653
						2:35	0.00267	0.06920
						2:40	0.00267	0.07187
						2:45	0.00267	0.07453
						2:50	0.00267	0.07720
						2:55	0.00267	0.07987
						3:00	0.00265	0.08252
						3:05	0.00258	0.08510
						3:10	0.00267	0.08777
						3:15	0.00267	0.09043
						3:20	0.00267	0.09310

AES 1-hr BC Coast[1]			AES 2-hr BC Coast[1]			SCS 24-hr Type 1A[2]		
Time	Absolute	Cumulative	Time	Absolute	Cumulative	Time	Absolute	Cumulative
						3:25	0.00270	0.09580
						3:30	0.00278	0.09858
						3:35	0.00292	0.10150
						3:40	0.00300	0.10450
						3:45	0.00293	0.10743
						3:50	0.00302	0.11045
						3:55	0.00308	0.11353
						4:00	0.00308	0.11662
						4:05	0.00308	0.11970
						4:10	0.00308	0.12278
						4:15	0.00315	0.12593
						4:20	0.00322	0.12915
						4:25	0.00325	0.13240
						4:30	0.00327	0.13567
						4:35	0.00333	0.13900
						4:40	0.00342	0.14242
						4:45	0.00348	0.14590
						4:50	0.00355	0.14945
						4:55	0.00362	0.15307
						5:00	0.00370	0.15677
						5:05	0.00383	0.16060
						5:10	0.00392	0.16452
						5:15	0.00398	0.16850
						5:20	0.00405	0.17255
						5:25	0.00412	0.17667
						5:30	0.00415	0.18082
						5:35	0.00408	0.18490
						5:40	0.00425	0.18915
						5:45	0.00432	0.19347
						5:50	0.00438	0.19785
						5:55	0.00448	0.20233
						6:00	0.00467	0.20700
						6:05	0.00500	0.21200
						6:10	0.00508	0.21708
						6:15	0.00515	0.22223
						6:20	0.00522	0.22745
						6:25	0.00528	0.23273
						6:30	0.00525	0.23798
						6:35	0.00492	0.24290
						6:40	0.00492	0.24782
						6:45	0.00505	0.25287
						6:50	0.00523	0.25810

AES 1-hr BC Coast[1]			AES 2-hr BC Coast[1]			SCS 24-hr Type 1A[2]		
Time	Absolute	Cumulative	Time	Absolute	Cumulative	Time	Absolute	Cumulative
						6:55	0.00543	0.26353
						7:00	0.00567	0.26920
						7:05	0.00600	0.27520
						7:10	0.00642	0.28162
						7:15	0.00682	0.28843
						7:20	0.00727	0.29570
						7:25	0.00777	0.30347
						7:30	0.01010	0.31357
						7:35	0.01783	0.33140
						7:40	0.01942	0.35082
						7:45	0.01995	0.37077
						7:50	0.01993	0.39070
						7:55	0.01937	0.41007
						8:00	0.01733	0.42740
						8:05	0.01200	0.43940
						8:10	0.01025	0.44965
						8:15	0.00912	0.45877
						8:20	0.00818	0.46695
						8:25	0.00745	0.47440
						8:30	0.00710	0.48150
						8:35	0.00750	0.48900
						8:40	0.00708	0.49608
						8:45	0.00675	0.50283
						8:50	0.00642	0.50925
						8:55	0.00608	0.51533
						9:00	0.00577	0.52110
						9:05	0.00550	0.52660
						9:10	0.00525	0.53185
						9:15	0.00505	0.53690
						9:20	0.00485	0.54175
						9:25	0.00465	0.54640
						9:30	0.00453	0.55093
						9:35	0.00467	0.55560
						9:40	0.00467	0.56027
						9:45	0.00453	0.56480
						9:50	0.00440	0.56920
						9:55	0.00433	0.57353
						10:00	0.00430	0.57783
						10:05	0.00417	0.58200
						10:10	0.00400	0.58600
						10:15	0.00400	0.59000
						10:20	0.00400	0.59400

AES 1-hr BC Coast[1]			AES 2-hr BC Coast[1]			SCS 24-hr Type 1A[2]		
Time	Absolute	Cumulative	Time	Absolute	Cumulative	Time	Absolute	Cumulative
						10:25	0.00393	0.59793
						10:30	0.00387	0.60180
						10:35	0.00400	0.60580
						10:40	0.00383	0.60963
						10:45	0.00383	0.61347
						10:50	0.00383	0.61730
						10:55	0.00377	0.62107
						11:00	0.00367	0.62473
						11:05	0.00367	0.62840
						11:10	0.00350	0.63190
						11:15	0.00350	0.63540
						11:20	0.00350	0.63890
						11:25	0.00343	0.64233
						11:30	0.00332	0.64565
						11:35	0.00325	0.64890
						11:40	0.00317	0.65207
						11:45	0.00317	0.65523
						11:50	0.00317	0.65840
						11:55	0.00313	0.66153
						12:00	0.00308	0.66462
						12:05	0.00308	0.66770
						12:10	0.00317	0.67087
						12:15	0.00317	0.67403
						12:20	0.00317	0.67720
						12:25	0.00320	0.68040
						12:30	0.00320	0.68360
						12:35	0.00300	0.68660
						12:40	0.00308	0.68968
						12:45	0.00302	0.69270
						12:50	0.00295	0.69565
						12:55	0.00295	0.69860
						13:00	0.00302	0.70162
						13:05	0.00308	0.70470
						13:10	0.00308	0.70778
						13:15	0.00302	0.71080
						13:20	0.00295	0.71375
						13:25	0.00292	0.71667
						13:30	0.00292	0.71958
						13:35	0.00292	0.72250
						13:40	0.00283	0.72533
						13:45	0.00283	0.72817
						13:50	0.00278	0.73095

AES 1-hr BC Coast[1]			AES 2-hr BC Coast[1]			SCS 24-hr Type 1A[2]		
Time	Absolute	Cumulative	Time	Absolute	Cumulative	Time	Absolute	Cumulative
						13:55	0.00278	0.73373
						14:00	0.00283	0.73657
						14:05	0.00283	0.73940
						14:10	0.00283	0.74223
						14:15	0.00277	0.74500
						14:20	0.00280	0.74780
						14:25	0.00280	0.75060
						14:30	0.00275	0.75335
						14:35	0.00275	0.75610
						14:40	0.00275	0.75885
						14:45	0.00275	0.76160
						14:50	0.00275	0.76435
						14:55	0.00272	0.76707
						15:00	0.00268	0.76975
						15:05	0.00275	0.77250
						15:10	0.00267	0.77517
						15:15	0.00267	0.77783
						15:20	0.00267	0.78050
						15:25	0.00267	0.78317
						15:30	0.00267	0.78583
						15:35	0.00267	0.78850
						15:40	0.00258	0.79108
						15:45	0.00258	0.79367
						15:50	0.00263	0.79630
						15:55	0.00263	0.79893
						16:00	0.00258	0.80152
						16:05	0.00258	0.80410
						16:10	0.00250	0.80660
						16:15	0.00257	0.80917
						16:20	0.00253	0.81170
						16:25	0.00253	0.81423
						16:30	0.00257	0.81680
						16:35	0.00250	0.81930
						16:40	0.00250	0.82180
						16:45	0.00243	0.82423
						16:50	0.00247	0.82670
						16:55	0.00250	0.82920
						17:00	0.00248	0.83168
						17:05	0.00242	0.83410
						17:10	0.00242	0.83652
						17:15	0.00242	0.83893
						17:20	0.00242	0.84135

AES 1-hr BC Coast[1]			AES 2-hr BC Coast[1]			SCS 24-hr Type 1A[2]		
Time	Absolute	Cumulative	Time	Absolute	Cumulative	Time	Absolute	Cumulative
						17:25	0.00242	0.84377
						17:30	0.00242	0.84618
						17:35	0.00242	0.84860
						17:40	0.00233	0.85093
						17:45	0.00233	0.85327
						17:50	0.00233	0.85560
						17:55	0.00233	0.85793
						18:00	0.00233	0.86027
						18:05	0.00233	0.86260
						18:10	0.00233	0.86493
						18:15	0.00227	0.86720
						18:20	0.00230	0.86950
						18:25	0.00230	0.87180
						18:30	0.00225	0.87405
						18:35	0.00225	0.87630
						18:40	0.00225	0.87855
						18:45	0.00225	0.88080
						18:50	0.00225	0.88305
						18:55	0.00222	0.88527
						19:00	0.00217	0.88743
						19:05	0.00217	0.88960
						19:10	0.00225	0.89185
						19:15	0.00218	0.89403
						19:20	0.00212	0.89615
						19:25	0.00212	0.89827
						19:30	0.00217	0.90043
						19:35	0.00217	0.90260
						19:40	0.00208	0.90468
						19:45	0.00208	0.90677
						19:50	0.00208	0.90885
						19:55	0.00208	0.91093
						20:00	0.00208	0.91302
						20:05	0.00208	0.91510
						20:10	0.00208	0.91718
						20:15	0.00202	0.91920
						20:20	0.00205	0.92125
						20:25	0.00205	0.92330
						20:30	0.00200	0.92530
						20:35	0.00200	0.92730
						20:40	0.00200	0.92930
						20:45	0.00200	0.93130
						20:50	0.00195	0.93325

AES 1-hr BC Coast[1]			AES 2-hr BC Coast[1]			SCS 24-hr Type 1A[2]		
Time	Absolute	Cumulative	Time	Absolute	Cumulative	Time	Absolute	Cumulative
						20:55	0.00195	0.93520
						21:00	0.00198	0.93718
						21:05	0.00192	0.93910
						21:10	0.00192	0.94102
						21:15	0.00192	0.94293
						21:20	0.00192	0.94485
						21:25	0.00188	0.94673
						21:30	0.00185	0.94858
						21:35	0.00192	0.95050
						21:40	0.00183	0.95233
						21:45	0.00190	0.95423
						21:50	0.00187	0.95610
						21:55	0.00183	0.95793
						22:00	0.00182	0.95975
						22:05	0.00175	0.96150
						22:10	0.00183	0.96333
						22:15	0.00177	0.96510
						22:20	0.00180	0.96690
						22:25	0.00180	0.96870
						22:30	0.00175	0.97045
						22:35	0.00175	0.97220
						22:40	0.00175	0.97395
						22:45	0.00175	0.97570
						22:50	0.00170	0.97740
						22:55	0.00167	0.97907
						23:00	0.00168	0.98075
						23:05	0.00175	0.98250
						23:10	0.00167	0.98417
						23:15	0.00167	0.98583
						23:20	0.00162	0.98745
						23:25	0.00162	0.98907
						23:30	0.00167	0.99073
						23:35	0.00167	0.99240
						23:40	0.00158	0.99398
						23:45	0.00158	0.99557
						23:50	0.00158	0.99715
						23:55	0.00158	0.99873
						24:00	0.00127	1.00000

Notes:

1) This is the official BC Coast AES distribution as published by NRC (1989) and has been updated from previous versions of the design manual.
2) This version of the SCS Type 1A distribution (NRCS, 1986) is interpolated to 5-minute timesteps, from the original 6-min timestep version, to better fit with standard reporting intervals.

5.3 HYDRAULIC ANALYSIS

This section outlines the design process and factors determining storm drainage flow within the City. For the design of storm drainage components, the following equation must be satisfied:

$$Q_{des} \leq Q_{cap}$$

Where:

Q_{des} = Design Flow (m^3/s)

Q_{cap} = Flow Capacity (m^3/s)

Refer to ***Figure 5-5*** for pipe flow properties.

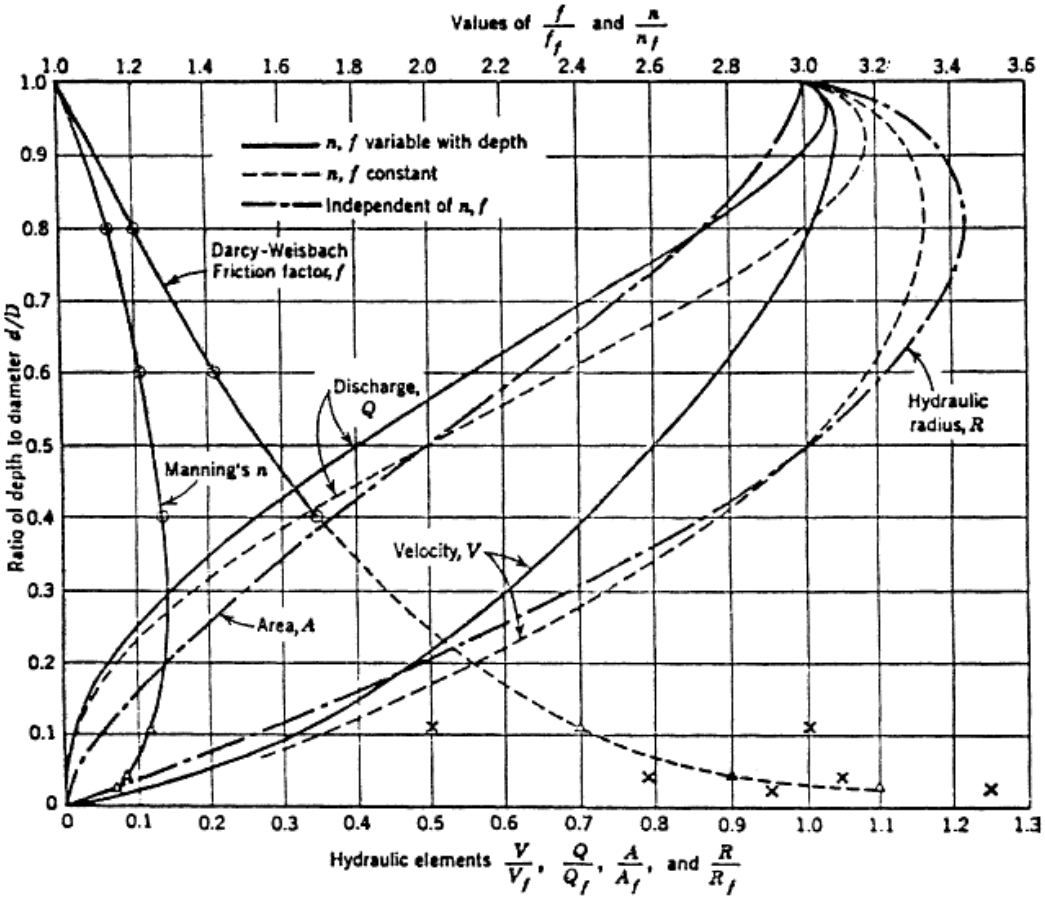


Figure 5-5: Hydraulic Elements Graph for Circular Sewers

From WPCF Manual of Practice No. 9 "Design and Construction of Sanitary and Storm Sewers" 1969 Ed.

5.3.1 MANNING'S FORMULA

Flow capacities of unpressurized gravity storm pipes, open channels, and road surfaces are calculated using Manning's Formula which is defined as:

$$Qcap = \frac{1}{n} R^{2/3} s^{1/2} A$$

Where:

$Qcap$ = Flow Capacity (m^3/s)

n = Manning's Roughness Coefficient = 0.013 for all smooth pipes (ex. PVC, Concrete, Clay)

R = Hydraulic Radius (m) = Cross-Sectional Flow Area (m^2) / Wetted Perimeter (m)

s = Slope of Hydraulic Grade Line (m/m)

A = Cross-Sectional Flow Area (m^2)

5.3.2 SURCHARGED PIPES

Under some conditions, it may be advantageous or unavoidable to design sewers to operate under a head or as pressure conduit. In such cases, the Darcy-Weisbach Formula for design shall be used. The Darcy-Weisbach Formula is as follows:

$$h_f = \frac{fLV^2}{D2g}$$

Where:

h_f = Friction Head Loss (m)

D = Diameter of Pipe (m)

V = Velocity of Flow (m/s)

g = Acceleration due to Gravity (9.81 m/s^2)

f = Friction Factor

L = Length of Pipe (m)

The friction factor in terms of the Manning Roughness Coefficient shall be given as:

$$f = \frac{125n^2}{D^{0.33}}$$

Where:

f = Friction Factor

n = Manning's Roughness Coefficient

D = Diameter of Pipe (m)

The Hydrograph Method with hydraulic modelling is an alternative option for designing surcharged sewers.

5.3.3 MAJOR SYSTEM

Provisions shall be made for surface overflow in the event rainfall occurs of greater intensity than the capacity of the minor system.

In every drainage area, surface water should be able to reach an outlet when storm sewers are overloaded without causing overland flooding of buildings. Ideally, and in most cases, particularly where the street pattern cuts across the direction of the natural drainage path, drainage easements must be obtained to a suitable outlet. Common major storm conveyance systems include swales, roadways, culverts and watercourses. Should the roadway be utilized the maximum flow depth shall not exceed the height of curb. A suitable alternative is to design the storm sewers and inlets to handle flows from a major storm.

5.3.4 HEAD LOSSES

Head loss when flow passes through a bend, junction or maintenance hole shall be accounted for in the design of the sewer system.

5.3.4.1 BENDS

The head loss through a bend for a pipe flowing under open channel flow conditions or under pressure shall be given as:

$$h_b = \frac{K_b V^2}{2g}$$

Where:

h_b = Head loss through the bend (m)

V = Velocity of Flow (m/s)

g = Acceleration due to Gravity (9.81 m/s^2)

K_b = See ***Table 5-9***

Table 5-9: Head Loss Coefficients

Bend Angle/Fitting Type	K_b
90˚ bend	1.0
45˚ bend	0.7
45˚ double-mitre bend	0.32
90˚ four-mitre bend	0.40
Other deflection angles	to be calculated by engineer

5.3.4.1 JUNCTIONS

The head loss through a junction without a deflection shall be given as:

$$h_e = \frac{KV^2}{2g}$$

Where:

h_e = Head loss through the junction (m)

K = 0.1 for accelerating flow and 0.2 for decelerating flow

V = Velocity of Flow (m/s)

g = Acceleration due to Gravity (9.81 m/s^2)

When designing maintenance hole junctions each incoming pipe shall be analyzed separately together with the outgoing pipe. All maintenance hole inverts shall be designed so that all incoming energy grade lines including head losses are equal or greater in elevation to the outgoing energy grade line.

5.3.4.2 MAINTENANCE HOLES

Losses through surcharged maintenance holes shall be given as:

$$h_b = \frac{K_1 {V_1}^2}{2g} + \frac{K_2 {V_2}^2}{2g}$$

Where:

V_1 = Velocity of flow of Incoming Pipe (m/s)

V_2 = Velocity of flow of Outgoing Pipe (m/s)

K_1 = 0.014 for fully developed benching and 1.0 for benching up to spring line of pipe only

K_2 = 0.010 for fully developed benching and 1.0 for benching up to spring line of pipe only

5.4 DESIGN OF STORM DRAINAGE COMPONENTS

This section outlines the design requirements for pipes, maintenance holes, appurtenances, flood control structures, ditches, culverts, and watercourses in the storm drainage system within the City of Vancouver.

5.4.1 GENERAL CONSIDERATIONS

Storm sewers shall be designed with consideration of the requirements outlined in *Chapter 2: Design Process & Coordination* and *Chapter 8:* Streets & Transportation.

5.4.2 STORM SEWERS

5.4.2.1 SIZE AND MATERIAL

The pipe outlined in ***Table 5-10*** is permitted for gravity sewer mains, unless otherwise approved by the City Engineer:

Table 5-10: Gravity Main Size and Materials

Pipe	Size (mm)	Standard
Non-Reinforced Concrete Cl. 3	200 - 750	*ASTM C14 / C443*
PVC SDR35	200 – 375	*ASTM D3034 / D2412*
PVC C900 (for low-cover situations)	200 - 375	*AWWA C900*
HDPE (for trenchless installations)	200 – 375	*ASTM D3035 / D3350*
Reinforced Concrete Cl. III, IV, and V	300 - 3050	*ASTM C76 / C443*

No lateral sewer shall be less than 250mm in diameter unless in a residential area where it cannot be extended. In no case shall it be less than 200mm.

Downstream pipe size reduction may only be used in special circumstances with City Engineer approval. A downstream pipe must not be reduced in size unless:

- It has increased slope to provide sufficient capacity.
- It is greater than or equal to 525mm.
- It is not reduced by more than two pipe sizes.
- A detailed hydraulic analysis has been done.

The selection of materials shall consider local conditions such as soil characteristics, heavy external loadings, depth of cover, abrasions, and similar problems. Pipe material and class shall be selected by the engineer of record. Signed and sealed structural calculations for the material selection shall be provided to the City. Refer to the *City of Vancouver Construction Specifications* for further requirements.

5.4.2.2 ALIGNMENT

Whenever possible, sewers shall be located on the high side of the street where only the high side is served by the lateral and on the low side of the street where both sides are served by the lateral. Wherever possible, the sewer shall be at a constant offset from the property line.

The following must also be considered when selecting the sewer alignment:

- Minimize crossing conflicts.
- Meet clearance and separation requirements in *Section 2.2.5*.
- The minimum edge to edge clearance between sewer maintenance holes is 0.15m.
- The minimum edge to edge clearance between a sewer maintenance hole and a sewer pipe is 0.15m.
- Minimize construction, public, and traffic impacts.
- Minimize construction costs.
- Maximize maintenance access.
- Consider long-term plans for separated sewer routing.
- Avoid trees and other surface features such as, but not limited to, traffic circles, bulges, landscaping, gate valves, gutters, catchbasins, retaining walls, trees, concrete curbs, sidewalks, or ramps.

5.4.2.3 DEPTH

The minimum depth of cover is 1.0m. The storm sewer must also be sufficiently deep to:

- Service basements by gravity that were previously serviced by gravity (existing pumped connections are not required to be converted to gravity connections).
- Allow for tie-ins of other mains and services.
- Structurally withstand surface loading.
- Avoid conflicts with other utilities.
- Prevent freezing.
- Accommodate future sewer separations and consider long-term plans for separated sewer routing.

Generally, the maximum depth of cover is such that the trench depth will not exceed 6.0m; depths greater than this require trenches designed by a professional engineer.

5.4.2.4 VELOCITY AND SLOPE

Storm mains shall be designed with a pipe slope which provides the minimum velocity at maximum flows as follows:

- Preferred minimum velocity: 0.76m/s
- Absolute minimum velocity: 0.61m/s

The pipe slope shall not be less than 0.5%.

Provisions shall be made for energy dissipation, erosion, and movement when the velocity of the design flow exceeds 4.6m/s, or as specified by the pipe manufacturer. Provisions shall be made when discharging into an open ditch or watercourse (avoid discharging perpendicularly into open watercourses). In addition, appropriate bank protection measures must be in place if discharging into open watercourses.

When lateral forces are excessive to unseat pipe joints, anchors will be required (i.e. steep slopes).

5.4.2.5 CURVED SEWERS

Horizontal and vertical curves will be permitted under special circumstances. Vertical curves may be required where excessive rock cuts are to be avoided and where energy dissipation is required. The following criteria applies to curved sewers:

- The rate of curvature must be uniform throughout the curve.
- Only one curve (horizontal or vertical) is allowed between consecutive maintenance holes.
- Curves must be formed through joint deflection or bends and not by bending of the pipe.
- The joint deflection must not be greater than 50% of the recommended maximum by the pipe manufacturer.
- The radius must meet the minimum requirements in ***Table 5-11***.
- Horizontal curves require tracing wire above the alignment and are to terminate at upstream and downstream maintenance holes. Warning ribbon is to be placed 1.0m above the top of the curved sewer.

Table 5-11: Minimum Curved Sewer Radii

Pipe Type	Pipe Size (mm)	Laying Length (m)	Minimum Radius (m)	Max Deflection[1]
Concrete Pipe	300	2.5	41	3˚31’
	375	2.5	50	2˚53’
	450	2.5	58	2˚27’
	525	2.5	67	2˚6’
	600	2.5	80	1˚47’
	675	2.5	89	1˚37’
	750	2.5	98	1˚28’
	900	2.5	116	1˚17’
	1050	2.5	113	1˚4’
PVC	200	-	61	Per manufacturer guidelines
	250	-	77	
	300	-	92	
	375	-	107	

Notes:

1) In no case shall the deflection be greater than 50% of the manufacturer’s recommended maximum deflection

5.4.2.6 BACKFILL AND MATERIALS

All backfill and sewer-related materials such as concrete and bedding shall be in accordance with the *City of Vancouver Standard Detail Drawings* and the *City of Vancouver Construction Specifications*.

5.4.2.7 STRUCTURAL DESIGN

The design engineer must ensure that the pipe is sufficiently designed to withstand loading that will be applied to it without deflection or damage as per manufacture specifications. The signed and sealed calculations shall be completed using the manufacturers recommendations and submitted to the City.

Concrete Pipe Strength Calculation

$D_{0.3}$ is to be used when calculating the design strength of concrete pipes, where $D_{0.3}$ is the minimum load required to produce a 0.3mm crack in a concrete pipe.

$$\text{Minimum Load (N)} = \text{Strength Class } D_{0.3} \left(\frac{\frac{\text{N}}{\text{n}}}{\text{mm}} \right) \text{ x Length of Pipe (m) x Inside Diameter (mm)}$$

5.4.3 MAINTENANCE HOLES

5.4.3.1 LOCATIONS

Maintenance holes must be placed at the following locations:

- At terminal ends.
- At all grade changes.
- At all size changes.
- At all alignment changes.
- At all sewer intersections.
- At a spacing of not more than 183m pipe length.
- At the downstream end of a curved sewer.
- At service connections outlined in *Section 5.6*.

5.4.3.2 LOADING

The BC CL-625 vehicle shall be used for loading designs, recognizing that the BC design vehicle includes higher axle load ratings than the CAN/CSA design vehicle.

5.4.3.3 SIZE AND BENCHING

Maintenance holes require a minimum of one 300mm wide bench. ***Table 5-12*** shows minimum sizes of standard maintenance holes based on the largest pipe diameter entering the maintenance hole. The angles, elevation and the number of incoming pipes must also be considered to ensure safe entry and structural integrity of the maintenance hole.

Table 5-12: Minimum Maintenance Hole Sizes

Pipe Diameter (mm)	Minimum Maintenance Hole Barrel Diameter for Pre-cast Base (mm)	Minimum Maintenance Hole Barrel Diameter for Cast-in-Place Base (mm)
150-450	1050	1050
525-600	1200	1200
675-750	1350	1350
900	1500	1500
1050	1800	1500
1200	1800 or Tee	1500 or Tee
1350-1500	2100 or Tee	1800 or Tee
1650-1800	2400 or Tee	2100 or Tee
2100	2750 or Tee	2400 or Tee
2400	3100 or Tee	2750 or Tee
2750	n/a	3100 or Tee

Precast tee maintenance holes can be used for 1200mm and larger pipe; in straight-through maintenance holes only. All junction maintenance holes to be installed with non-tee maintenance holes. Precast riser (tee) maintenance hole barrels are to be 1050mm diameter.

It is generally preferred to use a larger concentric maintenance hole with two benches (one on either side) instead of a smaller offset maintenance hole with one bench; however, in certain site conditions, the one-bench arrangement may be beneficial over the two-bench arrangement.

5.4.3.4 INLET AND OUTLET ELEVATIONS

The drop from the inlet invert elevation to the outlet invert elevation in the maintenance hole must meet the requirements in ***Table 5-13***:

Table 5-13: Minimum Maintenance Hole Drops

Alignment Deflection	Minimum Drop (mm)
0˚	10
≤ 45˚	30
45˚ - 90˚	50

The crown of the inlet pipe is to be the same elevation or higher than the crown of the outlet pipe.

5.4.3.5 DROP STRUCTURES

Drop structures should be avoided by adjusting the grade of the sewer, but where this cannot be achieved, provide drop structures according to ***Table 5-14***:

Table 5-14: Maintenance Hole Drop Structures

Difference in Invert (m)	Drop Type
≤ 0.25	Accommodated in Benching
0.26 – 0.6	Outside Open Ramp (for all pipe sizes)
≥ 0.61	Outside Closed Ramp for 200mm to 375mm Pipe Outside Open Ramp for ≥450mm Pipe(1)
≥ 0.9	Inside Drop (minimum 1200mm maintenance hole - upon special approval)

Notes:
(1) When invert difference provides enough space to install fittings, outside closed ramp can be used

The types of drop structures are listed in order of the City's preference. The Engineer of Record shall select the most suitable drop structure in their design drawings for the City Engineer's approval.

1) Closed ramp (*City of Vancouver Standard Detail Drawings S3.1*), outside drop (*MMCD* Standard Drawing S3), or outside ramp (*MMCD* Standard Drawing S3)
2) Inside ramp (*MMCD* Standard Drawing S3)
3) Open ramp (*City of Vancouver Standard Detail Drawings S3.1*)
4) Inside drops. Not a preferred option but if the Engineer of Record determines it is necessary, design shall be submitted to the City Engineer complete with one cross fitting at the top of the drop structure. The minimum clearance between the cross and inside wall of the maintenance hole shall be 0.9m.

5.4.3.6 HYDRAULIC LOSSES

For junctions of large pipes greater than 600mm, surcharged maintenance holes, maintenance holes with significant changes in alignment or grade, and high velocity flows, hydraulic losses must be calculated.

When designing maintenance hole junctions, each inlet pipe shall be analyzed separately along with the outlet pipe. All maintenance hole inverts shall be designed so that all incoming energy grade lines including head losses are equal or greater in elevation to the outgoing energy grade line.

Refer to *Section 5.3.4* for hydraulic loss calculations.

5.4.3.7 MAINTENANCE HOLE COVERS

For safety reasons, all new maintenance hole covers in playgrounds, and schoolyards shall be buried 150mm below grade and secured using one of the following methods:

- Bolt-down cover and frame.
- Locking pin system.

5.4.4 DRAINAGE

All streets and their elements must have adequate drainage. Ponding within City of Vancouver streets is not acceptable, unless otherwise approved by the City Engineer. For specific street design criteria, refer to *Chapter 8:*Streets & Transportation.

5.4.4.1 CATCHBASIN TYPES AND LOCATIONS

City of Vancouver's standard catchbasins shall be used. See *City of Vancouver Standard Detail Drawings*. When appropriate soils are present and approved by a professional geotechnical engineer, percolating catchbasins may be used with approval of the City Engineer.

Catchbasins must be placed to collect the full minor flows as well as the major system flows if the major system is designed to be conveyed in the minor system piping. The following outlines the typical catchbasin requirements:

- Located to meet the catchment areas and spacing requirements in ***Table 5-15***.
- Not located within painted crosswalks or curb ramps.
- Located at the beginning of the curb return or higher side of crosswalk.
- Prevent overflows to driveways, bicycle lanes, private properties, boulevards, and sidewalks.
- All catchbasins located at low points should provide a double catchbasin with leafcatcher (side inlet) (provide alternative overland route, system, or capacity to handle major storm where possible).

Double catchbasins are to be installed and designed as per *City of Vancouver Standard Detail Drawings S11.1*, two catchbasins with separate sumps. Note that only one sump, on the lower side, is to have a side inlet to maintain the integrity of the curb.

Table 5-15: Catchbasin Catchment Areas and Spacing

Type	Catchment Area / Spacing		
	Minimum	Preferred	Maximum
Typical Catchbasin Catchment Area			
New / Reconstructed Roads up to 4% Grade	350m^2	500m^2	600m^2
New / Reconstructed Roads over 4% Grade	250m^2	400m^2	500m^2
Rehabilitation Projects(1)	250m^2	500m^2	750m^2
Typical Catchbasin Spacing			
All roads	60m	-	150m

Notes:

(1) Match or reduce the catchment area from existing for rehabilitation projects when possible. Catchbasin catchment area governs in the event the maximum catchment area produces a spacing requirement below minimum spacing.

For all projects, detailed analysis is required and shall be compared to the areas and spacing requirements outlined in ***Table 5-15***. Catchbasin capacities are calculated using the orifice equation which is given by:

$$Q_{cap} = kCA\sqrt{2gh}$$

Where:

Q_{cap} = Inlet Flow Capacity (m^3/s)

k = Clogging Factor = 0.6

C = Orifice Coefficient = 0.8

A = Open Area (m^2) = 0.080m^2 for City of Vancouver Grate No. 31

g = Acceleration due to Gravity (m/s^2) = 9.81 m/s^2

h = Depth of Ponding (m)

Catchbasins shall be in accordance with the *City of Vancouver Standard Detail Drawings* and the *City of Vancouver Construction Specifications*.

5.4.4.2 LAWNBASINS

Lawnbasins may be required within boulevards and landscaped areas to prevent flooding or ponding.

Lawnbasins shall be in accordance with the *City of Vancouver Standard Detail Drawings* and *City of Vancouver Construction Specifications*.

5.4.4.3 LEADS

New single catchbasin and lawnbasin leads shall have a minimum diameter of 150mm. Double catchbasin and lawnbasin leads shall have a minimum diameter of 200mm.

The minimum slope of the lead shall be 2.0% unless otherwise specified by the City Engineer.

Leads are typically installed at a depth of 1.5m.

Leads shall be connected to the main in the same manner as service connections. Double catchbasins shall not be connected directly together but rather one basin will be wye'd into the lead of the other.

No catchbasin lead shall exceed 30m in length as measured horizontally between the main sewers and the catchbasin unless maintenance holes are provided.

5.4.4.4 FRAMES AND GRATES

Gutter inlet grates are typically used for catchbasins; however, curb inlet types may be required per Section 5.4.4.1 or as approved by the City Engineer. All catchbasin grates shall be designed to accommodate loading from all design vehicles.

All frames, grates, and appurtenances shall be in accordance with the *City of Vancouver Construction Specifications* and the *City of Vancouver Standard Detail Drawings*.

Catchbasin grates are to be set flush to the adjacent asphalt and gutterline.

To determine grate direction:

- When standing on the curb, looking at the catchbasin:
- If the dominant flow is coming from the right, select the “right” grate.
- If the dominant flow is coming from the left, select the “left grate.
- Catchbasins are to be labeled CB-R (rim elevation) for grates in the “right” direction.
- Catchbasins are to be labeled CB-L (rim elevation) for grates in the “left” direction.
- Catchbasins in a valley section lane can be in the “right” or “left” directions.

5.4.5 FITTINGS, COUPLINGS, AND CASTINGS

All fittings, couplings, castings, and appurtenances shall be in accordance with the *City of Vancouver Construction Specifications*.

5.4.6 SUBSURFACE DRAINS

Subsurface drains may be used where appropriate soils allow and where approved by a professional geotechnical engineer. Designs shall be done on a case-by-case basis and shall have no negative impact on the road structure. Subsurface drains must be able to overflow to the storm drainage system.

5.4.7 TRENCHLESS TECHNOLOGIES

The use of trenchless technologies in the City of Vancouver as a means of installing or rehabilitating underground sewer infrastructure must be approved by the Sewers and Drainage Design Branch prior to construction. The design engineer and contractor must be experienced in the proposed trenchless method.

5.4.8 DRAINAGE PUMP STATIONS AND FORCE MAINS

Pump stations and force mains must be designed in accordance with the City of Vancouver’s latest pump station and force main requirements. Drainage pump stations and force mains are to be required and designed on a case-by-case basis depending on project conditions. Contact the *Sewers and Drainage Design Branch* for information.

5.4.9 FLOOD CONTROL SYSTEMS

5.4.9.1 FLOOD MANAGEMENT INFRASTRUCTURE

Any work relating to flood management infrastructure in the City of Vancouver must refer to the *City of Vancouver Engineering Design Reference for Shoreline Flood Protection Works*, and any other relevant provincial and federal regulations and standards.

5.4.9.2 TIDE GATES

To control the water levels of the inland side of dikes and outfalls affected by tides, tide gates may be required. Tide gates shall be designed on a case-by-case basis in coordination with the *Sewers and Drainage Planning and Design Branches*. Debris protection should be included in the design of tide gates to prevent improper operation.

5.4.10 CULVERTS

Culverts must be designed to convey the major system flows (except if it is used exclusively as part of the minor system). The inlet and outlet capacity shall be considered when designing the culvert. Culverts must meet provincial and federal environmental requirements such as the *British Columbia Water Act* and the *Canada Fisheries Act*.

5.4.10.1 INLETS AND OUTLETS

All major system culverts require inlet and outlet structures. Inlet and outlet control conditions, erosion control, and energy dissipation must be considered when designing culvert inlets and outlets.

Inlets and outlets must be designed to prevent people from entering the system but allow maintenance and cleaning. Safety grates must be designed to break off in the event of heavy hydraulic loads caused by a blockage. Inlets and outlets shall be designed with aesthetics and safety in mind. Handrails are required where a fall hazard is present.

5.4.11 DITCHES AND SURFACE FLOWS

Manning's formula (*Section 5.3.1*) is used to determine the flow capacity of ditches and roadway surfaces for the major system. Select values for Manning's n values are shown in ***Table 5-16***. The design must consider flow velocities and the need for erosion control measures.

Table 5-16: Manning's Roughness Coefficients

Flow Medium	Manning's Roughness Coefficient (n)
Paved Roadways	0.018
Grassed Boulevards and Swales	0.030
Irregular or Treed Channels	0.040 to 0.100

5.4.12 WATERCOURSES

A watercourse is defined as either:

- A flowing stream with a definite channel, a distinct bed, and distinct banks or edges formed by the water cutting the soil.
- A definite channel provided by natural gullies, ravines, or depressions which when the water is not flowing, there is no distinct bed or any cutting of the soil marking the banks or edges of the channel.

No watercourse shall be diverted, blocked, or abandoned without approval of the City Engineer. The City Engineer may provide approval for:

- Widening, deepening, straightening, diverting, or otherwise improving natural and other watercourses and protecting the same encroachment and injury.
- Determining the position of such watercourses, whether upon City property or upon privately owned property, and for incorporating them into the City's drainage system.

When the City Engineer provides approval, any watercourse may be incorporated into the City's drainage system. However, care must be taken to ensure that the watercourse is improved to the point where it can adequately handle the volume of water diverted into it.

Watercourses must be designed in accordance with the *City of Vancouver Sewer and Watercourse By-law No. 8093*.

5.5 SEISMIC DESIGN STANDARDS

The choice of replacement strategy and pipe material is based on a risk assessment driven by the criticality of the pipeline, the susceptibility of the contextual ground conditions for wave propagation, and potential for Permanent Ground Deformation. A professional geotechnical engineer shall be retained to perform investigation, review and design for areas with seismic concern or weak ground condition. The City reserves the rights to request for a professional geotechnical engineer to review and design for a project, if the project site is deemed to be high risk for seismic activities and has known poor ground conditions.

Awareness and avoidance of these adverse conditions is the best approach to protect the system from risk associated with ground deformation. Strategies include:

- Limiting the number of non-restrained mains in a neighborhood susceptible to ground acceleration.
- Adding weight to maintenance holes to reduce buoyancy.
- Locating mains to occur outside of liquefaction zones.

5.6 SERVICE CONNECTIONS

Services must meet the most current edition of the *City of Vancouver Sewer and Watercourse By-law No. 8093*, the ***City of Vancouver Construction Specifications***, and the *City of Vancouver Standard Detail Drawings S7.1 to S7.4*.

5.6.1 LOCATION

Unless specifically exempted, all developed sites shall be provided with a connection. The storm service shall be to the right of the sanitary service when looking at the property from the street.

Service connections shall not exceed 30m in length as measured horizontally between the lateral sewer and the property line. If the service must be longer than 30m, a maintenance hole must be placed such that the longest section of service does not exceed 30m.

5.6.2 SIZE AND MATERIAL

Storm services shall be sized based on a 10-year design storm with a 5-minute inlet time and a runoff coefficient of 1.0 for the site area. No gravity storm service connection shall be less than 150mm in diameter.

The pipe outlined in ***Table 5-17*** is permitted for service connections:

Table 5-17: Service Size and Materials

Pipe	Size (mm)	Standard
PVC SDR28	150 - 150	*ASTM B182.1 / D2412*
PVC SDR35	200 – 375	*ASTM D3034 / D2412*
PVC Cl.50 DR18 (Force mains)	150 – 300	*AWWA C900 / M23*
Concrete Cl IV RC	450+	*ASTM C76*

5.6.3 DEPTH

The preferred connection depth to invert at the property line shall be 1.5m below the centerline of the street or lane. Exceptions are occasionally approved with the following conditions:

- The new connection by itself shall not preclude raising of the main sewer in the future.
- The new connection depth shall not increase the potential for flooding the new building.
- Where the property has not already been provided with a connection at the City's expense.

In no case shall the connection have less than 1.0m cover or greater than 2.4m depth at the property line.

5.6.4 VELOCITY AND SLOPE

Service connections shall be designed with a slope which provides the minimum velocity at maximum flows as follows:

- Preferred minimum velocity: 0.92m/s
- Absolute minimum velocity: 0.76m/s

The service slope shall not be less than 2%. Service slopes less than 2% to be approved by the City Engineer.

5.6.5 TIE-IN-REQUIREMENTS

See *City of Vancouver Standard Detail Drawings S7.1* and *S7.2* for tie-in requirements for service connections to the main.

5.6.6 INSPECTION CHAMBERS

Inspection chambers are required on all new services. The lid for the storm inspection chamber is to be green.

5.6.7 MINIMUM BUILDING ELEVATION (MBE)

The Minimum Building Elevation (MBE) is to be 0.6m plus the higher of:

- The 100-year design storm hydraulic grade line of the main at the connection.
- The invert of the service connection at the building location.

The designer must also check that the onsite connection elevations can meet the building code requirements.

5.6.8 GRAVITY CONNECTION RESTRICTIONS

During the design of a drainage facility, if existing dwellings are found to be below the hydraulic grade of a 5-year (residential) or 10-year (commercial and industrial) flow, any new or existing storm sewer connection shall be installed only as a pumped connection, with a sump pump installed on the private system with no direct connection to any areas below the surcharge level. Only that portion of the development which is below the surcharge level should be pumped. All other areas should flow to the connection by gravity.

5.7 GREEN RAINWATER INFRASTRUCTURE AND INTEGRATED RAINWATER MANAGEMENT

5.7.1 INTRODUCTION

Green Rainwater Infrastructure (GRI) refers to both a set of engineered systems and an approach to rainwater management, which uses both engineered and ecosystem-based practices to protect, restore and mimic the natural water cycle. In the City of Vancouver, Green Rainwater Infrastructure refers to anything that retains, detains, or treats rainwater. Green Rainwater Infrastructure systems may use soils, plants, trees and built structures to capture, store and clean rainwater before being absorbed in the ground or returning it to our waterways and atmosphere. The development of Green Rainwater Infrastructure is essential to meeting the goals and criteria outlined in several City of Vancouver documents:

- *City of Vancouver Rain City Strategy*
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- *City of Vancouver Greenest City Action Plan*
- *City of Vancouver Guidelines for Using Synchro Version 10*
- *City of Vancouver Climate Change Adaption Strategy*
-
- *Sewer and Watercourse By-law* 8093
- *City of Vancouver's obligations under the Metro Vancouver Liquid Waste and Resource Management Plan.*

This section provides technical guidance on how to design GRI systems that meet the City of Vancouver's performance goals and provide the durability and resiliency expected of its infrastructure. The information in this section is intended for use on municipal right-of-ways but may be referenced for use in other areas. The content should not be considered exhaustive. Many other systems and methods may be approved if it can be demonstrated that the designs will meet the City of Vancouver design targets.

Rainwater Management on private property is administered by the Office of the Chief Building Official in the Development, Buildings and Licensing Department. More information can be found at www.vancouver.ca/rainwater.

A brief description of each section is provided below:

- The *Introduction* section describes the primary motivations for Green Rainwater Infrastructure implementation in the City of Vancouver and provides descriptions of some of the common Green Rainwater Infrastructure system typologies.
- *Green Rainwater Infrastructure Design Targets* outlines the performance goals for Green Rainwater Infrastructure systems in the City of Vancouver.
- *Site Assessment and Design Considerations* provides an overview of the common design considerations for Green Rainwater Infrastructure design, guidance on how these

considerations may be addressed, and steps for successful Green Rainwater Infrastructure implementation.

Refer to *Chapter 2: Design Process & Coordination* for specific submission requirements. Sizing and modelling information for Green Rainwater Infrastructure systems may be found on the ***Green Rainwater Infrastructure webpage***. Construction Specifications and Standard Drawings for Green Rainwater Infrastructure systems may also be found on the Green Rainwater Infrastructure webpage. For more information on Green Rainwater Infrastructure and Rainwater Management in the City of Vancouver, please refer to the *City of Vancouver Rain City Strategy*

5.7.1.1 MOTIVATIONS FOR GREEN RAINWATER INFRASTRUCTURE

Green Rainwater Infrastructure is an emerging field and approach to rainwater management that uses both engineered and ecosystem-based practices to protect, restore and mimic the natural water cycle. It uses soils, plants, trees and built structures such as blue-green roofs, swales, rainwater tree trenches and rain gardens to capture, store and clean rainwater before being absorbed in the ground or returning it to our waterways and atmosphere. Green Rainwater Infrastructure can also include the harvest and reuse of rainwater.

Green Rainwater Infrastructure can be considered both a drainage infrastructure tool and an approach to water management and natural systems. Green Rainwater Infrastructure systems are an essential component of resilient cities. They can reduce sewer flows, improve runoff water quality, mitigate urban heat islands, expand urban biodiversity, and benefit the physical and mental well-being of urban residents. Well-designed Green Rainwater Infrastructure systems can provide all of these benefits. This document provides guidance on how Green Rainwater Infrastructure systems can meet the targets adopted by the City of Vancouver and also contribute to the City's livability and resilience.

The design and placement of Green Rainwater Infrastructure systems is also motivated by the City of Vancouver Equity Framework. High priority areas for new Green Rainwater Infrastructure systems include historically under-serviced areas of the City such as those with low tree canopy, high urban heat, and a deficit of park space.

5.7.1.2 GREEN RAINWATER INFRASTRUCTURE TYPOLOGIES

This chapter provides design guidance on basic typologies of Green Rainwater Infrastructure that may be used on City property. These include but are not limited to the following:

- **Bioretention** – Also known as rain gardens or bioswales, these systems may be designed for full infiltration, partial infiltration, and lined systems. Standard drawings for Bioretention systems are included in Section 4 of the GI Standard Drawings.
- **Rainwater Tree Trenches** – Tree trenches are a series of tree pits connected on the surface through continuous growing medium or in the subsurface by perforated pipes, structural soil or soil cells and receive stormwater from surface inlets. Standard drawings for Rainwater Tree Trenches are included in Section 5 of the GI Standard Drawings.

- **Subsurface Infiltration** – Subsurface infiltration practices can take many forms from linear gravel filled trenches to dry wells to chambers. Standard drawings for Subsurface Infiltration systems are included in Section 6 of the GI Standard Drawings.
- **Bioswales** – Bioswales are simple, linear forms of bioretention systems. They may be designed to receive road runoff, or only runoff from the boulevard, sidewalk, or bike lanes. These systems require less excavation depth than bioretention and may incorporate street trees. Standard drawings for Bioswales are included in Section 7 of the GI Standard Drawings.
- **Permeable Pavement** – Includes porous asphalt, pervious concrete, permeable concrete unit pavers, and grid pavers that may be filled with gravel or vegetation. Template drawings and Construction Specifications for Permeable Pavements are available upon request from the GI Branch.
- **Manufactured Treatment Devices** – Includes devices such as mechanical separators or oil-grit separators used for stormwater quality improvements.
- **Wetlands** – Includes engineered and natural wetland areas that received and manage stormwater from developed areas.

While these Green Rainwater Infrastructure typologies utilize many common principles, materials, and performance mechanisms, they have unique design considerations and best practices. Additional information on the recommended design strategies and principles for these typologies may be found on the Green Rainwater Infrastructure Website and in the *City of Vancouver Rain City Strategy*

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5.7.2 GREEN INFRASTRUCTURE DESIGN TARGETS

Green Rainwater Infrastructure is typically designed to manage small and frequent storms while allowing larger and extreme storms to safely bypass or be conveyed through the practice. However, GI systems may be designed to capture larger storm events to achieve stormwater system performance goals at the direction of the City Engineer. The guidelines in this manual focus on typical GI design for small and frequent events.

The *City of Vancouver Rain City Strategy*

and Integrated Rainwater Management Plan (IRMP) set design targets for Green Rainwater Infrastructure for the majority of the City where stormwater is piped directly to either combined sewer, ocean or waterway outfalls. Outside of the IRMP study area, two watersheds in Vancouver have remaining surface streams: Still Creek and Musqueam Creek. The Still Creek Watershed Management Plan has goals, but does not set design targets, and the Musqueam Creek Watershed Management Plan has not been completed. In the absence of targets for those watersheds, the Citywide IRMP targets will apply and are summarized in ***Table 5-18***.

Table 5-18: Green Rainwater Infrastructure Design Targets

Volume Reduction	Retain 48 mm of rainfall during a 48 mm, 24hr storm (90% of the average annual rainfall volume). Infiltrate, evapotranspirate, and re-use rainwater to the greatest extent practicable.	See *Section 5.7.2.2*
Drawdown Time	Green Rainwater Infrastructure systems should be designed such that the above-ground ponded volume of the system can drain within 24 hours after the end of the rainfall event, and the soil media should drain within 72 hours after the end of the rain event.	See *Section 5.7.2.3*
Water Quality	Remove 80% of Total Suspended Solids (TSS) by mass for particles < 50µm during the first 48 mm of rainfall (event representing 90% of the average annual rainfall volume) and/or remove 80% of TSS according to results provided by Environmental Technology Verification (ETV) or Technology Assessment Protocol - Ecology (TAPE).	See *Section 5.7.2.4*
Urban Biodiversity	Prioritize the development of vegetated infrastructure systems that can support urban ecology.	See the Biodiversity Strategy, Urban Forest Strategy, and GI Planting Guide
Urban Heat Island Reduction	Prioritize supporting tree canopy and implementation of GI in areas with a high urban heat island effect.	See the Climate Change Adaptation Strategy

5.7.2.1 DESIGN TARGET COMPLIANCE

Green Rainwater Infrastructure systems depend on environmental variables and space constraints that can vary significantly between sites. In areas with highly impermeable or contaminated soils, infiltration may be infeasible; a high groundwater table, steep slopes or bedrock may also limit surficial storage capacity.

An inability to meet design targets due to site constraints should not prevent the installation of Green Rainwater Infrastructure systems. Design targets are to be implemented to the "Greatest Extent Practicable" (GEP) to ensure that Green Rainwater Infrastructure systems are utilized wherever possible. The GEP recognizes that the benefits of Green Rainwater Infrastructure extend beyond traditional infrastructure servicing and that Green Rainwater Infrastructure systems are a public good, regardless of whether or not they provide the full 48mm of volume retention.

If meeting any of the numerical design targets described in *Section 5.7.2.* is infeasible due to site constraints, the GEP expectation may be met by allocating a specific percentage of the site area or contributing drainage area to appropriately designed Green Rainwater Infrastructure systems. For new roadway construction, a minimum of 4% of the contributing drainage area should consist of Green Rainwater Infrastructure to comply with the GEP expectation. Roadways or developments containing less than this target may be approved at the discretion of the *City Engineer*.

For information on planting within GRI system areas, please refer to the GRI Planting Design Guidelines.

5.7.2.2 VOLUME REDUCTION HIERARCHY

Rainfall runoff may be managed by Green Rainwater Infrastructure systems through retention, detention, infiltration, evapotranspiration, or filtration. The prioritization of these pathways is referred to in this document as a 'hierarchy' of preferred strategies. Rainwater management on a site with a depleted groundwater table may prioritize infiltration, whereas a high-density residential site with highly impermeable soils may prioritize filtration and detention.

The top priority for 48mm management is full infiltration and evapotranspiration. If a Rainwater Management Plan (RWMP) or geotechnical report for a given site demonstrates that full retention of the 48mm target is infeasible despite best efforts to accommodate the target, an allowance may be granted to provide 48mm of rainwater management through partial infiltration. Partially infiltrating Green Rainwater Infrastructure systems have a perforated underdrain to discharge runoff to the sewer system after it is slowed and filtered through a Green Rainwater Infrastructure system.

If the infiltration capacity is extremely low (<1mm/hr) or other constraints (e.g. high groundwater, tree retention, contaminated soils) prohibit the use of partially infiltrating Green Rainwater Infrastructure, allowance may be granted for a combined grey-green system that discharges filtered runoff to detention storage and slow release.

The designer must prioritize methods of capture according to the categories below. Justification must be provided for using the Priority 2 and 3 management options. Regardless of the criteria being met, the use of vegetation within rainwater management systems should be prioritized to meet the goals outlined in the City's biodiversity and urban forest strategy.

The priority tiers are as follows:

Priority 1: Full Infiltration

Priority 2: Partial Infiltration

Priority 3: Filtration and Detention

The City of Vancouver reserves the right to determine the rainwater management priorities for a particular site depending on the context of the proposed area and the needs of the surrounding sewer shed. For development areas, water re-use may be considered a Priority 1 management option. Criteria for using Priority 1 and 2 management systems are provided below.

Priority 1 Criteria:

- Sufficient setbacks from building foundations and utilities
- Downstream sewer inlets for accommodating overflow
- High infiltration capacity (e.g. greater than 15 mm/hr)
- Lack of contamination concerns
- Lack of slope stability concerns (as supported by a preliminary geotechnical study)

Priority 2 Criteria:

- Low infiltration capacity (e.g. less than 15 mm/hr, greater than 1 mm/hr)
- Limited available space for engineered infiltration systems due to onsite conditions, such as tree retention, building foundations, and utilities
- Seasonally high groundwater table or bedrock more than 0.6 m from the bottom of the practice
- Lack of contamination concerns
- Lack of slope stability concerns (as supported by a preliminary geotechnical study)

If the Priority 2 criteria are not met, Priority 3 alternatives should be considered. Priority 3 stormwater management strategies should include Green Rainwater Infrastructure systems and must be developed on a site-specific basis.

5.7.2.3 DRAWDOWN TIME

Drawdown time is a measure of the time it takes for water to drain out of a Green Rainwater Infrastructure system and is an important metric for performance. Green Rainwater Infrastructure systems store runoff onsite and slow its flow into sewer systems, but they also must be designed to drain quickly enough that they can accommodate runoff from another storm event. Excessive waterlogging can also be detrimental to plant health and may be seen by residents as a nuisance. *Section 5.4.4* states that adequate drainage must be provided in City of Vancouver Streets. However, limited ponding within City of Vancouver Streets is acceptable in some cases. Green Rainwater Infrastructure is outside of the conveyance area of Streets, and so ponding is acceptable and often required in Green Rainwater Infrastructure systems.

City of Vancouver Green Rainwater Infrastructure systems should be designed to comply with two drawdown time performance targets.

- Maximum duration of ponded surface water: 24 hours
- Time required for excess water to drain from the systems soil (i.e. time until soils return to their field capacity): 72 hours

Drawdown times can be calculated using an excel calculator or acceptable modelling software for the Hydrograph Method. Calculation methods must be approved by the City Engineer but may include PCSWMM, InfoWorks, ICM, or approved alternates.

Calculations should demonstrate that surface ponding in the system does not exceed 15cm during a 48mm storm event. An allowance for additional ponding may be granted for Green Rainwater Infrastructure systems with access prevention or systems that are not directly adjacent to pedestrian or roadway areas.

Additional information related to infiltration and exfiltration calculations is provided in the *GI Sizing and Modelling Guide* available on the Green Rainwater Infrastructure webpage.

5.7.2.4 WATER QUALITY

The first 48mm of rainfall from all pervious and impervious surfaces shall be treated to remove 80% Total Suspended Solids (TSS) by mass prior to discharge from the site. Treatment can be provided by either one Green Rainwater Infrastructure practice or structural Best Management Practice (BMP) or by means of a treatment train comprised of multiple practices.

80% TSS removal by mass can be provided by designing and constructing a vegetated Green Rainwater Infrastructure system to the standards outlined in this manual and any applicable construction specifications. A Green Rainwater Infrastructure system that complies with the design requirements in this chapter, including having an appropriate ratio of *impervious* contributing drainage area to *pervious* Green Rainwater Infrastructure area, referred to herein as the Impervious-Pervious (IP) ratio, is assumed to meet the water quality requirements. Additional information on appropriate IP ratios is included in *Section 5.7.3.8* and in the ***GI Sizing and Modelling Guide*** on the Green Rainwater Infrastructure webpage.

Compliance with the 80% TSS removal target may also be met using proprietary treatment devices. Proprietary treatment devices must be approved by City Staff and resources must be allocated for their continued maintenance. Proprietary treatment devices should demonstrate removal of 80% TSS for particles less than 50 microns and/or be certified by either the Washington State Department of Ecology's Technology Assessment Protocol –Ecology Program (TAPE) or Environmental Technology Verification (ETV) Canada. The applicant may propose other technologies but must provide supporting information that shows the technology meets the treatment standard.

5.7.3 SITE ASSESSMENT AND DESIGN CONSIDERATIONS

Prior to the design of any Green Rainwater Infrastructure system, the proposed site should be assessed for feasibility. The following guidance is intended to improve design times and ensure that Green Rainwater Infrastructure systems appropriately consider site conditions, however the following sections are not a comprehensive list of the site-specific factors that should be considered in Green Rainwater Infrastructure system design. ***Table 5-19*** provides an overview of some of the more frequently encountered site considerations for Green Rainwater Infrastructure systems. Additional information on these considerations is provided in the following sections.

Table 5-19: Considerations for GI Site Assessment

Required Information	Comments
Site Characterization	Designing Green Rainwater Infrastructure systems requires an assessment of the proposed location and any site characteristics that impact the design. Historical and future land use, existing trees, surrounding vegetation, road classification, and transportation needs should also be assessed, along with the presence of any City planning or construction initiatives in the surrounding area.
Geotechnical and Hydrogeological	A professional geotechnical and hydrogeological consultant should assess the subsoil composition, infiltration rates, and underlying groundwater quality characteristics near the proposed Green Rainwater Infrastructure system wherever a known hazard is present. See *Section 5.7.3.1*.
Services and Utilities	All services and utilities within 20 meters of the Green Rainwater Infrastructure system should be identified prior to Green Rainwater Infrastructure system design. Their approximate depths should be noted on a preliminary design drawing. See *Section 5.7.3.2*.
Contributing Drainage Area	Delineating and characterizing the contributing drainage area for the Green Rainwater Infrastructure system is an essential component of Green Rainwater Infrastructure sizing and determining future maintenance needs. See *Section 5.7.3.8*.
Topography and Grading	The slopes of the surrounding roadway, sidewalk, and boulevard will impact the grading of the Green Rainwater Infrastructure system and the need for internal weirs and/or check dams. See *Section 5.7.3.9*.
Streets Features	The removal, replacement, or addition of streets features including but not limited to signage, litter cans, water fountains, benches, or planters should be coordinated with the relevant City branches during the site assessment phase. See *Section 5.7.3.10*.

5.7.3.1 GEOTECHNICAL AND HYDROGEOLOGICAL ASSESSMENT

Site specific geotechnical studies are recommended to support the design of surface-level Green Rainwater Infrastructure systems and should include the following:

- An evaluation of the potential for and risks of onsite rainwater infiltration, such as slope stability, soil contamination, and nearby foundations and basements;
- The presence of contaminated groundwater and/or soils

- Results of infiltration testing at likely locations for infiltration practices and a proposed design infiltration rate;
- Soil stratigraphy; and
- Depth to bedrock and seasonally high groundwater at likely locations for infiltration practices.
- The minimum borehole depth for assessing geotechnical and hydrogeological conditions under a GRI system in a known hazard area shall be 3.0 meters.
- The stability of roadway bedding adjacent to Green Infrastructure areas must always be maintained.

