

SECTION 1 – SUPPLEMENTAL SPECIFICATIONS

STANDARD SPECIFICATIONS

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SECTION 1 – SUPPLEMENTAL SPECIFICATIONS

1.01 SCOPE

- .1 In case of inconsistency or conflict, these Supplemental Specifications supersede the General Conditions, General Requirements, Specifications, Drawings, and all other Tender and Contract documents.

1.02 AS-BUILT SUBMISSIONS

- .1 Drawings shall include all information as specified elsewhere for the construction drawings, but shall be corrected upon completion of construction to note all works removed or abandoned during construction. This information shall be retained in a digital point file.
- .2 All dimensions, elevations and inverts shown shall reflect the As-Built conditions of the construction and all references to "Proposed" shall be removed. As-Built drawings shall be to scale in accordance with the As-Built dimensions shown. The Revision Table shall be completed indicating the drawings are As-Built. **All changes and notes marked in "red ink" on the IFC drawings.**
- .3 All As-Built features shall be surveyed and survey points recorded in a digital point file with all changes marked on the IFC drawings in red ink. The As-Built drawing shall reflect the true elevation and location of all constructed features, in both the plan and profile views.
 - (a) Tolerance for moving features in the plan view drawings will be >0.9m (e.g. manholes installed less than 0.9m from design location do not need to be shifted on the as-builts/drawings).
 - (b) Tolerance for moving features in the profile view drawings will be >0.3m (e.g. manhole inverts installed less than 0.3m from the design location do not need to be shifted on the as-built/drawings).

All As-Built drawings shall also include the following information:

- (a) The location and elevation of all existing utilities and services encountered in the construction operation,
- (b) The location and invert elevation at property line of all individual service connections, and the wye chainage, at the main for all constructed and existing works,
- (c) A note on each drawing describing the type of trench material (sand, gravel, clay, hard pan, etc.) encountered during construction and the location and profile of all rock.
- (d) A detail for each tie in point to existing utilities and locations where restrainers are required.

1.03 SHOP DRAWINGS

- .1 The Contractor shall furnish to the Engineer, at proper times, all shop drawings including diagrams, illustrations, schedules, performance charts, brochures and other data necessary to clarify the work intended or to show its relation to adjacent work of other trades. The Contractor shall provide such additional drawings and shall make any changes or additions to such drawings or diagrams which the Engineer may require consistent with the Contract and will submit sufficient copies of the revised prints for review, all but three (3) of which all be

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returned to the Contractor following review

- .2 Prior to submission to the Engineer the Contractor shall review all shop drawings. By this submission, the Contractor represents that he has determined and verified all field measurements, field construction criteria, materials, catalogue numbers and similar data and that he has checked and coordinated each shop drawing with the requirements of the work and of the Contract Documents.
- .3 The Contractor shall submit shop drawings to the Engineer for review with reasonable promptness and in orderly sequence so as to cause no delay in the work of other contractors. If either the Contractor or the Engineer so requests, they shall jointly prepare a schedule fixing the dates for submission and return of shop drawings. Shop drawings shall be submitted in the form of a reproducible transparency or prints as the Engineer may direct. At the time of submission, the Contractor shall notify the Engineer in writing of any deviations in the shop drawings from the requirements of the Contract Documents.
- .4 The Engineer will review and return shop drawings in accordance with any schedule agreed upon, or otherwise with reasonable promptness so as to cause no delay. The Engineer's review shall be for conformity to the design concept and for general arrangement only and such review shall not relieve the Contractor of responsibility for errors or omissions in the shop drawings or of responsibility for meeting all requirements of the Contract Documents unless a deviation on the shop drawings has been specifically approved in writing by the Engineer.
- .5 The Contractor shall make any changes in shop drawings, which the Engineer may require consistent with the Contract Documents and resubmit unless otherwise directed by the Engineer. When resubmitting, the Contractor shall notify the Engineer in writing of any revisions other than those requested by the Engineer.

1.04 LOCATION OF THE WORKS

- .1 Where location dimensions for the proposed works are not shown on the drawings or digital file, the locations are intended to be approximate.
- .2 Unless otherwise specified, the Engineer will provide the Contractor with a copy of the digital drawing file for the Contractor and/or their surveyor to create a point file to be used for layout to perform the Work.
- .3 The Contractor shall perform all layout as required from the digital drawing file and shall be responsible for all dimensions and elevations determined from the digital information.
- .4 The Contractor shall review and be satisfied, before commencing any work, as to the meaning, intent, and accuracy of the information in the digital drawing file as it relates to control points, control lines, benchmarks, and the construction drawings.
- .5 Should the Contractor discover or suspect any errors in the digital drawing file provided by the Engineer, he shall at once discontinue the affected Work until such errors are investigated by the Engineer and, if necessary, rectified.
- .6 The Contractor shall carefully preserve bench marks, reference points and stakes. In case of willful or careless destruction or disturbance of such markers, he shall be charged with the expense of replacing them and shall be responsible for any mistakes that may be caused by their destruction, loss or disturbance.
- .7 In any dispute between the Contractor and the Engineer on the correctness of

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grades, locations, elevations of the installations or constructed works, the Contractor shall be responsible for proving by means of cut sheets and undisturbed stakes, that he has made the installation or construction in accordance with the layout provided.

- .8 The Contractor shall be required to maintain an "as-built" drawing set for the project, with all changes and notes marked in red ink and an "as-constructed" digital survey file. This information shall be available to the Engineer for review on request, and shall be submitted to the Engineer prior to issuing the Notice of Acceptance.
- .9 Legal survey markers, disturbed or removed by the construction operation that existed at a horizontal distance of 1.0 m or more from the maximum allowable trench width as shown on the standard drawings, shall be replaced at the Contractor's expense. If it is necessary to remove or disturb existing legal survey markers that are within the above limits, the Engineer shall be so notified a minimum of three (3) Business Days before such removal or disturbance and replacement will be at the Owner's expense.

1.05 LOCAL CONDITIONS

- .1 The Contractor shall, by personal inspection, examination, calculations or tests, or by any other means, satisfy himself with respect to the local conditions to be encountered and the quantities, quality, and practicability of the Work and of his methods of procedure. No verbal agreement or conversation with any officer, agent, or employee of the Owner, either before or after the execution of the Contract, shall affect or modify any of the terms or obligations herein contained.
- .2 Failure to properly assess the local conditions to be encountered and the quantities, quality and practicability of the work and his methods of procedure is a risk to be borne by the Contractor.

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11.00 SECTION 11 – REINFORCED AND PLAIN CONCRETE

ADD CLAUSES:

11.21 CODES AND STANDARDS

.1 Concrete work shall conform to the following codes and standards:

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11.22 CONCRETE

.1 Compressive Strength:

As specified in Tables 1 and 2 of CSA A23.1 for exterior walls and columns. Concrete shall develop a minimum compressive strength of 25 MPa at 28 days.

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SECTION 3 - GENERAL REQUIREMENTS STANDARD SPECIFICATIONS

3.01 SPECIFICATIONS, STANDARDS, OR METHODS

- .1 When references to the following capitalized abbreviations are made, they refer to Specifications, Standards, or Methods of the respective Association. Abbreviations listed herein but not mentioned in the specifications shall be disregarded.
- .2 The numbers and letters following the abbreviations denote the Association's serial designation for the Specification or Standard to which reference is made. All references to these Specifications, Standards or Methods shall, in each instance, be understood to refer to the latest adopted revision, including all amendments

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AGA	American Gas Association
AIEEE	American Institute of Electrical and Electronics Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
AWPA	American Wood Preservers' Association
AWS	American Welding Society
BCLNA	British Columbia Landscaping and Nursery Trades Association
BCNTA	British Columbia Nursery Trades Association
BCSLA	British Columbia Society of Landscape Architects
CEC	Canadian Electrical Code
CEMA	Canadian Electrical Manufacturers Association
CGA	Canadian Gas Association
CGSB	Canadian General Standards Board
CISC/ICCA	Canadian Institute of Steel Construction
CMHC	Canada Mortgage and Housing Corporation
CPCI	Canadian Prestressed Concrete Institute
CRCA	Canadian Roofing Contractors Association
CSA	Canadian Standards Association
CIU	Canadian Institute of Underwriters Association
CWB	Canadian Welding Bureau
CSPI	Corrugated Steel Pipe Institute
EI	Edison Electric Institute
IEC	International Electrotechnical Commission
IET	Institute of Engineers and Technology
IEEE	Institute of Electrical and Electronics Engineers, I (formerly IRE and IEE)
IES	Illuminating Engineering Society
ICEA	Insulated Cable Engineers Association
ISA	Instrument Society of America
IOS	International Organization for Standardization
NEMA	National Electrical Manufacturers Association
MOTI	Ministry of Transportation and Infrastructure
NBC	National Building Code of Canada
NEC	National Electrical Code

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NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NLGA	National Lumber Grades Authority
TAC	Transportation Association of Canada
SAE	Society of Automotive Engineers
UL	Underwriters' Laboratories, Inc.
WORKSAFEBC	Workers' Compensation Board
WCLIB	West Coast Lumber Inspection Bureau

(REVISED NOVEMBER 2016)

- .3 All static and dynamic units on drawings and specifications are S.I. units, conforming to Can-3-Z234.2-73, the International System of Units (S.I.) and Can/CSAZ234.1, Metric Practice Guide.
- .4 The S.I. Units accepted for the purpose of these standards, together with conversion factors relating them to equivalent imperial units are tabulated as follows:

ITEM	BASIC SI UNIT	(SIU) ABBREVIATION	EQUIVALENT IMPERIAL UNIT (EIU)	CONVERSION FACTOR (CF) (CF X EIU=SIU)
Length	metre	m	foot	0.3048
Length	millimetre	mm	inch	25.4
Area	square metre	m ²	square foot	0.0929
Area	square metre	m ²	square yard	0.836
Volume	cubic metre	m ³	cubic foot	0.0283
Volume	cubic metre	m ³	cubic yard	0.765
Volume	litre	L	imperial gallon	4.546
Mass	kilogram	kg	pound	0.454
Mass	tonne	t	ton (short)	0.907
Density	kilogram per cubic metre	kg/m ³	pound per cubic inch	27,680.0
Temperature	degree Celsius	C	degree Fahrenheit	(F-32) x 5/9 = C

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ITEM	BASIC SI UNIT	(SIU) ABBREVIATION	EQUIVALENT IMPERIAL UNIT (EIU)	CONVERSION FACTOR (CF) (CF X EIU=SIU)
Force	newton	N	pound force	4.448
Pressure*	kilopascal	kPa	pound per sq. inch	6.8948
Pressure*	kilopascal	kPa	inch water column	0.2491
Pressure, stress (concrete)	megapascal	MPa	pound per sq. in.	0.0069
Volume flow	litre per second	l/s	imperial gallon per minute	0.07758
Volume flow	cubic metre per second	m ³ /s	cubic feet per second	0.0283
Volume flow	litre per second	l/s	cubic feet per second	28.316
Power	kilowatt	kW	horsepower (electric)	0.746
Energy	joule	J	British Thermal Unit	1055.06
Illuminance	lux	lux	footcandles	10.76391
Frequency	hertz	Hz	Cycles per second	1.0

*As used in these standards, pressure shall mean gauge pressure unless otherwise noted.

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Standard Sieve Sizes

EIU	SI	EIU	SI	EIU	SI
4"	100 mm	1-1/2"	37.5 mm	3/8"	9.5 mm
3"	75 mm	1"	25 mm	1/4"	6.3 mm
2-1/2"	63 mm	3/4"	19 mm		
2"	50 mm	1/2"	12.5 mm		
#4	4.75 mm	#20	0.85 mm	#60	0.25 mm
#8	2.36 mm	#30	0.6 mm	#80	0.18 mm
#10	2 mm	#40	0.425 mm	#100	0.15 mm
#16	1.18 mm	#50	0.3 mm	#200	0.075 mm

Standard Pipe Sizes

EIU	SI	EIU	SI	EIU	SI
1/2"	12.5 mm	4"	100 mm	15"	375 mm
3/4"	19.0 mm	6"	150 mm	18"	450 mm
1"	25.0 mm	8"	200 mm	21"	525 mm
1-1/2"	37.5 mm	10"	250 mm	24"	600 mm
2"	50.0 mm	12"	300 mm	42"	1050 mm
2-1/2"	65.0 mm				

Concrete Strengths

EIU	SI
2200 psi	15 MPa
2500 psi	18 MPa
2900 psi	20 MPa
3700 psi	25 MPa
4500 psi	30 MPa
5000 psi	36 MPa

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Reinforcing Steel

Comparison of Imperial and Metric Sizes

(Note: % difference based on area of bars in in²)

IMPERIAL BAR			METRIC BAR			
SIZE	AREA in ²	AREA mm ²	SIZE	AREA in ²	AREA mm ²	METRIC BAR IS
#3	.11	71	10M	.16	100	45% L
#4	.20	129	10M	.16	100	20% S
#4	.20	129	15M	.31	200	55% L
#5	.31	200	15M	.31	200	SAME
#6	.44	284	20M	.47	300	6.8% L
#7	.60	387	20M	.47	300	22% S
#7	.60	387	25M	.78	500	30% L
#8	.79	510	25M	.78	500	1.3% S
#9	1.00	645	30M	1.09	700	9% L
#10	1.27	819	30M	1.09	700	14% S
#10	1.27	819	35M	1.55	1000	22% L
#11	1.56	1006	35M	1.55	1000	0.6% S
#14	2.25	1452	45M	2.33	1500	3.5% L
#18	4.00	2581	55M	3.88	2500	3.0% S

L = LARGER
S = SMALLER

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3.01A REFERENCE

- .1 The Manual of Engineering Standards and Specifications contains references to standard specifications for testing, materials, manufacturing installation and design procedures. This section provides the full descriptive title of referenced specifications.
- .2 All references listed shall be understood to refer to the latest adopted revision, including all amendments.
- .3 All references listed and referred to by the Manual of Engineering Standards and Specifications shall be part of the Manual as far as they are applicable to and not in consistent with the Manual.

SPEC NUMBER	TITLE
ANSI A 300	Standard Tree Care Operations
ANSI B 16.1	Cast Iron Pipe Flanges and Flanged Fittings
ANSI B 16.5	Standard Specification for Pipe Flanges and Flanged Fittings
ANSI/IES RP-8	Roadway Lighting
ANSI/NSF 61	NSF/ANSI 61 Drinking Water System Components – Health Effects
ASTM 3261	Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
ASTM A 48	Standard Specification for Gray Iron Castings
ASTM A 123/A 123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A 354	Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
ASTM A 536	Standard Specification for Ductile Iron Castings
ASTM A 563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM A 653/A 653M	Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process
ASTM A 746	Standard Specifications for Ductile Iron Gravity Sewer Pipe
ASTM A 775	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM A 775M	Standard Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM B 42	Standard Specification for Seamless Copper Pipe, Standard Sizes
ASTM B 62	Standard Specifications for Composition Bronze or Ounce Metal Castings
ASTM B 88	Standard Specification for Seamless Copper Water Tube
ASTM B 633	Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
ASTM B 766	Standard Specification for Electrodeposited Coatings of Cadmium

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ASTM C 14M	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 55	Standard Specification for Concrete Building Brick
ASTM C 67	Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile
ASTM C 76	Specification for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
ASTM C 76M	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulphate or Magnesium Sulphate
ASTM C 117	Standard Test Method for Material Finer Than 0.075 mm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C 127	Standard Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
ASTM C 131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C 136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C 140	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C 144	Standard Specification for Aggregate for Masonry Mortar
ASTM C 295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C 309	Standard Specification for Liquid Membrane - Forming Compounds for Curing Concrete
ASTM C 443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 443M	Standard Specifications for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C 478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
ASTM C 579	Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes
ASTM D 429	Standard Test Methods for Rubber Property - Adhesion to Rigid Substrates
ASTM D 638	Standard Test Method for Tensile Properties of Plastics
ASTM D 751	Standard Test Methods for Coated Fabrics
ASTM D 977	Standard Specification for Emulsified Asphalt
ASTM D 1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft ³ (2,700 kN-m/m ³))

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ASTM D 1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D 2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D 2412	Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D 2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D 2466	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D 2467	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2564	Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe Systems
ASTM D 2657	Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
ASTM D 2726	Standard Test Method for Bulks Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
ASTM D 3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D 3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D 3549	Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens
ASTM D 4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 6928	Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
ASTM D 6938	Standard Text Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
ASTM F 436	Standard Specification for Hardened Steel Washers
ASTM F 477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F 593	Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
ASTM F 594	Standard Specification for Stainless Steel Nuts
ASTM F 679	Standard Specification for Poly(Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings
AWWA C 104	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
AWWA C 110	Ductile-Iron and Grey-Iron Fittings
AWWA C 111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C 150	Thickness Design of Ductile-Iron Pipe
AWWA C 151	Ductile-Iron Pipe, Centrifugally Cast
AWWA C 153	Ductile-Iron Compact Fittings

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AWWA C 200	Steel Water Pipe, 6in (150mm) and Larger
AWWA C 203	Coal-Tar Protective Coatings and Linings for Steel Water
AWWA C 206	Field Welding of Steel Water Pipe
AWWA C 208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C 209	Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections and Fittings
AWWA C 210	Standard Specification for Liquid – Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C 213	Standard Specification for Fusion – Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
AWWA C 219	Standard Specification for Bolted, Sleeve – Type Couplings for Plain – End Pipe
AWWA C 500	Metal Seated Gate Valves for Water and Sewerage Systems
AWWA C 502	Dry-Barrel Fire Hydrants
AWWA C 504	Rubber-Seated Butterfly Valves
AWWA C 509	Resilient-Seated Gate Valves for Water Supply Service
AWWA C 600	Installation of Ductile Iron Water Mains and Their Appurtenances
AWWA C 651	Disinfecting Water Mains
AWWA C 800	Underground Service Line Valves and Fittings
AWWA C 900	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inch Through 12 Inch (100mm through and 300mm), for Water Transmission Distribution
AWWA C 905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 in. through 48 in. (350mm through 1200mm) for Water Transmission and Distribution
AWWA C 906	Standard Specification for Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) through 63 in. (1,600 mm), for Water Distribution and Transmission
AWWA M 11	Steel Pipe: A Guide for Design and Installation
AWWA M 17	Installation, Field Testing, and Maintenance of Fire Hydrants
CAN/CSA A 23.1	Concrete Materials and Methods of Concrete Construction/Test Methods and Standard Practices for Concrete
CAN/CSA A 23.2	Methods of Test for Concrete
CAN/CSA A 23.5	Supplementary Cementing Materials
CAN/CSA A 3000	Cementitious Materials Compendium
CAN/CSA 3 A 266.2	Chemical Admixtures for Concrete
CAN/CSA G 40.21	General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel
CAN/CSA Z 234.1	Canadian Metric Practice Guide
CGSB 41 GP 25M	Pipe, Polyethylene, for the Transport of Liquids
CSA 22.2 No. 85	Standard Specifications for Rigid PVC Boxes and Fittings
CSA 6164	Standard Specification for Concrete Masonry Units
CSA B 137.3	Rigid Polyvinyl Chloride (PVC) Pipe for Pressure Applications
CSA B 182.1	Plastic Drain and Sewer Pipe and Pipe Fittings
CSA B 182.2	PSM Type PVC Sewer Pipe and Fittings
CSA B 182.4	Profile PVC Sewer Pipe and Fittings

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CSA B 1800	Standard Specification for Thermoplastic Non-Pressure Piping Compendium
CSA C 22.2 No. 45.1	Canadian Electrical Code, Electrical Rigid Metal Conduit - Steel
CSA C 22.2 No. 211.2	Canadian Electrical Code, Rigid PVC (Unplasticized) Conduit
CSA A 231.1/A 231.2	Standard Specification for Precast Concrete Paving Slabs/Precast Concrete Pavers
CSA G 30.3	Cold Drawn Steel Wire for Concrete Reinforcement
CSA G 30.5	Welded Steel Wire Fabric for Concrete Reinforcement
CSA G 30.15	Welded Deformed Steel Wire Fabric for Concrete Reinforcement
CSA G 30.18	Carbon-Steel Bars for Concrete Reinforcement
CSA G 164	Hot Dip Galvanizing of Irregularly Shaped Objects
CSA S 16	Design of Steel Structures
CSA S 157	Strength Design in Aluminum
CSA S 269.3	Concrete Formwork
CSA W 48	Standard Specifications for Filler Metals and Allied Materials for Metal Arc Welding
CSA W 59	Welded Steel Construction (Metal Arc Welding)
CSA W 186	Welding of Reinforcing Bars in Reinforced Concrete Construction
IMSA 19-1	Standard Specifications for Polyethylene Insulated, Polyvinyl Chloride Jacketed Signal Cable
IMSA 50-2	Standard Specifications for Polyethylene Insulated, Polyethylene Jacketed, Loop Detector Lead-In Cable
MOTI SS 952	Contractor Supply Asphalt and Paving Materials for Highway Use

(REVISED NOVEMBER 2016)

SECTION 3 - GENERAL REQUIREMENTS STANDARD SPECIFICATIONS

3.01B SUPPLEMENTARY DOCUMENTS

- .1 The Manual of Engineering Standards and Specifications contains references to guidelines, governances, standards and strategies and reports. The intent of the supplemental documents is to provide additional information. Information provided in the supplemental documents does not replace or supersede the MoESS requirements.
 - (a) CNIB Position for Accessible Pedestrian Signals In Canada
www.cnib.ca/en/about/who/believe/documents/cnib_APS_position.doc
 - (b) City of Nanaimo, Steep Slope Development Permit Area Guidelines
<http://www.nanaimo.ca/assets/Departments/Community~Planning/Publications~and~Forms/SSguidelines.pdf>
 - (c) City of Nanaimo, Traffic and Highway Installation Guidelines
<http://www.nanaimo.ca/EN/main/departments/Engineering-Public-Works/4490/traffic-highway-guidelines.html>
 - (d) FHWA, Manual of Uniform Control Devices
<http://mutcd.fhwa.dot.gov/pdfs/2003/pdf-index.htm>
 - (e) NCHRP, Report 672 - Roundabouts an Informational Guide
<http://www.trb.org/Main/Blurbs/164470.aspx>
 - (f) Ministry of Transportation and Infrastructure, Manual of Standard Traffic Signs & Pavement Markings
http://www.th.gov.bc.ca/publications/eng_publications/electrical/MoST_PM.pdf
 - (g) Motor Vehicle Act Regulations - Division 23 – Traffic Control Devices
www.bclaws.ca/EPLibraries/bclaws_new/document/LOC/freeside/--%20M%20--/Motor%20Vehicle%20Act%20RSBC%201996%20c.%20318/05_Regulations/28_26_58%20Motor%20Vehicle%20Act%20Regulations/26_58_06.xml#part_division23
 - (h) BC Hydro, Street Light Information Management System (SLIM)
<https://www.bchydro.com/ex/streetlight/>
 - (i) City of Nanaimo, Urban Forest Management Strategy
<http://www.nanaimo.ca/assets/Departments/Parks~Rec~Culture/Publications~and~Forms/UFMS2010.pdf>
 - (j) BCLNA, British Columbia Landscape Standards
<http://bclna.com/bc-landscape-standards/>
 - (k) City of Nanaimo, Invasive Plant Management Strategy
<http://www.nanaimo.ca/EN/main/departments/Community-Planning/Environmental-Planning/invasive-plants/invasive-plant-management-strategy.html> (**REVISED NOVEMBER 2016**)
 - (l) Nanaimo Transportation Master Plan
<http://www.nanaimo.ca/assets/Departments/Engineering~Public~Works/Transportation~Master~Plan/2014-07-10%20Nanaimo%20Transportation%20Master%20Plan%20Final%20High%20Res.pdf> (**REVISED NOVEMBER 2016**)
 - (m) City of Nanaimo, Erosion and Sediment Control Guideline
<https://www.nanaimo.ca/assets/Departments/Building~Inspection/Publications~and~Forms/erosion.pdf> (**REVISED NOVEMBER 2016**)

SECTION 3 - GENERAL REQUIREMENTS STANDARD SPECIFICATIONS

- (n) Department of Fisheries and Oceans and the Ministry of Environment, Land Development Guidelines for the Protection of Aquatic Habitat
<http://www.dfo-mpo.gc.ca/Library/165353.pdf> (**REVISED NOVEMBER 2016**)
- (o) City of Nanaimo, Urban Forestry Management Strategy
<https://www.nanaimo.ca/assets/Departments/Parks~Rec~Culture/Publications~and~Forms/UFMS2010.pdf> (**REVISED NOVEMBER 2016**)

3.01C CITY BYLAWS (**REVISED NOVEMBER 2016**)

- .1 The Manual of Engineering Standards and Specifications shall be used in conjunction with the most current City bylaws that impact construction.
 - (a) Building Bylaw No. 5693
<http://www.nanaimo.ca/ByLaws/ViewBylaw/7224.pdf>
 - (b) Crossing Control Bylaw No. 5174
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/B5174cons.pdf>
 - (c) Development Parking Regulations Bylaw No. 7013
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/7013.pdf>
 - (d) Elimination of Dust Emissions Bylaw No. 4896
<http://www.nanaimo.ca/ByLaws/ViewBylaw/4896.pdf>
 - (e) Flood Prevention Bylaw No. 5105
<http://www.nanaimo.ca/ByLaws/ViewBylaw/5105.pdf>
 - (f) Management and Protection of Trees Bylaw No. 7126
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/B7126.pdf>
 - (g) Noise Control Bylaw No. 4750
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/4750.pdf>
 - (h) Official Community Plan Bylaw No. 6500
<http://www.nanaimo.ca/assets/Departments/Community~Planning/Ofical~Community~Plan~~~10~Year~Review/OfficialCommunityPlan2008.pdf>
 - (i) Soil Removal and Depositing Regulation Bylaw No. 1747
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/1747.pdf>
 - (j) Sewer Regulation and Charge Bylaw No. 2496
<http://www.nanaimo.ca/ByLaws/ViewBylaw/2496.pdf>
 - (k) Storm Sewer Regulation and Charge Bylaw No. 3808
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/3808.pdf>
 - (l) Traffic and Highways Regulation Bylaw No. 5000
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/3808.pdf>
 - (m) Tree Protection Bylaw No. 7126
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/B7126.pdf>
 - (n) Waterworks Rate and Regulation Bylaw No. 7004
<http://www.nanaimo.ca/UploadedFilesPath/Bylaws/B7004cons.pdf>
 - (o) Zoning Bylaw No. 4500
<http://www.nanaimo.ca/EN/main/departments/Current-Planning/Zoning.html>

(REVISED NOVEMBER 2016)

SECTION 3 - GENERAL REQUIREMENTS STANDARD SPECIFICATIONS

3.02 CONSTRUCTION PROGRAM

- .1 Prior to commencement of work specified herein, the Contractor shall submit to the Engineer for approval, a written construction program summarizing his proposed construction methods and sequences.
- .2 This program shall contain sufficient information on the following points for the Engineer assess the practicability of the proposed methods:
 - (a) Sources of aggregate
 - (b) Stripping methods
 - (c) Excavation and hauling methods
 - (d) Compaction equipment and methods for each type of fill and aggregate
 - (e) Watering and dewatering methods
 - (f) Waste material disposal locations
 - (g) Traffic control, if required
 - (h) Provision for access to adjacent properties, if required
 - (i) Hours of work

3.03 TEMPORARY CONSTRUCTION FACILITIES

- .1 Access Road:
 - (a) Temporary roads shall be constructed as required for access to the working areas. Access to temporary roads from public roads shall require prior written approval from the City of Nanaimo. Adequate drainage facilities in the form of ditches, culverts, or other conduits shall be installed as found necessary to maintain these roads. In the construction of access roads, existing drainage facilities, natural or otherwise, shall not be disturbed to the detriment of properties outside the working area and such facilities shall, unless otherwise provided elsewhere in the specifications, be restored to their original condition as far as is practical to do so on completion of the work.
- .2 Sanitary Facilities:
 - (a) Clean, sanitary, latrine accommodations shall be provided by the Contractor, and shall be located and maintained such that they are not offensive to any property owner or member of the public. The use of these facilities by persons engaged in the work shall be strictly enforced.
 - (b) These facilities shall be removed by the Contractor at the conclusion of the work or when instructed to do so by the Owner.

3.04 SPECIAL TOOLS, OPERATING MANUALS, AND SHOP DRAWINGS

- .1 For installations which include mechanical and electrical equipment or machinery having wearing parts and requiring periodical repair and adjustment, all special tools, wrenches, and accessories required for removing worn parts, making adjustments, and carrying out maintenance shall be supplied. All gauges, indicators, and lubricating devices necessary for the proper operation of the equipment shall be furnished.

SECTION 3 - GENERAL REQUIREMENTS STANDARD SPECIFICATIONS

- .2 With each piece of equipment, 4 sets of operating manuals and as-constructed shop drawings shall be supplied. The manuals should give the manufacturer's recommended maintenance schedules with the grades of lubricants required and instructions as to how the equipment may be taken apart for periodic inspection and replacement.
- .3 The Contractor shall furnish all lubricating oils, greases, fuels, water, and power necessary to operate all equipment furnished under this Contract for a period of time sufficient to indicate its full acceptance to the Engineer.

3.05 EXPLOSIVES

- .1 The General method of storage, handling, use and character of all explosives shall be subject to the Accident Prevention Regulations covering explosives, pursuant to the Workers' Compensation Act of British Columbia and must conform to local police requirements.
- .2 Explosives in excess of sixty-eight (68) kg shall be kept only in registered premises, which have been licensed under the Explosives Act (Canada).

3.06 BLASTING

- .1 Blasting will be permitted only after securing the approval of the Owner. Damage caused by blasting shall be repaired by the Contractor at his expense. The method and procedure employed for blasting shall be in accordance with Provincial and Municipal ordinances. The Contractor shall not do any blasting without first verifying that his insurance covers any loss of life or damage that may result from this work and includes a waiver of subrogation in favour of the Owner. The Owner, in granting approval for blasting, does not in any way assume responsibility for injury, loss of life, or damage that may result therefrom, and such approval shall not be construed as approval of the methods employed by the Contractor in blasting, the sole responsibility therefore being that of the Contractor.

3.07 SITE MAINTENANCE AND CLEANUP

- .1 The working areas shall be maintained in an orderly manner and shall not be encumbered with equipment, materials, or debris.
- .2 Cleanup shall be a continuing process from the start of the work to final acceptance of the project. The Contractor shall at all times, and without further order, keep property on which work is in progress free from accumulations of waste materials or rubbish caused by employees or by the work. Accumulations of waste materials which might constitute a fire hazard will not be permitted. Spillage from the Contractor's hauling vehicles on travelled public or private roads shall be promptly cleaned up. On completion of construction, the Contractor shall remove all temporary structures, rubbish, and waste materials resulting from his operations.

3.08 TIMING OF INSTALLATION

- .1 The Contractor shall schedule the work in a manner such that disruption of normal traffic and inconvenience to residents in the working area is kept to a minimum. Resurfacing of roads, testing of pipe, and cleanup of the site shall be completed no later than 30 days following commencement of construction on any street block.

SECTION 3 - GENERAL REQUIREMENTS STANDARD SPECIFICATIONS

- .2 Departure from scheduling as specified above will be permitted only with the written consent of the Owner to a request made by the Contractor.

3.09 WORK WITHIN ROAD RIGHTS-OF-WAY

- .1 All work within road rights-of-way shall be in strict conformance with, but shall not be limited to, the following requirements:
- (a) Where one-way traffic cannot be avoided, adequate traffic control in the form of signs, lights, barricades and/or flagmen or pilot cars must be provided.
 - (b) Where detours are available, they must be adequately designated with proper signs.
 - (c) Traffic must be restored to as near normal as possible when work is not in progress.
 - (d) Surface runoff is to be prevented from seeping into trenches.
 - (e) Excavation across entrances, whether private or commercial, shall be backfilled and thoroughly compacted, within two hours unless otherwise approved in writing by the tenant or property owner.
 - (f) Open cut excavation shall not be left open overnight or on weekends unless there are workmen on duty and there is authorization by letter from the City of Nanaimo.
 - (g) Adequate signs, barriers, flares, etc., to ensure the safety of the public and traffic are to be provided at all times. Lights and flares are to be in good working order at all times and are to be checked daily. Lights that are not operational shall be removed from the worksite.
 - (h) Existing drainage courses and culverts are to be preserved and maintained as required.
 - (i) If the City of Nanaimo, at any time, deems it necessary, a workman from the Operations Division, City of Nanaimo, will be stationed at the work site to ensure that no damage is done to existing services.
- .2 The Contractor shall make allowance in his tendered prices for all additional costs likely to be incurred in conforming with the Ministry of Transportation and Infrastructure regulations when working on or near a highway or right-of-way under the jurisdiction of the Ministry of Transportation and Infrastructure.

3.10 WORKSAFEBC

- .1 The Contractor shall comply, at all times, with the current Workers Compensation Act and the WorkSafeBC Occupational Health and Safety Regulation.
- .2 The Contractor shall have a current Occupational, Health & Safety Program and provide a copy of this program to the Owner.
- .3 Prior to commencing work, the Contractor shall forward a copy of their WorkSafeBC Notice of Project, Clearance Letter and Safety Program to the Owner.
- .4 If the Contractor is designated as the Prime Contractor, they shall fulfill the Prime Contractor responsibilities as defined in: **(REVISED NOVEMBER 2016)**
- (a) WorkSafeBC Occupational Health and Safety Regulation, Notice of project, Section 20.2, and Coordination of multiple employer workplaces, Section 20.3. **(REVISED NOVEMBER 2016)**

SECTION 3 - GENERAL REQUIREMENTS STANDARD SPECIFICATIONS

- (b) Workers Compensation Act (BC), Coordination at multiple-employer workplaces, Section 118, Subsections (1) & (2) and, **(REVISED NOVEMBER 2016)**
 - (c) General Requirements, Section 3.10 WorkSafeBC. **(REVISED NOVEMBER 2016)**
- .5 If the Contractor is designated as the Prime Contractor, they shall follow current WorkSafeBC regulations.
- .6 The workplace may have the following known operations and/or site conditions that could present a potential hazard to workers and other persons at the workplace. Other hazards may exist:

Example:

Asbestos Pipe	Energized Equipment
Confined Space	Traffic >30km/h
Underground Utilities	Tree Removal
Excavations	Hazardous Materials
Overhead Power Lines	Mobile Equipment

- .7 The City of Nanaimo has developed Safework Procedures for the guidance of Municipal Employees in addressing the aforementioned potential hazards. These procedures can be made available to the Contractor as reference in developing their own site specific safework procedures that will be utilized to protect the health and safety of all workers and persons on this project.

SECTION 3 - GENERAL REQUIREMENTS EXISTING STRUCTURES AND UTILITY WORKS

3.20 SCOPE

- .1 This specification refers to the location, protection, removal, and replacement of existing structures and utility works.
- .2 Existing structures shall mean all existing pipes, ducts, ditches, or other works forming a part of sewerage, drainage, water, telephone, electrical, gas or other utility systems as well as sidewalks, curbs, poles, fences, buildings, and other man-made things that may be encountered during construction.

3.21 SUPPLY OF MATERIALS

- .1 The Contractor shall supply all materials required for the specified location, protection, removal, and replacement of existing structures.
- .2 Unless specified otherwise, materials supplied for replacement of existing structures shall be at least equal to those being replaced.

3.22 LOCATION OF STRUCTURES

- .1 Prior to commencing any excavation the Contractor shall be responsible for locating existing surface and underground structures that may affect the work or may be damaged during construction.
- .2 Drawings or descriptions, verbal or otherwise, of existing structures or their location that are given to the Contractor are intended only as an aid to his location of these structures. Measurements and location of the existing underground structures shown on the drawings are not guaranteed to be accurate, and must be verified by the Contractor prior to proceeding with construction.
- .3 On request from the Engineer, the Contractor shall excavate and uncover underground structures for the purpose of establishing line or grade for proposed installation of piping or other works.

3.23 PROTECTION, ADJUSTMENT, AND SALVAGE OF STRUCTURES

- .1 Unless authorization from the Engineer is received for their removal, underground and surface structures encountered during construction shall be protected from damage. In the event of damage resulting from the construction operation, they shall be repaired or replaced at the contractor's sole expense to a condition which is at least the equivalent of that which existed prior to construction. On instructions from the Engineer certain works shall be salvaged and delivered to the City of Nanaimo Works Yard on Labieux Road.
- .2 All asbestos cement pipe damaged or disturbed during construction shall be removed and disposed of in accordance with WorkSafeBC regulations using proper safework practices. **(REVISED NOVEMBER 2016)**

SECTION 3 - GENERAL REQUIREMENTS EXISTING STRUCTURES AND UTILITY WORKS

3.24 EMERGENCY SITUATIONS

- .1 In emergency situations resulting from the construction operation, where life or property are endangered, the Contractor shall immediately take whatever action is required to eliminate the danger and shall also notify the appropriate authorities of the situation.
- .2 In the specific case of a water or sewer break, the contractor shall immediately notify the Public Works Department at 250-758-5222.
- .3 During periods when the Contractor's personnel are not on the job (after hours and weekends) at least one of the three Contractor's representatives in Nanaimo shall be available by phone contact. The names, addresses and phone numbers of the three Contractor's representatives shall be filed with the Engineer prior to commencement of construction and this list shall be updated by the Contractor as is necessary.
- .4 If the Contractor cannot be contacted to remedy the situation the Owner will take whatever action deemed necessary to eliminate the danger and all costs incurred shall be borne by the Contractor.

3.25 ACCESS MAINTAINED

- .1 Existing hydrants, valve or manhole covers, valve boxes, curb stop boxes, fire or police call boxes, and all other utility controls, warning systems, and appurtenances thereof shall not be obstructed or made inaccessible at any time by the construction work. Bridges, walks, or other temporary facilities shall be provided as may be necessary to ensure that these controls or warning systems are free for use in their normal manner at all times during construction.

3.26 CURTAILMENT OF UTILITY SERVICE

- .1 Where existing utilities such as water, sanitary sewer, storm sewer, electricity, telephone, and gas are serving the public, work shall be planned and executed such that there is no curtailment of service provided by these utilities without prior receipt of approval of the authorities responsible for provision and maintenance of these utilities. The Contractor shall obtain the above approvals from the recognized authorities controlling these utilities. If approval for such disruption of utility service is not granted, the Contractor may be able to establish temporary facilities to provide continuous utility service during the course of construction. Such temporary facilities shall only be implemented after receiving the approval of the utility authority and all costs relating to the establishment of temporary services shall be borne by the Contractor.
- .2 If the Contractor, after receiving approval of the responsible authorities, is to temporarily close off an existing utility, he shall, unless otherwise authorized by the Engineer, notify individual users of the utility at least twenty-four (24) hours prior to the time of shut-off.

3.27 SUPPORT OF STRUCTURES

- .1 Existing structures other than pipes shall be protected against damage from settlement by means of support or compaction of backfill as required. Support shall remain in place following backfill of excavations.

SECTION 3 - GENERAL REQUIREMENTS EXISTING STRUCTURES AND UTILITY WORKS

- .2 Backfill which is placed under or adjacent to existing structures which have been undermined during excavation shall be compacted in a manner which will prevent damage of the structure from settlement. Such backfill shall be of approved granular material suitable for compaction.
- .3 For support of existing piping, other than asbestos cement or cast iron piping, refer to Standard Drawing T-11 in Section 4 – Trench Excavation, Bedding and Backfill.
- .4 Where excavations for works cross underneath existing asbestos cement or cast iron piping the existing pipe shall be replaced by the Contractor with PVC pipe approved by the Engineer or supported with a concrete grade beam refer to Standard Drawing No. T-11, Section 4 – Trench Excavation, Bedding and Backfill as determined by the Engineer.

3.28 DRAINAGE FACILITIES

- .1 Existing culverts, enclosed drains, flumes and ditches, and other drainage structures affected by the work but left in place, shall be kept clear of excavated material at all times during construction. When it is necessary to temporarily remove an existing drainage structure, the Contractor shall provide suitable temporary ditches or other approved means of handling the drainage during construction.
- .2 Culverts and drain pipes shall be replaced on line and grade at the time of trench backfilling, in accordance with City of Nanaimo Standards and Specifications.
- .3 No chlorinated water shall be discharged into storm drainage facilities without prior approval from the City Engineer.
- .4 Prior to, and during construction, the Contractor shall take full responsibility for controlling erosion and sediment transfer by utilizing the guidelines contained in the handbook entitled, “Land Development Guidelines for the Protection of Aquatic Habitat”, by the Department of Fisheries and Oceans and the Ministry of Environment, to prevent discharge of sediment into City stormwater management systems and environmentally sensitive areas. It is incumbent for the contractor to acquire and be familiar with these guidelines.

3.29 WORK WITHIN RAIL RIGHTS-OF-WAY

- .1 Where construction occurs within Railway rights-of-way the Owner will obtain the necessary permit for installation. The Contractor shall provide written notice to the local Superintendent of the Railway company at least 48 hours prior to commencement of work, with copies to the Engineer.
- .2 The Contractor shall coordinate timing of installation, rail removal and replacement with the Railway District Superintendent.

SECTION 3 - GENERAL REQUIREMENTS EXISTING STRUCTURES AND UTILITY WORKS

3.30 HIGHWAY CROSSING

- .1 Where construction occurs on Provincial Highway rights-of-way the Owner will obtain the permit for Permission to Construct Works within Crown Lands. The Contractor shall be responsible for obtaining any other necessary construction permits and shall determine the complete requirements of the Ministry of Transportation and Infrastructure (MOTI). Installation within the right-of-way shall be strictly in conformance with MOTI requirements and regulations. If there is any conflict between MOTI requirements and these specifications, the MOTI requirements shall govern within the highway rights-of-way. The Contractor shall provide written notice to the MOTI at least 7 days prior to commencement of work with copies to the Engineer.

3.31 ELECTRICAL POWER, TELEPHONE, TELEVISION, CITY AND PRIVATE OWNED FIBRE OPTICS, CABLES AND CONDUITS

- .1 Electrical power, telephone, television, city and private owned fibre optics, cables and conduits may exist throughout the work area. B. C. Utility Companies shall be notified by the Contractor prior to excavation in the vicinity of any buried cables or ducts.

3.32 GAS PIPELINES

- .1 High pressure gas pipelines may exist throughout the area. The Contractor shall familiarize themselves with the requirements and regulations of the Standard Practice Instruction of the Gas Utility Company, the Gas Act, and the Pipe-Line Act of the Province of British Columbia with regard to work carried out in the vicinity of these pipelines, and shall comply with such requirements and regulations.
- .2 The local gas company shall be notified prior to excavation in the vicinity of buried gas mains.

3.33 POWER LINE CROSSING

- .1 Where construction crosses British Columbia Hydro and Power Authority (BCH&PA) rights-of-way, the Owner will obtain necessary permission beforehand. Construction within the right-of-way shall be strictly in conformance with BCH&PA requirements and regulations.

3.34 WORK IN VICINITY OF OVERHEAD POWER LINES

- .1 Equipment shall not be operated where it is possible to bring such equipment or any part of the equipment within 3 metres of any energized electrical conductor unless the following safety precautions are taken by the Contractor:
 - (a) The utility company is notified, the line de-energized, or effectively guarded against contact, or displaced or re-routed from the work area.
 - (b) The Workers' Compensation Board prior to commencement of construction is notified in accordance with their required procedure.
 - (c) For high-voltage transmission lines, a greater clearance is provided, as determined by the utility company.

SECTION 3 - GENERAL REQUIREMENTS EXISTING STRUCTURES AND UTILITY WORKS

3.35 RELOCATION OF EXISTING PIPING

- .1 Where existing underground piping parallels the centreline of the trench, or crosses the trench centreline and intersects the pipe to be installed and must, in either case, be relocated, the Contractor shall make arrangements for the relocation of existing piping or shall, having received the approval of the authority responsible for maintenance of the existing pipe, remove and relocate existing piping with his own forces. Where existing pipes cross the centreline of the trench but do not intersect the pipe to be installed, the Contractor will not disturb the existing pipes.

3.36 WATERCOURSE CROSSING

- .1 Where a watercourse crossing is required as part of the construction, the crossing construction shall be in accordance with the Ministry of Environment, Provincial Fish and Wildlife regulations and Federal Fisheries regulations where applicable.
- .2 The Owner will obtain the necessary initial permission from the authority having jurisdiction to construct works where a water course crossing is required. The Contractor shall provide written notice to the authority having jurisdiction at least seven (7) days prior to commencement of work, with copies to the Engineer.

3.37 DETOURS

- .1 All road closures and detours require approval from the City of Nanaimo. Applications for detours shall be made by the Contractor to the City of Nanaimo in writing at least seven (7) days in advance of the detour going into effect. Where detours are permitted the City of Nanaimo will notify the fire, police and ambulance departments as well as the bus service prior to the detour going into effect.
- .2 The Contractor shall notify the City of Nanaimo immediately following the resumption of normal traffic flow.

SECTION 3 - GENERAL REQUIREMENTS CLEARING AND GRUBBING

3.50 SCOPE

- .1 This specification refers to clearing and grubbing of the site for construction in the areas delineated on the drawings or described in the specifications.

3.51 SUPPLY OF MATERIALS

- .1 The Contractor shall supply all materials required for clearing and grubbing.

3.52 CLEARING AND GRUBBING

- .1 The area shall be cleared and grubbed within the limits designated by the Engineer on the site.
- .2 All trees and brush except those selected for preservation shall be cut, and along with all stumps, logs, roots, rotten wood, and other organic materials shall be removed from the site.
- .3 The above material shall be removed from the ground surface and to a minimum depth of 0.30 metres below.
- .4 All other rubbish and debris existing on the site shall be removed and disposed of. No burning will be allowed.
- .5 Where selective clearing is required, trees or groups of trees as designated on the drawings or marked by the Engineer in the field shall be preserved.
- .6 Trees shall be felled within the designated clearing area and those falling outside this area shall be cut up and returned to the clearing area for disposal.
- .7 Individual leaning or dangerous trees or snags adjacent to, but outside the designated clearing area, shall be cut and disposed of. Written permission shall be obtained from the Owner by the City of Nanaimo for this work.
- .8 Excavations resulting from removal of tree trunks, roots, or other material shall be filled and leveled by the Contractor as a part of the clearing and grubbing operation.

3.53 BURNING

- .1 No burning of wood waste, rubbish or debris is allowed in the City of Nanaimo.

3.54 MERCHANTABLE TIMBER

- .1 Merchantable timber cut during the clearing operation shall be trimmed of all branches and stockpiled on the site at a location designated by the Engineer. Such timber will remain the property of the Owner unless otherwise noted in the contract documents.
- .2 Removal of timber from dedicated road rights-of-way will be subject to permission from the Ministry of Forests, Lands and Natural Resource Operations. **(REVISED NOVEMBER 2016)**

SECTION 3 - GENERAL REQUIREMENTS CONTROL OF PUBLIC TRAFFIC

3.60 SCOPE

- .1 This specification refers to the control of public traffic in construction areas.

3.61 CONTROL OF PUBLIC TRAFFIC - GENERAL

- .1 The following general principles shall be maintained when performing construction or maintenance work upon Municipal streets and thereby affecting traffic through movement, access to properties and/or parking.
- .2 All control of public traffic will be carried out in accordance with the Ministry of Transportation and Infrastructure Traffic Control Manual for Work on Roadways and WorkSafeBC regulations.
- .3 Work on streets shall be completed as quickly as possible so as to only disrupt normal street operation for the shortest possible time.
- .4 Proposed projects shall be planned in such a way as to keep work areas and interference with traffic to a minimum.
- .5 Initial inspection of the site shall include observations of traffic intensity, property use and extent of no parking.
- .6 All job equipment not in use shall be sorted in such a manner as not to create view obstructions or unnecessary obstructions to vehicular or pedestrian traffic.
- .7 In certain instances, it may be required to perform construction jobs between traffic peaks, which will be noted as a condition on the permit to construct works on the Public Road Allowance, i.e. 9:00 a.m. to 4:00 p.m.
- .8 Emergency works shall have priority over traffic inconvenience insofar as is necessary to correct the problem. Nevertheless, every effort must be made to provide protection for the public and workers.
- .9 Partial or complete closure of major and collector roads requiring traffic detouring in at least one direction must be approved by the City of Nanaimo at least seven days prior to the start of construction.
- .10 No loose material like dirt, mud and debris should be allowed to accumulate or remain upon any sidewalk, street or driveway.
- .11 At any time, a Police Officer can override these provisions.

SECTION 3 - GENERAL REQUIREMENTS CONTROL OF PUBLIC TRAFFIC

3.62 USE OF FLAG PERSONS

- .1 Although the need for flag persons will be determined by the Engineer, it is generally expected that they will be required in the following situations:
 - (a) When public traffic is required to pass working vehicles or equipment which may block all or part of the travelled roadway.
 - (b) When it is necessary to institute a one-way traffic system through a construction area or other blockage where traffic volumes are heavy, approach speeds are high, and a traffic signal system is not in use.
 - (c) Where workers and/or equipment are employed on the travelled way over the brow of a hill, around a sharp curve or at any other location where oncoming traffic would not otherwise have adequate warning of their presence.
 - (d) In high speed, high volume areas where temporary protection is required while other traffic control devices (barricades, cones, signs, etc.) are being erected or taken down.
 - (e) For emergency protection when other traffic control devices are not readily available.
 - (f) In all situations where complete protection for workers, working equipment and public traffic is not provided by other traffic control devices.
 - (g) At the entrance to road closures and along detour routes where required.
- .2 Courtesy is of prime importance as many motorists tend to become irritable when held up by road work for any length of time. Each flagperson shall be fully conversant with all aspects of the situation requiring the delay and shall be ready to explain the hold-up, and its approximate duration, if required.
- .3 All flag persons must be trained and certified in a Traffic Control course acceptable to WorkSafeBC.
- .4 Flag persons and their equipment shall conform to WorkSafeBC regulations.

3.63 USE OF TRAFFIC CONTROL DEVICES

- .1 Traffic control devices shall be placed immediately before the work commences, except "parking restriction" signs which will be installed a minimum of 12 hours in advance.
- .2 Traffic control devices shall remain in place only as long as they are needed, and shall be removed immediately thereafter.
- .3 Any traffic control device not required at any time during the work shall be removed from view.
- .4 Traffic control devices used outside work hours (overnight, holidays and weekends) shall be maintained to produce a safe effect and be minimal obstructions to traffic, parking or access. Flashing beacons will be used to completely and properly identify all sites at night.
- .5 Traffic control devices shall at all times be in good repair.
- .6 Misapplication and excessive use of traffic control devices shall be avoided. This may cause confusion and result in disrespect for the instruction.

SECTION 3 - GENERAL REQUIREMENTS CONTROL OF PUBLIC TRAFFIC

- .7 Detoured traffic shall be afforded maximum practical protection, convenience and guidance by the proper use of traffic control devices.
- .8 Signs shall be mounted on weighted bases or folding frames, ensuring that they are held rigidly and maintained in a proper position.

SECTION 3 - GENERAL REQUIREMENTS

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT

Existing Structures and Utility Works	3.70
Clearing and Grubbing	3.71
Salvaged Materials	3.72
Control of Public Traffic	3.73
Removal of Existing Culverts	3.74
Removal of Existing Structures	3.75
Plug/Cap Existing Pipe	3.76
Grout Existing Pipe	3.77

SECTION 3 - GENERAL REQUIREMENTS

MEASUREMENT AND PAYMENT

3.70 EXISTING STRUCTURES AND UTILITY WORKS

Extra payment will not be made to the Contractor for expense incurred as a result of the presence of existing structures except as follows:

(a) Location of Existing Structures: Section 3.22.3

Where the Contractor is specifically instructed by the Engineer to locate, by excavating, underground structures for the purpose of establishing line or grade, the Contractor will be paid on the basis of the payment items shown on the Tender Form.

(b) Relocation of Existing Piping: Section 3.35

Where an existing pipe parallels the centreline of the trench and lies within the allowable trench width as shown on standard drawing T-1 or T-2, or crosses the trench and intersects the pipe to be installed and must, in either case, be relocated, the Contractor will, unless otherwise specified elsewhere herein, be paid on the basis of the payment items shown in the Tender Form. No payment will be made for delays, standby, or any claims of the Contractor other than for the actual cost of relocating the existing pipe, and no payment will be made for tunnelling under or protecting the existing pipe.

(c) Support of Existing Asbestos Cement or Cast Iron Piping Section 3.27

Standard Drawing T-11

Payment for work to support or replace existing asbestos cement or cast iron piping under which excavation for works crosses shall be made at the price quoted in the Tender Form. This price shall include supply of materials, excavation, disposal of materials, backfilling and all work incidental thereto.

3.71 CLEARING AND GRUBBING Section 3.52

Payment for clearing and grubbing will be made at the lump sum price shown in the Tender Form. This price shall include materials, and all work incidental thereto.

3.72 SALVAGED MATERIALS Section 3.23

This item covers the cost of salvage and delivery of salvaged items. This work shall be paid for on a per unit basis as shown in the Tender Form. No payment will be made for items damaged due to the act of removal or delivery.

SECTION 3 - GENERAL REQUIREMENTS

MEASUREMENT AND PAYMENT

3.73 **CONTROL OF PUBLIC TRAFFIC** Section 3.60, 3.61, 3.62, and 3.63

Payment will be made as a lump sum as shown in the Tender Form.

3.74 **REMOVAL OF EXISTING PIPE**

Payment for pipe removal will be made at the unit price per linear metre shown in the Tender Form for the various sizes of pipe. Measurement will be made horizontally along the centre line of the existing culverts.

This item covers the removal and disposal of all existing pipe, culverts, and headwalls designated on the drawings for removal including backfill of the trench with suitable native material. Where imported granular fill is required, it shall be paid for at the unit price quoted in the tender form.

Payment for the handling, cutting and removal of asbestos cement pipe will be made at the unit price per linear metre of pipe removed as shown in the Tender Form. This price shall include all labour, equipment and materials required for the proper removal and disposal of asbestos cement pipe as required by the WorkSafeBC Regulations.

3.75 **REMOVAL OF EXISTING STRUCTURES** Section 3.23

Payment for the removal and disposal of structures, as designated on the drawings, will be made at the unit price shown in the Tender Form.

- a) Valve Boxes – This price shall include the removal and disposal of the valve box, filling the valve stand pipe with pea gravel or non-shrink grout, abandoning valves in place unless otherwise shown on the drawings, and all work incidental thereto.
- b) Air Valve – This price shall include the removal and disposal of the air valve, air valve chamber, casting and lid, all associated piping and fittings, backfill and compaction with suitable native material, and all work incidental thereto.

For these pay items, import granular backfill where required, and surface restoration will be paid separately under the applicable unit rate in the Tender Form.

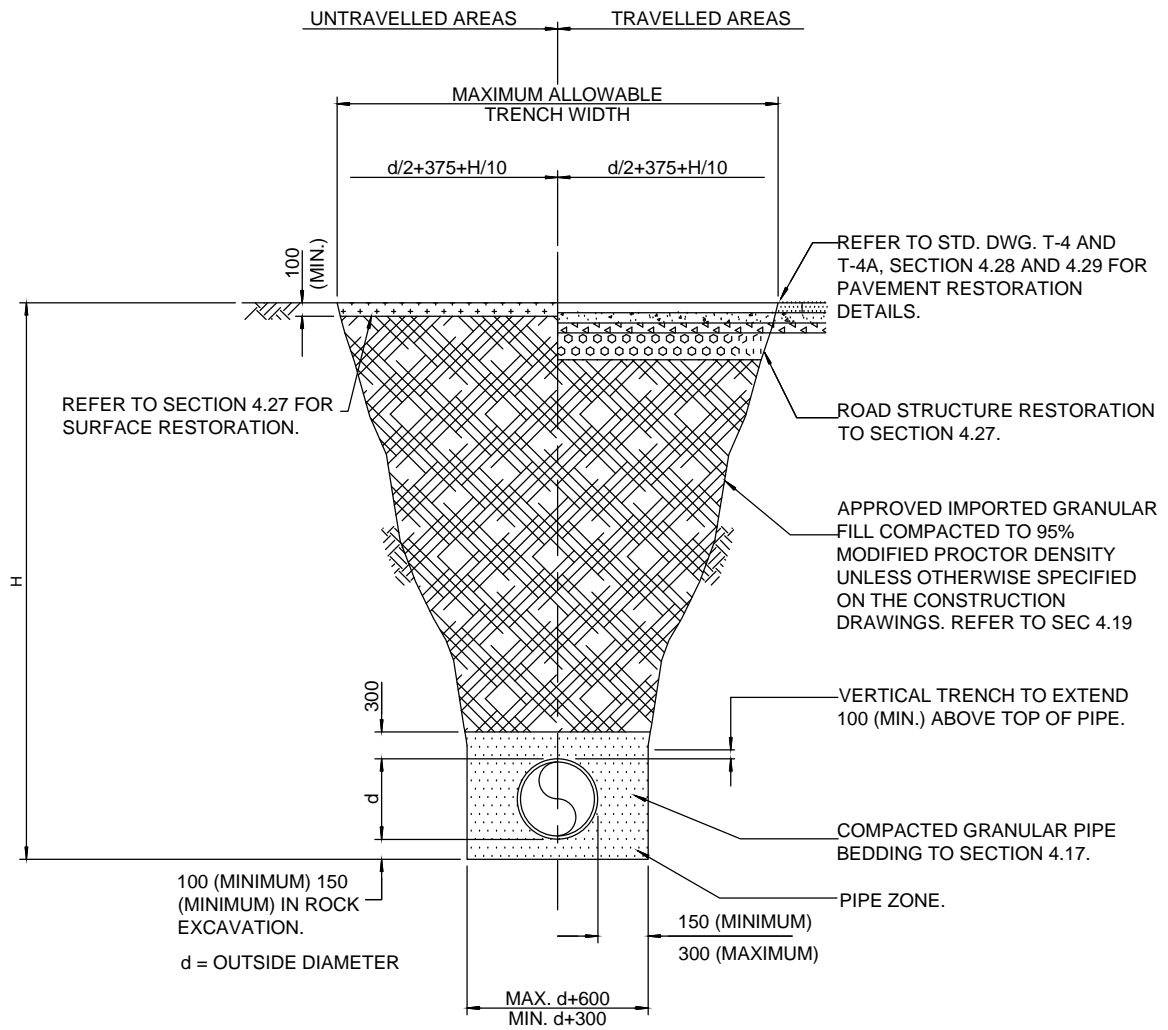
3.76 **PLUG/CAP EXISTING PIPE**

Payment for plugging or capping of existing pipe is to be made at the unit price per proposed pipe size shown in the Tender Form. This item covers the supply and installation of a manufactured cap or concrete plug as specified on the drawings for abandonment of existing pipe and includes backfill of the trench with suitable native material. Where imported granular fill is required, it shall be paid for at the unit price quoted in the tender form.

3.77 **GROUT EXISTING PIPE**

Payment for grouting of existing pipe is to be made at the unit price per linear metre for the various pipe sizes in the Tender Form. This item covers the supply and installation of a grout as specified on the drawings for abandonment of existing pipe.

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NOTES:
 1. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

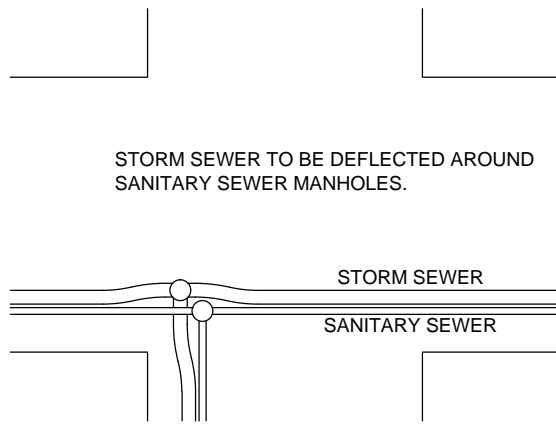
6.16.2016



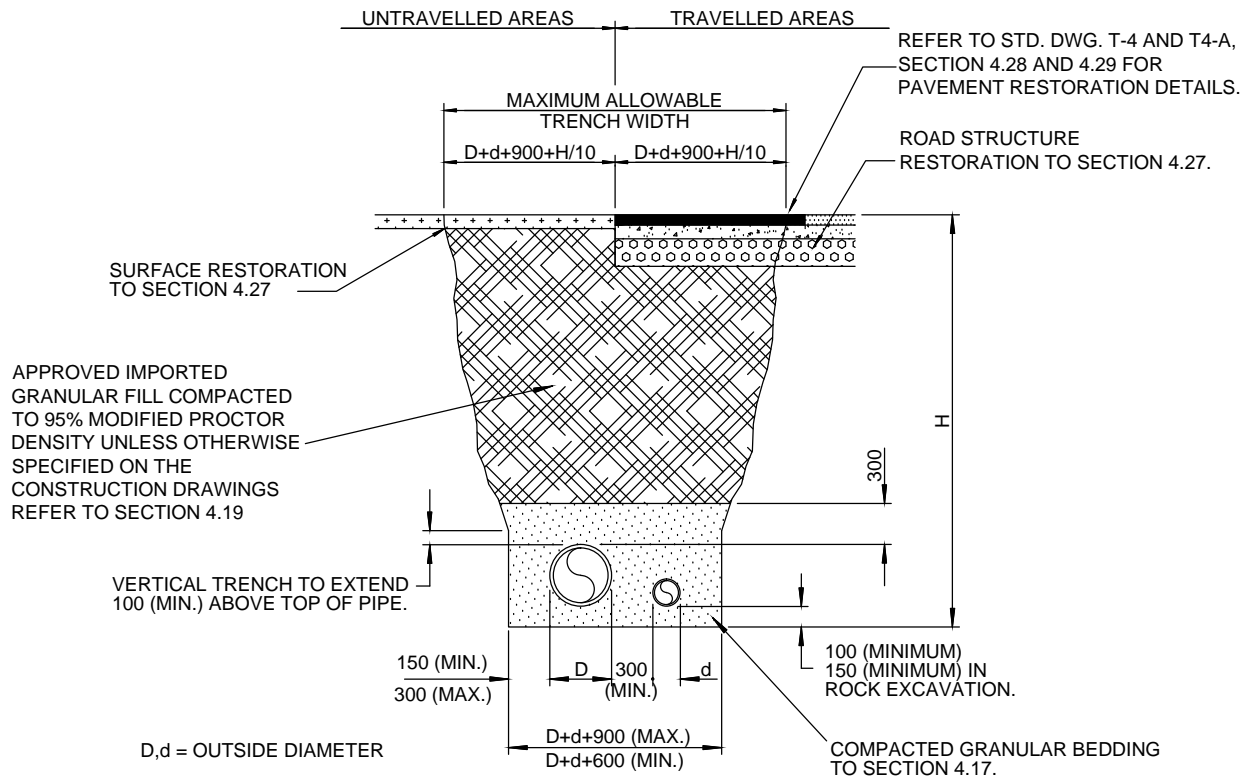
TRENCH DETAILS

Scale: NTS
 Created: OCT 2012
 Rev Date: NOV 2016
 Dwg No: T-1

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STORM SEWER TO BE DEFLECTED AROUND
SANITARY SEWER MANHOLES.



- NOTES:
1. REFER TO STANDARD DRAWING T-1 FOR ADDITIONAL TRENCH DETAILS.
 2. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

4.11.2016



SANITARY & STORM SEWER
IN COMMON TRENCH

Scale:	NTS
Created:	OCT 2012
Rev Date:	NOV 2016
Dwg No:	T-2

REFER TO STD. DWG. T-4 AND T-4A,
SECTION 4.28 AND 4.29 FOR
PAVEMENT RESTORATION DETAILS

SURFACE RESTORATION
TO SECTION 4.27

CONTROLLED DENSITY
FILL TO SECTION 4.24

100 (MIN.)
300 (MAX.)

d = OUTSIDE DIAMETER

100 (MINIMUM.) 150
(MINIMUM) IN ROCK
EXCAVATION.

PIPE ZONE.

COMPACTED GRANULAR
BEDDING MATERIAL TO
SECTION 4.17.

H

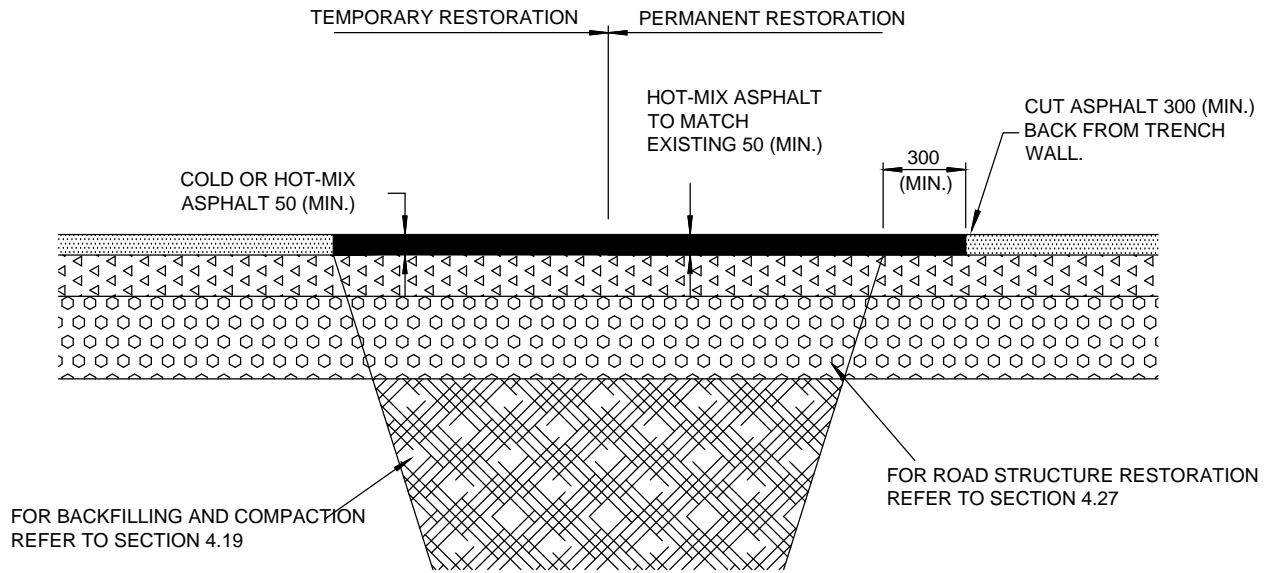
NOTES:

1. REFER TO STANDARD DRAWING T-1 FOR ADDITIONAL TRENCH DIMENSIONS AND DETAILS.
2. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

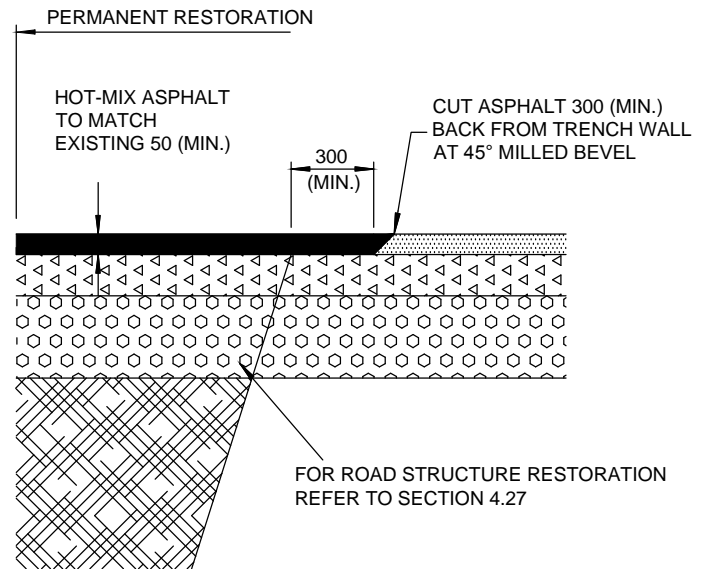


CONTROLLED DENSITY FILL
IN PAVED SURFACE AREA

Scale: NTS
 Created: MAY 1996
 Rev Date: NOV 2016
 Dwg No: T-3



ALTERNATIVE 1 - STRAIGHT CUT

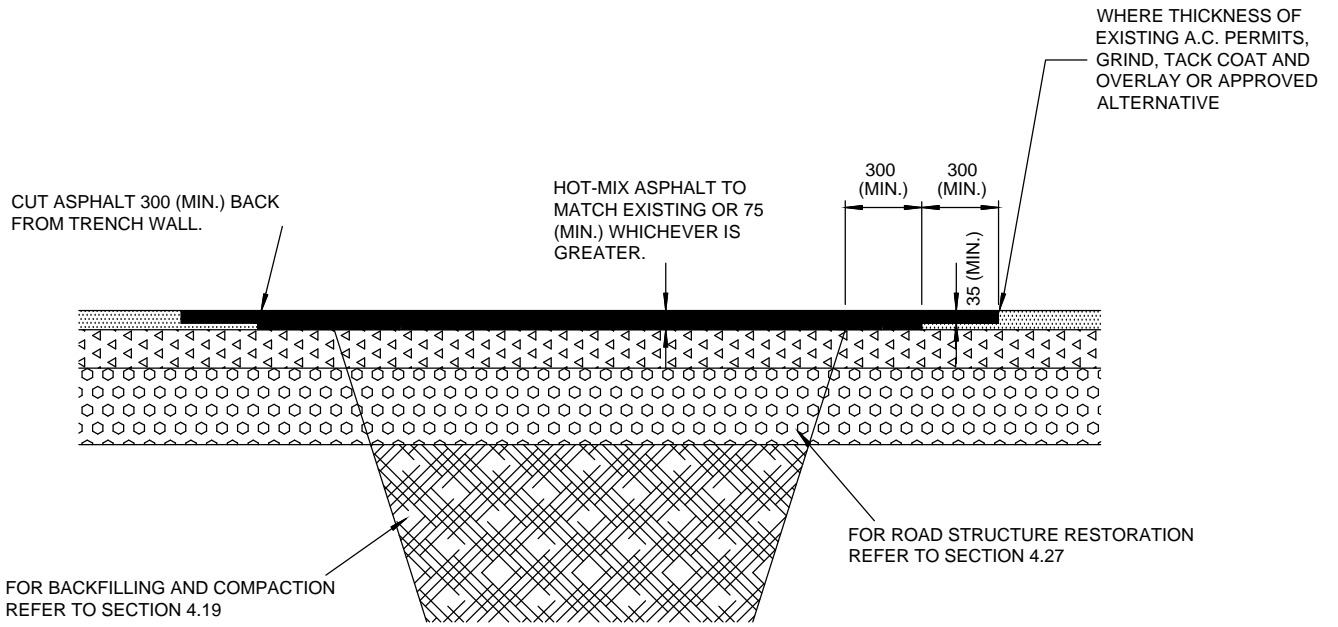


ALTERNATIVE 2 - BEVEL CUT

NOTES:

1. REFER TO STANDARD DRAWING T-1 FOR ADDITIONAL TRENCH DIMENSIONS AND DETAILS.
2. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

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PERMANENT RESTORATION

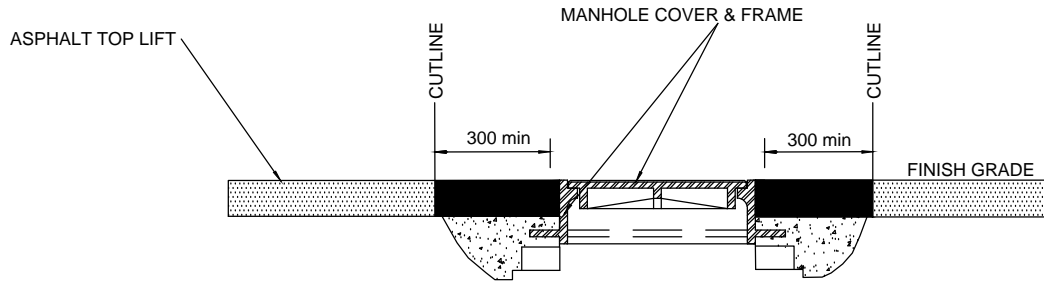
- NOTES:
1. REFER TO STANDARD DRAWING T-1 FOR ADDITIONAL TRENCH DIMENSIONS AND DETAILS.
 2. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

6.16.2016

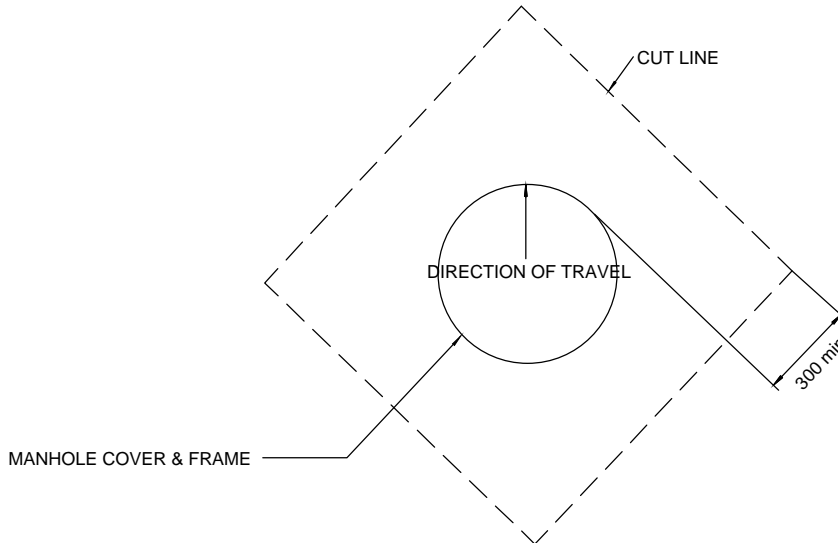


PAVEMENT RESTORATION TYPE 2
(75mm MINIMUM THICKNESS)

Scale:	NTS
Created:	OCT 2012
Rev Date:	NOV 2016
Dwg No:	T-4A



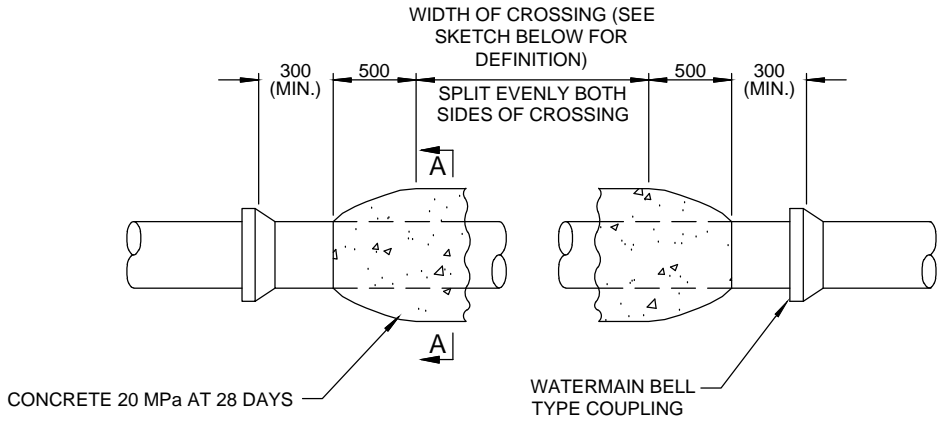
CONCRETE ENCASEMENT
SUPPORT DETAIL



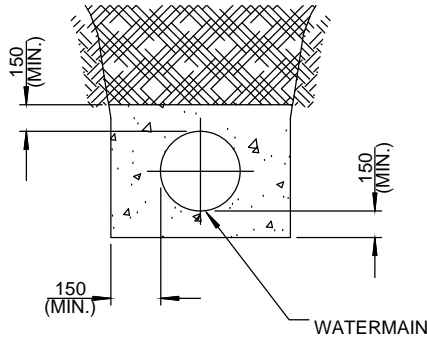
SQUARE CUT PLAN VIEW

NOTES:

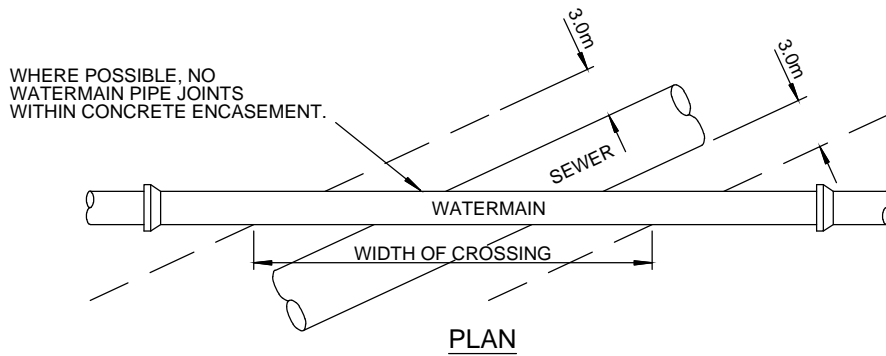
1. COVER MANHOLE WITH BUILDING PAPER AND CONSTRUCTION ASPHALT CONCRETE BASE COURSE AND WEARING COURSES.
2. SAW CUT SQUARE EXCAVATING AROUND MANHOLE 300mm MIN FROM MANHOLE FRAME.
3. RAISE MANHOLE COVER AND FRAME TO FINISH GRADE.
4. APPLY TACK COAT TO EDGES OF EXISTING PAVEMENT BEFORE INSTALLING PATCH.
5. FINISH JOINT WITH ASPHALT SEAL AND SAND.
6. REFER TO STANDARD DRAWINGS AS PER RELEVANT SECTIONS 5, 6, OR 7 FOR OTHER MANHOLE REQUIREMENTS.
7. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCT LIST WILL BE ACCEPTED FOR INSTALLATION.
8. REFER TO STANDARD DRAWING T-1 FOR ADDITIONAL TRENCH DIMENSIONS AND DETAILS.
9. ALL DIMENSIONS IN MILLIMETRES UNLESS SHOWN OTHERWISE.



ELEVATION

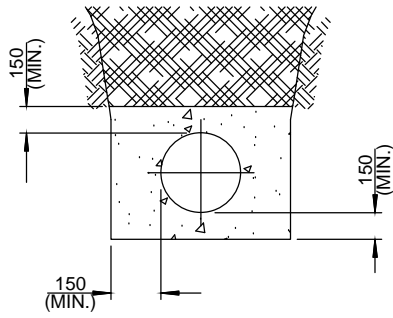


SECTION A-A

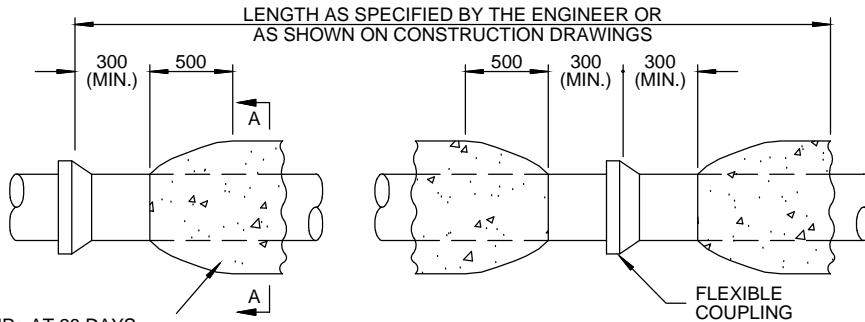


NOTES:

1. USE OF CONCRETE ENCASUREMENT WHERE MINISTRY OF HEALTH'S MINIMUM WATER/SEWER SEPARATION OFFSET CANNOT BE MET, REQUIRES APPROVAL BY THE MINISTRY OF HEALTH.
2. FOR PIPE PROTECTION WITH CONCRETE REFER TO STANDARD DRAWING T-6.
3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.



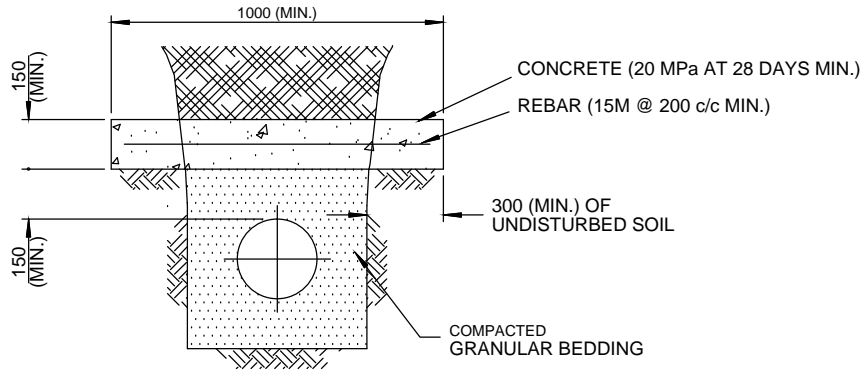
SECTION A-A



CONCRETE 20 MPa AT 28 DAYS

ELEVATION

ALTERNATIVE 1 - ENCASEMENT



ALTERNATIVE 2 - PROTECTIVE SLAB

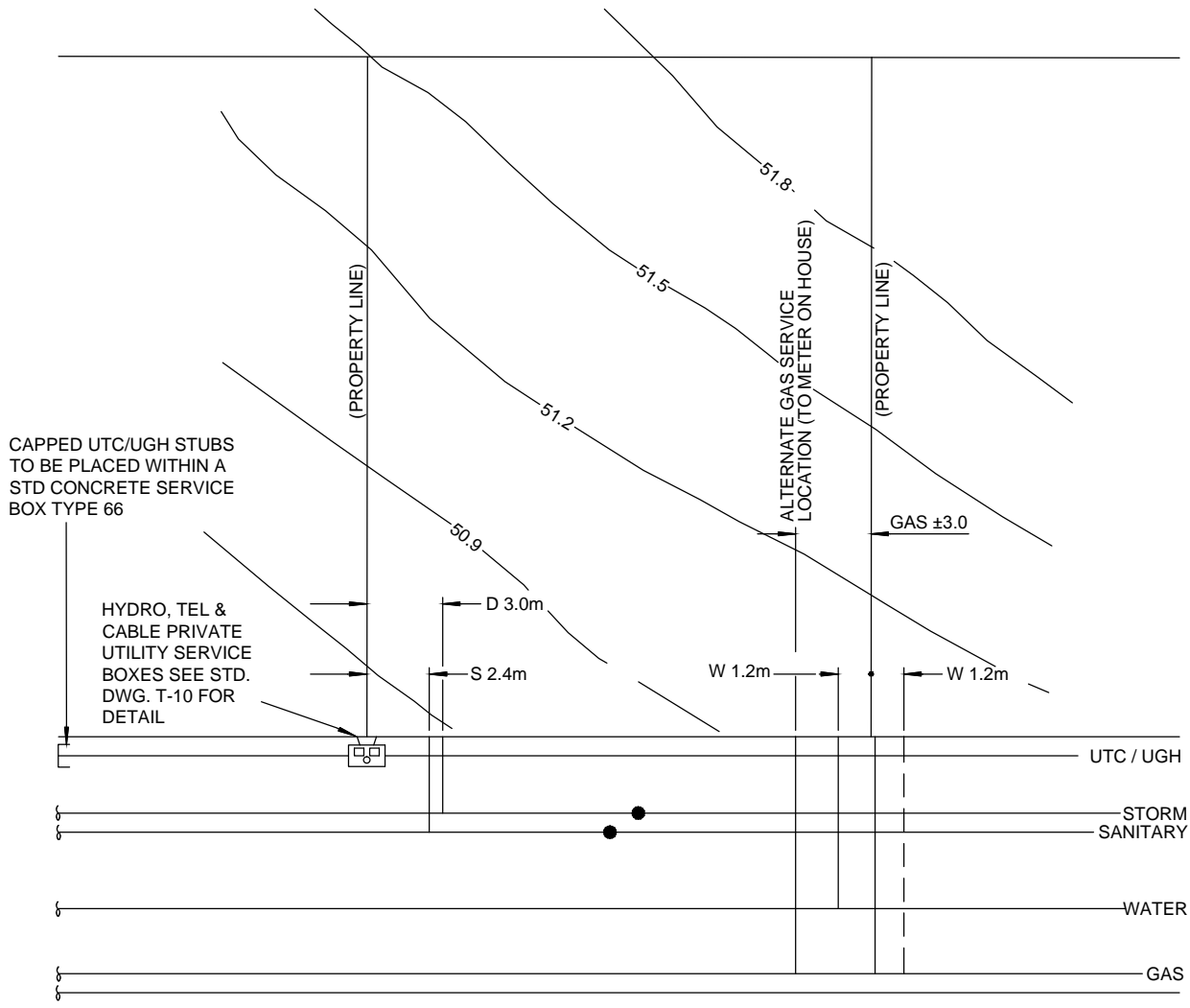
NOTES:

1. THE REQUIREMENT FOR CONCRETE PIPE PROTECTION SHALL BE DETERMINED BY THE ENGINEER. DIMENSIONS SHOWN ARE MINIMUM REQUIREMENTS AND SHALL BE MODIFIED TO SUIT PIPE LOADING CONDITIONS.
2. USE OF CONCRETE BEDDING OR HAUNCHING SHALL NOT BE PERMITTED ON PVC OR OTHER FLEXIBLE PIPE MATERIALS.
3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.



PIPE PROTECTION WITH CONCRETE

Scale:	NTS
Created:	OCT 1993
Rev Date:	NOV 2016
Dwg No:	T-6



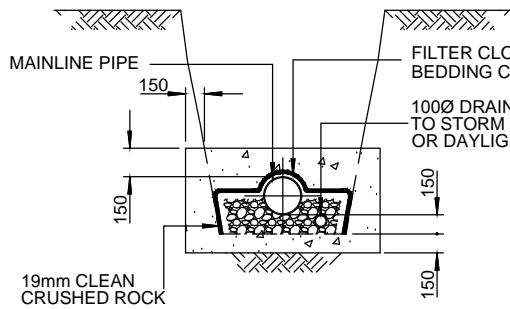
NOTES:

1. SANITARY AND STORM SEWER SERVICES TO BE INSTALLED ON THE LOWER SIDE OF THE LOT, AND WHERE POSSIBLE, SHALL BE FROM THE THE FRONT PROPERTY LINE
2. POLE RESERVE, IF REQUIRED, TO BE AT ALTERNATE LOT CORNER TO WATER SERVICES.
3. GAS SERVICES SHALL BE 1.0m MINIMUM SEPARATION FROM SANITARY, STORM AND WATER UTILITIES.
4. ALL DIMENSIONS IN METERS UNLESS OTHERWISE SHOWN.
5. CAPPED UTH/UGH STUBS MUST BE PLACED WITHIN A STANDARD CONCRETE SERVICE BOX TYPE 66.



TYPICAL LOCATION OF SERVICE CONNECTIONS TO RESIDENTIAL VACANT LOTS

Scale:	NTS
Created:	OCT 2012
Rev Date:	NOV 2016
Dwg No:	T-7

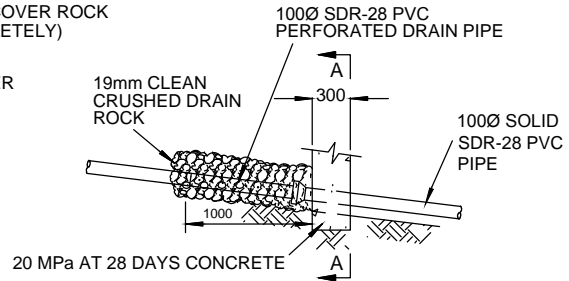


SECTION A-A

ALTERNATIVE 1

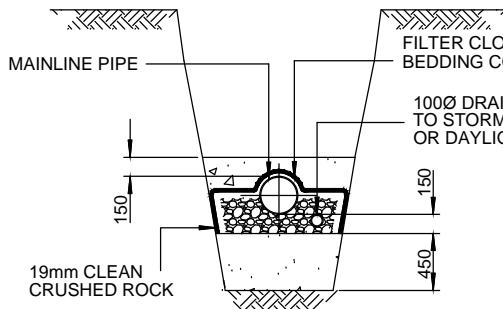
FOR USE IN TILLS AND OTHER STABLE, WELL COMPACTED NATIVE MATERIALS.

DETAIL OF DRAIN PIPE



PROFILE

NOTE: MAINLINE PIPE & FILTER CLOTH NOT SHOWN FOR CLARITY.

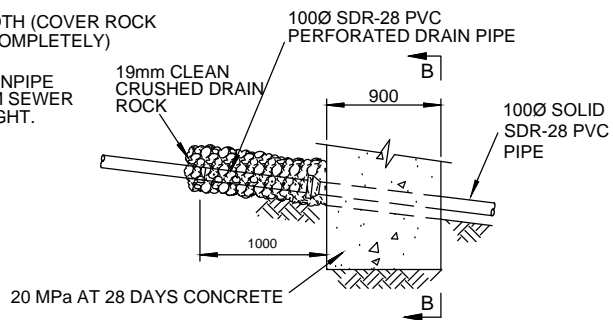


SECTION B-B

ALTERNATIVE 2

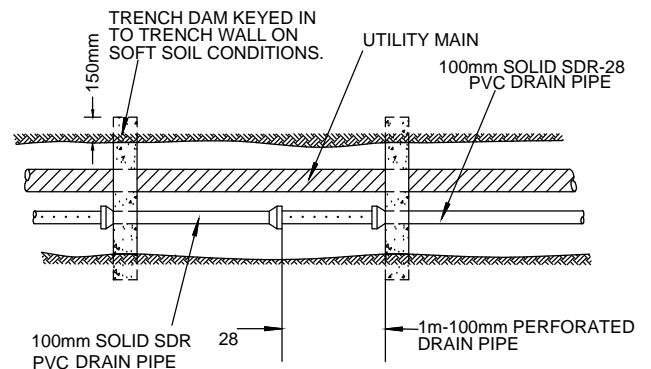
FOR USE IN CLEAN GRAVELS, SANDS AND OTHER LOOSE, PERMEABLE NATIVE MATERIALS.

DETAIL OF DRAIN PIPE



PROFILE

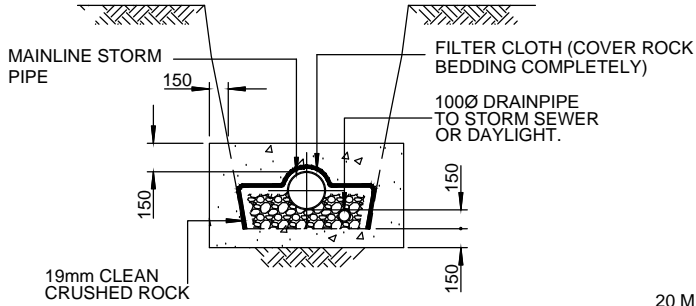
NOTE: MAINLINE PIPE & FILTER CLOTH NOT SHOWN FOR CLARITY.



TYPE 1-PLAN VIEW

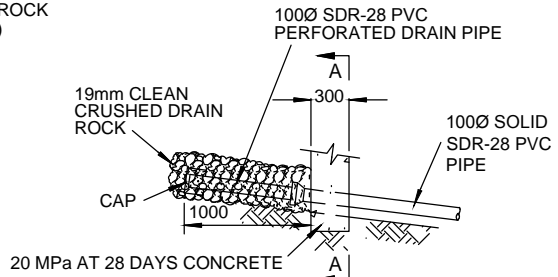
NOTES:

1. IF APPROVED BY THE ENGINEER, IN AREAS INACCESSIBLE BY CONSTRUCTION EQUIPMENT, WET, PRE-MIXED CONCRETE FILLED SANDBAGS MAY BE USED.
2. REFER TO SECTION 4.18 FOR TRENCH DAM SPACING.
3. PROVIDE TRENCH DRAINAGE TO AN ACCEPTABLE WATERCOURSE OR STORM COLLECTION SYSTEM FROM EVERY TRENCH DAM. HIGHEST END OF THE TRENCH DAM DRAIN PIPE SHALL BE CAPPED.
4. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.
5. ALL PIPE TO BE SDR-28 PVC.



SECTION A-A

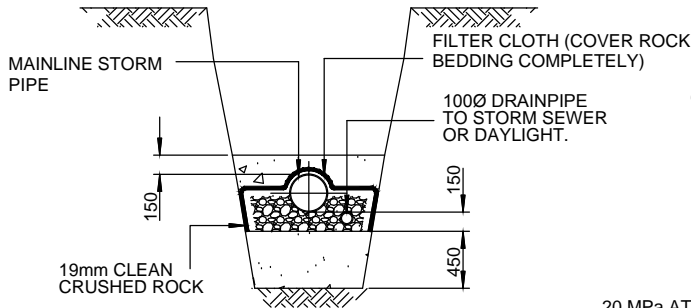
DETAIL OF DRAIN PIPE



PROFILE

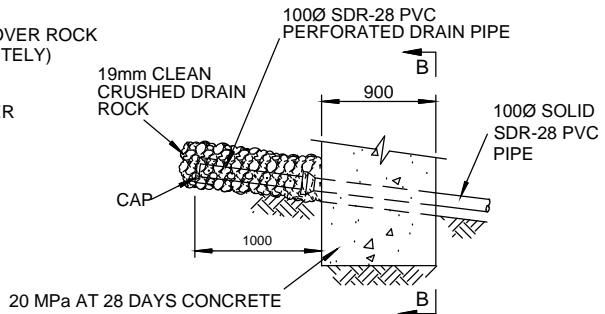
ALTERNATIVE 1
FOR USE IN TILLS AND OTHER STABLE,
WELL COMPACTED NATIVE MATERIALS.

