CITY OF KELOWNA

BYLAW NO. 12066

Amendment No. 21 to Subdivision, Development and Servicing Bylaw No. 7900

The Municipal Council of the City of Kelowna, in open meeting assembled, enacts that the City of Kelowna Subdivision, Development and Servicing Bylaw No. 7900 be amended as follows:

1. THAT **SUBDIVISION, DEVELOPMENT AND SERVICING BYLAW NO. 7900 Part 1 – INTRODUCTION – Section 4.1 Definitions** be amended by the following:

   a) adding the definition "Active Transportation Corridor" in it's appropriate location that reads:

   "Active Transportation Corridor" means a corridor reserved for human powered and electric assisted transportation modes such as walking or bicycling, amongst other modes, as defined in the current version of the City of Kelowna Pedestrian and Bicycle Mater Plan. An Active Transportation Corridor, or ATC, may exist along a Highway right-of-way or it may exist along other public land such as but not limited to, the Okanagan Rail Trail or Mission Creek Greenway";

   b) deleting the definition for "Certificate of Substantial Performance" that reads:

   "Certificate of Substantial Performance" means a certificate issued by the Consulting Engineer in accordance with Section 9.5 of this bylaw, certifying that Substantial Performance of all of the Works and Services has been achieved."

   And replacing it with:

   "Certificate of Substantial Performance" means a certificate issued by the Consulting Engineer in accordance with Section 9.5 of this bylaw, **verified by the City Engineer,** certifying that Substantial Performance of all of the Works and Services has been achieved";

   c) deleting the definition for "Certificate of Total Performance" that reads:

   "Certificate of Total Performance" means a certificate issued by the Consulting Engineer in accordance with Section 10.2 of this bylaw, certifying that Total Performance of all of the Works and Services has been achieved."

   And replacing it with:

   "Certificate of Total Performance" means a certificate issued by the Consulting Engineer in accordance with Section 10.2 of this bylaw, **verified by the City Engineer,** certifying that Total Performance of all of the Works and Services has been achieved.";

   d) deleting the definition for "Fees" that reads:

   "Fees" means those fees payable to the City in connection with the Subdivision or Development of land, as prescribed by the City of Kelowna Development Fees Application Bylaw No. 8034."

And replacing it with:

"Fees" means those fees payable to the City in connection with the Subdivision or Development of land, as prescribed by the current version of the City of Kelowna Development Fees Application Bylaw.";

e) deleting the definition for "General Conditions" that reads:

"General Conditions" means the following general conditions contained in Volume II of the Master Municipal Construction Document published by the Master Municipal Construction Documents Association, 1996, as may be amended from time to time, and referred to in the Specifications and Standard Detail Drawings: GC 4.2 (Safety), GC 4.3 (Protection of Work, Property and Public), GC 4.4 (Temporary Structure and Facilities), GC 4.12 (Inspections), and GC 20 (Laws, Notices, Permits and Fees).

And replacing it with:

"General Conditions" means the following general conditions contained in Volume II of the Master Municipal Construction Document published by the Master Municipal Construction Documents Association, 2009, as may be amended from time to time, and referred to in the Specifications and Standard Detail Drawings located in Schedule 5";

f) deleting the definition for "Highways" that reads:

"Highway" includes a street, road, lane, bridge, viaduct, walkway and any other way open to public use, but does not include an easement on private property.

And replacing it with:

"Highway" includes a street, road, lane, bridge, viaduct, walkway, active transportation corridor and any other way open to public use, but does not include an easement on private property.";

g) deleting the definition for "Highway Reservation Agreement" that reads:

"Highway Reservation Agreement" means an agreement between the Owner and the City, in the form prescribed by the City, as referred to in Section 526 of the *Local Government Act*."

And replacing it with:

"Highway Reservation Agreement" means an agreement between the Owner and the City, in the form prescribed by the City, as referred to in Section 513 of the *Local Government Act*.";

h) deleting the definition for "Latecomer Agreement" that reads:

"Latecomer Agreement" means an agreement between the Owner and the City, in the form prescribed by the City, as referred to in Section 939 of the *Local Government Act*."

And replacing it with:

"Latecomer Agreement" means an agreement between the Owner and the City, in the form prescribed by the City, as referred to in Section 508 of the *Local Government Act*.";

i) deleting the definition for "Maintenance Period (c)" that reads:

"(c) with respect to Works and Services that appear to be incomplete, defective or deficient during the Maintenance Period referred to in either (a) or (b) above, the period of one

year from the date on which such Works and Services are completed or corrected in accordance with Section 10.3"

And replacing it with:

"(c) with respect to Works and Services that appear to be incomplete, defective or deficient during the Maintenance Period referred to in either (a) or (b) above, the period of one year from the date on which such Works and Services are completed or corrected in accordance with Section 10.3

Notwithstanding, the Maintenance Period does not expire until the City has been contacted and conducts a final inspection of the Works";

j) deleting the definition for "OCP" that reads:

"OCP" means the City of Kelowna Official Community Plan (1994 – 2013) Bylaw No. 7600."

And replacing it with:

"OCP" means the current version of the City of Kelowna Official Community Plan Bylaw";

k) deleting the definition for "Specifications and Standard Detail Drawings" that reads:

"Specifications and Standard Detail Drawings" means the specifications and standard detail drawings for Works and Services prescribed by Volume II of the Master Municipal Construction Document, and the General Conditions referred to therein, published by the Master Municipal Construction Documents Association, 1996, attached as Schedule 6 hereto and as further amended or supplemented by City of Kelowna Construction Standards attached as Schedule 5 hereto.

And replacing it with:

"Specifications and Standard Detail Drawings" means the specifications and standard detail drawings for construction of Works and Services, located in Schedule 5 of this bylaw.";

l) deleting the definition for "Statutory Right-of-Way Agreement" that reads:

"Statutory Right-of-Way Agreement" means an agreement between the Owner and the City, in the form prescribed by the City, as referred to in Part 14 of the *Land Title Act*."

And replacing it with:

"Statutory Right-of-Way Agreement" means an agreement between the Owner and the City, in the form prescribed by the City, as referred to in Part 7, Division 11 of the *Land Title Act."*;

m) deleting the definition for "Substantial Performance" that reads:

"Substantial Performance" means the stage of completion of all of the Works and Services when:

(a) the Works and Services are ready to be used for their intended purpose, as certified by the Consulting Engineer; and

(b) the total of the incomplete, defective and deficient Works and Services can be completed at a cost, as estimated by the Consulting Engineer and verified by the City Engineer, of no more than 3% of the total cost of the Works and Services."

And replacing it with:

"Substantial Performance" means the stage of completion when:

All Works and Services, as certified by the Consulting Engineer, and verified and inspected by the City Engineer, is capable of completion or correction at a cost of not more than:

(a) 3% of the first $500,000 of the Works and Services;

(b) 2% of the next $500,000 of the Works and Services; and

(c) 1% of the balance of the Works and Services; and

the Works and Services, or a substantial part of it, is ready for use or is being used for the purpose intended";

n) deleting the definition for "Works and Services" that reads:

"Works and Services" includes Highways, sidewalks, boulevards, boulevard crossings, transit bays, street lighting, wiring, water distribution systems, fire hydrant systems, sewage collection and disposal systems, drainage collection and disposal systems and such other infrastructure or systems as may be provided within the City from time to time."

And replacing it with:

"Works and Services" includes Highways, sidewalks, boulevards, boulevard crossings, transit bays, street lighting, wiring, water distribution systems, fire hydrant systems, sewage collection and disposal systems, drainage collection and disposal systems and such other infrastructure or systems as may be provided within the City from time to time";

2. AND THAT **SUBDIVISION, DEVELOPMENT AND SERVICING BYLAW NO. 7900 Part5 - OWNER TO PERFORM WORK 9.6 Section Design and Construction Requirements** be amended:

Delete the following:

"As-Built Drawings and Disks. The Owner must provide the City in accordance with Section 9.5, Item (d) with detailed, reproducible as-built drawings of the Works and Services, sealed by the Consulting Engineer, and City compatible computer disks, as Constructed as of the date of Substantial Performance."

And replace with:

"As-Built/Record Drawings and Electronic Information. The Owner must provide the City in accordance with Section 9.5, Item (d) and Policy 265 (Engineering Drawing Submission Requirements), with detailed, reproducible as-built drawings of the Works and Services, sealed by the Consulting Engineer, and City compatible electronic information, as Constructed as of the date of Substantial Performance.;"

3. AND THAT **SCHEDULE 1 – WORKS & SERVICES REQUIREMENTS, WORKS & SERVICES REQUIREMENTS** Table be amended by:

(a) adding the following rows in their appropriate location that reads:

HD1	WTR	SWR	STM	UG	SL	URBAN	N/A	SS – R7	SS – R6
HD2	WTR	SWR	STM	UG	SL	URBAN	N/A	SS-R7	SS-R6
HD3	WTR	SWR	STM	UG	SL	URBAN	N/A	SS-R7	SS-R6
I6	WTR	SWR	STM	UG	SL	URBAN	N/A	SS-R5	SS-R6

(b) deleting text in the Table - ARTERIAL column that reads:

"IN ACCORDANCE WITH 'MAJOR ROAD NETWORK PLAN' CLASSIFICATION"

and replacing it with:

"IN ACCORDANCE WITH 'MAJOR ROAD NETWORK PLAN' CLASSIFICATION (SS-R8 to SS-R16)"

(c) amend Notes by deleting the following:

"(2) Where the collector road is on a bikeway route, as defined by the City's Bikeway Network Plan the road requirement will be based on Drawing Standard SS – R6";

and replacing it with:

"(2) Where the collector road is on a bikeway route, as defined by the City's Bikeway Pedestrian and Bicycle Master Plan or Transportation Master Plan, the road requirement will be based on Drawing Standard SS – R6.";

(d) amend Notes by adding the following in its appropriate location:

"(6) Active Transportation Corridors not located with road right-of-way's, such as but not limited to the Okanagan Rail Trail and Mission Creek Greenway, are transportation corridors requiring frontage improvements";

4. AND THAT **SCHEDULE 3 – QUALITY CONTROL AND ASSURANCE** be amended by adding the following at the end of the first paragraph:

"Professional Engineers shall fulfill their obligations under the Engineers and Geoscientists Act and the Engineers and Geoscientists of British Columbia's Quality Management Guidelines";

5. AND THAT **SCHEDULE 4 – Design Standards** be deleted in its entirety and replaced with Schedule "A" attached to and forming part of this bylaw;

6. AND THAT **SCHEDULE 5 – CONSTRUCTION STANDARDS, 1. CONSTRUCTION SPECIFICATIONS INDEX** be amended by removing the title:

"93 01S – Planting of Tress, Shrubs & Ground Covers"

and replacing it with:

"32 93 01S – Planting of Trees, Shrubs & Ground Covers";

7. AND THAT **SCHEDULE 5 – CONSTRUCTION STANDARDS, 1. CONSTRUCTION SPECIFICATIONS, Soil Cells Section 2.4** be amended by:

(a) removing the title in its entirety and replacing it with

"**Inspector Riser Assembly**";

(b) replacing "Fitings" with "Fittings";

8. AND THAT **SCHEDULE 5 – CONSTRUCTION STANDARDS, 1. CONSTRUCTION SPECIFICATIONS** be amended by replacing all instances of "Personel" with "Personnel";

9. AND THAT **SCHEDULE 5 – CONSTRUCTION STANDARDS, 2. STANDARD DRAWINGS, CITY OF KELOWNA STANDARD DRAWINGS INDEX AND CROSS-REFERENCE TO MMCD** be updated by adding the following in their appropriate location under **STORM AND SANITARY SEWERS**:

Comment	Dwg.	Title
Added	SS-S58	Groundwater Recharge Suitability Map
Added	SS-S59	Typical Lift Station Site Layout
Added	SS-S60	Sanitary Lift Station
Added	SS-S61	Above Ground Valve Kiosk
Added	SS-S62	Pigging Port
Added	SS-S63	Radio Antenna mast and Base

10. AND THAT **SCHEDULE 5 – Drawings – Index for Reference, CITY OF KELOWNA STANDARD DRAWINGS INDEX AND CROSS-REFERENCE TO MMCD** be updated by adding the following in their appropriate location under **STORM AND SANITARY SEWERS**:

Comment	Dwg.	Title
Added	SS-S58	Groundwater Recharge Suitability Map
Added	SS-S59	Typical Lift Station Site Layout
Added	SS-S60	Sanitary Lift Station
Added	SS-S61	Above Ground Valve Kiosk
Added	SS-S62	Pigging Port
Added	SS-S63	Radio Antenna mast and Base

11. AND THAT **SCHEDULE 5 – Drawings - Part 2b – Storm and Sanitary Sewers** be amended by adding a standard detailed drawing for **TYPICAL LIFT STATION LAYOUT SS-S59** as attached to and forming part of this bylaw as Drawing A;

12. AND THAT **SCHEDULE 5 – Drawings - Part 2b – Storm and Sanitary Sewers** be amended by adding a standard detailed drawing for **SANITARY LIFT STATION SS-S60** as attached to and forming part of this bylaw as Drawing B;

13. AND THAT **SCHEDULE 5 – Drawings - Part 2b – Storm and Sanitary Sewers** be amended by adding a standard detailed drawing for **ABOVE GROUND VALVE KIOSK SS-S61** as attached to and forming part of this bylaw as Drawing C;

14. AND THAT **SCHEDULE 5 – Drawings - Part 2b – Storm and Sanitary Sewers** be amended by adding a standard detailed drawing for **PIGGING PORT SS-S62** as attached to and forming part of this bylaw as Drawing D;

15. AND FURTHER THAT **SCHEDULE 5 – Drawings - Part 2b – Storm and Sanitary Sewers** be amended by adding a standard detailed drawing for **RADIO ANTENNA MAST AND BASE SS-S63** as attached to and forming part of this bylaw as Drawing E;

16. This bylaw may be cited for all purposes as "Bylaw No.12066, being Amendment No. 21 to Subdivision, Development and Servicing Bylaw No. 7900."

17. This bylaw shall come into full force and effect and is binding on all persons as and from the date of adoption.

Read a first, second and third time by the Municipal Council this

Adopted by the Municipal Council of the City of Kelowna this

Mayor

City Clerk

SCHEDULE 4

OF BYLAW 7900

CITY OF KELOWNA

DESIGN STANDARDS

0. GENERAL DESIGN CONSIDERATIONS

1. WATER DISTRIBUTION

2. SANITARY SEWER

3. STORMWATER MANAGEMENT

4. HIGHWAY

5. ROADWAY LIGHTING

6. TRAFFIC SIGNALS

7. LANDSCAPE AND IRRIGATION

8. HILLSIDE DEVELOPMENT STREET STANDARDS

GENERAL

This latest update of Schedule 4 of Bylaw 7900 - City of Kelowna Design Standards is based on the Municipal Infrastructure Design Guidelines 2014 as prepared under the auspices of the Master Municipal Construction Document Association (MMCDA), which is an association of British Columbia Municipalities, Regional Districts, Contractors and Consultants. The purpose of the Design Standards is to provide a standardized set of guidelines to be utilized by consultants, contractors and City staff involved with design and construction of municipal infrastructure. Users of this Schedule should note the following:

- These Standards are considered a "living document" and will be updated on a regular basis to reflect evolving industry advancements, new materials, improved methods and best practices.
- The contents of this manual are intended to complement the following documents:
    - MMCD Specifications and Standard Detailed Drawings.
    - City of Kelowna Schedule 5 – Supplementary Specifications and Supplementary Standard Detailed Drawings.
    - Policy 265 (Engineering Drawing Submission Requirements).
    - Policy 266 (Approved Products List).
- Links to other documents have been provided to augment the material included in these Design Standards.

This manual is not intended to be a substitute for sound engineering knowledge and experience. It is the designer's responsibility to exercise professional judgment on technical matters in the best interests of the owners and users of the infrastructure. Standards contained herein are provided to assist in making these judgments, but should not be used as a substitute. Since the standards are general, they do not, and cannot, cover all particular cases.

DISCLAIMER

This manual is not intended to be used as a basis for establishing civil liability.

0.0 General Design Considerations

0.1 General

This latest update of Schedule 4 of Bylaw 7900 - City of Kelowna Design Standards is based on the Municipal Infrastructure Design Guidelines 2014 as prepared under the auspices of the Master Municipal Construction Document Association (MMCDA), which is an association of British Columbia Municipalities, Regional Districts, Contractors and Consultants. The purpose of the Design Standards is to provide a standardized set of guidelines to be utilized by consultants, contractors and City staff involved with design and construction of municipal infrastructure. Users of this Schedule should note the following:

- These Standards are considered a "living document" and will be updated on a regular basis to reflect evolving industry advancements, new materials, improved methods and best practices.
- The contents of this manual are intended to complement the following documents:
    - MMCD Specifications and Standard Detailed Drawings.
    - City of Kelowna Schedule 5 – Supplementary Specifications and Supplementary Standard Detailed Drawings.
    - Policy 265 (Engineering Drawing Submission Requirements).
    - Policy 266 (Approved Products List).

- Links to other documents have been provided to augment the material included in these Design Standards.

This manual is not intended to be a substitute for sound engineering knowledge and experience. It is the designer's responsibility to exercise professional judgment on technical matters in the best interests of the owners and users of the infrastructure. Standards contained herein are provided to assist in making these judgments, but should not be used as a substitute. Since the standards are general, they do not, and cannot, cover all particular cases.

DISCLAIMER

This manual is not intended to be used as a basis for establishing civil liability.

0.2 Sustainability and Asset Management

Development of appropriate design guidelines for municipal infrastructure involves consideration of the principles of sustainability and asset management. These principles include the following:

- Improve and enhance quality of life.
- Minimize negative impacts on health, safety and the environment.
- Investigate the impacts of potential actions to manage and mitigate risk.
- Consistently make informed long-term infrastructure decisions.
- Minimize overall life cycle investment.

Some of the above principles involve conflicting priorities, for example, undue concentration on financial economies may have adverse impacts on environmental protection and life cycle costs of infrastructure.

A balanced approach to design of municipal infrastructure requires careful consideration of all of the above principles.

0.3 Independent Utilities

Independent utilities are those not normally supplied by municipal or regional authorities and are not included in these guidelines. Independent utilities include:

- Electrical power
- Communications (telephone, data, fibre optics and cable)
- Gas

Design of municipal infrastructure must include consideration of the above utilities. Design of these utilities is normally carried out by the utility owner and coordinated for conflicts by the municipal designer and/or the local authority.

In new urban developments, all wiring is generally to be underground as per Policy 101 – Conversion of Overhead Power Lines to Underground Installation. This excludes electrical transmission lines, which are normally located in separate rights-of-way.

0.4 Utility Rights-of-Way

Utility right-of-way locations should be selected to avoid environmentally sensitive areas, such as, watercourses, wetlands, wildlife migration corridors and forested areas, as outlined in the Official Community Plan (OCP).

Where the location of a municipal utility in a right-of-way is approved by the City, the minimum desirable right-of-way widths are as follows:

Table 0.4 Right-of-Way Widths

Service Type	**Right-of-Way Width**
Single service	Twice the depth from surface to the crown of the pipe plus trench width (4.5 m minimum width).
Two services within the same trench	Twice the depth from surface to the crown of the deeper pipe PLUS trench width (5.5 m minimum width).
Two or more services adjacent to one another but in separate trenches	Cumulative widths for single services (noted above) PLUS any difference to provide the required separation (6 m minimum width).
When the service is within a road allowance, and the distance from the property line to the centre of the service is less than one half of the width indicated above for a single service, the difference should be provided as right-of-way on the adjacent property.	
The rights-of-way noted are desirable but in some cases may not be practical and alternative	

combined right-of-way corridors may be required as approved by the City Engineer.

In all cases, the width of rights-of-way should be sufficient to permit an open excavation with side slopes in accordance with the WorkSafeBC Requirements for excavation and trenching safety, without impacting on or endangering adjacent structures.

Where required, sanitary trunk and interceptor sewers should have rights-of-way wide enough for future widening and/or twinning. The width of the right-of-way should be the required separation between pipe centrelines plus 2 times the depth to the crown of the deeper sewer.

The designer should provide cross sections indicating the minimum safe distances to adjacent building footings based on a safe angle of repose from the limits of the excavation.

Where a utility is located within a right-of-way, and valves, valve chambers, manholes, or other appurtenances which require maintenance are located within a right-of-way, maintenance road access from a public road must be provided. The maintenance access must be sufficiently wide and structurally adequate to support the maintenance vehicles for which the access is intended.

0.5 Utility Separation

Requirements for separation of sanitary or storm sewers from water mains are as follows, unless otherwise indicated by Interior Health (IH).

0.5.1 Horizontal Separation

At least three (3) metre horizontal separation (pipe wall to pipe wall) should be maintained between a water main and either a sanitary sewer or a storm sewer.

In special circumstances where 3.0 m separation is not possible, a smaller separation than 3.0 m may be permitted upon approval from Interior Health.

The designer shall obtain Interior Health approval for all water main designs prior to commencement of construction.

0.5.2 Vertical Separation

Where a water main crosses a sanitary sewer or storm sewer, the water main should be above the sewer with a minimum clearance of 0.45 m and installed in accordance with Interior Health requirements.

0.5.3 Sewers in Common Trench

In special circumstances when typical separation cannot be reasonably achieved (i.e. hill side development, rock excavation), storm and sanitary sewers may be installed in a common trench provided that the design has taken into account:

- Interference with service connections,
- Stability of the benched portion of the trench,
- Conflict with manholes and appurtenances.

The horizontal clearance between sewer pipes should be not less than 1.0 m. Separation between manholes should be not less than 0.3 m.

0.6 Trenchless Technologies

Installation or rehabilitation of pipelines using trenchless methods may be indicated. The MMCD Specifications Section 33.05.23 Trenchless Sewer Pipe Bursting; and MMCD Specifications Section 33.05.24 Cured in Place Pipe Liners are two examples of trenchless applications.

Circumstances favouring trenchless installation include:

- Installation or rehabilitation in heavily built-up areas,
- Stream crossings,
- Railway crossings,
- Highway crossings.

Available technologies include the following:

- Slip-lining
- Cured-in-place pipe (CIPP)
- Pipe bursting
- Horizontal directional drilling (HDD)
- Micro-tunnelling
- Pipe jacking

0.7 Seismic and Geo-hazard Design Standards

Underground utilities are at risk of damage caused by seismic events, soil liquefaction and land slides. The most significant seismically-triggered geo-hazard that underground utilities are exposed to is horizontal ground displacement from landslides and soil liquefaction induced lateral ground displacement. Seismic design standards must be considered in seismically active zones with a potential for landslide or soil liquefaction. This becomes even more critical when considering a shared fire flow and potable water distribution system, which, during a severe seismic event, is required to remain functional if it is to be relied upon to provide fire suppression throughout the community.

The design shall consider the stability of the soils present, as well as establishing the site's susceptibility to lateral ground displacement during seismic activity.

This section does not cover seismic design considerations of larger size chambers (typically in excess of 10 m^2 in footprint), pump station structures, storage tanks, reservoirs and similar large components of the water and sanitary systems. These structures, along with seismically resistant pipe connections, shall be individually assessed by civil, geotechnical and structural engineers using the latest edition of BC Building Code and Application of the Seismic Guidelines for Government to meet post-disaster requirements and other specialty seismic standards applicable to buried and above ground structures.

0.8 Referenced Standards

All referenced standards contained within (i.e. AWWA, BC Building Code, Water Supply for Public Fire Protection, etc.) are to be the most recent version unless specifically noted otherwise.

0.9 Record Drawings and Operation and Maintenance Manuals

Record drawings are to be prepared and submitted in accordance with Policy 265 (Engineering Drawing Submission Requirements).

Operation and Maintenance Manuals are to be prepared and submitted for pump stations, lift stations, PRVs, reservoirs, valves, air valves and appurtenances as described below:

Supply two (2) paper copies and one (1) electronic copy of operating and maintenance manuals prior to substantial completion.

Bind contents in a three-ring, hard covered, plastic jacketed binder with the name of the facility to be embossed onto binder cover and spine.

Each section shall be separated from the preceding section with a plasticized cardboard divider with a tab denoting contents of the section.

Contents to include:

- Title sheet, labelled "Operation and Maintenance Instructions", and containing project name and date.
- List of contents.
- Reviewed shop drawings of all equipment.
- Equipment list showing all model and serial numbers.
- All equipment manufacturers manuals.
- Record drawings of all mechanical, electrical, control and alarm installations.
- Full description of system operations including: design points, designed pump and system curves, ultimate capacity, area served and any relevant design criteria relevant to the operation of the system.
- Full description of entire mechanical, electrical and alarm system operation.
- Names, addresses and telephone numbers of all major sub-contractors and suppliers.
- Commissioning report showing pressures, flows, current drawings for all possible operating conditions.

0.10 Kiosks/Laminate Wrapping Requirements

All electrical kiosks to be wrapped with anti graffiti vinyl wrapping. Wrap material shall be a cast vinyl then laminated with a high gloss laminate. The wrap is to be visually pleasing and compliment the area it would be situated in considering the landscape, geography, or general theme of the specific area. Artwork to have a high degree of contrast so as to be more impervious to graffiti vandalism and not to be for commercial advertising. All artwork to be approved before installation.

0.11 Interpretation

If there is any inconsistency or conflict between the provisions of these Design Standards and the Standard Drawings the Design Standards shall govern.

1. WATER DISTRIBUTION

1.1 General
1.2 Metering
1.3 Per Capita Demand
1.4 Non-Residential Demand
1.5 Fire Flows
1.6 Design Flows
1.7 Water Pressure
1.8 Hydraulic Design
1.9 Minimum Pipe Diameter
1.10 Dead Ends
1.11 Minimum Depth of Cover
1.12 Grade
1.13 Corrosion Protection
1.14 Valves
1.15 Hydrants
1.16 Blow Offs and Blow Downs
1.17 Test Points
1.18 Air Valves
1.19 Thrust Restraint
1.20 Chambers
1.21 Service Connections
1.22 Alignments and Corridors
1.23 Reservoirs
1.24 Pump Stations
1.25 Pressure Reducing Valve (PRV) Stations
1.26 Facility Site Requirements

3 General

These guidelines are not intended to be a substitute for sound engineering knowledge and experience. Water distribution system designs should be prepared under the direction of a design professional who has the appropriate experience and is registered with Engineers and Geoscientists British Columbia.

Water for Kelowna is provided by the City of Kelowna Water Utility and three major water purveyors.

- Black Mountain Irrigation District
- Glenmore Ellison Improvement District
- Rutland Water Works

These design standards apply to the City of Kelowna Water Utility and are in general conformance with

the four major water purveyors. The Purveyors requirements may differ in some instances so it is the responsibility of the designer to confirm with the independent water purveyors regarding their specific requirements. The location of water infrastructure within roadways shall be in accordance with these standards.

4 Metering

Water meters tend to reduce per capita water demand and are required as per the City of Kelowna Plumbing Bylaw, Water Use Regulation Bylaw and Water Purveyors bylaw(s).

5 Per Capita Demand

Use the following per capita demands for future residential requirements:

- Average annual daily demand (ADD): 900 litres per capita per day (L/c/d)
- Maximum day demand (MDD): 1800 litres per capita per day
- Peak hour demand (PHD): 4000 litres per capita per day

Design population density:

Single Family	3.0 people/dwelling
Multi-Family	2.0 people/dwelling

6 Non-Residential Demand

Commercial, industrial and institutional demands should be determined using specific data related to the development or zoning. In the absence of such data, or municipal regulations, use the following for maximum day demands for single story buildings (MDD):

Commercial or institutional:	22,500 litres per hectare per day
Industrial:	100,000 litres per hectare per day

Note: the above rates do not include outdoor irrigation and assume that all connections are metered.

BL11913 amended section 1.5

7 Fire Flows

Fire flows are subject to the following minimum requirements (Table 1.5) for all offsite works.

Table 1.5 Minimum Required Fire Flow by Zoning Designation

General Zoning Designation	Minimum Fire Flow*
Single Family &Two Dwelling Residential	60 L/s
Modular / Mobile Home	60 L/s
Three & Four Plex Housing	90 L/s
Apartments, Townhouses	150 L/s
Commercial	150 L/s
Institutional	150 L/s
Industrial	225 L/s

*Off-site fire flow requirements are calculated in accordance with the requirements of the current edition of "Water Supply for Public Fire Protection - A Guide to Recommended Practice", published by Fire Underwriters Survey.

Subdivisions and main extensions must utilize hydraulic information from water model results provided by the City.

Onsite requirements are defined during the Building Permit process:

a) Fire flow requirements for structures are to be calculated based on the worst-case requirement consistent with Section 3.2.5.7 of the BC Building Code.
b) Where a structure design includes an automated sprinkler system to NFPA 13 as per Section 3.2.5.12 of the BC Building Code, then:
    i. The NFPA 13 fire flow result for the worst-case building shall be the fire flow requirement on site.
    ii. Confirmation of meeting the NFPA 13 requirement must be provided to the City.

The Owner or Developer must report to the City that the calculated fire flow does not exceed the minimum requirements for that zoning found in Table 1.5.

8 Design Flows

Unless otherwise indicated by the City Engineer, system design flows should be based on the ultimate population and fully developed non-residential land as anticipated in the Official Community Plan (OCP).

Total design flows (Q_{design}) are to be the greater of the following:

Q_{design} = MDD+FF Maximum Day Demand plus the Fire Flow, or

Q_{design} = PHD Peak Hour Demand

9 Water Pressure

The water system must be designed to provide domestic water at the building main floor elevation on each Parcel as follows:

Maximum allowable static pressure	830 kPa(120 psi)
Minimum static pressure	275 kPa(40 psi)
Minimum system pressure at Peak Hour Demand (PHD)	275 kPa(40 psi)
Minimum pressure in system during design Maximum Day Demand and Fire Flow (MDD+FF)	140 kPa(20 psi)

For large lot and hill side development the designer shall be responsible to identify suitable building elevations for all buildings based on available hydraulic pressure. Determination of pressure limits should include consideration of property elevations relative to street level. Designer to note properties on service cards and record drawings where pressure at service connection exceeds 75 psi.

Where the maximum pressure exceeds 515 kPa (75 psi), design must identify service connections that must be individually protected by pressure reducing valves located in the buildings being served.

10 Hydraulic Design

Where there is an existing hydraulic network in place, the City will provide any available information for assistance in designing changes to the network. Depending on the complexity and extent of the proposed distribution system, the City may require a hydraulic analysis design showing flows and pressures.

Use a proven network analysis computer model based on the Hazen-Williams formula:

$$Q = \frac{CD^{2.63}S^{0.54}}{278{,}780}$$ Where:

Q = Rate of flow in L/s
D = Internal pipe diameter in mm
S = Slope of hydraulic grade line in m/m
C = Roughness coefficient (Table 1.8)

Table 1.8 Roughness Coefficients for Various Pipe Materials

Pipe Material	C Factor
PVC	130

Cement Lined Ductile Iron, Cement Lined Steel, Asbestos Cement	120
Cast Iron	100

It should be noted that the values listed in the above table are for pipe losses only and do not include losses associated with fittings, tees and valves which also require design consideration.

The maximum allowable design velocity shall not exceed the following:

Pump Supply, Reservoirs and Trunk Mains 2.0 m/s

Distribution Lines
- At Peak Hour Demand (PHD) 2.0 m/s
- At Maximum Day Demand (MDD) plus Fire Flow (FF) 4.0 m/s
-

Designers are responsible for assuring that surge and transients pressures are accounted for in their design.

When water mains cross railroads, major regional roads including Provincial highways, or watercourses, a steel casing pipe must be provided and must be designed to all applicable static, dynamic and seismic loadings and all other requirements of the authority having jurisdiction. The water main must be constructed with the appropriate spacers to support the pipe and prevent sagging or uplift (floating) inside the casing pipe. The water main inside the casing must be joint restrained. Service connections crossing highways and railroads are not recommended and require approval from the City Engineer.