The design infiltration rate shall be determined by borehole infiltration test (ASTM D6391), double ring infiltrometer or auger hole (i.e. Guelph) permeameter (as outlined in ASTM D5126) or an approved equivalent and should be conducted at the estimated depth of the Green Rainwater Infrastructure system or a depth of 1.0m below surface level.

Boreholes for infiltration testing should be taken within the Green Rainwater Infrastructure system area wherever possible. All boreholes must be within 10.0 meters of the system footprint. Guidance for the number of test pits and/or soil borings for a given Green Rainwater Infrastructure asset is included in ***Table 5-20***.

Table 5-20: Infiltration Testing Guidelines

Infiltration GI Surface Area (m2)	Number of Test Pits or Boreholes	# of Infiltration Tests per Pit or Borehole
<50	1	1-2
50 to 900	2	
>900	2 per 450m^2	
Linear	1 per 100m	

Test locations should be spaced equidistant from one another. At least one infiltration test should be taken per borehole, though possibly more if infiltration rates during the test are inconsistent. The design infiltration rates should be calculated by dividing the measured infiltration rate by a safety factor of between 1 and 2, depending on the confidence in the infiltration rate test (high confidence, safety factor of 1, low confidence, safety factor of 2).

An additional round of tests should be conducted at 1.5 meters below the proposed bottom elevation of the system if there is significant variation in the initial results due to inconsistent geologic formation, soil texture or bulk density.

Feasibility assessments for Green Rainwater Infrastructure systems also include a review of known contaminated sites and all geotechnical and hydrogeological hazards identified by City of Vancouver staff. On-site boreholes, infiltration tests, soil analysis, and external geotechnical recommendations shall always be conducted for GRI systems planned within these areas. The feasibility of GI in these areas shall be determined on a site-by-site basis in collaboration with City of Vancouver staff.

All GRI systems in contaminated sites and/or in known hazard areas shall be partially infiltrating or non-infiltrating

5.7.3.2 UTILITY SETBACKS AND PROTECTION

With protective measures and sufficient setbacks, Green Rainwater Infrastructure systems can be successfully designed in proximity to most services and utilities. However, proximity to some utilities may lead to significant cost increases and introduce design complexities. The presence of the following services and utilities within the proposed work area for a Green Rainwater Infrastructure system should be discussed with the project planning team at the earliest opportunity:

- Sanitary or combined sewers.
- Water distribution systems.
- Street lighting and traffic signals.
- Above-ground BC Hydro lines.
- High voltage BC Hydro ducts.
- Third-party utilities (Fortis, Telus, etc.)
- Abandoned utilities.
- District energy systems
- Existing trees

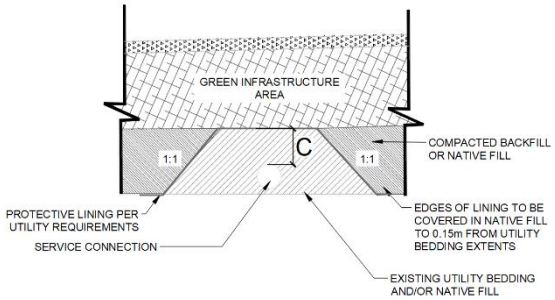
Utilities and services that pass under or adjacent to a Green Rainwater Infrastructure system may require protective measures to ensure that construction and operation of the system does not negatively impact service provision. Further information on Third-Party Utility Coordination can be found in *Chapter 7* or within supplementary design guidelines.

Unless otherwise noted, all clearances are measured from the outside edge of the service/utility to the nearest edge of the Green Rainwater Infrastructure practice. Reference drawings are provided below outlining the separation distances relative to Green Rainwater Infrastructure features. ***Table 5-21*** provides an overview of the required setbacks for services and utilities.

The setbacks and protective measures described in this section are preliminary and approximate. They are subject to change based on site-specific considerations and details related to the relevant on-site utilities. Utility coordination and protection measures on specific projects should always be confirmed with the appropriate City of Vancouver Engineering branches.

Wherever possible, utility bedding that passes through Green Rainwater Infrastructure systems should be surrounded by compacted backfill such as drain rock or structural soil. For information related to the bedding requirement for individual utilities, refer to the appropriate utility construction specifications and the guidance in the relevant chapter of the Engineering Design Manual.

Service Lateral Crossing GRI system



Service Parallel to GRI system

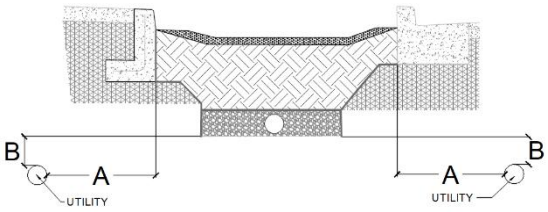


Figure 5-6: Reference Dimensions for GI Utility Separation

The *Maximum Separation Distance Requiring Protective Measures* is the distance between a utility and a Green Rainwater Infrastructure system at which protective measures for that utility are required, which are the **bold** numbers.

The *Minimum Separation Distance allowable* is the closest that a Green Rainwater Infrastructure system boundary may be located to that utility even with protective measures in place, which are the numbers in parenthesis. Exemptions to these values may be granted on a site-specific basis. If the separation distance is less than this value, the system boundaries must be adjusted to accommodate the setback.

Separation distances are to be measured from the outside of the utility to the nearest edge of the Green Rainwater Infrastructure system as defined by the vegetated area, infiltration area, or perforated pipe.

Table 5-21: Recommended GI Separation from Utilities and Services

Service	Maximum separation distance requiring protective measures (Minimum separation distance allowable) All units are in meters. <A	<B	<C	Protective measures required for service/utility when offset is not met
Parallel water distribution infrastructure	**3.0** (1.0)	**0.3** (0.3)	**0.3** (0.3)	Impermeable liner on the side of the GI trench nearest the water main. Dimensions and extents of liners must be determined on a site-specific basis. Refer to guidance provided in *Section 5.7.3.2 Utility Setbacks and Protection* for further information.
Storm sewer	**1.5** (0.0)	**0.3** (0.3)	**0.3** (0.3)	Non-woven geotextile
Sanitary sewer	**1.5** (0.3)	**0.3** (0.3)	**0.3** (0.3)	Refer to guidance provided in *Section 5.7.3.2 Utility Setbacks and Protection*.
Telco	Refer to *Chapter 7: Third-Party Utilities* for guidance on third-party utilities.			
Gas				
Street lighting				
BC Hydro (Subsurface)				
BC Hydro (Aboveground)				
Building foundations	**5.0** (1.0)	**N/A**	**N/A**	Impermeable liner on the edge of the GRI system nearest the building unless approved by the *City Engineer* and *Project Engineer*.
Retaining wall foundations	**3.0** (1.0)	**N/A**	**N/A**	N/A
District Energy Utilities	**1.2** (0.3)	**0.3** (0.3)	**0.3** (0.3)	Refer to guidance provided in *Section 5.7.3.2* Utility Setbacks and Protection.
Existing Trees	All setback distances to be determined in consultation with Urban Forestry.			

As shown in

Figure 5-6, service laterals that cross Green Rainwater Infrastructure systems should be surrounded by existing sub-base or the appropriate utility corridor aggregate and wrapped in the protective measure outlined in ***Table 5-21***. Further details for specific utilities are provided below.

For additional information regarding drawing requirements for services and utilities please see *Chapter 2: Design Process & Coordination*.

5.7.3.3 DISTRICT ENERGY UTILITY PROTECTION

Green Rainwater Infrastructure systems must have a separation distance of 1.20m from District Energy Utility (DEU) transmission lines within the roadway to ensure sufficient space for excavation and repair of the DEU system. If a DEU joint is within the excavation area of a Green Rainwater Infrastructure system, the joint should be wrapped and sealed with an impermeable liner. DEU sand bedding should be placed around the impermeable liner, and a non-woven geotextile should be wrapped around the sand bedding.

Wherever a DEU connection passes through a Green Rainwater Infrastructure system, non-woven geotextile should be placed around the DEU bedding to prevent the sand bedding from migrating into the Green Rainwater Infrastructure soil medium. Where Controlled Density Fill (CDF) is used for DEU connection bedding, a minimum of 0.30 m of soil should be placed above the CDF to allow for overlying plant growth.

Trees should not be planted near a DEU connection if the expected root zone may overlap with the DEU service.

See *Chapter 6: Neighbourhood Energy* for further information.

5.7.3.4 WATER MAIN INFRASTRUCTURE

Protective measures must be considered for any water main infrastructure within 3.0m horizontally from a Green Rainwater Infrastructure system or 1.0m vertically. The proposed protective measures for a Green Rainwater Infrastructure system within 3.0m of water service infrastructure must be reviewed and approved by the Waterworks Design Branch. Where protective measures are required, a variance form may need to be submitted to the Waterworks Design Branch for review. Waterworks Design will review the Green Rainwater Infrastructure design and obtain approvals from Vancouver Coastal Health (VCH). For new water infrastructure near existing Green Rainwater Infrastructure systems, proposed separation distances less than 3.0m will need to be reviewed concurrently with the proposed protective measures and approved by VCH.

Best practices for protection of water infrastructure near Green Rainwater Infrastructure systems are evolving. Contact the Green Rainwater Infrastructure Implementation Branch for clarification on current requirements and/or recommendations at raincity@vancouver.ca.

5.7.3.5 SANITARY AND STORM SEWER PROTECTION

Sanitary and combined sewer connections that pass through Green Rainwater Infrastructure systems should be wrapped with an impermeable liner around the sewer bedding or the pipe joints should be wrapped with an approved waterproofing material. The sanitary or combined pipes may also be upgraded to a pressure rated pipe in lieu of an impermeable liner. Storm sewer connections do not require impermeable lining or joint wrapping. Bedding for sewer connections passing through Green Rainwater Infrastructure systems should be wrapped with a geotextile to prevent fines migration between the connection bedding and the Green Rainwater Infrastructure backfill. Sewer bedding should always be surrounded by backfill that can be compacted to 95% MPD or an approved equivalent, such as structural soil.

If a new sanitary main is installed less than 1.5m horizontally from a Green Rainwater Infrastructure system and less than 0.3m beneath the bottom of the Green Rainwater Infrastructure system, the portion of the sewer adjacent to the Green Rainwater Infrastructure system should be wrapped with an impermeable liner (30 mil LLDPE waterproof membrane or approved equivalent). If a Green Rainwater Infrastructure system is installed less than 1.5m horizontally and less than 0.3m above a sanitary sewer, an impermeable liner should be installed on the side of the Green Rainwater Infrastructure system nearest the sanitary sewer. Storm sewer mains adjacent to Green Rainwater Infrastructure systems in the public ROW do not require protective measures.

Sewer bedding that is disturbed during Green Rainwater Infrastructure construction should be reinstalled and recompacted wherever it was disturbed during.

Green Rainwater Infrastructure systems must not be constructed within 0.3m of a sanitary sewer main or a storm sewer main to allow for excavation of the utilities without disturbing the system. Refer to *Chapter 4: Sanitary Sewer System* and *Chapter 5: Storm Drainage System* for more details.

5.7.3.6 OVERHEAD UTILITY CONFLICTS

Components of the GRI systems that require access for regular operations (cleanouts, catch basins, inspection chambers, maintenance holes, dry wells, etc.) should be located such that no third-party utility or other overhead infrastructure is within 6 vertical m of the access location and such that a maintenance vehicle can park and access the component by overhead boom.

Trees within Green Rainwater Infrastructure systems must also consider overhead utility conflicts in accordance with all applicable Urban Forestry guidance.

5.7.3.7 CITY OF VANCOUVER ELECTRICAL INFRASTRUCTURE

City of Vancouver electrical ducts and conduits may be placed within or adjacent to GRI systems, however any bedding material surrounding the electrical infrastructure within a GRI system must be wrapped in non-woven geotextile. City of Vancouver electrical infrastructure must always comply with relevant City of Vancouver and MMCD standards, which may not specify the acceptability of specific electrical equipment within GRI systems.

When electrical infrastructure is placed within a GRI system, all backfill materials surrounding electrical structures such as pole bases, junction boxes, cabinets, and kiosks, must comply with all relevant standards and ensure that the structural stability of the electrical infrastructure is not impacted during or after construction.

5.7.3.8 CONTRIBUTING DRAINAGE AREA

The contributing drainage area to Green Rainwater Infrastructure assets should be characterized at the preliminary design stage. The contributing drainage area should be demarcated by land use such that the total contributing paved areas and the total contributing vegetated or sodded areas are recorded. This demarcation is important to calculating the effective contributing drainage area. For rational method assessments, the effective contributing drainage areas can be calculated with a composite runoff coefficient weighted by the portion of vegetated and paved areas in the contributing drainage area. For Green Rainwater Infrastructure projects on City ROWs, the contributing drainage area should be delineated as the entirety of the ROW between the Green Rainwater Infrastructure asset and the nearest upstream catchbasin.

The composition of the contributing drainage area has important impacts on Green Rainwater Infrastructure design and performance. The presence of active construction, high traffic loading, and deciduous trees may increase sedimentation and debris in the Green Rainwater Infrastructure area and lead to greater maintenance needs. During the preliminary design stage, a description of the contributing drainage area should be recorded in project documentation.

Delineating the contributing drainage area is an essential step in sizing Green Rainwater Infrastructure systems at the preliminary and detailed design stages. Preliminary Green Rainwater Infrastructure sizing can be conducted using the Impervious-Pervious (IP) ratio, which compares the contributing *Impervious* catchment area to the *Pervious* Green Rainwater Infrastructure system area.

Example: If the GRI system consists of 10m^2 of pervious area, and 300m^2 of impervious roadway is directed to that system, the IP ratio is 30:1.

Table 5-22 provides recommended and maximum IP ratios for functional Green Rainwater Infrastructure sizing of different practices.

Table 5-22: GI Impervious to Pervious Ratios

GRI system Type	Recommended IP	Maximum IP
Bioretention	20:1	35:1
Tree Trenches	20:1	30:1
Infiltration Systems	20:1	45:1

These ratios should only be used to identify the approximate footprint requirements of Green Rainwater Infrastructure systems and may not represent the final sizing requirements once site-specific constraints and design capture targets are accounted for.

Permeable pavement systems should be designed so they do not accept any drainage from other areas and only manage the rainfall that falls on the permeable pavement surface.

5.7.3.9 TOPOGRAPHY AND GRADING

Prior to the design of any Green Rainwater Infrastructure system, the topography of the proposed site and the contributing drainage area must be assessed and reflected on preliminary drawings. Preliminary drawings should include key grades and overland flow paths of the surrounding area. It must be technically feasible to direct runoff from the intended contributing drainage area into the Green Rainwater Infrastructure system, which can be assessed with conventional grading design.

Site topography may impact system selection and design in a variety of ways, including but not limited to the following:

- Steep contributing drainage areas (>8%) may require additional erosion protection measures to reduce the impact of high-velocity runoff.
- Green Rainwater Infrastructure systems on sites with a slope greater than 3% may require weirs or check dams to encourage ponding across the length of the system. Weirs and check dams may be constructed of natural or constructed materials.
- When a low-point (sag) is present within the area proposed for a Green Rainwater Infrastructure system, an overflow inlet connected to the City sewer system should be designed with capacity to accommodate major storm events. Grading of surrounding features such as sidewalks, ramps, and curbs, may limit the available ponding depth in the system.
- An (outlet) curb cut shall be provided to maintain emergency overland flow routes wherever necessary.

5.7.3.10 STREET FEATURES

If a proposed Green Rainwater Infrastructure system is located on the boulevard or at an intersection, there may be existing street furniture installed within the design area. Street furniture includes but is not limited to benches, bike racks, bus shelters, waste receptacles, map stands, and advertising panels. During the site assessment, any street furniture found within the design area should be flagged for further review by the Street Furniture Coordinator at street.furniture@vancouver.ca.

If any waste receptacles are found within the design area, Solid Waste Services should be notified. If a proposed Green Rainwater Infrastructure system is located on the boulevard or at a commercial intersection and there are no waste receptacles on site during the site assessment, it could potentially be a site for planned waste receptacle installations and Solid Waste Services should be notified.

Street furniture, including waste receptacles, needs to be anchored on a concrete pad. A hard surface may also be required for the space between the street furniture concrete pad and the curb, which may conflict with Green Rainwater Infrastructure design.

Vegetated Green Rainwater Infrastructure areas should always be designed to accommodate required traffic signage. This may require sign bases with deeper concrete bases and longer poles to achieve the necessary signage height. Vegetated GI areas adjacent to curb ramps should only begin at the top of the adjacent curb ramp flair.

5.7.3.11 SYSTEM CONSTRAINTS

Design of the public built environment is complex, and flexibility is required to respond to local conditions, site constraints, and available guidance. The following design constraints and consideration are guidelines that should be considered for all Green Rainwater Infrastructure systems.

5.7.3.12 MAXIMUM PONDING DEPTH

Green Rainwater Infrastructure systems should be designed to maximize the surface area of ponded water. The depth of ponded water, as defined by the elevation difference between the catchbasin rim and the bottom of the vegetated area, should be no less than 10cm. The depth of this ponded water should be no greater than 15cm where a Green Rainwater Infrastructure system is immediately adjacent to a pedestrian area of roadway. Excessive water ponding in public areas can pose a risk to residents and may lead to difficulties ensuring the surface ponding drawdown time is less than 24 hours. Large Green Rainwater Infrastructure systems may have ponding depths greater than 15cm in areas of the system with more than two meters of separation from pedestrian areas or roadways. All Green Rainwater Infrastructure systems in the right-of-way should be designed to overflow onto the roadway to ensure that any overflow is directed to a downstream catchbasin.

5.7.3.13 MAXIMUM STEP HEIGHT

Where a Green Rainwater Infrastructure system is adjacent to a pedestrian area or a parking lane, the elevation difference between the surface of the Green Rainwater Infrastructure system and surrounding hard surfaces should not exceed 15cm. This elevation difference is referred to as the “step height” because it is the height that a pedestrian would have to step to enter the Green Rainwater Infrastructure system from an adjacent hard surface. The preferred step height is 10cm.

Pedestrian areas include but are not limited to sidewalks, plazas, and seating areas. The surface of the Green Rainwater Infrastructure system can be the top of soil or the top surface of concrete components. Where a Green Rainwater Infrastructure practice is adjacent to a public roadway that does not have street parking, the elevation difference between the roadway top of curb and the bottom of the Green Rainwater Infrastructure system should not exceed 20cm. If street parking is present, a 15cm maximum may be enforced. If the step height exceeds 15cm due to site constraints, vertical edge protection and/or a landscape buffer between the Green Rainwater Infrastructure system and the pedestrian area may be used at the discretion of the City Engineer.

This criteria is drawn from the Canadian Standards Association, Accessibility Standards Canada, and the U.S. Access Board – the best available guidance on elevation differences in the public right-of-way at the time of writing.

5.7.3.14 VEGETATED SLOPES

The vegetated portions of Green Rainwater Infrastructure systems should be flat wherever possible to encourage an even distribution of water for infiltration. However, a vegetated slope may be required due to grading constraints within a Green Rainwater Infrastructure system, a maximum 2:1 slope should be used to ensure slope stability without requiring compaction. A 3:1 slope is preferred under all conditions.

It is preferred that vegetated slopes in a Green Rainwater Infrastructure system have a 300mm wide "shoulder" that matches the grade of any adjacent pedestrian area.

5.7.3.15 RECOMMENDED STEPS FOR SUCCESSFUL DESIGN

The following steps provide an overview of the process for designing Green Rainwater Infrastructure systems in the municipal ROW.

Step 1: Site Assessment

The first steps to designing a Green Rainwater Infrastructure system are determining how much space is available for the system, and the boundaries of the contributing drainage area. Establishing site limitations and characteristics is a prerequisite for determining if a system meets the system design targets described in *Section 5.7.2*.

Step 2: Identify System Constraints

Once the boundaries of the system are determined, designers must identify the surrounding constraints, utilities, and required setbacks for the proposed area. Green Rainwater Infrastructure systems have a variety of setback requirements from utilities, sewers, existing trees and vegetation and foundations. At the initial design stage, designers must identify any feature which may impact the location, depth, or footprint of a Green Rainwater Infrastructure system. A BC One Call submission should always be made during the early stages of GI design to identify any utilities in the proposed area. This information is critical to determining the extents and typology within the proposed area.

Step 3: Establish the Infiltration Rate

The infiltration rate should be established using the standard methodology determined by the City of Vancouver as outlined in *Section 5.7.3.1 Geotechnical and Hydrogeological Assessment*.

Step 4: Identify System Alternatives

Once the system constraints and performance targets are identified, designers should consider which Green Rainwater Infrastructure systems are most likely to succeed on the proposed site and which system designs are best suited for the site context and any relevant City goals or targets for the proposed area.

Step 5: Calculate Proposed System Sizing

A preliminary sizing estimate is important to determine if the proposed GRI system will have capacity for the contributing drainage area. At the preliminary design stage, GRI systems should be assumed to have a ratio of contributing impervious drainage area to the GRI system area consistent with those outlined in *5.7.3.8 Contributing Drainage Area*. Additional sizing guidance is provided in the *GI Sizing and Modelling Guide*.

Step 6: Confirm System Performance

Once the system has been sized, it is important to verify system compliance with the relevant design targets as outlined in *Section 5.7.2*. Compliance should be assessed as a percentage completion of the relevant numerical targets.

Step 7: Re-assess and Optimize Design

If performance targets are not met initially, consider ways to optimize the performance of the system by increasing subsurface storage volume, increasing system surface area, providing more ponding volume, or adding additional systems. If necessary, return to Step 4 and re-consider other designs or typologies.

Step 8: Assemble Resources

Once a preliminary design has been finalized, the City of Vancouver Green Rainwater Infrastructure Standard Drawings should be reviewed to confirm all relevant standards and determine what system components have already been drafted. Guidance on the content required in GI project drawings is included in *Chapter 2: Design Process & Coordination*.

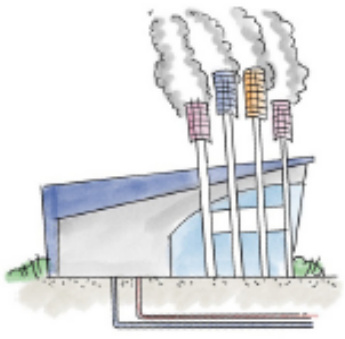
The City of Vancouver Green Infrastructure Implementation Branch has assembled a library of useful CAD resources that may be distributed to designers. These are available on the Green Rainwater Infrastructure website to simplify the process of adapting standard drawings to site-specific constraints. These resources are to be used at the discretion of the designer and should always be adjusted to site-specific constraints.

The City of Vancouver *Green Rainwater Infrastructure Planting Guidelines* are also available on the City of Vancouver website.

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6

NEIGHBOURHOOD ENERGY



Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Mark Schwark, P.Eng, Director, Water and Utilities Management

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NEIGHBOURHOOD ENERGY

6.1 INTRODUCTION

A key strategy to meeting the Climate Emergency Action Plan and Renewable City Strategy goals is to expand the False Creek Neighbourhood Energy Utility (NEU) and support the development and decarbonization of privately owned district energy systems (DES) throughout Vancouver. DES's supply centralized heating, hot water, and sometimes cooling for multiple buildings. These systems use low-carbon renewable energy sources, such as sewage waste heat, to reduce the use of fossil fuels. They also eliminate the need for boilers in individual buildings, and provide environmentally friendly, affordable heat and hot water.

Vancouver currently owns and operates the NEU system which serves the Olympic Village, Southeast False Creek, False Creek Flats and Mount Pleasant neighbourhoods. Refer to the service area boundary in Schedule A of the City of Vancouver Energy Utility System By-Law No. 9552

The design criteria in this manual are specific to the City-owned NEU. For work on other DES's check with the utility provider within that service area.

The following section *Design of Neighbourhood Energy Utilities Components* is a brief description of the general design parameters such as code compliance and design conditions for the components of the City's NEU system.

6.2 DESIGN OF NEIGHBOURHOOD ENERGY UTILITIES COMPONENTS

The intent of this section is to outline the core parameters of the components that comprise of the City-owned NEU. It primarily focuses on design considerations for installing utility infrastructure around them. In addition, it also highlights the key considerations for Developers within the service area connecting to the thermal network.

For design requirements for privately owned DES's, please consult with the utility owner.

6.2.1 GENERAL CONSIDERATIONS

NEU infrastructure shall be designed with consideration of the following requirements:

6.2.1.1 PROCESS FLUID

All process fluids are 100% treated, non-potable water unless approved otherwise by the City Engineer.

6.2.1.2 CODE COMPLIANCE

All designs must be in accordance with *CAN/CSA B51 Boiler, Pressure Vessel, and Pressure Piping Code*, *ASME B31.1 Power Piping*, and the requirements of Technical Safety British Columbia (TSBC).

6.2.1.3 DESIGN CONDITIONS

Table 6-1 outlines the typical design conditions on the NEU primary side:

Table 6-1: Design Conditions

Property	Specification
Design Pressure Rating	1,100 kPa (160 psi)
Design Temperature Rating	120˚C (115˚C for Kelit PEXR)
Design Pressure Loss in Piping	200-250 Pa/m
Supply Temperature Range	65˚C to 95˚C
Maximum Return Temperature Range	50˚C to 55˚C

Notes:
1) Any deviance from these conditions must be approved by the City Engineer.

6.2.2 DISTRIBUTION SYSTEM

Neighbourhood energy systems require a distribution network to deliver heating. The Distribution Piping System (DPS) is a pre-insulated two pipe closed loop system buried within the City's streets along with other utilities. The hot water generated at the False Creek Energy Centre and at satellite facilities is circulated through the pipelines to the customer buildings within the district energy network.

This section outlines the distribution network criteria:

6.2.2.1 PIPING

The two types of piping found in the NEU are:

1) EN253 pre-insulated bonded piping system for directly buried hot water networks (European Standard). Pipe assemblies of steel service pipes to EN 10217-2 Grade P235GH (ASTM A53 Grade B equal), polyurethane thermal insulation and outer casing of polyethylene. Complete with leak detection alarm wires.

   Typical standard of acceptance: Logstor Series 1 piping (or equivalent)

2) Cross-linked pre-insulated reinforced polyethylene (PEX) piping system for below ground installation.

   Typical standard of acceptance: Kelit PEXR piping (or equivalent)

Refer to the *NEU Standard Detail Drawing* for typical pipe installation details.

6.2.2.2 PIPING CLEARANCE REQUIREMENTS

Proposed utility installations, tree planting, or any landscape improvements in the vicinity of existing and proposed NEU District Energy Piping are requested to have a minimum vertical clearance of 0.3 m, and a horizontal clearance of 1.0 m. 90-degree crossings are preferred. For more detail, please refer to the *NEU Standard Detail Drawing* within the City of Vancouver's Design Standards document.

Utility installations, tree planting, or any landscape improvements crossing or exposing existing NEU District energy piping are expected to expose the piping either by hand or with a hydro-excavator. This work may only proceed after notifying the NEU Engineering Branch at least two working days in advance.

6.2.3 ENERGY TRANSFER STATIONS

An Energy Transfer Station (ETS) is the point of transfer of thermal energy via heat exchangers from the NEU to a connected building. Owned and operated by the NEU, an ETS is installed in the parkade of each development and acts as the boundary of ownership between the NEU and the connected building. Each ETS is constructed with a utility grade energy meter to measure the thermal energy consumed by the connected building for monthly billing purposes. Please refer to the *Neighbourhood Energy Utility Connectivity Guidelines & Requirements* document for technical guidelines and division of responsibility for the ETS infrastructure design and implementation.

6.2.4 DEVELOPMENT CONNECTIONS

For buildings connecting to the NEU, the Development team must obtain NEU approvals through the regular Development and Building permit process to initiate the service. Once approval is granted, the team must collaborate with the NEU to fulfill the requirements outlined in the *Neighbourhood Energy Utility Connectivity Guidelines & Requirements* and pre-commissioning checklists, as detailed below:

6.2.4.1 NEU CONNECTIVITY REVIEW

Prior to issuance of the full construction building permit, the NEU will complete a connectivity review of the building's mechanical design to ensure compatibility with the NEU system and that all connectivity requirements as outlined in the ***Neighbourhood Energy Utility Connectivity Guidelines & Requirements*** have been met. The Development team must submit all necessary drawings and documentation, and actively collaborate with the NEU team throughout the review process.

6.2.4.2 CONNECTION LEVY

Developers connecting to the NEU are required to pay an initial Connection Levy for the NEU to recover the cost of connecting new buildings. This is similar to the use of connection fees for waterworks and sewer utilities. The levy consists of two parts, a fixed portion and a variable outlined in more detail in the ***Energy Utility System By-law No. 9552***. Payment of this initial connection levy is a condition of building permit approval.

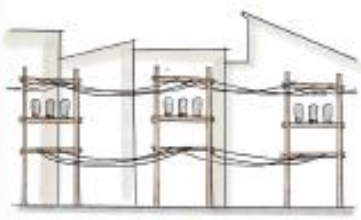
6.2.4.3 COMMISSIONING

The Developer is responsible for completing a pre-commissioning checklist (provided by the NEU) prior to scheduling the start-up with the NEU team. Once the commissioning has taken place, the Developer is responsible for completing any deficiencies outlined by the NEU team in a timely manner.

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7

THIRD PARTY UTILITIES



Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Mark Schwark, P.Eng, Director, Water and Utilities Management

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THIRD-PARTY UTILITIES

7.1 INTRODUCTION

This chapter describes the utility design requirements for the installation of underground and overhead third-party utilities within the City street right-of-way. The City maintains its design requirements to safeguard the public, protect City staff and contractors, effectively manage available street corridors for equitable use, and preserve the integrity of all buried utilities within its streets.

The following is a brief description of each section:

- The *Utilities Design* section outlines the specifics for third-party utility design such as depth of cover, alignment, and clearances.
- The *Construction Requirements* section directs to the *City of Vancouver Construction Specifications* that outline the requirements for construction of third-party utilities.
- The *Supplementary Information* section provides additional general information that must be considered during third-party utilities design and construction such as special pavements, abandoning utilities, and encroachments.
- The *Utility Drawing Submissions* section outlines the requirements for utility permit drawings such as title blocks, dimensions and record drawings.
- The *External Utility Electronic Submission* Standards section provides information relating to utility submissions such as coordinate systems, survey monuments and security.

Refer to *Chapter 2: Design Process & Coordination* for test hole submission requirements.

Utility companies must comply with ***City of Vancouver Street Utilities By-law No. 10361*** when working within the City street right-of-way.

7.2 UTILITIES DESIGN

With limited space available, third-party utility corridors must be carefully planned and utilized. This section outlines the design requirements for pipes, underground conduit, concrete encasement, maintenance holes, surface structures, poles and overhead wires for third-party utilities within the City of Vancouver.

7.2.1 DEPTH OF COVER

The minimum depth of cover for underground utilities within City streets varies depending on utility, plant type and location. The depth of cover for any utility is measured from the street surface to the top of the duct, if direct buried, or top of the concrete if the equipment is concrete encased. If the street elevation is subsequently altered, the utility may require modification to meet the minimum depth of cover requirements. It must not be assumed that all utilities are at standard depth. *Table 7-1* summarizes the minimum depth of cover, as it relates to the utility and plant type.

7.2.1.1 MINIMUM DEPTH OF COVER AND PROFILE REQUIREMENTS

Table 7-1 provides the minimum depth of cover and profile requirements:

Note the following definitions:

Lateral: an underground service crossing perpendicular to the street, to a property originating from a utility distribution system.

Main Ducts: an underground route or network running parallel to the road containing the infrastructure of utility equipment.

Table 7-1: Minimum Depth of Cover & Profile Requirements

Third Party Utility	Type of Plant / Equipment	Profile Requirements	Minimum Depth (mm)
Gas (FortisBC)	Services		610[1]
			460[2]
	Mains (150mm diameter)		760[3]
			610[4]
	Mains (200mm diameter)		910[3]
			610[4]
	Mains (250mm diameter and greater)	Profile required	1070
Electrical (BC Hydro)	Laterals (connections)		910
	Main Ducts	Profile required	1070
	Maintenance Hole Roofs		460
Telephone, Cable and Communications	Laterals (connections)		910
	Main Ducts	Profile required	1070
	Maintenance Hole Roofs		460
Coast Mountain Bus Company	DC Feeders	Profile required	1070
District Energy Systems (e.g. steam heat and hot water)	Main Pipes (including casing)	Profile required	1070
	Service Pipes		910
	Vents and Trap Lines		460
Greater Vancouver Water District (Water)	Mains	Profile required	1070
Greater Vancouver Sewerage and Drainage District (Sewer)	Mains	Profile required	1500

7.2.2 ALIGNMENT

With the growth in demand for underground space, utility corridors are becoming a scarce and limited resource. In preserving the City street for present and future use, the Utilities Management Branch coordinates its efforts to minimize the amount, while maximizing the efficient use, of underground space occupied by each utility.

To achieve the City's approval, all new proposed utility installations should strive to minimize the amount of plant on and within City streets. Alignments selected for proposed utility installations must adhere to the following conditions:

- Alignments of any new plant should coincide with that of existing plant.
- When installing underground service to the same customer, those services running in parallel alignments are required to share a common trench. Joint trench details must be clearly illustrated on utility company drawings.

- When abandoning plant, the alignment should replace or be placed immediately adjacent to the existing plant.
- Alignments must be parallel or perpendicular to street property lines.
- A continuous alignment for the length of the installation is preferred.
- All horizontal bends must be 90˚ and have a 0.91m radius.
- New and existing plant will occupy one utility corridor per street / lane way.
- Any exceptions require approval from the Utilities Management Branch.
- Proposed alignments in the vicinity of street trees must follow the requirements outlined in *Section 7.4.5*.

The Utilities Management Branch recognizes that existing plant located within the City streets may present obstacles in satisfying the conditions in this section. If a utility company has any concerns selecting an alignment, the Utilities Management Branch is available to assist in determining a suitable alignment.

7.2.3 UTILITY CLEARANCES

The City's utility clearance requirements have been developed over many years of field experience and by the application of a pragmatic approach that aims to balance all competing interests. Standard utility clearances between existing underground utilities have been established to minimize conflict and ensure a safe work zone exists around each utility's equipment. When construction activities require a utility to be temporarily or permanently relocated, arrangements that are equitable to all parties affected will be made via the Utilities Management Branch.

7.2.3.1 VERTICAL UTILITY CLEARANCE

The minimum vertical clearance when crossing a utility is 0.3m. All vertical clearances are measured from the closest outside edge to closest outside edge of the utility plant. Any exceptions to this clearance will require approval from the affected utility or utilities, as well as the Utilities Management Branch.

7.2.3.2 HORIZONTAL UTILITY CLEARANCE

All horizontal clearances are measured from the closest outside edge to closest outside edge of the utility plant. The minimum horizontal clearance for all City's utilities, inclusive of service connections, except sewer, water, and City's NEU District Energy is 0.3m. Water and the City's NEU District Energy Piping require 1.0m minimum horizontal separation to maintain sufficient bedding around the pipes. Sewer assets, maintenance holes, service connections, catchbasins and catchbasins leads require 1.5m horizontal separation. See below for further information. Any exceptions to this clearance will require approval / agreement from the affected utility or utilities, as well as the Utilities Management Branch.

Sewer asset construction often requires deep excavations with wider trenches to allow for extra shoring and safe working room. With the added concern of shallower utilities collapsing into deeper sewer trenches, the City places restrictive requirements on utilities, requiring a minimum horizontal clearance of 1.5m from all sewer assets. In addition, the City reserves the right to require additional clearance under special circumstances (e.g. future sewer separation work).

For additional utility clearance and separation requirements, please refer to *Section 2.2.5*. In instances where clearances in *Section 2.2.5* exceed those described in *Section 7.2.3*, the greater required clearance will apply.

7.2.4 CONCRETE ENCASEMENT

Encasement in concrete is required for the following utilities:

- BC Hydro.
- Telecommunications company duct banks containing 16 conduits or more. The Utilities Management Branch may also require smaller duct banks to be concrete encased under conditions of insufficient depth, wide radius bends or proximity to other utilities.
- Coast Mountain Bus Company.
- Private utility encroachments may require concrete encasements.

The City requires that all concrete encased ducts shall:

- Be able to support their weight over a perpendicularly positioned utility trench.
- Have a minimum 75mm width around the conduit.
- Have both vertical sides of the concrete encased duct bank formed.
- Meet minimum requirements as set by *CAN/CSA A23.1 Concrete Materials and Methods of Concrete Construction* and *CAN/CSA A23.2 Methods of Test and Standard practices for Concrete*.

7.2.5 MAINTENANCE HOLES

The following section outlines the City's design requirements as they pertain to standard maintenance holes. The City's primary concerns focus on the location of maintenance holes within the street corridor, capacity for adjustment, and drainage provisions.

7.2.5.1 LOCATION OF MAINTENANCE HOLES

To preserve utility corridor space for present and future needs, the City requires that installation of maintenance hole or access chambers:

- Have the longer side of the equipment aligned parallel to the property line.
- Be placed directly overtop the utility alignment and not offset to a side, unless an exemption has been approved by the Utilities Management Branch.
- Maintain a minimum clearance of 10m from street intersections measured from the property line. This requirement ensures ease of access and adequate visibility for vehicle traffic during maintenance activities.

- Preferably, be located in the boulevard or curb lane of the roadway and should avoid being placed in the sidewalk, so as to minimize disruptions during construction and maintenance activities. When there isn't sufficient space in the boulevard, some portion of the maintenance hole may overlap into the sidewalk; effectively straddling between sidewalk pavement and boulevard. Placement of the maintenance holes in the sidewalk will be carefully reviewed by the Utilities Management Branch on a case-by-case basis to ensure the safety of sidewalk users while considering the utility company's challenges due to space constraints.
- Are not permitted within a lane entrance or intersection curb return areas (refer to items in *Section 7.2.6.2* regarding ramp areas).
- Preferably, be located outside the drainage channel (swale) in the lane where the sewer main is not present.

7.2.5.2 VERTICAL ADJUSTMENT REQUIREMENT

As there is a potential for vertical grade changes to City roads, maintenance hole lids are required to be adjustable. To accommodate this, the maintenance hole lid frame is to sit on either bricks, pre-cast concrete slabs, or the equivalent. Furthermore, the neck of the maintenance hole must be a minimum 450mm in height to allow vertical adjustment to meet the finished grade of the roadway.

7.2.5.3 SEWERS AND DRAINAGE REQUESTS FOR UTILITY COMPANY MAINTENANCE HOLE DRAINS

A utility access chamber requiring a drainage connection to the City Sewer network is required to submit a drainage connection request to the Utilities Management Branch.

There is an annual charge, per drain, to connect to the City's storm, combined, or sanitary sewer systems. Note that there are some sewer lines that cannot be connected to. The utility company is responsible for doing the connection under the City's inspection.

The City requires that the utility company's installed portion of the maintenance hole drain meet the most current applicable standards as per *Section 4.4* and *Section 5.4*.

When submitting a drainage connection request to the Utilities Management Branch, the following items are required on the proposed drainage drawing(s) before Sewer Design can proceed with the review process:

- Plan view showing the proposed alignment of the drainage connection with chainage distance to the nearest perpendicular property line from the sewer main.
- Annotation identifying the proposed drain and pipe size, the tie-in location and the type of the existing sewer main (e.g. 300mm STM or 250mm COMB).
- Profile view, in proper scale, of the proposed drainage connection including the utility chamber and the existing sewer main at the correct invert elevation.

- Note on the drawing indicating that "THE UTILITY OWNER/CONTRACTOR IS REQUIRED TO CONTACT SEWER CONNECTIONS AT eng.swpermits@vancouver.ca. A MINIMUM OF 5 WORKING DAYS PRIOR TO ARRANGE FOR AN INSPECTION. THE UTILITY OWNER/CONTRACTOR IS RESPONSIBLE TO CONNECT TO THE SEWER MAIN AS PER CITY OF VANCOUVER SEWER CONNECTION STANDARD". The City will issue a payment notice for the inspection fee and the utility company will be required to make a payment prior to the construction start date.
- Any connections between maintenance holes to the draining (drainage system) maintenance hole.
- The existing drainage system for each maintenance hole shown on the design drawing (e.g. drain, rock pit, sump).
- Identification numbers for all maintenance holes.

In special circumstances, ductile iron pipe class C52, conforming to *AWWA C151/A21.51 Ductile-Iron Pipe, Centrifugally Cast, for Water* should be substituted:

- When the depth of cover is less than 1.2m.
- When the depth of cover is greater than 3.7m.
- If ground conditions are unstable.
- When crossing under railway tracks.
- If crossing a utility less than 450mm away.

Utility companies must be cognizant that the City of Vancouver at no time guarantees the long-term location or availability of any maintenance hole drains. From time to time, upgrades to the City's sewer network system may result in relocation of sewer mains. Costs associated with the relocation or removal of any existing drain, requested by the City, will be the responsibility of the utility company.

7.2.6 SURFACE STRUCTURES

The following sections detail loading and placement criteria of surface structures, including vaults, junction boxes, and non-standard maintenance holes.

7.2.6.1 LOADING CRITERIA

The City requires that all structures located within the City street constructed with non-standard maintenance hole frame and lid components, meet or exceed the City's minimum design load requirements. The most current edition of *CAN/CSA S6 Canadian Highway Bridge Design Code*, in conjunction with the *BC MoTI Bridge Standards and Procedures Manual*

, shall be the minimum acceptable design standard for these structures. The City recognizes that vehicles of varying size and weight frequently occupy sidewalks and other non-travelled portions of the street; note that the referenced design standard applies equally to structures within these areas. An exception to the aforementioned exists for those structures in boulevard and sidewalk areas, where a design load reduction pursuant to the most current edition of *CAN/CSA S6 Canadian Highway Bridge Design Code Section 3.8.4.4* of applies.

- The BC CL-625 vehicle shall be used for loading designs, recognizing that the BC design vehicle includes higher axle load ratings than the CAN/CSA design vehicle.

- Subject to the size of the intended structure, maintenance hole frame and lid components must account for the probability of loading from multiple axles (i.e. loading from axles 2 and 3).
- As tridem axles are permitted on single-unit vehicles in BC, the City recommends this loading configuration be considered in designs (British Columbia Commercial Transport Regulations).
- Several vehicle operators are known to operate vehicles within the City that exceed normal provincial loading regulations (e.g. Coast Mountain Bus Company states they have a provincial exemption to operate their buses to the full axle load rating of their vehicles. Coast Mountain Bus Company has stated that some of their buses have operational axle loads of up to 13,000kg on a single drive axle - approximately 127.5kN - when operating at full capacity).
- There is always variability in the actual vehicle operating loads. While there are provincial regulations and City by-laws regulating allowable axle loading (e.g. British Columbia Commercial Transport Regulations, City of Vancouver Street and Traffic By-law No. 2849), it cannot be guaranteed that vehicles will not exceed these legal load limits. There are real possibilities that vehicles, particularly overweight vehicles, exceeding legal load limits will enter into sidewalk areas and other non-traveled portions of the street.

7.2.6.2 PLACEMENT CRITERIA

Alongside the aforementioned loading criteria, surface structures shall comply with the following requirements:

- Clearance shall be maintained near standard pedestrian ramps. Placement criteria (applicable to double curb, large single ramp and lane curb ramp designs) shall be the greater of a:
    - 2.0m setback from the beginning or end of the curb radius to the closest edge of the structure, or
    - 3.0m setback from the adjoining street property line to the closest edge of the structure.
- Clearance shall be preserved to allow for construction of standard road configurations where existing curbs, sidewalks or other similar street infrastructure were not built to meet current standards (i.e. the provision for future flared lane entrances, curb ramps).
- Vault installations adjacent to existing buildings shall accommodate future grade changes, where existing elevations and structures (e.g. road, sidewalk, building grades, and curb face height) have not been constructed to current City standards.
- Vaults shall maintain a minimum 1.0m clearance from typical surface features such as poles, fire hydrants and street furniture.
- Vaults shall maintain the distance of twelve times the tree trunk diameter measured at 1.4m above ground. Refer to Section 7.4.5 for more information.
- Vaults should maintain a minimum 1.0m clearance from residential and business entrance / walkways (i.e. garage, gate, door, etc.).
- Standard clearances from all other utilities shall be maintained.

- The ideal location for vaults is in the boulevard adjacent to the property line (as close to the adjacent property line as possible). When there isn't sufficient space in the boulevard, some portion of the vault may overlap into the sidewalk; effectively straddling between sidewalk pavement and boulevard. Placement of the vaults in the sidewalk will be carefully reviewed by the Utilities Management Branch on a case-by-case basis to ensure safety of the sidewalk users while considering the utility company's challenges due to space constraints.
- The vault roof is to be installed at the City design grade. In situations where there is an improved boulevard, the vault will meet existing street grade. For those installations in unimproved boulevards, and non-development related installation, the City may provide design grades at all four corners of the vault. For the development related installation, the developer's civil engineering consultant to provide the design grades.
- Utility equipment is not permitted in roadways or crossings.
- Vaults should not be located in front of or behind bus-stop shelters.
- The maximum gap permitted for all grates shall be 6.0mm. Exceptions are non-walking surface areas which will be reviewed on a case-by-case basis.
- A minimum allowance for a 150mm vertical adjustment of the equipment is required to accommodate changes to street grade and settling.
- All equipment (e.g. lids, covers) must consider 'vulnerable street users' and have a minimum 0.5 and 0.6 wet and dry coefficient of friction, respectively.
- Equipment must be located within the existing utility alignments and / or corridors and will not be permitted where proposed placement may inhibit the use of a future corridor or limit optimum use of such space.
- To minimize the amount of utility corridor space occupied, equipment is to be installed with the longer side parallel to the property line and the width of the equipment should be minimal relative to similar equipment and the width of the duct bank.
- Vault locations should accommodate standard street treatments (e.g. front boulevards, sidewalks, pedestrian lane crossings).
- Property owners shall be notified (depending on the size of the equipment) prior to the submission of any proposed drawing to the City, where equipment may possibly be situated. Notification is not a request for approval from property owners, but awareness for overall design considerations.
- Attention must be paid to overhead encroachments (e.g. awnings, building overhangs, canopies) that may be installed directly over proposed locations.
- Locates for all buried utility equipment and service connections within the immediate area of a proposed alignment must be undertaken and included on proposed drawings.
- Where equipment is to service a new development or redevelopment, plant shall be located on private property.
- FortisBC Gas Regulator Station structures are only permitted on local streets, laneways and private property.
- Square lid vaults utilized by the telecommunications company are only permitted in the boulevard.
- Preferably vaults shall be located outside the drainage channel (swale) in the lane where the sewer main is not present.

7.2.7 ABOVEGROUND STRUCTURES

The City's preferred location for aboveground structures is on private property, with the exception of communication and monitoring kiosks (i.e. low voltage enclosure). This equipment may be placed on City streets, following review by the Utilities Management Branch and neighbourhood notification. The utility company shall provide the notification to provide adjacent property owners including an accurate rendering of the proposed facility. Final approval considerations include aesthetics as it relates to the overall streetscape, effects on vehicle and pedestrian movements, sightlines and the position of the equipment. The following sections detail the City's requirements for aboveground structures.

7.2.7.1 LOCATION OF ABOVEGROUND STRUCTURES

City street space is extremely limited throughout the City due to necessary City structures and services, and pedestrian movement remains a priority. Proposals for locations of aboveground structures on City property will be thoroughly reviewed on a case-by-case basis taking into consideration of the following placement criteria, in addition to the clearances outlined in *Section 2.2*:

Location:

- Shall be located on flankage streets ("side" streets) where possible or laneways preferably near the back of the property against a hedge, wall or fence, as to minimize the visual impact on the adjacent property.
- Shall be located against the adjacent property line.
- Shall be located within the existing utility alignments and / or corridors and will not be permitted where proposed placement may inhibit the use of a future corridor or limit optimum use of such space.
- Shall be limited to one piece of aboveground equipment per adjacent property.
- Where equipment is to service a new development or redevelopment, this facility shall be located on private property.
- Aboveground equipment shall maintain the following clearances from stated objects:
    - Minimum 1.0m clearance from typical features such as poles, fire hydrants, planters and street furniture.
    - Minimum 1.0m from all vehicle crossings.
    - Minimum 1.0m from pedestrian entrances to residential and commercial properties (not applicable to those located within curb return / pedestrian ramp areas, as defined in *Section 7.2.6.2*).
    - Minimum 0.3m from sidewalks and future sidewalks (not applicable to those located within curb return / pedestrian ramp areas, as defined in *Section 7.2.6.2*).
    - Located between the back of sidewalk and property line, with a maximum offset of 1.2m from the property line to the roadside face of the box.
    - Where boulevards are less than 4.4m in width, a minimum clear path of 3.15m from the gutter-line to the roadside face of the equipment must be maintained.
    - Minimum of 3.0m from a lane or street property line.
- The City may place additional restrictions on a site-by-site basis, where concerns regarding sight lines arise.

- Aboveground equipment shall not:
    - Be in front of windows, doors and gates.
    - Be located adjacent to sidewalk cafes.
    - Obstruct driver or pedestrian sight lines or otherwise compromise public safety.
    - Require pedestrians to adjust their line of travel to pass the aboveground equipment.
    - Be in front of or behind bus-stop shelters.
    - Be within any transit loading or unloading area in a manner that interferes with boarding, disembarking, or queuing by transit passengers.
    - Obstruct the operation of the public bike share system or shared E-scooter system.
    - Be permitted within lane entrance or intersection curb return areas (refer to items in *Section 7.2.6.2* regarding pedestrian ramp areas).

7.2.7.2 DOWNTOWN/COMMERCIAL ZONE LOCATIONS

- Downtown kiosk locations will be reviewed on a case-by-case basis due to the different layout of the downtown streets and the various competing interests for space. Locations will be reviewed primarily for impact to pedestrian movements and adjacent property owners among other considerations.

7.2.7.3 AESTHETICS / DESIGN / MAINTENANCE

- Height of the aboveground equipment shall be limited to the minimum height needed for the equipment.
- Aboveground equipment shall be always maintained and kept free of graffiti.
- In certain locations aboveground equipment shall have a peaked or rounded roof on the top to deter unwanted activity.
- Aboveground equipment shall be positioned with the longer side and / or doors of the aboveground equipment running parallel to the street property line.
- The foundation shall not extend beyond the edges of the aboveground equipment and shall be installed flush to meet street design grade.

7.2.7.4 OTHER CRITERIA

- Property owners and local Business Improvement Areas shall be notified by letter with a rendering of the facility prior to the final approval of the proposed aboveground equipment location. Utility company contact information shall be included on the letter. Notification is not a request for approval from property owners, but awareness for overall design considerations. The City shall be copied on all notifications and resulting correspondence.
- Attention must be paid to overhead encroachments (e.g. awnings, building overhangs, canopies) that may be installed directly over proposed locations.
- Drawing submittals shall meet the requirements of *Sections 7.5.5* and *7.6.6*.
- When choosing equipment locations, consideration should also be given to limiting construction impacts to the street space and to vegetation where possible.

7.2.7.5 BC HYDRO PAD MOUNTED TRANSFORMERS AND ABOVEGROUND VISTA SWITCHES

- This equipment is to be situated in a BC Hydro right-of-way, on private property, and is not permitted within City streets.

7.2.7.6 STEAM HEAT VENT PLANTERS

- Steam vents are to be designed and installed flush with the ground outside of the main pedestrian walking path. The steam vent planter is no longer approved for installation on City streets, with all existing planters eventually being removed.

7.2.8 POLES, PILASTERS, TRANSFORMERS, AND ANCHORS

The following section details the City's design requirements for utility poles, pilasters, transformers and anchors. The City does not permit any utility to install new pole lines or extensions to existing pole lines. Any additional poles proposed within an existing pole line will be discouraged and must be approved by the Utilities Management Branch. Moreover, the installation of new "H-frame" poles is not permitted.

7.2.8.1 LOCATION OF POLES

When an additional pole is to be installed on a street or an existing pole is to be relocated, there are standard pole locations for placement. Existing conditions, specifically building setting, will generally restrict available locations. Generally, pole locations shall be:

- At lot lines or projected lot lines.
- A minimum 1.0m clear of vehicular crossings.
- A minimum 1.7m clear of fire hydrants.
- A minimum 1.0m clear of catchbasins.
- A minimum 1.0m clear of crosswalks.

Standard pole offsets (from pole centre to property line) in lanes with a width of:

- Less than 3.1m, are not permitted.
- From 3.2m to 6.1m wide, is 0.4m.
- From 6.2m to 10.1m wide (West End), is a minimum of 0.4m to 0.9m.

Standard pole offsets (from pole centre to property line) in streets with a pavement width of:

- Up to 11m is 4.0m.
- From 11.1m to 12.0m is 3.0m.

For street widths greater than 20m or for those streets with boulevards narrower than the standard offset, the pole centre should be located 760mm from the centre of pole to the face of curb. Future curb locations must be confirmed with the Utilities Management Branch.

7.2.8.2 PILASTERS

The maximum height of pilasters with guard as set by the City in:

- Lanes is 300mm;
- A street boulevard is 50mm; and
- A street sidewalk is 50mm.

The pilasters are not to extend into the travelled portion of the sidewalk or past the roadside face of the pole.

7.2.8.3 OVERHEAD TRANSFORMERS

All overhead transformer installations must be reviewed by the Utilities Management Branch, to ensure their presence minimizes the impact on the surrounding neighbourhood. Considerations taken into account include location, where overhead transformer installations must be immediately adjacent to the property requiring the service and ensuring that they meet or exceed applicable standards as established by *CAN/CSA Canadian Electrical Code with bulletins issued by Electrical Safety Branch of the Province of British Columbia and the City of Vancouver*. Notification to adjacent property owners is required for all new overhead transformer placements. Notification shall include property owners with an accurate rendering of the proposed transformer location. Additional notification may be required by the City on a case-by-case basis.

7.2.8.4 DOWN GUY AND ANCHOR

The location of down guy and anchor equipment is determined by either BC Hydro or Telus, based on the needs of their equipment on pole lines. All new anchor locations must be approved by the Utilities Management Branch. Due to the serious impact this equipment can have on adjacent properties, a thorough review is carried out to ensure there is a balance between the needs of the utility company and affected property. The presence of existing anchors can also raise concerns for property redevelopment projects, resulting in a need to have the down guy and anchor relocated. The preferred resolution has involved altering the length of the existing down guy and anchor, to suit the proposed development. The following are general location requirements for down guy and anchors installations:

- The down guy must be parallel to the property line, maintain the same offset as the pole line and not extend past the street or lane property line.
- Guy wire in close proximity of or touching a street light pole or luminaire shall be wrapped by approved guy cover.
- A sidewalk guy must be installed at right angles to the property line, with the anchor at a maximum distance of 0.3m from property line.
- Access to existing entrances or driveways must not be compromised.
- The down guy must not cross in front of a gas meter, Pad Mounted Transformer, or any other utility equipment located on private property.
- Anchor must meet the minimum separation from the City's utilities as stated in *Section 7.2.3.2*.
- Anchor and down guy installation at a new location will require notification to the adjacent property owners with an accurate rendering of the proposed anchor and down guy. Notification is not a request for approval from property owners but awareness of overall design considerations.

7.2.8.5 STEEL TROLLEY POLES

The location of steel trolley poles must:

- Be at lot lines or projected lot lines.
- Maintain a minimum 1.0m clearance from vehicular crossings.
- Maintain a minimum 1.7m clearance from fire hydrants.
- Maintain a minimum clearance from intersection and lane curb return areas (as defined in *Section 7.2.6.2*).
- Maintain a minimum 1.5m clearance from catchbasins.
- Maintain a minimum 1.0m clearance from crosswalks.
- Be 430mm from the face of the curb to the centre line of the pole for A7E pole types.
- Be 460mm from the face of the curb to the centre line of the pole for A3E pole types.
- Be 535mm from the face of the curb to the centre line of the pole for A20E and A23E pole types.

The installation of anchor guy wires, where new trolley poles and foundations are being installed, is not permitted.

7.2.9 OVERHEAD WIRES

The minimum above ground clearance for any overhead wire or cable installation across or along any street or lane shall be the greater of:

- The applicable clearance defined in the latest version of *CAN/CSA C22.3 No. 1 Overhead Systems*, or 4.9m.

Any utility with overheard wire installations found below the minimum height allowance will be required to be adjusted upon receiving notification from the City. Avoid alignments with potential conflicts with street trees, where possible.

7.2.10 SURFACE INLAY FIBRE AND MICROTRENCHING

Surface Inlay Fibre (SIF) and microtrenching is permitted on a conditional basis in the City of Vancouver. Utility companies wishing to utilize this installation technique are required to enter into a separate Municipal Access Agreement with the City specifically for the use of SIF and microtrenching and adhere to installation standards.

This section has been developed to accommodate the installation of surface inlay fibre within the City street right-of-way on a conditional basis.

Surface inlay does not meet the utility installation standards for the City of Vancouver. However, considering the benefits of this facility with its ability for low impact installation into sensitive areas such as special pavements, congested utility corridors or areas with major traffic volumes, the City is permitting construction and operation of equipment on a conditional basis, with certain considerations. The installation of this technology at the surface of pavement or sidewalk puts it at extraordinary risk compared to other utility installation technologies, and as such, there can be no liability to the City of Vancouver for damages to this equipment incurred when the City or others undertake any works. With the inherent susceptibility to damage, the City strongly recommends redundancy be built into each installation project.

If these conditions are agreeable, the City of Vancouver will consider surface inlay subject to the following technical specifications:

- Drawing Submissions – Drawings are to be submitted as per *Sections 7.5.5* and *7.6.6*.
- Alignment – The existing streetscape is the prime consideration for the choice of a running line. There are three types of settings encountered on the street right-of-way: improved boulevards, unimproved boulevards, and travelled road surface.

7.2.10.1 IMPROVED BOULEVARD

An improved boulevard includes the hard surface structures located between the face of the curb or edge of pavement and the property line. These are the top of curb, the front boulevard (or utility strip), the sidewalk, and the back boulevard (or building strips when adjacent to buildings). Allowable alignments within this area include:

- In the front boulevard (or utility strip), between the back of curb and front of sidewalk.
- In the back boulevard (or building strip), between the back of sidewalk and property line.

7.2.10.2 UNIMPROVED BOULEVARD

An unimproved boulevard includes the grass area and gravel shoulder. Installation is acceptable anywhere within this area and can be installed with up to 225mm cover. The fibre may also be encased within an additional sheath for protection, subject to approval by the Utilities Management Branch on an individual basis. Those companies employing SIF within these areas should be aware that any unimproved boulevard may undergo future improvements, with the installation of sidewalks, curbs and gutters, street trees or a portion of an asphalt road.

7.2.10.3 TRAVELLED ROAD SURFACE

The travelled portion of the road includes materials consisting of asphalt, concrete and paving stones. Acceptable alignments in asphalt streets are between the edge of the road and the edge of the gutter, and a crossing perpendicular to the street (refer to depth criteria under *Section 7.2.10.5*). Alignments wholly within the asphalt running parallel to the street will not be permitted, except within lanes. Construction alignments in lanes, paved or unpaved, shall have an offset of 0.3m from the property line unless otherwise approved by the Utilities Management Branch. The approved alignment must be adhered to and no deviations around temporary street occupying items such as parked cars, garbage containers, will be accepted. The criteria regarding equipment depth applies equally to installations within lanes.

A concrete road consists of large panels of concrete with thicknesses ranging from 125mm to 300mm, and a joint key that is typically 1/4 to 1/3 the thickness of the panel. Fibre may be installed in the seams between panels if it does not compromise the joint key (must not be disturbed) or cut across a panel. These seams will permit a running line parallel to the street or a crossing perpendicular to the street.