NOTE: MAINLINE PIPE &
FILTER CLOTH NOT
SHOWN FOR CLARITY.



SECTION B-B

DETAIL OF DRAIN PIPE



PROFILE

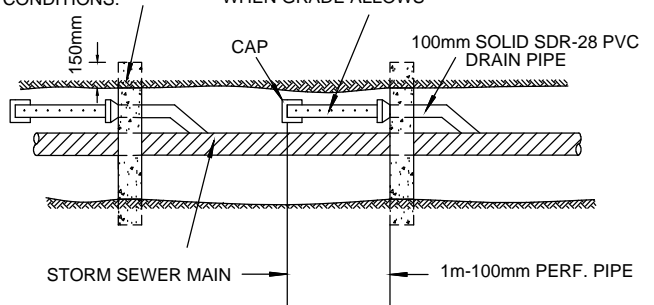
ALTERNATIVE 2
FOR USE IN CLEAN GRAVELS, SANDS AND
OTHER LOOSE, PERMEABLE NATIVE MATERIALS.

NOTE: MAINLINE PIPE &
FILTER CLOTH NOT
SHOWN FOR CLARITY.

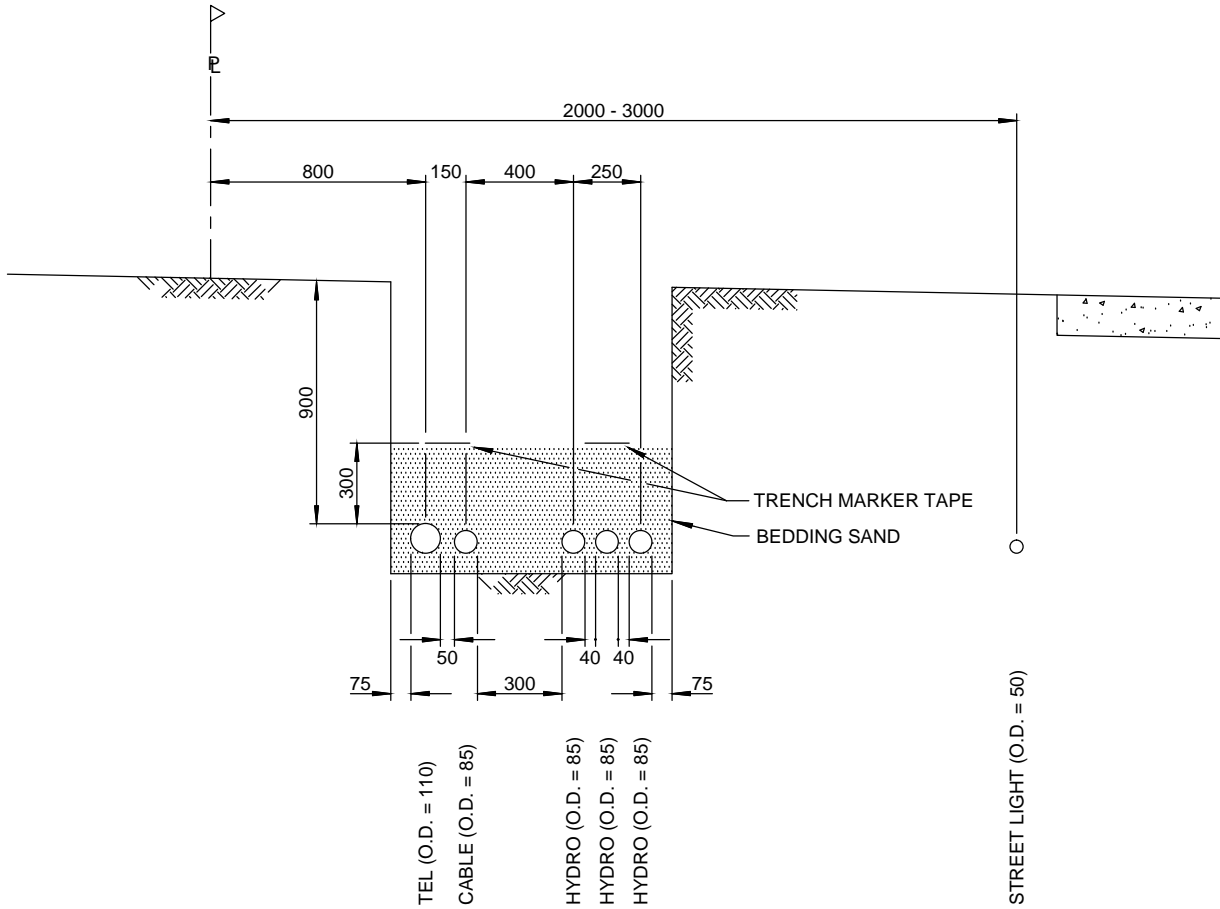
NOTES:

1. IF APPROVED BY THE ENGINEER, IN AREAS INACCESSIBLE BY CONSTRUCTION EQUIPMENT, WET, PRE-MIXED CONCRETE FILLED SANDBAGS MAY BE USED.
2. REFER TO SECTION 4.18 FOR TRENCH DAM SPACING.
3. PROVIDE TRENCH DRAINAGE TO AN ACCEPTABLE WATERCOURSE OR STORM COLLECTION SYSTEM FROM EVERY TRENCH DAM. HIGHEST END OF THE TRENCH DAM DRAIN PIPE SHALL BE CAPPED.
4. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.
5. ALL PIPE TO BE SDR-28 PVC.

TRENCH DAM KEYED IN TO TRENCH WALL ON SOFT SOIL CONDITIONS. 100mm PERFORATED DRAIN SDR-28 PVC PIPE MAY BE TIED INTO STORM MAIN WHEN GRADE ALLOWS



TYPE 2-PLAN VIEW

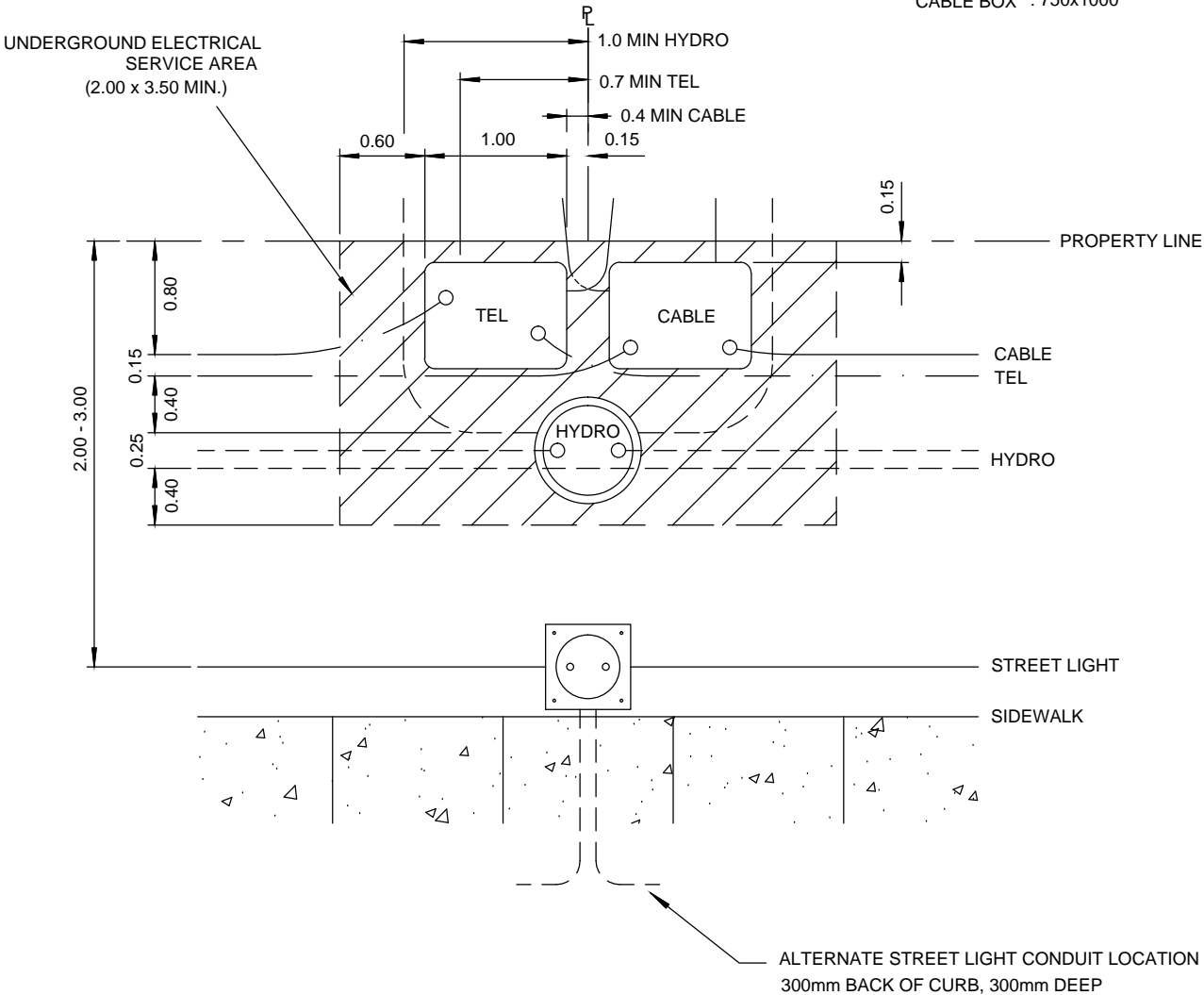


NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.
2. REFER TO UTILITY CONSTRUCTION DRAWINGS FOR DUCT SIZE AND OTHER CONSTRUCTION REQUIREMENTS.
3. ALL UTILITIES SHALL BE TRACEABLE ELECTRONICALLY

APPROXIMATE DIMENSIONS (mm)

HYDRO BOX : 750Ø
 TEL BOX : 750x1000
 CABLE BOX : 750x1000



NOTE:

1. REFER TO SECTION 9 - STREETS, TRAFFIC SIGN AND MARKINGS FOR STREET LIGHT AND SIDEWALK OFFSETS.
2. FOR STREET LIGHT OFFSETS LESS THAN 3.00m, HYDRANTS AND STREET LIGHT POLES SHALL NOT BE LOCATED WITH UNDERGROUND ELECTRICAL SERVICES.
3. SERVICE BOXES SHALL HAVE MINIMUM SEPARATION OF 300mm.
4. REFER TO UTILITY CONSTRUCTION DRAWINGS FOR FURTHER DETAILS.
5. ALL UTILITIES SHALL BE TRACEABLE ELECTRONICALLY.
6. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SHOWN.

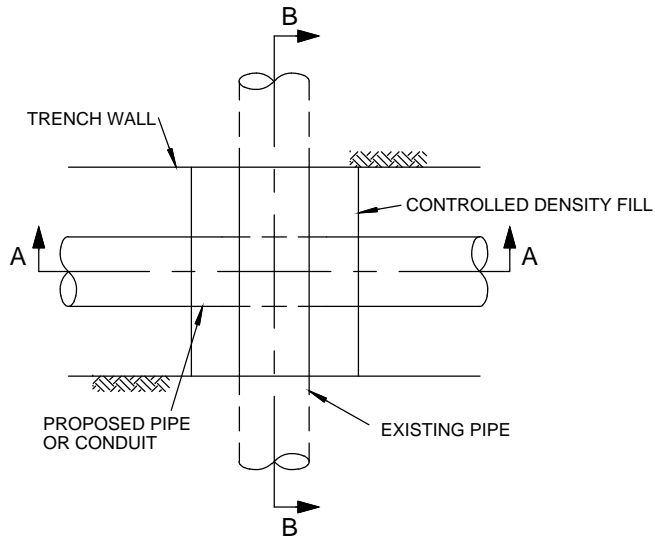
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6.16.2016

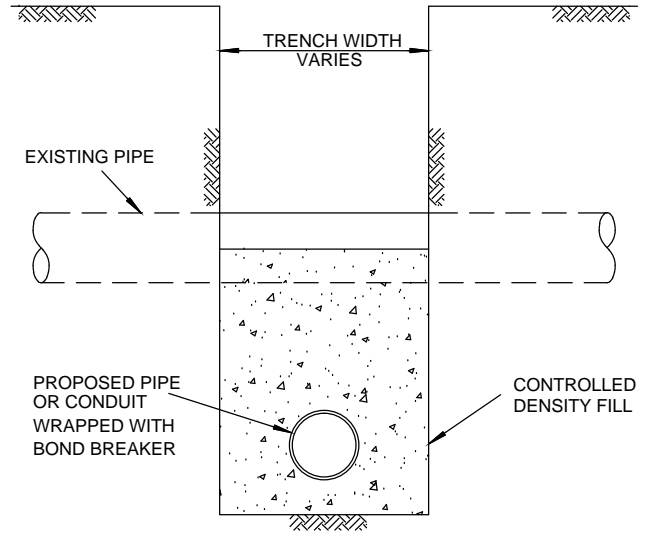


**PRIVATE UTILITIES
 UNDERGROUND ELECTRICAL
 TYPICAL SERVICE BOX LOCATION**

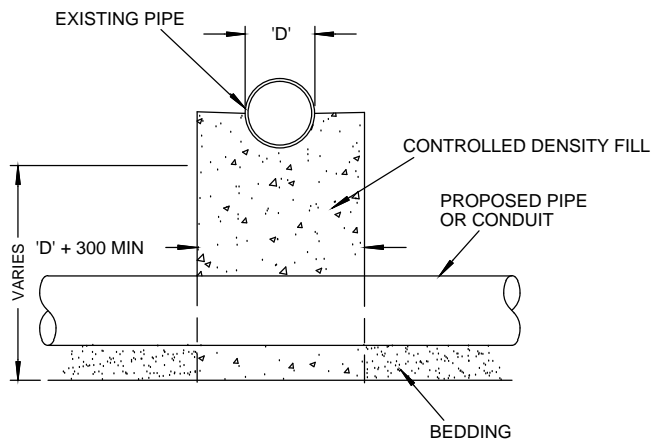
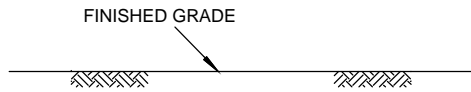
Scale: NTS
 Created: OCT 2012
 Rev Date: NOV 2016
 Dwg No: T-10



PLAN



SECTION B-B



SECTION A-A

NOTES:

1. ALL DIMENSION IN MILLIMETERS UNLESS SHOWN OTHERWISE.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENTS

Authorized Hand Excavation	4.70
Trench Rock Excavation	4.71
Over excavation and Placement of Base Gravel Material	4.72
Additional Concrete and Controlled Density Fill	4.73
Trench Dams	4.74
Surface Restoration	4.75

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL

MEASUREMENT AND PAYMENT

4.70 **AUTHORIZED HAND EXCAVATION** Section 4.09

Payment for authorized hand excavation will be made at the unit price per cubic metre if shown in the Tender Form and will be based on the trench depth. This price shall include supply of materials, hand excavation, hand backfilling, and all work incidental thereto.

4.71 **TRENCH ROCK EXCAVATION** Section 4.07B

Payment for trench rock excavation will be made as shown in the Tender Form:

(a) **By Volume Measurement:**

Payment will be made for excavation of single boulders, pieces of concrete, or masonry having individual volumes exceeding one cubic metre in volume.

Measurement for trench rock excavation will be calculated based on:

1. The depth from the top of the rock surface to 150 mm below the bottom of the pipe barrel.
2. The maximum allowable trench dimensions as per T-1, or for common trenches, as per T-2.
3. The length measured horizontally along the centre line of the trench.
4. Cross sectional measurements will be made at 3 m intervals or as required.
5. In the event that the average rock width is less than 600 mm in any 3 m interval, payment will be based on a 600 mm minimum rock width.

This price shall include excavation, disposal of rock, and all work incidental thereto.

4.72 **OVEREXCAVATION AND PLACEMENT OF BASE GRAVEL MATERIAL**

Section 4.07B (d) (e) and 4.14

Payment for authorized overexcavation and placement of base gravel material or other material specified will be made at the unit price per tonne of material placed as shown in the Tender Form. This price shall include supply of materials, overexcavation and disposal of the unsuitable material, placement and compaction of the specified base gravel material, special bracing and sheeting as may be required, and all work incidental thereto. Payment for this work will only be made when, in the opinion of the Engineer, it is necessitated by the natural existence of unsatisfactory soil conditions. No payment will be made for unauthorized over excavation which has resulted from acts, neglects, or delays of the Contractor.

4.73 **ADDITIONAL CONCRETE AND CONTROLLED DENSITY FILL**

- (a) Concrete Fill Section 4.21 - Standard Drawing T-5 and T-6
- (b) Controlled Density Fill - Section 4.24 - Standard Drawing T-3

Payment for additional concrete or controlled density fill for pipe base, encasement, or backfill in the trench will be made at the unit price per cubic metre shown in the Tender Form. Measurement will be

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL

MEASUREMENT AND PAYMENT

based on the design dimensions of the concrete placed. This price shall include supply of materials, concrete work, form work, curing and protection and all work incidental thereto.

4.74 **TRENCH DAMS** Section 4.18 Standard Drawing T-8

Payment for trench dams will be made at the unit price per trench dam shown in the Tender Form. This price shall include supply of materials, installation and all work incidental thereto.

4.75 **SURFACE RESTORATION** Section 4.27, 4.28 & 4.29

Payment for surface restoration will be made at the price per square metre as shown on the Tender Form for the various types of surface restoration. The permanent traveled area surface restoration for Haliburton Street will be completed under other sections as part of the road restoration.

- a) For surface restoration of untraveled areas, (boulevards, rights-of-way and private property), price shall include all labour, equipment and materials necessary to restore untraveled areas, to a condition equal to or better than existed prior to construction and in accordance with the specifications and drawings.
- b) For surface restoration of traveled areas, (roads, shoulders, driveways, sidewalks, curbs and walkways), price shall include all labour, equipment and materials necessary to restore the traveled areas, to a condition equal to or better than existed prior to construction and in accordance with the specifications and drawings. **This price shall include surface cutting and removal, supply and installation of gravel materials, and restoration of the travelled surface.**
- c) For temporary surface restoration of traveled areas, (roads, driveways, sidewalks, curbs and walkways), price shall include all labour, equipment and materials necessary to restore and maintain the traveled surface, as directed by the Engineer, using the materials as shown on the Tender Form.

Tender quantities are based on the allowable trench width limits as shown on Standard Drawings T-1 or T-2. Surface restoration beyond these limits will be at the Contractor's expense where the Contractor employs methods that damage areas beyond these limits without prior authorization from the Engineer.

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SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

4.01 SCOPE

- .1 This specification refers to trench excavation, bedding, backfill and all work pertaining thereto.
- .2 Trenches shall be excavated only as far in advance of the pipe laying operation as safety, traffic, and weather conditions permit. Caution shall be exercised with respect to structures, piping, or other man-made obstacles that may exist within the working area and due consideration given to the protection and support of such properties and structures.
- .3 Only those products approved by the City Engineer or listed in the City of Nanaimo Approved Products List will be accepted for installation.

4.02 TESTING

- .1 The Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates non-compliance with the specifications, additional testing shall be required at the Contractor's expense.
- .2 The Contractor, as directed by the Engineer, shall supply specimens or samples for testing.
- .3 The types of tests listed below are the minimum testing requirements. The Engineer shall determine if additional testing is required.
 - (a) Regular sieve analysis of aggregate gradation on materials to be incorporated in the works.
 - (b) Determination of optimum moisture content and Modified Proctor Density (ASTM D1557) on all materials to be used for import bedding and backfill.
 - (c) Field density tests taken on the compacted backfill.
 - (d) Other tests as may be required.

4.03 -NOT USED-

4.04 PRECUTTING PAVED SURFACES

- .1 When trenching along or across a paved surface, pavement shall first be sawn or cut by methods approved by the Engineer in straight lines parallel to the trench centreline. The total cut width of pavement shall not be greater than the specified maximum trench width at the ground surface shown on the drawings. Concrete curbs and sidewalks shall be sawn at existing joints.
- .2 Where, in the opinion of the Engineer, existing pavement is in poor condition, pavement may be cut by hand, mechanical means, or trenching equipment.
- .3 When asphalt cutting around a manhole is required to repair the manhole frame and cover, it shall be done in accordance with Standard Drawing No. T-4B.
- .4 Pavement that has been cut and removed to permit trenching shall be disposed of as waste material and shall not be placed in the trench backfill. Pavement that has been removed by grinding may be re-used as backfill if approved by the Engineer.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

- .5 Pavement Restoration shall be done in accordance with Section 4.28 - Pavement Restoration.

4.05 SITE PREPARATION

- .1 Remove all brush, weeds, grasses and accumulated debris from the trench width and working area.
- .2 Where directed by the Engineer for trenchwork in existing lawns, carefully cut and remove sod prior to excavation.
- .3 For trenchwork in landscaped statutory rights-of-way, carefully remove fences, shrubs, small trees and other items for replacement after backfilling is completed. If, in the opinion of the Engineer, removed trees are too large to be replaced, the contractor shall not be responsible for their replacement unless otherwise noted on the construction drawings.
- .4 For trenchwork in landscaped boulevards, the Contractor shall provide 14 days notice to all property owners for the removal of all fences, shrubs, small trees or other structures or plantings within the road rights-of-way that the property owner wishes to retain. Plantings and structures listed above, not removed by the property owner upon expiration of the 14 day notice, shall be removed and disposed of by the Contractor.
- .5 Remove all top soil within the trench width and where required in the working area, and stockpile for replacement at locations approved by the Engineer. Stumps, boulders and other deleterious material shall be removed from the top soil and disposed of as specified in Section 4.11 – Disposal of Excavated Material. Do not handle top soil while it is wet or frozen.
- .6 Cut pavement, sidewalks and curbs in accordance with Section 4.04 – Precutting Paved Surfaces.
- .7 Provide temporary drainage control to protect construction area and adjacent properties. Provide siltation controls to protect natural watercourse or existing storm drainage systems.

4.06 TRENCH ALIGNMENT AND DEPTH

- .1 The trench shall be excavated so that pipe can be laid to the established alignment and depth with allowance made for specified trench wall clearances and bedding as required.
- .2 Prior to, or at the commencement of construction, the contractor shall check existing mains for line and elevation at the point of connection. If they are different than what is shown on the construction drawings, the contractor shall immediately report the difference to the Engineer and cease construction pending direction from the Engineer.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

4.07 TRENCH EXCAVATION

- .1 Trench excavation shall be classified as common or rock excavation.
- .2 Trenches shall be excavated to the section and dimensions as shown on the drawings. Trench stability and safety procedures shall conform to WorkSafeBC Regulations.
- .3 Ledge rock, boulders, and large stones shall be removed to provide a clearance of at least 150mm around all sides of pipe, fittings and appurtenances.
- .4 In road rights-of-way, the trench width shall be kept to a minimum and the trench width be such that at least one-way traffic can be maintained at all times unless otherwise approved by the City Engineer.
- .5 To prevent damage to existing utilities, excavate the last 300mm above the utility by hand.
- .6 If, in the opinion of the Engineer, trench width exceeds the maximum allowable for pipe support, the contractor may be required to provide a higher class of bedding, a pipe with a higher strength class or concrete encasement at no extra cost to the owner.
- .7 Excavation for manholes shall be to dimensions which will permit assembly of the sections in accordance with these specifications. **(REVISED NOVEMBER 2016)**
- .8 Excavate trenches only as far in advance of pipe laying operation as safety, traffic and weather conditions permit. In no case shall open trenches exceed 30 metres.
- .9 All excavations left unattended shall be adequately protected with approved fencing and barricades and with flashing lights where required.

4.07A COMMON EXCAVATION

- .1 Common excavation is the excavation and removal of all material encountered which is not classified as rock.

4.07B ROCK EXCAVATION

- .1 Rock excavation is:
 - (a) The removal of detached masses of rock including single boulders, and pieces of concrete or masonry having individual volumes in excess of 1 cubic metre, or solid rock which requires drilling and blasting or breaking with a power-operated tool for its removal.
 - (b) Removal of soft or disintegrated rock which can be removed with a hand pick or power-operated excavator or shovel, or previously blasted or broken stone in rock fills or elsewhere with individual volumes less than one cubic metre, or boulders or pieces of fractured rock which do not occur naturally within the excavated volume but fall into the excavation from the adjacent area, shall not be classified as rock excavation. Hardpan (glacial till) shall not be classified as rock excavation.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

- (c) Overbreak, is that portion of solid rock which is excavated, displaced or loosened outside the limits used to calculate the volume of rock excavation and will be classified as unauthorized overexcavation.
- (d) Authorized overexcavation is that excavation required by the Engineer as a result of unsuitable foundation conditions not resulting from the Contractor's operation.
- (e) Unauthorized overexcavation is that excavation required as a result of the Contractor's operation as determined by the Engineer. Replacement of unauthorized overexcavation shall be at no additional cost to the Owner.

.2 Rock excavation for trenches:

- (a) Where rock is encountered in the trench or pit, the method of removal shall be agreed with the Engineer before its removal.
- (b) When blasting is required during excavation, the Contractor shall exercise extreme care and shall limit the use of explosives to such charges that shall not cause damage to existing pipelines, other utilities or private property. Blasting shall be done by experienced persons, qualified for the work. The compliance with regulations regarding the use and storage of explosives shall be the responsibility of the Contractor and he shall be responsible for any accidents or injury, loss and/or damage which might occur as a result of his blasting.
- (c) Overbreak shall be removed as directed by the Engineer and replaced with imported granular fill, placed and compacted as specified herein at no additional cost to the Owner.

4.08 -NOT USED-

4.09 HAND EXCAVATION

- .1 Mechanical trenching and backfilling equipment shall be used except where by so doing, damage to trees, buildings, sidewalks, curbs, piping, or other existing structures or man-made obstacles above or below ground cannot be avoided. Trenches shall be hand excavated and backfilled where such obstacles prevent the use of mechanical equipment.
- .2 Authorized hand excavation shall be restricted to trench excavation in statutory rights-of-way and only in those locations which, in the opinion of the Engineer, necessitate hand excavation methods.
- .3 The following and similar circumstances shall not be considered as authorized hand excavation:
 - (a) Crossing of existing structures and utility works;
 - (b) Where lighter or smaller mechanical equipment could be used;
 - (c) Where, by the use of close sheeting, timber support, equipment pads, or other facilities, mechanical equipment could be used; or
 - (d) Where the presence of timbering, sheeting, well pointing equipment, or other Contractor placed obstacles restrict the use of mechanical equipment.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

4.10 PILING OF EXCAVATED TRENCH MATERIAL

- .1 Common excavation approved by the Engineer as approved native backfill, may be piled along the trench in accordance with WorkSafeBC regulations and provided the working space is adequate for this purpose and provided that by so doing the backfill material does not spill onto private properties adjacent to the line of the trench thereby disturbing fences, buildings, shrubs, lawns, or other items of value.
- .2 Piling of excavated material along the trench shall not unduly restrict cross traffic at road intersections. Material shall be cleared from road intersections and provision made for use of the cross road by traffic as soon as possible after excavation has taken place. Pedestrian traffic to individual properties shall be maintained at all times and timber bridges shall be provided where it is necessary to cross open trenches. Roadways, driveways, and drainage facilities shall not be blocked unnecessarily. The spoil pile shall be located such that hindrance to local traffic is minimal.
- .3 In order that excavated material may be piled along the trench, roads may be temporarily closed to traffic with the permission of the City of Nanaimo and providing that adequate detour traffic routes can be established to move traffic around the construction area, and providing also that street entrances to driveways are not blocked from vehicular traffic for periods in excess of one day. One lane shall be kept open at all times for emergency vehicles unless otherwise approved by the City Engineer.
- .4 Where excavated material cannot be piled along the trench in compliance with the above restrictions, it shall be trucked to locations where backfilling is taking place or trucked to stockpile for return to the trench at the time of backfilling. Alternatively, subject to approval of the Engineer, excavated material may be wasted and replaced with approved material at the time of backfilling.
- .5 The contractor shall retain sufficient approved native backfill material for the backfilling of the trench. Surplus approved native backfill material shall be taken to and used at other locations within the project site suitable for material placement.
- .6 The contractor shall take all measures required to protect approved native backfill from contamination, segregation and weather.

4.11 DISPOSAL OF EXCAVATED MATERIAL

- .1 Surplus or waste excavated material shall be removed from the trench area during the excavation or backfilling operations and shall not be left along the trench following the completion of backfilling the trench.
- .2 Surplus excavated material which is not required for the works, as shown on the drawings or specified elsewhere herein, shall be disposed of at sites obtained by the Contractor. Waste material shall not be dumped on private property without the written permission of the owner of the property and a fill permit obtained from the City of Nanaimo.
- .3 The Contractor shall exercise particular care to avoid spillage on paved roadways over which excavated material is hauled, and any such spillage shall be cleaned up promptly by sweeping.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

- .4 Failure to immediately begin cleanup of spillage from roadways when required by the City of Nanaimo will result in the Contractor being charged all costs accrued by the City of Nanaimo to do the cleanup work.
- .5 Care shall also be exercised to avoid spreading the excavated material over a wide area and rutting or otherwise damaging unnecessarily adjacent property when side casting of excavated material is permitted.

4.12 BRACING AND SHEETING

- .1 Trenches shall be excavated, sheeted and braced in accordance with WorkSafeBC regulations or as may be necessary to protect life, property, and structures adjacent to the work, the work itself, or to maintain trench widths within the specified limits. Trench sheeting and bracing shall be located no closer than 150mm to the widest section of any installed pipe.
- .2 Whenever possible, vertical trench timber or sheeting shall be placed so that it does not extend below the springline of the pipe being installed. When it is necessary to place sheeting or timber below the pipe springline, as in the case of overexcavation for trench bottom stabilization, sheeting shall be raised in 600mm lifts and all backfill placed below the level of the pipe springline shall be thoroughly compacted on each lift to fill the void left by the raised sheeting.
- .3 Trench sheeting and bracing shall be removed, except in situations where the removal of trench sheeting and bracing will result in damage to adjacent structures. When sheeting and bracing is left in place, it shall be cut off above springline.
- .4 Where sheeting or timber is removed from a trench in which backfill is to be compacted, it shall be removed in a manner which permits compaction of the backfill in the manner specified.
- .5 WorkSafeBC approved cages may also be used in place of sheeting.

4.13 DEWATERING

- .1 During construction, ground and surface water shall be controlled to the extent that excavation and pipe installation can proceed in the specified manner and such that the trench bottom is not disturbed to the detriment of the pipe installation. Trench water shall not be permitted to enter the pipe being installed unless approval is received from the Engineer.
- .2 Pumps, well points, or other equipment shall be employed to keep excavations free of water. Caution shall be exercised to make sure that foundation problems with existing structures and works under construction do not result from the selected method of dewatering excavations.
- .3 Discharge from pumps, well points, or other dewatering equipment shall be located and controlled such that loss, damage, nuisance, or injury does not result.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

- .4 The contractor shall be responsible for any claims or actions resulting from the dewatering operation.

4.14 TRENCH BOTTOM CONDITIONS

- .1 Trenches shall be maintained such that pipe can be installed without allowing water, muck, silt, gravel, or other foreign material into the pipe. Material remaining in the trench bottom on completion of machine excavating which has been disturbed or softened by workmen or trench water shall be removed before bedding material is placed. The trench bottom shall be firm and capable of supporting the pipe to be installed.
- .2 When, in the opinion of the Engineer, the material in the trench bottom is found to be unstable or otherwise unsuitable for pipe support or the support of appurtenant structures, the Engineer shall direct the contractor to utilize the most suitable of the following stabilization methods:
 - (a) Overexcavate to suitable subgrade and backfill with base gravel and compact to 95% Modified Proctor Density (ASTM D1557). Use of import granular fill, subbase gravel, drainrock or bedding material shall be at the discretion of the Engineer.
 - (b) Use of concrete bedding as directed by the Engineer.
 - (c) Other methods as proposed by the Engineer and approved by the City Engineer.

4.15 AUGERING

- .1 Augering shall be performed with hand- or power-operating equipment, subject to the approval of the Engineer.
- .2 Auger holes shall terminate in open trench.
- .3 Augering shall be performed such that undermining or displacement of the roadway structure does not result and the completed auger hole is not more than 50mm larger in diameter than the maximum outside diameter of the casing pipe or pipe to be augered.
- .4 The augered hole shall be to the correct line and grade. If an obstruction is encountered that will cause deviation from the correct line and grade, a new hole shall be augered.

4.16 CASING PIPES

- .1 Casing pipes shall be as shown in the construction drawings and shall be laid to the grade and alignment shown.
- .2 The same bedding and backfill criteria shall be used for casing pipe as required for main piping.
- .3 All pipe joints within the pipe casing shall be fully restrained with approved mechanical restrainers and shall be approved by the Engineer.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

4.17 BEDDING WITHIN PIPE ZONE

- .1 Bedding materials shall be granular in nature, free of organic material, silt or clay, and shall conform to the following gradation limits when tested in accordance with ASTM C136:

Gradation Limits (Percent by Weight Passing)		
<u>Sieve Designation</u>	<u>Type 1</u>	<u>Type 2</u>
19.0 mm	100	90 - 100
12.5 mm		65 - 85
9.5 mm	85 - 100	50 - 75
4.750 mm	70 - 100	25 - 50
2.36 mm		10 - 35
1.18 mm	20 - 65	
0.850 mm		5 - 20
0.6 mm	0 - 45	
0.425 mm		0 - 15
0.180 mm		0 - 8
0.15 mm	0 - 10	
0.075 mm	0 - 5	0 - 5

- .2 Type 1 is the standard acceptable bedding material. Type 2 shall be used where specified by the Engineer.
- .3 Other acceptable bedding materials, for use only where shown on the construction drawings or as approved by the Engineer, are drainrock or native material.
- .4 The bedding material shall cover the full width of the trench bottom and have a minimum depth of 100mm on completion of compaction. In rock excavation the minimum depth of bedding below the pipe shall be 150mm after completion of compaction.
- .5 Bedding material shall be compacted in maximum 150mm lifts to 95% of Modified Proctor Density (ASTM D1557).
- .6 Bedding material shall be placed in such a manner that the pipe is evenly supported throughout its length by the pipe bedding material.
- .7 Placement and compaction of the bedding material shall not damage or displace the pipe.
- .8 Bedding material shall be leveled across the full width of the trench to an elevation of 300mm above the crown of the pipe.

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4.18 TRENCH DAMS

- .1 Trench dams shall be constructed on all utility main lines where grades are ten percent (10%) or greater, or when indicated on the construction drawings. **(REVISED NOVEMBER 2016)**
- .2 All trench dams on utility mains shall be constructed in accordance with Standard Drawing No. T-8. Trench dams on storm sewer gravity mains as per Standard Drawing No. T-8A requires approval by the City Engineer.
- .3 All trench dam drain pipes shall be capped at the highest end of the run.
- .4 Trench dam spacing shall be as follows:

SANITARY AND STORM GRAVITY SEWERS		WATERMAINS AND FORCEMAINS	
SLOPE	MAX. SPACING	SLOPE	MAX. SPACING
10% - 15%	30m	10% - 29%	10m (upon approval of City Engineer)
15% - 20%	25m	30% - Over	See Section 4.18.5
20% - 35%	20m		
35% - 50%	15m		
50% - Over	10m		

(REVISED NOVEMBER 2016)

- .5 Where the slope of the watermain is 30% or greater, a geotechnical study shall be submitted to assess slope stability. Geotechnical studies shall be completed in accordance with the "Guidelines for Legislated Landslide Assessments for Proposed Residential Development in British Columbia" published by APEGBC. Additionally, the City Engineer may request a geotechnical study regardless of the pipe grade if the stability of the adjacent slope is in question. **(REVISED NOVEMBER 2016)**
- .6 If approved by the Engineer, concrete trench dams may be constructed of wetted sandbag sacks filled with wet pre-mixed concrete for areas inaccessible by construction equipment. Sacked concrete shall be laid in courses such that joints in succeeding courses are staggered. Courses shall be a minimum of nine (9) per vertical metre and shall be placed around the pipe and keyed into the trench walls to form a water tight dam.
- .7 Relief drains shall be installed on all trench dams to an acceptable watercourse or storm sewer system.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

4.19 BACKFILL AND COMPACTION

.1 Backfill material shall be:

- (a) Imported granular fill (Section 4.20 – Imported Granular Fill)
- (b) Approved native material (Section 4.23 – Approved Native Backfill)
- (c) Controlled density fill (Section 4.24 – Controlled Density Fill)

.2 General:

- (a) Placement and compaction of backfill material shall not damage or displace the pipe.
- (b) Remove shoring or cages in such a manner as to allow proper compaction and to prevent trench walls from collapsing.
- (c) Place backfill in lifts suitable to the soil type and compaction equipment being used as determined by the Engineer.
- (d) Import granular fill shall be used for backfill unless native soils are suitable and approved by the Engineer, and are specified on the construction drawings.
- (e) Deficiencies in the quantities of approved native backfill material which are the result of the Contractor's operation shall be replaced with imported granular fill at no additional cost to the Owner.
- (f) Trenches shall be backfilled to a depth to allow for surface restoration in accordance with Section 4.27 – Surface Restoration.

.3 Traveled Surfaces:

- (a) Traveled surfaces are roadways, lanes, driveways, road shoulders, sidewalks, walkways or other surfaces on which vehicular or pedestrian traffic normally travels. The ultimate extent of the traveled surface must be considered.
- (b) Under no circumstances shall a trench in a traveled area be left in a hazardous condition.
- (c) Trenches in traveled surfaces shall be backfilled with imported granular fill in accordance with Section 4.20. Approved native backfill shall be used when directed by the Engineer in accordance with Section 4.23. Trenches located in existing arterial, collector or commercial/industrial roads shall be backfilled with controlled density backfill in accordance with Section 4.24.
- (d) Approved native backfill shall be compacted to 95% Modified Proctor Density (ASTM D1557).

.4 Untraveled Surfaces:

- (a) Untraveled surfaces are all other surfaces not classified as traveled surfaces.
- (b) Untraveled surfaces shall be backfilled with approved native backfill and compacted to 90% Modified Proctor Density (ASTM D1577).

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4.20 IMPORTED GRANULAR FILL

- .1 The Contractor shall import granular fill for trench backfill, unless the material excavated from the trench is suitable and approved by the Engineer.
- .2 All imported granular fill for trench backfill shall consist of well graded granular material, with not more than 8% passing the 0.075 mm sieve, which contains no stones larger than 150mm in diameter and contains no stumps, roots, organic or other deleterious material.
- .3 All imported granular fill shall require approval by the Engineer prior to placement.
 - (a) A wet sieve analysis (ASTM C117) may be required by the Engineer to confirm the fines content of the imported granular fill material.
- .4 The use of quarried or blast rock as import granular fill for trenches requires specific approval by the City Engineer unless listed in the City of Nanaimo Approved Product List. Quarried or blast rock shall be hard and durable, well graded, with not more than 8% passing the 0.075 mm sieve, which contains no stones larger than 150 mm in diameter and no stumps, roots, organic or other deleterious material.

4.21 CONCRETE

- .1 Concrete for pipe base, encasement or backfill shall have a minimum compressive strength of 20MPa at twenty-eight (28) days and be in accordance with Section 11.31 – Concrete.
- .2 Backfill material shall not be placed over the concrete until the concrete has obtained its initial set but in no case shall time be less than one hour.

4.22 ROAD SUB-BASE GRAVEL COURSE

- .1 The road sub-base gravel shall be in accordance with Section 9.29 - Road Sub-Base Gravel Course.

4.22A ROAD BASE GRAVEL COURSE

- .1 The road base course gravel shall be in accordance with Section 9.30 - Road Base Gravel Course.

4.23 APPROVED NATIVE BACKFILL

- .1 Approved native backfill shall be soils native to the excavation and suitable for backfilling to the required compaction densities as determined by the Engineer.
- .2 The maximum size rock in approved native backfill shall be 200mm in any dimension.
- .3 Approved native backfill material placed within 600mm of the finished surface shall have a maximum rock size of 75mm measured in any dimension.

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- .4 Unsuitable native materials, i.e. rock, clay or silt may be mixed with granular material for use as approved native backfill if approved by the Engineer. In no case shall the silt and clay content exceed 30% by volume.

4.24 CONTROLLED DENSITY FILL

- .1 All materials and methods shall conform to CAN/CSA A23.1 and A23.2.
- .2 Materials:
- (a) Portland cement: Type 10 to CAN/CSA A3000, for winter conditions Type 30 may be used. **(REVISED NOVEMBER 2016)**
 - (b) Fly Ash: Type F to CAN/CSA A23.5.
 - (c) Water: To CAN/CSA A23.1.
 - (d) Aggregate: To CAN/CSA A23.1.
 - (e) Air entraining admixture: To CAN3 - A266.2. **(REVISED NOVEMBER 2016)**
 - (f) Chemical admixtures: To CAN3 - A266.2. Use of admixtures to accelerate or retard curing as directed by the Engineer. **(REVISED NOVEMBER 2016)**
- .3 Mix Design:
- (a) Compressive strength: 0.5MPa at twenty-eight (28) days.
 - (b) Cement content: 25kg per m³.
 - (c) Slump: 150 - 200mm
 - (d) Air entrainment: 4 - 6%
- .4 Formwork:
- (a) Formwork, if required, shall conform to CSA S269.3.
- .5 Placement:
- (a) Provide the Engineer with twenty-four (24) hours notice prior to placing controlled density backfill.
 - (b) Segregation of the material during placement shall not be permitted. Pumping of controlled density fill is permitted if approved by the Engineer.
 - (c) Internal vibrators or other methods of consolidation may be used to ensure undercut areas of pavement are fully supported.
 - (d) When using controlled density fill to bed and surround the pipe, material shall be placed so as not to damage or displace the pipe.
 - (e) Begin placement of controlled density fill at the high end of sloping trenches.
 - (f) Do not place load on the controlled density backfill until authorized by the Engineer.
 - (g) Steel road plates or other approved means of supporting traffic shall be used until surface restoration can proceed.

4.25 VARIATION IN SPECIFICATION REQUIREMENTS FOR TRAVELED SURFACES

- .1 Requirements under Section 4.19 - Backfill and Compaction, Section 4.27 - Surface Restoration and Section 4.28 - Pavement Restoration may be modified or deleted as determined and authorized by the Engineer depending on soil conditions, the condition of

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

the existing pavement and road structure, traffic control, future planned construction or other reasons, that affect work outlined under the aforementioned specification sections.

4.26 FISH HABITAT GRAVEL

- .1 Gravel shall be composed of inert, non-fractured smooth washed aggregate.
- .2 Gradation:

GRADATION LIMITS (Percent by Volume & Percent by Weight Passing)		
US STANDARD SIEVE SIZE	GRADATION LIMITS (PERCENT BY WEIGHT PASSING)	PERCENT BY VOLUME
100 mm	100	0
75 mm	95	5
50 mm	80	15
37.5 mm	60	20
19 mm	25-30	30-35
9.5 mm	10-15	10-20
6.3 mm	0 - 15	0 - 15
4.75 mm	0 - 5	0 - 5

4.27 SURFACE RESTORATION

- .1 General:
 - (a) Surface restoration shall be completed immediately following the backfilling operation.
 - (b) Restore all disturbed surfaces to a condition equal to or better than the condition that existed prior to construction to the satisfaction of the Engineer unless otherwise specified.
 - (c) Repair any damage to adjacent lands or improvements.
 - (d) Damage to paved surfaces shall be seal coated, patched or replaced in an approved manner to the satisfaction of the Engineer.
 - (e) Damage to graveled surfaces shall be restored by scarifying, regrading and compacting the surface, or if required, regravelling the surface with base gravel or approved equivalent to the satisfaction of the Engineer.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

.2 Traveled Surfaces:

- (a) Restoration of traveled surfaces shall conform to the following minimum requirements, or to the existing road structure, whichever is greater, unless otherwise noted on the construction drawings.

LOCATION	SUB-BASE	BASE	SURFACE TREATMENT
Gravel Roads	300mm	50mm	-
Gravel Shoulders	300mm	50mm	-
Asphalt Roads (Existing)	250mm	100mm	50mm Asphalt
Asphalt Roads (With CDF)	CDF	100mm	50mm Asphalt
Gravel Driveways	-	100mm	-
Asphalt Driveways	-	100mm	50mm Asphalt
Concrete Driveways*	-	100mm	100mm Concrete
Asphalt Sidewalks	250mm	100mm	50mm Asphalt
Concrete Sidewalks	250mm	100mm	100mm Concrete
Asphalt Walkways	150mm	50mm	50mm Asphalt

- * Concrete driveways within the road rights-of-way shall be restored in accordance with the asphalt driveway requirements where the abutting street is not constructed with concrete curb and gutter or where future road widening will be required.

- (b) Place and compact sub-base, and base to 95% Modified proctor Density (ASTM D1557).
- (c) Restore asphalt road surfaces in accordance with Section 4.28 – Pavement Restoration.
- (d) If approved by the Engineer, excavated road gravel may be reused for the sub-base course.
- (e) Concrete shall be in accordance with Section 8 – Curbs, Sidewalks and Walkways.

.3 Ditches:

- (a) Reshape ditches to the original lines, grades and sections as existed prior to construction unless otherwise shown on the construction drawings.
- (b) Restore ditch with a minimum of 300mm of import granular fill, or other material specified by the Engineer where stability of ditch slopes and bottom cannot be maintained.
- (c) Compact to 95% Modified Proctor Density (ASTM D1557).

.4 Boulevards, Statutory Rights-of-way and Private Property:

- (a) Surface restoration in untravelled boulevard areas shall be limited to the replacement of topsoil, grass, gravel, rock chips or bark mulch (subject to drainage conditions) unless otherwise stated in the construction drawings or contract documents.
- (b) Surface restoration shall be a minimum depth of 100mm, or to meet pre-construction conditions, whichever is greater, unless otherwise noted on the construction drawings.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

- (c) Restore unimproved areas with materials equivalent to the surface conditions prior to construction.
- (d) Restore gardens with materials approved by the Engineer including top soil, bark mulch, rock chips or other materials required to match pre-construction conditions.
- (e) Restore lawns with sod removed prior to construction, otherwise restore lawn with top soil approved by the Engineer and seed or sod to match existing lawn.
- (f) Restore gravel surfaces with equivalent granular materials.
- (g) Restore driveways in accordance with Section 4.27.2.
- (h) Restore landscaped areas in accordance with Section 4.27.5.
- (i) Surface restoration in statutory rights-of-way shall also be in accordance with the rights-of-way condition sheet.
- (j) Prior to acceptance of the work, the contractor shall obtain and submit, in duplicate to the Engineer, a written release from each owner of property, where works were constructed or damaged, certifying that the owner is satisfied with the completed works.

.5 Landscaped Areas:

- (a) Top soil, shrubs, small trees, fences and other items removed prior to, or during construction shall be replaced to the satisfaction of the property owner.
- (b) Replacement shrubs, trees and plants shall be planted at a suitable time of the year in accordance with good horticultural practice to provide a maximum assurance of survival.
- (c) During the maintenance period, any trees, shrubs or plants which show signs of dying as a result of the Contractor's operation shall be replaced with new plantings of a similar variety, age and size at no extra cost to the owner.

4.28 PAVEMENT RESTORATION

- .1 All pavement restorations with a minimum 75mm asphalt thickness shall be constructed in accordance with Standard Drawing No. T-4A or as directed by the Engineer. All pavement restorations with less than 75mm asphalt thickness shall be constructed in accordance with Standard Drawings No. T-4 or as directed by the Engineer.
- .2 All pavement restorations where asphalt cutting around a manhole is required, shall be done in accordance with Standard Drawing No. T-4B.
- .3 All excavations in traveled paved areas shall be patched on the same day as the excavation with a temporary or permanent patch, or with approved steel plates, unless otherwise directed by the Engineer.
- .4 Temporary Pavement Patching:
 - (a) All temporary patching and steel road plates shall be installed and maintained to ensure safe and smooth conditions.
 - (b) Temporary patching shall consist of cold or hot mix asphaltic concrete as approved by the Engineer and placed to a minimum compacted thickness of 50mm.
 - (c) Use of steel road plates shall require approval from the Engineer and shall only be used where the specifications or drawings require the trench to be left open. (i.e. to allow curing of concrete or controlled density fill.) Steel plates shall be rated to meet traffic loading requirements.

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

.5 Permanent Asphaltic Concrete Pavement Patching:

- (a) Install permanent pavement patch within 15 days of the excavation unless otherwise approved by the Engineer.
- (b) Remove and dispose of all broken, cracked, damaged or temporary pavement as well as paved areas showing settlement.
- (c) All pavement outside the allowable trench width, as shown on Standard Drawing No. T-1, that is damaged as a result of the contractor's operation shall be removed; all backfill beneath the damaged pavement recompacted; and the pavement reinstated in accordance with these specifications at no additional cost to the Owner.
- (d) If required, re-cut existing pavement so that the location and alignment of the patch is in accordance with Section 4.29 – Final Cutting Paved Surfaces, and so that the pavement edge is a minimum of 300mm from the trench wall.
- (e) Excavate patch, as required, to ensure placement of the specified thickness of road base. Road base material and placement shall be in accordance with Section 9 - Streets, Traffic Signs and Markings.
- (f) Pavement edges shall be thoroughly cleaned. Tack coat, in accordance with Section 12.27, shall be applied to completely cover all pavement edges. **(REVISED NOVEMBER 2016)**
- (g) Minimum compacted pavement thickness shall be equal to the existing pavement thickness or 50mm, whichever is greater.
- (h) Material and placement of pavement shall be in accordance with Section 12 - Asphaltic Concrete Paving.
- (i) Finished permanent pavement patch shall be smooth and match adjacent pavement grades and be free of humps, depressions or ridges and within 6mm of the existing pavement grades when measured with a 3.0m straightedge, but not uniformly high or low.
- (j) The contractor shall maintain all pavement patches in complete repair during the warranty period. Should a dangerous situation arise, the pavement patch shall be repaired immediately upon notification by the Engineer, unless otherwise directed by the Engineer.

.6 Temporary RAP Patching: **(REVISED NOVEMBER 2016)**

- (a) The RAP specifications shall be in accordance with Section 12.23.3(a) – Recycled Asphalt Pavement. **(REVISED NOVEMBER 2016)**
- (b) Minimum compacted RAP thickness shall be 50mm or as specified in the contract documents. **(REVISED NOVEMBER 2016)**
- (c) RAP patches shall be compacted to 95% modified proctor, (ASTM D1557) in one lift so the finished grade is at or above the existing pavement surface. **(REVISED NOVEMBER 2016)**
- (d) If the finished grade is below the existing pavement surface, the RAP shall be scarified, additional RAP material added, and recompacted so the finished grade is at or above the existing pavement surface. **(REVISED NOVEMBER 2016)**
- (e) If the finished grade is above the existing pavement surface, it shall be trimmed flush with the existing pavement surface. **(REVISED NOVEMBER 2016)**
- (f) Temporary RAP patches are to be used only on low volume roads unless directed otherwise by the City Engineer. **(REVISED NOVEMBER 2016)**

SECTION 4 - TRENCH EXCAVATION, BEDDING AND BACKFILL SPECIFICATIONS AND INSTALLATION

4.29 FINAL CUTTING PAVED SURFACES

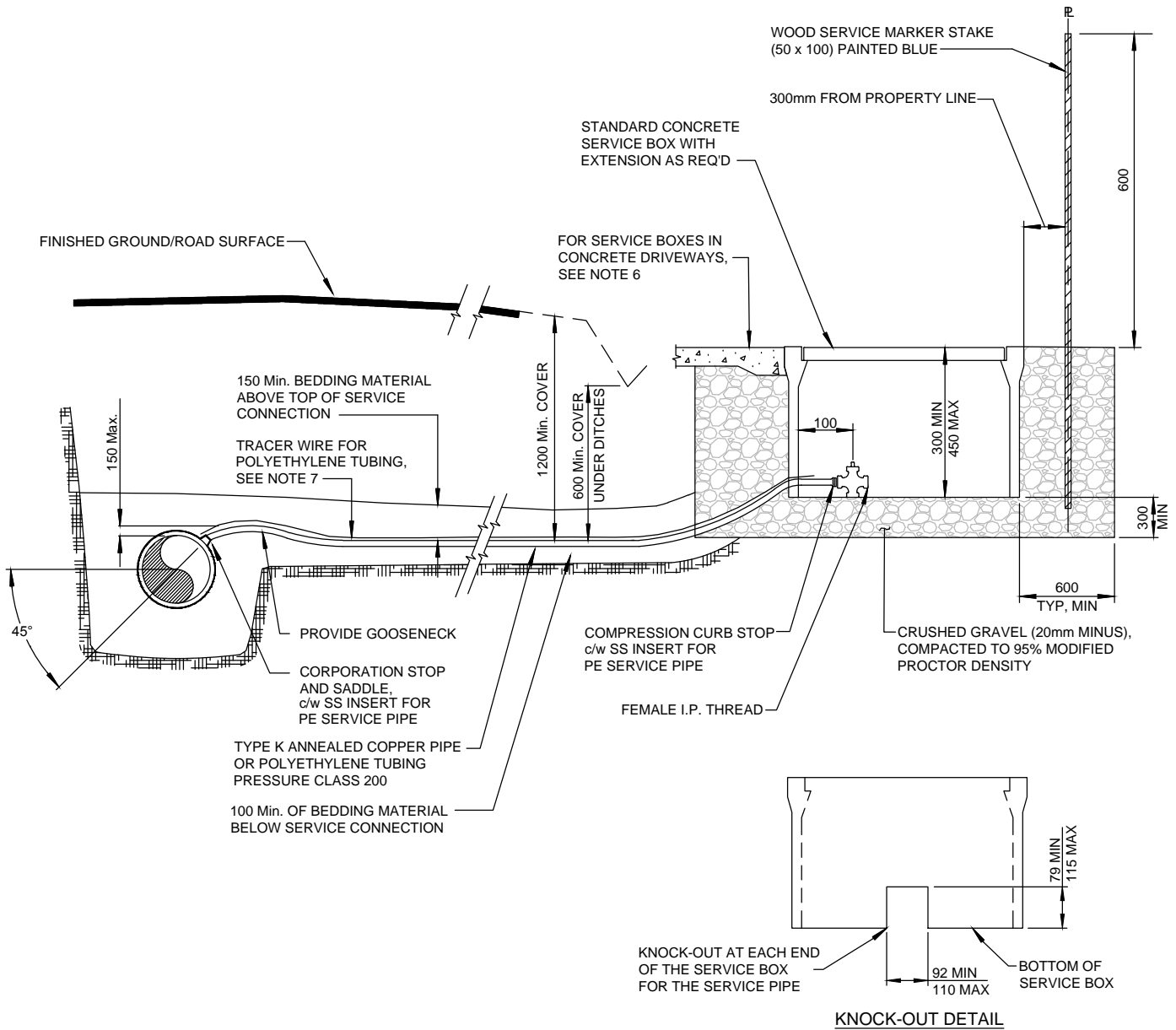
- .1 All final pavement cuts shall be sawn in accordance with Section 4.28 – Pavement Restoration.
- .2 All final cuts shall be a minimum of 300mm from the trench wall.
- .3 All longitudinal pavement cuts in streets shall lie outside a vehicle wheel path, unless otherwise directed by the Engineer.

4.30 TRENCH SETTLEMENT DURING GUARANTEE PERIOD

- .1 The Contractor shall replace materials and rectify all failures that occur as a result of settlement of trench backfill or collapse of trench walls during the guarantee period as specified in Section 2.03 – Materials and Workmanship, Article 29.
- .2 Trenches in which backfill settles shall be refilled with the specified backfill material, and paved surfaces that are adjacent to trenches or on trench backfill, which fail during this period, shall be replaced or repaired in an approved manner.

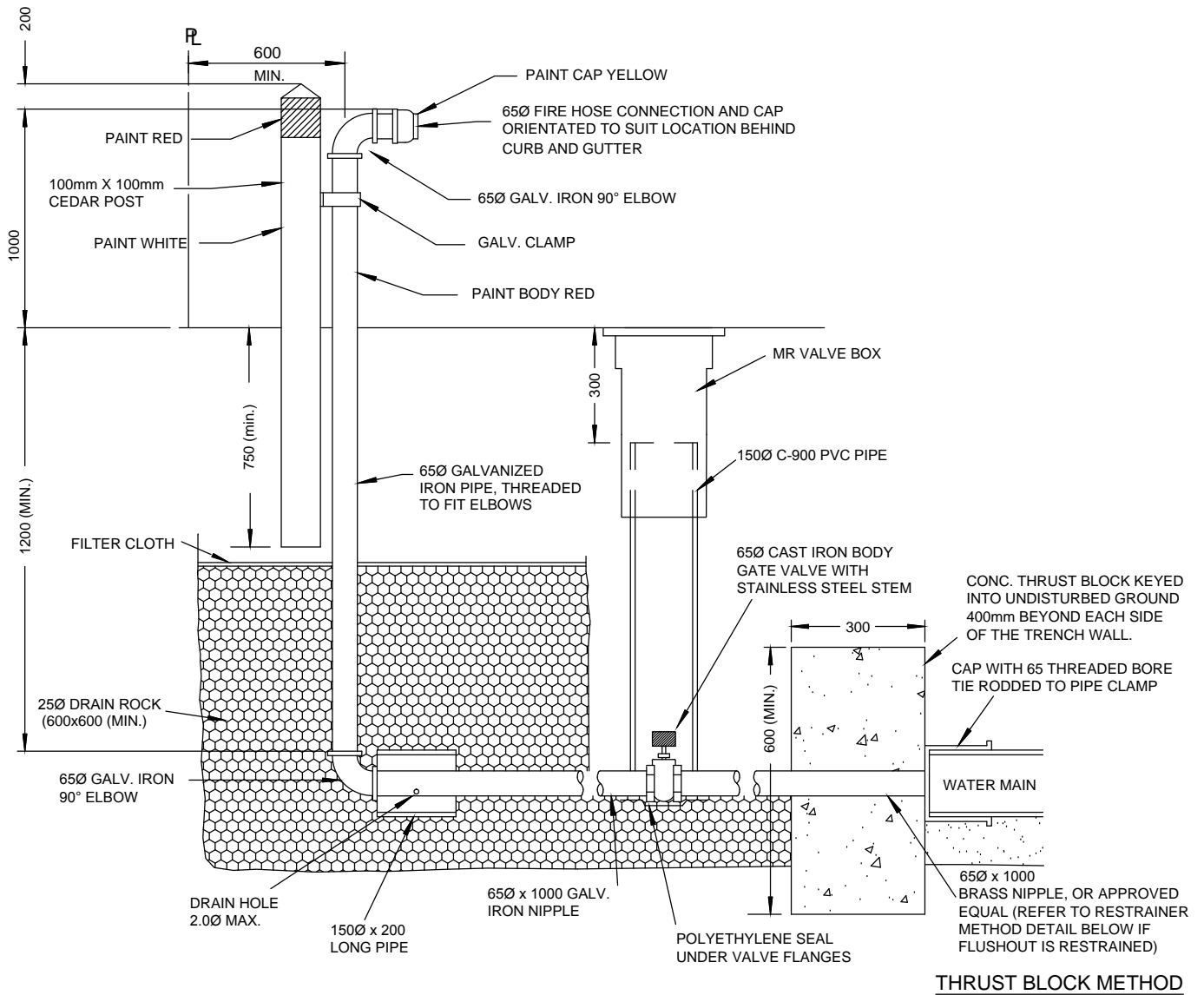
4.31 PRIVATE UTILITIES IN CITY RIGHTS-OF-WAY

- .1 Private utilities within City of Nanaimo road rights-of-way generally shall follow the alignments shown on Standard Drawings No. T-9 and T-10.
- .2 All private utilities shall be traceable electronically.
- .3 Installation of private utilities shall require prior approval by the City Engineer.



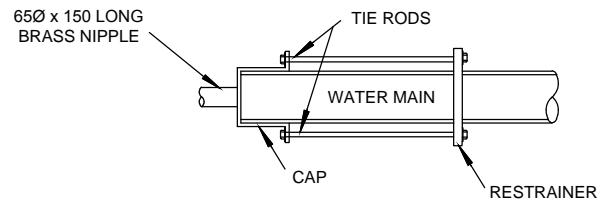
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 5.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. NOMINAL TRENCH WIDTH FOR SERVICE CONNECTION TO BE 600mm.
3. CONCRETE SERVICE BOX SHALL BE INSTALLED AS PART OF THE INITIAL SERVICE INSTALLATION AS PER SECTION 5.56.6
4. FOR 19mm and 25mm DIA. WATER CONNECTION, SERVICE BOXES SHALL BE CONCRETE WITH TOUCH READ CAST IRON LIDS.
5. FOR 38mm AND 50mm DIA. WATER CONNECTION, SERVICE BOXES SHALL BE CONCRETE WITH STEEL TOUCH READ TRAFFIC LIDS.
6. WHEN SERVICE BOX IS WITHIN A CONCRETE DRIVEWAY, CONCRETE ADJACENT TO THE SERVICE BOX MUST BE A MINIMUM OF 150mm THICK FOR A MINIMUM DISTANCE OF 150mm AROUND THE OUTSIDE EDGES OF THE SERVICE BOX.
7. TRACER WIRE SHALL BE 14 GAUGE AND BLUE IN COLOUR AS PER SECTION 5.30.1. TRACER WIRE SHALL BE INSTALLED AS PER THE MANUFACTURER'S RECOMMENDATIONS AND BE ATTACHED TO THE CORPORATION STOP AND RUN ON TOP OF THE SERVICE PIPE TO THE CURB STOP WHERE IT SHALL BE COILED NEATLY WITHIN THE BOX WITH 600mm OF SURPLUS LENGTH. TRACER WIRE SHALL BE SECURED TO THE SERVICE PIPE AT 1.0m INCREMENTS USING ELECTRICAL TAPE. WIRE SHALL NOT BE WRAPPED AROUND THE SERVICE PIPE.
8. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
9. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

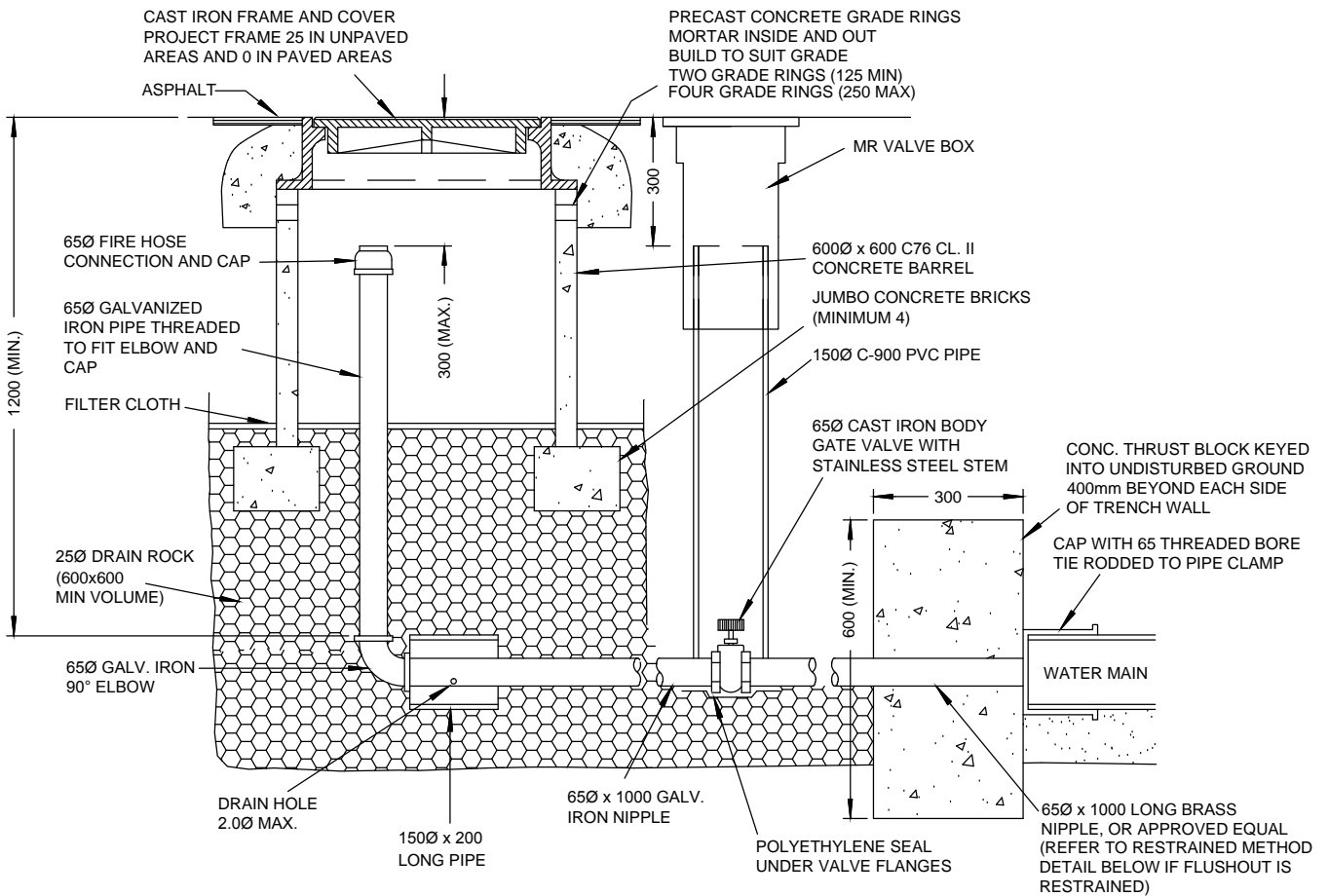


NOTES:

1. NOMINAL TRENCH WIDTH FOR FLUSHOUT IS 600mm
VALVE BOX NOT TO CONFLICT WITH CURB AND GUTTER
CURB AND GUTTER NOT SHOWN
2. 1500 x 200 PIPE TO BE PLACED AROUND PIPE
AT DRAIN HOLE TO PREVENT EROSION.
3. ABOVE GROUND FLUSHOUT TO BE RESTRAINED
AS PER THRUST BLOCK OR RESTRAINER METHOD
AT THE DISCRETION OF THE ENGINEER.
4. WHEN RESTRAINER METHOD IS USED, RESTRAIN AS PER
MANUFACTURER'S RECOMMENDATIONS.
5. ONLY PRODUCTS APPROVED BY CITY ENGINEER AND
LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS
LIST WILL BE ACCEPTED FOR INSTALLATION
6. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN



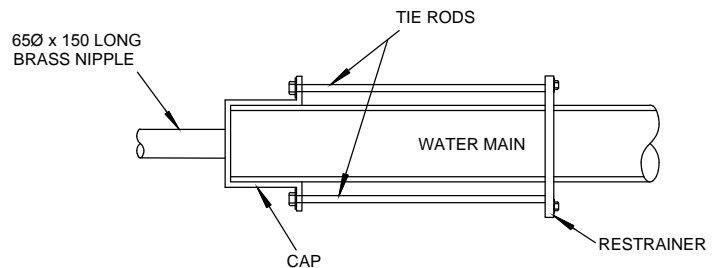
RESTRAINER METHOD



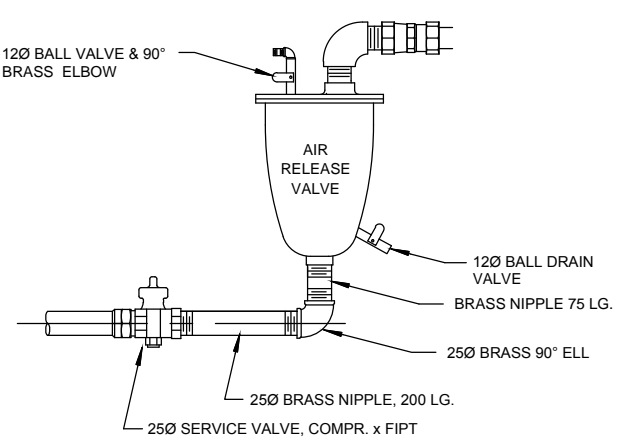
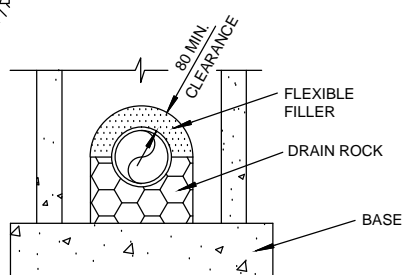
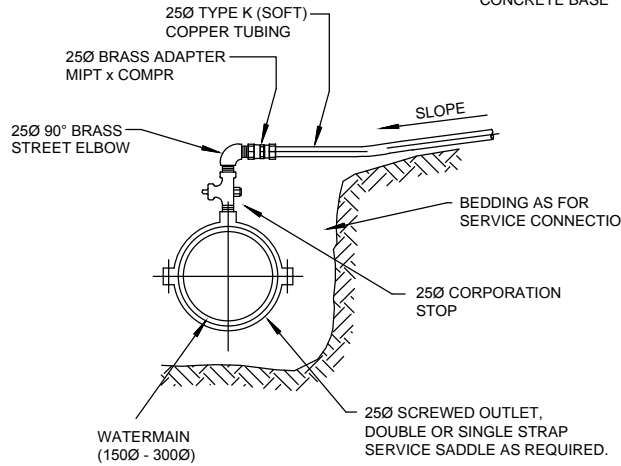
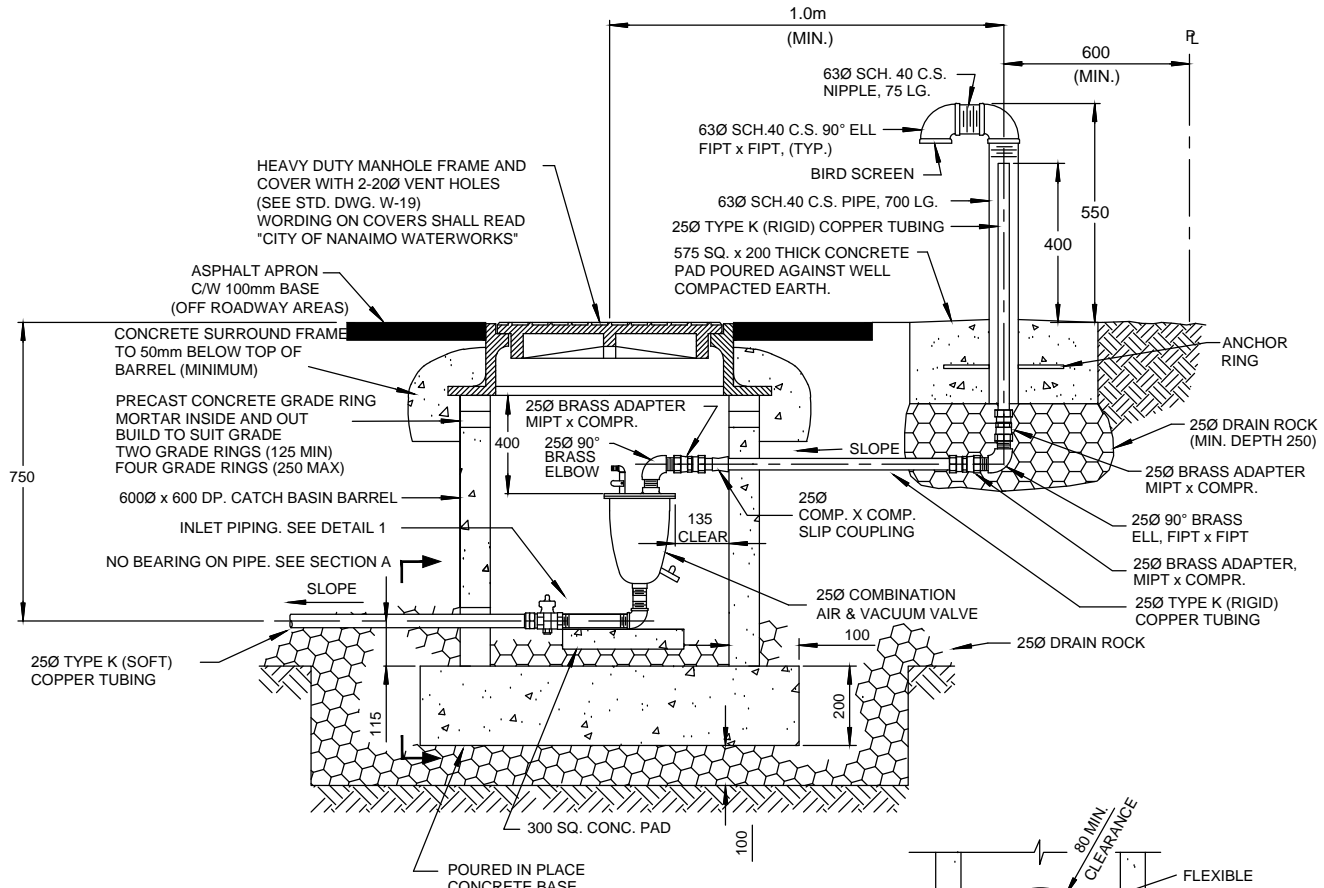
NOTES:

1. NOMINAL TRENCH WIDTH FOR FLUSHOUT IS 600mm
VALVE BOX NOT CONFLICT WITH CURB AND GUTTER
CURB AND GUTTER NOT SHOWN.
2. LETTERING ON MANHOLE COVER SHALL REFER TO
"CITY OF NANAIMO WATERWORKS"
LETTERING SHALL BE 25 FLATTENED FACE GOTHIC
LETTERING WITH FACE OF LETTERS RAISED TO THE
SAME ELEVATION AS THE TOP OF THE RIBS.
3. NOT TO BE USED IN AREAS WHERE WATER TABLE
COULD BE ABOVE FIRE HOSE CONNECTION.
4. SURROUNDING GRADE TO DRAIN AWAY FROM COVER.
5. 1500 x 200 PIPE TO BE PLACED AROUND PIPE
AT DRAIN HOLE TO PREVENT EROSION.
6. FLUSHOUTS LOCATED ON GRAVEL ROADS OR SHOULDERS
REQUIRE A 1.5m X 1.5m HOT MIX ASPHALT APRON,
50mm THICK.
7. BELOW GRADE FLUSHOUT TO BE RESTRAINED AS PER
THRUST BLOCK OR RESTRAINER METHOD AT THE
DISCRETION OF THE ENGINEER.
8. WHEN RESTRAINER METHOD IS USED, RESTRAIN AS PER
MANUFACTURER'S RECOMMENDATIONS.
9. ONLY PRODUCTS APPROVED BY CITY ENGINEER AND
LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS
LIST WILL BE ACCEPTED FOR INSTALLATION.
10. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE
SHOWN.

THRUST BLOCK METHOD



RESTRAINER METHOD



NOTES:

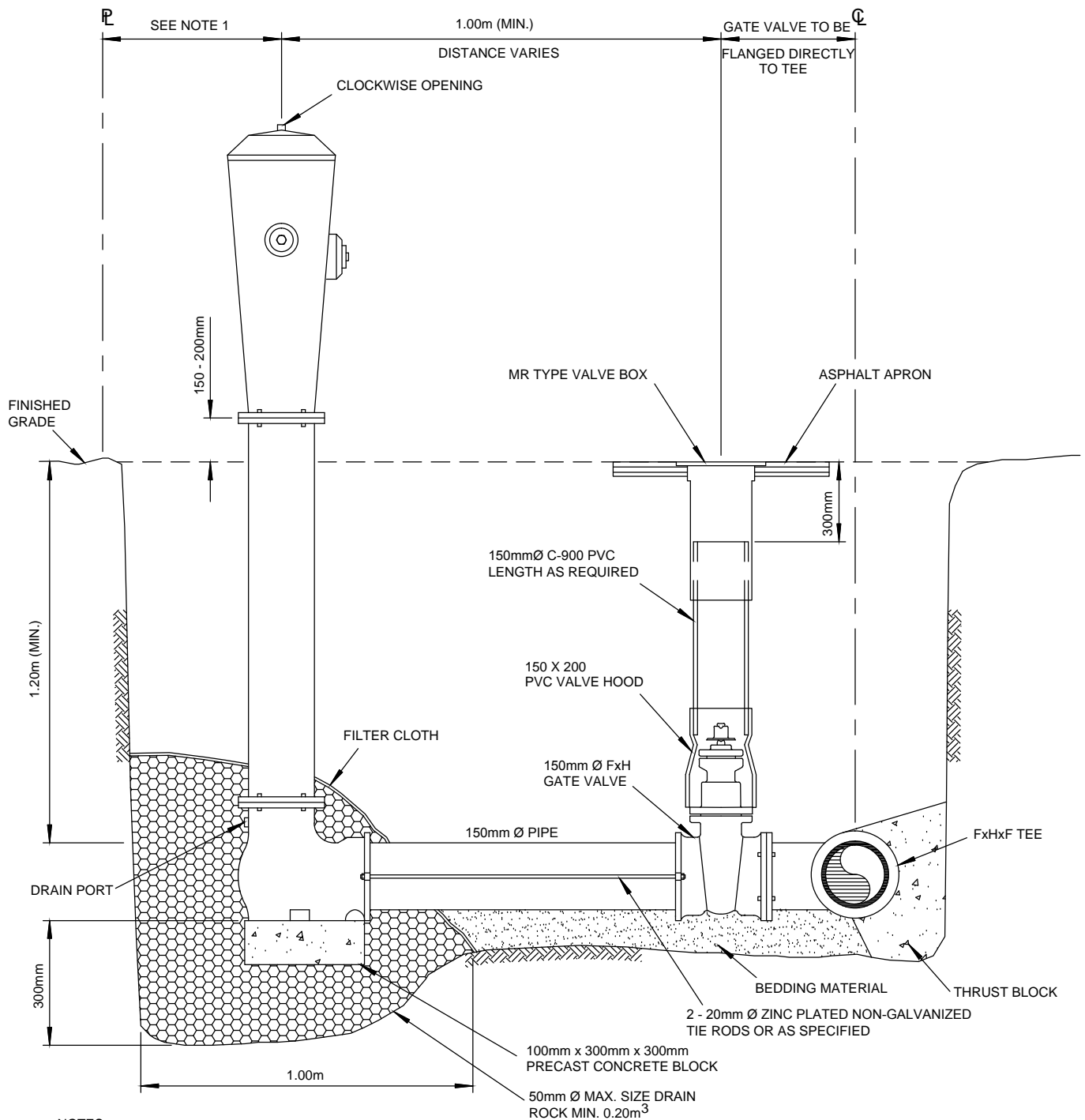
1. CHAMBERS LOCATED ON GRAVEL ROADS OR SHOULDERS REQUIRE A 1.5m x 1.5m HOT MIX ASPHALT APRON, 50 THICK
2. PLACE FILTER CLOTH OVER DRAIN ROCK PRIOR TO BACKFILL.
3. ABOVE GROUND VENT PIPING TO BE PAINTED FOREST GREEN.
4. PRECAST CB BARREL SHALL BE AN ACCEPTABLE ALTERNATIVE TO MANHOLE BARREL AND POURED IN PLACE BASE
5. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION
6. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

DETAIL 1



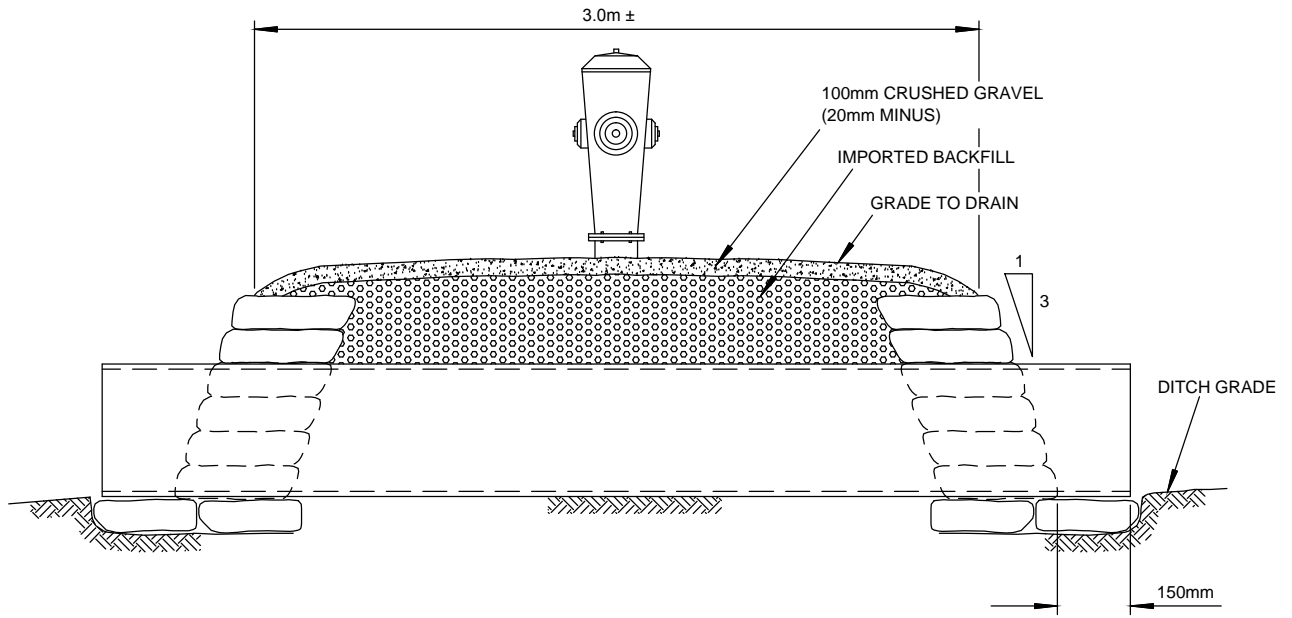
AIR RELEASE VALVE ASSEMBLY AND CHAMBER FOR 150Ø - 300Ø MAIN

Scale:	NTS
Created:	MAY 2013
Rev Date:	NOV 2016
Dwg No:	W-4

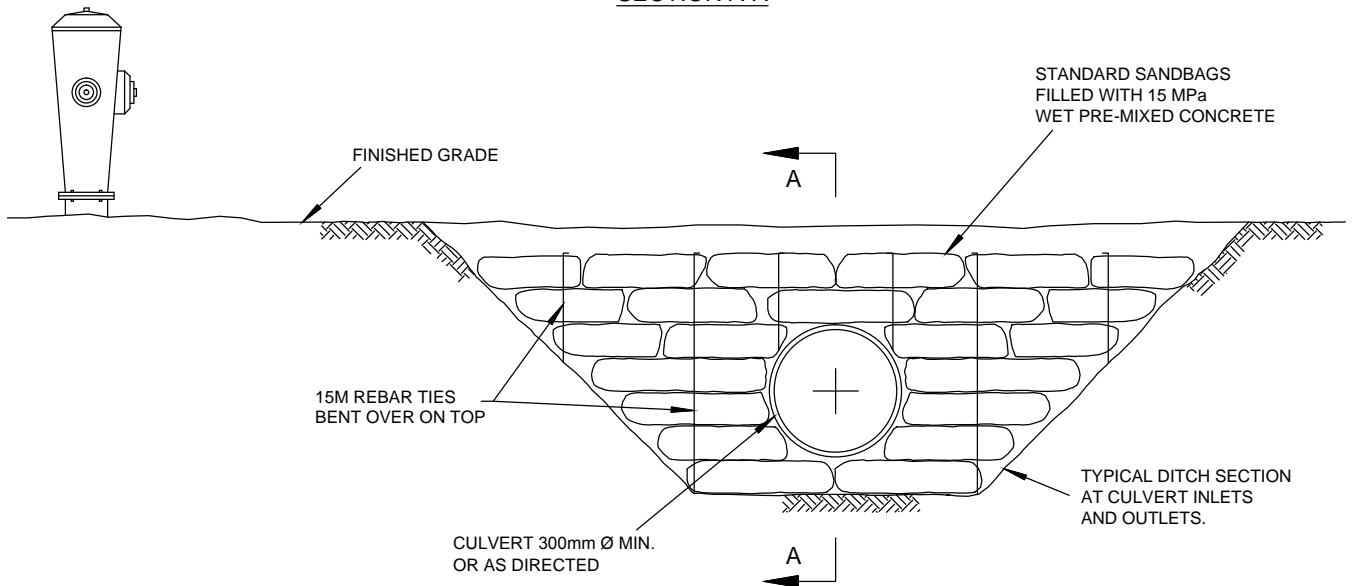


NOTES:

1. FOR HYDRANT OFFSETS REFER TO DESIGN DRAWINGS. AT NO TIME SHALL HYDRANTS BE CONSTRUCTED CLOSER THAN 1.0 METERS TO THE PROPERTY LINE.
2. HOSE AND PUMPER NOZZLE MUST FACE CURB.
3. HYDRANT FLANGES SHALL BE SET 150 - 200mm ABOVE A POINT 2% UP FROM THE TOP OF THE CURB OR FROM THE TOP OF THE EDGE OF THE ASPHALT WHERE THERE IS NO CURB UNLESS OTHERWISE DIRECTED BY THE CITY ENGINEER.
4. VALVE BOXES LOCATED OUTSIDE PAVED AREAS REQUIRE A 1.5m X 1.5m HOTMIX ASPHALT APRON, 50mm THICK.
5. FOR VALVE NUT EXTENSION REQUIREMENTS REFER TO STD. DWG. NO. W-16.
6. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR CONSTRUCTION.
7. OUT OF SERVICE HYDRANTS SHALL BE BAGGED AS PER 5.52.2(h).



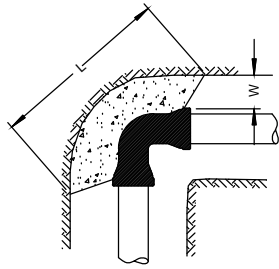
SECTION A-A



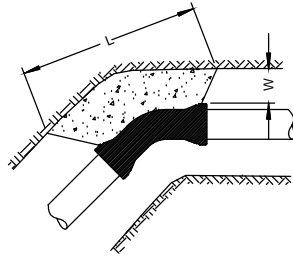
ELEVATION

NOTES

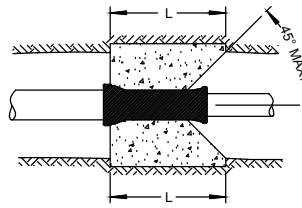
1. IF THE HORIZONTAL DIRECTION OF FLOW AT CULVERT INLETS AND OUTLETS EXCEEDS 30°, THE SANDBAG BULKHEADS REQUIRE CURVED WING WALLS TO FUNNEL THE FLOW.
2. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.



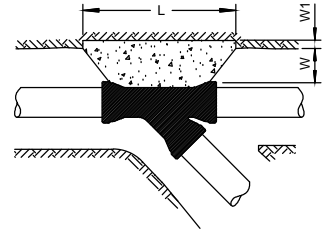
HORIZONTAL 90° BEND



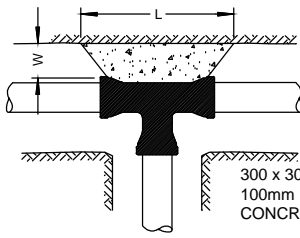
HORIZONTAL 45° BEND



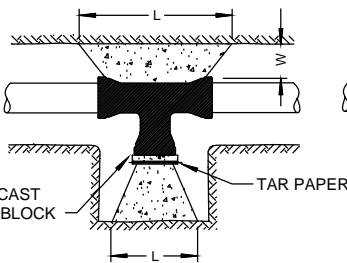
REDUCER



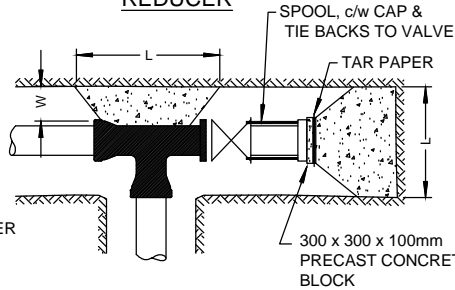
WYE



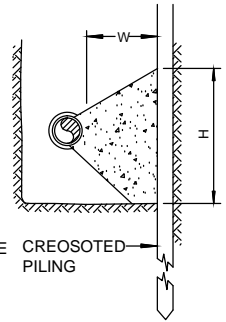
TEE



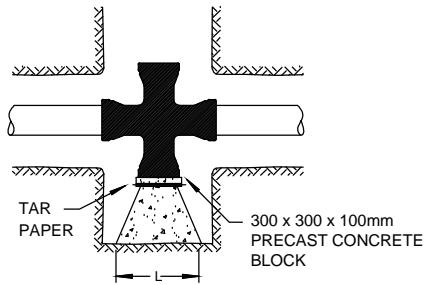
TEE WITH PLUG



TEE WITH VALVE



CREOSOTED PILING

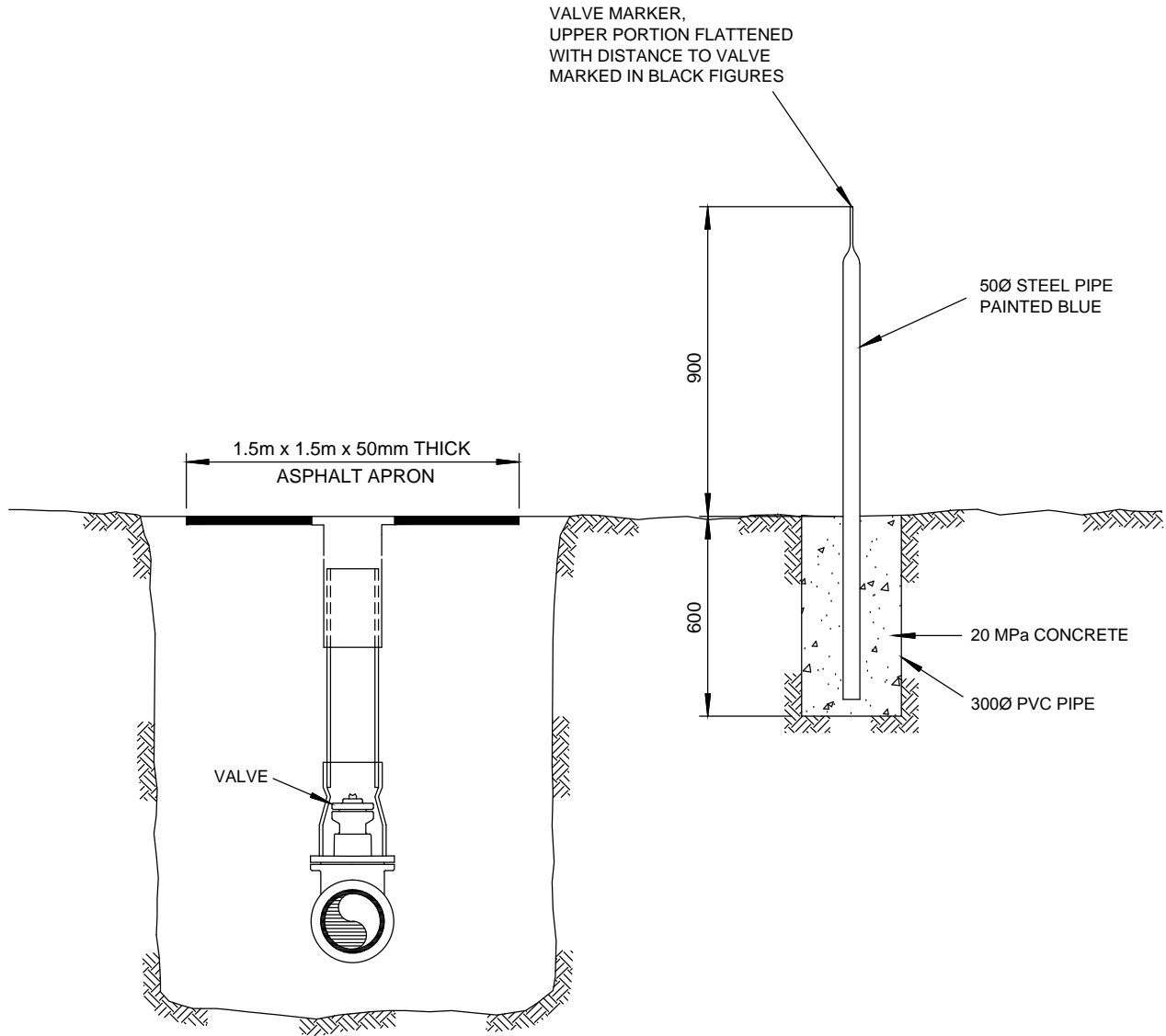


CROSS WITH PLUG

NOTES:

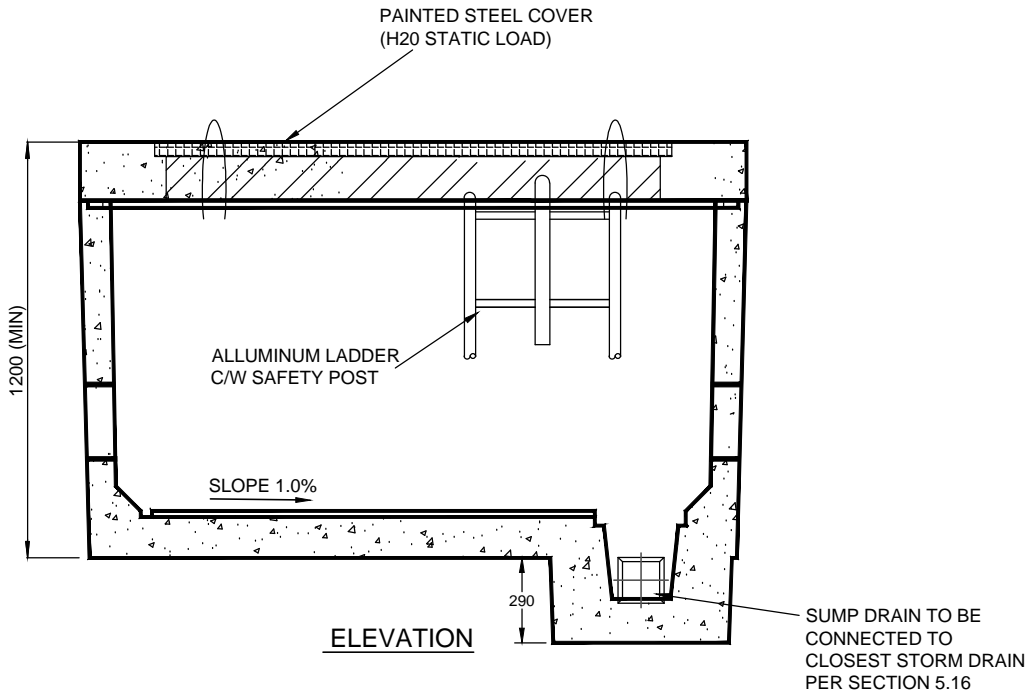
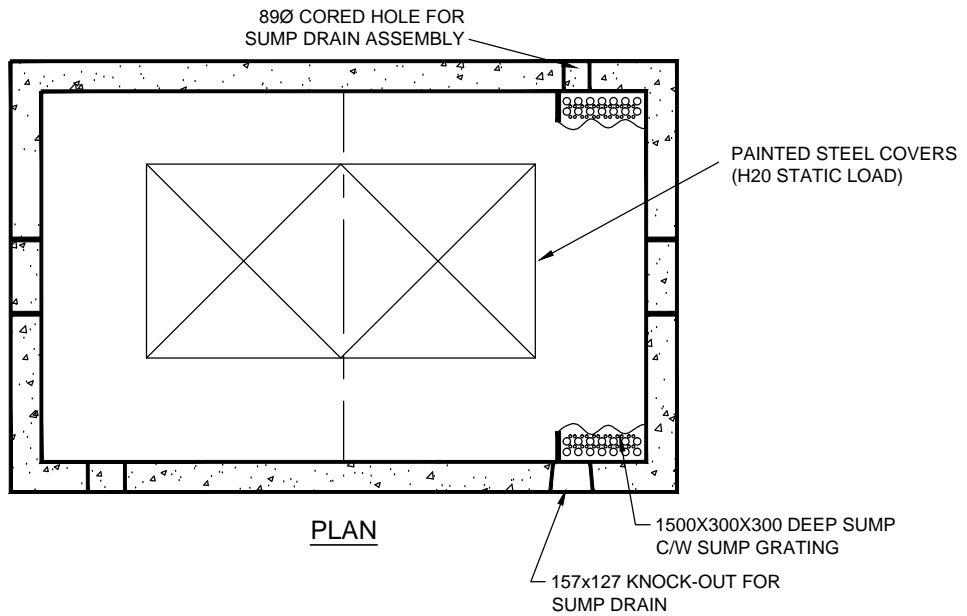
1. ALL DIMENSIONS ARE IN MILLIMETRES.
2. DIMENSIONS APPLY TO THE LARGER DIAMETER END OF THE FITTING.
3. FOR CONCRETE SPECIFICATIONS SEE SECTION 11.
4. CONCRETE MINIMUM COMPRESSIVE STRENGTH SHALL BE 20MPa @ 28DAYS.
5. WHERE GROUND CANNOT BE EXCAVATED TO FREE STANDING UNDISTURBED SOIL, SMALL PLANK SHEET PILING SHALL BE DRIVEN TO PROVIDE UNDISTURBED THRUST AREA. PILING TO BE DRIVEN PRIOR TO EXCAVATING FOR THRUST BLOCK. PILING SHOULD BE USED ONLY BELOW THE PERMANENT WATER TABLE.