11 Minimum Pipe Diameter

Distribution mains: 200 mm*

Fire hydrant connections: 150 mm

Service connections: 19 mm CU / 25 mm PE

Service diameter for buildings with sprinklers to be determined on a case by case basis based on fire flow demand.

* For looped distribution mains with lengths less than 500 m in residential subdivisions, the diameter can be reduced to 150 mm, providing that fire flow requirements can be met.

* Subject to approval of the City Engineer, distribution main minimum diameter in residential areas may be reduced to 100 mm provided that the main terminates in a short residential cul-de-sac, has a length less than 80 m, serves no fire hydrants or fire sprinkler systems and where no further extension is planned.

* In separated water systems where irrigation and fire flow are separated from domestic (potable)

water, the minimum pipe size for the domestic water system may be 100 mm.

For commercial/industrial/institutional areas, the minimum allowable water main size shall be 200 mm diameter.

12 Dead Ends

Water mains must be looped wherever possible. Where dead ends are unavoidable, and approved by the City Engineer, blow-offs shall be provided (see Section 1.16 for sizing).

The maximum length of any permanent non-interconnected water main is 200 m. All mains exceeding 200 m in length, unless it is a temporary situation, must be looped.

Where the water system network is deficient, installation of additional water main capacity may be required and may necessitate the provision of rights-of-way in favour of the City.

13 WD_Minimum_Depth_of_Cover

The cover over any water main must not be less than 1.5 m from pipe crown to surface. U-bends should be used to avoid conflict and maintain minimum depth of cover. Rigid insulation may be used to provide protection to the water main from freezing for short sections of water main (< 4 m) with approval from the City Engineer, as per manufacturer's recommended guidelines for Utility line insulation (ex. DOW Tech Solutions 602.0 Styrofoam Brand Highload Insulation for Buried Utility lines).

14 Grade

Water mains must be designed with a rising grade wherever possible, to minimize high points in the main. Grades should be straight lines between defined deflection points. Elevations should be recorded on record drawings.

The minimum grade of water mains shall be 0.1%. Grading should be designed to minimize the number of high points and maintain continuous grade.

When the slope exceeds 15%, provide anchorage, joint restraints, trench dams and trench drainage as per standard MMCD drawing G8. Provide geotechnical engineering report where appropriate that assesses slope stability.

15 Corrosion Protection

Where there is a potential for encountering corrosive soils, a geotechnical corrosion analysis on the alignment of any proposed metallic water main or metallic appurtenances shall be conducted to determine the corrosiveness of the native soils and the suitability of metallic pipe and appropriate corrosion protection measures. One example is MMCD Specification Section 26 42 13, Cathodic Protection.

Regardless of soil condition, all metallic pipe shall be installed with poly-wrap as per the manufacturers

recommended procedures.

Petrolatum tape and paste shall be used to wrap all nuts and bolts on buried metallic fittings and joint restraint fasteners.

Metallic water main with less than 400 mm diameter are not permitted.

16 Valves

In general, valves should be located as follows:

- In intersections, either in a cluster at the pipe intersection or at projected property lines to avoid conflicts with curbs and sidewalks:
    - 3 valves at "X" intersection;
    - 2 valves at "T" intersection;
    - Or as directed by the City Engineer, in order to allow for the isolation of specific sections of the main, minimize service disruption and/or facilitate network operation and maintenance.
- Not more than 200 m apart (except on trunk mains greater than 300 mm diameter, where spacing can be increased upon approval of the City Engineer). Where possible avoid the use of inline valves.
- In locations and at a frequency so that not more than two hydrants are out of service when a section of the main is turned off. An isolation valve is required for each hydrant, typically flanged to the hydrant tee.
- Not more than 20 service connections isolated.

In order to permit the use of pigging cleaning methods the valve sizing and type selection should be as follows:

- The valves shall be the same diameter as the water main.
- All valves shall be gate valves. Butterfly valves with appropriate chamber sized for maintenance and replacement may be used in special circumstances for water mains greater than 400 mm with approval from the City Engineer.

17 Hydrants

Fire hydrants should be located in general at street intersections and as follows:

- Not more than 150 m apart in single family residential areas measured along road centre line.
- Not more than 100 m apart in higher density residential, commercial, industrial and institutional areas.
- Hydrant locations as per BC Building Code for all buildings.
- In accordance with "Water Supply for Public Fire Protection - A Guide to Recommended Practice" (latest edition), published by Fire Underwriters Survey.

- 1.5 m back from curb or 0.5 m back of sidewalk to centre line of hydrant.
- Minimum 1.0 m clear of any other utility structure in all directions.
- Minimum 3.0 m clear in direct line with hose connections.
- At property lines in mid-block locations.
- SRW required where open cut excavation to base of hydrant assembly extends into private property.
- Bollards or concrete barriers for hydrant protection may be required at the City Engineer's discretion.

Hydrants shall not be located on sidewalks. Where this is not possible and with approval from the City Engineer, a minimum distance of 1.5 m must be maintained between the front of the pumper port and the back of curb, in accordance with the Transportation Association of Canada Manual for Canadian Roads.

On arterial highways with, or designated to be constructed with, a raised median, fire hydrants shall be installed on both sides of the highway with each side treated exclusively for spacing requirements.

18 Blow Offs and Blow Downs

Blow-offs shall be provided at the terminal ends of all water mains whether permanent or temporary to facilitate scouring velocities during flushing. Blow-off sizes are:

- 50 mm dia. for 100 mm dia. water mains (see Drawing SS-W8A)
- 100 mm dia. for 150 mm dia. and larger water mains (see Drawing SS-W8B)

Where practical, and approved by the City Engineer, a hydrant may serve a secondary role as a blow-off.

On all mains greater than 300 mm diameter, install blow downs at the lowest point in the water main profile between the line valves.

19 Test Points

Test points shall be installed on all water mains in order to provide for the ability to collect water samples in accordance with AWWA C651 – Disinfecting Water Mains.

20 Air Valves

Combination air valves shall be installed at the summits of all mains. Air valves may not be required on water mains 200 mm diameter and smaller upon approval by the City Engineer for the following:

- Where active service connections are suitably located to dissipate entrapped air,
- Where the difference in elevation between the summit and valley is less than 600 mm and it can be shown that air pockets will be carried by typical flows.

Air valve sizes, subject to design analysis, are as follows (Table 1.18):

Table 1.18 Typical Air Valve Sizes

Water Main Size	Valve Size
100 mm to 300 mm	25 mm
350 mm to 600 mm	50 mm
Larger than 600 mm	Special design

Air valves must be vented to an appropriate secured above-grade location to eliminate any potential for cross connection in a flooded or contaminated chamber.

21 Thrust Restraint

Cast in place concrete thrust blocking and/or adequate joint restraining devices must be provided at bends, tees, wyes, reducers, plugs, caps, valves, hydrants and blow-offs. Bends at 5-degrees may not require thrust blocking and/or joint restraining devices provided they are properly engineered.

The restraint system must take into account potential future excavations in the vicinity of the water main. Design calculations must be based on fitting type, water pressure and soil conditions.

Precast thrust blocks are not permitted except in combination with joint restraints as approved by the City Engineer.

When required, provide the City Engineer with calculations for the thrust block/joint restraint design.

22 Chambers

Chambers or manholes should allow adequate room for maintenance, including headroom and side room. Access openings must be suitable for removing valves and equipment and permitting inspection cameras and pigging equipment. The chamber is to be provided with a drain to a storm sewer or ditch, complete with backflow prevention, to prevent flooding of the chamber. Rock pits may be considered subject to suitable soil and groundwater conditions and subject to approval by the City Engineer. A pumping system may be required for drainage.

Adequate venting should be provided. The City Engineer may require provision of forced ventilation, lighting, heating and dehumidification. Access and ventilation details must comply with WorkSafeBC requirements.

Insulation to prevent freezing should be provided where necessary.

23 Service Connections

Service connection size should be calculated on the basis of the designated land use including sprinkler systems and/or on-site hydrants, where applicable. The minimum size is outlined in 1.9 - Minimum Pipe Diameter.

All service connections to be made with service saddles at water main.

Multiple corporation stops must have a minimum spacing of 1.0 m.

The curb stop at the end of each service pipe must be located as per SS-W2. Where such locations will conflict with other services, the location may be revised with the approval of the City Engineer.

Each connection of 100 mm or larger shall be installed with tee and isolation gate valve on the service at the water main. The designer may choose to add an additional valve at property line to facilitate testing and tie-in procedures.

Services and curb stops must have a minimum depth of cover of 1.5 m and curb stops must be no deeper than 2.0 m. Valve boxes shall be used for curb stops greater than 50 mm diameter.

24 Alignments and Corridors

On straight roads, water mains should have straight alignments with uniform offsets between intersections.

For curved roads and alignments, where approved by the City Engineer, design joint deflections shall be limited to half the maximum deflection specified by the pipe manufacturer or through the use of 5-degree bends. Pipe alignment to be at a parallel offset with an established road right-of-way or property line.

Metallic marking tape labeled WATERWORKS is to be placed above all pipes at a depth of 0.45 m below finished grade in statutory rights-of-way or irregular alignments.

Water mains on new roads must be located as indicated in the applicable Standard Drawing typical cross-section.

Where a water main crosses private land, right-of-way requirements are as indicated in Section 0.3, General Design Considerations – Utility Rights-of-Way.

Clearance from sewer is as indicated in Section 0.4, General Design Considerations – Utility Separation.

25 Reservoirs

The following reservoir design standards apply to the City of Kelowna Water Utility and are in general agreement with the other four water purveyors in Kelowna. The designer should consult with the applicable water purveyor for specific design details.

1.23.1 Preliminary Design

Reservoir design shall include a preliminary design which is to be approved by the City Engineer before the detail design begins. Preliminary designs should cover the following issues:

- Site layout,
- Design standards,
- Volume,
- Shape,
- Number of cells,
- Geotechnical report on foundation conditions,
- Appearance.

1.23.2 Reservoir Capacity

Reservoir capacity must not be less than the greater of the following:

- One-day average annual consumption for the service area.
- Total Storage Volume = A + B + C
  Where:
  A = Fire Storage (from Fire Underwriters Survey guide)
  B = Equalization Storage (25% of Maximum Day Demand)
  C = Emergency Storage 25% of (A + B).

1.23.3 Reservoir Structural Design Codes

Design in accordance with the latest edition of the BC Building Code and one of the following specialty codes:

- ACI 350/350R: Code Requirements for Environmental Engineering Concrete Structures, and Commentary.
- PCA: Circular Concrete Tanks Without Prestressing.
- ACI 350.3/350.3R: Seismic Design of Liquid Containing Concrete Structures, and Commentary.
- AWWA D11O: Wire and Strand-Wound Circular Prestressed-Concrete Water Tanks.
- AWWA D115-06 Tendon-Prestressed Concrete Water Tanks.
- AWWA 0100-11 Welded Carbon Steel Tanks for Water Storage.
- AWWA D103: Factory-Coated Bolted Steel Tanks for Water Storage.

1.23.4 Reservoir Design Features

1. Seismic Loading: Design for the following:

   - Watertight structure and fully operational mechanical equipment, following a 475 year return period earthquake.
   - Repairable damage and no uncontrolled release of water following a 2475-year return period earthquake.

2. Two cells, each containing one-half of total required volume and capable of being drained and filled independently.
3. Reservoir to be below ground, unless approved by the City Engineer.
4. Each cell is to have an access opening and hatch in the roof for cleaning and maintenance with minimum dimension 900 mm x 900 mm. Opening to be located so that the overflow pipe is clearly visible inside the reservoir, when viewed from the opening.
5. For all access hatches, a survey mark inlaid inside showing the geodetic elevation is to be provided.
6. Finished elevation of the top of the hatch when closed to be 0.6 m above the finished elevation of the reservoir roof.
7. Access hatch(es) to have the following:
    - Aluminium 1/4" tread plate
    - Perimeter drain
    - Perimeter sealing gasket
    - Slam lock with aluminium removable sealing plug and opening tool
    - Flush lift handle
    - Gas spring assist cylinder
    - 90-degree hard open arm
    - Flush fitting padlock tang
8. The hatch must be reinforced for 1,465 kg/m² (300 lbs./sq.ft.) complete with hatch alarm.
9. All fasteners for the hatch to be made of 316 stainless steel.
10. Ventilation pipes or openings sized to handle appropriate intake and exhausting volumes of air for filling and drawing the reservoir. Ventilation pipes outlets to be screened.
11. Reservoir floor to slope to drain sump.
12. Drain sump to be a minimum of 1000 mm X 1000 mm X 400 mm, invert of drain pipe to be flush with sump floor, grating to be installed over sump.
13. Sub-drain under floor to collect and drain any leakage (may be connected to overflow pipe provided suitable measures are incorporated to prevent surcharging).
14. Overflow drain to be provided and sized to transmit the maximum pump discharge with all pumps running.
15. A stainless steel interior wall ladder is required from roof access to floor. All ladders to meet WCB regulations, supply attachment points for fall arrest equipment.
16. Top rung of the ladder to be the same elevation as the finished elevation of the reservoir roof.
17. Where public access could be gained to reservoir, install appropriate fall prevention railings.
18. Re-chlorination may be required based on demand forecasts. Chlorine residual analyser required.

19. All pipework within the reservoir to be PVC or fiberglass except overflow fitting which may be stainless steel to AWWA standards.
20. All metal parts within the reservoir including bolts, nuts, screws, anchors, ladders etc. to be 316 stainless steel. All welded stainless steel components located in the reservoir to be appropriately passivated.
21. Reservoir inlet pipe to terminate with a diffuser positioned opposite the reservoir outlet and a distance of ¾ the length of the reservoir from the outlet. Diffuser to cover ¾ the wall length.
22. Ports in diffuser pipe to be engineered to produce circulation within the reservoir during fill cycle.
23. Diffuser to incorporate removable end caps.
24. Backup high and low level control balls for each cell set at 40% and 95% levels, (not to contain lead or mercury).
25. The reservoir must be cleaned, disinfected and leak tested to AWWA and local authority requirements.
26. Gated black chain link perimeter fencing is required to address security and safety issues.
27. Landscaping acceptable to the City is to be provided including irrigation.
28. In special circumstances, at the request of the City Engineer, vehicle access road to the top of the reservoir roof to be provided.
29. Manuals to be supplied as per Section 0.8.

1.23.5 Reservoir Valve Chamber

Reservoir to incorporate valve chamber containing:

1. Chamber to include all valves associated with the reservoir operations.
2. Design in accordance with seismic codes noted above.
3. Entrance at grade large enough to permit safe removal of largest single piece of equipment.
4. Lifting beams and hoists where necessary to enable removal of equipment or components.
5. Floor drains and drainage system.
6. Separate inlet and outlet piping including check valves to separate inlet and outlet flows.
7. All inlet and outlet piping to incorporate a ¾ inch sampling port with isolating ball valve.
8. A 19 mm Schedule 80 PVC sample line with isolating ball valve for each cell terminating in the middle of a cell wall at the 50% level and extending 25% towards the centre of the reservoir.
9. A 50 mm 316 stainless steel schedule 80 pipe with isolating ball valve extending into each cell for connection of cleaning hoses.

10. A 19 mm stainless steel pipe with isolating ball valve extending into each cell connected to a pressure transmitter for level sensing.
11. Minimum 30 amp, 120 VAC electrical service.
12. Heat, light and ventilation to meet WCB requirements and to maintain minimum 5-degree C on coldest day. Insulate interior walls and ceiling as required.
13. All control wiring junction boxes.
14. A PLC control system to current Pump Operations standards.
15. Chlorine residual analyzer.
16. Interior and exterior of all steel piping to be coated to AWWA standards, or use 316 stainless steel.
    - Inlet piping – Mid Blue
    - Outlet piping – Dark Green
    - Drain piping – Gull Grey
    - All other piping – Mid Blue
    - Include flow direction arrows where appropriate.
17. Check valves to show direction of flow with white painted arrows.
18. PLC controlled modulating inlet valve where more than one reservoir serves a single zone.
19. PLC control to City of Kelowna SCADA system, including:
    - Security switches
    - Discharge and suction pressure transmitters
    - Temperature sensor
    - Flowmeter
    - Uninterruptable power supply
    - Radio or hard wire modem
    - External antenna
    - Operator interface panel
20. The modulating inlet valve shall:
    - Have non-contact 0 - 100% valve position indicator with 4-20 mA output.
    - Be hydraulically operated with pressure tank (minimum 40 psi) sized to operate valve for 3 cycles during power failure.
    - Be complete with a hydraulically operated diaphragm actuated globe or angle.
    - Pattern valve of 'Powertrol type'.
    - Pilot system to be protected by single continuous flow 100 micron filter.
    - Space for safe and convenient operating and maintenance access to all valves, piping, equipment and instrumentation.
    - Manuals to be supplied as per Section 0.8.

26 Pump Stations

The following Pump Station design standards apply to the City of Kelowna Water Utility. The designer should consult with the applicable water purveyor for specific design details.

1.24.1 Preliminary Design

Pump station design must include a preliminary design report which is to be approved by the City Engineer before detailed design proceeds. Preliminary designs should include the following issues:

- Location
- Capacity
- Number and type of pumps
- Preliminary piping layout
- Type and appearance of structure
- Foundation conditions
- Maintenance requirements and access
- Energy requirements
- Standby power
- HVAC
- Controls and monitoring

1.24.2 Capacity

Pumping capacity should be designed to suit the particular circumstances. In general, capacity should meet maximum day demand with the largest pump out of service and balancing storage online. If balancing storage is not on line, pumping capacity should meet peak hour demand with the largest pump out of service. Stand-by power should be provided, where sufficient reservoir storage does not exist, to allow the greater of maximum day demand plus fire flow or peak hour demand (MDDD+FF, or PHH) during a power outage.

1.24.3 Design Features

1. Structure, piping and mechanical systems designed in accordance with seismic codes for post-disaster structures.
2. Located above 200-year flood level or 1.0 m above highest recorded flood elevation.
3. Reinforced concrete, blockwork or brick construction, aesthetically pleasing.
4. Access doorways sized so that the largest single piece of equipment may be safely removed and replaced. Lifting hooks or rails with pulley blocks as required.
5. Adequate HVAC with filtered air inlet.
6. Standby power.

7. Adequate lighting.
8. Housekeeping pads for MCC's.
9. Electric motors to be-premium efficiency.
10. Motors to have thermal protection.
11. Motors 200 hp and above to have analogue vibration recording and protection.
12. All pilot, air relief discharge to be piped to floor drains to avoid standing water.
13. Air relief valves and pilot lines to be piped to floor drains.
14. Hydraulically operated pump control valves with isolation valves.
15. Flow meter and totalizers.
16. Spring return 'silent" check valves.
17. High pressure and surge relief valves with isolation valves.
18. Suction and discharge pressure gauges for each pump with isolation valves.
19. Mechanical pump seals.
20. Lockable roof hatches for motor and pump removal.
21. Water quality sampling ports.
22. Off road vehicle parking.
23. Landscaping to City Parks Department specifications.
24. Interior and exterior of pipework to be coated to AWWA standards. Exterior colours to be:

    - Inlet piping – Mid Blue
    - Outlet piping – Mid Blue
    - Drain piping – Gull Grey
    - All other piping – Mid Blue
    - Include flow direction arrows where appropriate.
    - Check valves to show direction of flow with white painted arrows

25. Pump system to be PLC controlled and connected to City of Kelowna Pump Operations SCADA system.
26. Control system to include but not limited to:

    - Security switches
    - Discharge and suction pressure transmitters
    - Temperature sensor
    - Uninterruptable power supply
    - Radio or hard wire modem
    - External antenna

- Operator interface panel
- Power meter without outputs to PLC
- Phase loss protection
- 5 spare fuses for all fuse holders
- Current copy of PLC and MMI program to be left in control enclosure
- (see Pump Operations Department for current standards).

27. Motors to be 600volt, 3 phase.
28. Hour meters and ammeters for each pump.
29. Power factor correction if required by Power Authority.
30. MCC, breaker boxes, receptacles to be labelled.
31. Station to be cleaned and dust free.
32. Separate or isolated room required for electrical.
33. Noise attenuation to suit the location and local authority.
34. Manuals to be provided as per Section 0.8.

27 Pressure Reducing Valve (PRV) Stations

The following PRV design standards apply to the City of Kelowna Water Utility. Designer should consult with the applicable water purveyor for specific design details.

PRV station design parameters should be reviewed and approved by the City Engineer before detailed design proceeds. PRVs are to be above ground stations housed in a suitable kiosk. Above ground installation to be located outside of road ROW or in approved location.

1.25.1 Preliminary Design Parameters

- Design Flows: peak hour, maximum day plus fire.
- Continuous, emergency or fire flow operation.
- Location.
- Kiosk details: structure and access, controls and monitoring, HVAC.

1.25.2 Design Features

- PRV to be above ground including electrical kiosk.
- Minimum chamber size: 4 m x 2 m x 2 m (inside dimensions).
- Minimum 30 amp, 120 VAC service.
- External kiosk and antenna.
- Forced air ventilation, heat and light.
- Isolating valves.
- Parallel pressure reducing valves sized for peak hour and maximum day plus fire flows.

- Air release valves.
- Water quality sample points.
- Sump drain to storm.
- Hatch as per Reservoir section.
- Off road vehicle parking.
- Manuals to be provided as per Section 0.8.
- Landscaping.
- Basket strainers upstream of each control valve.
- Upstream and downstream pressure gauges.
- Flowmeter.
- Interior and exterior of pipework coated to AWWA standards, or use stainless steel.
- PLC-controlled with connection to City SCADA system, including:
  - Security switches
  - Discharge and suction pressure transmitters
  - Temperature sensor
  - Flow meter and transmitter
  - Uninterruptible power supply (UPS)
  - Radio or hard wire modem
  - External antenna, height designed for communication connection (min. 6 m)
  - Operator interface panel.

28 Facility Site Requirements

Paved vehicular access must be provided to all reservoirs and pump stations. The minimum standard must be for an emergency access road as shown in the Standard Drawings, with drainage provisions as may be required.

Provision shall be made for vehicle turn-around and crane access.

Provide site grading and landscaping plans that identifies drainage issues, retaining walls and site safety issues.

2. Sanitary Sewers

2.1 General
2.2 Per Capita Flow
2.3 Non-Residential Flows
2.4 Peaking Factor
2.5 Infiltration
2.6 Design Flow
2.7 Pipe Flow Formulas
2.8 Flow Velocities
2.9 Alignment
2.10 Minimum Pipe Diameter
2.11 Minimum Grade
2.12 Curved Sewers
2.13 Depth
2.14 Manholes
2.15 Odour Control
2.16 Service Connections
2.17 Locations and Corridors
2.18 Lift stations
2.19 Force Main
2.20 Noise Control
2.21 On-site Sewage Disposal (Septic Systems)
2.22 Low Pressure Sewers

2.1 General

These guidelines are not intended to be a substitute for sound engineering knowledge and experience. Sanitary sewer system designs shall be prepared under the direction of a design professional who has the appropriate experience and is registered with Engineers and Geoscientists British Columbia.

Sanitary sewers are intended to convey wastewater only as specified in the Sanitary Sewer/Storm Drain Regulation Bylaw.

These guidelines apply to City of Kelowna sewage collection system only.

2.2 Per Capita Flow

In absence of sanitary sewer flow data, sanitary sewer design shall be based on an average daily dry weather flow (ADWF) of 300 litres/capita/day, except when used for the analysis of older areas (pre-1980), where a ADWF = 420 litres/capita/day shall be used.

For system design in undeveloped areas, ADWF shall be estimated based on current zoning as follows:

Table 2.2 Flow Values for Undeveloped Residential Areas

Zoning	Population/ Hectare (gross)	Population/Unit
Single Family	24-30	3
Multi-Family Low	65	2
Multi-Family Medium	120 (3 storey)	2
Multi-Family High	320-960 (4-12 storey)	2
Mobile Home	40	2

2.3 Non-Residential Flows

Average dry weather flows (ADWF) for non-residential areas should be based on specific data related to the development. In the absence of such data, use the following flow values which are based on zoning designations (Table 2.3):

Table 2.3 Flow Values for Non-Residential Areas

Land Use	Equivalent Population/Hectare (gross)	ADWF* (L/ha/day)
Commercial	83	25,000
Institutional	83	25,000
Industrial	83	25,000

*ADWF calculated at 300 Litres per day per capita

2.4 Peaking Factor

The peaking factor is the ratio of peak dry weather flow (PDWF) to the average dry weather flow (ADWF). Where possible, the peaking factor should be based on locally recorded flow data from similar developments. It is recommended that if possible residential equivalents not be used but that each customer type calculates peak flows independently. When using hydraulic modelling software it is recommended that diurnal patterns be used that reflect varying time of day flows from each customer class. In the absence of such data, the peaking factor is to be calculated using the design residential population and non-residential equivalent population, with the formula indicated below:

The ADWF is multiplied by the Peaking Factor to determine PDWF The Peaking factor is calculated as follows:

$$\text{Peaking Factor} = f \times \left(1 + \frac{14}{4 + \sqrt{P}} \right)$$

where: P = Population in Thousands

f = Reduction factor, applied as follows:

- New residential areas = 0.75
- Old residential areas = 0.85
- Commercial and Industrial area = 1.00

2.5 Infiltration

Design flow should include an infiltration allowance to cover groundwater infiltration and system inflows. For urban, suburban or commercial areas, the allowance should be based on the gross tributary area and the following:

- New system with pipes above groundwater table: 0.06 L/s/ha (5,184 L/d/ha)
- Old system (pre-1980) and/or pipes below groundwater table: 0.12 L/s/ha (10,368 L/d/ha)

The above values are based on systems where roof leaders and foundation drains are not connected to the sanitary sewer.

For older systems it is recommended that the above value be confirmed with flow monitoring since, in some systems, this value can be substantially higher.

For low density areas with large lots (>90 m frontage), or spaces between developed areas, the infiltration allowance should be based on the total sewer system pipe sizes and lengths, including sewer mains, service connections and building sewers, and the following:

- New system with pipes above groundwater table: 0.45 L/mm dia./100m length/hour
- Old system (pre-1980) and/or pipes below groundwater table: 1.0 L/mm dia./100m length/hour

2.6 Design Flow

Design flow Q = PWWF = (population and equivalent) x (per capita flow) x (peaking factor) + (infiltration allowance).

2.7 Pipe Flow Formulas

For Gravity Sewers use Manning's Formula: $Q = \frac{AR^{0.667}S^{0.5}}{n}$

Where: Q = Design flow in m^3/s
A = Cross sectional area in m^2
R = Hydraulic radius (area/wetted perimeter) in m
n = Roughness coefficient, where:
$n_{concrete}$ = 0.013
n_{PVC} = 0.011

Pipes shall be designed so that the sewer flow does not exceed d/D=0.67 for pipes 250mm diameter and less, or d/D=0.75 for pipes greater than 250mm diameter. (d=flow depth and D=pipe diameter).

For Sewage Force Mains use Hazen-Williams formula: $Q = \frac{CD^{2.63}S^{0.54}}{278{,}780}$

Where: Q = Rate of flow in L/s
D = Internal pipe dia. in mm
S = Slope of hydraulic grade line in m/m
C = Friction coefficient = 120 for all pipe

2.8 Flow Velocities

Minimum design velocities:

- Gravity sewers: 0.60 m/s
- Force mains: 0.75 m/s

Where steep grades result in velocities exceeding 6.0 m/s, sewer design must consider measures to prevent pipe and manhole erosion, movement and the effects of dynamic loading. Pipe anchors shall be installed on steeper grades in accordance with MMCD standard drawings.

2.9 Alignment

Except as indicated for Curved Sewers (Section 2.12), horizontal and vertical alignments should be straight lines between manholes for gravity sewers, and between defined deflection points for force mains.

Force main line and grade requirements are as indicated for water mains. Air release valves are required at high points.

2.10 Minimum Pipe Diameter

- Residential: 200 mm except for the upstream section where future extension is not possible, in which case 150 mm is acceptable provided it has a grade of 1% or greater.
- Commercial and Industrial: 250 mm except for the upstream section where future extension is not possible, in which case 200 mm is acceptable provided it has a grade of 0.6% or greater.
- Service connections: 100 mm
- Sewage force mains: 100 mm.

Gravity sewer mains shall be designed so that the sewer flow does not exceed d/D = 0.67 for pipe diameters of 250 mm and less, or d/D=0.75 for pipe diameters greater than 250 mm. (where d=flow depth and D=pipe diameter).

2.11 Minimum Grade

Minimum grades of gravity sewers are as required to obtain the minimum velocity of 0.60 m/s. If the calculated design flow is not expected to produce a velocity of at least 0.6 m/sec., then the minimum grade shall be calculated on the basis of the pipe flowing 35% full at a theoretical velocity of 0.6 m/sec.

Force main grades are as indicated for Water section of these design standards.

2.12 Curved Sewers

Where permitted by the City Engineer, horizontal and vertical curves may be formed using pipe joint deflections as follows (no deflection along the pipe barrel permitted):

- Minimum radius = 60 m.
- Constant radius throughout curve and constant offset to road centreline where possible.
- Joint deflection not to exceed 75% of maximum recommended by pipe manufacturer.
- Minimum design velocity = 0.9 m/s.
- Only one horizontal and/or vertical curve allowed between manholes.
- Curve locations to be accurately recorded on record drawings.

2.13 Depth

Sewers should be of sufficient depth to:

- Permit gravity service connections to basements on both sides of the road.

- The minimum depth of the sewer main (from the surface of the road or ground to the top of pipe) is normally 2.0 m.
- Prevent freezing. Minimum depth is 1.2m (measured from the surface to the top of pipe).
- Allow for future extension(s) to properly service all of the upstream tributary lands for ultimate development.
- Clear other underground utilities.
- Prevent damage from surface loading.
- Maximum cover depth: 4.5 m, except under special circumstances and with the City Engineer's approval. Pump services shall be used on low side where maximum cover would be exceeded.

2.14 Manholes

2.14.1 Manholes are required at the following locations:

- Every change of pipe size.
- Every change in grade, except as indicated in the Curved Sewers section.
- Every change in direction, except as indicated in the Curved Sewers section.
- Upstream and downstream end of curvilinear sewer mains.
- Every pipe intersection except for 100 mm and 150 mm service connections (see Section 2.16).
- Upstream end of every sewer line.
- Every future pipe intersection.
- All terminal ends, except as noted in section 2.14.3.
- 150 m maximum spacing.

Sanitary manhole rim elevation shall not be located in a low point that may be subject to ponding or storm water infiltration and shall be designed to be:

- Above the adjacent storm manhole rim and catch basin elevations.
- Above the surrounding ground elevation when the manhole is located off road to prevent inflow from ponding.

2.14.2 Hydraulic Details

Crown elevations of inlet sewers not lower than crown elevation of outlet sewer. When connecting a collector sewer main to a trunk sewer 300 mm or greater, the invert of the collector main must not connect lower than 0.75D (¾ of the pipe diameter).

Minimum drop in invert elevations across manholes:

- Straight run: 10 mm drop
- Deflections up to 45-degrees:-25 mm drop
- Deflections 45 to 90-degrees: 50 mm drop.

Drop manhole and ramp structures should be avoided where possible by steepening inlet sewers. Where necessary, provide drop structures as follows (table 2.14):

Table 2.14 Drop Structures

Invert Difference	**Structure**
Up to 0.45 m	Inside Ramp
0.45 to 0.90 m	Outside Ramp
Greater than 0.90 m	Outside Drop*
*Inside drop may be used if specifically approved by the City Engineer.	

Drop manholes and outside ramps must be installed in accordance with standard drawings.

The maximum deflection angle created in a junction is 900.

Force main discharges should be directed into the receiving manhole outflow pipe. Manhole benching should be extended a minimum 200 mm above the force main crown. If a manhole drop cannot be avoided, an inside drop pipe is required as approved by City Engineer.