Paving stones come in a wide variety of styles and designs. An alignment for surface inlay fibre will be required to be within an existing seam between bricks. Running lines parallel to or perpendicular to the street are acceptable where they are found in these situations.

Any project that cannot meet the alignment criteria, must apply to the Utilities Management Branch for assistance to determine an acceptable alternative. Any alternate alignment chosen that cuts across or otherwise damages a concrete sidewalk stone or curb and gutter, will be charged the full replacement cost of that item.

7.2.10.4 CONSTRUCTION

Surface inlay construction must adhere to all City of Vancouver by-laws and the utilities standards for utility construction, as outlined in the *City of Vancouver Construction Specifications*. When required, the City will request a traffic plan to be submitted as per the *City of Vancouver Construction Specifications*.

7.2.10.5 DEPTH

The depth of installation will vary depending on type of street surface and whether the equipment is "direct buried" or encased within a protective sheath. The minimum depth for all installations will be such that 20mm will be allowed from the road surface to the top of the equipment for appropriate joint sealant adhesion. The following are depth guidelines for typical streets:

- Concrete sidewalk – Maximum 150mm in the joint only.
- Boulevard and gravel verge – Maximum 225mm.
- Gutter / road edge – Maximum 150mm.
- Concrete road panel – In the joint, to the depth of the joint key.
- Asphalt road:
    - Arterial Roads – The acceptable depth for installation in an asphalt road will be one-third the existing pavement depth. The thickness of existing pavement (including the concrete base) will be proven by the utility company prior to installation, with the removal of a 100mm diameter core that must be viewed and approved by the Utilities Inspector.
    - Residential Roads and Lanes – Most residential roads are only 50mm to 150mm thick. The maximum depth in residential streets will be one-third the existing pavement depth.

The permit drawing is required to show the proven depth of pavement at all asphalt installation locations by the removal of asphalt core samples. The core sample locations must be shown on the permit drawing, at least one per block. The Utilities Management Branch Inspector must be present when the core samples are taken.

Any project that cannot meet the depth criteria must apply to the Utilities Management Branch to determine if an acceptable alternative exists. There will be no exceptions to the maximum depth criteria in an asphalt road.

7.3 CONSTRUCTION REQUIREMENTS

Third-Party utilities have varying construction requirements based on the type of utility and the proposed design. Refer to the *City of Vancouver Construction Specifications* and the *City of Vancouver Standard Detail Drawings* for the requirements common to all third-party utilities installation.

7.3.1 CONSTRUCTION SPECIFICATIONS

The *City of Vancouver Construction Specifications* and the *City of Vancouver Standard Detail Drawings* outline standards, specifications, and procedures for construction and restoration works of street, sidewalk, utility service cuts and trenches. The document provides best practices guidelines for City forces and utility companies, ensuring that excavations, backfill material, installation and compaction procedures, density requirements, and surface restoration on City streets are carried out in accordance with the best available standards and procedures.

Any backfill product that is requested for use that is not contained in the *City of Vancouver Construction Specifications* and *City of Vancouver Standard Detail Drawings* will require a review and specific written permission from the City prior to its use.

7.3.2 TRENCHLESS CONSTRUCTION

The Utilities Management Branch will review the trenchless construction on a case-by-case basis. Third party utilities shall provide the type of trenchless method that will be utilized at a design review stage and notify the Utilities Management Branch upon the permit drawing submission.

7.3.2.1 HORIZONTAL DIRECTIONAL DRILLING (HDD)

This section outlines the design and construction requirements for horizontal directional drilling (HDD) methodology.

A utility company proposing a horizontal directional drilling method to install the equipment should submit the following items to the Utilities Management Branch for review at a design stage:

- Geotechnical recommendations confirming suitability of the method of installation. Geotechnical assessment shall include anticipated vibration and settlement impacts. Vibration monitoring plan should also be prepared if the professional geotechnical engineer recommends it.
- Based on the geotechnical assessment, the proposed equipment shall maintain the recommended minimum separation by a professional engineer or minimum separation required by the City, whichever is greater, to existing sewer main, catchbasins and catchbasins leads, water main and other City's infrastructure.
- Provide detailed plan and profile drawing of the proposed work, additional information can be found below.
- Plan and profile requirements:

- Utility company to create profile(s) for the proposed alignment where trenchless method is proposed.
- Profile shall include locations and depth of all existing sewer main, services including catchbasin leads, water main, hydrant leads, and services greater than or equal to 100mm along the alignment.
- Profiles shall be generated using the information from the daylighting (see requirements stated below) and topographic survey.
- Entry and exit pits shall be shown in the plan and profile including preliminary dimensions and offsets from the property lines.

Utility company proposing the HDD will be required to complete daylighting based on the following criteria:

- All existing sewer main, services including catchbasins and leads, water main and services within 3.0m horizontally and 1.5m vertically of the proposed utility alignment shall be exposed using hydro-excavation, hand excavation, or another approved method to confirm alignment and depth. Exposed utilities shall be surveyed and shown on the submitted plan and profile.
- All sewer main, services including catchbasins and leads, water mains, hydrant leads, and services greater than or equal to 100mm in diameter and crossing the proposed utility shall be exposed, surveyed, and shown on the plan and profile.
- Sewers & Water services less than 100mm in diameter shall be exposed, surveyed, and shown on the plan and profile, at the discretion of the Engineer of Record (EOR).

When crossing all existing sewer mains, pre and post CCTV inspection will be required to performed by the utility company. Any and all damage(s) to the City's infrastructure as a result of the HDD will be repaired and/or replaced at the cost of the utility company that proposed HDD.

7.4 SUPPLEMENTARY INFORMATION

The following section provides valuable supplementary information for those engaged in utility design and construction activities within City streets.

7.4.1 CITY UTILITY AND PAVING SCHEDULE

The *Engineering Services Department* provides frequent updates of their planned street construction program including grind and overlay, sidewalk, left turn bay, and sewer and water construction, as well as a host of other street upgrade programs. The comprehensive list contains the current year's projects, as well as long range plans of up to seven years. The Utilities Management Branch, in its efforts to promote construction coordination, e-mails project schedule information to utility companies for their internal review. The City's intent is to provide an opportunity for companies to forecast any conflicts with current City projects and assist with their long-range planning schedules.

7.4.2 CITY OF VANCOUVER CONSTRUCTION PROJECTS

The City of Vancouver website, at www.vancouver.ca/streets-transportation/roadwork.aspx contains information about major roadwork projects within the City such as sewer and water main work, road closures, and other works that may potentially affect the public. The information provided is intended to assist in the planning and scheduling of utility construction and maintenance projects.

7.4.3 SPECIAL PAVEMENTS

In select areas throughout the City, a number of streets have been surfaced with special pavements. In this context, special pavements refer to all non-asphalt and non-concrete surfaces such as brick, and granite. In other areas of the City, namely older streets and lanes, the original "historical" pavement surface (designated and protected under the authority of City Council) may have been repaired or overlaid with asphalt or concrete. For construction requirements for working in special pavement areas, refer to *Section 3.2* of the ***City of Vancouver Construction Specifications***.

7.4.4 GEOSYNTHETICS

In select areas throughout the City, the underlying soil contains deep peat deposits, a low strength and highly compressible material that results in varying amounts of settlement when loaded. The pavement structures within these areas have been modified by the addition of geotextile fabric (resembles a heavy white or black cloth), and geogrid (resembles a black snow fence lying flat), to improve their performance.

The Utilities Management Branch has identified several known areas of peat deposit within the City that currently employ the use of geosynthetics as a part of the pavement structure, those include:

- 16th Avenue from Sophia Street to St. George Street.
- 17th Avenue from Carolina Street to the lane west of Fraser Street.

- 18th Avenue from Prince Albert Street to Fraser Street.
- Skeena Street from 2nd Avenue to 3rd Avenue.
- 19th Avenue from Fraser Street to Price Albert.

The City recognizes that the list of streets containing peat deposits, noted above, may be amended periodically as new locations are identified.

Companies engaged in utility construction activities within these areas, whether excavating through or restoring the geotextile fabric, must follow the procedure as set out by the City in *Section 33 50 01S: Third-Party Utilities* and *Section 31 32 19: Geosynthetics* of the ***City of Vancouver Construction Specifications***. Refer to a ***Standard Detail Drawing*** *R2.5* (typical cross section of roads on peat) for restoration, backfill, and construction details when working in peat areas.

7.4.5 STREET TREES

Boulevard trees situated on City property are protected by the *City of Vancouver Street Tree By-law No. 5985*. Utility companies and their contractors must make all efforts to protect trees from potential damage during construction and maintenance activities. When conflicts arise between a proposed utility design and existing street trees, the approved utility permit drawing will have a condition noted to contact the Vancouver Park Board (VPB Urban Forestry) thirty days prior to commencing construction. It is important that the requirement to contact VPB Urban Forestry be met to provide ample time for VPB Urban Forestry to assess the construction site and determine construction techniques that will minimize disruption to the existing trees and their root systems.

VPB Urban Forestry reserves the right to request an updated arborist report and require an ISA Certified Arborist to be onsite during excavation and construction activities to provide supervision and guidance. Request for street tree removals will be subject to review and authorization by VPB Urban Forestry as well as the payment of appraised value or replacement costs and a public notification period.

The utility company proposing to install equipment in the vicinity of City trees must consider and adhere to the following criteria and requirements, in accordance with the ***Construction Specifications Section 33 50 01S*** *for Third Party Utilities*:

- Clearly indicate the locations of all City trees on design drawings.
- Ensure all contemporary root preservation options and technologies are considered prior to requesting VPB Urban Forestry to review the proposed utility design. Root preservation options include, but not limited to:
    - alternate alignment(s);
    - directional drilling;
    - air-spading;
    - low pressure hydro-vac;
    - flexible conduit;
    - hand-digging; and
    - minimize utility footprint to limit incursion into root zones and impacts on tree canopy.

- Twelve times the tree trunk diameter at breast height (DBH), measured at 1.4m above ground, is the best practice per the Pacific Northwest Chapter of the ISA for tree protection zones (TPZ). TPZ less than twelve times DBH may be considered, but must be approved by VPB Urban Forestry.
- Any work within a TPZ will trigger tree protection measures, in accordance with the Protection of Trees Bylaw No. 9958 – Schedule A and as approved by VPB Urban Forestry. The measure may include hiring an ISA-certified arborist to provide oversight during excavation and a follow-up report to VPB containing photographic evidence of intact bark on preserved stems and roots.
- No net loss of tree planting sites is permitted. All design work must include provision for minimum one to one replacement should any tree removal be required to facilitate utility installations. This includes replacement of growing medium for the future growth of roots to a volume of $30m^3$/tree. Soil volumes less than $30m^3$/tree may be considered but must be approved by VPB Urban Forestry.
- Damage to trees resulting from failure to follow VPB Urban Forestry specifications may result in liability for the partial or complete appraised value of the damaged tree(s). The value will be determined by VPB Urban Forestry using the standard method taken from the Guide for Plant Appraisal, current edition, by the Council of Tree & Landscape Appraisers.

7.4.6 ABANDONED PLANT

In the event that a utility company no longer requires the use of their authorized plant located within City streets, they must notify the City Engineer promptly in writing of the abandonment. Notification should include details of the plant such as size, depth and material and what hazardous materials are present within the plant such as asbestos. Upon notification, the Utilities Management Branch may require the utility company to remove or decommission the abandoned plant within 90 days from the date of the notification. Additional requirements may be put in place depending on presence of hazardous materials. Proper notification ensures that City records are kept current and up-to-date, and that future street space is preserved.

For additional abandonment requirements, refer to the *City of Vancouver Construction Specifications*.

7.4.7 SURVEY MONUMENTS

To ensure every effort is made to protect survey monuments, during the utility construction approval process, the Utilities Management Branch will review each proposed drawing for potential conflicts with monuments. However, it remains the responsibility of the utility company to take the necessary steps to locate and avoid these monuments, as well as making arrangements with the Utilities Management Branch for referencing and monitoring all monuments within the construction area. A map of all control monuments within the City, and a book listing all control monuments, their locations and elevations, is available from the Land Survey Branch and additional information can be found in *Section 2.3.5*.

For construction related requirements, refer to the *City of Vancouver Construction Specifications*.

7.4.8 DAMAGE AND GRAFFITI

All aboveground utility structures are at risk of being damaged or defaced. *City of Vancouver Graffiti By-law No. 7343* prohibits the placement of graffiti on private and City property. The Utilities Management Branch expects all utility companies will have in place, a regular maintenance program that includes inspection of their aboveground equipment for damage and graffiti, and its repair or removal if required.

7.4.9 NOISY UTILITY EQUIPMENT

The Utilities Management Branch will not permit audible noises emanating from utility equipment located within the City streets, at any time. Utility companies with equipment emitting audible noises, such as from a cooling fan, electrical transformer or other device, will be required to repair their apparatus to be effectively silent in operation.

7.4.10 AREAWAYS

Areaways are underground extensions of private property onto City streets. They are considered encroachments. The extent can range from a few square feet, to an underground structure surrounding the entire building perimeter, and extending up to 10 feet from the property line. Normally, an areaway is leased from the City, under the terms and conditions of an agreement, and any utility wishing to access the space as part of the running line would be required to negotiate access from the parties to the agreement. Refer to *Section 8.12.5* for additional information.

7.4.11 ATTACHMENTS TO CITY STRUCTURES

The Third-Party Utility company shall submit a completed application form to the Utilities Management Branch, requesting approval to attach equipment to a City Structure, in accordance with the requirements in this manual, *City of Vancouver Street Utilities By-law No. 10361*, or applicable agreement.

It is the responsibility of the utility company to provide detailed drawings clearly illustrating the proposed location of the equipment, attachment details including the type, size and depth of fasteners, supports, conduits, and any additional information deemed necessary by the Utilities Management Branch.

The Utilities Management Branch will forward all information provided by the utility company to the Streets Design Branch - Structures for a detailed review. Following its review, the Streets Design Branch - Structures will provide the Utilities Management Branch with its comments and / or interim approval, with the Utilities Management Branch issuing final approval.

The utility company shall not reduce the vertical clearance under a bridge and be mindful of the aesthetics of the proposed attachment, locating conduits within the bridge structure, and ensuring that they are not visible below the bottom edge of the girder, where possible.

There shall be no attachments to pre-stressed I-girders, railings or rail posts on any City Structure.

As a prerequisite for approval, the final design of the equipment attachment to a City Structure must be reviewed by the structural Engineer of Record for the structure (the original engineering consultant firm responsible for designing the bridge or structure), or if not possible, by a professional engineer acceptable to the Streets Design Branch - Structures.

The utility company shall acquire the services of a professional engineer who shall be directed to:

- Conduct a detailed review of the final design for the proposed utility attachment to a City Structure.
- Provide certification in the form of a signed and sealed letter stating that the utility attachment and / or any activities required to complete the attachment (e.g. coring), will not negatively affect the structural integrity of the City Structure, nor will it create any additional maintenance for the City.
- Provide details regarding acceptable locations for all holes to be cored into a City Structure (if required), as well as technical specifications on how existing rebar and core holes may be located as to minimize cutting of existing reinforcement in the concrete (e.g. with the use of a pacometer). All coring holes shall be laid out by the engineer, with coring work only permitted following the written approval by the Streets Design Branch - Structures.
- Provide technical specifications and details on how to locate the existing rebar to minimize cutting of the reinforcement in the concrete (e.g. with the use of a pacometer) for each utility support / fastener attachment of the City Structure.
- Provide details on how the City Structure will be restored to its preconstruction state or condition (e.g. sealing of holes) prior to the utility company's work.
- Provide details regarding any ongoing inspection or maintenance activities required by the utility company. Required activities shall be carried out by the utility company or its agent, and a copy of such activity reports shall be provided to the Streets Design Branch - Structures in a timely manner.
- Provide such information noted above, in a form prescribed by the City, to the Utilities Management Branch for review. All inspection and maintenance activities must be approved by the City, prior to such work being undertaken.
- Provide personnel to be on-site during the first complete coring operation (if coring is required) and as required thereafter. If coring is required, provide details and confirmation regarding how many additional attachments can be made to the City Structure, and that the proposed utility attachment will not prevent future installations to the City Structure.
- Sign an agreement, in a form prescribed by the City Engineer, specifying the terms and conditions under which the utility company has been granted permission to attach the utility to the City Structure.

7.4.12 ANTENNA INSTALLATIONS ON CITY INFRASTRUCTURE

The City will refer to Council approved policy framework consisted of the "Contracting Protocol for Antenna Installations on City-Owned Poles" and the form of licence agreement for "Antenna Installations on City-Owned Poles". The Utilities Management Branch will provide additional guidelines and requirements to the utility company at the pre-proposal consultation stage.

7.5 UTILITY DRAWING SUBMISSIONS

The following section outlines the requirements for utility drawing submissions made to the City of Vancouver. All utility permit application submissions must include an electronic drawing of the proposed installation. As the City will not accept multiple works on a single drawing, applicants must submit separate drawings for each installation. Upon request, the Utilities Management Branch will provide the City GIS base information for the area of the proposed utility design. In order to receive this information, the GIS Database License Agreement must first be completed and returned to the City. Only electronic submission will be accepted as outlined in *Section 7.6.1*. This section provides guidance on the basic procedures for Computer Aided Design and Drafting (CADD) drawing submissions to the City.

In an effort to ensure consistency and accuracy, all submissions must adhere to the Utilities Management Branch's drawing standards. Proposed utility designs shown superseded on a previously approved and constructed plan will not be accepted. They should not be included as a revision to an existing drawing, and will require a new drawing number, as well as meet all other approval requirements.

7.5.1 STANDARD METRIC SCALES

Scales:

- 1:500 Horizontal scale for plan drawing.
- 1:250 Horizontal scale for plan drawing in congested areas.
- 1:100 Vertical scale for profile.
- 1:25 Detail of ducts, poles, boxes, and other related infrastructure.
- 1:50 Detail of ducts, poles, boxes, and other related infrastructure.

The metre (m) unit is used for:

- Horizontal distances.
- Elevations (vertical datum CGVD28).
- Offsets.
- Outside dimensions of maintenance holes, boxes, etc.

The millimetre (mm) is unit used for:

- Duct cross-section details.
- Duct or pipe diameters.

7.5.2 BASE PLAN

Upon request, the Utilities Management Branch can provide a GIS base plan drawing containing all underground utilities. The GIS base plan drawing will be valid for one year from the date issued. All base plan submissions to the City should include the following details:

- North arrow (at top corner of drawing).
- Street, lane and easement property lines.
- Street names.

- Lot lines and lot legal descriptions.
- Title.
- Scale.

7.5.3 TITLE BLOCK

Location:

- The title block will include a description of the construction site using north-south and east-west street names (e.g. lane south of Broadway, Laurel Street to Oak Street, or 8th Avenue east of Cambie Street). Where possible, lanes should be described using “lane south” or “lane west” naming convention. For those permit applications with site services, if available the site address should be noted.

Type of installation. This indicates whether the work is overhead or underground. Each work is to be detailed as follows:

- Overhead - Identify whether the work is a new installation or upgrade of existing utility equipment.
- Underground - Identify whether the work is a joint trench. This will reference the drawing number for any other works, another utility company may be installing or have installed in the joint trench construction (i.e. Telus, Hydro, etc.). All utility companies will submit separate utility permit drawings.

Revisions to existing drawings:

- When a change that has been approved by the City is made on the permit drawing and the drawing has been resubmitted for approval, a revision number along with a brief description of the change (e.g. duct offset on Cambie Street) must be included. Any drawing submitted as a revision will require re-approval.

7.5.4 RELATED DRAWINGS

A related drawing is a drawing that includes work that is to be carried out in conjunction with work on the original drawing (e.g. aerial work, utility abandonment). Related drawings are to be referenced by an appropriate drawing number and adhere to the City utility drawing standards.

7.5.5 DIMENSIONS

All utility equipment shown on the permit drawing must be dimensioned as follows:

- Offsets are required from street or lane property lines (perpendicular to the property line), for all poles, ducts, pipes, maintenance holes, boxes and valves.
- Distances are required from the closest street or lane property line (parallel to property line), for all poles, site services, duct bends, maintenance holes, boxes and valves. This is commonly referred to as the “chainage” distance.
- The drawing must show all existing utilities, correctly dimensioned and labelled.
- Include the offset and description of the proposed ducts or pipes.
- Show outside dimensions of all maintenance holes, boxes, etc., in separate detail.

- Radius and angle of all bends.
- Location and height of pole pilasters.
- Cross-section of the duct configuration, showing minimum cover, duct size and the outside dimensions for concrete encasement of ductbank (if applicable).

7.5.6 PROFILE

A profile is required for permit drawings for the following installations:

- All utility main ducts.
- Any ductbank with over 16 or more ducts.
- Coast Mountain Bus Company DC feeder ductbanks.
- FortisBC Gas mains over 250mm in diameter.
- Creative Energy steam mains.
- Metro Vancouver sewer and water mains.

The profile must clearly identify:

- Vertical scale.
- Size and number of ducts or pipes.
- Cross-section of all utilities being crossed, drawn to scale and labelled.

7.5.7 RECORD DRAWINGS

Record Drawings serve as the final record of what has been installed within the City streets, and the City may be required to rely exclusively on a Record Drawing for design, construction, or maintenance activities. The Record Drawing must show all information incorporated by the City upon approval, alongside those changes made in the field, and shall be provided to the City within 30 days following the completion of construction. All Record Drawings submitted to the City must be certified by the permit holder as the final Record Drawings.

7.5.8 ABBREVIATIONS

Abbreviations are outlined in ***Table 7-2***:

Table 7-2: Abbreviations

Abbreviation	Utility	Owner
C	Steam Heat Pipe	Creative Energy
E	Electrical Distribution Duct	BC Hydro
E#	High Voltage Transmission Duct	BC Hydro
E(TR)	Trolley D.C. Feeder	Coast Mountain Bus Company
E(G)	Cathodic Protection Duct for Gas Main	FortisBC
G	Gas Main	FortisBC
G@	Trunk Pressure Gas Main (operating at 700 kPa pressure)	FortisBC
G*	Trunk Pressure Gas Main (operating at over 700 kPa pressure)	FortisBC
(PTE)	Private Utility	Various
S	Sewer (combined, storm, or sanitary)	City of Vancouver
S(F.M.)	Sewer Force Main	City of Vancouver
S(D)	Collector Sewer	Metro Vancouver
12”/8”S	Twin Sewer (size indicated)	City of Vancouver
8’x 8’S	Box Sewer (size indicated)	City of Vancouver
T	Telephone Duct	Telus
TeraSpan	Surface Inlaid Fibre Optic Cable	TeraSpan Networks
A2B	Surface Inlaid Fibre Optic Cable	A2B Fibre Inc.
Novus	Surface Inlaid Fibre Optic Cable	Novus Entertainment Inc.
T(co. name)	Telecommunications Duct	Telephone Company Name (e.g. Telus, Shaw)
T.V.(Shaw)	Duct (Communication or T.V.)	Shaw Communications Inc.
V.E.D.	Vancouver Electrical Duct (City Communication)	City of Vancouver
S.L.	Street Lighting Duct	City of Vancouver
W	Water Main	City of Vancouver
W(D)	Feeder Water Main	Metro Vancouver

7.5.9 CANCELLED DRAWINGS

The City must be promptly informed of any proposed utility permit drawing that has been cancelled.

7.5.10 UTILITY COMPANY STANDARDS

All utility drawings submitted for permit approval must clearly indicate on the drawing if they require additional considerations for the following:

- Installation methods.
- Vertical or horizontal clearances.
- Special backfill.
- Other issues unique to the utility's equipment.

The Utilities Management Branch will assess whether accommodations for the utility plant can be made at the selected location, based on set standards, or if all may be better served with alternate location.

7.6 EXTERNAL UTILITY ELECTRONIC SUBMISSION STANDARDS

The purpose of this section is to provide guidance on the basic procedures for Computer Aided Design and Drafting (CADD) for external utility plan submissions at the City of Vancouver. These procedures and guidelines ensure consistent products, appearance and accuracy.

7.6.1 INTRODUCTION

Digital spatial data specifications and standards are defined to provide corporate structure to data files. Adherence to these standards will assist in the preparation of drawing files and decrease the amount of verification necessary. In addition, these standards are designed to facilitate transfer of spatial data between branches of the City of Vancouver, software packages, projects, contractors, GIS and general users of the City of Vancouver's digital data. The ability to communicate effectively regarding digital data requires a common understanding regarding current data standards.

7.6.1.1 ROLES AND RESPONSIBILITIES

The Utilities Management Branch is responsible for maintaining all communications regarding external utility plan submissions. *Engineering GIS & CADD Services* is responsible for maintaining standard CADD base files and supporting standard layouts, templates, devices, symbols, and server processes. CADD clients are responsible for maintaining the integrity of CADD base files, supporting information and server environment. CADD clients are responsible for the maintenance of base information as input to the City of Vancouver GIS for their specific program areas.

7.6.1.2 SCOPE

All users of the City of Vancouver's CADD server will incorporate and provide input to these standards to develop a citywide understanding of CADD. The information stored and distributed on the CADD server is proprietary. Reproduction or distribution of this data is strictly prohibited.

7.6.2 GENERAL DATA SPECIFICATIONS

The following section outlines the general data specifications as set by the City of Vancouver.

7.6.2.1 PROJECTION

Universal Transverse Mercator Projection (UTM) is the standard projection used by the City of Vancouver.

7.6.2.2 UTM ZONE

The City of Vancouver is in UTM Zone 10.

7.6.2.3 ORIGIN

An origin set at 0,0,0 will be the standard for all digital spatial data files for the City of Vancouver.

7.6.2.4 UNITS OF RESOLUTION

Metres (m) is the resolution for digital data in the City of Vancouver.

7.6.2.5 HORIZONTAL DATUM

North American Datum of 1983. NAD83(CSRS).

7.6.2.6 COORDINATE SYSTEM

Eastings and Northings will be used for coordinate location references. Autodesk Map UTM83-10 is the assigned coordinate system for the City of Vancouver.

7.6.2.7 SPHEROID

Spheroid: WGS 84

7.6.2.8 OBJECTS IN DESIGN DRAWING

Objects in design drawing must correspond to the assigned coordinate system.

7.6.3 SURVEY MONUMENTS

The following section outlines the specifications for survey monuments as set by the City of Vancouver.

7.6.3.1 GRID COORDINATES

Grid coordinates are preferred for electronic record drawing submissions. If grid coordinates are not supplied, the ground transformation formula is required.

7.6.3.2 TABLET MARKING

All surveys will note the tablet markings (e.g. V-2166) of the monument referenced from the City of Vancouver Integrated Survey Area No. 31.

7.6.3.3 ELEVATIONS AND VERTICAL DATUM

All elevations are to be based on the CGVD28 vertical reference datum. The datum derivation must be clearly stated on all drawings.

7.6.4 SECURITY

7.6.4.1 VIRUS CHECKING

All files from external sources will be scanned for viruses prior to opening or executing.

7.6.4.2 SUBMISSIONS

E-mail address for plan submissions is covutilities@vancouver.ca.

7.6.5 GENERAL AUTOCAD FILE FORMAT SPECIFICATIONS

The following section outlines the specifications for AutoCAD files as set by the City of Vancouver.

7.6.5.1 FORMAT AND VERSION

AutoCAD 2007 drawing format (DWG) or newer is the standard file format for the City of Vancouver CADD files. However, the DWG file must be saved in 2013 or older when submitting to the City for review and approval.

7.6.5.2 NAMING CONVENTION

All electronic Utility Plan submissions must be named by the Plan Number being submitted (e.g. DS-6709.dwg). Record Drawings must be submitted based upon a copy of the approved permit file number with the "_Record" suffix (i.e. DS-6709_Record.dwg).

7.6.5.3 LAYER DRIVEN FEATURES

All element specifications will be determined by layer (i.e. colour, lineweight). All elements on a layer will conform to the standards and specifications for that layer (see layers).

7.6.5.4 DRAWING ORIENTATION

All drawings, with the exception of site plans (i.e. the inside of a chamber), will use project north alignment rather than true north. True north may be indicated with a north arrow based on current declination to indicate potential view rotation.

7.6.5.5 TOPOLOGICAL VALIDATION

The standards for topology must be met. Digital data must be vector and poly clean. The following errors are unacceptable: dangling nodes, undershoots, intersection errors, loops, open polygons, slivers and zero area polygons.

7.6.5.6 BASE PLAN DRAWING

City of Vancouver base plan drawing in AutoCAD format is available upon request via e-mail to covutilities@vancouver.ca. Please contact the Utilities Management Branch for additional details.

7.6.6 LAYERS

Utility layers, listed in ***Table 7-3***, will be electronically processed to update the City of Vancouver GIS system. Layer names and object types (linetype or symbol column) are of primary importance for plan submission, a key to the seamless integration of external data.

When submitting a drawing containing an existing Telco Duct, the duct would be a line on the U_TELCO_DUCT layer. Similarly, if you are submitting a drawing with an existing Telco Maintenance Hole, it would be represented as a symbol on the U_ TELCO_MANHOLE layer. For any new proposed equipment, please append 'PROPOSED' to the layer name (i.e. U TELCO DUCT PROPOSED, U TELCO MANHOLE PROPOSED, U HYDRO DISTRIBUTION DUCT PROPOSED). Reference layers and other drawing layers not included in the layers table, can use their existing naming convention or use the standards set in the City of Vancouver comprehensive template and documentation that is available upon request.

Table 7-3: Layers

Layer Name	Linetype or Symbol	Colour	Description
U_COV_ELECTRICAL_DUCT	Continuous	Black	Electrical Duct
U_COV_ELECTRICAL_DUCT_LBL	Continuous	Black	Electrical Duct Label
U_COV_ELECTRICAL_DUCT_LBL_REF	Continuous	Black	Electrical Duct Label Reference[(1)]
U_ENCROACHMENT_PRIVATE	Continuous	134	Private Encroachment
U_ENCROACHMENT_PRIVATE_LBL	Continuous	134	Private Encroachment Label
U_ENCROACHMENT_PRIVATE_REF	Continuous	134	Private Encroachment Reference
U_GAS_MAIN	Continuous	Orange	Gas Main
U_GAS_MAIN_ABANDONED	Continuous	White	Abandoned Gas Main
U_GAS_MAIN_LBL	Continuous	Orange	Gas Main Label
U_GAS_MAIN_REF	Continuous	Orange	Gas Main Reference
U_GAS_VAULT	Continuous	Orange	Gas Vault
U_GAS_VAULT_REF	Continuous	Orange	Gas Vault Reference
U_HYDRO_DISTRIBUTION_BOX	Symbol Layer	Red	Hydro Distribution Box
U_HYDRO_DISTRIBUTION_BOX_REF	Continuous	Red	Hydro Distribution Box Reference
U_HYDRO_DISTRIBUTION_DUCT	Continuous	Red	Hydro Distribution Duct
U_HYDRO_DISTRIBUTION_DUCT_LBL	Continuous	Red	Hydro Distribution Duct Label
U_HYDRO_DISTRIBUTION_DUCT LBL_REF	Continuous	Red	Hydro Distribution Duct Label Reference

Layer Name	Linetype or Symbol	Colour	Description
U_HYDRO_DISTRIBUTION_MANHOLE	Symbol Layer	Red	Hydro Distribution Maintenance Hole
U_HYDRO_DISTRIBUTION_MANHOLE_REF	Continuous	Red	Hydro Distribution Maintenance Hole Reference
U_HYDRO_DISTRIBUTION_POLE	Symbol Layer	Red	Hydro Distribution Pole
U_HYDRO_DISTRIBUTION_POLE_REF	Continuous	Red	Hydro Distribution Pole Reference
U_HYDRO_DISTRIBUTION_STUB	Symbol Layer	Red	Hydro Distribution Stub
U_HYDRO_DISTRIBUTION_STUB_REF	Continuous	Red	Hydro Distribution Stub Reference
U_HYDRO_SUBSTATION	Continuous Symbol Layer	Red	Hydro Substation
U_HYDRO_SUBSTATION_REF	Continuous	Red	Hydro Substation Reference
U_HYDRO_TRANSMISSION_DUCT	ACAD_ISO02 W100	Red	Hydro Transmission Duct
U_HYDRO_TRANSMISSION_DUCT_LBL	Continuous	Red	Hydro Transmission Duct Label
U_HYDRO_TRANSMISSION_DUCT_LBL_REF	Continuous	Red	Hydro Transmission Duct Label Reference
U_HYDRO_TRANSMISSION_DUCT_REF	ACAD_ISO02 W100	Red	Hydro Transmission Duct Reference
U_RESERVED_CORRIDOR	Continuous	Cyan	Reserved Utility Corridor
U_RESERVED_CORRIDOR_LBL	Continuous	Cyan	Reserved Utility Corridor Label
U_RESERVED_CORRIDOR_REF	Continuous	Cyan	Reserved Utility Corridor Reference
U_STEAMHEAT_MANHOLE	Symbol Layer	Magenta	Steam Heat Maintenance Hole
U_STEAMHEAT_MANHOLE_REF	Continuous	Magenta	Steam Heat Maintenance Hole Reference
U_STEAMHEAT_PIPE	Continuous	Magenta	Steam Heat Pipe
U_STEAMHEAT_PIPE_LBL	Continuous	Magenta	Steam Heat Pipe Label
U_STEAMHEAT_PIPE_LBL_REF	Continuous	Magenta	Steam Heat Label Reference
U_STEAMHEAT_PIPE_REF	Continuous	Magenta	Steam Heat Pipe Reference
U_TELCO_ABANDONED	Continuous	Yellow	Telco Object Abandoned
U_TELCO_BOX	Symbol Layer	Yellow	Telco Box
U_TELCO_BOX_REF	Continuous	Yellow	Telco Box Reference
U_TELCO_CHAMBER	Continuous	Yellow	Telco Chamber
U_TELCO_DUCT	Continuous	Yellow	Telco Duct
U_TELCO_DUCT_LBL	Continuous	Yellow	Telco Duct Label

Layer Name	Linetype or Symbol	Colour	Description
U_TELCO_DUCT_LBL_REF	Continuous	Yellow	Telco Duct Label Reference
U_TELCO_DUCT_REF	Continuous	Yellow	Telco Duct Reference
U TELCO_MANHOLE	Symbol Layer	Yellow	Telco Duct Maintenance Hole
U_TELCO_MANHOLE_REF	Continuous	Yellow	Telco Duct Maintenance Hole Reference
U_TELCO_POLE	Continuous Symbol Layer	Yellow	Telco Pole
U_TELCO_POLE_REF	Continuous	Yellow	Telco Pole Reference
U_TELCO_SACPAD	Symbol Layer	Yellow	Telco Sac Pad
U_TELCO_SACPAD_REF	Continuous	Yellow	Telco Sac Pad Reference
U_TELCO_STUB	Symbol Layer	Yellow	Telco Stub
U_TELCO_STUB_REF	Continuous	Yellow	Telco Stub Reference

Notes:

1) Reference (suffix_REF) layers are intended for those utility objects not included in design submission but necessary for reference.

7.6.7 SYMBOLS

Symbol name (or block name), its location based upon insertion point and layer inserted, are of primary importance and listed in ***Table 7-4***. The symbol configuration or block shape, colour etc. is not critical.

Table 7-4: Symbols

Symbol	Symbol Name	Description
	U_HYDRO_DISTRIBUTION_BOX	Utility Hydro Distribution Box
	U_HYDRO_DISTRIBUTION_MANHOLE	Utility Hydro Distribution Maintenance Hole
	U_HYDRO_DISTRIBUTION_POLE	Utility Hydro Distribution Pole
	U_HYDRO_DISTRIBUTION_STUB	Utility Hydro Distribution Stub
	U_HYDRO_SUBSTATION	Utility Hydro Substation
	U_STEAMHEAT_MANHOLE	Utility Steamed Heat Maintenance Hole

	U_TELCO_BOX	Utility Telephone Company Box
	U_TELCO_MANHOLE	Utility Telephone Company Maintenance Hole
	U_TELCO_POLE	Utility Telephone Company Pole
	U_TELCO_SACPAD	Utility Telephone Company Sacpad
	U_TELCO_STUB	Utility Telephone Company Stub
	SL_NODE_POLE_TROLLEY	Street Electrical Trolley Pole
	U_TRANSIT_POLE	Transit Pole

7.6.8 LINE STYLES

Line styles are controlled by layer. Only standard AutoCAD line styles are supplied. Custom line styles are currently created on a per project basis.

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STREETS & TRANSPORTATION



8

Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Paul Storer, P.Eng, Director, Transportation Eric Mital, P.Eng, Director, Streets

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STREETS & TRANSPORTATION

8.1 INTRODUCTION

Vancouver is a Vision Zero city, with a goal to eliminate all traffic-related fatalities and serious injuries. Engineering Services operates a large network of streets, some of which border and overlap other jurisdictions such as TransLink, the Ministry of Transportation and Transit, and nearby municipalities who also share this goal and responsibility.

The following is a brief description of each section:

- The *Design Approach* section outlines the overarching principles involved in complete streets design. It includes sections such as prioritization, street types, and accessibility.
- The *Transportation Assessment and Management Study* section outlines resources available to complete transportation assessments.
- The *Sidewalks and Pedestrian Facilities* section specifies the requirements for pedestrians.
- The *Bicycle Facilities* section outlines specific requirements for designing for bicycles.
- The *Transit Facilities* section discusses how transit fits into the complete streets design and outlines specific requirements for designing for buses.
- The *Motor Vehicle Facilities* section outlines the requirements for motor vehicles.
- The *Intersections* section specifies the requirements for intersection design.
- The *Pavement Markings* section provides information on the specific requirements of pavement markings in the City of Vancouver.
- The *Traffic Signage* section gives signage and wayfinding standards for pedestrians, bicycles, and motor vehicles.
- The *Pavement Design* section outlines the requirements for pavement design and performance and includes a section on specialty pavements.
- The *Structural Design* section provides general requirements for Vancouver-specific structures such as bridges, seawalls, docks, and walls.

Refer to *Chapter 2: Design Process & Coordination* for specific submission requirements.

8.2 DESIGN APPROACH

Vancouver is a multi-modal city. The transportation network should be designed to provide people with safe, convenient, and delightful options as outlined in the *City of Vancouver Vision Zero Action Plan, City of Vancouver Complete Streets Policy Framework*, *City of Vancouver Transportation 2040 Plan*, and other guiding documents. For further information relating to the design philosophy, process, and coordination, refer to *Chapter 1:* Introduction and *Chapter 2: Design Process & Coordination*.

8.2.1 HIERARCHY OF MODES

As outlined in the *City of Vancouver Transportation 2040 Plan*, City street designs should support Vancouver's "hierarchy of modes" for moving people and the efficient movement of goods. Prioritized below is Vancouver's "hierarchy of modes" for moving people:

1) Walking.
2) Cycling.
3) Transit.
4) Taxi, Commercial Transit, and Share Vehicles.
5) Private Automobiles.

The hierarchy is intended to help ensure that the needs and safety of each group of street users are considered in priority when decisions are being made.

People walking, cycling, and rolling are much more likely to be injured or killed in the event of a collision with a motor vehicle, so there is an extra burden of care to ensure people choosing these modes are safe and comfortable.

Each time a new roadway is designed or an existing one changed, opportunities for improving walking, cycling, and transit will be reviewed, and protected bicycle facilities are to be included in all new arterial, collector, and select local roadway design and construction.

In addition to moving people, the efficient movement of goods and City service vehicles will continue to be a high priority for the City. Long distance goods movement is important to provincial and national economies and to Vancouver's role as a port city. Smaller scale local movement is essential to a thriving economy and high quality of life.

Emergency services also require special consideration. Designers must consider measures to help ensure that police, fire, ambulance, and other emergency providers can reach their destinations in a timely fashion.

This is a general approach and in highly constrained urban environments, it is not always possible to provide the ideal facilities for all users' needs. This is especially the case for streets with limited rights-of-way that play a special role for a particular mode or use (such as transit or goods movement).

8.2.2 DESIGN DISCRETION

Street design is a complex endeavor, and designs must respond to varied local conditions and site constraints. Designers must recognize not all streets are the same - some are part of the transit or truck network, for example, while others might be gathering spaces. Some streets may function in different ways depending on the time of day, week, or season. Commercial streets should be lively spaces that attract people and support local businesses.

Design decisions require flexibility to balance the use of available guidance and engineering judgement with innovations in street design and technological advances. This set of criteria is intended to supplement existing manuals and standards including the *MMCD, City of Vancouver Construction Specifications,* the *City of Vancouver Standard Detail Drawings*, and guidance issued by the National Association of City Transportation Officials (NACTO), the Transportation Association of Canada (TAC) *Geometric Design Guide for Canadian Roads* (GDG) and *Manual of Uniform Traffic Control Devices for Canada* (MUTCDC), and others.

Where compromises are required, prioritize the safety of vulnerable road users. First check for potential reductions in the widths and number of roadway lanes; consistent with the hierarchy, do this in a way that is sensitive first to transit bus operations and secondarily to other large vehicles. Reallocation of sidewalk space is generally the least practical option due to reconstruction and should be considered last after all other absolute minimums.

8.2.3 STREET TYPES AND CLASSIFICATION

Generally, all streets in the City of Vancouver are designed to be in an urban context, and features may vary to match adjacent land uses. For example, pedestrian access is a primary consideration in commercial areas while trucking movement is a primary consideration in industrial areas.

Street classifications based on roadways describe access and mobility functions for motor vehicles and should not be the overriding criteria for street design. Due to historic and current policy decisions, streets considered to be arterials in the motor vehicle network have a high concentration of commercial and institutional destinations, an increased role in new housing stock, significant roles in the walking and transit networks, and desire lines for cycling and micromobility. The designer must understand how a street interfaces and functions with surrounding land use and the intended functionality for walking, cycling, transit and public life.

Roadway classifications are outlined in the most current edition of the TAC Geometric Design Guide for Canadian Roads. Although the City of Vancouver has not formally classified streets or roadways, ***Table 8-1*** outlines different types of streets used in the City of Vancouver, including some multi-modal considerations:

Table 8-1: Street Classification

Classification	Description
Pathways and Car Free	Provide safe, accessible, and vehicle-free corridors for people to walk, run, bicycle and gather. Walking and cycling/rolling are separated in most circumstances, with context-sensitive design treatments for plazas and commercial high streets.
Car Light	Provide quality spaces for people by restricting motor vehicles and encouraging slow speeds. People cycling typically share the roadway with motor vehicle traffic; at a target volume of 500/day this is considered suitable for all ages and abilities. Motor vehicles are generally restricted through diversionary measures, but there may be other access or time-of-day systems.
Lanes	Land access, loading, and sanitation operations are the primary functions of a lane. Lanes are less than 10m, generally 6m wide, and mostly serve the rear of parcels. The Street and Traffic By-law has specific speed and right-of-way provisions. Local motor vehicle traffic will generally only travel along a laneway for 1-2 blocks with minimal through traffic function. Separate facilities for walking and cycling are generally not provided, though sidewalks may be required where primary building entrances front the lane.
Local	Land access is the primary function of a local street while people movement by motor vehicle is a secondary consideration. People movement by walking and cycling may be particularly important on some local streets, often designated as greenways. Sidewalks are provided on both sides. People cycling typically share the roadway with motor vehicle traffic, except where there are heavier vehicle volumes. Traffic calming measures may be considered, especially along cycling routes and around schools and parks.
Collector	People movement and land access are of equal importance for collector roads. Sidewalks are provided on both sides. On cycling routes, protected facilities must be considered.
Arterial	People movement is the primary consideration for arterial roads while driveway access for motor vehicles is typically not permitted. Major arterials often have multiple lanes for moving traffic and regional goods. Arterials also serve as major bus routes and may have bus priority measures including dedicated lanes. Generous sidewalks are required on both sides. On cycling routes, protected facilities must be considered.

Beyond motor vehicle-centred classifications there are other designated roles a street may fulfill, for example:

- Greenways:
    - Paths and Car-Free Streets. Provide an accessible separation between walking and cycling. Motor vehicles are generally excluded, and when service and emergency vehicles are allowed, they share with the bike path. Refer to *Section 8.4.7* on how to design paths in a car-free space. This is the most comfortable treatment for greenways.

    - Local Street Bikeways. The accessible separation between walking and cycling/motor vehicles is generally in the form of a barrier curb. Refer to *Section 8.5.2* on how to design roadways appropriate for all ages and abilities shared cycling and motor vehicle traffic.
    - Protected Bike Lanes. Provide an accessible separation between walking and cycling. Motor vehicles are on a separate parallel roadway. Refer to *Section 8.5.1* on how to design a safe arterial street. This is used to close gaps on high vehicle volume streets, when necessary.
- Complete Streets: generally arterial or collector streets with protected bike lanes and bus service.
- All Ages and Abilities (AAA) Cycling: specific additional motor vehicle volume/speed, width and other targets to facilitate AAA cycling even on streets with no dedicated cycling lanes.
- Major Bikeway Network (MBN)/Regional Greenways Network: higher order cycling networks connecting Vancouver's major and regional destinations, spanning shore to shore beyond city boundaries and fostered by TransLink/Metro Vancouver.
- Frequent Transit Network (FTN): where transit service runs at least every 15 minutes in both directions throughout the day and into the evening, every day of the week.

Specialty treatment areas must be respected and incorporated into proposed designs. The location of these areas and specialty treatment details can be found in the *City of Vancouver Streetscape Design Guidelines* available on the City of Vancouver website.

8.2.4 MAJOR ROAD NETWORK

The Major Road Network (MRN), as defined on the TransLink website, is a designated network of arterial streets that are of particular significance to regional transportation for supporting goods movement, transit services, and traffic movement. The network spans Metro Vancouver and is jointly managed and maintained by TransLink and the municipalities. Modifications to the MRN, such as signal installations and left-turn bays are eligible for cost-shared funding from TransLink. TransLink must be notified of all modifications with the potential of reducing the people-moving capacity along the MRN. The *City of Vancouver Transportation 2040 Plan* recognizes the importance of the MRN in facilitating the movement of goods and services, transit, and general traffic throughout the region. It identifies the City's desire to include additional roads in the designated MRN.

Several of the City's roads are part of the regional MRN including Broadway, 41st Avenue, Granville Street, Oak Street, Cambie Street, and Knight Street, among several others. Any changes impacting the people and goods moving capacity of the MRN (temporary or permanent) will require coordination with TransLink.

8.2.4.1 TRUCK ROUTES

In addition to the Major Road Network, the City of Vancouver has designated truck routes in the *City of Vancouver Street and Traffic By-law No. 2849* to maximise trucking efficiency, reduce truck use on other streets, and to minimize roads required to be designed for large vehicles. See the City of Vancouver website for a map of all truck routes in the City.

8.2.5 MAJOR BIKEWAY NETWORK

The Major Bikeway Network (MBN), as defined on TransLink's website, is a proposed 850-kilometre network of cycling facilities connecting Urban Centres and major destinations across Metro Vancouver. The MBN is intended to make it safer, more comfortable, and more convenient to use active transportation, including e-bikes and e-scooters for longer trips as well as support shorter trips within communities. The planning and design of MBN routes should consider TransLink guidelines. MBN routes are eligible for additional cost sharing with TransLink.

8.3 TRANSPORTATION ASSESSMENT AND MANAGEMENT STUDY

Transportation studies requested by the City may include a Transportation Impact Study, a Parking and Loading Study, and a Transportation Demand Management Plan; collectively called a Transportation Assessment and Management Study (TAMS). The guidelines for such studies can be found on the City's website that establish the scope, form, and analysis required to properly assess the impacts of a proposed development on existing transportation infrastructure, determine the required mitigation measures, and document the results.

8.4 SIDEWALKS AND PEDESTRIAN FACILITIES

Everyone is a pedestrian. Pedestrians are the top priority in the City of Vancouver's transportation hierarchy. Walking or rolling is a fundamental part of all trips and inclusive pedestrian design not only accommodates but welcomes people of all abilities, particularly those with disabilities. Pedestrians are vulnerable road users, and safety and comfort for everyone is paramount on all streets. This section outlines the criteria for designing sidewalks and pedestrian facilities in the City of Vancouver.

The City of Vancouver's goal is to prioritize pedestrians, and the greatest area of concern to pedestrians is locations where vehicles are encountered. There are ways to prioritize pedestrians such as shortening crossing distances by providing curb bulges, reducing the number of traveling lanes for vehicles, reducing the number of driveways across sidewalks, normalizing intersections wherever possible to reduce skewed road alignments and slip lanes, and by providing pedestrian activated audible signals. Where there are traffic signals, the feasibility of implementing a Leading Pedestrian Interval (LPI) may be considered.

8.4.1 ACCESSIBLE PEDESTRIAN DESIGN

Vancouver streets must be accessible to all members of the public of varying ages and abilities. All designs must meet the accessibility requirements outlined in *Chapter 2: Design Process & Coordination* as well as in this chapter.

8.4.1.1 DEFINITIONS

It is essential that design for people with mobility challenges should be to the highest possible standards. This requires knowledge of the capabilities of different types of people. This section provides information on the basic human requirements for ease of movement. In designing or modifying pedestrian facilities, the designer should aim to be generous in the allocation of space.

The term disability is a broad one, which includes people with physical, sensory, or mental impairment. Many, though not all, face barriers to movement in the environment. Accessible design intends to remove or reduce these barriers for those with disabilities, as well as many other people not conventionally considered to have a disability who also encounter barriers to movement.

Disability is defined by the World Health Organization (WHO) as the temporary, prolonged, or permanent reduction or absence of the ability to perform certain commonplace activities or roles, sometimes referred to as activities of daily living.

There are various ways or models used to define disability, but accessible design is mainly concerned with the following:

- **Locomotion** - which includes people who use wheelchairs and those who can walk but only with difficulty often using some form of aid such as a stick or walking frame. Almost 70% of people with a disability have locomotion difficulties; those with walking difficulties outnumber users of wheelchairs by about 10:1.

- **Seeing** - which can be subdivided into people who are blind or have low vision.
- **Hearing** - which can also be subdivided into those who are profoundly deaf and those with impaired hearing, ranging from mild to severe deafness.
- **Reaching, Stretching, and Dexterity** - frequently the result of arthritis, which can make these movements painful and difficult, muscular dystrophy causing a loss of muscular strength, or complaints of the nervous system.
- **Learning Disability** - making it hard to understand complicated information or to use complex machines (like some ticket machines).

It should be remembered that these categories are not mutually exclusive. Many people with disabilities, particularly older people, have more than one impairment. The following sections give some basic information on the space needed by people when they are standing or moving. There is a lot of variation in this, but if the dimensions given below are used, then the great majority of people with disabilities will be able to move around the urban environment much more easily.

Some specific design features are essential for safe and comfortable movement by those with disabilities or limited mobility, while also benefitting the general public.

People who are visually impaired and those of limited vision need a good level of lighting and large and legible street signage. These features also create a greater sense of security and make reading signs easier, and therefore providing an essential service for people with a particular disability but also benefitting a wider group of people. For street lighting design requirements, refer to *Section 10.3*.

Certain types of disabilities may have more specific needs in order to safely navigate. For example, audible tones, accessible signals, and cues at a controlled pedestrian crossing are beneficial for a person who is blind is to know when the walk signal is displayed.

8.4.1.2 WALKING DISTANCES

Walking distances were researched in some detail in the late 1980s and, based on research, the values in ***Table 8-2*** are recommended for maximum distances between a resting spot, such as a bench:

Table 8-2: Walking Distances

Impaired Group	Recommended Distance Between Resting Spot
Wheelchair users	150m
Visually impaired	150m
Mobility impaired using a stick	50m
Mobility impaired without walking aid	100m

These figures are average measures; there is a lot of variation between individuals.

Seating and resting areas are important for everyone but are particularly important for wheelchair users, pedestrians experiencing sight loss, the mobility impaired, and seniors. Designers should provide opportunities for rest at regular intervals by increasing the amount of seating available along sidewalks and other pedestrian paths throughout their project. Providing frequent flat resting areas on corridors with steep grades can also provide respite for users and allow others to pass. Gradients, weather conditions, and presence of handrails will also affect the distances people are able to walk comfortably.

Research based on a follow-up study to the *UK London Area Travel Survey* found that of all the people with a disability who were able to walk at all, approximately 30% could manage no more than 50m without stopping or having severe discomfort and a further 20% could only manage between 50m and 200m.

8.4.1.3 STANDING

Standing is difficult and painful for some disabled people, particularly those with arthritis, rheumatism, and back problems. In the same study as that mentioned above, 9% of the survey respondents could only stand for less than a minute without discomfort, 24% could manage between one and five minutes and a further 22% could stand for up to ten minutes. The findings from this study emphasize the importance of providing plenty of appropriately placed and designed seating at places where people may have to wait and along pedestrian routes.

8.4.1.4 DESIGNING FOR FLUSH CROSSINGS

Without a curb or significant grade break, flush crossings lack important cues to alert pedestrians who are partially sighted or blind that they are entering a roadway. To help provide hazard warning cues, the City of Vancouver requires the installation of truncated dome surfaces, a type of Tactile Walking Surface Indicator (TWSI), on pedestrian crossings that have a grade break less than 5% between sidewalk and top of ramp. Truncated dome surfaces should also be installed in pairs that bracket each leg of a full street crossing if the approach of any leg in that crossing is flush (see *City of Vancouver Standard Detail Drawings C8.5* for use in conjunction with crosswalks, and *C8.6* and *C8.7* for individual ramps*)*.

Truncated dome surfaces should be installed in safety yellow (ISO 3864), which generally provides the best visibility against most surrounding pavements. The City Engineer may specify a different truncated dome colour (usually cast iron) in special circumstances or specify the colour of directional tactile features differently from truncated dome surfaces.

Although there is currently no requirement to retrofit truncated dome surfaces at curb ramps or refuge islands that are not being rehabilitated, in some cases, the City may require the use of surface-applied truncated dome surfaces to be installed on existing ramps to achieve the bracketing of a crossing or consistency within an intersection or along a corridor. The installation of surface-applied truncated dome surfaces will be required and approved on a case-by-case basis.

Truncated dome surfaces are not required at driveway and lane crossings as vehicle volumes tend to be low at these locations and drivers are legally required to come to a complete stop before crossing a sidewalk. However, for very high-volume driveways or lanes that act as the leg of an intersection, installing truncated domes on either end of the crossing may be a reasonable design solution.

When utility conflicts arise, whenever possible the truncated dome surface should be shifted or intersection geometry adjusted to avoid the utility. Where this is not possible, truncated dome tiles should be cut to fit tightly around utility conflicts. Examples of truncated domes well integrated with utility lids are shown in ***Figure 8-1***.

<table>
<tr>
<td colspan="2"> 
Tiles cut to accommodate a maintenance hole or water valve cover. In order to accomplish this, the cover was traced onto the truncated dome tiles and the outline was cut offsite. (Vancouver: Richards St / Dunsmuir St and Hornby St / Drake St)</td>
<td>
Example of cast iron tiles accommodating a maintenance hole cover, where the cover itself includes a tactile pattern similar to truncated domes. (Toronto, ON)</td>
</tr>
<tr>
<td>
Water valve reasonably accommodated, but utility conflict could have been avoided by shifting back 100mm to 200mm.</td>
<td>
Water valve accommodated due to minimum distance between two sets of tiles (Vancouver: Richards St / Smithe St)</td>
<td>
Junction box located to accommodate tiles (Vancouver: Richards St / Dunsmuir St)</td>
</tr>
</table>

Figure 8-1: Truncated dome surfaces fit around utility conflicts

Refer to the *City of Vancouver Standard Detail Drawings C8.5 to C8.7* for specific truncated dome surface placement details.

8.4.1.5 TRUNCATED DOME SURFACES AT PEDESTRIAN RAIL CROSSINGS

Similar to street crossings, sidewalks or pedestrian paths that cross railways at grade should always bracket the railway crossing with truncated dome surfaces. Truncated dome surfaces shall span the full width of the approaching sidewalk and be installed perpendicular to the sidewalk. Consult Transport Canada Regulations and any relevant guidance such as PROWAG R305.2.5 as supplements. In general, placement in the City of Vancouver is at least 2.0m from closest approach of truncated dome surface to the nearest rail, recognizing most such crossings have existing constraints and that placement at less than 2.0m may be within the Transport Canada clearance envelope.

8.4.2 SIDEWALK DESIGN PRINCIPLES

Sidewalk design should conform to the requirements outlined in this section, and the see ***City of Vancouver Standard Detail Drawings***, with additional consideration for current guidance in relevant manuals such as the BC Active Transportation Design Guide, the CSA Group's Accessible Design for the Built Environment, and the *TAC Geometric Design Guide for Canadian Roads*.

Streets shall be designed to provide safe and comfortable pedestrian movement for people of all abilities. Sidewalks should be generous, unobstructed, and accessible.

Concrete pavers can be used in the boulevards and furnishing strips but should generally be avoided in the sidewalk clearway. When used, pavers must have a small (2-6mm) chamfer edge and be installed in a smooth, uniform, 90-degree herringbone pattern to produce lower vibration exposure. Covers and grates are to be avoided in walking areas and preferably located in a utility strip / front boulevard or median. When they cannot practically be located out of the sidewalk clearway, covers and grates shall be installed flush with the surrounding surface and slip- resistant.

In general, the Engineering Services Department strives to consistently place sidewalks in a logical order to assist wayfinding and provide guidance throughout the City for all pedestrians and, in particular, people who are blind. The minimum sidewalk width typically allows for people using wheelchairs to pass one another as well as accommodating people walking side by side and communicating through sign language. Curb ramps are installed to provide access for people who use wheelchairs or other forms of mobility aids.

Standards for sidewalks are outlined in the *MMCD* and are generally used by municipalities in British Columbia. The Engineering Services Department has the ***City of Vancouver Construction Specifications*** that is used in conjunction with the *MMCD*. The design standards for sidewalks and curb ramps are contained in the *City of Vancouver Standard Detail Drawings C1.1* to *C2.2* and *C8.1* to *C9.1*.

8.4.3 GEOMETRY

8.4.3.1 SIDEWALK WIDTHS

The pedestrian realm is the publicly accessible space between the back of curb and the property line (or partly/wholly on private property through a statutory right of way). This space typically consists of sidewalks, which provide clear space for walking; and front and back boulevards, which provide space for trees, utilities, and street furniture. Redevelopment projects on commercial corridors have historically been asked to provide a minimum of 5.5m from the back of curb. This is typically conceptualized as 1.0m for the back boulevard, 3.0m for clear sidewalk width, and 1.5m for the front boulevard. Sidewalk patios and merchandise displays may encroach and reduce the clearway width below 2.4m if not accounted for in the back boulevard. Refer to *Section 2.2.3* for more information on sidewalks within street rights-of-way (SRW). Sidewalk widths should be as per ***Table 8-3***. Dedications and statutory rights-of-way for public passage through at-grade set back areas may be required. Similarly, corner cuts may be required for adequate sight lines and pedestrian circulation.