MINIMUM THRUST AREAS FOR FITTINGS AT 1034 kPA PRESSURE AND FOR SOILS WITH MIN. BEARING OF 96kPa (NOT TO BE USED FOR SOFT CLAY, MUCK, PEAT, etc.)											
TYPE OF FITTING	FITTING SIZE		OUTSIDE OF FITTING TO BEARING FACE		LENGTH	HEIGHT	TYPE OF FITTING	FITTING SIZE		OUTSIDE OF FITTING TO BEARING FACE	
	D	W	L	H				D	W	W	L
90° BEND	150	300	900	450	CROSS	150	300		600	450	
	200	350	1050	600		750	600				
	250	375	1450	750		1000	750				
	300	400	1650	900		1200	900				
45° BEND	150	300	450	450	45° WYE	150	300	300	450	450	
	200	350	600	600		200	350	400	600	600	
	250	375	750	750		250	375	500	750	750	
	300	400	900	900		300	400	600	900	900	
11 1/4° BEND 22 1/2° BEND	150	300	450	225	* REDUCER	150	300	150	450	450	
	200	350	600	300		200	350	200	600	600	
	250	375	835	450		250	375	250	750	750	
	300	400	900	450		300	400	300	900	900	
TEE	150	300	600	450	CAPS AND PLUGS (IF NOT BOLTED)	150	300		450	450	
	200	350	750	600		200	350		600	600	
	250	375	1000	750		250	375		750	750	
	300	400	1200	900		300	400		900	900	



NOTES:

1. FOR USE ONLY WHERE VALVE BOXES ARE LOCATED OUTSIDE THE PORTION OF A STREET.
2. THE VALVE MARKER SHALL BE LOCATED ON SITE BY THE ENGINEER, WITH THE FLATTENED END AND MARKED DISTANCE FACING THE VALVE BOX.
3. VALVE BOXES IN UNPAVED AREAS REQUIRE A 1.5m x 1.5m HOTMIX ASPHALT APRON, 50mm THICK.
4. FOR VALVE NUT EXTENSION REQUIREMENTS REFER TO STD. DWG. NO. W-16
5. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

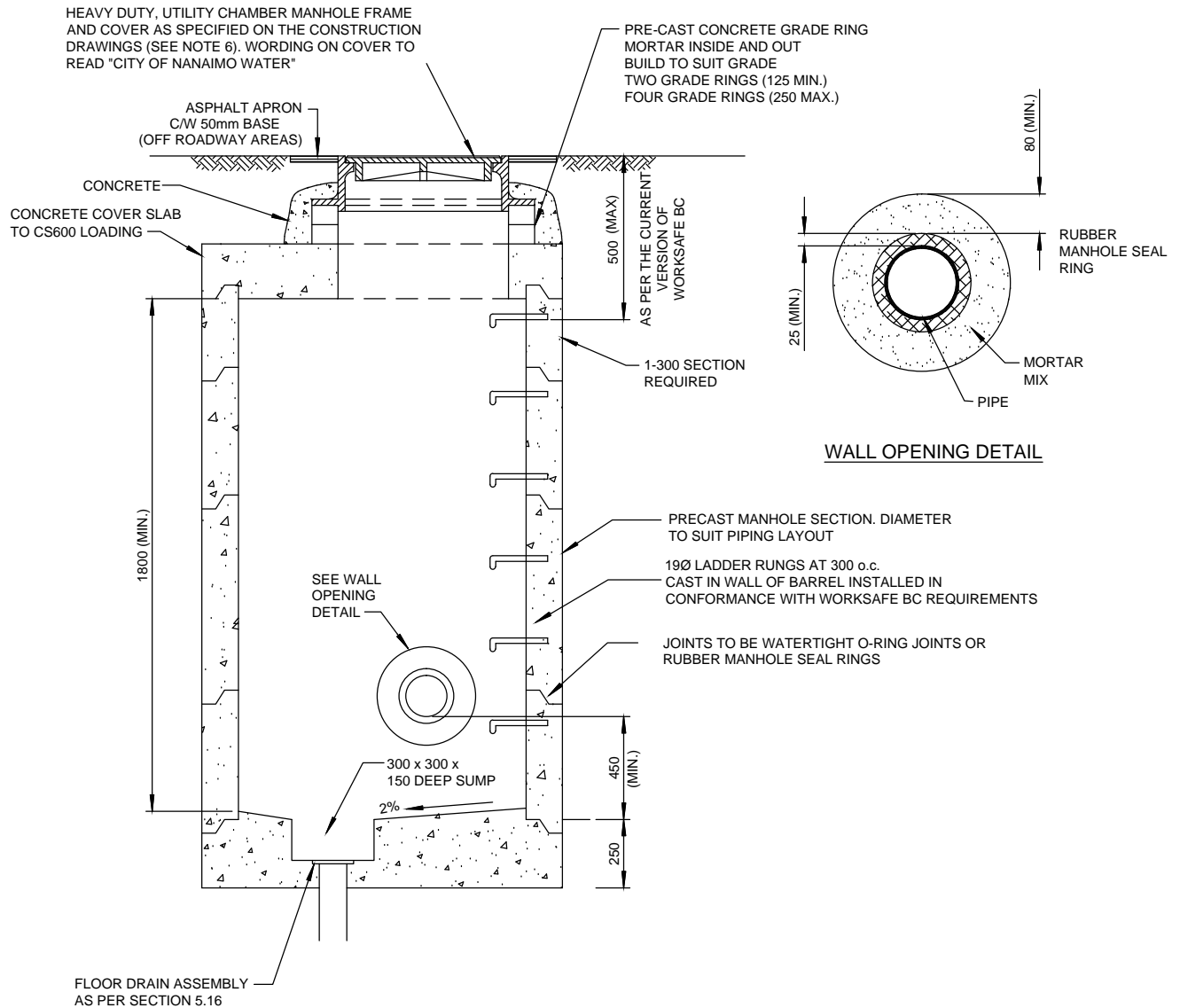


NOTES:

1. USE THIS DRAWING ONLY AS A GUIDE. DETAIL DESIGN SHALL CONSIDER EXISTING SITE AND SOIL CONDITIONS AND INCLUDE STEEL REINFORCEMENT.
2. CONCRETE AND REINFORCING STEEL SHALL CONFORM TO SECTION 11.
3. DESIGN VAULT TO WITHSTAND CS600 LOADING.
4. SIZE VAULT TO PROVIDE MINIMUM CLEARANCES AS PER SECTION 5.13.
5. CHAMBERS LOCATED ON GRAVEL ROADS OR SHOULDERS REQUIRE A 1.5m X 1.5m HOT MIX ASPHALT PERIMETER APRON, 50mm THICK.
6. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.
8. MINIMUM 200mm CLEAR DISTANCE FROM FLANGE OR BOLTED CONNECTION TO THE INSIDE WALL.

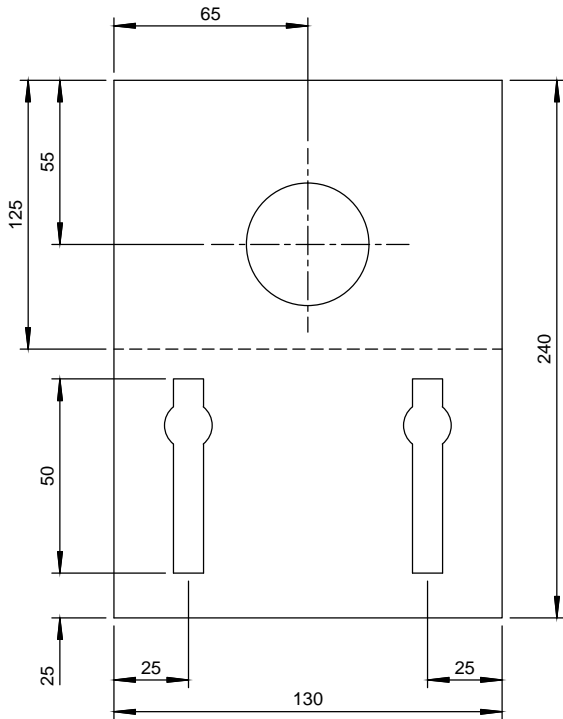
MINIMUM INTERVAL DIMENSION FOR THE PRECAST VAULT METER CHAMBER

DOMESTIC/ FIRE METER	LENGTH	WIDTH
100-150Ø	2000	1200
150-250Ø	2600	1200

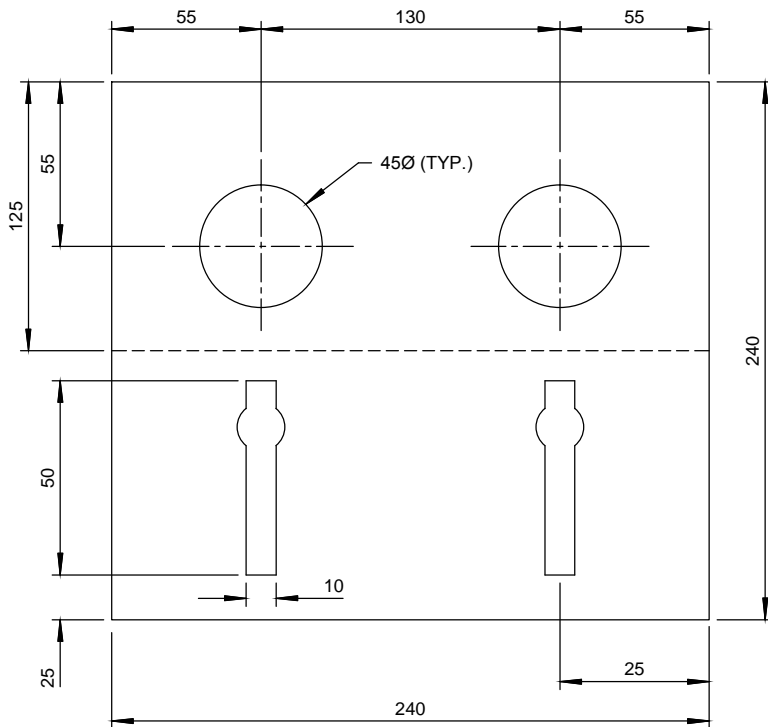
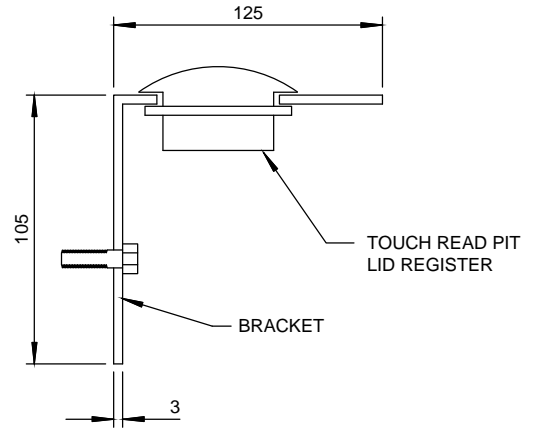


NOTES:

1. CHAMBERS LOCATED IN UNPAVED AREAS REQUIRE 1.5m x 1.5m GRAVEL OR PAVED SURFACE AROUND COVER. PROJECT COVER 0mm IN PAVEMENT OR 25mm IN UNPAVED AREAS
2. CHAMBER MANHOLES LOCATED IN UNPAVED AREAS REQUIRE A 1.5m X 1.5m, 50mm THICK HOT MIX ASPHALT APRON.
3. ONLY PRODUCTS APPROVED BY THE DIRECTOR OF ENGINEERING AND PUBLIC WORKS AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION
4. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN
5. MINIMUM 200mm CLEAR DISTANCE FROM FLANGE OR BOLTED CONNECTION TO THE INSIDE WALL
6. WATERTIGHT MANHOLE FRAME AND COVER WHEN SPECIFICALLY APPROVED BY THE ENGINEER



SINGLE METER BRACKET

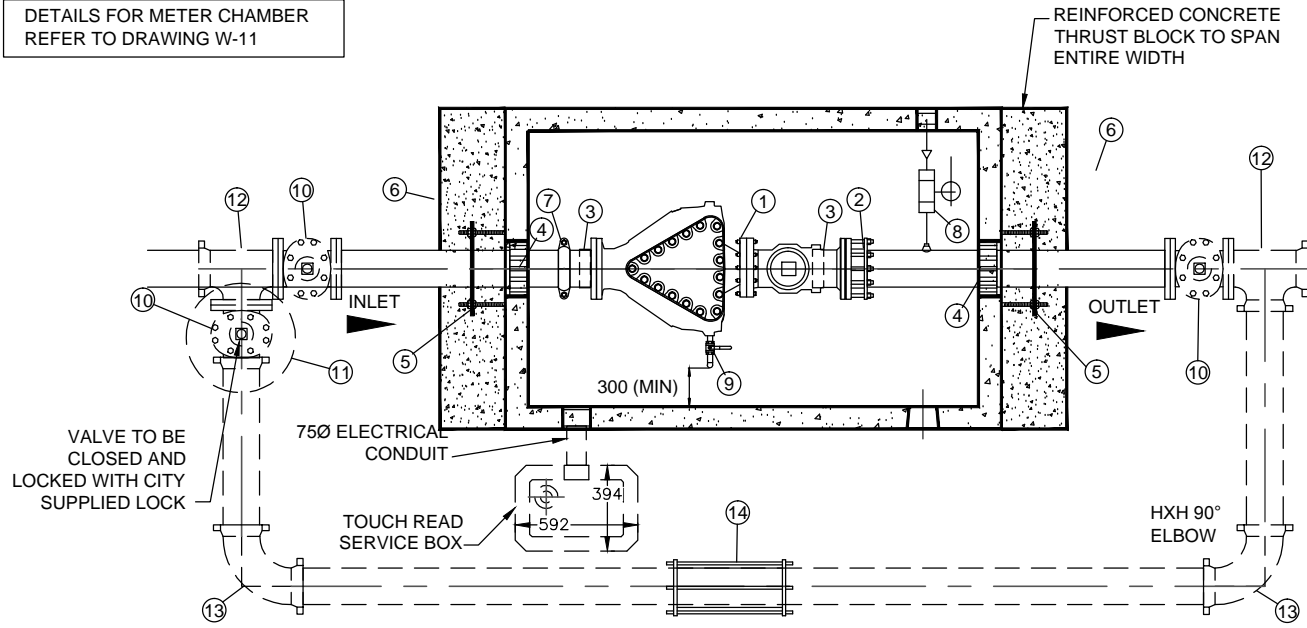


DOUBLE METER BRACKET

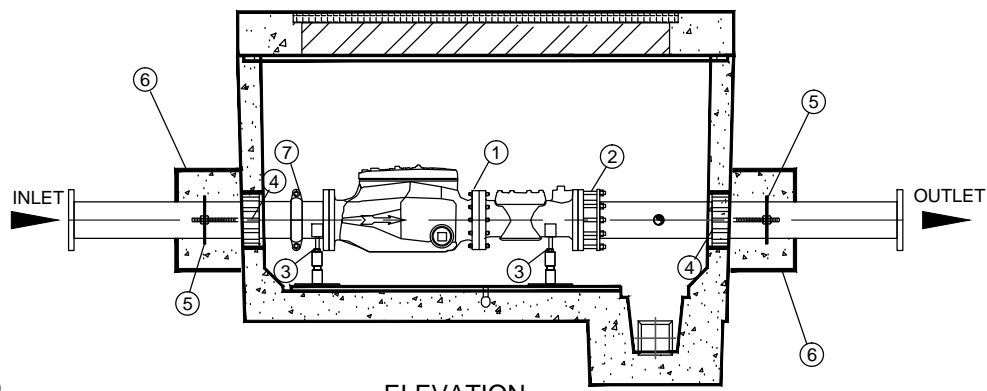
NOTES:

1. BRACKETS TO BE CONSTRUCTED OUT OF 3mm ALUMINUM PLATE
2. BRACKETS TO BE MOUNTED WITH TWO 6mm STAINLESS STEEL BOLTS WITH LEAD ANCHORS
3. IN PRECAST MANHOLE METER CHAMBERS THE BRACKET SHALL BE MOUNTED BETWEEN THE FIRST AND SECOND LADDER RUNG
4. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN

DETAILS FOR METER CHAMBER
REFER TO DRAWING W-11



PLAN



ELEVATION

MATERIAL LIST

- ① WATER METER (FIRE)
- ② FLANGE COUPLING ADAPTER FOR STEEL PIPE
- ③ GALVANIZED STEEL ADJUSTABLE PIPE SUPPORT
- ④ PIPE SEAL ASSEMBLY
- ⑤ THRUST-SEAL PLATE C/W BOLTS
- ⑥ REINFORCED CONCRETE THRUST BLOCK TO SPAN ENTIRE WIDTH
- ⑦ COUPLING
- ⑧ SUMP JET (OPTIONAL)
- ⑨ STRAINER DRAIN ASSEMBLY
- ⑩ GATE VALVE
- ⑪ VALVE BOX C/W LOCKING LID
- ⑫ TEE
- ⑬ 90° ELBOW
- ⑭ COUPLING

NOTE:

1. THRUST BLOCKING TO BE INSTALLED AS REQUIRED.
2. METER ASSEMBLY TO BE SUPPORTED BY STEEL PIPE SUPPORTS AS REQUIRED
3. FABRICATED STEEL PIPE AND FITTING TO BE SCHEDULE 40 SANDBLASTED, EPOXY LINED, AND COATED TO AWWA C-210 & ANSI/NSF-61 SPECIFICATION.
4. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER OR LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION. ONLY UL LISTED/FM APPROVED PRODUCTS SHALL BE APPROVED FOR FIRELINE SERVICE.
5. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.



FIRE/DOMESTIC WATER METER
PIPING LAYOUT (100Ø - 250Ø)

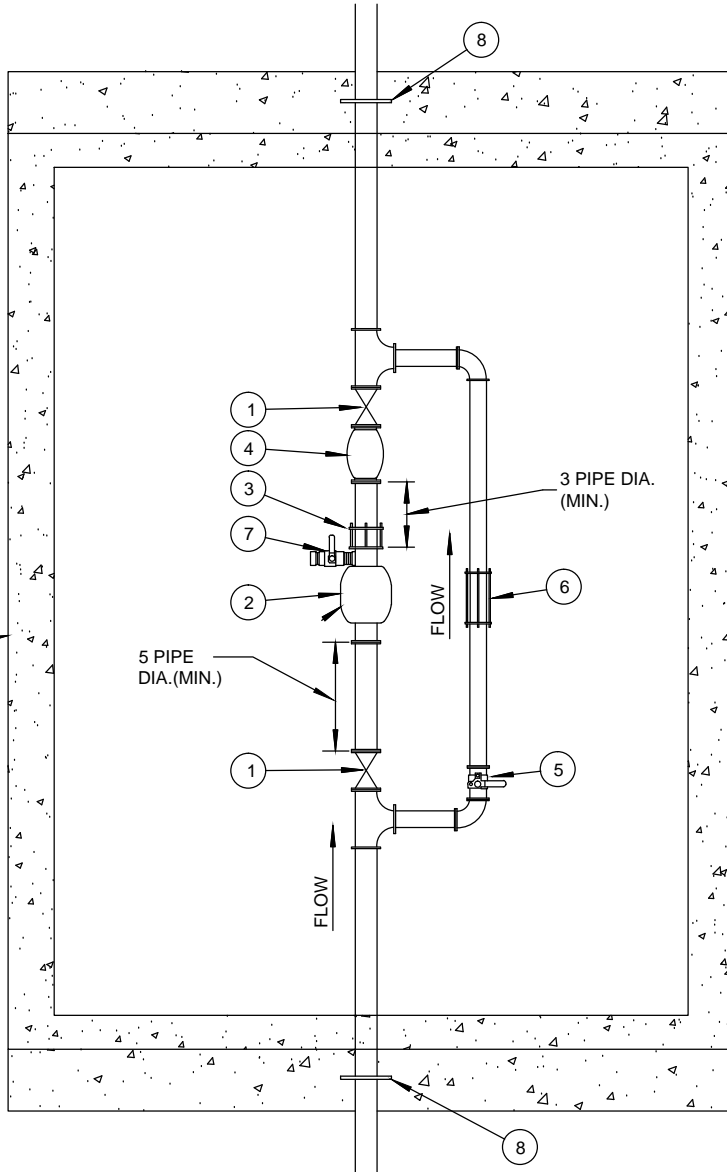
Scale: NTS
Created: MAY 2013
Rev Date: NOV 2016
Dwg No: W-13

MATERIAL LIST

- ① GATE VALVE
- ② WATER METER
- ③ FLANGED COUPLING ADAPTOR
- ④ SILENT CHECK VALVE
- ⑤ LOCKING BALL VALVE
- ⑥ COUPLING
- ⑦ TEST PORT WITH VALVE (FOR 100Ø METERS OR LARGER)
- ⑧ THRUST RINGS, c/w REINFORCED CONCRETE THRUST BLOCK TO SPAN ENTIRE WIDTH

PRECAST VAULT
METER CHAMBER

SEE DRAWING W-11
FOR METER CHAMBER
DETAILS

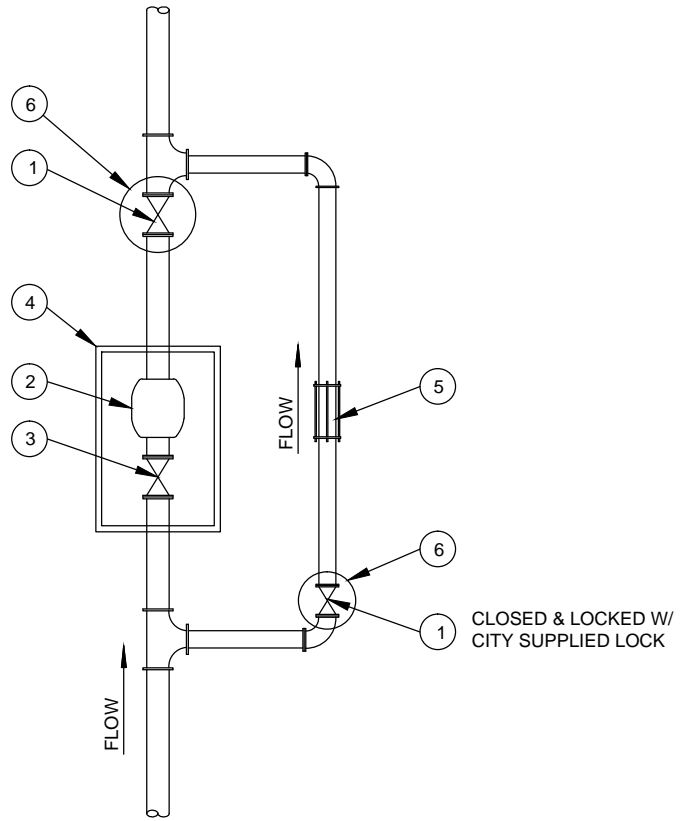


NOTES:

1. METER ASSEMBLY TO BE SUPPORTED BY STEEL PIPE SUPPORTS AS REQUIRED.
2. THRUST BLOCKING TO BE INSTALLED AS REQUIRED.
3. METER BY-PASS MAY BE INSTALLED OUTSIDE THE CHAMBER. VALVES OUTSIDE THE CHAMBER SHALL BE C.I. OR D.I. GATE VALVES AS PER SECTION 5.24.
4. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCT LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.

MATERIAL LIST

- ① GATE VALVE
- ② WATER METER - DOMESTIC
- ③ CURB STOP
- ④ METER BOX
- ⑤ COUPLING
- ⑥ VALVE BOX



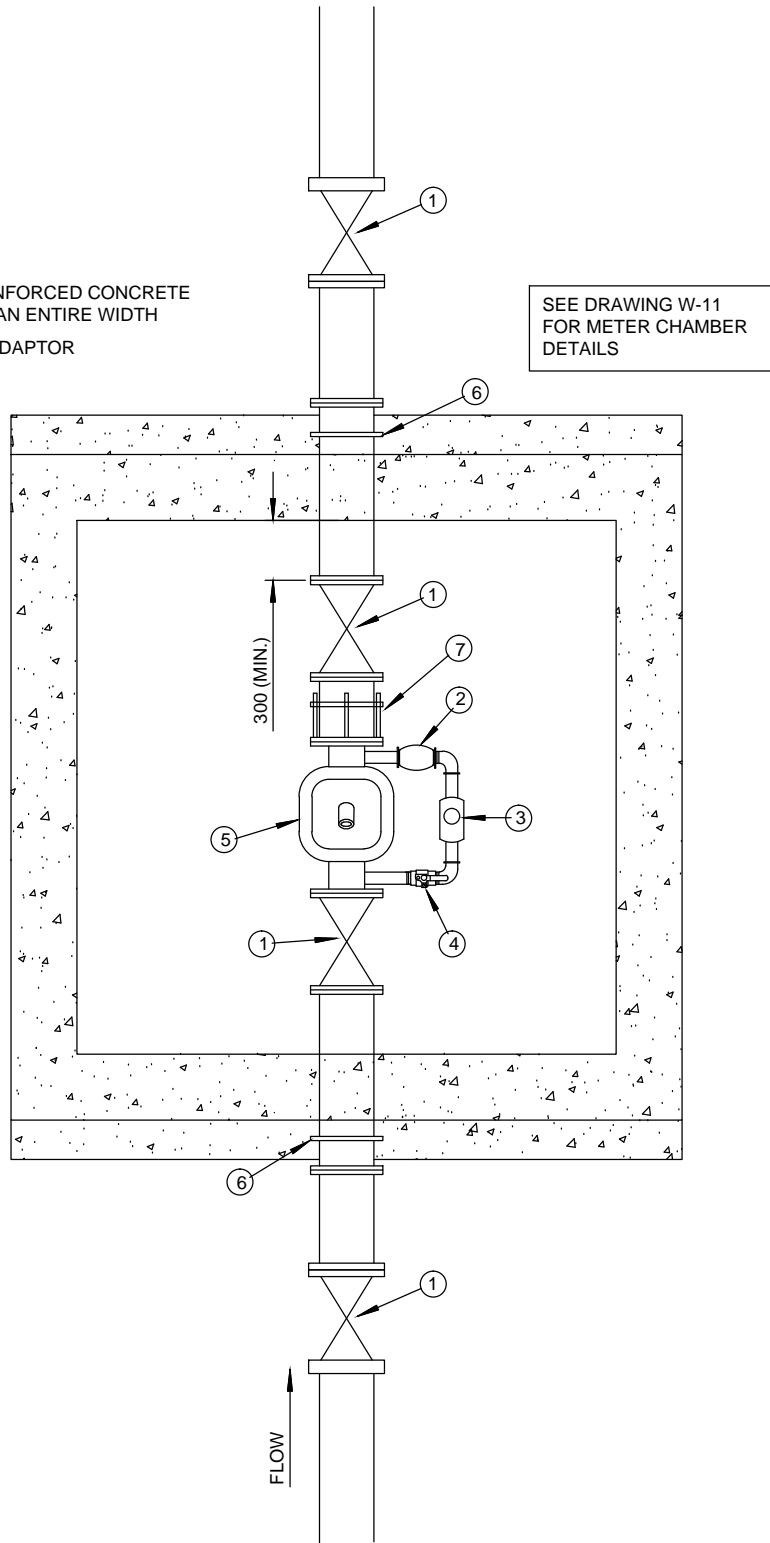
PLAN

NOTES:

1. METER BY-PASS MAY BE INSTALLED OUTSIDE THE METER BOX. VALVES OUTSIDE THE METER BOX SHALL BE AS PER SECTION 5.30.8
2. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCT LIST WILL BE ACCEPTED FOR INSTALLATION

MATERIAL LIST

- ① GATE VALVE (OS&Y)
- ② CHECK VALVE
- ③ BY-PASS METER
- ④ LOCKING BALL VALVE
- ⑤ DETECTOR CHECK
- ⑥ THRUST RING, c/w REINFORCED CONCRETE THRUST BLOCK TO SPAN ENTIRE WIDTH
- ⑦ FLANGED COUPLING ADAPTOR
- ⑧ TEE
- ⑨ 90° ELBOW
- ⑩ COUPLING



NOTES:

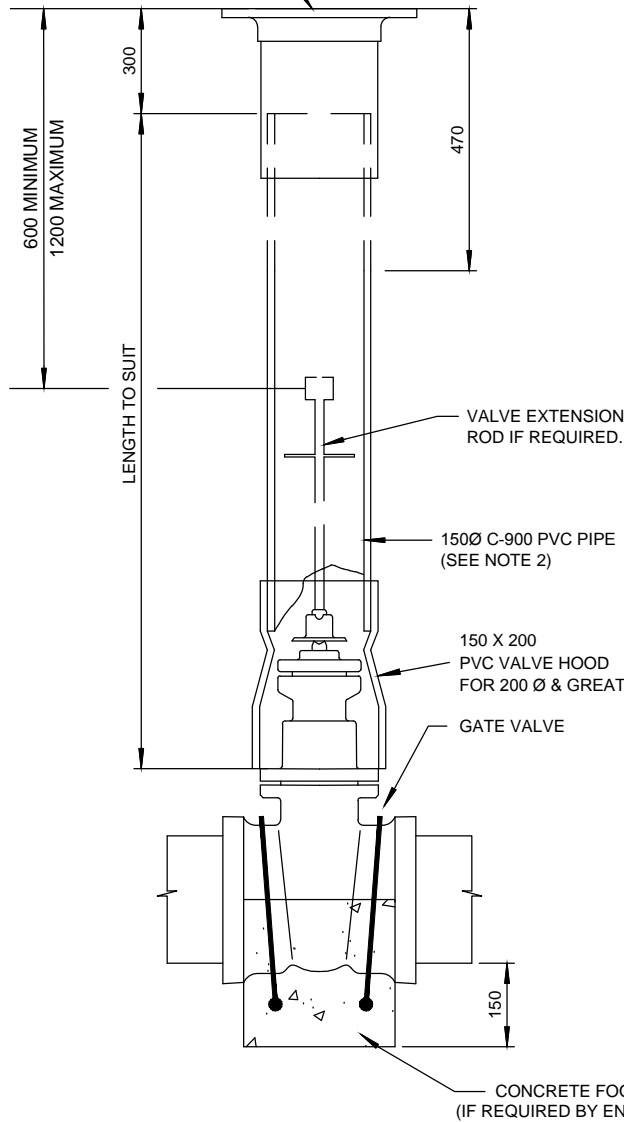
1. METER ASSEMBLY TO BE SUPPORTED BY STEEL PIPE SUPPORTS AS REQUIRED
2. THRUST BLOCKING TO BE INSTALLED AS REQUIRED
3. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCT LIST WILL BE ACCEPTED FOR INSTALLATION. ONLY UL/FM LISTED PRODUCTS SHALL BE APPROVED FOR FIRE LINE SERVICE



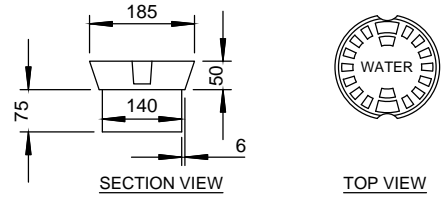
DETECTOR CHECK FIRE LINE SERVICE
PIPING LAYOUT (100Ø - 250Ø)

Scale: NTS
Created: MAY 2013
Rev Date: NOV 2016
Dwg No: W-15

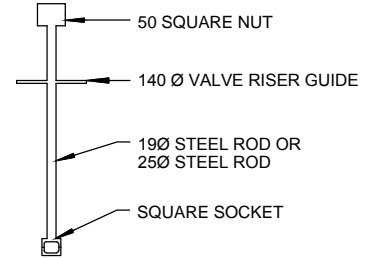
150Ø MR VALVE BOX
AS PER DWG. NO. W-16A



ASSEMBLY WITH CONCRETE FOOTING

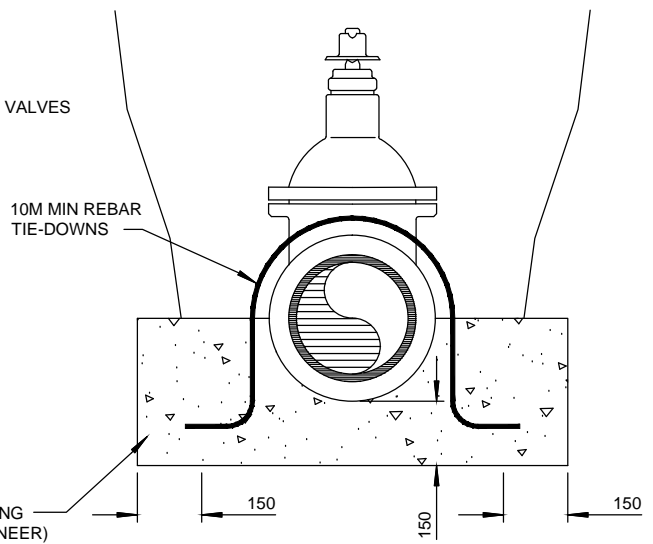


PARSONS LONG NECK LID
(NELSON + MR TYPE)



VALVE EXTENSION ROD

EXTENSION RODS REQUIRED WHEN BURY DEPTH EXCEEDS 1.2m FROM TOP OF VALVE TO GROUND LEVEL. TOP OF EXTENSION ROD NUT SHALL BE 600mm MINIMUM AND 1200mm MAXIMUM TO GROUND LEVEL.



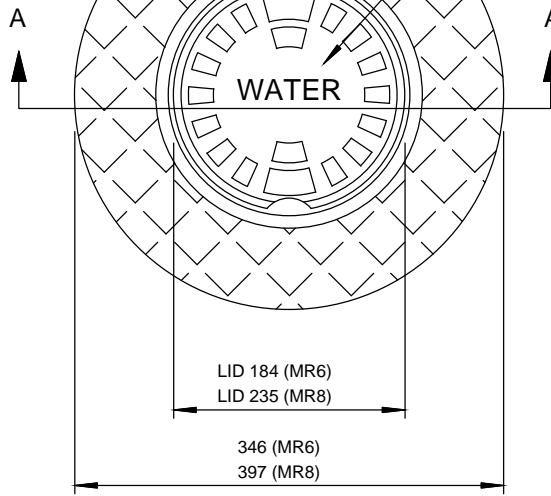
SECTION OF CONCRETE FOOTING

NOTES:

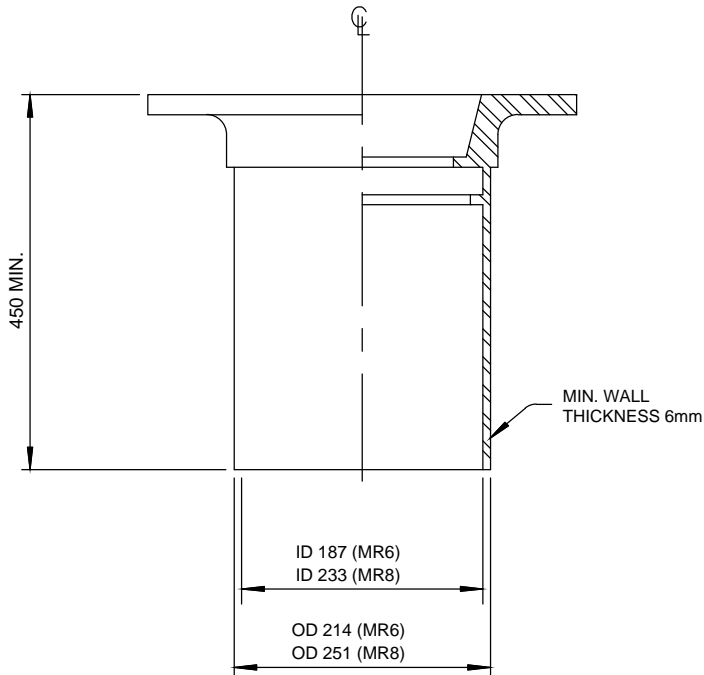
1. VALVE RISER PIPE IN TRAVELED AREAS SHALL BE 150Ø DR-18 PVC AND IN UNTRAVELED AREAS SHALL BE 150Ø DR-35 PVC AT THE DISCRETION OF THE ENGINEER.
2. VALVE BOX SHALL BE MR TYPE AS PER STD. DWG. NO. W-16A. NELSON-TYPE VALVE BOX SHALL BE USED IN NON-PAVED AREAS AT THE DISCRETION OF THE ENGINEER.
3. ALL MR AND NELSON BOX LIDS SHALL BE PARSONS LONG NECK.
4. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR CONSTRUCTION.
5. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SHOWN.
6. NO TIE-DOWNS REQUIRED IF VALVE FLANGED TO RESTRAINED TEE.

3mm RAISED SINGLE DIAMOND CHECKER PLATE FLANGE

PARSONS LONG NECK LID C/W WORD "WATER" STAMPED IN 20mm HIGH LETTERING FOR IDENTIFICATION



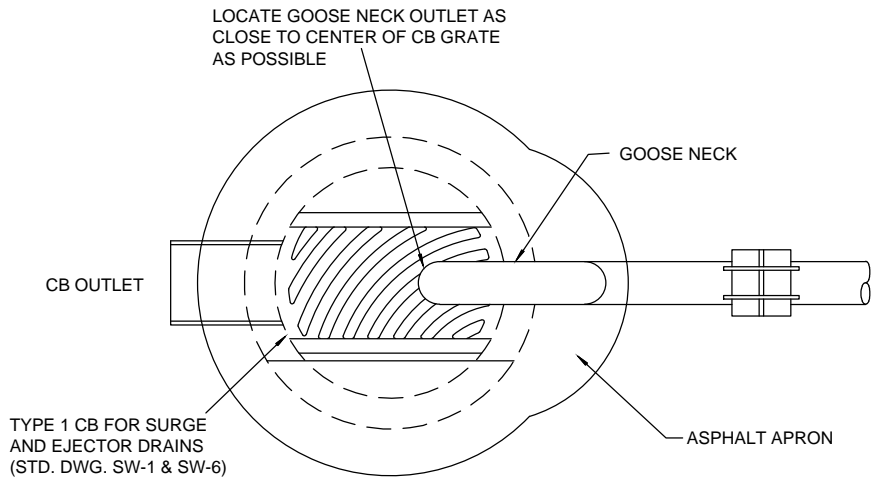
PLAN



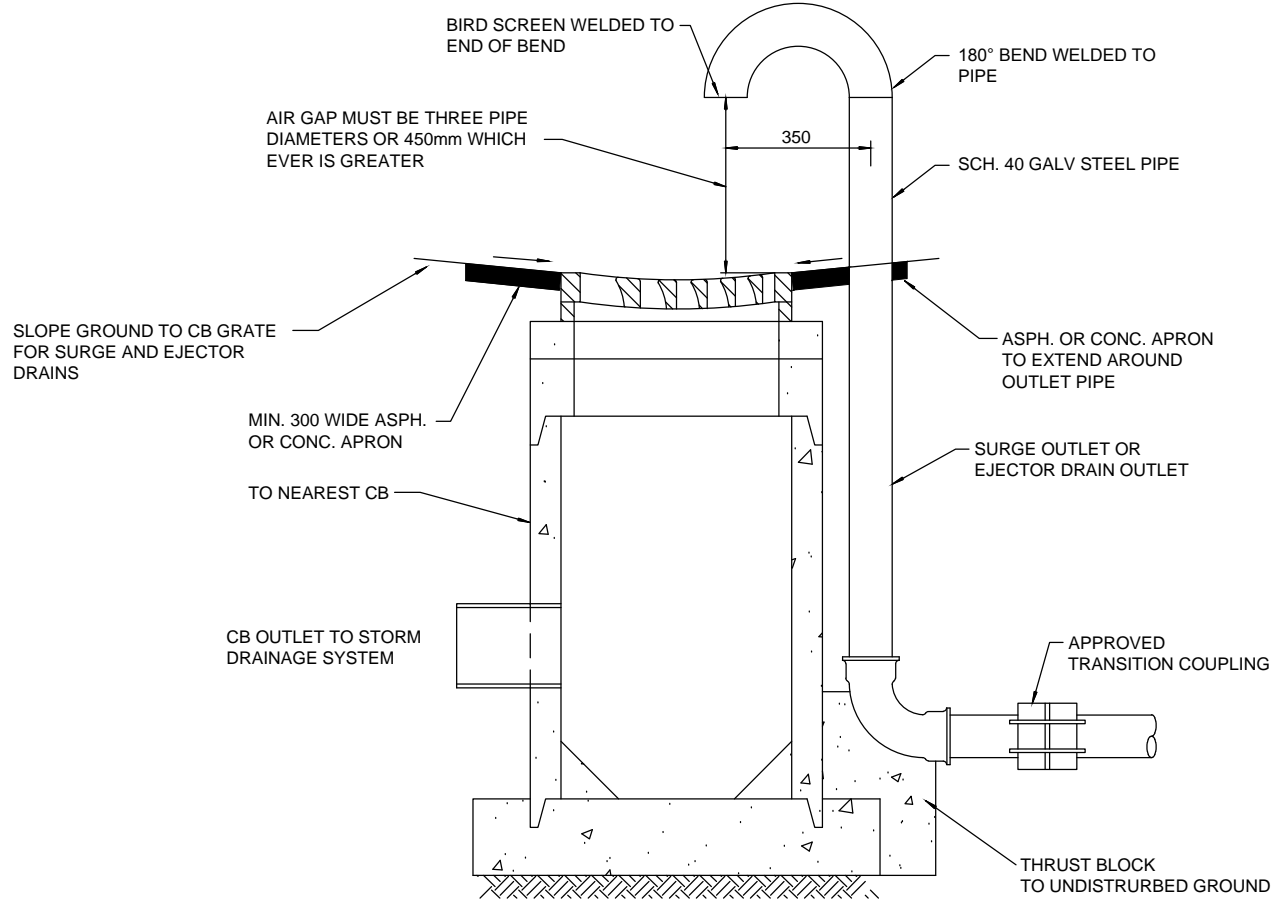
SECTION A - A

NOTES:

1. FINISH COATING TO BE BITUMINOUS DIP.
2. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCT LIST WILL BE ACCEPTED FOR CONSTRUCTION.
3. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.



PLAN VIEW



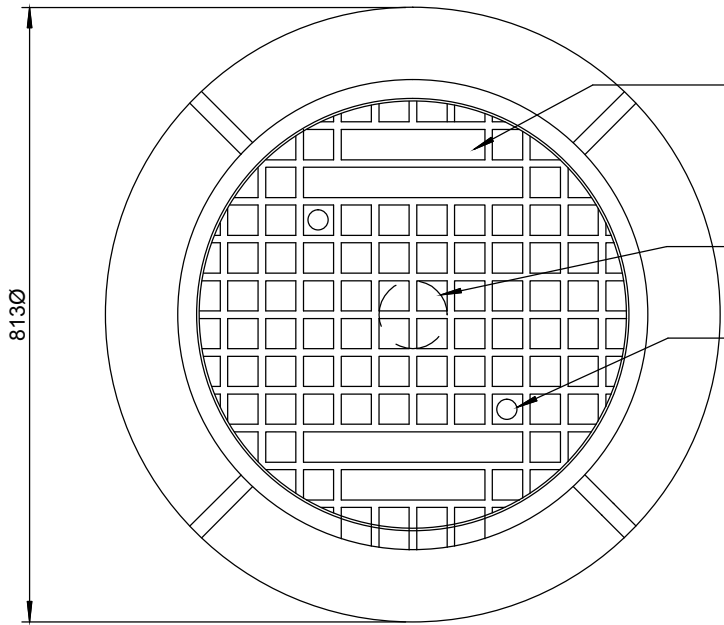
SIDE VIEW

- NOTE:**
- 1.) CONCRETE NO POST BARRIER PROTECTION REQUIRED FOR VENTS WITHIN 4.0m OF ROADWAY
 - 2.) ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
 - 3.) ALL DIMENSION IN MILLIMETERS UNLESS OTHERWISE SHOWN.



**GOOSE NECK FOR
PRESSURE REDUCING
STATION DRAIN**

Scale:	NTS
Created:	MAY 2012
Rev Date:	NOV 2016
Dwg No:	W-18

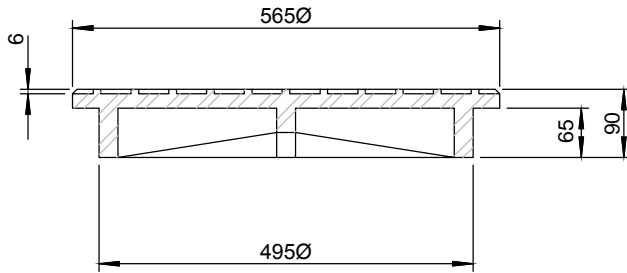
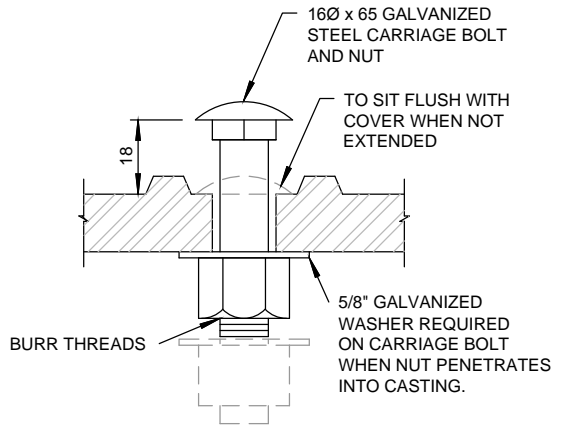


REFERRING TO "CITY OF NANAIMO WATER",
LETTERING SHALL BE 25 FLATTENED FACE
GOTHIC WITH FACE OF LETTERS RAISED TO THE
SAME LEVELS AS THE TOP OF THE RIBS
(IN STATUTORY RIGHTS-OF-WAY INCLUDE THE
WORDING "DO NOT COVER" ON THE MANHOLE LID)

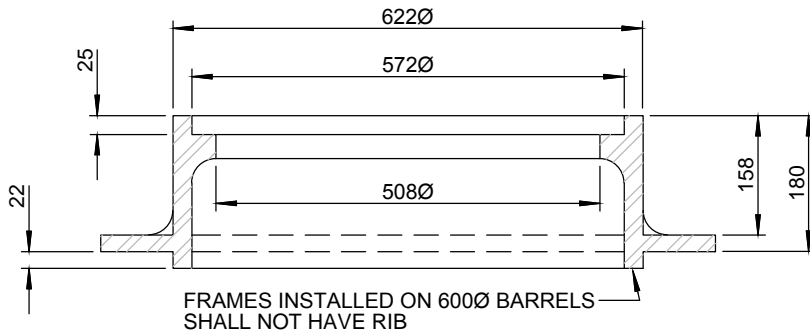
MANUFACTURER'S SYMBOL 90 MAXIMUM DIMENSION
CIRCLE OR SQUARE

2-21Ø HOLES

PLAN



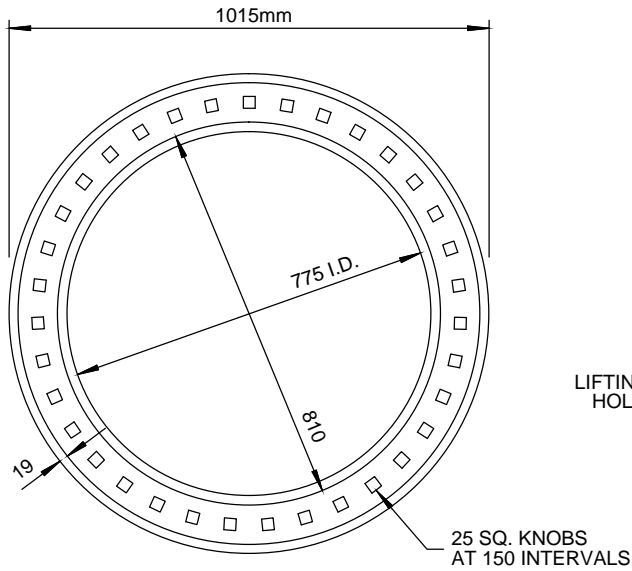
COVER



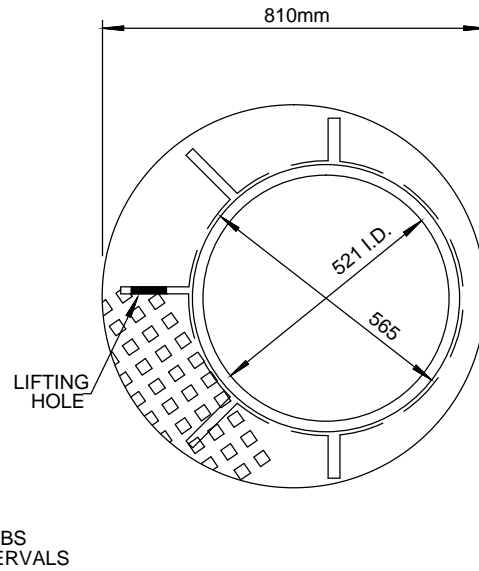
FRAME

NOTES:

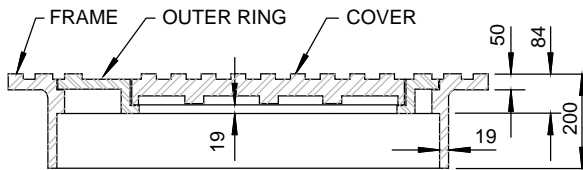
1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 5.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. ALL BEARING SURFACES BETWEEN FRAME, COVER AND RISER RINGS SHALL BE MACHINED FOR NON-ROCKING FIT IN ALL POSITIONS. ALLOW 1.5mm RAISED FACE IN CASTINGS FOR MACHINING.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



PLAN OF FRAME



PLAN OF OUTER RING

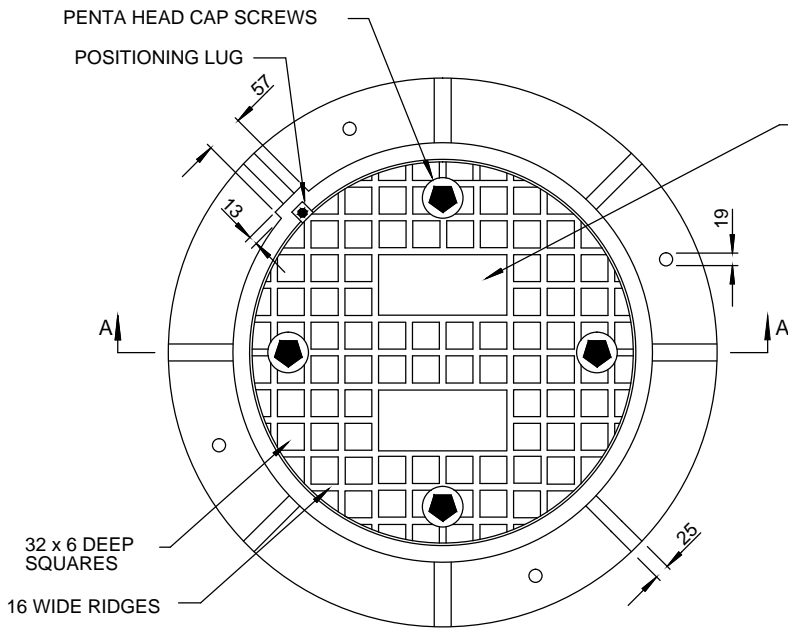


SECTION OF FRAME, RING AND COVER

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 5.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. THIS MANHOLE FRAME AND COVER IS TO BE USED FOR ACCESS TO UNDERGROUND UTILITY CHAMBERS, INCLUDING PUMPS STATIONS AND PRVs, WHERE A LARGER ACCESS DIAMETER IS REQUIRED.
4. FOR COVER LETTERING AND BOLTING REQUIREMENTS REFER TO STD. DWG. W-19 OR W-21.
5. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
6. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

APPLICATION: UNITS ARE FOR USE IN AREAS WHERE FLOODING OR HIGH TIDES ARE POSSIBLE. THIS UNIT SHALL HAVE A POSITIONING LUG IN COVER FOR EASY REPLACEMENT OF CAP SCREWS AND SHALL BE EQUIPPED WITH FOUR ONLY 19Ø HOLES IN FRAME FOR ANCHOR BOLTS AS SHOWN.



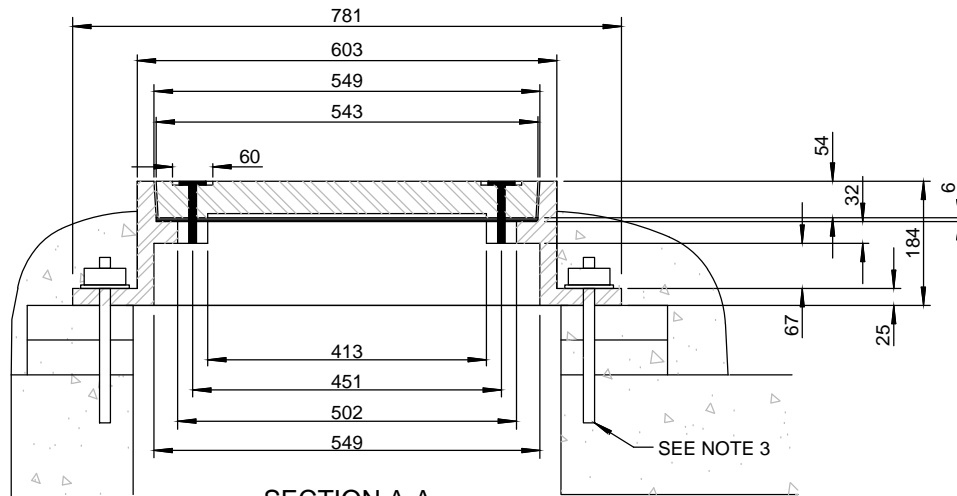
REFERRING TO "CITY OF NANAIMO WATER", LETTERING SHALL BE 25 FLATTENED FACE GOTHIC WITH FACE OF LETTERS RAISED TO THE SAME LEVELS AS THE TOP OF THE RIBS (IN STATUTORY RIGHTS-OF-WAY INCLUDE THE WORDING "DO NOT COVER" ON THE MANHOLE LID)

WEIGHT OF UNIT SHOWN IS
 FRAME = 113.4 kg
 COVER = 56.7 kg

FURNISHED WITH:

- A) FOUR 13x57 PENTA HEAD STAINLESS STEEL CAP SCREWS TO DISCOURAGE VANDALISM.
- B) A 6mm THICK NEOPRENE GASKET FULLY ENCOMPASSING BOLT HOLES.
- C) METAL SURFACES BETWEEN FRAME AND COVER MACHINED TO ENSURE NON ROCKING FIT IN ALL POSITIONS. ALLOW 1.5 RAISED FACE IN CASTING FOR MACHINING.
- D) MANUFACTURE BOLT HOLES TO PERMIT INTERCHANGING OF COVERS BETWEEN FRAME UNITS.

PLAN



NEOPRENE GASKET

DIA. OF COVER ----- 543
 THICKNESS OF COVER -- 54
 DIA. OF FRAME ----- 781
 DEPTH OF FRAME ----- 184

SECTION A-A

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 5.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. FRAME SHALL BE SET IN MORTAR AND BOLTED TO THE MANHOLE SLAB WITH 19Ø STAINLESS STEEL BOLTS, WASHERS AND NUTS.
4. THIS DRAWING TO BE READ IN ACCORDANCE WITH DRAWING W-11A.
5. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
6. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

G:\INFRASTRUCTURE\PLANNING\STANDARDS & PRODUCTS\MOOSE\SECTION 5\11\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 5 DWGS\W-21

6.23.2016



WATERTIGHT MANHOLE
 FRAME AND COVER

Scale: NTS
 Created: MAR 2016
 Rev Date: NOV 2016
 Dwg No: W-21

SECTION 5 - WATER DISTRIBUTION SYSTEM

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT

Water Main Pipe	5.70
Water Main Fittings	5.71
Flange Adaptors and Joint Restraints	5.72
Water Main Gate Valves	5.73
Hydrants Assemblies	5.74
Air Valves and Fittings	5.75
Connection to Existing Main Piping	5.76
Connections to Existing Services	5.76A
Service Connection Pipe	5.77
Corporation Stops and Saddles	5.78
Curb Stops	5.79
Meter Service Boxes, Box Extensions, and Lids	5.80
Touch Read Meters	5.81
Wrap Watermain Joints	5.82
Temporary Overland Service	5.83

SECTION 5 - WATER DISTRIBUTION SYSTEM

MEASUREMENT AND PAYMENT

The Contractor will note that the tendered price for all items specified in this section will include but not be limited to the following: Please refer to Section 4 – Trench Excavation, Bedding and Backfill for further clarification of these items.

- (a) materials
- (b) excavation
- (c) dewatering
- (d) bracing & sheeting
- (e) bedding
- (f) pipe installation
- (g) backfill with imported material and/or controlled density fill
- (h) maintenance

The Contractor will note that payment for surface restoration and asphalt removal is paid in accordance with Section 4.75.

5.70 PIPE Section 5.43

Payment for water main pipe will be made at the unit price per linear metre shown in the Tender Form for the various sizes and class of pipe. Measurement will be made horizontally along the centreline of the installed pipe including fittings. This price shall include materials, excavation, dewatering, bracing & sheeting, bedding, pipe installation, backfill with imported material and/or controlled density fill, and maintenance, test points and testing as specified, and all work incidental thereto except those items for which payment is specified additional to that for piping.

5.71 FITTINGS Section 5.48

Payment for fittings will be made at the unit price per fitting shown in the Tender Form. This price shall include supply of materials, installation of the fitting, thrust blocking, and all work incidental thereto. Payment will be in addition to that of 5.70.

5.72 FLANGE ADAPTORS AND JOINT RESTRAINTS Section 5.47

Where noted on the Drawings or specifically requested by the Engineer, payment for flange adaptors and joint restraints shall be made at the unit prices shown in the Tender Form. This price shall include supply of materials, bolts, installation, and all work incidental thereto. Payment will be in addition to that of 5.70.

5.73 GATE VALVES Section 5.50 Standard Drawing W-16

Payment for valves will be made at the unit prices shown in the Tender Form for gate valves. This price shall include supply of materials, installation of the valve and valve box, valve hood, riser pipe, asphalt apron, valve marker and thrust blocking if required, and all work incidental thereto. Payment will be in addition to that of 5.70.

SECTION 5 - WATER DISTRIBUTION SYSTEM

MEASUREMENT AND PAYMENT

5.74 HYDRANT ASSEMBLIES Section 5.52.1, 5.52.2, 5.52.3 Standard Drawings W-5

Payment for hydrant assemblies will be made at the unit price shown in the Tender Form as follows:

- a) Hydrant Assemblies
This price shall include supply of materials, installation of the hydrant, hydrant lead, valve, valve box riser pipe, tie rods, drain rock, and all work incidental thereto. Payment will be in addition to that of 5.70.

5.75 AIR VALVES AND FITTINGS Section 5.54 Standard Drawing W4

Air valves and fittings will be paid for at the unit price shown in the Tender Form. This price shall include excavation, supply of materials, piping, pipe saddle, vent piping, gate valve, air valve, manhole, manhole frame and cover, adjustment to final grade, asphalt apron and all work incidental thereto. Payment will be in addition to that of 5.70.

5.76 CONNECTION TO EXISTING MAIN PIPING Section 5.49

Payment for connections to existing piping will be made at the unit price per connection shown in the Tender Form. This price shall include supply of couplings, materials, and all work incidental thereto. Payment will be made in addition to that of 5.70.

5.76A CONNECTIONS TO EXISTING SERVICES Section 5.49

Payment for connections to existing services will be made at the unit price per connection shown in the Tender Form regardless of existing service depth. This price shall include supply of materials, and all work incidental thereto.

5.77 SERVICE CONNECTION PIPE Section 5.56

Payment for water service connection pipe will be made at the unit price per linear metre shown in the Tender Form. Measurement will be made horizontally along the centreline of the installed pipe from the centre of the main pipe to the curb stop. This price shall include supply of materials, pipe installation, testing, flushing, chlorination, and all work incidental thereto, except those items for which payment is specified additional to that for water connection pipe.

5.78 CORPORATION STOPS AND SADDLES Section 5.30.2, 5.30.6, 5.56.4 (f)

Payment for corporation stops and saddles will be made at the unit price shown the Tender Form. This price shall include supply of materials, drilling and tapping the main pipe, installation, and all work incidental thereto. Payment will be in addition to that of 5.81.

5.79 CURB STOPS Section 5.56.6 (a)

SECTION 5 - WATER DISTRIBUTION SYSTEM

MEASUREMENT AND PAYMENT

Payment for curb stops will be made at the unit price shown in the Tender Form. This price shall include supply of materials, installation of curb stop, and all work incidental thereto. No additional payments will be made for supply and installation of test points. Payment will be in addition to that of 5.81.

5.80 METER SERVICE BOXES, BOX EXTENSIONS, AND LIDS Section 5.56.6 (b)

Payment for meter service boxes, box extension, and touch read lids will be made at the unit price shown in the Tender Form. This price shall include supply of materials, installation of service boxes and all work incidental thereto. Payment will be in addition to that of 5.81.

5.81 TOUCH READ METERS Section 5.57

Payment for touch read meters will be made at the unit price shown in the Tender Form. This price shall include completion of meter cards, supply of materials (the meter will be supplied by the Corporation), installation of meter, touch read sensor and all work incidental thereto. This pay item includes installing new meters in both existing and new meter boxes. Payment will be made in addition to that of 5.81.

5.82 WRAPPING WATER MAIN JOINTS

Payment for wrapping of water main joints will be made for each joint at the unit rate shown in the Tender Form. This price shall include the supply of materials and installation as per AWWA standards.

5.83 TEMPORARY WATER SERVICES

Payment for temporary water services will be made at the lump sum price shown in the Tender Form. This price shall include supply of materials and installation of pressure caps and overland services, test, disinfect, maintain temporary overland services, valve isolations, removal, and all work incidental thereto to provide water services and protection to the existing watermain.

SECTION 5 - WATER DISTRIBUTION SYSTEM CONTENTS

DESIGN CRITERIA

SECTION NO.

Scope	5.01
Water Demand	5.01A
Table W-1 Hydrant Fire Flows by Land Use Zone	Table W-1
Water Pressure	5.02
Velocity	5.02A
Design Population	5.03
Hydraulic Network	5.04
Water Distribution Piping	5.05
Service Connections	5.06
Hydrants	5.07
Valves	5.08
Thrust Blocks and Joint Restraints	5.09
Watermain Location, Depth and Grade	5.10
Utilities in Private Lands	5.10A
Pressure Reducing Stations	5.11
-Not Used-	5.12
Meter Chambers	5.13
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Flushouts	5.15
Floor Drain Assembly Chamber Design	5.16

(REVISED NOVEMBER 2016)

SPECIFICATIONS

Scope	5.20
Materials Testing	5.21
Watermain Pipe	5.22
Watermain Fittings	5.23
Watermain Valves	5.24
Watermain Valve Boxes	5.25
Watermain Valve Markers	5.26
Hydrants	5.27
Flushouts	5.28
Air Valves and Fittings	5.29
Water Service Connections	5.30
Pressure Reducing Stations	5.31
Flange Adapters and Joint Restraints	5.32
Floor Drain Assemblies	5.33
Meter Chambers	5.34
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(REVISED NOVEMBER 2016)

SECTION 5 - WATER DISTRIBUTION SYSTEM CONTENTS

INSTALLATION

Trench Excavation, Bedding and Backfill	5.40
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SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

5.01 SCOPE

- .1 Waterworks design shall follow accepted engineering principles, the Provincial Health Branch requirements, the Fire Underwriters Survey Guidelines and the following design criteria:

5.01A WATER DEMAND

- .1 The water distribution system shall be designed according to the following minimum demands:

(a) Residential:

Average daily per capita	455 L
Maximum daily per capita	1135 L
Maximum peak per capita	1820 L

(b) Commercial and Industrial:

Commercial and other non-residential water demands are normally included in the per capita design consumptions for the overall Community. Heavy industrial, industry parks, and shopping centers must be accounted for separately in any proposed development which includes such zoning.

(c) Fire:

Watermains servicing fire hydrants shall be sized to provide Fire Flows in accordance with the recommendations of the Fire Underwriters Survey publication 'Water Supply for Public Fire Protection' 1999 edition. Calculations supporting the theoretical fire flow available are to be submitted with the design drawings. **(REVISED NOVEMBER 2016)**

Fire flow requirements for a development with a sprinklered building under the Building Code shall be determined in accordance with the water supply requirements in National Fire Protection Association (NFPA) 13. **(REVISED NOVEMBER 2016)**

All fire hydrants shall be installed on a looped water system unless otherwise approved by the City Engineer. Water distribution systems shall also be designed to ensure that fire flow, as required by the Insurers' Advisory Organization (IAO), is available for the required duration. **(REVISED NOVEMBER 2016)**

The maximum allowable reduction to a calculated fire flow for a sprinkler system, as determined in Part 3 of Appendix H3 - Fire Flow Calculation Sheet shall be fifty percent (50%).

Design for fire flows shall consider present available flow and anticipated ultimate available fire flow from the City of Nanaimo's water system.

New water distribution piping shall be capable of delivering the required fire flows with a minimum of 75l/s during Maximum Day Demand and a residual pressure at all flowing hydrants of 150kPa. The hydrant fire flow for new piping shall be the value in Table W-1 "Hydrant Fire Flows by Land Use Zone" for all properties served by the new piping.

SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

For new developments, a balance of pipe size, water quality and existing fire flows at the main will be considered. If the fire flow requirements, as calculated above, cannot be supplied by the existing water distribution system at time of development, available fire flows shall be reviewed with the City Engineer. The developer will be required to either upgrade portions of the system at their own cost or modify the proposed development to match existing fire flows at the main.

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TABLE W-1: HYDRANT FIRE FLOWS BY LAND USE ZONE

LAND USE ZONE (BYLAW 4500)		Hydrant Flows at main (ℓ/s)
R1 - 3	Single Dwelling Residential	75
R4	Duplex Residential (not sprinklered)	150
R5	Three & Four Unit Residential	110
R6	Townhouse Residential	130
R7	Row House Residential ((s) for larger buildings)	90
R8	Medium Density Residential	240
R9 *	High Density (High Rise) Residential	300
R10	Steep Slope Residential (SFD / (s) for Multi)	75 / 175
R11	Recreational Vehicle Park	120
R12	Mobile Home Park Residential	120
R13	Old City Duplex Residential	180
R14	Old City Low Density (Four plex) Residential	115
R15	Old City Medium Density Residential	140
AR1	Rural Resource	75
AR2	Urban Reserve	75
COR1	Residential Corridor	230
COR2 *	Mixed Use Corridor	300
COR3 *	Community Corridor	300
CC1	Local Service Centre	105
CC2	Neighbourhood Centre	200
CC3 *	City Commercial Centre	300
CC4 *	North Nanaimo Urban Centre	300
CC5	Hospital Urban Centre	240
CC6	Commercial Recreation Centre (s)	----
DT1	Core ((s) for high rise)	230
DT2	Fitzwilliam	300
DT3 *	Wallace	300
DT4	Terminal Avenue	210
DT5	Chapel ((s) for high rise)	240
DT6 *	Port Place ((s) for high rise)	300
DT7	Quennell Square	225
DT8	Old City Mixed Use	140
DT9	Old City Central	150
DT10	Old City Infill Business Commercial	170
DT11	Old City Infill Service Commercial	170
DT12	Gateway	215
PRC1/2/3	Parks, Recreation and Culture One, Two, Three (s)	----
I1	Highway Industrial	225
I2 *	Light Industrial	300
I3 *	High Tech Industrial	300
I4 *	Industrial	300
CS1/2/3	Community Service One, Two, Three (s)	----
W1	Waterfront	75
W2 *	Harbour Waterfront	300
W3	Newcastle Waterfront	285
W4 *	Industrial Waterfront	300
CD1 - CD6	Comprehensive Development (s)	----

Land uses marked * require limitation to 300 ℓ/s

Land uses marked (s), and all high rises require site specific calculations

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SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

5.02 WATER PRESSURE

- .1 Minimum design distribution pressure in all areas at peak hour demand is 275kPa based on design low reservoir level. With the combination of maximum daily demand and the specified fire flow, the minimum residual water pressure at the fire hydrant is 138kPa. Where these minimum design pressures cannot be maintained due to an increase in elevation or distance from the point of connection, a booster pump station and/or emergency storage shall be provided as part of the distribution system. **(REVISED NOVEMBER 2016)**
- .2 The maximum allowable distribution line pressure is 860kPa static, except where individual connections are permitted directly from trunk mains and where special precautions are taken. Otherwise, where distribution pressures will exceed 860kPa static due to a drop in elevation, a pressure reducing station shall be installed as part of the distribution system. Where distribution pressures exceed 550kPa, occupants of existing houses in the area shall be advised to install individual pressure reducing valves.

5.02A VELOCITY

- .1 The maximum desirable velocity at maximum peak hour flow shall not exceed 2.0m/s. **(REVISED NOVEMBER 2016)**
- .2 The maximum desirable velocity during fire flow conditions *plus* the maximum day rate shall not exceed 3.0m/s. **(REVISED NOVEMBER 2016)**

5.03 DESIGN POPULATION

- .1 Design populations used in calculating water demands shall be computed in accordance with the City of Nanaimo's population predictions or with the planned development in the area to be served, whichever is larger. In the absence of detailed design population information, the following minimum design population densities shall be used.

<u>Land Use</u>	<u>Population Density</u>
Single Family	36 persons per hectare
Low density multi-family	48 persons per hectare
High density multi-family	120 persons per hectare
Industrial & Commercial	36 persons per hectare

5.04 HYDRAULIC NETWORK

- .1 Depending on the complexity and extent of the proposed distribution system, the City may require, for new developments, a hydraulic network analysis diagram showing maximum design flows and pressures. If this information is required, it shall be stated at the time of the feasibility review and shall be submitted by the applicant with the detailed design application. The hydraulic network shall be designed to distribute the maximum design flows in accordance with Section 5.02 – Water Pressure and Section 5.02A – Velocity.
- .2 Field testing of design flows and existing network capacity may be required by the City Engineer.

SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

5.05 WATER DISTRIBUTION PIPING

- .1 The general requirements for the distribution piping are as follows:
- (a) Numerous trunk lines and secondary feeders shall be installed throughout the system. Mains must be adequate to deliver consumption and fire flow demands for the area served, and should be spaced not more than 1000m apart and looped. For extensions to the distribution network, all water distribution piping shall be looped. When looping is not feasible, temporary or permanent dead ends shall be approved at the discretion of the City Engineer.
 - (b) Pipes on a grid system in residential areas shall be a minimum of 200mm diameter, except that 150mm diameter may be allowed for short interconnecting streets, or short dead ends not over 100m long. Where dead ends or poor grids are likely to last over two years, greater pipe diameters may be required and shall be evaluated for peak hour and fire flow requirements.
 - (c) Lines furnishing domestic supply only, and not serving hydrants, may be 100mm in diameter. Where a watermain ends in a dead-end or a valve is normally closed, a fire hydrant or flushout shall be provided for flushing purposes. No flushout shall be connected to a sewer.
 - (d) The distribution piping and all the ancillary components of the water system work together to provide the service. The longevity and reliability of this overall system is critical to the sustainability of the service. To ensure longevity of the systems, including all of the components from the pipe and fittings to curb stop, there are two options: **(REVISED NOVEMBER 2016)**
 - (i) Provide a soils corrosivity report prepared by a professional engineer based on field samples covering the entire alignment with spacing no greater than 150m apart, a minimum of 2 samples shall be provided. The report must outline the required protective measures for all buried metallic components from pipe and fittings, to appurtenances. This report is to be prepared based on the methodology outlined in AWWA C105 Appendix A. **(REVISED NOVEMBER 2016)**
 - (ii) Material selection and corrosion protection measures that assume the soils are corrosive (corrosive is defined as a soil exceeding 10 points based on AWWA C105 Appendix A) shall be provided. For all buried metallic components, specific measures may include cathodic protection, petroleum tape application, or non corrosive material choice such as stainless steel. **(REVISED NOVEMBER 2016)**
 - (e) All pipes shall be designed for the maximum pressures and earth loading to which the pipe will be exposed. For PVC pipe, in no case shall the design working pressure or Dimension Ratio be less than DR18 and 1030kPa. In areas where static pressures are greater than 860kPa, the Dimension Ratio shall be DR14.
 - (f) Design criteria for any watermain piping 350mm or greater in diameter requires City Engineer approval. **(REVISED NOVEMBER 2016)**

5.06 SERVICE CONNECTIONS

- .1 Design drawings shall show the arrangement for water service connections. The minimum size of service connection to be specified is 25mm diameter for polyethylene service tubing and 19mm diameter for copper. All components shall be the same size as the service pipe to which they are connected, except for 25mm diameter polyethylene service tubing, the

SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

corporation stop, curb stop and water meter shall be 19mm diameter. All lots shall be provided with their own water service. **(REVISED NOVEMBER 2016)**

- .2 The maximum length of water service connections from the watermain to the property line shall be 30m unless otherwise approved by the City Engineer.
- .3 For all services greater than 50mm diameter, a gate valve c/w valve box shall be provided at the watermain tee. There shall also be a gate valve at the property line. **(REVISED NOVEMBER 2016)**
- .4 Water service connection locations shall be coordinated with gas, cable, hydro and telephone utilities to avoid any conflict with their installations at the property lines of lots.
- .5 Each lot shall be serviced by one only service connection for domestic water.
- .6 Domestic and fire services shall be separate. The domestic water meter shall be downstream from the separation point. Combined lines may be considered with the approval of the City Engineer. **(REVISED NOVEMBER 2016)**
- .7 The City of Nanaimo Water Meter Sizing Calculation Sheet in Appendix H4 shall be used for sizing of water meters. **(REVISED NOVEMBER 2016)**

5.07 HYDRANTS

- .1 The minimum hydrant connection size shall be 150mm.
The minimum depth of cover shall be 1.20m.
Drain outlets shall be provided.
- .2 Hydrants shall be constructed in accordance with Standard Drawing No. W-5 - Hydrant Connection. The bottom flange of the hydrant shall be located between 150mm to 200mm above final grade. **(REVISED NOVEMBER 2016)**
- .3 Hydrant spacing shall be the most conservative of the following:
 - (a) B.C. Building Code requirements for sprinkler systems and the Fire Underwriters Survey Guide.
 - (b) The maximum lineal distance between hydrants shall be 140m in single family and duplex land use zones where sprinklers are not required.
 - (c) The maximum spacing of hydrants in commercial, industrial, institutional and multi-family residential zones shall be 90m. **(REVISED NOVEMBER 2016)**
- .4 Two gate valves shall be provided at a hydrant assembly:
 - (a) A gate valve, flanged to a flanged tee on the hydrant lead. Hydrants shall not be flanged to the main or gate valve.
 - (b) A gate valve flanged to the flanged tee at the main. The location of this valve shall be on the upstream side of a dead-end main. **(REVISED NOVEMBER 2016)**
- .5 Hydrant access crossings shall be provided for hydrant installations adjacent to open ditches as per Standard Drawing No. W-7.
- .6 Hydrants shall be located as per the offsets shown on the Standard Drawings in Section 9 - Streets, Traffic Signs and Markings, and where possible at property corners. Hydrants shall

SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

be located 2.0m (minimum) from the edge of present and future vehicular traveled areas; a minimum of 3.0m from lamp standards, hydro poles, or other obstructions; and shall not be constructed closer than 1.0m from front property line. **(REVISED NOVEMBER 2016)**

- .7 The maximum design flow per hydrant shall be 100l/s. Where greater flows are required, additional hydrants shall be provided within a distance approved by the Fire Department.
- .8 Preferably, hydrants shall be located on low points in the pipe system in conjunction with hydrant spacing for fire control.

5.08 VALVES

- .1 In general, valves shall be located as follows: **(REVISED NOVEMBER 2016)**
 - (a) In intersections either in a cluster at the pipe intersection or at projected property lines to avoid conflicts with curbs, gutters and sidewalks. Normally, 3 valves will be required at an "X" intersection of mains, and 2 valves at a "T" intersection of mains. **(REVISED NOVEMBER 2016)**
 - (b) Distance between valves shall not be more than 150m. **(REVISED NOVEMBER 2016)**
- .2 Unless otherwise permitted, valves shall be the same size and class as the pipe in which they are installed. Resilient seat gate valves shall be used up to and including 300mm diameter. Valves may be rubber seated butterfly valves if approved by the City Engineer. **(REVISED NOVEMBER 2016)**
- .3 Thrust blocking or other restraints shall be provided on valves.
- .4 Use of butterfly valves requires approval by the City Engineer. Butterfly valves shall not be direct buried. Chambers shall be provided for all butterfly valves.

5.09 THRUST BLOCKS AND JOINT RESTRAINTS **(REVISED NOVEMBER 2016)**

- .1 Provide concrete thrust/reaction blocks or restraints on all tees, bends (>5 degrees), valves, caps and fittings. For pipes equal to or less than 300mm nominal diameter, refer to Standard Drawing No. W-8 for the minimum thrust/reaction block dimensions. Thrust/reaction and restraint calculations shall be completed by the Design Engineer and details shall be shown on the design drawings in the following cases: **(REVISED NOVEMBER 2016)**
 - (a) For sizes larger than 300mm diameter.
 - (b) Where pressures exceed 1034kPa.
 - (c) Where allowable soil bearing is less than 96kPa.
 - (d) Where vertical thrust/reaction blocking is required. **(REVISED NOVEMBER 2016)**
 - (e) Where joint restraints are used.
- .2 Thrust calculations for joint restraints shall be done in accordance with the manufacturer's specifications. The type of joint restraint and length of pipe to be restrained shall be clearly indicated on the design drawings. All tie rods and joint restraints shall be protected with an approved petrolatum protection coating meeting AWWA Standards. **(REVISED NOVEMBER 2016)**

SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

- .3 Tie rods and joint restraints shall be provided, as a minimum for the following locations:
(REVISED NOVEMBER 2016)
- (a) Hydrants
 - (b) Blow-offs
 - (c) Temporary caps
 - (d) Fittings or pipes larger than 300mm
 - (e) Carrier pipe in casings
 - (f) Connections to valves outside PRVs and other chambers
 - (g) Any other location required by the Design Engineer or City Engineer.
- (REVISED NOVEMBER 2016)**

5.10 WATERMAIN LOCATION, DEPTH AND GRADE

- .1 The minimum depth of cover shall be 1.20m unless otherwise permitted by the City Engineer. Minimum cover over watermain pipe crossings under ditches shall be 0.5m.
(REVISED NOVEMBER 2016)
- .2 Unless otherwise approved by the Engineer, tolerances for pipe alignment and grade shall be:
- | | |
|-----------|-------|
| Alignment | ±50mm |
| Grade | ±25mm |
- (REVISED NOVEMBER 2016)**
- .3 Watermains shall be located not less than 3.0m clear distance horizontally and 0.45m clear distance vertically from all sewer lines, unless otherwise permitted by the City Engineer and the Provincial Health Department. Normal watermain offsets are shown in the standard drawings for roadways. **(REVISED NOVEMBER 2016)**
- .4 If pipe alignment is not feasible as a means of establishing required separations due to conflict with existing services, crossings shall be arranged such that the crossover occurs on nominal pipe length centers and all joints within 3m of the crossing shall be secured with concrete encasement (as per Standard Drawing No. T-5), petrolatum tape, shrink wrap or approved equivalent in accordance with the Ministry of Health permit requirements.
- .5 Watermains shall be designed with a rising grade (minimum 0.1%) wherever possible, to minimize high points in the main. Where a high point is unavoidable, an air release valve shall be installed in accordance with Section 5.14. **(REVISED NOVEMBER 2016)**
- .6 For trench dam design, refer to Section 4.18 - Trench Dams. **(REVISED NOVEMBER 2016)**

5.10A UTILITES IN PRIVATE LANDS

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

- .1 The design of utilities shall avoid crossing private lands as much as possible.
- .2 Utilities following property boundaries across private lands shall generally be offset a minimum 2.0m from the property boundary. **(REVISED NOVEMBER 2016)**
- .3 Appurtenances such as valves, etc., shall not be located on property boundaries.

SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

- .4 Utilities shall not cross private parcels in such a manner that they render the property unusable. Special consideration must be given to ensure the location of the utility crossing minimizes the limitations on the future use of the property.
- .5 For minimum widths of statutory right-of-way and working widths refer to Appendix D.
- .6 For a sample statutory right-of-way condition sheet, refer to Appendix C, Standard Drawing No. RW-2.
- .7 For an Easement Release and Inspection Form Following the Construction of the Utility, refer to Appendix C.

5.11 PRESSURE REDUCING STATIONS

- .1 A pressure reducing station shall be required where the static pressure in the proposed distribution system will exceed 860kPa. In general, the pressure reducing station shall be located at the elevation where the static pressure initially exceeds 860kPa.
- .2 General requirements for pressure reducing stations shall be as follows:
 - (a) A valved bypass shall be provided.
 - (b) A downstream surge relief valve shall be provided to release pressure in the event of a failure of the pressure reducing valve(s). The surge relief valve may be incorporated into the pressure reducing station or may be located at some other suitable location within the distribution system. The surge relief valve shall drain to an adequate storm drainage facility, as approved by the City Engineer. Upstream surge relief valves shall be provided as required.
 - (c) Pressure reducing valves shall be sized to provide adequate pressure control through all ranges of design flows. If necessary, two or more pressure reducing valves of varying sizes shall be provided in the one station. Pressure reducing valves shall be equipped with valve stem position indicators.
 - (d) Each pressure reducing and surge relief valve shall be provided with isolating valves and shall be installed so that individual components may be easily removed for repair or replacement.
 - (e) The pressure reducing station equipment shall be enclosed in a watertight reinforced concrete vault designed to CS600 loading with a standard manhole cover or other opening large enough to remove the largest single piece of equipment in the station. Station floors shall be sloped at 2.0% towards a floor drain assembly in accordance with Section 5.16 – Floor Drain Assembly Chamber Design.
 - (f) Pressure gauges complete with snubbers and isolating valves shall be installed to register both upstream and downstream pressure. Gauges shall be mounted so they may be read from the manhole access lid without entering the chamber.
 - (g) Adequate strainers shall be supplied on the water used for controlling the regulating valves and on the main intake.
 - (h) Pressure reducing stations shall be located outside of the travelled portion of any street and must be vented to promote air circulation.
 - (i) Inside walls, floors and ceilings of stations to be painted with a white water soluble cement base paint manufactured for the purpose of sealing concrete.
 - (j) Exterior walls below grade shall be black damp-proofed (tar coated) to prevent leakage.

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5.12 -NOT USED- (*REVISED NOVEMBER 2016*)

5.13 METER CHAMBERS

- .1 All water services must be metered and all meters must be contained in an approved chamber or meter box normally located in:
 - (a) the road right-of-way at the property line of the lot served for services 50mm in diameter or less.
 - (b) a statutory right-of-way on private property for services larger than 50mm in diameter. Chamber shall be as close to property line as possible.
 - (c) Alternate locations may be considered with the approval of City Engineer. (*REVISED NOVEMBER 2016*)
- .2 Larger strata developments are to have a single meter at the property line with a privately owned watermain. A City owned watermain with individually metered units may be considered for small strata developments with the approval of the City Engineer. (*REVISED NOVEMBER 2016*)
- .3 For small services, 50mm in diameter or less, manufactured meter service boxes in accordance with Section 5.30 – Water Service Connections, clause 5.30.4 are adequate. For larger services, the meter shall be contained in a chamber designed to accommodate the meter arrangement including associated piping, isolation valves, and bypasses and shall be in accordance with Section 5.34.
- .4 The meter shall be installed in a horizontal plane.
 - (a) Avoid locating meter boxes, Hydro, telephone, cable vaults and junction boxes in sidewalks.
 - (b) If sidewalk location unavoidable, situate box to maximize unobstructed walking corridor.
- .5 Isolation valves shall be provided on both sides of meters 50mm diameter and larger. Valves for fire line services shall be in accordance with NFPA regulations.
- .6 The following requirements are to be applied in the design of meter chambers.
 - (a) The chamber shall be sized so that the meter and associated piping are accessible for meter reading, servicing and inspecting. A minimum of 600mm clearance shall be provided between the walls and the meter including associated piping. At least 600mm of head space shall be provided from the highest point on the meter including associated piping to the bottom of the vault cover, and a minimum of 450mm of clearance provided above the chamber floor. Overall inside height of the chamber shall not be less than 1.8m.
 - (b) The meter shall be protected against freezing, mechanical damage and tampering.
 - (c) Bypass and isolation valves may be located in approved valve boxes outside the chamber to minimize chamber size.
 - (d) The chamber shall be constructed of reinforced concrete designed to withstand CS600 loading with a standard manhole cover or other approved opening large enough to remove the largest single piece of equipment.
 - (e) The meter chamber shall be designed as a vault in accordance with Standard Drawing No. W-11. The meter chamber can be designed as a manhole with a precast circular manhole barrel only when the meter and associated piping can be

SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

installed allowing for the required clearances to the chamber wall and approved by the City Engineer.

- (f) Chambers, either vaults or manholes, that contain valves, flushouts, meters or other appurtenances shall allow for adequate room for maintenance including headroom and side room. Access openings must be suitable for removing valves and equipment.
 - (g) The chamber shall not be located or constructed such that it is an obstacle or hazard to the customer or public safety.
 - (h) The lid of the chamber shall be flush with the surrounding grade and the ground surface shall be graded to direct drainage away from the chamber.
 - (i) An adequate floor drain assembly shall be provided and designed in accordance with Section 5.16 – Floor Drain Assembly Chamber Design.
 - (j) A safe permanent access ladder shall be provided which meets the WorkSafe BC requirements for fixed ladders.
 - (k) Exterior walls below grade shall be watertight.
 - (l) Interior surfaces of chambers for meters 50mm diameter and larger to be painted with white, waterproof masonry wall coating that penetrates and seals pores in masonry surface.
- .7 A valved bypass shall be provided for meters 38mm diameter and larger to avoid service shutdown during meter maintenance. For combination fire service and domestic meters, the bypass shall be sized for the largest flow rate. In the absence of the flow rate, the bypass shall be the same diameter as the service. **(REVISED NOVEMBER 2016)**
- .8 The City has a Cross Connection Control program that requires all new developments to install Premise Isolation. The Premise Isolation will be privately owned. Refer to CSA B64.10, BC Building Code and appropriate City of Nanaimo bylaws. **(REVISED NOVEMBER 2016)**

5.14 AIR VALVES

- .1 Combination air valves shall be provided at all high points of the watermain or where a closed valve creates a high point (i.e. closed valve to isolate pressure zone) and located off the travelled portion of the road. **(REVISED NOVEMBER 2016)**
- .2 Combination air valves shall be a minimum of 25mm diameter. **(REVISED NOVEMBER 2016)**
- .3 For mains 300mm diameter and larger, the air valve type, (combination, release or vacuum) and size shall be determined by the Design Engineer and the details shall be on the design drawings. **(REVISED NOVEMBER 2016)**
- .4 Combination air valve chambers shall be drained to ensure that the chamber does not flood. **(REVISED NOVEMBER 2016)**
- .5 Combination air valves must be vented to an appropriate above-grade location to eliminate potential cross-connection in a flooded or contaminated chamber. **(REVISED NOVEMBER 2016)**

5.15 FLUSHOUTS

- .1 Flushouts shall be provided at the ends of all dead end mains whether permanent or temporary. **(REVISED NOVEMBER 2016)**

SECTION 5 - WATER DISTRIBUTION SYSTEM DESIGN CRITERIA

- .2 On all mains greater than 350mm diameter, flushouts shall be installed at the lowest points in the watermain network. **(REVISED NOVEMBER 2016)**
- .3 Above-ground flushouts shall only be installed in areas where high ground water tables prohibit the installation of below-grade flushouts.
- .4 Above-ground flushouts shall be located as per the offsets shown for hydrants on the Standard Drawings in Section 9 - Streets, Traffic Signs and Markings. Flushouts shall be located 2.0m (minimum) from the edge of present and future vehicular traveled areas and shall not be constructed closer than 0.6m from front property line.
- .5 Where practical, and with the approval of the City Engineer, hydrants may also be used in a secondary role as a flushout. **(REVISED NOVEMBER 2016)**

5.16 FLOOR DRAIN ASSEMBLY CHAMBER DESIGN

- .1 Chambers are to be designed to include a drain to a storm sewer or ditch.
- .2 Floor drain assemblies shall be designed in accordance with Section 7 – Stormwater Management System with adequate capacity to keep the chamber dry at all times.
- .3 Floor drain systems shall provide no risk of flooding of the chamber.
- .4 Sumps shall be provided at the low point of the meter chamber for all floor drain assemblies.
- .5 The design of floor drain assemblies shall consider the following options in the order presented:
 - (a) Sump drain to an adequately sized and normally dry rock pit or gravity flow to daylight. **(REVISED NOVEMBER 2016)**
 - (b) Where ground water tables permit, a perimeter drain around the base of the meter chamber with gravity connection to storm sewer mains. The City Engineer may approve raising the perimeter drain to the bottom of the water pipe to provide sufficient grade for a gravity connection.
 - (c) Alternatives require approval by City Engineer. **(REVISED NOVEMBER 2016)**

SECTION 5 - WATER DISTRIBUTION SYSTEM SPECIFICATIONS

5.20 SCOPE

- .1 This specification refers to pressure pipe and appurtenant fittings for water distribution piping and water service connections. Only those products approved by the City Engineer and listed in the City of Nanaimo Approved Products List will be accepted for installation.