2.14.3 Temporary Clean-Outs

Temporary clean-outs may be provided at terminal sections of a main provided that all of the following conditions are met:

- Future extension of the main is proposed or anticipated within 3-years.
- The length of sewer to the downstream manhole does not exceed 45.0 m.
- The depth of the pipe does not exceed 2.0 m at the terminal point.

2.15 Odour Control

Odour control shall be considered in all sanitary sewer systems designs. Of particular importance are areas where sewage has the potential to go septic. This typically occurs within pump station wet wells or sanitary force mains where sewage age exceeds 4 hours. Once the sewage has gone septic odours can be released not only from the pump station but also from the air release valves on sanitary force

mains and the discharge manhole. In this situation odour gasses can be released and cause a significant public nuisance. Hydrogen sulphide is also toxic and explosive and can pose a risk to human health.

By properly designing a sewer system, odours can be reduced and where they can't be avoided technologies exist to reduce or eliminate odour and dangerous gases.

The following criteria must be met in all sanitary sewer systems

- Dissolved sulphide maximum limit at any point in the system is to be 0.5 mg/l.
- Odour Criteria:
    - At 10 m from any gravity main, force main, manhole and lift station or other sewer facility (summer conditions, winds between 2-10 km/h), 1.0 odour units.
    - Where sewer facilities are close to houses, parks or walkways, 0.0 odour units.
- Analysis for odour and sulphides may be required.
- Odour Control provision shall be designed to accommodate both at 25% buildout and at 100% buildout.
- All lift station designs to include odour control or the provision for future odour control facilities.

When selecting the appropriate odour control technologies, the designer shall consider operating variables such as flow rates, power and consumables. It should be recognized that estimating the pre-treatment hydrogen sulfide gas concentrations is critical in evaluating the various technologies. All Odour Control treatment designs to be approved by the City Engineer.

2.16 Service Connections

Every legal lot and each unit of a residential duplex shall be provided with a separate service connection.

Lots are allowed one service connection per property. In special circumstances where the servicing of all buildings on existing Industrial or Commercial properties is not feasible, two services may be permitted if authorized by the City Engineer.

Service connections shall not be extended at an angle that exceeds 45° from perpendicular to the main, and in no case shall a service connection be placed so that it extends in front of any property other than the one being serviced.

Unless otherwise approved by the City Engineer, connections are to service all plumbing by gravity. Building elevations should be established accordingly. Pumped connections may be permitted if approved by the City Engineer prior to sewer design. Pumped connections shall be considered as an option to eliminate mains in rear yard rights-of-way.

2.16.1 Size

- Pipe size is to accommodate peak design flow.
- Minimum pipe size is 100 mm diameter for residential services and 150 mm for all other services.

2.16.2 Location and Depth

Connections to large lots are to be located at the lower portion of each lot. For urban developments, locate connections in accordance with standard drawings. Service connections must be installed at least 0.5 m horizontally from the water service and a minimum of 1.5 m from any side lot line.

Service connections shall not be extended at an angle that exceeds 45° from perpendicular to the main, and in no case shall a service connection be placed so that it extends in front of any property other than the one being serviced.

The minimum depth of a service at the property line must be 1.5 m provided that gravity service to the Minimum Building Elevation is available.

2.16.3 Grade

Minimum grade from property line to sewer main:

- 100 mm diameter pipe: 2.0%
- 150 mm diameter pipe: 1.0%
- Larger sizes: Grade based on minimum velocity of 0.75 m/s.

2.16.4 Details

Use standard wye fittings for connections to new mains. For connections to existing mains, use wye saddles or, where approved by the City Engineer, insertable tees may be used. The service connection centreline must not be below the sewer main centreline.

Service connections may be permitted into manholes provided:

- The connection is not oriented against the flow in the main.
- The connection enters the manhole so the service invert is no lower than the sewer main crown.
- Manhole hydraulic requirements are met.

Inspection chambers (IC) are required for all service connections unless the service is less than 2.5 m long and ties into a manhole. Service boxes are to be installed on every inspection chamber.

Inspection manholes are required on all industrial connections. Inspection manholes will be required for commercial connections at the discretion of the City Engineer. Inspection manholes shall be installed on private property as close to property line as practical to allow for access by the City.

Manholes are required at the main on service connections in accordance with standard drawing.

The maximum length of any service connection is 30 m. Connections exceeding 30 m in length will be treated as mains.

2.17 Locations and Corridors

Sanitary sewers to be located within roadways, preferably along the centerline, as shown in the applicable standard road cross-section drawings. Manhole covers to be located outside of wheel path.

For curved roads and alignments, where approved by the City Engineer, pipe alignment to be at a parallel offset with an established road right-of-way or property line.

Servicing from roadways is required unless a depth of greater than 4.5 m would be required to provide gravity service. Rear yard sewers are to be avoided, and advance approval is required from the City Engineer.

Where the main may exceed 4.5 m depth of cover to provide a gravity service, the City Engineer may permit a design based on sewer pumps. Ideally, main floors should be designed for gravity service.

Where a sewer crosses private land, right-of-way requirements are as indicated in Section 0.3 - Utility Rights-of-Way.

Clearance from water mains as detailed in General Design Considerations Section 0.4.

Common trench with storm sewer per General Design Considerations Section 0.4, may be approved at the discretion of the City Engineer.

2.18 Lift Stations

The use of sanitary lift stations is to be discouraged. Any proposed use of lift stations must receive prior approval from the City Engineer. Sanitary lift stations should normally be located within a right-of-way outside the required road dedication.

This section covers both dry well and submersible sewage lift stations. Larger capacity sewage lift stations or lift stations with special design or siting requirements may require additional assessment

and review of criteria.

Preliminary design must be approved by the City Engineer before detailed design proceeds.

2.18.1 Preliminary Design Requirements

System layout: Select location(s) to minimize the number of sewage lift stations and avoid lift stations wherever practical.

Capacity: The lift station must be designed to handle the ultimate flows of the designated catchment. Design must consider short, intermediate and long-term future flows.

Location and Layout: The location and layout of a lift station must include an assessment of the following basic design considerations:

- Type of station and impact on neighbours.
- Construction dewatering requirements.
- Access for construction.
- Access for maintenance.
- Aesthetics, noise, odour control and landscaping requirements.
- Security against vandalism and theft.
- Flood elevations. Station uplift design must be based on maximum load level.
- Proximity of receiving sewers, water mains, and adequate power supply.
- Minimizing energy requirements.
- Standby power and its compatibility.
- Soils. Geotechnical investigations must be undertaken prior to site approval.
- Convenience of operation and maintenance.
- Safety for operators and public.
- Capital and operation and maintenance costs.
- Radio Path assessment on existing and proposed building line of sight.
- Off street Parking (5 m x 7 m) shall be provided for pump maintenance.
- Fenced perimeter with 1.8 m high black chain link fencing. Fencing to MMCD standards.
- Above ground valve chamber with no ladder or platform requirement for maintenance access.

2.18.2 Design Features

Lift stations should be designed with a minimum of two pumps, each capable of handling the maximum flow condition. A mixer should be provided, or one pump equipped with an automatic flush valve.

Where the design flow exceeds the capacity of a single, commonly available pump, use three or more pumps with capacities such that there is always one pump available for standby.

(1) Pump requirements:

- Capable of passing solids up to 75 mm in size.
- Equipped with appropriately rated stainless steel chain and connecting rings.
- Equipped with hour meters.
- Easily removed for maintenance.
- Maximum motor speed: 1750 RPM.
- Explosion proof.
- Operate on a 347/600 volt electrical source (pump motors between 5 hp and 75 hp (max) and to be 600 volt 3 phase type).
- Able to operate alternately and independently of each other.
- Able to meet maximum flow condition with one pump in failure mode.
- Designed so that each motor does not cycle more than 4 times in one hour under normal operating conditions. For example, in a duplex pump station that is designed to alternate the pump starts, each motor can have a maximum of 4 starts in an hour which could result in a total of 8 motor starts per hour for this station.
- All pumps must be factory tested prior to installation.
- Wet well storage shall be sized assuming pump is fully submersed and will accommodate design flow with no storage in the pipe network.
- All internal piping and fittings shall be 316 stainless steel (Victaulic style) as per Approved Products List.
- Pump start water level to be set above the top of the pump casing to prevent buildup on pump and reduce level monitoring issues.

(2) Motor cables, power cables, etc., must be continuous from within the pump station to within the kiosk unless an adequate exterior pull pit and junction box is installed.

(3) Levels to be controlled by ultrasonic level transmitter with emergency high and low level

balls. A radar level transmitter is required when lift station service is in an area that produces large amounts of "foam" or "steam" e.g. a laundry facility. Level transmitters to be accessible at the top of the wet well to be serviced without entering into the lift station.

(4) All auxiliary equipment and control panels must be mounted in a suitable kiosk adjacent to the station. The kiosk must be located a minimum of 3.0 m from the station lid.

(5) The control kiosk must be designed to contain all control and telemetry equipment on the front panel and all power equipment on the rear panel.

(6) Check valves must be ball lift check valves. All valving to be installed in an above ground kiosk.

(7) All stations require an explosion-proof exhaust fan which can be activated by manual switch, and which meets WCB requirements for ventilation in a confined space.

(8) The entrances to all stations must be waterproof and be provided with a suitable lock. The access must be a minimum 900 mm x 900 mm in size. The access hatch shall have:

- An aluminum ¼" tread plate
- A perimeter drain
- A perimeter sealing gasket
- A slam lock with an aluminum removable sealing plug and opening tool
- A flush lift handle
- A gas spring assist cylinder
- A 90-degree hold open arm
- A flush fitting padlock tang.

The hatch must be reinforced for 1465 kgs/m² (300 lbs./sq.ft.). All fasteners to be made of 316 stainless steel.

The entrance must be above ground level where feasible but, in no case, more than 300 mm above the ground.

(9) All wiring must be explosion-proof, Class 1, Division 2, and electrical design and installation is subject to the acceptance of the Provincial Safety Inspector. Metal stations must be protected by impressed current cathodic protection.

(11) All stations must provide an automatic generator for standby power in case of power failure. Provision for a telemetry system must be included for connection into the Municipality's Telemetry System. For small lift stations with an ultimate capacity less than

100 units, emergency storage may be considered in place of standby power; emergency storage is to be based on 8 hours of average day flows.

(12) All equipment must be CSA approved and have at least a one year guarantee for parts and labour.

(13) Designer is to provide three copies of Operating and Maintenance Manuals (see Section 0.8).

(14) Wet well to have above ground valve chamber that houses the ball check and isolation plug valves for each pump as well as the air relief valve and flow meter. Valve chamber to have at a minimum 50 mm of insulation, 1000W intrinsically safe baseboard heater, door seals, floor drain back to the wet well with p-trap and the air relief drain ports piped to the Valve Chamber floor drain. A plug valve is required on the influent line and on each pump discharge. The valves must be outside the station and be complete with square operating nut and nelson box. Gear box on plug valves in the ground to be designed for submersion.

Mixer to be provided only when required for the purposes of odour control (no automatic flush valves).

(15) If a lift station is authorized, by the City Engineer, to be constructed in an area that may be subject to vehicle loads, the roof and cover of the pump station should be designed to withstand a loading of H-20 (highways standard). Roof design to also allow for fall arrest assembly on the roof (2X's the max arresting force, typically 1800 lbs).

(16) Provision(s) must be made for standby pumping from an external source. An adaptor flange ("Kamlock") complete with a quick coupling and lockable cap will be required.

(17) The area around the station and all associated equipment or building must be asphalted. The size of the area to be determined by the requirements for maintenance.

(18) Stations to be fiberglass unless otherwise approved by the City Engineer The surfaces of all steel components and fibreglass stations must receive at least two coats of two component white epoxy enamel. Concrete wet wells are discouraged but where approved, must be designed and constructed to prevent sulphide corrosion, and the concrete surface must be coated with at least 2 coats of blue epoxy and then an additional 2 coats of white epoxy. All steel piping and components to be 316 stainless steel.

(19) The wet well bottom must be sloped to direct all solids into the pump suction. The influent line must be located tangent to the wet well to encourage scouring of the wet well.

(20) The station shall be complete with an Uninterruptable Power Supply (UPS) to serve all alarms and controls.

(21) Separate starter enclosures must be provided for each pump.

(22) PLC control to be based on City of Kelowna standards.

(23) Station communication to be provided via radio transmission compliant with the City's telemetry system, and an antenna must be installed on a suitable mast or pole to ensure reliable transmission.

(24) An hour meter must be built into the panel for each pump.

(25) An amp meter must be provided for each pump.

(26) Minimum storage between the high level alarm and the start of overflow under the more critical of:

- Minimum 1 hour in wet well at average wet weather flow.
- Minimum 1 hour in wet well and influent pipes at peak wet weather flow.

Ensure operating level is above the top of the pumps to keep the pumps submerged (Minimum 1 m separation between the inlet pipe invert and pump stop level).

(27) Station to have a magnetic flow meter located in above ground valve chamber.

(28) Station to allow removal of pumps using hoist truck with 1.8 m (6') boom.

(29) Perimeter fencing is to be provided. The fence must be made of black chain link and installed with privacy slats. Fence to be minimum 1.8 m high with minimum 5 m wide opening for vac truck access.

(30) Landscaping, acceptable to the City, is to be provided including irrigation.

(31) Noise control may be required when criteria in Section 2.16 is exceeded.

(32) Odour control may be required when criteria in Section 2.17 is exceeded.

(33) Minimum barrel size must be 2440 mm (8') in diameter.

2.19 Force Main

As part of the lift station design, the following criteria must be noted in the design of force main systems: Design computations for force mains must be made using a 'C' factor of 120 (for PVC pipe)

and then re-calculating the system curve using a 'C' factor of 145 to ensure adequate motor horsepower and pump characteristics. Show pump and system curves on design drawings.

2.19.1 Velocity

At the lowest pump delivery rate anticipated to occur at least once per day, a minimum cleansing velocity of 0.75 m/sec should be maintained. Maximum velocity should not exceed 4.0 m/s.

2.19.2 Air Relief Valve

An automatic air relief valve must be placed at high points in the force main to prevent air locking when the difference in elevation between the invert of the summit and the invert of the valley is greater than the diameter of the pipe. The air relief valve must be located in a chamber, complete with adequate and environmentally safe drainage and odour control, unless a suitable injected odour control agent is used at the Lift Station. Air valve must be vented and drained into the gravity sanitary sewer system at a manhole, where possible.

2.19.3 Termination

Force mains should enter the gravity sewer system so that the force main invert is not more than 200 mm above the crown of the pipe in the receiving manhole. A smooth, turbulent free transition must be incorporated. If the receiving manhole design does not allow this, then a manhole drop structure in accordance with the standard drawings is required.

2.19.4 Size

The minimum size for force mains is 100 mm diameter.

2.19.5 Materials

Force mains must generally meet the standards specified for water mains and in accordance with Schedule 5, however there are specific requirements for force mains that may supersede water main standards, as follows:

- Force main pipe must be identifiably different than water main pipe. Refer to supplemental specifications 5.1 Section 33 34 01S.
- Valves used on force mains, pigging ports or cleanouts shall be lubricated full port plug valves size on size sufficient for long term use in a corrosive environment. Plug valve gear boxes installed in the ground must be designed for submersion conditions.

2.19.6 Loads and Transient Pressures

All force mains must be designed to prevent damage from superimposed loads. Must also be designed to prevent damage from water hammer or column separation phenomena. Transient surge and cyclic surge analysis must provide at least a 75-year life of the pipe.

2.19.7 Corrosion and Odour

Corrosion and odour control is required when limited daytime flows, or long force main lengths cause the pumped sewage to remain in the force main for longer than 45 minutes.

2.19.8 Pigging Port

A "size on size" pigging port that is convenient for the City Operations to use and maintain must be incorporated in the force main outside of the Lift Station.

2.20 Noise Control

Noise levels for facilities must not exceed 65 dB at property line or 20 m away whichever is closer.

2.21 On-site Sewage Disposal (Septic systems)

On-site sewage disposal systems will only be considered for properties that are:

- Not near or adjacent to the City's sanitary sewer system, and
- Greater than 1 ha in size.

Where permitted, site conditions and on-site sewage disposal systems shall meet the BC Public Health Act "Sewerage System Regulation" and Ministry of Health Special Conditions for placing septic systems with Environmental Control Zones. The City Engineer' approval is required for on-site sewage disposal systems.

2.22 Low Pressure Sewers

Low pressure sanitary sewer systems servicing a group of properties is discouraged and requires approval from the City Engineer. Preliminary design must be approved by the City Engineer before detailed design proceeds.

BL8847 replaced Part 3 Drainage
BL11913 replaced Part 3 Drainage

3 Stormwater Management

3.1 General
3.2 Stormwater Flow Control
3.3 On-Site Stormwater Management and Practice
3.4 Runoff Analysis
3.5 Site and Lot Grading
3.6 Minimum Building Elevations (MBE)
3.7 Rational Method
3.8 Hydrograph Method
3.9 Minor System Design
3.10 Major System Design
3.11 Runoff Controls
3.12 Outlet Controls
3.13 Drainage Pump Stations
3.14 Erosion and Sediment Control (ESC)

3.1 General

The City stormwater system integrates surface water flows collected through the City's infrastructure and the natural watercourses that flow into Okanagan Lake. Proper integrated stormwater management practice mitigates impacts with the goal of maintaining Okanagan Lake as a high quality water source, with an abundant water supply, and with a balanced ecosystem. While urban, agricultural and natural areas all benefit from Okanagan Lake, drainage impacts from our systems must be mitigated, as well as be resilient to flood hazard and a changing climate.

The presence of an existing stormwater management facility does not imply that there is adequate capacity to receive the design flow, nor does it imply the facility is necessarily acceptable to the City. Where required, stormwater facilities must be upgraded to accommodate the appropriate flow as specified in this standard.

3.1.1 Outcomes

With respect to stormwater, the City's goals are to:

a) Improve and protect water quality from creek flows, outfalls and groundwater entering Okanagan Lake.

b) Reduce the risk of health hazard, life, and damage to property and infrastructure from flooding, and provide strategies to attenuate peak flows and volumes.

c) Preserve and protect aquatic and riparian habitat and provide opportunity for restoration.

d) Minimize risks to the Okanagan Lake drinking water source.

e) Increase the resiliency of our watersheds to climate change impacts.

This stormwater management standard applies the latest Best Management Practices (BMP) and processes in use in British Columbia. New systems and development within the City are to use the practices described within this Section as a *minimum* standard.

All flows must be routed through sewer pipe, ditching, water courses, riparian areas, or road allowances with the required capacity and right of way access for operation and maintenance. The City requires that major system flows must be safely routed downstream to an adequately sized municipal drain or natural watercourse without impacting private property.

3.1.2 Regulations

Stormwater management designs must conform to this standard, City of Kelowna bylaws, regulations and policies; in addition to federal and provincial statutes where applicable. These include but are not limited to the following:Supplementary Design Criteria

- Existing Master Drainage Plans,
- Local Government Act
- Fisheries Act of BC
- Water Sustainability Act
- BC Water Act
- Navigable Waters Protection Act
- Canada Wildlife Act
- Migratory Birds Convention Act
- Dike Maintenance Act
- Standards and Best Practices for Instream Works (Canada/BC)
- Land Development Guidelines for the Protection of Aquatic Habitat (Canada/BC)
- Urban Runoff Quality Control Guidelines for British Columbia
- National Guide to Sustainable Municipal Infrastructure (Canada)
- Canadian Dam Association Dam Safety Guidelines

3.1.3 Climate Change

The City accepts that climate patterns are changing, and that its customers are impacted by creek flooding, lake rises, temperature fluctuations and fire. The design standards for infrastructure outlined in this bylaw are to be considered a minimum expectation. The City requires that design professionals consider impacts of climate change, through potential changing weather patterns or water levels when implementing a design; particularly in components where critical and long term

design decisions are being made, or in areas where the consequence of failure is high.

To account for a changing climate, the capacity of storm works will include an additional 15 percent (15%) upward adjustment, and applied to the rainfall intensity curve stage (IDF) in Section 3.7.2. This is consistent with recommendations in EGBC (2018): Legislated Flood Assessments in a Changing Climate in BC.

The design professional will be required to consider debris flow and flow management as a result of higher peak flows.

On larger projects, basin characteristics are required elements of the Stormwater Management Plan (See Section 3.2.1). Developers will need to anticipate this form of analysis as part of their overall cost strategy.

3.1.4 Hillside Areas

Hillside areas or areas of poor infiltration conditions have been identified by the City in Drawing **SS-S58.**

a) For development in Hillside Areas, the City focus is on safe conveyance of water. Roof or site drainage must discharge directly to the storm system. This focus is to not allow infiltration to ground except for foundation drainage. Where storm drains are not available or not considered feasible, minor system designs (see 3.2.a below) will require a hydrogeological review provided by a qualified Professional (P.Eng. or P.Geo.) to ensure that site infiltration is possible while not exceeding pre-development conditions, not impacting slope stability or off-site seepage, or not directly impacting downhill properties. The terms of reference of the review must be confirmed by the City Engineer and approved as a condition for obtaining a Development Permit.

b) For new development where Groundwater Recharge is designated **Not Suited**, the City will not permit minor systems (see Item 3.2a) to infiltrate to ground.

3.2 Stormwater Flow Control

The City's Stormwater Management system consists of three main components:

a) **The Minor System** consists of sewer pipes, gutters, catch basins, driveway culverts, open channels, watercourses and storm water management BMPs designed to capture, convey, treat or modify flows up to a 5-year return design event as directed by the City.

b) **The Major System** consists of surface flood paths, roadways, roadway culverts, channels and storm water management facilities designed to capture, convey, treat or modify larger flows up to a 100-year return design event. A piped minor system may be enlarged or supplemented to accommodate major flows. Major roads and arterials, bridges and creek protection armouring are to be designed for the 1 in 200 year event. This is discussed further in Section 3.10.

c) **The Natural System** consists of all natural lakes, rivers, creeks, streams and ephemeral drains that flow naturally downstream ultimately to Okanagan Lake. Natural system capacity and water quality

can be impacted negatively by incoming Minor or Major systems.

3.2.1 Stormwater Management Plan

Stormwater Management Plans are required for all municipal development. A plan should include the following:

a) Tributary areas in the catchment which identify existing and potential land uses or current development.

b) References to applicable Area Stormwater Drainage Plans.

c) Details indicating how the proposed site relates to the Master Plan and its recommendations. Contours at 0.5 m elevation intervals.

d) Conceptual lot grading patterns.

e) Existing watercourses, including environmental classifications and/ or fish presence information, if available.

f) Layouts of existing and proposed drainage systems.

g) Major flow paths to a municipal drain or natural watercourse without impacting private property.

h) Proposed control features to meet the water quantity and quality targets identified in the applicable Master Plan

i) Locations, sizes, design flows, volumes, and capacities of all existing and proposed works.

j) Capacity assessment of receiving downstream works, or reference to the applicable Master Plan demonstrating adequate capacity. The City will provide the required stormwater area plans upon request.

k) Minor and Major hydraulic grade line elevations on profiles for all proposed works.

l) Proposed service connection locations and their associated minimum building elevations (MBE). Pre and post development flows both entering and leaving the subject lands.

   i. Pre development is defined as the natural condition prior to any development changes, including those resulting from past development activities.

m) The City may exempt plan requirements for development in rural or agricultural areas upon request or determination by the City Engineer.

3.3 On-Site Stormwater Management and Practice

3.3.1 Storm Effluent Limitations to City Storm System

a) For structures designed or constructed above the proven high groundwater table, intermittent stormwater pumping will be permissible to the City stormwater system where approved by the City Engineer. All operations and testing must be consistent with the

requirements in Sanitary Sewer/Storm Drain Regulation Bylaw 6618.

b) Where structures are designed or constructed below the proven high groundwater table, permanent groundwater pumping will not be permitted to discharge to the storm system. The City will approve designs that include provisions for eliminating groundwater penetration into the structure, while addressing buoyancy concerns. These design aspects must be reviewed and approved by the City Engineer.

c) Refer to the latest BC Building code for drainage discharge requirements in parkades.

3.3.2 Water Quality

Whether water is routed through creeks, pipelines or infiltration into ground, the City will require consideration for treatment, emergency management and maintenance of the stormwater infrastructure and water quality. Stormwater designs on private property must meet or exceed minimum water quality guidelines prior to entering the City storm system. Water quality for a minor system flow (50% of the 1 in 2-year) must meet minimum BC Ministry of Environment Recreational Water Quality Guidelines and as per Sanitary Sewer/Storm Drain Regulation Bylaw 6618 .

3.3.3 Construction Sites

The City storm system can be used for temporary site water management provided the water quality exiting the property meets BC Ministry of Environment Recreational Water Quality Guidelines. This temporary use must be approved by the City prior to issuance of the Development Permit and/or Building Permit, following a confirmation of capacity within the downstream system, and adequacy of the quality of storm effluent. There must be no discharge to the sanitary sewer system.

3.3.4 High Density Residential, Commercial and Industrial Storm Systems

a) A control manhole is to be installed within 3 metres of the property line, and downstream of any water quality enhancement system. The manhole will include provision for isolating runoff into the City Storm system.

b) The City requires access to the structure in an emergency and inspection. An SROW is required. Provisions must be considered for response to emergency toxic spills on site. Any costs associated with emergency response are the responsibility of the property owner.

c) Water quality enhancement systems such as oil/grit separators, fuel/water separator (where required), naturalized storm ponds or other approved systems are the responsibility of the site owner, and must be maintained on a regular basis. The City can request regular maintenance records.

d) Minor system flows must meet water quality guidelines described above prior to discharging to a creek or city storm system.

e) On industrial sites where perforated storm systems or dry wells are used, the design must include provisions to manage emergency spills on site and minimize groundwater impacts.

3.4 Runoff Analysis

Storm drainage design should be carried out using one or both of the following methods. Calculations are to be submitted with designs.

a) **Rational Method:** To be used only for hydrologically simple and uniform areas with contributing area less than 10 Ha.

b) **Hydrograph Method**: Applicable for all larger areas or more hydrologically complex catchments, or where stormwater management systems require more than basic conveyances. Use SWMM based models or approved equivalent to analyze these processes. Each model must include a level of complexity dependent on the watershed and the hydrologic processes that need to be considered (e.g., detention, groundwater recharge and infiltration, evapotranspiration, continuous simulation, etc.).

For all modelling, use the rainfall Intensity Duration Frequency (IDF) curves found in standard drawing **SS-S56**. Both historical data as well as climate change information must be incorporated into the runoff analysis.

3.5 Site and Lot Grading

Grading is to comply with the BC Building Code and the following:

a) Swales and site drainage must be constructed to prevent ponding within lots, with runoff routed, where possible, to storm services in public streets or other appropriate stormwater management system for the site.

b) Grade lots to drain to an approved City drainage system or roadway. Use 1% minimum grade. Grading directly to a natural drainage path must include adequate erosion control and water quality improvement measures.

c) Avoid drainage across adjacent lots. Where cross-lot drainage is unavoidable, provide adequate measures such as channelling, swales, inlets or piped connections to direct flow appropriately. A statutory right of way in favour of the City or private easement is required for unobstructed access.

d) Positive drainage is required for buildings and foundations.

e) Set building elevations above the hydraulic grade line (HGL) of the major drainage system as per Minimum Building Elevations (MBE) guidelines below.

3.6 Minimum Building Elevations (MBE)

The MBE applies to the elevation of the lowest floor slab in a building or the underside of the floor joists where the lowest floor is constructed over a crawl space. Crawl space is defined as the space between a floor and the underlying ground having a maximum height of 1.2 m to the underside of the joists and not used for the storage of goods or equipment damageable by flood waters.

The MBE is to be at least 0.60 m above the storm sewer service connection invert and 0.30 m above the major drainage system hydraulic grade line (HGL), whichever governs except where permissible on Hillside development where:

- foundation drains are disconnected from the storm main; or
- intermittent foundation pumping has backflow prevention.

For developments within close proximity to the Okanagan Lake shoreline, the MBE is elevation 343.66m. Further consideration shall be given to wind and wave action when setting the required MBE.

For sites near a watercourse where a floodplain elevation has been established through flood mapping, the MBE is to be a minimum of 300mm above the 200-year return period peak flood elevation or as per City of Kelowna Mill Creek Flood Plain Bylaw No. 10248. Where a flood elevation has not been established, setbacks are to be as per the Provincial guidelines or 1.5 metres above the natural boundary of any watercourse, lake, marsh or pond.

3.7 Rational Method

The Rational Method for calculation of peak flows is as follows:

$$Q = R\ A\ I\ N$$

Where:

Q = Peak flow in cubic metres per second (m^3/s)
R = Runoff Coefficient (C) x Adjustment Factor (C_{AFs})
A = Area of catchment in hectares (ha)
I = Intensity of rainfall (mm/hr)
N = 1/360

Factors for use in the Rational Formula are indicated below.

3.7.1 Runoff Coefficients (C)

The following runoff coefficients are for use with the Rational Formula. These coefficients are for general application only. Design values are subject to verification by the designer and approval by the City. Higher values may be applicable in those areas which experience rainfall during the winter when the ground is frozen.

Table 3.7.1 Runoff Coefficients (C)

Land Use	Percent Impervious	C	
		Minor Storm (1:5 year)	Major Storm (1:100 Year)
Residential			
• Suburban Residential (Lots>0.4 ha)	20%	0.35	0.40
• Low Density (Single Family)	40%	0.50	0.55
• Medium (Multi-Units Detached)	65%	0.60	0.65
• High Density (Multi-Units Attached)	90%	0.85	0.90
Commercial	90%	0.85	0.90
Industrial	90%	0.85	0.90
Institutional (e.g. Schools)	80%	0.75	0.80
Parks/Grasslands	20%	0.20	0.30
Cultivated Fields	30%	0.30	0.40

Runoff Coefficient Adjustment Factor (C_{AF})

An adjustment factor is to be applied to the runoff coefficient to reflect variations in soil permeability and slope.

Table 3.7.2 Runoff Coefficient - Soil Adjustment Factor (C_{AF})

Soil type and Slope	C_{AF}
Sandy soil with flat slope (up to 5%)	0.9
Sandy soil with steep slope (over 5%)	1.0
Clayey soil with flat slope (up to 5%)	1.0
Clayey soil with steep slope (over 5%)	1.1
Rock	1.1

Note: The above runoff coefficient adjustment factors are subject to verification by the designer. The product of C and C_{AF} can not exceed 1.0.

3.7.2 Rainfall Intensity (I)

Rainfall intensity for use in the Rational Method should be determined using the rainfall IDF curve in standard drawing **SS-S56** for the City of Kelowna. This curve was developed from the Atmospheric Environment Service recording station located at the Kelowna international Airport. To account for climate change, as noted in Section 3.1.3, **a 15 percent increase (15%)** will be applied to the intensity derived from the IDF curve. The duration is equal to the Time of Concentration (Tc), as calculated below.

Time of Concentration (Tc)

The time of concentration is the time required for runoff to route from the most remote part of the catchment area under consideration to the design outlet node. The time of concentration can be calculated using the following formula:

$$T_c = T_i + T_t$$

Where:

T_c = time of concentration (minutes)
T_i = inlet or overland flow time (minutes)
T_t = travel time in sewers, ditches, channels or watercourses (minutes).