Table 8-3: Sidewalk Clear Widths

Land Use (Current or anticipated future)	Constrained	Minimum	Preferred
Residential or Industrial (detached, duplex, multiplex, townhouse)	1.8m	1.8m	2.4m
Residential (low-rise)	1.8m	2.1m	2.4m
Residential (mid-rise, high-rise), FTN and/or Greenway	2.4m	2.4m	3.0m
Commercial and/or Mixed-Use	2.4m	3.0m	depends on volume

Notes:

1) Sidewalk widths shall be modified on a case-by-case basis based on considerations including adjacent land use, pedestrian volumes, transit, being part of a greenway, etc.
2) Significant work should be made to retain trees in the front boulevard.
3) Additional setbacks and/or right-of-way may be required on a case-by-case basis.
4) When widening the pedestrian realm on commercial streets, a 3.0m sidewalk clear zone and a wider boulevard to prevent encroachment of commercial uses is often appropriate. Some existing commercial streets, particularly downtown, have higher pedestrian volume and have been designed with sidewalk clearways above 3.0m to around 5.0m. The City Engineer will confirm a sidewalk clear zone width based on pedestrian volumes, public life demands, nearby sidewalk widths, development adjacencies, and other use trade-offs. For a new public realm where existing volumes or widths are unavailable, 4.0m may be used for anticipated high volume corridors.
5) The above table assumes a street with two sidewalks. For a pathway or car-free greenway with one walking path, refer to Section 8.4.7. The City Engineer will confirm a clearway width generally of at least 1x and up to 2x the above table depending on context.

Street dedication is preferred for the full clear sidewalk width. If not feasible, statutory right-of-way agreements as a condition of development can provide the necessary space.

However, when placing sidewalks on SRW, the following considerations must be followed:

- Maintain and keep sidewalks clear at their desired widths
- Maintain a consistent standard surface treatment with a cold joint at the property line. If a trench drain is required, it must be placed entirely on the private side of the property line. Where feasible, align the sidewalk to run parallel to cold joints or trench drains to avoid accessibility and aesthetic issues.
- Continue to provide all necessary infrastructure to support the public realm; confirm whether it can be located on SRW or must be within the street dedication
- Keep temporary transitions on dedicated lands and build out the SRW to permanent design standards
- Larger treed front boulevards may necessitate larger SRW requirements to provide the desired sidewalk width

8.4.3.2 ALIGNMENT

In general, the alignment of the sidewalk should be parallel to the alignment of the property line and road centerline. Sidewalks are to follow straight and consistent alignments with continuity to curb ramps across streets, lanes, intersections, and other interruptions to help improve wayfinding for people with visual impairments. The sidewalk may need to meander around obstacles although this should be avoided when possible and allow for at least a 1:3 taper or equivalently large radius curve. Sidewalks are required on both sides of the road unless specified otherwise by the City Engineer.

8.4.3.3 CROSSFALL AND GRADES

Sidewalks should be designed with a 2% crossfall draining towards the gutter line; however, when site constraints exist, the crossfall may be reduced to a minimum of 1% or increased to a maximum of 4%.

Where achievable, sidewalks should be designed with a maximum longitudinal/running slope of 5%. Consider providing flat landing areas with seating where possible in locations with steep longitudinal and crossfall slopes. Steep slopes, particularly on existing streets, affect users differently. Power chair users may be able to handle a higher gradient and benefit from a straight alignment. Manual wheeled device users may require shallower slopes with rest areas. Cane users with companions may benefit more from a carefully designed set of stairs (wide steps, handrails on both sides, consistent and moderate rise and run of steps, visible and tactile edges and hazards, rest points, etc). Consider how to provide different options within the same street.

Maintain sidewalk crossfall and longitudinal slopes as closely as possible through continuous sidewalk treatments when crossing driveways, laneways, and minor streets (See *Standard Detail Drawings C7.1-7.4,* and *C9.2-9.4*).

8.4.4 SIDEWALK TYPES

The typical sidewalk in the City of Vancouver is light broom-finished Portland-cement Concrete with sawcut joints; however, many areas in the City have special concretes and treatments such as exposed aggregates, exposed glass, or pavers. The location of these areas and specialty treatment details can be found in the *City of Vancouver Streetscape Design Guidelines* on the City of Vancouver website. The designer should confirm with the City which sidewalk treatment is to be used for the specific design area.

8.4.5 SURFACE SLIP RESISTANCE

Broom-finished concrete sidewalks with sawcut control joints provide the best surface for people with limited mobility, and users of wheelchairs, scooters, and strollers. Vibrations are drastically reduced from those which have troweled control joints. Surface slip resistance of any material on the sidewalk should meet ASTM E303 standards with a minimum British Pendulum Number (BPN) of 55 measured under wet conditions. This performance requirement applies throughout the service life of the surface treatment, not only at the time of installation, to ensure consistent safety and durability.

8.4.6 BOULEVARDS

Front boulevards, also referred to as utility strips or tree boulevards, are located between the back of curb or pavement edge and the sidewalk, and may contain utility covers, poles, street furniture and street trees. Back boulevards are located behind the sidewalk typically towards the building. Where widths are constrained, front boulevards take precedence over back boulevards as they act as a buffer to traffic and provide room for streetscape amenities and urban forestry.*)*. Boulevards should be designed with the same longitudinal and crossfall slope criteria as sidewalks. Where required, adjust crossfall slopes within the boulevard to prioritize pedestrian facilities.

Refer to the *City of Vancouver Boulevard Gardening Guidelines* and *Chapter 9: Streetscape & Urban Forest* for softscape treatments other than sod. ***Table 8-4*** outlines the widths and materials for boulevards. Additional setbacks and / or rights-of-way may be required where a second row of trees or patio areas are desired.

Table 8-4: Boulevard Widths and Materials

Land Use	Back Boulevard Width			Front Boulevard Width			Boulevard Material
	Constrained	Minimum	Preferred	Constrained	Minimum	Preferred	
Residential	0.3m	1.2m	1.5m	1.2m	2.0m	>2.0	Softscape topsoil and sod
Commercial	1.0m	1.8m	≥2.5m	1.2m	1.5m	≥2.0	Hardscape

Notes:

1) Where the adjacent property has a compatible hardscape area with no setback, the absolute minimum back boulevard is 0m with a cold joint at PL.
2) Where the adjacent property has a building with no setback, the absolute minimum back boulevard is 0m with a 0.3m concrete building strip within the street width.
3) Where the back boulevard and/or adjacent property is softscape, the absolute minimum total softscape width is 0.6m, 0.3m of which must be provided within the property line to allow for concrete formwork.
4) Streetlights or trolley poles require a boulevard width of 0.9m.

5) Sidewalk patios require a minimum back boulevard width of 1.8m. In the front boulevard, they would additionally require a buffer to traffic and/or parked car doors.
6) For street trees, achieving the minimum front boulevard should be prioritized over the minimum back boulevard.
7) Boulevard widths exclude curb widths, which is currently an additional 0.15m. In general, add 0.15m for each roadway or bike lane adjacent a boulevard, and 0m for each sidewalk or similar. The total minimum tree able median width from curb face to sidewalk is therefore 1.35m; between curb face and edge of bike path is 1.5m.

Table 8-5 provides the typical slopes for boulevard and cut and fill slopes.

Table 8-5: Boulevard Slopes

Type	Slope		
	Minimum	Preferred	Maximum
Concrete	1%	Match Sidewalk (2%)	4%
Softscape	1%	3%	10%
Cut Slope (Non-Walkable or Temporary)	1%	-	50%
Fill Slope (Non-Walkable or Temporary)	1%	-	25%

8.4.7 PATHWAYS AND CAR-FREE GREENWAYS

Walking paths should be a minimum width based on ***Table 8-2***, but in many cases will need to account for pedestrian volumes and the recreational functions of greenways. In these cases, walking pathways generally range from a 3.0m minimum width to a preferred width of 4.5m or wider in higher volume areas.

Walking and cycling paths of similar width are preferred. Although these paths do not need to be exactly parallel and immediately adjacent, a nearby walking path should always serve the same destinations, be obvious to users, and be at least as attractive as walking on the bike path in terms of materials, conflicts, obstructions, bends, and legibility. Communicate the purpose of each path through material conventions (sawcut concrete walking path vs. asphalt bike path), and add sign and paint as needed, particularly in off-street contexts.

Avoid multi-use paths and paint separation. Instead, provide a boulevard to separate walking and cycling whenever possible. In constrained environments, use a barrier curb or Type E curb. For a retrofit or flush condition, use a raised median, barriers and furniture, or tactile warning delineator (trapezoid). Multi-use paths generally lead to:

- Significantly worsened accessibility, particularly low/reduced vision
- Reduced user comfort, particularly pedestrians with mobility or sensory limitations
- Increased potential for conflict (speed differential, limited width, direction of travel, etc.)

Although some regional guidance supports multi-use paths in low-volume contexts, those volumes are unusual in the core city context of Vancouver. Further, with an increase in electrified bicycles and micromobility, speeds along off-street facilities are increasing with an 85th percentile speed approaching 30kmh. Vancouver has been working to separate multi-use paths, particularly on the

Seaside Greenway, which has allowed for the lifting the previous electric device ban which had poor compliance and differential outcomes (e.g. ban on seniors needing electric assist).

Off a greenway/designated through cycling route, to make "last block" cycling connections, or as an interim treatment due to construction phasing, carefully implemented multi-use paths may be appropriate. Pay attention to managing conflicts between low/no vision pedestrians and silent micromobility devices, managing conflicts at intersections, and transitioning multi-use pathways back into separate cycling and pedestrian pathways in an accessible manner.

Vancouver does not currently have car-free greenways or streets along a significant length of commercial high street, although they are expected to be delivered based on current policy. Context-sensitive design treatments will be developed for these initial streets.

8.4.8 STREET TREES

Street trees serve a number of purposes in the urban environment. As well as absorbing CO_2, they create a natural barrier between the road and pedestrian walkways, provide shade to pedestrians, and keep hardscapes cooler in the hot weather. Trees also intercept rainfall to reduce run-off into the storm basins. Along with these attributes, Vancouver has been challenged by the impact to sidewalks. The City has actively pursued species that have less invasive root systems, are hardy, pest / disease resistant, and meet the requirements for their unique location. To try and mitigate the impact of the root systems on sidewalks, Vancouver installs root barriers at all new street trees. These shields deflect the roots down under the sidewalk far enough below the surface to reduce and delay disruption to the sidewalk. Refer to *Chapter 9: Streetscape & Urban Forest* for additional information.

8.4.9 STREET FURNITURE AND ABOVE GROUND UTILITIES

Street furniture and utilities may be an obstacle to pedestrians that use mobility aides and pedestrians who are blind or have low vision. For this reason, the City endeavours to place infrastructure such as posts, poles, and fire hydrants in the front boulevard of the sidewalk area and leave the minimum sidewalk clearance as specified in *Section 8.4.3* behind the front boulevard. When or where placement of furniture, like bus shelters or benches, cannot be accommodated in such a manner, the default is to provide a minimum clear sidewalk, as per ***Table 8-3***. Refer to *Chapter 9: Streetscape & Urban Forest* for additional information.

8.5 BICYCLE FACILITIES

Following pedestrians, people cycling are the next consideration in the City of Vancouver's transportation hierarchy. As another vulnerable road user, the safety and comfort of cyclists and other similar wheeled road users must be maintained through thoughtful design. This section outlines the criteria for designing bicycle facilities as part of a network of complete streets in the City of Vancouver.

8.5.1 BICYCLE FACILITY DESIGN PRINCIPLES

Bicycle facility design should generally follow best practices, such as design guidance detailed in the *BC MoTI Active Transportation Design Guidelines*

NACTO Guidelines, *Vélo Québec Planning and Design for Pedestrians and Cyclists*, *MassDOT Separated Bike Lane Planning & Design Guide*

and the Dutch *CROW Design Manual for Bicycle Traffic (from the Netherlands)*

as well as the *TAC Geometric Design Guide for Canadian Roads*.

The following should also be considered when designing bicycle facilities:

- The design should consider the City's transportation policy to build and upgrade cycling routes that are safe and comfortable for people of all ages and abilities.
- Care should be taken to reduce the risk of a collision between people cycling and motor vehicles or between people cycling and pedestrians. Dangerous configurations must be avoided.
- The design should reduce the risk of a collision between opening parked cars' doors and the person cycling. This remains a particular concern along commercial arterials without protected bike lanes where the result is more likely to be fatal, but protected bike lanes without an adequate door zone buffer or shared local street facilities with high parking turnover can still see collisions of this type.
- The design of protected bicycle lanes should ensure a fully accessible pedestrian realm, maintaining cane-detectable separation to ensure pedestrians experiencing sight loss are able to avoid the bicycle lane. Softscape boulevards, barrier curbs, and Type E curbs are generally appropriate for increasingly constrained situations. A Tactile Warning Delineator (trapezoid) is the appropriate tactile feature for retrofit/flush conditions to define an edge if approved by the City Engineer.
- Covers and grates are to be avoided in cycling areas and preferably located in a utility strip / front boulevard or median with openings at right angles to the predominant direction of travel. When they cannot practically be located out of the bikeway, covers and grates shall be installed flush with the surrounding surface and slip-resistant. The use of Type E/Type F curbs (with a 0.15m gutter pan) should be combined with recessed or alterative CB placement so that the grate does not extend outside the gutter pan.
- The design should consider changes to operations and maintenance practice, including access to poles, trees, waste containers, and other street furniture.

Bicycle design speed is based on the preferred speed of faster cyclists. Typically, the design speed is 30km/hr (corresponds to approximately R20m inside radius); however, for bicycle facilities with downgrade hills exceeding 4%, a 50km/hr design speed may be used (R30m). The design speed shall be confirmed with the City prior to designing the bicycle facility. In general, fit the largest reasonable radius when unconstrained to avoid side-swipe conflicts and design locations where reduced radii are warranted (such as turns between two routes and at crosswalks) carefully. Uphill cycling does not require a different radius but may warrant a wider facility or separation on a lower volume street.

8.5.2 AAA NETWORK

Vancouver has a vision to make cycling safe, convenient, comfortable, and fun for people of All-Ages-and-Abilities (AAA) including families with children, seniors, and new riders. An inviting and connected network of low stress AAA routes will provide a wide spectrum of the population the option to cycle for most short trips. The designer must also consider the various types of bicycles and other wheeled active transportation modes including cargo bicycles, bicycle trailers, skateboards, rollerblades, e-bikes, adaptive cycles, and emerging electric wheeled mobility devices. The general approach to creating AAA routes on City streets are:

- Ensuring low motor vehicle volumes, < 500/day target (< 50/hr), and speeds, < 30km/hr, on local streets by using traffic calming and diversionary measures as needed.
- Providing physical separation on busy streets.
- Provide equal or greater unsignalized priority (e.g. two-way stop), limit crossings to one lane per direction, and/or signalize

Additional considerations when designing AAA routes can be found in the *City of Vancouver Design Guideline for AAA Cycling Routes*.

8.5.3 TYPES OF BICYCLE FACILITIES

Accommodating people of all-ages and-abilities is a key consideration in choosing an appropriate bicycle facility type. It is recognized that this is an ambitious goal requiring significant upgrades to existing bicycle infrastructure to achieve. Therefore, in the short term, infrastructure can be upgraded incrementally moving along the spectrum towards AAA. Potential facility types are shown in ***Figure 8-2***.



Figure 8-2: Spectrum of Facility Types

The selection of a specific facility type may also consider:

- Site constraints such as right-of-way width, existing conditions, grades, and terrain.
- The volume of expected bicycle trips and network connectivity needs.
- The street classification, function, and vehicle speeds.
- Financial and other scope constraints.

8.5.3.1 OFF-STREET BICYCLE PATHWAYS

Off-street bicycle paths are pathways that do not follow the same alignment as a roadway, such as pathways through parks or segments of the Seawall. They are the most comfortable facility for people on bicycles. Off-street bicycle pathways generally should be paved with asphalt. However, paving stones, sawcut concrete, or other special treatments may be considered through parks, plazas, and other context-sensitive areas. While some existing off-street pathways are shared with pedestrians, in most situations new off-street pathways should be designed with separate and intuitive walking and cycling space.

8.5.3.2 PROTECTED BICYCLE LANES

Protected bicycle lanes are paved lanes that are separated from motor vehicles by a physical barrier and are a key feature of complete streets. The physical barrier protects people on bicycles from motor vehicles in the mid-block enhancing comfort and safety. They may consist of raised buffers such as curbs, gravity barriers, or planters with the bicycle lane at road grade; raised buffers such as curbs with the bicycle lane flush with the buffer; or parking lanes protecting the bicycle lane from motor vehicle traffic.

Special attention must be given to the design of intersections. Protected bicycle lanes may be two-way, one-way on each side of the road, or one-way on one side of the road. In general, due to intersection complexity, two-way protected bicycle lanes are not allowed on one side of two-way roadways. At many locations protected bicycle signal phases are required or recommended: refer to the *City of Vancouver Traffic Signal Timing Guidelines* (recommended guideline for Protected and Permissive Turns) which includes the following:

A protected-only turn phase or bike phase with a separated turning facility or physically reinforced turn restriction should be provided in each of the following situations, unless otherwise approved by the City of Vancouver:

- Motor vehicle right-turn against a bi-directional protected bike lane.
- Motor vehicle left-turn against a bi-directional protected bike lane (regardless of motor vehicle one-way or two-way operation).
- Motor vehicle right-turn against a uni-directional protected bike lane with peak hour vehicle turning volumes approaching 150 vehicles per hour.
- Motor vehicle left-turn against an opposing uni-directional protected bike lane with peak hour vehicle volumes approaching 150 vehicles per hour, or if the left turn is across multiple vehicle lanes.

A protected-only turn phase or bike phase with a separated turning facility or physically reinforced turn restriction should be provided if any of the following factors are present, unless otherwise approved by the City of Vancouver.

- Difficulty for drivers or cyclists caused by skewed geometry, reduced visibility, obscured sight-lines, or grade difference.
- Opposing pedestrian or cyclist volumes are significantly high (i.e. areas in close proximity to transit stations and/or stadia).
- High volume of turning heavy vehicles.
- Outside urban areas where traffic speeds are higher and bicycle traffic is less predominant.
- On or after a steep downhill grade.
- Where bicycle traffic arrives from an unusual direction, such as turning to or from a bidirectional bike lane directly into a crossing.

In most locations where permissive motor vehicle turns remain, additional regulations are required. These include:

- No right turn on red restrictions
    - Shall be installed for turns crossing a bi-directional protected bike lane perpendicularly

    - May be required for certain configurations of bicycle box where a turn would conflict
- Yield on turn signs
    - Shall be installed at all street and lane intersections where there are permissive right or left turns across unidirectional or bidirectional protected bike lanes;
    - Should be used at driveway crossings with adjacent unidirectional or bidirectional protected bike lanes, especially ones serving more than a single family home or with unfamiliar users (people who do not drive in the area on a regular basis);
    - Despite the above, an exception where yield-on-turn signage may not be required is when there are permissive left turns across an oncoming unidirectional protected bike lane. In this case, drivers expect and are legally required to yield to oncoming traffic. Signs should only be considered in this case when the oncoming bike lane may not be expected, such as a counterflow bike lane along a one-way street;
    - Shall indicate green colouring where green surface treatment is used; and
    - Shall indicate the direction(s) that bikes should be expected to travel
    - Shall be placed at or as near as possible to the point where the vehicle may be required to stop. However, where nearside placement is not practical, signage may be placed exclusively on the far side of the intersection;
    - Should be supplemented with a farside sign at signalized or complicated intersections; and
    - Should be mounted in a position similar to other traffic control signage using engineering judgement

Permissive turns at unsignalized intersections should also be managed through continuous sidewalk and bike lane treatments (see *Section 8.8.1.5)* where possible. Turn lanes are often used regardless of yield-on-turn or protected-only signal phasing; in particular, motor vehicles turning parallel to a bi-directional protected bike lane at a street intersection should do so from a dedicated turn lane.

8.5.3.3 LOCAL STREET BIKEWAYS

Local street bikeways are streets with low motor vehicle traffic volumes and speeds, which create conditions that are comfortable for people cycling to share the road with motor vehicles. Local street bikeways should include signage and pavement markings to raise awareness to all road users that this is a shared facility between people cycling and driving. To enhance the safety and comfort for all users, traffic calming and diversionary measures are often used to reduce motor vehicle volumes and speeds and help to facilitate through movement by bicycles. Treatments at major intersections, such as signals, median refuges, or other lane reductions, are provided to facilitate crossings for people walking and cycling.

Local street bikeways are typically defined by their retention of on-street parking access and lack of physical separation as primary considerations. This requires a careful balance of motor vehicle volumes and speeds, which are strongly influenced by the roadway width and parking spaces to create a situation where drivers need to slow and seek gaps in parking to pass each other.

In general, the target roadway width for a local street bikeway is:

- 8m with parking on one side
- 10m with parking on both sides

Above these dimensions, drivers begin being able to pass each other freely and the speed/volume reducing functions diminish. Below these dimensions, encounters between oncoming bicycle and motor vehicle traffic may become uncomfortable. In both cases, these problems are more acute at volumes and speeds greater than are considered appropriate for all ages and abilities. Widths of 0.5m narrower (7.5m and 9.5m respectively) generally allow good sharrow and speed cushion placement. If volumes and parking turnover can be carefully controlled, widths up to 1m narrower (7m and 9m respectively) may be acceptable and approved by the City Engineer depending on local context and emergency vehicle operations. Conversely, even if volumes and speeds are otherwise quite low, widths more than 0.5m wider (8.5m and 10.5m) are rarely desirable. This results in widths between 8.5m and 9.5m being too narrow for parking on both sides but likely to lead to higher speeds when parking is provided on only one side. In these cases, speed cushions (see *Section 8.7.9.1*) should be considered. In rare circumstances creating equivalent widths using back-in angle parking may be appropriate if there are no other options to narrow the roadway, though two sides of parallel parking are normally preferred.

If no on-street parking is permitted, car-free segments would ideally be incorporated since such a street should have essentially no through function, only local access to driveways and laneways. Reductions in road width below 6.0m should still be carefully considered, and alternate speed reduction measures explored such as vertical/horizontal deflection and local narrowing.

Although parking occupancies below 40% may mitigate for a reduced width, consolidating parking to one side is preferred. Avoid parking on the “left” side of a shared roadway with one-way motor vehicle traffic, particularly for multiple spaces, high turnover, or high proportion of unfamiliar drivers. Local street bikeways should not include a directional dividing line and, as such, the entire clear width is intended to be used for both directions of traffic.

The City of Vancouver now refers to local street bikeways as greenways, but the Engineering Design Manual retains this term specifically with regard to the street’s function for cycling as compared to, for example, greenways which include protected bike lanes or bicycle paths.

8.5.3.4 PAINTED BICYCLE LANES AND PAINTED BUFFERED BICYCLE LANES

Painted bicycle lanes, even with painted buffers, are not considered All Ages and Abilities and are not a preferred facility type. Limit their use to where construction and development phasing requires an interim implementation for later upgrading, particularly over short stretches. Maximize the length of the bike lane which can have physical protection, even if intermittent, and follow the guidance for a protected bike lane. On many streets without parking, an absolute minimum unidirectional/single file travel bike lane raised to curb height without a dedicated buffer has a similar width as a minimum painted bike lane, generally 1.5m.

8.5.3.5 SHARED USE LANES

Shared use lanes on higher-volume streets, even when supplemented with green surface treatment, are not considered All Ages and Abilities and are not a preferred facility type. This includes "share the road" signs, most uses of "sharrows" other than along local street bikeways, and similar signs and paint used along a travel lane. As with painted bike lanes, use a minimum protected bike lane where space allows. Sharrows on a typical laned roadway other than those centred in the travel lane are no longer compatible with BC's Safe Passing Distance Law.

8.5.4 GEOMETRY

8.5.4.1 LANE WIDTHS

Lane widths are influenced by the shy distance from adjacent obstructions, as nearby objects can reduce the comfort and confidence of cyclists. Consequently, lane width requirements are closely tied to edge conditions and whether the facility accommodates unidirectional or bidirectional travel. Preferred riding surfaces include asphalt, concrete, or other smooth, stable materials, while perforated or uneven surfaces such as wide gutter pans, catch basins, finger joints, and vents should generally be avoided. The BC Safe Passing Law should always be considered when designing for lane widths.

Table 8-6 provides the minimum and preferred widths for bicycle facilities:

Table 8-6: Bicycle Facility Widths

Bicycle Facility	Absolute Minimum Width	Minimum Width	Preferred Width
Two-Way Protected Bicycle Lane	2.7m	3.0m	3.5m-4.5m
One-Way Protected Bicycle Lane	1.5m	2.0m	2.4m-3.0m
Painted Bicycle Lane	N/A	1.5m	Use protected bike lane
Off-Street Bicycle Paths	Case-by-case basis, generally according to protected bicycle lanes above		

Notes:

1) Absolute minimums in this table are intended for extremely constrained situations and require approval from the City Engineer.
2) For high volumes facilities such as the seawall, use the higher end of the design range.
3) Edge conditions must be considered when determining appropriate bicycle lane width. If vertical obstructions such as lamp poles are present, then an additional width of 0.3m (0.6m preferred) should be added to the values in the table above. Gutter pans and drainage grates must also be considered as they can reduce usable bicycle lane width.
4) The use of absolute minimum widths is intended for short distances (e.g. past bus stops) and requires approval from the Director of Transportation.
5) When used for a short section as part of a diverter, a width between 1.8-2.0m between vertical curbs generally supports both reasonable width for cycling as well as discouraging driver non-compliance.

6) A typical path-size street sweeper has a width of 2.2m. For paths below this width that do not allow overhang, such as with barrier curb on both sides, confirm maintenance operations with Sanitation.

8.5.4.2 HORIZONTAL AND VERTICAL ALIGNMENT

Horizontal and vertical alignments including horizontal curvature, stopping sight distances, and vertical curvature shall be based on the *TAC Geometric Design Guide for Canadian Roads*.

8.5.4.3 GRADES

Bicycle facility grades should be kept to a minimum of 1%. A 3% grade or less is preferred when designing new bicycle bridges or ramps. Where this is not achievable because of significant costs or impacts, grades up to 5% may be considered. Steeper grades when following topography may be considered for short distances where no reasonable alternatives exist.

The slope and distance are both key factors that dictate the significance of a grade. For example, a small gradient but sustained downhill grade can quickly lead to higher speeds, requiring more design attention to sightlines, conflict management, signal operations, and curvature. Similarly, a small gradient but sustained uphill grade can require significantly more effort than a shorter but larger gradient hill.

To compare slopes, use the CROW Slope Severity Index method, as in the *Design Manual for Bicycle Traffic*, of squaring elevation gain and dividing by its length. Sharp elevation gains of less than 1m are often negligible for a bicycle user already in motion, if graded smoothly, but would not be for many pedestrians or users starting from a stop. Larger elevation gains can quickly drop manual bicycle speeds to the point where stability decreases. Greater widths may be required to compensate along with protection from motor vehicle traffic at a lower threshold.

Where new grades are being set, or a grade separation is introduced, aim to keep people cycling relatively flat and ramp the intersecting facility up or over. Underpasses, providing sufficiently wide, straight, and naturally illuminated are also preferred as they provide opportunities for shorter elevation change, acceleration away from intersections, and deceleration toward intersections.

8.5.4.4 CROSSFALL

Bicycle facility crossfalls typically match the roadway crossfall outlined in *Section 8.7.3.4* if it is at the same elevation and adjacent to the roadway or the sidewalk crossfall outlined in *Section 8.4.3.3* if it is at the same elevation and adjacent to the sidewalk. For adequate drainage, the bicycle facility cross fall may be 1-4% with a 2% crossfall preferred.

For raised protected bike paths, maintain the bike path crossfall and longitudinal slopes as closely as possible through continuous bike path treatments when crossing driveways, laneways, and minor streets (See *Standard Detail Drawings C7.3* and *C9.3*). In constrained locations increased crossfall on the bike path is preferrable to on the sidewalk (See *Standard Detail Drawing C7.4*).

8.5.4.5 BICYCLE LANE BUFFERS

Buffers are lateral spaces separating a bicycle facility from other street features. They may include painted gore areas, different material types, curbs, low landscaping, trees, or other physical features. ***Table 8-7*** provides minimum and preferred widths for buffers separating bicycle lanes from parking lanes, travel lanes, and sidewalks.

Table 8-7: Buffer Widths

Buffer Type (from face of curb or centre of paint line)	Minimum Width	Preferred Width
Between Protected Bicycle Lane and Parking Lane		
Raised Buffer, and Painted Buffer with intermittent physical separation	0.8m	≥1.0m
Raised Buffer with Trees	1.5m	≥2.3m
Raised Buffer Zone Adjacent to High-Volume Drop-off	0.9m	≥1.65m
Bus Stop Island with Shelter	2.75m	≥ 3.0m
Between Bicycle Lane and Travel Lane		
Raised Buffer (Bicycle lane at road grade)	0.4m(1)	≥0.8m(1)
Raised Buffer (Bicycle lane flush with buffer)	0.15m(1)	≥0.6m(1)
Raised Buffer with Trees (Including top of curb with bicycle lane flush with buffer)	1.5m	≥2.3m
Between Bicycle Lane and Sidewalk		
Raised buffer or trapezoid delineator	0.3m	
Bevel Curb (50mm Elevation Difference)	0.15m	
Treed Median (Same elevation)	1.35m	≥2.15m

Notes:

1) The minimum widths are for unidirectional bicycle lanes. For bidirectional bicycle lanes, these values are increased to a minimum of 0.6m and >1.0m preferred.
2) Painted buffers alongside parking should have intermittent physical separation, generally of the same width as the painted buffer, at the front of each marked parking space, with a length of approximately 1.5m, and of a type/placement to allow free access from all doors and between cars to the bike lane but minimizing potential for trips and motor vehicle entry.
3) Treed widths account for boulevard minimums and curb faces

Any exceptions below the minimum widths listed above require approval from the Director of Transportation.

8.6 TRANSIT FACILITIES

Transit is the third consideration in the City of Vancouver's transportation hierarchy. Along busy bus routes, facilities for transit vehicle priority may be given greater importance than other modes in the hierarchy. The provision of high-quality transit shelters and waiting areas are also important considerations for complete streets design. This section outlines the criteria for designing transit facilities in the City of Vancouver.

8.6.1 TRANSIT DESIGN PRINCIPLES

Transit facilities are an integral component of the City's transportation network. All street designs are required to make provisions for existing bus routes and stops as well as making considerations for future transit facilities.

Transit designs must correspond to current guidelines such as the:*Technology Assessment Protocol - Ecology (TAPE)*

- *TransLink Bus Infrastructure Design Guidelines*
- *TransLink Bus Infrastructure Design Guidelines*
- *TransLink Transit Passenger Facility Design Guidelines.*
- *TransLink Design Guide for Bus Stops Adjacent to Cycling Infrastructure*
- *TransLink Transit Service Guidelines*
- *Canadian Urban Transit Association (CUTA) Guidelines.*
- *TAC Canadian Transit Handbook.*
- *NACTO Transit Street Design Guide.*

8.6.2 BUS INFRASTRUCTURE

8.6.2.1 LANE WIDTHS

Refer to *Section 8.7.3.1* for preferred lane widths.

Care should be taken when designing the curb lane at bus stops. Curb lanes at bus stops should be either the standard minimum width in ***Table 8-10*** of 3.5m or below (an in-lane stop, holding all traffic behind), between 4.5m-4.8m wide (causing cars to stop behind the loading bus but allowing people cycling to continue or be passed safely under the new BC 1m law), or greater than 5.8m wide allowing both cars and people cycling to pass the loading bus.

Public Bike Share and Shared Electric Scooter stations are generally not approved to back directly into a lane transit operates in and may require additional buffers if not relocated.

8.6.2.2 BUS STOPS

Refer to *Technology Assessment Protocol - Ecology (TAPE)*

TransLink Bus Infrastructure Design Guidelines (BIDG) for bus stop requirements, such as bus zones, passengers landing pads, and door clearances. Requirements may differ based on the type of buses (standard and/or articulated) in the fleet and serving the bus stop and can change over time. There may also be situations that require additional clearances beyond the design guidelines and require consideration of other bus stop amenities. Specific stop requirements are to be confirmed with the Transportation Design Branch and CMBC. The following provides some examples of where practice in the City of Vancouver differs from the BIDG.

Concrete bus slabs in the roadway shall be in accordance with the *City of Vancouver Standard Detail Drawings C16.1*. For development plans, shelter placement and requirements should be incorporated into development conditions. Placement of bus shelters should consider proximity of power connection to street lighting conduit.

When constructing the bus stop, the concrete passenger landing pad should be a preferred 16.0m (minimum 15.5m for articulated bus stops and 9.5m for standard bus stops). These dimensions exceed the BIDG as they account for operational flexibility and placement of the ID within the pad. There should be no obstructions within 2.4m downstream of the bus ID to accommodate the installation of waste receptacles along with the concrete pad as a suitable anchoring surface. Follow the BIDG guidance for depth (3.0m preferred, 2.75m minimum) and include a shelter and bench whenever possible at all new stops. Due to future proofing or operational requirements, bus stop criteria are to be confirmed with the Transportation Design Branch.

For island platform bus stops, refer to TransLink & BC MOTT guidance (Design Guide for Bus Stops Adjacent to Cycling Infrastructure); design elements classified as "core treatments" should be incorporated. This section is intended to supplement TransLink/MOTT, in particular to provide guidance & commentary on consideration of elements beyond the “core treatments” identified by TransLink/MOTT. As design guidance in this area is in continuous development for accessibility, consultation with visually impaired and limited vision users and groups is strongly encouraged on every such design and location.

Edge zones: where feasible (e.g. through street reconstruction), Type E curb delineation is recommended on both sides of the bike lane to provide a detectable edge, reduce shy distance, and more easily support raised crossings between the sidewalk and island platform. For retrofit scenarios where the bike lane is otherwise at road grade, the bike lane should ramp up to the sidewalk elevation locally between the crosswalks at the bus stop. For retrofit scenarios where the bike lane is at the sidewalk elevation, a trapezoid/TWD or another reliably detectable edge between bike lane and sidewalk should be used, and between the bike lane and island platform.

Bike path crossings: in general, aligned with bus doors, prioritizing the front door at the ID. For stops that serve articulated buses, crossings aligned with front and rear doors may be preferable to avoid multiple crossings that are spaced too closely together. Consider furniture arrangements that promote the marked crossings, being cautious of sightlines. Crossings should generally be flush with the sidewalk/platform to improve accessibility for people with mobility challenges and reinforce priority for people crossing the bike lane. Where the bike lane is at intermediate level with Type E curb delineation on both sides, this is preferably achieved through planar concrete ramps 0.5m long with cold joints and target 12% grade breaks to prioritize pedestrians and accessibility by reducing bike speed. In the event of drainage challenges, ramping pedestrians down into the crossing instead would require additional space for ramps on top of wheelchair maneuvering on the platform; alternate pedestrian priority measures should be considered. The first crosswalk someone cycling encounters and/or the front door are a priority for raised crossings or other measures. For guidance on crosswalk signage, refer to *8.8.1.4*.

Enhanced crossing treatments: In general, integrating an island platform bus stop with a signalized crossing is strongly recommended where feasible, as this not only reduces the need for a pedestrian to cross the bike lane to access the bus stop, but also gives people the choice to cross the bike lane at the intersection, where some people may feel more comfortable crossing. Rectangular Rapid Flashing Beacons (RRFBs) have received mixed feedback, particularly as they do not resolve the fundamental concern regarding determining when it is safe to cross the bike lane and may not rank highly in priority compared to unsignalized crossings of collector/minor arterial roadways where RRFBs are typically installed.

Bike path widths: While in general, higher widths are desirable to improve cycling comfort and enable passing, adjacent the island platform (and particularly at bike path crossings), reduced widths may help to encourage desired yielding behaviour. Care should be taken to ensure any amenities on the platform, street furniture, or other physical obstructions are set back from the bike path to maintain adequate shy distance. Refer to *8.5.4.1* for details.

8.6.2.3 PRIORITY BUS LANES

Priority bus lanes should be considered along routes with high transit ridership. This may include full-time or time-restricted priority lanes. Generally bus lanes are being installed with longer peak hours and in both directions as a transition toward 7am-7pm, 7 days a week (7-7-7). The decision between 7-7-7 and full time is usually with enforcement as a consideration, including the appropriateness of red surface treatment.

A typical bus lane in Vancouver is in the curb lane, however alternate configurations can help mitigate for issues including legal and illegal parking, right turn conflicts, and conflicts with bicycle/micromobility users.

Moving the bus lane away from the curb allows parking retention, and by allowing both in-lane and in-bay stops can better accommodate different stopping patterns (see *8.6.2.5*). Physically separate busways isolate all parking conflicts, and can justify reducing remaining roadway through emergency vehicle use, but careful measures are needed to manage turning conflicts, minimize vehicle incursion, and allow boarding islands on one or both sides as appropriate (generally in the shadow of where turn lanes are provided, which may or may not be far side of the intersection). Refer to *Section 8.10.3* for information on sign placement.

Adding protected bike lanes avoids conflicts in safety and speed (in particular, buses and bicycles have similar average speeds but very different patterns such that they can hold each other up easily) - bus lanes in the right-most travel lane will otherwise become bus-bike lanes in urban environments and should always be legalized as a result.

8.6.2.4 BUS LANE RED SURFACE TREATMENT

Refer to *Section 8.9.1.14* for information related to red surface treatment for bus lanes.

8.6.2.5 BUS BULBS

Bus bulbs are sidewalk extensions that bump out the bus stop into the parking lane. These create more space for pedestrians and allow buses to stop in the travel lane and reduce delays from entering and exiting the bus stop. These improve bus movement as they avoid the bus having to merge into traffic. They are typically considered as part of a transit priority project, at high ridership stops, and areas where a wider sidewalk is desired. These can be made from interim or permanent materials. For permanent applications, refer to *Section 8.7.9.2* on curb bulges. Follow similar guidance for depths, corner radii, parking transition radii as other bulges, but with a specific focus on lane widths compatible with *Section 8.6.2.1*. Consult the Transportation Design Branch for specific applications.

On a street with only one travel lane per direction, a bus bulb creates a situation where the bus stops in the only lane available. These can be an effective transit priority measure but require mitigations for potential crosswalk/intersection blocking:

- A nearside stop is strongly recommended to avoid following drivers blocking crosswalks
- Restrict turns where possible to facilitate the bus reaching the nearside stop
- Provide 15m from stop bar to ID, to address potential for traffic delay at signal

It may be impractical to put a bus stop sufficiently downstream of an intersection to accommodate the potential volume of following/turning traffic at a busy intersection.

Where local and rapid services exist on the same street, consider bus lane in lane two, with express stops on bulb and local/trolley stops at curb. Note that this will require attention to the relative stop placement and pulling buses straight to curb.

8.6.3 STREETCARS

Consideration of streetcar space requirements and operation is required along streets where future streetcar routes are planned. Refer to the latest City plans and streetcar studies for proposed routing.

8.6.4 FERRIES

New and upgraded ferry docks shall be designed for wheelchair accessibility. Other requirements and features shall be determined on a case-by-case basis.

8.7 MOTOR VEHICLE FACILITIES

Motor vehicles will continue to be an important consideration for the foreseeable future. Designing for vehicles includes private passenger vehicles, shared vehicles, buses, and large and small trucks. Improving safety, improving reliability, and managing congestion are important factors as the City develops a complete street network. Also, curbside management including goods loading, passenger loading, and parking must be considered. This section outlines the criteria for designing vehicular facilities in the City of Vancouver.

8.7.1 MOTOR VEHICLE DESIGN PRINCIPLES

Motor vehicle design should conform to the requirements outlined in this section, the *MMCD Design Guideline Manual* and the *TAC Geometric Design Guide for Canadian Roads*.

As outlined in *Section 8.2.1*, it is important to ensure the hierarchy is considered when making design priority decisions.

8.7.2 DESIGN, CONTROL, AND MANAGED VEHICLES

Design, control, and managed vehicle selection is a key criterion in defining roadway geometry. Safety is directly related to geometry through speed and yielding performance. The effective radius (e.g. “racing line path”) of a corner may be greater than the physical radius due to the number and widths of lanes, presence of median, stop bar setback, and other features that need to be accounted for. There is an inherent conflict between accommodating design and control vehicles without increasing the speed of the smaller and significantly more common managed vehicles.

To help manage turn speeds, designs should make every effort to tighten effective turn radii as much as feasible while still accommodating design, control, and managed vehicles as needed.

Table 8-8: Design, Control, and Managed Vehicle Requirements

	Managed Vehicle	Design Vehicle	Control Vehicle
Purpose	Ensures the design manages the speed of smaller vehicles making up the majority of all traffic	Ensures the design makes appropriate accommodations for larger vehicle types present on a frequent (at least daily) basis	Ensures the very largest reasonable vehicle types can still navigate the intersection, slowly and infrequently
Typical representative vehicle (see ***Table 8-9***)	P	MSU	VFRS ladder
Other potential types:	other small car templates with approximately 1m tighter min radius, if they can be shown to be more appropriate	garbage truck (e.g. laneways), transit bus, coach bus, semitrailer trucks, VFRS ladder (along routes and near halls)	coach bus, larger semitrailer trucks (where rare but reasonably present)

	Managed Vehicle	Design Vehicle	Control Vehicle
Turns from/to:	Turning from the inside lane to inside lane or outside lane to outside lane as appropriate.	May need to straddle the outside lane line/use more than one lane on entry or exit. May need to wait for traffic on the cross-street to clear the intersection.	May need to use two or more lanes on entry and exit. May need to wait for intersection and approaches to be free of traffic, even with right-of-way.
		VFRS when responding generally turns to/from the leftmost lane and may use oncoming on entry.	
Traffic circles and similar traffic calming measures:	Should use device correctly without encroaching into (unmarked) crosswalks	May need to shortcut a left turn at traffic circles or otherwise bypass local street traffic calming	
Swept path includes:	Remaining on the roadway in the correct lane without traversing mountable features.	• May mount physical islands • May encroach on painted islands • May briefly encroach on one-way bicycle lanes (away from stop bars and waiting areas and in the same direction as bicycles) • May sweep over limited portions of the boulevard (preferably softscape)	
Swept path does not include:	With possible exceptions for responding emergency vehicles, do not encroach into: • protected waiting areas along sidewalks and walking paths (such as curb ramps and hardscaped intersection corners contiguous with the sidewalk) • protected waiting areas along bike lanes (such as bicycle stop bars, protected intersection corners, and bicycle boxes when possibly occupied) • the travelled portion of sidewalk (exception: the portion of a continuous sidewalk such as in *C7.1* and *C9.2* that is both sidewalk and crossing) • bidirectional and contraflow bike lanes • street furniture, poles, metal bollards		

All turns at an intersection must be tested in swept path analysis software to ensure the turning movements are accommodated for the design, control and managed vehicles unless otherwise approved by the City Engineer. Note that software modelling can be unreliable and field tests may sometimes be required, both to calibrate new vehicles and to layout particularly crucial constraints (e.g. in survey paint and cones).

Consistent with NACTO's *Don't Give Up at the Intersection,* the design for permissive or protected-permissive turning movements should accommodate swept path tests conducted between 5km/h and 15km/h (continuously or from stop condition as appropriate). 5km/h represents a practical minimum where slower speeds are unlikely to provide a significantly tighter swept path. Conversely, outside of protected signal phase movements, the design should be tested at 20km/h to show that these movements are not possible without, for example, mounting curbs that would act to reduce speed to 15km/h or below.

In general, these speeds for a managed vehicle correspond to an effective radius below 5.5m. In many contexts, this corresponds to a physical corner radius of 4.5m or less, but the effective radius can also be reduced by constructing bulges and extending physical separations, with truck aprons or as mountable as needed to accommodate design and control vehicles.

Where the swept paths track over unexpected areas, such as areas of boulevard or median where poles, furniture, or plantings may otherwise be installed, show them explicitly on the geometric drawing so these areas can be kept clear. Where mountable curbs and other features are required, show them clearly on the drawing and document which movements and vehicles are entering which areas.

Signalized intersections:

- All turns should be on the correct side of the directional dividing line (DDL) outside the stop bars (possible exceptions for emergency vehicles, such as entering the intersection from the left side of a DDL, or control vehicles, such as when being flagged)
- A stop bar setback of up to 5.0m from marked crosswalk can be employed; avoid setbacks approaching a full car length due to worsening compliance (expect those greater than 3.0m to be closely reviewed). The crosswalk can also be widened or potentially setback from the intersection in compliance with relevant sections. Care should be taken that this does not result in increased turning speeds for permissive turns.

Protected-only signalized movements:

- Higher turn speeds (20km/h and up) may be acceptable given signal separation from conflicting motor vehicles and vulnerable street users
- Higher radii may be acceptable barring e.g. impacts on crosswalk length
- Design vehicles should not straddle between turn and through lanes where the green phases for the multiple lanes are significantly different thus causing either lane to be unable to proceed on green; control vehicles may need to use both lanes of dual turns
- Corner radii below 5.5m (particularly below 4m) may be associated with vehicles not clearing the intersection/crossings during the appropriate protected turn phase; lagging turn phases are preferred, particularly in this situation

Prohibited movements:

- Test and physically prevent/restrict to the lowest speed as much as possible through the use of practical minimum radii and medians (e.g. 3m if bicycle turns still permitted, else 1m if curb and gutter, 0.3m otherwise)

Laneways:

- The full unobstructed width of a (constrained) laneway can be used on entry and exit
- Use a garbage truck as the design vehicle unless a more specific local use is known

- Lane returns should generally be designed to the standard geometry and radius, though custom designs may be required for a single lane roadway

Driveways:

- For turning movements at typical driveways and taking into account localized design considerations, design and control vehicles can use the full width of the driveway and turns can be made assuming a 'start from stop'.
- Only use a design vehicle larger than P if known to actually be used or properly accommodated on private property.

Table 8-9: Common City of Vancouver Design, Control, and Managed Vehicles

Vehicle Type	Specification	Use
Passenger Car	P (*TAC-1999*)	The typical 'managed vehicle' template to be accommodated in all turns at all intersections.
Delivery Truck	MSU (*TAC-1999*)	The typical 'design vehicle' template to be accommodated in all turns at all intersections.
Ladder Truck	105' Ladder (VFRS)	The typical 'control vehicle' template to be accommodated in all turns at all intersections
City Bus	Standard Bus – New Flyer (CMBC) Standard Bus – Nova (CMBC)	The typical public transit bus 'design vehicle' templates to be accommodated in all turns along all bus routes. Standard buses refer to 12.4m (40ft) long CMBC vehicles of either the New Flyer or Nova make, in contrast to articulated buses which are 18.5m long (60ft) There are substantial differences in vehicle sizes, wheel bases, and turning performance between CMBC design vehicles and those in the default TAC vehicle library. Designers should use CMBC design vehicles. Standard buses (CMBC New Flyer or Nova) must be accommodated for all turns comprising a bus route, including less frequently used transit service routes / short turns. Buses shall generally make right turns from the curb lane and/or at 1.5m from the curb; however, straddling lanes may be considered. A bus may make a right turn into the left-most receiving lane. Bus stops must be considered in combination with these turning movements to ensure the appropriate number and length of vehicles are able to pull straight to the curb. Routes planned or operating community shuttles should be designed around an assumption of future standard bus operations, with localized exceptions as required.
Articulated Bus	Articulated Bus – New Flyer (CMBC)	The typical public transit bus 'design vehicle' template to be accommodated in all turns along bus routes where articulated buses currently operate or plan to operate in the future.

Vehicle Type	Specification	Use
Tour Bus / Motor Coach	BUS-14M (*AASHTO-2011*)	The typical bus 'design vehicle' template to be accommodated in all turns along common tour bus routes.
Small Semitrailer Truck	WB-12 (*TAC-1999*)	The typical semitrailer truck 'design vehicle' template to be accommodated in all turns along common access routes to and at the delivery access points for certain commercial buildings with class C loading.
Medium Semitrailer Truck	WB-15 (*TAC-1999*)	The typical semitrailer truck 'design vehicle' template to be accommodated in all turns along common access routes to and within light industrial areas (I and M zones other than I-2 and M-2), in all turns within heavy industrial areas (I-2 and M-2), and at the delivery access points for certain commercial buildings with class C loading.
Large Semitrailer Truck	WB-17 (*TAC-1999*)	The typical semitrailer truck 'design vehicle' template to be accommodated in all turns along and between truck routes, in all turns along common access routes to and within heavy industrial areas (I-2 and M-2), and at the delivery access points for certain commercial buildings with class C loading. Engineers/designers should verify if there is a need to accommodate an even larger truck such as a WB-19 or WB-20 from *TAC-1999*.
Large Semitrailer Truck	WB-20 (*TAC-1999*)	The typical semitrailer truck 'design vehicle' template to be accommodated in all turns along and between truck routes servicing the Port of Vancouver.

8.7.3 GEOMETRY

This section outlines the criteria for roadway geometry including lane widths, alignments, grades, crossfall, vehicular clearances, and sightlines in the City of Vancouver.

8.7.3.1 LANE WIDTHS

Design consistency is a factor in traffic safety. Designers should avoid large variations in lane widths and other design elements, where possible. In most cases, the preferred width is also the minimum width. In cases where there is extra width, the pedestrian space, the boulevard, or the treed median should often be widened rather than widening the travel lanes.

Table 8-10 outlines the lane widths by facility type.

Table 8-10: Lane Width by Facility Type

Lane	Absolute Minimum Width	Minimum/Preferred Width	Maximum Width
Parking Lanes			
Design only in combination with adjacent travel lane. Generally not marked, though generally 2.5m wide when marked.			
Non-Bus / Truck Route Travel Lanes			
Multi Lane			
○ curb lane with parking	5.2m	5.5m	No greater than 6.2m
○ rightmost lane without parking	2.8m	3.0m	No greater than 3.4m
○ other through lane	2.7m	3.0m	No greater than 3.2m
○ turn lane	2.7m	2.8/3.0m	No greater than 3.2m
Single Lane			
○ with parking	5.5m[1]	5.5m	No greater than 6.2m
○ without parking	2.9m[1]	3.0m	No greater than 3.5m
Bus / Truck Route Travel Lanes			
Multi Lane			
• *with bus/truck operations*[2]			
○ curb lane with parking	5.8m	5.8m	No greater than 6.2m
○ curb lane without parking	3.0m	3.2/3.3m	No greater than 3.5m
○ other through/ turn lane	3.0m	3.2m	No greater than 3.2m

Lane	Absolute Minimum Width	Minimum/Preferred Width	Maximum Width
Bus / Truck Route Travel Lanes			
Multi Lane			
• *without bus/ truck operations*			
○ curb lane with parking	5.5m	5.8m	No greater than 6.2m
○ curb lane without parking	2.8m	3.0m	No greater than 3.3m
○ other through/ turn lane	2.8m	3.0m	No greater than 3.0m
Single Lane			
○ with parking	To be confirmed with CMBC	6.2m	No greater than 6.2m
○ without parking	3.5m	3.5m	No greater than 3.6m

Notes:

1) For non-bus/truck-route single lane roadways, refer to *Section 8.9.1.11* for when an unlaned roadway would be appropriate, which may enable a narrower roadway.
2) Generally, exactly one through lane will be considered to be the primary lane for buses and trucks, usually the rightmost. Where buses may operate out of two lanes, such as a through and a turn, total of two lanes should be 6.2m.
3) Lane widths may widen in bends and curves
4) Absolute minimums in this table are intended for extremely constrained situations, turn lanes, and/or multilane one-ways and require approval from the City Engineer.
5) Existing City streets may not meet these requirements.
6) Single lane means per direction.
7) Lane widths are measured from gutter line (curb face) when adjacent to curb and gutter, or centre of lane line
8) Protected bike lanes are the preferred treatment on most laned roadways. The BC MVA safe passing distance of 1m is accounted for in maximum lane widths by minimizing unsafe passing and encouraging single file operations. In unusual situations, a curb lane width of 4.5-4.8m without parking may be an acceptable exception where it avoids other hazards related to merging bikes into traffic. Above this width absolute minimum protected bike lanes begin to be feasible and drivers may begin to treat it as space for two vehicles to pass.

Lane widths along horizontal curves on truck routes require special attention due to the wide turning travel envelope. The lane width on curves should be sufficient to handle the turning travel envelope of the design vehicle plus a minimum 0.2m width on both sides. If necessary, this is typically done by providing a wider lane width through the curve and transitioning the wider lane into the straight segment using compound curves with a 500m radius. A less desirable and effective option is to use simple curves with such radii that would create a wider lane width at the center of the curve (i.e. not a constant offset from the centerline through the curve). This is typically only done with mild deflection angles or when a physical constraint limits the inner curve. In all cases, the lane width should be able to accommodate a street sweeper.

Wider lanes are associated with higher speeds and lanes above the target width up to the maximum should be used sensitively to specific contexts and otherwise avoided. Narrow lane widths are a speed management and safety strategy when used appropriately and also prioritize other modes whether separated or shared. Aim to achieve the target/minimum consistently across the lanes. Where constrained and approved to do so, use absolute minimum widths with engineering judgement to allow minimum or slightly above minimum widths for walking and cycling. Use absolute minimum widths on other lanes to achieve minimums for lanes buses operate in.

Unlaned roadways may not require the same widths as laned roadways*1*. In general, widths for higher volumes would follow the table above, whereas particularly low volume (local streets) with on-street parking can often operate as narrower courtesy streets.

In the City of Vancouver, the typical rights-of-way are 66’ (20m), 80’ (24m) and 99’ (30m) operating as 4 and 6 lane arterial streets. This means that in the majority of the cases, the design lane widths will tend towards the minimum or absolute minimum, as per

Table 8-13 In the rare cases when there is a surplus of roadway width, a priority order should be set regarding what to favour. This should be analyzed on a case-by-case basis.

8.7.3.2 ALIGNMENT AND CURVATURE

Alignment and curvature (horizontal and vertical) shall follow the *TAC Geometric Design Guide for Canadian Roads*. In general, R300m is used as a minimum for multilane arterial horizontal curves, even though this is not formally guided by standards such as *TAC Geometric Design Guide for Canadian Roads*. Road alignments with radii under 300m can be considered in specific circumstances, such as arterials with a single lane per direction, constrained widths or lengths, where needed to achieve other key objectives, clearly legible curvature, and supportive urban contexts. High bus or truck traffic may still require lane width adjustments or larger radii to maintain safety and operational performance.

For local streets and similar context, more significant curvature and alignment changes may be acceptable and even preferred, see *section 8.7.9* on traffic calming.

8.7.3.3 LONGITUDINAL GRADES

Roadway grades should meet the requirements of ***Table 8-11***. Exceptions to these values due to site constraints must be approved by the City of Vancouver.

Table 8-11: Longitudinal Grades

Type	Grades		
	Minimum	Preferred	Maximum
Lanes with Asphalt Gutters	1.0%	1.5%	12%
Lanes with Concrete Gutters	0.5%	1.0%	12%
Streets with Asphalt Gutters	1.0%	1.5%	10%
Streets with Concrete Gutters	0.5%	1.0%	10%
Curb Returns from Beginning of Curve (BC) – End of Curve (EC)	1.0%	1.5%	N/A
Curved Sections of Gutter	1.0%	1.5%	N/A

The maximum change in grade for a roadway not at an intersection is 2% over 8.0m (or 4% over 16m) which corresponds to an equivalent K-value of 4. For grade changes within intersections, see *Section 8.8.4.5*.

8.7.3.4 CROSSFALL

City of Vancouver streets and lanes vary in cross section and may be crowned, center valley, or crossfall. Roadways and lanes should follow crossfalls outlined in ***Table 8-12***:

Table 8-12: Crossfalls

Type	Crossfall		
	Minimum	Preferred	Maximum
Lane Entrances	1.0%	2.0%	5.0%
Lanes	1.0%	2.0% - 3.0%	5.0%
Paver Surfaces	1.5%	2.0%	3.0%
Residential, Collector	1.0%	2.0% - 3.0%	5.0%
Industrial, Commercial, Arterial, Bus / Truck Routes	1.0%	2.0%	4.0%

Horizontal and Vertical Clearances

Table 8-13 outlines the required clearances applicable to the roadway:

Table 8-13: Horizontal and Vertical Clearances

Clearance Type	Required Clearance
Horizontal	
Street appurtenances (cabinets, furniture, etc.) clearance to curb face	Preferred Minimum = 0.55m Absolute Minimum = 0.40m
Streetlight /signal pole/ trolley pole center to curb face	Standard = 0.76m

Clearance Type	Required Clearance
Vertical	
Roadway to bottom of structure	Minimum = 5.5m
Roadway to communications and guy wires	Minimum = 5.0m
Roadway to electrical conductors up to 90kV	Minimum = 5.5m

Notes:

1) When vertical clearance requirements cannot be met, low clearance signs W-18 and W-19 are to be installed.
2) For existing streets, it may not be possible to achieve absolute minimum clearances. In these situations, street appurtenances should not be placed any closer than existing infrastructure.

8.7.3.5 SIGHT LINES AND DISTANCES

Sight lines and distances shall meet the requirements of the *TAC Geometric Design Guide for Canadian Roads*. It is especially important to consider sightlines on bikeways and near schools, parks, and other areas with high pedestrian traffic.

8.7.4 CURB AND GUTTERS

Curbs should be according to the *City of Vancouver Standard Detail Drawings C4.1* to *C6.2*. ***Table 8-14*** provides the typical curbs used in the City:

Table 8-14: Curb Types

Curb Type	Typical Application	Considerations
Concrete Curb Type A	Barrier curb and gutter used on City streets.	Standard barrier curb for most applications to separate motor vehicle traffic from other road users.
Concrete Curb Type B	Shallow-depth barrier curb and gutter, not used unless approved by the City.	-
Concrete Curb Type C	Shallow-depth rollover curb and gutter, not used unless approved by the City.	-
Concrete Curb Type D	Rollover curb and gutter for mountable applications. Applications include property access in laneways; notable driveways; and/or crossings at raised bicycle lanes, particularly where driveway locations are in close succession, locations may change, or boulevard width is unavailable. In many other circumstances, *Standard Detail C7.1* is more appropriate.	Rollover curbs are mountable by most motor vehicles and is not typically used to separate motor vehicle traffic from other road users. Rollover curbs are intended to slow motor vehicles crossing a pedestrian or bicycle facility.

Curb Type	Typical Application	Considerations
		This curb type should generally not be used perpendicular to a bicycle facility or connections used by a significant number of micromobility users.
Concrete Curb Type E	Bevelled curb and gutter, typically used to provide detectable separation, particularly for white cane users, between raised protected bicycle lanes and an adjacent sidewalk in constrained locations where other forms of detectable separation are not feasible (e.g. softscape, raised planters or raised concrete islands). It is also used as an alternative to flush concrete banding to assist with grading tie-in constraints or to provide a continuous channel to convey surface drainage, where applicable.	This curb type is only effective at providing detectable longitudinal delineation that is parallel to the direction of pedestrian travel. It is not as easily detectable with a white cane or underfoot when approached at an angle close to perpendicular to the gutter line. Where applicable, bevelled curbs should be continuous along driveways as it does not impede vehicular access while providing a constant cane-detectable edge. This curb type generally should not be used to separate motor vehicles from other road users. Grates should generally be recessed or relocated to not extend out of the 0.15m gutter pan.
Concrete Curb Type F	Barrier curb with narrow gutter pan, typically installed in bicycle lanes at road grade to maximize the effective bicycle lane width. It is also used as an alternative to flush concrete banding to assist with grading tie-in constraints or to provide a continuous channel to convey surface drainage where applicable.	Cannot be installed along general purpose travel lanes unless approved by the City. Grates should generally be recessed or relocated to not extend out of the 0.15m gutter pan.

Curb Type	Typical Application	Considerations
150mm or 300mm wide Flush Concrete Band	Concrete band, flush in elevation with adjacent surface treatments to delineate a difference in material. Concrete bands are also installed adjacent to bicycle lanes to help support the asphalt edges, reduce heaving from tree roots, and improve grading.	Concrete band depth and thicknesses may vary for different applications or avoided if adjacent to existing mature trees if confirmed by the City.