5.21 MATERIALS TESTING

- .1 If, in the opinion of the Engineer, testing is required, the Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates inadequacies, additional testing may be required by the Engineer.
- .2 The Contractor as directed by the Engineer shall supply specimens or samples for testing.

5.22 WATERMAIN PIPE

- .1 The sizes and types of pipe to be used shall be shown on the drawings. **(REVISED NOVEMBER 2016)**

- .2 Ductile Iron Pipe:

- (a) Standard Specifications:

Ductile iron pipe shall conform to AWWA C151 and AWWA C150.

- (b) Supplementary Data:

Unless otherwise specified on the construction drawings, all pipe shall have a minimum pipe class as follows:

<u>Pipe Size</u>	<u>Class</u>
75 - 300	350
350 - 500	250

An affidavit of compliance with the standard specifications and supplementary data shall be submitted from the supplier.

All pipe supplied shall bear the underwriter's label.

Joints shall be a mechanical type conforming to AWWA C111 or shall be rubber gasket, bell and spigot, Tyton joint, or as approved.

- (c) Protective Coatings:

Ductile iron pipe shall be cement-lined conforming to AWWA C104.

A cathodic protection system shall be provided where warranted by soil conditions.

Polyethylene Encasement to ANSI/AWWA C1054/A21.5 and ASTM A674 where warranted by soil conditions. **(REVISED NOVEMBER 2016)**

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.3 STEEL PIPE

(a) Standard Specifications:

Steel pipe, fittings and specials, shall conform to the following standard specifications:

ASTM A36 – Standard Specification for Carbon Structural Steel

AWWA C200 - Standard for Steel Water Pipe 150mm and larger ASTM A36

AWWA C205 – Standard for Cement – Mortar Protective Lining and Coating for Steel Water Pipe 4 in. (100mm) and Larger-Shop Applied (**REVISED NOVEMBER 2016**)

AWWA C207 – Standard for Steel Pipe Flanges for Waterworks Service Sizes 4 in. through 144 in. (100mm through 3,600mm) (**REVISED NOVEMBER 2016**)

AWWA C208 - Standard for dimensions for Steel Water Pipe Fittings

AWWA C606 – Standard for Grooved and Shouldered Joints (**REVISED NOVEMBER 2016**)

(b) Supplementary Data:

An affidavit of compliance with the standard specifications and supplementary data shall be submitted from the supplier.

Hydrostatic mill test reports for each length of pipe shall be submitted from the supplier.

Wall thicknesses shall be determined in accordance with AWWA Manual M11 Steel Pipe Design and Installation and the following criteria:

Minimum wall thickness shall be 6.3mm.

Pipe shall be electric resistance welded or fusion welded, with spiral or longitudinal seams. Pipe shall have 1 or 2 longitudinal seams with no girth seam, or one longitudinal seam with girth seams 1.5m - 2.75m apart, or spiral seams. If girth seams are used, adjacent seams within a pipe length shall be arranged so that their longitudinal seams do not form a continuous line. Seams shall be staggered on alternate seams on each side of top centreline so that each seam is approximately 100mm from the top centreline.

Pipes, fittings and special sections shall be complete with all materials necessary to complete a watertight joint by methods other than welding equipment, or coal-tar enamel.

The joints shall be plain ends for mechanical couplings.

(c) Protective Coatings:

The interior surface of the steel pipe fittings and specials shall be cleaned and lined with an epoxy paint, in conformance with AWWA C210 or C213 and ANSI/NSF61. Epoxy paint shall be applied such that there is a minimum thickness of 406 micro-meters. The maximum coating thickness shall be of 508 micro-meters built up after two or more coats, or as recommended by the individual product supplier. Note, for 100% solids, chemically cured epoxies, the maximum thickness may be increased

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above 508 micro-meters. This coating shall also apply to the interior of steel reservoirs.

The exterior surface of buried steel pipe, fittings and specials shall be coated in accordance with AWWA C203 and AWWA C209 and finished with a coal tar epoxy or coal tar enamel and a Kraft paper outer wrap, or; the exterior surface of the pipe shall be coated with extruded polyethylene. Heat shrink sleeves shall be provided for all welded pipe joints. Special sections and fittings shall be coated with a primer and wrapped with polyethylene tape to provide a corrosion resistant coating equal to the extruded pipe coating.

The exterior protective coating for fittings and pipe inside underground chambers shall consist of 2 coats of coal tar epoxy, as per AWWA C210 and painted with marine enamel in colours approved by the City Engineer.

.4 POLYVINYL CHLORIDE (PVC) PIPE

(a) Standard Specifications:

100 to 300mm dia to AWWA C900 and CSA B137.3
350 to 1200mm dia to AWWA C905 and CSA B137.3 **(REVISED NOVEMBER 2016)**

(b) Supplementary Data:

Unless otherwise stated in the drawings, all pipe shall be as stated in Section 5.05(e) – Water Distribution Piping. An affidavit of compliance with the standard specifications and supplementary data shall be submitted from the supplier. All pipe shall be ULC Listed and be CIP size equivalent. Joints for PVC pipe shall have a mechanical seal formed by a preformed rubber gasket in a bell or coupling. It is mandatory that the push-on integrally thickened bell and spigot type conform to ASTM D3139 Clause 6.2 with single elastomeric gasket to ASTM F477. Couplings shall be of a class and strength equivalent to the pipe. **(REVISED NOVEMBER 2016)**

All PVC water pipe shall be blue in colour.

.5 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

(a) Standard Specifications:

HDPE pipe to be used for watermains only, at the discretion and approval of the City Engineer. (HDPE pipe shall not be used for services.)

Projects in which HDPE pipe is proposed shall be accompanied by complete HDPE specifications for approval.

HDPE pressure pipe shall conform to AWWA C906 (Standard for Polyethylene Pressure Pipe & Fittings, 100mm through 1575mm for Water Distribution and Transmission). **(REVISED NOVEMBER 2016)**

Iron pipe size equivalent outside diameter.

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(b) Fittings:

Fabricated HDPE mitered fittings shall be AWWA C906 suitable for pressure rating as specified in Contract Documents.

Molded HDPE fittings shall be ASTM 3261 suitable for pressure rating specified and fusion to main pipe with dimensions as specified in Contract Documents.

(c) Supplementary Data:

An affidavit of compliance with the standard specifications and Section 5.05 – Water Distribution Piping shall be submitted from the supplier. All pipe shall bear the underwriters label.

Joints for HDPE pipe shall be heat butt fusion to ASTM D2657 and in accordance with manufacturer's recommendations.

Fittings to be compatible with approved mechanical joint fittings and valves without special adapters. See City of Nanaimo Approved Product List.

Couplings shall be of a pressure rating and strength equivalent to the pipe.

5.23 WATERMAIN FITTINGS

- .1 All fittings for ductile iron and PVC pipe shall be:
 - (a) Cast iron fittings manufactured to AWWA C110 designed for a minimum working pressure of 1035kPa, and cement mortar lined to AWWA C104.
 - (b) Asphalt coated ductile iron compact fittings manufactured to AWWA C153, designed for a minimum working pressure of 2415kPa, and cement mortar lined to AWWA C104.
 - (c) Asphalt coated ductile iron fittings manufactured to AWWA C110, designed for a minimum working pressure of 2415kPa and cement mortar lined to AWWA C104.
- .2 The design pressure rating of all fittings shall meet or exceed the pressure class of the pipes they are connected to.
- .3 Mechanical seal joints on fittings to pipe shall be formed by a bell equipped with closed tie-rod lugs and preformed rubber gasket suitable for the pipe to which the joint is made.
- .4 Flanged joints on fittings shall be flat faced conforming in dimension and drilling to ANSI B16.1.
- .5 Ends shall be flanged or belled to suit pipe ends.
- .6 Thrust blocks or joint restraints shall be provided as shown in the drawings.
- .7 In areas where the static pressure exceeds 1380kPa, fittings shall be as approved by the City Engineer.

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5.24 WATERMAIN VALVES

- .1 Refer to Section 5.08 - Valves.
- .2 Unless otherwise permitted, only valves conforming to the following specifications shall be installed in the distribution system:

(a) Gate Valves:

Gate valves shall be in accordance with AWWA C500 and the following supplementary data:

- (i) Gate valves shall have a cast iron or ductile iron body, bronze mounted.
- (ii) Gate valves shall be solid wedge gate or double-disc parallel seat, with a non-rising stem.
- (iii) Valve ends shall be provided to fit the pipe.
- (iv) The position of the valve in line shall be vertical.
- (v) Stem seals shall be o-ring.
- (vi) Valves shall open to the left (counter-clockwise).
- (vii) Extension pieces complete with valve riser guide shall be used where valve bury is deeper than 1.2m below finished grade. Valve nut extension rods shall be a minimum 600mm below finished grade. Refer to Standard Drawing No. W-16.
- (viii) Gears will be required on valves 400mm in diameter and larger. Gear cases shall be totally enclosed.
- (ix) Valves shall be flanged to fittings.
- (x) Bypasses will be provided on valves 510mm in diameter and larger. Ends shall be bell or mechanical at junctions with pipe. Joints shall be formed with a mechanical seal which is the equivalent of that used in jointing the pipe.
- (xi) Valves shall have a 50mm square operating nut.

(b) Rubber Seated Butterfly Valves:

Butterfly valves for water service shall be short body flanged type or wafer body type conforming to AWWA C504, suitable for a maximum non-shock shut-off pressure of 1035kPa. Valve construction shall be as follows, or as approved.

- (i) Body material shall be ductile or cast iron.
- (ii) Disc material shall be ductile or cast iron.
- (iii) Valve seats shall be of new natural or synthetic rubber.
- (iv) Valve shaft material shall be 18-8 stainless steel type 304 or 316. Shaft shall be pinned to the disc. Shaft sizing shall be in accordance with AWWA C504.
- (v) Body shall be complete with shaft bushing and locating lugs for flange bolts.
- (vi) Valve operators shall be worm gear type totally enclosed and waterproofed and equipped with adjustable stops. All valves shall be equipped with a standard 50mm square operating nut and the operator shall be located on the side of the valve with the spindle in a vertical position.
- (vii) Valve shall be designed for the extreme maximum flows for both opening and closing.
- (viii) Valve ends shall suit the pipe.
- (ix) Valves shall open to the left (counter-clockwise).
- (x) Shaft seals shall be of the o-ring type.

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- (xi) A reinforced concrete chamber (designed to meet CS600 loading requirements) shall be provided for each butterfly valve as shown on the drawings. Valves shall not be direct buried.

- (c) Resilient Wedge Gate Valves:
 - (i) Valves shall conform to the latest revision of AWWA Standard C509 Resilient Seated Gate valves and shall be UL listed and FM approved
 - (ii) Valves shall be non-rising stem, open left (counter-clockwise) and have a 50mm square operating nut.
 - (iii) The wedge shall be ductile or cast iron completely encapsulated with urethane rubber.
 - (iv) The rubber shall be permanently bonded to the wedge and meet ASTM D429 for test for rubber metal bond.
 - (v) Stems for non-rising assemblies shall be cast bronze with integral collars or stainless steel in full compliance with AWWA. The non-rising stem stuffing box shall be the O-ring seal type with two rings located above the thrust collar; the two rings shall be replaceable with the valve fully open and subjected to full rated working pressure.
 - (vi) There shall be two low torque thrust washers located above and below the stem collar. The stem nut shall be made of solid bronze. There shall be a smooth unobstructed waterway free of all pockets, cavities and depressions in the seat area.
 - (vii) The body and bonnet shall be coated with fusion bonded epoxy both interior and exterior. Each valve shall have the manufacturer's name, pressure rating and the year of manufacture cast on the body. Prior to shipment, each valve shall be tested by hydrostatic pressure equal to twice the specified working pressure.
 - (viii) Every valve will have a positive stop to prevent distortion to the wedge.
 - (ix) Valve operating nuts greater than 1.2m below finished grade require a valve nut extension rod complete with valve riser guide. Valve nut extension rods shall be a minimum 600mm below finished grade. Refer to Standard Drawing No. W-16.

5.25 WATERMAIN VALVE BOXES

- .1 Where valves are located in the roadway, valve boxes shall be MR Type of cast iron and telescoping so that surface loads are not transmitted to the valve body or pipeline. A minimum of 450mm of adjustment shall be available on all valve boxes. PVC C900/C905 valve hoods shall be used on all 200mm and larger underground valve installations.
- .2 Valve box lids shall have a non-rocking fit and extend 75mm into the valve box from the lid seat as shown on Standard Drawing W-16.
- .3 Minimum requirements for valve box risers in traveled and untraveled areas shall be DR18 pipe.

5.26 WATERMAIN VALVE MARKERS

- .1 Valve markers are required to indicate the locations of the valves.

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- .2 Where valve boxes are located outside the paved portion of a road, these markers shall be constructed of 50mm steel pipe painted blue and set in a concrete base. They shall extend one 1.0m above the ground surface. The markers shall be located on site at a location determined by the Engineer opposite the valve and the distance to the valve is to be painted in black figures on a flattened upper portion of the marker.
- .3 Where valve boxes are located in the paved portion of the road, valve tag markers shall be installed in a nearby reasonable location. **(REVISED NOVEMBER 2016)**

5.27 HYDRANTS

- .1 Installed fire hydrants shall meet the following specifications:
 - (a) Hydrants shall be compression type complying fully with AWWA standard C502.
 - (b) Hydrants shall be clockwise opening and have a standard pentagonal operating nut with a circle diameter of 44.5mm.
 - (c) The inlet connection shall be 150mm diameter and made of the same material as the mainline piping. The hydrant shall have a bell and preformed rubber gasket suitable for connection to the pipe being used.
 - (d) Hydrants shall have two nominal 65mm diameter hose outlets without independent cut-off. The 65mm diameter hose outlets shall conform to the B.C. Fire Hose Thread Standards, nominal 65mm I.P., 75mm O.D. male, 8 threads per 25mm, tapering from 75.72mm minimum O.D. to 82.63mm maximum O.D.

There shall also be one nominal 100mm diameter (120mm O.D.) pumper outlet. The 100mm diameter pumper outlet shall conform to the B.C. Fire Hose Thread Standards, nominal 100mm I.P., 117.5 mm O.D. male, 6 threads per 25mm.

- (e) Hydrant bodies shall be painted with red rust paint above the bury line. Hydrant ports and bonnets shall be painted with a base coat of aluminum rust paint and a top coat of bright yellow rust paint.
 - (f) Drain outlets shall be provided.
 - (g) Depth of bury shall be as required to provide the specified minimum cover on the connecting pipe and the required position of the hydrant flange relative to the finished ground elevation.
 - (h) For new installations, fire hydrant extensions will require approval from the Engineer.
 - (i) Subject to the discretion of the City Engineer, hydrant flow test on all new hydrants, in accordance with NFPA 291, may be required. **(REVISED NOVEMBER 2016)**
- .2 Tie Rods and Nuts:
 - (a) Tie rods to be continuous threaded, quenched and tempered alloyed steel to ASTM A354, Grade BC. To be zinc plated to ASTM B766. Tie rod sizes to be minimum 19mm diameter or greater as shown on the Contract Drawings.
 - (b) Nuts and internally threaded couplings to be heavy hex finish to ASTM A563. Washers to be flat hardened steel to ASTM F436. All to be zinc plated to ASTM B633 or cadmium plated to ASTM B766.
 - (c) All tie rods, nuts and washers shall be coated with approved petrolatum corrosion protection. **(REVISED NOVEMBER 2016)**

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.3 Hydrant Access Crossings:

- (a) Culvert headwalls shall be as specified in Section 7.35B - Culvert Headwalls.
- (b) Culverts shall be as specified in Section 7.35A - Culverts.
- (c) Gravel surfacing shall be as specified in Section 9.30 – Road Base Gravel Course.

5.28 FLUSHOUT

- .1 All piping and fittings shall be 65mm diameter iron pipe thread, galvanized steel pipe.
- .2 Shutoff valve shall be a 65mm cast iron gate valve meeting all specifications for main line valves.
- .3 Vertical section of flushout above ground shall be supported by a 100 x 100mm cedar post, painted white with a red top and extending 1.20m above finished grade.
- .4 Above ground flushout bodies shall be painted with red rust paint above the grade line. Flushout caps shall be painted with a base coat of aluminum rust paint and a top coat of bright yellow rust paint.
- .5 The valve box shall be a MR type of cast iron and telescoping so that surface loads are not transmitted to the valve body or piping. A minimum of 300mm of adjustment shall be available. The 65mm diameter fire hose connection and cap shall meet standard B.C. Fire Hose Thread Requirements.
- .6 Below grade flushouts shall conform to Standard Drawing No. W-2B.

5.29 AIR VALVES AND FITTINGS

- .1 All air valves shall be combination air release valves. Bushings, reducers and unions to be used in the valve connection shall be brass manufactured to ASA specification A 40.2 using ASTM B62 bronze. Nipples shall be standard brass and threaded at both ends.
- .2 Service valves for use in air valve assemblies shall have screw ends and shall be brass or bronze. All packing shall have each ring cut to fit, with staggered joints. Continuous (spiraled) packing shall not be used. Gate valves 100mm or less in diameter shall be wedge disc type with non-rising stem, hand wheel and stuffing box glands, as specified for 1375kPa water (860kPa steam) service.
- .3 All air valves shall have two 12mm ball-type drain valves as shown on Standard Drawing No. W-4.
- .4 Air valves for watermains greater than 300mm diameter shall be as approved by the City Engineer.

5.30 WATER SERVICE CONNECTIONS

.1 Pipe:

- (a) Tubing for underground services 75mm diameter and smaller shall be:
 - (i) type K annealed copper conforming to ASTM B88M or

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(ii) class 200 Polyethylene tubing to AWWA C901.

- (b) Service supply lines larger than 75mm diameter shall be as specified for the watermain pipe.
- (c) Tracer wire shall be installed with polyethylene tubing and shall be blue in colour and be 14 gauge wire.

(REVISED NOVEMBER 2016)

.2 Corporation Stops:

- (a) Corporation stops shall be bronze conforming to ASTM B62 and conform to AWWA C800 with AWWA standard threaded inlet and compression copper outlet.
- (b) Shutoff head shall be solid tee head type.
- (c) All pipe for installation inside the meter chamber up to 75mm diameter shall be copper or brass. Only compression, or threaded joints shall be permitted.
- (d) All pipe for installation inside the meter chamber over 75mm diameter shall be ductile iron or epoxy coated steel pipe. **(REVISED NOVEMBER 2016)**

.3 Curb Stops:

- (a) Curb stops shall be bronze conforming to ASTM B62 and be supplied with compression and female iron pipe thread outlets. **(REVISED NOVEMBER 2016)**
- (b) Shutoff head shall be solid tee head type.

.4 Meter Service Boxes, Box Extensions and Lids:

- (a) Service boxes for water services 25mm diameter and smaller shall be 300mm x 500mm concrete meter boxes complete with cast iron traffic cover marked "water". Where approved by the City Engineer, plastic meter service boxes may be used in existing landscape areas. They are not to be used in existing, proposed or future driveway locations. **(REVISED NOVEMBER 2016)**
- (b) Service boxes for 38 - 50mm diameter water services shall be 425 x 750mm concrete boxes complete with steel traffic covers marked "Water". **(REVISED NOVEMBER 2016)**
- (c) Service boxes or chambers for water services larger than 50mm diameter shall be specified as per Section 5.34 - Meter Chambers.
- (d) Meter box lid shall be suitable for mounting of a "touch pit read" register unit. **(REVISED NOVEMBER 2016)**

.5 Couplings and Joints:

- (a) Couplings for jointing copper shall be compression type. Sweated joints shall not be permitted. **(REVISED NOVEMBER 2016)**

.6 Pipe Saddles:

- (a) Tapping threads to be tapered to AWWA C800. **(REVISED NOVEMBER 2016)**
- (b) Saddles shall be compliant with NSF61. **(REVISED NOVEMBER 2016)**
- (c) Gasket shall be styrene butadiene rubber (SBR) to ASTM D2000 specifications or other approved gasket material. The Design Engineer shall specify the appropriate gasket material. **(REVISED NOVEMBER 2016)**
- (d) Saddles for ductile iron pipe: **(REVISED NOVEMBER 2016)**

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- (i) Saddles for 19mm to 50mm services to have a ductile iron body to ASTM A536. **(REVISED NOVEMBER 2016)**
 - (ii) Anti-corrosive coating to AWWA C219, AWWA C210, or AWWA C213. **(REVISED NOVEMBER 2016)**
 - (iii) Two high strength low alloy steel straps to AWWA C111, or Type 304 stainless steel U-bolt straps, with minimum width per strap of 50mm. **(REVISED NOVEMBER 2016)**
- (e) Saddles for PVC pipe to AWWA C900/905:
- (i) To provide full support around circumference of pipe, saddles with lugs or U-bolt straps that may gouge or deform the pipe are not allowed. **(REVISED NOVEMBER 2016)**
 - (ii) Saddles for 19mm to 50mm services shall be:
 - 1. Bronze body to ASTM B62 and two stainless steel straps to ANSI T304 with minimum width per strap of 50mm.
 - 2. All-stainless steel broadband saddle to ANSI T304; for services less than 37mm diameter, saddle shell must be a minimum of 125mm wide and have double bolts; for services 37mm to 50mm, saddle shell must be a minimum of 190mm wide and have double bolts. Saddles to come with donut style gasket and stainless steel shell must be minimum 18 gauge thickness. All stainless steel to be fully passivated to ASTM A240. **(REVISED NOVEMBER 2016)**
- (f) Pipe saddles shall be installed on all PVC pipe service junctions. **(REVISED NOVEMBER 2016)**

.7 Meters:

- (a) Meters shall be compatible with "Sensus Touch Read" automated meter reading and billing system. Meters installed in meter chambers shall be equipped with a Touch Read Pit Lid register mounted on a bracket as per Standard Drawing No. W-12.
- (b) All meters shall be equipped with encoder type remote – registers and provide at least 8 digit visual and encoded registration. **(REVISED NOVEMBER 2016)**
- (c) For single family servicing, meters shall be 19mm minimum positive displacement meters.
- (d) For duplex servicing, meters shall be 25mm positive displacement meters.
- (e) All meters larger than 25mm require approval from the City Engineer.
- (f) All meters 100mm and larger shall be equipped with a test port or test tee and be plumbed with the appropriate isolation valves and bypass to facilitate in-situ testing of the meter. **(REVISED NOVEMBER 2016)**
- (g) All meters used for a fire line service shall be UL listed and FM approved. **(REVISED NOVEMBER 2016)**
- (h) All meters shall read in cubic meters.

.8 Gate Valves Domestic Service:

- (a) Gate valves shall be as per Section 5.24 – Watermain Valves, clause 5.24.2(a) and (c). **(REVISED NOVEMBER 2016)**

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.9 Gate Valves Fire Line Service:

- (a) All valves shall be in conformance with NFPA regulations.
- (b) Solid wedge and parallel seat valves shall be in conformance with Section 5.24 – Watermain Valves, clause 5.24.2(a) and shall be UL listed and FM approved.
- (c) Resilient wedge valves shall be in conformance with Section 5.24 – Watermain Valves, clause 5.24.2(c). **(REVISED NOVEMBER 2016)**
- (d) Valves installed in chambers shall be OS&Y type or shall be supplied with indicator posts.

5.31 PRESSURE REDUCING STATIONS

.1 Valves:

- (a) Pressure reducing valves shall be hydraulically operated, pilot controlled diaphragm-type globe or angle valves.
- (b) The main valve shall have a resilient disc and a removable seat ring.
- (c) The main valve trim shall be stainless steel.
- (d) The valve stem on 50mm and larger valves shall be guided at both ends.
- (e) All repairs shall be possible without removing valve from main line.
- (f) All wetted surfaces on main valve shall be coated with an epoxy protective coating.
- (g) All PR valves shall have a position indicator.
- (h) All PR valves shall have Y strainers or basket strainers installed upstream of the main valve and upstream of the control pilot.
- (i) All PR valves shall have speed controls between pilot and main valve body.
- (j) All PR valves used for fire line service shall be UL Listed and FM approved **(REVISED NOVEMBER 2016)**

.2 Gauges, pressure snubbers, isolation valves for gauges:

- (a) All pressure gauges shall have a 90mm minimum dial size with a 6.5mm NPT bottom connection.
- (b) All gauges shall be installed with a piston-type snubber.
- (c) All gauges shall be installed with a brass gate valve for isolation.
- (d) All gauges in pressure reducing chambers shall be mounted so they can be read from the manhole lid access.
- (e) Small diameter piping up to 60mm shall be copper, or brass.
- (f) Piping over 75mm shall be flanged steel pipe.

5.32 FLANGE ADAPTERS AND JOINT RESTRAINTS

- .1 Flange adapters and joint restraints shall conform to AWWA C219 and be UL listed and/or FM approved. Flanged joints shall conform to AWWA C110 and ANSI B16.1, Class 125.
- .2 Flange adapters and joint restraints shall be ductile iron conforming to ASTM A536 with an anti-corrosion coating on the interior and exterior rings conforming to AWWA C219.
- .3 Bolts and nuts shall be high strength low alloy steel conforming to AWWA C111, or stainless steel conforming to ASTM F593 and F594. Rolled threads, fit and dimensions shall be to AWWA C111. **(REVISED NOVEMBER 2016)**

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- .4 Tie rods shall be continuous threaded, quenched and alloyed steel conforming to ASTM A354, Grade BC and hot-dipped galvanized in accordance with ASTM A153. Coarse threads shall have Class 2A tolerance before galvanizing.
- .5 Compression gaskets shall conform to AWWA C219.
- .6 Flange adapters and joint restraints shall be designed to be suitable for the type pipe for which they are installed.

5.33 FLOOR DRAIN ASSEMBLIES

- .1 Pipe and fittings for gravity connections shall conform to Section 7.22A – Piping, Fittings and Services, clause 7.22A.5.
- .2 Pipe and fittings for 19mm to 100mm diameter sump pump connections shall conform to Section 5.30 – Water Service Connections.
- .3 Services junctions at the storm main, where permitted, shall conform to Section 7.23 – Service Junctions.
- .4 Sump drainer assemblies, if required, shall consist of a backflow preventer, ejector pump, foot valve, strainer and float assembly connected to the watermain with a saddle and corporation stop conforming to Section 5.30 – Water Service Connections.
- .5 Sumps shall have minimum dimensions of 300 x 300 x 150mm.
- .6 Perimeter drains shall consist of:
 - (a) 100mm diameter PVC certified to CSA B182.1. Includes drain rock and geotextile wrap. **(REVISED NOVEMBER 2016)**

5.34 METER CHAMBERS

- .1 Precast Manhole Sections
 - (a) Unless otherwise approved, all manholes sections shall be precast reinforced concrete conforming to ASTM C478.
 - (b) All precast sections shall be complete with ladder rungs.
 - (c) O-ring rubber gaskets shall conform to ASTM C443.
- .2 Precast Manhole Bases
 - (a) Precast manhole bases shall be reinforced concrete in accordance with ASTM C76 Class III or better.
- .3 Manhole Tops
 - (a) Manhole tops shall be flat slab, precast concrete. Tops shall be reinforced to meet CS600 loading requirements. Precast tops shall conform to ASTM C478 with approved offset opening for frame and cover.

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.4 Manhole Covers and Frames

- (a) Covers and frames shall be cast iron and certified to meet CS600 loading requirements with the bearing faces of the cover to be frame machined for a non – rocking fit.
- (b) Patterns, dimensions and weights shall be in accordance with the Standard Drawings. Covers shall have "CITY OF NANAIMO WATER" permanently embossed on the covers.
- (c) Standard manhole frame and cover shall conform to Standard Drawing No. W-19 –Manhole Frame and Cover.
- (d) Utility chamber manhole frame and cover shall conform to Standard Drawing No. W-20 – Utility Chamber, Manhole, Frame, Ring and Cover.
- (e) A watertight manhole frame and cover, if required, shall conform to Standard Drawing No. W-21 - Watertight Manhole Frame and Cover.
- (f) Covers located in statutory rights-of-way shall be permanently embossed with the additional wording "DO NOT COVER".
- (g) Refer to Section 5.58 for frame and cover installation.

.5 Manhole Steps

- (a) Steps shall conform to ASTM C478 for manhole steps and ladders and shall be a 19mm diameter aluminum alloy conforming to CSA S157.
- (b) All steps shall be complete with approved polyethylene anchor insulating sleeves and installed in 25mm to 26mm diameter precast or drilled holes in a manhole section.
- (c) Refer to Section 5.58 for manhole steps installation.

.6 Concrete

- (a) The compressive field strength of concrete for manhole bases shall be not less than 20MPa at 28 days.
- (b) All concrete work shall conform to Section 11 – Reinforced and Plain Concrete Works.

.7 Precast Concrete Grade Ring

- (a) A precast concrete grade ring conforming to ASTM C478 shall be used.

.8 Touch Read Meter Bracket

- (a) Touch read meter bracket shall conform to Standard Drawing No. W-12.

5.35 -NOT USED-

(REVISED NOVEMBER 2016)

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

5.40 TRENCH EXCAVATION, BEDDING AND BACKFILL

- .1 Refer to Section 4 - Trench Excavation, Bedding and Backfill for installation requirements.

5.41 PIPE ALIGNMENT (**REVISED NOVEMBER 2016**)

- .1 The pipe shall be laid on line and grade in accordance with the construction drawings. Each pipe shall be checked for line and grade as it is installed. Methods to maintain pipe alignment and grade shall be approved by the Engineer. (**REVISED NOVEMBER 2016**)
- .2 The following methods shall be used when a main is to be installed on a curve to maintain a constant offset within the road allowance:
 - (a) Deflection of Joints as per Section 5.46 – Deflection.

For: Ductile Iron Pipe, as per AWWA C600/82
For: PVC Pipe, as specified in the Uni-Bell Handbook of PVC Pipe
 - (b) Manufactured 5° PVC bends.

Arcing or bending of the pipe is not permitted.
- .3 Refer to Section 5.10 – Watermain Location, Depth and Grade for design criteria.

5.42 PIPE CUTTING

- .1 Pipe cutting shall be done in the manner recommended by the pipe manufacturer employing tools designed for this purpose.
- .2 Cutting of asbestos cement pipe shall conform to WorkSafe BC requirements.

5.43 PIPE INSTALLATION

- .1 Pipe shall be installed in strict accordance with the manufacturer's recommended practice.
- .2 Pipe shall be checked before being lowered into the trench to ensure that no foreign material, manufacturer's defects, or cracks exist that might prevent the proper jointing of the pipe or its operation.
- .3 The open end of the pipe in the trench shall be suitably covered to prevent entrance of trench water and other material during periods when pipe is not being installed.
- .4 Precautions shall be taken to ensure that displacement of the pipe in the trench does not occur through soil displacement or floatation due to the presence of trench water. Pipe that has been displaced shall be removed from the trench and re-laid.

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

5.44 JOINTS AT RIGID STRUCTURES

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

5.45 HORIZONTAL AND VERTICAL CURVES

- .1 Pipe on horizontal and vertical curves shall be laid true to the curve of the radius shown on the drawings and in accordance with field lines and grades for each curve supplied by the Engineer. Variations in vertical curves and grades within the allowable joint deflection may be allowed where approved by the Engineer.

5.46 DEFLECTION

- .1 Unless otherwise specified, the amount of pipe deflection at joints and couplings shall not exceed the limit as specified by the manufacturer. **(REVISED NOVEMBER 2016)**

5.47 PIPE RESTRAINT

- .1 All fittings shall be restrained either by concrete thrust blocks as per Standard Drawing W-8 or joint restraints as indicated on the construction drawings, as directed by the Engineer.
- .2 Concrete thrust blocking shall be placed between undisturbed ground and the fitting to be anchored. The area of thrust block bearing on pipe and on ground shall be as shown on the Standard Drawings or as otherwise indicated on the construction drawings. Concrete shall be so placed that pipe and fitting joints are accessible for repair. Bolts on flanged fittings shall not be encased in concrete. A polyethylene plastic barrier shall be provided between all fittings and concrete for thrust blocking. Concrete specifications shall be as per Section 11 – Reinforced and Plain Concrete Works.
- .3 Joint restraints shall be installed in accordance with the manufacturer's specifications. The length of pipe to be restrained shall be as shown on the construction drawings.

5.48 FITTINGS

- .1 Fittings shall be installed at the locations shown on the drawings or as directed by the Engineer. Fittings shall be flanged to valves unless otherwise directed by the Engineer.

5.49 CONNECTIONS TO EXISTING PIPING

- .1 All connections to existing piping services, and appurtenances shall be made by the City of Nanaimo forces unless otherwise authorized by the City Engineer.
- .2 All connections to existing piping and services shall utilize a manufactured rubber gasket bell and spigot joint or dresser coupling designed for types of pipes to be connected.

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

5.50 VALVES

- .1 All valves shall be set plumb directly on the centreline of the pipe and installed in accordance with Standard Drawing No. W-16.
- .2 Valve boxes in unpaved areas shall have a 1.0m wide, 50mm thick asphalt apron around the valve box. **(REVISED NOVEMBER 2016)**
- .3 Abandoned Valve Box Removal
 - (a) Cut asphalt around valve box. Remove valve extension, mud and debris from valve riser box prior to filling with pea gravel. Valve box shall not be pulled prior to filling with pea gravel.
 - (b) Existing riser pipe must be minimum 300mm below final grade. Riser pipe shall be cut down where necessary so that the existing riser pipe is a minimum 300mm below finished grade.
 - (c) The minimum 300mm grade difference shall be backfilled with 25mm crush gravel and compacted to City of Nanaimo standards. Temporary cold mix asphalt to be used where necessary.

5.51 VALVES MARKERS

- .1 All valve markers shall be installed in accordance with Standard Drawing No. W-9.

5.52 HYDRANTS

- .1 All hydrants shall be installed in accordance with Standard Drawing No. W-5.
- .2 Hydrant Installation:
 - (a) Hydrants shall be installed at the locations shown on the construction drawings and as specified in Section 5.07 - Hydrants, clause 5.07.6.
 - (b) Hydrant installation shall be in general accordance with AWWA manual M17.
 - (c) Tie rods shall be in accordance with Section 5.27 – Hydrants, clause 5.27.2.
 - (d) Hydrants shall be set plumb and such that the pumper nozzle faces, and is at right angles to, the road centreline unless otherwise directed by the Engineer.
 - (e) Hydrants shall be set with the ground flange 150 - 200mm above finished ground or sidewalk surface unless otherwise directed by the Engineer. **(REVISED NOVEMBER 2016)**
 - (f) Care shall be taken in installing the connection pipe from the main to the hydrant to ensure that the hydrant is set at the specified level.
 - (g) Drain rock shall be placed as shown on the Standard Drawing for a hydrant connection to a level above the hydrant drain openings. The drain rock shall be covered with filter cloth before backfilling to prevent plugging up of the drainage pit.
 - (h) After installation, hydrants shall be covered with firmly secured black plastic bag until they are put into service. **(REVISED NOVEMBER 2016)**

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

.3 Hydrant Thrust Blocking:

- (a) Hydrant thrust blocking shall only be used in situations where installation of tie rods is not acceptable as determined by the Engineer.
- (b) Care shall be taken to ensure that concrete for thrust blocking does not interfere with the operation of flange bolts and nuts or prevent proper operation of hydrant drains.
- (c) Thrust block bearing areas shall be as shown on the drawings.

.4 Hydrant Access Crossings:

- (a) Culverted hydrant access crossings shall be constructed as shown on the Standard Drawings.
- (b) Culvert headwalls shall be constructed in accordance with Section 7.66 - Culvert Headwalls.
- (c) Culverts shall be constructed in accordance with Section 7.65 - Culvert Installation.
- (d) Gravel surfacing shall be constructed in accordance with Section 9.54 - Placing and Compacting Sub-base and Base Course.

5.53 FLUSHOUT INSTALLATION

- .1 All flushouts shall be installed in accordance with Standard Drawing No's. W-2A and W-2B and located as directed by the Engineer.
- .2 Flushouts shall be set plumb.
- .3 Care shall be taken in installing the piping, drain hole and drain rock to ensure that the flushout will drain when the 65mm diameter gate valve is closed.

5.54 AIR VALVE INSTALLATION

- 1. All air valves shall be installed in accordance with Standard Drawing No. W-4 and located as directed by the Engineer.

5.55 FLOOR DRAIN ASSEMBLY INSTALLATION

- .1 Drain assemblies shall be installed as shown on the construction drawings.
- .2 Drain assembly connections to storm sewer mains, where approved by the City Engineer, shall be in accordance with Section 7.61 – Service Connection Installation.

5.56 WATER SERVICE CONNECTION INSTALLATION

- .1 All water service connections up to and including 50mm diameter shall be installed in accordance with Standard Drawing No. W-1. **(REVISED NOVEMBER 2016)**
- .2 All water service connections greater than 50mm diameter shall be installed as shown on the drawings.
- .3 Location of Water Service Connections:
 - (a) Install service connections to the locations and depths as shown on the drawings or as specified by the Engineer.

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

- (b) Water service connections to each individual property shall have their own independent connection to the watermain.

.4 Water Service Connection Installation:

- (a) Trenches shall be excavated where possible so that the pipe can be installed at right angles to, and in a direct line from, the main pipe to the terminus of the service.
- (b) The trench shall be excavated to provide a minimum cover of 1.2m over the service connection pipe and raised for the curb stop as shown on Standard Drawing No. W-1 for services up to and including 50mm diameter in size. **(REVISED NOVEMBER 2016)**
- (c) In rock, the trench is to be extended 3.0m into the property to facilitate future extension of the service connection. **(REVISED NOVEMBER 2016)**
- (d) The trench bottom shall be graded to form a continuous support along the service pipe. All rocks or projections within 150mm of the service tubing shall be removed. **(REVISED NOVEMBER 2016)**
- (e) When the service box is to be installed in a driveway, a 150mm wide x 150mm deep concrete apron shall be installed around the concrete service box in addition to the 25mm minus crush gravel base structure. **(REVISED NOVEMBER 2016)**
- (f) For services up to and including 50mm diameter, the pipe shall be connected to the corporation stop and a gooseneck formed as shown on the drawings. **(REVISED NOVEMBER 2016)**
- (g) When polyethylene tubing is installed and squeezers are used, the area squeezed shall be marked with yellow electrical tape so that the location is not squeezed again to prevent damage. **(REVISED NOVEMBER 2016)**
- (h) Copper pipe shall be cut with square ends and reamed with the proper tools. Care shall be taken to prevent the pipe from kinking or buckling on short radius bends. Joints shall be made using the specified couplings. Sweated joints shall not be made. **(REVISED NOVEMBER 2016)**
- (i) Pipe installed in an augered hole shall be protected with a cap or plug to prevent the entrance of foreign material into the pipe.
- (j) A gate valve c/w valve box shall be provided at the main on all services over 50mm diameter. **(REVISED NOVEMBER 2016)**
- (k) After installation, water service connection locations shall be marked with a 50 x 100mm pressure treated wood marker stake painted blue and located at the terminus of the water service next to the service box. The stake shall extend from a point approximately 600mm above ground to 600mm below ground except in locations where the extension of the stake above ground surface would be hazardous, in which case the stake shall be placed at a location satisfactory to the Engineer.

.5 Tapping Main Pipe:

- (a) Taps shall be made in the main pipe by workmen using tools in good repair with the proper adapters for the size of main being tapped. Pipe shall be tapped while under internal water pressure unless otherwise approved by the Engineer. The minimum distance of a tapping shall be 1.0m from a pipe end or joint, or 2.0m from a pipe end equipped with a flushout and a minimum of 1.0m from an adjacent tapping unless a greater distance is specified by the pipe manufacturer.
- (b) Service connections tapped to 100mm diameter main pipes and AC and PVC main pipes (all diameter) shall have approved pipe saddles for hot tapping. **(REVISED NOVEMBER 2016)**

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

- .6 Curb Stop and Service Box Installation:
- (a) The curb stop shall be installed as shown on the drawings or in the locations directed by the Engineer and shall be provided with a plastic plug to prevent the entrance of foreign material.
 - (b) The service box shall be installed when the service is installed from the main to the property line. The service box shall be installed plumb with the center of the top of the lid 25mm above finished grade in untraveled areas and 0 - 6mm below finished grade in travelled areas as shown on Standard Drawing No. W-1. **(REVISED NOVEMBER 2016)**

5.57 WATER METERS

- .1 Water meters shall be installed by City of Nanaimo forces unless otherwise authorized by the City Engineer.
- .2 Install meters in accordance with the manufacturer's recommendations.

5.58 METER CHAMBERS

- .1 All meter chambers shall be constructed in accordance with Standard Drawing No. W-11 unless otherwise shown on the construction drawings.
- .2 The floor drain system shall be installed in accordance with Section 5.55 – Floor Drain Assembly Installation.
- .3 Install valves, fittings and meters according to the manufacturer's recommendations at the locations shown on the construction drawings.
- .4 Support valves, fittings and meters by means of steel pipe supports.
- .5 Install touch read meter bracket between the first and second ladder rung in accordance with Standard Drawing No. W-12.
- .6 If required by the Engineer, meter chambers shall be tested for leakage after the installation of equipment by filling the chamber to the underside of the roof slab with water. The test duration shall be a minimum of three hours. No leakage will be allowed.
- .7 Precast Manhole Sections
 - (a) Precast manhole barrel sections shall be placed plumb.
 - (b) Joints between the top riser and the cover slab shall be made watertight with cement mortar. Prior to placing sections, the mating faces shall be thoroughly soaked with water and a layer of cement mortar shall be spread on the lower face. After sections are placed, excess mortar which has been squeezed out shall be removed and the joint made flush inside and out.
 - (c) Joints between precast manhole barrels must utilize O-ring gaskets and shall conform to the manufacturer's specifications. The inside surface of the precast barrel at the O-ring joints shall be filled with cement grout to a smooth finish.
 - (d) Damaged O-ring manhole joints require removal and replacement of damaged manhole section. Mortar patching of damaged area if approved by the Engineer, shall require the removal of the O-ring gasket and installation as per Section 5.58.7(b).

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

- (e) Refer to Section 5.34 for precast manhole section specifications.

.8 Manhole Concrete Bases

- (a) All water shall be removed from the excavation prior to placing base concrete. The base shall be constructed such that the first section of a precast section can be set plumb with uniform bearing throughout its full circumference.
- (b) If material in the bottom of the trench is unsuitable for support, the bottom shall be over excavated to firm base as determined by the Engineer and backfilled to the required grade with thoroughly compacted base gravel as specified for trench bottom stabilization under the applicable item included in Section 4 - Trench Excavation Backfill and Bedding.
- (c) Where overexcavation and backfill with base gravel is not practical, special structural support shall be provided as specified for trench bottom stabilization under the applicable item included in Section 4 - Trench Excavation, Backfill and Bedding.
- (d) Concrete manhole bases shall be constructed as shown on the drawings.
- (e) Refer to Section 5.34 for precast manhole bases section specifications.

.9 Precast Manhole Bases

- (a) Installation of precast manhole bases shall conform to 5.58.8.
- (b) Precast manhole bases shall be placed on 150mm thick base of 40mm drain rock.
- (c) Use of precast concrete bases requires approval by the Engineer.

.10 Concrete

- (a) Concrete work shall be as specified under the Section 11 - Reinforced and Plain Concrete Works.

.11 Frames and Covers

- (a) Frames shall be set on precast concrete grade rings to bring the cast iron manhole frame up to grade as shown on the Standard Drawings. Contractor to install a minimum of two (2) 62.5mm thick concrete grade rings to a maximum of four (4) 62.5mm thick grade rings. The concrete grade rings shall be laid in common bond with raked mortar joints and shall be mortared inside and outside of the manhole.
 - (i) Fine grade elevation adjustments of frames shall be done with a minimum of 3, steel only, shims equally spaced.
- (b) Manhole covers shall be installed:
 - (i) for unpaved areas, covers shall have a 1.5m x 1.5m, 50mm thick asphalt apron. Covers shall be set flush with the asphalt surround.
 - (ii) for paved areas, covers shall be flush with finished pavement grade with a maximum allowed variance of 6mm lower than the finished pavement grade. Covers shall not protrude above the finished pavement.
- (c) Steel manhole riser rings shall be used in easements only.
- (d) Refer to Section 5.34 for manhole covers and frames specifications.

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

.12 Manhole Steps

- (a) Manhole steps shall be installed in manhole sections by the manufacturer unless circumstance dictates otherwise, in which case approval must be received from the Engineer.
- (b) The distance from the top of the chamber manhole, to the first manhole step shall conform to WorkSafe BC requirements.
- (c) Refer to Section 5.34 for manhole step specifications.

5.59 -NOT USED-

5.60 PRESSURE REDUCING STATIONS

- .1 Pressure reducing stations shall be installed in accordance with the construction drawings and supplementary specifications.

5.61 PRESSURE AND LEAKAGE TESTING

- .1 Pressure and leakage tests shall be performed on all installed pipes, hydrants, valves, fittings and service connections.
- .2 Pressure and leakage tests can be commenced upon completion of all underground utility installation. Prior to testing, concrete thrust blocking shall be sufficiently cured to restrain fittings, valves and hydrants.
- .3 Testing procedures shall be submitted to the City Engineer for approval prior to commencement of testing. **(REVISED NOVEMBER 2016)**
- .4 Hydrant lead valves and service corporation stops shall be fully opened during the test. As a preliminary step, the entire system may be pressure and leakage tested at once. Pressure and leakage tests shall be carried out between valved sections of the installation such that every valve in the system is tested for leakage in the shut-off position.
- .5 Pressure and leakage testing shall be conducted in the presence of the Design Engineer, and the City of Nanaimo Works Inspector. **(REVISED NOVEMBER 2016)**
- .6 Pressure and leakage tests for ductile iron piping shall be in accordance with AWWA C600.
- .7 Testing of welded steel piping shall be in accordance with AWWA C206. No leakage shall be allowed.
- .8 Pressure and leakage tests for PVC pipe shall be performed in the following manner:
 - (a) Fill the section to be tested slowly with water and expel all the air from the section.
 - (b) If air relief valves are not required at the high points of the test section, the pipe shall be tapped to release all air and approved plugs inserted upon completion of testing.
 - (c) Pump water into the test section until the static pressure reaches 1035kPa or 1.5 times the average system operating pressure at the point of test, whichever is greater.
 - (d) Maintain the test pressure in the pipe to ± 70 kPa throughout the duration of the test by the addition of a measured quantity of water. The duration of the test shall be a minimum of one hour.

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

- (e) The quantity of water required to maintain the test pressure shall be considered to be the leakage.
- (f) The allowable leakage shall be determined from the following formula: **(REVISED NOVEMBER 2016)**

$$L = \frac{SD \times \text{square root of } P}{715,317} \quad \text{(REVISED NOVEMBER 2016)}$$

in which L = allowable leakage (liters/hour)
S = length of the test section, in meters
D = nominal diameter of the pipe run in mm
P = average test pressure during the leakage test in kPa
(REVISED NOVEMBER 2016)

- (g) Should testing disclose leakage above the maximum allowable leakage, the contractor shall locate and repair or replace the defect and retest the section until test results are satisfactory.
- (h) A copy of the leakage and test pressure report shall be forwarded to the City Works Inspector.
- (i) Prior to accepting the work, all valves shall be checked to ensure they fully open.

5.62 FLUSHING, CHLORINATION AND BACTERIAL SAMPLING **(REVISED NOVEMBER 2016)**

- .1 Prior to chlorination, all piping and appurtenances shall be flushed with a minimum velocity of 1.0m/s. Dispose of flushing water only to drainage works capable of carrying the flows. When flushing the watermain into a sanitary sewer, the downstream capacity shall be reviewed with City of Nanaimo Operations staff.
- .2 The Design Engineer shall arrange, undertake and ensure all piping and appurtenances are flushed, chlorinated, flushed of chlorinated water and tested for bacteria according to the latest edition of AWWA C651. **(REVISED NOVEMBER 2016)**

On completion of chlorination, the entire piping system shall be thoroughly flushed and filled with potable water prior to bacterial sampling. **(REVISED NOVEMBER 2016)**

Flushing chlorination and bacterial sampling shall be conducted in the presence of the Design Engineer and the City of Nanaimo Works Inspector. **(REVISED NOVEMBER 2016)**

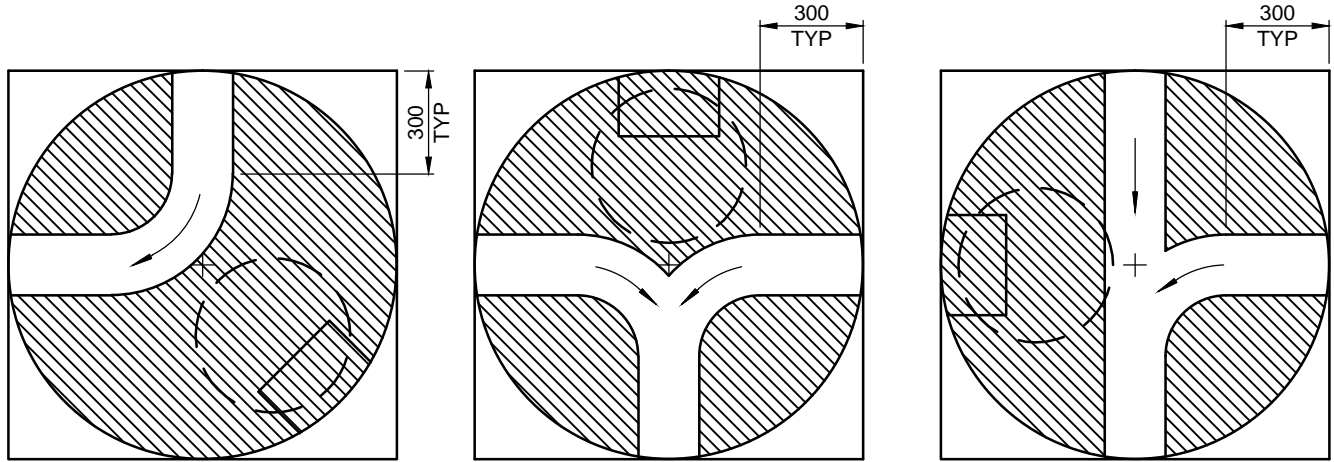
- .3 Chlorinated water shall be disposed of in a way that will not cause harm or damage to vegetation or aquatic life in bodies of water or water courses. Points of discharge are to be approved by the Engineer.

5.63 NOTIFICATION TO ENGINEER - SYSTEM TESTS AND FINAL CONNECTION **(REVISED NOVEMBER 2016)**

- .1 The City Engineer and the City of Nanaimo Works Inspector shall be given 48 hours written notice in advance of all system tests and pipe chlorination by the Contractor.

SECTION 5 - WATER DISTRIBUTION SYSTEM INSTALLATION

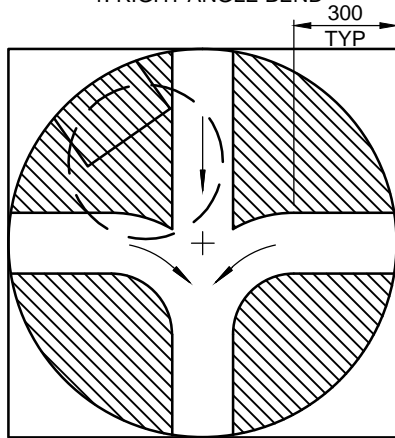
- .2 On new water systems no physical connection (tie-in) to the public system shall be made until the new system passes: **(REVISED NOVEMBER 2016)**
 - (a) flushing, **(REVISED NOVEMBER 2016)**
 - (b) pressure testing, **(REVISED NOVEMBER 2016)**
 - (c) disinfection, **(REVISED NOVEMBER 2016)**
 - (d) satisfactory bacterial testing results by an accredited certified lab. **(REVISED NOVEMBER 2016)**
- .3 Upon satisfactory passing, the Design Engineer shall submit copies of all the above noted test results to the City Engineer with their written recommendation on connection to the Public Water Supply. **(REVISED NOVEMBER 2016)**
- .4 The City Engineer will review the provided test results and recommendation from the Design Engineer and if acceptable may grant Approval to Connect to the Public Water Supply. Under no circumstances shall a connection to the Public Water Supply be undertaken without an Approval to Connect issued by the City Engineer. **(REVISED NOVEMBER 2016)**
- .5 Once Approval To Connect is granted, the time to connect (tie-in) to the Public Water Supply shall be no greater than 7 calendar days, otherwise bacterial testing results will be invalid and will need to be redone. The short spool pieces, fittings and couplers required to complete the connection shall be cleaned and disinfected to AWWA standards. All final connections (tie-ins) shall be reviewed by the Design Engineer. Once final tie-in is complete and the system is in operation, the tie-in shall be reviewed by the Design Engineer for water leaks prior to backfilling and covering up. **(REVISED NOVEMBER 2016)**
- .6 Tie-in and connection shall be conducted in the presence of the Design Engineer and the City of Nanaimo Works Inspector. **(REVISED NOVEMBER 2016)**
- .7 Final Connections: **(REVISED NOVEMBER 2016)**
 - (a) If Connection is 1 pipe length or less (6m or less) spray or swab disinfect all parts just prior to connection. **(REVISED NOVEMBER 2016)**
 - (b) If connection is greater than 1 pipe length (plus 6m), pipe must be set up above ground, disinfected and bacterial samples taken as described in AWWA C651 Section 5. Ends of pipe must be sealed watertight until installed. **(REVISED NOVEMBER 2016)**



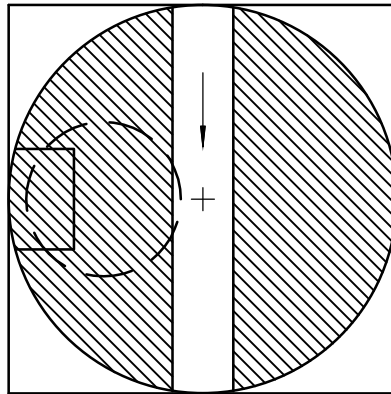
1. RIGHT ANGLE BEND

2. TEE CONNECTION

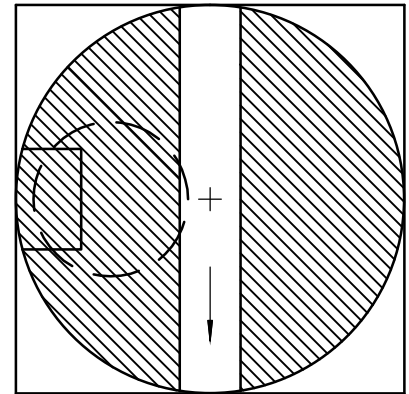
3. THREE WAY JUNCTION



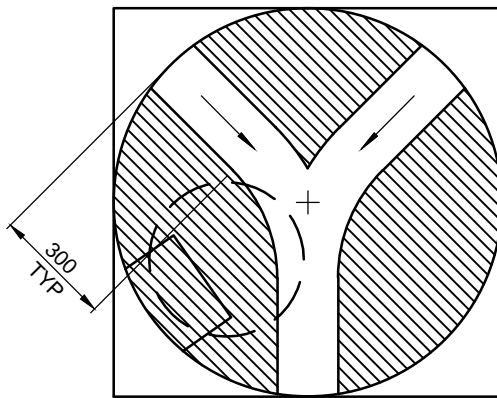
4. FOUR WAY JUNCTION



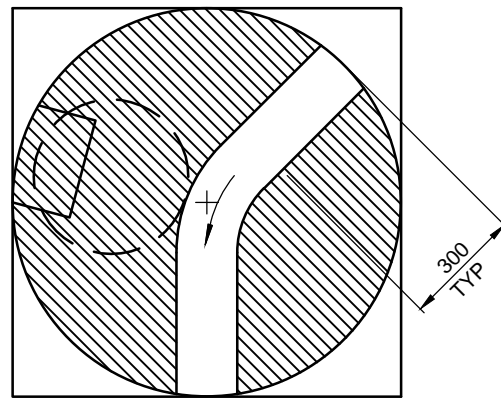
5. STRAIGHT THROUGH



6. DEAD END



7. WYE CONNECTION



8. 45° BEND

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR MANHOLE CHANNELING, REFER TO SECTION 6.49.
3. ALL CHANNELS SHALL BE FINISHED WITH A STEEL TROWEL. BENCHING (HATCHED AREAS), SHALL BE BROOM FINISHED.
4. MANHOLE COVER AND RUNG LOCATIONS SHALL BE AS SHOWN, UNLESS NOTED OTHERWISE.
5. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
6. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

G:\INFRASTRUCTURE PLANNING\STANDARDS & PRODUCTS\SMO\SEDITION NO11\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 6 DWGS\S-2

MANHOLES INSTALLED IN GRAVEL SURFACES SHALL HAVE A 50mm THICK x 1.5m \varnothing ASPHALT APRON ON 100mm OF COMPACTED CRUSHED GRAVEL

TO CONFORM TO WORKSAFE BC, OR 500mm MAX

MANHOLE FRAME TO BE CONCRETED TO MANHOLE LID

PRECAST GRADE RINGS, 2 MIN; 4 MAX

PRECAST MANHOLE LID

RUNGS CAST INTO WALL OF BARREL TO CONFORM TO WORKSAFE BC REQUIREMENTS

RUBBER MANHOLE ADAPTER RING FOR PVC PIPES

600 MIN FOR COMPACTION

PRECAST MANHOLE BARREL, SEE DESIGN FOR SIZE

BACKFILL WITH IMPORTED GRANULAR FILL

PRECAST PRE-BENCHED MANHOLE BASE

150mm OF 38mm DRAIN ROCK ON APPROVED SUB-GRADE

ROAD STRUCTURE

TYPICAL SECTION
1:25

USE SHORT MANHOLE BARREL AS FORM. ENSURE TOP IS LEVEL PRIOR TO POURING CONCRETE

CONCRETE BLOCK TO SET MANHOLE BARREL HEIGHT

75 MIN

PRECAST MANHOLE BARREL, SEE DESIGN FOR SIZE

SLOPE BENCHING 1:10

CAST-IN-PLACE MANHOLE BASE

WHERE POSSIBLE, USE HALF PIPE SECTIONS, OR BREAK-OUT TOP HALF OF PIPE

CAST MANHOLE BASE ON UNDISTURBED SOILS

CAST-IN-PLACE BASE

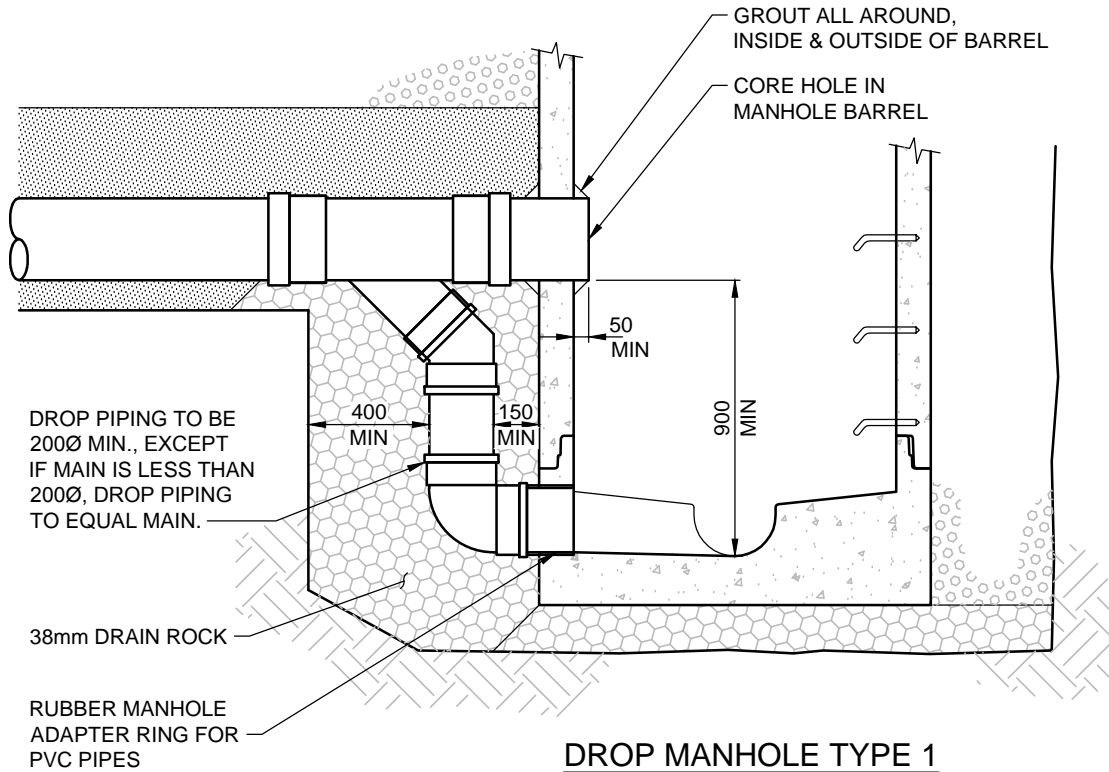
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR MANHOLE BENCHING, SEE STD DWG S-1.
3. FOR FRAME AND COVER DETAILS, SEE STD DWG S-9.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

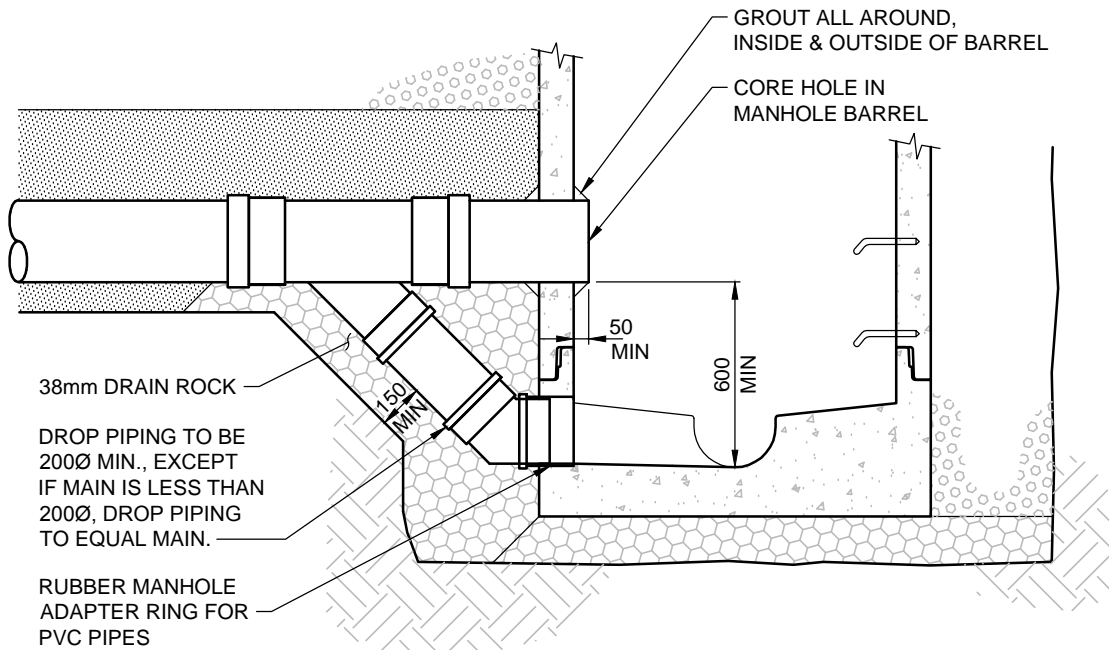


SANITARY MANHOLE

Scale: 1:25
Created: MAR 2016
Rev Date: NOV 2016
Dwg No: S-2



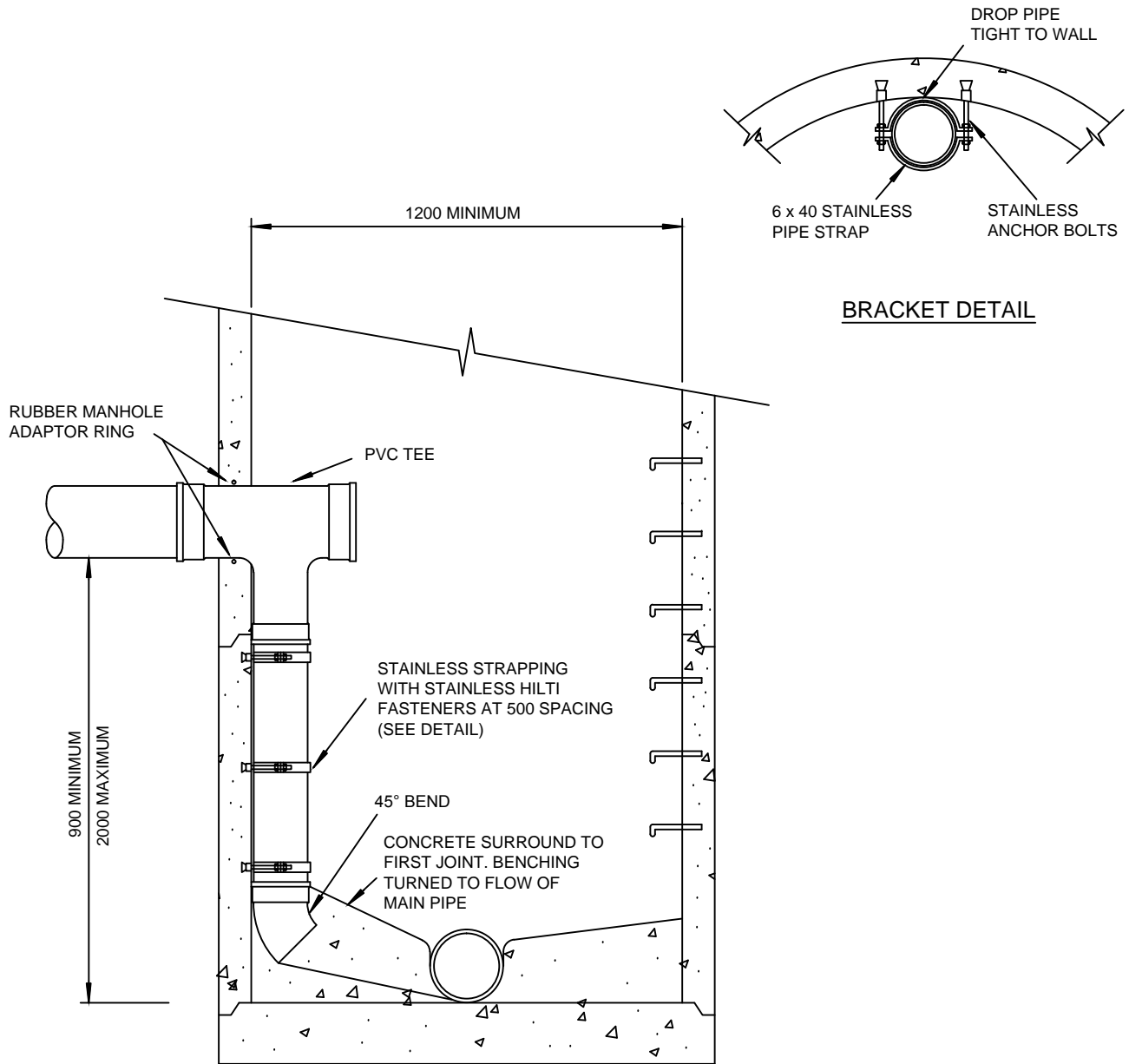
DROP MANHOLE TYPE 1
1:25



DROP MANHOLE TYPE 2
1:25

NOTES:

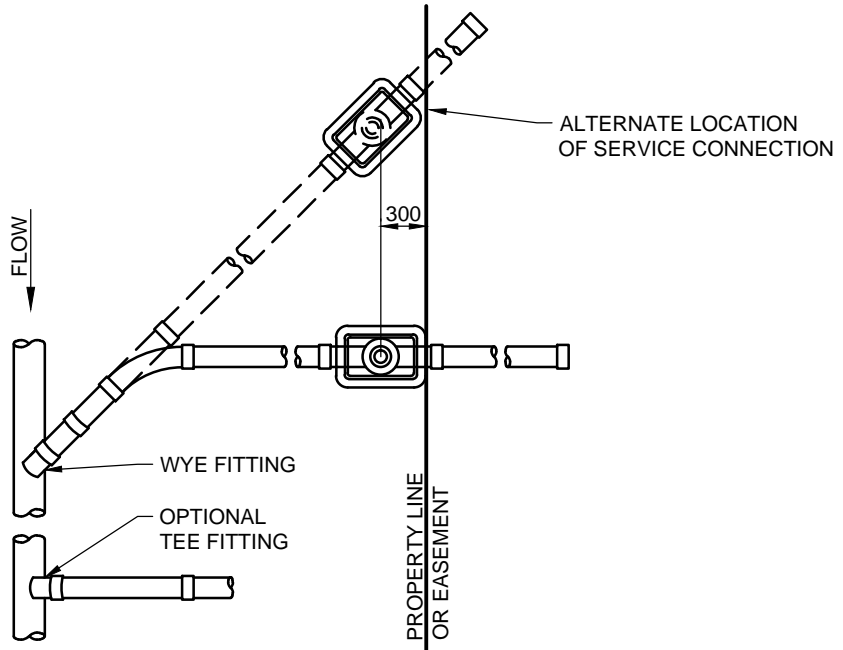
1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR MANHOLE DETAILS, SEE STD DWG S-2.
3. FOR MANHOLE BENCHING, SEE STD DWG S-1.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



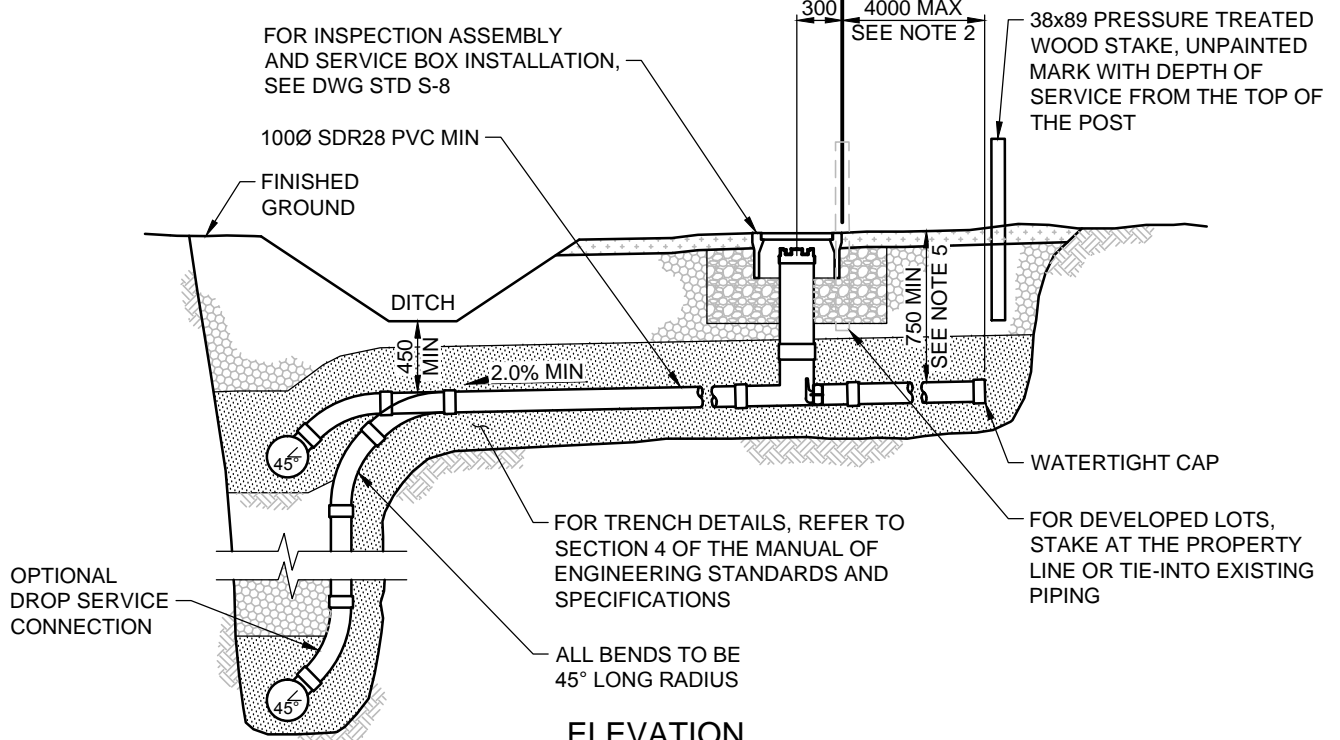
DROP MANHOLE - TYPE III

NOTES:

1. INSIDE DROP TO BE USED ONLY WHERE PERMITTED BY THE CITY ENGINEER.
2. MAXIMUM SIZE OF DROP PIPE TO BE 150Ø DR28 PVC.
3. THIS DRAWING SHOWS INSIDE DROP ONLY. SEE DRAWING S-2 FOR ALL OTHER DEATILS PERTAINING TO MANHOLE REQUIREMENTS.
4. ALL DIMENSIONS IN MILLIMETERS UNLESS SHOWN OTHERWISE
5. ALL MOUNTING & BRACKET HARDWARE, (STRAPS & BOLTS) SHALL BE STAINLESS STEEL
6. DROP PIPE SHALL BE TIGHT TO THE INSIDE FACE OF THE MANHOLE BARREL.



PLAN
1:50



ELEVATION
1:50

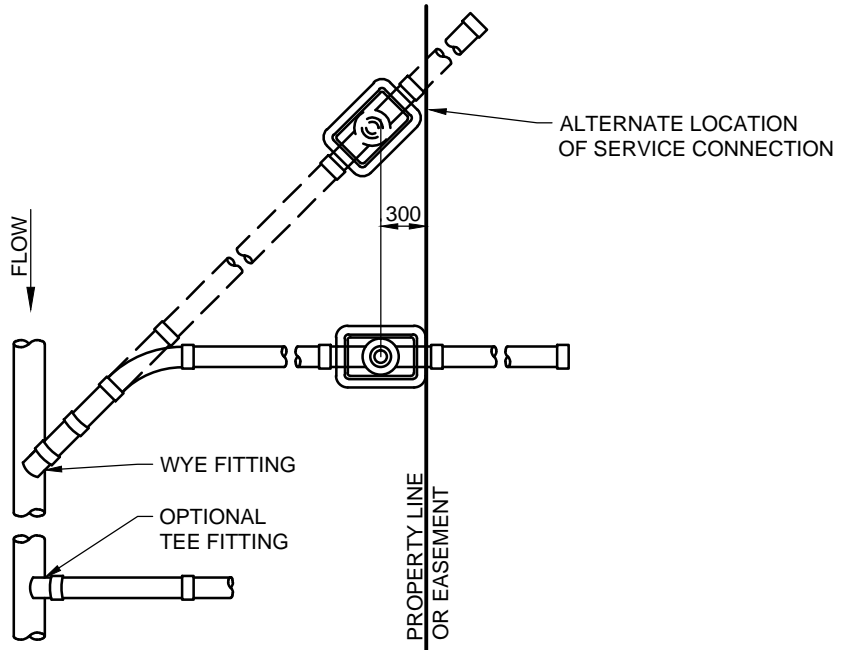
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. WHERE DEPTH OF SERVICE AT PROPERTY LINE IS GREATER THAN 2.0m, EXTEND THE SERVICE PAST THE PROPERTY LINE EQUAL TO ITS DEPTH, TO MAXIMUM OF 4.0m.
3. WHERE SERVICE IS INSTALLED IN ROCK, THE TRENCH IS TO EXTEND 3.0m PAST THE PROPERTY LINE.
4. SANITARY SEWER INSPECTION ASSEMBLY, INCLUDING PROPERTY SIDE STUB TO BE WHITE.
5. SERVICE PIPE DEPTH TO BE INSTALLED TO PROVIDE SUFFICIENT DEPTH TO SERVICE THE BASEMENT PLUMBING BY GRAVITY IN ACCORDANCE WITH THE BC PLUMBING CODE. MINIMUM COVER OF SERVICE PIPE AT PROPERTY LINE TO BE 0.75m.
6. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

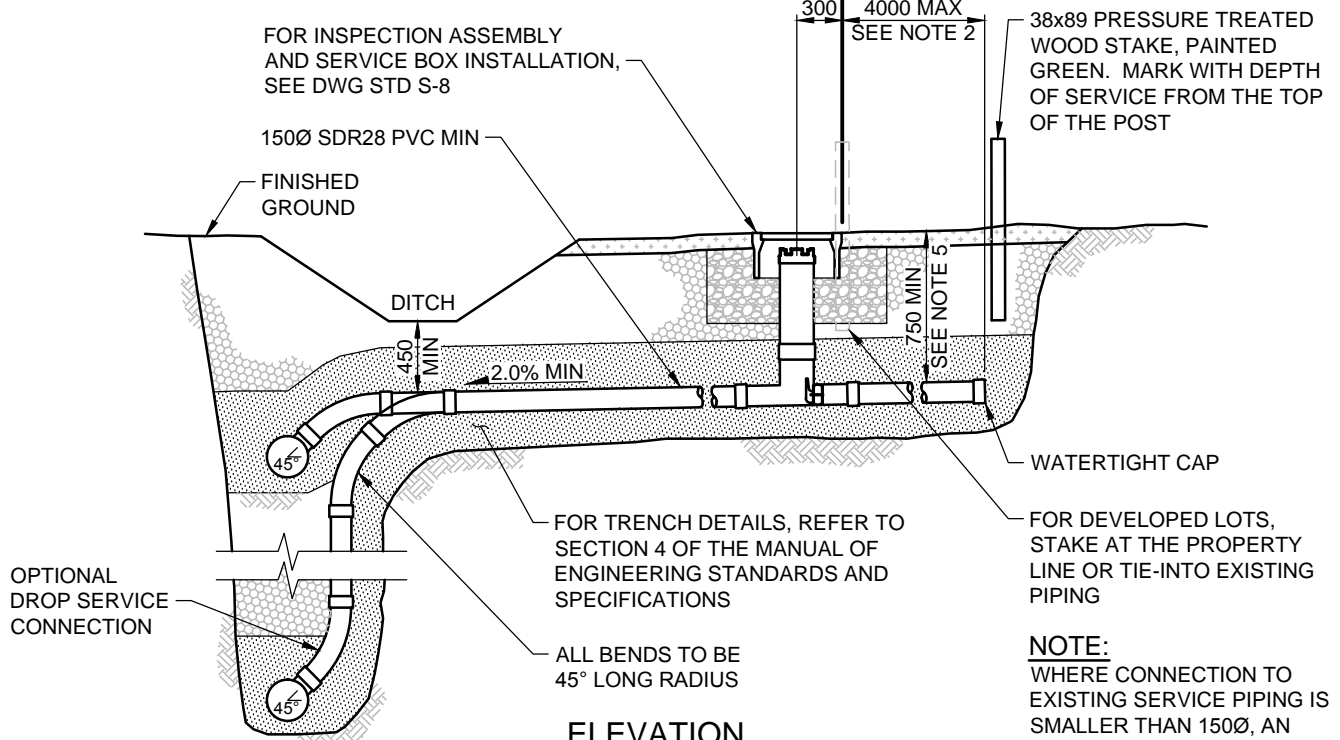


GENERAL SANITARY SERVICE CONNECTION DETAIL
RISER AND NON-RISER TYPES

Scale:	1:50
Created:	MAR 2015
Rev Date:	NOV 2016
Dwg No:	S-5



PLAN
1:50



ELEVATION
1:50

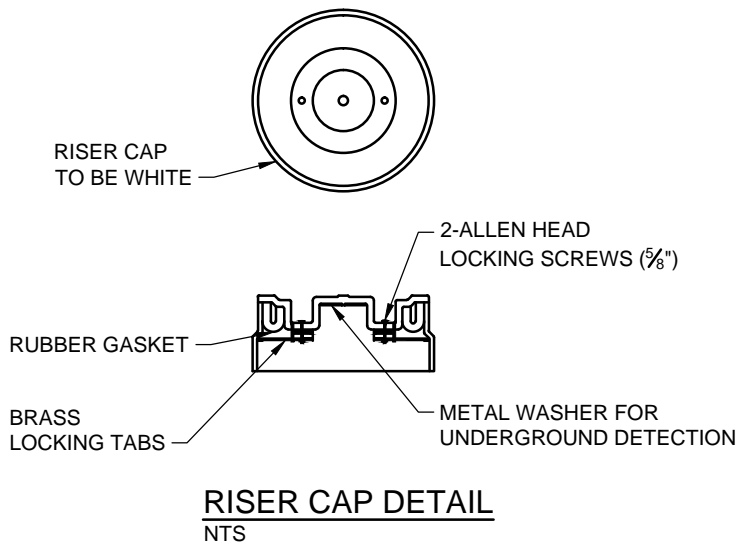
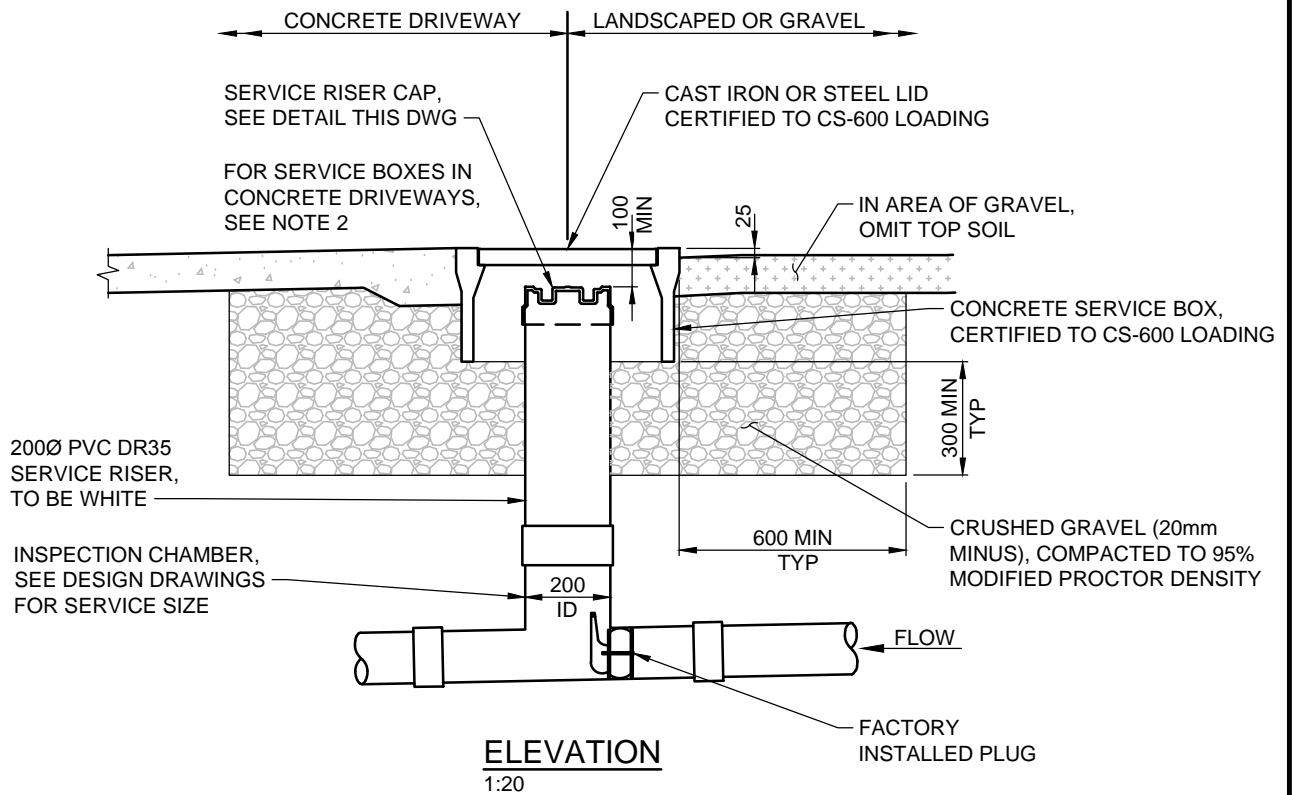
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. WHERE DEPTH OF SERVICE AT PROPERTY LINE IS GREATER THAN 2.0m, EXTEND THE SERVICE PAST THE PROPERTY LINE EQUAL TO ITS DEPTH, TO A MAXIMUM OF 4.0m.
3. WHERE SERVICE IS INSTALLED IN ROCK, THE TRENCH IS TO EXTEND 3.0m PAST THE PROPERTY LINE.
4. SANITARY SEWER INSPECTION ASSEMBLY, INCLUDING PROPERTY SIDE STUB TO BE WHITE.
5. SERVICE PIPE DEPTH TO BE INSTALLED TO PROVIDE SUFFICIENT DEPTH TO SERVICE THE BASEMENT PLUMBING BY GRAVITY IN ACCORDANCE WITH THE BC PLUMBING CODE. MINIMUM COVER OF SERVICE PIPE AT PROPERTY LINE TO BE 0.75m.
6. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



COMMERCIAL AREAS SANITARY SERVICE CONNECTION DETAILS
RISER AND NON-RISER TYPES

Scale:	1:50
Created:	MAR 2016
Rev Date:	NOV 2016
Dwg No:	S-7



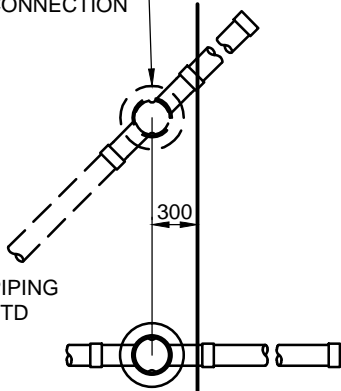
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. WHEN SERVICE BOX IS WITHIN A CONCRETE DRIVEWAY, CONCRETE ADJACENT TO THE SERVICE BOX MUST BE A MINIMUM OF 150mm THICK FOR A MINIMUM DISTANCE OF 150mm AROUND THE OUTSIDE EDGES OF THE SERVICE BOX.
3. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
4. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

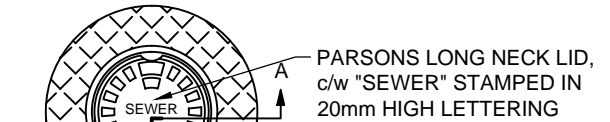
ALTERNATE LOCATION
OF SERVICE CONNECTION

FOR SERVICE PIPING
DETAILS, SEE STD
DWG S-5

PROPERTY LINE
OR EASEMENT

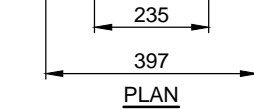


PLAN - VALVE BOX LOCATIONS
NTS

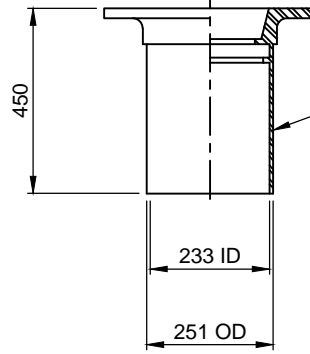


PARSONS LONG NECK LID,
c/w "SEWER" STAMPED IN
20mm HIGH LETTERING

3mm RAISED SINGLE
DIAMOND CHECKER
PLATE FLANGE



PLAN



6mm WALL THICKNESS
MIN

NOTE:
FINISH COAT TO BE
BITUMINOUS DIP

SECTION A-A

MR STYLE VALVE BOX

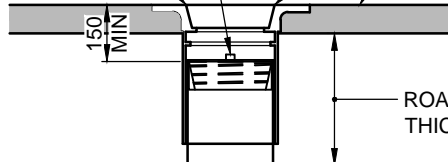
1:15

MECHANICAL SCREW PLUG,
SEE DETAIL THIS DWG

MR TYPE VALVE BOX,
SEE DETAIL THIS DWG

SET COVER FLUSH
WITH FINISHED GRADE

ASPHALT,
THICKNESS VARIES



ROAD STRUCTURE,
THICKNESS VARIES

200Ø PVC DR35
SERVICE RISER,
TO BE WHITE

INSPECTION CHAMBER,
SEE DESIGN DRAWINGS
FOR SERVICE SIZE

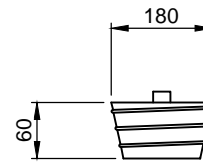
200
ID

FLOW

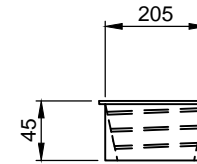
FACTORY
INSTALLED PLUG

INSPECTION ASSEMBLY ELEVATION

1:20



RIGID PLASTIC PLUG



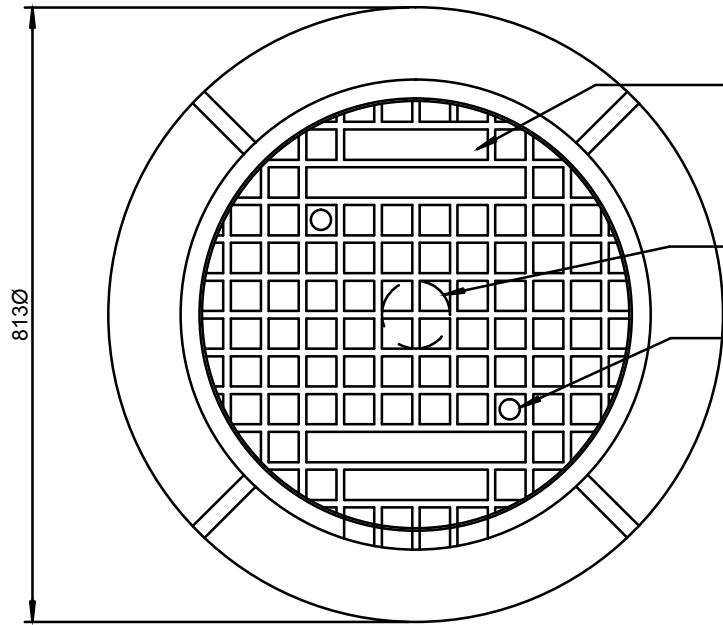
RUBBER SEALING COLLAR

MECHANICAL SCREW PLUGS

1:10

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
3. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

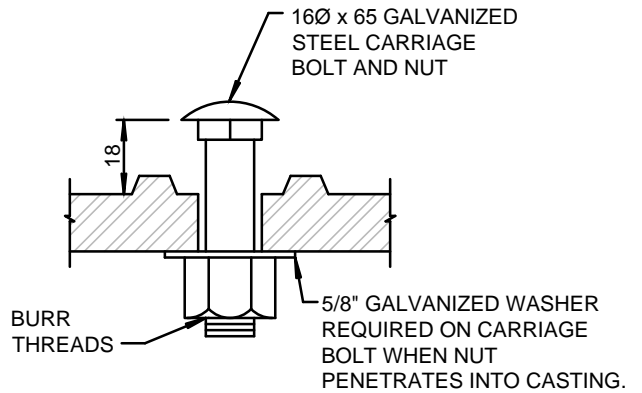


REFERRING TO "CITY OF NANAIMO SANITARY SEWER",
 LETTERING SHALL BE 25 FLATTENED FACE
 GOTHIC WITH FACE OF LETTERS RAISED TO THE
 SAME LEVELS AS THE TOP OF THE RIBS
 (IN STATUTORY RIGHTS-OF-WAY INCLUDE THE
 WORDING "DO NOT COVER" ON THE MANHOLE LID)

MANUFACTURER'S SYMBOL 90 MAXIMUM DIMENSION,
 CIRCLE OR SQUARE

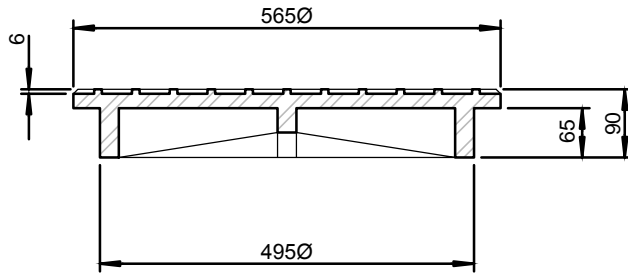
2-21Ø HOLES

PLAN

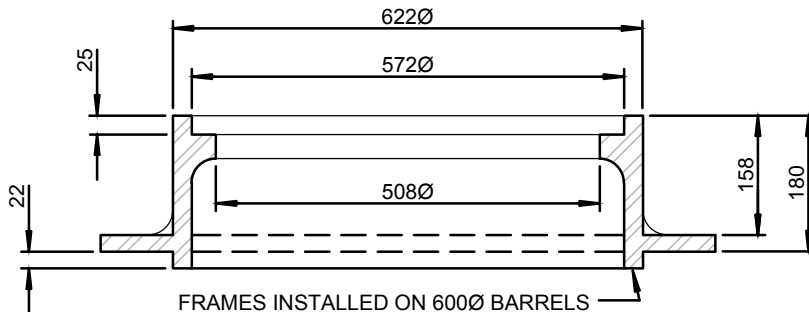


IMPORTANT:
CARRIAGE BOLT TO EXTEND
EXACTLY 18mm ABOVE CASTING.