Inlet or Overland Flow Time (Ti)

Typical inlet times for urban areas, assuming BMP's are not applied, are as follows:

a) Single Family Lot 10 minutes
b) Multi-Family Lot 8 minutes
c) Commercial/Industrial/Institutional 5 minutes

For relatively flat areas, the inlet time for larger areas can be calculated using the "Airport Method" as follows:

$$T_i = 3.26 \frac{(1.1 - C) L^{0.5}}{S^{0.33}}$$

Where:

T_i = inlet time (minutes)
C = runoff coefficient (See above)
L = travel distance (Maximum length = 300 m)
S = slope of travel path (%)

Travel Time

The travel time for routing in sewers, ditches, channels or watercourses can be estimated using

the Modified Manning formula:

$$T_t = \frac{L\,n}{60\,R^{0.667}\,S^{0.5}}$$

Where:

T_t = travel time (minutes)
L = length of flow path (m)
n = Manning roughness coefficient:
0.050 Natural channels
0.030 Excavated ditches
0.013 Pipe and concrete lined channels.
R = Hydraulic radius = Area/Wetted Perimeter (m)
S = slope (m/m)

3.7.3 Design Summary Sheet

All design calculations are to be tabulated and shown on the design drawings, or in a report and summarized on design drawings.

3.8 Hydrograph Method

Analysis using the Hydrograph Method requires computer modeling capable of analyzing the hydrologic characteristics of the watershed and generating runoff hydrographs.

For City applications, SWMM based models are appropriate. The City of Kelowna must be consulted before selecting a more specialized software program.

3.8.1 Modelling Procedures

Modelling results are to be calibrated using observed historical rainfall and flow data from the design watershed. Sensitivity of the model predictions to variations of key parameters should be tested and the findings used to develop a realistic and conservative model.

At a minimum, post-development hydrographs are to be generated at key points of the drainage system for a 5-year and 100 year design storm with durations of 1, 2, 6, 12, and 24 hours for each development condition. A different range of storm durations may be appropriate, subject to City approval. This will identify the critical storm event to be used in designing the system component. Note that the storm durations that generate the critical peak flow may be different from the durations that generate the critical storage volume.

Systems with a number of interconnected ponds or with restricted outlet flow capacity may require a more detailed analysis for sequential storm events or modelling with a continuous rainfall record.

Detailed designs should include hydraulic grade lines (HGLs) of the minor and major systems plotted on profiles of the minor system components and compared with MBE to demonstrate flood protection.

3.8.2 Submission of Modelling Results

Modelling results are to be submitted to the City in a report or drawing containing at least the following information:

a) Stormwater Control Plan as defined in Section 3.2,
b) Name and version of modelling program(s)
c) Parameters and simulation assumptions.
d) Design precipitation details.
e) Pre-development and post-development hydrographs.

3.9 Minor System Design

The minor system includes all drainage works that collect, convey, detain, divert and intercept design storm runoff. The minor design event must be the 5-year design storm.

3.9.1 Pipe and Channel Capacity

Use Manning's formula.

$$Q = \frac{A\,R^{0.667}\,S^{0.5}}{n}$$

Where:

A = Cross sectional area in m^2
R = Hydraulic radius (area/wetted perimeter) in m
S = Slope of hydraulic grade line in m/m
n = Roughness coefficient:
0.013 for all smooth pipes.
0.024 for corrugated pipes and culverts.

3.9.2 Flow Velocities

a) Pipes/Culvert Flow

   i. Minimum design velocity for pipes flowing full or half full: 0.60 m/s.

   ii. Where grades are greater than 10%, measures are required to prevent pipe erosion and movement such as control structures and/or tie-backs and anchor blocks.

   iii. Where a storm sewer discharges into a watercourse, provide riprap bank protection and, if necessary, energy dissipation facilities. Avoid discharge perpendicular to stream flow.

b) Conveyance channels must be armoured and sized for a 1:100-year event. For riprap design chart see standard drawing **SS-S57**.

c) Road Ditches

   i. Maximum road ditch velocity is 0.5 m/s without armouring.

   ii. Ditch Inlets - Ditch inlets to storm sewers must include wing wall structures, safety grillage for large pipes (>600 mm diameter), debris screens and sedimentation basins.

3.9.3 Alignment

Except as indicated for Curved Sewers, horizontal and vertical alignments are to be straight lines between manholes.

3.9.4 Minimum Pipe Diameter

- Storm Sewers 250 mm
- Culverts crossing roads 450 mm
- Culverts crossing driveways 300 mm
- Catch Basin Leads 200 mm
- Double Catch Basin Leads 250 mm

Downstream pipe sizes are not to be reduced unless the downstream pipe is 600 mm diameter or larger and increased grade provides adequate capacity. Detailed hydraulic analysis is required. The maximum reduction is one standard pipe size.

3.9.5 Minimum Grade

Minimum grades of storm sewers are as required to obtain the minimum velocity of 0.6 m/s at design flow except for catch basin leads and service connections, for which minimum grades are as indicated in Section 3.9.12, Service Connections.

3.9.6 Curved Sewers

Where permitted by the City, horizontal and vertical curves may be formed using pipe joint deflections as follows:

a) The radius of the curve is to be no less than the recommended manufacturer's minimum radius of curvature at a constant radius.

b) Horizontal curves must be parallel to the centre line of road at a constant offset.

c) Only one horizontal curve is permitted between manholes, unless the mainline is installed and appropriately anchored outside the road on a steep hill slope requiring multiple vertical curves.

d) Where the pipe curve does not have a consistent offset from a road centre line, the offsets must be properly referenced on Record Drawings.

e) Subject to City Engineer approval, curved storm sewer systems larger than 600 mm diameter may include deflections formed by mitred bends to a maximum mitre of 45°.

3.9.7 Depth

The minimum depth of the sewer must be sufficient to provide all service connection piping with a minimum cover of 1.2m to the top of the service, anywhere within the finished right-of-way. In no instance shall the cover over the crown of the sewer main be less than 1.2m when installed in travelled areas. The depth of course can be reduced to 1.0m when installed outside of travelled areas.

a) The maximum depth of cover must be 4.5m, except under special circumstances and with permission of the City Engineer.

b) For catch basin leads, the minimum depth of cover is 0.90m.

3.9.8 Pipe Joints

All pipe joints are to be watertight.

3.9.9 Perforated Storm Pipe

a) The City will only consider the installation of perforated storm sewers and/or dry wells to discharge water back to the ground where soil conditions, slope and water table elevation are suitable. The perforated pipe system design must be designed to provide surcharge conditions.

b) Perforated pipes can only be installed in areas of the City described as "Possibly Suited" in the Groundwater Recharge Suitability Map in Standard Drawing **SS-S58** and confirmed by a hydro-geotechnical site investigation.

3.9.10 Manholes

a) Manholes are required at:

   i. Every 150m or less.

   ii. Every change of pipe size.

   iii. Every change in grade, except on curvilinear pipe alignments.

   iv. Every change in direction, except on curvilinear pipe alignments.

   v. All terminal sections.

   vi. Every sewer main intersection.

b) Placement of manholes in existing or future wheel paths must be avoided.

c) Manhole sizes must be in accordance with the Standard Drawings: Manhole connection details as per MMCD S3 & S4, or City of Kelowna supplemental standard drawing **SS-S1a**".

d) Hydraulics: Crown elevations of inlet sewers not lower than crown elevation of outlet sewer. When connecting a collector sewer main to a trunk sewer 300 mm or greater, the invert of the collector main must not connect lower than 0.75D (¾ of the pipe diameter).

e) Minimum drop in invert elevations across manholes:

   i. Straight run: 10 mm drop

   ii. Deflections up to 45 degrees: 25 mm drop

   iii. Deflections 45 to 90 degrees: 50 mm drop

f) Drop manhole and ramp structures should be avoided where possible by steepening inlet sewers. Where necessary, provide drop structures as follows (table 3.9.10):

Table 3.9.10 Drop Structures

Invert Difference	Structure
Up to 0.45m	Inside Ramp
0.45 to 0.90 m	Outside Ramp
Greater than 0.90 m	Outside Drop*

*Inside drop may be used if specifically approved by the City Engineer.

g) Drop manholes and outside ramps must be installed in accordance with standard drawings.

h) Hydraulic losses are to be calculated for manholes with significant change of grade or alignment. For high velocity flows, particularly for pipes 600 mm or larger, detailed analysis is required using the Froude number, or utilizing appropriate computer models. The Manning's equation should not be relied on for pipe slopes above 10%. For low to moderate

velocities and smaller pipes, use the following formula:

$$H_L = k\, v^2/2g$$

Where:

H_L = head loss (m)
v = flow velocity entering junction (m/s)
g = gravitational acceleration (9.81 m/s^2)
k = head loss coefficient (1.0 for channeled 90^o bends and tees, to 1.5 without channelized benching)

Where benching is used, the minimum drops listed above are applicable for velocities below 1 m/s. Where flows exceed 1 m/s, H_L should be specifically computed and used as the drop across the junction.

3.9.11 Catch Basins

a) Catch basins are required at regular intervals along roadways, at intersections and at low points to:
    i. Prevent overflows to driveways, boulevards, sidewalks and private property.
    ii. Avoid interference with crosswalks.
    iii. Avoid low points in curb returns at intersections.
b) Catch basin leads are minimum 200 mm diameter.
c) Minimum grade of a catch basin lead is 1%.
    i. Catch basin leads require a 0.9 m minimum cover. If 0.9 m is not available, design to protect from freezing and traffic loads; design calculations must be provided.
d) Spacing is to provide sufficient inlet capacity to collect the entire minor flow or major flow, where required, into the sewer system.
e) Local suppliers are required to provide rating curves for available catch basin grates. As a general rule, space catch basins to drain maximum impervious areas of:
    i. 500 m^2 on roads with grades up to 4%,
    ii. 400 m^2 on roads with grades greater than 4% at 100 m maximum.
f) Lawn basins are required on boulevards and private properties where necessary to prevent ponding or flooding of sidewalks, boulevards, driveways, buildings and yards.
g) Double or twinned catch basins must not be connected directly together, rather one basin will be wyed into the lead of the other. Maximum lead length to the mainline must be 30 meters and be minimum 250mm diameter. Each CB will have a trapping hood (standard drawing **SS-S54**).
h) Double or twinned catch basins are to be provided at all sag points or sump locations as a minimum. Inlet calculations are required where the major storm needs to be accommodated,

such as downhill cul-de-sacs or where there is potential for excessive ponding or overflow onto private property.

i) Oversized grates and/or secondary emergency inlets must be considered where leaves and/or debris collection is anticipated.

3.9.12 Service Connections

Service connections to the City storm system are required for all multi-family, commercial, industrial and institutional land uses.

Single Family Residential service connections to the City Storm system are required in instances where site conditions do not provide for safe infiltration or dispersal of storm water on site. The safe use of infiltration is to be confirmed by a qualified Professional.

a) Service connection requirements:
    i. The minimum storm service diameter for any property is 150mm.
    ii. Inspection chambers (ICs) are required to be installed as per **SS-S7** and **SS-S9**. Where this is not possible, identify offset on the record drawings and service card. An IC is not required on residential connections where the service is less than 2.5 m long and connected directly into a manhole.
    iii. Refer to Drawing **SS-S50** for all service connection requirements to a storm mainline.
    iv. All storm services 200 mm and larger require a manhole either on the storm mainline or on the storm service at the property line. The service manhole must be offset from the property line a sufficient distance to ensure replacement will not impact private property.
    v. Flow control manholes are to be installed on the private side of the property line as per Drawing **SS-S55**.
    vi. Service connections are permitted into manholes as per Drawing **SS-S1a**.
    vii. Depth to be minimum 1.2 m.
    viii. Minimum grade from property line to storm sewer main is 2%.
    ix. Wye fittings are preferred for service connections into proposed City storm sewers. Insertable tees are permitted into 250mm or larger existing mains.

b) Roof Leaders (drains):
    i. Where permissible and not in Hillside Areas, roof water is expected to be contained on site as part of best management practices to meet requirements for pre-development storm rate. Acceptable best management practices include splash-pad onto green space, rain harvesting systems or appropriately sized rock pits where soil infiltration parameters permit.
    ii. Roof leaders are not permitted to be directed to any infiltration device or soak away

pit near to or part of an engineered retaining wall or reinforced earth structure.

iii. Roof leaders or inlets from downward sloping driveways in Hillside Areas must be connected to the City storm sewer.

c) Perimeters Drains

i. Perimeter drains for buildings are required as per the British Columbia Building Code.

ii. Discharge may be to the surface or a soak away pit.

iii. Foundation perimeter drains are not permitted to be directed to any infiltration device or soak away pit that impacts an engineered retaining wall or reinforced earth structure.

iv. Foundation perimeter drains can be routed by gravity through a storm service to the storm sewer provided that:

- the elevation of the basement/crawlspace floor is at least 600 mm above the MBE (Section 3.6), or
- 600 mm above the anticipated or known high ground water table, or
- 600 mm above the 100 year hydraulic grade line within the sewer main at that point, whichever is higher.

v. Where a sump pump is required, a backflow prevention device must be installed as part of the mechanical configuration to prevent backflow into a basement from the City Storm sewer.

vi. As per Section 3.3.1, permanent groundwater pumping is not permitted to City storm sewers.

3.9.13 Perforated Sub-Drains

Perforated subsurface drainage systems designed for the purpose of permanent groundwater level reduction are not permitted to be connected to the City Storm sewer system.

3.9.14 Locations and Corridors

Wherever possible, storm sewers and service connections should be located within the public road right of way. Side or rear yard easements should be avoided where possible. Where it can't be avoided, statutory right-of-ways will be required for permanent City access.

3.10 Major System Design

The major drainage system includes all drainage pathways that convey, detain and/or intercept flows in excess of the capacity of the minor system. Its primary purpose is to provide flood protection for the 1:100 year return event. The major system generally includes surface flow paths such as ditches, swales, sewers, roadways, plus roadway culverts and watercourses.

3.10.1 Surface Flow Routing

All surface flows should have specially designed routes that are preserved and protected by right-of-ways and are accessible for maintenance. Design criteria include:

a) HGL is to be at least 600 mm below the MBE of adjacent buildings.

b) Maximum flow depth on roadways: 300 mm. Boulevards and intersecting driveway profiles will need to be set such that roadway surface flows are contained within the public right-of-way.

c) One lane, or a 3.5 m width at the crown of each roadway, is to be free from flooding.

d) Where a roadway is used as a major flow path, the road grades are to be designed to accommodate and control the flow at intersections.

e) Flood routing is not permitted on to private property except in engineered flow channels or sewers protected in a statutory right-of-way.

f) Overflow routes are required at all sags and low points in roadways and other surface flow routes.

g) Major flood routes are required to exit down-slope in cul-de-sacs with Statutory Rights of Way established.

3.10.2 Surface Flow Capacity

Flow capacity of road surfaces and swales can be calculated using the Manning formula, presented in Section 3.9.2, Time of Concentration. Typical values of the Manning Roughness Coefficient "n" are:

a) 0.018 for paved roadway

b) 0.03 for grassed boulevards and swales

c) 0.04 to 0.10 for irregular or treed channels.

Design detail is to include consideration of flow velocities and the potential requirement for erosion control measures. Ditches should be designed using a low n-value to determine velocity and provide the basis for stable channel design and a high n-value to determine ditch capacity and free board to prevent flooding or submergence of adjacent roadway subgrades.

3.10.3 Piped System

As noted in Section 3.2.1, the minor drainage system may be enlarged or supplemented to accommodate major flows in special circumstances. Modifications to the design criteria must be included in Stormwater Management Plan. Design considerations include:

a) Provision of adequate inlets to accommodate major flows. Capacity calculations are to be provided in the Stormwater Management Plan.

b) The requirement for surface overflow routes at potential surface ponding locations.

c) Flow depth and velocity.

d) Where applicable, design in accordance with minor drainage system guidelines.

3.10.4 Culverts and Bridges

The following service levels are to be used for design:

Road Class	**Design Flood Frequency for Bridges and Culverts**
Arterial and Collector	1:200 Year Flood
Local	1:100 Year Flood + provision for overflow if on major channel

The fishery value (aquatic classification) of the watercourse will establish the design requirements for the crossing. Particular designs will apply if fish passage is needed. Approvals are required under the BC Water Act and the Federal Fisheries Act, and may be required under the federal Navigable Waters Protection Act.

Culvert design is to be in accordance with the procedures outlined in an applicable design manual including but not limited to:

a) American Concrete Pipe Association - Concrete Pipe Design Manual

b) Corrugated Steel Pipe Institute - Handbook of Steel Drainage and Highway Construction Products.

c) Standards and Best Practices for ln-stream Works - Culverts, Province of British Columbia and DFO.

Inlet and outlet protection is required for all major system culverts. Design considerations are to include inlet control and outlet control conditions, energy dissipation and erosion control measures.

The City requires all municipal channel culverts 500mm or greater to be constructed with headwalls, end-walls and safety grillage as per Standard Drawings.

3.10.5 Watercourses

Natural watercourses are integral components of both the major drainage system and the ecological system. Riparian areas are to be preserved and/or enhanced to sustain habitat for aquatic and other wildlife as well as convey storm runoff.

Increases in peak storm flows and volumes to major watercourses and receiving waters shall be minimized. Consideration must be given to fish bearing streams and to streams presently at capacity.

Designers must consider all federal, provincial and municipal laws, regulations and guidelines noted above, and must obtain comments and approvals from the appropriate agencies.

Runoff Controls

Runoff controls are required to meet the objectives indicated previously. The controls may include:

3.10.6 Detention Storage

Detention storage is used to capture and store water on site to assure that storm releases are limited to the pre-development release rate for a 1 in 5 year storm. Drainage Basin Plans are available upon request to the City Engineer.

As a guideline, detention storage is not required on any lands west of Richter Street between Bernard Avenue to the north and Wardlaw Avenue to the South unless approved by the City Engineer. Where peak flow rates or volumes are increased and will cause detrimental impacts, provisions for downstream improvements must be provided in order to mitigate the impacts.

Detention storage options and design guidelines include the following:

3.10.7 Parking Lot Storage

a) Requires detailed lot grading design to ensure proper drainage, pedestrian safety and convenience, and major flow paths .

b) Maximum ponding depth: 300 mm outside vehicle stalls, 150 mm within vehicle stalls, however, also with consideration to frequency of ponding and impact to users of the parking lot.

3.10.8 Underground Storage

a) Facilities include tanks and oversized pipes, with outlet controls.

b) Tanks, fencing and graded slopes to be constructed off-line and on-site.

c) Cross sections and inlet and outlet locations should be designed to minimize maintenance requirements.

d) Structural design to accommodate traffic loads and groundwater pressure.

e) Maintenance access provisions required.

3.10.9 Dry Detention Ponds

a) Intended to provide storage only during severe storm events.

b) May be on-line or off-line, although off-line is preferred. Fencing and graded slopes required.

c) May accommodate active recreational uses.

d) Overflow elevations to be coordinated with MBEs.

e) Emergency overflow spillway to be constructed for 1:100yr storm event.

f) Design details, other than discharge rates should be in accordance with current technologies as outlined in Land Development Guidelines for Protection of Aquatic Habitat (Canada/BC).

g) Provide warning signage indicating facility is a stormwater detention structure subject to flooding or rapid water level changes. Signs to be posted at all public access points or road frontages.

3.10.10 Wet Detention Ponds

a) Intention is to provide on-line detention storage and maintain a permanent minimum water levels.

b) Catchment area must be large enough to provide sufficient base flow to ensure wet storage and is sustained without becoming stagnant (based on local hydrologic characteristics).

c) Generally located off-site, and must include fencing and graded slopes on-site.

d) Can provide a public amenity within a passive park.

e) Overflow elevations to be coordinated with MBEs.

f) Design details, other than discharge rates, should be in accordance with current technologies as outlined in Land Development Guidelines for the Protection of Aquatic Habitat (Canada/BC), and related documents.

g) Provide warning signage indicating facility is a stormwater detention structure subject to flooding or rapid water level changes. Signs to be posted at all public access points or road frontages.

3.10.11 Subsurface Disposal / Infiltration Systems

a) These systems are intended to promote stormwater retention and groundwater recharge.

b) Suitable for high permeability soils with low groundwater elevation. Geotechnical investigation is required.

c) Design details should be in accordance with current technologies as outlined in Infiltration systems guidelines in land Development Guidelines for the Protection of Aquatic habitat (Canada/BC), and related documents.

d) Stormwater infiltration basins planned for Hillside Areas must be designed by a qualified Professional with experience in hydrogeology. The design must be reviewed and confirmed by the City Engineer. See Section 3.1.4.

3.11 Outlet Controls

Outlet controls for storage facilities may be designed using the standard orifice and weir equations:

Orifice Equation:

$$Q = C\,A\,(2\,g\,h)^{0.5}$$

Where:

Q = release rate (m^3/s)
C = orifice coefficient (0.62 for sharp or square edge, 0.85 for rounded edge)
A = area of orifice (m^2)
g = gravitational acceleration (9.81 m/s^2)
h = net head on orifice (m)

Weir Equation:

$$Q = CLH^{1.5}$$

Where:

Q = release rate (m^3/s)
C = weir coefficient
L = effective length of weir crest (m)
H = net head on weir crest (m)

Larger storage facilities are to include provisions for discharges at rates greater than the design release rate (i.e., major storm event and emergency conditions). Rapid drawdown of the water level may be necessary for emergency purposes or to restore the available storage to accommodate subsequent storm events. Simple reducers are permitted on smaller facilities.

Orifices shall be fixed and designed to pre-development outflow rate. Adjustable mechanisms such as slide gates or removable orifice plates are not permitted unless approved by the City Engineer.

Design of inlet and outlet structures is to include consideration of energy dissipation and erosion control. Safety grates are required over all inlet and outlet openings larger than 500 mm diameter. Locks for access hatches are required.

The following is an introductory list of some runoff controls focused on water quality treatment.

a) Bio-filtration Swales and Constructed Wetlands

b) Intended to provide bio-filtration and sediment removal.

c) May be designed to provide on-line detention storage as well as quality treatment.

d) May be located on-site or off-site.

e) Qualified professional required for design.

f) Design requires consideration of climatic conditions.

3.11.1 Oil and Grit Separators

Oil and Grit Separators are required:

a) On site with parking for 50 or more vehicles (does not apply to parkades).

b) On all industrial zoned properties, unless it can be proven that there is no risk of storm water contamination.

c) Supplier design details are required.

Design criteria for Oil and Grit Separators must include:

a) Devices must have a current Canadian Environmental Technology Verification (ETV) or ISO 14034 ETV verification.

b) A target Total Suspended Solids removal of 60% of the ETV Particle Size Distribution.

c) Performance predictions for all proposed units.

d) A maintenance plan and commitment from all Owners. This will be included in the business license renewal.

e) A location on-site, including a Statutory Right of Way or covenant on title should the City need to inspect the unit.

3.11.2 Oil/Water Separators

a) Required for gas stations, vehicle service areas and storage areas for highway vehicles and construction equipment.

b) Design details in accordance with current technologies as outlined in Urban Runoff Quality Control Guidelines for British Columbia.

3.12 Drainage Pump Stations

Drainage pump stations are not commonly used in the City. Where drainage pumping is required, the designer must review the design concept and proposed guidelines with the City, submit a pre-design report and obtain approval of the City before proceeding with design. At a minimum, the pre-design report should include the following:

a) Delineated catchment area map

b) Estimated flows and HGL

c) Pump station location

d) Connection to existing infrastructure.

3.13 Erosion and Sediment Control (ESC)

All construction projects in the City require an Erosion and Sediment Control (ESC) Plan approved by the City. Storm water runoff from construction sites commonly contains significantly higher contaminant concentrations than storm water from developed sites. Poor construction practices and lack of attention to detail are contributors to sediment transport, in turn impacting both downstream infrastructure, aquatic habitats and Okanagan Lake.

Erosion and Sediment Control will be managed as a separate process with a cost identified as a separate line item in the development planning process

The following policies will be administered:

a) No Person may cause, or permit another Person to cause, sediment or sediment-laden water to discharge into the storm system, with concentrations greater than 75 milligrams per litre (ppm) of total suspended solids (TSS). A sample measuring greater than 60 nephelometric turbidity units (NTU) will be the trigger point where the sample must also be sent to the lab for analysis.

b) A Security Deposit for ESC Works equal to 3% of the Consulting Engineer's opinion of probable costs of civil earthworks and infrastructure will be added to the Servicing Agreement.

   i. The Security Deposit submitted is to secure the full and proper compliance with the provisions of the By-law. In the event, that the Owner, Developer, or Person Responsible has not complied with the provisions of this By-law, the necessary funds from the security deposit may be drawn down, at the City's option, and the money used either by the City or its agents to protect the storm system from sediment or sediment-laden water in adherence with the terms and conditions of this By-law. Notwithstanding, the City is under no obligation to initiate or complete remedial works in or under the Land.

   ii. If the amount of the security deposit is insufficient for the City to complete the ESC Facilities, the Owner and Developer jointly and severally will pay any deficiency to the City on demand.

c) The Owner must retain a Qualified Professional (P.Eng, RPBio, P.Ag, AScT, CPESC, CISEC or CESCL) responsible for inspecting and monitoring the ESC Facilities weekly and after any rain event which exceeds the intensity of 25mm of total rainfall depth in a 24-hour period. All records and data must be made available to the City upon request. Should a site be determined to be non-compliant, the Professional will be responsible for submitting notification and presenting a remediation plan to the City within two days of the event.

d) The ESC will include a construction plan and site management plan ESC features must be installed before any clearing, excavation, or soils mobilization takes place.

e) The fundamental approaches to effective ESC include:

   i. reduce clearing and grading and preserve natural vegetation as much as possible;
   ii. phase construction to limit soil exposure at any one time, particularly in wet seasons;
   iii. stabilize exposed soils as quickly as possible, whether temporary or permanent;
   iv. protect slopes and cuts;

v. prepare the site to limit soil tracked off-site by haul vehicles;
vi. sweep off-site streets when dirt is tracked;
vii. filter runoff water before it leaves the site;
viii. install filters or barriers to protect downstream drains and inlets;
ix. adjust ESC plan to suit changing weather and construction phasing;
x. assess ESC practices after rain event; and
xi. maintain the works throughout construction.

Ideally, practices and features are put in place to prevent erosion from occurring in the first place, but realistically some degree of erosion and sediment transport will occur. When it does, other practices and features are to intercept and capture the sediment before reaching vulnerable areas. As such, the following sub-sections introduce ESC practices in two core categories; erosion control and sediment control.

3.13.1 Erosion Control

Rainfall and wind can aggressively displace and transport soil, although rainfall tends to be the more damaging in BC climates. The soil composition has a significant bearing on its erosion potential. The first line of defense is to either maintain or provide protective cover to the soil. Ideally, natural vegetative cover is maintained for areas that do not need to be disturbed. Where soils do need to be exposed or stockpiled, temporary covers should be applied when rainfall events are imminent.

For exposed site areas, straw mulch is the most common form and can be effective with low cost. However, it is commonly not applied thick enough or replenished frequently enough. It is important that a uniform blanket be provided and refreshed as the straw decays or is displaced. For the most part, bare soil should not be visible.

For steeper slopes, or for areas exposed and inactive for considerable time, manufactured erosion control blankets may be most appropriate. There are many products available and local suppliers should be consulted for the selection of the appropriate one. While they have a higher purchase cost, with proper selection and installation they will provide longer and more effective service with far less maintenance than straw mulch.

For soil stockpiles, poly tarps should be applied when the stockpile is inactive, including short overnight periods if there is any threat of precipitation. If inactive for considerable time, other measures such as temporary seeding, mulching, or matting may be considered.

Once disturbance to an area is complete, permanent cover practices should be established as soon as possible. Top dressing the area with topsoil having high organic content in itself can be a significant benefit; a minimum of 100 mm should be applied for purposes of erosion control. Greater depth is often required to meet landscape growing medium and hydrologic management needs. Sodding, broadcast seeding, hydro-seeding, and drill seeding are acceptable methods to re-establish a blanket of vegetative.

Aside from maintaining good quality ground cover, there are a number of other techniques that can be applied as erosion control, including the following, but not necessarily limited to those below. They should be selected based upon the specific conditions and requirements of the site.

Construction of stable haul roads for transport vehicles coming and going from the site is required.

At a minimum, haul roads include 200 mm of a coarse granular running surface, but strong consideration for underlying filter fabric, and potentially geogrid reinforcing in weak soils, should be given;

a) Intercept trenches on the upstream edges of the working area to redirect runoff;

b) Terracing steeper slopes;

c) Scarifying the soil surface;

d) Bio-engineered protection of very steep slopes;

e) Rip-rap with appropriate underlying filter.

3.13.2 Sediment Control

Silt fences can be an effective barrier to contain soil, but are not an effective filter of sediment laden runoff. Their permeability is insufficient to allow water to pass through, and therefore more commonly act as a dam which is then often undermined or circumvented by the flow of water. When used appropriately as a soil containment barrier, they must be sufficiently installed and maintained. Design criteria include: stakes should be > 7.5cm in diameter and > 1.5m long and driven > 40cm into the ground; stakes should be < 2.4m apart unless wire backing is used; and bottom should be buried in a trench > 20cm.

a) Storm drains and catch basins potentially receiving site runoff are to be protected with filters.

b) Straw bales and gravel berms are to be used within flow paths to slow water and promote trapping of coarse sediment. Note that these are less effective for fine sediment.

c) Dust control is required at all times.

d) Soil transport from vehicles coming and going from the site must be controlled. Where a wheel wash facility is constructed, wash water must be appropriately contained and treated prior to release off-site.

e) Sediment ponds (or basins) are generally applied to larger construction sites (> 2 hectares) to settle suspended sediments larger than 0.02mm. The outlet should consist of a perforated riser pipe with a gravel jacket. Internal gravel baffles are to be installed to create individual cells to reduce velocities and prevent short circuiting of flow to the outlet. As a design guideline, ponds should be sized to accommodate 125 m^3/ha of site area. Of this volume, at least 20% should be dedicated to a forebay. The remainder, as a permanent pool, should measure 1.3-1.8m in average depth, and not exceed 2.4m.

f) Sediment traps are similar to sediment ponds, but designed for small sites. Generally fed by swales, these facilities are located on the low-side of the site to receive site runoff water and allow settling of solids before discharge off-site.

4 DESIGN STANDARDS HIGHWAY

BL10696 amended the following:

4.1 General
4.2 Road Classification
4.3 Vertical Alignment
4.4 Horizontal Alignment
4.5 Road Cross-Section
4.6 Curb and Gutter, Sidewalks and Bikepaths
4.7 Appurtenances
4.8 Pavement Structure
4.8.1 Subgrade Preparation
4.8.2 New Pavement Design
4.8.3 Design of Overlays for Existing Pavements

LIST OF TABLES

NO.	TITLE	PAGE
Table 1	*Roadway Classification*	*3*
Table 2	**Geometric Standards**	**5**
Table 3	**Asphalt Depth vs. Design Traffic**	**9**
Table 4	**Base Quality Requirements**	**10**
Table 5	**Minimum Standard Pavement Structures**	**11**
Table 6	**Benkleman Beam Criteria for Overlays**	**12**

4.1 General

All highways (roads, lanes, Active Transportation Corridors) within the City of Kelowna shall be designed with good engineering judgement, in accordance with the recommended practice as outlined in the most current editions of the following design guidelines, unless specifically addressed by City Bylaw or policy:

- Transportation Association of Canada – Geometric Design Guide for Canadian Roads;
- Transportation Association of Canada – Manual of Uniform Traffic Control Devices for Canada;
- Other applicable Transportation Association of Canada best practice design guides, such as but not limited to, the Canadian Roundabout Design Guide, the Canadian Guide to Traffic Calming, Pedestrian Crossing Control Guide and Bikeway Traffic Control Guidelines for Canada;
- Master Municipal Construction Documents Association – Design Guidelines;
- British Columbia Active Transportation Design Guide, and
- BC Transit Infrastructure Design Guidelines

Developments may require Frontage Roads, double Frontage lots, deep lots with rear service Lanes, or such other treatment as may be necessary in the public interest for the adequate protection of residential properties and to afford separation of through and local traffic.