8.7.5 MEDIANS AND ISLANDS

Medians and islands are generally designed according to the following:

- *TAC Geometric Design Guide for Canadian Roads*.
- *TAC Synthesis of Practices for Median Design*.

For constructability purposes, the minimum radius for median round-offs is 0.6m. This radius can be reduced to 0.3m for cast-in-place medians. While narrower medians using other construction methods are possible, a 0.6m median does not support installation of wider signs, and narrower medians in high pedestrian contexts may be less visible to those crossing the roadway. Medians shall be in accordance with the *City of Vancouver Standard Detail Drawings C15.1* or *C15.2*.

Median design should consider the needs for emergency vehicle access and any signal infrastructure that may need to be installed.

In general, a vertical face is preferred to discourage unintended motor vehicle overtracking, but narrower, smaller, or poorly arranged islands can be obstacles particularly for people walking and cycling. In specific situations, portions may be built flush/with ramps to allow walking and cycling, or with mountable faces to allow limited cycling access. A fully flush or zero-face island can help communicate an area without paint, but has limited effectiveness in terms of restricting motor vehicle movements or discouraging people cycling near bollards (see section 8.7.6).

Typical median height is 0.15m, whether a standard Type A curb or cast-in-place island. Higher curbs may be appropriate where the likelihood and consequences of large or fast vehicle mounting is increased, such as particularly tight turns protecting refuges for walking and cycling.

Lower curbs may be appropriate where the mounting of design or control vehicles, but not managed vehicles, is desired. VFRS generally accepts a localized roadway narrowing to 3.5m (plus any additional for turning movements) between standard vertical curbs and other elements. Within this 3.5m, they are accepting of mounting up to a 0.08m vertical face, which can include portions of traffic diverters and other medians. Avoid vertical faces of less than 0.05m near bicycle movements as they can be a hazard and are less effective. Ensure these swept paths are shown on design drawings and/or expressed in the physical infrastructure to help avoid conflicts with later poles, posts, and furniture.

Section 8.7.2 allows for design and control vehicles to mount certain curbs but not sweep into other protected spaces such as curb ramps and bike stop bars where someone may be waiting. Where a mountable curb is used near a protected space, a second (higher) vertical curb may be required to prevent vehicles from mounting the entire island. Portions of the island may exceed 0.15m high as a result, but generally will transition back to a standard 0.15m vertical face.

8.7.6 BOLLARDS

The first strategies to restrict motor vehicle entry to a path are the design of the entry (e.g. visual narrowing) and clear identification through sign and paint. The use of bollards in pathways (including knock-down and break-away post) should be minimized and only used when necessary to prevent frequent motor vehicle incursion onto a bicycle lane, pathway or public space. If rigid bollards or other hard barriers are appropriate, they should be in accordance with *City of Vancouver Standard Detail Drawings C12.1* to *C12.8*.

Where bollards or other hard barriers are used in the centre of a pathway, carefully consider locations which are at least 15m from a decision point to avoid distraction. Mitigation measures such as low landscaping, tactile warnings (for 10m or more in advance and at least 0.3m wider than the bollard) or other design and visibility treatments should be considered to minimize collision risk, though allowing the necessary shy distance begins to provide space for small motor vehicle entry. Attempt to operate the path first without the bollard to see if driver non-compliance is a net safety issue, as encroachment is likely to be relatively infrequent and at slow speeds on most paths. Alternatives to rigid bollards include flexible bollards and when the pathway width allows, a centre median that splits the point of entry into two pathways, but these too should be located to minimize collision potential.

8.7.7 GENERAL PARKING AND CURBSIDE MANAGEMENT

There are seven basic types of curbside regulations used within the City of Vancouver:

- No posted regulations (i.e. unregulated parking).
- Residential Parking Restrictions (i.e. No Parking Except with Permit).
- Time limited parking (e.g. 1-hour or 2-hour time restrictions).
- Metered Parking.
- Rush Hour Regulations (e.g. No Stopping 7 AM – 9:30 AM, 3 PM – 6 PM).
- Special Zones (e.g. Commercial Vehicle Loading Zones, Passenger Zones, etc.).
- Motorcycle Parking.

With the exception of rush hour regulations, the Parking Management Branch must be consulted to determine the appropriate types of regulations to be installed on a street. For the installation of rush hour regulations, the Parking Management Branch and the Traffic & Data Management Branch must be consulted. Rush hour parking restrictions are generally complementary to protected bike lanes, provided widths and sightlines allow for both modes, but can otherwise worsen cycling conditions versus a full-time travel lane. Painted bike lanes and sharrows, no longer recommended, are also particularly poor combinations with rush hour restrictions. With the exception of parking meters, all regulatory signage regarding parking regulations can be found in the *City of Vancouver Sign Code Inventory*.

Parking layout shall be in accordance with the following:

- *City of Vancouver Street and Traffic By-law No. 2849.*
- *City of Vancouver Parking Meter By-law No. 2952.*
- *Section 8.7.8.*
- *British Columbia Motor Vehicle Act.*

Typical on-street parallel parking space widths are determined through the geometric design of the street. These are generally not marked, except in situations where the location of parking spaces would otherwise be unclear, such as along interim build protected bike lanes where parking "Ts" may be appropriate.

The most common parking restrictions in place by by-law, or provincial legislations, are shown in ***Figure 8-3***:

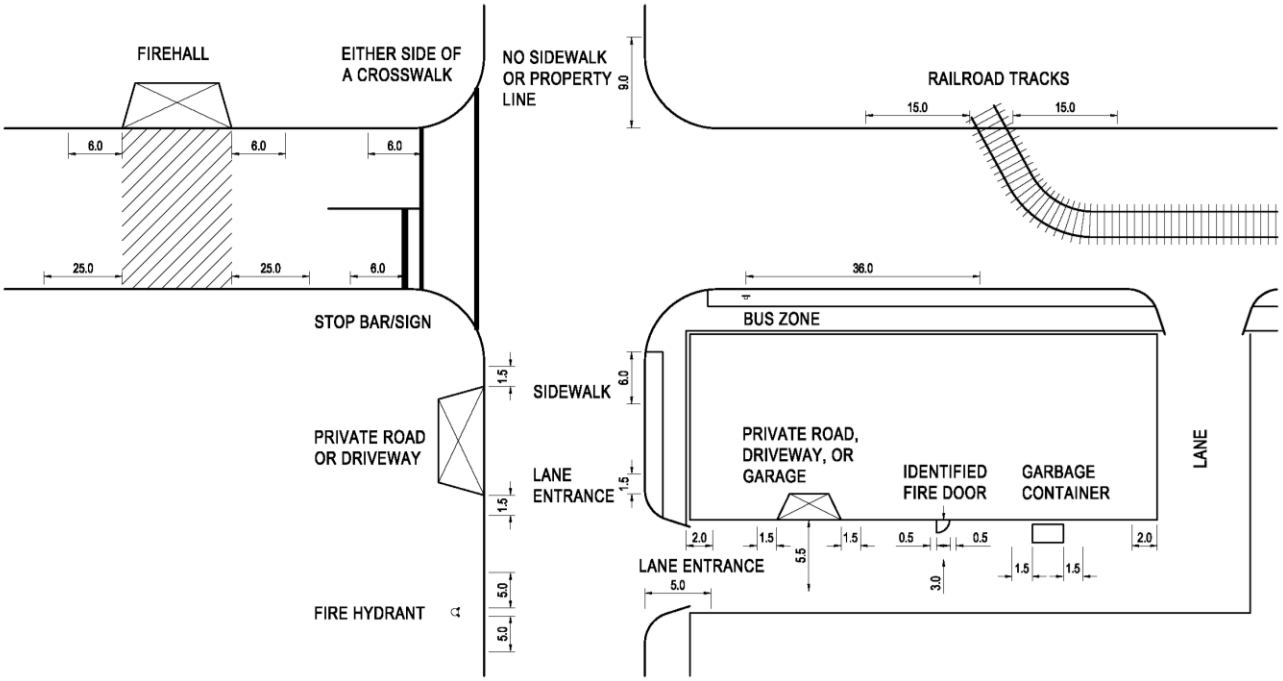


Figure 8-3: Parking Restrictions

Review the City of Vancouver's *Street and Traffic bylaw* closely as several restrictions may apply simultaneously. In many cases, 6m from property line governs at intersections. This is based on the *Street and Traffic* definition of crosswalk "b," with unmarked crosswalks existing across each roadway at a street intersection regardless of curb ramps, paved sidewalks, or "T" intersections. Consider increasing corner clearances near crosswalks where there is a significant safety benefit of better sightlines. Consider increasing corner clearances on both sides of a downhill approach with significant bike traffic and where there is no stop/signal control. This should be by at least one additional car length (approximately 6m) for visibility of drivers at the stop sign or yielding at a traffic circle. In most cases, corner bulges (*Section 8.7.9.2*) help reinforce the increased clearance and mitigate for higher potential vehicle turning speeds. Avoid leaving sections of legal parking too short to be used by most vehicles.

Lane returns and driveway flares come in different shapes and sizes, but the 1.5m should be signed relative to the end of flare/corner radius where the curb has returned to full height and the prevailing alignment of the roadway.

8.7.7.1 NO POSTED REGULATIONS

If a street is determined to need no posted regulations, no regulatory parking signage is required. However, in locations of unusual or non-standard geometry, "No Stopping" regulations may be required for clarity as in the above.

8.7.7.2 PARKING METERS

Parking meter layout should be in accordance with the *City of Vancouver Standard Detail Drawings R9.1*. The following outlines other parking meter requirements:

- If parking meters are to be installed in a softscape boulevard, sleeves should be placed in a concrete pad that consists of 0.4m^3 of concrete and is at least 100mm thick. At least 100mm of clearance should be between the edge of the concrete pad and the outer edge of the metal sleeve.
- Any parking meter sleeves to be placed on a structure must be coordinated with the Streets Design Branch. Meter heads shall be placed parallel to the curb line.
- Parking meters (poles and equipment) are to be installed by the Parking Operations and Enforcement Branch.

Where pay stations are specified by the City of Vancouver, refer to *Standard Detail Drawings C19.4 and C19.5*.

8.7.7.3 ACCESSIBLE PARKING SPACES

In general, off-street parking spaces provide more opportunities to achieve multiple accessible parking space objectives and should be considered wherever available as a reasonable alternative.

Street parking spots that are marked with accessible parking signs are installed as close to curb ramps as possible, preferably the first spot after the intersection on the right hand side if this area is not already designated for a bus zone, though similar locations near driveways may be acceptable. If a new ramp is created to serve a midblock space, use visual accessibility design principles to avoid confusion with crosswalk curb ramps. For example, avoid scoring the letdown and separate it from the travelled portion of the sidewalk. Where the space adjoins a local street boulevard with a commercial or greater than low-rise residential use, provide a concrete pad of at least 2.5m wide between the curb and the sidewalk. If there is an existing pad for a parking meter, expand that existing pad; otherwise, roughly centre on the parking space. Other similar zones, such as for HandyDART and passenger zones, should follow similar principles.

This location provides easy access to the curb ramp at the intersection and facilitates movement from the road to the sidewalk particularly with a rear or passenger-side lift. However, not all users are passengers, not all aids use a ramp or lift, and different users have different needs which could include:

- Ability to exit to roadway height rather than sidewalk height

- Need to exit from left (e.g. driver) rather than right
- Need for additional time to exit on the traffic side, particularly with manual aids, and thus would benefit from multiple travel lanes or additional width to allow traffic to bypass
- Use of electric vehicle charging infrastructure with a mobility aid or wheelchair

During significant street redesign projects, alternate configurations such as mounting the vehicle up to a sidewalk level accessible parking space provided sufficient flat and open space may be preferred.

If an intervening protected bike lane is present, ensure that there is an accessible path of travel to the sidewalk, such as a ramp to a raised bike lane with curbs no steeper than Type E, or a gap to access a road-level protected bike lane to reach the nearest sidewalk ramp. A particularly good combination is to build a dedicated ramp into the curb bulge transition before the accessible parking space. Generally a zebra crossing would not be provided to an individual parking space and only to transit stops or equivalently busy special zones. Use ramps, curb types, and truncated dome surfaces as appropriate.

Although angle and perpendicular spaces are generally not preferred or possible on-street, these can be more accessible particularly with a back-in space with additional room for buffers. Dimensions of perpendicular accessible spaces can be found in the *Parking By-Law No. 6059 Design Supplement*.

8.7.7.4 SPECIAL ZONES

The installation of special zones such as commercial vehicle loading zones, loading zones, passenger zones, and taxi zones must be coordinated with the Parking Management Branch. Generally, special zones should be placed to easily fit in with existing meter layouts. A typical length for a special zone is two metered spaces which is approximately 12m to 13m.

8.7.7.5 BUS ZONES

Installation of bus zones must be coordinated with the *Bus Integration Group in the Transportation Design Branch*. Refer to the *TransLink Bus Infrastructure Design Guidelines* for layout criteria. Bus zones must accommodate the design vehicle(s), the CMBC Standard and/or CMBC Articulated buses, and the number of bus services which may vary based on the bus route. The typical length for bus zones may vary from 18m to over 42m.

8.7.7.6 MOTORCYCLE PARKING

Motorcycle parking layout should be in accordance with the *City of Vancouver Standard Detail Drawings R8.15*.

8.7.8 PRIVATE PROPERTY LOADING ZONES

Refer to the *City of Vancouver Parking and Loading Design Supplement* on the City's website for designing private property loading zones in the City of Vancouver.

8.7.9 TRAFFIC CALMING

This section outlines the criteria for traffic calming measures in the City of Vancouver.

8.7.9.1 SPEED HUMPS, SPEED TABLES, AND SPEED CUSHIONS

Speed humps are selected based on the desired speed reduction. Speed humps are generally not located on arterial streets, collector streets, truck routes, industrial areas, major transit routes, roads that are part of an emergency route, roads part of a major road network, or local roads with a slope of 8% or higher.

The following types of speed humps are used and can be found in the *City of Vancouver Standard Detail Drawings C18.1* to *C18.3*:

- 3.6m long / 80mm high sinusoidal speed hump for 30km/hr zones.
- 4.0m long / 80mm high sinusoidal speed hump for all other streets.
- 3.6m long / 102mm high sinusoidal speed hump for lanes.

Speed humps must be accompanied by the required paint markings and signage. Signage includes speed hump warning signs (WA-22) and speed limit sign (RB 1-2 for 30km/hr) in both directions. In the case of T-intersections, additional warning signs and speed limit tab should be placed at the top of the T. Paint markings include shark's teeth.

Other forms of vertical and horizontal deflection may be appropriate for certain streets where speed humps are not suitable. For example, where traffic calming is to be implemented on transit routes, speed tables, instead of speed humps, are the preferred speed management implementation as shown in City of Vancouver Standard Detail Drawings C18.4 and C18.5 which consists of a:

- 1.8m long sinusoidal approach
- 3.1m long plateau at 80mm height, and a
- 1.8m long sinusoidal departure

Given the special operational characteristic and needs of buses, the following considerations should be incorporated in the design:

- Speed tables should not be installed immediately before or after a bus stop as they may affect the stability of the customer who are walking to the doors for alighting, walking to their seats, or moving toward the back of the bus. It is recommended that speed tables be located at least 25m (80ft) in advance or after a bus stop. Consider alternate measures to improve pedestrian crossings near bus stops where possible.
- Typically, buses cannot travel over a speed table at the same speed as passenger vehicles. A special transit speed reduction warning sign may be required to advise the operators of the speed at which they should travel over the speed hump.

Where traffic calming is to be implemented on a local street bikeway in mixed traffic, speed cushions, instead of speed humps, are the preferred speed management implementation as shown in City of Vancouver Standard Detail Drawings C18.6 to C18.8 which consist of:

- 3.6m long / 80mm high sinusoidal speed cushions for the 30km/hr speed limit of a local street bikeway
- Bike slot(s) generally 1.2m wide to allow people cycling to bypass the cushions

- Cushions of variable widths as shown to locate the bike slots based on the roadway width and presence of parking on one or both sides, with a centre cushion of minimum 2.0m to avoid incentivizing drivers crossing into oncoming traffic

Given the special operational characteristic and needs of bicycles, the following considerations should be incorporated in the design:

- To avoid later reconstruction, first ensure that the parking on the local street bikeway is appropriate for the width of the roadway as in *Section 8.5.3.3* and, if only one side is appropriate, which side of the street produces a better result (e.g. on the right side of one-way motor vehicle traffic, supporting curb bulge placement as in *Section 8.7.9.2*, etc)
- Local street bikeways with speed cushions will also have sharrows as located in *Section 8.9.1.3*. To ensure viable speed cushion placements, the bicycle slots are sometimes not aligned to typical sharrow placement. In these situations, space cushions and sharrows apart along the block. Speed cushion profiles above the recommended roadway widths for one- and two-sided parking have been provided as speed reduction becomes more important and physically narrowing the roadway may not be possible. Speed cushion profiles below the recommended roadway widths have not been provided and would only be used when directed by the City Engineer. In some situations speed humps and other vertical deflection may be preferred on these narrower roadways
- Where speed cushions are installed on a roadway without curbs, identify the effective roadway width based on the location of parking. If 2.0m or wider speed cushions and 1.2m bike slots can be provided fully on the pavement, speed cushions may still be an appropriate treatment, even if trimmed to match the edge of the asphalt, subject to approval by the City Engineer. Installing curbs and a full asphalt roadway, as well as local asphalt widening, are generally preferred options.

8.7.9.2 CURB BULGES

Curb bulges may be used for the following reasons:

- At street corners and mid-block crossings, bulges provide the crossing pedestrian with a shorter crossing distance and a safe waiting area and lookout point from behind parked cars.
- Curb bulges can define the required parking clearances.
- Curb bulges can be used to restrict certain turning movements.
- In combination with traffic circles and raised crosswalks, they can serve as a traffic calming device.
- Curb bulges can be used at bus stops (bus bulbs) to create more space for pedestrians, to prevent cars from passing while the bus is stopped, and to eliminate the need for buses to merge into traffic.
- Curb bulges can be used to install green infrastructure, streetscape amenities, and seating areas

The following criteria applies to the design of curb bulges:

- See the *City of Vancouver* Standard Detail Drawings *R4.1 and R4.2*.
- The desired effect should be maximized without causing other unwanted inconvenience or driving hazard.

- The length of the bulge should match the no stopping regulation or bylaw requirements (see section 8.7.7) as closely as possible, and provide the necessary length for bus stops, GI, sightlines, or other features. This may require extending through additional driveways or intersections.
- Bulges should generally be between 1.8-2.0m wide to align with the typical edge line of parked cars and align with road user expectations, particularly using bicycles and micromobility. Bulges should not be narrower than 1.5m, except in special circumstances – first consider consolidating parking to one side. Bulges may be wider in circumstances such as:
    1) On excessively wide low volume roadways, generally up to a practical maximum of 2.5m or minimum of 6.0m roadway
    2) On streets with protected bike lanes, to create the intended lane widths with and without parking while allowing for bus islands and protected intersections
    3) On blocks with long or regular bulges (half the block or more), treat the bulge as the new roadway edge at its lane width and the parking as in bays
    4) On the departure side of the intersection, provided the lane width is consistent through the intersections (e.g. with upstream bulge)
    5) The resulting lane width would otherwise encourage unsafe side-by-side cycling and driving (see section 8.7.3.1), and the upstream lane narrowing has been considered carefully.
- Bulges at bus stops will be governed by factors such as the required amount of additional sidewalk space for passenger loading and unloading, and the resulting curb lane width.
- Prioritize the following, such as in instances where bulges cannot fit on both sides:
- Shortening unsignalized crosswalks without stop control
    1) Providing bulges on the approach side of the crosswalk
    2) Locating and lengthening bulges uphill of the intersection (to improve sightlines and GI potential)
    3) Bulging on both sides of the same corner to maximize cost efficiency
- All bulges must have object markers on the approach side.
- The reverse curbs must be a minimum of 0.6m from the intersection curb return (shown as T in the *City of Vancouver* Standard Detail Drawings *R4.2)*.
- Design should consider underground conflicts that may conflict with bulge design and any associated signal upgrades.
- Curb bulges often require CB changes which could provide an opportunity to combine with a raised crosswalk. This is particularly helpful where the bulge has been located on a non-stop controlled leg and/or has GI potential.

8.7.9.3 DIVERTERS

Diversionary traffic calming measures are implemented on local streets to reduce the volume of vehicles on the street. Typically, diversionary traffic calming is installed as part of a bikeway project to reach the City's AAA goals, or it may be a requirement of development to reduce the impact of increased trips from the development on surrounding streets. Traffic diverters are a custom design for each intersection, and depending on the goal of the project, different vehicle turns may be prohibited. Some examples of diversionary traffic calming to restrict vehicle movements are right-in / right-out only, no-entry, right / left turn only (diagonal diverter), full closure, or a center median where turns are restricted on and off an arterial street. The diverter should be designed so that it is physically challenging for a vehicle to disobey the turn restrictions. Roll-over curbs or aprons should be used to narrow the road for managed (typically passenger) vehicles while still allowing larger (design and/or control) vehicles, such as fire / garbage trucks to physically make the turn.

Care should be taken when designing traffic diverters to ensure that they comfortably accommodate pedestrians and cyclists. Generally, while diverters restrict vehicle turns, bicycles will be exempted from the prohibition with "except bicycles" on the sign restriction.

8.7.9.4 TRAFFIC CIRCLES

Note: this section refers only to smaller "traffic-calming" circles at the intersections of two local street roadways. This section should not be confused with roundabouts, which are uncommon in Vancouver and have a different set of design requirements.

The City of Vancouver does not currently install a significant number of traffic circles and recommends considering alternative treatments including traffic diverters, raised/continuous crossings, and bulges as appropriate. At intersections of two all ages and abilities local street bikeways, consider alternative configurations that minimize stop control. Most traffic circles with a bicycle-motor vehicle collision count atypical of a local/local intersection have been removed. Research also suggests traffic circles may correlate with single-rider collisions which are more difficult to track.

Historically, traffic circles were installed in residential areas to help to reduce vehicle speeds and collisions at intersections. Traffic circles are not appropriate for all intersections, but can be considered for installation on local residential streets when the following criteria is met:

- The local streets have relatively wide front boulevards and/or can have relatively deep curb bulges
- The traffic circle radius deflects vehicles but not into the pedestrian crossing zone.
- Adequate sightlines are maintained.

Traffic circles shall be avoided under the following conditions:

- Bus routes, emergency response routes, school zones, and industrial areas.
- Offset intersections or intersections with unusual geometry.
- Cycling routes where there are steep grades approaching the intersections.
- Locations where there may be a conflict between informal right-of-way expectations and those of a traffic circle (e.g. a busier street for motor vehicles crossing a busy bikeway)

Traffic circles shall be designed with the following requirements:

- Typically, there are two design vehicles when designing a traffic circle: a passenger car (P) and a larger vehicle like an MSU or an emergency vehicle (fire truck).
- The design vehicles must be able to maneuver all turns in all directions with parked cars at all legal locations nearest to the intersections (typically 6.0m from the nearest edge of the closest sidewalk).
- The center of the circle should be at the center of the two intersecting streets.
- The inner circle shall be the largest possible to allow the larger design vehicle to physically make all movements while getting as close to the curb returns as possible and without the need to drive over the inner circle.
- As a general guide, the outer circle (apron) shall be offset from the inner circle by 0.6m if the inner circle is less than 2.0m in diameter or 1.0m if the inner circle is 2.0m in diameter or greater. The larger design vehicle is allowed to drive over the outer circle apron.
- Passenger car vehicles should not intrude on the pedestrian's path across the intersection (the crosswalk) when making any legal turns, should not mount over the outer circle, and should not conflict with corner radii or parked vehicles.
- Passenger cars shall not be able to drive straight through the intersection without being obstructed by and maneuvering around the traffic circle so that they cannot speed through the intersection.
- The traffic circle shall have appropriate signage such as corner clearance signs and obstruction signs.
- If the circle has vegetation in the centre, planting should be selected and maintained to guarantee proper sightlines, as per *Chapter 9: Streetscape & Urban Forest* and the ***City of Vancouver Construction Specifications***.

When appropriate, generally during retrofits, traffic circles will be signed with the modified yield sign illustrating circular flow on their approaches.

8.8 INTERSECTIONS

Intersections are where the majority of collisions occur between road users due to the complex decision-making required and potential conflicts between road user movements. Where practical, modes should be separated in both space and time at the intersections to minimize conflicts. This section outlines the criteria for designing intersections in City of Vancouver.

8.8.1 DESIGNING FOR PEDESTRIANS

Pedestrians with disabilities are the most vulnerable road users at intersections, and so intersections must be designed around making pedestrian movements safe, visible, and protected for everyone. This section outlines the criteria for ramps and crosswalks at intersections.

8.8.1.1 CURB RAMPS

Curb ramps are designed for people with limited mobility, and users of wheelchairs, scooters, and strollers. However, the lack of curb can pose a risk for people with visual impairments. Curb ramps should be considered for installation at all corners and crosswalks and should be aligned in the desired direction of travel and land pedestrians safely in the crosswalk. Ideally the lateral position of curb ramps should align with the upstream sidewalk or pedestrian path, and otherwise allowing for a 1:3 taper or better. Ensure the drop curb portion of the ramp remains within the bounds of the crosswalk.

For a typical curb return, the preferred design is to install double curb ramps wherever possible (see *Standard Detail Drawing C8.1*). A large single curb ramp or parallel ramp should only be used in constrained conditions where a double curb ramp is not feasible, subject to approval by the City Engineer. For a typical corner radius and approximately perpendicular intersection, 6m+ from curb to pole/CB should easily accommodate double ramps and 5-6m could accommodate double ramps after relocating the conflicts or with reasonable modifications, such as allowable reductions in the flare length, flare-flare spacing, and corner radius.

In the event of a ramp conflict with a traversable utility cover or maintenance hole, most conflicts will be accepted provided they are safe and lead to a constructible result regarding, for example, grade breaks and flares. As in *Section 8.8.1.2*, vertical elements, catch basins, and similar obstructions should not be located in either the dropped portion of the ramp, the crosswalk, or immediately behind the crosswalk on the sidewalk. See *Section 8.4.1.4* for more information on adjusting truncated dome surface layout around utility covers. Provide the widest ramp possible, up to the width of the associated crosswalk (flares do not need to be located within the associated crosswalk).

Directional score lines are designed to assist the alignment of people with visual impairments who use a white cane as a navigation aid. As such, scorelines shall be parallel to the crosswalk and to the receiving curb ramp wherever possible, and always direct pedestrians safely to the opposite curb.

Curb ramps shall be installed with a maximum grade of 8.3% (ranges between 5% and 7% are preferred). Any grade or grade break less than 5% may be difficult for pedestrians who are fully blind or partially sighted to detect, as a change in grade is often used as an important cue that they are leaving the sidewalk and entering the roadway. As such, truncated dome surfaces are required in the curb ramp in these circumstances (see *Section 8.4.1.4*). Where there is sufficient public space, a preferred level landing area of at least 1.2m (min. 0.9m) shall be provided at the top of curb ramps to accommodate pedestrians passing through who do not intend to cross the road as well as providing a level space for those using the curb ramp to turn onto the perpendicular sidewalk.

For double curb ramps:

- Where adjacent softscape treatment is desired, sod may be installed between the two ramps where there is a reasonable expectation that the adjacent property owner will maintain the grass.
- A minimum 1.0m of full-height curb between the flares of two adjacent ramps is typically required.
- For further details, see *City of Vancouver Standard Detail Drawings C8.1*.

For large single curb ramps:

- To be used when double curb ramps cannot be accommodated to the satisfaction of the City Engineer.
- The ramp must adequately land a pedestrian in either crosswalk.
- For further details, see *City of Vancouver Standard Detail Drawings C8.2*.

For lane curb ramps:

- Continuous sidewalk treatments shown in the *City of Vancouver Standard Detail Drawings C9.2 onward* are now preferred.
- In residential areas where a softscape boulevard exists, a concrete flare may not be required.

Curb ramps shall be designed in accordance with the *City of Vancouver Standard Detail Drawings C8.1* to *C9.1*.

8.8.1.2 MARKED CROSSWALKS

Note: this section refers primarily to marked, but unsignalized crosswalks.

Marked crosswalks are the first step in enhancing a pedestrian crossing. The minimum standard involves pavement markings indicating the crosswalk and accompanying signs. Marked crosswalks are used to alert motorists to expect pedestrians crossing and to direct pedestrians to the preferred crossing location. Most intersections (e.g. local streets) are not marked with any kind of paint or signage but are legal crosswalks for pedestrians to whom people driving or cycling are required to yield, although in very rare circumstances pedestrian crossing can be prohibited with signage to mitigate potential safety concerns.

The following reference documents shall be used:

- *MUTCD*.
- *BC MoTI Pedestrian Crossing Control Manual for British Columbia*

- *TAC Pedestrian Crossing Control Guide*.
- *City of Vancouver Construction Specifications*.
- *City of Vancouver Standard Detail Drawings R8.1* and *R8.9* to *8.13*

Key aspects to consider when selecting the preferred crossing are listed below:

- Natural pedestrian desire lines.
- Presence of favorable pedestrian supporting infrastructure (i.e. curb, sidewalk, curb ramps, curb bulges and lighting if possible).
- Shortest distance for pedestrians to cross the street.
- Proximity to pedestrian generators (i.e. bus stops, schools, playgrounds).
- Guaranteed adequate sightlines of pedestrians crossing.
- Avoidance of potential obstacles such as utility poles, fire hydrants, trees, catch basin grates, and raised traffic islands.
- Avoidance of conflict zones such as driveways.
- No crossings in front of the stop-controlled legs of the intersection.

Marked pedestrian crosswalks must have side mounted back-to-back Pedestrian Crosswalk (RA-4R (right) or RA-4L (left)) signs (*MUTCD Sec A6.4.1*). In the case of marked crosswalks adjacent to an elementary or secondary school, back-to-back School Crosswalk (RA-3R (right) or RA-3L (left)) signs (*MUTCD Sec A6.4.1*) must be used. The pedestrian crosswalk signs shall be oriented so that the sign faces down the roadway. If visibility of the marked crosswalk is limited, Crosswalk Ahead warning signs (WC-2R/L or WC-16R/L for school crosswalks) are required.

Marked crosswalks are recommended only at secondary arterial or collector streets with the exception of crossings serving community amenities (e.g. schools, playgrounds, senior homes, among others) on residential streets. Additionally, marked crosswalks are generally not recommended at multilane (more than one vehicle lane in each direction) roads due to ‘multiple threat’ risk. New construction on multilane roads generally requires marked crosswalks with signals.

Marked crosswalks can be installed at non-signalized intersections based on a detailed study of the following factors:

- Pedestrian volumes.
- Age and ability of pedestrians.
- Nearest alternative pedestrian crossings.
- Traffic speed and volume.
- Adequate gaps in traffic to cross safely.
- Crosswalk warrants as per the *TAC Pedestrian Crossing Control Guide* and the *BC MoTI Pedestrian Crossing Control Manual for British Columbia*
-
- Presence of pedestrian generators.
- Pedestrian collision data.
- Driver’s courtesy.
- Road geometry and visibility.

The use of zebra markings is recommended for all marked crosswalks due to their increased visibility. Zebra markings consist of 0.6m wide bars with 0.6m gaps in between. The length of the bars (width of the crossing) is typically 3.0m, but wider crosswalks can be used when higher pedestrian volumes exist (e.g. downtown). There must be a minimum 0.3m gap at each edge of the crossing so that there is a contrasting strip of asphalt between the concrete sidewalks and the white pavement markings. Marked crosswalks require corner clearances (minimum 6.0m, preferably 10.0m or longer) by using No Stopping Anytime signage to ensure proper sightlines.

8.8.1.3 SCHOOL CROSSWALKS

School crosswalks generally follow the principles outlined for zebra crosswalks above. School crosswalks are usually marked on the side of an intersection closest to the school; however, the far side may be marked where conditions warrant and where it is recommended by school staff in consultation with City staff. Requests for school crosswalks are referred to City staff by the school for their investigation and recommendation. City staff investigate on the basis of number of children crossing, routes used by children to go to and from school, available gaps in traffic flow, and adjacent crossing facilities.

Pavement markings shall be installed as described in the *MUTCD (Fig C3-1)* at locations described above. *Section 8.9.1.7* outlines the material requirements for crosswalk markings.

School crosswalks require corner clearances (minimum 6.0m) to be established by using No Stopping Anytime signing. Refer to *Section 8.8.1.2* for the installation of signs. School crosswalk signing remains in place during the summer months.

8.8.1.4 PEDESTRIAN CROSSINGS ACROSS BICYCLE LANES

Pedestrian crossings at protected bicycle lanes and bicycle paths are modified zebra crossings as follows:

- 3.0m long by 0.3m wide bars aligned with the movement of bicycle traffic.
- Minimum 0.15m gap (maximum 0.3m) at either end of the crossing so that there is a contrasting strip of asphalt between the adjacent concrete and the white pavement markings.
- Remaining gaps between bars to be spaced evenly and preferably around 0.3m.

The City of Vancouver uses both path-size crosswalk signs (RA 4.1) and "bikes yield to pedestrians" signs (RB 39) depending on the context and number of crossing points at a location and will confirm which treatment(s) and placement(s) are appropriate. "Bikes yield to pedestrians" yellow diamond warning signs are no longer recommended.
In cases where a pedestrian crossing traverses both a bicycle lane and adjacent motor vehicle lane where there is no pedestrian refuge between the two, the standard crosswalk pavement markings (0.6m wide bars) and RA 4 signs shall be used.

8.8.1.5 RAISED CROSSINGS

There are several types of raised crossings which should generally be selected as follows:

- The sidewalk crosses a driveway or laneway

    - Use continuous sidewalk and/or bike path treatment (recommended for all locations). See *Standard Detail Drawings C7.1* onward (driveways) and *C9.2* onward (laneways).
- Intersection consists of one street or midblock path with unsignalized priority (e.g. stop or yield control) and one without
    - Use continuous sidewalk and/or bike path treatment along the priority street or path to reinforce priority, particularly for streets with protected bike lanes and high streets
    - Use raised crosswalk for upgraded crossings of the priority street where such a treatment is appropriate
    - Use raised intersection with caution, select ramps based on traffic control
- Intersection consists of streets with equal priority
    - Use raised intersection to communicate the equal priority
    - Select ramp based on traffic control, e.g. use continuous sidewalk ramp standards to reinforce all-way stop control
- Crosswalk is midblock or uncontrolled intersection (no stop or signalized legs)
    - Use raised crosswalk per leg or as entire raised intersection where such a treatment is appropriate
- Crosswalk is at slip lane
    - Consider removing slip lane, followed by continuous sidewalk, followed by raised crosswalk
- Crosswalk is part of a signalized intersection
    - In general, individual crosswalks at a signalized intersection should not be raised
    - Do not use a continuous sidewalk/bike lane treatment for a crossing that is meant to be, or could be interpreted as, controlled by a traffic signal. If it can be designed to be distinct from a nearby signal, and not signalized itself, it may be appropriate per the above criteria
    - Some projects are piloting raised intersections at full signals. These do not function as raised crosswalks so much as measures to visually prioritize the public realm, provide a flatter walking experience, and allow for flexible street use. Depending on the selected design speed and use of sinusoidal asphalt or planar concrete of various heights and slopes, they may also have a smaller speed reduction function that should be suitable for the context of the roadways involved.
- Crosswalk is of a bike path
    - Along car-free streets, at bus stops, or connecting to priority passenger zones like elementary schools, use a 0.5m long planar concrete ramp with similar 12% grade break targets to the continuous sidewalks where the bike path has Type E curbs on both sides
    - Along roadway level protected bike lanes at intersections, use an adapted version of the raised crosswalks for the roadway
    - Along sidewalk level protected bike lanes at intersections, use a shorter ramp or no ramp as appropriate

- Raised crossings may be less effective against faster types of bicycles and their riders and pose greater risk to micromobility users. Ensure the context justifies versus other measures to improve yielding compliance such as narrowing to single file per direction. When crossing a bike route, facility, or busy informal route use continuous sidewalk treatment with caution, and avoid Type C/D curb

Table 8-15: Raised Crossing Roadway Ramp Types

	Raised crosswalk or raised intersection for speed reduction		Raised intersection for urban design and minor speed reduction	
Type	1	2	3	4
Traffic control device on this leg	Stop sign or equivalent	No stop sign, no traffic signal	Traffic signal	Traffic signal
Design Speed	0-10kmh	20-30kmh	30-40kmh	50kmh
Planar concrete	1.2m long, 12% grade-breaks, cold joints at top and bottom	1.8m long, 8% grade breaks	2.0m long, 4% grade breaks for a “half height” raised intersection	N/A
Sinusoidal asphalt	N/A	1.5m long, profile as in C17.3	2.0m long, profile as in C18.2	Use long asphalt ramps and adjust sidewalk profiles

Continuous sidewalks do not have zebra markings and follow City of Vancouver Standard Detail Drawings C9.2. Avoid crossing transit routes (particularly where buses are in revenue service) and use with caution around significant emergency response routes.

Raised crosswalks shall generally follow the principles outlined for zebra crosswalks above but must also be in accordance with the *City of Vancouver Standard Detail Drawings C17.1* to *C17.4*. Raised crosswalks must also follow the principles listed in *Section 8.7.9.1*.

Raised crosswalks on a transit route must be in accordance with the *City of Vancouver Standard Detail Drawings C17.5* and *C17.6* and the following considerations should be incorporated in the design:

- Raised crosswalks should not be installed where transit vehicles are making a turning movement or navigating a horizontal curve / deflection.
- Raised crosswalks should not be installed immediately before or after a bus stop as they may affect the stability of passengers who are walking to the doors for alighting, walking to their seats, or moving toward the back of the bus. It is recommended that the raised crosswalk be located at least 25m (80ft) in advance or after a bus stop.
- Planar concrete ramps should be 4% grade break or less, with specific locations confirmed by CMBC

8.8.1.6 LANE CROSSINGS

Lane crossings shall be designed in accordance with the *City of Vancouver Standard Detail Drawings C9.2* and *R7.1*. Continuous sidewalk raised crossings at laneways are almost always preferred, exceptions for retrofits are where only one return requires minor changes or in situations of especially challenging grading without sufficient back boulevard. In this case, modifications in response to the context (such as adjusting a ramp to meet existing CBs, or elevations to meet existing buildings) to maintain the design intent may be appropriate.

8.8.1.7 STANDARD MARKED CROSSWALKS

Standard marked crosswalks are limited to signalized intersections. Marked crosswalks shall consist of two white parallel lines. The width of each line shall be 0.2m (*MUTCD Fig. C1-1* or *BC MoTI Pedestrian Crossing Control Manual for British Columbia*

Figure 1.1).

The width between the crosswalk lines shall be determined by guidelines described in the *BC MoTI Pedestrian Crossing Control Manual for British Columbia*

. Generally, the width will be 3.0m unless pedestrian volumes indicate that a greater width is required or unless physical features indicate that a narrower crosswalk should be installed. In the latter case, the crosswalk should not be less than 2.5m wide. When possible, crosswalks in the downtown core will be a minimum of 4.0m wide and a typical maximum of 6.0m wide.

The marked crosswalk line nearest the intersection should be inset a minimum of 0.6m from the projected edge of the roadway curb line (*MUTCD Section A6.3*) and no greater than 2.0m except in the case of an intervening bicycle crossing. In the case of intersections with intersecting crosswalks, it is desirable that the point where the intersection-side crosswalk lines intersect be a distance of 1.0m or less from the edge of the curb return with a maximum of 2.0m where possible.

Standard crosswalks do not require side mounted Pedestrian Crosswalk signs to accompany them.

8.8.2 DESIGNING FOR BICYCLES

Special care must be used when designing bicycle facilities at intersections. Designers should minimize conflicts between all modes by heightening visibility, denoting a clear right of way, and facilitating eye contact and awareness of all users. Safe and comfortable intersections also reduce the risk of injury for all users in the event of a crash. A variety of design treatments may be used depending on the facility type and context. Refer to design guidance from TAC, NACTO, CROW, and other emerging sources. Contact Transportation Design Branch staff for the latest guidelines and advice on complex intersection designs.

Sections 8.9.1.12 and *8.9.1.13* outline bicycle pavement markings including the typical use of green treatments at intersections and bicycle stencils and sharrows.

8.8.3 DESIGNING FOR MOTOR VEHICLES

While motor vehicle occupants are the least vulnerable road users at intersections, motor vehicle drivers also carry the most responsibility to ensure the safety of others. Designing intersections to provide drivers with clear visibility and easily understood information is key to designing safer intersections. This section outlines the criteria for vehicular design at intersections.

8.8.3.1 DESIGN VEHICLES

The design vehicle determined in *Section 8.7.2* shall be used for the design of intersections.

8.8.3.2 TURNING MOVEMENTS

The designer shall ensure that the intersection design is suitable to handle the turning movements of the largest design vehicle without mounting the curb (except in the case of rollover curb applications).
For turning movements at typical driveways and taking into account localized design considerations, design and control vehicles can use the full width of the driveway and turns can be made assuming a 'start from stop'.

8.8.4 INTERSECTION GEOMETRY

This section outlines the required geometry for intersection in the City of Vancouver.

8.8.4.1 INTERSECTION ALIGNMENTS AND SPACING

Intersection alignments and spacing shall follow the *TAC Geometric Design Guide for Canadian Roads*.

8.8.4.2 TURN LANES

Turn lanes shall be designed according to the *TAC Geometric Design Guide for Canadian Roads*. Left-turn bays and lane transition radii are outlined in the *City of Vancouver Standard Detail Drawings R4.3*.

8.8.4.3 OFFSET INTERSECTIONS

Through traffic lanes which have no pavement markings across an intersection should have a deflection less than 1:60 with an absolute maximum of 1:40. Offsets over 1:60 should be marked with continuity lines. Measure offset for each lane or directional dividing line from outside of the crosswalk or stop bar to the outside of crosswalk or stop bar as appropriate. Any offsets over half a lane width on a multilane arterial should generally be avoided.

8.8.4.4 CURB RETURNS

Curb returns shall generally be in accordance with the *TAC Geometric Design Guide for Canadian Roads*. Compound curves may be required on arterial streets for specific situations and design vehicles. All new curb returns are to be constructed with standard curb ramps or include curb cuts to allow for future curb ramps where there are not already sidewalks.

Table 8-16 outlines the typical curb return radii; however, the design must be confirmed using swept path analysis software for managed, design, and control vehicles at the applicable design speeds, as described in *Section 8.7.2*.

Table 8-16: Curb Return Radii

Location	Curb Return Radius
Turn Restricted including bicycles	1.0m
Lane Entrances	2.0m
Bicycles Only (No Motor Vehicles)	3.0m
Motor Vehicles	5.5m

Notes:

1) Lane entrances may require custom designs when the roadway has one lane per direction
2) Bicycles only may be reduced to 2.5m for bidirectional PBLs, other constrained protected intersections
3) Radii greater than 4.0m may require other speed reduction measures for managed vehicles. Conversely, radii less than 5.5m may require truck aprons and other mountable features to accommodate design and control vehicles. See *Section 8.7.2*.
4) Where larger radii are required for design and control vehicles in industrial areas or along bus routes, use a compound curve of 4.0 or 5.5m at the corner and larger radii to transition

Curb returns shall be designed with a preferable continuous grade of 1.5% and an absolute minimum grade of 1.0%.

8.8.4.5 GRADES, CURVATURE, AND SIGHT LINES

Intersections shall meet the grading, curvature, and sight line distance requirements outlined in the *TAC Geometric Design Guide for Canadian Roads*. For roads of different classification, the crossfall and profile of the lower classification road should be varied to suit the profile and crossfall of the higher classification road. For driveway or laneway access that involves atypical grades and/or design vehicles, vertical modelling may be required to determine clearances for appropriate design vehicles. The maximum changes in grades through an intersection are outlined in ***Table 8-17***:

Table 8-17: Intersection Changes in Grade

Intersection Type	Maximum Change in Grade	Equivalent K Value
Signalized Intersections	2.5% over 8.0m (or 5% over 16m)	3.2
Stop Sign Only Intersections	3.0% over 5.0m (or 6% over 10m)	1.6
Driveway and Lane Entrances	12.0% over 5.0m	-

8.8.5 RAILWAY CROSSINGS

For the design of railway crossings, the following acts, regulations, and standards must be followed:

- *Transport Canada Grade Crossing Standards*.
- *Transport Canada Grade Crossing Regulations*.
- *Transport Canada Railway Relocation and Crossing Act*.
- *Transport Canada Railway Safety Act*.
- *TAC Geometric Design Guide for Canadian Roads*.
- *MUTCD*.
- Applicable railway operator regulations (CN Rail, CP Rail, BNSF, SRY).

See *Section 8.4.1.4* for details on appropriate tactile walking surface indicators at rail crossings.

8.9 PAVEMENT MARKINGS

Pavement markings are important to separate road users into their respective spaces. Pavement markings in the City of Vancouver generally follow the *MUTCD* with the exception of the specific requirements outlined in this manual. This section outlines the criteria for pavement markings in the City of Vancouver. For material specifications and installation requirements, refer to the ***City of Vancouver Construction Specifications***.

8.9.1 ROADWAY MARKINGS

This section outlines the types of roadway markings in the City of Vancouver and the general criteria for their design.

8.9.1.1 LINE PATTERNS

For roadway pavement markings, standard line patterns shall be in accordance with the *MUTCD* and the *City of Vancouver Standard Detail Drawings R8.1*. Line Patterns on new asphalt are installed in thermoplastic and supplemented with raised pavement markers (RPMs) every 9.0m.

8.9.1.2 REFLECTIVE PAVEMENT MARKERS

In general, reflective pavement markers shall be used to define directional dividing lines and lane lines on all new paving or road marking projects.

Reflective pavement markers shall be placed in line with and in front of lane line and directional dividing line dashes, leaving approximately 0.2m of clear pavement between the marker and the dash. For directional dividing line dashes, reflective pavement markers shall be placed at the approach end of the dash.

For solid lane lines and directional dividing lines, reflective pavement markers shall be placed abutting the line on the north side of the line for east / west streets and on the west side of the line for north / south streets, leaving approximately 25mm of clear pavement between the marker and the lane line. For double solid directional dividing lines, the markers shall be placed between the lines.

Where a directional dividing line or lane line separates into two lines for a gore area or for an obstacle in the roadway, reflective pavement markers should be installed on the traffic side of the lines.

Reflective pavement markers shall not be placed on guide or continuity lines.

8.9.1.3 MEDIAN GORE AREAS

Median gore areas are defined to be those gore areas where traffic passes in opposite directions past the gore area. Diagonal lines painted on the roadway for these installations should be marked 0.6m wide and spaced at 3.15m intervals. Gore areas are to be installed in thermoplastic in accordance with the *MUTCD* and the *City of Vancouver Standard Detail Drawings R8.2* and *R8.3*.

8.9.1.4 BICYCLE LANE BUFFER GORE AREAS

Bicycle lane buffer gore areas are defined to be those gore areas where there is a vehicle travel lane adjacent to a buffered bicycle lane. Diagonal lines painted on the roadway for these installations should be marked 0.1m wide and spaced at 4.0m intervals.

8.9.1.5 ARROWS

Thermoplastic shall be used for marked turn arrows, and paint shall be used for merge arrows.

New arrow markings for turn bays shall be located as shown in the the *City of Vancouver Standard Detail Drawings R8.4* to *R8.5* and the *MUTCD*. For through or turning lanes where there is no fixed-length turning bay, new arrow markings shall be installed according to the general spacing specifications in the *MUTCD*.

The *City of Vancouver Standard Detail Drawings R8.4* to *R8.5* and the *MUTCD* illustrates the design shapes for marked arrows and the alignment specifications for multi-lane applications. Existing marked arrows shall be remarked in their present locations. However, if the pavement is resurfaced or sandblasted, new arrows should be installed according to the standards discussed above.

New merge arrow markings to indicate the termination of a travel lane will be located as illustrated in the the *City of Vancouver Standard Detail Drawings R8.6* to *R8.7* and the *MUTCD* unless otherwise specified by the Traffic & Data Management Branch. Existing merge arrows will be remarked in their present configuration. However, if the pavement is resurfaced or sandblasted new arrows will be installed according to the above standards.

8.9.1.6 RESERVED LANES

Reserved lanes shall be marked as per the design shown in the *City of Vancouver Standard Detail Drawings R8.8* and the *MUTCD*. Reserved lane pavement markings shall be centered in the lane and spaced 50m apart.

8.9.1.7 CROSSWALKS

Crosswalks shall be marked in thermoplastic. *Section 8.8.1* outlines specific requirements for crosswalk layouts.

8.9.1.8 STOP BARS

New stop bars at marked crosswalks should be 0.3m wide, oriented perpendicular to the path of the vehicle travel, and located 1.0m clear distance from the marked crosswalk line furthest from the intersection (*MUTCD Sec A6.3, Fig C1-1, Sec C3.2*). For multilane arterials, each lane should have a separate stop bar staggered along the 1.0m clear offset from the pedestrian crossing. For skewed intersections, stop bars should meet the requirements in the *City of Vancouver Standard Detail Drawings R8.14*. Stop bars should be installed in thermoplastic.

Bicycle lane stop bars should also be 0.3m wide, but oriented parallel to the cross street (rather than perpendicular to the path of travel for bicycles). The bicycle lane stop bar should be located 0.5m clear offset from the marked crosswalk or edge of intersecting travelled path. Vehicle stop bars are recommended to be set back at least 2.0m from the bicycle stop bar to improve visibility at permissive turn conflicts, particularly right turns restricted on red. When setting stop bars back for large vehicle turns, generally amounts less than a car length are preferred to improve compliance; if more is required, first consider widening the crosswalk and slightly increasing its offset from the intersecting roadway.

Where stop signs are installed, stop bars must also be installed to show the intended stopping location for the front bumper of vehicles. For new markings, stop bars should be installed according to the dimensions shown in ***Figure 8-4*** for each specific case. Stop bar locations may need to be adjusted to accommodate vehicle movements or other site-specific requirements.

When remarking existing stop bars, the old bar can be remarked provided the front of the existing bar is within 0.3m of the front of the stop bar location for a new install. Existing painted stop bars should be remarked 0.3m wide, regardless of their original width. Thermoplastic stop bars should be patched the same as their original width, either 0.3m or 0.4m. If old locations are not within this tolerance, the Traffic & Data Management Branch shall be consulted. In no case shall marking result in two lines.

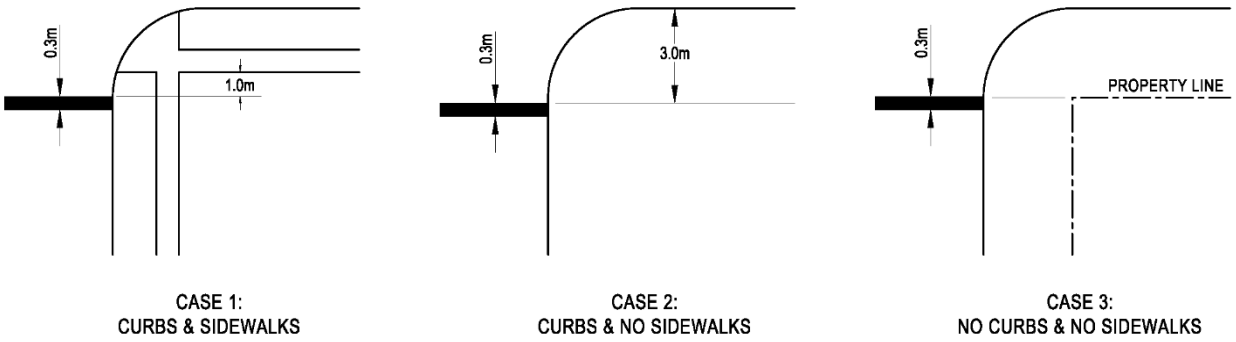


Figure 8-4: Stop Bar Placement

8.9.1.9 YIELD MARKINGS

TAC MUTCD-C included guidance on triangular yield markings (“yield teeth”) which are 0.3m wide and 0.45m long with 0.1m gaps when painted on the road. On protected bike lanes, the yield teeth consist of blocks 0.15m wide by 0.3m long with 0.1m gaps. These are still relatively uncommon in the City of Vancouver and should be used only when directed. Yield markings should be installed in preformed thermoplastic.

Yield bars, as in the BC MOTT specification found on roundabouts, are 0.4m wide by 0.6m long blocks with 0.6m gaps when painted on the road. On a few historical cycling projects, the yield bar consisted of blocks 0.2m wide by 0.3m long with 0.3m gaps. Neither are currently in common use and are not preferred due to potential confusion with elephant’s feet and lack of local user experience.

8.9.1.10 PAINTED CURBS AND MEDIANS

Curbs shall not be painted to indicate traffic regulations such as parking restrictions.

For medians and islands in the middle of multi-lane roadways, the end of the traffic island facing approaching vehicle traffic or bicycle traffic shall be painted yellow provided this provides good contrast and would not be confused with other nearby paint markings and materials. The end of the island is defined as the area from the tip of the island to 1.0m beyond the point where the curved section joins the tangent section in the island's structure (see ***Figure 8-5***).

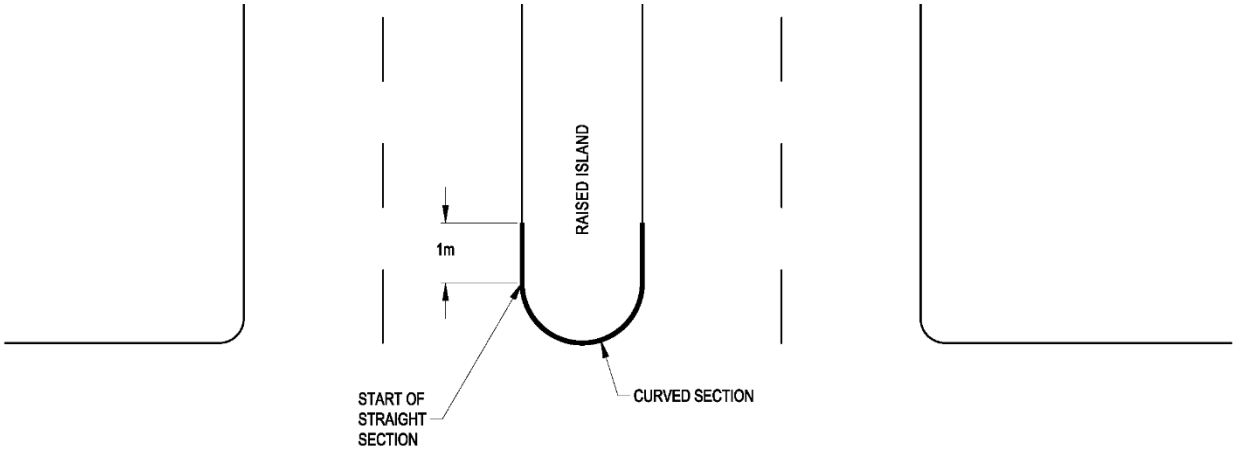


Figure 8-5: Painted Medians

Directional dividing lines shall be painted up to the edge of the median only unless otherwise specified.

For medians and islands along protected bike lanes and local streets, only the sharply curved noses should be painted yellow where specified in the design. The nose of medians or traffic islands facing approaching bicycle traffic should typically be painted yellow in circumstances such as:

- The first nose before or after an intersection, driveway, or pedestrian crossing.
- Bicycles transitioning from mixed traffic to a protected bicycle lane or refuge.
- Bicycles making a change in direction.
- Wide intersections.
- Where an object marker would be placed but cannot due to vehicle mounting/swept path or other considerations.

It should typically not be painted yellow in circumstances such as:

- Intermittent physical separation and/or drainage gaps along what is otherwise a continuously painted or delineated bike lane buffer.
- Entire protected intersection corners or traffic diverter islands at intersections
- Where an object marker alone adequately serves the same purpose.

8.9.1.11 DIRECTIONAL DIVIDING LINES

A Directional Dividing Line (DDL) is used to separate two-way traffic on arterial and collector roadways when traffic volumes, vehicle size, and geometric conditions dictate. Directional dividing lines are generally installed on the following two-way roadways:

- Streets with greater than 8000 vehicles/day or more than one lane per direction.
- Streets where steep grades or sharp curves limit visibility.
- Bus routes.
- Bidirectional protected bicycle lanes and paths.

Directional dividing lines may also be installed on a case-by-case basis on:

- Two-way left turn lanes.
- Streets with 5000-8000 vehicles/day.
- Truck routes.
- On local streets with no DDL, 10m in advance of a full traffic signal.

Directional dividing lines shall consist of a 0.1m wide solid yellow line broken at intersections. At uncontrolled intersections, a 3.0m dashed yellow line shall be marked in the centre of the intersection.

Directional dividing lines on protected bicycle lanes and paths shall consist of a 0.1m wide yellow dashes 1.0m long with 3.0m gaps. Through curves and for 10m approaching pedestrian crossings, bicycle lane DDL shall be solid.

Directional dividing lines on new asphalt are installed in thermoplastic and supplemented with raised pavement markers (RPMs) every 9.0m.

Lane lines and directional dividing lines are not only associated with increased travel speeds, they also affect the default unposted speed limit in the City of Vancouver: 30km/h without, and 50km/h with. Omitting lane lines and directional dividing lines, as well as the potential this unlocks to redesign the street, have the potential to improve safety on certain streets.

8.9.1.12 BICYCLE GREEN SURFACE TREATMENT

In 2011, the Transportation Association of Canada (TAC) and the US Federal Highway Administration (FHWA) reserved the colour green to be used on street surfaces to denote cycling facilities.

The City of Vancouver uses green paint to identify areas where people biking cross and share the road with motor vehicles. In addition, the City uses green colour to highlight bicycle boxes which identify a safe refuge place for people biking as they wait to turn. ***Table 8-18*** highlights in general terms those locations where green treatment should and should not be used. Note, however, that every installation, including ones not covered in the guidelines, requires professional judgement and evaluation on a case-by-case basis.

In general, green paint and elephants' feet are used together in bike crossings, as both imply right-of-way even if they do not create it legally. Exceptions discussed in the table include the use of elephants' feet with a zebra crossing (designating a crosswalk along a shared path where cycling is allowed) or a particularly low volume driveway.

Bicycle green surface treatment is installed using Methyl Methacrylate (MMA) or preformed thermoplastic.