CARRIAGE BOLT DETAIL



COVER



FRAMES INSTALLED ON 600Ø BARRELS
 SHALL NOT HAVE RIB

FRAME

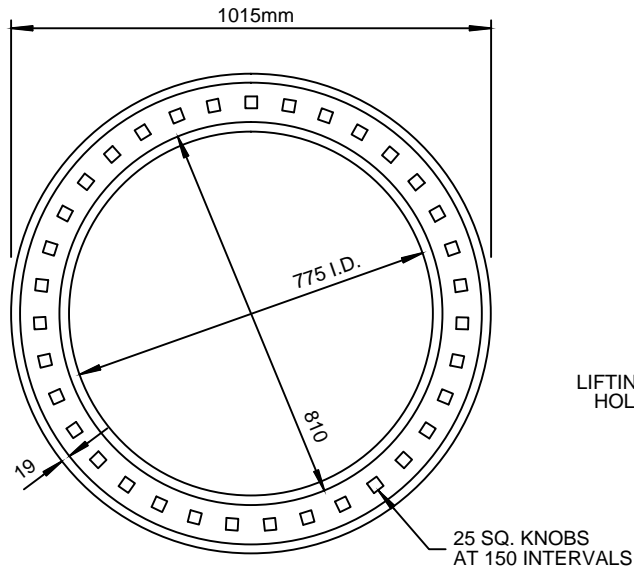
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. ALL BEARING SURFACES BETWEEN FRAME, COVER AND RISER RINGS SHALL BE MACHINED FOR NON-ROCKING FIT IN ALL POSITIONS. ALLOW 1.5mm RAISED FACE IN CASTINGS FOR MACHINING.
4. PAINT THE INSIDE SURFACE OF THE MANHOLE FRAME IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATION WITH ENAMEL RUST PAINT. COLOUR TO BE YELLOW.
5. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
6. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

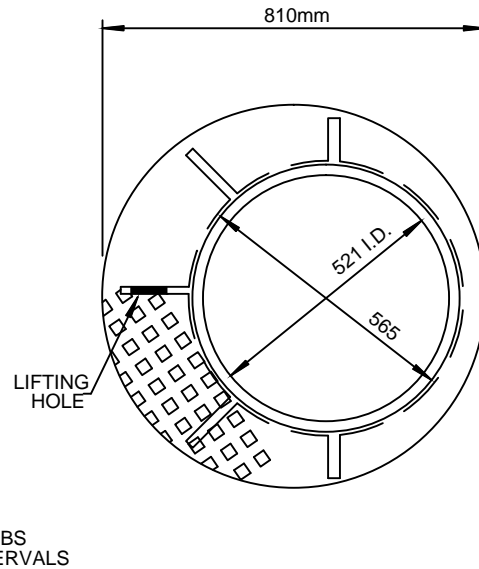


SANITARY MANHOLE
 FRAME AND COVER

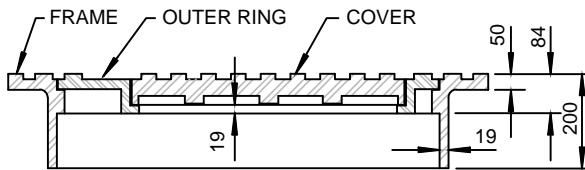
Scale: NTS
 Created: MAR 2016
 Rev Date: NOV 2016
 Dwg No: S-9



PLAN OF FRAME



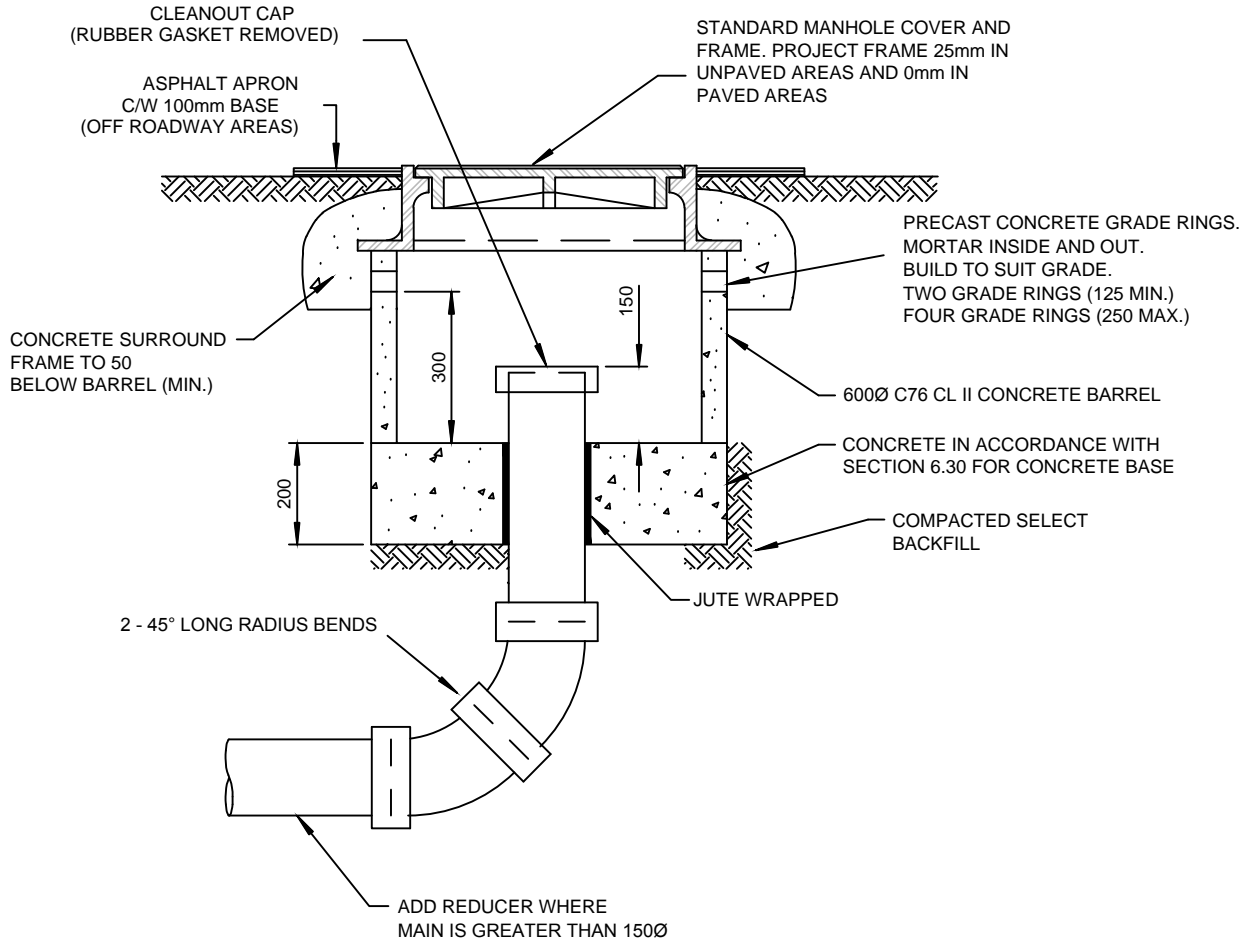
PLAN OF OUTER RING



SECTION OF FRAME, RING AND COVER

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. FOR COVER LETTERING AND BOLTING REQUIREMENTS REFER TO STD. DWG. S-9 OR S-15.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



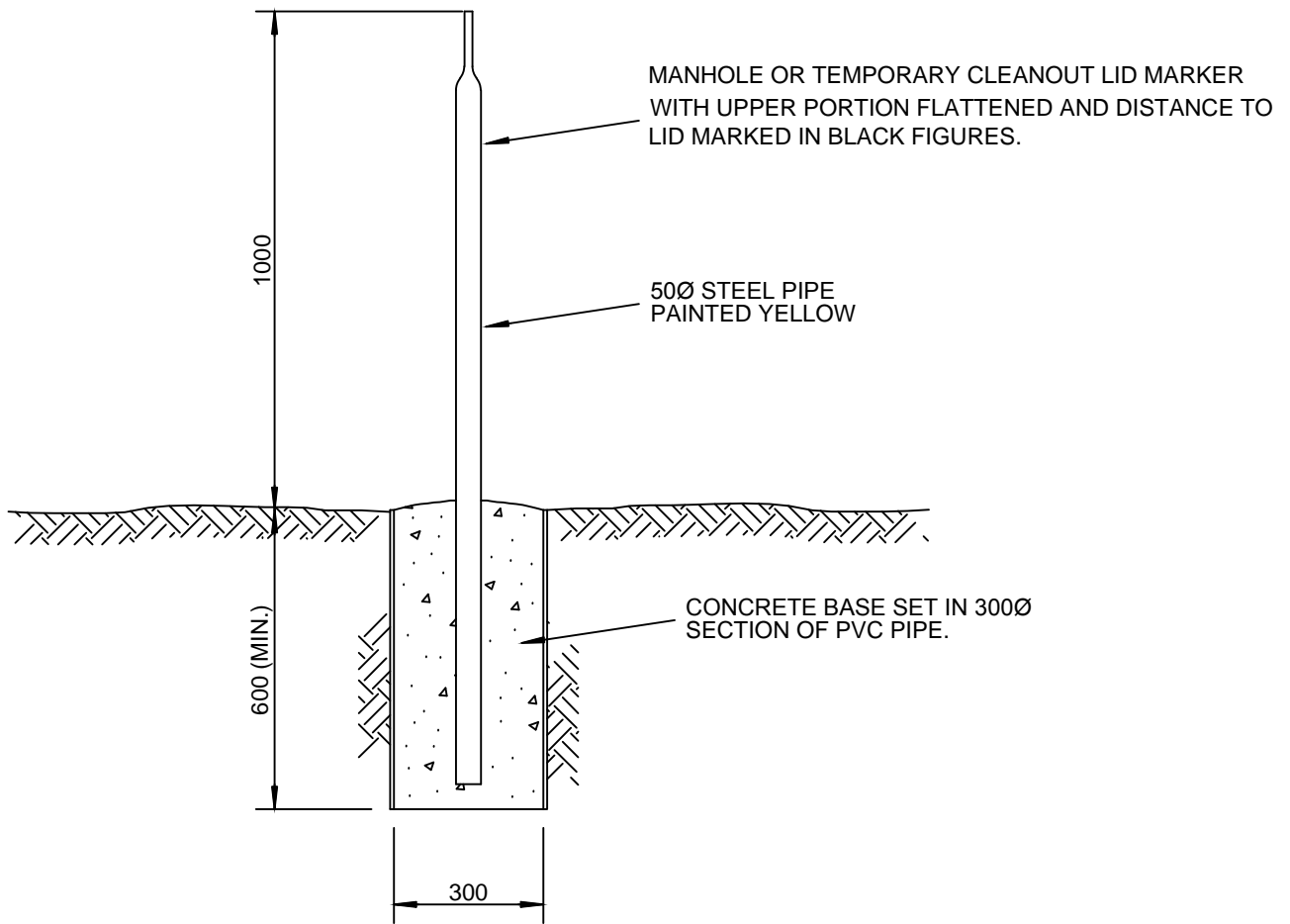
NOTES:

1. TEMPORARY CLEANOUT STRUCTURES MAY ONLY BE USED AT THE DISCRETION OF THE CITY ENGINEER WHERE THERE IS DEVELOPMENT PHASING.
2. USE WHERE NO SERVICE EXTENSION IS REQUIRED.
3. FRAME AND COVER TO STANDARD DRAWING S-9 (SANITARY MANHOLE FRAME AND COVER), OR STANDARD DRAWING S-15 (WATERTIGHT SANITARY MANHOLE FRAME AND COVER).
4. CLEAN OUT STRUCTURES LOCATED ON GRAVEL ROADS OR SHOULDERS REQUIRE A 1.5 m X 1.5 m HOT MIX ASPHALT APRON, 50 mm THICK.
5. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION
6. ALL DIMENSIONS IN MILLIMETERS UNLESS SHOWN OTHERWISE



TEMPORARY SANITARY CLEANOUT STRUCTURE

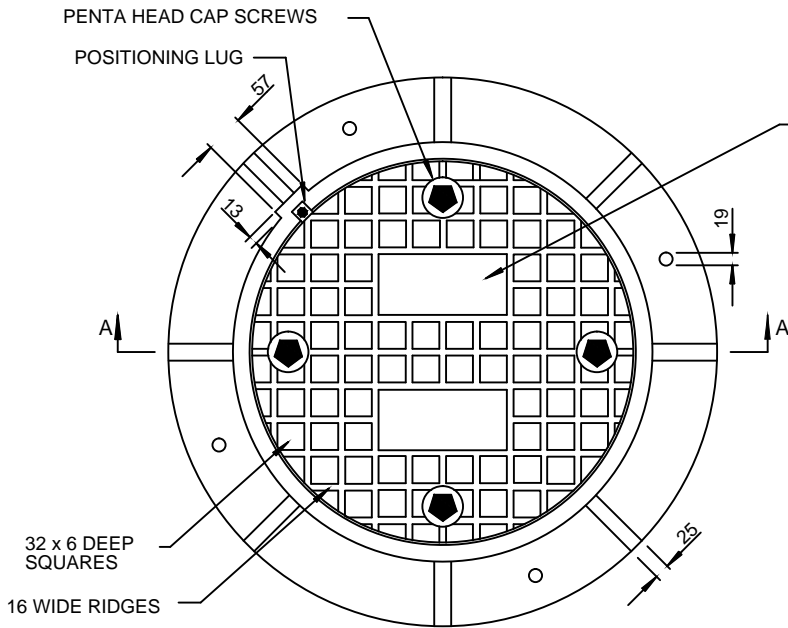
Scale:	NTS
Created:	JUNE 2013
Rev Date:	NOV 2016
Dwg No:	S-12



NOTES

1. FOR USE ONLY WHERE MANHOLE OR TEMPORARY CLEANOUT LIDS ARE LOCATED OUTSIDE THE PAVED PORTION OF A STREET.
2. THE MARKER SHALL BE LOCATED ON SITE BY THE ENGINEER WITH THE FLATTENED END AND MARKED DISTANCE FACING THE LID.
3. ALL DIMENSIONS IN MILLIMETERS UNLESS SHOWN OTHERWISE.

APPLICATION: UNITS ARE FOR USE IN AREAS WHERE FLOODING OR HIGH TIDES ARE POSSIBLE. THIS UNIT SHALL HAVE A POSITIONING LUG IN COVER FOR EASY REPLACEMENT OF CAP SCREWS AND SHALL BE EQUIPPED WITH FOUR ONLY 19Ø HOLES IN FRAME FOR ANCHOR BOLTS AS SHOWN.

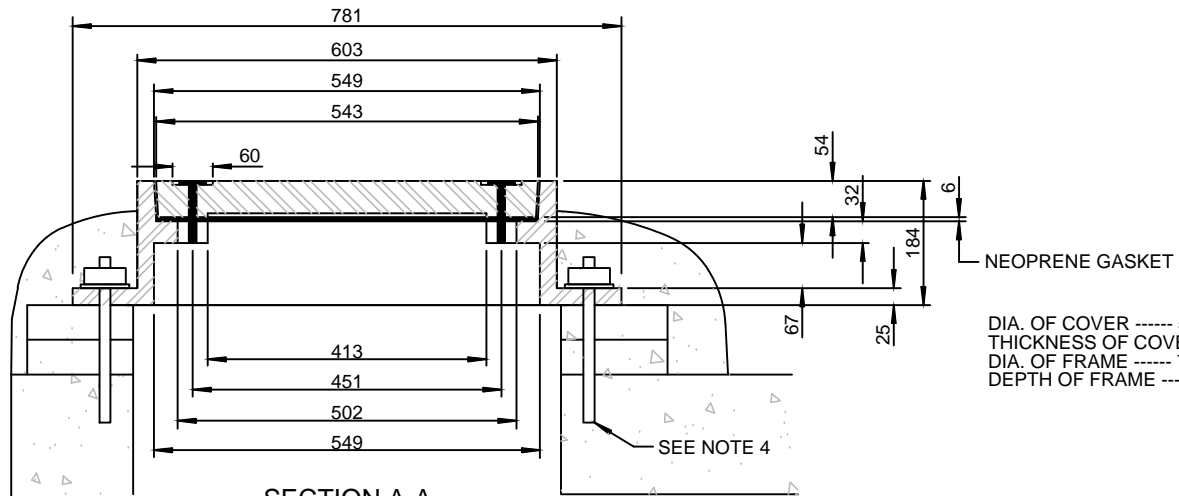


REFERRING TO "CITY OF NANAIMO SANITARY SEWER", LETTERING SHALL BE 25 FLATTENED FACE GOTHIC WITH FACE OF LETTERS RAISED TO THE SAME LEVELS AS THE TOP OF THE RIBS (IN STATUTORY RIGHTS-OF-WAY INCLUDE THE WORDING 'DO NOT COVER' ON THE MANHOLE LID)

WEIGHT OF UNIT SHOWN IS
 FRAME = 113.4 kg
 COVER = 56.7 kg

- FURNISHED WITH:
- A) FOUR 13x57 PENTA HEAD STAINLESS STEEL CAP SCREWS TO DISCOURAGE VANDALISM.
 - B) A 6mm THICK NEOPRENE GASKET FULLY ENCOMPASSING BOLT HOLES.
 - C) METAL SURFACES BETWEEN FRAME AND COVER MACHINED TO ENSURE NON ROCKING FIT IN ALL POSITIONS. ALLOW 1.5 RAISED FACE IN CASTING FOR MACHINING.
 - D) MANUFACTURE BOLT HOLES TO PERMIT INTERCHANGING OF COVERS BETWEEN FRAME UNITS.

PLAN



DIA. OF COVER ----- 543
 THICKNESS OF COVER -- 54
 DIA. OF FRAME ----- 781
 DEPTH OF FRAME ----- 184

SECTION A-A

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 6.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. PAINT THE INSIDE SURFACE OF THE MANHOLE FRAME IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATION WITH ENAMEL RUST PAINT. COLOUR TO BE YELLOW.
4. FRAME SHALL BE SET IN MORTAR AND BOLTED TO THE MANHOLE SLAB WITH 19Ø STAINLESS STEEL BOLTS, WASHERS AND NUTS.
5. THIS DRAWING TO BE READ IN ACCORDANCE WITH DRAWING S-2.
6. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

G:\INFRASTRUCTURE PLANNING\STANDARDS & PRODUCTS\MOESSE\EDITION NO11\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 6 DWGS\S-15

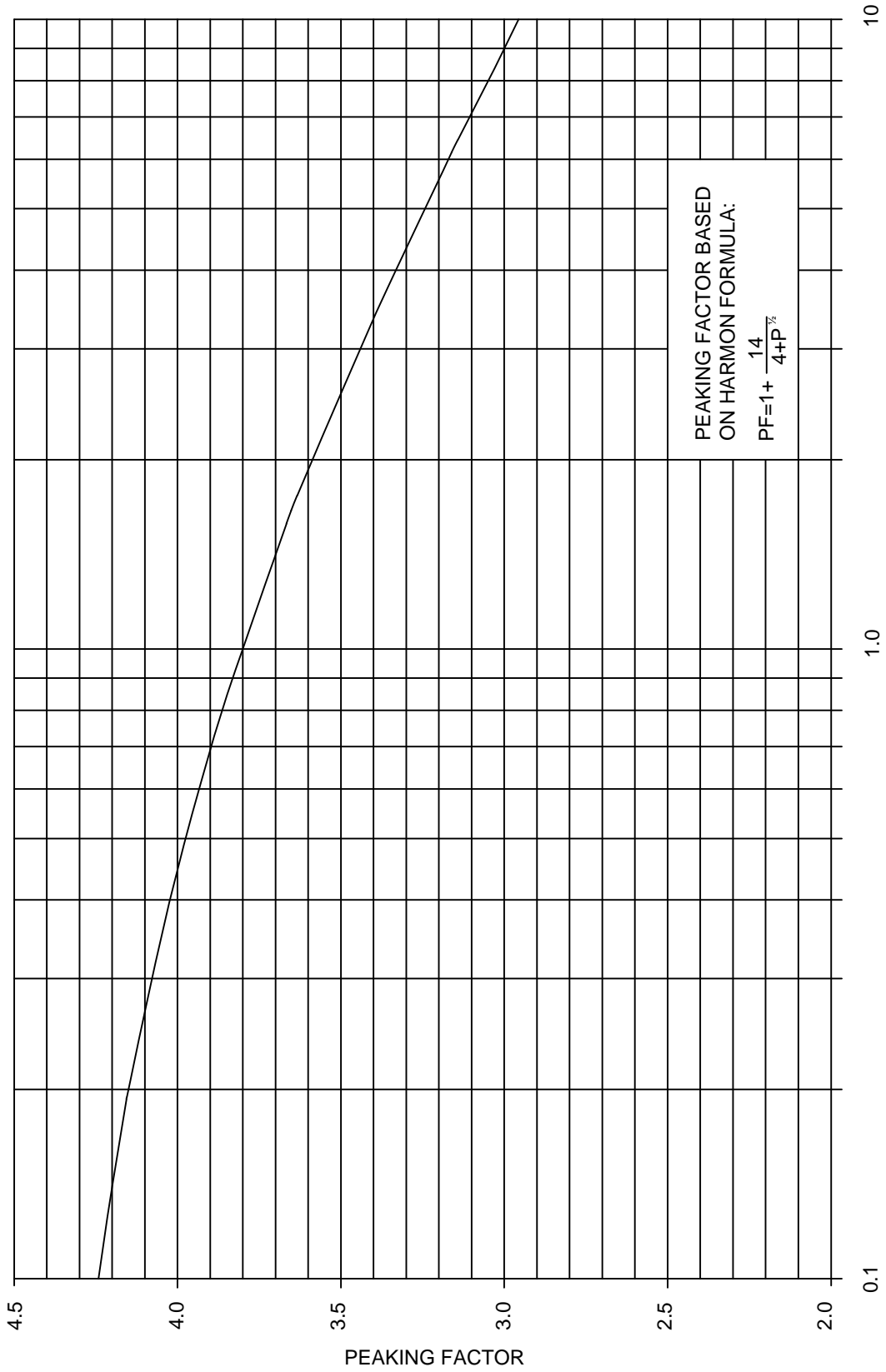
6.16.2016



WATERTIGHT SANITARY MANHOLE
 FRAME AND COVER

Scale: NTS
 Created: MAR 2016
 Rev Date: NOV 2016
 Dwg No: S-15

HARMON PEAKING FACTOR CURVE



DESIGN CONTRIBUTORY POPULATION IN THOUSANDS



SANITARY SEWER PEAKING FACTOR

Scale: NTS
 Created: MAY 2001
 Rev Date: NOV 2016
 Dwg No: SAN-1

SECTION 6 - SANITARY SEWER SYSTEM

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT

Piping and Fittings	6.70
Additional Excavation and Backfill	6.71
Rebench Existing Manhole	6.72
Abandon Existing Air Valve/Blowdown Chamber	6.73
Air Valve c/w Chamber	6.74
Blowdown c/w Chamber	6.75
Chase River Crossing	6.76

SECTION 6 - SANITARY SEWER SYSTEM

MEASUREMENT AND PAYMENT

The Contractor will note that the tendered price for all items specified in this section will include but not be limited to the following: Please refer to Section 4 - Trench Excavation, Bedding and Backfill for further clarification of these items.

- (a) materials
- (b) excavation
- (c) dewatering
- (d) bracing & sheeting
- (e) bedding
- (f) pipe installation
- (g) backfill with imported material and/or controlled density fill
- (h) video inspection
- (i) maintenance

The Contractor will note that payment for surface restoration and asphalt removal is paid in accordance with Section 4.75.

6.70 PIPING AND FITTINGS Section 6.42 - 6.46

Payment for piping and fittings will be made at the unit price per linear metre shown in the Tender Form for the various sizes and class of pipe. Measurement will be made horizontally along the centreline of the installed pipe, including fittings, from centre-to-centre of manholes or to the end of the pipe, whichever is applicable. This price shall include materials, excavation, dewatering, bracing and sheeting, bedding, pipe installation, backfill with imported material and/or controlled density fill, video inspection and maintenance, testing as specified, and all work incidental thereto.

6.71 ADDITIONAL EXCAVATION AND BACKFILL

Payment will not be made as a separate item for excavation, backfill and work applicable thereto required at any structure specified in this section. The cost of such work shall be included in the applicable prices for the various structures shown in the Tender Form.

6.72 REBENCH EXISTING MANHOLE

Payment for re-benching existing manholes includes all materials and work including dewatering and temporary water diversion to enable re-benching the existing manhole and all related work shown on the Contract Drawings.

6.73 ABANDON EXISTING AIR RELEASE/BLOWDOWN CHAMBER

Payment for abandoning existing manholes will be made at the unit price shown in the Tender Form. This price shall include draining the existing manhole, plugging existing pipes with concrete, supply and installation of drain rock and filter fabric, removal of upper section of the manhole, backfill, compaction, and all related work shown on the Contract Drawings.

SECTION 6 - SANITARY SEWER SYSTEM

MEASUREMENT AND PAYMENT

6.74 AIR RELEASE C/W CHAMBER

Air valves and fittings will be paid for at the unit price shown in the Tender Form. This price shall include excavation, supply of materials, piping, pipe saddle/ supports, vent piping, gate valves, air valve, small diameter valves, manhole, rock put, manhole frame and cover, adjustment to final grade, asphalt apron and all related work shown on the Contract Drawings

6.75 BLOWDOWN C/W CHAMBER

Blowdown piping and fittings will be paid for at the unit price shown in the Tender Form. This price shall include excavation, supply of materials, piping, pipe saddle/ supports, vent piping, gate valve, small diameter valves, manhole, rock put, manhole frame and cover, adjustment to final grade, asphalt apron and all related work shown on the Contract Drawings

6.76 CHASE RIVER CROSSING

Installation of the above grade Chase River crossing will be paid at the lump sum price shown in the Tender Form. Payment includes mobilization/ demobilization, piles, casing, pipe spacer, end seals, straps, pedestrian barrier forcemain installation and all related work shown on the Contract Drawings.

SECTION 6 - SANITARY SEWER SYSTEM CONTENTS

<u>DESIGN CRITERIA</u>	<u>SECTION NO.</u>
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Sewage Flows	6.01A
Sewage Characteristics	6.02
Hydraulics	6.03
Piping	6.04
Manholes	6.04A
Pumping Stations	6.05
Force Mains	6.06
Siphons	6.07
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Scope	6.20
Materials Testing	6.21
Piping, Fittings and Services	6.22
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Joints	6.23
Service Junctions	6.24
Precast Manhole Sections	6.25
Precast Manhole Bases	6.25A
Manhole Tops	6.26
Manhole Covers and Frames	6.27
Manhole Steps	6.28
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Concrete	6.30
Precast Concrete Grade Ring	6.31
Temporary Cleanout Frames and Covers	6.32
Pipe and Fittings for Drop Manhole Structures	6.33
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Manhole and Temporary Cleanout Lid Markers	6.35
Service Boxes	6.36
Pumping Stations	6.37
(REVISED NOVEMBER 2016)	
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Trench Excavation, Bedding and Backfill	6.40
Pipe Alignment and Grade	6.40A
Pipe Cutting	6.41
Pipe Installation	6.42
Force Main Installation	6.42A
Joints at Rigid Structures	6.43
Horizontal and Vertical Curves	6.44
Deflection	6.45
Fittings and Joints	6.46
Connections to Existing Piping and Appurtenances	6.47
Service Connection Junctions	6.48

SECTION 6 - SANITARY SEWER SYSTEM CONTENTS

<u>INSTALLATION (cont'd)</u>	<u>SECTION NO.</u>
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Precast Manhole Bases	6.49A
-Not Used-	6.50
Precast Manhole Sections	6.51
Concrete	6.52
Frames and Covers	6.53
Manhole Steps	6.54
Drop Manhole Structures	6.55
Stubs	6.56
Temporary Cleanouts	6.57
-Not Used-	6.58
Pumping Stations	6.58A
Service Connection Installation	6.59
Cleaning and Flushing	6.60
Notification to City of Nanaimo	6.61
Leakage Testing of Gravity Sewers	6.62
Testing of Force Mains	6.63
Video Inspecting Mains and Service Connections	6.64
Smoke Testing	6.65
Testing of Pumping Stations	6.66
Pipe Video and Manhole Condition Report Format (REVISED NOVEMBER 2016)	6.67

<u>STANDARD DRAWINGS</u>	<u>DWG. NO.</u>
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Sanitary Manhole	S-2
Sanitary Drop Manhole	S-3
Inside Drop Manhole Detail for 200 dia. Sewers	S-3A
General Sanitary Sewer Connection Detail Riser and Non-riser Types	S-5
Commercial Areas Sanitary Service Connection Details Riser and Non-riser Types	S-7
Sanitary Service Box and Inspection Assembly Installation	S-8
Sanitary Service Box and Inspection Assembly Installation in Paved Lanes and Roadways	S-8A
Sanitary Manhole Frame and Cover	S-9
Utility Chamber Sanitary Manhole Frame, Ring and Cover	S-10
Temporary Sanitary Cleanout Structure	S-12
Sanitary Manhole and Temporary Cleanout Lid Marker	S-14
Watertight Sanitary Manhole Frame and Cover	S-15
Sanitary Sewer Peaking Factor (REVISED NOVEMBER 2016)	SAN-1

SECTION 6 - SANITARY SEWER SYSTEM DESIGN CRITERIA

6.01 SCOPE

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

6.01A SEWAGE FLOWS

- .1 Sanitary sewer systems shall be designed to accommodate peak sewage flows with an allowance for inflow and infiltration. The discharge of storm water into the sanitary sewer system will not be allowed.
- .2 Design contributory populations shall be computed in accordance with the City of Nanaimo population predictions or with the planned development in the tributary area based on the Official Community Plan, whichever is the larger.
- .3 In the absence of detailed design population information, the following minimum design population densities shall be used:

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

ppu = persons per unit
pph = persons per hectare

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

$$PF = 1 + 14/(4+P^{0.5}) \quad (\text{shown graphically on drawing SAN-1})$$

Where P is the design contributory population, in thousands. **(REVISED NOVEMBER 2016)**

In cases of large populations, greater than 1000, and trunk sewer designs, a sanitary sewer model approved by the City Engineer shall be used.

.5 Peak Inflow and Infiltration (I&I)

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

SECTION 6 - SANITARY SEWER SYSTEM DESIGN CRITERIA

- .6 Design sewage rates of flow shall be computed by adding peak sewage flow to peak inflow and infiltration.
- .7 Sanitary sewage design calculations shall be prepared in a format in accordance with Appendix H1 – Sanitary Sewer Flow Analysis – Calculation Sheet.

6.02 SEWAGE CHARACTERISTICS

- .1 Sewage quality criteria shall be as follows:

Sewage Quantity (ADWF)
in the

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

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

SECTION 6 - SANITARY SEWER SYSTEM DESIGN CRITERIA

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

6.03 HYDRAULICS

- .1 No gravity sewer shall be less than 200mm in diameter except that in residential areas 150mm diameter may be approved by the City Engineer in the final section of a gravity sewer, providing the pipe has the required capacity and extension in the future, is precluded by physical barriers or there is existing alternate pick-up of adjacent areas. Unless otherwise approved by the City Engineer downstream pipe diameter shall be greater than or equal to upstream pipe diameter.
- .2 Except under special circumstances, gravity sewers shall be designed to achieve a minimum daily self-cleansing velocity of 0.75m/s.
- .3 A Mannings roughness co-efficient of 0.013 shall be used for design of gravity sewers and service connections.
- .4 Design of gravity sewers to flow at less than 70% of diameter.
- .5 Service connections shall be 100mm in diameter minimum. Service connections to other than single family dwellings shall be minimum 150mm diameter in accordance with design flows and available grades. Water and sewer services in a common trench shall be in accordance with the requirements of the Ministry of Health.
- .6 Minimum grade of gravity sewers are as required to obtain the minimum velocity of 0.75m/s, except for terminal sewers which are to be as follows: **(REVISED NOVEMBER 2016)**
- | | |
|--|--------------------|
| (a) Sewers servicing less than 10 houses | 1.0% minimum grade |
| (b) Sewers servicing less than 25 houses | 0.6% minimum grade |

6.04 PIPING

- .1 Depths:
- (a) Depths of all gravity sewer mains and service connections shall be such that all basements in the area the sewer is intended to serve can be drained by gravity. Where properties cannot be serviced by a gravity connection, an explanation of the reasons shall be submitted to the City Engineer for approval. Pump stations from individual properties, shall have a gravity connection from the property line to the main sewer pipe.
- (b) Minimum cover on gravity sewers shall be 1.5m in travelled roads and 1.0m in untravelled areas. Unless otherwise approved by the City Engineer, the maximum cover depth over gravity sewers is 4.5m.
- (c) Minimum cover on service connections shall be 750mm from finished grade.
- (d) Where minimum cover cannot be provided, an explanation of the reasons and pipe loading calculations shall be submitted with the proposed method of pipe protection to the City Engineer for approval. Design services shall meet the minimum building elevation based on the lot topography in order to avoid excessively deep service inspection assemblies.

SECTION 6 - SANITARY SEWER SYSTEM DESIGN CRITERIA

.2 Curved Sewers:

- (a) Horizontal curves will be permitted where the configuration of the property lines requires curvature for a constant offset and where the design velocity exceeds 1m per second.
- (b) Radius of curvature shall be uniform throughout the curves and shall not be less than 60m radius, or the manufacturer's minimum pipe radius, whichever is greater. Miter bends shall not be used unless otherwise approved by the City Engineer.
- (c) Vertical curves may be approved where excessive depths or rock cuts are to be avoided or where energy dissipation is required.
- (d) Only one vertical and/or horizontal curve shall be permitted between manholes.

.3 Location of Sewers:

- (a) Wherever possible, sewers shall be located on the high side of the street centre line where only the high side is served by the sewers and on the low side of the street where both sides are served by the sewers. Normal sanitary sewer main offsets are shown in the standard drawings for roadways. Wherever possible, the sewer shall be located on the opposite side of the street centre line from the watermain and at a constant offset from the property line.
- (b) Sanitary sewers and service connections shall be located not less than 3.0m horizontally and 0.45m vertically distant from all water pipes, unless otherwise approved by the Provincial Department of Health.
- (c) Sanitary sewer mains may be installed in a common trench with storm sewers provided the minimum outside pipe separation is 300mm.
- (d) All lots shall be provided with a sanitary sewer service connection unless otherwise approved by the City Engineer. Service connections shall be located to the offsets as shown on Standard Drawing No. T-7.

.3A Utilities in Private Lands

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

- (a) The design of utilities shall avoid crossing private lands as much as possible.
- (b) Utilities following property boundaries across private lands shall generally be offset a minimum 2.0m from the property boundary. **(REVISED NOVEMBER 2016)**
- (c) Appurtenances such as manholes, valves, etc., shall not be located on property boundaries.
- (d) Utilities shall not cross private parcels in such a manner that they render the property unusable. Special consideration must be given to ensure the location of the utility crossing minimizes the limitations on the future use of the property.
- (e) For minimum widths of statutory right-of-way and working widths refer to Appendix D.
- (f) For a sample statutory right-of-way condition sheet, refer to Appendix C, Standard Drawing No. RW-2.
- (g) For an Easement Release and Inspection Form Following the Construction of the Utility, refer to Appendix C.

SECTION 6 - SANITARY SEWER SYSTEM DESIGN CRITERIA

.4 Service Connection Lengths, Grade and Alignment:

- (a) The maximum length of a sanitary sewer service connection as measured horizontally between the sanitary sewer and the property line shall be 30m. Sanitary sewer services longer than 30m shall require approval by the City Engineer. All inspection assemblies required for service connections in excess of 30m in length shall be shown on the design drawings.
- (b) Service connections shall be designed at a grade of not less than two percent (2%) unless otherwise directed by the Engineer. **(REVISED NOVEMBER 2016)**

.4A Number of Service Connections per Lot

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

.5 Selection of Pipe Material and Class:

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

6.04A MANHOLES

- .1 Distances between manholes shall not exceed 120m, unless otherwise approved by the City Engineer.
- .2 Manholes shall be located at grade and alignment changes, at pipe size changes, at the upstream end of all gravity sewers, and at the junctions of all gravity sewers.
- .3 Cleanouts may not be substituted for manholes at the upstream end of gravity sewers. Temporary cleanout structures may only be used at the discretion of the City Engineer where there is development phasing. **(REVISED NOVEMBER 2016)**
- .4 Where the difference in elevation between incoming and outgoing sewers exceeds 600mm, standard drops for pipe sizes 375mm or less shall be used as shown in the standard drawings. Differences in elevation between 150mm and 600mm shall be avoided where possible. Inside drops into an existing standard diameter manhole may be permitted at the discretion of the City Engineer, only under exceptional circumstances. The inside drop manhole shall accommodate the incoming sewer without compromising working space within the manhole. **(REVISED NOVEMBER 2016)**

SECTION 6 - SANITARY SEWER SYSTEM DESIGN CRITERIA

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

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

- .6 Where cast-in-place type manholes are proposed, design and construction details shall be submitted to the City Engineer for approval.
- .7 Manholes shall be located to avoid any conflict with curb and gutter or sidewalks.
- .8 A watertight manhole frame and cover shall be required for all sewer manholes located in areas where flooding can occur or in areas subject to vandalism (i.e. Parks, undeveloped rights-of-way, etc.).

6.05 PUMPING STATIONS

- .1 This section applies to all municipal owned and operated sanitary sewer pumping stations. Properties serviced by individual sewer pumps shall be connected to the municipal sewer system by a gravity service connection from the property line to the municipal sewer system. Non-municipal owned sewer pumps shall conform to the Provincial Health Branch requirements and the City of Nanaimo Building By-laws.
- .2 Sanitary sewer pumping stations shall be permitted only at locations where gravity connections from an existing or proposed trunk sewer cannot be provided. Pump stations require approval from the City Engineer. The extent of the works and technical specifications shall be determined on a site specific basis at the discretion of the City Engineer. **(REVISED NOVEMBER 2016)**

6.06 FORCE MAINS

- .1 All forcemains shall be designed for a 1m/s minimum velocity and a detention time at minimum design ADWF not exceeding 12 hours.
- .2 Forcemains shall be designed without high points unless otherwise approved by the City Engineer. If approved, an air-relief valve shall be provided at high points in the line.
- .3 The top of the forcemain shall be below the hydraulic grade line at minimum pumping rate.

SECTION 6 - SANITARY SEWER SYSTEM DESIGN CRITERIA

6.07 SIPHONS

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

SECTION 6 - SANITARY SEWER SYSTEM SPECIFICATIONS

6.20 SCOPE

- .1 This specification refers to gravity sewer pipe and appurtenant fittings for sanitary sewers. Only those products approved by the City Engineer and listed in the City of Nanaimo Approved Products List will be accepted for installation.
- .2 Refer to Section 4 - Trench Excavation, Bedding and Backfill for related specifications.

6.21 MATERIALS TESTING

- .1 If, in the opinion of the Engineer, testing is required, the Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates inadequacies, additional testing may be required by the Engineer.
- .2 The Contractor as directed by the Engineer shall supply specimens or samples for testing.
- .3 The types of tests listed below may be required by the Engineer unless in the opinion of the Engineer other testing is required.
- .4 Joints for sanitary sewer main pipe and fittings and service connection pipe and fittings shall be capable of meeting the following exfiltration tests. The Engineer may require that these tests be carried out by the Contractor or his supplier prior to acceptance of pipe on the project.

(a) Pipes in Proper Alignment:

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

(b) Pipes in Maximum Deflected Position:

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

(c) Pipes in Maximum Lateral Misalignment:

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

SECTION 6 - SANITARY SEWER SYSTEM SPECIFICATIONS

6.22 PIPING, FITTINGS AND SERVICES

- .1 The sizes and types of pipe to be used are shown on the drawings.
- .2 Concrete Pipe:
 - (a) Non-reinforced concrete pipe and fittings shall conform to ASTM C14M, Class 3, to a maximum diameter of 600mm and shall be designed with flexible rubber gasket joints conforming to ASTM C443M.
 - (b) Reinforced circular concrete pipe and fittings shall conform to ASTM C76M, Class III or higher, for all pipe greater than 600mm diameter and shall be designed with flexible rubber gasket joints conforming to ASTM C443M.
 - (c) Pipe with chips, cracks, porous concrete or any other defects which impair joint sealing or durability will not be accepted.
- .3 Polyvinyl Chloride (PVC) Pipe (Smooth Profile):
 - (a) Pipe and fittings up to 675mm diameter shall be DR35. Pipe and fittings shall have a minimum pipe stiffness of 320kPa at 5.0% deflection when tested in accordance with ASTM D2412.
 - (b) Pipe and fittings shall be manufactured to the following specifications:

100mm - 375mm dia. to ASTM D3034 and CSA B182.2
450mm - 675mm dia. to ASTM F679 and CSA B182.2
 - (c) Pipe and fittings shall include integral bell and spigot ends with stiffened wall section and a formed groove for a rubber gasket conforming to ASTM F477.
 - (d) All PVC sanitary gravity main pipes shall be green in colour.
- .4 Ductile Iron Pipe:
 - (a) Pipe and fittings shall conform to ASTM A746 or as approved by the City Engineer.
- .5 Polyvinyl Chloride (PVC) Service Pipe:
 - (a) All sanitary service inspection assemblies shall be white in colour.
 - (b) Sanitary service connections of 100mm diameter shall be DR28 and conform to CSA B182.1. Pipe and fittings shall have elastomeric seal joints, locked in gasket and integral bell joint features.
 - (c) Sanitary service connections greater than 100mm diameter shall be as specified for PVC (smooth profile) mainline pipe.
- .6 High Density Polyethylene (HDPE) Pipe (Smooth Profile):
 - (a) Pipe shall conform to CGSB 41-GP-25M. Pipe material shall conform to ASTM D1248 Type III, Class C, Category 5, Grade PE35-10.
 - (b) Minimum acceptable pipe class shall be DR26 with a hydrostatic design stress of 10MPa.
 - (c) All pipe shall bear the pipe series designation and manufacturers name.

SECTION 6 - SANITARY SEWER SYSTEM SPECIFICATIONS

- (d) Fittings for polyethylene pipe, if required, shall be detailed and manufactured by the pipe manufacturer. Miter bends shall be fiberglass reinforced. Pipe deflected up to manufacturer's recommended minimum radius may be used in place of fabricated miter bends and to form the required vertical and horizontal curves. Polyethylene fittings shall have a pressure rating at least equal to that of the pipe being joined.

6.22A FORCE MAINS

- .1 The sizes and types of pipes to be used are shown on the drawings.
- .2 Ductile Iron Pipe:
 - (a) Pipe shall conform to AWWA C150 and C151 and shall be cement mortar lined in accordance with AWWA C104.
 - (b) Joints shall be a mechanical type conforming to AWWA C111 or shall be rubber gasket, bell and spigot tyton joint.
- .3 Polyvinyl Chloride (PVC) Pressure Pipe:
 - (a) Pipe shall be ULC approved and have cast iron pipe equivalent outside diameter.
 - (b) Pipe shall be manufactured to the following specifications:

100mm - 300mm dia. to	AWWA C900 and CSA B137.3
350mm - 900mm dia. to	AWWA C905 and CSA B137.3
 - (c) Pipe shall be compatible with mechanical and push-on joint fittings and valves without the use of special adapters.
 - (d) Pipe shall include push-on integrally thickened bell and spigot type joints conforming to ASTM D3139 with single elastomeric gasket conforming to ASTM F477.
 - (e) All PVC sanitary force main pipe shall be white in colour. **(REVISED NOVEMBER 2016)**
- .4 High Density Polyethylene (HDPE) - Smooth Profile:
 - (a) High Density Polyethylene (HDPE) pipe shall conform to Section 6.22.6, except that the minimum acceptable pipe class shall be DR21.

6.23 JOINTS

- .1 Sanitary sewer main pipe and fittings and service connections pipe and fittings shall be jointed with a rubber gasket or other preformed, factory-manufactured gasket or approved material designed for use with the specified pipe. Solvent connected joints and fittings will not be permitted.
- .2 High Density Polyethylene (HDPE) Pipe (Smooth Profile) Joints:
 - (a) Joints shall be by thermal butt-fusion and constructed in accordance with the manufacturer's specifications.
 - (b) Flange joints shall be used to join long sections of butt-jointed pipe or as shown on the construction drawings.

SECTION 6 - SANITARY SEWER SYSTEM SPECIFICATIONS

- (c) Flanges for polyethylene pipe shall be slip-on type installed in conjunction with stub ends supplied by the pipe manufacturer. The flanges shall be Class 150 meeting ANSI B16.5 drilling dimensions. Flanges shall be carbon steel.
- (d) All flanged joints shall be separated by a neoprene gasket bonded to one of the flange faces. Neoprene for flange gaskets shall be 3mm thick with holes drilled for flange bolts and size equal to flange diameter.
- (e) Flanged joints and flange bolts shall be stainless steel, complete with isolation washers.
- (f) Refer to Section 6.46 for fitting and joint installation.

6.24 SERVICE JUNCTIONS

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

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

.2 PVC Pipe (Smooth Profile):

- (a) Service connections to PVC mainline pipe shall be made with extrusion molded PVC or fabricated PVC fittings manufactured to ASTM D3034, CSA B182.1 and CSA B182.2.
- (b) The use of saddles instead of manufactured wye fittings shall require approval by the City Engineer. Refer to Section 6.48 for service connection junction installation.

.3 PVC Pipe (Ribbed Profile):

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

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

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

SECTION 6 - SANITARY SEWER SYSTEM SPECIFICATIONS

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

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

6.25 PRECAST MANHOLE SECTIONS

- .1 Unless otherwise approved, all manhole sections shall be precast reinforced concrete in accordance with ASTM C478.
- .2 All precast sections shall be complete with ladder rungs.
- .3 O-ring rubber gaskets shall conform to ASTM C443.
- .4 Refer to Section 6.51 for precast manhole sections installation.

6.25A PRECAST MANHOLE BASES

- .1 Precast manhole bases shall be reinforced concrete in accordance with ASTM C76 Class III or better.
- .2 All dimensions, specifications and installations shall conform to the requirements for cast-in-place manhole bases in accordance with Section 6.49 – Cast-In-Place Manhole Concrete Bases, Section 6.49A - Precast Manhole Bases and the Standard Drawings.
- .3 Pipe alignment, grade and invert elevations in the precast manhole bases shall conform to the construction drawings.

6.26 MANHOLE TOPS

- .1 Manhole tops shall be flat slab, precast concrete. Tops shall be reinforced to meet CS600 loading conditions. Precast tops shall conform to ASTM C478 with approved offset opening for frame and cover.

6.27 MANHOLE COVERS AND FRAMES

- .1 Covers and frames shall be cast iron and certified to meet CS600 loading requirements with the bearing faces of the cover to be frame machined for a non-rocking fit.
- .2 Patterns, dimensions and weights shall be in accordance with the Standard Drawings. Covers shall have "CITY OF NANAIMO SANITARY SEWER" permanently embossed on the cover.
- .3 Standard manhole frame and cover shall conform to Standard Drawing No. S-9 - Sanitary Manhole Cover and Frame.
- .4 Utility chamber manhole frame and cover shall conform to Standard Drawing No. S-10.

SECTION 6 - SANITARY SEWER SYSTEM SPECIFICATIONS

- .5 A watertight manhole frame and cover, if required shall conform to Standard Drawing No. S-15 - Watertight Sanitary Manhole Frame and Cover.
- .6 Covers located in statutory rights-of-way shall be permanently embossed with the additional wording "DO NOT COVER".
- .7 Refer to Section 6.53 for frames and covers installation.

6.28 MANHOLE STEPS

- .1 Steps shall conform to ASTM C478 for manhole steps and ladders and shall be: 19mm diameter aluminum alloy conforming to CSA S157.
- .2 Refer to Section 6.54 for manhole steps installation.

6.29 -NOT USED- (**REVISED NOVEMBER 2016**)

6.30 CONCRETE

- .1 The compressive strength of concrete for manhole bases shall be not less than 20MPa at 28 days.
- .2 All concrete work shall conform to Section 11 - Reinforced and Plain Concrete Works.

6.31 PRECAST CONCRETE GRADE RING

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

6.32 TEMPORARY CLEANOUT FRAMES AND COVERS

- .1 Temporary cleanout structures may only be used at the discretion of the City Engineer where there is development phasing.
- .2 Temporary cleanout frames and covers shall be as specified for sanitary manhole frames and covers. (**REVISED NOVEMBER 2016**)

6.33 PIPE AND FITTINGS FOR DROP MANHOLE STRUCTURES

- .1 Pipe and fittings for drop manhole structures shall be as specified under Section 6.22 – Piping, Fittings and Services and Section 6.23 - Joints.
- .2 Refer to Section 6.55 for drop manhole structure installation.

SECTION 6 - SANITARY SEWER SYSTEM SPECIFICATIONS

6.34 - NOT USED -

6.35 MANHOLE AND TEMPORARY CLEANOUT LID MARKERS

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

6.36 SERVICE BOXES

- .1 Service boxes for single sanitary sewer services shall be 300 x 500mm concrete boxes complete with cast iron traffic cover marked "Sewer" and concrete extension sections as required.
- .2 Service boxes for twin sanitary sewer services shall be 425 x 750mm concrete boxes complete with steel traffic cover marked "Sewer" and concrete extension sections as required. .

6.37 PUMPING STATIONS

- .1 The specifications shall be determined on a site specific basis at the discretion of the City Engineer. **(REVISED NOVEMBER 2016)**

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

6.40 TRENCH EXCAVATION, BEDDING AND BACKFILL

- .1 Refer to Section 4 - Trench Excavation, Bedding and Backfill for installation requirements.

6.40A PIPE ALIGNMENT AND GRADE

- .1 The pipe shall be laid on the alignment and grade in accordance with the construction drawings. Methods to maintain pipe alignment and grade must be approved by the Engineer. Each pipe shall be checked for line and grade as it is installed.
- .2 Unless otherwise directed by the Engineer, tolerances for pipe alignment and grade shall be:

Alignment	=	± 50mm
Grade	=	± 10mm

6.41 PIPE CUTTING

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

6.42 PIPE INSTALLATION

- .1 Pipe shall be installed in strict accordance with the manufacturer's recommended practice.
- .2 Pipe shall be checked before being lowered into the trench to ensure that no foreign material, manufacturer's defects, or cracks exist that might prevent the proper jointing of the pipe or its operation.
- .3 The open end of the pipe in the trench shall be suitably covered to prevent entrance of trench water and other material during periods when pipe is not being installed.
- .4 Precautions shall be taken to ensure that displacement of the pipe in the trench does not occur through soil displacement or floatation due to the presence of trench water. Pipe that has been displaced shall be removed from the trench and re-laid.
- .5 Lifting holes in concrete pipe shall be plugged with prefabricated plugs in non-shrink grout, or other plugs recommended by the pipe manufacturer.
- .6 The contractor shall use methods for installing pipe in an auger hole or casing pipe as described on the construction drawings.

6.42A FORCE MAIN INSTALLATION

- .1 Force mains shall be installed according to installation requirements in Section 6.42 – Pipe Installation.
- .2 Thrust blocking to be installed in accordance with Section 5.47 - Pipe Restraint.

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

6.43 JOINTS AT RIGID STRUCTURES

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

6.44 HORIZONTAL AND VERTICAL CURVES

- .1 Pipe on horizontal and vertical curves shall be laid true to the curve of the radius shown on the drawings. Variations in vertical curves and grades within the allowable pipe deflection may be allowed where approved by the Engineer.

6.45 DEFLECTION

- .1 The amount of pipe deflection at joints and couplings shall be the limit as specified by the manufacturer. PVC pipe shall not be deflected at joints or couplings.

6.46 FITTINGS AND JOINTS

- .1 Fittings shall be installed at the locations shown on the construction drawings or as directed by the Engineer. Fittings shall be installed in accordance with the manufacturer's specifications.
- .2 High Density Polyethylene (HDPE) Pipe (Smooth Profile):
 - (a) Pipe shall be joined by the thermal butt fusion method.
 - (b) The contractor shall make arrangements to have the pipe jointing carried out by the pipe manufacturer or certified personnel, familiar with the jointing technique, using equipment and techniques specifically designed for the pipe diameter and material being jointed.
 - (c) Where required, flanged joints shall be used for connecting long pipe sections.
 - (d) The joint shall consist of a polyethylene stub end butt fused to the end of pipe and a carbon steel slip-on flange.
 - (e) Refer to Section 6.23 for joint specifications.
- .3 Sewage Force Mains:
 - (a) Install thrust blocking in accordance with Section 5.47 – Pipe Restraint.

6.47 CONNECTIONS TO EXISTING PIPING AND APPURTENANCES

- .1 All connections to existing piping, services, and appurtenances shall be made by City of Nanaimo forces unless otherwise authorized by the City Engineer.
- .2 All connections to existing piping and services shall utilize a manufactured rubber gasket bell and spigot joint or dresser coupling designed for the types of pipes to be connected.
- .3 The use of field joints or rubber repair couplings shall require the approval of the Engineer.

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

- .4 Rubber repair couplings must have 4 stainless steel clamps complete with stainless steel anti shear band. Only those products approved by the City Engineer will be accepted for installation.
- .5 Slip couplers shall be used on PVC pipes. Rubber repair couplings are not to be used on PVC pipes.

6.48 SERVICE CONNECTION JUNCTIONS

- .1 Locations of service connection junctions to the sewer shall be installed as shown on the construction drawings or as directed by the Engineer during construction.
- .2 Where service connections are not constructed in conjunction with the mains, fittings shall be provided with approved caps or plugs and markers as specified in Section 6.59 – Service Connection Installation, clause 6.59.3(i). Caps or plugs for sanitary sewers shall be watertight and suitably blocked to withstand test pressures.
- .3 Concrete Pipe (Reinforced and Non-reinforced):
 - (a) Field break-in and mortar patch joints shall not be used unless approved by the City Engineer. If approved, the following shall apply:
 - (i) Service connections shall be manufactured using a sanded PVC male and stub pipe with integral bell.
 - (ii) Break into the pipe by coring to within 40mm of the outside diameter of the service stub. All exposed reinforcing steel shall be removed.
 - (iii) Insert the stub into the core ensuring that no portion of the service stub protrudes past the inside of the concrete pipe wall, and the stub length shall be equivalent to the thickness of the concrete pipe wall and the length of the stub's integral bell.
 - (iv) Prepare non-shrink, fast setting cementitious grout with a 3:1 sand/cement mix to a "dry pack" consistency. Pack grout tightly into the void between the stub and the pipe and mound around the stub for lateral support.
 - (v) Hand finish interior and exterior grout surfaces to a smooth finish.
 - (vi) In order to prevent damage to the field joint, allow sufficient time for grout to develop strength prior to installation of connecting pipe or backfilling.
 - (vii) Installation shall be inspected by the Engineer prior to backfilling.
 - (b) Refer to Section 6.24 for service junction specifications.
- .4 PVC Pipe (smooth profile):
 - (a) Service saddle connections shall not be used unless approved by the City Engineer.
 - (b) If approved, installation of service saddle connections shall conform to the following:
 - (i) Drill hole into mainline pipe to the exact dimension of the new connection.
 - (ii) The use of saddles instead of manufactured wye fittings shall require approval by the City Engineer. Saddles shall be cast iron with alignment rings complete with stainless steel bands.
 - (iii) Attach service saddle in accordance with the manufacturers specifications.

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- (c) Refer to Section 6.24 for service junction specifications.
- .5 PVC Pipe (ribbed profile):
 - (a) Installation of service saddle connections shall conform to Section 6.48.4
- .6 High Density Polyethylene (HDPE) Pipe (Smooth Profile):
 - (a) Service connections to mainline pipe using manufactured fittings shall be in strict accordance with manufacturer's instructions.
 - (b) Connection of HDPE service junctions to non-pressurized PVC service pipe shall be with flexible couplings. Flexible couplings shall be manufactured from elastomeric PVC, and be held in place with series 300 stainless steel worm gear clamps.
 - (c) Refer to Section 6.24 for service junction specifications.
- .7 High Density Polyethylene (HDPE) Pipe (Open Profile):
 - (a) Installation of service saddle connections shall conform to Section 6.48.4.
 - (b) Refer to Section 6.24 for service junction specifications.
- 6.49 CAST-IN-PLACE MANHOLE CONCRETE BASES (REVISED NOVEMBER 2016)
 - .1 All water shall be removed from the excavation prior to placing base concrete. The base shall be constructed such that the first section of a precast section can be set plumb with uniform bearing throughout its full circumference.
 - .2 If material in the bottom of the trench is unsuitable for support, the bottom shall be over excavated to firm base as determined by the Engineer and backfilled to the required grade with thoroughly compacted base gravel as specified for trench bottom stabilization under the applicable item included in Section 4 – Trench Excavation, Backfill and Bedding.
 - .3 Where over excavation and backfill with base gravel is not practical, special structural support shall be provided as specified for trench bottom stabilization under the applicable item included in Section 4 – Trench Excavation, Backfill and Bedding.
 - .4 Concrete manhole bases shall be constructed as shown on the drawings. Pipes and fittings through the manhole shall be supported on concrete blocks and the concrete base poured around the pipe to a depth of at least 150mm below the bottom of the pipe and up to the springline of the pipe. Install rubber manhole adapter rings on all plastic pipe installed in the manhole base.
 - .5 Invert elevations of pipes at the manhole shall be checked by the Contractor prior to and following placement of base concrete around the pipe to ensure that all pipes are installed at the design elevation.
 - .6 Variations in manhole inverts from established grade or elevation shall be corrected.
 - .7 Manhole channeling shall be constructed as shown on Standard Drawing S-1 or as shown on the construction drawings. Channeling shall be constructed to have a minimum 0.3m straight section before the change in direction within the manhole. **(REVISED NOVEMBER 2016)**

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- .8 The channels in the base of manholes shall be shaped and finished to provide smooth passage for the sewage in order to minimize head losses and deposits at bends and at junctions of channels. **(REVISED NOVEMBER 2016)**
- .9 Channels shall be accurately formed. The practice of forming channels roughly to shape and finishing with cement mortar will not be permitted. The channels shall be steel trowel finished. **(REVISED NOVEMBER 2016)**
- .10 Benching in manholes shall be sloped to drain. While green, the concrete benching shall be given a broom finish to produce a non-skid surface. **(REVISED NOVEMBER 2016)**

6.49A PRECAST MANHOLE BASES

- .1 Installation of precast manhole bases shall conform to Section 6.49 – Cast-In-Place Manhole Concrete Bases.
- .2 Precast manhole bases shall be placed on 150mm thick base of 38mm drainrock. **(REVISED NOVEMBER 2016)**
- .3 Plastic and concrete pipes installed in the precast manhole base shall utilize rubber manhole adapter rings to seal the connection.
- .4 Refer to Section 6.25A for precast manhole bases specifications.

6.50 -NOT USED- **(REVISED NOVEMBER 2016)**

6.51 PRECAST MANHOLE SECTIONS

- .1 Precast manhole barrel sections shall be placed plumb.
- .2 Joints between the top riser and the cover slab shall be made watertight with cement mortar. Prior to placing sections, the mating faces shall be thoroughly soaked with water and a layer of cement mortar shall be spread on the lower face. After sections are placed, excess mortar which has been squeezed out shall be removed and the joint made flush inside and out.
- .3 Joints between precast manhole barrels must utilize O-ring gaskets and shall conform to the manufacturer's specifications. The inside surface of the precast barrel at the O-ring joints shall be filled with cement grout to a smooth finish.
- .4 Damaged O-ring manhole joints require removal and replacement of damaged manhole section. Mortar patching of damaged area if approved by the Engineer, shall require the removal of the O-ring gasket and installation as per Section 6.51.2.
- .5 Refer to Section 6.25 for precast manhole sections specifications.

6.52 CONCRETE

- .1 Concrete work shall be as specified under the Section 11 - Reinforced and Plain Concrete Works.

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

6.53 FRAMES AND COVERS

- .1 Frames shall be set on precast concrete grade rings to bring the cast iron manhole frame up to grade as shown on the Standard Drawings. Contractor to install concrete grade rings to a minimum of 50mm thick and to a maximum of 100mm thick. The concrete grade rings shall be laid in common bond with raked mortar joints and shall be mortared inside and outside of the manhole. **(REVISED NOVEMBER 2016)**
 - (a) Fine grade elevation adjustments of frames shall be done with a minimum of 3, steel only, shims equally spaced.
- .2 Manhole covers shall be installed:
 - (a) for unpaved areas, covers shall have a 1.5m x 1.5m, 50mm thick asphalt apron. Covers shall be set flush with the asphalt surround.
 - (b) for paved areas, covers shall be flush with finished pavement grade or a maximum of 6mm lower than finished pavement grade. Covers shall not protrude above the finished pavement.
- .3 Steel manhole riser rings shall be used in easements only.
- .4 The inside surface of the manhole frame shall be painted yellow with an enamel rust paint in accordance with the manufacturer's specifications.
- .5 Refer to Section 6.27 for manhole covers and frames specifications.

6.54 MANHOLE STEPS

- .1 Manhole steps shall be installed in manhole sections by the manufacturer unless circumstance dictates otherwise in which case approval must be received from the Engineer.
- .2 The distance from the top of the manhole cover, to the first manhole step, shall conform to WorkSafe BC requirements.
- .3 All steps shall be complete with approved polyethylene anchor insulating sleeves and installed in 25mm to 26mm diameter precast or drilled holes in a manhole section.
- .4 Refer to Section 6.28 for manhole steps specifications.

6.55 DROP MANHOLE STRUCTURES

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

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

6.56 STUBS

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

6.57 TEMPORARY CLEANOUTS

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

6.58 -NOT USED- (*REVISED NOVEMBER 2016*)

6.58A PUMPING STATIONS

- .1 Pump stations shall be constructed in accordance with the approved construction drawings, the installation requirements shall be determined on a site specific basis at the discretion of the City Engineer. (*REVISED NOVEMBER 2016*)

6.59 SERVICE CONNECTION INSTALLATION

.1 Location of Service Connections:

- (a) Service connections are to be installed at the locations and depths as specified by the Engineer. For new connections, where the depth of the service connection exceeds 2m, the service shall be extended into the property the same distance as the depth of the service, up to a maximum distance of 4m. This shall be done during the installation of the service connection from the main to the property.
- (b) At no time shall two or more sanitary services be coupled into one lead crossing the street or right-of-way. Each service shall have its own independent connection into the main sewer.

.2 Grade and Alignment of Service Connections:

- (a) Trenches shall be excavated so that pipe can be installed in a direct line from the service connection fitting at the sewer or from a manhole to the terminus of the service. Service pipe shall be installed at a uniform grade between the terminus at the property line and the junction fitting (or upper end of a service drop) at the sewer. (*REVISED NOVEMBER 2016*)

.3 Sanitary Sewer Service Connection Installation:

- (a) Pipe shall be installed in strict accordance with the manufacturer's recommended practice.
- (b) Pipe shall be checked before being lowered into the trench to ensure that no foreign material, manufacturer's defects, or cracks exist that might prevent the proper jointing of the pipe or its operation.
- (c) The Contractor shall use methods for installing pipe in an auger hole or casing pipe as described in Section 4 - Trench Excavation, Bedding and Backfill.

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

- (d) The trench shall be excavated to provide a minimum cover of 0.75m over the service connection pipe at property line.
- (e) In rock, the trench is to be extended 3m into the property to facilitate future extension of the service connection.
- (f) The trench bottom shall be graded to form a continuous support along the service pipe. All rocks or projections which might prove detrimental to the pipe shall be removed.
- (g) Joints shall be made using the specified couplings. Glued joints shall not be made.
- (h) Approved watertight caps suitably supported by sandbags to prevent leakage shall be installed on sewer services at the terminus of each service.
- (i) A 38mm x 89mm pressure treated wood marker stake shall be placed at the service terminus as shown on the drawings to facilitate future location of the service pipe. This stake shall extend from a point approximately 600mm above ground to 600mm below ground except in locations where the extension of the stake above ground surface would prove hazardous, in which case the stake shall be cut off flush with the ground surface. The stake shall be marked in an approved manner to show the depth of the service pipe invert below the top of the stake. The stake shall be unpainted to visually identify the sanitary sewer service connections. The Engineer will record the invert elevation of the service connection assembly prior to placement of the cap by the Contractor. **(REVISED NOVEMBER 2016)**
- (j) Inspection assemblies shall be installed as shown on the standard drawings.
- (k) The service box shall be installed plumb with the lid 25mm above finished grade in unpaved areas, and 0 - 6mm below finished grade in paved areas.

.4 Riser Service Connections:

- (a) Riser service connections shall be installed as shown on Standard Drawing No.'s S-5 or S-7 in locations shown on the construction drawings. **(REVISED NOVEMBER 2016)**

6.60 CLEANING AND FLUSHING

- .1 On completion of the sewer pipe installation, the pipes shall be cleaned to the satisfaction of the Engineer and the City of Nanaimo Public Works Inspector by power flushing with water to remove all foreign matter.
- .2 Ensure that snow chains are installed at the downstream manhole so that no foreign material passes beyond downstream manhole. Flow through the system shall remain unimpeded at all times while snow chains are installed.
- .3 Begin cleaning from the upstream pipe in the system and proceed downstream. Under no circumstances is the pipe cleaning process to proceed downstream until all contributing upstream pipes have been successfully cleaned and approved by the Engineer, the City of Nanaimo Public Works Inspector or by the City of Nanaimo CCTV contract administrator.
- .4 Manholes shall be cleaned after the upstream section of pipe has been successfully cleaned and approved by the Engineer, the City of Nanaimo Public Works Inspector or by the City of Nanaimo CCTV contract administrator.

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

- .5 Pipes shall be cleaned in the direction of flow and shall not be flushed in a backflush direction unless approved by the City Engineer, by the City of Nanaimo Public Works Inspector or by the City of Nanaimo CCTV contract administrator.
- .6 Under no circumstances shall debris pass beyond the downstream manhole. Active vactoring shall remove all debris at the snow chains installed at the downstream manhole.
- .7 Dispose of debris at approved dump site such as the Regional District of Nanaimo's landfill or by the CCTV contract administrator's approved alternative.
- .8 Decanting of liquid waste accumulated during debris removal is permitted at a controlled release rate, to a maximum of 8 litres per second, at a location approved by the City of Nanaimo CCTV contract administrator.
- .9 Timeframe between cleaning and video inspection of pipeline shall not exceed 24 hrs unless approved by the City Engineer.

6.61 NOTIFICATION TO CITY OF NANAIMO

- .1 The City Inspector shall be given 48 hours notice of all tests.

6.62 LEAKAGE TESTING OF GRAVITY SEWERS

- .1 Leakage tests shall be performed by the Contractor on all sanitary sewers and sewer service connections, manholes and appurtenances.
- .2 Type of Test:
 - (a) Tests on gravity sewers and manholes shall be either exfiltration or infiltration water tests as directed by the Engineer. Manholes shall be tested separately from gravity sewers.
 - (b) In lieu of leakage testing with water, the Engineer may permit testing with low pressure compressed air.
 - (c) Testing shall only be carried out after all underground work is complete.
 - (d) Copies of all test results must be forwarded to the City Inspector.
- .3 Testing Equipment:
 - (a) The Contractor shall furnish all the necessary testing equipment, including suitable removable watertight plugs and test balls, and shall perform the tests in a manner satisfactory to the Engineer. Testing equipment must provide readily observable and reasonably accurate measurements of leakage under the specified conditions. The Contractor must comply with all WorkSafe BC regulations covering the use of air testing, and ensure that safe working practices are used in the application of the test.

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

.4 Water Exfiltration Test:

- (a) On an exfiltration test, the test section shall be sealed at its lower extremity by means of a watertight plug. The test section shall be filled with water such that a minimum hydrostatic head of 600mm is placed on the pipe at its upper extremity. The head of water on the pipe shall be taken as the distance from the top of the pipe being tested to water surface at the point of measurement. The test pressure shall be maintained above the 600mm minimum head for a period of not less than one hour, and unless excess exfiltration requires further testing, not greater than 8 hours. Pressures in excess of 3m water head are not recommended. Damage resulting to pipe as a result of testing shall be repaired by the Contractor at no cost to the owner.
- (b) Manholes shall be tested independent of the sewer pipe for leakage by filling the chamber to the underside of the roof slab with water. The test duration shall be a minimum of three hours. No leakage shall be permitted in manholes.
- (c) In areas where the groundwater table is above the sewer invert level, the test shall be increased by a height equal to the distance from the sewer invert level to the water table elevations.
- (d) Exfiltration test sections shall normally have a manhole at both extremities. If, however, sewer grades are such that a test section cannot be terminated at a manhole without placing excess pressure on the pipe or joints, apparatus shall be provided to enable testing without having manholes at the upper and lower ends of a test section.
- (e) Gravity sewers, service connections and appurtenant structures thereon shall be constructed such that leakage, as evidenced by exfiltration tests, is less than that calculated using the following formula:

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

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

- (f) The above leakage limit will constitute the total maximum allowable leakage of any test section of gravity sewer. Where service connections exist along the test section, the allowable leakage from service pipe calculated by the use of the formula in Section 6.62.4 (e) will be added to that of the main sewer to arrive at the total allowable leakage unless the elevation of the service connection pipe is greater than the maximum water elevation. No additional leakage allowance will be made for manholes existing along the test section.
- (g) The maximum allowable leakage for an exfiltration test will be that calculated by the formula in Section 6.62.4 (e) regardless of the test head of water employed. Where a section of sewer is found to have leakage exceeding the allowable limit, replacement or repairs shall be made to reduce the amount of leakage to or below the allowable limit. Repaired sections shall be retested until they meet the allowable limit.
- (h) All point sources of leakage exceeding 1.2 litres per minute (from poor joints, improper connections, etc.) shall be made watertight by the Contractor to the satisfaction of the Engineer.
- (i) The Contractor shall dispose of the water used for testing in a manner approved by the Engineer.

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

.5 Water Infiltration Tests:

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

.6 Air Test:

- (a) Air test shall not be used with concrete sewers.
- (b) On an air test, the section to be tested shall be plugged at each end and all service laterals, stubs and fittings properly capped or plugged.
- (c) Air shall be supplied to the test section slowly, filling the line to a constant pressure of 24.0 kilopascal (kPa). The air pressure inside the pipe shall not exceed 28kPa except in the case where the groundwater level is above the sewer line being tested. In the event of the groundwater level being above the invert, the air test pressure must be increased by 1.0kPa for each 100mm of groundwater above the invert.
- (d) The air supply is throttled to maintain the internal pressure above 20kPa for a minimum of 5 minutes to stabilize the temperature in the pipe. After stabilization, the air pressure is adjusted to 24.0kPa and the air supply shut off or disconnected. Timing commences and the time required for the line pressure to drop to 20.5kPa is noted.
- (e) If the time required to drop from 24.0 to 20.5kPa is greater than allowable, the test section shall have passed.
- (f) For the air test the minimum time allowable is calculated from the following tables:

Time Requirements for Air Testing

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

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

6.63 TESTING OF FORCE MAINS

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

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

6.64 VIDEO INSPECTING MAINS AND SERVICE CONNECTIONS

- .1 All pipe video inspection including methods of cleaning, equipment and rates of camera travel, shall be in accordance with the UK Water Research Centre's (WRc), Sewage Rehabilitation Manual, most current edition.
- .2 For gravity sewers and service connections, the contractor shall arrange for video inspection to check alignment, grade, and condition of the main sewer pipe including service connection leads.
 - (a) Illumination depth of field shall be no less than 3 joints for standard joint and spigot pipe types to allow for pipe deflection assessments (9m). No dark/opaque circle shall be visible in the middle of this depth of field viewing area.
 - (b) Eliminate steaming and fogging encountered during the inspection survey by introducing forced air flow by means of fan.
 - (c) Camera lens to remain free of grease or other deleterious matter to ensure optimal clarity.
 - (d) Pan and tilt view each service connection (junction) such that the camera looks down the centreline of the service, pause for a minimum of five (5) seconds and note condition of the joint and/or pipe/service interface.
 - (e) Camera guides (Skids) shall not be visible at either side of the pipe during normal camera travel or during Pan & Tilt operation. Configuration of camera/guides shall be altered to alleviate this problem.
 - (f) CCTV push camera work shall be video captured (complete with skids for centering) from the main wye pulling back to entrance point to avoid an invert only view.
 - (g) A winch line shall be provided to support camera travel in steep, slippery or relined pipe sections.
 - (h) Position camera lens centrally in the pipeline with a positioning tolerance of $\pm 10\%$ off the vertical centerline axis of the pipeline. For elliptical pipe the camera to be positioned $\frac{2}{3}$ the height of the pipe measured from the invert.
 - (i) Position camera lens looking along the longitudinal axis of pipeline except when viewing service connections or panning defects.
 - (j) Instantaneous travelling speed of the camera in the pipeline to be as follows:
 - i) 0.1m/s for pipeline of diameter less than 200mm.
 - ii) 0.15m/s for diameters 200mm and larger but not exceeding 310mm: and
 - iii) 0.20m/s for diameters exceeding 310mm.
- .3 The inspection shall include the preparation of:
 - (a) a 4.7GB DVD MPEG4 video data disk. Picture size: NTSC 640x480 pixels, aspect ratio 4:3, 29.97 frames per second @ 8 megabits per second capture rate. Individual MPEG4 video files shall not exceed 1.7GB in size. DVD data disk shall be finalized after burn.
 - (b) a Microsoft Access database CD of the Header and Observation codes as specified by City Engineer.
 - (c) a pipe condition assessment paper report.

All submitted to the Engineer.

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

- .4 The Engineer shall review the, DVD and CD and pipe condition report and provide certification that the condition of the installed pipe is accurately recorded and the pipe installation meets the City of Nanaimo Standards and Specifications.
- .5 The DVD and CD, pipe condition report and certification shall become the property of the City of Nanaimo.
- .6 Variations in line or grade of pipe, from that established by the Engineer prior to installation, and any jointing, pipe cleaning, or other deficiencies discovered during the inspection, shall be rectified. Reinspection of the pipe may be required by the Engineer at the contractor's expense.
- .7 During this test, manhole construction and invert elevations shall be checked and any variations from the established grade, drawings, or specifications, shall be rectified.
- .8 If directed by the Engineer, the contractor shall arrange for a reinspection of the pipe at the contractor's cost, for the warranty inspection one month prior to the end of the maintenance period.
- .9 Video inspection and pipe condition coding shall be undertaken only by personnel with current Canadian certification by a City approved agency.

6.65 SMOKE TESTING

- .1 The Engineer shall arrange for smoke testing of all installed gravity sanitary mains in the presence of the City of Nanaimo Works Inspector.
- .2 The Engineer shall provide as-built service location information to the City of Nanaimo Works Inspector prior to smoke testing.
- .3 Cross-connections noted during the smoke testing shall be corrected and the as-built service location information revised.

6.66 TESTING OF PUMPING STATIONS

- .1 Wet well chambers shall be tested for exfiltration by filling the chamber to the underside of the roof slab with water. The test duration shall be a minimum of three hours. No leakage shall be permitted.
- .2 In areas of high groundwater tables, the engineer may require an infiltration test. No leakage shall be permitted.
- .3 Pumping stations shall be tested using water. Station shall be tested through its operating range to confirm float operation, pumps, controls, alarms, backup power, manual operation and operation with the City of Nanaimo's portable power unit.
- .4 A noise level test shall be required to confirm pumping station and standby power are within specified acceptable limits.

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6.67 PIPE VIDEO AND MANHOLE CONDITION REPORT FORMAT

- .1 Reference plans shall accompany reports with manholes labeled and inspected sections highlighted. Manhole and pipe numbering shall conform with the construction drawings, or if available, City of Nanaimo pipe and manhole numbers. Reports shall be submitted in both digital and hardcopy formats.
- .2 All sewer defects shall be photographed and included with the report and referenced by numbers accordingly.
- .3 The video pipe condition rating report format shall be in accordance with the UK Water Research Centre's (WRc), Sewerage Rehabilitation Manual, most current edition.

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

WRc GRADING SYSTEM

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

SECTION 6 - SANITARY SEWER SYSTEM INSTALLATION

Every video inspected sewer will be assigned a composite score when it scores under each defect category which are added as per the following table:

WRc - SEWER RATING COMPOSITE SCORES

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

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

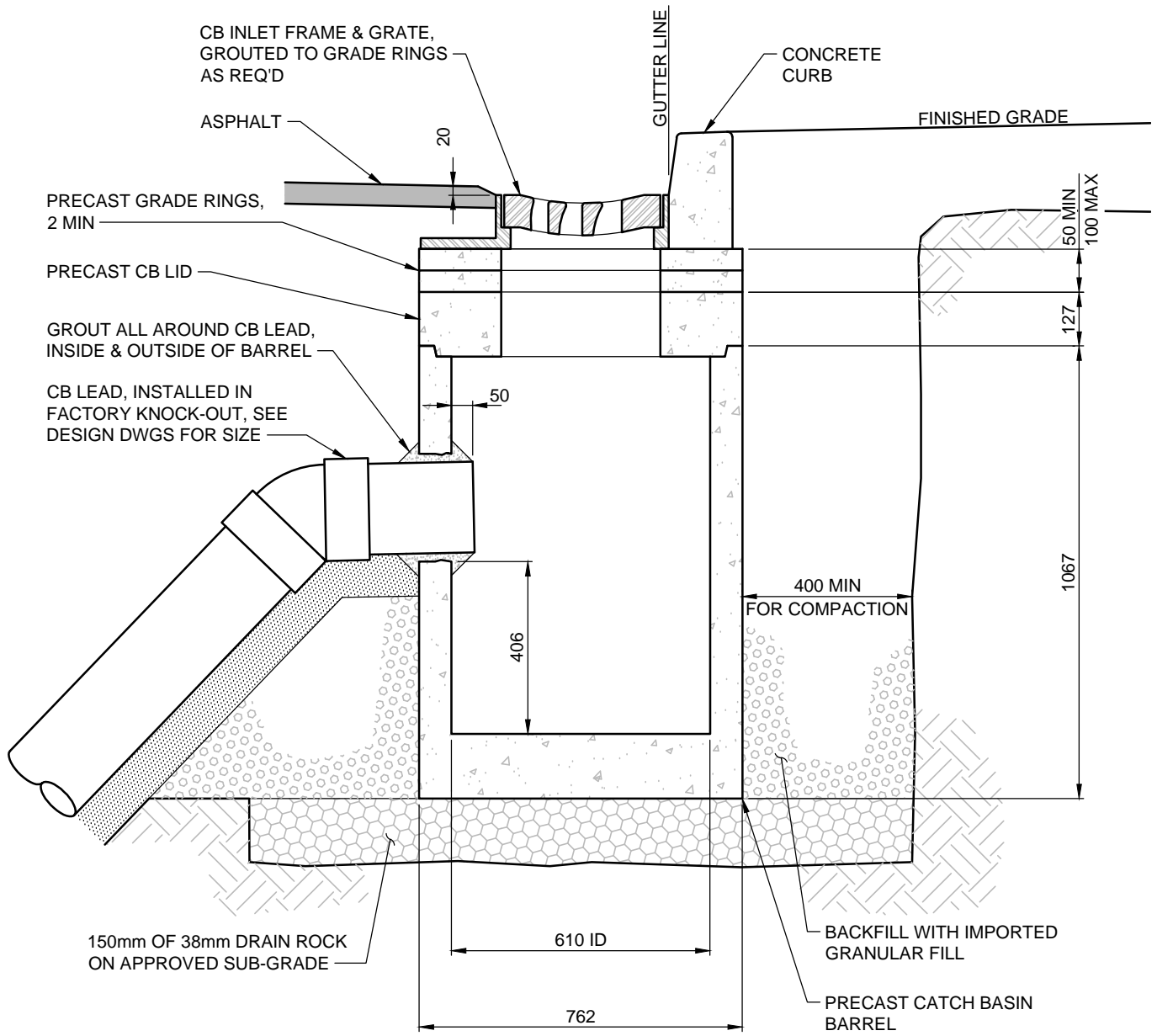
- (a) Date of survey.
- (b) Contractor Project Index No. (i.e. Tape No. V2-1234)
- (c) Survey No.
- (d) Start MH No.
- (e) Finish MH No.
- (f) Line ID No.
- (g) Direction of Camera Travel.
- (h) Street Location (Road Name or RW No.).
- (i) Distance from the manhole rim to pipe invert.
- (j) Length of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

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- .4 All pipe video inspections shall include an annotated map with the following information:
- (a) Manhole and catchbasin locations with labels.
 - (b) City of Nanaimo drawing numbers.
 - (c) Manhole ID numbers (as per the City of Nanaimo GIS numbering system).
 - (d) Catchbasin ID numbers (as per the City of Nanaimo GIS numbering system).
- .5 Computer database file to contain identical survey report information as the printed report exclusive of photographs. Index numbers and distance of survey information shall numerically increase. For an individual survey, whether the information is sorted by index or distance, the result will be in the same order.
- .6 All pipe video inspection operators shall be thoroughly trained with current Canadian certification by a City approved agency.
- .7 Manhole video inspection is not required. Manholes shall be rated as per the following table and form part of the video inspection report.

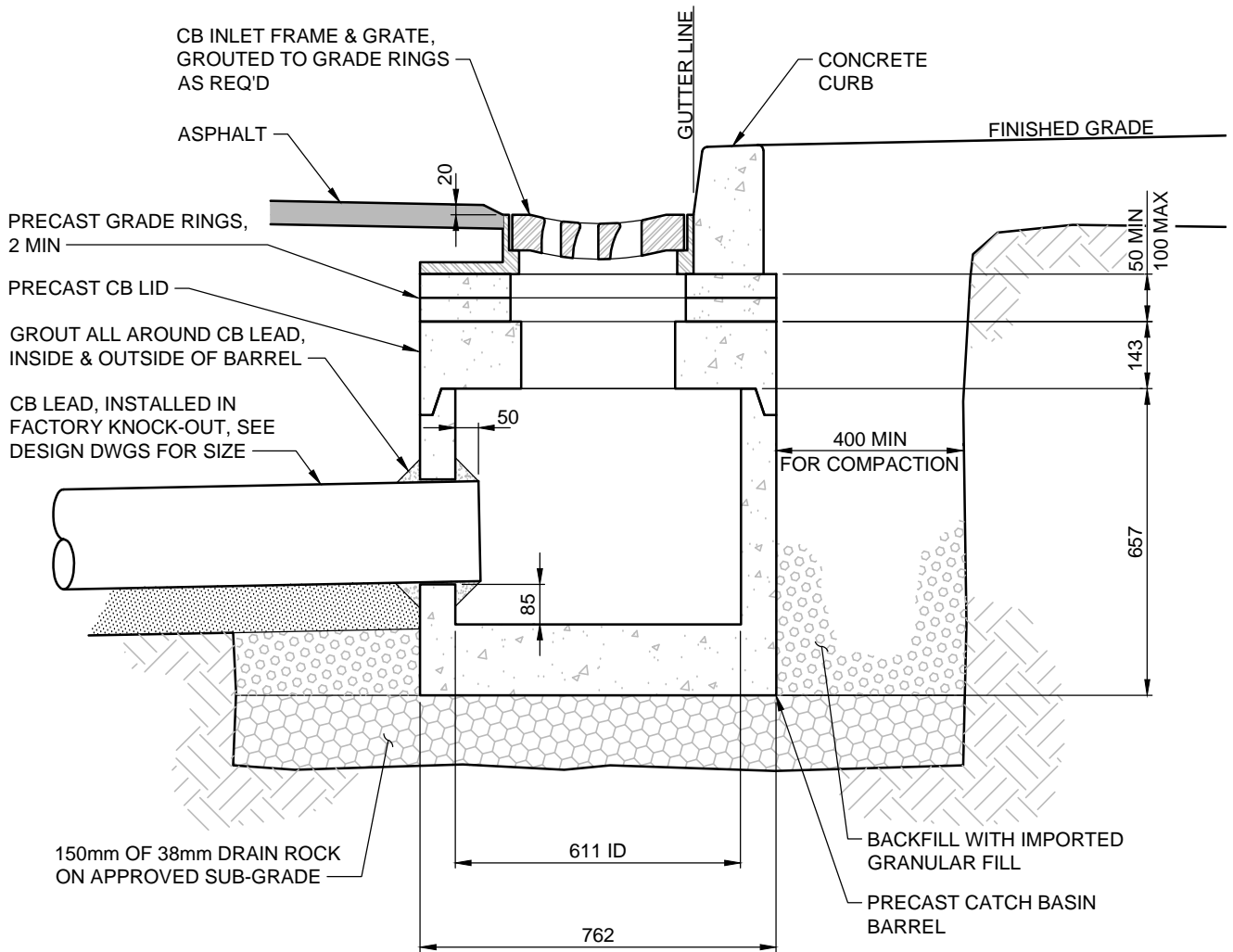
MANHOLE RATING SYSTEM

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



NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR FRAME & GRATE DETAILS, SEE STD DWG SW-6.
3. ALL JOINTS TO BE PRE-WETTED BEFORE MORTAR IS PLACED.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.
6. CATCH BASIN LID TO MEET CS-600 LOADING.

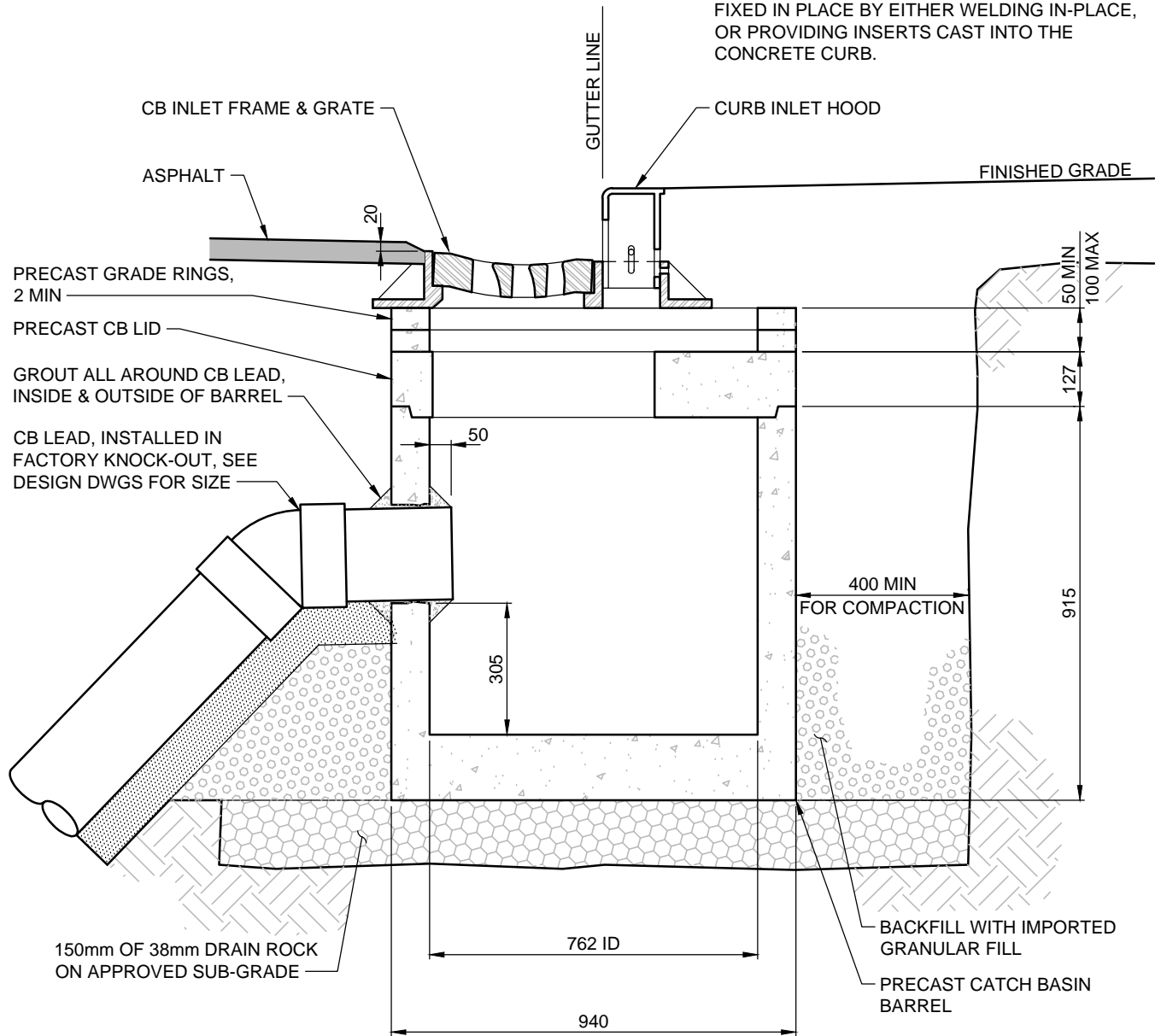


NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR FRAME & GRATE DETAILS, SEE STD DWG SW-6.
3. ALL JOINTS TO BE PRE-WETTED BEFORE MORTAR IS PLACED.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.
6. CATCH BASIN LID TO MEET CS-600 LOADING.

NOTE:

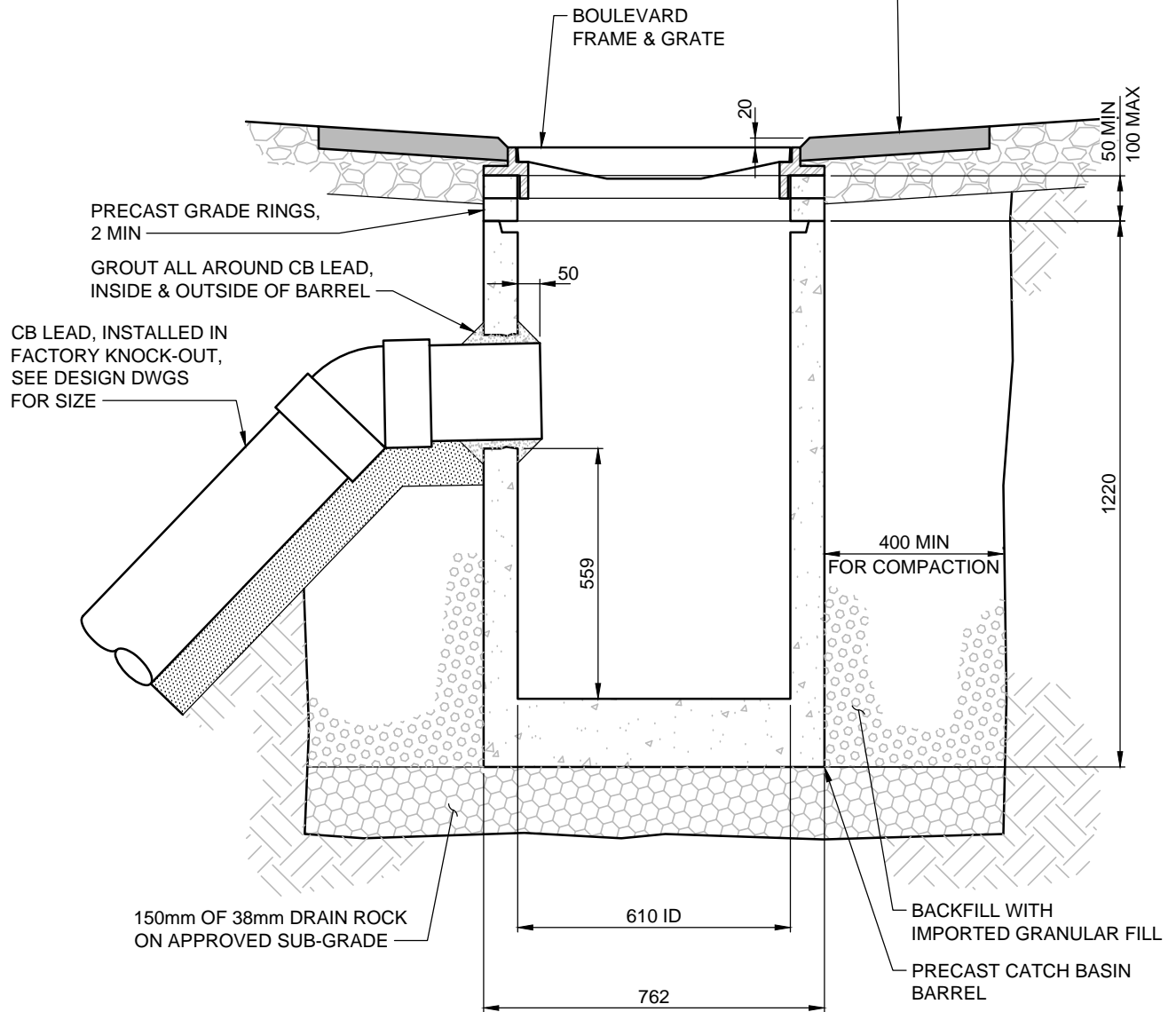
TOP OF HOOD TO BE FLUSH WITH TOP OF CURB. PRIOR TO CASTING THE CONCRETE CURB, THE CURB INLET HOOD IS TO BE PERMANENTLY FIXED IN PLACE BY EITHER WELDING IN-PLACE, OR PROVIDING INSERTS CAST INTO THE CONCRETE CURB.



NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR FRAME & HOOD DETAILS, SEE STD DWG SW-7.
3. ALL JOINTS TO BE PRE-WETTED BEFORE MORTAR IS PLACED.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.
6. CATCH BASIN LID TO MEET CS-600 LOADING.

CATCH BASINS INSTALLED IN GRAVEL SURFACES SHALL HAVE A 50mm THICK x 1.5mØ ASPHALT APRON ON 100mm OF COMPACTED CRUSHED GRAVEL



NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR FRAME & GRATE DETAILS, SEE STD DWG SW-8.
3. ALL JOINTS TO BE PRE-WETTED BEFORE MORTAR IS PLACED.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

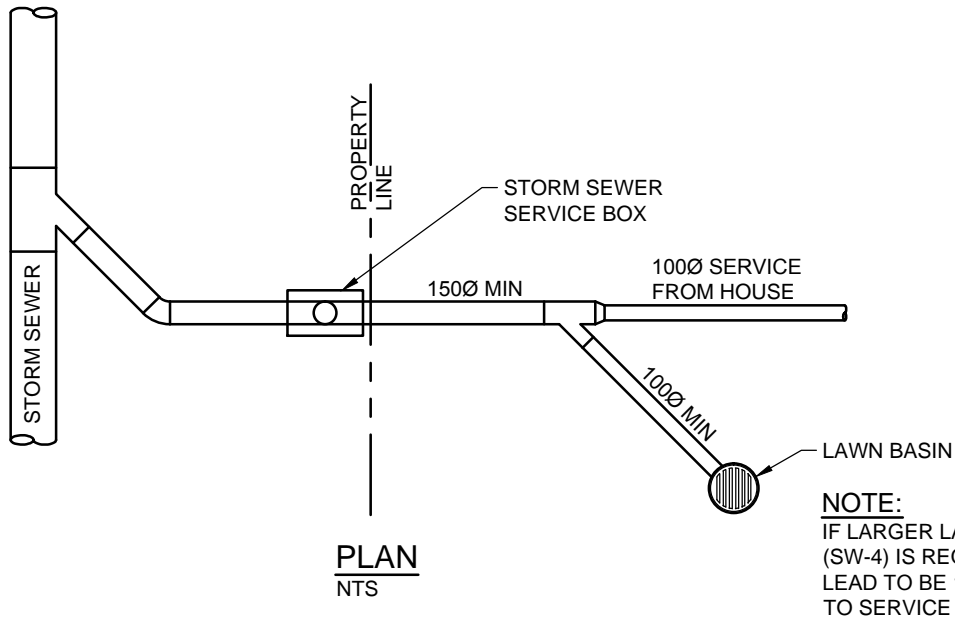
TENTATIVE INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS / W/ISSUE EDITION NOT FINAL DRAFT FINAL DRAFT STANDARD CAD DRAWINGS SECTION 7 DWG SW-4

6.16.2016

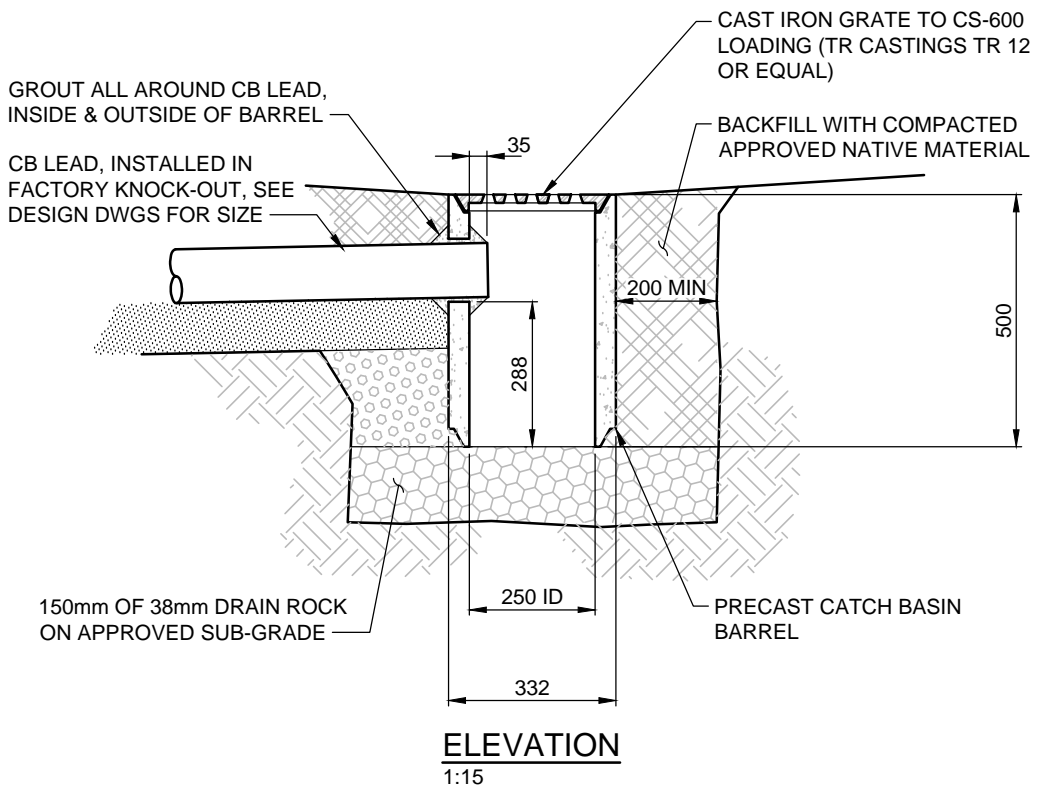


BOULEVARD CATCH BASIN

Scale:	1:15
Created:	JAN 2016
Rev Date:	NOV 2016
Dwg No:	SW-4



NOTE:
IF LARGER LAWN BASIN (SW-4) IS REQ'D, THE CB LEAD TO BE 150Ø PVC TO SERVICE BOX.

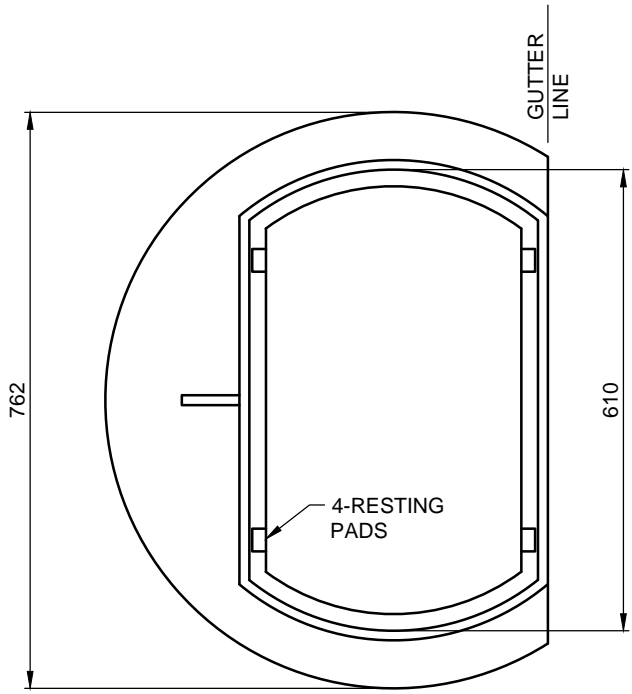


- NOTES:**
1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
 2. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
 3. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

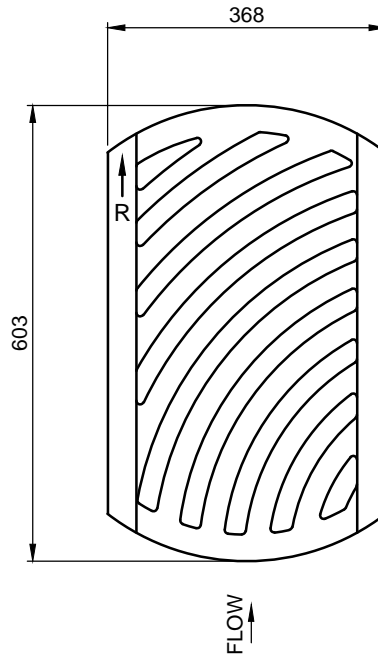


SMALL LAWN BASIN ON PRIVATE PROPERTY

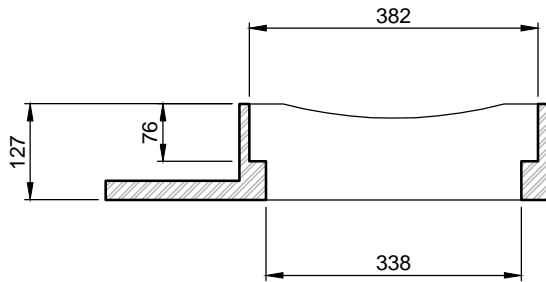
Scale:	1:15
Created:	JAN 2016
Rev Date:	NOV 2016
Dwg No:	SW-5



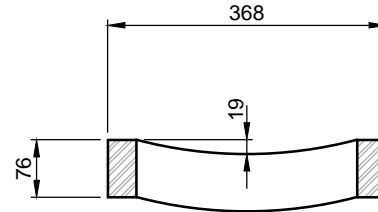
FRAME PLAN



GRATE PLAN



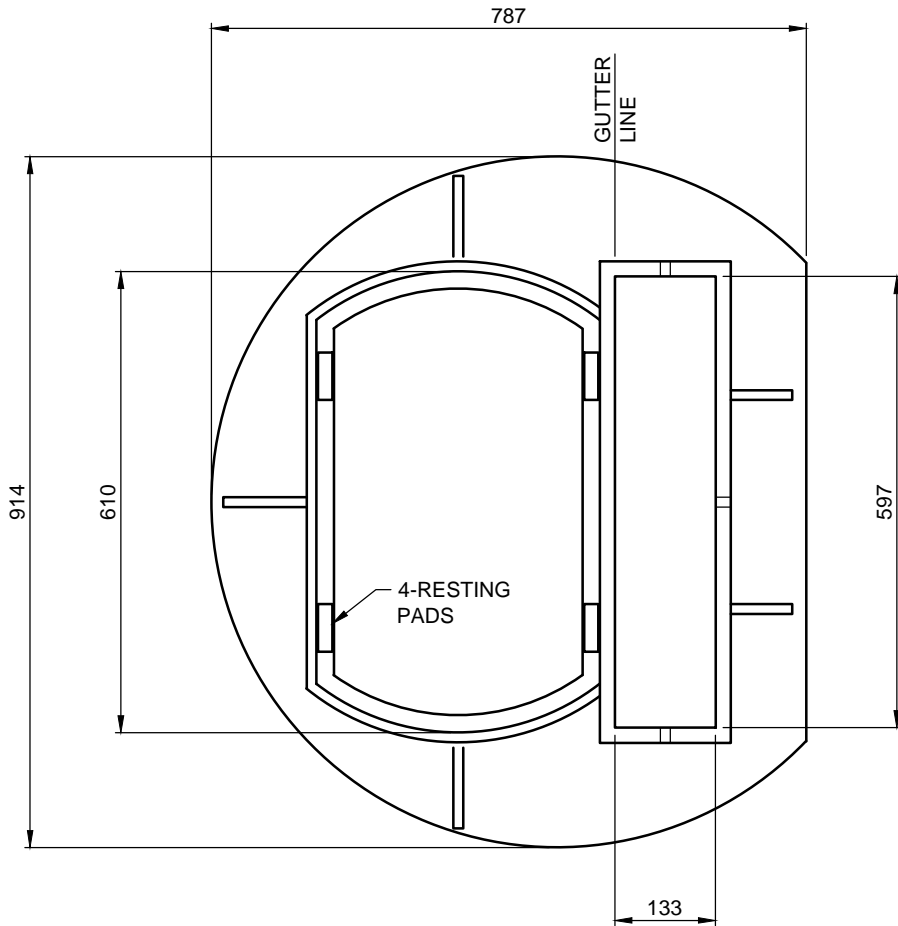
FRAME SECTION



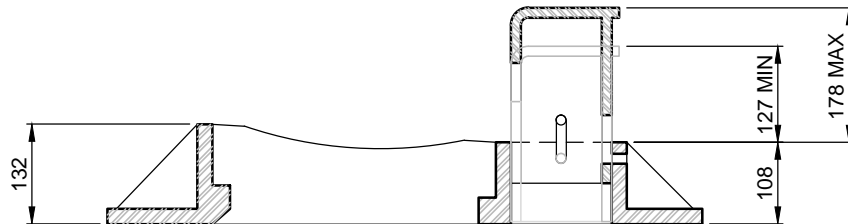
GRATE SECTION

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
4. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



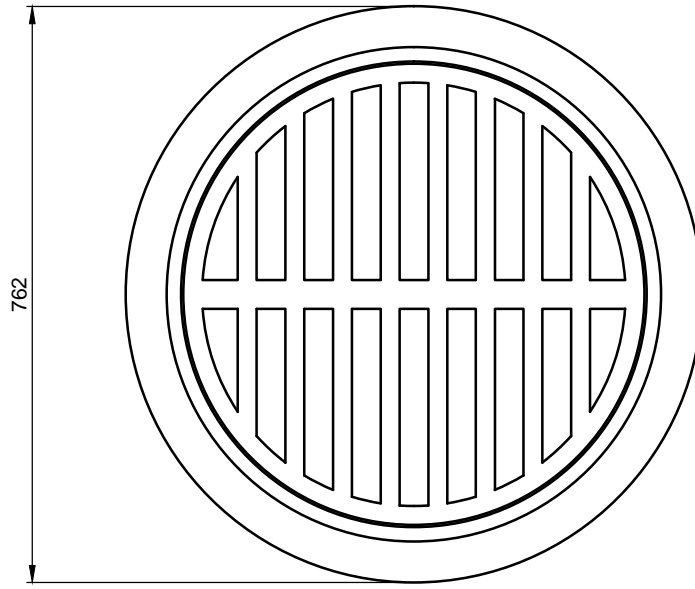
FRAME PLAN



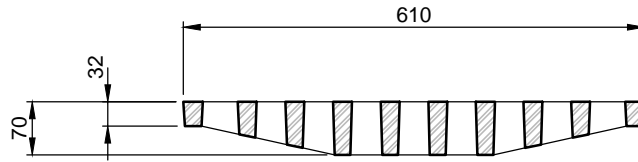
SECTION

NOTES:

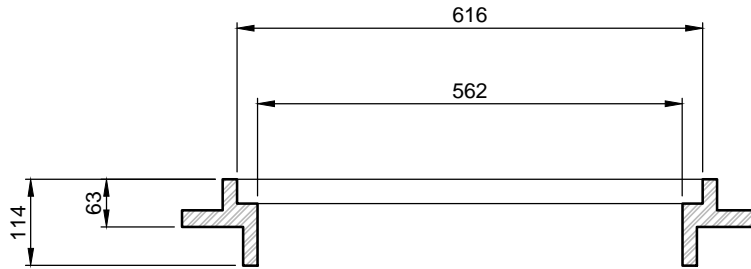
1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. FOR GRATE, SEE STD DWG SW-6.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



FRAME AND GRATE PLAN



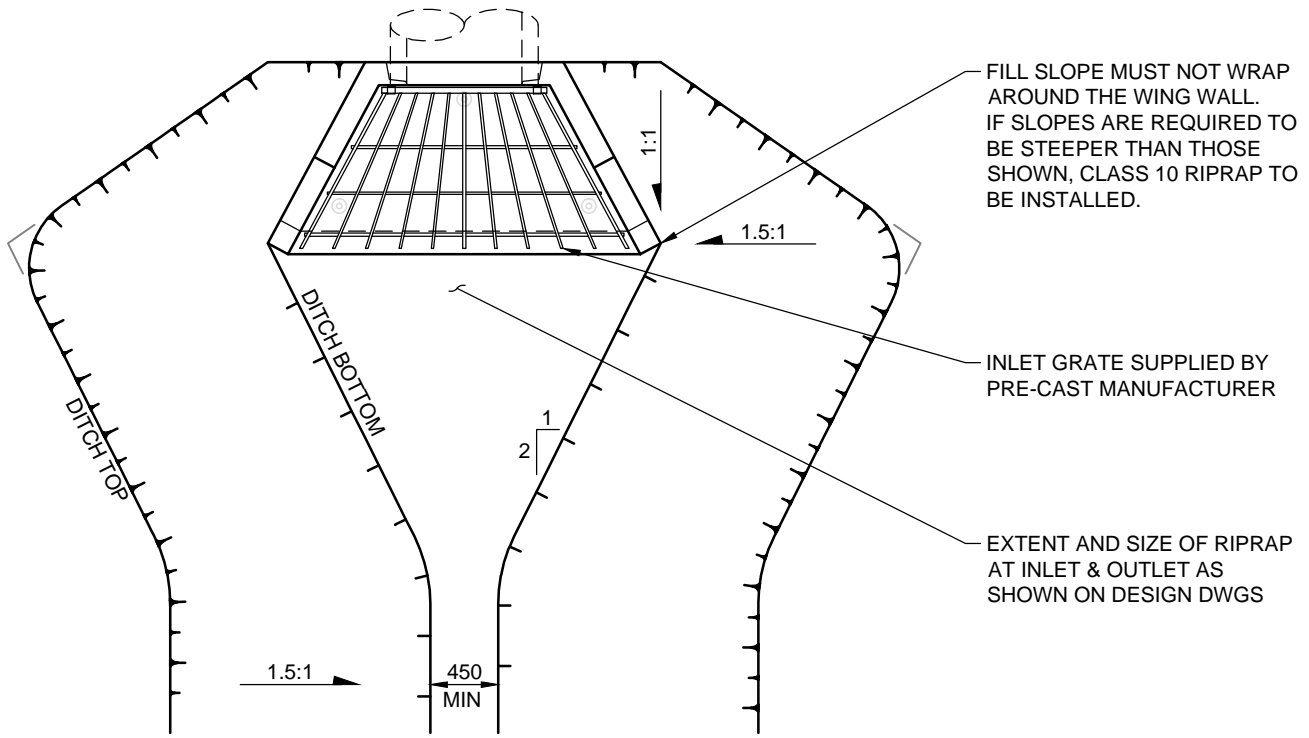
GRATE SECTION



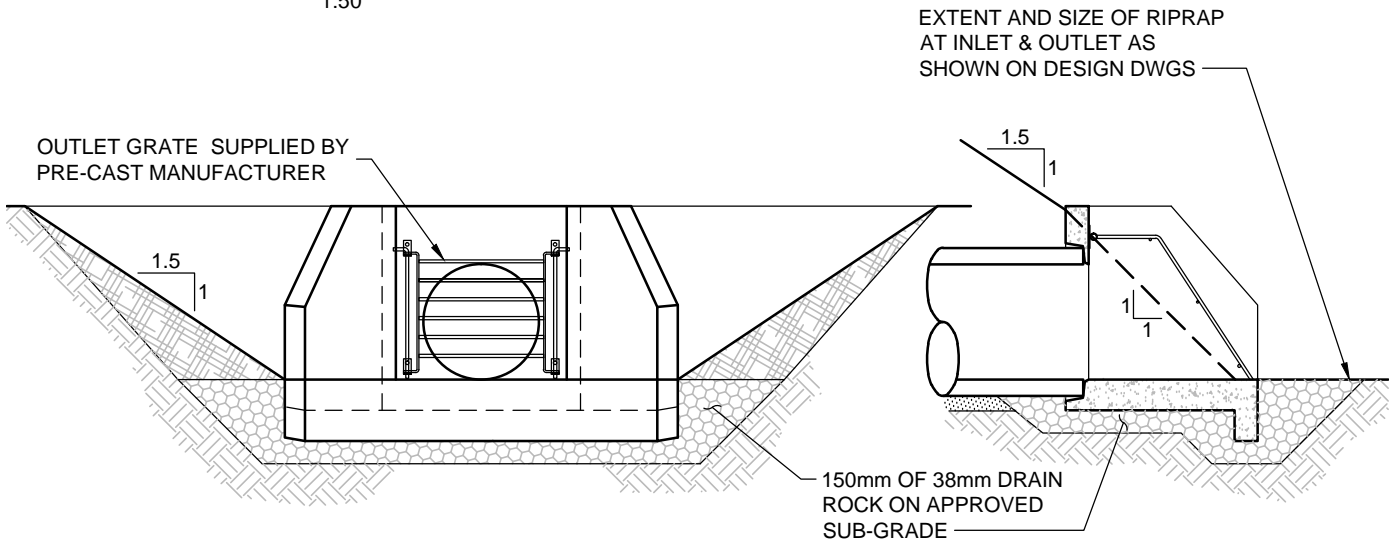
FRAME SECTION

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. ALL BEARING SURFACES BETWEEN FRAME, COVER AND RISER RINGS SHALL BE MACHINED FOR NON-ROCKING FIT IN ALL POSITIONS. ALLOW 1.5mm RAISED FACE IN CASTINGS FOR MACHINING.
3. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
4. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



PLAN (INLET SHOWN)
1:50

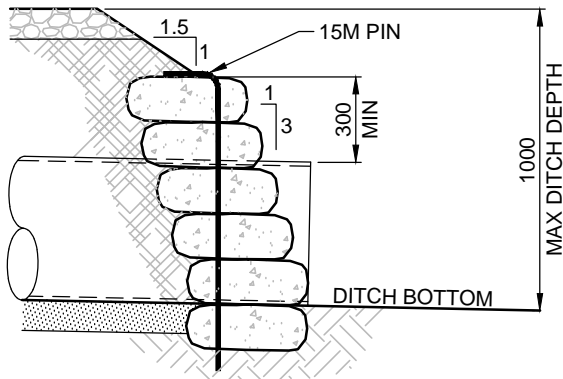


ELEVATION (OUTLET SHOWN)
1:50

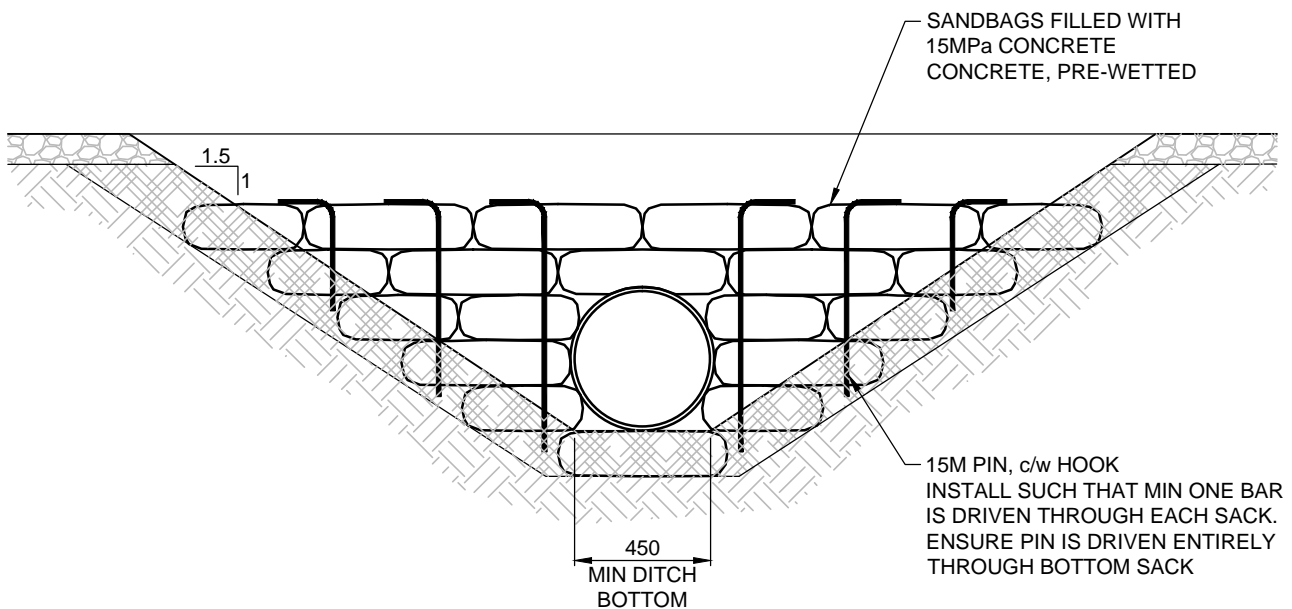
SECTION
1:50

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. INLET AND OUTLET GRATES TO BE WELDED AND HOT-DIP GALVANIZED TO ASTM A123/A123M.
3. GRATES TO BE EASILY LIFTED TO ALLOW ACCESS TO THE PIPE FOR CLEARING OF DEBRIS.
4. GRATES TO BE DESIGNED IN ACCORDANCE WITH SECTION 7.11.
5. IF SPECIFIED ON DESIGN DRAWINGS, GUARD RAIL TO BE INSTALLED PER STD DWG SW-12.
6. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



SECTION
1:25

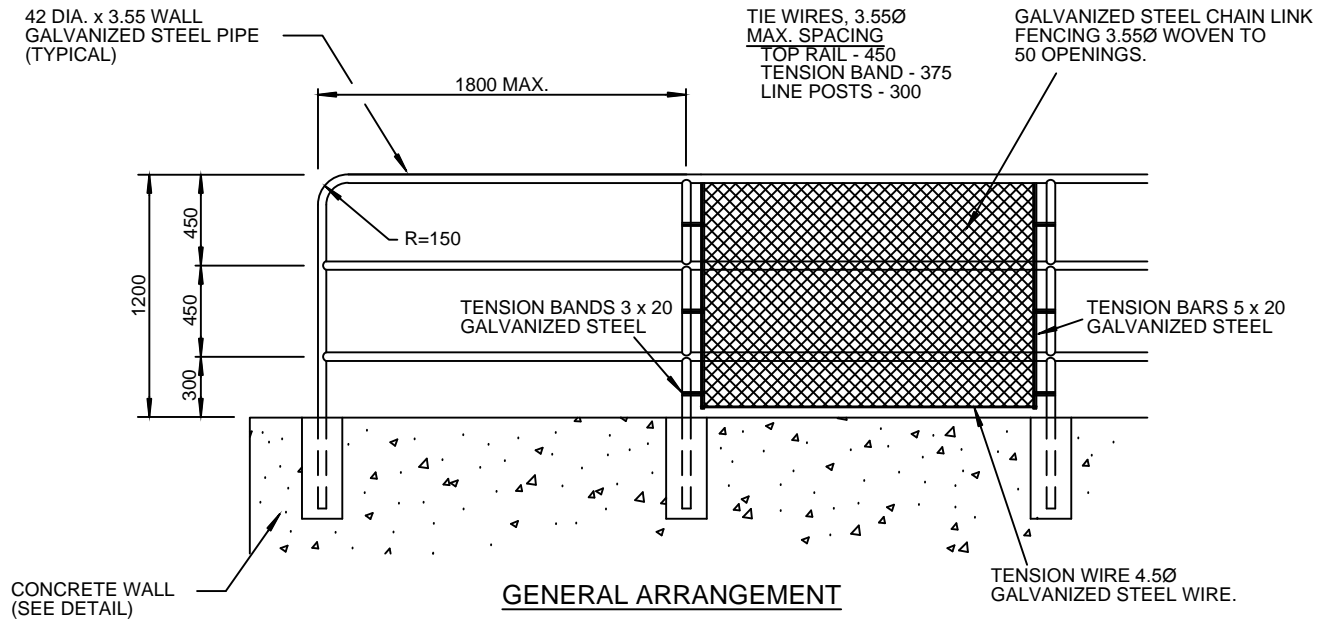


ELEVATION
1:25

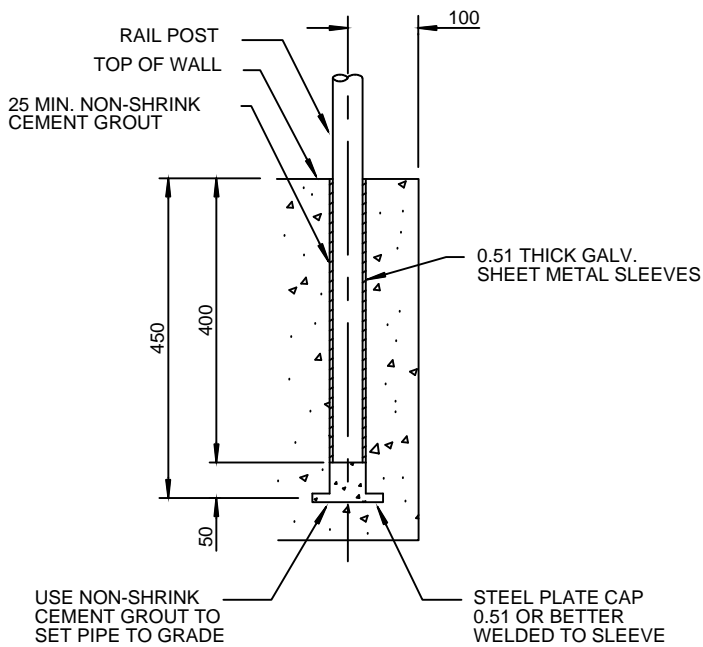
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
3. THIS HEADWALL IS FOR DRIVEWAY CULVERTS AND HYDRANT ACCESS ONLY, UNLESS APPROVED BY CITY ENGINEER.
4. IF HORIZONTAL ANGLE BETWEEN THE DITCH FLOW AND CULVERT INLET OR OUTLET EXCEEDS 30°, THE HEADWALL WILL REQUIRE WING WALLS TO FUNNEL FLOW TO PREVENT EROSION TO WALLS OF THE DITCH. SEE DESIGN DRAWINGS FOR DETAILS
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

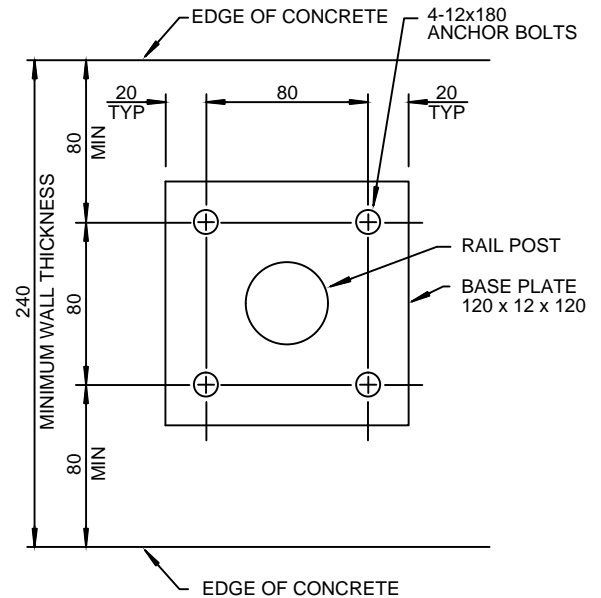
TENTATIVE INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS (W/ISSUE EDITION NOT FINAL) DRAFT STANDARD CAD DRAWING SECTION 7 DWG SW-12



GENERAL ARRANGEMENT



EMBEDDED MOUNTING



ATTACHED MOUNTING

CONNECTION DETAILS

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
3. ALL JOINTS MITRED, WELDED ALL AROUND AND GROUND SMOOTH.
4. INSTALLATION OF CHAINLINK FENCING AS REQUIRED BY THE CITY ENGINEER.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

6.16.2016



GUARD RAIL

Scale: NTS
 Created: NOV 1997
 Rev Date: NOV 2016
 Dwg No: SW-12

TENTATIVE INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS (W/ISSUE EDITION NOT FINAL) DRAFT FINAL DRAFT STANDARD CAD DRAWING SECTION 7 DWG SW-13

MANHOLES INSTALLED IN GRAVEL SURFACES SHALL HAVE A 50mm THICK x 1.5m \varnothing ASPHALT APRON ON 100mm OF COMPACTED CRUSHED GRAVEL

TO CONFORM TO WORKSAFE BC, OR 500mm MAX

MANHOLE FRAME TO BE CONCRETED TO MANHOLE LID

PRECAST GRADE RINGS, 2 MIN; 4 MAX

PRECAST MANHOLE LID

RUNGS CAST INTO WALL OF BARREL TO CONFORM TO WORKSAFE BC REQUIREMENTS

RUBBER MANHOLE ADAPTER RING FOR PVC PIPES

600 MIN FOR COMPACTION

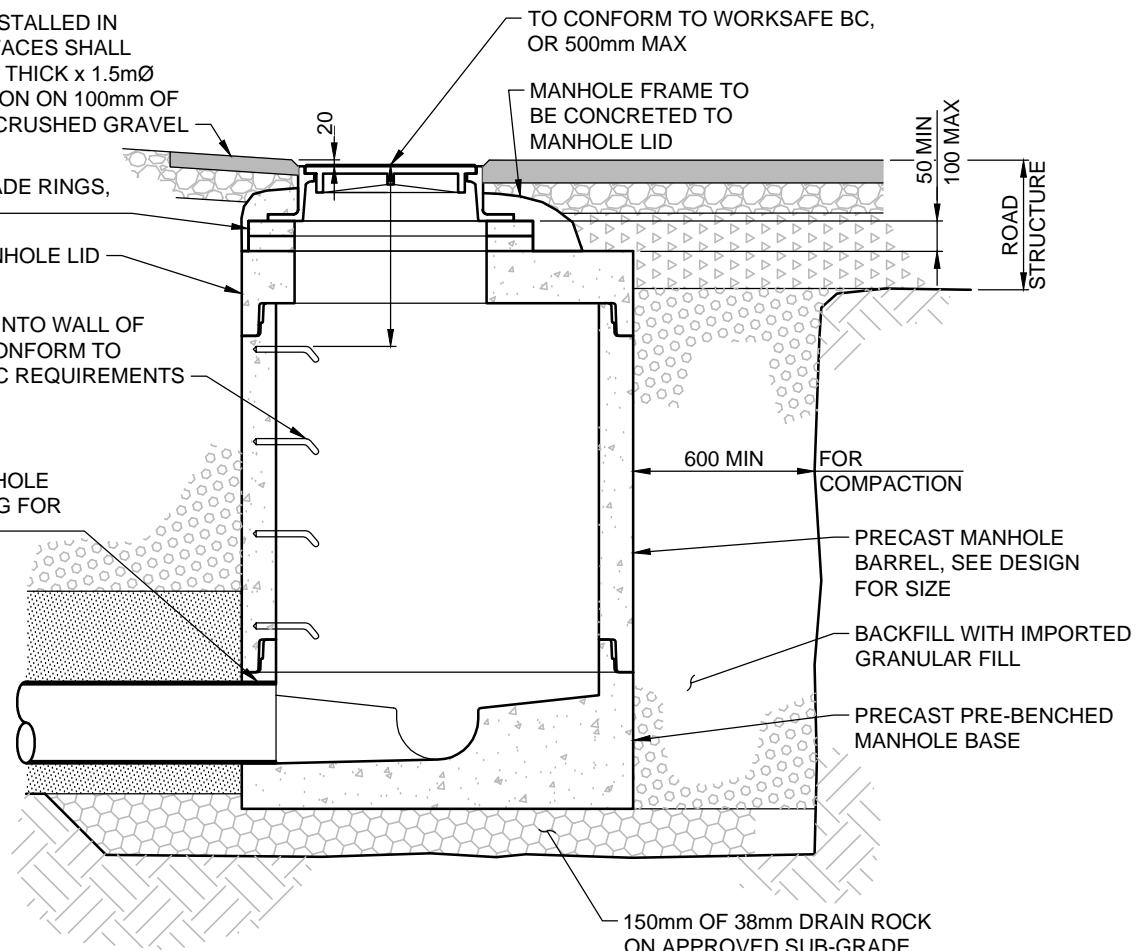
PRECAST MANHOLE BARREL, SEE DESIGN FOR SIZE

BACKFILL WITH IMPORTED GRANULAR FILL

PRECAST PRE-BENCHED MANHOLE BASE

150mm OF 38mm DRAIN ROCK ON APPROVED SUB-GRADE

ROAD STRUCTURE



TYPICAL SECTION
1:25

USE SHORT MANHOLE BARREL AS FORM. ENSURE TOP IS LEVEL PRIOR TO POURING CONCRETE

CONCRETE BLOCK TO SET MANHOLE BARREL HEIGHT

75 MIN

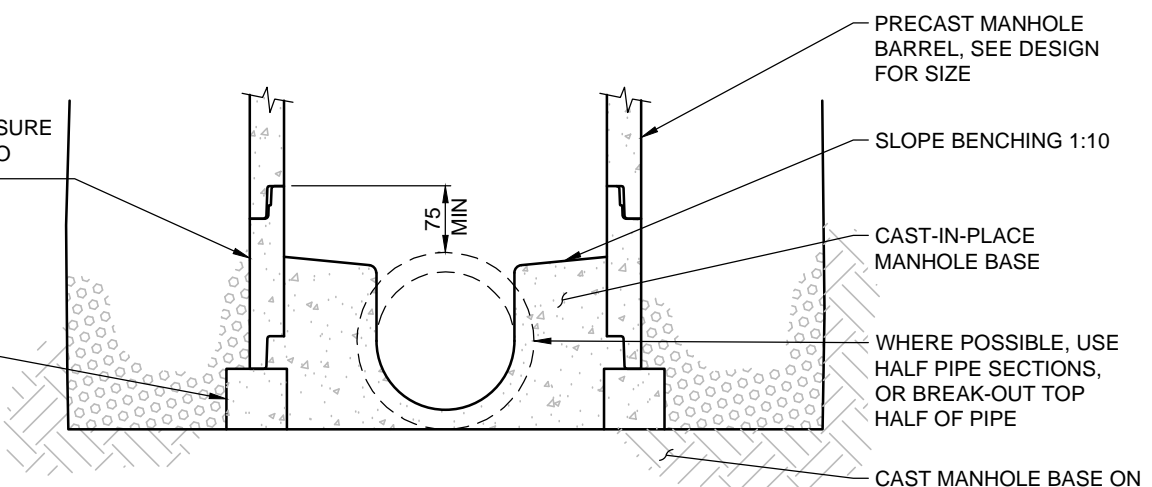
PRECAST MANHOLE BARREL, SEE DESIGN FOR SIZE

SLOPE BENCHING 1:10

CAST-IN-PLACE MANHOLE BASE

WHERE POSSIBLE, USE HALF PIPE SECTIONS, OR BREAK-OUT TOP HALF OF PIPE

CAST MANHOLE BASE ON UNDISTURBED SOILS



CAST-IN-PLACE BASE

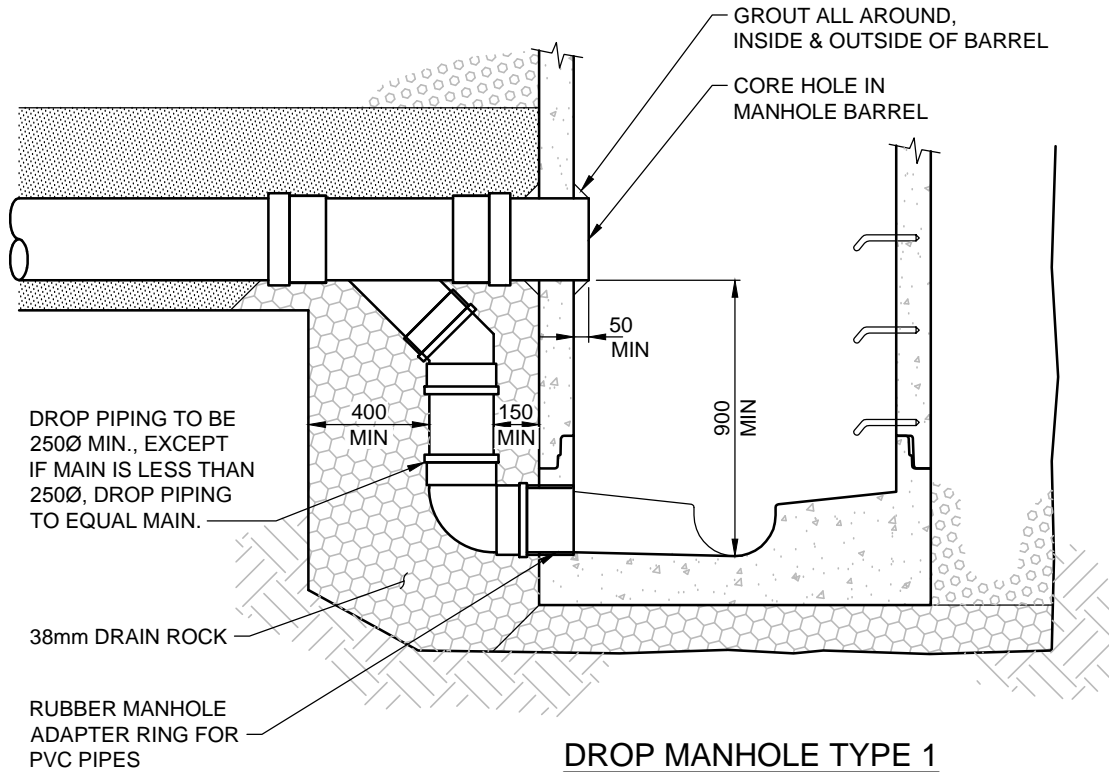
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR MANHOLE BENCHING, SEE STD DWG SW-15.
3. FOR FRAME & COVER DETAILS, SEE STD DWG SW-16.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

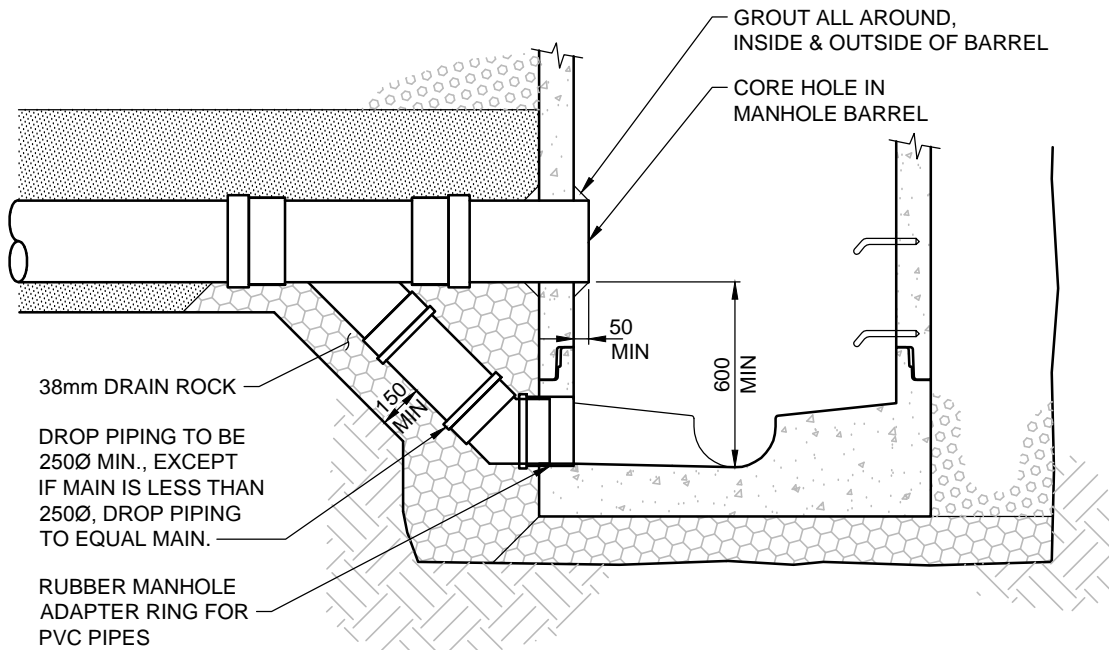


STORM MANHOLE

Scale:	1:25
Created:	FEB 2016
Rev Date:	NOV 2016
Dwg No:	SW-13



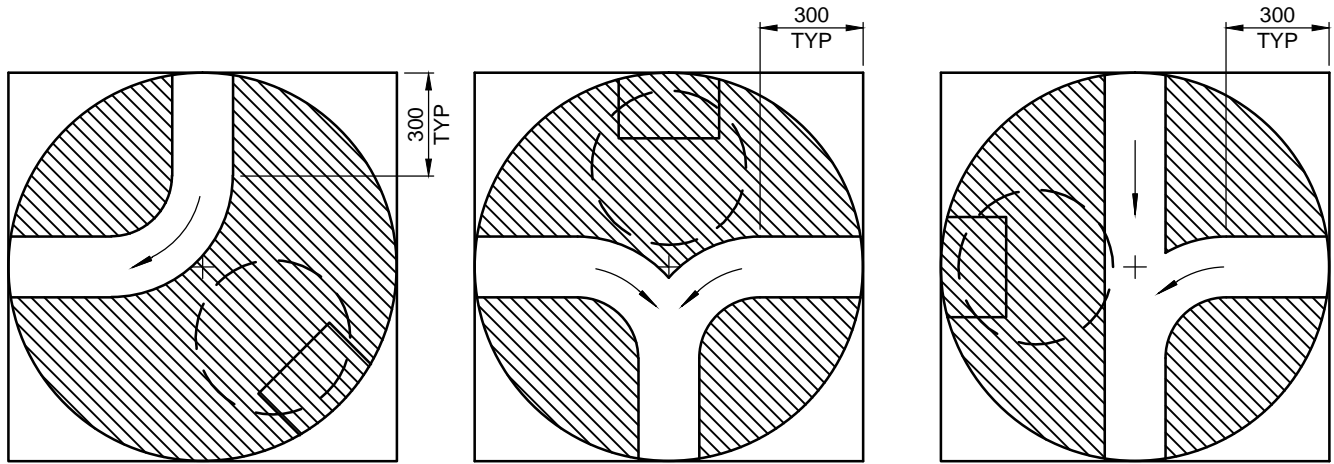
DROP MANHOLE TYPE 1
1:25



DROP MANHOLE TYPE 2
1:25

NOTES:

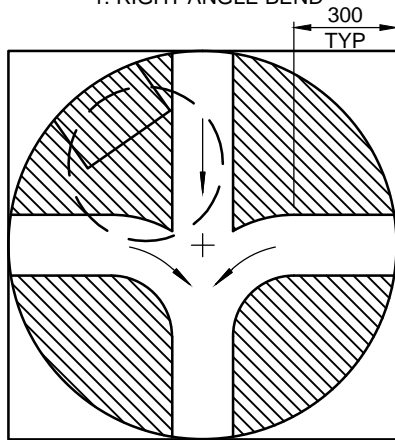
1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR MANHOLE DETAILS, SEE STD DWG SW-13.
3. FOR MANHOLE BENCHING, SEE STD DWG SW-15.
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



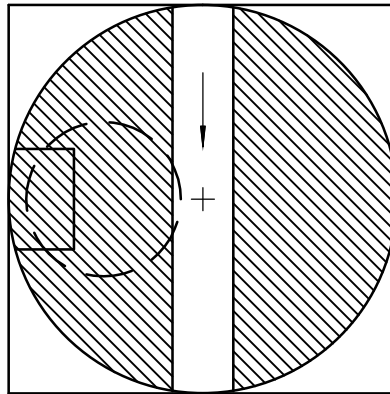
1. RIGHT ANGLE BEND

2. TEE CONNECTION

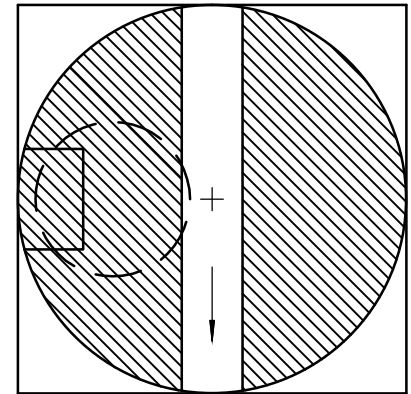
3. THREE WAY JUNCTION



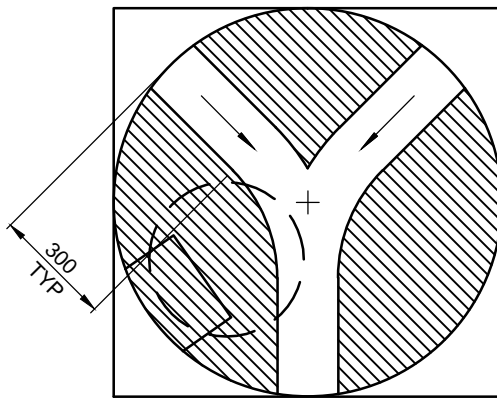
4. FOUR WAY JUNCTION



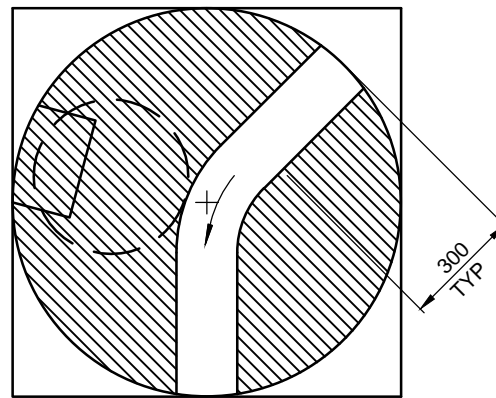
5. STRAIGHT THROUGH



6. DEAD END



7. WYE CONNECTION

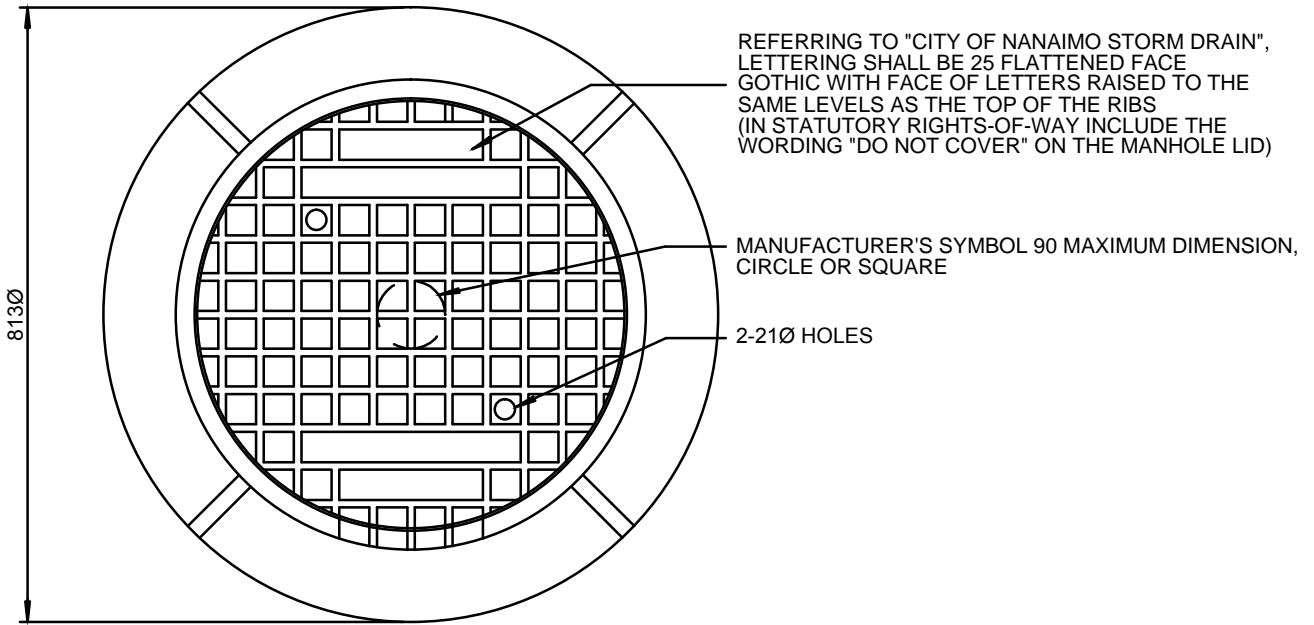


8. 45° BEND

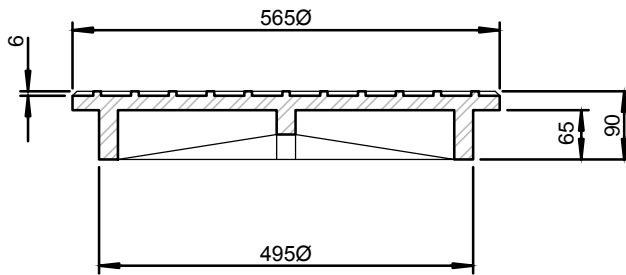
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR MANHOLE CHANNELING, REFER TO SECTION 7.49.
3. ALL CHANNELS SHALL BE FINISHED WITH A STEEL TROWEL. BENCHING (HATCHED AREAS), SHALL BE BROOM FINISHED.
4. MANHOLE COVER AND RUNG LOCATIONS SHALL BE AS SHOWN, UNLESS NOTED OTHERWISE.
5. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
6. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

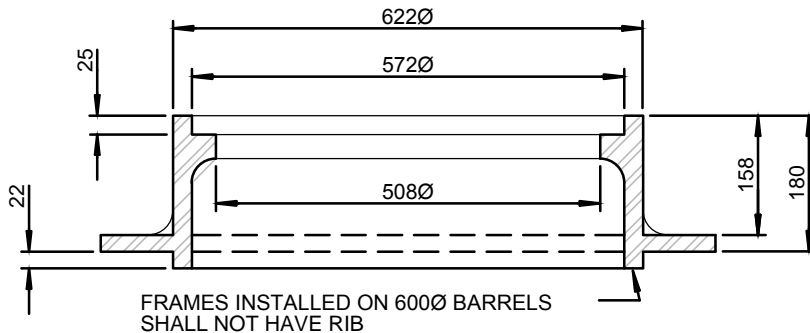
UTENT&PW\INFRASTRUCTURE PLANNING\STANDARDS & PRODUCTS\IWO\SECTION NOT\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 7 DWG\SSW-16



PLAN



COVER



FRAME

NOTES:

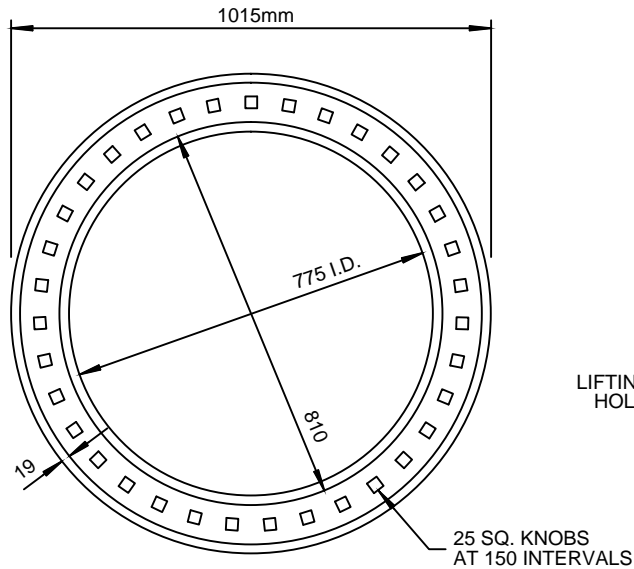
1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. ALL BEARING SURFACES BETWEEN FRAME, COVER AND RISER RINGS SHALL BE MACHINED FOR NON-ROCKING FIT IN ALL POSITIONS. ALLOW 1.5mm RAISED FACE IN CASTINGS FOR MACHINING.
4. PAINT THE INSIDE SURFACE OF THE MANHOLE FRAME IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATION WITH ENAMEL RUST PAINT. COLOUR TO BE GREEN.
5. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
6. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

6.16.2016

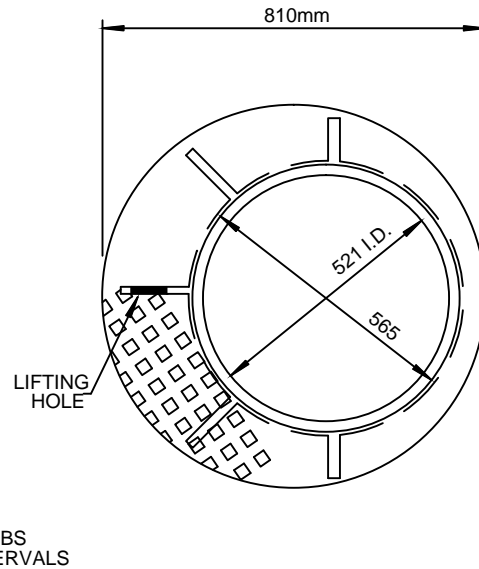


STORM MANHOLE
FRAME AND COVER

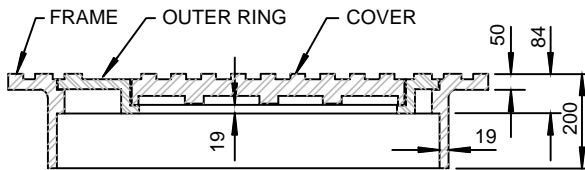
Scale: NTS
 Created: MAR 2016
 Rev Date: NOV 2016
 Dwg No: SW-16



PLAN OF FRAME



PLAN OF OUTER RING

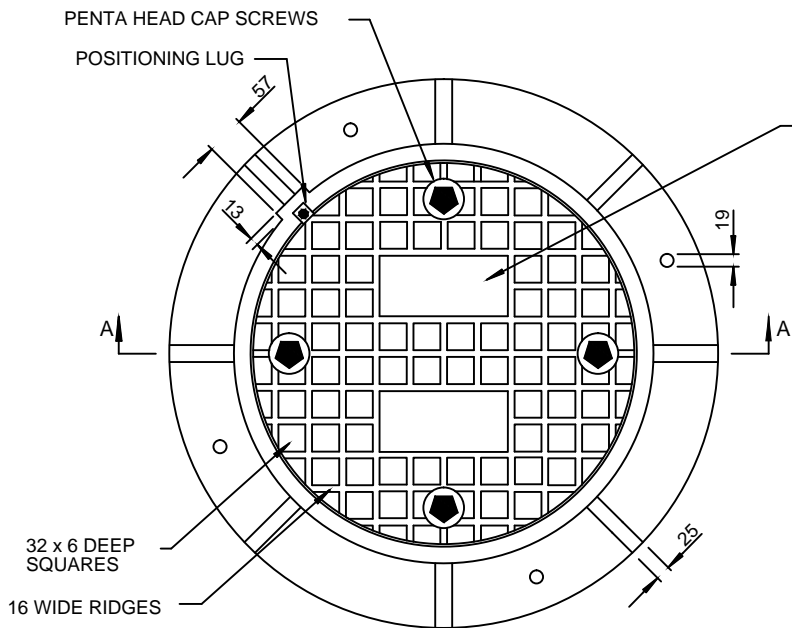


SECTION OF FRAME, RING
AND COVER

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. FOR COVER LETTERING AND BOLTING REQUIREMENTS REFER TO STD. DWG. SW-16 OR SW-18 (WATERTIGHT COVER).
4. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
5. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

APPLICATION: UNITS ARE FOR USE IN AREAS WHERE FLOODING OR HIGH TIDES ARE POSSIBLE. THIS UNIT SHALL HAVE A POSITIONING LUG IN COVER FOR EASY REPLACEMENT OF CAP SCREWS AND SHALL BE EQUIPPED WITH FOUR ONLY 19Ø HOLES IN FRAME FOR ANCHOR BOLTS AS SHOWN.

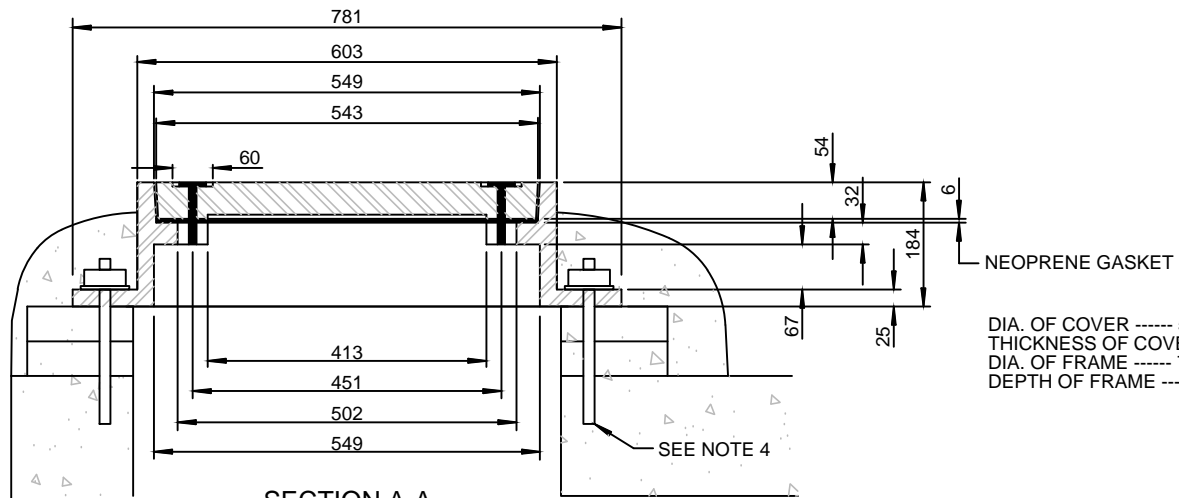


REFERRING TO "CITY OF NANAIMO STORM DRAIN", LETTERING SHALL BE 25 FLATTENED FACE GOTHIC WITH FACE OF LETTERS RAISED TO THE SAME LEVELS AS THE TOP OF THE RIBS (IN STATUTORY RIGHTS-OF-WAY INCLUDE THE WORDING "DO NOT COVER" ON THE MANHOLE LID)

WEIGHT OF UNIT SHOWN IS
 FRAME = 113.4 kg
 COVER = 56.7 kg

- FURNISHED WITH:
- A) FOUR 13x57 PENTA HEAD STAINLESS STEEL CAP SCREWS TO DISCOURAGE VANDALISM.
 - B) A 6mm THICK NEOPRENE GASKET FULLY ENCOMPASSING BOLT HOLES.
 - C) METAL SURFACES BETWEEN FRAME AND COVER MACHINED TO ENSURE NON ROCKING FIT IN ALL POSITIONS. ALLOW 1.5 RAISED FACE IN CASTING FOR MACHINING.
 - D) MANUFACTURE BOLT HOLES TO PERMIT INTERCHANGING OF COVERS BETWEEN FRAME UNITS.

PLAN



DIA. OF COVER ----- 543
 THICKNESS OF COVER -- 54
 DIA. OF FRAME ----- 781
 DEPTH OF FRAME ----- 184

SECTION A-A

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. CASTINGS SHALL BE CERTIFIED TO MEET CS-600 LOADING.
3. PAINT THE INSIDE SURFACE OF THE MANHOLE FRAME IN ACCORDANCE WITH THE MANUFACTURER'S SPECIFICATION WITH ENAMEL RUST PAINT. COLOUR TO BE GREEN.
4. FRAME SHALL BE SET IN MORTAR AND BOLTED TO THE MANHOLE SLAB WITH 19Ø STAINLESS STEEL BOLTS, WASHERS AND NUTS.
5. THIS DRAWING TO BE READ IN ACCORDANCE WITH DRAWING SW-13.
6. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

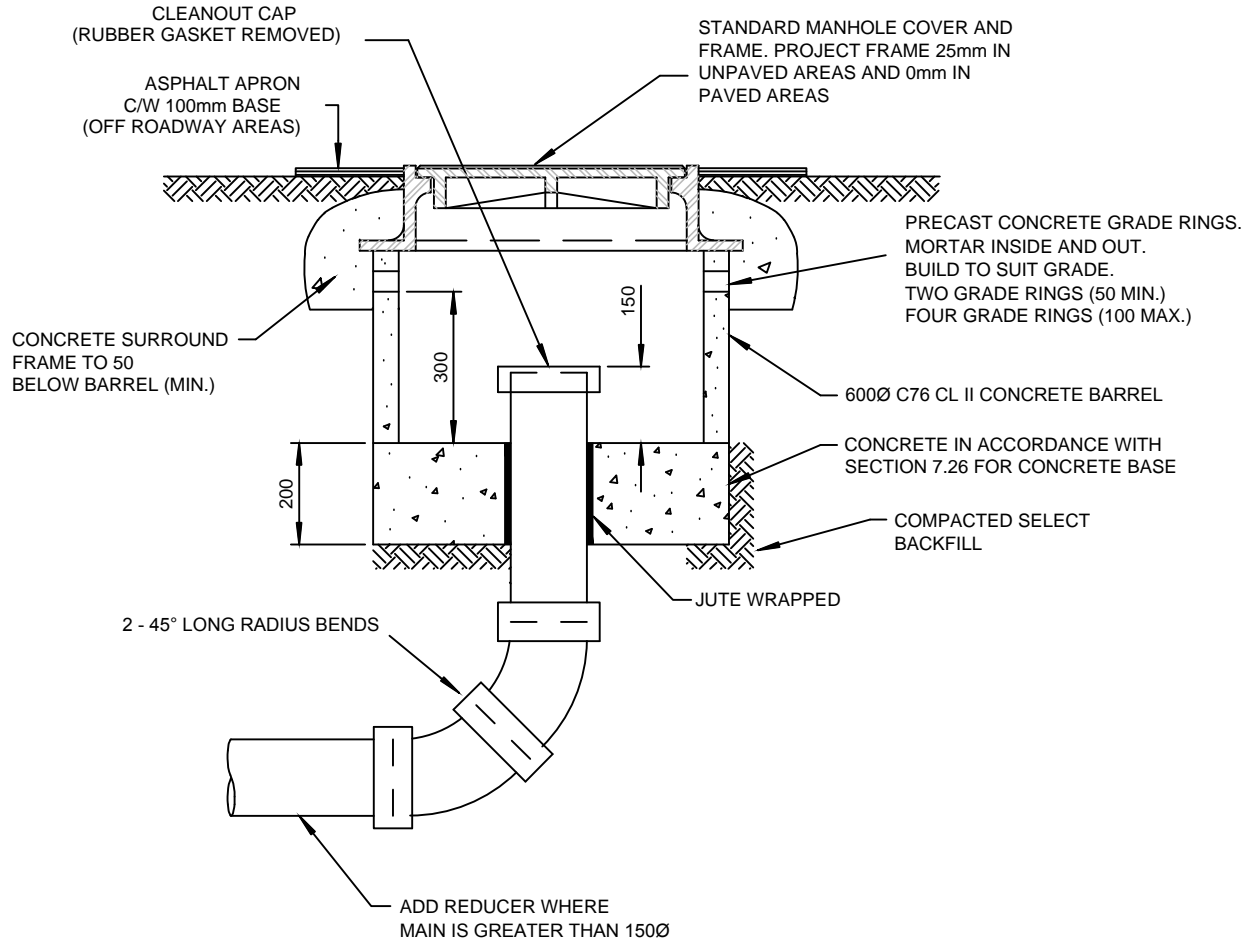
WATER & P/W INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS / W02 / EDITION NOT FINAL / DRAFT / FINAL DRAFT / STANDARD CAD DRAWINGS / SECTION 7 DWG / SW-18

6.16.2016



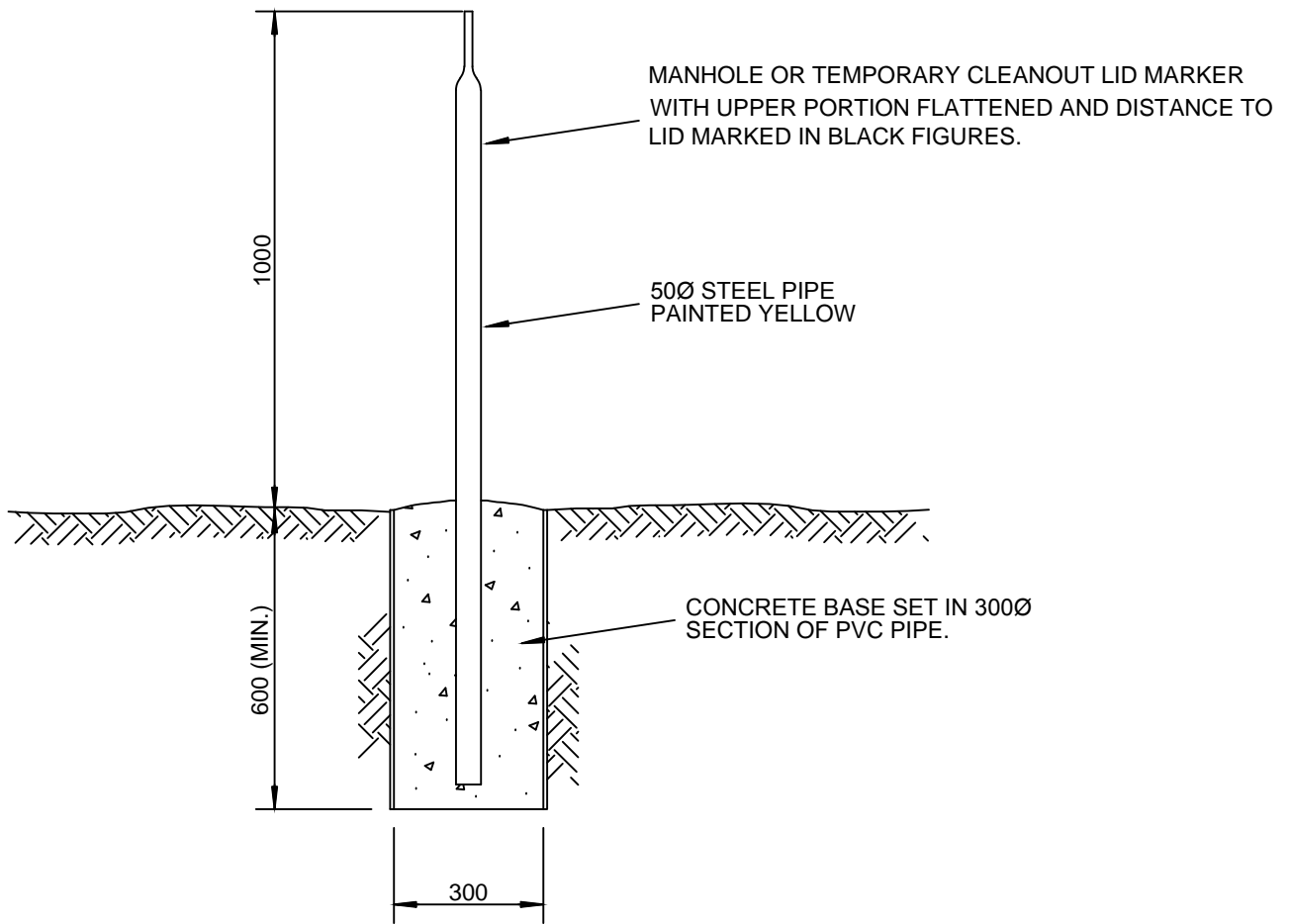
WATERTIGHT STORM MANHOLE
 FRAME AND COVER

Scale: NTS
 Created: MAR 2016
 Rev Date: NOV 2016
 Dwg No: SW-18



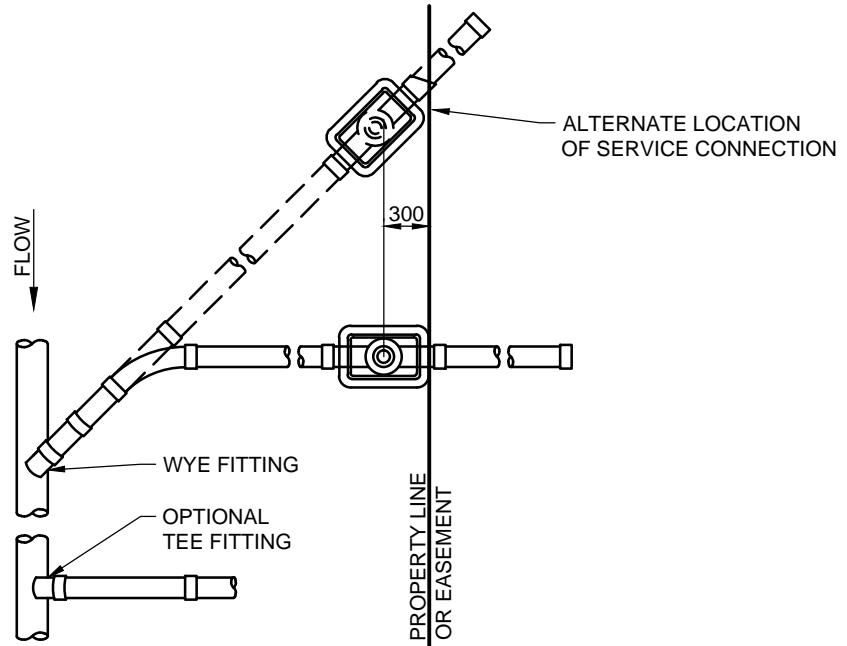
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. TEMPORARY CLEANOUT STRUCTURES MAY ONLY BE USED AT THE DISCRETION OF THE CITY ENGINEER WHERE THERE IS DEVELOPMENT PHASING.
3. USE WHERE NO SERVICE EXTENSION IS REQUIRED.
4. FRAME AND COVER TO STD. DWG. SW-16 OR SW-18 (WATERTIGHT COVER).
5. CLEANOUT STRUCTURES LOCATED ON GRAVEL ROADS OR SHOULDER REQUIRE A 1.5m x 1.5m HOT MIX ASPHALT APRON, 50mm THICK.
6. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

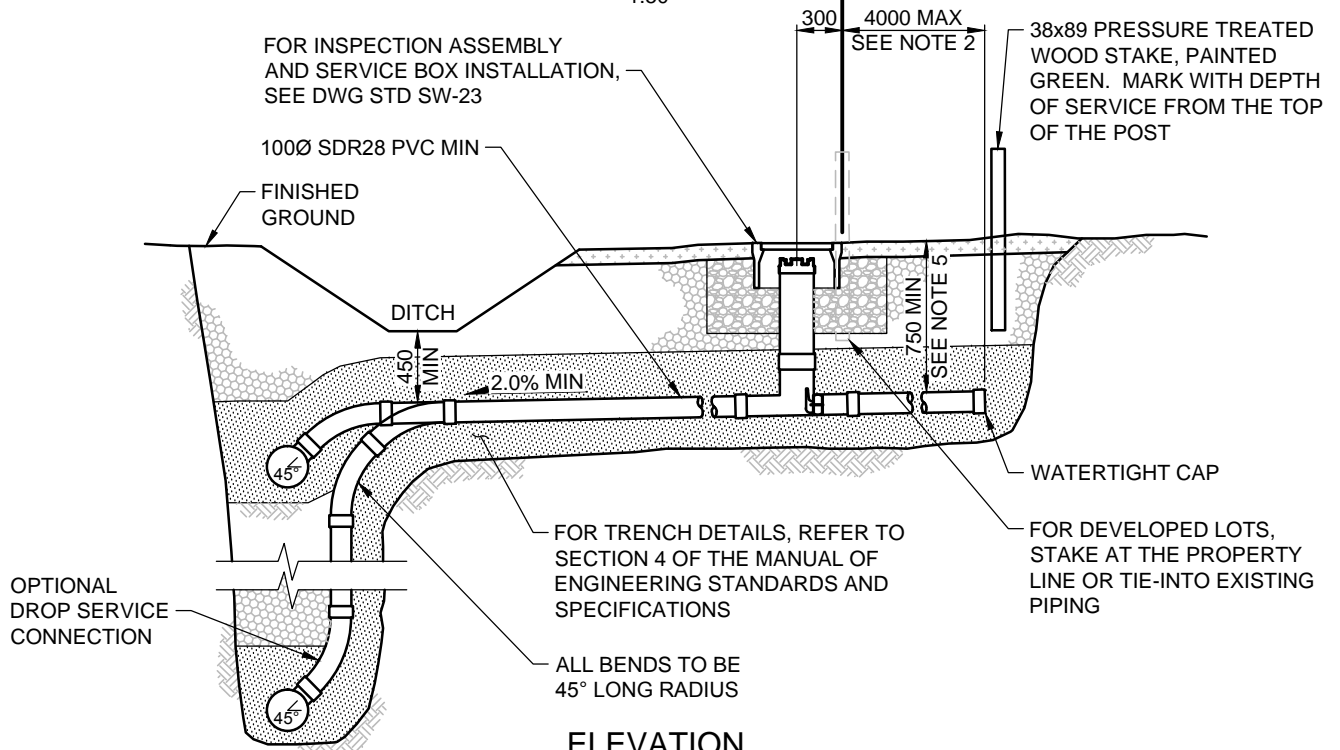


NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. FOR USE ONLY WHERE MANHOLE OR TEMPORARY CLEANOUTS ARE LOCATED OUTSIDE THE PAVED PORTION OF THE STREET
3. THE MARKER SHALL BE LOCATED ON SITE BY THE ENGINEER WITH THE FLATTENED END AND MARKED DISTANCE FACING THE LID.
4. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



PLAN
1:50



ELEVATION
1:50

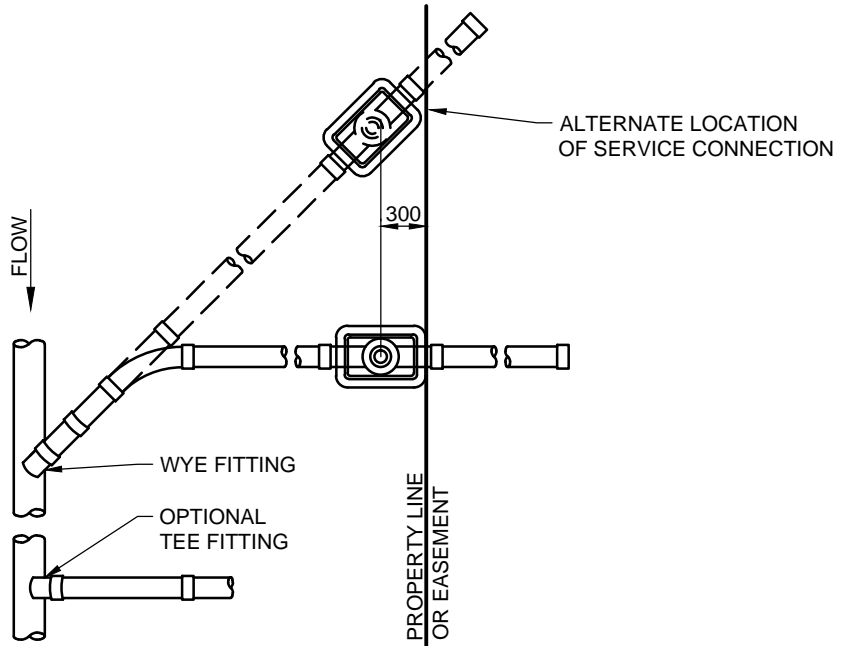
NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. WHERE DEPTH OF SERVICE AT PROPERTY LINE IS GREATER THAN 2.0m, EXTEND THE SERVICE PAST THE PROPERTY LINE EQUAL TO ITS DEPTH, TO A MAXIMUM OF 4.0m.
3. WHERE SERVICE IS INSTALLED IN ROCK, THE TRENCH IS TO EXTEND 3.0m PAST THE PROPERTY LINE.
4. STORM SEWER INSPECTION ASSEMBLY, INCLUDING PROPERTY SIDE STUB TO BE GREEN.
5. SERVICE PIPE DEPTH TO BE INSTALLED TO PROVIDE SUFFICIENT DEPTH TO SERVICE THE BASEMENT PLUMBING BY GRAVITY IN ACCORDANCE WITH THE BC PLUMBING CODE. MINIMUM COVER OF SERVICE PIPE AT PROPERTY LINE TO BE 0.75m.
6. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

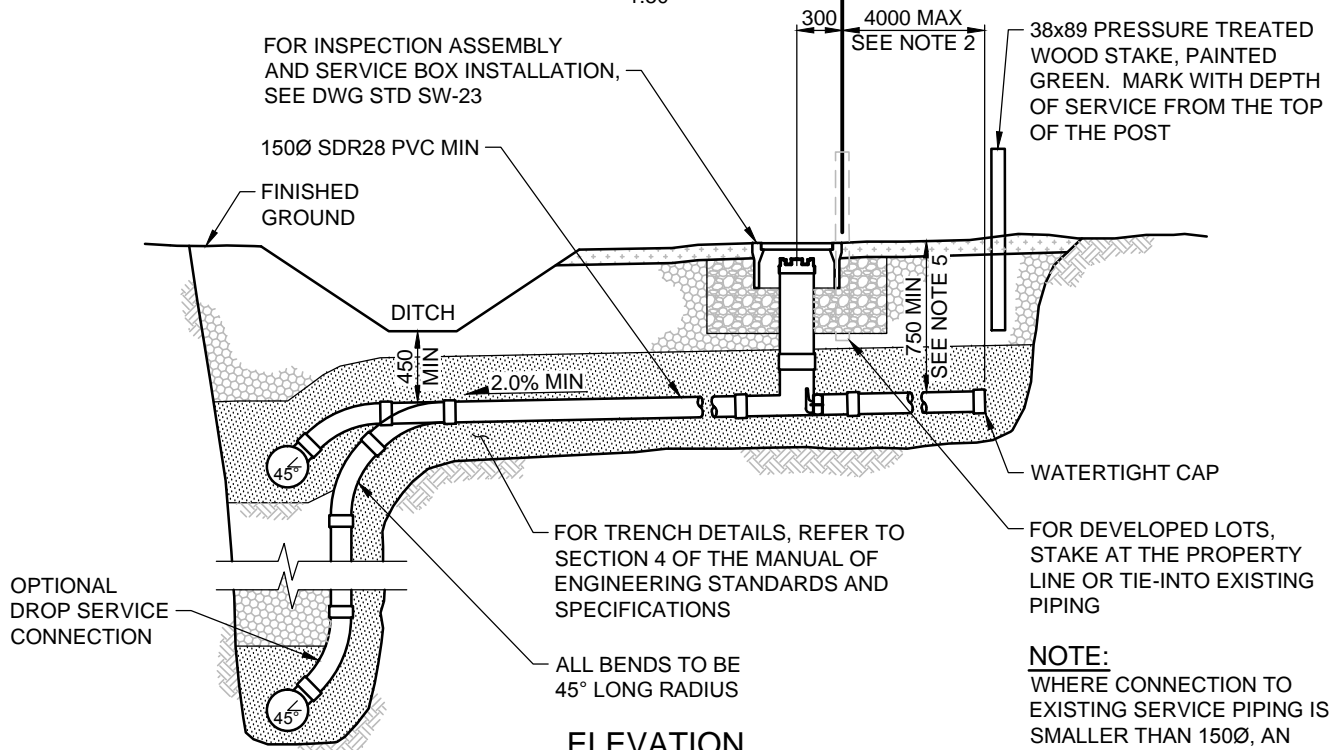


GENERAL STORM SERVICE CONNECTION DETAIL
RISER AND NON-RISER TYPES

Scale:	1:50
Created:	MAR 2016
Rev Date:	NOV 2016
Dwg No:	SW-21



PLAN
1:50



ELEVATION
1:50

NOTES:

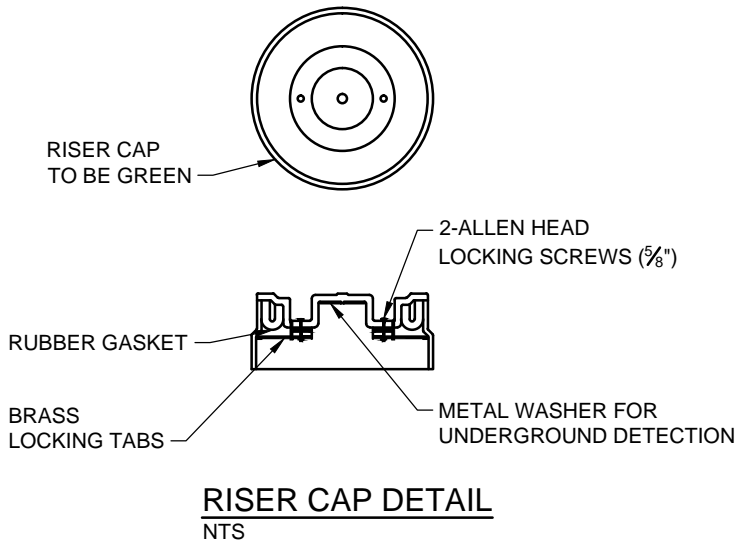
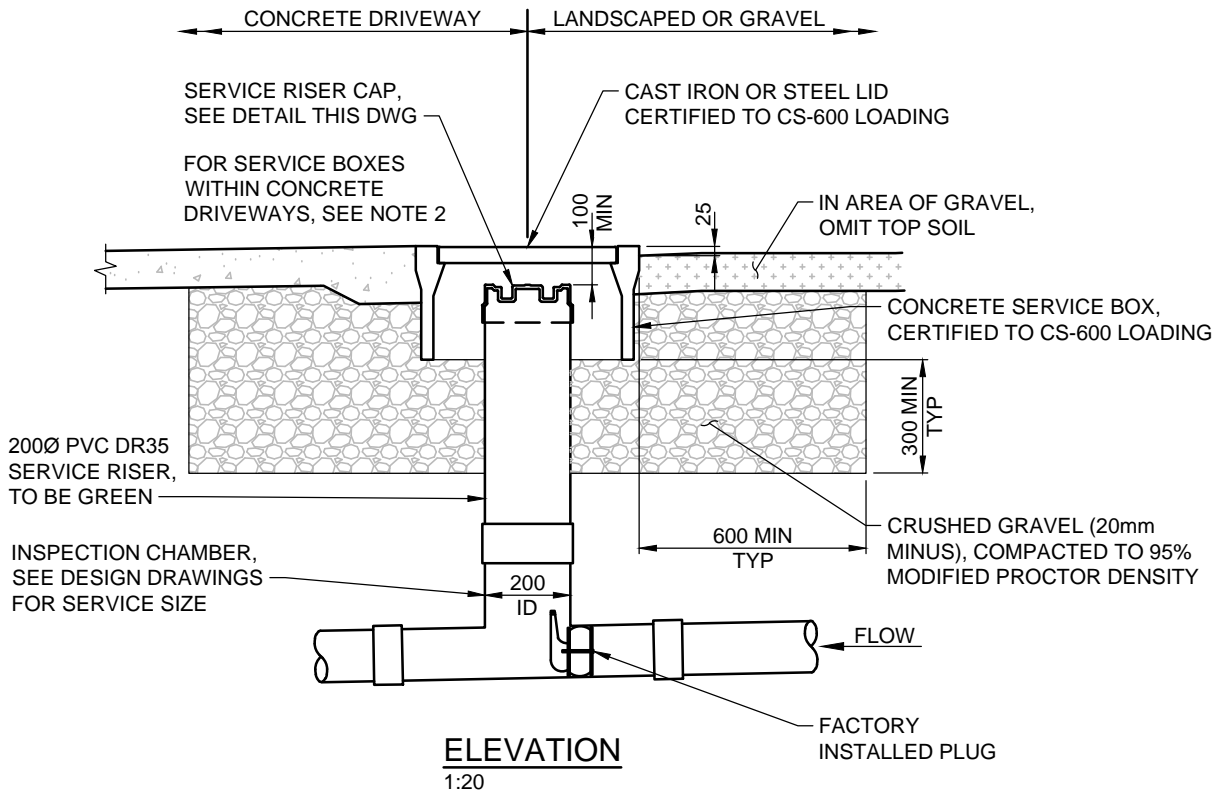
1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. WHERE DEPTH OF SERVICE AT PROPERTY LINE IS GREATER THAN 2.0m, EXTEND THE SERVICE PAST THE PROPERTY LINE EQUAL TO ITS DEPTH, TO A MAXIMUM OF 4.0m.
3. WHERE SERVICE IS INSTALLED IN ROCK, THE TRENCH IS TO EXTEND 3.0m PAST THE PROPERTY LINE.
4. STORM SEWER INSPECTION ASSEMBLY, INCLUDING PROPERTY SIDE STUB TO BE GREEN.
5. SERVICE PIPE DEPTH TO BE INSTALLED TO PROVIDE SUFFICIENT DEPTH TO SERVICE THE BASEMENT PLUMBING BY GRAVITY IN ACCORDANCE WITH THE BC PLUMBING CODE. MINIMUM COVER OF SERVICE PIPE AT PROPERTY LINE TO BE 0.75m.
6. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
7. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

NOTE:
WHERE CONNECTION TO EXISTING SERVICE PIPING IS SMALLER THAN 150Ø, AN ECCENTRIC REDUCER SHALL BE INSTALLED.



COMMERCIAL AREA STORM SERVICE CONNECTION DETAIL RISER AND NON-RISER TYPES

Scale:	1:50
Created:	MAR 2015
Rev Date:	NOV 2016
Dwg No:	SW-22



NOTES:

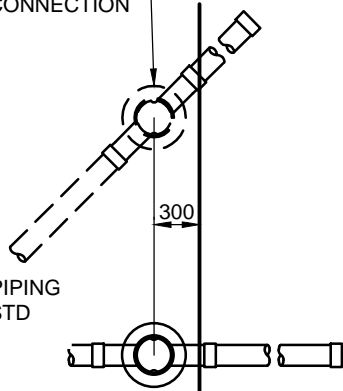
1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. WHEN SERVICE BOX IS WITHIN CONCRETE DRIVEWAY, CONCRETE ADJACENT TO THE SERVICE BOX MUST BE A MINIMUM OF 150mm THICK FOR A MINIMUM DISTANCE OF 150mm AROUND THE OUTSIDE EDGES OF THE SERVICE BOX.
3. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
4. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.

TENTATIVE INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS (ISSUE EDITION NOT FINAL) DRAFT FINAL DRAFT STANDARD CAD DRAWINGS SECTION 7 DWG SW-24

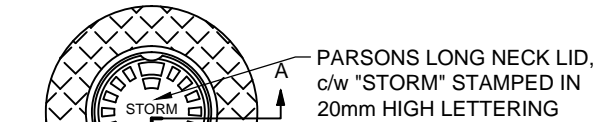
ALTERNATE LOCATION
OF SERVICE CONNECTION

FOR SERVICE PIPING
DETAILS, SEE STD
DWG SW-21

PROPERTY LINE
OR EASEMENT

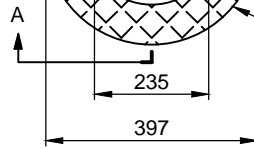


PLAN - VALVE BOX LOCATIONS
NTS



PARSONS LONG NECK LID,
c/w "STORM" STAMPED IN
20mm HIGH LETTERING

3mm RAISED SINGLE
DIAMOND CHECKER
PLATE FLANGE



NOTE:
FINISH COAT TO BE
BITUMINOUS DIP

MR STYLE VALVE BOX

1:15

MECHANICAL SCREW PLUG,
SEE DETAIL THIS DWG

MR TYPE VALVE BOX,
SEE DETAIL THIS DWG

SET COVER FLUSH
WITH FINISHED GRADE

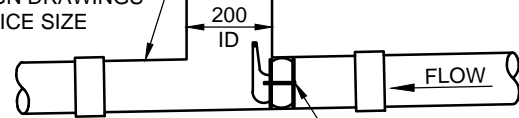
ASPHALT,
THICKNESS VARIES



ROAD STRUCTURE,
THICKNESS VARIES

2000Ø PVC DR35
SERVICE RISER,
TO BE GREEN

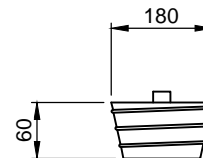
INSPECTION CHAMBER,
SEE DESIGN DRAWINGS
FOR SERVICE SIZE



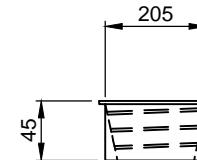
FACTORY
INSTALLED PLUG

INSPECTION ASSEMBLY ELEVATION

1:20



RIGID PLASTIC PLUG



RUBBER SEALING COLLAR

MECHANICAL SCREW PLUGS

NTS

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. ONLY PRODUCTS LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
3. ALL DIMENSIONS ARE MILLIMETERS UNLESS NOTED OTHERWISE.