In reviewing engineering plans, the Approving Officer or Building Inspector must consider the sufficiency and suitability of the proposed Road system, the arrangement, width, grade and location of all Roads in relation to existing and planned Roads, to topographical features, to public convenience and safety, and to the proposed uses of the land to be served by suchRoads.

The arrangement of Highways in a Subdivision must either:

(a) provide for the continuation or appropriate projection of existing Roads in surrounding areas;or
(b) where topographic or other conditions make continuation or projection of existing Roads impractical, provide an adequate and suitable Highway system having regard to the uses of the land to be served.

The dimensions, locations and standard of all Roads in a proposed Subdivision must conform substantially to any applicable community plan.

Local residential Roads must be aligned so that their use by through traffic will be discouraged.

Cul-de-sac Roads, designed to be permanent, must be provided at the closed end with an area designed to permit safe and adequate space for the turning of motorvehicles.

Walkways must be provided where they are deemed desirable to provide access through the Subdivision to schools, playgrounds, shopping centres, transit, beaches and other community facilities or for proper circulation of pedestrian traffic.

Jogs in Highway alignment at intersections may be allowed provided that the distance between centre lines is sufficient to maintain traffic safety.

Intersections are to be designed and located within a range of angles between 70º and 110º.

To reduce vehicular delays and for safety considerations, modern roundabouts must be considered as the first option for intersection designs where all way stop control or traffic signals are warranted by traffic analysis.

In the design of all street intersections, including those with lanes and walkways, the Consulting Engineer must give consideration to providing adequate sight and stopping distances for conflicting traffic streams involving pedestrians, bicycles and/or vehicles. The City of Kelowna Traffic Regulation Bylaw No. 8120 prohibits sight

obstruction greater than 1 m in height within 8 m of intersections.

If reversed curves are required in a Highway alignment, the City Engineer may require that they be separated by means of tangents of sufficient length.

Where angular deflections occur in a Highway alignment, the City Engineer may require that the angle be replaced by a curve of suitable radius.

Designs for significant work to a major collector or arterial road identified on the Major Road Network and Road Classification Plan, must undertake an independent Road Safety Audit.

Road name signs and traffic signs required as a result of constructing or improving Roads must be provided by the City of Kelowna at the expense of the Owner.

Transit bays must be provided where required by the City Engineer.

4.2 Road Classification

The roadway classification applicable to the Road under consideration will be determined from Table 1. Where topographical or other conditions make continuation or projection of an existing street impractical, the City Engineer will review the Developer's proposal and may approve the alternative.

NOTE: All vertical and horizontal alignment elements will be designed utilizing information from Tables 1 and 2 and in accordance with:

1. Transportation Association of Canada - Geometric Design Guide for Canadian Roads, 2017 Edition.

TABLE 1 – ROADWAY CLASSIFICATION

Road Class/R.O.W. Improvements	Road Allowance Width (min.)	Surface Width (min.)	Curb Type	Standard (Dwg. No.)
LANES				
Residential and Emergency and Private Access Roads	6.0	6.0	N/A	SS-R2
Commercial	7.6	7.6	N/A	SS-R2
LOCAL STREET				
Class -1, 2 Lane - ULU	18	10.3	Rollover N/A	SS-R3
- RLU	18	7.0	Rollover N/A	SS-R3
Class -2, 2 Lane - ULU	15	9.1		SS-R4
- RLU	15	7.0		SS-R4
COLLECTOR STREETS				
Class -1, 2 Lane - UCU –	20	13.1	Barrier	SS-R5
- RCU -	20	10.0	N/A	SS-R6
Class -1, 2 Lane - UCU – with BikeLanes	22	14.5	Barrier	SS-R7
- RCU - with Bike Lanes	22	10.0	N/A	
Class -2, 2 Lane - UCU -	18	11.3	Rollover N/A	
• RCU -	18	10.0		
ARTERIAL STREETS				
Class -1, 4 (6) Lane - UAD - Parkway	35	21.5	Barrier	SS-R8
Class -1, 4 Lane (Ult.) - UAD - Parkway	30	21.5	Barrier	SS-R9
Class -1, 2 Lane (Stage I) - UAD - Parkway	30	21.5	Barrier	SS-R10
Class -1, 2(4) Lane - RAD -	30	20.6	N/A	SS-R11
Class -2, 4 Lane - UAD - Residential	30	20.9	Barrier	SS-R12
Class -2, 3 Lane (one way) -UAU – Residential	20	12.3	Barrier	SS-R13
Class -2, 2 Lane - RAU - Residential	20	10.3	N/A	SS-R14
Class -3, 4 Lane - UAU - TwnCntre	28	20.9	Barrier	SS-R15
Class -3, 3 Lane (one way) - UAU - TwnCntre	25	17.7	Barrier	

Note the following definitions:

ULU	-	Urban/Local/Undivided	RCU	-	Rural/Collector/Undivided
RLU	-	Rural/Local/Undivided	UAU	-	Urban/Arterial/Undivided
UCU	-	Urban/Collector/Undivided	UAD	-	Urban/Arterial/Divided
RAU	-	Rural/Arterial/Undivided	RAD	-	Rural/Arterial/Divided

Surface Width - on urban section, this measures from face of curb to face of curb

- on rural section, it measures from the edge of asphalt to edge of asphalt.

4.3 Vertical Alignment

The vertical alignment of roads must be set so the grades of driveway to adjacent properties will conform to MMCD Drawing C7. Where it is impractical to meet this criteria, the City Engineer may approve the use of private access roads.

The minimum and maximum road centreline grades allowed on various classes of roads must be as per Table 2.

TABLE 2 - GEOMETRIC STANDARDS

Facility Classification	Design Speed (km/h) (min.)	% Super. Elevation (max.)	Radius (metres) (min.)	% Grade		K-Value (min.)			Sight Distance (min.)	
				Min.	Max.	Crest	Sag		Stopping (metres)	Decision (metres)
							No Illum.	Illum.		
Walkway				1.0	15					
Emergency Access	30		12	1.0	15		2			
Driveway Single Fam.				1.0	15					
Driveway Multi-Fam.	30			1.0	12					
Rear Laneway See Notes Below	40	*I.C.	18	1.0	12 (10)	4	7	4	45	110 - 160
Local Roadway See Notes Below	50	*N.C.	100	0.5	12 (10)	7	11	6	65	140 - 190
Collector Roadway See Notes Below	50	6 (4)	115 (500)	0.5	10 (8)	7	11	6	65	140 - 190
Arterial Roadway See Notes Below	70	6 (4)	190 (1,000)	0.5	8 (6)	22	25	15	110	200 - 270

Notes: 6% super-elevation only permitted on collector roads in segments without intersecting roads or private access.

Notes: Through roads at an intersection are governed by the numbers shown in brackets, with the reduced grades on each side of the intersection for a distance equivalent to the "stopping sight distance".

*Inverted Crowns (I.C.) and Normal Crowns (N.C.) shall be built with 2% crossfall.

At road intersections, the minor road and/or cul-de-sac must be constructed with an approach grade of not greater than 3% for a distance of not less than 15 m from the adjacent edge of asphalt of the major road.

The draining grade around the outside curb of a cul-de-sac must be not less than 0.50% and not greater than 5.00%. Longitudinal gradients of cul-de-sac bulbs shall not exceed 5.00%.

When a cul-de-sac is at the bottom of a hill, the longitudinal gradient of the first 50m of roadway uphill from the cul-de-sac bulb shall not exceed 5.00%. The maximum longitudinal gradient for the rest of the hill shall not exceed 8.00%.

When a cul-de-sac is at the top of a hill, the longitudinal gradient for the roadway downhill from the cul-de-sac must not exceed 12.00%.

All changes in gradient over 1.00% on arterial and collector Roads and over 2.00% on all other road classifications must be connected by vertical curves. Vertical curves must be designed in accordance with the latest edition of the Geometric Design Guide for Canadian Roads as published by the Transportation Association of Canada.

Standard cross slopes (normal crown) must be 2.00% on all road classifications unless specified otherwise by the City Engineer. Design road elevations must give due consideration to flood-proofing requirements of adjacent properties. Full road crossfall (reverse crown) may be considered in special circumstances, as a means of more closely matching property grade adversity on either side of thehighway.

The length of a transition from a normal cross-sectioned road to a section of road where there is super-elevation or crossfall must, in no case, be less than 70 m for a 50 kmh designed road or 110 m for a 70 kmh designed road. In selecting the length of the transition, care and consideration must be given to draining all of the pavement. Typically, if no horizontal spiral curve is used, 60% of the super-elevation is introduced prior to the beginning of the curve, and the balance is developed in the curve.

Gutter elevations on curb returns and cul-de-sacs must be shown on the drawings at the beginning, one- quarter points and end of curb returns and at 7.50 m intervals around cul-de-sacs.

4.4 Horizontal Alignment

The horizontal centreline alignment of the road will be located on the centreline of the right-of-way, unless approved otherwise by the City Engineer. Typical locations of works and utilities in Roads are shown on Standard Drawings.

Centreline chainage stations must be fully referenced and dimensioned from property lines.

Minimum radius of curve and maximum super-elevation normally allowed are shown in Table 2 (Geometric Standards). The Minimum radius of curb return at intersections must be 7.50 m. Transitions in road widths, tapers, etc., must be formed with smooth curves and tangents, including no less than 30:1 for

50 km/h design speeds and preferably 40:1 tapers.

A horizontal curve must be fully described showing internal angle, radius, tangent length and arc.

Curb returns located on roads within industrial and commercial districts may require a larger radius to facilitate truck traffic and bus traffic, and will be as specified by the City Engineer.

When a new road with curbs intersects an existing road without curbs, only half the curb returns must be constructed unless the road design for the uncurbed road is available and will allow construction of the full curb returns. Full curb returns must be constructed at the intersection of two curbed roads.

A cul-de-sac, turn-around, or a second point of access is required at the terminus of roads longer than 90m.

4.5 Road Cross-Section

The standard Road cross-section shall be as detailed in Table 1. Measurement for roadway width shall be measured from face of curb, or edge of asphalt, to centreline of paint line.

Note that the objectives of the standard road cross-sections as detailed in Table 1 and the Standard Drawings are the clear and intended goals on all roadways within the City of Kelowna. It is recognized, however, that ambient conditions may require variance from these standards in existing and substantially "built-up" areas, where provisions to accommodate the required roadway modification may not have been anticipated. A variance to these standards may be considered by the City Engineer.

For the design of local and collector roads with on-street parking, curb extensions shall be considered at intersections and at pedestrian crossings.

For road designs in rock cut sections, a rockfall catchment area sized by a qualified Geotechnical Engineer (minimum 3.0m wide), is required. The rockfall catchment area is defined as the area between the edge of the highway pavement (or back of sidewalk if present) and the base of the rock slope. This structure has the function of preventing fallen rock from reaching the highway (or sidewalk) surface and intercepts seepage water from the rock cut.

For all urban roads in cut sections greater than 1 m, a 100 mm perforated subdrain located 600 mm deep (minimum dimensions), is required behind the sidewalk or curb. The sub-drain shall connect to the nearest catchbasin with a long radius bend and include an inspection chamber with service box at the top end.

4.6 Curb and Gutter, Sidewalks and Bike Lanes

The standards for curbs, gutters, sidewalks and bike lanes shall be as detailed in Table 1 and in the MMCD standard drawings and City of Kelowna supplemental drawings to the MMCD.

Each property shall only have one (1) driveway access per road frontage. Upon demonstrated need and approval from the City Engineer, more than one (1) driveway access may be granted to service stations, major commercial and other developments. Where a lot abuts a lane or road of different classification, the driveway shall be located to access the lane or road of the lower classification.

Residential driveway access onto an arterial or Class 1 collector road, is not permitted unless alternate access is impossible. Wherever physically possible, alternate local road or lane access shall be dedicated to preclude residential driveways accessing directly onto major roads.

Residential driveway accesses serving corner lots shall be a minimum of 7 m from the lot corner nearest the intersection. All residential driveway accesses shall have a minimum width of 4 m and a maximum width of 6 m.

Driveway accesses to commercial and industrial corner lots shall be a minimum of 15 m from the property line of the adjoining road. The maximum width of a driveway to a commercial or industrial property having only one access shall be 11 m. The maximum width of each driveway to a commercial or industrial property having more than one access shall be 9 m. A variance to these standards may be considered by the City Engineer.

At the discretion of the City Engineer, access to large parking areas shall be by curb returns rather than a driveway letdown. The City Engineer may require deceleration and acceleration lanes for access off major roads for safety reasons and to minimize disruption to traffic flows. Design of such access shall follow the recommendations in the Ministry of Transportation & Highways, Highway Engineering Branch "Design Manual".

Wheelchair ramps must be provided at all intersections as an integral part of the sidewalk.

4.7 Appurtenances

All proposed traffic islands, retaining walls, guard-rails, and permanent barricades must be designed in keeping with good engineering practices.

Traffic control devices shall be designed and installed in accordance with applicable and current City of Kelowna requirements.

For all utility poles and tie-downs which require re-locating prior to road construction, the utility must confirm the feasibility of their re-location prior to design completion.

4.8 Pavement Structure

4.8.1 Subgrade Preparation

Subgrade preparation shall be considered integral for construction of new roads.

Frost Susceptible Soils (ML): The susceptibility of soils to frost heave is commonly classified using the US Corp of Army Engineers four categories, as shown in Table 15.2 of the "Canadian Foundation Engineering Manual", 3rd edition, 1992. All geotechnical reports shall address the frost susceptibility of the subgrade soil.

Swelling Soils (CH): Pockets of soils known to change volume with variation of moisture content are known to exist in several locations within the limits of the City of Kelowna. These soils are typically identified as high plastic clays (CH) using the Unified Soil Classification System and Atterberg Limits index test (ASTM D4318). Where these soils are encountered as subgrade, special subgrade preparation considerations are required, as outlined below.

Scarification should render the subgrade to cohesive pieces of a maximum size of 20 mm to allow adequate moisture conditioning of the soil. The soil should be moisture conditioned to achieve a homogeneous moisture content between 0 and 3% over optimum. Following moisture conditioning, the subgrade soil should be compacted to a minimum of 95% of Modified Proctor density, as determined by ASTM D1557. The subgrade should be covered with granular sub-base as soon as practical to minimize the variation of the moisture content in the subgrade. The contractor should be aware that additional moisture condition and compaction may be required, at the contractor's expense, should the moisture content be allowed to vary significantly from optimum prior to placing the sub-base.

4.8.2 New Pavement Design

Designers of pavement structures shall consider four primary factors in undertaking a specific design. These are:

Subgrade support quality (geotechnical report)

Design life (20 years)

Traffic loading (expressed in ESALs)
Climate

New pavement structures shall be designed in accordance with the methodologies presented in "AASHTO Guide for Design of Pavement Structures", 1993. The pavement structure shall be designed for a twenty (20) year design life.

The AASHTO design method is based on a Structural Number (SN) for the entire pavement structure (i.e. hot mix asphalt, granular base and granular sub-base). The method incorporates the subgrade strength expressed as the Subgrade Resilient Modulus (Mr), and design loading (ESALs). Each component of the pavement structure is assigned a layer coefficient.

Subgrade strength is frequently characterized utilizing the California Bearing Ratio (CBR) test procedure (ASTM D1883). This test should be performed on soaked subgrade soil specimens compacted to 95% of Modified Proctor density as determined by ASTM D1557. The Resilient Modulus may be approximated from the soaked CBR test values using the following relationships:

Mr (MPa) = 10.3 CBR, or
Mr (psi) = 1500 CBR

The soaked CBR properties of subgrade soil should be determined at a frequency of at least one test per every 150 lineal metres, or a portion there of, and for each major soil type encountered. Where more than one test is required, the tests should be evenly spaced.

The required SN for the pavement structure is the sum of the product of the layer coefficient, the component thickness, and a drainage coefficient for each component:

eq'n (1) $SN = a_{ac}D_{ac} + a_bD_bM_b + a_{sb}D_{sb}M_{sb}$

where:

SN	=	Structural Number for pavement structure
a_{ac}	=	layer coefficient for hot mix asphalt (0.4)
a_b	=	layer coefficient for granular base (0.14)
a_{sb}	=	layer coefficient for granular sub-base (0.10)
D_{ac}	=	Thickness of hot mix asphalt (mm)
D_b	=	Thickness of granular base (mm)
D_{sb}	=	Thickness of granular sub-base (mm)
M_b & M_{sb}	=	layer drainage coefficient (1.0 for Kelowna)

Road classifications, design traffic values and minimum depths of hot mix asphalt and granular base components of the total pavement structure are defined in Table 3.

Table 3 - Minimum Asphalt & Granular Base Depth vs Design Traffic

Road Classification	Design Traffic (ESALs) (1)	Minimum Depth of Hot Mix Asphalt	Minimum Depth of Granular Base
Walkways	n/a	50	75
Local, Lanes & Access Roads	2.8×10^4 (28,000)	50	75
Collector	2.8×10^5 (280,000)	100	75
Arterial (2)	1.0×10^6 (1,000,000)	100	75

Notes:

(1) See Part 1 – Chapter 1 of AASHTO for definition of an Equivalent Single Axle Load (ESAL).

(2) Special design reviews may be requested by the City Engineer.

Standard pavement structures, including required SN values, are provided on Table 4 for three strengths of subgrade. The standard pavement structures incorporate the minimum depths of hot mix asphalt and granular base shown in Table 3.

Table 4 - Standard Pavement Structures

Street Classification	Structure Component	Thickness in mm for Soaked CBR [1] of		
		3.0[4]≤CBR≤5	**5.0≤CBR≤10**	**CBR≥10**
Walkways	Asphalt - Surface Course	50	50	50
	Granular Base	75	75	75
	Granular Sub-base [3]	150	150	150
	Required SN Value	n/a	n/a	n/a
Local, Lanes & Access Roads	Asphalt - Surface Course	50	50	50
	Granular Base	75	75	110 [2]
	Granular Sub-base [3]	275	165	0
	Required SN Value	58	47	35
Collector	Asphalt - Surface Course	40	40	40
	Asphalt - Base Course	60	60	60
	Granular Base	75	75	100 [2]
	Granular Sub-base	335	185 [3]	0
	Required SN Value	84	69	53
Arterial	Asphalt - Surface Course	40	40	40
	Asphalt - Base Course	60	60	60
	Granular Base	75	75	75
	Granular Sub-base	535	355	155 [3]
	Required SN Value	104	86	66

Notes:

(1) Soaked CBR value shall be at 95% of Modified Proctor maximum dry density and optimum moisture content, as determined by ASTM D1557.

(2) Placement of equivalent sub-base layer is not practical and shall be replaced with additional granular base.

(3) Maximum aggregate size of sub-base material to be no more than 50% of total depth of sub-base.

(4) Where the top 1 m of subgrade has a soaked CBR value of less than 3, then the subgrade strength should be supplemented with an additional thickness of granular sub-base material in order to achieve a soaked CBR value of 3 or greater. The thickness of the supplemental sub-base and the corresponding composite CBR value for the top 1 m of composite subgrade can be determined by the following formula:

$$\text{CBR Composite} = ((t_{ssb} \times CBR_{ssb}^{0.33} + (100 - t_{ssb}) \times CBR_{sg}^{0.33})/100)^3$$

Where CBR Composite is 3 or greater.

t_{ssb} = thickness of supplemental sub-base (cm). CBR_{ssb} = CBR value of supplemental sub-base. CBR_{sg} = CBR value of subgrade soil.

Design pavement structure to be placed on a prepared subgrade or adequately compacted fill embankment. Refer to Section 4.8.1 and 02226 of the MMCD.

Granular base and granular sub-base to have a minimum soaked CBR value of 80 and 20, respectively (refer to City Supplemental S02226).
For design purposes, the maximum subgrade soaked CBR value shall not exceed 10.

Required physical properties for granular base and granular sub-base are given in Schedule 5, Section S02226.
Staged construction may be considered by the City Engineer when a road is to be constructed and to be widened at a later date.

Table 4 provides standard pavement structures for roads constructed on only three strengths of subgrade. Alternate pavement structures may be designed based on the SN determined using Figure 1. For example, for a Collector Road with soaked subgrade CBR value of 4, then the corresponding pavement structure requires a SN of 75. Using eq'n (1), and the specified layer coefficients, a suitable pavement structure alternative may be determined as shown on Table 5:

Table 5 - Example Pavement Structure

Pavement Structure Component	Thickness, D (mm)	Layer Coefficient, a	SN
Hot Mix Asphalt	100	0.40	40
Granular Base	100	0.14	14
Granular Sub-base	210	0.10	21
Total SN			75

Note that the minimum depths of hot mix asphalt and granular base shown on Table 3, and the required SN have been met.

The curves shown on Figure 1 are derived from the methodologies presented in AASHTO. A description of all variables used to derive the curves is presented in the MoT Technical Circular T - 9/95, "Pavement Design Standards".

5 ASHTO Structural Number (SN) Values
for Kelowna Street Classifications
as a Function of Soaked Subgrade CBR Value

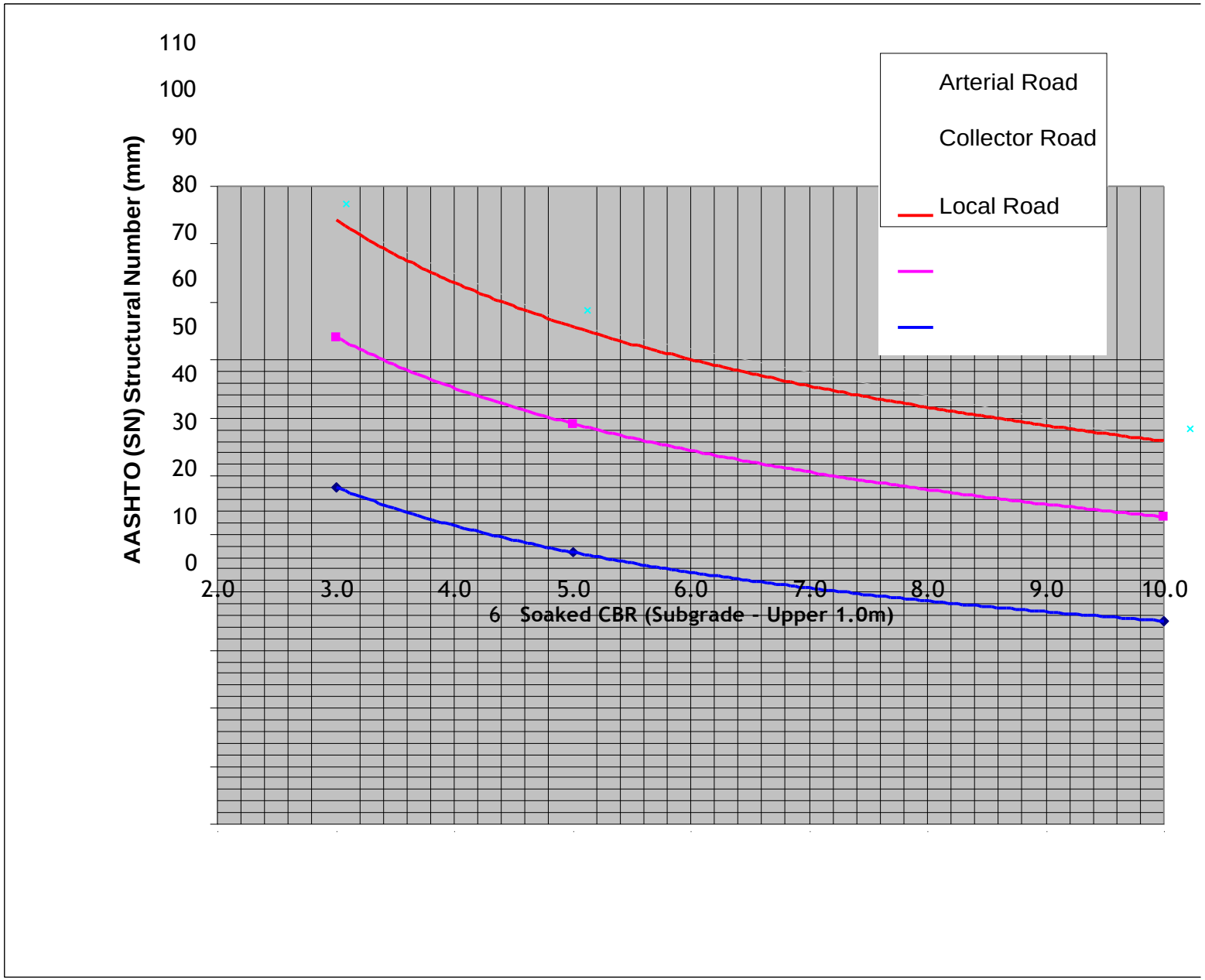


FIGURE 1

4.8.3 Design of Overlays for Existing Pavements

Overlay designs for existing pavements are to be performed in accordance with "Technical Publication No. 12" published by the Roads & Transportation Association of Canada. The design criteria for overlays are based on limiting Benkelman Beam deflections as follows in Table 6:

Table 6 - Benkelman Beam Criteria for Overlays

Road Classification	Maximum Deflection (mm)
Arterial Roads	1.00
Collector Roads	1.25
All Other Road Classifications	1.50

Notes:

(1) The design Benkelman Beam rebound ($x + 2\square$) should be determined on the basis of at least 10 uniformly spaced readings per two-lane kilometre (one half in each lane).

(2) The summary rebound statistic for a pavement section should be seasonally adjusted to the spring peak rebound value.

5 Roadway Lighting

5.1 General
5.2 Codes, Rules, Standards and Permits
5.3 Roadway and Pedestrian Criteria
5.4 Light Measurements
5.5 Variable Lighting Criteria
5.6 Street Lighting
5.7 Sidewalk Lighting
5.8 Intersection Lighting
5.9 Crosswalk Lighting
5.10 Walkways
5.11 Roundabout Lighting
5.12 Tunnel Lighting
5.13 Poles
5.14 Pole Foundations
5.15 Luminaires
5.16 Power Supply and Distribution
5.17 Design

5.1 General

Street Lighting (also referred to as Roadway Lighting) generally refers to lighting of streets and roadways including sidewalk, crosswalks, intersection, roundabouts, walkway and tunnels. The principal purpose of street lighting is to enhance visibility at night. For a pedestrian, street lighting improves visibility of the surroundings and the sidewalk, while for the driver of a motor vehicle it increases visibility resulting in more time to stop or to maneuver around an obstruction. Good lighting has been shown to significantly reduce night-time collisions specifically on urban streets, urban and rural intersections, roundabouts and mid-block crosswalks.

This bylaw is intended to provide some basic lighting and electrical criteria and guidelines to aid in the design of street lighting. Further information should be obtained from the most current edition of the Transportation Association of Canada (TAC) Guide for the Design of Roadway Lighting. Those undertaking street lighting design must be knowledgeable of all parts of the TAC guide.

These design guidelines are not intended to be a substitute for sound engineering knowledge, experience in street lighting design and the Canadian Electrical Code. Roadway lighting designs should be prepared under the direction of a design professional registered with Engineers and Geoscientists of British Columbia (EGBC).

5.2 Codes, Rules, Standards and Permits

Street lighting shall be designed to meet the required levels of illumination and uniformity at the lowest

annual cost to the City. Streetlight materials selected must be based on minimizing energy demand, long term annual costs, including replacement costs and maximize service life. Street lighting systems shall be designed in general conformance with the following.

5.2.1 Codes Rules and Regulations

- Canadian Electrical Code, latest edition, and bulletins issued by Electrical Safety Branch of the Province of British Columbia.
- AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals or CAN/CSA-S6-00 Canadian Highway Bridge Design Code,
- WorksafeBC,
- Canadian Standards Association (CSA),
- Local Power Utility Company regulations,
- Regulations issued by municipal, provincial and federal Authorities.

5.2.2 Standards and Guidelines

- TAC-Guide for the Design of Roadway Lighting,
- Canadian Standards Association (CSA),
- Local Power Utility Company regulations,
- MMCD Standard Specifications and Drawings, plus Supplementary Specification Drawings,
- Approved Products List 266 and Council Policy 265.
- IESNA RP8 (current revision)

5.2.3 Permits

- Electrical Permits as required by provincial or municipal inspection authorities

5.3 Roadway and Pedestrian Criteria

Street lighting illumination levels are defined by the road classification and the pedestrian activity level on the sidewalk adjacent to the roadway..

Street classifications are defined as follows:

- Arterial: Serves a continuous route primarily for inter-community through-traffic.
- Collector: Performs the dual function for traffic of land access and movement between arterial and local streets.
- Local: Provide direct land access and is not intended to carry through traffic.

Night-time pedestrian activity levels on sidewalks and in crosswalks are defined as follows.

- High: Areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness.
- Medium: Areas where lesser numbers of pedestrians utilize the streets at night, Typical are downtown office areas, blocks with libraries, apartments, neighbourhood shopping, industrial, parks, and streets with transit lines.
- Low: Areas with very low volumes of night pedestrian usage. These can occur in any of the cited roadway classifications but may be typified by suburban single family streets. Very low density residential developments, and rural or semi-rural areas.

The choice of the appropriate pedestrian activity level for a street should be based on engineering judgement. If needed, one-hour pedestrian counts can be taken during the first hour of darkness on selected days, to estimate average pedestrian traffic counts. A section of typical land use can be sampled by counting one or two representative blocks, or a single block of unusual characteristics can be counted, perhaps at a different hour, such as discharge from a major event Recommended pedestrian activity levels are defined as follows:

- Low- 10 or fewer
- Medium – 11 -99
- High – 100 or more

These volumes represent the total number of pedestrians walking in both directions in a typical block or 200-meter section. Additional definition are as follows:

- Sidewalk: Pedestrian movement adjacent to the street
- Walkway: Pedestrian movement away from the street
- Crosswalk: Marked pedestrian access across a street
- Bikeway: Marked area between the sidewalk and street. From a lighting perspective a bikeway shall be considered part of the street and street lighting levels shall therefore apply to the street and bikeway.

5.4 Light Measurements

5.4.1 Illuminance

When lighting is incident upon a surface, it creates "illuminance" on that surface. Illuminance is a measure of the light landing on a defined area therefore, the more lumens on a given surface area, the greater the level of illuminance. The illuminance method of design is used for lighting sidewalks, crosswalks, intersection and roundabouts and curved streets. Illuminance can be calculated using two methods vertical or horizontal.

5.4.2 Luminance

Luminance is the concentrations of light (intensity) reflected towards the eyes per unit area of surface. As road surfaces do not reflect light uniformly, reflectance varies depending on the angle of the incident light in both the vertical and horizontal plane, and, on the angle that the driver views the pavement. For a Luminance calculation the driver's viewing angle is fixed at one degree below the horizontal and an observer distance of approximately 83m. The luminance design method is suitable for straight sections of a street and tunnels.

5.4.3 Veiling Luminance

Veiling luminance (also referred to as disability glare) may be numerically evaluated. Because of contrast reduction by disability glare, visibility is decreased. Increasing the luminance level will counter act this effect by reducing the eye's contrast sensitivity. As glare limits our visibility, veiling luminance is an important consideration.

The effect of veiling luminance on visibility reduction is dependent upon the average lighting level, or average luminance level, of the pavement.

5.5 Variable Lighting Criteria

5.5.1 Light Sources and Luminaries

Light sources shall be LED and selected from the City of Kelowna Approved Products List, which is subject to change from time to time.The list is based on a review of energy efficiency and cost/benefit of installation and ongoing operation. The City is sensitive to light pollution and selects luminaires that are night sky friendly, meaning that they minimize glare while reducing light trespass and skyglow.

5.5.2 Light Loss Factor (LLF)

A Light Loss Factor of 0.8 is to be applied.

5.6 Street Lighting

Street lighting levels for various street types and night-time pedestrian activity levels are defined in the the Transportation Association of Canada Guide for the Design of Roadway Lighting.
Luminance calculations should be used for straight sections of roadway but are not practical on curved and steep grade roadways. Lighting for curved sections (less than 600m radius) and steep grades (6% or greater) should be calculated using horizontal illuminance values.
Use R2/R3 pavement classification for typical asphalt streets, For a definition of other pavement classification refer to the Transportation Association of Canada Guide for the Design of Roadway Lighting.