Table 8-18: Green Treatment Uses

Location and Description	Example
Generally, Includes Green Treatment	
✓ Bicycle crossings with conflicts: Example conflicts include permissive left and / or right turns or compliance problems with turn restrictions. Green treatment may be limited to the portion(s) of the crossing where conflicts occur.	
✓ Bicycle crossings forming part of an "All Ages and Abilities" corridor: During network build-out, green paint will generally be included in all bicycle crossings of busier streets. This is intended to aid wayfinding and awareness of quality bicycle facilities.	
✓ Major driveway crossings: This includes painted / protected bicycle lanes, bicycle paths, and some shared-use lanes (next item). It includes driveways to commercial properties, multi-family residential buildings, and parking lots.	
✓ Other locations where frequent crossing conflicts can be expected	
Facility no longer recommended, but would be painted green	
✓ High volume mixed-use or "sharrow" lanes: Green-backed sharrows (white sharrows on green rectangles) may be used to increase the visibility of sharrows or to highlight driveway conflicts. These would typically be limited to areas with heavy bicycle traffic or significant crossing conflicts. (Physical separation is preferred other than as part of a local street bikeway)	

Location and Description	Example
✓ Painted bicycle lanes approaching intersections (away from curb): Green paint should be used where motor vehicles merge across or travel on both sides of a bicycle lane approaching an intersection; this includes bicycle-only turn lanes as well as painted bicycle lanes between through and right-turn motor vehicle lanes, parking lanes, and bus lanes. Green paint should be limited to intersection approaches. (Physical and signal separation are preferred)	
✓ Merging and Mixing Zones: Green backed sharrows should be used where protected bicycle lanes merge into a shared use lane. This includes mixing zones where turning vehicles and through bicycles share a lane approaching intersection. (Physical and signal separation are preferred)	 *Example from San Francisco*
✓ Bicycle boxes: All configurations are filled with green, including advance stop bars and two-stage left turn boxes. (Protected intersection treatments are preferred)	
Generally, Doesn't Include Green Treatment	
✗ Very low volume driveways Driveways leading to single family homes or gated maintenance accesses generally see a very low volume of users already familiar with the conflict and green treatment can be omitted.	
✗ Bicycle crossings without conflicts Where turns are fully prohibited to general traffic and physically reinforced, the use of green treatment may be unnecessary or send a conflicting message	

Location and Description	Example
✗ Painted bicycle lanes approaching intersections (against the curb): In this situation, green paint may discourage drivers from merging into the bicycle lane to make a right turn, as required under the *British Columbia Motor Vehicle Act*. Where turning across the bicycle lane is preferred over merging into the bicycle lane, a median on approach with green treatment in the crossing itself and appropriate yield signage and / or signalization is generally appropriate.	
✗ Shared crossings for walking and cycling: Where crossbike markings ("elephants' feet") are combined with a marked crosswalk with no separation for different users, green treatment is inappropriate. Green helps to identify dedicated bicycle crossings as distinct from crosswalks in other locations, potentially discouraging people from walking in the crossing. Consider zebra crossing markings or other patterns instead to increase visibility for drivers, and separate crossings for walking and cycling wherever possible.	
✗ Bicycle crossings where bicycle traffic never has right-of-way: At bicycle crossings where two-way stop control (or similar) favours cross traffic, the addition of green paint may imply bicycles have the right-of-way and lead to undesired / incorrect yielding behaviour. Green paint is similarly not recommended across the major street at half-signals. Consider full signalization, providing all-way stop control, reorienting the stop signs, or otherwise.	

8.9.1.13 STENCILS

Sharrows, or shared lane markings, are symbols placed on the pavement surface in the intended area of bicycle travel. They help cyclist position themselves in a lane that is shared with motor vehicles. Sharrows are often positioned to the left of parked vehicles to encourage cyclists to ride outside of the 'door zone' along local streets. Sharrows are the appropriate marking along local street bikeways where cycling is in mixed traffic.

They are also occasionally used to fill short gaps on the bicycle network along major streets and through transitions such as where bicycle lanes merge into turn lanes, but these are not a preferred treatment and would not be considered part of the All Ages and Abilities network unless motor vehicle volumes are consistent with those for local street bikeways; first ensure that a protected bike lane cannot be achieved, then centre sharrows in the middle of the relevant travel lane. Sharrows are also sometimes used for wayfinding or to highlight the presence of people cycling through challenging intersections. ***Table 8-19*** provides more details on Vancouver's use of sharrows and other standard bicycle stencils.

Sharrows alone are not sufficient to create a cycling facility on local streets. They must be used in conjunction with other engineering measures to control vehicle speeds and volumes as well as appropriate crossing measures at busy intersections.

Table 8-19: Stencils

Stencil	Typical Use	Placement	Lateral Placement
TAC Standard Bicycle Sharrow 	• Local streets where people biking share the roadway with motor vehicles. • Transitions where bicycle only space transitions into shared bicycle / vehicle space such as where bicycle lanes transition into turn lanes through an intersection. (optional green backing). • Through some intersections for wayfinding and to bring greater bicycle visibility.	• Typically, one entrance sharrow per block offset approximately 15m from the general alignment of the cross street. • Optional second set of staggered sharrows evenly spaced mid-block for long blocks >180m or busy downtown bikeways. • Optional paired sharrows at intersections and lanes where the bicycle facility has right of way. • See ***Figure 8-6*** for placement details	• Typically, centred in the travel lane or, • Centred in the right half of the travel portion of a local street. The travel portion is the curb-to-curb width minus 2.5m for each side of parking. • Where parking is allowed, 3.4m min. and 4.0m max. from curb face to the centre of the sharrow. • Away from gutter pans where there is no parking, 1.0m min. from curb face to centre of sharrow.

Stencil	Typical Use	Placement	Lateral Placement
TAC Standard Elongated Bicycle Stencil 	• Protected Bicycle Lane adjacent to roadway where vehicles are physically prevented from driving on.	• General bicycle stencils placement is 50m. • On facilities adjacent to parked cars the general spacing is 18m.	• Centred in bicycle facility for unidirectional lanes. • Centred in the right half of bicycle facility for bidirectional protected bicycle lanes.
TAC Bicy vith Elon ond  	• Painted bicycle lane where vehicles are not physically prevented from driving on. • Paint buffered bicycle lanes. • Also used as the first stencil at the entrance to protected bicycle lanes.	• General bicycle stencils placement is 50m. • On protected bicycle lanes adjacent to parked cars the general spacing is 18m. (every third parking space).	• Centred in bicycle facility for painted unidirectional lanes. • Centred in the right half of bicycle facility for bidirectional buffered bicycle lanes.

Stencil	Typical Use	Placement	Lateral Placement
Off-Street Bicycle Path Stencil 	• Off-street bicycle pathway away from road or through a park. • Extension of a similar facility for a short section along a street	• General bicycle stencils placement is 50m. • Tighter spacing may be considered near sharp corners. • Stencils should also be used at pathway entrances and on the far side of marked pedestrian crossings.	• Centred in the right half of a bidirectional bicycle path or in the middle of a unidirectional one.
Pedestrian Path Stencil 	• Off-street pedestrian pathway adjacent to bicycle pathway • Where the pedestrian and bicycle facilities are otherwise difficult to visually distinguish.	• Same as for the off-street bicycle stencil placement and should go adjacent to them on the pedestrian part of the pathway.	• Centred in middle of the pedestrian part of the pathway. • Alternate the direction of subsequent stencils on a bidirectional path
Multi-use Path Stencil 	• Off-street shared pathway away from road or through a park and other short, shared connections • See *Section 0* on when multi-use path is an acceptable facility type	• Same as for the off-street bicycle path stencil	• Centred in the right half of a bidirectional path or in the middle of a unidirectional one.

Stencil	Typical Use	Placement	Lateral Placement
Non-Elongated Bicycle Stencil 	• Within protected bicycle lane crossings bound by elephant's feet.	• Aligned consistent with direction of bicycle traffic. • One stencil centered the path of each motor vehicle lane between the typical tire path. • Staggered on two-way bicycle crossings so only one stencil for each travel lane.	• Centered in the crossing where there is one-way bicycle traffic. • Centered in the right half of the crossing where there is two-way bicycle traffic.
Bicycle Arrow Stencils 	• To reinforce a mandatory turn • To designate a turn lane • To wayfind a turn in a bike route at an intersection	• Aligned consistent with direction of bicycle traffic. • May be combined with other bicycle stencil types • Typically 1-3 such stencils as appropriate to provide warning in advance and at the decision point	• Aligned with the other type of bicycle stencil or centred within the appropriate portion of the travelled path

Dimensions and additional arrow stencils are shown in *Standard Detail Drawing R8.16*. Stencils are installed using preformed thermoplastic or Methyl Methacrylate (MMA).

The typical sharrow placement along local streets is provided in ***Figure 8-6***:

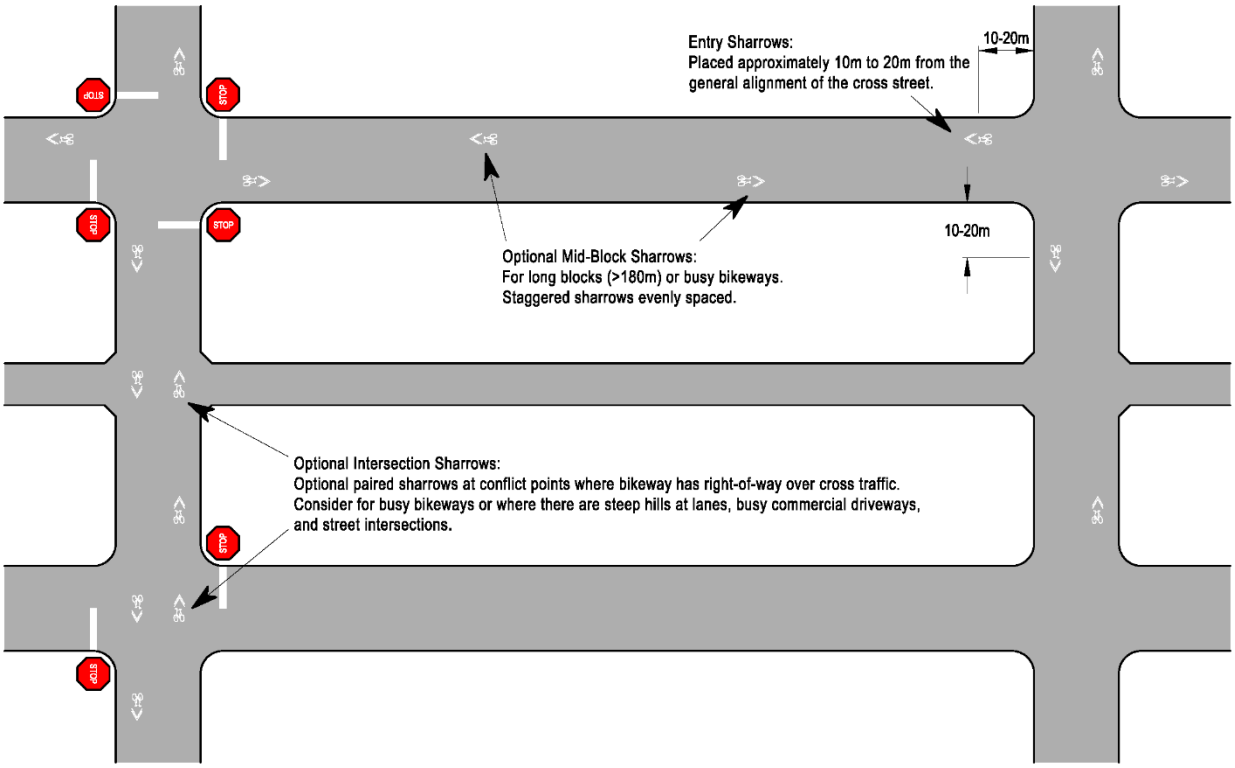
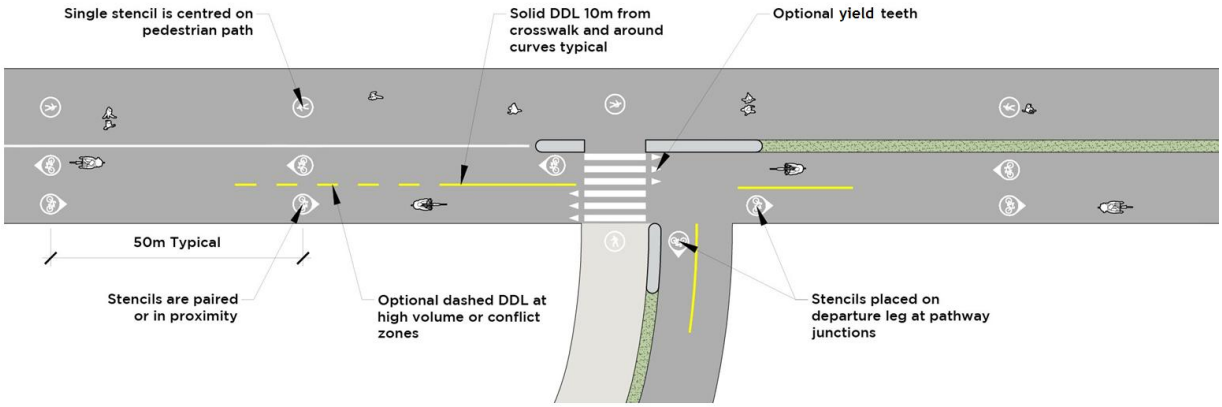


Figure 8-6: Sharrow Placement

Figure 8-7 shows the typical stencil placement for off-street pathways.



Notes:

- Directional arrows to be used on stencils involving bicycle only traffic.
- Bike stencils to be oriented to indicate the direction of bike traffic.
- Closer stencil placement is suggested along high conflict areas and along curves so that one set of stencils is visible at all times.
- DDL is 10cm wide per the city standard for bike paths. The white line between the bike and walking path is typically 20cm wide.

Figure 8-7: Typical Stencil Placement for Off-Street Pathways

8.9.1.14 BUS LANE RED SURFACE TREATMENT

Red surface treatment may be considered at key locations to highlight bus priority lanes, bus stops, and other areas of high conflict between buses and motor vehicles. Painted or colored pavement surfaces should provide a minimum skid resistance of 55 British Pendulum Number (BPN), measured under wet conditions. This performance requirement applies throughout the service life of the surface treatment, not only at the time of installation, to ensure consistent safety and durability. The application of red pavement or high-friction aggregate for bus priority areas should be evaluated based on bus operating conditions such as frequent stopping or passenger loading, its use across the city to ensure treatments are applied in meaningful locations that maintain visibility and effectiveness, and maintenance considerations to minimize cost and effort by limiting the extent of treatments to key areas such as stop zones rather than entire lanes. Recognizing this as an emerging practice, coordination with the Transportation Division should be undertaken to confirm current standards, testing procedures, and best practices for the use of high-friction composite surfaces such as MMA-based or colored pavement systems.

8.10 TRAFFIC SIGNAGE

Traffic signs regulate, warn, and inform road users. Detailed sign plan drawings prepared for the City of Vancouver are to be consistent with the latest edition of the *MUTCD* with the exception of specific requirements outlined in this manual. See also *Section 2.4.5.3* for Signage Plan requirements.

8.10.1 SIGN CODE INVENTORY

Contact the Traffic & Data Management Branch to obtain the most current *City of Vancouver Sign Code Inventory*. The *City of Vancouver Sign Code Inventory* includes regulatory, warning, guide and information, and temporary condition signs. Any custom / wayfinding signs shall be approved by the City prior to use. When requesting the installation or removal of signs, they should be identified by message and sign number.

8.10.2 SIGN ARRANGEMENT

When there is to be more than one sign on a pole, the following rules should be observed (see ***Figure 8-8*** for more details):

- For two signs, position the more restrictive sign above the other. It is also acceptable to have them side-by-side with the more restrictive one to the left of the other provided the directions in which the regulations extend do not conflict.
- For three signs, the most restrictive sign is placed above the other two which are placed side-by-side. The positioning of the bottom two will depend on which one is more restrictive or in which direction the regulations extend.
- The sign arrangement must be consistent throughout any one block (either all stacked one above the other or all side-by-side).
- On all regulatory parking or stopping signs, arrows shall be used to indicate the zone covered by a regulation.

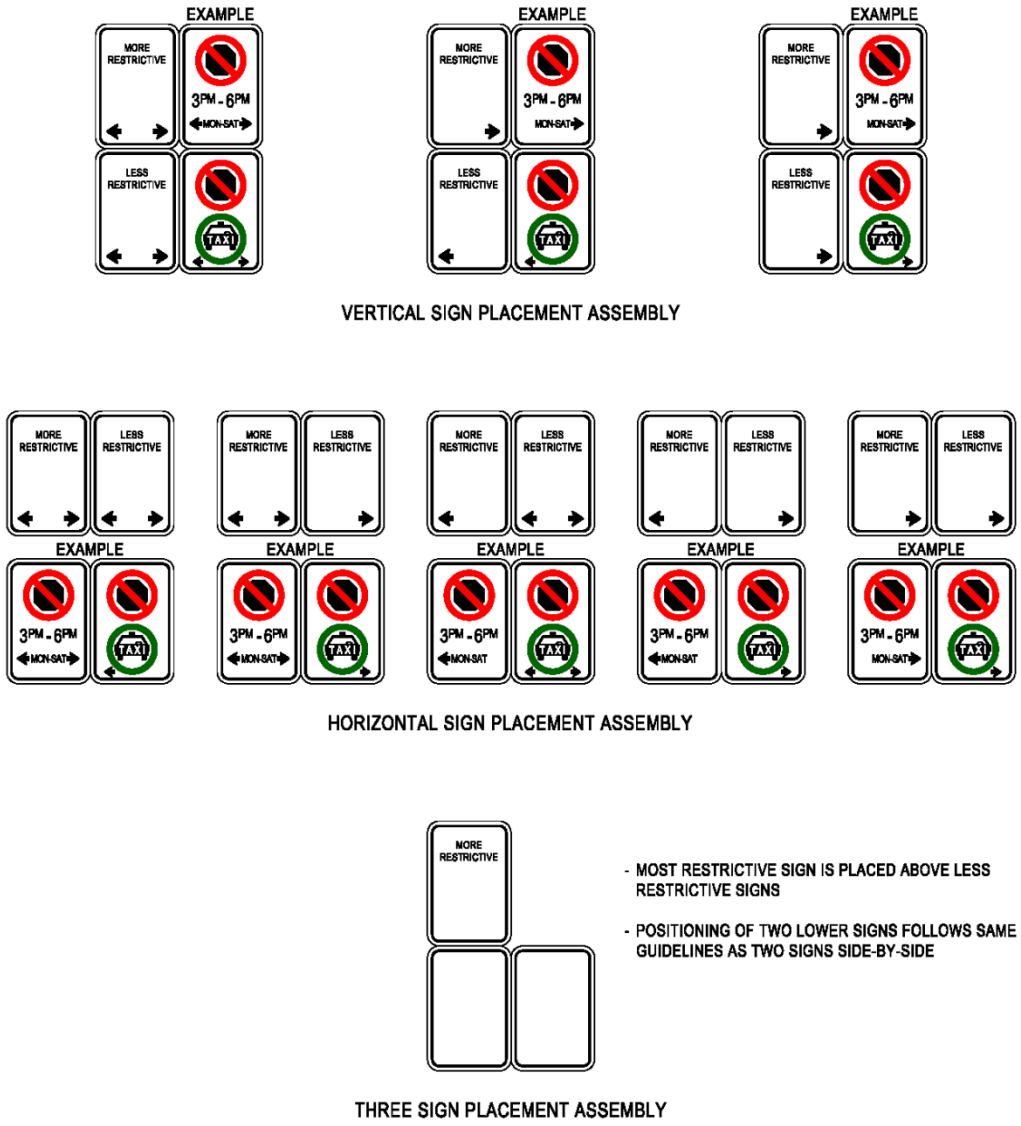


Figure 8-8: Sign Arrangement Guidelines

8.10.3 SIGN PLACEMENT

Whenever possible, steel utility poles should be used to support most signs. Accordingly, sign layouts should be coordinated with steel utility pole layouts or designs.

The minimum height to the bottom of any sign shall be 2.1m, and the maximum height to the top of any sign shall be 3.3m as shown in ***Figure 8-9***. One exception would be median signs which shall have a minimum height as shown in ***Figure 8-10***, but avoid locating signs at head and torso height on refuges or pedestrian islands, particularly at unsignalized arterial crossings. Another exception is for signs mounted along bicycle paths where there are different visibility and clearance considerations, and the minimum is 2.3m. Above this height, signs on narrow medians may be offset to the bike lane side provided there are not other conflicting emergency vehicle requirements. These heights are shown in ***Table 8-20***.

Whenever possible, curbside permanent and temporary signage shall be placed to have sufficient clearance from travel lanes to avoid contact with large vehicles (emergency vehicles, buses, truck, etc) and not be a hazard to pedestrians. Where overhead signage is placed over travel lanes, the underside of the sign shall have a vertical clearance of 5.5m from the road surface.

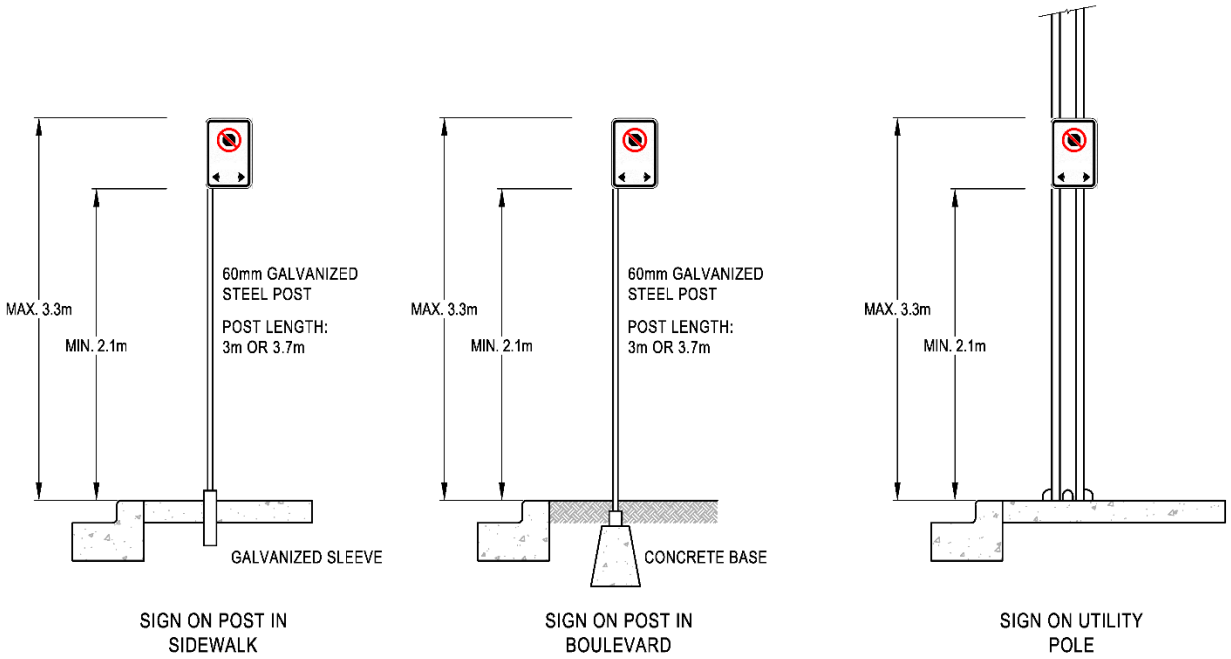


Figure 8-9: Typical Sign Installation

Table 8-20: Typical Sign Mounting Heights Along Off-Street Pathways

Sign Type and Placement Situation	Height to Bottom of Sign
• Bicycle size object marker (150mm x 450mm).	0.3m (typical)
• Small signs less than 300mm wide that do not overhang by more than 150mm. • Larger signs placed in a median > 0.3m from pathway edge and placed in a space where people are physically discouraged from walking and biking under (e.g. if there are plantings, a physical feature or raised concrete median to discourage walking under the sign).	1.2m – 1.6m
• Walking/cycling delineation signs (IB 23-1 & 2). • Large signs (>300mm wide) where it is possible for people to walk or ride under or in areas prone to heavy vandalism.	2.3m - 2.4m

8.10.3.1 KEEP RIGHT SIGNS

Keep Right signs are mounted 1.2m above the island surface unless specified otherwise. They are installed 2.5m from the end of the traffic islands and shall generally be accompanied by an object marker. Where medians continue for several blocks and are broken at intersecting streets, an object marker shall be installed below the Keep Right sign at the approach of the first median (***Figure 8-10*** Case 1), and only the Keep Right sign shall be mounted on the subsequent medians (***Figure 8-10*** Case 2). The Keep Right signs shall be mounted on obstructions where possible. Keep Right Signs in traffic circles shall be as per *City of Vancouver Standard Detail Drawings R5.1*.

While these are normal practices, in some cases the installation of a Keep Right sign may obstruct road user visibility. In these cases, the Keep Right sign may be omitted providing an object marker is used. In cases where traffic islands are narrow, a narrow object marker (WA 36-1) may be used to prevent it from being struck by vehicles. Care should be taken when installing Keep Right signs and object markers on refuge traffic islands so that the signage itself does not hide pedestrians from view.

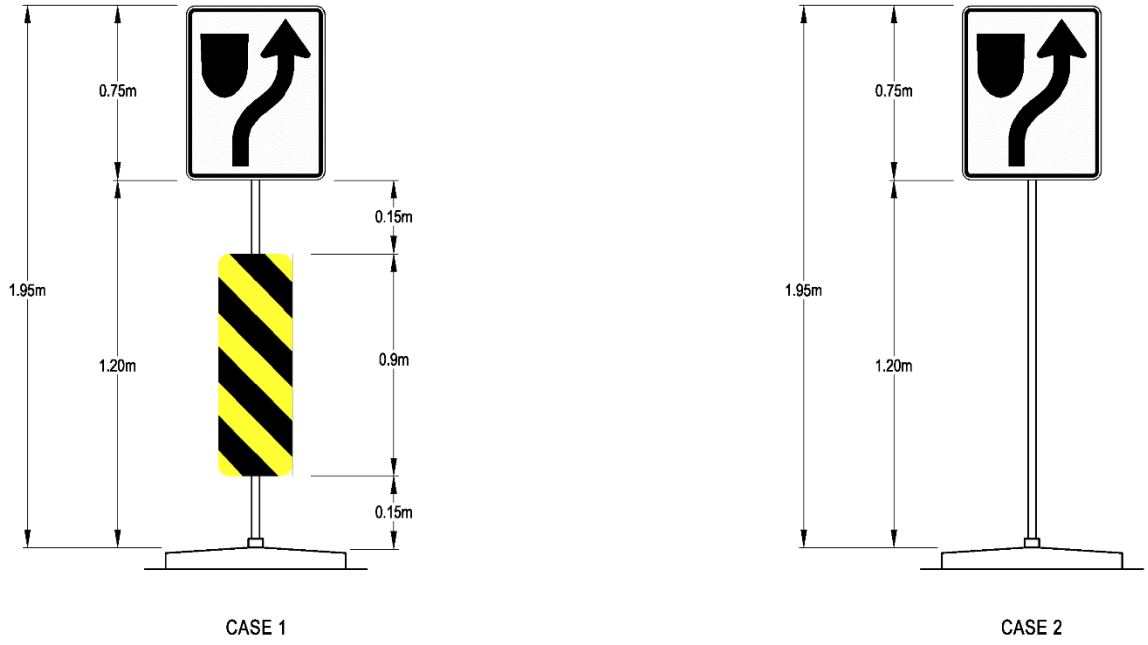


Figure 8-10: Keep Right Sign Placement

8.10.3.2 OBJECT MARKERS

Object markers identify a change in roadway or path width created by an island, median, bulge, or similar feature. The type of object marker is based on which side or sides traffic passes (***Figure 8-11***). Where motor vehicles approach such a point, select the object marker based on motor vehicle traffic regardless of whether bikes are in mixed traffic or any separate facility. Where there is no motor vehicle traffic in that direction or at all, select the object marker based on bicycle traffic.

On traffic islands where a Keep Right sign is not used, the object marker shall be installed 1.0m from the end of the island. In cases where traffic islands are narrow, a narrow object marker (WA36-1) may be used to prevent it from being struck by vehicles.

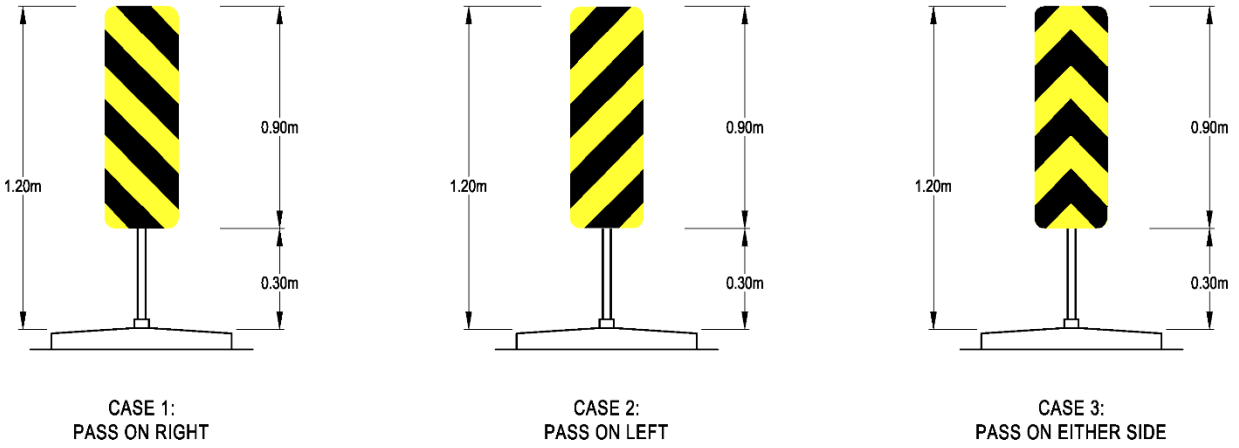


Figure 8-11: Object Marker Sign Placement

8.10.3.3 PARKING REGULATION SIGN SPACING

For block-long regulations, sign spacing should be every second pole on most arterials where curbside activity is light, provided that the view of the sign is not obstructed and the pole spacing is 33m or less. In general, if utility poles are not available, the spacing between signs should be a minimum of 30m and a maximum of 60m.

For partial-block curbside regulations that end at a lane, no sign is required to terminate the regulation. Legally, lanes are defined as streets and as such define the end of the curbside regulation.

For partial-block regulations that end at a driveway, a sign is required to terminate the regulation. Driveways are not legally defined as streets and do not define the end of the regulation.

8.10.3.4 SCHOOL / PLAYGROUND AHEAD SIGNS

The School Ahead sign (WC1) shall be used on all streets adjacent to elementary and secondary schools, and the Playground Ahead sign (WC3) shall be used on all streets adjacent to playgrounds. School signage is installed where playgrounds and school grounds coincide. School Ahead signs (WC1) may also be installed in advance of major intersections which are signalized and where school students cross the street. Private and independent schools are included for this type of signage. Unless the street is an arterial street, 30km/h tabs shall also be used for playgrounds and 30km/hr At All Times for schools. These reduced speed zones when signed are enforceable under *Section 44* of the *City of Vancouver Street and Traffic By-law No. 2849*. The signs shall be installed at the beginning of the property. If there are any T-intersections adjacent to this property, a sign will be erected facing the leg of the intersection as shown in ***Figure 8-12*** Case 1. In the case of a mid-block installation, the sign will be erected at the start of the property on the right side of the street as shown in ***Figure 8-12*** Case 2.

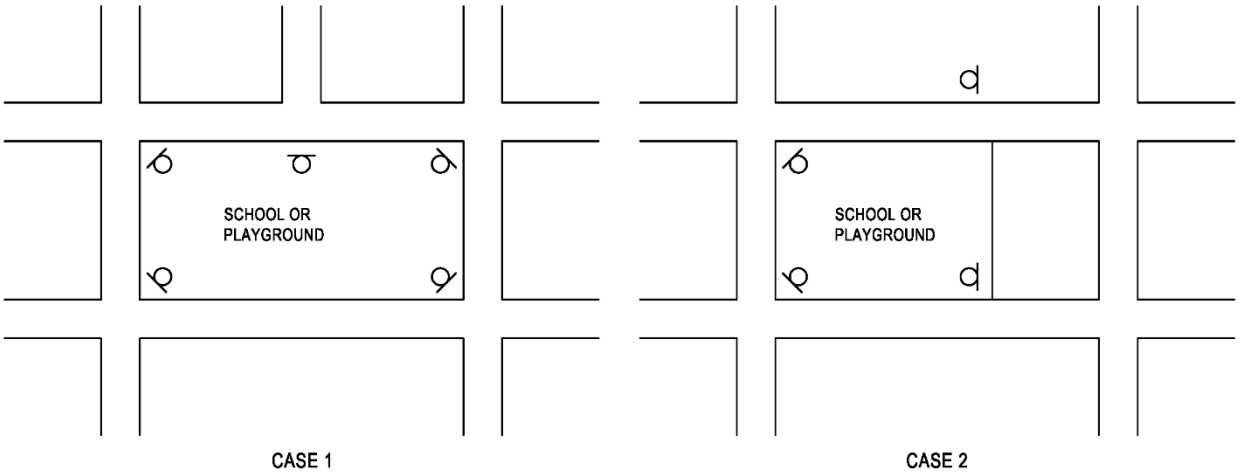


Figure 8-12: School and Playground Zone Sign Locations

8.10.4 STREET NAME SIGNS

Side-mounted and overhead signs should include street name and type such as street, avenue, etc. Side mounted street name signs should also include the appropriate block number. If a street has been designated as a cycling route, the bicycle pictogram shall also appear on the street name sign. A white border should be used for both side-mounted and overhead street name signs. The text font should be Clearview for all signs. Examples can be found below in ***Figure 8-13***.

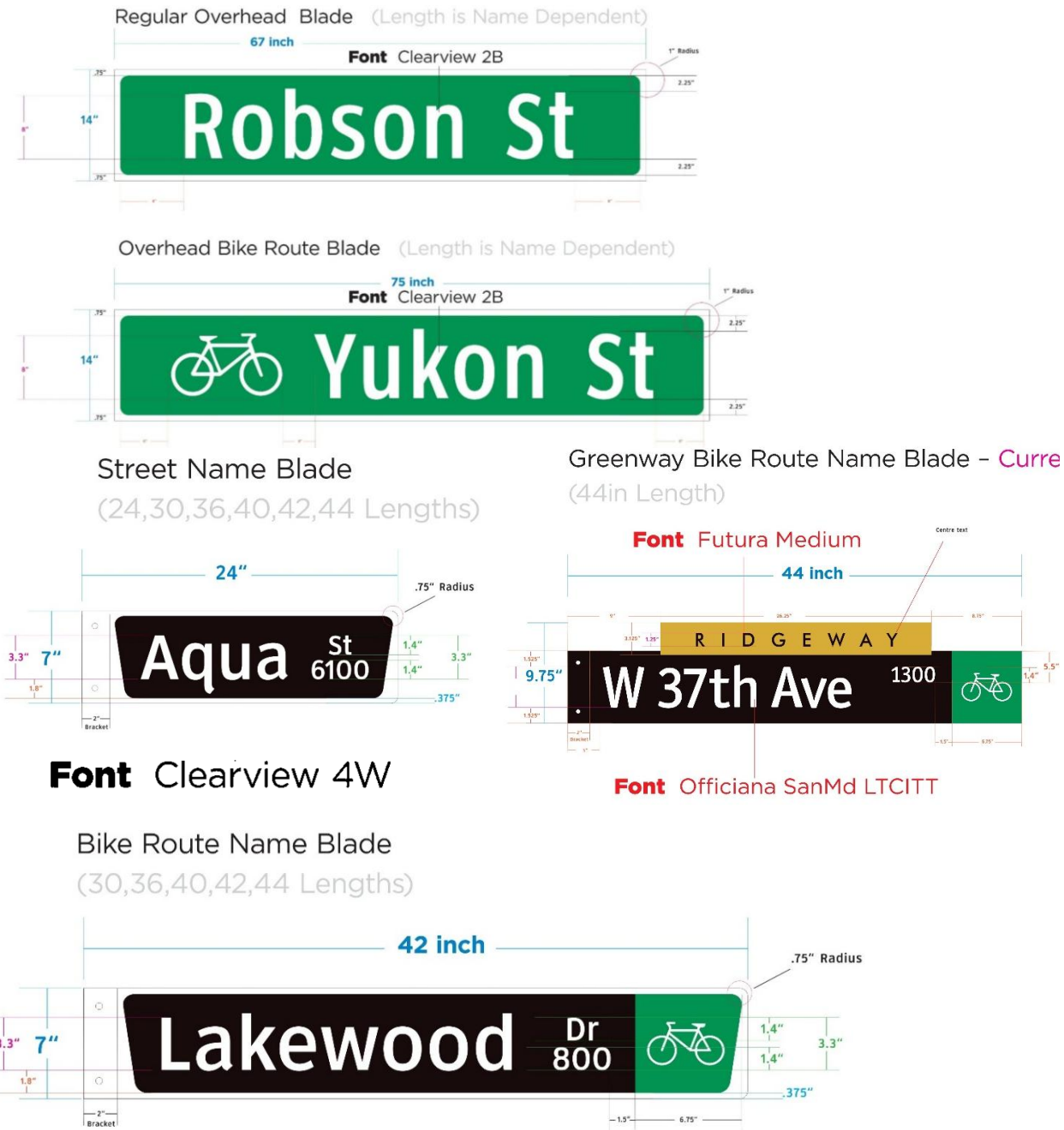


Figure 8-13: Street Name Sign Examples

Street names should always be written in full, with the first letter of each word capitalized (the rest are to be lower case). The following are the only acceptable abbreviations. Please note, no period "." should be used after the abbreviations.

- Avenue: Ave
- Boulevard: Blvd
- Court: Crt
- Crescent: Cres
- Diversion: Div
- Drive: Dr

- Highway: Hwy
- Place: Pl
- Square: Sq
- Street: St
- East: E
- West: W
- North: N
- South: S
- Great: Gt

Side-mounted street name sign blades should be installed on existing poles, such as street lighting or trolley poles, if such poles are within 6.0m of the intersecting curb line. Preference should be given to a pole which provides good visibility from all directions and is near a source of street lighting. If no existing pole satisfies these conditions, then a galvanized steel post shall be installed in accordance with above location guidelines. Side-mounted street name sign blades should be staggered in height. Minimum installation height from the ground to the lowest mounted blade is to be 3.3m. ***Figure 8-14*** below shows the typical placement of street name blades at various intersection types. Side-mounted signs are to be white lettering on black backgrounds.

Overhead street name signs should be installed on existing signal davit arms or signal span wires on the far side of the intersection facing oncoming traffic. They are to be centered on the approach lanes at the height of the center of the red lens in the signal head. Overhead signs are to be white lettering on green backgrounds.

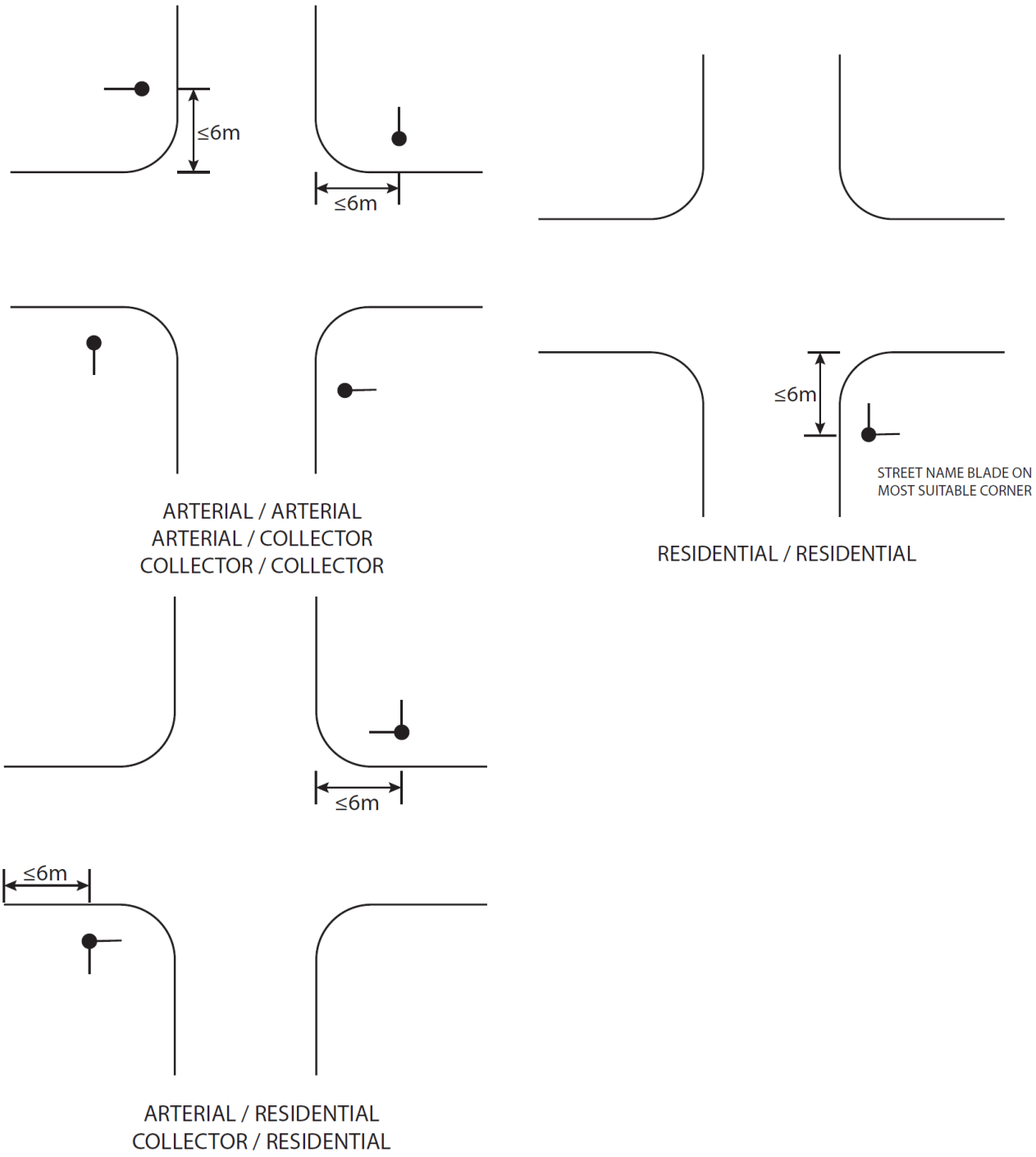


Figure 8-14: Typical Street Name Blade Placements

8.11 PAVEMENT DESIGN

Pavement design influences the lifespan, maintenance requirements, and driveability of the road. This section outlines the criteria for pavement design in the City of Vancouver.

8.11.1 DESIGN PRINCIPLES

Pavement design should be based on one of the following methods:

- Past history of successful pavements in adjacent similar areas.
- Where specific pavement design is required by the City, the pavement structure can be determined using the *TAC Pavement Design and Management Guide* or other industry best practices as appropriate.

Pavement design is to include consideration of the subgrade condition, frost susceptibility, moisture conditions, and subgrade drainage provisions.

Regardless of the method used for pavement structure design, pavement component thicknesses should be equal to or greater than the minimum thicknesses shown in *Section 8.11.2*.

Minimum design life for all classifications of roads is 20 years.

8.11.2 ASPHALT PAVEMENT DESIGN

In the City of Vancouver, asphalt pavement design shall follow the minimum as shown in ***Table 8-21***:

Table 8-21: Asphalt Pavement Structures

Classification	Minimum Pavement Thickness
Local / Residential (Light Duty) Streets and Lanes	35mm AC Surface Course 40mm AC Lower Course 150mm Granular Base 300mm Granular Subbase
Higher Zoned Collector / Residential Streets	50mm AC Surface Course 90mm AC Lower Course 150mm Granular Base 300mm Granular Subbase
Higher Zoned Collector / Residential Lanes	50mm AC Surface Course 75mm AC Lower Course 150mm Granular Base 300mm Granular Subbase
Arterial / Industrial Streets (Rehabilitation only to match existing and as approved by the City)	50mm AC Surface Course 150mm AC Lower Course (2x75mm lifts) 150mm Granular Base 300mm Granular Subbase
Bus Routes (Rehabilitation only to match existing and as approved by the City)	50mm AC Surface Course 180mm AC Lower Course (2x90mm lifts) 150mm Granular Base

Classification	Minimum Pavement Thickness
	300mm Granular Subbase
P.C.C. Base (New Infrastructure and Rehabilitation of Industrial, Arterial & Bus Routes)	50mm AC Surface Course 75mm AC Lower Course 175mm PCC Base 150mm Granular Base 300mm Granular Subbase
Protected Bicycle Lanes	75mm (in 2 lifts) 9.5mm AC Surface Course or MMCD Upper Course #2 150mm Granular Base
Overlay of Existing Pavements	50mm AC Surface Course

8.11.3 CONCRETE PAVEMENT DESIGN

Where applicable, concrete pavement designs should follow the design principles outlined in Section 8.11.1. When rehabilitating or repairing a street with existing concrete pavement, the concrete thickness should be 250mm or match the existing pavement, whichever is greater. Bus slabs are considered a concrete roadway treatment and should include details on sizing and placement relative to adjacent painted bike lanes, while also meeting the cross-sectional pavement structure and reinforcement details outlined on SDD C16.1. Aligning with either the full width or none of the adjacent lane is preferred.

Where new concrete roadways are installed a contrasting colour should be used to distinguish the roadway (with the exception of concrete bus slabs in an asphalt roadway and minor rehabilitation works of existing concrete) as darker and the sidewalk or walking path as lighter to enhance visual distinction and user clarity. Similarly, a concrete bike path should also be darker to distinguish for a lighter-coloured sidewalk or walking path.

8.11.4 SPECIAL PAVEMENTS

There are numerous alternatives to conventional asphalt or Portland-cement concrete pavements. The City of Vancouver has previously applied special pavements as outlined in the following sections and may specify special pavement use on certain projects. All special pavements must be approved by the City Engineer.

8.11.4.1 PERMEABLE OR PERVIOUS PAVEMENTS

Traditional pavements can be replaced with permeable pavements to decrease the impervious area and the Urban Heat Island Effect (UHIE). Permeable pavements include interlocking pavers or porous / permeable concrete or asphalt. These options promote infiltration and groundwater recharge while preventing the heating and conveyance of storm water into the storm drainage system. Pervious paving is most suitable for low-traffic areas such as lanes, unimproved shoulders, driveways, parking areas, and other locations as approved by the City Engineer.

The base of infiltration beds should be flat to maximize the infiltration area. The maximum slope of a porous surface should be limited to 5%.

The most appropriate locations for these treatments include parking lanes and bays, select laneways and the asphalt surface is used by cyclists along bikeways, boulevard areas adjacent to sidewalks, and plazas or public spaces. In plazas and public spaces, walking clear widths, ramps, and other pedestrian areas should be assumed to be constructed with sawcut concrete.

Permeable Pavement Structure

From the bottom up, the standard porous asphalt pavement structure consists of:

- An uncompacted subgrade to maximize the infiltration rate of the pavement system.
- A geotextile fabric that allows water to pass through but prevents migration of fine material from the subgrade into the stone recharge bed.
- A stone recharge bed consisting of clean single-size crushed large stone with about 40 percent voids (this serves as a structural layer and also temporarily stores stormwater as it infiltrates into the soil below).
- A stabilizing course of "choker course" consisting of a clean single-size crushed stone smaller than the stone in the recharge bed to stabilize the surface.
- An open graded porous surface with interconnected voids that allows storm water to flow through the pavement into the stone recharge bed.

The surface component of pervious pavement can be:

- Porous asphalt or porous concrete.
- Concrete modular pavers with gapped joints that allow water to percolate through.

Details about the types of permeable pavements for stormwater management can be found in the following publications:

- *NAPA IS-131 Porous Asphalt Pavements for Stormwater Management*.
- *ACI 522.1 Specification for Pervious Concrete Pavement*.
- *ICPI Permeable Interlocking Concrete Pavement*.

8.11.4.2 QUIET PAVEMENT

Quiet pavement is porous asphalt, often referred to as Open Graded Friction Course, placed as a surfacing layer over conventional impervious asphalt to reduce traffic noise. An additional benefit is the splash and spray from tires is reduced and thus visibility and traction is improved.

Additional design information for the porous asphalt can be found in:

- *NAPA IS-115 Open-Graded Asphalt Friction Courses, Design, Construction & Maintenance*.

8.11.4.3 REDUCE, REUSE, RECYCLE

The interest in reusing and recycling construction materials is growing. Coupled with the need to preserve non-renewable resources by reducing aggregate mining and the increasing cost of transporting and disposing of spent materials, there may be significant savings realized in the recycling of construction materials. Any proposed designs including recycled or reclaimed asphalt must be approved by the City Engineer. The resulting asphalt mix properties of the mix with reclaimed asphalt pavement (RAP) or other recycled materials need to meet the same performance requirements as the conventional asphalt mixture they are intending to replace.

8.12 STRUCTURAL DESIGN

8.12.1 GENERAL

8.12.1.1 CHANGING EXISTING STRUCTURES

Unless otherwise stipulated, prior to the implementation of a proposed change of use or change in functional programming of an existing structure, the structure is to be assessed to determine if any safety upgrades are warranted. Examples of safety upgrades could include, but not be limited to, the strengthening of deficient structural elements resulting from recommendations of a load rating study or seismic assessment or the installation of new or modifications to existing handrails and barriers as a result of recommendations from a safety assessment or road safety audit.

8.12.1.2 MAINTENANCE MANUALS

Maintenance manuals shall be prepared and submitted for all new City-owned heavy civil assets such as bridges, shoreline structures, and tunnels. The maintenance manual shall be signed and sealed by a professional engineer. The maintenance manual must include, but not be limited to, the following sections:

- Table of Contents.
- Section 1: Design Information (code, performance criteria, loading data, design team information, etc.).
- Section 2: Asset Value (broken down by component).
- Section 3: Construction Material Information (material grades, specifications, catalog data, mill certificates, shop drawings, etc.).
- Section 4: Operations and Maintenance Plan.
- Section 5: IFC Drawings (11x17 format) and Construction Specifications.
- Section 6: Construction Photographs.
- Section 7: Construction Logs, Field Reports, and Site Instructions.
- Section 8: Post Earthquake Assessment Guide Insert.
- Section 9: Quality Reports.
- Section 10: Permits.
- Section 11: Background Reports – Geotechnical, Environmental, Archeological, Other.
- Section 12: Record Drawings (11x17 format).
- Section 13: Legal Agreements.
- Section 14: Inspection Report – (Post-Construction).
- Section 15: As-Built Survey (Post-Construction – signed by a B.C.L.S.).
- Section 16: Final Letter Recommending Acceptance with signed Certificates (substantial and total performance) attached.

The following documents should also be submitted separately with the maintenance manual:

- Record Drawings – half-size record drawings are to be submitted in both hard copy (one full set) and soft copy formats (pdf and dwf).

- Inspection Report (Post-Construction) - the report is to follow the *Bridge Condition Index and Implementation Manual and User Guide*.
- As-Built Survey (Post-Construction – Signed by a B.C.L.S.) – half-size record drawings are to be submitted in both hard copy (one full set) and soft copy formats (pdf and dwg). The survey shall be based on the City of Vancouver's Standard Datum NAD83 (CSRS).
- All elevations shall be based on the CGVD28 vertical reference datum.

8.12.2 BRIDGES

8.12.2.1 DESIGN CODE

All bridge designs must be in accordance with the following most current design codes, standards, and guidelines:

- *CAN/CSA S6 Canadian Highway Bridge Design Code.*
- *BC MoTI Bridge Standards and Procedures Manual*
- *TAC Guide to Bridge and Combination Barriers.*

8.12.2.2 BRIDGE LOADING

Vehicular Loading

Bridges shall be designed with the following vehicular loads:

- CL-625 and BCL-625.
- City of Vancouver Fire Apparatus - Where the bridge provides fire access to adjacent development sites, the bridge shall be designed to accommodate the City of Vancouver fire apparatus with outriggers placed and ladder extended at maximum reach and angle causing the greatest outrigger load. A review with the Vancouver Fire and Rescue Services and the Planning, Urban Design, and Sustainability Department will be required to fully delineate access requirements.

Pedestrian Loading

Where portions of the bridge pedestrian facility support or facilitate public gatherings, full pedestrian loading may need to apply locally without reduction.

8.12.2.3 DESIGN LIFE, DURABILITY, AND MAINTENANCE

Unless otherwise directed by the City Engineer, the bridge shall be designed to have a durability that will ensure a minimum design service life of 75 years without replacement of any major components including the bridge deck. Design calculations for corrosion and other time-related durability analysis shall use a design service life of 100 years.

Maintenance considerations such as worker access, equipment access, widths, etc. must be included in the bridge design.

8.12.2.4 SEISMIC DESIGN

Importance Category

Major Route importance category shall apply to all bridges that:

- Are located within or connected to the downtown core.
- Are located on a major arterial (truck route, MRN transit route, or evacuation route).
- Provide street grade access to adjacent developments.
- Are located above habitable space.
- Are located above critical infrastructure.

Performance Based Design

Performance based design shall be required for all Major Route importance category bridges (regular and irregular) with a seismic performance category of 3. Minimum seismic analysis requirements must be adjusted accordingly.

Seismic Monitoring System

All new bridges and bridges undergoing seismic upgrades shall be pre-serviced with power cabling, communications cabling, and predefined monitoring locations to tie into the BCSims network. Seismic analysis shall identify and recommend multiple movement and acceleration thresholds for key primary and secondary locations on the bridge structure. Movement thresholds shall be at a minimum Green, Amber (inspection required), and Red (closure).

8.12.2.5 WEARING SURFACES

The design of wearing surfaces must consider urban design principles for the area and may result in either an asphalt or concrete wearing surface as follows:

- For concrete wearing surfaces, stainless steel reinforcing is preferred. The bridge must be designed (including loading and detailing requirements) to accommodate for a possible future, thin, high-performance overlay.
- For asphalt wearing surfaces, waterproofing membranes must be installed.

For the design of all new structures, a financial and lifecycle analysis shall be prepared to review the benefits and costs associated with either system.

8.12.2.6 EXPANSION JOINTS

For new joint replacement work, expansion joints should be minimized wherever practical. When necessary, jointless designs are preferred, and strip seals are generally favored over compression seals. Use of finger joints in locations where micromobility users may be present is generally discouraged whenever feasible alternatives are available. Although micromobility activity is often concentrated in protected curbside lanes, these facilities may be detoured during major renewals or modified over time, so all locations should be treated with care.

8.12.2.7 HANDRAILS

Handrail design shall consider and be compatible with area urban design principles. Handrails shall be simple, easy to maintain, and easily sourced from readily available materials. Tensioned cable handrails are generally not acceptable except in very unique situations. Glass panels shall not be allowed.

Refer to *Section 8.12.2.8* for additional design requirements.

Handrails adjacent to bicycle facilities reduce the effective path width by encroaching on the lateral clearance needed for handlebars and should be considered as a potential obstruction depending on the shape. An additional 0.6–0.9 m should be added to the path width in such conditions.

8.12.2.8 MEANS PREVENTION

Crisis Phones

Unless otherwise specified, all bridges shall be pre-serviced with communications, power, and supports to accommodate crisis phones. The quantity and location must be determined in consultation with Emergency Management. As a guide, a minimum number of two phones, one per side, shall be accommodated; however, on longer bridges, more locations shall be considered and pre-serviced.

Means Prevention Fencing

Unless otherwise specified, on all medium to high level bridges or bridges situated over large volumes of vehicular traffic where there is a significant drop, handrails including supports shall be designed for the inclusion of means prevention fencing. Means prevention fencing does not need to be implemented at initial construction, but the design process shall prepare a 100% design of the means prevention fencing as well as a conversion design for the modification of the regular handrail. Means prevention fencing design shall consider and be compatible with adjacent urban design principles.

8.12.2.9 COATINGS

Where coatings are introduced, the service environment shall consider Vancouver as having at least a C3 Atmospheric Corrosivity Category for a medium coastal area with low salinity. The coating system shall have a minimum practical service life of 20 years.

In addition, where microclimate (C4 and C5) zones are identified, coating performance shall be adjusted accordingly.

8.12.3 MARINE AND COASTAL STRUCTURES

In addition to industry standards and codes, the design of marine and coastal structures should be in accordance with the following:

- *City of Vancouver Recommended Guidelines for Universal Access to Public Docks in False Creek.*

8.12.4 RETAINING WALLS

Cast-in-place retaining walls are the standard and preferred wall type in the City and should be in general conformance with the following:

- *City of Vancouver Standardized C.I.P. Conventional Retaining Wall.*
- *City of Vancouver Standardized C.I.P. L-Shape Retaining Wall.*
- *City of Vancouver Standardized C.I.P. Zero PL Retaining Wall.*

Other types of retaining wall may be considered for approval and should be in general conformance with the following:

- *City of Vancouver Modular Concrete Block Retaining Wall.*
- *City of Vancouver Vegetated Wire Face Retaining Wall.*
- *City of Vancouver Standardized Soil Bag Wall.*

Retaining walls designs must also meet the following criteria:

- Retaining wall designs must be signed and sealed by a professional engineer.
- Railings and / or guardrails are required where excessive drops exist.
- Control joints must be incorporated in the wall.
- Special relief motives may be embedded in the face of the wall provided minimum cover requirements are met.
- Private wall systems may not rely on passive soil pressure.
- Private wall systems must be wholly contained on private property unless authorized via a registered encroachment agreement or similar means. Approval of encroachment shall be obtained through the Utilities Management Branch.
- A drainage system must be connected on the private side. Weep holes are discouraged and may not be approved.

Retaining walls adjacent to bicycle facilities reduce the effective path width by encroaching on the lateral clearance needed for handlebars and pedals. An additional 0.6–0.9 m should be added to the path width in such conditions.

8.12.5 AREAWAYS

Areaways are below-grade structures adjacent and attached to buildings that encroach into City streets. They are considered encroachments. They are the responsibility of the property owner.

Areaway encroachments are permitted subject to the approval of the City. Where an encroachment is permitted, the terms of its existence are typically contained within a legal document (areaway or encroachment agreement) registered on title. However, in some instances, agreements are not in place, and the terms and conditions of the *City of Vancouver Encroachment By-law No. 4243* apply.

8.12.5.1 APPLICABLE BY-LAWS AND STANDARDS

The following by-laws and standards apply to areaways:

- *City of Vancouver Encroachment By-law No. 4243* (applies since the areaway encroaches into a City street).
- *Vancouver Building By-Law*
- (applies since the areaway is part of a building).
- *City of Vancouver Construction Specifications* (applies to the restoration, backfill material, and functional design and performance of the surface of the areaway (the sidewalk surface)).

8.12.5.2 ENCROACHMENT BY-LAW NO. 4243

The *City of Vancouver Encroachment By-law No. 4243* lays out the terms and conditions for an encroachment that exists or is proposed to exist in, on, and / or under a City street. The terms cover items such as liability, indemnity, responsibility for maintenance, repairs, default, and removal.

The owner of the encroachment, and for the sake of further clarification meaning not the City, is responsible and liable for maintenance, repair, and removal.

Refer to the building encroachment guide on the City of Vancouver website.

8.12.5.3 VANCOUVER BUILDING BY-LAW

The *Vancouver Building By-Law* prescribes the minimum design and structural requirements for the repair or removal of areaways. The by-law is accessible online. Division C, Part 1, Section 1.8 – Street Regulations, and Division B, Part 4 – Structural Design are of particular interest and should be reviewed.

8.12.5.4 CITY OF VANCOUVER CONSTRUCTION SPECIFICATIONS

The purpose of the *City of Vancouver Construction Specifications* is to provide standards, specifications, and procedures to ensure that construction works on City streets are carried out in accordance with the best available standards and procedures. The *City of Vancouver Construction Specifications* supplement the Master Municipal Construction Documents (*MMCD*). Refer to the *City of Vancouver Construction Specifications* for information on the most applicable methods for dealing with areaway removal or repair.