STORM SERVICE BOX AND INSPECTION ASSEMBLY
INSTALLATION IN PAVED LANES AND ROADWAYS

Scale: AS NOTED

Created: MAR 2016

Rev Date: NOV 2016

Dwg No: SW-24

SHORT DURATION RAINFALL INTENSITY-DURATION FREQUENCY DATA FOR NANAIMO
 (BASED ON RECORDING RAIN GAUGE DATA FOR THE PERIOD 1980 - 2005 FROM CITY OF NANAIMO PUBLIC WORKS YARD)

CURVES BASED ON
 FORMULA: $I = A \times T^B$

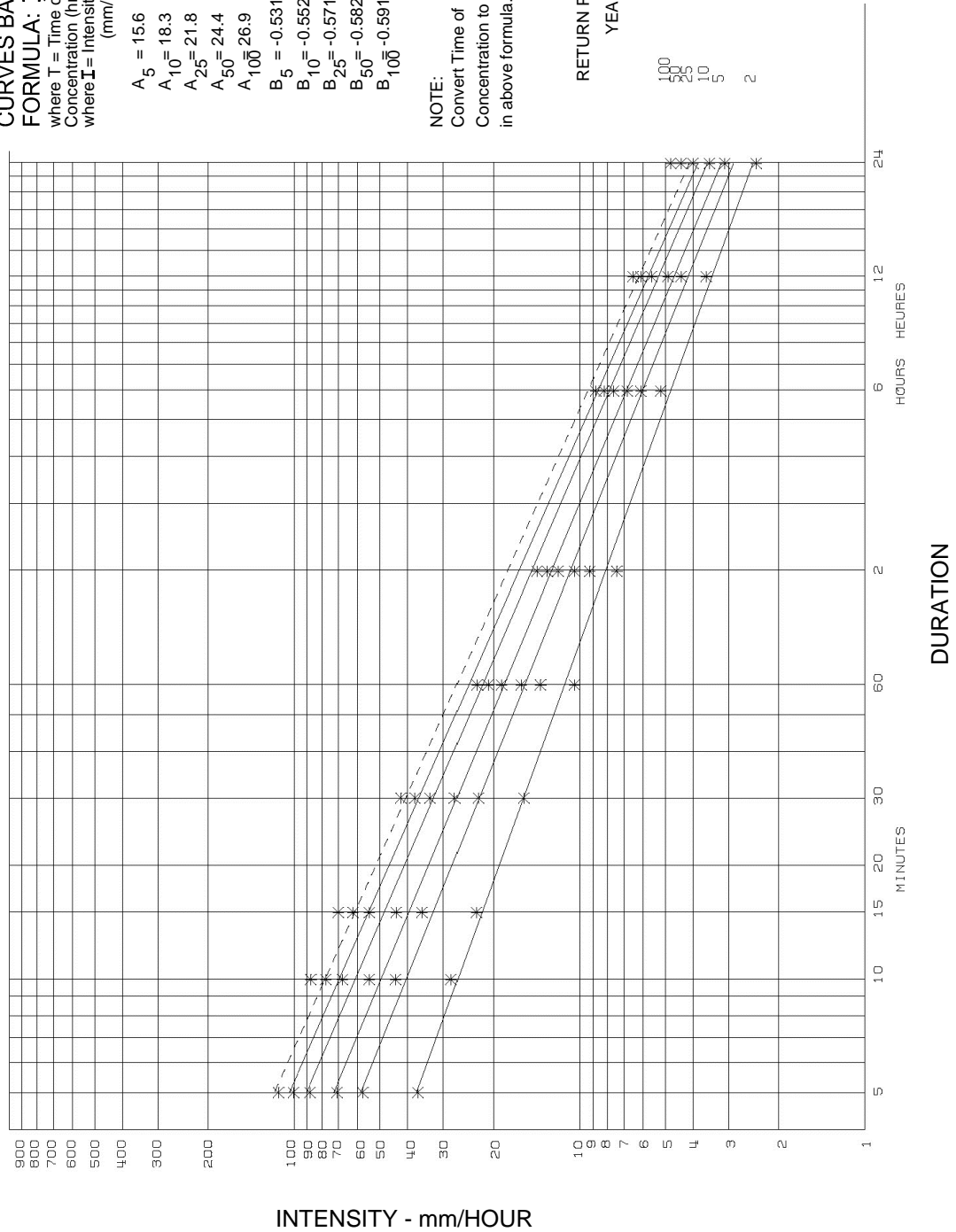
where T = Time of
 Concentration (hr) and
 where I = Intensity
 (mm/hr)

- A₅ = 15.6
- A₁₀ = 18.3
- A₂₅ = 21.8
- A₅₀ = 24.4
- A₁₀₀ = 26.9
- B₅ = -0.531
- B₁₀ = -0.552
- B₂₅ = -0.571
- B₅₀ = -0.582
- B₁₀₀ = -0.591

NOTE:
 Convert Time of
 Concentration to HOURS
 in above formula.

RETURN PERIODS
 YEARS

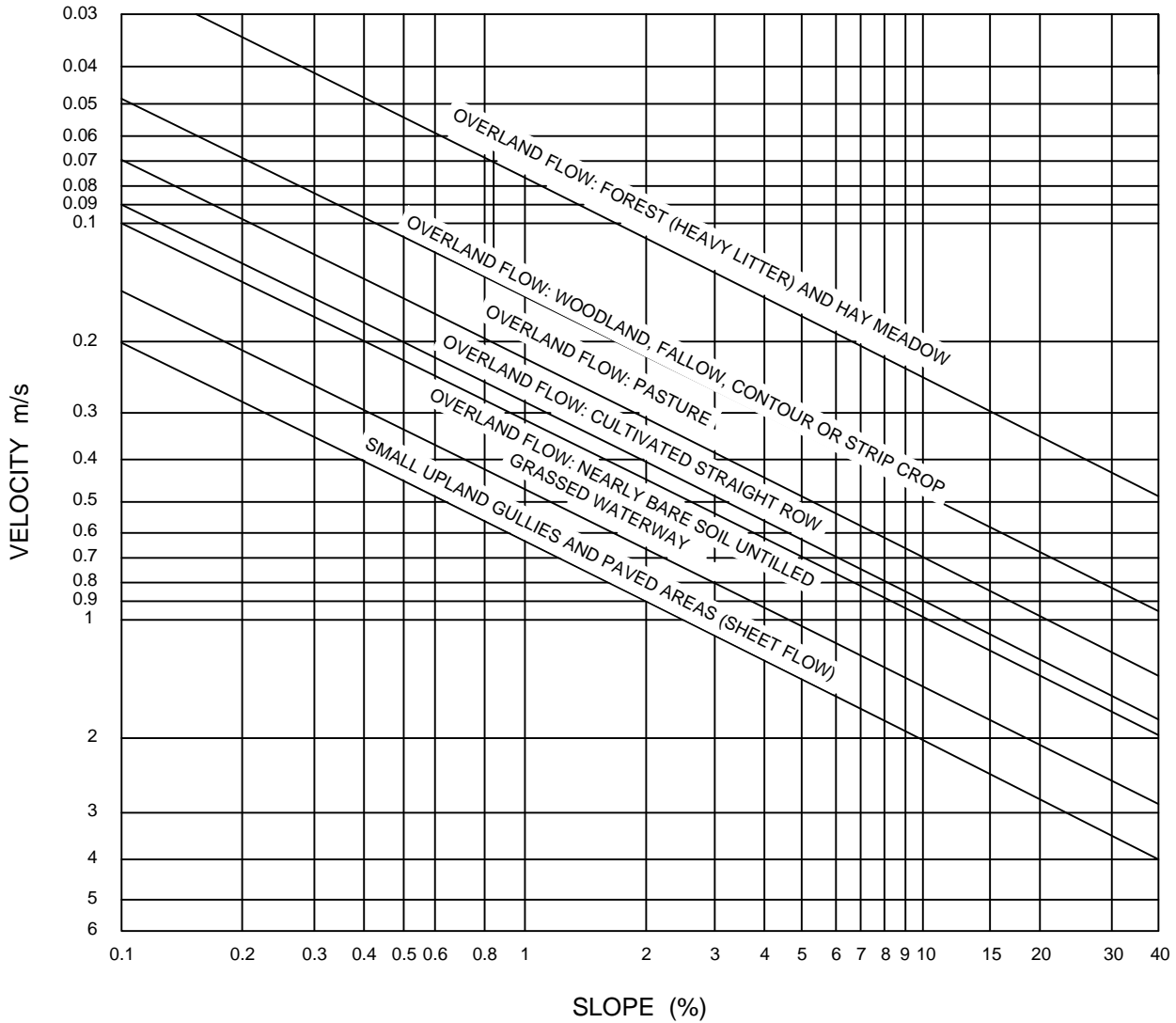
- 100
- 50
- 25
- 10
- 5
- 2



NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.





UPLAND METHOD FOR ESTIMATING TIME OF CONCENTRATION

NOTES:

1. THIS DRAWING SHALL BE USED IN ACCORDANCE WITH SECTION 7.0 OF THE MANUAL OF ENGINEERING STANDARDS AND SPECIFICATIONS, LATEST EDITION.
2. THIS TABLE IS LIMITED FOR USE IN DRAINAGE BASINS UP TO 10km².
3. THIS TABLE DOES NOT MAKE ALLOWANCES FOR VARIATIONS IN SOIL TYPES AND MAY UNDERESTIMATE TIMES FOR PERMEABLE BASINS.



SECTION 7 - STORM SEWER SYSTEM

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT

Piping and Fittings	7.70
Precast Manholes Sections	7.71
Catch Basins	7.72
Manhole Frames and Covers	7.73
Storm Sewer Service Connection Piping	7.74
Service Connection Inspection Assembly	7.75

SECTION 7 - STORM SEWER SYSTEM

MEASUREMENT AND PAYMENT

The Contractor will note that the Tendered Price for all items specified in this section will include but not be limited to the following: Please refer to Section 4 - Trench Excavation, Bedding and Backfill for further clarification of these items.

- (a) materials
- (b) excavation
- (c) dewatering
- (d) bracing & sheeting
- (e) bedding
- (f) pipe installation
- (g) backfill with imported material
- (h) video inspection
- (i) maintenance

The Contractor will note that payment for surface restoration and asphalt removal is paid in accordance with Section 4.75.

7.70 PIPING AND FITTINGS Section 7.42 - 7.46

Payment for piping and fittings will be made at the unit price per linear metre shown in the Tender Form for the various sizes and class of pipe. Measurement will be made horizontally along the centreline of the installed pipe, including fittings, from centre-to-centre of manholes or to the end of the pipe, whichever is applicable. This price shall include materials, excavation, dewatering, bracing and sheeting, bedding, pipe installation, backfill with imported material, video inspection and maintenance, testing as specified, and all work incidental thereto except those items for which payment is specified additional to that for gravity sewer pipe.

7.71 PRECAST MANHOLE SECTIONS Section 7.51 and 7.55

Payment for manholes will be made at the unit price per vertical metre per diameter of manhole barrel shown in the Tender Form.

Measurement will be made from the lowest channel invert in the manhole to the bottom of the manhole cover slab. This price shall include materials, installation, grouting, and all work incidental thereto except those items for which payment is specified additional to that for manholes.

7.72 CATCH BASINS Section 7.60

Payment for catch basins will be made at the unit price as shown in the Tender Form for the specified type of catch basin. This price shall include materials, installation, brickwork, concrete, grouting, adjustment to grade, asphalt apron and all work incidental thereto.

7.73 MANHOLE FRAMES AND COVERS Sections 7.49, 7.52, 7.53 and 7.54

Payment for manhole frames and covers will be made at the unit price shown in the Tender Form. This price shall include materials, installation, brickwork, concrete channeling and grouting, adjustment to grade, asphalt apron and all work incidental thereto. Payment will be in addition to that of 7.71 above.

SECTION 7 - STORM SEWER SYSTEM

MEASUREMENT AND PAYMENT

7.74 STORM SEWER SERVICE CONNECTION PIPING Section 7.61.3

Payment for sewer service connection pipe will be made at the unit price per linear metre shown in the Tender Form for the various sizes of pipe. Measurement will be made horizontally along the centreline of the installed pipe from the centre of the gravity sewer main to the terminus of the service pipe or from the bend fitting in the case of riser service connections.

This price shall include materials, excavation, dewatering, bracing & sheeting, bedding, pipe installation, backfill with native material, and maintenance, testing as specified, bends, caps and other fittings, and all work incidental thereto except those items for which payment is specified additional to that for sewer service connection pipe.

7.75 SERVICE CONNECTION INSPECTION ASSEMBLY Section 7.61.3 (j) & (k) and 7.61.4

Standard Drawing SW-11

Payment for service connection inspection assemblies will be made at the unit price shown in the Tender Form. This price shall include installation of pipe, fittings, marker posts, concrete service box, other materials and all work incidental thereto.

SECTION 7 - STORMWATER MANAGEMENT CONTENTS

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Summary of Stormwater and Environmental Protection Design Criteria	7.02
Stormwater Runoff	7.03
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Major System	7.05
Pipe Design Details	7.06
Culverts	7.07
Ditches (within road right-of-way)	7.08
Swales (within road right-of-way)	7.09
Open Channels (within private property and easements)	7.10
Inlet and Outlet Structures	7.11
Storage Facilities	7.12
Rainwater Best Management Practices	7.13
Water Quality	7.14
Climate Change	7.15
(REVISED NOVEMBER 2016)	
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Materials Testing	7.21
Piping, Fittings and Services	7.22A
Joints	7.22B
Service Junctions	7.23
Perforated Drains	7.24
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Precast Manhole Bases	7.25B
Manhole Tops	7.25C
Manhole Covers and Frames	7.25D
Manhole Steps	7.25E
-Not Used-	7.25F
Concrete	7.26
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Not Used	7.30
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Catch Basin Castings	7.31B
Inlet and Outlet Structures	7.32
Energy Dissipater Outlet Structures	7.33
Inlet and Outlet Protective Fencing and Handrails	7.34
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Culvert Headwalls	7.35B
Riprap	7.36
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(REVISED NOVEMBER 2016)	

SECTION 7 - STORMWATER MANAGEMENT CONTENTS

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Pipe Cutting	7.41
Pipe Installation	7.42
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Deflection	7.45
Fittings and Joints	7.46
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SECTION 7 - STORMWATER MANAGEMENT CONTENTS

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Small Lawn Basin on Private Property	SW-5
Catch Basin Frame and Grate	SW-6
Adjustable Curb Inlet Catch Basin Frame and Hood	SW-7
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(REVISED NOVEMBER 2016)	

SECTION 7 - STORMWATER MANAGEMENT DESIGN CRITERIA (REVISED NOVEMBER 2016)

7.01 INTRODUCTION

.1 Scope:

Stormwater management is the term traditionally used when referring to managing rainfall using design storms and sizing drainage facilities. Rainwater management refers to frequently occurring events. In this section, the term stormwater management is used and is intended to include the scope of rainwater management.

.2 Objectives:

- (a) Overall – To provide flood protection, drainage, and minimize impacts on the aquatic environment. Achieve a balance between protecting property from flood hazards and protecting the aquatic environment in terms of both water quality and quantity.
- (b) Major System – To safely convey the 1:100 year storm event with overland and piped flow to a suitable receiving body.
- (c) Minor System – To safely contain the 1:5 year storm within the minor system.
- (d) Rainwater Best Management Practices – To emulate the natural conditions of undeveloped land by capturing or retaining small rainwater events and infiltrating the water into the ground.
- (e) Existing Watercourses – To ensure that the quality and quantity of flows do not adversely affect the receiving waters.

.3 City Bylaws:

This manual should be used in accordance with the most recent version of other City policies and bylaws including, but not limited to those listed below:

- (a) Stormwater Management in Nanaimo
- (b) Official Community Plan
- (c) Other bylaws pertaining to stormwater as listed in Section 3.01(c) City Bylaws

.4 Other Applicable Government Initiatives:

In addition, this manual should be used in accordance with other applicable government policies, guidelines and documents, including, but not necessarily limited to the following:

- (a) Federal Fisheries Act
- (b) Provincial Fish Protection Act
- (c) Fish-Stream Crossing Guidebook, Revised Edition, Ministry of Forests, Lands and Natural Resource Operations, Ministry of Environment
- (d) Stormwater Source Control Guidelines 2012 – Metro Vancouver
- (e) Stormwater Planning: A Guidebook for British Columbia

.5 Previous Design Criteria:

City of Nanaimo utility systems have been constructed over many years using design criteria and practices that were in place at the time. The current criteria is to be used when designing all new infrastructure and when assessing the adequacy of existing systems. Existing systems which do not meet current design criteria will be evaluated on a case-by-case basis and upgraded as resources permit. When replacing existing infrastructure,

**SECTION 7 - STORMWATER MANAGEMENT
DESIGN CRITERIA
(REVISED NOVEMBER 2016)**

should the existing system not meet current criteria, the Design Engineer will be responsible to ensure the design is appropriate and founded on solid engineering principles and practices.

.6 Development Requirements:

(a) Responsibilities:

Development proponents shall be responsible for designing stormwater systems which consider watershed management, flood protection, drainage, riparian area, and watercourse protection.

Post-development run-off release rates must be designed to consider the capacity of the downstream drainage system and the erosion of any downstream watercourses. The design must ensure that the frequency and magnitude of erosion events do not increase when compared to the pre-development conditions. These requirements are further detailed in Section 7.03.7 - Peak Flow and Runoff Volume Control.

For new developments and re-developments that drain to watercourses, frequently occurring post-development run-off volumes and rates must be designed to emulate pre-development conditions. These requirements are further detailed in Section 7.03.7 - Peak Flow and Runoff Volume Control.

For developments and re-developments that do not drain into a creek or river system, but discharge directly into pipes, ditches or overland flow paths which discharges directly into the Strait of Georgia, hydraulic control facilities may not be required as for discharge to watercourses. These requirements are further detailed in Section 7.03.7 - Peak Flow and Runoff Volume Control.

The stormwater system must be designed in a manner which prevents pollutants and sediment from entering watercourses and ocean from the development both during and after construction. These requirements are further detailed in Section 7.14 Water Quality.

Construction activities must be managed to minimize the impact to adjacent watercourses as set out in the "Storm Sewer Regulation and Charge Bylaw No. 3808" and Erosion and Sediment Control Guideline.

It is the Design Engineer's responsibility to ensure that all applicable guidelines, standards, bylaws, and other regulations and policies are strictly followed.

(b) Reporting:

Development proponents shall prepare a Stormwater Management Plan for developments of more than three lots single or duplex residential lots and for all multi-family, commercial, industrial, and institutional developments, or at the discretion of the City Engineer. All Stormwater Management Plans shall be presented in a report which includes:

**SECTION 7 - STORMWATER MANAGEMENT
DESIGN CRITERIA
(REVISED NOVEMBER 2016)**

- (i) A tributary area plan outlining all areas included in the stormwater calculations, tributary to the rainwater management measures and minor and major systems.
- (ii) An overall plan showing major and minor systems and rainwater management measures (quantity and/or quality control as required). The plan shall, at minimum, include reference to street names and the legal addresses of adjacent lots; it is encouraged to include references to City of Nanaimo GIS pipe and manhole ID numbers for existing infrastructure. The design flows shall be marked on the drawing at all discharge points from the property.
- (iii) Detailed design drawings for the proposed minor and major systems and rainwater management measures. The drawings should show the routing of flows and the hydraulic grade line of all piped flows.
- (iv) A plan showing the pre and post-development topography that adequately describes the terrain.
- (v) Summary tables that provide the following key design information:
 - (a) Total catchment area
 - (b) Pre and post-development catchment area runoff coefficients used, if used.
- (vi) Design calculations including:
 - (a) Where applicable as described in Section 7.03.7 - Peak Flow and Runoff Volume Control, a review of the downstream infrastructure to the nearest trunk storm sewer or ocean. Where it is found that the discharge from the development alters the flows entering the downstream pipe to a point where the pipes no longer have sufficient capacity, the report shall include specific recommendations on downstream improvements to be made to accommodate the additional drainage.
 - (b) Hydraulic and Hydrologic design calculations for the pipe network using either the Rational Method and Manning's Equation or computer modeling.
 - (c) Design calculations for storage facilities including the storage volume, facility size and flow control considerations.
 - (d) Design calculations for rainwater management best practices including the rainwater design volume and facility size.
 - (e) Time of concentration design calculations including a rationale explaining which method was chosen and why that method was chosen.
- (vii) The report shall include details regarding the provisions included to address water quality leaving the site and entering the minor system.
- (viii) For systems which include works or facilities which require ongoing maintenance, an operation and maintenance plan shall be provided detailing the inspection and maintenance requirements.
- (ix) All Stormwater Management Plans are to be signed and sealed by a Professional Engineer licensed in British Columbia.

**SECTION 7 - STORMWATER MANAGEMENT
DESIGN CRITERIA
(REVISED NOVEMBER 2016)**

7.02 SUMMARY OF STORMWATER AND ENVIRONMENTAL PROTECTION DESIGN CRITERIA

- .1 This section provides a summary of all the design criteria to be used for the planning and design of stormwater management infrastructure. The planning and design for Stormwater Management Plans must meet the following criteria:
- (a) A minor system conveyance capacity up to the 1:5-year return period storm to minimize inconvenience of frequent surface runoff.
 - (b) A major system conveyance capacity up to the 1:100-year return period storm to provide safe conveyance of flows to minimize damage to life and property.
 - (c) For areas draining to watercourses: Provide volume reduction, detention, and water quality treatment to minimize erosion and protect aquatic habitat and water quality.
 - (d) For areas draining directly to the ocean: Volume reduction is not required; however, detention for the protection of downstream infrastructure may be required and water quality treatment.
 - (e) Volume reduction: Retain, infiltrate, or reuse the 6-month, 24-hour (50% of the 2-year, 24-hour) post development runoff volume. For Nanaimo, this equates to approximately 31mm of rainfall depth.
 - (f) Detention: Detain post-development flows to pre-development levels for the 6-month, 24-hour (50% of the 2-year, 24-hour) event for areas draining to watercourses to minimize erosion. If downstream drainage system cannot accommodate the 5-year post-development flows, detain them to pre-development levels.
 - (g) Provide water quality treatment for 90% of the average annual runoff (the 6-month, 24-hour storm or 50% of the 2-year, 24-hour storm) for impervious surfaces exposed to vehicle traffic as described in Section 7.14 - Water Quality. Remove 80% of Total Suspended Solids over 50µm particle size.
 - (h) Account for climate change in stormwater management designs as described in Section 7.15 - Climate Change.

7.03 STORMWATER RUNOFF

.1 Scope:

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

.2 Catchment Areas:

Ultimate land use for the purpose of stormwater calculations shall be determined by referring to the current "Official Community Plan" and the current Official Regional District Community Plans for the area outside the City.

The contributing catchment area shall be governed by the natural contours of the land and any changes to the topography caused by the development. The catchment shall also consider any overall catchment areas which have been established by the City of Nanaimo.

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.3 Rainfall Data:

(a) IDF Curves:

Intensity/Duration/Frequency data has been compiled into the IDF Curves shown on Standard Drawing No. SW-25 for the applicable design year return period rainfall.

(b) Rainfall Gauges:

The City of Nanaimo has several rainfall gauges with historical rainfall data. This rainfall data is available for reference if desired; however, it is up to the individual engineer to verify the quality of the data. In the future, specific data sets may become available.

.4 Time of Concentration:

(a) Definition:

Time of Concentration is the time required for stormwater runoff to travel from the most remote point of the drainage basin to the point of interest and having the greatest impact on downstream flows.

(b) Method:

There are several methods available to calculate time of concentration such as the Upland Method, Kinematic Wave Equation, Kirby Equation, Kirpich Equation, and others. The Design Engineer shall determine the most appropriate method of calculating the time of concentration. Overland flow times in undeveloped areas may be estimated using the Upland Method of Estimating Time of Concentration as shown on Standard Drawing No. SW-26 if the slope and land use of the area is known.

(c) Minimum and Maximum Time of Concentration:

The minimum time of concentration for all calculations shall be 5 minutes. The maximum time of concentration shall be 10 minutes for the overland flow component into the stormwater system in fully developed areas. Time of concentration with large areas of land which will remain undeveloped shall be determined by one of the above mentioned methods.

.5 Rational Method:

(a) Application:

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

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(b) Formula:

$$Q = CIA \times 2.78$$

Where:

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

(c) Coefficient of Runoff (C):

The choice of coefficient of runoff “C” shall be based on ground slope, type of ground or surface cover, soil conditions, size of drainage area and the expected ultimate land use of the properties within the drainage areas. Selection of the runoff coefficient for existing areas shall include a review of the orthographic photo to determine the impervious area.

The choice of the coefficient shall be guided by the expected characteristics of the proposed development and fall within the following ranges for new development:

TYPE OF DEVELOPMENT	COEFFICIENT OF RUNOFF
Industrial	0.80 to 1.00
Commercial Business Areas, Multi-Family	0.65 to 0.90
Single Family Residential and Low Density Multi-Family	0.50 to 0.80
Rural Areas, Parks, Golf Courses	0.25 to 0.55

(d) Presentation:

Where the rational formula is used, two copies of the storm sewer design calculations, in a format in accordance with Appendix H2, Stormwater Management Flow Analysis – Calculation Sheet shall be submitted.

6 Computer Simulation Methodology:

(a) Application:

For all stormwater calculations which include detention storage or other runoff controls and/or a catchment greater than 20 hectares, a computer simulation model shall be used. The model results must be used for design and sizing of all pipes and storage facilities.

(b) Stormwater Modeling Software:

The City of Nanaimo supports the use of any interface that supports the SWMM modeling engine for the creation of hydrologic and hydraulic computer models. The use of the other types of software requires the prior approval of the City Engineer.

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(c) Hydrology Methods:

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

(d) Storage Analysis:

Comprehensive analysis of the storage should be completed by the Design Engineer including a review of all storm durations up to the 24-hour event to determine the governing storm duration. In the future, the City may require continuous modeling be completed for storage analysis.

(e) Procedure:

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

(f) Presentation:

A report is required to document the design rationale used to develop the model. The report is to be included in the Stormwater Management Plan. At a minimum, the report shall include the following:

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

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.7 Peak Flow and Runoff Volume Control:

(a) Developments Not Upstream of a Creek, River or Wetland:

For new developments and re-developments that do not drain into a creek or river system, but discharge directly into pipes, ditches, or overland flow paths which discharge directly into the Strait of Georgia, storm water management facilities may not be required for hydraulic control. However, the Developer will be responsible for any downstream upgrades to the major or minor system extending to the nearest trunk sewer or outlet which is required as a result of the increased runoff from the development. Alternatively, the Developer may install hydraulic controls and provide storage which ensure the peak flow from the development site is maintained to pre-development conditions for the minor and major systems.

(b) Developments Upstream of a Creek, River, or Wetland:

For new developments and re-developments that eventually discharge into a creek, river or wetland system, controls are required to prevent erosion and shall recognize both peak flow rates and the duration of the peak flows. The objective is to limit both the magnitude and duration of post-development peak flows to that of the pre-development conditions, as much as possible.

(c) Post-Development Peak Flow and Runoff Volumes Shall be Controlled in Two Ways:

(i) Post-development 2-year and 5-year peak flows shall be controlled to 2-year and 5-year pre-development levels such that the post-development hydrographs shall emulate the pre-development hydrographs for both the 2-year and 5-year return periods. It is understood that it can be challenging to emulate existing conditions; at a minimum, the post-development hydrograph shall show that:

- (a) The peak flow does not exceed the pre-development peak flow.
- (b) The duration of the peak flow does not exceed the duration of the pre-development peak flow.

(ii) 6-Month, 24-Hour Storm Retained or Infiltrated Onsite:

Approximately 90% of all rainfall in BC are small rainfall events which, on most undeveloped sites, are primarily infiltrated into the soil. By incorporating rainwater best management practices, including rainwater best management practices, the majority of this rainfall can be infiltrated into the ground or retained for slow release. The rainwater management target is the 6-month, 24-hour post-development runoff volume. Research has indicated that this is consistent with 50% of the 2-year, 24-hour rainfall event volume. For Nanaimo, this equates to approximately 31mm of rainfall depth.

(iii) Care should be taken to ensure that watercourse base flows are not adversely affected by peak flow and runoff volume controls, or other hydrologic changes.

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- (d) Pre-development is defined as a natural state; in most cases, a forested area should be assumed. However, if it can be shown that the land's natural state was something other than forested, such as a meadow or rocky outcrop, it will be acceptable. Structures, parking areas, and manmade surfaces are not considered to be pre-development.
- (e) The above requirements for developments, to ensure runoff emulates the existing natural conditions, are necessary to protect the watersheds. However, the City does recognize that these targets may be challenging to achieve on some sites. Subject to the approval of the City Engineer, the City may accept Stormwater Management Plans which do not meet the targets outlined above, if the Design Engineer is able to provide evidence that:
 - (i) The development site has characteristics which make it challenging to meet the targets outlined above.
 - (ii) The intent of the above requirements has been achieved.

.8 Water Quality Treatment Event:

The Water Quality Design Storm is considered the 6-month, 24-hour (50% of the 2-year, 24-hour) event. This event captures approximately 90% of the average annual runoff. Larger events should be bypassed around water quality treatment facilities to minimize suspension and washing through sediments.

7.04 MINOR SYSTEM

.1 Definition:

The minor system shall be designed to convey the 1:5-year design storm. The minor system includes all drainage works that convey, detain, divert, and intercept the minor design runoff including pipes, catch basins, manholes, swales, ditches, etc., and other appurtenances designed to ultimately discharge into a major system.

.2 Location:

The minor system shall normally be located in road right-of-way for ease of access to repair or maintain the system. Where the minor system is located in private property, the flow route shall be preserved by restrictive covenants and/or statutory right-of-way for ease of access to repair or maintain the system.

.3 Trunk Storm Sewers:

Storm sewers 600mm in diameter or larger, or servicing an urban drainage basin in excess of 20 hectares, will be considered trunk sewers.

7.05 MAJOR SYSTEM

.1 Definition:

The major system shall be designed to convey the 1:100 year design storm. The major system includes all drainage works that convey, detain, divert and intercept the major

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design runoff including pipes, manholes, swales, ditches, etc., and other appurtenances designed to ultimately discharge into a natural watercourse.

.2 Location:

- (a) Generally, the major system shall be overland flow paths where the design flow can be conveyed in public road right-of-way and adequate watercourses. Where adequate overland major system paths cannot be established, pipes and culverts of the minor system may be enlarged to accommodate the major flow subject to approval of the City Engineer.
- (b) When the major flow is accommodated by a public street, the street shall be designed to provide sufficient hydraulic capacity to handle the major flow. Planning the major drainage system shall be done simultaneously with street layout and gradient planning to define the function of the streets as part of the storm drainage system.
- (c) When major flow is overland through private property, the flow route shall be protected and preserved by restrictive covenants and/or statutory right-of-way for ease of access to repair or maintain the system.
- (d) Overland flow paths through private property shall be designed to minimize property damage and endangerment to public safety and have a suitable erosion protection.
- (e) If no safe overland flow path exists, the storm sewer system must be designed to be the major system and sized to convey the major design storm to the outlet.
- (f) Where the major flow is accommodated through the storm sewer system, additional catch basins may be required to ensure the flow can be captured by the minor system. The capability of the catch basins to accept the major flow is to be reviewed and confirmed.

.3 Discharge to Existing Watercourses:

- (a) The discharge to an existing watercourse shall be designed in a way that protects the watercourse from erosion. Flow velocities exceeding 1.5m/s require an energy dissipater to reduce flow velocity to an acceptable rate.
- (b) When improvements are required to a natural watercourse, design concepts which preserve and enhance the natural characteristics of the watercourse shall be employed.

.4 Flooding:

- (a) The major system routing may allow for minor inconvenience such as localized flooding of streets and green spaces (parks, boulevard, landscaped areas, naturally vegetated areas, etc.), but no major damage such as damage to dwellings, significant erosion of private property, or damage to public facilities shall result from the major storm. Any allowances for minor inconvenience flooding shall be mentioned in the Stormwater Management Plan and shall be approved by the City Engineer.
- (b) Full width cross-sections shall be provided showing the depth of the major flow along public streets, private property, ditches, and watercourses at typical and critical areas of the overland flow path.
- (c) The major system shall be designed such that all habitable portions of buildings including basements are a minimum 0.3m above the major flow hydraulic grade line. No building shall have the bottom of its foundation less than 0.3m above the

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maximum high water elevation of any storm water storage facility. In circumstances where lower building elevations are desired, the minor system may be enlarged to accommodate the major flow.

- (d) Existing buildings constructed to a previous standard may not have this protection from the major system. As a result, if a lot is redeveloped, the new minimum habitable floor elevation on that lot may not be the same as the previous minimum habitable floor elevation.
- (e) The grading for new developments shall ensure that the slope of the ground around structures has positive drainage away from structures.

.5 Roadway:

- (a) Where the road is used to accommodate major flow, the following criteria must be considered:
 - (i) For local streets, the maximum depth at the crown of the road is to be 50mm.
 - (ii) For neighborhood collectors, minor collectors, major collectors and arterial roads, a minimum of 3.0m width of the road shall be free from flooding.
 - (iii) Care should be taken when designing intersections of roads which are used to convey the major storm so that flows can pass over the cross street.
 - (iv) Care should be taken designing the grading at road curves and at locations where the major flow path turns at intersections or at tee intersections.
 - (v) Cul-de-sacs which are down slope from the street will not be accepted as part of the major system unless approved by the City Engineer.
 - (vi) Care should be taken when designing driveways which are downhill from streets which form part of the major system. Type 2 driveway letdowns shall be avoided as shown in Standard Drawing No. CS-5A.
- (b) When the street forms part of the major system, it shall be crowned and have curb and gutter capable of handling the major flows.
- (c) The hydraulic capacity of a street section to convey water shall be calculated by the Manning Equation subject to the above conditions for major flows in a roadway.

7.06 PIPE DESIGN DETAILS

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

- (a) The minimum design velocity for pipes shall be 1.0m/s.
- (b) Where the pipe discharge velocity of the design flow exceeds 1.5m/s, into an open ditch or watercourse, provision shall be made for the installation of an energy dissipater to reduce flow velocity to the acceptable rate.
- (c) There are no maximum allowable velocities; however, where velocity exceeds 3.0m/s or grades exceed 10%, the need for scour protection shall be examined and anchor blocks shall be required as per Standard Drawing No. T-8 and Standard Drawing No. T-8A.
- (d) All 100mm diameter service connections shall have a minimum grade of 2%.

.2 Pipe and Service Connection Sizes:

- (a) Minimum pipe diameters shall be 250mm. In residential areas, 200mm diameter may be approved by the City Engineer in the final section of a lateral sewer providing

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the pipe has the required capacity and extension in the future is precluded by physical barriers or there is existing alternate pick-up of drainage from adjacent areas.

- (b) Unless otherwise approved by the City Engineer, downstream pipe diameter shall be greater than or equal to upstream pipe diameter.
- (c) Residential service connections shall be a minimum 100mm diameter, except service connections servicing lawn basins shall be a minimum 150mm diameter.
- (d) Commercial and Industrial service connections shall be a minimum 150mm diameter.

.3 Selection of Pipe Material and Class:

The Design Engineer shall consider earth and live loading, soil conditions, and design life of the installation for determining pipe material and class. Pipe materials and brands shall be per the City of Nanaimo's Approved Products List.

.4 Pipe Friction Factors:

Storm sewers shall be designed using the Manning Formula. The minimum 'n' value shall be 0.013 for all approved pipes.

.5 Pipe and Service Connection Depths:

(a) Minimum Cover:

- (i) Storm sewers shall have 1.5m of cover in road right-of-way.
- (ii) Storm sewers shall have 1.0m of cover in untraveled areas.
- (iii) Service connections shall have 0.75m of cover.
- (iv) Where minimum cover cannot be provided, an explanation of the reasons and pipe loading calculations shall be submitted with the proposed method of pipe protection to the City Engineer for approval.

(b) Where practical, service connections shall be deep enough to accommodate by gravity the lowest elevation of each lot serviced. Where it is not practical or where servicing the low elevation of the lots would require utilities in private lands, the development shall be graded in such a way which prevents overland flow from impacting neighboring structures.

(c) In addition, all existing foundation drains shall be accommodated. For vacant lots, service connections shall also be deep enough to accommodate by gravity foundation drains for future building(s) constructed to the minimum basement floor elevation as determined by the Design Engineer.

(d) Storm sewer mains shall be deep enough that all service connections accommodating surface and foundation drainage from all lots in the upstream drainage basin can be drained to the storm sewer system by gravity.

.6 Curved Pipes:

(a) Horizontal curves will be permitted where the configuration of the property lines requires curvature for a constant offset and where the design velocity exceeds 1.0m/sec.

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

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- (c) Radius of curvature shall be uniform throughout the curves and shall not be less than 60m or the manufacturer's minimum pipe radius, whichever is greater. Mitre bends shall not be used unless otherwise approved by the City Engineer.
- (d) Only one vertical and/or one horizontal curve shall be permitted between manholes.

.7 Location of Storm Sewer Mains and Service Connections:

- (a) Storm sewer mains shall be located not less than 3.0m horizontally and 0.45m vertically from all watermains unless otherwise approved by the Provincial Department of Health. Normal storm sewer main offsets are shown in the standard drawings for roadways.
- (b) If there is a significant elevation difference between the lots on opposite sides of the street, if possible, storm sewers shall be located on the low side of the street where both sides are served by the sewer. If only the high side of the street is serviced by the storm sewer, storm sewers shall be located on the high side of the street.
- (c) All lots shall be provided with a storm sewer service connection, unless otherwise approved by the City Engineer. Service connections shall be located to the offsets as shown on Standard Drawing No. T-7.
- (d) Storm sewer mains may be installed in a common trench with sanitary sewers provided the minimum outside pipe separation is 300mm.

.8 Utilities in Private Lands:

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

- (a) The design of utilities shall avoid crossing private lands. Utilities in private lands shall require the approval of the City Engineer. Approval will only be granted where it is shown that all other options have been exhausted.
- (b) Utilities following property boundaries across private lands shall generally be offset a minimum 2.0m from the property boundary.
- (c) Appurtenances such as manholes, valves, etc., shall be located entirely on one property, they shall not be located on property boundaries.
- (d) Utilities shall not cross private parcels in such a manner that they render the property unusable. Special consideration must be given to ensure the location of the utility crossing minimizes the limitations on the future use of the property.
- (e) For a sample statutory right-of-way condition sheet, refer to Appendix C, Standard Drawing No. RW-2.
- (f) For an Easement Release and Inspection Form Following the Construction of the Utility, refer to Appendix C.
- (g) For minimum widths of statutory right-of-way and working widths refer to Appendix D.

.9 Service Connection Lengths:

- (a) The maximum length of a storm sewer service connection measured horizontally between the storm sewer and the property line shall be 30m. Storm sewer services longer than 30m shall require approval by the City Engineer. All inspection assemblies required for service connections in excess of 30m in length shall be shown on the design drawings.
- (b) For industrial, commercial, and multi-family servicing, and/or where oil interceptors are required, manholes shall be provided where the service connects with the main or at the property line regardless of the size of the service.

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

.10 Number of Service Connections per Lot:

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

.11 Manholes:

- (a) Distances between manholes shall not exceed 120m unless otherwise approved by the City Engineer. For pipes larger than 600mm in diameter, manhole spacing may be increased to 180m.
- (b) Manholes shall be located at grade and alignment changes, at lateral size changes, at the upstream end of all lateral sewers, and either at the junctions of all lateral sewers with the main or at property line for services 250mm and larger.
- (c) Cleanouts may only be used at the upstream end of lateral sewers in a temporary situation during a phased development where the future phase of the development will remove the cleanout.
- (d) Outside drops shall be provided for pipe sizes 375mm or less where the difference in elevation between incoming and outgoing sewers exceed 600mm. Drops less than 600mm in elevation shall be accommodated by manhole benching. Precast manhole barrels shall be sized according to nominal inside pipe diameter and depth as detailed below:

Minimum		
Pipe Size (Nominal)	Depth of Manhole (Top of Cover to Inv.)	Barrel Size (Inside Dia.)
150 - 375mm	0 - 5.9m	1050mm
150 – 375mm	6.0 – 9.0m	1200mm
150 – 600mm	9.0m or greater	1500mm
400 – 600mm	0.0 – 8.9m	1200mm
675 – 750mm	All Depths	1350mm
900 – 1050mm	All Depths	1500mm
Minimum barrel sizes shall be increased for manholes with multiple large pipes.		

- (e) Where cast-in-place manholes are proposed, all design and construction details shall be submitted to the City Engineer for approval.
- (f) Manholes shall be designed to incorporate a minimum pipe invert elevation difference of at least 25mm, in addition to the normal grade of the storm sewer, wherever a horizontal deflection exceeding 45 degrees occurs. Smaller pipe sizes shall be crown to crown with larger pipe sizes when entering manholes. For super critical flows or large pipes (>600mm diameter), the hydraulic losses through

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manholes shall be calculated and the corresponding drop in inverts across the manhole shall be included in the design where appropriate.

- (g) Manholes shall be located to avoid any conflict with curb and gutter or sidewalks.
- (h) A watertight manhole frame and cover shall be required for all sewer manholes where flooding can occur or in areas subject to vandalism (i.e. parks, undeveloped right-of-ways, etc.).

.12 Catch Basins:

- (a) Catch basins shall be provided at regular intervals along streets, at street intersections, and at all low points in the street.
- (b) Catch basins located in streets shall be spaced to collect a maximum of 450m² of pavement drainage where grades do not exceed 5%. On grades over 5% the maximum area collected shall be reduced to 300m².
- (c) Double catch basins are required at all low points in roads and downhill cul-de-sacs except where located along non-mountable curb which provides for installation of a single curb inlet, refer to the curb inlet standard drawing. Location requirements for the different catch basin types shall conform to the following:
 - (i) Curb inlet catch basins shall be used in locations along non-mountable curbed roads at all low points or in other areas where additional inlet capacity is required.
 - (ii) Boulevard catch basins shall be used in boulevards and easements outside of the paved road.
 - (iii) Lawn basins shall be used for locations on private property where, at the discretion of the City Engineer, drainage is required to be contained and prevented from flowing onto other properties.
 - (iv) Shallow catch basins shall be used in locations where it is not possible to provide a catch basin with a sump.
- (d) Catch Basin Leads:
 - (i) Single basin leads shall have a minimum diameter of 200mm.
 - (ii) Double basin leads shall have a minimum diameter of 250mm.
 - (iii) Lawn basin leads shall have a minimum diameter of 150mm.
 - (iv) Leads over 30m shall have a minimum diameter of 250mm.
 - (v) Double basin leads shall be wyed together. Basins shall not be directly connected.
 - (vi) The desired grade for catch basin leads is 2%. Where it is impractical to obtain 2%, a catch basin lead with a 1% grade is acceptable.

.13 Surcharge:

- (a) In areas of new construction, storm sewer pipes shall be designed so that the minor storm hydraulic grade line is within the pipe and the hydraulic grade line meets the requirements set out in Section 7.05 - Major System.
- (b) When necessary, and subject to approval by the City Engineer, storm sewers may be permitted to temporarily discharge into existing ditches with submerged outlets, to allow future extension of the sewer at an adequate depth. In these cases, a hydraulic

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gradient must be calculated and shown on the plan to ensure that no danger of flooding will result.

.14 Trench Dams:

- (a) Where there is any possibility of groundwater concentration to other utility trenches, storm sewer connections and trench dams shall be provided per Section 4.18 - Trench Dams.

.15 Subsurface Drains:

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

7.07 CULVERTS

.1 General:

- (a) Generally, culverts shall be sized to suit the drainage area and shall not be smaller than upstream culverts without prior approval of the City Engineer.
- (b) Inlet and outlet structures shall be appropriately designed with energy dissipation, scour protection, erosion control and overflow protection as needed.

.2 Road Culverts:

- (a) Road culverts shall be designed to accommodate the major system. The culvert inlet may surcharge under the major storm. The surcharge at the inlet shall meet the flooding requirements of the major system as specified in Section 7.05 - Major System.
- (b) Road culverts shall be minimum 450mm diameter regardless of hydraulic capacity.
- (c) Road crossings of watercourses which are, or could be fish bearing, shall be designed to provide fish passage where possible. Open bottom culverts are preferable.

.3 Driveway Culverts:

- (a) Driveway culverts shall be designed to accommodate the minor storm with the headwater not above the crown of the pipe.
- (b) Driveway culverts shall be minimum 300mm diameter regardless of hydraulic capacity.

7.08 DITCHES (WITHIN ROAD RIGHT-OF-WAY)

- (a) Ditches shall be used in road allowances where there is no curb and gutter to direct minor and major flows towards watercourses or the nearest piped system.
- (b) Ditches shall be designed to promote groundwater infiltration.
- (c) Ditches adjacent to travelled roadways shall not exceed 1.9m in depth.

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- (d) Ditches shall be trapezoidal in shape having maximum side slopes of 1-1/2 H:1V and a minimum bottom width of 450mm.
- (e) The minimum grade of a ditch shall be 0.5%.
- (f) The maximum velocity in an unlined ditch shall be 1.5m/s. Higher velocities may be permitted where soil conditions are suitable or where erosion protection has been provided. Excessive velocities should be avoided by using a piped system instead of ditches.
- (g) On steep slopes, grade control structures may be required.

7.09 SWALES (WITHIN ROAD RIGHT-OF-WAY)

- (a) Swales shall be used in road allowances where there is no curb and gutter to direct minor and major flows towards watercourses or the nearest piped system or on private property in conjunction with lot grading to protect properties from overland sheet flow.
- (b) Swales shall be designed to promote groundwater infiltration.
- (c) Swales shall have a minimum depth of 150mm, and a minimum width of 1.5m.
- (d) The minimum grade of a swale shall be 1.0%.
- (e) Swales shall not be used where the velocity exceeds 1.5m/s or on excessively steep slopes.

7.10 OPEN CHANNELS (WITHIN PRIVATE PROPERTY AND EASEMENTS)

- (a) The design of open channels as part of the major or minor system shall be restricted to the following maximum velocities:
 - (i) Unlined channel: 1.5m/s
 - (ii) Suitably lined channel: 3m/s
- (b) If the mean velocity exceeds that permissible for the particular kind of soil or is greater than 1.5m/s, the channel shall be suitably lined to protect it from erosion.
- (c) The maximum depth of flow shall not exceed 300mm with a freeboard of 150mm.
- (d) Side slopes on designed channels shall not exceed 3H:1V.
- (e) Open channels shall be designed where possible to promote infiltration.

7.11 INLET AND OUTLET STRUCTURES

- (a) Inlet and outlet structures shall be required on all storm sewer pipes and culverts. Headwater requirements shall be as per Section 7.07 - Culverts.
- (b) A trash rack is required as part of all inlet structures to storm sewer pipes. Trash racks may be required on culverts at the discretion of the City Engineer.
- (c) Trash rack hydraulic and structural design shall allow for passage of design flows with 50% blockage of the trash rack with debris.
- (d) A safety grillage is required as part of an outlet structure from storm sewer pipes greater than 450mm in diameter or 3.0m in length. Safety grillages may be required on culverts at the discretion of the City Engineer.
- (e) Pipe leaving inlet structures, where the inlet elevation significantly higher than the storm sewer, shall have a maximum grade of 5% for minimum 2.0m. After the 2.0m, the pipe grade can be adjusted with a vertical curve to attain design depth.
- (f) Cast-in-place inlet and outlet structures shall be designed by a structural engineer to suit the specific site and soil conditions. Standard drawings shall be used as a guide for specific design criteria. Approved prefabricated inlet and outlet structures may be used.

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The Engineer shall ensure the structures are designed to suit the existing site and soil conditions.

- (g) Sandbag headwalls shall not be used except for driveway crossings or hydrant access crossing.
- (h) Outlets for storm sewers having velocities in excess of 1.5m/s shall incorporate a method to dissipate the energy so that the water will not scour the receiving channel.
- (i) All inlet and outlet structures shall include provisions for safe maintenance access and shall conform to WorkSafeBC requirements.

7.12 STORAGE FACILITIES

.1 General:

- (a) The design of permanent storage facilities forming part of the major system shall be an integral part of the overall drainage basin plan.
- (b) The design of permanent storage facilities shall consider safety and economical maintenance of operations. Storage facilities should also, where possible, be designed as multiuse facilities that include recreational, environmental and aesthetic aspects.
- (c) Storage facilities shall accommodate the entire future developed tributary area.
- (d) Depending on the site specific characteristics, a combination of storage and other groundwater recharge facilities may be appropriate to effectively reduce the runoff from development sites.

.2 Ownership:

- (a) Single Family and Duplex Residential:

Large storage facilities servicing single family or duplex residential developments will be owned and maintained by the City. Storage facilities constructed as part of a Bare Land Strata single family or duplex residential development will be owned and operated by the Strata Corporation.

- (b) Multi-Family Residential, Commercial, Industrial, and Institutional:

Storage facilities required as part of a multi-family, commercial, industrial, or institutional development will be owned and operated privately. Facilities may be underground or above ground including roof top or parking lots.

.3 Storage Facility Options:

- (a) Constructed Wetland:

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

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(b) Wet Pond:

A wet pond is a method where rainwater runoff is collected and stored for a significant amount of time. The water is usually released after the storm has ended. These may form a recreational or aesthetic facility centered on a permanent pool of water.

(c) Dry Pond:

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

(d) Underground Storage:

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

(e) Other Methods:

There are a variety of other ways to store rainwater onsite including rooftop storage, parking lot storage, infiltration swales, rain gardens and many others. The City of Nanaimo is open to innovative ways to store and infiltrate rainwater subject to the approval of the City Engineer.

.4 General Design Guidelines:

- (a) Storage facilities shall be tailored to suit the unique characteristics of the site and shall include a geotechnical evaluation to address the groundwater table interaction, and the permeability and stability of the existing soils.
- (b) Maximum grade for a dry detention pond shall be 4H:1V.
- (c) Maximum wet detention pond shall be 7H:1V from the normal water level to a depth of 0.4m; steeper side slopes may be considered if the safety risks are minimized such as separating the area from the public or the pond being inaccessible due to vegetation. Slopes of 4H:1V vertical shall be used for 0.4m depth below water level to the bottom of the pond.
- (d) Storage facilities shall be designed to accommodate the design storage volume with a freeboard of 300mm.
- (e) Where practical, sub-surface drains shall be provided to ensure that the storage facility can be completely drained. Where subsurface drains cannot be installed, the pond shall be designed so that mobile pumping equipment may be installed and used to drain the pond.
- (f) All existing and future foundation drains shall drain by gravity to the storage facility inlet pipe above the design storage level.
- (g) An overflow spillway shall be provided to handle potential peak runoff from the major storm or a blockage to the outlet. Discharge shall be to the major system downstream flow path.

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- (h) An 8.0m buffer zone shall be provided along the top of wet ponds, dry ponds, and constructed wetlands with a minimum building set-back of 15m from the top of the storage facility.
- (i) An access at least 3.0m wide shall be provided to all storage facilities for maintenance purposes. The access shall allow the passage of motor vehicles unless otherwise approved by the City Engineer.
- (j) Storage facilities shall be appropriately landscaped and protected from erosion.
- (k) Inlets for the storage facility shall be a form of surcharging manhole or catch basin inside the facility. Open channels in the storage facility shall not be permitted.
- (l) The outlet control for storage facilities shall be designed for easy access and maintenance and shall be provided with a lock to prevent vandalism.
- (m) The pond design will include a sediment removal process for control of heavy solids which may be washed to the pond during the construction period associated with the development of the contributing basin. Sediment basins will be provided at all inlet locations for continued use after completion of the subdivision development.
- (n) Additional design guidelines can be found in the Department of Fisheries and Oceans Land Development Guidelines for the Protection of Aquatic Habitat.

.5 Temporary Storage Facilities:

- (a) Where land development occurs in advance of completed drainage basin facilities, temporary storage facilities may be utilized on an individual basis as approved by the City Engineer.
- (b) The design of temporary storage facilities shall consider the following:
 - (i) The temporary storage facility meets or exceeds the requirements of this section for permanent storage facilities unless otherwise noted.
 - (ii) All storm drainage systems discharging to the temporary storage facility can be connected to the permanent drainage works when completed and the temporary facility is abandoned.

.6 Storage Facility Outlets:

- (a) The outlet of the storage facility should be designed to control the outflow as calculated in the Stormwater Management Plan.
- (b) The outlet structure for a storage pond shall discharge to a point downstream which has the ability to safely and adequately accommodate the maximum discharge.
- (c) Outlet structures shall be freeflow and ungated. Controls such as orifices and weirs are the preferred method of controlling the outflow. Manual controls such as gates, valves, or stop logs are discouraged. A valve will be permitted in the drain of a storage pond.
- (d) Outlet structures shall conform to Section 7.11.
- (e) For outlets that are not submerged, a lattice type cover over the inlet end of the outlet is preferred. A limiting velocity of 1m/s is required for the design of the lattice.
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- (f) Outlets shall be designed to all appropriate WorkSafeBC requirements for entry and exit.
- (g) Outlet structure shall be designed to allow easy and safe access for cleaning of the inlet side during peak runoff.

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7.13 RAINWATER BEST MANAGEMENT PRACTICES

.1 Introduction:

The development of previously vegetated land significantly changes the hydrological characteristics of the land by removing vegetation, changing the topography of the land, increasing impervious surfaces, and changing drainage paths. Traditionally, the increase in stormwater runoff, which is created by this development, has been mitigated through detention storage to control peak runoff and by increasing the hydraulic capacity of the drainage system. Recently, there has been progress toward considering more than just the hydraulic aspects of rainwater runoff to include aspects such as the natural hydrologic process, the overall watershed, and water quality. Some of the rainwater best management practices described in this section were developed as an attempt to mimic the natural characteristics of a watershed. Many of them promote infiltration of rainwater into the ground and provide groundwater recharge benefits in addition to rainwater runoff control. Rainwater best management practices may also be called: rainwater BMPs, stormwater source controls, low impact development BMPs, or rainwater management methods.

The use of rainwater best management practices is required wherever technically feasible for new developments and re-developments which outlet into a creek or river system. For developments that do not drain into a creek or river system, but discharge directly into pipes, ditches, or overland flow paths which discharge directly into the Strait of Georgia, rainwater best management practices may not be required for runoff volume control, but may be an effective option for stormwater treatment.

.2 Types of Rainwater Best Management Practices:

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

(a) Infiltration Swales:

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

(b) Rain Gardens:

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

(c) Absorbent Landscaping:

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

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(d) Green Roof:

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

(e) Infiltration Trenches:

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

(f) Soak-Away Manholes:

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

(g) Pervious Paving:

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

(h) Deep Groundwater Recharge:

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

(i) Retention:

Retention of rainwater runoff involves storage and release of rainwater at very low rates, to mimic natural groundwater interflow rates. This is similar to detention, but the release rate is very low, at 0.25 L/s/ha. The water is released through a control orifice to the municipal minor drainage system.

(j) Other Methods:

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

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.3 Application:

(a) Single Family and Duplex:

Due to the small lot size, limited oversight once developed, and potential for multiple owners and other aspects related residential subdivisions, the application of best management practices for Single Family and Duplex developments is limited to absorbent landscaping and disconnected roof leaders or neighbourhood based solutions. It may not be appropriate to disconnect roof leaders for some development sites such as small lot developments, areas with high ground water tables, or other site specific issues.

Best management practices other than absorbent landscaping can be integrated into each lot of the development; however, they will not form part of the calculation for reduction in runoff. Pervious driveways and patios are strongly encouraged.

(b) Multi-Family Residential, Commercial, Industrial, and Institutional:

The use of rainwater best management practices to infiltrate or retain rainwater is required for multi-family, commercial, industrial, and institutional developments in order to preserve the natural hydrologic condition as much as possible.

(c) Steep Slope Development:

Steep slope residential developments (R10 Zoning) may not be suitable for some rainwater best management practices. Developments in these areas will require specific attention to methods of retention and detention so that post development targets can be met.

.4 Design:

(a) Detailed methodology for the design of rainwater best management practices can be found in Metro Vancouver's "Stormwater Source Control Design Guidelines 2012". An overview of some of the design considerations are listed below.

(b) Sizing Methods:

There are several ways to size and design rainwater best management practices. It can be complex and it is generally recommended that continuous simulation modeling be completed over an extended period of time (at least one year). Programs capable of continuous modeling shall be in accordance with Section 7.03.6(b). For sites where rainwater management best practices will be used in a series or "chain", continuous simulation for sizing and design is required.

Alternatively, for individual facilities, rainwater management best practices can be designed using spreadsheets to calculate the water balance and size of facility, or the equations provided in Metro Vancouver's "Stormwater Source Control Design Guidelines, 2012" can be used for facility sizing and design to meet the rainwater management target.

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(c) Soil Hydraulic Conductivity:

For practices that infiltrate water into the ground, the expected rate of infiltration is described by the soil's saturated hydraulic conductivity. For planning purposes, the following hydraulic conductivity rates can be used:

Sand	210mm/hr
Loamy Sand	61mm/hr
Loam	13mm/hr
Silt Loam	6.8mm/hr
Sandy Clay Loam	2.3mm/hr
Sandy Clay	1.5mm/hr
Silty Clay	0.9mm/hr
Clay	0.6mm/hr

For detailed design purposes, onsite infiltration testing is required and the rates must be recommended by a Geotechnical Engineer based on field testing and analysis.

Rainwater infiltration and groundwater recharge facilities are still encouraged on sites with moderate or low soil hydraulic conductivity even though the target infiltration volume may not be able to be accommodated by the facility. Retention type facilities may be investigated to make up the difference.

(d) Groundwater:

Rainwater infiltration and groundwater recharge shall not be placed in areas with unsuitably high groundwater. The seasonally high groundwater table should be at least 600mm below the bottom of the infiltration facility.

(e) Bedrock:

Rainwater infiltration and groundwater recharge facilities may not be practical in areas where there is bedrock close to the surface. There shall be a minimum of 600mm between the bottom of the infiltration facility and bedrock. It should be noted that certain types of bedrock are highly pervious (i.e. fractured sandstone) and suitable for infiltration.

(f) Drinking Water Wells:

The design of groundwater recharge facilities shall be separated from drinking water wells and must meet all Ministry of Health guidelines for separation of wells from septic fields.

(g) Water Quality:

Water infiltrated into the ground shall be uncontaminated. Sites which present a high risk of groundwater contamination shall provide appropriate pre-treatment and spill control, if necessary, prior to infiltrating rainwater runoff. Examples of these sites include:

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- (i) Automobile Service Yards, and
- (ii) Industrial Chemical Storage Facilities.

(h) Contaminated Soils:

Sites with contaminated soils shall be reviewed by a Geotechnical Engineer and/or Hydrogeologist for suitability for rainwater infiltration into the ground.

(i) Steep Slopes and Unstable Soils:

Sites containing steep slopes, near steep slopes, or unstable soils shall be reviewed by a geotechnical engineer for suitability for rainwater infiltration and groundwater recharge facilities, but generally these facilities are prohibited in such conditions as they can saturate soils and can exacerbate slope instability. Designers should refer to the City's Development Permit Areas, DPA 3 and DPA 5, for areas where there may be concerns for surface water control and/or subsurface infiltration. It is important that infiltrated water does not seep out in down slope areas impacting other properties. If there is a reason for concern with the suitability of proposed on-site infiltration facilities, the City Engineer may request review by a Hydrogeologist or Geotechnical Engineer.

(j) Overflows:

Rainwater best management practices shall be designed with an overflow into the minor or major drainage system.

(k) Maintenance:

The design of rainwater best management practices shall be such that the maintenance required in order for the facilities to properly operate shall be minimized. Regular maintenance which is required shall be identified in the Stormwater Management Plan.

(l) Sediment Loads:

All rainwater management best practices, other than green roofs, shall be designed in such a way that there is a simple procedure for removing sediment which does not require confined entry. Specific attention shall be paid to the construction period. Infiltration facilities shall be designed in a way which prevents sediment from entering the facility and plugging the water-soil interface.

7.14 WATER QUALITY

.1 Introduction:

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

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.2 Treatment:

(a) High Risk Sites:

Sites which present a high risk of groundwater or receiving water contamination shall provide appropriate treatment prior to water entering the stormwater system. Examples of these sites include:

- (i) Automobile Service Yards, and
- (ii) Industrial Chemical Storage Facilities.

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

(b) Parking Areas:

All uncovered parking areas greater than 100m² in size shall require treatment to remove oil, total suspended solids (TSS), and other contaminants. Treatment can be achieved by draining the parking area to rainwater best management practices or by installing a mechanical method of removing the contaminants. Where possible, treatment using rainwater best management practices is preferred as they provide additional rainwater management benefits at the same time as water quality treatment.

(c) Design Requirements for Water Quality Treatment:

On sites where water quality treatment is required, including when mechanical treatment is selected (such as an oil water separator), the facilities must be designed to treat 90% of the total volume of stormwater runoff for a typical year or the 6-month, 24-hour post development flow volume which is equivalent to 31mm of rainfall per square metre of impervious area. Maintenance manuals shall be provided for all mechanical treatment facilities.

(d) Sediment:

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

(e) Water Quality:

Treated water shall meet the British Columbia Approved Water Quality Guidelines as set out by the Water Protection and Sustainability Branch of the Ministry of Environment.

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7.15 CLIMATE CHANGE

.1 Rainfall Patterns:

- (a) The City of Nanaimo recognizes that our climate is changing and the change may impact the rainfall patterns which are historically seen in Nanaimo. It is not fully clear as to what impact climate change will have and requirements to accommodate climate change may be adjusted over time. However, to accommodate the expected changes in climate patterns, the design of stormwater management systems shall be conservative in nature and make allowance for climate change. Based on the Association of Professional Engineering and Geoscientists of BC guidance¹ and current down scaled climate model projections from the Pacific Climate Impacts Consortium² a 10% increase in design peak flow capacity is required to be designed into new minor system infrastructure to account for climate change. Major system flow paths and infrastructure should have a 20% increase in design peak flow capacity over the standard sizing developed from the IDF curves to mitigate the potential of major system flood increases due to climate change.

.2 Sea Level Rise:

- (a) The City of Nanaimo recognizes that our climate is changing and the change may impact the sea levels. Development sites which are near the waterfront may be required to review and accommodate sea level rise in their development. Sea level rise is a complex problem and requirements will be established on a site by site basis; requirements to accommodate climate change may also be adjusted from time to time. For cases where exact sea level rise has not been determined, the predicted rise of 1.0m by the end of the century shall be used as a minimum.³

¹ APEGBC, Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC, 2012, Section 3.5.3, Pg. 23 and Section H.3.1., pg. 123.

² <http://www.pacificclimate.org/analysis-tools/plan2adapt> Potential Impacts for Nanaimo in the 2080's.

³ APEGBC, Professional Practice Guidelines – Legislated Flood Assessments in a Changing Climate in BC, 2012, Section H5, Pg. 127.

SECTION 7 - STORMWATER MANAGEMENT SPECIFICATIONS

7.20 SCOPE

- .1 This specification refers to gravity sewer pipe and appurtenant fittings for storm sewers. Only those products approved by the City Engineer and listed in the City of Nanaimo Approved Products List will be accepted for installation.
- .2 Refer to Section 4 - Trench Excavation, Bedding and Backfill for related specifications.

7.21 MATERIALS TESTING

- .1 If, in the opinion of the Engineer, testing is required, the Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates inadequacies, additional testing may be required by the Engineer.
- .2 The Contractor, as directed by the Engineer, shall supply specimens or samples for testing.
- .3 The types of tests listed below may be required by the Engineer unless in the opinion of the Engineer other testing is required.
- .4 Joints for storm sewer main pipe and fittings and service connection pipe and fittings shall be capable of meeting the following exfiltration tests. The Engineer may require that these tests be carried out by the Contractor or his supplier prior to acceptance of pipe on the project.

(a) Pipes in Proper Alignment:

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

(b) Pipes in Maximum Deflected Position:

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

(c) Pipes in Maximum Lateral Misalignment:

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

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7.22A PIPING, FITTINGS AND SERVICES

- .1 The sizes and types of pipe to be used are shown on the drawings.
- .2 Concrete Pipe:
 - (a) Non-reinforced concrete pipe and fittings shall conform to ASTM C14M Class 3 to a maximum diameter of 600mm and shall be designed with flexible rubber gasket joints conforming to ASTM C443M.
 - (b) Reinforced circular concrete pipe and fittings shall conform to ASTM C76M Class III or higher for all pipe greater than 600mm diameter and shall be designed with flexible rubber gasket joints conforming to ASTM C443M.
 - (c) Pipe with chips, cracks, porous concrete, or any other defects which impair joint sealing or durability will not be accepted.
- .3 Polyvinyl Chloride (PVC) Pipe (Smooth Profile):
 - (a) Pipe and fittings up to 675mm diameter shall be DR35. Pipe and fittings shall have a minimum pipe stiffness of 320kPa at 5.0% deflection when tested in accordance with ASTM D2412.
 - (b) Pipe and fittings shall be manufactured to the following specifications:
100mm - 375mm dia to ASTM D3034 and CSA B182.2
450mm - 675mm dia to ASTM F679 and CSA B182.2
 - (c) Pipe and fittings shall include integral bell and spigot ends with stiffened wall section and a formed groove for a rubber gasket conforming to ASTM F477.
 - (d) All PVC storm pipe shall be green in colour.
- .4 Ductile Iron Pipe:
 - (a) Pipe and fittings shall conform to ASTM A746 or as approved by the Engineer.
- .5 Polyvinyl Chloride (PVC) Service Pipe:
 - (a) All storm service inspection assemblies shall be green in colour.
 - (b) Storm service connections of 100mm diameter shall be DR28 and conform to CSA B182.1. Pipe and fittings shall have elastomeric seal joints, locked in gasket, and integral bell joint features.
 - (c) Storm service connections greater than 100mm diameter shall be as specified for PVC (smooth profile) mainline pipe.
- .6 High Density Polyethylene (HDPE) Pipe (Smooth Profile):
 - (a) Pipe shall conform to CGSB 41-GP-25M. Pipe material shall conform to ASTM D1248 Type III, Class C, Category 5, Grade PE35-10.
 - (b) Minimum acceptable pipe class shall be DR26 with a hydrostatic design stress rating of 10MPa.
 - (c) All pipe supplied shall bear the pipe series designation and manufacturer's name.

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- (d) Fittings for polyethylene pipe, if required, shall be detailed and manufactured by the pipe manufacturer. Mitre bends shall be fiberglass reinforced. Pipe deflected up to manufacturer's recommended minimum radius may be used in place of fabricated mitre bends and to form the required vertical and horizontal curves. Polyethylene fittings shall have a pressure rating at least equal to that of the pipe being joined.

7.22B JOINTS

- .1 Storm sewer main pipe and fittings and service connection pipe and fittings shall be jointed with a rubber gasket or other pre-formed, factory-manufactured gasket or approved material, designed for use with the specified pipe. Solvent connected joints and fittings will not be permitted.
- .2 High Density Polyethylene (HDPE) Pipe (Smooth Profile) Joints:
 - (a) Joints shall be by thermal butt-fusion constructed in accordance with the manufacturer's specifications.
 - (b) Flange joints shall be used to joint long sections of butt-jointed pipe or as shown on the construction drawings.
 - (c) Flanges for polyethylene pipe shall be slip-on type installed in conjunction with stub ends supplied by the pipe manufacturer. The flanges shall be Class 150 meeting ANSI B16.5 drilling dimensions. Flanges shall be carbon steel.
 - (d) All flanged joints shall be separated by a neoprene gasket bonded to one of the flange faces. Neoprene for flange gaskets shall be 3mm thick with holes drilled for flange bolts and size equal to flange diameter.
 - (e) Bolts and nuts for flanges shall be stainless steel complete with isolation washers.
 - (f) Refer to Section 7.46 for fitting and joint installation.

7.23 SERVICE JUNCTIONS

- .1 Concrete Pipe (non-reinforced and reinforced):
 - (a) Service connections shall be manufactured using a sanded PVC male end stub pipe with integral bell.
 - (b) Stub orientation may be at 45° or 90° to the centerline of the mainline pipe (either at 9 o'clock to 11 o'clock, or at 10 o'clock to 3 o'clock).
 - (c) Field break-in and mortar patch joints shall not be used unless approved by the City Engineer. Refer to Section 7.48 for service connection junction installation.
- .2 PVC Pipe (Smooth Profile):
 - (a) Service connections to PVC mainline pipe shall be made with extrusion molded PVC or fabricated PVC fittings manufactured to ASTM D3034, CSA B182.1 and CSA B182.2.
 - (b) The use of saddles instead of manufactured wye fittings shall require approval by the City Engineer.
 - (c) Refer to Section 7.48 for service connection junction installation.

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.3 PVC Pipe (Ribbed Profile):

- (a) Ribbed pipe shall only be used if repairing an existing ribbed pipe section.
- (b) Service connections to PVC mainline pipe shall be made with extrusion molded or fabricated PVC fittings manufactured to ASTM D3034, CSA B182.1 and CSA B182.2.
- (c) For Connections more than two pipe sizes smaller than the mainline, prefabricated service saddle connections may be approved.
- (d) Refer to Section 7.48 for service connection junction installation.

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

- (a) Service connections to HDPE mainline pipe shall be made with manufactured fittings, electro-fused or heat-welded to the mainline pipe. Mechanical connections, if used shall be water-tight.
- (b) Refer to Section 7.48 for service connection junction installation.

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

- (a) Service connections to HDPE mainline pipe shall be made with extrusion molded or fabricated fittings manufactured to CSA B182.1, B182.2 and B182.4.
- (b) For service connections more than two pipe sizes smaller than the mainline, prefabricated service saddle connections may be approved.
- (c) Refer to Section 7.48 for service connection junction installation.

7.24 PERFORATED DRAINS

- .1 The granular material for perforated drains shall be a clear round drain rock with 100% passing 40mm and 0% passing 10mm screens.
- .2 Piping shall be a minimum 150mm diameter DR28 PVC perforated pipe. A minimum of 50 perforations 5mm in diameter per linear metre of pipe shall be required for all pipe sizes.
- .3 Perforations shall be located in the bottom half of the pipe only.
- .4 Filter fabric shall be non-woven polyester fabric conforming to:

Tensile Strength (ASTM 1682)	=	250N	(minimum)
Bursting Strength (ASTM D-751)	=	865kPa	(minimum)
Permeability	=	2×10^{-2}	cm/s

SECTION 7 - STORMWATER MANAGEMENT SPECIFICATIONS

7.25A PRECAST MANHOLE SECTIONS

- .1 Unless otherwise approved, all manholes sections shall be precast reinforced concrete conforming to ASTM C478.
- .2 All precast sections shall be complete with ladder rungs.
- .3 O-ring rubber gaskets shall conform to ASTM C443.
- .4 Refer to Section 7.51 for precast manhole sections installation.

7.25B PRECAST MANHOLE BASES

- .1 Precast manhole bases shall be reinforced concrete in accordance with ASTM C-76 Class III or better.
- .2 All dimensions, specifications, and installations shall conform to the requirements for cast-in-place manhole bases in accordance with Section 7.49 - Cast-In-Place Manhole Concrete Bases, Section 7.52 - Precast Manhole Bases and the Standard Drawings.
- .3 Pipe alignment, grade, and invert elevations in the precast manhole bases shall conform to the construction drawings.

7.25C MANHOLE TOPS

- .1 Manhole tops shall be flat slab, precast concrete. Tops shall be reinforced to meet CS600 loading requirements. Precast tops shall conform to ASTM C478 with approved offset opening for frame and cover.

7.25D MANHOLE COVERS AND FRAMES

- .1 Covers and frames shall be cast iron and certified to meet CS600 loading requirements with the bearing faces of the cover to be frame machined for a non-rocking fit.
- .2 Patterns, dimensions and weights shall be in accordance with the Standard Drawings. Covers shall have "CITY OF NANAIMO STORM DRAIN" permanently embossed on the covers.
- .3 Standard manhole frame and cover shall conform to Standard Drawing No. SW-16 - Storm Manhole Frame and Cover.
- .4 Utility chamber manhole frame and cover shall conform to Standard Drawings No. SW-17 - Utility Chamber Storm Manhole Frame, Ring and Cover.
- .5 A watertight manhole frame and cover, if required, shall conform to Standard Drawing No. SW-18 - Watertight Storm Manhole Frame and Cover.
- .6 Covers located in statutory right-of-way shall be permanently embossed with the additional wording "DO NOT COVER".
- .7 Refer to Section 7.54 for frame and cover installation.

SECTION 7 - STORMWATER MANAGEMENT SPECIFICATIONS

7.25E MANHOLE STEPS

- .1 Steps shall conform to ASTM C478 for manhole steps and ladders and shall be a 19mm diameter aluminum alloy conforming to CSA S157.
- .2 Refer to Section 7.55 for manhole steps installation.

7.25F -NOT USED- (**REVISED NOVEMBER 2016**)

7.26 CONCRETE

- .1 The compressive field strength of concrete for manhole bases shall be not less than 20MPa at 28 days.
- .2 All concrete work shall conform to Section 11 - Reinforced and Plain Concrete Works.

7.27 PRECAST CONCRETE GRADE RINGS

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

7.28 TEMPORARY CLEANOUT FRAMES AND COVERS

- .1 Temporary cleanout structures may only be used at the discretion of the City Engineer where there is development phasing.
- .2 Temporary cleanout frames and covers shall be as specified for storm manhole frames and covers. See Section 7.25D - Manhole Covers and Frames. (**REVISED NOVEMBER 2016**)

7.29 PIPE AND FITTINGS FOR DROP MANHOLE STRUCTURES

- .1 Pipe and fittings for drop manhole structures shall be as specified under Section 7.22A - Piping, Fittings and Services and Section 7.22B - Joints.
- .2 Refer to Section 7.56 for drop manhole structures installation.

7.30 - NOT USED -

7.31A PRECAST CATCH BASIN BARRELS AND LEADS

- .1 Catch basin barrels shall be 600mm or 750mm diameter as noted on the standard drawings and shall be reinforced concrete conforming to ASTM C478, Class III.
- .2 Catch basin leads shall be of the same material as the main piping and use the same type of joints, gaskets, and fittings.
- .3 Leads shall be 200mm in diameter (minimum) for single basins and 250mm in diameter (minimum) for double basins, and shall be connected to sewers with manufactured wyes or tees. Leads over 30m in length shall be 250mm in diameter.

SECTION 7 - STORMWATER MANAGEMENT SPECIFICATIONS

7.31B CATCH BASIN CASTINGS (REVISED NOVEMBER 2016)

- .1 Catch basin frame and grating shall be in accordance with Standard Drawings: (REVISED NOVEMBER 2016)
 - (a) SW-6 - Catch Basin Frame and Grate
 - (b) SW-7 - Adjustable Catch Basin Frame and Hood
 - (c) SW-8 - Boulevard Catch Basin Frame and Grate(REVISED NOVEMBER 2016)

7.32 INLET AND OUTLET STRUCTURES

- .1 Concrete inlet and outlet structures shall be precast unless approved by the City Engineer. (REVISED NOVEMBER 2016)
- .2 Cast-in-place concrete inlet and outlet structures shall be designed by a structural engineer. Concrete shall be as specified in Section 11.0 - Reinforced and Plain Concrete Works. (REVISED NOVEMBER 2016)
- .3 The trash rack shall be pre-fabricated to match the pre-fabricated inlet or outlet structure. Custom built trash racks shall be constructed with 20mm diameter hot dipped galvanized bar. (REVISED NOVEMBER 2016)

7.33 ENERGY DISSIPATOR OUTLET STRUCTURES

- .1 Energy dissipators shall be constructed of concrete and be designed to reduce runoff velocities to less than 1.5m³/s and dispose runoff evenly. (REVISED NOVEMBER 2016)

7.34 INLET AND OUTLET PROTECTIVE FENCING AND HANDRAILS

- .1 Unless otherwise specified, protective fencing, and handrails including posts, pipe rails, and hardware are to be hot dip galvanized steel. Mesh shall be 50mm wire mesh, 9 gauge, hot dip galvanized, or plastic coated.

7.35A CULVERTS

- .1 Concrete pipe shall conform to Section 7.22A - Piping, Fittings and Services, clause 7.22A.2.
- .2 PVC pipe shall conform to Section 7.22A - Piping, Fittings and Services, clause 7.22A.3.
- .3 Ribbed PVC pipe shall only be used for driveway culverts and shall conform to CSA B1800. (REVISED NOVEMBER 2016)

SECTION 7 - STORMWATER MANAGEMENT SPECIFICATIONS

7.35B CULVERT HEADWALLS

- .1 Sacks shall be 0.25 kg burlap with approximate inside dimensions of 350 x 900 mm as measured when the sack is laid flat.
- .2 The compressive field strength of concrete shall not be less than 15MPa at 28 days. All concrete work shall conform to Section 11.0 - Reinforced and Plain Concrete Works.
- .3 Reinforcing bars shall be 15M intermediate grade steel conforming to CSA G30.18, Grade 400.
- .4 Composite material headwalls may be used for culvert headwalls at the discretion and on approval of the City Engineer.

7.36 RIPRAP

- .1 Riprap shall be hard, dense, durable quarry stone, free from seams, cracks, or other structural defects, with a specific gravity of not less than 2.65.
- .2 The gradation of rock sizes (mass in kg) for each class of riprap shall conform to the following table:

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

Example: For Class 50 Riprap

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

SECTION 7 - STORMWATER MANAGEMENT SPECIFICATIONS

7.37 MANHOLE AND TEMPORARY CLEANOUT LID MARKERS

- .1 Markers are required, where manhole and temporary cleanout lids are not located within developed road right-of-way or residential properties, to indicate the location of the manholes and temporary cleanouts. These markers shall be constructed of 50 mm galvanized steel pipe painted with a minimum of two coats of yellow exterior duty paint applied in accordance with the manufacturer's recommendations and set in a concrete base. The markers shall extend 1.0m above the ground surface. The markers shall be located on site at a location, determined by the Engineer, opposite the manhole or temporary cleanout lid and the distance to the lid is to be marked in black figures on a flattened upper portion of the marker. See Standard Drawing No. SW-20 - Storm Manhole and Temporary Cleanout Marker. **(REVISED NOVEMBER 2016)**

7.38 SERVICE BOXES

- .1 Service boxes for single storm sewer services shall be 300mm x 500mm concrete boxes complete with cast iron traffic cover marked "Storm" and concrete extension sections as required.
- .2 Service boxes for twin storm sewer services shall be 425mm x 750mm concrete boxes complete with steel traffic cover marked "Storm" and concrete extension sections as required.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

7.40 TRENCH EXCAVATION, BEDDING AND BACKFILL

- .1 Refer to Section 4 - Trench Excavation, Bedding and Backfill for installation requirements.

7.40A PIPE ALIGNMENT AND GRADE

- .1 The pipe shall be laid on the alignment and grade in accordance with the construction drawings. Each pipe shall be checked for line and grade as it is installed. Methods used to maintain pipe alignment and grade shall be approved by the Engineer.
- .2 Unless otherwise directed by the Engineer, tolerances for pipe alignment and grade shall be:

Alignment	=	±	50mm
Grade	=	±	10mm

7.41 PIPE CUTTING

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

7.42 PIPE INSTALLATION

- .1 Pipe shall be installed in strict accordance with the manufacturer's recommended practice. Joint gaskets are required unless stated otherwise by the Engineer.
- .2 Pipe shall be checked before being lowered into the trench to ensure that no foreign material, manufacturer's defects, or cracks exist that might prevent the proper jointing of the pipe or its operation.
- .3 The open end of the pipe in the trench shall be suitably covered to prevent entrance of trench water and other material during periods when pipe is not being installed.
- .4 Precautions shall be taken to ensure that displacement of the pipe in the trench does not occur through soil displacement or floatation due to the presence of trench water. Pipe that has been displaced shall be removed from the trench and relaid.
- .5 Lifting holes in concrete pipe shall be plugged with prefabricated plugs in non-shrink grout, or other plugs recommended by the pipe manufacturer.
- .6 The contractor shall use methods for installing pipe in an auger hole or casing pipe as described in Section 4 - Trench Excavation, Bedding and Backfill.

7.43 JOINTS AT RIGID STRUCTURES

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

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

7.44 HORIZONTAL AND VERTICAL CURVES

- .1 Pipe on horizontal and vertical curves shall be laid true to the curve of the radius shown on the drawings. Variations in vertical curves and grades within the allowable pipe deflection may be allowed where approved by the Engineer.

7.45 DEFLECTION

- .1 The amount of pipe deflection at joints and couplings shall be the limit as specified by the manufacturer. PVC pipe shall not be deflected at joints or couplings.

7.46 FITTINGS AND JOINTS

- .1 Fittings shall be installed at the locations shown on the construction drawings or as directed by the Engineer. Fittings shall be installed in accordance with the manufacturer's specifications.
- .2 High Density Polyethylene (HDPE) Pipe (Smooth Profile):
 - (a) Pipe shall be joined by the thermal butt fusion method.
 - (b) The contractor shall make arrangements to have the pipe jointing carried out by the pipe manufacturer or certified personnel, familiar with the jointing technique, using equipment and techniques specifically designed for the pipe diameter and material being jointed.
 - (c) Where required, flanged joints shall be used for connecting long pipe sections.
 - (d) The joint shall consist of a polyethylene stub end butt fused to the end of pipe and a carbon steel slip-on flange.
 - (e) Flanged joints and flange bolts shall be stainless steel, complete with isolation washers.
 - (f) Refer to Section 7.22B for joint specifications.

7.47 CONNECTIONS TO EXISTING PIPING AND APPURTENANCES

- .1 All connections to existing piping, services, and appurtenances shall be made by City of Nanaimo forces unless otherwise authorized by the City Engineer.
- .2 All connections to existing piping and services shall utilize a manufactured rubber gasket bell and spigot joint or dresser coupling designed for the types of pipes to be connected.
- .3 The use of field joints or rubber repair couplings shall require the approval of the Engineer.
- .4 Rubber repair couplings must have 4 stainless steel clamps complete with stainless steel anti shear band. Only those products approved by the City Engineer will be accepted for installation.
- .5 Slip couplers shall be used on PVC pipes. Rubber repair couplings are not to be used on PVC pipes.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

7.48 SERVICE CONNECTION JUNCTIONS

- .1 Service connection junctions shall be installed at the locations shown on the construction drawings or as directed by the Engineer during construction.
- .2 Where service connections are not installed in conjunction with the main, fittings shall be installed in the sewerline to accommodate the service connections, and caps or plugs shall be installed in the fittings. Markers shall be installed as specified in Section 7.61 - Service Connection Installation, clause 7.61.3 (i).
- .3 Concrete Pipe (Reinforced and Non-reinforced):
 - (a) Field break-in and mortar patch joints shall not be used unless approved by the City Engineer. If approved, the following shall apply:
 - (i) Service connections shall be manufactured using a sanded PVC male end stub pipe with integral bell.
 - (ii) Break into the pipe by coring to within 40mm of the outside diameter of the service stub. All exposed reinforcing steel shall be removed.
 - (iii) Insert the stub into the core ensuring that no portion of the service stub protrudes past the inside of the concrete pipe wall, and the stub length shall be equivalent to the thickness of the concrete pipe wall and the length of the stub's integral bell.
 - (iv) Prepare non-shrink, fast setting cementitious grout with a 3:1 sand/cement mix to a "dry pack" consistency. Pack grout tightly into the void between the stub and the pipe and mound around the stub for lateral support.
 - (v) Hand finish interior and exterior grout surfaces to a smooth finish.
 - (vi) In order to prevent damage to the field joint, allow sufficient time for grout to develop strength prior to installation of connecting pipe or backfilling.
 - (vii) Installation shall be inspected by the Engineer prior to backfilling.
 - (b) Refer to Section 7.23 for service junction specifications.
- .4 PVC Pipe (Smooth Profile):
 - (a) Service saddle connections shall not be used unless approved by the Engineer.
 - (b) If approved, installation of service saddle connections shall conform to the following:
 - (i) Drill hole into main line pipe to the exact outside diameter of the new connection.
 - (ii) The use of saddles instead of manufactured wye fittings shall require approval by the City Engineer. Saddles shall be rigid PVC material complete with rubber seating gasket. Saddle to be attached to pipe with stainless steel banding straps.
 - (iii) Attach service saddle in accordance to the manufacturer's specifications.
 - (c) Refer to 7.23 for service junction specifications.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

.5 PVC Pipe (Ribbed Profile):

- (a) Installation of service saddle connections shall conform to Section 7.48.4.
- (b) Refer to Section 7.23 for service junction specifications.

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

- (a) Service connections to mainline pipe using manufactured fittings shall be in strict accordance with manufacturer's instructions.
- (b) Connection of HDPE service junctions to non-pressurized PVC service pipe shall be made with flexible couplings. Flexible couplings shall be manufactured from elastomeric PVC and be held in place with series 300 stainless steel worm gear clamps.
- (c) Refer to Section 7.23 service junction specifications.

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

- (a) Installation of service saddle connections shall conform to Section 7.48.4.
- (b) Refer to 7.23 for service junction specifications.

7.49 CAST-IN-PLACE MANHOLE CONCRETE BASES **(REVISED NOVEMBER 2016)**

- .1 All water shall be removed from the excavation prior to placing base concrete. The base shall be constructed such that the first section of a precast section can be set plumb with uniform bearing throughout its full circumference.
- .2 If material in the bottom of the trench is unsuitable for support, the bottom shall be overexcavated to firm base as determined by the Engineer and backfilled to the required grade with thoroughly compacted base gravel as specified for trench bottom stabilization under the applicable section included in Section 4 - Trench Excavation, Bedding and Backfill.
- .3 Where overexcavation and backfill with base gravel is not practical, special structure support shall be provided as specified for trench bottom stabilization under the applicable section included in Section 4 - Trench Excavation, Bedding and Backfill.
- .4 Concrete manhole bases shall be constructed as shown on the drawings. Pipes and fittings through the manhole shall be supported on concrete blocks and the concrete base poured around the pipe to a depth of at least 150mm below the bottom of the pipe and up to the springline of the pipe. Install rubber manhole adaptor rings on all plastic pipe installed in the manhole base.
- .5 Invert elevations of pipes at the manhole shall be checked by the Contractor prior to and following placement of base concrete around the pipe to ensure that all pipes are installed at the designed elevation.
- .6 Variations in manhole inverts from established grade or elevations shall be corrected.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

- .7 Manhole channelling shall be constructed as shown on Standard Drawings or as shown on the construction drawings. Channeling shall be constructed to have a minimum 0.3m straight section before the change in direction within the manhole. **(REVISED NOVEMBER 2016)**
- .8 The channels in the base of manholes shall be shaped and finished to provide smooth passage for the storm water in order to minimize head losses and deposits at bends and at junctions of channels. **(REVISED NOVEMBER 2016)**
- .9 Channels shall be accurately formed. The practice of forming channels roughly to shape and finishing with cement mortar will not be permitted. The channels shall be steel trowel finished. **(REVISED NOVEMBER 2016)**
- .10 Benching in manholes shall be sloped to drain. While green, the concrete benching shall be given a broom finish to produce a non-skid surface. **(REVISED NOVEMBER 2016)**

7.50 -NOT USED- **(REVISED NOVEMBER 2016)**

7.51 PRECAST MANHOLE SECTIONS

- .1 Precast manhole barrel sections shall be placed plumb.
- .2 Joints between the top riser and the cover slab shall be made watertight with cement mortar. Prior to placing sections, the mating face shall be thoroughly soaked with water and a layer of cement mortar shall be spread on the lower face. After sections are placed, excess mortar shall be removed and the joint made flush inside and out.
- .3 Joints between precast manhole barrels must utilize o-ring gaskets and shall conform to the manufacturer's specifications. The inside surface of the precast barrel at the o-ring joints shall be filled with cement grout to a smooth finish.
- .4 Damaged o-ring manhole joints require removal and replacement of damaged manhole section. Mortar patching of damaged area, if approved by the Engineer, shall require removal of the o-ring gasket and installation as per Section 7.51.2.
- .5 Refer to Section 7.25A for precast manhole section specifications.

7.52 PRECAST MANHOLE BASES

- .1 Installation of precast manhole bases shall conform to Section 7.49 - Cast-In-Place Manhole Concrete Bases. **(REVISED NOVEMBER 2016)**
- .2 Precast manhole bases shall be placed on 150mm thick base of 38mm drain rock. **(REVISED NOVEMBER 2016)**
- .3 Plastic and concrete pipes installed in the precast manhole base shall utilize rubber manhole adaptor rings to seal the connection.
- .4 Refer to 7.25B for precast manhole bases specifications.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

7.53 CONCRETE

- .1 Concrete work shall be as specified under Section 11.0 - Reinforced and Plain Concrete Works.

7.54 FRAMES AND COVERS

- .1 Frames shall be set on precast concrete grade rings to bring the cast iron manhole frame up to grade as shown on the Standard Drawings. Contractor to install concrete grade rings to a minimum of 50mm thick and to a maximum of 100mm thick. The concrete grade rings shall be laid in common bond with raked mortar joints and shall be mortared inside and outside of the manhole. **(REVISED NOVEMBER 2016)**
 - (a) Fine grade elevation adjustments of frames shall be done with a minimum of 3, steel only, shims equally spaced.
- .2 Manhole covers shall be installed:
 - (a) for unpaved areas: Covers shall have a 1.5m x 1.5m, 50mm thick asphalt apron. Covers shall be set flush with the asphalt surround.
 - (b) for paved areas: Covers shall be flush with pavement grade with a maximum allowed variance of 6mm lower than finished pavement. Covers shall not protrude above finished pavement.
- .3 Steel manhole riser rings shall be used in easements only.
- .4 The inside surface of the manhole frame shall be painted green with an enamel rust paint in accordance with the manufacturer's specifications.
- .5 Refer to Section 7.25D for manhole covers and frames specifications.

7.55 MANHOLE STEPS

- .1 Manhole steps shall be installed in manhole sections by the manufacturer unless circumstance dictates otherwise in which case approval must be received from the Engineer.
- .2 The distance from the top of the manhole cover to the first manhole step, shall conform to WorkSafeBC requirements.
- .3 All steps shall be complete with approved polyethylene anchor insulating sleeves and installed in 25mm to 26mm diameter precast or drilled holes in a manhole section.
- .4 Refer to Section 7.25E for manhole steps specifications.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

7.56 DROP MANHOLE STRUCTURES

- .1 Manhole drop structures shall be constructed as shown on Standard Drawing No. SW-14 - Storm Drop Manhole. **(REVISED NOVEMBER 2016)**

7.57 STUBS

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

7.58 TEMPORARY CLEANOUTS

- .1 Temporary cleanouts shall be constructed as shown on the Standard Drawings.

7.59 -NOT USED- **(REVISED NOVEMBER 2016)**

7.60 PRECAST CATCH BASIN BARRELS AND LEADS **(REVISED NOVEMBER 2016)**

- .1 Catch basins shall be installed in accordance with the Standard Drawings.
- .2 Catch basin leads shall be installed to allow passage of video cameras and flushing equipment. Installation of mitred bends may be allowed to avoid pipe conflicts or insufficient bury. Mitre bends shall not exceed 45° and there shall be a minimum 1.0m separation between mitre bend hubs.
- .3 Catch basin leads taken into manholes shall be benched in the same manner as main line piping.
- .4 Catch basin grates are to be set 20mm below the gutter line. The gutter and blacktop are to be shaped to form a dish around the inlet.
- .5 Construction and finishing of catch basins shall be the same as for manholes as described in Section 7.54 - Frames and Covers.
- .6 Catch basin leads are to protrude 50mm into the catch basin barrel and shall be grouted inside and outside of the barrel in accordance with the Standard Drawings.
- .7 There shall be a 400mm minimum clearance between the outside of the catch basin barrel and the trench wall to allow for compaction.
- .8 Curb inlet catch basins are to be installed to be rigid once installed and the inlet hood remain flush with the top of the curb. **(REVISED NOVEMBER 2016)**

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

7.61 SERVICE CONNECTION INSTALLATION

.1 Location of Service Connections:

- (a) Service connections are to be installed at the locations and depths as specified by the Engineer. Where the depth of the service connection exceeds 2.0m, the service shall be extended into the property the same distance as the depth of the service, up to a maximum distance of 4.0m. This shall be done during the installation of the service connection from the main to the property.
- (b) At no time shall two or more storm services be coupled into one lead crossing the street or right-of-way. Each service shall have its own independent connection into the main sewer.

.2 Grade and Alignment of Service Connections:

- (a) Trenches shall be excavated so that pipe can be installed in a direct line from the service connection fitting at the sewer or from a manhole to the terminus of the service. Service connections shall be installed at a grade of not less than 2% unless otherwise directed by the Engineer. Service pipe shall be installed at a uniform grade between the terminus at the property line and the junction fitting at the sewer or upper end of a service drop.

.3 Storm Sewer Service Connection Installation:

- (a) Pipe shall be installed in strict accordance with the manufacturer's recommended practice.
- (b) Pipe shall be checked before being lowered into the trench to ensure that no foreign material, manufacturer's defects, or cracks exist that might prevent the proper jointing of the pipe or its operation.
- (c) The Contractor shall use methods for installing pipe in an auger hole or casing pipe as shown on the construction drawings.
- (d) The trench shall be excavated to provide a minimum cover of 0.75m over the service connection pipe at property line.
- (e) In rock, the trench is to be extended three 3.0m into the property to facilitate future extension of the service connection.
- (f) The trench bottom shall be graded to form a continuous support along the service pipe. All rocks or projections which might prove detrimental to the pipe shall be removed.
- (g) Joints shall be made using the specified couplings. Glued joints shall not be made.
- (h) At the terminus of each sewer service approved watertight caps suitably supported by sandbags shall be installed to prevent leakage.
- (i) A 38mm x 89mm pressure treated wood marker stake shall be placed at the service terminus as shown on the drawings to facilitate future location of the service pipe. This stake shall extend from a point approximately 600mm above ground to 600mm below ground except in locations where the extension of the stake above ground surface would prove hazardous, in which case the stake shall be cut off flush with the ground surface. The stake shall be marked in an approved manner to show the depth of the service pipe invert below the top of the stake. The stakes shall be painted green to visually identify the storm sewer service connections. The Engineer will take invert elevations of the service connection assembly prior to placement of the cap by the Contractor. **(REVISED NOVEMBER 2016)**

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

- (j) Inspection assemblies shall be installed as shown on the standard drawings.
- (k) The service box shall be installed plumb with the lid 25mm above finished grade in unpaved areas and 0 - 6mm below finished grade in paved areas.