5.7 Sidewalk Lighting

Sidewalk lighting levels for various pedestrian activity levels are defined in the Transportation Association of Canada Guide for Design of Roadway Lighting. Refer to TAC guide for grid set-up and spacing.

5.8 Intersection Lighting

Intersection lighting levels for various street types and pedestrian activity level are defined in the intersection Horizontal Illuminance Table found in the Transportation Association of Canada Guide for Design of Roadway Lighting.

5.9 Crosswalk Lighting

Visibility of crosswalk users can be best achieved by placing poles in advance of the cross walk to create high levels of vertical illumination thus improving driver visibility of pedestrians. This is covered in more detail in the Transportation Association of Canada Guide of the Design of Roadway lighting.

This is primarily aimed at mid-block crosswalks and crosswalks at free turn lanes where island are present. It is doubtful crosswalk levels will be achieved for the main road crossings at signalized intersections; however, by placing the first lighting pole on the approach roads (away from the intersection) within one pole mounting height from the crosswalk, partial vertical Illumination levels can be achieved at the crosswalk. Refer to the Transportation Association of Canada Guide of the Design of Roadway lighting.

5.10 Walkways

Walkways between roadways where the roadway is lit at either end and there is a straight line of sight will not have additional lighting added.

5.11 Roundabout Lighting

Roundabouts have more complex visibility consideration than typical intersections. Key deign consideration in lighting roundabouts include the following;

- The effectiveness of motor headlights is limited in a roundabout due to the constrained curve radius, making the street lighting system a necessity to aid in the night time visibility of obstructions, hazards and pedestrians in crosswalks.
- Where there is no lighting on the approach streets, lighting should be added on the approaches for a distance of approximately 80m in advance of the roundabout crosswalk.

Lighting for a roundabout street surface shall meet or exceed the levels for an intersection. Crosswalks shall meet vertical lighting levels listed for crosswalks. For further information on Roundabout Lighting refer to the Transportation Association of Canada Guide for the Design of Roadway Lighting or IESNA RP8-18.

5.12 Tunnel Lighting

Lighting for streets and sidewalks in tunnels less than 25m in length shall meet the lighting levels required for the approached street and sidewalk. Lighting may be required in daytime depending on the amount of daylight penetration. Lighting for tunnels over 25m in length are covered in the IESNA RP-8-18..

5.13 Poles

Pole types and heights are to be as specified in the Approved Products List
Where poles are mounted on top of service bases they shall be supplied 0.9m shorter. For rural roads, if approved by the City and the power company, light may be installed on the power poles.
Poles shall be located at the outer edges behind curb and gutter or edge of pavement, or in special circumstances, in the median of the street. The exact offset of the pole (behind curb, edge of pavement or sidewalk) is typically defined via standard local authority road cross-section drawings which show all utilities and equipment locations for various road types. Where standard cross sections are not available then poles and foundations shall be located to:

- Provide at least 0.3m clearance from the back of curb of roadway

- Maintained wheelchair access on sidewalk
- Not to be in conflict with other utilities or overhead power lines as defined in CSA standards and by the local utility.
- Poles shall be located within 0.6 meters of the property corners and shall not conflict with driveways, underground services and fire hydrants

In areas where speed is over 60km/hr with no curb and gutter clear zones shall be considered in accordance with the Transportation Association of Canada Geometric Design Guide for Canadian Roads. Pole Spacing patterns include staggered, opposite and one side arrangements, depending on the roadway classification, road geometrics and lighting level design criteria.

5.14 Pole Foundations

The MMCD Standard Specifications and Drawings define typical bases to support standard lighting poles. The designer is responsible for determining the suitability of these standard foundations for the given soil conditions. Where soil conditions are in question a geotechnical engineer should consulted to define the suitability of the base. Where foundations are not suitable, customs foundations will be required.

5.15 Luminaires

Refer to City of Kelowna Approved Products List.

5.16 Power Supply and Distribution

The designer shall confirm voltage and locations of suitable power sources for the proposed lighting system. Roadway lighting systems shall be serviced from a 120/240-volt single phase 3 wire system. Power is generally supplied by the utility though an unmetered service when servicing only street lights, however, in some instances the utility power provider may require a metered service. Metering requirements must be confirmed with local utility provider. Where tree lights and pole receptacles are included, the utility company may require a metered service. Power will be controlled from an approved service disconnect point allowing electrical isolation for de-energized work. If an installation calls for multiple streetlights the system should be designed to minimize the number of service disconnects required.

The lighting system shall be fed via a service base which shall contain panel boards, breakers, lighting contactor(s) and photocell bypass switch as per MMCD Standard Specifications and Drawings. The lighting shall be controlled by a single photocell located on a luminaire nearest the service panel.

Power distribution requirements include;

- Wiring to be installed in minimum 50mm Rigid PVC conduit
- Wiring to be stranded copper with RW90 insulation.
- Wiring to be Colour coded per Canadian Electrical Code.
- Conduit burial depth as specified in the Canadian Electrical Code.
- Conduit alignments shall be designed to avoid tree roots.

5.17 Design

5.17.1 Lighting

Lighting design requires a computer lighting design software such AGI32 or Visual Roadway Tool and lighting supplier photometric files in IESNA format. Typically, luminaire photometric files are based on a reference lamp which can vary from the actual lamp used in the test, provided it is similar. This is referred to as "relative" photometry. LED photometric files must be "absolute" which means the photometric file must be for the exact luminaire being tested.

5.17.2 Decorative Lighting

Where decorative street lighting is required to enhance the streetscape it will be limited to the palette specified in the Approved Products List.
When installed in front of a property luminaires will be supplied with house side shields as standard.

5.17.3 Electrical

Design requirements include:

- Meet all requirements of the Canadian Electrical Code (CEC), latest edition, and bulletins issued by Electrical Safety Branch of the Province of British Columbia.
- Maximum voltage drop from branch circuits: 3%
- Provisions for future expansion.
- Conductor sizes: maximum #6 RW90, minimum #10 RW90 for branch circuits
- For branch circuits the load not to exceed 80% of the breaker rating (as per CEC).
- Accommodation of loads for pole receptacles, if applicable
- Junction boxes to conform to City of Kelowna standard drawings.
- All empty conduits shall have a 6mm nylon pull string installed and the ends capped.
- Traffic signal interconnection / communication conduit design shall be common trenched with the street lighting conduit system

5.17.4 Drawing Requirements

Lighting design drawings shall show all civil drawing information such as curbs, sidewalks, property lines, all physical features that may impact the lighting design, as well as the lighting poles, service/control equipment and wiring. Lighting drawings shall fully describe the proposed installation and all related existing lighting and electrical information. The detailed information required on the drawings shall include, but not be limited to the following:

- Site plan drawings at a scale of 1:500 showing poles locations, conduit and service equipment. For beautification type projects, which have more electrical features such as pedestrian scale lighting and pole/tree receptacles, site plan drawing at a scale of 1:250 may be required. Poles and service equipment shall all be located by station and offset. Conduit shall be located by offset from edge of pavement or face of curb and gutter:
- Legend and notes:

- Completed Lighting Design Criteria Figure 6.6 for each road, walkway, intersection or roundabout:
- List specific product such as luminaires, pole anchor bolts and related hardware, junction boxes and service panels by manufacturer, make and model number.
- Drawings shall include sufficient street name and land or block location information to identify particular sections of road referenced in the lighting design summaries.

All lighting drawings shall be signed and sealed by a professional Engineer registered with the EGBC. Design drawings shall be submitted for approval along with signed and sealed computer lighting calculations.
The electrical systems must be installed in accordance with the requirements of the appropriate utility company.

Where overhead distribution is permitted, pole and anchor locations must be approved by both the City Engineer and the appropriate utility company. Care must be taken to avoid aerial trespass.

Plans and agreements for rights of way for anchors, pad-mounted transformers, etc., must be provided and registered by the Developer.

The City's requirements for allowing overhead or underground wires is as follows:

a) In all Town Center and Village Center areas as identified by the Official Community Plan all wires shall be buried and installed in conduits.
b) All streets and highways that are created as a result of new development shall have all wires buried underground.
c) Outside of these areas where existing overhead wires parallel the existing road the developer shall have the option to bury or to leave overhead the wires.
d) On roadways identified in the City's 20 Year Servicing Plan for upgrade and urbanization, all service wires crossing the roadway must be buried.

6 Traffic Signals

6.1 General
6.2 Standardization
6.3 Codes, Rules, Standards and Permits
6.4 Signal Heads
6.5 Pole Placement and Wiring
6.6 Left Turn Phasing
6.7 Advanced Warning Flashers
6.8 Signal Pre-emption
6.9 Audible Pedestrian Signals
6.10 Control Types
6.11 Detection Methods
6.12 Signal Timing Plans
6.13 Signal Coordination
6.14 Pedestrian Controlled Signals
6.15 Poles and Foundations
6.16 Controller Cabinets
6.17 Traffic Controller Equipment
6.18 Power Supply and Distribution
6.19 Uninterruptable Power Supplies (UPS's)
6.20 Signs
6.21 Drawing Requirements

6.1 General

The purpose of these design standards is to establish the traffic signal design standards used for all projects undertaken within the City of Kelowna.

These guidelines are not intended to be a substitute for sound engineering knowledge and experience. Traffic signal designs are highly specialized therefore all designs are to be prepared under the direction of a design professional who has a minimum of five years of traffic signals experience.

Lighting requirements for intersections are defined in the City of Kelowna Roadway Lighting Bylaw.

6.2 Standardization

Traffic signal details are standardized throughout British Columbia to avoid potential confusion of the travelling public, both local and visiting and are defined in the BC Motor Vehicle Act.

6.3 Codes, Rules, Standards and Permits

Traffic signal systems are to be designed in general conformance with the following:

6.3.1 Codes, Rules and Regulations

- Canadian Electrical Code, latest editions, and bulletins issued by Electrical Safety Branch of the Province of British Columbia.
- AASHTO Standard Specification for Structural Supports for Highway Signs, Luminaires and Traffic Signals or CAN/CSA-S6-00 Canadian Highway Bridge Design Code,
- WorkSafeBC,
- Local power utility regulations,
- Regulations and policies issued by municipal, provincial and federal authorities.

6.3.2 Standards

- Canadian Standards Association (CSA),
- Local power utility standards,
- MMCD Standard Specifications and Drawings, plus City Supplementary Specifications and Drawings.
- BC Ministry of Transportation Electrical and Traffic Engineering Manual
- Institute of Transportation Engineers (ITE)
- National Electrical Manufacturers Association (NEMA) - Traffic Controller Assemblies
- Canadian Manual of Uniform Traffic Control Devices (MUTCD)
- British Columbia Pedestrian Crossing Control Manual.
- City of Kelowna approved products list.

6.3.3 Permits

- Electrical permits as required by provincial or municipal inspection authorities
- Right-of-way and utility crossing permits for crossings of electrical transmission lines, railways, highways and regional, provincial and federally regulated pipelines.

6.4 Signal Heads

Signals should be mounted on vertical posts or horizontal mast arms

General locations of signal heads are as follows:

- Primary: Mounted over the roadway which a vehicle is travelling upon. (refer to MUTCD for mounting)
- Secondary: Mounted to the left of the roadway which a vehicle is travelling upon (Refer to MUTCD and City Supplemental Specification drawings for mounting)
- Auxiliary: Mounted at any other location to enhance visibility. (Refer to MUTCD and City Supplemental Specification drawings for mounting)
- Pedestrian: Mounted on the far side of the intersection in line with the painted crosswalk. (refer to MUTCD and City Supplemental Specification drawings for mounting)
- Bicycle: Mounted in a location clearly visible to an approaching cyclist. Used in special circumstances and in consultation with the City.

Each signalized vehicle movement (phase) at an intersection requires a minimum of one primary and one secondary signal head. Additional signal heads may be required if visibility is a concern.

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 80 km/h. Refer to Canadian Manual of Uniform Traffic Control Devices (MUTCDC).

Visibility of a signal head is influenced by three factors:

- Vertical, horizontal and longitudinal position of the signal head.
- Height of driver's eye
- Windshield area

Lateral vision is considered to be excellent within 5° degrees of either side of the centerline of the eye position (10° cone) and adequate within 20° (40° cone). Horizontal signal position should therefore be as follows:

- Primary heads within the 10° cone
- Secondary heads within the 40° cone.

Vertical vision is limited by the top of the windshield. Signal heads should be placed within a 15° vertical sight line. Overhead signals should be located a minimum of 15 m beyond the stop line. Refer to Canadian Manual of Uniform Traffic Control Devices (MUTCDC) for additional details.

Drivers of vehicles following high vehicles must be able to see at least one signal head upon reaching the dilemma point. The dilemma point is defined as the location where a driver's visibility of the signal indication goes from green to yellow and driver must decide either to bring the vehicle to a safe stop or proceed through and clear the intersection prior to the start of the conflicting green.

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.

Signal heads need to stand out from the surroundings in order to prevent confusion due to distractions. Primary signal heads should have backboards. Backboards are optional for secondary and auxiliary heads. Backboards should be yellow with a reflective surface. A 75mm fluorescent yellow retro-reflective tape border (ASTM Type 9 sheeting) on the outside edge of the entire backboard shall be installed

Signal head materials will be yellow polycarbonate for primary heads and green polycarbonate for secondary and pedestrian signal heads.

Signal head sizes are to be as indicated in Figure 6.4.1 below.

Figure 6.4.1 Signal Head Sizes

SIGNAL HEAD TYPE	AREA CLASSIFICATION LENS SIZE AND SHAPE
Primary	300 mm round
Secondary and Auxiliary	300 mm round
Bike	300 mm round (bike symbol)
Pedestrian	Combination walk/don't walk indication 300mm square (12” x 12”) or Combination walk/don't walk indication with countdown timer 450mm x 406mm (18” x 16”)

Combination walk/don’t walk heads to be installed where there is a high volume of young children or the elderly crossing and on all roadways with two lanes or more in each direction.

All signal displays shall be LED and ITE approved. Tunnel visors are required on all signal heads.

Figure 6.4.2 Signal Head Placement

STRAIGHT THROUGH LANES		
No. of Lanes	No. of Primary Heads	Placement of Primary Heads
One	One	Centered over through lane
Two	Two	Centered over each through lane
Three	Three	Centered over each through lane
LEFT TURN LANES		
Protected/Permissive	4 Sections with Flashing Green Arrow and Steady Yellow Arrow	Centered over left-most through lane
Protected – Single Left Turn Lane	3 Section with Steady Green Arrow	Centered on the left turn lane, either post mounted in median or mast-arm mounted
Protected – Dual Left Turn Lanes	3 Sections with Steady Green Arrow	Centered on the left turn lane, either post mounted in median or mast-arm mounted

6.5 Pole Placement and Wiring

6.5.1 Pole placement

Signal poles should be placed between 1m and 3m from the face of curb or edge of pavement, preferably behind the sidewalk. Pole arms should be oriented at 90° to the centerline of the road, except where the intersection is skewed. When laying out a skewed intersection, ensure the arms do not block the view of the signal heads for other approaches.

Other key considerations for pole placement are:

- Ease of access to pushbutton for pedestrians, handicapped and the visually impaired in accordance with the TAC - Guidelines for Understanding, Use and Implementation of Accessible Pedestrian Signals.
- Maintaining 1.2m wheelchair access around poles and from pushbuttons to wheelchair ramps.
- Minimizing the number of poles required.
- Locating poles outside vehicle turning radii to avoid damage.
- Underground and overhead utility conflicts.

- For optimum visibility of vehicle, bicycle and pedestrian heads

6.5.2 Conduit

- Conduit should be installed parallel or perpendicular to the roadway and routed to run in a direct line between poles and junction boxes. Skewed road crossings are to be avoided.
- Conduits shall be installed by qualified personnel and certified with the BC Technical Safety Authority as an underground raceway installer (UR)
- Ninety-degree bends are to be kept to a minimum and not exceed the maximum as per the Canadian Electrical Code. If this is not possible an additional junction box shall be installed.
- All conduit will be RPVC.
- For each road crossing two 75mm and two 50mm diameter conduits shall be run.
- Communications conduit shall be 75mm in diameter.
- Shall be installed to conform to the Canadian Electrical Code.
- All empty conduits will have a pull string installed and be capped.

6.5.3 Junction Boxes

Will be installed:

- At each pole and controller for splicing and have bonding installed, as per Supplementary Specification Drawings.
- Concrete junction boxes will have a galvanized lid marked with "KELTS" for traffic signals and "COMM" for communication conduits, as per Supplementary Specification Drawings.

6.5.4 Conductors

For signal control:

- Stranded, multi conductor, IMSA cable will be used to connect the controller cabinet to each of the junction boxes on the corner nearest to the traffic signal pole. The wire will run continuous with no splices between the controller and the destination junction box.
- Single conductor stranded #14 RW90 will be installed from the junction boxes to poles. The wire will run continuous with no splices between the junction box and the signal head.
- Signal wiring to be spliced in junction boxes only.
- Streetlight wiring will have an in-line fuse installed in pole hand-hole and be of the type

noted in the approved products list.

- All conductors to be bundled and marked as per the City color coding

6.6 Left Turn Phasing

Left turn phasing options are numbered as follow in the NEMA convention: Phase 1 for SBLT, 3 for WBLT, 5 for NBLT and 7 for EBLT. This is in conjunction with straight through phasing as follows: Phase 2 for northbound, 4 for eastbound, 6 for southbound and 8 for westbound.

Left turn phasing options are as follows:

- **Permissive** - Green ball display. A Permissive left turn has no signal indication other than a green ball, which permits a vehicle to turn left when there is a gap in the opposing traffic.
- **Protected** - Green arrow display. A Protected left turn presents a continuous green arrow indication while all opposing traffic is held by a red ball. A Protected Left Turn is always terminated with a yellow ball.

Protected left turns are typically used in the following circumstances: Dual left turn lane.

- Limited sight distance to oncoming vehicle.
- High pedestrian volumes.
- High speeds.
- High collisions.
- Left turn phase is in a lead-lag operation.
- Split phasing.
- When crossing more than 2 lanes of traffic.

- **Protected/Permissive** - Yellow/Flashing Green arrow display. A Protected/Permissive left turn presents a flashing green arrow and yellow arrow followed by a green ball. During the flashing phase (advanced movement), opposing through traffic is held by a red ball. After the left turn phase has timed out, left turn traffic is presented with a green ball permitting the movement when safe. The protected green arrow is always terminated with a non-flashing yellow arrow indication.

Protected/Permissive left turns are appropriate in cases where:

- Single left turn lane.

- Good sight distance to oncoming vehicles.
- Volumes warrant it.
- Low collisions probability.

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.

6.7 Advanced Warning Flashers

Advanced warning flashers (AWF) should be used where sight distance and grade to an intersection is less than optimal, or where design speed of the road is sufficiently high to justify warning motorists of signal status. Follow Ministry of Transportation and Infrastructure Electrical and Traffic Engineering Design Guidelines for the design and placement of Advance Warning Flasher Signs.

Where AWF are required a back up power supply (UPS) will be installed.

6.8 Signal Pre-emption

Consult with the City to determine if pre-emption equipment is required at the intersection. The City shall supply and install all equipment, other than the cable, which the City will supply to the contractor for installation.

6.9 Audible Pedestrian Signals

Where required by the City, use audible pedestrian signals to assist visually impaired pedestrians.

The City will supply all equipment. The contractor will install the wiring and pushbutton units and the City will install the cabinet equipment.

6.10 Control Types

Traffic signals will be designed to be fully actuated, meaning they require traffic detectors for all phases. Fully actuated controls allow for the maximum flexibility of signal control.

6.11 Detection Methods

Traffic detection for signal actuation is typically accomplished through one of the following methods:

- Vehicle detector loops (induction). - If detector loops being installed, they must be of the preformed type, as per approved products list, and laid in the crush under the asphalt layers.
- Image sensor (video detector system). City will supply and install equipment. City will supply the wire to the contractor for installation.

Other methods are available and will be at the discretion of the City as to the choice of system used.

6.12 Signal Timing Plans

The City will create and or approve signal timing plans.

6.13 Signal Coordination

The City will create and or approve signal coordination plans.

6.14 Pedestrian Controlled Signals

There are two styles of pedestrian controlled signals, a traffic signal with a green-yellow-red indication, and a special crosswalk signal. The requirement for a pedestrian signal and the type of signal to be installed will be established by the City and should be supported by warrants as indicated in the BC Pedestrian Crossing Control Manual.

a) **Pedestrian signals** serve pedestrian traffic only and are generally placed in areas of high pedestrian traffic or in school zones.

A full pedestrian signal has heads placed on the main road only. Cross street traffic is controlled by signage. When not activated, the signal presents a flashing green ball indication to drivers. When the signal is activated by a pedestrian, the flashing green ball indication becomes a steady green ball, followed by a yellow and then red ball. Pedestrian heads provide the Walk/Don't Walk indications to the pedestrian.

Pedestrian signals as above will have vehicle detection installed on the main street. This will allow the signal to extend the green time during periods of heavy traffic, to ensure more efficient flow.

b) **Special Crosswalk Signals** consist of signage and pedestrian controlled lighting designed to draw driver attention to the crosswalk.

See TAC guidelines for pedestrian crosswalks and City supplemental drawings to match the crosswalk with the road type.

See approved products list for the type of controller to be installed.

Where a suitable power source is not available or is costly to deliver to the site, solar powered crosswalks can be considered.

6.15 Poles and Foundations

The MMCD Standard Specifications and Drawings define typical signal poles. Traffic signal poles shall be designed to accommodate the weight of the arms and the items mounted on the poles, as well as wind and ice loading, arm length, anchor bolt size and concrete base size.

The MMCD Standard Specifications and Drawings define typical bases to be used with standard signal poles. The designer is responsible for determining the suitability of these standard foundations for the given soil conditions. Where soils are in question a geotechnical engineer should be consulted to define the suitability of the foundations for the given soil conditions. Where foundations are not suitable, custom foundations will be required.

Refer to the City supplemental drawings for any additional information.

When selecting pole location identify and avoid possible utility conflicts. If installing close to a tree, the base should be outside of the drip line

The identification numbering of bases/poles for traffic signals on plans will start at one and increase in a clockwise direction starting at the base/pole nearest to traffic controller location

6.16 Controller Cabinets

The City shall supply and install controller cabinets.

Cabinets should be located entirely within the road right-of-way, including the concrete pad and door swing. Location should be safe and reasonably protected from motor vehicle damage, with access door on the side away from the sidewalk where possible and the signals visible from the access.

The cabinet will have a concrete pad allowing a safe platform while accessing and working in and around. See City supplemental drawings.

Adequate working space from other equipment and structures will be provided as per the Canadian Electrical Code.

6.17 Traffic Controller Equipment

The City shall supply and install all controller equipment.

6.18 Power Supply and Distribution

A metered power supply is required from the electrical utility. The designer shall confirm voltage and locations of suitable power sources for the proposed signal system. Signals systems are serviced from a 120/240 volt single phase 3 wire system.

Refer to City supplemental drawings for installation of meter and service panel.

Grounding shall be as per MMCD Standard Specifications and Drawings.

Contractor to consult with local power authority of any special installation requirements and service location.

6.19 Uninterruptable Power Supplies (UPS's)

The City shall supply and install UPS equipment

6.20 Signs

Overhead street name signs shall be installed on signal pole arms. Signs to be banded with manufactured wind dampening sign brackets. Signs shall be blue background with 215mm high white clear-vue font (alternate colours may be required by the local jurisdiction). Sign sheeting shall be ASTM Type 9. Other signs mounted on signal poles may include turn restriction signs, lane use signs, one-way signs, etc. as required by the BC Motor Vehicle Act and defined in the MUTCDC.

6.21 Drawing Requirements

Signal design drawings shall show all civil drawing information such as curbs, sidewalks, property lines, utilities, pavement markings, all physical features that may impact the signal design, as well as the signal and lighting poles, detector loops, service/control equipment and wiring. Signal drawings shall fully describe the proposed installation and all electrical and lighting information. The detailed information required on the drawings shall include, but not be limited to the following:

Plan/profiles or underground drawings.

- Scale is 1:200.
- The plan will have the north arrow oriented at 0 degrees.

- Existing and proposed civil information including roadway, sidewalks, letdowns, underground utilities, signing and road markings
- The designed signal including pole locations, controller, conduits, power and communications junction boxes, wiring/cabling, point of electric service.
- Poles and service equipment shall be located by station and offset. Conduit shall be located by offset from edge of pavement or curb and gutter;
- General notes
- Existing signal equipment to be retained and/or removed
- City colour code chart.)
- Pole coordinate table
- Signal display schematic
- Signal phasing diagram
- Intersection illuminance table
- Loop detector coordinate table (if applicable)
- Image sensor table (if applicable)
- References to Supplementary Standard Drawings

Plan view or Elevation

- Scale 1:75
- Elevation and description for each signal pole including corresponding concrete base type, signal displays, luminaire, push buttons, signs and image sensor (if applicable)
- Pre-approved product list for applicable equipment to be supplied
- Reference to Supplementary Standard Drawings

All signal drawings shall be signed and sealed by a Professional Engineer.

Design drawings shall be submitted for approval by the City.

7 Landscape and Irrigation

7A Landscape and Irrigation Water Conservation
7A.1 General
7A.2 Water Conservation Requirements and Report
7B Landscape
7B.1 General
7B.2 Boulevard Landscape
7B.3 Median Landscape
7B.4 Utilities Coordination with Planning
7B.5 Plant Material
7B.6 Landscape Maintenance Schedule
7C Irrigation
7C.1 General Irrigation Requirements
7.C.2 Irrigation Plan and Irrigation Design Report Requirements for Works and Services
7.C.3 Establishment Watering Provisions in Single Family Subdivisions
7.C.4 Irrigation Service Connections

7A Landscape and Irrigation Water Conservation

7A.1 General

7A.1.1 Application

For purposes of this bylaw, an automatic irrigation system means any outdoor watering device that includes a timeclock, connected valves opened by the timeclock, and underground distribution pipe to water outlets used for watering plant materials.

These landscape standards and specifications shall apply:

(a) To all landscape areas within highway limits in the City of Kelowna including: medians, soft landscape areas between the curbs and the highway limits, and plantings in urban plaza and sidewalk areas.

(b) To new construction and rehabilitated landscapes for City projects including all utilities and facilities for water, sanitary sewer, drainage, electrical and communication Works and Services infrastructure.

The following exemptions to the requirements of Section 6 apply:

(a) Projects where the sum of all new or renovated landscape areas does not exceed 100 square metres in area are exempt from the requirement for landscape and irrigation plan and detail submittals set out in these requirements.

(b) Projects without an automatic irrigation system are exempt from the irrigation system design guidelines, but the landscape, grading and soil management requirements and related drawing submittals other than irrigation drawings still apply;

Landscape and irrigation shall be designed, installed and operated to meet the requirements of the City of Kelowna Water Regulation Bylaw No. 10480, including the requirement to not exceed the Landscape Water Budget for landscape areas of the project and to calculate the Estimated Landscape Water Use.

The standards specified herein reflect the City's minimum expectations and are intended for most applications. These standards may be enhanced or revised by the City or the Owner at the discretion of the City Engineer where the Works and Services are intended for large, complex, unusual and innovative applications and provided they meet the intent and objectives of the requirements herein.

7A.1.2 Qualifications

The Owner, at their expense, shall retain as a Qualified Professional a Landscape Architect registered with the British Columbia Society of Landscape Architects (BCSLA) to design, inspect and certify all landscape Works and Services covered by this section.

The Owner, at their expense, shall retain as a Qualified Professional a Certified Irrigation Designer registered with the Irrigation Industry Association of British Columbia (IIABC) to design, inspect and certify all irrigation Works and Services covered by this section.

With proper qualifications from both BCSLA and IIABC, one individual may serve as both the Landscape Architect and Certified Irrigation Designer.

For the Works and Services covered by this section the Landscape Architect(s) and/or Certified Irrigation Designer(s) shall have the powers and responsibilities prescribed elsewhere in this bylaw to the Contract Administrator.

7A.2 Water Conservation Requirements and Report

All subject applications shall include a Landscape Water Conservation Report – either as a set of drawings or a bound report - that defines how the development will meet the design requirements for water conservation. The report shall meet the requirements of the City prior to "Issued for Construction" Documents or Building Permits under this bylaw. The Landscape Water Conservation Report shall:

(a) Include the calculations for the proposed landscape area of Landscape Water Budget and Estimated Landscape Water Use in the format as required by the City of Kelowna (equivalent to Schedule C in the City of Kelowna Water Use Bylaw No. 10480).

(b) Indicate by drawings, notes, specifications and if necessary other written materials how the application complies with or varies from the Design Criteria 6A.2.1and 6A.2.2 below.

(c) The City may, at its discretion, accept the information in two stages: Stage One requires the report and a conceptual landscape drawing with corresponding hydrozone and Landscape Water Conservation Report – and may be submitted at the Preliminary Layout Review or Application

for Subdivision Approval stage for Subdivision Projects, or Building Permit application stage for Works and Services in Development Projects. Stage Two requires detailed landscape and irrigation drawings and specifications, and update to the report and calculations, to be generally consistent with and substituting for the earlier design concept submission – Stage Two must be submitted and approved prior to City Engineer's "Issued for Construction' documents in both Subdivision and Building Permit processes.

7A.2.1 Landscape Design

The Applicant shall appoint a Qualified Professional to create and submit a Landscape Plan and supervise installation to produce a landscape installation that:

(a) Groups planting areas into 'hydrozones' of high, medium and low or unirrigated/unwatered areas. Submit a plan diagram and table showing the extent and area of hydrozones in the project.

(b) Shows appropriate use of plant material with similar water demand within hydrozones.

(c) Maximizes the percentage of landscape area that is unirrigated/unwatered area, commensurate with landscape aesthetics and plant survival e.g. using pervious paving, unplanted stone or organic mulch, pervious deck (strive for a minimum of 25% of the total landscape area).

(d) Maximizes retention or replanting of vegetation with low water-use requirements after the establishment period e.g. existing native vegetation to remain, wildflower meadow, rough grass, xeriscape plant species (strive for a minimum of 25% of the total landscape area).

(e) Designs to minimize mown turf areas that are high water use areas (strive for 25% of total landscape area, and consider a maximum of 50% of the total landscape area) – substitute with areas of lower water use treatments.

(f) Provides mulch cover to shrub and groundcover areas, to reduce evaporation from soil.

(g) Uses recirculated water systems for any water features such as pools and fountains.

(h) Ensures landscape installation standards including growing medium depth and quality to meet the requirements of this bylaw. A submitted soils report or notes on the plans shall indicate proposed growing medium depth, amendments, and shall refer to appropriate sections of the reference or supplementary specifications, or the qualified professional shall supply a custom specification of similar detail.

(i) Includes the following written declarations signed by a licensed Landscape Architect qualified by the British Columbia Society of Landscape Architects (BCSLA):

- At the time of application:"This landscape plan is subject to and complies with the Landscape Water Conservation Design requirements of the City of Kelowna for the efficient use of water".

- At the time of substantial performance of the construction: "This landscape installation complies substantially with the submitted water conservation and landscape plans, specifications and reports."

7A.2.2 Irrigation Design

If irrigation is to be installed, the Applicant shall appoint a Qualified Professional to create and submit an Irrigation Plan and supervise installation to produce an irrigation system that:

(a) Groups irrigation circuits/ zones into 'hydrozones' of high, medium and low or unirrigated areas consistent with the landscape planting plan.

(b) Uses reclaimed or recycled water or rainwater capture from roofs or rain barrels for outdoor water use when such is available, as a substitute for use of potable water.

(c) Minimizes use of high-volume spray heads, and employs drip or low volume irrigation where practical to meet the watering needs of hydrozones.