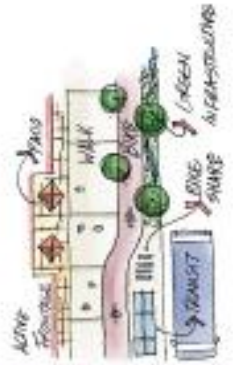
8.12.5.5 DOCUMENTATION SUBMISSION REQUIREMENTS

When permits are applied for to either repair, modify, or remove an areaway, the following document types, including but not limited to, shall be submitted during the permit process:

- Signed and sealed design drawings and specifications.
- Quality Documents (refer to the *City of Vancouver Construction Specifications*).
- Letters of Assurance:
    - *Schedule B-1 "Assurance of Professional Design and Commitment for Field Review".*
    - *Schedule B-2 "Summary of Design and Field Review Requirements".*
    - *Schedule C-B "Assurance of Professional Field Review and Compliance".*
- Record Drawings.

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STREETSCAPE & URBAN FOREST



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Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Eric Mital, P.Eng, Director, Streets Amit Gandha, Director, Parks Lisa Parker, MBCSLA, Director, Public Space & Street Use Jonathan Mc Dermott, P.Eng, Director, Solid Waste Management

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STREETSCAPE & URBAN FOREST

9.1 INTRODUCTION

This chapter outlines the requirements for streetscapes including horticulture, urban forest and public realm amenities in the City of Vancouver. Quality streetscapes contribute greatly to the quality of life of Vancouver's inhabitants and provide a wide variety of environmental, social, and economic benefits.

The City of Vancouver provides, preserves, and advocates for a rich and diverse streetscape while balancing competing street right-of-way uses and considerations in order to enhance the wellbeing of individuals and communities in the City. These guidelines are administered by the City Engineer, in consultation with the General Manager of the Planning, Urban Design, and Sustainability Department and the General Manager of the Vancouver Board of Parks and Recreation *(*Vancouver Park Board*)*.

The following is a brief description of each section:

- The *Streetscape* section outlines the design requirements for features such as street furniture and shared micromobility systems within Vancouver's street right of way.
- The *Urban Forest* section outlines selection and placement requirements for street trees within the street right of way, including street trees required as part of a development permit process.
- The *Street Horticulture* section outlines design requirements for shrubs, groundcovers, grass, sod, and seeding.
- The *Growing Medium* section outlines requirements for structural soil use.

Refer to *Chapter 2: Design Process & Coordination* for specific submission requirements.

9.2 STREETSCAPE

Streetscapes create a functional and inviting public realm, supporting social connection, recreation, ecology, active transportation, and economic activities. The public realm is essential for our health and well-being, and these spaces serve as living rooms and backyards for many people, including the most vulnerable members of our communities. It is fundamental to participating in public life. Vancouver's public realm also aims to preserve the history and unique identity of various neighbourhoods. This section outlines criteria and background documentation for streetscapes and the public realm.

9.2.1 STREETSCAPES

The following standards and guidelines shall be used for the design of streetscapes in the City of Vancouver:

- *City of Vancouver Streetscape Design Guidelines.*
- City of Vancouver Council-approved Community Plans and Public Realm Plans.
- *City of Vancouver Boulevard Gardening Guidelines.*
- *City of Vancouver Design Guidelines for Large Sidewalk Patios on City Property and Sample Drawings.*
- *City of Vancouver Plaza Design Guidelines.*
- *City of Vancouver Parklet Manual.*
- *City of Vancouver Streetscape Garbage and Recycling Enclosure Siting Manual.*

For more on streetscapes please visit the City of Vancouver website.

9.2.2 STREET FURNITURE

This section describes guidelines for siting, installation and ownership of street furniture which apply to all streetscape classifications.

For more information on street furniture call 3-1-1, visit the City of Vancouver website, or email: street.furniture@vancouver.ca

9.2.2.1 ROLES AND RESPONSIBILITIES

Most street furniture in Vancouver is maintained by a Street Furniture Contractor. All street furniture removals, relocations and installations must be approved by the City. City staff in the Street Activities Branch review locations for site safety, competing uses of street space, impacts to development, transportation network connectivity, and other site-specific considerations.

9.2.2.2 STANDARD GUIDELINES FOR SITING STREET FURNITURE

Placement of street furniture requires consideration of clearances to and from other infrastructure. Clearance requirements are provided in *Section 0.*

The following shall be considered when placing street furniture in the public realm:

- All furniture must be installed on the City's public street right-of-way, which is managed by Engineering Services. Clearance from fire, loading, bus and taxi zones as well as access/egress from buildings or other emergency exits (e.g. rapid transit stations).
- Street furniture must be set back to avoid blocking sightlines at sidewalks, intersections, crosswalks, driveways, and other areas where vehicles and pedestrians may conflict. A minimum 10-metre setback from intersections is typically required to maintain clear visibility. Advertisement panel on street furniture must not be obstructed.
- Allow sufficient sidewalk clearance for pedestrians to pass, refer to *Section 8.4.3.1* for minimum and preferred sidewalk widths.
- Follow accessibility design principles. Reference *Chapter 2: Design Process & Coordination* as well as in this chapter.
- Follow Crime Prevention Through Environmental Design (CPTED) principles.
- Provide sufficient clearance to open car doors when adjacent to parking areas.
- Must not prevent access to amenities such as public toilets, patios, or public spaces.

9.2.2.3 STANDARD GUIDELINES FOR DESIGN OF STREET FURNITURE

Installation of furniture requires the following detailed during design:

- All furniture must be fastened with tamper proof bolts.
- Distance from a fastening bolt location to any surface joint (e.g., the edge of the concrete slab) should be greater than 0.075m (3").
- The surface must be leveled with a maximum cross slope of 3% and have a consistent grade (i.e. no grade transitions) along the length with a maximum slope of 5%.
- If the surface isn't suitable for installation, a concrete pad may be required. Before pouring the pad, the location must be checked on VanMap to see if it's in an archaeologically sensitive area. If it is, the City's Archaeology Heritage Resource Protection Policy must be followed.

9.2.2.4 BENCHES

Benches support active transportation by providing respite, especially for those who have mobility impairments. Benches also support public life by encouraging people to linger, enhancing the street as a public space.

Recommended locations for benches are as follows:

- Areas where it is desirable to linger, or where a resting area is needed. To support accessible pedestrian design, the recommended typical distances between resting spots, such as benches, should be 50m to 200m.
- Highly visible locations to improve safety and deter vandalism.
- Under building canopies or trees to provide shelter or shade
- Refer to *Section 9.2.2.2* and *Section 0* for guidelines on siting street furniture and above ground clearances.
- Benches facing the street shall be a minimum of 1.8m from the front of curb.
- Benches with backs to the street shall be a minimum of 0.6m from the front of curb.

9.2.2.5 BIKE RACKS

Well-located safe and secure bike racks are an important factor in encouraging people to cycle in the City of Vancouver. Bike racks are recommended for short-term bike parking.

Recommended locations for bike racks are as follows:

- Highly visible areas.
- Commercial areas.
- Areas near designated cycling routes.
- Under weather protection where possible.
- Minimum of 0.75m between the front of the curb and the closest part of the bike rack. This is to leave enough space for a bike to be parked between the bike rack and the front of the curb.
- Bike racks placed at the back of the sidewalk shall leave a minimum of 0.9m from the building to leave enough space for a bike to be parked between the bike rack and building.
- Minimum 2.0m clearance from a bus zone, including bus shelters.
- Minimum 0.9m clear space between bicycle racks located parallel to each other.
- Refer to *Section 9.2.2.2* and *Section 0* for guidelines on siting street furniture and above ground clearances.

9.2.2.6 ON-STREET BIKE CORRALS

On-street, bike corrals are considered where physical restrictions such as sidewalk width prevent installation on the sidewalk within the guidelines above or where there is high demand for bike parking and existing bike racks are at capacity. Recommended locations for Bike Corrals are as follows:

- Situated on streets where there is high pedestrian activity and /or commercial storefronts.
- Not located in any location which has rush hour regulations.
- Not located adjacent to a bus stop or loading zone.
- Minimum of 2.0m from the edge of the pedestrian crosswalk.

9.2.2.7 LARGE MAP STANDS

Large map stands help visitors and residents navigate the city and encourages walking.

Recommended locations for map stands include the following:

- Close to intersections and in high traffic corridors.
- Near transit interchanges.
- Close to places of interest such as tourist/visitor destinations and amenities, and business improvement areas.
- Refer to *Section 9.2.2.2* and *Section 0*.

Small wayfinding maps are being phased out across the city, and being removed where necessary.

9.2.2.8 PUBLIC TOILETS ON THE STREET RIGHT OF WAY

To supplement public washrooms, freestanding public toilets have been installed in some areas in or near the metro core. These facilities offer comfort, hygiene, accessibility and security to the public.

Recommended locations for public toilets on the street right-of-way are as follows:

- Places of high public use such as major urban spaces, near parks, transit interchanges, tourist/ visitor destinations, where people have lunch outdoors, or close to street vendors selling food and beverage.
- Follow Crime Prevention Through Environmental Design (CPTED) principles.
- Located through consultation with property owners, BIAs and/or neighbourhood groups or associations.
- Located away from:
    - Establishments such as outdoor cafes/restaurants.
    - Areas where patrons wait for access to not impede pedestrian flow.
- Refer to Section 9.2.2.2 and Section 0.
- There shall be a 3.0 – 4.0m of clearance at the entrance of the Public Toilet.
- There shall be a minimum of 2.0m of clearance to the public toilet service access panel.
- There shall be a min of 1.5m of clearance at ad panels to accommodate ad panel door swing.

Engineering design drawings are required for the installation of public toilets. The design shall incorporate all necessary utility and civil works, including water, sanitary sewer, electrical, telecommunications, and associated site preparation.

9.2.2.9 WASTE RECEPTACLES

Well-located waste receptacles have a significant role in preventing litter and maintaining cleanliness of the public realm. Siting of litter cans and cart enclosures must be coordinated through Solid Waste Services Branch.

There are two main types of waste receptacles on City property that are collected by City crews:

1) **Litter cans**, which are standalone garbage cans owned and installed by the Street Furniture Contractor. Installation of these cans must be coordinated through the Street Activities Branch.

2) **Cart enclosures**, which may be standalone garbage receptacles *or* may include recycling receptacles and which have a rolling tote inside, are owned and installed by City crews.

Recommended locations for waste receptacles include the following:

- Safe and efficient access for servicing by Sanitation Operations should be considered for every placement of a waste receptacle.
- Placements in No Stopping zones are preferred to ensure access at time of collection.
- Waste receptacles should generally be placed in commercial areas with considerable foot traffic as follows:
    - Near intersections with higher volume pedestrian flows.
    - In areas where litter is consistently reported.
    - Along pedestrian routes to and from areas of public assembly.
    - Near places where people assemble frequently.
    - Near urban parks and public open spaces.
    - Near transit hubs.
    - At transit stops in commercial areas.
- Must not interfere with a permitted street vendor location and access/egress to the permitted location (if on a sidewalk or plaza).
- Refer to *Section 9.2.2.2* and *Section 0* for further details.

Waste receptacle siting requirements can be found in City of Vancouver Streetscape Garbage and Recycling Enclosure Siting Manual. For specific waste management and resource recovery design standards, refer to *City of Vancouver Garbage & Recycling Storage Amenity Design Supplement*

9.2.2.10 BUS SHELTERS

Bus shelters protect waiting passengers from poor weather and provide additional amenities such as benches, route maps, and lighting.

Bus shelters are recommended for all bus stops; however, priority should be given to stops with the following criteria:

- High boarding volumes.
- Terminals or major transfer points.
- Near schools, seniors' housing developments, community and recreation centres, HandyDART bus stop, and major trip generators such as shopping malls.

9.2.2.11 BUS SHELTER DESIGN GUIDELINES

- A standard bus shelter should incorporate seating for at least three people and a clear area for one wheelchair.
- Typical bus shelter dimensions are approximately 4.3m long by 2.2m wide by 2.6m high
- An overhead clearance of 2.7m must be maintained for wheelchair ramp deployment and access to the front doors of the bus.
- Where the minimum sidewalk clearance cannot be maintained, the standard bus shelter design shall be modified to achieve this (e.g. ad panel rotated or detached).

- Bus shelter canopy may extend over sidewalk clearance provided minimum vertical clearance of 2.25m is maintained. It shall not extend over a bicycle lane or vehicle lane.
- The shelter shall be no farther than 9.0m from the bus I.D. pole for passenger convenience.
- The closest portion of the shelter should maintain a minimum lateral clearance of 0.6m from the curb face to avoid contact with a bus (to account for the maximum rear sweep of a bus).
    - In narrow areas where adequate space is not available to site a bus shelter, consider locations immediately downstream.
- Passengers waiting in the shelter must be able to clearly see approaching buses.
- There shall be a 3.0m wide direct clear path from the bus I.D. pole to the sidewalk.

For further details refer to *Section 8.6.1.*

9.2.3 SHARED MICROMOBILITY SYSTEMS

Vancouver's shared micromobility systems, Public Bike Share (PBS) and Shared E-scooter System (SES) are an important part of the City of Vancouver's commitment to green transportation. By partnering with third parties to provide safe and accessible shared micromobility systems, the City of Vancouver can support the extension of transit and walking trips, reduce the need for personal vehicle trips, and trigger greater interest in sustainable travel.

9.2.3.1 ROLES AND RESPONSIBILITIES

The PBS and SES systems in Vancouver are owned and operated by third parties. All stations must be approved by the City Engineer or their designate. City staff review station documentation for site safety, competing uses of street space, impacts to development, transportation network connectivity, and other site-specific considerations.

To optimize system utilization and maximize ridership, stations will be located on the street, on City-owned land, parks (including other land under the jurisdiction of the Board of Parks and Recreation), land owned by other public agencies or institutions, or on private property.

9.2.3.2 GUIDING PRINCIPLES FOR STATION SITING

Opportunities for station siting prioritize safe access, connections to transit, proximity to comfortable cycling facilities, convenience to destinations, and maintaining system network density. Stations will be located proximal to commercial / shopping districts; residential neighbourhoods; parks; destinations and attractions; community facilities and amenities; large sporting, performance, and event venues; and educational institutions. Where applicable, stations should be visible from all rapid transit station entrances, express bus (B-Line) stops, and other transportation hubs. As well, stations need to be located for maximum visibility with unrestricted public access 24 hours a day, 365 days a year.

Based on industry-leading practices, stations will be located every 200-300m, or approximately every 2-3 blocks. Throughout the service area, stations will be spaced no greater than 300m apart to serve 150m radius catchment areas, maintaining a minimum station density of 10 stations per square kilometer. The size of each station is based on the relative demand expected taking into consideration adjacent land uses, population, transit nodes, recreational destinations, and other trip generating sources. In areas of high demand, station density and station size will be increased to support increased ridership.

Shared micromobility stations will be located on both public and private-zoned lands, in parks, and on street right-of-way.

Where applicable, the Vancouver PBS and SES systems follows the NACTO Guidelines and the ITDP Bikeshare Planning Guide.

9.2.3.3 SITE SPECIFIC REQUIREMENTS

Stations may be located on public rights-of-way, on private property, or on other zoned lands. Site specific requirements for stations are shown in ***Table 9-1***:

Table 9-1: Bike Share Facility Requirements

Property	Public Right-of-Way
Size	The length of stations varies based on demand and availability of street space.
	The full length of the space is to be continuous. The physical station with docked bicycles is 2.0m wide and has a required bicycle maneuvering zone of 2.0m for a total width of 4.0m. There is also an option for bi-directional stations which require a total width of 8.0m.
Location	The station must be clearly visible to the public with 24/7 public access and easy access to the street.
Surface Treatment	A hard surface is required with no utility access points within the shared micromobility stations. Any utility access point within 1.0m of the shared micromobility space is to be identified and shown in a detailed drawing submitted. Acceptable surfaces include cast-in-place concrete (saw cut or broom finished), asphalt, and pavers. Other firm, paved materials are subject to approval.
Grades	The surface must be leveled with a maximum cross slope of 3% and have a consistent grade (i.e. no grade transitions) along the length with a maximum slope of 5%. At a minimum, spot elevations at the four corners of the station must be provided.
Sun Exposure	Since the station operates on solar power, no vertical obstructions including awnings or canopies are permitted. Ideally, the station should receive 5 hours of direct sunlight per day.
Power	Provision of an electrical service connection is to be available when specified.

Property	Public Right-of-Way
Access	There shall be no conflicting site features near the PBS and SES space (e.g. drain, tree, vault, etc.). Any site feature within 1.0m of the PBS and SES space is to be identified on a detailed drawing (see *Section 2.4.15*). Site features at the boundaries of the PBS and SES space such as landscaping, windows, vents, or hose bibs are subject to approval. Consideration shall be made for nearby uses such as access, maintenance, or privacy that may interact / interfere with the station operations. Access and maintenance must not disrupt the PBS and SES station, noting that some features have different access requirements (e.g. fire department connections require uninterrupted road access). Access

9.3 URBAN FOREST

The City of Vancouver is committed to increasing the Urban Forest as outlined in the *Urban Forest Strategy, VanPlay: Vancouver's Parks and Recreation Services Master Plan, Climate Emergency Action Plan and VanPlan*. Vancouver's Urban Forest contributes to the health of the environment and of every resident and visitor. This section outlines criteria for tree protection, and selecting and locating trees in the Street rights-of-way to ensure the Urban Forest is healthy and resilient.

9.3.1 TREES

The development community, utility contractors, and all City of Vancouver departments have an important role to play in the management, protection and expansion of the urban forest. They are frequently called upon to provide and plant new trees, or work near existing trees while protecting their value. There are many challenges to the task of integrating urban forest management with other elements of urban function. This section, in conjunction with the Development Permit process, outlines the criteria for tree protection and planting in the City of Vancouver's street rights-of-way.

9.3.2 GENERAL AUTHORITY

This section outlines the authority in charge of maintenance of trees and the general rules for all trees in the City of Vancouver. All trees within the boundaries of Vancouver form part of the Urban Forest.

9.3.2.1 STREET TREES ON RIGHT-OF-WAY

All trees located on street rights-of-way, including lanes, are administered under the terms of the *City of Vancouver Street Tree By-law No. 5985*. The by-law stipulates that:

- Trees planted in the City street right of way are property of the City of Vancouver. Care and custody of trees in street rights-of-way reside with the Vancouver Park Board. The planting of any tree in a boulevard shall be in compliance with standards set by the City Engineer and the General Manager of the Vancouver Board of Parks and Recreation.
- No person shall remove, destroy, cut, deface, trim or in any way injure, impair or interfere with any street boulevard tree except as expressly authorized to do so by the General Manager of the Board of the Vancouver Board of Parks and Recreation or their designate and carried out by a qualified and insured private tree company.
- Tree protection barriers for existing street trees shall be in compliance with the City of Vancouver Protection of Trees By-law No. 9958 – Schedule A and Construction Specifications.
- The Vancouver Park Board may destroy, remove, transplant, or otherwise dispose of any street tree or shrub on any boulevard where approved by the General Manager of Park Board or the City Engineer.

9.3.2.2 LANE TREES

Trees in lanes exist throughout Vancouver even though the City does not plant or give permission to plant trees in lanes. Most lane trees are volunteers that established themselves as part of natural propagation or were planted by adjacent property owners without City approval. Lane trees entirely on City property may be removed by the City, with or without notice to adjacent property owners, when required for lane access or improvements on City land.

Where the lanes are open to public traffic, trees entirely on City property fall within the care and custody of the Vancouver Park Board. Where the lanes have been closed off to access by private property extensions, enclosures, hedges, or structures, responsibility may be shared between the Vancouver Park Board and adjacent beneficiaries of the land around its base, including any costs of mitigation and removal of hazard trees, and in such cases additional consultation may be required.

Application for the removal of lane trees may be made through the City Engineer. If the trunk of a tree crosses multiple property lines, consent from adjacent property owner(s) may be required, depending on the reason for removal.

9.3.2.3 PRIVATE PROPERTY TREES

Trees located on private property are the responsibility of the property owner. The removal of those with a diameter over 20cm is administered by the Community Services Group, as mandated by the *City of Vancouver Protection of Trees By-law No. 9958*.

9.3.3 STREET TREE PLACEMENT

9.3.3.1 GENERAL GUIDELINES

Unlike other utilities with flexible alignments, trees achieve optimal performance when planted at the centre of the boulevard between the curb and the sidewalk. Boulevard width is a fundamental design parameter that governs tree size, spacing, long-term health, and the potential for conflicts with other streetscape elements. Street trees shall be located at the centre of the widest feasible boulevard within the street cross-section to maximize canopy capacity and support Vancouver Plan and Complete Streets objectives, including shade, pedestrian comfort, urban heat mitigation, and ecological function. Because trees lack the alignment flexibility of other utilities, their space should be defined early and protected throughout design. This establishes the street tree right-of-way as a dedicated zone within the street cross-section to support healthy, mature trees.

The City of Vancouver seeks to maximize canopy coverage on City streets while recognizing that transportation corridors must accommodate multiple, competing demands, including mobility, goods movement, and infrastructure. Street tree design shall consider the following in addition to boulevard widths outlined in ***Table 8-2***/***Table* 8-3**:

- Protect continuous linear space for trees aligned with the centre of boulevards as a core public-realm and streetscape design requirement.

- Select species or cultivars that maximize canopy potential while remaining compatible with surrounding streetscape and transportation functions.
- Address public safety, visibility, and lighting requirements based on documented analysis.
- Clearly show existing trees, as well as existing and proposed utilities and streetscape elements, on tree planting plans.
- Install street trees with City-approved tree grates or surrounds in accordance with the City of Vancouver Streetscape Design Guidelines or direction from City staff.

Trees shall not be planted in the following locations:

- Over building encroachments under the sidewalk (areaways).
- Under existing canopies and overhead signs.
- In between signal poles at an intersection.

9.3.3.2 SPACING AND SOIL VOLUME REQUIREMENTS

Tree spacing and soil volume requirements are outlined in ***Table 9-2***:

Table 9-2: Tree Spacing and Soil Volumes

Tree Size Category	Average Spacing	Soil Volume Per Solitary Tree	Soil Volume (Shared /Row of Trees)
Large	9.0m – 11m	$30m^3$	$20m^3$
Medium	8.0m – 10m	$20m^3$	$15m^3$
Small	7.0m – 10m	$10m^3$	$5.0m^3$
Columnar	7.0m – 10m	$20m^3$	$15m^3$

Soil Volumes may be achieved through various methods. Ideally, access to good native soil is preferred. When this is not obtainable, due to existing conditions or construction practices, volumes may be obtained through the installation of structural soil (calculated at 50% volume) or soil cells when appropriate and approved by the City Engineer.

Structural soil and soil cells are only permissible when installing new trees. Soil cells may only be used during new road construction when utilities will not be impacted, no native soil is available due to extenuating circumstances, and the City Engineer approves.

In addition, soil cell installations must meet the appropriate City loading requirements.

9.3.3.3 CLEARANCES

Minimum clearances between trees and other above-ground infrastructure, measured from the outer edge of infrastructure, are outlined *in Chapter 2, Section 2.2.5: Clearances from Below-Ground Infrastructure* and *Section 2.2.6: Clearances from Above-Ground Infrastructure*. These minimums must be met to ensure tree health, public safety, and compatibility with surrounding streetscape elements.

The final placement and spacing of street trees must be approved by both the City Engineer and the Vancouver Park Board.

9.3.4 TREE SPECIES SELECTION

The Vancouver Park Board's Urban Forestry provides care and custody of public street and park trees (following a two-year warranty period if trees were delivered through development). Stewardship is intended to last for many decades. It is essential to ensure that the proper tree is planted and, consequently, species / cultivated variety / form of trees planted on public property must be approved by the Vancouver Park Board, Urban Forestry at: pbdevelopment.trees@vancouver.ca. Species selection criteria are as follows:

- Adapted to future climates.
- Compatibility with local growing conditions.
- Adequate space above and below ground to reach maturity.
- Branch failure or wind-throw resistance.
- Pest resistance.
- Low maintenance.
- Diversity within Vancouver's public tree population.
- Aesthetically appropriate considering pre-existing vegetation.

9.3.4.1 RECOMMENDED STREET TREE SPECIES

To support City of Vancouver tree diversity and climate-change adaptation objectives, the City has identified preferred tree species for planting. This list is not comprehensive, may evolve over time in response to changing conditions, priorities, and species availability. City staff may approve alternative species where appropriate. Species are grouped by mature size and form, including large, medium, and small trees.

Table 9-3: Recommended Street Tree Species

Small Trees	Medium Trees	Large Trees
Amelanchier 'Standing Ovation' / 'Obelisk' (*Amelanchier alnifolia*)	Black Tupelo (*Nyssa sylvatica*)	European Beech (*Fagus sylvatica*)
Whitebeam (*Sorbus aria*)	Chinese Pistache (*Pistacia chinensis*)	European Hornbeam (*Carpinus betulus*)
Watereri Scots Pine (*Pinus sylvestris* 'Watereri')	Golden Rain Tree (*Koelreuteria paniculata*)	Garry Oak (*Quercus garryana*)
Japanese Black Pine (*Pinus thunbergii*)	Hedge Maple (*Acer campestre*)	Hungarian Oak (*Quercus frainetto*)
Japanese Tree Lilac (*Syringa reticulata*)	Hackberry (*Celtis occidentalis*)	Incense Cedar (*Calocedrus decurrens*)
Japanese Maple – tree form varieties (*Acer palmatum*)	Hardy Rubber Tree (*Eucommia ulmoides*)	Kentucky Coffeetree (*Gymnocladus dioicus*)
Lavallée Hawthorn (*Crataegus × lavalleei*)	Japanese Zelkova (*Zelkova serrata*)	Elm 'Endeavor' (*Ulmus* 'Endeavor')
Seven-Son Flower (*Heptacodium miconioides*)	Persian Ironwood (*Parrotia persica*)	Ginkgo (*Ginkgo biloba*)

Small Trees	Medium Trees	Large Trees
Amur Maackia (*Maackia amurensis*)	American Hophornbeam (*Ostrya virginiana*)	Heritage Oak (*Quercus* × *macdanielii*)
Strawberry Tree (*Arbutus unedo*)	Turkish Hazel (*Corylus colurna*)	Scarlet Oak (*Quercus coccinea*)
Tibetan Cherry (*Prunus serrula*)	Yellowwood (*Cladrastis kentukea*)	Willow Oak (*Quercus phellos*)

As living systems, trees cannot be designed with the same precision as engineered infrastructure. Tree size classifications are approximate and intended as guidelines. Actual growth varies due to genetics, site conditions, and long-term development, and trees may take many years to reach their mature size.

9.3.5 TREE PLANTING AND WATERING

9.3.5.1 PLANTING WINDOW

Trees should be planted during the dormant or low-stress periods to maximize establishment success. In Vancouver's coastal climate, the preferred planting season is September 15th (after leaf drop) to April 30th (before leaf-out)

Summer planting should be avoided unless enhanced watering and monitoring can be guaranteed.

9.3.5.2 TREE PLANTING STOCK REQUIREMENTS

All trees shall meet Park Board planting standards and shall:

- Be from City-approved species lists and Park Board staff.
- Meet minimum size requirements:
- Deciduous: 6 cm caliper
- Coniferous: 2.5 m minimum height
- Be free of pests, disease, girdling roots, and structural defects.
- Have a single leader with the lowest permanent branch at a minimum height of 2.0 m unless otherwise approved by the Park Board.

9.3.5.3 INSTALLATION STANDARD

Trees shall be installed in accordance with the following:

- Trunk shall be vertical and centered within the planting pit.
- Top of root ball shall be level with adjacent finished grade.
- Upper one-third of root ball shall be free of burlap, twine, and binding materials.
- No exposed wire basket shall present a tripping hazard.
- Root barriers shall be installed where required in accordance with Engineering Specifications.

- Structural soil shall be provided where required in accordance with Engineering Specifications.

9.3.5.4 GRASS BOULEVARD TREE REQUIREMENTS

Where trees are installed in grass boulevards:

- A plastic trunk guard shall be installed.
- A wood chip mulch ring with a minimum diameter of 750 mm shall be applied, with mulch kept clear of the stem.
- Stakes shall be removed after one (1) year.

9.3.5.5 WATERING REQUIREMENTS

Newly planted trees require consistent deep watering during establishment.

For the following 24 months after planting provide 20–40 litres per tree per watering, 1–2 times per week during dry periods (May-September).

During periods of drought and extreme heat increase frequency as needed to maintain moist soil within the root zone.

9.3.5.6 COMPLIANCE

All tree planting shall comply with Park Board Tree Planting Checklist requirements and City of Vancouver Engineering Specifications. Trees failing inspection shall be replaced at the Contractor's cost. The two-year warranty will begin following a Park Board – Urban Forestry inspection and certification of trees prior to April 30th or after September 15th each calendar year.

9.3.6 AWNING AND CANOPY SETBACKS FROM TREES

The City of Vancouver recognizes that street trees are an important element along commercial corridors and downtown streets. All new awnings and canopies must be able to accommodate the maturing crowns of existing and future trees. ***Table 9-4*** provides a quick reference for those who wish to install an awning or canopy overhanging City property. The accompanying drawings illustrate typical situations that arise and show minimum setbacks of awnings from existing and potential future trees. These setbacks recognize that trees grow, and that conflicts can be ratified with branch pruning only so far as to not cause damage or disfigurement to the tree.

Table 9-4: New Awning Setbacks

Type of Tree / Situation	Minimum Awning Setback
New Columnar Trees (Narrowly Shaped at Maturity)	120cm
New Large, Medium, or Small Spreading trees	180cm
Existing Tree	180cm or more depending on size and shape of tree

9.3.6.1 TYPICAL COMMERCIAL STREET

On typical commercial streets, the overhang of the awning should come no closer than 180cm to the centre of the tree trunk. ***Figure 9-1*** and ***Figure 9-2*** show typical commercial street awning configurations.

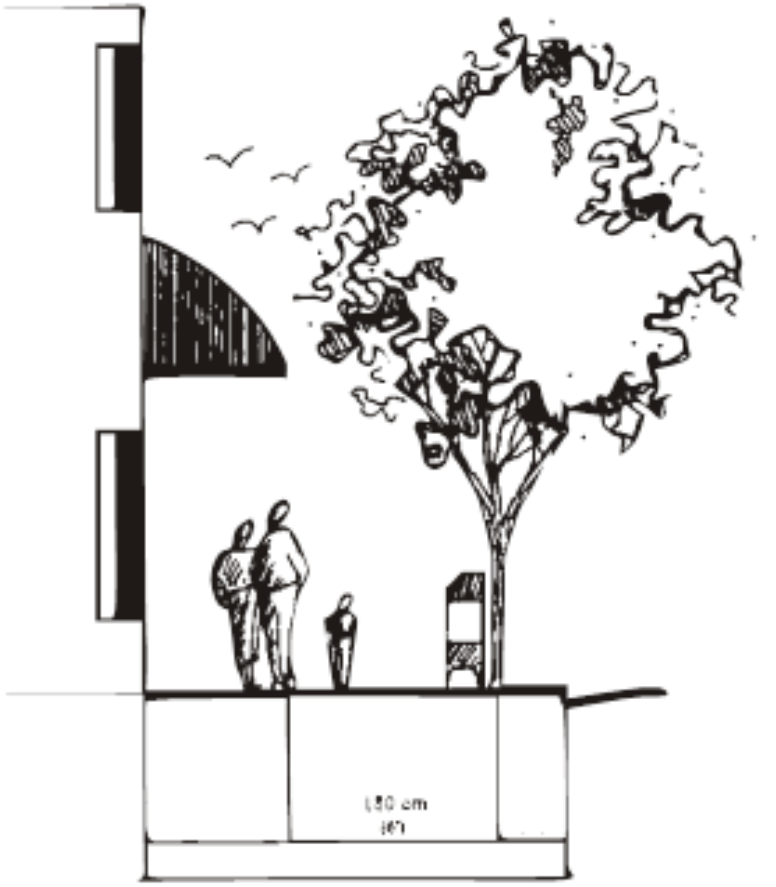


Figure 9-1: Typical Commercial Street Awning Section

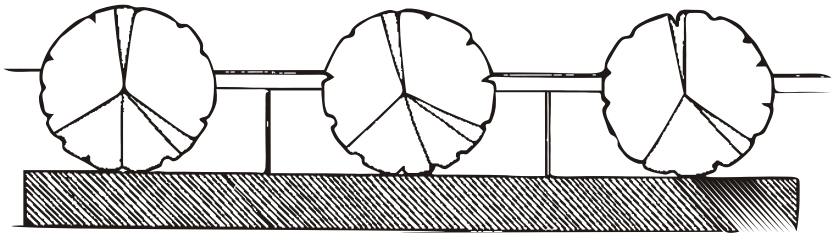


Figure 9-2: Typical Commercial Street Awning Plan

9.3.6.2 EXISTING TREE CROWN – PROPOSED AWNING CONFLICTS

Awnings must be variably shaped in order to accommodate existing trees when pruning would be harmful to them. ***Figure 9-3*** and ***Figure 9-4*** show awning configurations for proposed awnings that conflict with existing tree crowns.

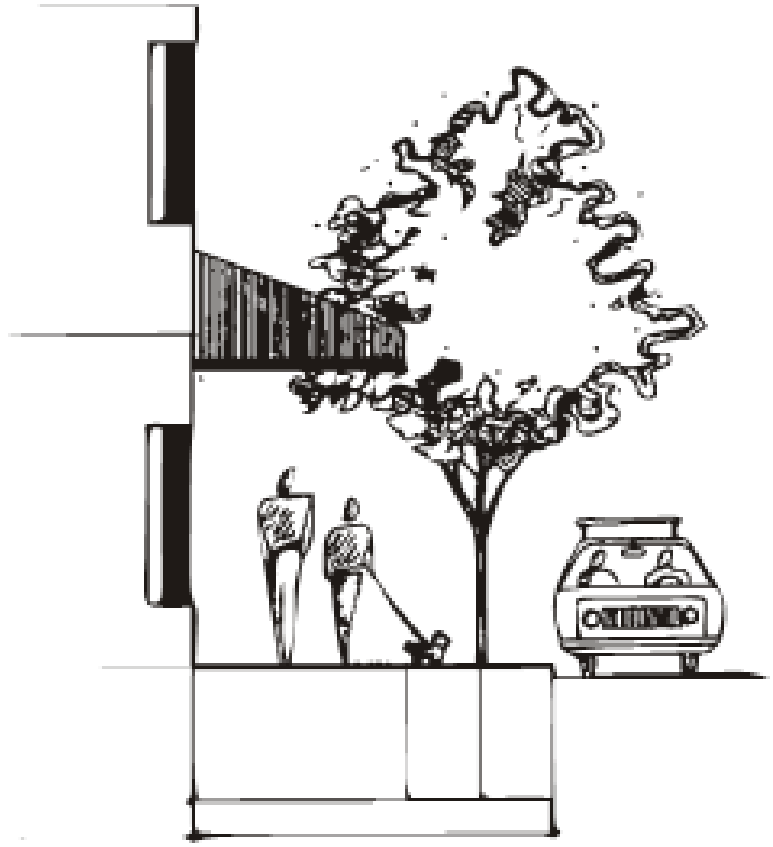


Figure 9-3: Existing Tree Crown - Proposed Awning Conflict Section

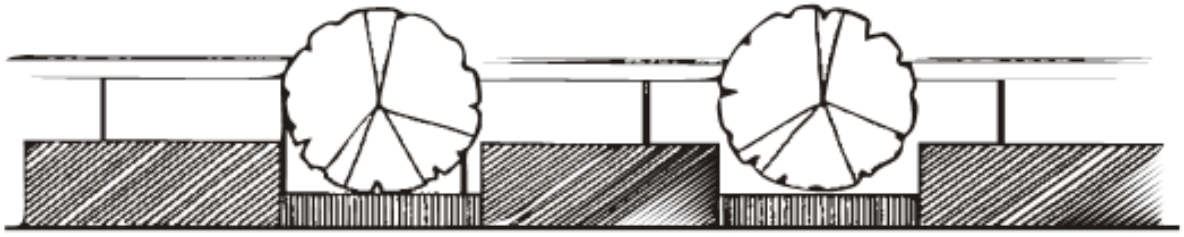


Figure 9-4: Existing Tree Crown - Proposed Awning Conflict Plan

9.3.6.3 CONSTRAINED COMMERCIAL STREET

The Vancouver Park Board specifies wider growing trees wherever space allows. The overhang of the awning should come no closer than 120cm to the centre of the tree trunk. ***Figure 9-5*** and ***Figure 9-6*** show awning configurations for narrow boulevards where trees with a columnar habit are being used.

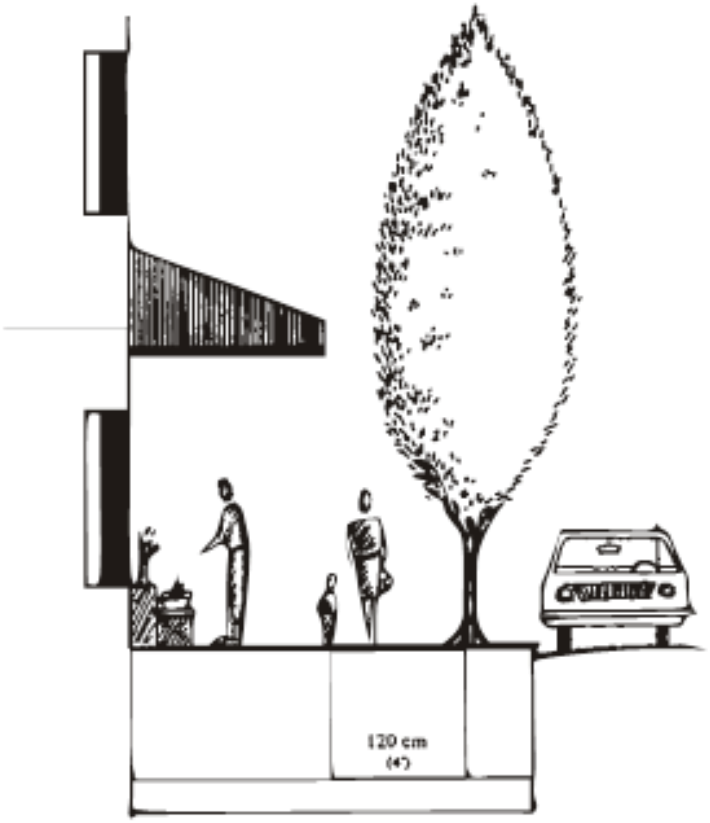


Figure 9-5: Narrow Boulevard Columnar Tree Awning Section

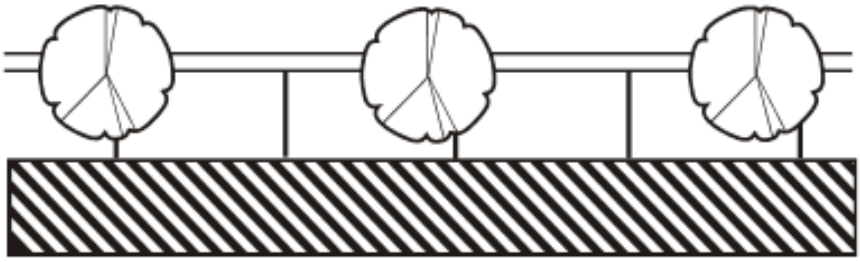


Figure 9-6: Narrow Boulevard Columnar Tree Awning Plan

9.4 STREET HORTICULTURE

Street horticulture or plantings serve an important purpose both aesthetically and in terms of ecological resiliency and rainwater management.

Plantings should be:

- Native or adapted species that require little maintenance and thrive in the local climate.
- Drought tolerant, observing the City of Vancouver Water Wise Landscape Guidelines.
- Diverse species that attract pollinators.

Plantings should not:

- Conflict with weather protection.
- Obstruct sightlines for vehicle movement.
- Obstruct the movement of pedestrians or cyclists.

9.4.1 GREEN STREETS PROGRAM

Green Streets gardens exist throughout the city. These gardens are available for members of the community to adopt and care for. They provide wildlife habitat, community connection, and public safety by supporting traffic calming. Most are located at intersections in corner bulges boulevards, or in traffic circles.

Many will have a sign marking it as part of the program. The sign will note whether the garden is either 'adopted' by someone in the community or 'available'. Available gardens are maintained by city crews. Contact green.streets@vancouver.ca if you would like to adopt or are doing work next to a garden that may be part of the program.

Learn more about the Green Streets Program in the City of Vancouver website.

9.4.2 A SHRUBS AND GROUNDCOVERS

Recommended plant lists for boulevard spaces can be found in the City of Vancouver website. Contact green.streets@vancouver.ca for more information.

9.4.3 GRASS

The proper installation of grass boulevards in high-use areas, particularly adjacent to commercial and higher-zoned residential properties, is critical to provide a long-lasting streetscape treatment that will meet the expectations of the City and adjacent residents / businesses. Refer to the *City of Vancouver Construction Specifications* for soil mixtures. Artificial turf is not an acceptable boulevard treatment.

9.4.3.1 SOD AND SEEDING

If sod is used, it must be suitable for high-traffic areas, offer good wear tolerance, shall be grown on sand or sandy loam based medium and shall be un-netted. Netted sod and sod grown on silt-clay based medium are not acceptable. Preference will be for sods that include drought tolerant grass species like creeping red fescues. If drought tolerant species are not present in the sod, it is recommended that these be introduced.

For seeded areas, the seed mix shall be a premium grade suitable for high-traffic areas and offer good wear and drought tolerance. Refer to the *City of Vancouver Construction Specifications* for acceptable seed mixes.

9.5 GROWING MEDIUM

9.5.1 GROWING MEDIUM

The location of growing medium placement dictates which mix to use. Typically, in boulevards with new trees and sod lawn or planting, the Street Shrub Mix, as specified in the *City of Vancouver Construction Specifications*, is used at a depth to give a sufficient soil volume for each tree. When planting trees in the boulevard, the Street Turf Mix, as specified in the *City of Vancouver Construction Specifications*, does not provide enough organics for satisfactory long-term growth. The Street Turf mix is suitable for boulevard areas with grass only.

9.5.2 STRUCTURAL SOIL

The City of Vancouver aims to soften the urban hardscape with trees planted on City property. However, in heavily hardscaped areas, there are often inadequate soil resources on site to achieve a healthy tree canopy. Further, typical resilient sidewalk subgrade is a poor growing medium for trees, and either prevents them from growing or causes the roots to stay shallow beneath the concrete surface.

While the typical tree pit provides approximately 3.0m^3 of soil, success for the tree will only be possible if there is accessible native soil to augment available resources. In locations where native soil is not accessible, trees will not thrive or live long enough to achieve the desired effect. These situations typically occur on filled-in tidal flats or places where large volumes of soil have been removed prior to the construction of a major project.

Structural soil can be used to mitigate insufficient or inadequate native growing medium as a subgrade that performs the dual purpose of supporting loadbearing hardscapes while also providing a suitable growing environment for tree roots. It consists of a measured mix of rock and soil whereby the load bearing is fully accomplished by an angular granite matrix while the pore space is filled with soil. Structural soil can promote stable, healthy, long-lived trees while reducing the potential negative implications of large-scale root development under hard surface areas such as adjacent Portland-cement concrete sidewalks. For the City of Vancouver's accepted structural soil mix and installation requirements, refer to the *City of Vancouver Construction Specifications*. Structural soil can be used to mitigate insufficient or inadequate native growing medium as a subgrade that performs the dual purpose of supporting loadbearing hardscapes while also providing a suitable growing environment for tree roots. It consists of a measured mix of rock and soil whereby the load bearing is fully accomplished by an angular granite matrix while the pore space is filled with soil. Structural soil can promote stable, healthy, long-lived trees while reducing the potential negative implications of large-scale root development under hard surface areas such as adjacent Portland-cement concrete sidewalks. For the City of Vancouver's accepted structural soil mix and installation requirements, refer to the *City of Vancouver Construction Specifications*.

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TRAFFIC SIGNALS & ELECTRICAL



Approval Table

Revision	Date	Description of Revision	Approval
0	November 2019	Initial version	Megan Pate
1.1	April 2026	Various amendments	Eric Mital, P.Eng, Director, Streets Paul Storer, P.Eng, Director, Transportation

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TRAFFIC SIGNALS & ELECTRICAL

10.1 INTRODUCTION

Vancouver's traffic signals and electrical system are a crucial part of making the City of Vancouver's streets safer and more accessible. By keeping roads and sidewalks illuminated, pedestrians, cyclists, and motorists are all visible and able to share the roadway safely. Through the effective use of traffic signals, pedestrian movements are kept separate from cyclists and vehicles, and vehicular traffic flows smoothly. This chapter outlines the design criteria for street lighting and traffic signals in the City of Vancouver and all associated electrical infrastructure.

The following is a brief description of each section:

- The *General Design and Analysis* section outlines the general codes, regulations and standards for street lighting and traffic signal design.
- The *Street Lighting Design and Analysis* section outlines the analysis required for street lighting and the possible conflicts street lighting may encounter.
- The *Design of Street Lighting Components* section outlines the design components of the street lighting system in use.
- The *Traffic Signal Design and Analysis* section outlines the analysis required for traffic signal design and the process for phasing, timing, and coordination of traffic signals.
- The *Design of Traffic Signal Components* section the outlines the design components of the traffic signal systems in use in the City.

Refer to *Chapter 2: Design Process & Coordination* for specific submission requirements.

10.2 GENERAL DESIGN AND ANALYSIS

This section outlines general design criteria and other requirements for street lighting and traffic signals.

10.2.1 GENERAL CONSIDERATIONS

Street lighting and traffic signals and associated electrical infrastructure must be designed with consideration of the requirements outlined in *Chapter 2: Design Process & Coordination*, *Chapter 7: Third-Party Utilities*, and *Chapter 8:* Streets & Transportation. All electrical drawings must be signed and sealed by a professional engineer registered with EGBC.

10.2.2 ABBREVIATIONS

Abbreviations are as follows:

- CD Candela.
- CEC *CAN/CSA Canadian Electrical Code with bulletins issued by Electrical Safety Branch of the Province of British Columbia and the City of Vancouver*.
- CMBC Coast Mountain Bus Company.
- CSA Canadian Standards Association.
- EGBC Engineers and Geoscientists British Columbia.
- IESNA Illuminating Engineering Society of North America.
- ITE Institute of Transportation Engineers.
- K Kelvin.
- LED Light Emitting Diode.
- MMCD Master Municipal Construction Documents
- MoTI Ministry of Transportation and Infrastructure.
- MUTCD Manual of Uniform Traffic Control Devices for Canada
- NEMA National Electrical Manufacturers Association.
- TAC Transportation Association of Canada.
- UPD Unit Power Density (Watts/m^2).

10.2.3 STANDARDIZATION

The City uses standardized products and methods that are defined in the ***City of Vancouver Construction Specifications*** and the *City of Vancouver Standard Detail Drawings*. The designer should follow the products and methods of the City's standards unless otherwise directed by the City Engineer.

Traffic signal displays (signal heads) and general operation are standardized throughout British Columbia to avoid potential confusion of the travelling public. These elements are defined in the *British Columbia Motor Vehicle Act*. Standardized items include:

- Vertical mounted signal heads.

- Left and right-side secondary heads.
- Order of signal indication.

10.2.4 CODES, REGULATIONS, AND STANDARDS

The most current edition of the following documents provide background and direction for street lighting and traffic signal design in the City of Vancouver:

10.2.4.1 CODES AND REGULATIONS

- BC Hydro regulations.
- *CAN/CSA Canadian Electrical Code with* bulletins issued by Electrical Safety Branch of the Province of British Columbia and the City of Vancouver.
- *CAN/CSA S6 Canadian Highway Bridge Design Code*.
- Coast Mountain Bus Company regulations.
- FortisBC regulations.
- Railway regulations.
- Regulations issued by municipal, provincial and federal authorities.
- Telus regulations.
- *Transport Canada Grade Crossing Regulations*.
- WorkSafeBC regulations.

10.2.4.2 STANDARDS AND GUIDELINES

- ANSI/IES RP-8: Lighting Roadway and Parking Facilities
- BC Hydro standards.
- British Columbia Motor Vehicle Act.
- British Columbia Motor Vehicle Act Regulations *Division 23 – Traffic Control Devices*.
- BC MoTI Electrical and Traffic Engineering Manual
- BC MoTI Pedestrian Crossing Control Manual for British Columbia
- CAN/CSA standards.
- *City of Vancouver Construction Specifications*.
- *City of Vancouver Standard Detail Drawings*.
- Coast Mountain Bus Company standards.
- Fortis BC standards.
- IES LM-79 Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products.
- IES LM-80 Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
- IES TM-15 Luminaire Classification System for Outdoor Luminaires and *Addendum A: Backlight, Uplight, and Glare (BUG) Ratings*.
- IES TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources.
- ITE standards.
- Master Municipal Construction Documents
- *TAC Accessible Pedestrian Signals Guidelines*.
- *TAC Bikeway Traffic Control Guidelines for Canada*.
- *TAC Guide for the Design of Roadway Lighting*.

- *TAC Manual of Uniform Traffic Control Devices for Canada (MUTCD).*
- Telus standards.

10.2.5 PERMITS

Permits will generally be as follows:

- Interconnection permits from rail companies, Ministry of Transportation and Infrastructure, or other authorities.
- Right-of-way and utility crossing permits for crossings of electrical transmission lines; railways; highways; and regional, provincial and federally regulated pipelines.
- Electrical permits.

10.2.6 UNDERGROUND AND OVERHEAD CONFLICTS

It is the designer's responsibility to investigate proposed and existing underground utilities and resolve all conflicts to the best of their ability based on the information available. Required clearances for below and above ground assets / utilities can be found in *Sections 2.2.5* and 0, respectively. Third-party utility clearances can be found in *Chapter 7: Third-Party Utilities*. The designer is required to add a note to drawings putting the onus on the contractor to contact BC One Call prior to any construction work. Utility information shall be confirmed by the Utilities Management Branch. All underground utilities shall be shown on the drawings clearly with unique line types and confirmed by cross-referencing GIS data with City of Vancouver utility plate maps.

The designer shall obtain permits and approvals for crossings of electrical transmission lines, railways, and regulated pipelines.

Overhead power lines in proximity of poles can represent significant risk and safety concerns if safe working and operating clearances are not met. The designer shall confirm clearances from overhead power lines to poles and luminaires. Where overhead lines exist, the designer shall survey lines with a laser range finder or appropriate device. Where new power lines are proposed, the pole and line heights shall be confirmed with BC Hydro. A one-sided spacing or a shorter pole may also be considered where overhead power line clearances can't be met. The designer shall add the note in ***Figure 10-1*** onto the drawings to put the onus onto the contractor to meet all safety requirements prior to installing the pole.

OVERHEAD POWER LINE CONFLICTS

CONTRACTOR SHALL CONFIRM ON SITE PRIOR TO CONSTRUCTION THAT POLES & EQUIPMENT WILL MEET WorkSafeBC CLEARANCE REQUIREMENTS FOR OVERHEAD PRIMARY AND SECONDARY LINES. CONTRACTOR TO REPORT ANY CONFLICTS OR DISCREPANCIES TO THE ENGINEER OF RECORD PRIOR TO CONSTRUCTION

Figure 10-1: Overhead and Underground Drawing Notes

It is the designer's responsibility to contact BC Hydro for the required clearances for higher voltages, and to contact Coast Mountain Bus Company for the required clearances for trolley wires close to signs, signal heads, signal arms, luminaires, luminaire arms, and poles.

10.3 STREET LIGHTING DESIGN AND ANALYSIS

The City of Vancouver operates, updates, and maintains a street lighting system to light streets and roadways including sidewalks, crosswalks, intersections, roundabouts and multi-use pathways. The principal purpose of street lighting is to enhance visibility at night. For a pedestrian, this generally means better visibility of their surroundings while on the sidewalk. For cyclists and motorists, street lighting means more time to stop when needed or to safely avoid an obstacle. This section outlines design criteria and other requirements for street lighting.

10.3.1 GENERAL REQUIREMENTS FOR LIGHTING

Designs shall meet the lighting requirements of the applicable Illuminating Engineering Society (IES) standards as the primary reference and the *TAC Guide for the Design of Roadway Lighting* as a secondary reference. These requirements and standards are applicable except where noted in this document. Where conflicts arise between the *TAC Guide for the Design of Roadway Lighting* or IESNA documents and the *City of Vancouver Engineering Design Manual*, the *City of Vancouver Engineering Design Manual* shall take precedence. The information in this document is based on IESNA and TAC lighting standards as well as the *MMCD*.

All consultants are required to consult with the City to determine and receive acceptance of specific design requirements. Some lighting designs will be new, while others will be modifications to existing lighting to suit road modifications or a rehabilitation or upgrade of the existing system.

The City is committed to reducing community-based greenhouse gas emissions through energy efficient lighting using LED light sources. Designs that meet lighting requirements while reducing energy consumption are required.

Lighting is generally required on all streets, intersections, roundabouts, mid-block crosswalks, sidewalks, bike lanes, multi-use pathways, and at all at-grade railway crossings where warranted by *Transport Canada Grade Crossing Standards* and *Transport Canada RTD-10 Road/Railway Grade Crossing Technical Standards and Inspection, Testing and Maintenance Requirements*. Lighting is not required on laneways unless specifically defined by the City. Lighting requirements for laneways shall be confirmed with the City on a case-by-case basis.

Lighting of guide signs will not be required where retro-reflective sign sheeting material is ASTM Grade IV or better. Signs will be illuminated via sign luminaires where lower grade sheeting is used or where car headlights will not illuminate sign sheet due to road curvature. Where lighting is required, it shall meet the requirements defined in the *TAC Guide for the Design of Roadway Lighting*.

Street lighting is also installed as part of a traffic signal installation; refer to *Section 10.5* and *Section 10.6* for more information.

The communication ducting is common-trenched with street lighting unless specified otherwise by the City Engineer. The typical trench details are defined in *City of Vancouver Standard Detail Drawing G4.7*.

10.3.2 MEASUREMENTS

Refer to the latest edition of *ANSI/IES RP-8: Lighting Roadway and Parking Facilities*

10.3.3 LIGHTING DESIGN AND CRITERIA

Minimum wattage luminaires providing the desired lighting at the optimized pole spacing are the preferred design solution. Luminaires with lower driver current shall be considered where possible to reduce glare. This involves selecting the most effective luminaire photometric files and then optimizing the spacing via computer lighting design software. All lighting simulations must be completed in AGi32 lighting design software using metric units to at least one decimal point. Pole spacing must be adjusted to suit intersections, driveways, and lot configurations.

To meet horizontal intersection lighting levels, luminaires must be installed on signal poles to minimize the number of poles at the intersection. The pole spacing at intersections is governed by the proposed signal pole locations. Additional street light poles may be required to meet recommended vertical illumination levels. Pole locations at signalized intersection are defined in *Section 10.6.1.1* and *City of Vancouver Standard Detail Drawings E7.20*.

Where existing luminaires are being replaced with new luminaires of a different technology (i.e. High-Pressure Sodium to LED), the street lighting conversions should just exceed minimum performance criteria. The designer shall model the existing lighting installation using computer software in order to determine existing light levels. The designer shall provide the lighting calculations (AGi files) to the City, documenting the process and results prior to finalization of the design package. The City will review all AGi calculations for conformance to design criteria, but the design consultant's Engineer of Record remains responsible for the design and calculations.

Lighting design requires use of computer lighting design software (AGi32) and the photometric files from lighting suppliers in IES format. Typically, luminaire photometric files are based on a lamp that can vary from the actual lamp used in the test, provided it is similar. This is referred to as "relative" photometry. For LED lighting, the photometric files should be "absolute", which means the photometric file shall be for the exact luminaire tested.

The designer shall select the photometric file for luminaires that light the roadway and sidewalks and reduce spill light and glare impacts on local residents. This shall be done by following ANSI/IES RP-8, Recommended Practice: Lighting Roadway and Parking Facilities and analyzing luminaire optical systems using the BUG method defined in *IES TM-15 Luminaire Classification System for Outdoor Luminaires and Addendum A: Backlight, Uplight, and Glare (BUG) Ratings*. The maximum nominal BUG rating of luminaires shall be B2-U0; however, a lower BUG rating should be used where possible. The glare rating is to be considered and shall be kept to a minimum value where possible. Exceeding the backlight rating (B) limit is acceptable if required to achieve the specified sidewalk lighting levels. Refer to *Section 10.4.1.2* for luminaire selection.

The designer shall apply a Light Loss Factor (LLF) to the lighting design. For LEDs, the LLF is a combination of several factors representing deterioration of the lamp and luminaire over their life span which is applied to a lighting design. The LLF is incorporated into the design calculations.

LLF = LLD x LDD x LATF

- Lamp Lumen Depreciation (LLD) shall be based on 100,000 hours of operation using the supplier's *IES TM-21 Projecting Long Term Lumen Maintenance of LED Light Sources* data for the selected luminaire.
- Luminaire Dirt Depreciation (LDD) = 0.90, as per *IES DG-4 Design Guide for Roadway Lighting Maintenance* for an enclosed and gasketed roadway luminaire installed in an environment with less than 150µg/m^3 airborne particulate matter and cleaned every eight to ten years.
- Luminaire Ambient Temperature Factor (LATF) = +15°C.

Typical LLFs for different types of luminaires are shown in ***Table 10-1*** and shall not be used where the exact LLF can be calculated.

Table 10-1: Typical Light Loss Factors

Luminaire Type	Light Loss Factor	
LED	0.8	(Unless other LLD can be proven)
High Pressure Sodium	0.72	(Calculating light loss factors for High Pressure Sodium and Metal Halide is defined in the *TAC Guide for the Design of Roadway Lighting*)
Metal Halide	0.6	

Streets, sidewalks, intersections, and roundabouts require different levels of lighting based on the road classification and level of pedestrian activity. Arterial, collector, and local street classifications appropriately describe general levels of vehicular traffic and conflict. However, a second type of conflict, which is responsible for a disproportionate number of nighttime fatalities, is the vehicle / pedestrian interaction. The magnitude of pedestrian flow is nearly always related to the abutting land use. Three classifications of pedestrian night activity levels and the types of land use they are typically associated with are the following:

- **High** - Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. This includes streets in commercial areas with 100 pedestrians or more in the one-hour period with the highest average annual nighttime pedestrian volume. Local roads will typically not warrant a high level unless they can be proven to have a high level of pedestrian activity. The most common streets with high activity will be collectors and arterial classifications.
- **Medium** - This shall apply to all roads with the exception of those defined as high or low.
- **Low** - Areas with low numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. This will include streets in industrial and residential areas with 10 pedestrians or fewer in the one-hour period with the highest average annual nighttime pedestrian volume. The most common street will be a local classification.

The pedestrian activity along with the road classification will be determined by the City to define the required luminance or illuminance, uniformity, and veiling luminance lighting requirements. It is important to note that a medium or high level of pedestrian activity may require additional poles and luminaires to meet the required levels of lighting on the sidewalks. In all cases, lighting design criteria and calculations shall be provided in a table, with demonstrations for mid-block lighting and intersections provided in ***Table 10-2*** and ***Table 10-3***, respectively.

Table 10-2: Mid-Block Lighting Design Criteria Example

Lighting Design Criteria Table – IES RP-8-18			
	Recommended Levels	Calculated Levels	MID-BLOCK
Street/Block Number(S) & Street Name	000 Block ABC Street		
Roadway Classification	Major (Arterial)		
Pedestrian Activity/Conflict Level	Medium		
Lamp Wattages (W) And Light Source Type	24-70W LED		
Light Loss Factor(S)	0.853, 0.840		
Roadway Luminaire Mounting Height (m)	9.1m		
Pedestrian Luminaire Mounting Height (m)	4.5m		
Max Pole Spacing (m)	30m		
Roadway Horizontal Luminance (E_{avg})	0.90 cd/m^2	0.94 cd/m^2	
Roadway Horizontal Uniformity Ratio (E_{avg}/E_{min})	$\leq$ 5.0	2.35	
Roadway Max Veiling Luminance Ratio (Lv_{max}/Lv_{avg})	0.3	0.27	
Sidewalk Horizontal Illuminance Level (E_{avg})	5.0 Lux	5.2 Lux	
Sidewalk Horizontal Uniformity Ratio (E_{avg}/E_{min})	4.0	2.35	
Bikeway Horizontal Illuminance Level (E_{avg})	10.0 Lux	10.5 Lux	
Bikeway Horizontal Uniformity Ratio (E_{avg}/E_{min})	4.0	3.2	

Table 10-3: Intersection Lighting Design Criteria Example

Lighting Design Criteria Table – IES RP-8-18			
	Recommended Levels	Calculated Levels	Intersection
Intersection Streets (North-South / East-West)	ABC St / W 99th Ave		
Roadway Classifications	Major (Arterial) / Local (Residential)		
Pedestrian Activity/Conflict Level	High		
Lamp Wattages (W) And Light Source Type	83W, LED		
Light Loss Factor(S)	0.853		
Roadway Luminaire Mounting Height (m)	9.1m		
Pedestrian Luminaire Mounting Height (m)	N/A		
Pole Layout (As Designed)	1-2 Per Corner		
Intersection Horizontal Illuminance Level (E_{avg})	26.0 Lux	26.82 Lux	
Intersection Horizontal Uniformity Ratio (E_{avg}/E_{min})	≤ 3.0	2.17	

10.3.3.1 STREETS

Street lighting levels for various street types and pedestrian activity levels are defined in the *TAC Guide for the Design of Roadway Lighting* and *ANSI/IES RP-8: Lighting Roadway and Parking Facilities*

When tying into or modifying an existing system, the system shall be designed so existing lighting is operational during hours of darkness. The designer shall provide a design for temporary roadway lighting.

In areas where only one side of a road is to be developed, the lighting shall be designed for the complete road width. Only poles and luminaires along the property frontage being developed shall be installed but luminaires shall be installed on both sides of the road. At intersections, the entire intersection lighting shall be upgraded to meet the latest standards as outlined in this document. Locations and types of all future poles and luminaires shall be clearly indicated on the drawings and the lighting calculations included. Provisions shall be made for future extension of the conduit system to the opposite side of the roadway by providing empty conduits across the roadway where future lights will be located or where we need to connect to existing conduit system. Field validation of a lighting system's performance may be done by illuminance.

10.3.3.2 SIDEWALKS, BIKE LANES, MULTI USE PATHWAYS

The designer shall confirm with the City whether additional pedestrian lighting is required on sidewalks. Where defined by the City, sidewalk lighting shall meet lighting levels for various pedestrian activity defined in *ANSI/IES RP-8: Lighting Roadway and Parking Facilities*

Sidewalk, bike lane, and multi-use pathway lighting levels for various pedestrian activity levels are defined in *ANSI/IES RP-8: Lighting Roadway and Parking Facilities*

10.3.3.3 INTERSECTIONS

Intersection lighting levels for various street types and pedestrian activity levels are defined in *ANSI/IES RP-8: Lighting Roadway and Parking Facilities*

10.3.3.4 MID-BLOCK CROSSWALKS

Mid-block lighting levels for various street types and pedestrian activity levels are defined in *ANSI/IES RP-8: Lighting Roadway and Parking Facilities*

10.3.3.5 ROUNDABOUTS

Roundabout lighting levels for various street types and pedestrian activity levels are defined in *ANSI/IES RP-8: Lighting Roadway and Parking Facilities*

10.3.4 STREET TREES

Trees, existing or proposed, pose a challenge to lighting design as they block light and reduce lighting below required levels. ***Figure 10-2*** shows an existing residential road in the City with a very large tree canopy. In this case, the davit style poles would have the majority of their light blocked out when the trees are in full bloom. Though this is an extreme scenario in terms of light blockage, the potential for street tree conflicts throughout the City is a design consideration for existing and proposed street lighting.



Figure 10-2: Existing Tree Canopy

All designs need to take into consideration light blockage from landscaping and street trees. Where trees exist or are proposed, lights may have to be installed on custom arms that extend out over the roadway beyond the ultimate tree canopy. With the lighting extended over the roadway, additional pedestrian scale lighting will often be required to properly light the sidewalks. The proposed locations, spacing, pole height, arm length and spacing of trees may also need to be adjusted in conjunction with lighting pole spacing.

Some examples of lighting layouts and trees are provided in ***Figure 10-3*** and show some options for locating lighting poles and trees. The height and size of tree canopy (drip line), light level requirements, and pole heights are factors when defining the lighting layout. Typically, using only pedestrian-scale lighting will not be suitable for roads with trees that are over two lanes wide in commercial areas. The key is to take the impacts of the tree trunk and canopy (at fully maturity) into account in the lighting design. This may mean using lower level pedestrian-scale lighting under the tree canopy to reduce light blockage.

For new installations with trees, the tree type and layout will typically be designed by a landscape architect. It is imperative that the lighting be designed and integrated into the landscape design as the tree spacing will often have to be adjusted. The lighting can't be designed in isolation from the landscape design as the landscape design will impact the lighting levels.

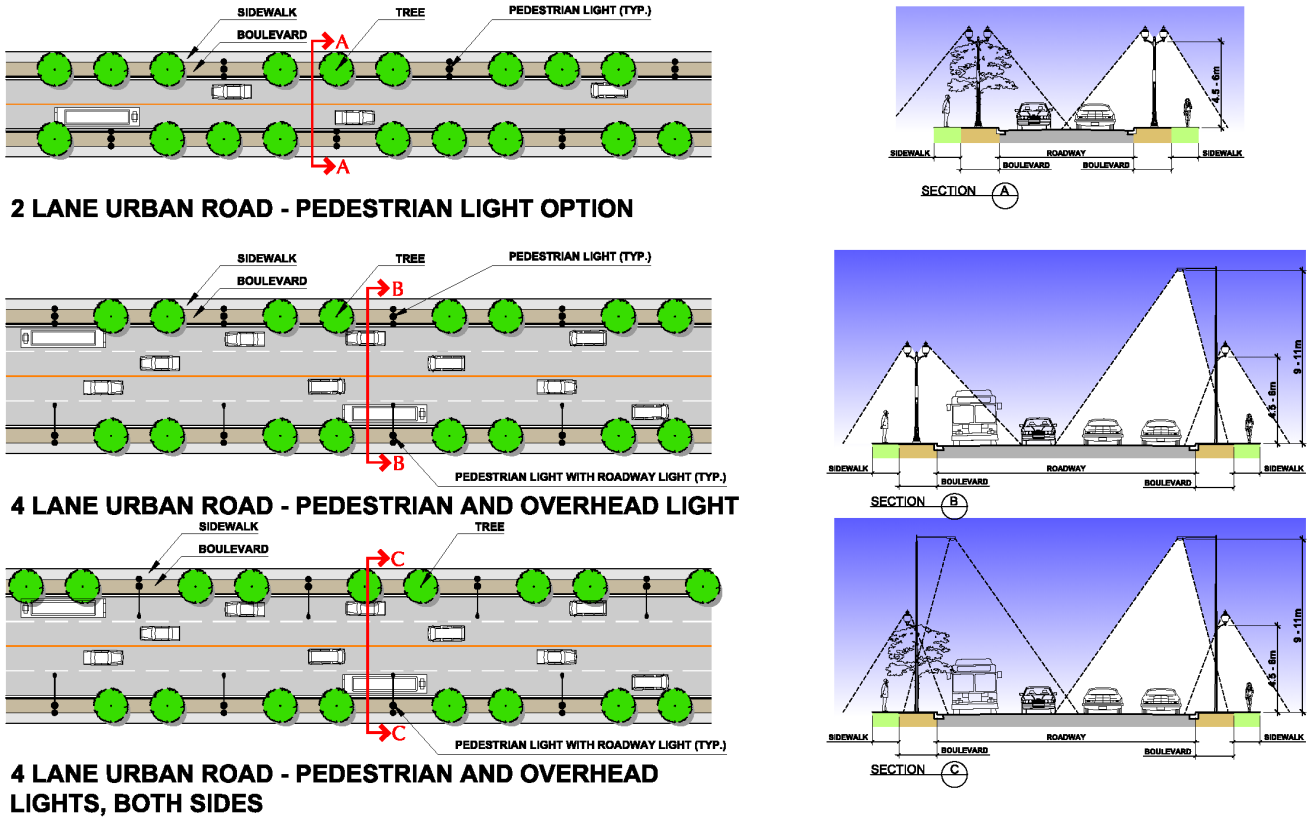


Figure 10-3: Tree and Lighting Layout Options

Where trees exist and impact the lighting, tree pruning can be considered. ***Figure 10-4*** shows the recommended procedure for assessing and mitigating the impacts of trees via pruning. Where pruning is required, its viability shall be discussed with the City and their arborist. As trees vary in foliage, shape, and size, it is not practical to calculate the exact impacts.

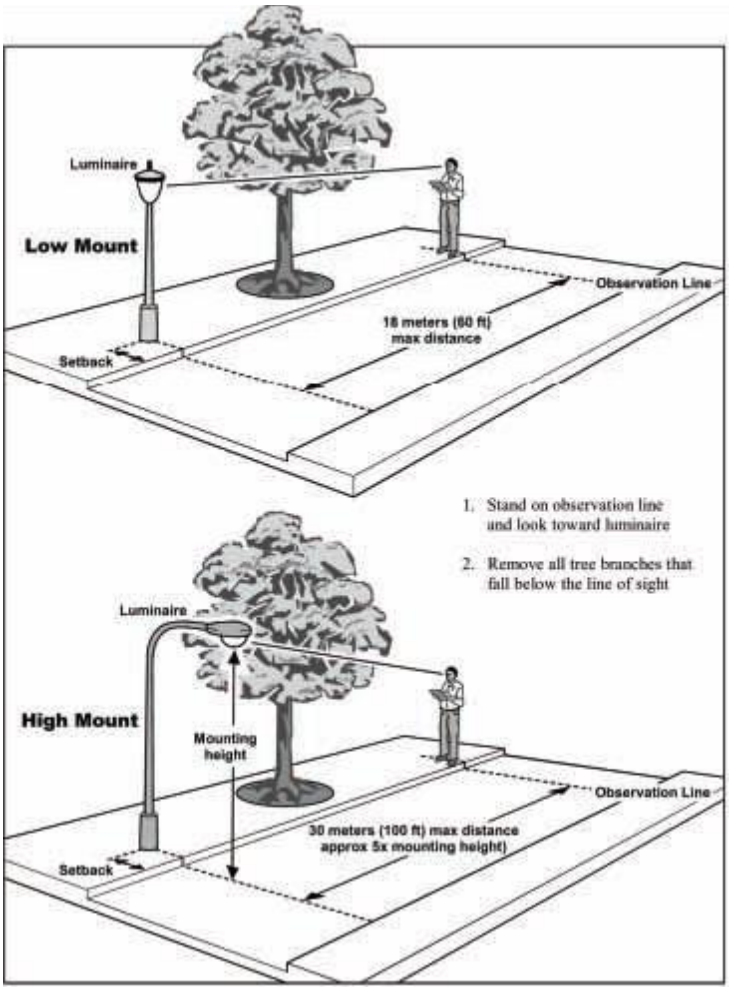


Figure 10-4: Tree Pruning

Another impact of trees is the need to work around root systems when installing a conduit trench or pole foundation. It is required that the City Arborist be contacted during design stage to review impacts of proposed work around trees. Refer to *Section 10.4.2* for preferred conduit locations.

10.4 DESIGN OF STREET LIGHTING COMPONENTS

The principal purpose of street lighting is to enhance the safety of pedestrians, cyclists, and vehicles. Street lights are also important to the accessibility and appeal of neighbourhoods and communities. This section outlines the design requirements for all street light components, including poles, luminaires, conduit, junction boxes, kiosks, and other components that make up street lighting systems in the City of Vancouver.

10.4.1 POLES AND POLE MOUNTED DEVICES

Unless a special decorative pole style is required by the Electrical Design Branch, approved poles shall be the City of Vancouver standard davit pole as per the City of Vancouver Construction Specifications. Davit pole heights shall be 7.6m or 9.1m high. Where trolley poles exist or are proposed, lighting can be mounted on these poles with a luminaire arm that bolts onto a flange or clamps onto the pole shaft that meets the approval of the Coast Mountain Bus Company and is as per the *City of Vancouver Standard Detail Drawings*. For consistent appearance, where trolley poles are required on only one side of the road, similar looking lighting poles shall be proposed for the other side of the road.

Poles shall be provided with a galvanized and powder coated finish. It is the designer's responsibility to confirm colour by RAL number. The RAL number shall be confirmed with the City Engineer.

Decorative pedestrian scale poles shall be 4.0m to 6.0m high unless specified otherwise by City Engineer. Pole details are defined in the *City of Vancouver Standard Detail Drawings*. Decorative poles may have specific shapes, colours, and styles along with banner arms, flower basket hangers, and other miscellaneous devices. Where decorative street lighting is used to enhance the streetscape, the following details are required as part of the decorative lighting design:

- Shop drawings of the street light poles proposed complete with pole design criteria, sealed by the supplier's professional engineer registered with EGBC.
- Detailed information and specifications of the luminaires proposed.
- Detailed information on pole accessories (i.e. decorative bases, banner arms, and receptacles).
- Drawings detailing the assembled pole and luminaire units.
- Structural assessment of pole and foundation capacity to support all proposed equipment. Refer to *Section 10.4.1.3*.

10.4.1.1 POLE PLACEMENT

Poles shall be located at the outer edges behind the curb and gutter or edge of pavement or, in special circumstances, in the median of the street. Where median lighting is being considered, the lighting levels on any sidewalks shall be met, or additional supplemental sidewalk lighting may be required.

The pole shall typically be 760mm from the centre of pole to the face of curb except for CMBC poles which shall typically be located immediately behind the curb. Pole bases should be installed parallel to the curb. Poles shall be located in a manner to reduce impacts on building occupants, i.e. in between residential units, at lot lines, and away from windows, etc. In laneways, poles shall be located as close to the property lines as possible. Poles shall be located at curb returns and suit intersections and pedestrian walkways while staying clear of driveways and wheelchair ramps. Further, pole spacing shall be governed by roadway width, road configuration, and intersecting property lines. For power lines, the proposed poles shall meet the minimum clearance from buildings and street lights as outlined in BC Hydro standards. For CMBC lines, clearances specified in the CMBC standards are to be met.

Poles shall meet the clearance requirements in *Chapter 0* and *Section 7.2.8.1*.

Pole spacing patterns include staggered, opposite, one-side, and median-mount arrangements, depending on the roadway classification and road geometrics. The pole arrangements shall generally be as follows:

- Roads 8.5m and narrower – Staggered or one-sided spacing.
- Roads over 8.5m wide - Staggered or opposite spacing.
- Poles should only be located in medians if a clearance of 0.5m from the pole face to curb face can be maintained. A minimum of two consecutive poles should be required before considering poles in medians.

10.4.1.2 LUMINAIRES

Any proposed lighting installations must be with LED luminaires. The designer shall contact the City Engineer for approved luminaires.

The designer shall be responsible to ensure that the luminaire meets or exceeds all requirements and meets all required lighting levels.

In the case of decorative lighting, the luminaire colour shall match the pole, so the exact RAL colour number shall be defined on the design drawings.

The designer shall confirm the style/make of luminaire with the City Engineer for all decorative roadway and pedestrian installations. The designer shall specify the exact luminaire model number including wattage, operating current and photometric distribution, colour temperature, and voltage on the design drawings. The City shall define a required CCT for all new LED lighting on roadways, intersections, roundabouts, mid-block crosswalks, and walkways. The City requires all luminaires to have a minimum 3G vibration rating and be supplied with an ANSI 7-pin receptacle and integral surge protection.

10.4.1.3 CONCRETE BASES

The *City of Vancouver Construction Specifications* and *City of Vancouver Standard Detail Drawings* define typical concrete bases to go with standard lighting poles. These are typically poured-in-place as defined on the *City of Vancouver Standard Detail Drawings CE1.1* to *CE1.7*, which better accommodates existing utilities than pre-cast concrete bases. The designer shall fully investigate utilities to determine whether concrete bases will fit in the locations proposed. Where a concrete base needs to be customized to accommodate utilities, it shall be designed by a structural engineer registered with EGBC. Concrete bases shall be based on the pole base reaction forces for a fully loaded pole and shall take into account the soil conditions present.

The City has identified areas under *Section 7.4.4* where deep peat deposits and other poor soil conditions have been encountered. In these areas, structural and geotechnical review of the concrete bases shall be undertaken. Contact the City for further information on general soil conditions within project limits.

Where concrete bases are proposed in laneways or areas without suitable protection for poles (i.e. areas without barrier curbs), raised bases shall be used.

10.4.2 CONDUIT

All conduits shall be shown on the electrical drawings. Conduit shall be grey RPVC as per *CAN/CSA C22.2 No. 211.2 Rigid PVC (Unplasticized) Conduit* and orange RPVC for communications conduits. The designer shall review and meet requirements listed in *Chapter 7: Third-Party Utilities*.

Designers should allow for future expansion of conduit system using junction boxes and/or stubbing out ducts at construction limits of developments. All empty conduits shall have a 6.0mm nylon pull string installed and capped ends.

The preferred location of electrical conduits is typically back of sidewalk. Conduit alignments shall be designed to avoid tree roots and tree protection zones as outlined by the landscape architect and / or arborist. Conduits shall be located to meet standard clearances to proposed, existing and other utilities as specified in *Chapter 2: Design Process & Coordination*. The designer shall prepare trench cross-section drawings for all scenarios. The drawings shall show conduits in the trench along with other conduits and utilities as per the *City of Vancouver Standard Detail Drawings*, specifically *G4.7*, which outlines the required minimum number of conduits in low and high density areas.

10.4.3 JUNCTION BOXES

Junction boxes shall be shown on the drawings to scale. They shall be used where required to connect conduits, where the conduits will run in multiple directions, or to terminate conduit runs. Junction boxes shall be located outside of vehicular areas, driveways, wheelchair ramp areas and, where possible, outside of walking areas (sidewalks) and cycle paths; this includes avoiding placing them between pedestrian ramps and traffic signal poles to ensure accessibility to current or future push buttons. In laneways, where installations in vehicular areas are unavoidable, traffic – rated junction boxes shall be proposed and located as close to the property line as possible. Placement of junction boxes shall be coordinated with landscape, streetscape designs and the Green Rainwater Infrastructure Implementation Branch. Where possible, junction boxes should be grouped together. Junction boxes shall also be accessible with a workable space around. Refer to *City of Vancouver Standard Detail Drawings E2.4* and *City of Vancouver Construction Specifications Section 26 56 01 2.5.*

Bell ends and conductors support bar shall be installed in all junction boxes as per *City of Vancouver Standard Detail Drawings E2.3 and E2.4.*

The approved junction boxes are listed in the *City of Vancouver Construction Specifications* and shown in the *City of Vancouver Standard Detail Drawings*. H20 traffic rated junction boxes must be used in vehicular areas. Preferred junction box locations are shown in the *City of Vancouver Standard Detail Drawings E7.20.* Refer to ***Figure 10-5*** for an example of a junction box and wiring.

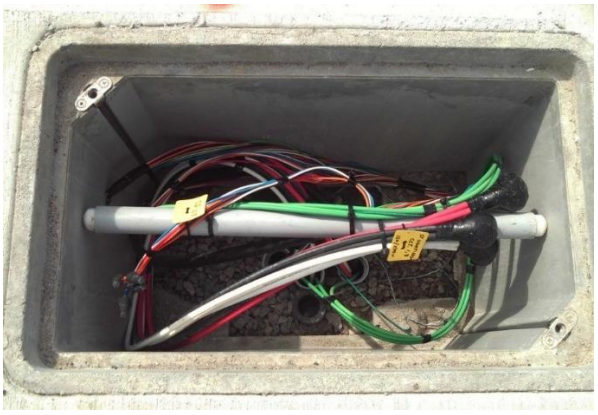


Figure 10-5: Street Lighting Junction Box Example

10.4.4 POWER SUPPLY AND DISTRIBUTION

All new service installations must be metered as per *City of Vancouver Standard Detail Drawings* E7.23A, 7.23B, 7.24, 7.25A, and E7.25B.

The designer shall confirm the voltage and location of power sources for the proposed installation. The designer shall confirm if a new service is required or an existing power system in the area is suitable for the upgrade. If the new service is required, the designer must coordinate the new service connection with BC Hydro.

The designer shall select a suitable service location based on availability and what meets the City and BC Hydro standards. The designer shall also confirm the service location with BC Hydro as part of the design process.

The BC Hydro power supply shall feed into a metered pedestal, cabinet, or kiosk that shall contain, but is not limited to, the following: panel boards, breakers, lighting contactors, a surge protection device, and a hand-off-auto switch. They are defined on the *City of Vancouver Standard Detail Drawings* E7.23A, 7.23B, 7.24, 7.25A, and E7.25B. Currently, the lighting is controlled by a single photocell located on top of the pole.

The preferred service voltage is 120/208V or 120/240V. Where an alternate voltage such as 347/600V is the only power supply available, a service kiosk with transformer will be required as per *City of Vancouver Standard Detail Drawings E7.25A or E7.25B*.

The *City of Vancouver Standard Detail Drawings* E7.23A, 7.23B, 7.24, 7.25A, and E7.25B show general single line. The size, rating, and number of contactors and breakers will vary and must be defined on the design drawings. The designer shall define the interrupting capacity (kAIC) of the breakers on the design drawings.

As the cabinets and kiosks are large, they will require planning to define a suitable location. When choosing service cabinets and kiosks, the designer shall select the appropriate size to suit the future loads.

The service cabinet shall be located:

- Off the roadway where it is not likely to be impacted by motor vehicles.
- Preferably not on private property. In the case where the only option is on private property, approval must be received from the property owner and it must be accessible to City crews with no restriction at all times.
- Where it will not be a hazard or obstruction to pedestrians.
- Where it does not block sight lines.
- Where it can be easily accessed for servicing.
- Where it does not impact business and is not a cause for complaint (follow the same requirements and process as defined in *Section 10.6.6*).

When tying into an existing system, designers shall confirm that the system meets *CAN/CSA Canadian Electrical Code with bulletins issued by Electrical Safety Branch of the Province of British Columbia and the City of Vancouver* and, if necessary, modify the system to meet current requirements.

10.5 TRAFFIC SIGNAL DESIGN AND ANALYSIS

The City of Vancouver operates, updates and maintains traffic signals throughout the City. The signals are connected to a Traffic Signal Management System that collects traffic flow data via detection systems and monitors traffic conditions with Pan-Tilt-Zoom (PTZ) cameras. Connecting to the system is an integral part of traffic signal design. Specific communications and system requirements for each traffic signal will be required for every design and shall be reviewed with the City. There may be substantial underground conduit installation required to connect to the nearest network access point.

This document is intended to provide specific City traffic signal and electrical requirements to aid in the design of traffic signals. Street lighting is required at all signalized intersections; however, some scenarios may not be defined in this document.

Traffic signal designs shall meet the requirements of references indicated in *Section 10.2.4,* though requirements outlined in sections of the *City of Vancouver Engineering Design Manual* will always take precedence. The exception to this is when conflicts arise between this manual and the *British Columbia Motor Vehicle Act*, which holds priority.

The sections below outline the processes, procedures and other requirements for traffic signals and their connection to the Traffic Signal Management System.

10.5.1 REQUIREMENTS

Before signal design, the designer must consult with the Traffic & Data Management Branch to establish the specific project requirements. Signal designs may be new, modifications to existing signals to suit road modifications, or rehabilitations or upgrades to existing signals; each situation is unique and requires a tailored approach.

When modifying existing signals, the design must ensure that the signal can remain in operation with no or minimal down time. Where shut down is required, it shall be in off-peak periods, and all required flagging and traffic control shall be defined and provided. The designer may be required by the City to provide an approved traffic management plan as part of the design package.

The *City of Vancouver Engineering Design Manual* shall be used in conjunction with the *British Columbia Motor Vehicle Act Regulations Division 23 - Traffic Control Devices* and the *British Columbia Motor Vehicle Act*.

10.5.2 SIGNAL PHASING, TIMING, AND COORDINATION DESIGN

10.5.2.1 PHASING, TIMING, AND COORDINATION PLANS

The Traffic & Data Management Branch prepares the majority of the signal timing and coordination plans; when needed, the consultant may be required to design the signal timing records (TSRs). Where signals are within a 400m spacing, coordination is required to optimize operation and reduce delay. Signals within a 100m spacing typically require pre-emption through hard-wire connection. This requirement shall be confirmed with the Traffic & Data Management Branch. Signal phasing must be supported by traffic capacity analysis (i.e. Synchro) and approved by the Traffic & Data Management Branch before initiating traffic signal design. Please refer to the:

City *of Vancouver Streetscape Garbage & Recycling Enclosure Siting Manual*

City of Vancouver Traffic Signal Timing Guidelines

City of Vancouver Guidelines for Using Synchro Version 10

10.5.2.2 LEFT TURN PHASING

Left-turn phase options at signalized intersections are as follows:

- Permissive - Green ball display. A permissive left turn has no left-turn arrow display, which permits a left turn while yielding to opposing traffic.
- Protected Only - Green arrow display. A protected left turn has a solid green arrow indication while all conflicting movements are held by a red display. A protected left turn is always terminated with a yellow ball display.
- Protected / Permissive - Flashing green arrow display. A protected / permissive left turn presents a flashing green arrow followed by a solid amber arrow. During the flashing phase (advanced lagging movements), opposing through traffic is held by a red display. After the amber arrow has timed out, left-turn traffic is presented with a green ball display permitting the movement while yielding to opposing traffic. A lagging arrow may be permitted where the left turn trap is not present.

Care should be taken when considering a left-turn phase, as it can impact the intersection level of service by increasing the total cycle length. Refer to the *BC MoTI Electrical and Traffic Engineering Manual*

Protected / permissive phasing is generally used for left turns because of its greater efficiency. However, protected only phasing should be considered based on the criteria outlined in *BC MoTI Electrical and Traffic Engineering Manual*

10.5.2.3 SIGNAL PRE-EMPTION

Signal pre-emption allows the normal signal operation to be replaced by a special pattern for a specific temporary use. Common types of pre-emption are for railway or emergency vehicles. Railway pre-emption is hard-wired from the traffic controller to the railway signal control cabinet. Contact the City to define the need and specific requirements for railway and firehall pre-emptions; the consultant may propose alternate pre-emptions that are to be reviewed by the City.

10.6 DESIGN OF TRAFFIC SIGNAL COMPONENTS

Traffic signals are traffic control devices positioned at road intersections, pedestrian crossings, and other locations to control competing flows of traffic. Traffic signals alternate the right of way accorded to all road users by displaying lights of standard colors that are defined in the *British Columbia Motor Vehicle Act*. In addition to information about traffic signals, this section also includes pedestrian / cyclist signals and Rectangular Rapid Flashing Beacons that are focused on safe pedestrian and cyclist movements.

The principal purpose of traffic signals is to enhance the safety of vehicular traffic, cyclists, and pedestrians. They are also important to increase intersection capacity. The City is committed to accessible pedestrian signals and signals that accommodate cyclists; designs shall take this into account.

The key elements of traffic signals are sensors to detect vehicles, pushbuttons to sense pedestrians and/or cyclists, displays (signal heads) to indicate stop and go and a control device referred to as a controller. Other elements include poles, concrete bases, conduit, wiring, signages, cameras, and an electrical service.

This section outlines the design requirements for all traffic signal components, including signal heads, poles, vehicle detection, conduit, junction boxes, kiosks, and other components that make up traffic signals and intelligent transportation systems in the City of Vancouver.

10.6.1 POLES AND POLE MOUNTED DEVICES

Signal poles are defined in the *City of Vancouver Standard Detail Drawings* and the *City of Vancouver Construction Specifications*. Traffic signal poles and anchor bolts shall be designed to accommodate the weight and length of the arms and the items mounted on the poles as well as wind and ice loading. Pole type shall be determined based on pole design criteria and with the objective to minimize the overall number of poles located on any corner. The designer shall provide the pole design criteria in the electrical drawings for the City's approval. Pole loading shall be confirmed from a City-approved pole supplier's structural engineer and submitted to the City. The City no longer allows cable spans to support signal heads. All cable spans must be replaced with signal poles and arms, except for temporary signals.

Trolley or custom poles shall have upper (at signal arm) and lower (above base plate) hand-holes; for trolley poles, both shall be large size. Handholes shall be placed against the flow of traffic or facing the sidewalk.

Where existing trolley poles will be used for signals, a clamp-on mast arm adapter for signal and luminaire arms shall be used and shall be designed to meet the City and Coast Mountain Bus Company standards. CMBC must be informed and will approve any proposed attachment on existing trolley poles. Generally, CMBC is responsible for supplying and installing all trolley poles. Refer to the *City of Vancouver Standard Detail Drawings E4.26A* and *E4.26B* for luminaire arm details. Signal heads, equipment and signs that will be attached to the adapter must be approved by the pole supplier's structural engineer based on pole, anchor bolt, and foundation capacity. These adaptors shall be designed by a structural engineer and shall meet the approval of CMBC. Pole bases should be installed parallel to the curb, refer to the *City of Vancouver Standard Detail Drawings* E5.19. City discretion remains to approve designs that don't align with the guideline.

The designer shall include custom signal and trolley pole shop drawings complete with pole design criteria, signed and sealed by the supplier's professional engineer registered with EGBC.

Poles shall be provided with a powder coat finish. It is the designer's responsibility to confirm the colour by RAL number with the City.

10.6.1.1 POLE PLACEMENT

Poles shall be located at the outer edges behind the curb and gutter or edge of pavement to accommodate accessible pedestrian signal requirements and to provide the required access for pedestrians of all abilities. Refer to the *TAC Accessible Pedestrian Signals Guidelines*.

Street or signal poles are typically located 760mm from the centre of the pole to the face of the curb except for CMBC poles which shall typically be located immediately behind the curb. However, they can be offset further away from the curb if required. One benefit of locating the poles further from the curb is better accommodation of truck turning. Poles shall be located to accommodate intersections, property corners, and pedestrian walkways. Locate poles at curb returns and clear of driveways and wheelchair ramps. Cyclist poles are typically located 510mm from the center of pole to the face of curb (refer to *City of Vancouver Standard Detail Drawings E5.19)*. Trolley poles should be located in coordination with CMBC.

Poles shall meet the clearance requirements in *Sections 2.2.5* and *0* and *Section 7.2.8.1*.

Signal poles should be placed as shown in the *City of Vancouver Standard Detail Drawings E7.20*. Intersections shall have a signal pole and a signal post or luminaire with signal heads at the curb return.

Pole arms should be oriented at 90° to the centre-line of the road, except where the intersection is skewed. When laying out a skewed intersection, the signal arms should typically be parallel with the approach stop bar, so the signal arms do not block the view of the signal heads for other approaches. City remains discretion to approve designs that do not align with the guideline.

Key considerations for pole placement are:

- Ease of access to pushbuttons for all pedestrians, including those with disabilities
- Maintaining wheelchair access around poles and from pushbuttons to wheelchair ramps
- Locating poles outside vehicle turning radiuses to avoid damage
- Underground and overhead utility conflicts
- Visibility of vehicle and pedestrian heads

- Access to cyclist pushbutton without dismounting the bicycle

10.6.1.2 SIGNAL HEADS

Signal heads must be visible to vehicles, pedestrians, and cyclists; therefore, proper signal head placement is essential. Major factors to consider in assessing signal head visibility are road geometry, design speed, spacing between vehicles, and the horizontal and vertical signal head locations.

All signal displays are to be LED.

General locations of signal heads are as follows:

- Primary: Mounted over the roadway that a vehicle is to enter.
- Secondary: Mounted to the left and right side of the roadway that a vehicle is to enter.
- Tertiary: Mounted to the right of the primary head or other location to enhance visibility. Contact the City to define specific needs and requirements.
- Pedestrian: Mounted on the far side of the intersection in line with the painted crosswalk.
- Bicycle: Mounted on the near side and far side of the intersection where the cyclist is to enter and depart the intersection. Contact the City to define specific needs and requirements.

All primary and tertiary signal heads have yellow backboards to improve signal head visibility. A 75mm fluorescent yellow retro-reflective tape border (ASTM Type 9 or higher sheeting) on the outside edge of the entire backboard is also required to further increase signal visibility.

Signal visibility distance is defined as the distance in advance of the stop line from which a signal must be continuously visible for approach speeds varying between 40 and 80km/h. Visibility distance guidelines are shown in ***Table 10-4***.

Table 10-4: Signal Head Visibility Distance Guidelines

Design Speed (km/h)	Minimum Visibility (m)	Desirable Visibility (m)	Add for % Downgrade (m)		Subtract for % Upgrade (m)	
			5%	10%	5%	10%
40	65	100	3	6	3	5
50	85	125	5	9	3	6
60	105	160	7	16	5	9
70	130	195	11	23	8	13
80	160	235	15	37	11	20

Notes:
1) Source *MUTCD Section B3.4 Table B3-2.*

Visibility of a signal head is influenced by multiple factors:

- Vertical, horizontal, and longitudinal position of the signal head
- Height of driver's eye
- Windshield area
- Overhead trolley wires
- Trees and other obstructions

Lateral vision is considered to be excellent within 5° of either side of the centre-line of the eye position (10° cone) and adequate within 20° (40° cone). Horizontal signal position as defined in the *MUTCD Section B3.4.1* and *Figure B3-6* shall be as follows:

- Primary heads within the 10° cone for each approach lane.
- Secondary heads within the 40° cone for each approach lane.
- Where the 40° cone of vision cannot be met for a far-left side secondary head and there is only one primary head or where there are protected left turn signals, an additional right side mounted tertiary head will be required.

Vertical vision is limited by the top of the windshield. Signal heads should be placed within a 15° vertical sight line as defined in the *MUTCD Section B3.4.1* and *Figure B3-6*. Overhead signals should be located a minimum of 15m beyond the stop line. For any further information on signal head visibility refer to the *MUTCD Part B*.

The effectiveness of flashing signals is influenced by flash rates. Recommended rates are:

- Red and amber signals: 60 flashes per minute.
- Arrows: 120 flashes per minute.
- Red-hand: 60 flashes per minute.

The ON and OFF flash periods should be equal.

Visors are required on all signal heads. Cowl-type visors are standard, except in the following cases, where tunnel visors should be considered:

- Fully protected left-turn signal heads.
- At skewed intersections, where the signal heads may be viewed from other approaches.

Signal head sizes are shown in ***Table 10-5***:

Table 10-5: Signal Displays

Signal Head Type	Display Colour, Size, and Shape
Primary	300mm R-Y-G round with backboard 300mm Y-G bimodal arrow or 300mm G Arrow
Secondary	200mm R-Y-G round 300mm Y-G bimodal arrow or 300mm G Arrow
Tertiary	300mm R-Y-G round with backboard 300mm Y-G bimodal arrow or 300mm G Arrow
Pedestrian	450 x 400mm walk / don't walk indication with countdown timer

Signal mounting heights and mounting are as follows:

- Primary - Mounted with adjustable bracket on signal arm 5.0m to 6.0m from bottom of backboard to roadway.
- Tertiary - Mounted on signal pole shaft 4.8m from bottom of backboard to roadway.
- Secondary - Mounted on signal pole shaft 3.2m from bottom of head to sidewalk.
- Pedestrian - Mounted on pole shaft 2.4m from bottom of head to sidewalk.
- Bicycle – Mounted on signal pole shaft or on signal post 3.2m from bottom of head to sidewalk (where signal heads conflict, the bike head should be below the secondary head).

As per the *British Columbia Motor Vehicle Act*, each approach to an intersection requires a minimum of one primary and one secondary signal head. The City requires two secondary heads where possible to improve visibility.

The general City standard is protected / permissive for left turn signals. The use of protected only left turns is defined in *Section 10.5.2.2* and must be approved by the City.

A right turn overlap phase requires the right-side secondary head to be a 4 lens head. The primary head is not impacted by the overlap.

General signal head placement is defined in ***Table 10-6*** and ***Table 10-7*** and visualized in ***Figure 10-6***.

Signal heads should not be placed above a lane (or a lane line adjacent to a lane) that has part time or full time parking.

The cone of vision of the signal heads should always be checked. The details in the tables are the ideal situations, but it should be understood that engineering judgement is required.

Table 10-6: Signal Head Placement for Straight Through Lanes

No. of Travel Lanes	No. of Primary Heads	Placement of Primary Heads
One	One	Centred over through lane.
Two	One	Centered over leftmost through lane
Three	Two	Centered over each lane line with the exception of where a protected / permissive left turn display is required then that head shall be positioned as noted below or with the exception of curbside parking/bus lane (see note above)

Table 10-7: Signal Head Placement for Left Turn Lanes

Left Turn Type	Primary Head Type	Placement of Primary Heads
Protected / Permissive Left Turn	4 Sections with Flashing Green Arrow and Steady Yellow Arrow	Located over leftmost through lane (1/4 lane width from the left); however, signal head may need to be moved left within the lane to meet the cone of vision requirements.
Protected - Single Left/Right Turn Lane	3 Sections with Steady Green Arrow	Centred on the left/right turn lane, either pole mounted in the median or signal-arm mounted. Signal arm mounted is preferred.

Left Turn Type	Primary Head Type	Placement of Primary Heads
Protected - Dual Left Turn/Right Lanes	3 Sections with Steady Green Arrow	Centered between the turn lanes, (one signal head) either pole mounted in the median or signal-arm mounted. Signal arm mounted is preferred.

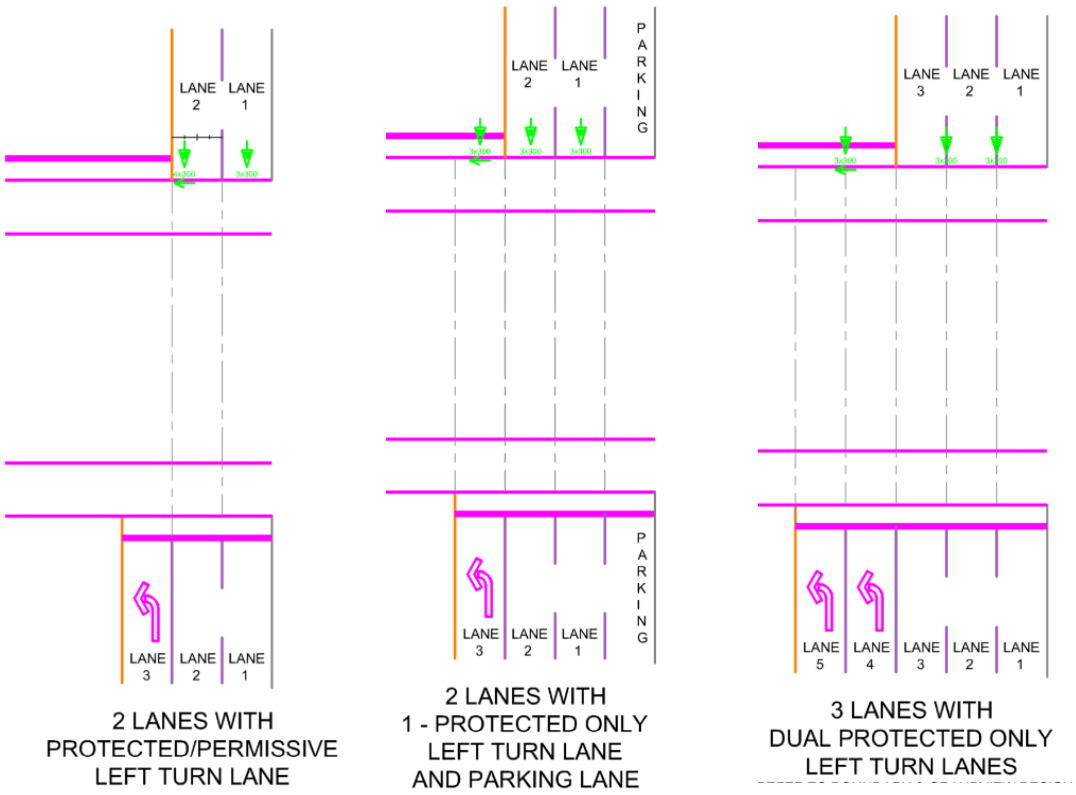


Figure 10-6: Examples of signal head placement

Signal head placement will also be determined by traffic signal phasing. Prior to starting a design, review of signal head locations and phasing must be approved by the Traffic & Data Management Branch.

10.6.1.3 PEDESTRIAN AND CYCLIST PUSHBUTTONS

Pushbuttons shall be located to accommodate pedestrians and shall be fully accessible. Pedestrian pushbutton placement shall meet the *TAC Accessible Pedestrian Signals Guidelines* (also see section 10.6.1.4).

Refer to the *MMCD* and *City of Vancouver Standard Detail Drawings* for details of a pushbutton sign unit. The designer shall indicate left, right, and bi-directional arrows to suit. Pushbutton mounting heights are as follows:

- Ped Pushbutton (standalone) - 1.07m from the centre of the pushbutton to pedestrian refuge grade.
- Cyclist Pushbutton (standalone) - 1.07m from the centre of the pushbutton to the cyclist grade.

- Combined Pedestrian Cyclist Pushbutton – 1.07m from the centre of the pushbutton to sidewalk (pedestrian refuge at protected intersection) grade.

Cyclist pushbuttons or another detection system shall be provided at or in advance of the traffic signal. Cyclist push buttons shall be installed on a pole located at the end of the curb radius or where a cyclist does not have to dismount to push the button (refer to *City of Vancouver Standard Detail Drawings E5.19* for offsets). An example of a cyclist pushbutton is shown in ***Figure 10-7***.

Where a heavy volume of cyclists is present or where a pushbutton can't be provided in an accessible location, consider using a suitable detection system for cyclists (i.e. micro-radar, camera, or loops). Consult the City for details of cyclist detection systems.



Figure 10-7: Cyclist Pushbutton

10.6.1.4 AUDIBLES / ACCESSIBLE PEDESTRIAN SIGNALS

Accessible Pedestrian Signals (APS) or Audibles are installed to improve signalize crosswalk safety for blind and low-vision pedestrians. APS units are the push button unit (*City of Vancouver Standard Detail Drawings E6.4* and *E6.5) and* Audible units are mounted above the pedestrians on the pedestrian signal (*City of Vancouver Standard Detail Drawings E5.12*). APS is the standard but, where not possible, audibles can be considered.

They are both interconnected with the walk signal and produces a "Cuckoo" or "Chirp" sound, depending on the direction of crossing. The "Cuckoo" sound is used for north-south walk direction crossings and the "Chirp" is used for east-west walk direction crossings. Where the streets are not oriented north-south and east-west, maintain consistency with adjacent signals.

APS shall follow the guidelines defined in the *TAC Pedestrian Crossing Control Guide*, Section B5.3.2 of the *MUTCD*, and Section 4.13 in the *City of Vancouver Traffic Signal Timing Guidelines*.

In general, the City aims to install APS or audibles at all intersections, but the selected unit (if any) depends on factors including infrastructure feasibility (pole placement, wiring etc.) and community needs.

The use of audible signals or APS shall be approved by the City prior to design. Audibles are located on signal poles as per the *City of Vancouver Standard Detail Drawings E5.12*. APS installations should follow *City of Vancouver Standard Detail Drawings E6.4 & E6.5*. Refer to City of Vancouver Approved Products List for latest approved models of audible speakers and APS units.

10.6.1.5 PEDESTRIAN / CYCLIST CROSSING CONTROL

Signalized crossing control can be via flashing beacon, full traffic signals, or pedestrian traffic signals (referred to in the *TAC Pedestrian Crossing Control Guide* as half signals). A decision support tool has been developed internally and consists of a preliminary assessment to identify whether a location is a candidate for pedestrian crossing control and treatment selection. The Traffic & Data Management Branch will determine the type of crossing control required using the tool at the outset of a project.

A pedestrian/cyclist signal is a traffic signal with signal heads placed on the main street only. Minor street traffic is controlled by stop signs. The pedestrian/cyclist signal rests in flashing green. Once the pedestrian or cyclist pushbutton is pressed and the minimum flashing green time is exceeded, the yellow and red clearance interval is displayed, and the pedestrian phase is serviced. The signal then returns to flashing green.

The type and use of pedestrian signals shall be confirmed with the City. Generally Rectangular Rapid Flashing Beacons are used on collectors or secondary arterials with two lanes of travel. Full signals and pedestrian/cyclist signals are the case of multi-lane arterials and will be informed by the results of a crossing study undertaken to determine whether flashing beacons or a signal warranted. Warrants are based on pedestrian/cyclist crossing volumes, number of vehicle travel lanes, traffic volumes, speed limits, among other factors. An example of a typical flashing beacon installation is shown in ***Figure 10-8***.



Figure 10-8: Rectangular Rapid Flash Beacons

10.6.1.6 SIGNS AND OTHER DEVICES

Street name signs shall be located on signal pole arms between signal heads as shown on ***Figure 10-9*** and ***Figure 10-10***. When trolley running lines (straight and turn lines) are in between the two primary heads, an alternative location for street name blade sign installation is close to the pole shaft for easier installation and maintenance. Other regulatory signs mounted on signal poles may include turn-restriction signs, lane-use signs, one-way signs, transit signals, firehall signals, and cyclist signals (display), as defined by the *British Columbia Motor Vehicle Act* and the *MUTCD*. Signs shall be mounted with sign mounting brackets defined on the City's approved products list (can be obtained by requesting from the City). Railway crossing blank-out signs may be required where the signal is in close proximity to a railway and a turning movement is restricted to periods during railway pre-emption. Signs shall be located to provide good visibility to the driver, with regulatory signs located directly beside signal heads to aid in driver comprehension. The designer shall show all signs on the elevation view of the design drawings



Figure 10-9: Sign Location Example 1



Figure 10-10: Sign Location Example 2

The designer shall confirm with the City the requirements for pedestrian, cyclist, and vehicle count stations with the use of varying technology, for example inductive loops, roadway sensors, above ground detection technology, and cameras. These may all be required as part of a standard signal design and the data may be collected and transmitted via the City's Traffic Signal Management System.

Traffic cameras, radios, and antennas may also be required on signal pole arms. Radios and antennas would have a similar mount. These devices shall be mounted to provide the required view in the case of cameras and line-of-sight to the next device in the case of antennas and radios. The designer shall define the locations of these devices on the design drawings. The City may require cameras to be included as part of the signal design at all major intersections (see Section 10.6.1.9). The designer shall confirm the requirements for cameras with the City.

All devices mounted on signal arms shall be safety-cabled or chained to the signal arm. Street name signs shall have two safety cables and regulatory signs shall have one safety cable.

10.6.1.7 ADVANCED WARNING FLASHERS

Advanced warning flashers and signs (***Figure 10-11***) may be considered where sight distance to an intersection is less than optimal or where design speed of the road is sufficiently high to justify warning motorists of signal status. Refer to the *BC MoTI Electrical and Traffic Engineering Manual*

for warrant, design, and placement of advanced warning flashers.



Figure 10-11: Advanced Warning Flashers and Sign

10.6.1.8 CONCRETE BASES

For concrete base requirements, see *Section 10.4.1.3*.

10.6.1.9 CAMERAS

Traffic cameras should be considered for installation on arterial roadways to provide an effective means to monitor traffic and weather conditions. The designer will specify which camera model is preferred and acceptable based on hardware requirements and model availability. Refer to *City of Vancouver Standard Detail Drawings City of Vancouver Standard Detail Drawings E7.22*.

10.6.2 CONDUIT

All conduits shall be shown on the electrical drawings. Power conduits shall be grey RPVC as per *CAN/CSA C22.2 No. 211.2 Rigid PVC (Unplasticized) Conduit* for power cabling. Communications conduits shall be RPVC (orange) for 103mm conduits and DB2(orange) for any smaller diameters. The designer shall review and meet requirements listed in *Chapter 7:*Third-Party UtilitiesThird-Party Utilities.

All empty conduits shall have a 6.0mm nylon pull string installed and capped ends.

General conduit locations, number, type and size for signalized intersections are shown in the *City of Vancouver Standard Detail Drawings E7.20, E7.21 and G4.7*. The minimum traffic signal and communications conduits at signalized intersections shall be as follows:

- Conduits around the intersection as per the *City of Vancouver Standard Detail Drawings E7.20*.
- Conduits from the junction boxes to each pole base as per the *City of Vancouver Standard Detail Drawings E7.20*.
- Interconnect conduits as per the *City of Vancouver Standard Detail Drawings E7.20*.
- Conduit to other devices shall be determined depending on specified wiring requirements.

The required number of conduits shall be as per *City of Vancouver Standard Detail Drawings G4.7* and must be provided across minimum three of four legs of the intersection with the traffic controller located at centre of load.

Refer to *Section 10.4.4* for electrical service installations details.

Conduit alignments shall be designed to avoid tree roots and tree protection zones as outlined by the City Arborist. Conduits shall be located to meet standard clearances to existing and other utilities.

The designer shall prepare trench cross-section drawings for all scenarios. The drawings shall show conduits in the trench along with other conduits and utilities as per the *City of Vancouver Standard Detail Drawings,* specifically *G4.7*, which outlines the required minimum number of conduits in low-density and high-density areas.

Refer to *Section 10.4.2* for additional conduit installation requirements.

10.6.2.1 SIGNAL WIRING

Signal wiring shall be via a 25 conductor signal cable that shall run from the controller to one of the traffic signal junction boxes in each corner. Separate cables shall be pulled from the controller to each corner. Signal cable colour coding is defined in the *City of Vancouver Standard Detail Drawings E7.13*. Individual No. 14 AWG RW90 conductors shall be run from the traffic signal junction box to the pole lower handhole, and then to the signal equipment. Individual No. 10 AWG RWU90 conductors with a 5 amp in-line fuse shall run from the junction box to the luminaire. Conductors shall be spliced in the junction boxes or at the lower pole hand holes. All field wires inside the UPS battery box shall be coiled and have a minimum of 3.0m slack. All field wires inside the junction box shall have a minimum of 1.0m slack. All field wires inside the pole hand hole shall have a minimum of 0.3m lead wire for splicing.

Each pair of detector loops shall be fed with an outdoor-rated No. 20 AWG shielded cable.

Antennas, radios, and traffic cameras shall typically be fed with fibre and then outdoor rated coax or CAT 6 cable to the device. All wiring shall be labelled and secured to the cable support in the junction boxes. Signal and communications wiring shall be installed and tagged by the installer.

10.6.3 VEHICLE DETECTION AND DATA COLLECTION

For general information and further background on vehicle detection systems, refer to the *ITE Traffic Detector Handbook*.

Detection locations and details shall be as per the *City of Vancouver Standard Detail Drawings E8.7 and E8.12*. Where protected / permissive left turns are proposed, queue detection is required.

Vehicle detection in the City of Vancouver mainly consists of radar detection (refer to the approved products list) and in-ground inductive loops. Intersection vehicle detection shall consider an above ground detection technology first; all damaged loops impacted by the construction shall be replaced by above ground technology where feasible (in ground detection will be approved by the City on a case-by-case basis). For arterial intersections, including along truck routes, in-ground loops are not preferred due to frequency of damage. Alternative technologies including infrared, magnetic induction or camera-based detection may be considered. Technology used for detection shall be confirmed by the Traffic & Data Management Branch and Traffic Signal Shop. The installation of radar detection may require the installation of a traffic camera. Refer to the *City of Vancouver Standard Detail Drawings E8.14*.

In addition to intersection vehicle detection, system detector loops for data collection may be required on the far side of each intersection approach to collect traffic volume, speed, and classification data.

Confirm the requirements, type and location of detection with the Traffic & Data Management Branch and Traffic Signal Shop.

10.6.4 JUNCTION BOXES AND VAULTS

Junction boxes and vaults shall be shown on the drawings to scale. They shall be used where required to connect conduits where the conduits will run in multiple directions or to terminate conduit runs. Junction boxes shall be located outside of driving surfaces, driveways, wheelchair ramp areas and, where possible, outside of walking areas (sidewalks) and cycle paths; this includes avoiding placing them between pedestrian ramps and traffic signal poles to ensure accessibility to current or future push buttons. Placement of junction boxes and vaults shall be coordinated with landscape, streetscape designs, Green Rainwater Infrastructure Implementation Branch and the City Engineer. Junction boxes and vaults shall also be accessible with a workable space around. Junction boxes shall be used as follows:

- Type 3 - Typically used for street lighting, on end conduit runs for detector loop feeds, and bicycle counter equipment.
- Type 4 - Typically used for signals depending on number of conduits (seven or less) entering and leaving the box.

- Type 5 - Typically used for signal and or communications at corners of intersections as shown in the *City of Vancouver Standard Detail Drawings E7.20* or when the box exceeds seven conduits.
- Type 6 - Typically used near electrical cabinets/kiosks, traffic signal controllers and as pull boxes for communication ducts between 243 vaults.
- Type 243 – Typically used for communications straights runs.
- Type 1.5 – Typically used for communications T-runs.

The various types of junction boxes available are listed in the ***City of Vancouver Construction Specifications*** and shown on the *City of Vancouver Standard Detail Drawings*. H20 traffic rated junction boxes must be used in vehicular areas. Preferred junction box locations are shown in the *City of Vancouver Standard Detail Drawings E7.20*. Refer to ***Figure 10-12*** for an example of signal wiring in a junction box.

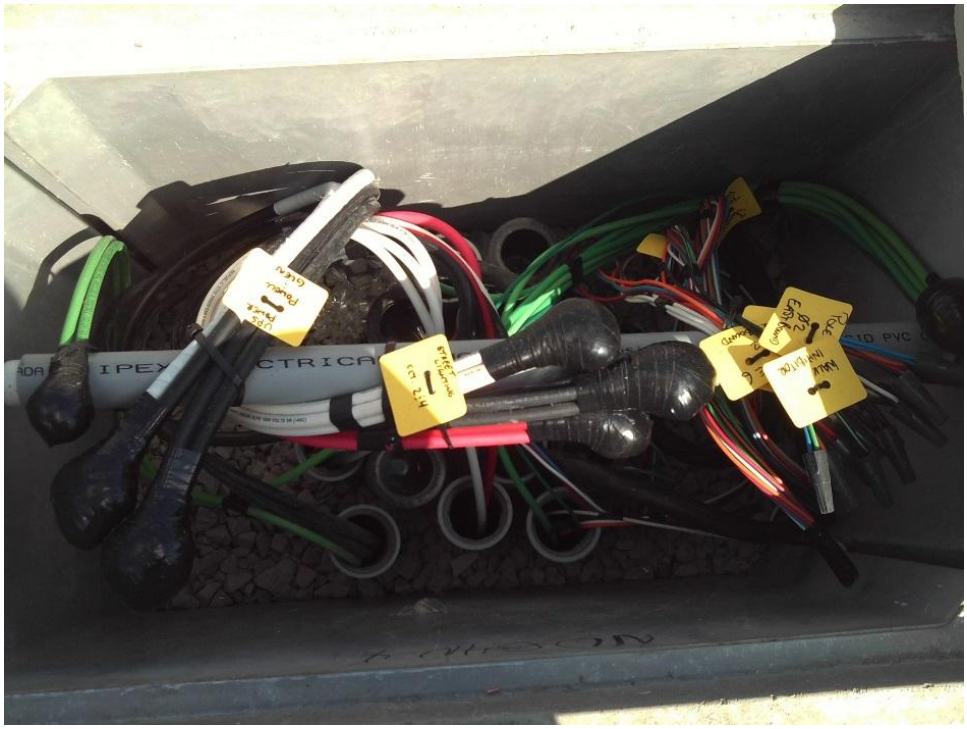


Figure 10-12: Junction Box Signal Wiring Example

Communications vaults are used to connect communications duct banks. Vaults are typically Type 243 as shown in ***Figure 10-13***. Vault placement and type are also specified in the *City of Vancouver Standard Detail Drawings E7.20 and E7.21*.



Figure 10-13: Communications Vault

10.6.5 COMMUNICATIONS SYSTEM

The design shall provide a complete communications system design including conduit, vaults, and fibre / copper cables / wireless which shall connect to and integrate with the City signal communications and CCTV system.

Communications ducting, vaults, and junction boxes are always required at new signals and may also be required at existing signals where ducting does not exist. A general communications ducting system layout is defined in the *City of Vancouver Standard Detail Drawings E7.21*. The communications ducting shall be installed in a common trench with signal and lighting and shall be detailed on those drawings. Communications conduit must use sweeping bends to avoid damage to the cables during installation. Conduits shall enter the junction boxes horizontally and parallel to the long side of the No. 5 and No. 6 junction boxes. 90-degree bends in the junction boxes are not allowed, and conduit entering the junction boxes shall have bell ends.

It is the responsibility of the designer to coordinate and design the communications connectivity to the City's Traffic Signal Management System. Assigned communications circuit numbers shall be reflected in the drawing's title block. The designer shall define cable installation, testing, and commissioning to the point of connection, which may be outside of their project boundaries. The design shall also update the City network diagram drawings.

Modifications or upgrades may be required at the communications connection point to accommodate communications connectivity.

Additional conduit runs are to be included with any required electrical conduit runs for roadway lighting, to provide additional capacity for City needs, such as telecommunications.

At a minimum, install the following communications conduit runs in high-density areas (all arterial and secondary arterials and all downtown areas) as per *City of Vancouver Standard Detail Drawings G4.7*.

At a minimum, install the following communications conduit runs in low-density areas (areas not designated as high-density areas, e.g. local residential roads) as per *City of Vancouver Standard Detail Drawings G4.7*.

10.6.6 TRAFFIC CONTROLLERS

Controller cabinets are available in various sizes and styles depending on equipment requirements. Controller cabinets shall be Type 332 and / or listed in City approved product list. The designer shall confirm the type and colour of controller with the City.

Cabinets should be located downstream of traffic entirely within the City right-of-way, including the standing pad and door swing. The cabinet shall be located:

- To avoid pedestrian desire line.
- Where the signal is fully visible from the cabinet for maintenance personnel.
- Where it does not unduly impact business and residence entrances.
- Where it avoids restricting sight lines.
- Where it is protected from motor vehicle accident damage (e.g. downstream of traffic behind signal pole).
- The front door of the cabinet shall be placed so that the technician is facing the intersection.

Early in the design stage, the designer shall prepare a preliminary electrical drawing identifying the location, dimension, and position of the controller cabinet to scale for the City Engineer to review.

An Uninterruptable Power Supply (UPS) shall be used for all new signals or existing signals where modifications are required. ***Figure 10-14*** shows a controller cabinet with a UPS. The UPS battery enclosure is located between the controller cabinet and the concrete base.

The RAL colour of the controller cabinet and the UPS enclosure shall match those of the signal poles and shall be confirmed with the City.

Traffic controllers, cabinets, and the UPS shall be supplied, installed, set-up, tested, and commissioned by the City's electrical crews. The contractor shall install the concrete base and coil and tag the wiring for the City to perform the connection. Refer to the *City of Vancouver Standard Detail Drawings E1.3* for controller base detail.



Figure 10-14: Type 332 Controller Cabinet with Battery Box

10.6.7 POWER SUPPLY AND DISTRIBUTION

Power is generally supplied by BC Hydro. Refer to *Section 10.4.4* for power supply and distribution criteria. Signal controller shall be supplied by 120 VAC, single phase.

Installation of a bonding wire between the service panel or kiosk and to TS controller cabinet must be continuous system and shall be without joints or splices throughout its length. The only permissible exception is if the drawing notes that an irreversible ground compression connector can be used and applied with a compression tool.