(d) Uses surface or subsurface drip irrigation or low volume irrigation technology to water long, narrow or irregularly shaped areas including turf areas less than 2.4m in width.

(e) Keeps drip, spray and rotor heads (different precipitation rates) on different irrigation circuits.

(f) Designs with irrigation head-to-head coverage in accordance with manufacturer's specifications.

(g) Ensures matched precipitation rates on each irrigation circuit.

(h) Minimizes the elevation change in each irrigation circuit – and where required provides pressure compensating devices to minimize pressure variations or check valves to stop low head drainage.

(i) Ensures irrigation mainlines are proved leak-free with hydrostatic tests, as a part of the construction quality assurance review. Re-test irrigation mainlines after major repair or nearby excavation work.

(j) Provides pressure regulating devices to ensure irrigation outlets are operating at the manufacturer's optimum pressure range.

(k) Designs head placement and type, and adjusts head radius, arc and alignment to avoid overspray of paved surfaces or buildings.

(l) If irrigating slopes greater than 25%, designs an irrigation system with a precipitation rate not greater than 20mm/hour.

(m) Provides automatic shut off devices that shut off the system in cases of pipe leak or breakage, and that shut off the system when rain is present.

(n) Installs - and programs to minimize water use – one or more 'Smart Controllers' with water-conserving functions. Acceptable Smart Controllers are identified in the City of Kelowna Water Regulation Bylaw 10480. Includes a written Irrigation Schedule or equivalent instructions for operation of the Smart Controller, with a copy stored with the controller cabinet, that adjusts the amount of applied water scheduled to be applied on a daily basis – schedule different run-times as weather changes, by using the weather-sensitive features of a Smart Controller. In cases where manual irrigation

(o) program adjustment is temporarily required, adjust water programming at least once per month to recognize that highest water need is in July and lower water needs exist in other months of the growing season.

(p) Ensures irrigation design and installation standards including adjustments and scheduling meet the requirements of the Supplementary Specifications in , Schedule 5 Construction Standards, or a custom or alternate irrigation specification at a similar level of detail provided by the Qualified Professional.

(q) Includes the following written declarations signed by a Certified Irrigation Designer qualified by the Irrigation Industry Association of BC (IIABC):

- At the time of application:"This irrigation plan is subject to and complies with the Irrigation Water Conservation Design requirements of the City of Kelowna for the efficient use of water."
- At the time of substantial performance of the construction: "This irrigation installation complies substantially with the submitted water conservation and irrigation plans, specifications and reports".

7B Landscape

7B.1 General

7B.1.1 General Landscape Requirements

The general design and construction of the landscape shall be in accordance with the standards set out in this section.

Street Tree plantings shall be required on streets and highways in all subdivisions where new roads (including cul-de-sacs) or road extensions are required.

All soft Boulevard and Median Areas within the highway limits shall be landscaped to the standards of *Section 6B.2 Boulevard* and *Section 6B.3 Medians.*

Rough grass or wildflower mixture may be used on all or part of boulevards visually backed by areas of woodland or rural appearance - subject to the approval of the City Engineer.

The Landscape Maintenance Period for landscape establishment shall be one year from the date of Substantial Performance of the landscape components of the work. All landscape areas shall be provided establishment maintenance which shall include irrigation maintenance and watering, mowing, weeding, pruning and supplemental fertilization until the end of the Landscape Maintenance Period. The Landscape Maintenance Period shall continue until a Certificate of Acceptance of all Landscape Works and Services is issued by the City upon the expiration of the Landscape Maintenance Period.

Plants or other materials that fail in the Landscape Maintenance Period shall be replaced at no cost to the City. Replacement trees shall be guaranteed for a further year after planting, with maintenance and replacements repeated until trees are provided that are acceptable to the City at the end of the Landscape Maintenance Period.

The use of Naturescape or similar wildlife habitat principles in landscape development is encouraged. Refer to Naturescape Kit Southern Interior, available from Naturescape British Columbia.

Site and planting design shall co-ordinate with watering 'hydrozones' and irrigation plans in accordance with *Sub-Section 6C – Irrigation*.

All landscape and irrigation products, installation and operations shall be completed in accordance with the requirements of Schedule 5 of this Bylaw.

7B.1.2 Landscape Plan Requirements for Works and Services

For landscape Works and Services that will be owned by the City of Kelowna, the Owner's Qualified Professional is required to submit the following plans, gain City 'Issued for Construction" documents, and certify construction quality assurance. Landscape plan and design submittals required are:

(a) Landscape Plan
(b) Landscape Grading Plan
(c) Landscape Water Conservation Report as required by the Water Regulation Bylaw.

The following information shall be shown on the Landscape Plan:

(a) property lines and easements.
(b) buildings, edge of pavement, curb lines and curbs, sidewalks, lighting fixture locations, surface utilities and related service boxes or other elements that would affect the landscape and street tree location.
(c) Location of all existing vegetation to remain.
(d) Location of retaining walls and existing or proposed slopes that exceed 3:1 vertical.
(e) Location of all proposed trees, shrubs, ground cover and lawn areas.
(f) Indication of which areas will be seeded grass vs sodded lawn.
(g) Plant list showing botanical name, common name, size at planting, quantity, typical spacing, and root zone volume of supplied growing medium for trees.
(h) Location of all proposed trees, shrubs, ground cover and lawn areas.
(i) Hydrozone information table for the project.
(j) Planting hydrozones – delineate and label each hydrozone by number, letter or other method and identify each area of similar water requirement e.g. high, medium, low, or no supplemental water after establishment. Hydrozones may be shown on a separate drawing if required for clarity.
(k) Water features, if applicable.
(l) Type of mulch and application depth.
(m) Growing medium depths for each planting type.

The following information shall be shown on the Landscape Grading Plan.

(a) Spot elevations of top and bottom of retaining walls and at top and bottom of any slopes exceeding 3:1
(b) Drainage patterns by slope arrow and percent slope. Drain inlets or culvert inlet elevations.
(c) Finished floor elevations if applicable.
(d) General shaping of finished grades by a combination of proposed contour, spot elevations and slope arrows for landscape areas that are bermed, dished, or that have noteworthy grading constraints or design intents.
(e) Stormwater retention or infiltration facilities if applicable.
(f) Rain harvesting or catchment technologies if applicable.

The general requirements used by the City for review of the Landscape and Grading Plan is specific to the site and use thereof. The landscape design shall:

(a) respond functionally and aesthetically to existing and proposed land uses, utilities, terrain and flood patterns, drainage facilities, roads, driveways, cycle, transit and pedestrian facilities;
(b) promote accessibility as it relates to pedestrians, cyclists and people with limited physical or visual abilities
(c) consider appearance of the proposed plant material and site landscape, including appropriateness, aesthetics, visual screening, sight lines and functionality

(d) provide access for maintenance equipment and personnel;
(e) allow for cost effective maintenance methods and practices;

(f) provide access to park, recreation or environmental opportunities;
(g) incorporate protection of existing trees where feasible;
(h) consider protection of the natural environment and restoration or enhancement of natural habitat;
(i) coordinate with engineering site drainage, water levels, ponding and overland flow;
(j) consider design features that minimize the opportunity for crime and undesirable behavior;
(k) provide for weed control;
(l) coordinate with sediment and erosion control practices;
(m) follow fire hazard reduction principles.

The completed Landscape and Grading Plan(s) shall be considered part of the package that forms the "issued for Construction" documents.

7B.1.3 Landscape Construction

Prior to the start of construction the Owner shall provide the City with a schedule of construction of the landscape and irrigation Works and Services and Related Work. In addition, the Owner shall provide the City with the name and contact information for the Consulting Landscape Architect and Engineer, Certified Irrigation Designer, the general Contractor and the Landscape Contractor of the site, as well as the designated Contract Administrator for each of the Landscape and Irrigation works.

Proposed changes to the landscaping from that shown on the "Issued for Construction" Landscape Drawings or related documents shall be submitted to the City for review and approval at least five (5) working days prior to anticipated construction of the change. Submission of a proposed change in no way implies or suggests approval of the proposed change by the City.

Changes to the landscaping performed without approval from the City will not be accepted at the time of Substantial Performance or Total Performance. Changes to the landscaping performed without approval from the City will be corrected by the Owner at the Owner's expense or the cost of making the corrections will be held back by the City upon release of the Performance Bond.

7B.2 Boulevard Landscape

Unless specified otherwise herein boulevards shall be vegetated with sodded lawn or densely planted groundcover. Rough grass and/or wildflower seeding may be used on boulevards and side slopes that are visually backing onto natural or rural areas, or for temporary boulevard treatments, subject to the approval of the City Engineer.

For the boulevards of arterial and collector roads within Urban and Village Centre DP areas, the treatment shall be as per the streetscape improvement plan for that area.

For boulevards adjacent to commercial property and locations outside Urban/Village Centre DP areas, or where no plan is in place, the boulevard treatment shall generally be turf or hard-surfaced, and shall include street trees and irrigation. Acceptable hard surface materials for the boulevard may include:

(a) unit pavers
(b) exposed aggregate concrete;
(c) stamped and coloured concrete;

(d) irrigated turf; or
(e) xeriscape or dryland landscaping

For boulevards where the land use of the adjacent property is industrial, institutional or multi-family the boulevard treatment shall generally be street trees and turf or dryland landscaping, serviced and maintained by the Owner of the parcel with the boulevard frontage.

For boulevards where the land use of the adjacent property is one, two or four-family residential or park, and where the boulevard is accessible for maintenance mowing and watering from the adjacent property, the boulevard treatment shall generally be street trees and turf,

For boulevards where it is unlikely that the adjacent property owner will be able to adequately maintain the boulevard, the boulevard treatment shall generally be hard surfaced and may include street trees. Acceptable boulevard materials in these cases may include:

(a) unit pavers; or
(b) exposed aggregate concrete

7B.3 Median Landscape

The landscaping of medians shall be designed and constructed generally as follows:

(a) for Highway 97 and Highway 33 - with sloped aprons of concrete unit pavers with irrigated street trees and irrigated landscaping;
(b) in Urban Centre and Village Centre DP Areas - except as described above or per the approved streetscape improvement plan for that area, with sloped aprons of concrete unit pavers and irrigated street trees; or
(c) elsewhere - with sloped aprons of exposed aggregate concrete, concrete unit pavers or stamped and coloured concrete and irrigated street trees..

The landscaping of roundabouts and cul-de-sac islands shall have a hard surface material or landscaping with low shrubs or groundcovers, and should feature:

(a) a single specimen tree;
(b) a group of like trees; or
(c) public art if the roundabout or cul-de-sac is in an Urban or Village Centre. The selection, design and placement of public art shall be made in cooperation with the Public Art Committee.

Lighting of trees or public art in a median shall be provided as required by the Parks Division or the Public Art Committee.

7B.4Utilities Coordination with Planning

Underground utilities shall be aligned and buried to provide a continuous 1.0m deep utility-free trench beneath tree planting locations.

Planting and paving design shall be co-coordinated with the design and construction of surface utility boxes, such that boxes fall entirely within either a paved surface or entirely within a planted surface but

not partly in paving and partly in planting and that grades and alignment of boxes match the final design and construction of all elements to create a co-coordinated and orderly appearance, free of trips and hazards.

7B.5 Plant Material

7B.5.1 Urban Trees in Pavement

Select urban trees in pavement in accordance with Section 7B.5.6.

Select and site urban trees in pavement to eliminate long term above-ground and below ground conflicts with utilities, buildings and structures, and pedestrian and vehicular traffic.

7B.5.2 Planting Details and Procedures

Landscape Drawings shall specify the appropriate planting detail standard from the City of Kelowna Standard Details.

All planting shall meet the City of Kelowna Specifications in Schedule 5.

7B.5.3 Planting Provisions in Single Family Subdivisions

Street trees and landscape finish of the public highway fronting occupied homes shall be completed no later than the date that 85% of the homes in a single family development are completed and occupied. Earlier completion dates are encouraged provided that landscape maintenance and repair is provided at no cost to the City until such time as units are occupied.

Planting of street trees in the hot dry summer period of June, July and August is discouraged, due to the risk of failure of the planting caused by heat and drought.

Minimum number of boulevard trees shall be calculated as follows:

(a) Medium Trees (± 10 - 20m ht. at maturity) Greater of 1 per lot or 15m.
(b) Small Trees (Under 10m ht. at maturity) Greater of 1 per lot or 10m.
(c) Plantings of trees closer than 6m on centre shall require the written concurrence of the City Engineer.
(d) Locate trees fronting on single family lots in locations that avoid all utility service alignments and driveways. Generally this will lead to tree placement in the half of the lot frontage away from the driveway side, and not at either the lot centerline or at a lot line.

7B.5.4 Plant Material Selection

7B.5.4.1 Plant Materials:

(a) Plants shall have the ability to withstand adverse conditions such as airborne pollutants, maximum sun exposure and reflected heat from pavements, high winds and abrasive forces, occasional snow loading and exposure to salt from road clearing operations, and limited root zone soil volumes.

(b) Plant hardiness requirements vary by elevation. Plants shall be hardy to Canadian Plant Hardiness Zone 5A to 1A as site conditions dictate.

(c) Plants shall be capable of reduced water demand following a one year establishment period.

(d) Plants shall have relatively low maintenance attributes including: fine to medium leaf size and canopy density; non-fruit bearing or having only berry-sized non-staining and non-toxic fruits; low susceptibility to disfiguring or fatal diseases and infestations; infrequent demands for pruning, fertilizing and other cultural requirements.

(e) Plants shall be of appropriate size and form at maturity to meet criteria in Section 6B.5.6 *Street Tree Selections and Soil volumes*.

7B.5.4.2 Lawns/Fine Grass, Rough Grass and Wildflowers:

(a) Sod shall be used on all lawn/fine grass areas. Seeding, as an alternate, shall require approval of the City Engineer.

(b) Rough grass and wildflower areas shall be seeded. Seeding method shall be noted on drawings.

(c) Areas to be seeded with grades greater than 3:1 and/or highly erodible soils shall be hydroseeded with a nurse crop seed mix, a hydraulically applied erosion control mulch, or erosion control blanket. Erosion control method to be noted on drawings.

7B.5.4.3 Trees

(a) Boulevard or 'street' trees shall be of a single species/cultivar on either side of the street within a given block. Median tree species may vary.

(b) Street tree species shall vary between intersecting streets. Street tree selection will be made with consideration of maintaining a diverse and varied street tree distribution across a neighbourhood to minimize disease risks.

(c) All street trees shall have:

i. A compact or upward branching structure.
ii. Ability to withstand pruning for pedestrian, vehicle and/or building clearance without compromise to tree health or form.
iii. Absence of species/varietal characteristics of structural weakness, susceptibility to wind damage, or thin, easily damaged bark.

7B.5.5 Street Tree Size, Spacing and Location

Trees shall be minimum 5 cm caliper measured at 300mm above the rootball at the time of planting, and of uniform size if planted in a boulevard row.

Tree branch clearance requirements are 5m over the traveled portion of road and 2.25m over the sidewalk.

7B.5.6 Street Tree Selections and Soil Volumes

Refer to City of Kelowna website for requirements for tree species selections: http://www.kelowna.ca/CM/Page292.aspx

Trees for directly under Hydro lines

(a) Minimum allowable soil volume per tree is 4 cu.m. with 1m depth pit.
(b) Mature height not greater than 7.62m.

Trees for beside hydro lines

(a) Minimum lateral distance from nearest line 2.75m.
(b) Minimum allowable soil volume per tree is 4 cu.m. with 1m depth pit.
(c) Mature spread not greater than 5m.

Trees for limited available soil volume

(a) Minimum allowable soil volume per tree is 4 cu.m. with 1m depth pit.
(b) Mature height not greater than 10m.

Trees for available soil volumes of 9 cu. m. or greater

(a) 1m pit depth
(b) Mature height not greater than 20m.

Trees for a wide boulevard or wide median use only

(a) Minimum available root zone of 20 cu. m. per tree
(b) Minimum boulevard or median width of 3.5m

7B.5.7 -Setbacks for Trees

Minimum setbacks for trees to objects in new developments shall be as follows:

Underground street light conduit or irrigation main	0.6m
Other underground utilities	3.0m
Lamp standards	6.0m
Steel and wooden utility poles	3.0m
Driveways	1.5m
Catch basins	1.5m
Manholes, valve boxes, services	3.0m
Sewer service boxes	3.0m
Fire hydrants	2.0m
Road intersection	7.0m

Curb face (see SS-L3 for Root Barriers required)	0.5m
Sidewalk	0.85m
Curb face and sidewalk with root barrier	0.60m
Buildings - fastigiate (columnar) tree	2.0m
Buildings - regular crown tree	3.0-5.0m

The City Engineer may consider custom setbacks where trees are being installed in existing streets with established utilities.

7B.6Landscape Maintenance Schedule

The Owner's qualified professional shall submit a maintenance schedule with the Certificate of Substantial Performance. It shall include timing and arrangements for:

(a) Routine inspection
(b) Aerating and dethatching turf areas
(c) Replenishing mulch
(d) Fertilizing
(e) Pruning
(f) Weeding

The project applicant is encouraged to implement sustainable or environmentally-friendly practices for overall landscape maintenance.

7C Irrigation

7C.1 General Irrigation Requirements

(a) A complete and working automatic irrigation system shall be provided for all landscaped areas within a high, medium or low hydrozone of a Highway, utility parcel or utility facility. Temporary watering provisions shall also be made for planted areas of a 'non-irrigated' hydrozone – to allow for watering through a maximum 1 year establishment period or in severe drought.

(b) Boulevard trees, shrubs and ground covers shall be watered from an automatic irrigation system.

(c) Urban trees in pavement shall be irrigated with an automatic irrigation system that may include bubblers or drip elements.

(d) Sleeves shall be provided under sidewalks and driveways, and to medians / islands, as required for installation and maintenance of the irrigation system without removing surface paving.

(e) Provide a flow sensor and master valve, both connected to the controller, that will stop flow to the system or irrigation circuit in cases of an irrigation water leak. Provide an isolation gate valve upstream of all automatic sprinkler valves.

(f) Design to water plant materials with different watering requirements (e.g. grass vs. shrub areas and high vs medium vs low water use shrub areas) on different valve circuits.

(g) Where surface sprinklers are used, ensure unobstructed sprinkler coverage to tree bases from at least two sides.

(h) Every drip system shall be designed with a filter, pressure regulator, flush valve and air relief valve. The drip component manufacturer's instructions for installation and maintenance shall be included in the project specifications.

(i) The Irrigation System shall perform to within 15% of the targeted application efficiency standards for irrigation systems, as determined by the Irrigation Association and the Irrigation Industry Association of British Columia, as follows:
   i. Spray Zones: 75% or higher;
   ii. Rotor Zones: 80% or higher;
   iii. Microjet Irrigation Zones: 85% or higher.
   iv. Drip Irrigation Zones: 90% or higher.

(j) Sprays and rotors shall be designed with head to head coverage to meet the application efficiency standards.

(k) It is the responsibility of the Certified Irrigation Designer to identify to the Owner and to the City of Kelowna any landscape impediments, existing or planned, that will impede reaching the targeted efficiencies. At the discretion of the City of Kelowna, irrigation system design audits may be performed to ensure design efficiency has been met.

(l) The Irrigation System shall be designed with minimal pressure losses where possible. Pressure losses between any two sprinklers on the same zone shall be less than 10%.

(m) Pipes shall be sized to allow for a maximum flow of 1.5m/sec.

(n) The Irrigation System shall be sized and designed to 80% of Point of Connection available flow and pressure; allowing for 20% growth of system or 20% reduction in operating pressure while retaining targeted operational efficiencies.

(o) Locate Point of Connection or Pedestal to meet the following requirements:

i. No Pedestal or Point of Connection locations will be permitted with medians without the explicit written consent of the City of Kelowna.
ii. No Pedestal location shall be subject to application of irrigation watering.
iii. No Point of Connections shall be placed within a sidewalk without the explicit written consent of the City of Kelowna.

(p) The irrigation design shall include voltage loss calculations to the electrical control valve furthest from the controller. The drawings are to include:

i. A chart comparing the actual voltage drop to the allowable voltage drop on common and zone signal wires;
ii. Voltage loss shall not exceed the maximum voltage loss as specified by the manufacturer of the irrigation controller;
iii. Indicate wire locations, wire gauge required, spare wires and necessary splice box locations on the Contract Drawing.

(q) Install one spare control wire for every five (5) electric control valves connected to the controller;
(r) Install one spare common wire for every ten (10) electric control valves connected to the controller.

(s) Irrigation sleeves shall be installed to route irrigation lines under hard surfaces and features. Non-metallic CSA approved electrical conduit shall be installed adjacent to irrigation sleeves.

(t) Electric control valves used in the design of the Irrigation System are to remain consistent in size and manufacturer, where possible. Renovations or additions to the Irrigation System shall use the same manufacturer, model and size that exist on site. It is permissible to use an electric control valve from a different manufacturer for specialized applications. In general:
i. Electric control valves must be sized to the design flow;
ii. Drip and Micro irrigation zones must include filtration and pressure regulation to manufacturers' specifications. Drip and Micro zones must have an isolation valve prior to zone valve for maintenance of filtration.
iii. Unless it has deemed not possible, valves are to be located on the periphery of green spaces and where available, within planting beds.
iv. Design approval will be required to insert valve locations within hardscape surfaces.

(u) Sprinklers used in the design of the Irrigation System are to remain consistent in size, nozzling and manufacturer. Renovations or additions to the existing Irrigation System shall use the same manufacturer, model and size that exist on site. Sprinkler choice is based upon:
   i. Available operating pressure at the base of the sprinkler;
   ii. Desired radius;
   iii. Type of landscape/plant material to be irrigated.
   iv. Preference will be given to sprinklers incorporating pressure compensating devices.
   v. Preference will be given to sprinklers incorporating check valves to reduce low head drainage.

(v) Sprinkler arcs, radius and alignment are to be designed and capable of adjustment to minimize overspray onto adjacent surfaces outside of landscape areas.

(w) Drip line and emitters must incorporate technology to limit root intrusion.

(x) Specify all irrigation components from a coordinated manufacturer's line listed in the Subdivision, Development & Servicing Approved Products List Policy 266.

(y) All irrigation products, installation and operations shall be completed in accordance with the requirements of Schedule 5.

(z) The Landscape Maintenance Period for landscape establishment shall be one year from the date of Substantial Performance of the landscape components of the work. All landscape areas shall be provided establishment maintenance which shall include irrigation maintenance and watering.

7C.2 Irrigation Plan and Irrigation Design Report Requirements for Works and Servies

For irrigation Works and Services that will be owned by the City of Kelowna, the Owner's Qualified Professional is required to submit the following plans and reports, gain City "Issued for Construction" status, and certify construction quality assurance:

a) Irrigation Plan
b) Landscape Water Conservation Report (in accordance with Water Use Regulation Bylaw 10480)
c) Irrigation Design Report
d) Maintenance Schedule

The following information shall be shown on the Irrigation Plans and Landscape Water Conservation Report

(a) Name and contact information for the IIABC Certified Designer.

(b) Name and contact information for the water utility provider and the electrical utility provider.

(c) property lines.

(d) buildings, edge of pavement, curb lines and curbs, sidewalks, lighting fixture locations, surface utilities and related service boxes or other elements that would affect the irrigation system – but with an objective of minimizing drawing clutter.

(e) Location of all existing vegetation to remain.

(f) Location of retaining walls and slopes that exceed 3:1 vertical.

(g) Landscape Water Budget, and Estimated Landscape Water Use and calculations (in accordance with Schedule C of the Water Regulation Bylaw No. 10480 - may be a separate Landscape Water Conservation Report).

(h) Hydrozones shall be designated by number, letter or other designation.

(i) Designate the areas irrigated by each valve (irrigation zones) and assign a number to each valve.

(j) Indication of which irrigation zones will be automatic vs manual watering systems. Clearly identify any 'temporary zones': those zones which are intended to operate for less than a two (2) year grow in period.

(k) Schematic layout showing all points of connection, backflow prevention, water meters, electrical supply and meters, winterization facilities, timeclocks, heads, valves, piping, sleeves, sensors and other elements critical to construction and maintenance of the irrigation system.

(l) Irrigation legend describing brand, model and size of timeclocks, heads, valves, piping, sleeves, sensors and all other elements shown on the irrigation plan.

(m) Any details specific to the project that are not included in Schedule 5.

The Irrigation Design Report shall be submitted with the Irrigation Plans, in booklet form on 8.5 x 11 paper and shall include:

(a) Static water pressure obtained either by pressure gauge reading from the site; or from the City of Kelowna.

(b) Design flow calculations indicating maximum water flows required to irrigate the proposed site in the desired water window;

(c) Water utility jurisdiction; inclusive of any regulations or restrictions imposed by the said water utility that will affect the operation of the Irrigation System.

(d) The electrical requirements necessary to operate the proposed Irrigation System. Verification from the applicable electrical utility that the service is available and what is required to route it to the necessary location(s);

(e) Identification of the micro-climates throughout the proposed site;

(f) A chart illustrating a zone by zone breakdown of the following items;
   i. Type of plant material
   ii. Product Type (micro, spray, rotor); and area based calculated precipitation rates.
   iii. Required operating pressure
   iv. Required zone flow
   v. Zone valve size

(g) Scheduling data utilizing a maximum ET value of 7"/month (Kelowna July ET); taking into consideration soil type, slope and micro-climate. Show the cumulative watering time required to water all circuits in the project. Except where otherwise required or approved, the irrigation water window shall not be greater than 6 hours per day on an odd or even scheduling format.

7C.3 Establishment Watering Provisions in Single Family Subdivisions

Watering provisions are required for establishment of all street tree planting. Automatic irrigation systems to be provided to the boulevard area as an extension of privately held irrigation systems on the fronting lot. Provide irrigation sleeves across the sidewalk at the lot centerline and across the driveway as necessary to accommodate the irrigation pipe connecting all landscape areas and the fronting boulevard and medians.

In cases where boulevard landscape and related irrigation is being installed in advance of single family lots being occupied, the developer is to install a temporary irrigation system to water the boulevard. When private homes are constructed and occupied, within 6 months of occupancy the developer must arrange to have the boulevard irrigation fronting each lotremoved from the temporary irrigation system and attached permanently to the irrigation system of the fronting lot. Design of the temporary irrigation system may follow one of two general arrangements:

FULL LANDSCAPED BOULEVARD: generally in accordance with Schedule 5 Standard Drawing "Temporary Boulevard Irrigation", based on a spray or drip irrigation system to serve grass, groundcover, shrubs and trees in the boulevard, OR

TREES ONLY BOULEVARD: if trees only are being planted, with dryland or paved landscape in between, a Root Watering System (Double) on public property shall be provided that meets the requirements Schedule 5 Standard Drawings.

(a) For temporary boulevard irrigation systems, and/or for permanent median irrigation systems, water supply, backflow prevention and irrigation smart controller shall be provided in central location(s) in the subdivision, with valves and distribution piping designed in accordance with Section *6C – Irrigation*. Water supply may be obtained from the services of the new lots. A water billing account must be established prior to use.

(b) Irrigation sleeves for the temporary or permanent boulevard and median systems shall be provided under all driveways or other paved areas to provide pipe access to all landscape areas within the highway for installation and maintenance of the irrigation system without removing surface paving.

(c) The City will withhold part of the maintenance bond at a value of 140% of the cost of connecting temporary irrigation in boulevards to permanent irrigation systems on fronting private lots, and abandonment of any temporary irrigation system. If this conversion is not completed by the Developer within 6 months of home occupancy, the City may if necessary at the Developer's expense undertake the connection of the boulevard irrigation system to the adjacent private lot system and decommission the temporary irrigation with its own forces.

7C.4 Irrigation Service Connections

Except as required otherwise all landscaped areas of a Highway or Utility Facility shall be serviced with a metered water service (50mm diameter, and a metered electrical service (120/240 volts, 60 amps minimum). Provision of water and electrical services by the Owner shall include the establishment of service accounts with the utility providers, all necessary permits, testing and certification, and all materials, labour, fees and utility costs necessary to provide the service until the end of the Landscape Maintenance Period.

8 Hillside Development Street Standards

8.1 General
8.2 Street Trees
8.3 Hillside Street Classification
8.3.1 Arterial Streets
8.3.2 Village Collector Streets ("Main Street")
8.3.3 Collector Streets
8.3.4 Minor Collector Streets
8.3.5 Village Local Streets
8.3.6 Local Streets
8.3.7 Public Lanes
8.3.8 Cul-de-Sac Streets and Hillside Emergency Accesses

- **LIST OF TABLES (located at back of section)**

NO.	TITLE
Table 1	Hillside Street Standards
Table 2	Alignment Design Criteria

- **LIST OF DRAWINGS (located at back of section)**

NO.	TITLE
TYP-1	Local Road
TYP-01SW	Local Road – Optional Sidewalk TYP-02 Minor Collector – No Parking – No Access
TYP-03	Minor Collector – Parking – Access One Side
TYP-04	Minor Collector – Parking – Access Both Sides

8.1 General

Where development lands receive hillside zoning (Residential Hillside (RH) zone or "h" designation to parent RU1 zone), these standards may be utilized in place of the specific sections in the HIGHWAY DESIGN STANDARDS (Section 4 of this Schedule). The Hillside Street Standard drawings are included in Schedule 5, Section 2 (Drawings) of this Bylaw.

The hillside standards have been designed for environmental sensitivity with reduced physical impacts in mind. Generally, the street standards proposed herein have been drawn from the following principles:

- The public interest requires safe, liveable and attractive streets that contribute to the urban fabric;
- Streets should be designed to suit their function. Many streets, especially local ones, have purposes other than vehicular traffic;
- A hierarchical street network should have a rich variety of types, including bicycle, pedestrian and transit routes; and
- Standards should be developed to enhance local streets' contributions to urban design. Issues such as sense of enclosure, landscaping, parking, building setbacks,

surface materials, street furniture, signs and street lighting are vital determinants of liveability in neighbourhoods.

These street standards have largely been designed for application under specific traffic volumes and development densities. Traffic volume determines which general street type (Arterial, Collector, Minor Collector, Local, etc.) is required to service an area and, in most cases, density of fronting development determines which specific street condition ("Condition A", "Condition B", "Condition C", etc.) will be applied. In the case of Collector Streets, whether or not the street acts as a village centre "main street" is also a factor. For Arterial Streets, proximity to a village centre and local environmental conditions are the determinants of "condition" application.

Development that has direct public street access is defined as "fronting" the street. In other words, only those units that are oriented to the street are considered to "front" on it. This will most often occur in areas of fee-simple single family, mixed- use, or apartment development. Circumstances where strata units "front" onto a public street may also arise; however, strata and bareland strata developments will primarily be serviced by Private Streets. Standards for Public Lanes, Cul-de-sac Streets and Hillside Emergency Accesses are also included.

8.2 Street Trees

Street trees contribute to the liveability of a street. Trees modify the microclimate and foster a sense of comfort and safety for drivers and pedestrians by creating an edge between the sidewalk and the moving traffic. In hillside areas it is desired that the natural landscape be more prominent. While in some instances, such as along Arterials and Collectors and in a village centre, street trees are thought to be appropriate, even necessary, in other areas a more natural approach is desired, and the retention of natural vegetation is encouraged.

Therefore, those hillside street standards that will be applied to areas that will have a tighter "fit" to the natural landscape will not be required to incorporate street trees. For Minor Collector Streets and Local Streets street trees are considered optional. The planting of stands of native trees and vegetation is encouraged in these areas to contribute some of the elements of liveability that would otherwise be missed with the elimination of formal street tree plantings. Street trees and landscaping are to be to the satisfaction of the City's Development Services Department/Subdivision Approval Branch and a landscape plan showing proposed planting on private property are required. The City's Development Services Department/Subdivision Approval Branch will require a performance bond for landscaping on private property.

A discussion of each class of street follows.

8.3 Hillside Street Classification – See Table 1

An overall plan is required allocating the location of each street type and its relationship to adjacent land uses proposed. A discussion of each class of street follows.

8.3.1 Arterial Streets

Arterial streets provide a continuous drive path for inter-community through traffic. The Arterial corridors of hillside areas will be different in that, while they will continue to provide a throughway for automobiles, the experience will take on qualities of a scenic drive.

8.3.2 Village Collector Streets ("Main Street")

Collector streets perform the dual function of land access and traffic movement between arterial and local roads. In the village centre the unique and very social function of this more localized type of street will be reflected in a more urban feel than will be found on collectors elsewhere throughout the site.

8.3.3 Collector Streets

Collector streets perform the dual function of land access and traffic movement between arterial and local roads; however, this more localized type of street plays a social as well as a functional role in the neighbourhood. Street design, therefore, must balance all objectives including, but not limited to, the need to provide a driving path for automobiles to access the neighbourhood.

8.3.4 Minor Collector Streets

There is the potential for some portions of Collector streets to experience lower traffic volumes. In these instances, Minor Collector streets will be utilized. Toward reducing the street section, a sidewalk will be provided on only one side of the street for all Minor Collectors.

8.3.5 Village Local Streets

The residential areas of the village centre will be more urban than those that will be found elsewhere within the Hillside areas. Narrow local streets with on-street parking and framed by street trees and sidewalks on both sides will provide a comfortable environment for all users in the neighbourhood. This condition is for use where development fronts at least one side of the street.

8.3.6 Local Streets

Local streets serve a multitude of functions that are important in the day-to-day lives of residents: residents walk their dogs on the street, they wash their cars on the street and they meet and talk to their neighbours on the street. Children play on the street, they learn to ride their bicycles on the street; they treat the street as an extension of the local neighbourhood park system. At this level, the street plays a very social role. Local street design, therefore, should continue to be sensitive to the needs of non-vehicle street users as well as seeking the best fit between street and landscape.

8.3.7 Public Lanes

Public Lanes are also used by the residents of a community as a venue for social interaction and play and they can contribute greatly to the fabric of a liveable community. One opportunity for their use, however, is in areas such as the village centre. Such higher density development is generally located in more gently sloping areas where steeply sloping terrain is not an issue. The inclusion of Public Lanes in these neighbourhoods will contribute to the more urban feel envisioned as well as provide an alternate route for bikes and pedestrians.

8.3.8 Cul-de-Sac Streets Hillside Emergency Accesses and Hillside Private Lanes

In complex topographic hillside areas long streets may be required to access developable pockets within areas of steep terrain. Due to the complex topography it may not be possible for connectivity to be achieved at both ends of a street. However, in response to public safety a:

1) A cul-de-sac, turn-around, or a second point of access is required at the terminus of roads longer than 90m.
2) A Hillside Emergency and Utility Vehicle Access is required on roads between 90m and 360m in length, serving more than 100 units*.
3) Access Public Lane is required within the last 360m on roads longer than 360m and serving/designed to serve up to 100 units*.
4) Local street is required within the last 360m on roads longer than 360m and serving more than 100 units*.

*unit count total shall include all units that depend on a single point of access to the major road network, including branching cul-de-sacs. The number of units shall include the maximum potential unit count of single family, multi-family, secondary suite/carriage houses as permitted by zoning. For non-residential land uses, building occupancy will be considered.

. Beyond 600 units, a 3rd access route is required. Turnarounds are required every 360m.

In general, temporary secondary points of access will not be considered. However, a Hillside Emergency Access may be considered, consistent with the limitations of this access type, where it is; 1) ultimately replaced by a permanent connection on another alignment or to higher standard (i.e. public lane, local street, etc.), 2) constructed over the applicants lands within a highway road reservation, 3) constructed to the Hillside Emergency Access standard (but unpaved) and 4) maintained by the applicant to the satisfaction of the Fire Department. Temporary secondary points of access will not be considered to defer the construction of ultimate works on the same alignment.

Maintaining street connectivity for safety reasons wherever possible will remain a priority.

Cul-de-Sac

- ROW: min 13.0m radius;
- Radius to edge of paved surface: min 12.0m radius;
- Alternative types of street turnarounds will be considered for use based on site specific topographic conditions. In certain circumstances reduced cul-de-sac radii or hammer head type turnarounds will be permitted.

Hillside Emergency Access

- Maximum grade: 15%;
- 4.5m ROW; 4.5m roadway;
- Horizonal Alignment, Minimum Radius = R12m
- Vertical Alignment, Minimum K Value = 2
- Design Vehicle, Fire Truck
- Restrict non-emergency vehicles access through the use of removable bollards or gates;
- Shared use with pedestrian trails.

Hillside Private Lanes/Emergency Access Lanes/Maintenance Roads

Maximum grade: 15%;

Private Lanes must have a turn-around at or near their terminus. Acceptable turn-around types include cul-de-sac, eyebrow or hammerhead.

6.0m ROW; 6.0m roadway.

Hillside Development Street Standards

BL10696 Amended Table 1:
Hillside Street Standards

TABLE 1

Street Conditions			Street Section Specifications							
Street Type and Condition (Std Drawing number)		**Max. Units Served**	**Design Speed[1] (km/h)**	**Max. Grade (%)**	**ROW (m)**	**Street Width[2] (m)**	**Parking**	**Curb & Gutter**	**Sidewalk[3]**	**Street Trees**
Arterial Streets		**>600**								
Condition A (median) (SS-H1)	within village centre where environmental conditions permit		60 (50)[4]	8 (10)[11]	23.0	16.0[5]	none permitted	barrier curb required	Required both sides[6]	required both sides and in median
Condition B (SS-H2)	within 10-minute walking distance[7] of village centre; or, within village centre where environmental conditions do not permit the use of Condition A		60 (50)[4]	8 (10)[11]	17.0[8]	10.0[8]	none permitted	barrier curb required	Required both sides[6]	required both sides
Condition C (SS-H3)	greater than a 10-minute walking distance[7] from village centre.		60 (50)[4]	8 (10)[11]	15.0[8]	10.0[8]	none permitted	barrier curb required	Required one side[6]	required both sides
Village Collector Streets (main street)		**600**								
Condition A (SS-H4)	• where commercial development fronts street		50	10	20.0	12.8	required on-street both sides	barrier curb required	required both sides	required both sides
Condition B (SS-H5)	• where no commercial development fronts street		50	10	20.0	12.8	required on-street both sides	barrier curb required	required both sides	required both sides
Collector Streets		**600**								
Condition A (SS-H6)	• development[9] fronts both sides		50 (40)[4]	10 (12)[11]	18.2[8]	8.6[8]	required above curb both sides	rollover curb required	required both sides[6]	required both sides
Condition B (SS-H7)	• development[9] fronts one side only		50 (40)[4]	10 (12)[11]	14.9[8]	8.6[8]	required above curb one side	rollover curb required[12]	required one side[6]	required both sides
Condition C (SS-H8)	• no development[9] fronts street		50 (40)[4]	10 (12)[11]	14.0[8]	8.6[8]	none permitted[10]	rollover curb required[12]	required one side[6]	required both sides
Minor Collector Streets		**500**								
Condition A (SS-H9)	• development[9] fronts both sides; or, • development[9] fronts one side only		50 (40)[4]	10 (12)[11]	13.3[8]	7.0[8]	required above curb one side	rollover curb required	required one side[6]	required on one side
Condition B (SS-H10)	• no development[9] fronts street		50 (40)[4]	10 (12)[11]	12.4[8]	7.0[8]	none permitted[10]	rollover curb required	required one side[6]	required on one side

Hillside Development Street Standards

BL10696 Amended Table 1: Hillside Street Standards

TABLE 1

Street Conditions			Street Section Specifications							
Street Type and Condition (Std Drawing number)		**Max. Units Served**	**Design Speed[1] (km/h)**	**Max. Grade (%)**	**ROW (m)**	**Street Width[2] (m)**	**Parking**	**Curb & Gutter**	**Sidewalk[3]**	**Street Trees**
Village Local Streets		**200**								
Village Local (SS-H11)	• development[9] fronts at least on side		40 (30)[4]	12	17.4	8.7	required on-street both sides	barrier curb required	required minimum one side[6]	required both sides
Local Streets		**200**								
Condition A (SS-H12)	• development[9] fronts both sides		30	15	14.1	6.0	required above curb both sides	rollover curb required	optional one side[6]	required on one side
Condition B (SS-H13)	• development[9] fronts one side only		30	15	12.3	6.0	required above curb one side	rollover curb required	optional one side[6]	required on one side
Condition C (SS-H14)	• no development[9] fronts street		30	15	10.5	6.0	none permitted[10]	rollover curb required	optional one side[6]	required on one side
Public Lane		**10**								
(SS-H15)	• all cases		20	12 (15)[11]	6.0	5.7	on edge of paved surface	rollover curb required	none	--
Hillside Emergency and Utility Vehicle Access		**--**								
• provide a secondary access route, if possible, where a cul-de-sac exceeds maximum street length as specified by the City of Kelowna. Radius (min) = 12m; K (min) = 2.			--	15	4.5	4.5	--	--	--	--

Notes:

1. See Table 2 for alignment design criteria for each design speed.
2. Street width measured from curb face (gutterline).
3. For all conditions, sidewalks should terminate at a destination or connect with another sidewalk or trailhead.
4. Minimum permitted design speed reduction, where necessary due to topographic constraints, and approved by the City.
5. Separate left turn lanes to be provided in the medians.
6. Where issues of livability warrant, (e.g. extreme topographic conditions) sidewalk(s) may be located in a separate dedicated corridor

and street ROW width reduced accordingly. Unless necessary for pedestrian connectivity to schools, parks, commercial areas or land beyond, a sidewalk is not required for local streets accessing 30 lots or less. Street right of way may be reduced accordingly if a sidewalk is not required. (see Standard Drawings)

7. For this purpose, the 10-minute walking distance is considered to be ½ mile (0.8 km).
8. Where required, ROW and street widths will be increased at major intersections to provide for separate turning lanes.
9. "Development" includes all residential, mixed-use, commercial, institutional and park uses.
10. All parking shall be managed on-site or within small parking pullouts, as required.
11. Maximum grade permitted where necessary due to topographic constraints and as approved by the City.
12. Where no fronting development (driveway access not required), barrier curbs to be considered to restrict illegal parking on sidewalks.

Table 2
Alignment Design Criteria

BL10640 amended the following:

1. Horizontal Curve Radii

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Roadway Crossfall				
normal crown (-2%)	260m	165m	90m	25m
2% superelevation	205m	120m	65m	25m
4% superelevation	150m	80m	45m	22m
6% superelevation	120m	-	-	-
Through Intersections	200m	120m	70m	40m

2. Superelevation

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Maximum Superelevation	6%	4%	4%	4%
Maximum Superelevation at Intersections	4%	4%	4%	4%

3. Superelevation Transition Lengths

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Transition Lengths (2 / 4-lane roadways)				
normal crown to +2%	24m / 36m	22m / 34m	20m	20m
normal crown to +4%	38m / 54m	33m / 50m	30m	30m
normal crown to +6%	48m / 72m	-	-	-
Min Tangent Length between reversing curves				
2% superelevation (2 / 4-lane roadways)	15m / 22m	13m / 20m	12m	12m
4% superelevation	28m / 42m	26m / 40m	24m	22m
6% superelevation	42m / 64m	-	-	-

1 Values for transition lengths include tangent runout applied at the same rate as superelevation runoff.

2 60% of superelevation runoff occurs on the tangent approach and 40% on the curve, resulting in a minimum length of tangent between reversing curves of 120% of the superelevation runoff length.

Table 2 (continued)
Alignment Design Criteria

4. Gradients

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Minimum Grade	0.5%	0.5%	0.5%	0.5%
Maximum Grades				
on horizontal tangents	8%[1]	10% [2]	12%	12%
on minimum radius horizontal curves [3]	8%	9%	10%	10%
Grades Through Intersections				
with design speed on major road	8%	8%	8%	-
approach distance for major road [4]	15 / 5m [5]	5m	0m	-
with design speed on minor road	5% [6]	5%	6%	6%
approach distance for minor road [7]	20m	15m	5m	5m

1 Under special circumstances, grades up to 10% may be permitted.
2 Under special circumstances, grades up to 12% may be permitted.
3 Applies where radius is less than 1.5 times minimum allowable radius.
4 Minimum distance back from the gutter line of the minor road that the specified grade may not be exceeded.
5 Distances for design road approach to intersection with collector road / local road.
6. 4% desirable.
7 Minimum distance back from the gutter line of the major road that the specified grade may not be exceeded.

5. Vertical Curve K Values

Criteria	60 km/h	50 km/h	40 km/h	30 km/h
Minimum Crest	15	8	4	2
Minimum Sag	10	7	4	2
Crest / Sag on approach to stop condition	4	3	2	2

K values listed assume that new roadways will be illuminated

6. Stopping Sight Distances

Criteria		60 km/h	50 km/h	40 km/h	30 km/h
Down grades:	12%	109	78	52	34
	9%	101	73	50	32
	6%	94	69	48	31
	3%	89	66	46	30
	0%	85	63	45	30
Up grades:	3%	81	61	44	29
	6%	78	59	42	29
	9%	76	57	41	28
	12%	73	56	40	28

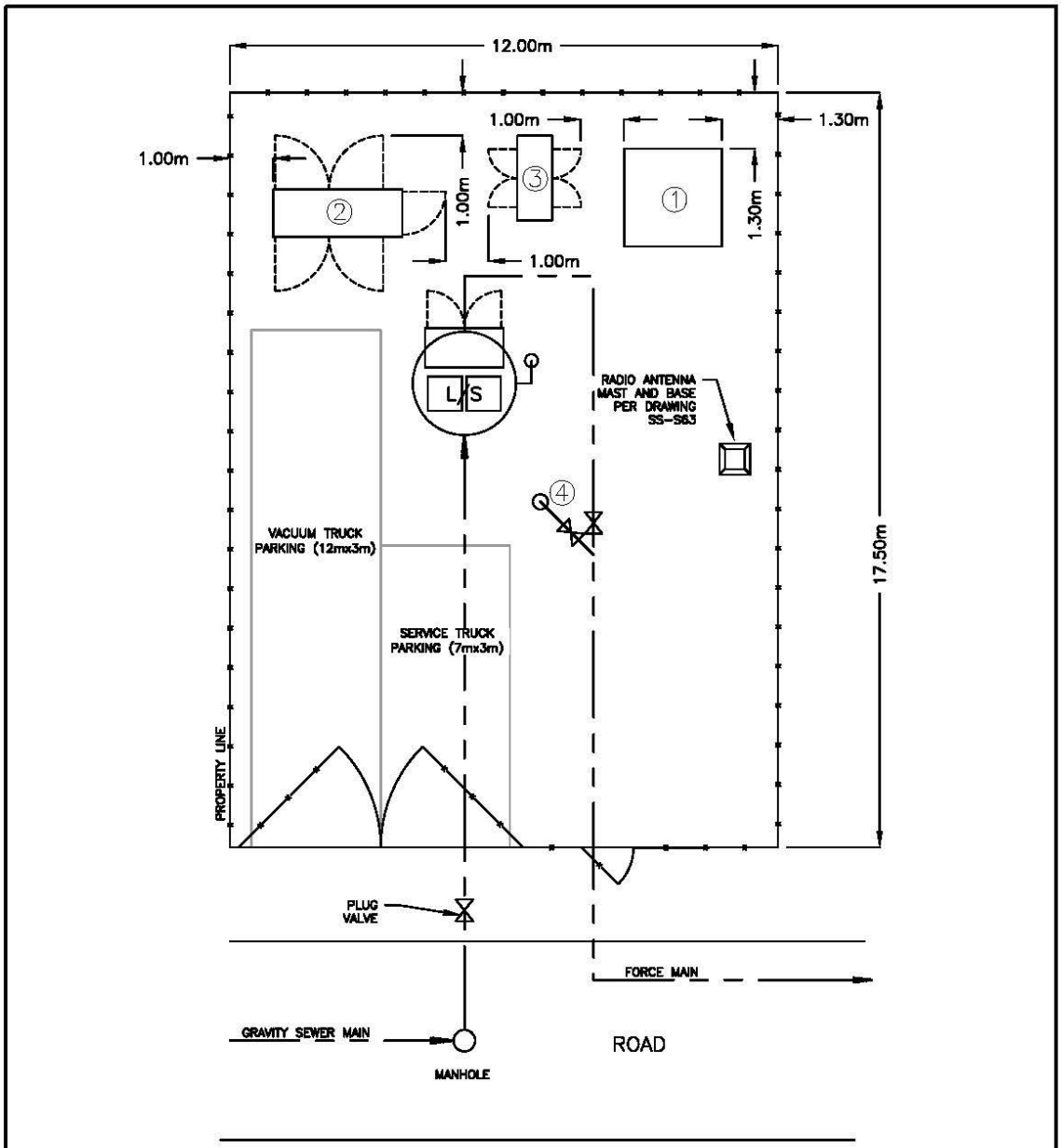
7. Decision Sight Distance

Minimum decision sight distance for 60 km/h: 175m – 235m.

1. Note that decision sight distance applies only to multi-lane roads at intersections.
2. The range of values recognizes the variation in complexity that occurs at various sites. For less complex situations, values towards the lower end of the range are appropriate and for more complexity, values at the upper end are used.

Drawing A

BYLAW NOTE



NOTES:

1.) IF PERMANENT GENSET IS NOT REQUIRED, PROVIDE A LOCATION FOR A PORTABLE GENSET.
2.) CONDUIT FROM KIOSK TO PROPERTY LINE REQUIRED FOR FUTURE FIBRE CONNECTION. TERMINATE IN JUNCTION BOX.
3.) CHEMICAL FEED CONDUIT TO BE STUBBED FOR FUTURE ODOUR CONTROL BUILDING.
4.) OFF STREET PARKING TO ACCOMMODATE A VACUUM TRUCK (HSU) AND FULL SIZE PICKUP TRUCK SIMULTANEOUSLY.
5.) ANTENNA MAST LOCATION TO BE DETERMINED BASED ON SITE CONDITIONS.
6.) ENTIRE SITE TO BE PAVED AND FENCED c/w VEHICLE ACCESS GATES AND MAN GATE.
7.) IF ODOUR CONTROL BUILDING IS REQUIRED, AN ADDITIONAL 13mx13m AREA MAY BE REQUIRED.
8.) CONCRETE BASES FOR TRANSFORMER, ELECTRICAL KIOSK AND GENSET TO BE 200mm ABOVE GRADE.

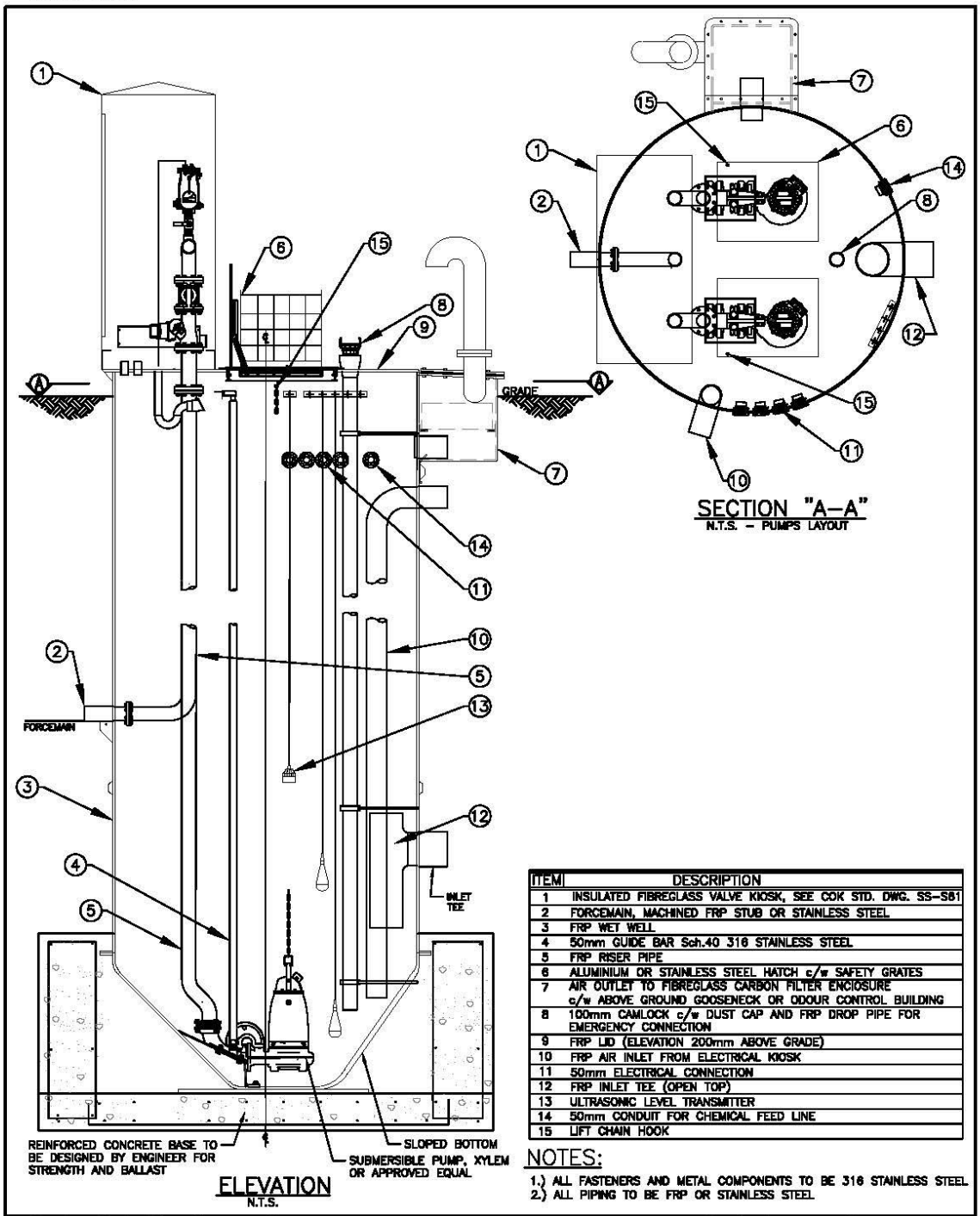
LEGEND

① TRANSFORMER
② ELECTRICAL KIOSK
③ GENSET
④ PIGGING PORT PER DRAWING SS-S62

STANDARD DETAIL DRAWING	DATE: 05/22/20	TYPICAL LIFT STATION SITE LAYOUT	DWG. NO. SS-S59	City of Kelowna
	SCALE: NTS			

Drawing B

BYLAW NOTE



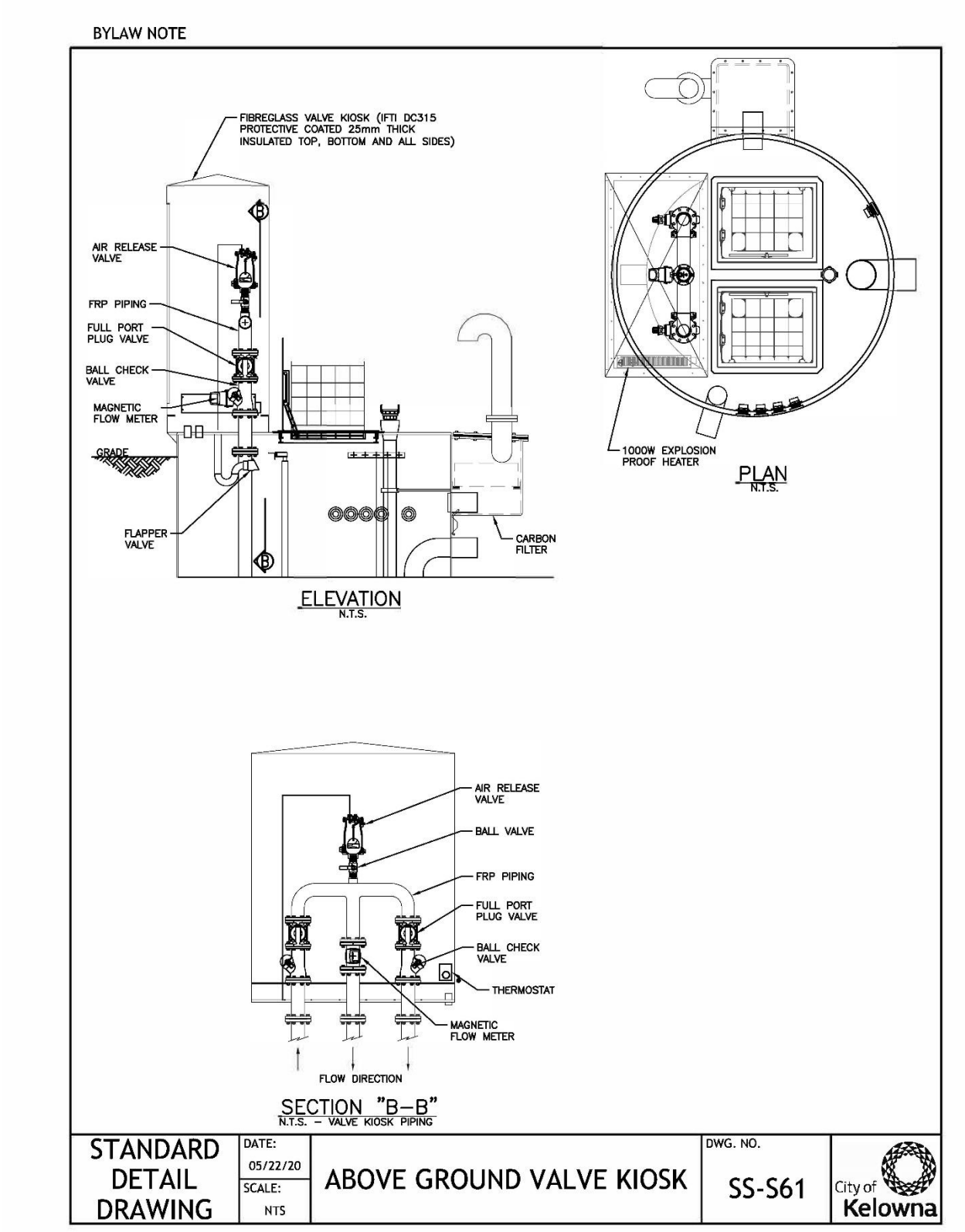
ITEM	DESCRIPTION
1	INSULATED FIBREGLASS VALVE KIOSK, SEE COK STD. DWG. SS-S81
2	FORCEMAIN, MACHINED FRP STUB OR STAINLESS STEEL
3	FRP WET WELL
4	50mm GUIDE BAR Sch.40 316 STAINLESS STEEL
5	FRP RISER PIPE
6	ALUMINIUM OR STAINLESS STEEL HATCH c/w SAFETY GRATES
7	AIR OUTLET TO FIBREGLASS CARBON FILTER ENCLOSURE c/w ABOVE GROUND GOOSENECK OR ODOUR CONTROL BUILDING
8	100mm CAMLOCK c/w DUST CAP AND FRP DROP PIPE FOR EMERGENCY CONNECTION
9	FRP LID (ELEVATION 200mm ABOVE GRADE)
10	FRP AIR INLET FROM ELECTRICAL KIOSK
11	50mm ELECTRICAL CONNECTION
12	FRP INLET TEE (OPEN TOP)
13	ULTRASONIC LEVEL TRANSMITTER
14	50mm CONDUIT FOR CHEMICAL FEED LINE
15	LIFT CHAIN HOOK

NOTES:

1.) ALL FASTENERS AND METAL COMPONENTS TO BE 316 STAINLESS STEEL
2.) ALL PIPING TO BE FRP OR STAINLESS STEEL

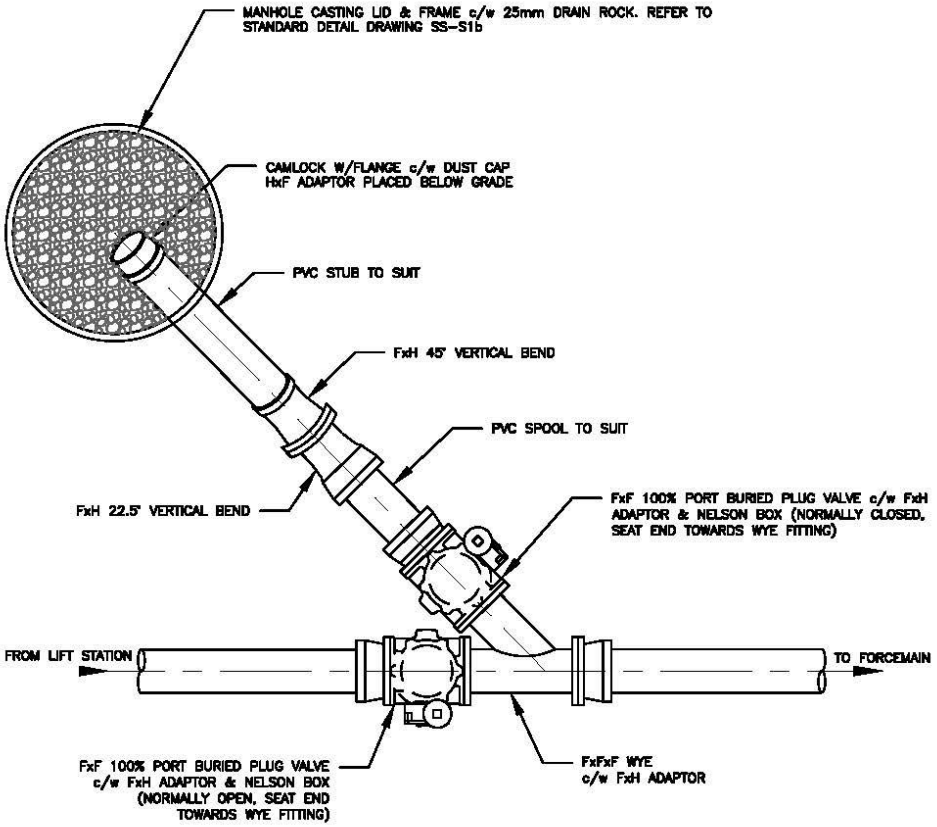
STANDARD DETAIL DRAWING	DATE: 05/22/20 SCALE: NTS	SANITARY LIFT STATION	DWG. NO. SS-S60	City of Kelowna

Drawing C


BYLAW NOTE
FIBREGLASS VALVE KIOSK (IFTI DC315 PROTECTIVE COATED 25mm THICK INSULATED TOP, BOTTOM AND ALL SIDES)
AIR RELEASE VALVE
FRP PIPING
FULL PORT PLUG VALVE
BALL CHECK VALVE
MAGNETIC FLOW METER
GRADE
FLAPPER VALVE
CARBON FILTER
ELEVATION
N.T.S.
1000W EXPLOSION PROOF HEATER
PLAN
N.T.S.
AIR RELEASE VALVE
BALL VALVE
FRP PIPING
FULL PORT PLUG VALVE
BALL CHECK VALVE
THERMOSTAT
MAGNETIC FLOW METER
FLOW DIRECTION
SECTION "B–B"
N.T.S. – VALVE KIOSK PIPING
STANDARD DETAIL DRAWING
DATE: 05/22/20
SCALE: NTS
ABOVE GROUND VALVE KIOSK
DWG. NO. SS-S61
City of Kelowna

Drawing D

BYLAW NOTE



PLAN VIEW

NOTES:

1.) ALL FITTINGS SHALL BE JOINT RESTRAINED.
2.) SIZE OF ALL FITTINGS AND PIPE TO MATCH SIZE OF FORCEMAIN.

STANDARD DETAIL DRAWING	DATE: 05/22/20 SCALE: NTS	PIGGING PORT	DWG. NO. SS-S62	City of Kelowna

Drawing E

BYLAW NOTE