.4 Riser Service Connections:

- (a) Riser service connections shall be installed as shown on Standard Drawings No. SW-21 - General Storm Service Connection Detail, Riser and Non Riser Types or Standard Drawing No. SW-22 - Commercial Areas Storm Service Connection Detail, Riser and Non Riser Types in locations shown on the construction drawings.
(REVISED NOVEMBER 2016)

7.62 NOTIFICATION TO THE CITY OF NANAIMO

- .1 The City of Nanaimo Works Inspector shall be given 48 hours notice of all tests.

7.62A CLEANING AND FLUSHING

- .1 On completion of the sewer pipe installation, the pipes shall be cleaned to the satisfaction of the Engineer and the City of Nanaimo Public Works Inspector by power flushing with water to remove all foreign matter.
- .2 Ensure that snow chains are installed at the downstream manhole so that no foreign material passes beyond downstream manhole. Flow through the system shall remain unimpeded at all times while snow chains are installed.
- .3 Begin cleaning from the upstream pipe in the system and proceed downstream. Under no circumstances is the pipe cleaning process to proceed downstream until all contributing upstream pipes have been successfully cleaned and approved by the Engineer, the City of Nanaimo Public Works Inspector, or by the City of Nanaimo CCTV contract administrator.
- .4 Manholes shall be cleaned after the upstream section of pipe has been successfully cleaned and approved by the Engineer, the City of Nanaimo Public Works Inspector, or by the City of Nanaimo CCTV contract administrator.
- .5 Pipes shall be cleaned in the direction of flow and shall not be flushed in a backflush direction unless approved by the City Engineer, by the City of Nanaimo Public Works Inspector, or by the City of Nanaimo CCTV contract administrator.
- .6 Under no circumstances shall debris pass beyond the downstream manhole. Active vactoring shall remove all debris at the snow chains installed at the downstream manhole.
- .7 Dispose of debris at approved dump site such as the Regional District of Nanaimo's landfill or by the CCTV contract administrator's approved alternative.
- .8 Decanting of liquid waste accumulated during debris removal is permitted at a controlled release rate, to a maximum of 8l/s, at a location approved by the City of Nanaimo CCTV contract administrator.
- .9 Timeframe between cleaning and video inspection of pipeline shall not exceed 24 hrs unless approved by the City Engineer.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

- .10 Ensure all environmental mitigation is in accordance to current BC Ministry of Environment and Department of Fisheries and Oceans Standards.

7.63 VIDEO INSPECTING MAINS

- .1 All pipe video inspection including methods of cleaning, equipment and rates of camera travel, shall be in accordance with the UK Water Research Centre's (WRC), Sewage Rehabilitation Manual, most current edition.
- .2 For gravity sewers, other than service connections, the contractor shall arrange for video inspection to check alignment, grade, and condition of the main sewer pipe including catch basin leads.
- (a) Illumination depth of field shall be no less than 3 joints for standard joint and spigot pipe types to allow for pipe deflection assessments (9.0m). No dark/opaque circle shall be visible in the middle of this depth of field viewing area.
 - (b) Eliminate steaming and fogging encountered during the inspection survey by introducing forced air flow by means of fan.
 - (c) Camera lens to remain free of grease or other deleterious matter to ensure optimal clarity.
 - (d) Pan and tilt view each service connection (junction) such that the camera looks down the centreline of the service, pause for a minimum of five (5) seconds and note condition of the joint and/or pipe/service interface.
 - (e) Camera guides (Skids) shall not be visible at either side of the pipe during normal camera travel or during Pan & Tilt operation. Configuration of camera/guides shall be altered to alleviate this problem.
 - (f) CCTV push camera work shall be video captured (complete with skids for centering) from the main wye pulling back to entrance point to avoid an invert only view.
 - (g) A winch line shall be provided to support camera travel in steep, slippery, or relined pipe sections.
 - (h) Position camera lens centrally in the pipeline with a positioning tolerance of $\pm 10\%$ off the vertical centerline axis of the pipeline. For elliptical pipe the camera to be positioned $2/3$ the height of the pipe measured from the invert.
 - (i) Position camera lens looking along the longitudinal axis of pipeline except when viewing service connections or panning defects.
 - (j) Instantaneous travelling speed of the camera in the pipeline to be as follows:
 - i) 0.1m/s for pipeline of diameter less than 200mm
 - ii) 0.15m/s for diameters 200mm and larger but not exceeding 310mm: and
 - iii) 0.20m/s for diameters exceeding 310mm
- .3 The inspection shall include the preparation of:
- (a) a 4.7GB DVD MPEG4 video data disk. Picture size: NTSC 640x480 pixels, aspect ratio 4:3, 29.97 frames per second @ 8 megabits per second capture rate. Individual MPEG4 video files shall not exceed 1.7GB in size. DVD data disk shall be finalized after burn. **(REVISED NOVEMBER 2016)**
 - (b) a Microsoft Access database CD of the Header and Observation codes as specified by the City Engineer.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

(c) a pipe condition assessment paper report.

All submitted to the Engineer.

- .4 The Engineer shall review the DVD, CD, and pipe condition report and provide certification that the condition of the installed pipe is accurately recorded and the pipe installation meets the City of Nanaimo Standards and Specifications.
- .5 The DVD, CD, and pipe condition report and certification shall become the property of the City of Nanaimo.
- .6 Variations in line or grade of pipe, from that established by the Engineer prior to installation, and any jointing, pipe cleaning, or other deficiencies discovered during the inspection, shall be rectified. Reinspection of the pipe may be required by the Engineer at the contractor's expense.
- .7 During this test, manhole construction and invert elevations shall be checked and any variations from the established grade, drawings, or specifications, shall be rectified.
- .8 If directed by the Engineer, the contractor shall arrange for a reinspection of the pipe at the contractor's cost, for the warranty inspection one month prior to the end of the maintenance period.
- .9 Video inspection and pipe condition coding shall be undertaken only by personnel with current Canadian certification by a City approved agency.

7.63A SMOKE TESTING

- .1 The Engineer shall arrange for smoke testing of all installed storm mains in the presence of the City of Nanaimo Works Inspector.
- .2 The Engineer shall provide as-built service location information to the City of Nanaimo works Inspector prior to smoke testing.
- .3 Cross-connections noted during the smoke testing shall be corrected and the as-built information revised.

7.64 DRAINAGE DITCH CONSTRUCTION

- .1 Drainage ditches shall be excavated to the line and grade shown on the construction drawings or as otherwise determined by the Engineer.

7.65 CULVERT INSTALLATION

- .1 Trenches for culvert installation shall be excavated to the required depth and grade and backfilled in accordance with the requirements for storm mainlines.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

.2 Concrete Pipe:

- (a) Install pipe in accordance with Section 7.42 - Pipe Installation.

.3 Polyvinyl Chloride (PVC) Pipe:

- (a) Install pipe in accordance with Section 7.42 - Pipe Installation.

7.66 CULVERT HEADWALLS

- .1 Culvert headwalls shall be constructed as shown on the Standard Drawings.

.2 "Wet-mix" Sandbags:

- (a) The sandbag sacks shall be wetted and filled with wet premixed concrete and folded at the top to retain the concrete at the time of placing.
- (b) Immediately after being filled with concrete, sacks shall be placed and lightly tamped to conform with the slope, culvert pipe, and adjacent sacks in-place.
- (c) Sacked concrete shall be laid in courses such that joints in succeeding courses are staggered. Courses shall be a minimum of ten per vertical metre. Dirt and debris shall be removed from the top of sacks before the next course is laid thereon.
- (d) Prior to sacked concrete setting, courses of bags shall be tied by driving a 15M reinforcing bar vertically from top to bottom through each course so that displacement will not occur after the final set of concrete. Top of reinforcing bar shall be bent over on top.

- .3 Headwalls shall be protected from heavy rainfall and from contacting water for a period of at least 24 hours after placing.

- .4 Composite culvert headwalls shall be installed as per manufacturer's recommendations and Engineer approved design drawings.

7.67 PERFORATED DRAINS

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

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

- .3 Place a 150mm thick layer of drain rock and install the perforated pipe. Perforations shall be installed on the bottom half of the pipe.

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

- .5 Place remaining 150mm of drain rock or, if specified, top soil to finish grade.

- .6 Install all manholes as per Section 7.0 - Stormwater Management. **(REVISED NOVEMBER 2016)**

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

7.68 INLET AND OUTLET STRUCTURES

- .1 Inlet and outlet structures shall be installed in accordance with Standard Drawings. **(REVISED NOVEMBER 2016)**
- .2 Excavate to the lines and grades as shown on the construction drawings. If subgrade is unsuitable for support as determined by the Engineer, the bottom shall be excavated and backfilled to the required grade with road base gravel compacted to 95% modified proctor or drain rock. **(REVISED NOVEMBER 2016)**
- .3 Structure shall be placed on a minimum of 100mm (compacted thickness) of road base gravel compacted to 95% modified proctor. Where groundwater is present, drainrock may be substituted for road base gravel if approved by the Engineer.
- .4 All concrete work shall be in accordance with Section 11.0 - Reinforced and Plain Concrete Works.

7.69 RIPRAP

- .1 Areas to receive riprap shall be trimmed to a uniform surface, to the grades shown on the drawings. Before rock placement commences, loose materials shall be removed and minor pot holes and hollows filled in with select granular sub-base, well tamped in.
- .2 Geotextile material and placement, where required, shall be as shown on the drawings.
- .3 At the toe of sloped riprap, larger rocks shall be placed regularly enough to form a firm foundation, 50% thicker than the required nominal thickness.
- .4 Other large rocks shall be regularly spaced. Smaller rocks shall be well positioned to form an interlocking, even surface.

7.70 PIPE VIDEO AND MANHOLE CONDITION REPORT FORMAT

- .1 Reference plans shall accompany reports with manholes labeled and inspected sections highlighted. Manhole and pipe numbering shall conform with the construction drawings, or if available, City of Nanaimo pipe and manhole numbers. Reports shall be submitted in both digital and hardcopy formats.
- .2 All sewer defects shall be photographed and included with the report and referenced by numbers accordingly.
- .3 The video pipe condition rating report format shall be in accordance with the UK Water Research Centre's (WRc), Sewerage Rehabilitation Manual, most current edition. Structural defects shall be properly weighted with the appropriate scores assigned to them as shown in the following table:

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

WRc GRADING SYSTEM

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

Every video inspected sewer will be assigned a composite score when it scores under each defect category which are added as per the following table:

WRc - SEWER RATING COMPOSITE SCORES

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

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

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

- (a) Date of survey.
 - (b) Contractor Project Index No. (i.e. Tape No. V2-1234)
 - (c) Survey No.
 - (d) Start MH No.
 - (e) Finish MH No.
 - (f) Line ID No.
 - (g) Direction of Camera Travel.
 - (h) Street Location (Road Name or RW No.).
 - (i) Distance from the manhole rim to pipe invert.
 - (j) Length of Capture.
 - (k) Total of Captured CCTV.
 - (l) Current weather information.
- .4 All pipe video inspections shall include an annotated map with the following information:
- (a) Manhole and catch basin locations with labels.
 - (b) City of Nanaimo drawing numbers.
 - (c) Manhole I.D. numbers (as per the City of Nanaimo GIS numbering system).
 - (d) Catch basin I.D. numbers (as per the City of Nanaimo GIS numbering system).
- .5 Computer database file to contain identical survey report information as the printed report exclusive of photographs. Index numbers and distance of survey information shall numerically increase. For an individual survey, whether the information is sorted by index or distance, the result will be in the same order.
- .6 All pipe video inspection operators shall be thoroughly trained with current Canadian certification by a City approved agency.
- .7 Manhole video inspection is not required. Manholes shall be rated as per the following table and form part of the video inspection report.

SECTION 7 - STORMWATER MANAGEMENT INSTALLATION

MANHOLE RATING SYSTEM

INTERNAL CONDITION GRADE	TYPICAL DEFECT DESCRIPTION
1 (least defective)	-No observable structural defects. -No observable signs of infiltration.
2	-Minor cracks, chips, spalling. -Signs of minor staining, but no infiltration.
3	-Fractures, medium spalling, defective pipe/MH joints. -Some staining, mineral build-up and seeding infiltration. Possible infiltration through manhole cover.
4	-Broken manhole wall, channel or riser assembly, multiple fractures, medium wear. -Moderate staining, mineral build-up and running infiltration. -Infiltration through manhole cover. -Manhole frame and cover cracks or broken.
5 (most defective)	-Failure in manhole wall, channel or riser assembly, multiple fractures with deformation, large wear. -Heavy staining, mineral build-up and gushing infiltration. -Surface ponding and infiltration through manhole cover. -Manhole frame and cover cracks or broken.

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SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS CONTENTS

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(REVISED NOVEMBER 2016)

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS DESIGN CRITERIA

8.00 SCOPE

- .1 For the purpose of this specification the following definitions shall apply:
 - (a) Curbs refer to concrete curbs with or without integral gutters unless otherwise noted.
 - (b) Sidewalk refers to concrete sidewalks adjacent to a street or curb and located within a road right-of-way unless otherwise noted.
 - (c) Walkway refers to asphalt paved or concrete sidewalks located outside of road right-of-ways unless otherwise noted.
- .2 Concrete paver surface treatment shall be in accordance with Section 13 - Concrete Pavers.
- .3 Curbs, (concrete and asphalt) sidewalks and walkways shall be designed in accordance with the following design criteria.

8.01 RIGHT-OF-WAY AND PAVEMENT WIDTHS

- .1 Sidewalk pavement widths shall be in accordance with the road classification of the adjacent street. All sidewalk widths shall be 1.5m except: **(REVISED NOVEMBER 2016)**
 - (a) Sidewalks adjacent to Urban Arterial, Major Collector, and Minor Collector streets shall be 1.8m wide. **(REVISED NOVEMBER 2016)**
 - (b) Sidewalks are not required adjacent to Lanes and Rural Local streets. **(REVISED NOVEMBER 2016)**
- .2 A minimum of 1.2m of unobstructed width is required on all sidewalks and walkways. **(REVISED NOVEMBER 2016)**
- .3 Walkway pavement widths shall be a minimum of 3.0m as specified in the Standard Drawings.
- .4 Walkway rights-of-way shall be a minimum of 6.0m unless otherwise approved by the City Engineer.

8.02 CURBS - GENERAL

- .1 All curbs shall be non-mountable concrete curbs except curbs within cul-de-sac bulbs shall be mountable concrete curbs, unless otherwise approved by the City Engineer.
- .2 Where intersecting streets have both mountable and non-mountable curbs, non-mountable curbs shall be required for the curb returns and along the tangent to the first driveway or lane crossing located in accordance with Section 8.04 – Driveway and Lane Crossings.
- .3 Curbs within driveway or lane crossings in industrial and commercial areas require an additional concrete footing or reinforcing steel as shown on Standard Drawing No. CS-1.
- .4 Minimum radius of curb returns at street intersections shall be 9.0 m for urban local collectors and local streets, and 12m for industrial/commercial, urban collector and arterial streets.
- .5 Radius of curbs forming nodes at intersections or mid-block shall be a minimum 5.0m concave or 3.0m convex radius. Refer to Standard Drawing No. CS-9 - Curb Extension Detail.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS DESIGN CRITERIA

- .6 The radius of curb returns at street intersections shall be governed by the wider of the intersecting streets.
- .7 Asphalt Curb:
 - (a) On pavement edges where concrete curb is not required, a temporary 100mm asphalt curb shall be provided for drainage and traffic control unless otherwise specified on the construction drawings.
 - (b) Asphalt curbs may also be required to provide a transition from new concrete curbs to existing roadworks.

8.03 WALKWAY VEHICLE BARRICADES

- .1 Barrier posts as shown on Standard Drawing No. CS-14 should be used on multi-use pathways, when necessary to prevent vehicle access. Telescoping bollards as shown on Standard Drawing No. CS-15 should be used for fire lane access.
- .2 Barrier posts should be installed in odd numbers (one, three or five) so that the centre post is positioned on the centreline of the pathway.
- .3 Barrier posts may be fixed or removable.
- .4 Walkway barrier baffles as shown on Standard Drawing No. CS-13 should not be used on multi-use pathways.

8.04 DRIVEWAY AND LANE CROSSINGS

- .1 Driveway and lane crossings shall be provided in sidewalks constructed where non-mountable curbs are used.
- .2 Driveway and lane crossings shall be constructed in accordance with the Standard Drawing No. CS-5A, Type 2 or No. CS-5B, Type 3. Standard Drawing No. CS-5, Type 1 shall only be used when approved by the City Engineer. **(REVISED NOVEMBER 2016)**
- .3 Driveway and lane crossings shall be located in accordance with the City of Nanaimo's Crossing Control Bylaw.
 - (a) Maximum driveway width for single family residential lot with either mountable or non-mountable curb shall be 6.0m.
 - (b) Maximum driveway width for all other zoned lots shall be 9.0m unless otherwise approved by City Engineer.
- .4 Driveway and lane crossings shall not exceed a crossfall of 8.3%.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS DESIGN CRITERIA

8.05 STANDARD LONGITUDINAL GRADE

- | | | |
|----|---------------------------|-------|
| .1 | Concrete gutter (minimum) | 0.50% |
| | Curb return (minimum) | 1.0% |
| | Curb return (maximum) | 12.0% |
| | Sidewalks (minimum) | 0.50% |
| | Sidewalks (maximum) | 12.0% |
| | Walkways (minimum) | 0.50% |
| | Walkways (maximum) | 12.0% |
- .2 The longitudinal grade for sidewalks shall follow road grades. Other measures or steps may be required to reduce longitudinal grade for walkways exceeding maximum grades.
- .3 Curb return grades shall provide a smooth transition between intersecting gutter grades.

8.06 SIDEWALK AND WALKWAY CROSSFALL GRADE

- | | | |
|----|-------------|------|
| .1 | Minimum | 1.0% |
| | Recommended | 2.0% |
| | Maximum | 4.0% |
- .2 Crossfall grades in excess of 4.0% shall only be permitted for short sections at driveway or lane crossings subject to approval by the City Engineer.
- .3 In no case shall the crossfall grades exceed 6.0%.
- .4 The sidewalk shall slope down to the curb as shown on the Standard Drawings.
- .5 Sidewalk driveway crossings shall be constructed in accordance with Section 8.04 – Driveway and Lane Crossings. **(REVISED NOVEMBER 2016)**

8.07 SIDEWALK AND WALKWAY THICKNESS

- .1 Concrete sidewalk thickness shall be minimum 150mm behind mountable curbs and at all driveway and lane crossings.
- .2 Concrete sidewalk thickness behind non-mountable curbs shall be minimum 100mm, except at all driveway and lane crossings where the concrete thickness shall be minimum 150mm as shown on Standard Drawing No.'s CS-5, CS-5A and CS-5B.
- .3 Walkways shall be paved with minimum 50mm thick asphaltic concrete or constructed of concrete, in accordance with the requirements for sidewalks. Concrete thickness in walkways shall be minimum 150mm where there is potential for vehicle passage, and minimum 100mm where there is no potential for vehicle passage.

8.08 CURB, SIDEWALK AND WALKWAYS - MINIMUM BASE AND SUB-BASE

- .1 The minimum base and sub-base requirements for curbs and sidewalks not separated by a boulevard shall be the same as that required for the adjacent street and in accordance with Section 9.06.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS DESIGN CRITERIA

- .2 Walkways and sidewalks separated by a boulevard shall have a minimum compacted thickness of:
- (a) 150mm Coarse Gravel Sub-base, compacted 75mm minus (**REVISED NOVEMBER 2016**)
50mm Crushed Gravel Base, compacted 20mm minus (**REVISED NOVEMBER 2016**)

OR

 - (b) 150mm Crushed Gravel Base, compacted 20mm minus (**REVISED NOVEMBER 2016**)

8.09 PEDESTRIAN SIDEWALK RAMPS

- .1 Pedestrian sidewalk ramps shall be provided:
- (a) in sidewalks at every pedestrian road crossing,
 - (b) in raised traffic islands where they form a continuation of a sidewalk network across a road intersection.
- .2 The design of pedestrian sidewalk ramps shall be in accordance with the Standard Drawings.

8.10 SIDEWALKS IN CUL-DE-SACS

- .1 The location of sidewalks in cul-de-sacs shall be as shown on the Standard Drawings for cul-de-sacs contained in Section 9 - Streets, Traffic Signs and Markings.

8.11 TERMINATION OF SIDEWALKS

- .1 Sidewalks shall be terminated in a manner that is safe for pedestrians and as follows:
- (a) At the beginning of the curb return if construction of the intersection is not required.
 - (b) At the end of the curb return if construction of the intersection is required.
 - (c) At the end of the development phase or property line.
 - (d) At other specified locations as required by the City Engineer.
- .2 Extend and terminate sidewalks as required to allow wheelchair access to pedestrian pushbuttons.

8.12 STAIRWAYS

- .1 Where walkway grades exceed 12%, stairways shall be installed to suit adjacent topography.
- .2 Walkways requiring stairways shall have a minimum of three stairs, and landings at all entrances to the walkway.
- .3 Walkway barriers, as per Standard Drawing No. CS-13, shall be required at all entrances to walkways containing a stairway. Barriers shall be installed a minimum of 1.5m from the last stair.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS DESIGN CRITERIA

- .4 Landings at a 2% grade, are required at the top and bottom of all stairways. Stairways shall have a maximum of 12 risers between landings.
- .5 Concrete stairways shall be designed in accordance with Standard Drawing No. CS-16. **(REVISED NOVEMBER 2016)**
- .6 Wooden stairways shall be designed in accordance with Standard Drawing No. CS-17. **(REVISED NOVEMBER 2016)**

8.13 SIDEWALK HANDRAIL

- .1 Sidewalks or walkways adjacent to retaining walls or other vertical drops exceeding a slope of 1.5H:IV or height of 0.6m shall require a handrail, or 1.2m high chain link fence. **(REVISED NOVEMBER 2016)**
- .2 Other unsafe areas, as determined by the City Engineer, may also require the installation of a handrail, or chain link fence.

8.14 BUS STOP/PULLOUT CONFIGURATIONS

- .1 Bus stops and bus pullout locations will be determined by the Regional District of Nanaimo Transit and the City of Nanaimo Engineer. See Standard Drawing No.'s CS-20 and CS-21 for bus stop and pullout configurations.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS SPECIFICATIONS

8.20 SCOPE

- .1 This specification refers to concrete curb and gutter, concrete sidewalks, concrete stairways, asphalt curbs and asphalt walkways.
- .2 Specifications for reinforced and plain concrete works shall be as specified under Section 11 - Reinforced and Plain Concrete Works, except as modified by this section.
- .3 Only those products approved by the City Engineer and listed in the City of Nanaimo Approved Products List will be accepted for installation.

8.21 CURB AND SIDEWALK CONCRETE

.1 Mix Design:

Mix design shall conform to the following:

(a) Hand Formed Curb and Gutter, Sidewalks and Stairways:

Slump: 80mm
Air Entrainment: 5% - 8%
Maximum aggregate size: 20mm
Minimum cement content: 335 kg/m³
Minimum 28 day compressive strength: 32MPa

(b) Extruded Curb and Gutter:

Exposure Class: C-2
Slump: 0 - 2mm
Air Entrainment: 6% - 9%
Fineness modulus: 2.2 - 3.1
Maximum aggregate size: 12.5mm
Minimum cement content: 335 kg/m³
Minimum 28 day compressive strength: 32MPa

.2 Admixtures:

Admixtures for the prevention of freezing shall not be used. Use of other admixtures shall require the approval of the City Engineer.

8.22 CURING COMPOUND

- .1 Curing compound shall be spray-applied, liquid type conforming to ASTM C309 containing a fugitive dye.

8.23 CURB AND SIDEWALK EXPANSION JOINTS

- .1 Preformed bituminous impregnated fiber board for expansion joints shall conform to ASTM D1751 with the same shape as the concrete cross sections and having a minimum thickness of 13mm.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS SPECIFICATIONS

8.24 CURB AND SIDEWALK ISOLATION JOINTS

- .1 Longitudinal joints and joints around poles and structures shall be made with 6mm thick preformed bituminous impregnated fiber board material conforming to ASTM D1751, precut to the required section.

8.25 REINFORCING STEEL

- .1 Reinforcing steel shall be intermediate grade steel conforming to CSA G30.18, Grade 400. Steel shall be free of excessive rust, scale or other coatings that will adversely affect the bond.

8.26 COMMON EXCAVATION

- .1 Common excavation is the excavation and removal of all material encountered which is not classified as rock.

8.27 IMPORTED GRANULAR FILL

- .1 Imported granular fill shall conform to Section 9.28A - Imported Granular Fill.

8.28 EARTH FILL

- .1 Earth fill shall include all fills comprised of common excavation containing less than 15% by volume of rock larger than 150mm in size free of organic and deleterious matter and frozen earth lumps and shall be approved by the Engineer.

8.29 IMPORTED EARTH FILL

- .1 Imported earth fill is defined as material imported from outside the project site to meet the specifications of earth fill.

8.30 GRANULAR BASE

- .1 Granular base shall conform to Section 9.30 - Road Base Gravel Course.

8.31 SELECT GRANULAR SUBBASE

- .1 Select granular sub-base shall conform to Section 9.29 – Road Sub-base Gravel Course.

8.32 FORMS

- .1 Forms may be either steel or wood.
- .2 Wood forms shall be of select dressed lumber, well seasoned, straight, free from defects, thoroughly cleaned not less than 40mm thick, and not less than 5 m long.
- .3 Steel forms shall be thoroughly cleaned and free of twists and warps.
- .4 Flexible forms shall be used for all curves having a radius of less than 60 m.
- .5 Forms shall be to the shape, lines and full dimensions of the work being formed.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS SPECIFICATIONS

.6 Form release agents shall conform to Section 11.22 - Form Release Agent.

8.33 EXTRUDING MACHINE

- .1 The extruding machine shall require approval by the Engineer. The machine shall be fitted with a template for the curb specified on the construction drawings and consistent with the cross-sections shown on the Standard Drawings.
- .2 Rails for the extruding machine shall be rigid enough to ensure no deflection from established line and grade occurs.
- .3 Asphalt extruding curb machine shall require approval by the Engineer. The machine shall be fitted with a template consistent with the section shown on Standard Drawing No. CS-12.

8.34 TRANSITION SIDEWALK

- .1 Transition sidewalk refers to all portions of concrete or asphalt placed as "fill-in" sidewalk between existing curbs and sidewalk, sidewalks and inset building walls, sidewalks and paved parking area.

8.35 SCREEDS

- .1 Power screeds, approved by the Engineer, may be used to screed formed sidewalks.

8.36 ASPHALT

- .1 Asphalt pavement for walkways shall be as specified under Section 12 - Asphaltic Concrete Paving except as modified herein:

Marshall stability at 60°C - 227 kg minimum 50 blows

Percent voids total mix - 3% - 5%

Maximum aggregate size - 13mm

- .2 Asphalt Curb:

- (a) Asphalt mix shall conform to Section 12 - Asphaltic Concrete Paving.
- (b) Bituminous tack coat shall be SS-1 or SS-1h asphalt emulsion conforming to Section 12 - Asphaltic Concrete Paving.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS SPECIFICATIONS

8.37 -NOT USED-

8.38 -NOT USED-

8.39 WALKWAY BARRIERS

.1 Materials for walkway barriers shall be as specified in the Standard Drawings.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS INSTALLATION

8.40 SCOPE

- .1 Installation for reinforced and plain concrete works shall be as specified under Section 11 - Reinforced and Plain Concrete Works, except as modified by this section.

8.41 COMMON EXCAVATION

- .1 Common excavation shall be carried out such that curb and gutter and sidewalks can be constructed to the line and grade shown on the drawings.

8.42 CUTTING AND REMOVAL OF EXISTING ASPHALTIC AND CONCRETE PAVEMENT, SIDEWALK, CURB, AND CURB AND GUTTER

- .1 Existing asphaltic pavement, sidewalk, curb and gutter shall be cut in a straight line parallel to the line of the proposed work as per the requirements of Section 4.04 - Precutting Paved Surfaces and Section 4.29 - Final Cutting Paved Surfaces.
- .2 Existing concrete pavement, sidewalk, curb and gutter shall be removed by cutting the concrete at the nearest joint or other location designated by the Engineer.
- .3 The top surface of the remaining concrete section shall have a neat vertical face with a straight edge for a minimum of 1/4 the depth of the section.
- .4 All material removed shall be disposed of as waste material.

8.43 SUBGRADE, SUB-BASE AND BASE PREPARATION

- .1 Subgrade, Sub-base and Base installation shall be in accordance with Section 9 – Streets, Traffic Signs and Markings.
- .2 The Subgrade, Sub-base and Base shall be approved by the Engineer prior to placement of forms and/or guides.

8.44 CROSS-SECTION

- .1 The cross-sections of the curb, gutter and sidewalk shall conform to the cross-sections as detailed on the Standard Drawings.

8.45 PLACING CONCRETE

- .1 The base, forms and/or rails shall be approved by the Engineer prior to the placement of concrete.
- .2 Concrete shall be placed within 1.5 hours of batching time into approved preset forms or an approved extruding machine.
- .3 Successive batches shall be deposited in a continuous operation. Under no circumstances shall partially set concrete be used.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS INSTALLATION

- .4 **Concrete shall not be placed during wet weather, on ponded water, on a frozen base, or when it appears likely that the air temperature will fall below 5° C within 24 hours unless special precautions approved by the Engineer are taken. Concrete shall be kept at a temperature of not less than 13° C for at least 72 hours after placing.**
- .5 The concrete placing operation shall be timed to permit edging and finishing in daylight hours.
- .6 Granular base shall be moistened prior to placement of concrete.
- .7 Concrete placement shall only be discontinued at expansion, construction or isolation joints.
- .8 Water shall not be added to the concrete mix unless the measured slump is less than the mix design criteria and less than 60 minutes of batching time has elapsed. The addition of water to the concrete mix shall be in accordance with CAN/CSA-A23.1.

8.46 HAND FORMED CONCRETE SECTIONS

- .1 The base shall be approved by the Engineer prior to placement of the forms.
- .2 Forms shall produce a true line free from waves or irregularities in line or grade. Forms shall be thoroughly cleaned and freshly oiled with form oil before concrete is placed. After forms have been set to line and grade, they shall be adequately braced, tied, and checked with a template to ensure proper setting. Concrete shall not be placed until the forms have been inspected and approved by the Engineer.
- .3 A mechanical pencil vibrator not exceeding 50mm in diameter or a power screed shall be used as the concrete is being placed to produce a dense concrete. The use of a vibrator shall not exceed fifteen seconds in any one location.
- .4 Face forms shall be removed as soon after pouring as is possible without resulting in damage to the curb in order to permit finishing. Under no circumstance shall the face forms remain in place overnight.

8.46A EXTRUDED CONCRETE SECTIONS

- .1 The base shall be approved prior to placement of concrete.
- .2 Guides for the extruding machine shall produce a true line free from waves or irregularities in line or grade and be sufficiently supported to ensure no deflection occurs.
- .3 Concrete shall not be placed until guides have been approved by the Engineer.
- .4 Extruded sections shall conform with cross-sections shown on the Standard Drawings.
- .5 Where the Engineer is not satisfied with the extruded product, defective sections shall be removed and the replacement of defective sections and all remaining sections shall be completed by hand placement procedures.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS INSTALLATION

8.47 TRANSITION SIDEWALK AND WALKWAY (REVISED NOVEMBER 2016)

- .1 Transition sidewalk or walkway shall be constructed at all locations designated by the Engineer and shall be edged and finished in a manner compatible with the adjacent sidewalk or walkway and shall be to the satisfaction of the Engineer. (REVISED NOVEMBER 2016)

8.48 CURB AND SIDEWALK EXPANSION JOINTS

- .1 Transverse expansion joints for curb and gutter shall be formed at both sides of lanes and driveway crossings, at both ends of all curb returns, and both sides of catchbasins 1.0m from the centreline of the catchbasin and at all other locations designated by the Engineer.
- .2 Transverse expansion joints for sidewalks shall be formed at both sides of lanes and driveway crossings, at both ends of curb returns, at both sides of manholes, 0.75m from the centre line of the manhole and at all other locations designated by the Engineer.
- .3 Extend joint through full depth of concrete. Fill joint with expansion joint material.

8.49 CURB AND SIDEWALK CONTRACTION JOINTS

- .1 Contraction joints shall be constructed by cutting a groove through the surface of the concrete to a minimum of 1/2 of the depth of the concrete section at the point of cut.
- .2 Contraction joints shall be constructed:
 - (a) For sidewalks up to 3.0m wide, lateral control joints shall be spaced at intervals equal to the width of the sidewalk.
 - (b) For sidewalks wider than 3.0m, lateral control joints shall be spaced at 3.0m intervals, as well as longitudinal control joints, located such that a 2.0m corridor is maintained.
- .3 Contraction joints for curbs shall be constructed:
 - (a) For curbs separated from sidewalk, control joints shall be spaced at 3.0m intervals.
 - (b) For curbs abutting sidewalk, control joints shall be spaced to match the contraction joints in the adjacent sidewalk or multi use pathway, with a minimum spacing of 2.0m and maximum spacing of 4.0m.
- .4 Sidewalk slabs shall be uniform in size and cut square where possible.

8.50 CURB AND SIDEWALK ISOLATION JOINTS

- .1 Isolation joints shall be fabricated around telephone poles, light poles, hydrants, manholes, and all other structures located in the concrete section by wrapping 6mm thick preformed bituminous impregnated fiber board material around the structure.
- .2 Longitudinal isolation joints shall be formed between sidewalk and existing curbing and where sidewalk is installed directly against a wall or other structure.
- .3 Bond break compound may be used in lieu of the isolation joint between sidewalk and abutting curb where approved by the Engineer.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS INSTALLATION

8.51 CURB AND SIDEWALK EDGING AND FINISHING

.1 Concrete curb and gutter:

- (a) Concrete curb and gutter shall have a steel trowel finish. The surface shall have a smooth even dense texture free from blemishes.
- (b) The finish on curb and gutter sections shall be within 5mm of the design grade and cross-section, but not uniformly high or low when measured with a 3m straightedge placed anywhere along the curb and gutter.

.2 Sidewalks and Stairways:

- (a) Finish sidewalks and stairways to a smooth surface with a magnesium or wood float trowel.
- (b) The surface of concrete sidewalks and stairways shall be finished prior to final set with a broom finish to provide a uniform, non-skid surface and finishing edges with a steel edging trowel in accordance with the patterns shown on the standard drawings. Alteration of the finishing pattern as shown on the standard drawings requires approval by the City Engineer.
- (c) Under no circumstances shall the concrete be overworked by trowelling, dusted with dry cement, or finished with a mortar coat.
- (d) Finish driveway and lane crossings and sidewalk ramps as shown on the standard drawings.
- (e) The finish grade surface of concrete sidewalks and stairways shall be 0 - 6mm above the finish elevations of structures, including but not limited to, manholes, valves, service boxes and survey monuments.
- (f) Finished surfaces shall be within 6mm of the design grade and cross-section, but not uniformly high or low when measured with a 3m straightedge placed anywhere on the surface.

8.52 CURING CONCRETE

- .1 As soon as the concrete has obtained its initial set, it shall be sprayed with 2 coats of membrane curing compound as specified in Section 8.22 – Curing Compound. Other methods of curing require approval by the Engineer prior to placing concrete.

8.53 PROTECTING CONCRETE

- .1 Tarpaulins shall be used to protect freshly finished concrete from dust, rain or frost. Protective coverings used for heating purposes shall be kept clear of the concrete to permit unimpeded circulation of air.
- .2 Suitable traffic barriers shall be erected to protect concrete from equipment, vehicles and pedestrian traffic.
- .3 Supervision, as required, shall be provided to prevent damage by vandalism until the concrete has set.
- .4 No construction equipment shall be worked adjacent to the curb until the concrete has attained adequate strength. This shall be for at least 7 days or as directed by the Engineer.

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS INSTALLATION

8.54 DAMAGED CONCRETE

- .1 Where concrete shows evidence of damage or freezing, as determined by the Engineer, the entire section lying between consecutive contraction joints shall be removed and replaced at the Contractor's expense.

8.55 ASPHALT WALKWAYS

- .1 Asphalt walkways shall be installed in accordance with Section 12 - Asphaltic Concrete Paving.
- .2 The base shall be approved prior to placement of asphalt.
- .3 Any segregated coarse aggregate shall be removed from the surface. Walkway shall be finish rolled with a steel wheel roller. Completed walkway shall have a tight, fine finished surface, free from depressions.
- .4 The surface of the finished walkway shall be within 10mm of the design grade and cross section when measured with a 3.0m straightedge placed anywhere on the surface.
- .5 Compaction requirements shall be a minimum of 95% of the design compacted density.

8.56 CONCRETE WALKWAYS

- .1 Concrete walkways shall be installed in accordance with the requirements for concrete sidewalks.

8.57 BOULEVARDS

- .1 Boulevards within the statutory rights-of-way shall be graded towards the walkway and be finished with a 100mm thick layer of topsoil including grass seeding or sod as directed by the Engineer and in accordance with the standard drawings.

8.58 CATCH BASINS AND MANHOLES

- .1 Catch basin and manhole frames shall be adjusted horizontally and vertically as necessary to match the finished alignment and grade prior to or at the time of concrete placement.

8.59 -NOT USED-

8.60 BACKFILL AND CLEANUP

- .1 The gravel road base adjacent to the curb shall be filled tight to the curb, graded, compacted and left in a neat condition.
- .2 The boulevard area adjacent to the curb or sidewalk shall be cleared of construction debris and raked clear of all rock exceeding 50mm in its largest dimension.
- .3 The boulevard area shall be backfilled to within 50mm of the top of the curb for a minimum width as shown on the drawings, such that the water does not undermine the curb installation. Backfill shall be compacted to 90% of Modified Proctor Density (ASTM D1557). It is not the

SECTION 8 – CURBS, SIDEWALKS AND WALKWAYS INSTALLATION

intention that boulevard areas be completely filled but that they be left in a neat order and in at least as good condition as existed prior to commencement of construction.

- .4 Complete boulevard grading in accordance with Section 9.60 - Boulevard Grading.

8.61 CONCRETE TESTING

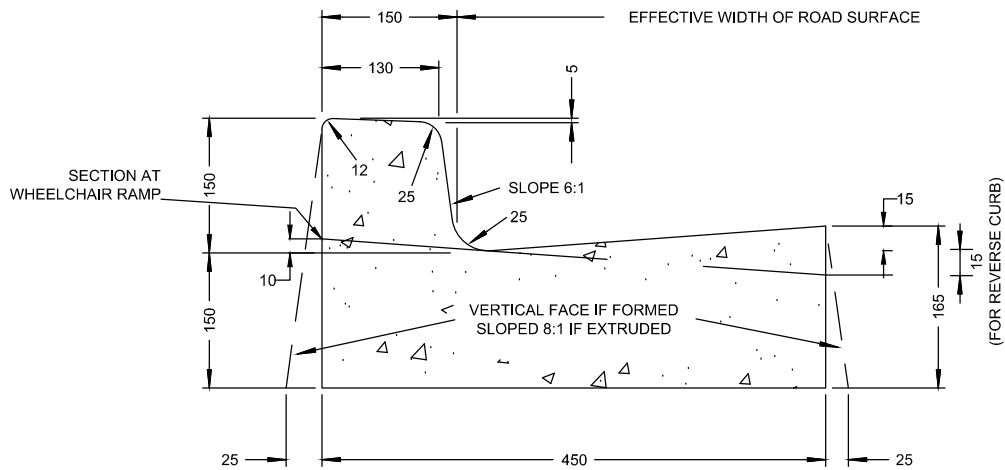
- .1 The Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates inadequacies, additional testing may be required.
- .2 The Contractor as directed by the Engineer shall supply specimens or samples for testing.
- .3 The types of tests listed below are the minimum testing requirements. The Engineer shall determine if additional testing is required.
 - (a) One strength test (three - specimen cylinders as per the requirements of CSA A23.1) shall be made for each 150lm of work constructed. In no case, however, shall there be less than one test for concrete placed in one day. One cylinder shall be tested at 7 days, 2 at 28 days.
 - (b) One core test (for thickness) shall be made for each 80lm constructed. Cores are to be taken on a random basis as directed by the Engineer.
 - (c) Other testing as required by Sections 11.25 – Forms and Section 11.26 – Premoulded Joint Filler.

8.62 WALKWAY BARRIERS

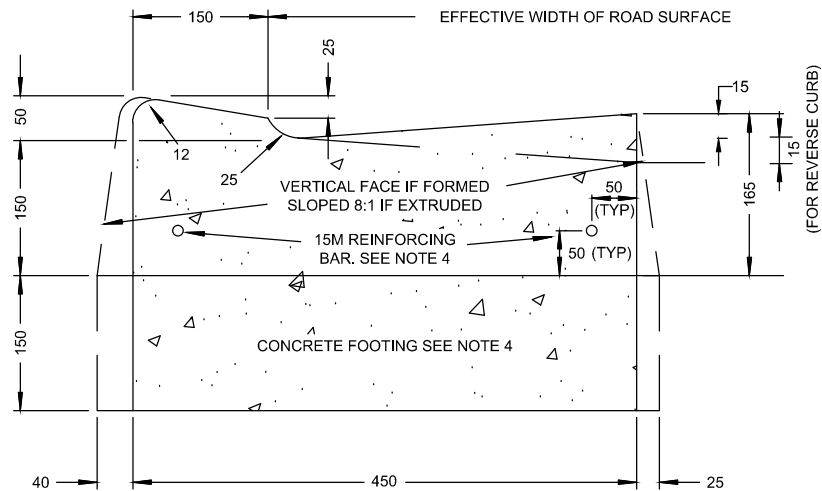
- .1 Walkway barriers shall be constructed in accordance with the standard drawings.

8.63 ASPHALT CURB

- .1 The asphalt surface on which the curb is to be placed shall be cleaned of all dirt, loose and broken materials.
- .2 The asphalt surface shall be prepared by applying an undiluted tack coat at the rate of 0.5kg/m². The tack coat shall form a continuous film over the surface and shall be allowed to dry prior to curb placement.
- .3 The asphalt curb shall be placed to the line, grades and dimensions as shown on the construction drawings. Acceptable conditions for placement shall be in accordance with Section 12 - Asphaltic Concrete Paving.
- .4 Areas inaccessible to the asphalt curb machine shall be compacted by hand tampers.

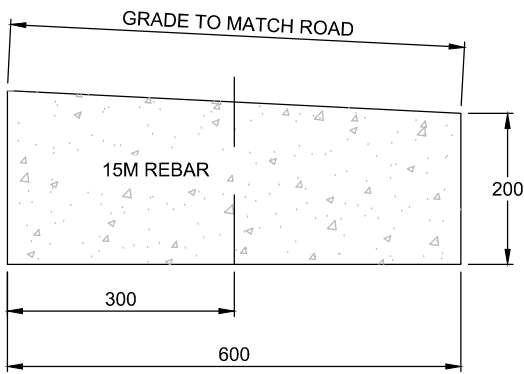


CURB WITH INTEGRAL GUTTER

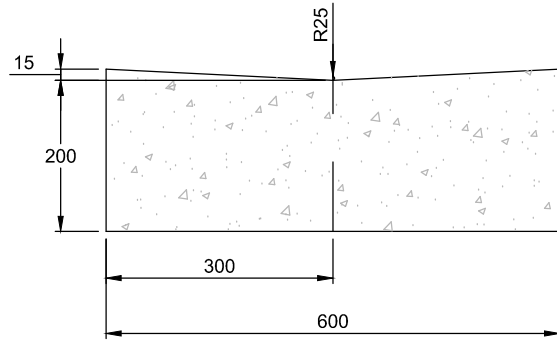


DROP CURB WITH INTEGRAL GUTTER

- 1) FOR BASE AND SUB-BASE REQUIREMENTS, REFER TO SECTION 8.08
- 2) FOR CONCRETE DETAILS REFER TO SECTION 8 AND 11.
- 3) THE LENGTH OF TRANSITION FROM ONE TYPE OF CURB TO ANOTHER SHALL BE THE GREATEST OF:
 - a) 50 x DIFFERENCE IN OVERALL CURB HEIGHTS.
 - b) 25 x DIFFERENCE IN GUTTER WIDTHS.
 - c) 2.0 METERS.
- 4) REINFORCING BARS OR CONCRETE FOOTING REQUIRED FOR LANE ACCESSSES AND FOR COMMERCIAL AND INDUSTRIAL DRIVEWAY ACCESSSES.
- 5) REVERSE CURB SHALL BE APPROVED BY CITY ENGINEER.
- 6) ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.



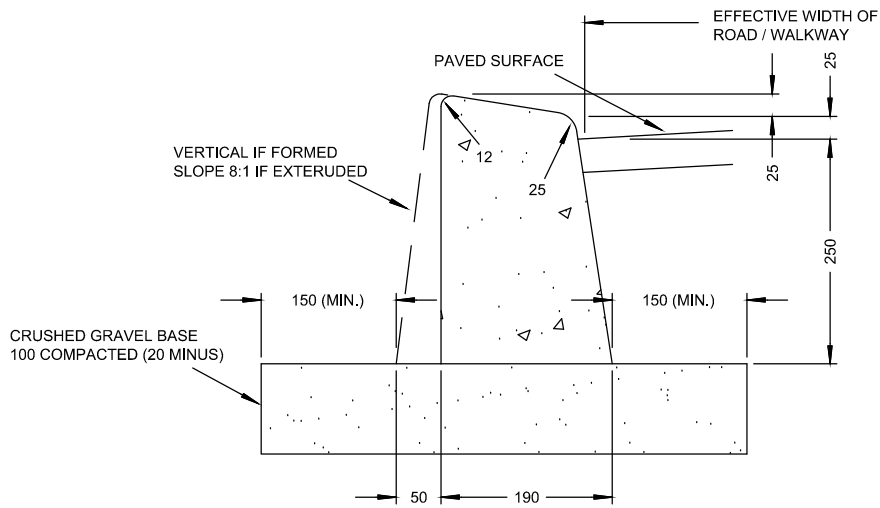
FLAT CURB



VALLEY CURB

NOTES:

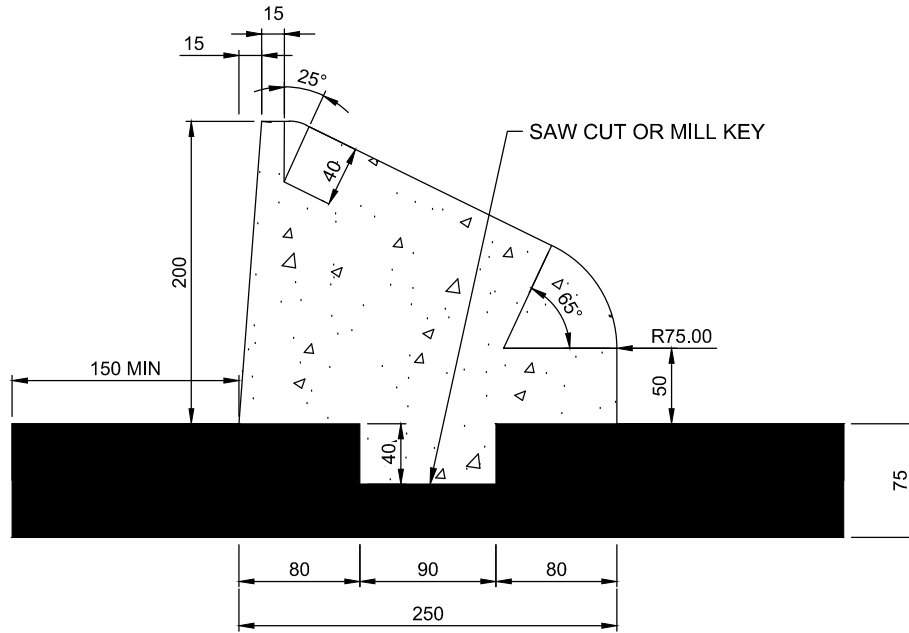
- 1) CURB AND GUTTER TO BE BEDDED ON 100 COMPACTED THICKNESS OF 20 MINUS CRUSHED GRAVEL.
- 2) FOR CONCRETE DETAILS REFER TO SECTION 8 AND 11.
- 3) AT LOCATIONS OTHER THAN PEDESTRIAN CURB LET DOWNS, THE LENGTH OF TRANSITION FROM ONE TYPE OF CURB TO ANOTHER SHALL BE THE GREATEST OF:
 - a) 50 x DIFFERENCE IN OVERALL CURB HEIGHTS.
 - b) 25 x DIFFERENCE IN GUTTER WIDTHS.
 - c) 2.0 METERS.
- 4) MIDPOINT OF CURB SHALL ALIGN WITH THE UPSTREAM AND DOWN STREAM CURB FACES.
- 5) ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.



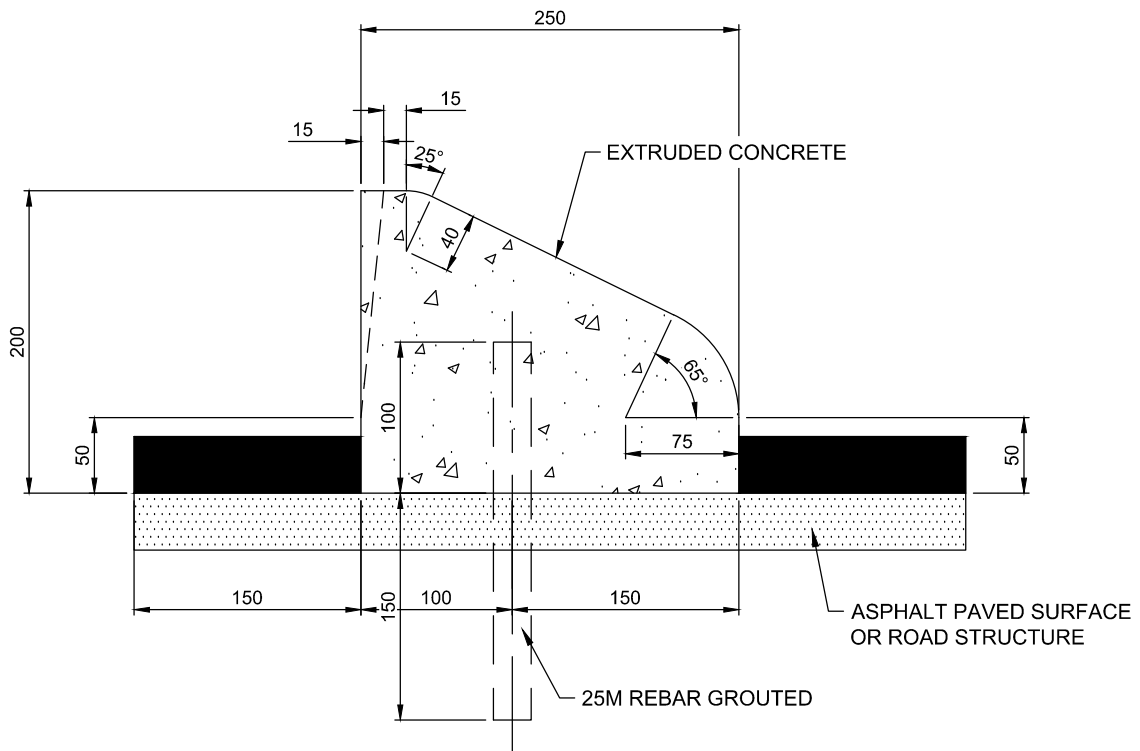
DROP CURB CROSS-SECTION

NOTES:

1. CURB AND GUTTER TO BE BEDDED ON 100 COMPACTED THICKNESS OF 20 MINUS CRUSHED GRAVEL.
2. FOR CONCRETE DETAILS REFER TO SECTION 8 AND 11.
3. THE LENGTH OF TRANSITION FROM ONE TYPE OF CURB TO ANOTHER SHALL BE THE GREATEST OF:
 - a) 50 x DIFFERENCE IN OVERALL CURB HEIGHTS.
 - b) 25 x DIFFERENCE IN GUTTER WIDTHS.
 - c) 2.0 METERS.
4. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.



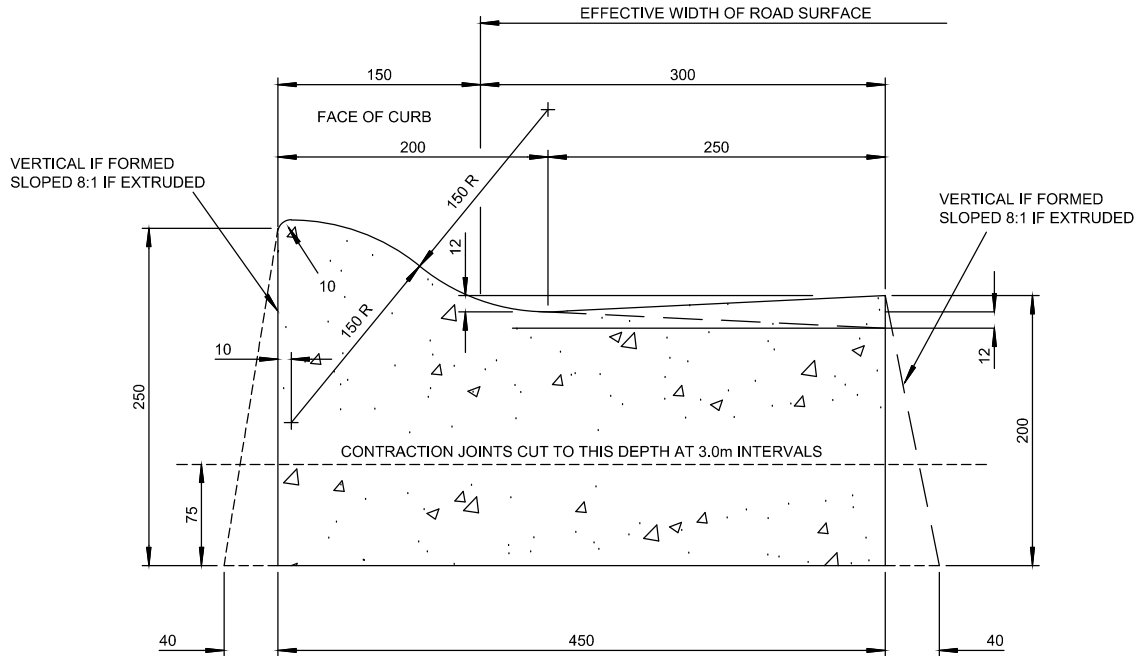
ALTERNATIVE 1



ALTERNATIVE 2

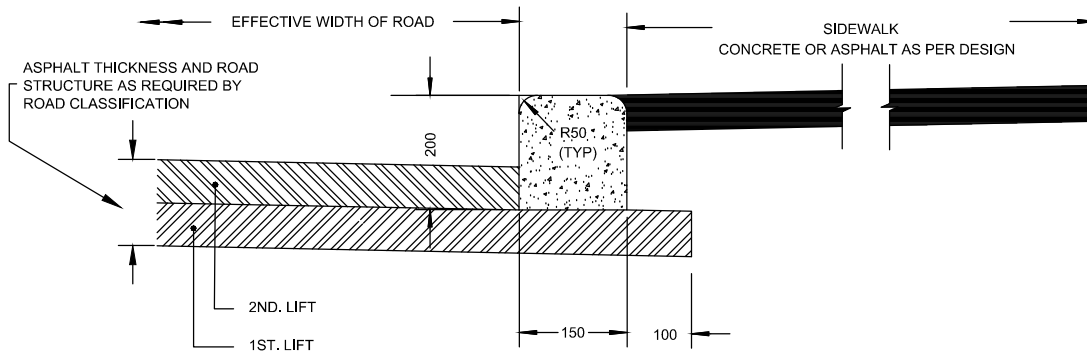
NOTES:

- 1) INSTALL 25M REBAR AT 300 c/c FROM THE B.C. TO THE E.C. OF ALL TRAFFIC ISLAND CORNERS.
- 2) ALTERNATIVE 2 CURB SHALL BE INSTALLED ON FIRST LIFT OF ASPHALT AND KEYED IN WITH THE FINAL LIFT OF ASPHALT.
- 3) ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

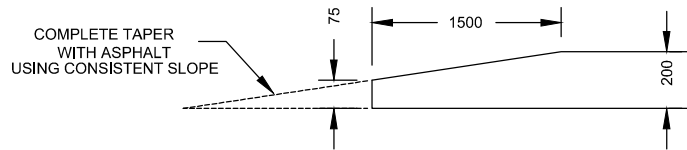


NOTES:

1. MOUNTABLE CONCRETE CURBS SHALL BE USED WITHIN CUL-DE-SACS ONLY OR WHERE APPROVED BY CITY ENGINEER.
2. CURB AND GUTTER TO BE BEDDED ON 100 COMPACTED THICKNESS OF 20 MINUS CRUSHED GRAVEL.
3. FOR CONCRETE DETAILS REFER TO SECTION 8 AND 11.
4. THE LENGTH OF TRANSITION FROM ONE TYPE OF CURB TO ANOTHER SHALL BE THE GREATEST OF:
 - a) 50 x DIFFERENCE IN OVERALL CURB HEIGHTS.
 - b) 25 x DIFFERENCE IN GUTTER WIDTHS.
 - c) 2.0 METERS.
5. REVERSE CURB SHALL BE APPROVED BY CITY ENGINEER.
6. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.



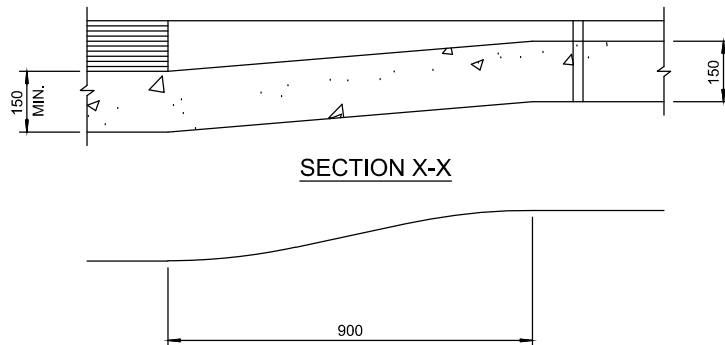
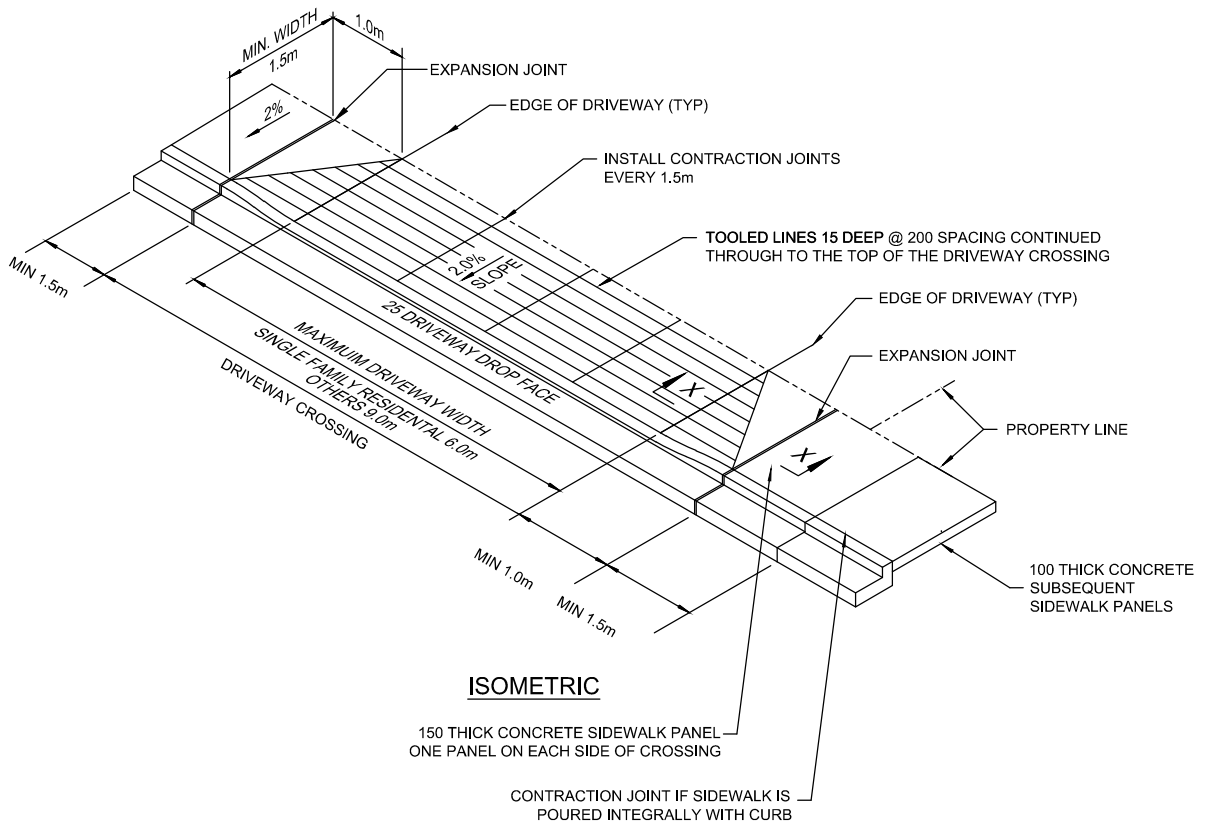
EXTRUDED CONCRETE CURB WITH SIDEWALK
N.T.S.



LETDOWN DETAIL
N.T.S.

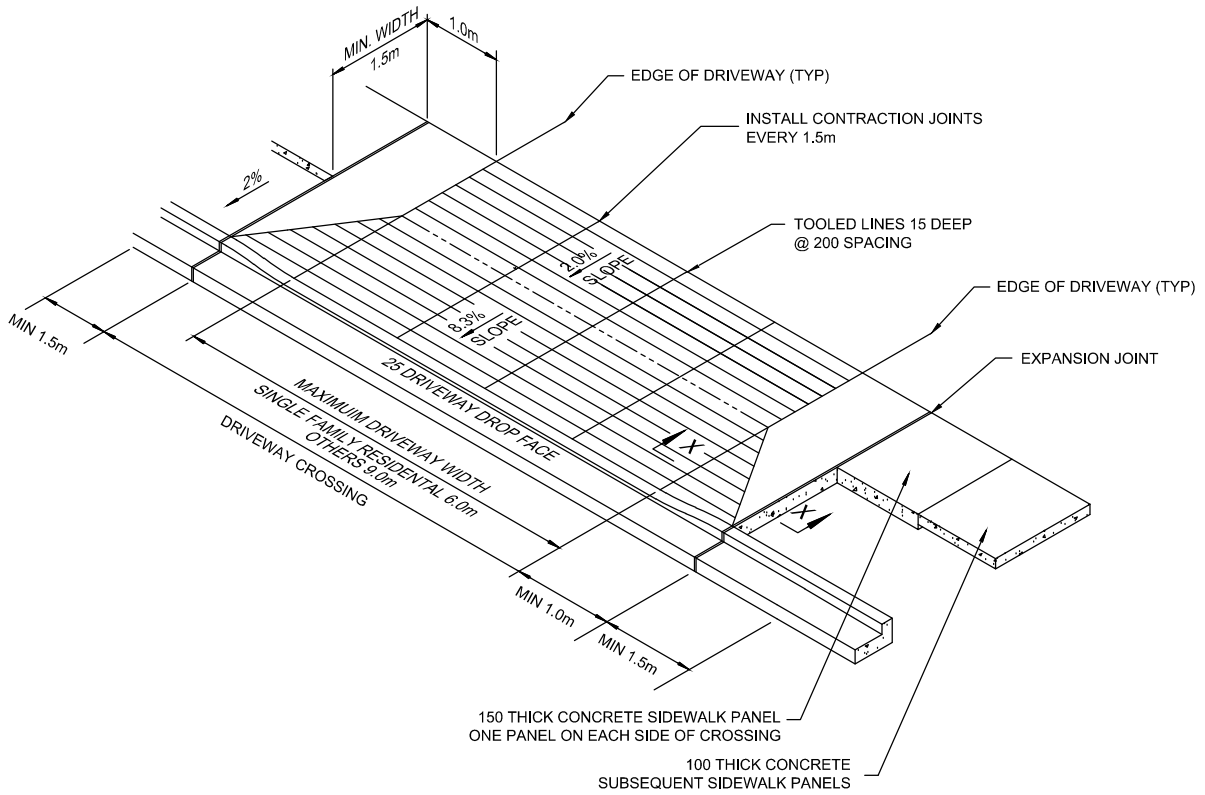
NOTES:

- 1 APPLICATION OF THIS STANDARD AT THE DISCRETION OF THE CITY ENGINEER.
- 2 WIDTH OF SIDEWALK TO BE AS PER REQUIREMENTS FOR ROAD CLASSIFICATION.
- 3 BASE & SUB-BASE FOR SIDEWALK AS PER SPECIFICATIONS.
- 4 PROVIDE 1.5m TAPER TO ZERO HEIGHT AT DROP LOCATIONS.
- 5 CURB HEIGHT 150mm IF INSTALLED ON FINAL LIFT AND 200mm IF INSTALLED ON BOTTOM LIFT.
- 6 ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN

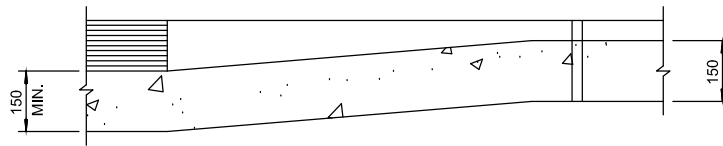


NOTES:

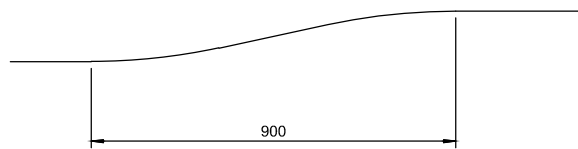
- 1) MINIMUM CONCRETE SIDEWALK THICKNESS AT CROSSING SHALL BE 150 AND SHALL INCLUDE ONE PANEL ON EACH SIDE OF THE CROSSING AS SHOWN.
- 2) ALL LANE ACCESSES AND COMMERCIAL AND INDUSTRIAL ACCESSES SHALL HAVE THE CURB REINFORCED IN ACCORDANCE WITH STD. DWG CS-1.
- 3) CROSSINGS SHALL CONFORM TO THE CITY'S CROSSING CONTROL BYLAW.
- 4) ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.
- 5) FOR BASE AND SUBBASE REQUIREMENTS REFER TO SECTION 8.08.



ISOMETRIC



SECTION X-X



CURB DROP DETAIL

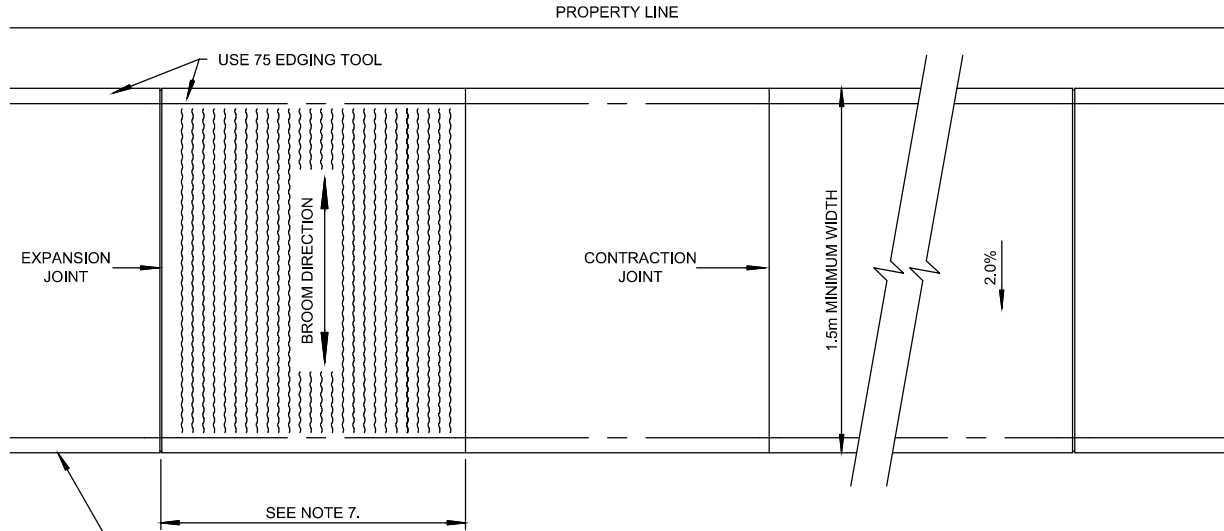
NOTES:

- 1) ALL LANE ACCESSES AND COMMERCIAL AND INDUSTRIAL ACCESSES SHALL HAVE THE CURB REINFORCED IN ACCORDANCE WITH STD. DWG. CS-1.
- 2) CROSSINGS SHALL CONFORM TO THE CITY'S CROSSING CONTROL BYLAW.
- 3) ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.
- 4) MINIMUM CONCRETE THICKNESS OF CROSSING SHALL BE 150 AND SHALL INCLUDE ONE PANEL ON EACH SIDE OF THE CROSSING AS SHOWN.
- 5) FOR BASE AND SUBBASE REQUIREMENTS REFER TO SECTION 8.08.

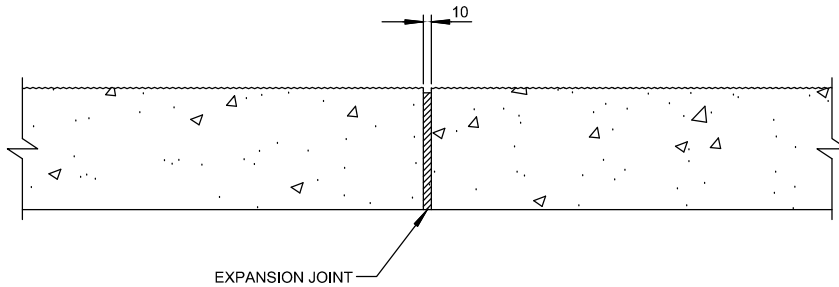


TYPICAL SIDEWALK AND DRIVEWAY CROSSING TYPE 3

Scale: N.T.S.
 Created: NOV 2012
 Rev Date: NOV 2016
 Dwg No: CS-5B

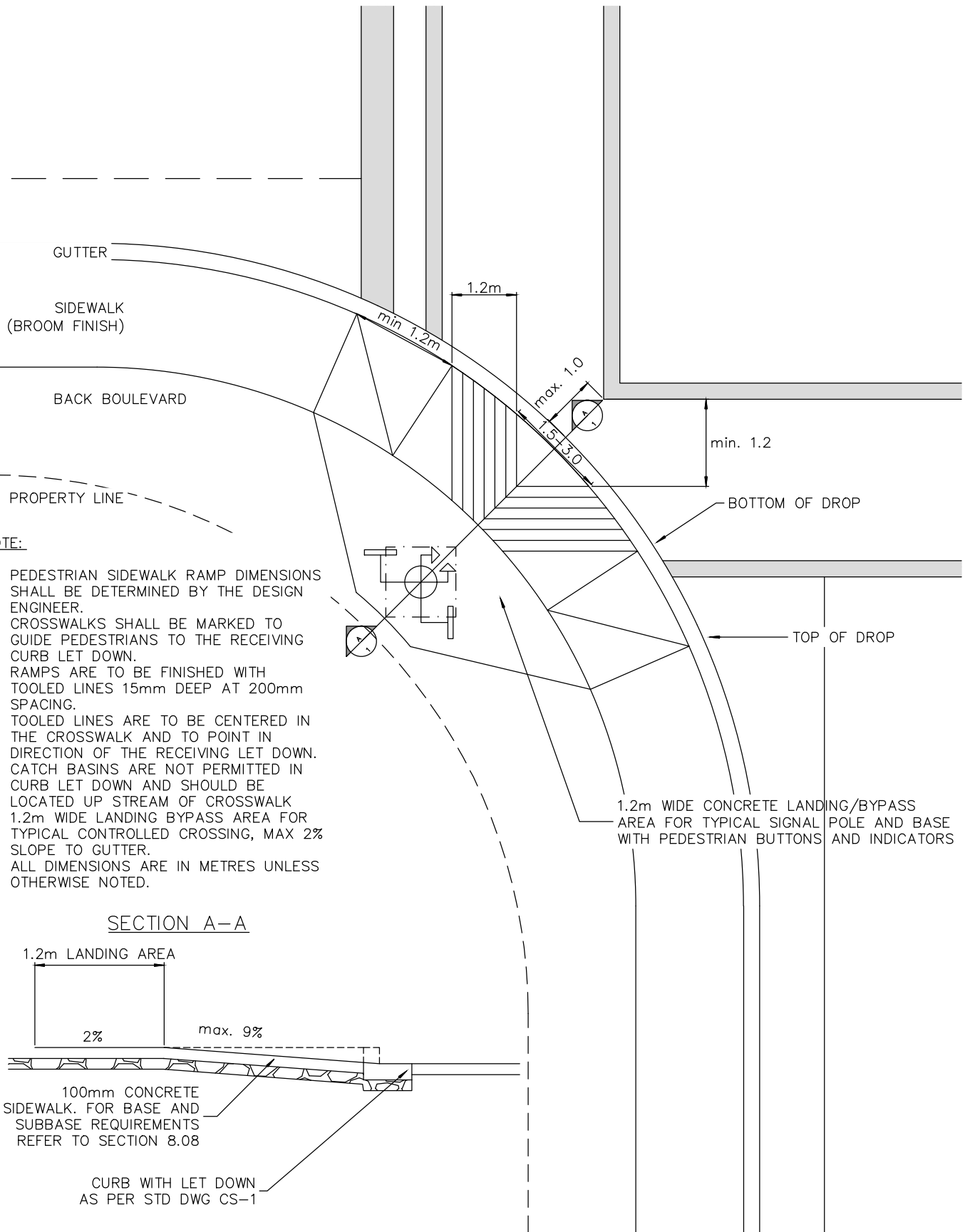


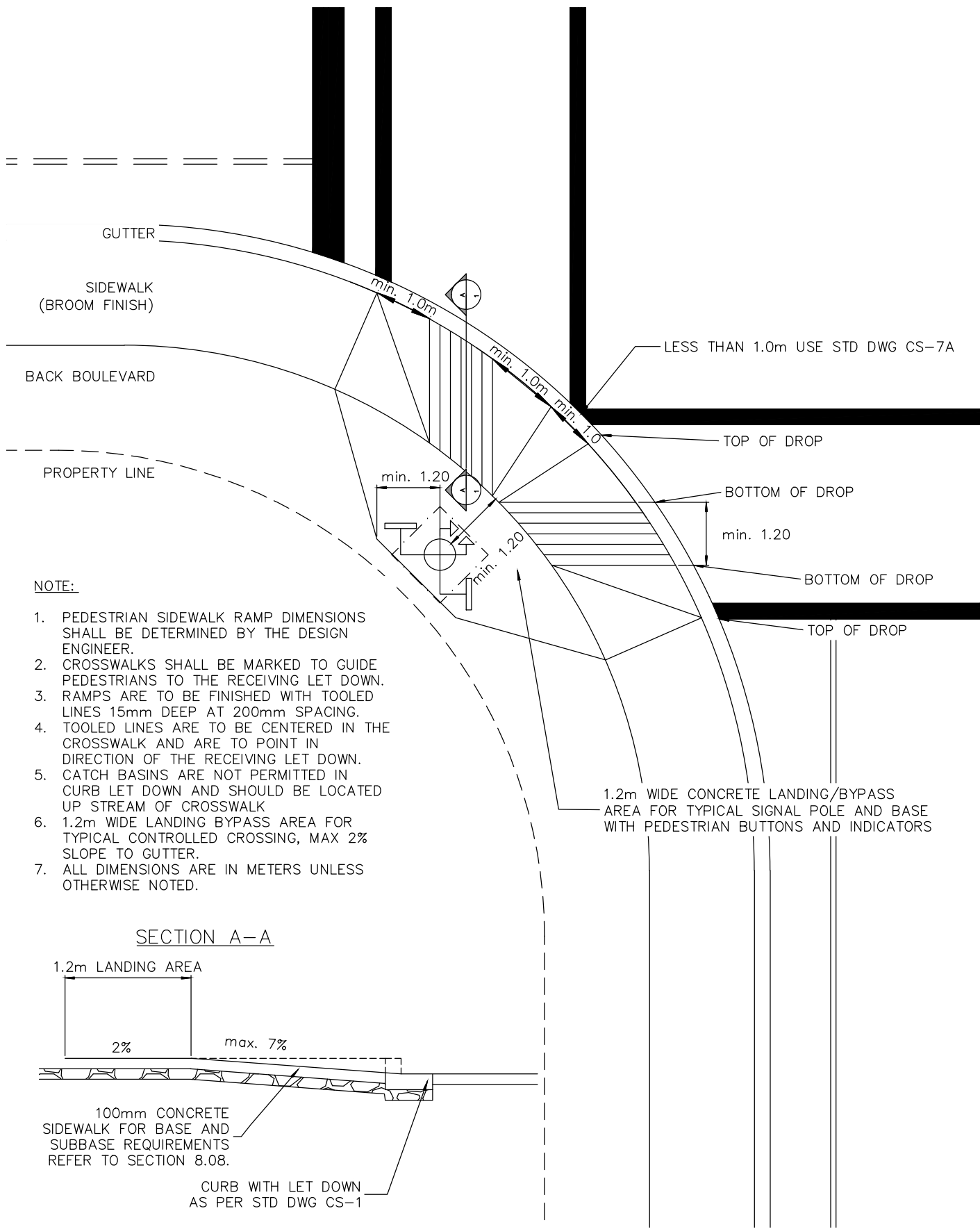
CONTRACTION JOINT IF SIDEWALK IS POURED INTEGRALLY TO CURB. ISOLATION JOINT IF SIDEWALK IS POURED ADJACENT TO CURB. BOND BREAK COMPOUND MAY BE USED WHERE APPROVED BY THE ENGINEER.



NOTES:

1. FOR DRIVEWAY CROSSING DETAIL SEE DWG. CS-5, CS-5A, & CS-5B
2. SIDEWALKS SHALL HAVE BROOMED FINISH.
3. FOR CONCRETE DETAILS SEE SPECIFICATIONS.
4. FOR SIDEWALK THICKNESS SEE SECTION 8.07.
5. FOR BASE AND SUBBASE REQUIREMENTS SEE SECTION 8.08.
6. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.
7. REFER TO SECTION 8.49 FOR INSTALLATION DETAILS.

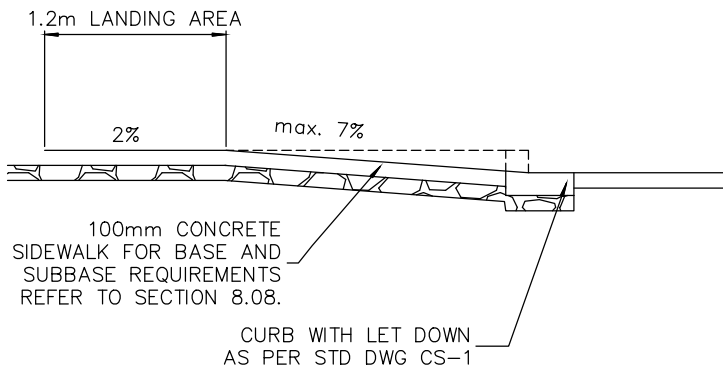


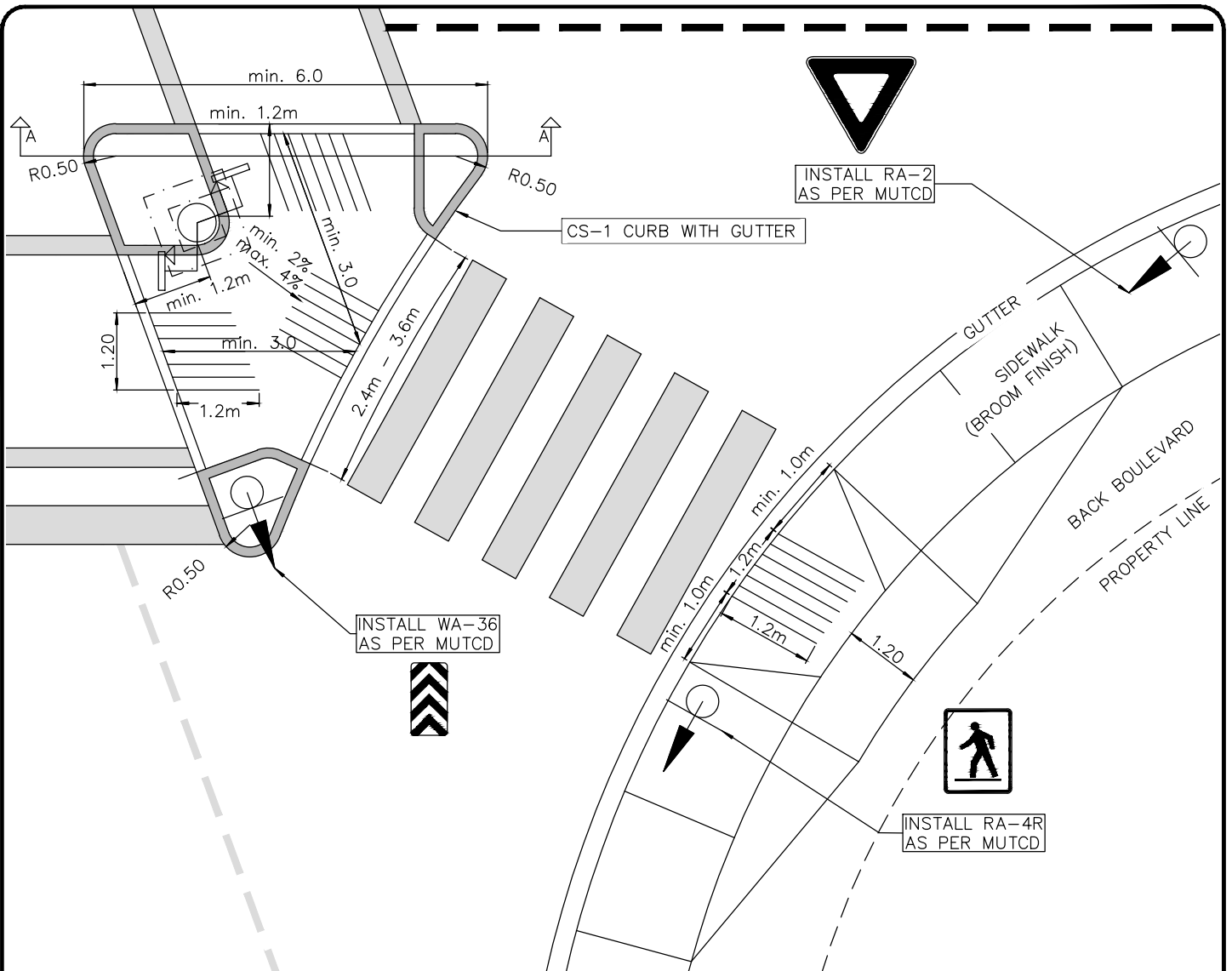


NOTE:

1. PEDESTRIAN SIDEWALK RAMP DIMENSIONS SHALL BE DETERMINED BY THE DESIGN ENGINEER.
2. CROSSWALKS SHALL BE MARKED TO GUIDE PEDESTRIANS TO THE RECEIVING LET DOWN.
3. RAMPS ARE TO BE FINISHED WITH TOOLED LINES 15mm DEEP AT 200mm SPACING.
4. TOOLED LINES ARE TO BE CENTERED IN THE CROSSWALK AND ARE TO POINT IN DIRECTION OF THE RECEIVING LET DOWN.
5. CATCH BASINS ARE NOT PERMITTED IN CURB LET DOWN AND SHOULD BE LOCATED UP STREAM OF CROSSWALK
6. 1.2m WIDE LANDING BYPASS AREA FOR TYPICAL CONTROLLED CROSSING, MAX 2% SLOPE TO GUTTER.
7. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE NOTED.

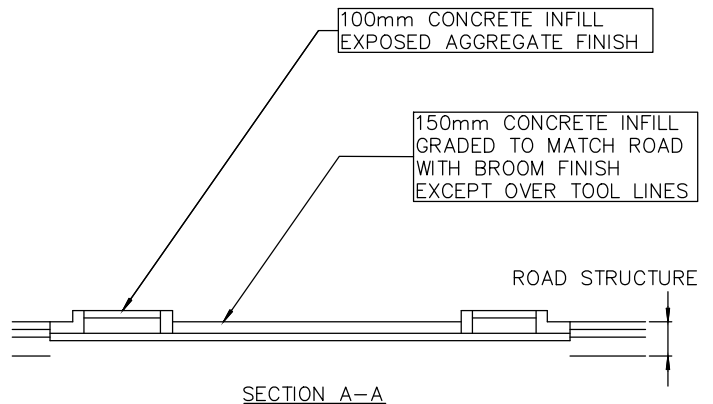
SECTION A-A



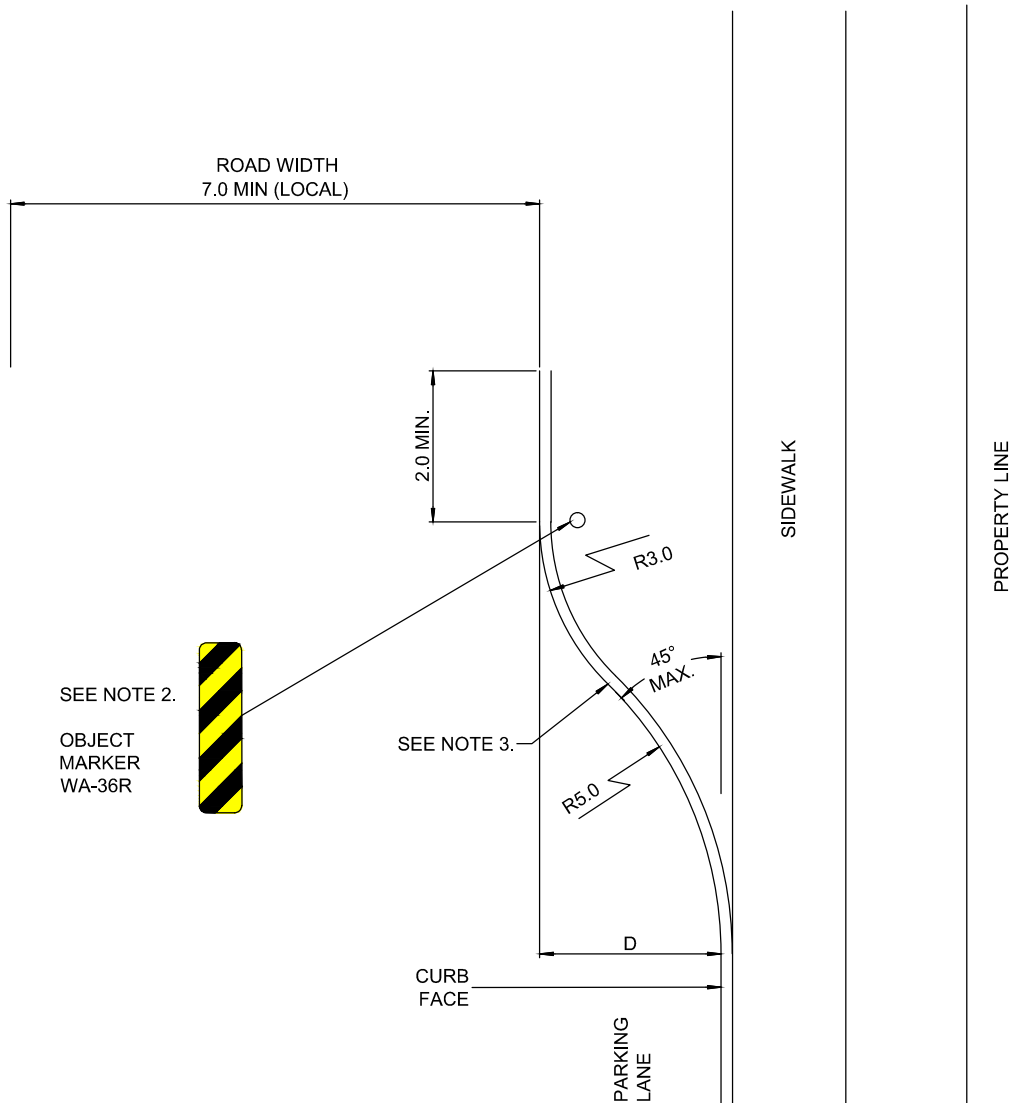


NOTE:

1. ISLAND PEDESTRIAN CROSSWALK RAMP DIMENSIONS SHALL BE DETERMINED BY THE DESIGN ENGINEER.
2. CROSSWALKS SHALL BE MARKED TO GUIDE PEDESTRIANS TO THE RECEIVING CURB LET DOWN.
3. RAMPS ARE TO BE FINISHED WITH TOOLED LINES 15mm DEEP AT 200mm SPACING.
4. TOOLED LINES ARE TO BE CENTERED IN CROSSWALK AND TO POINT IN DIRECTION OF RECEIVING LET DOWN.
5. INFILL AREA TO BE BROOM FINISHED, EXCEPT OVER TOOL LINES.
6. INFILL AREA TO BE GRADED TO ENSURE DRAINAGE MATCHES ROAD. MINIMUM 2% TOWARDS EDGE OF ROAD.
7. CATCH BASINS ARE NOT PERMITTED IN CURB LET DOWN AND SHOULD BE LOCATED UP STREAM OF CROSSWALK
8. ISLAND MUST ENSURE A MINIMUM OF 3.0m BETWEEN THE CENTERLINES OF ANY TWO CROSSWALKS.
9. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE NOTED.
10. SIGN LOCATIONS ARE APPROXIMATE AND WILL NEED TO BE ADJUSTED TO SUIT PROJECT LOCATION.

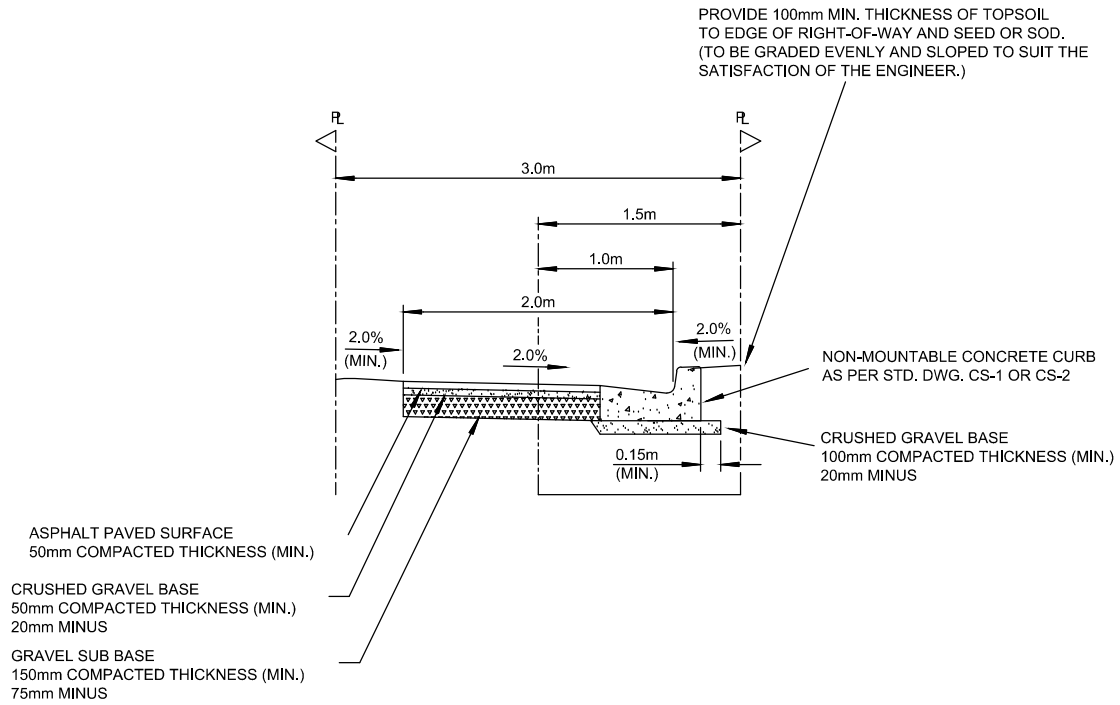


SECTION A-A

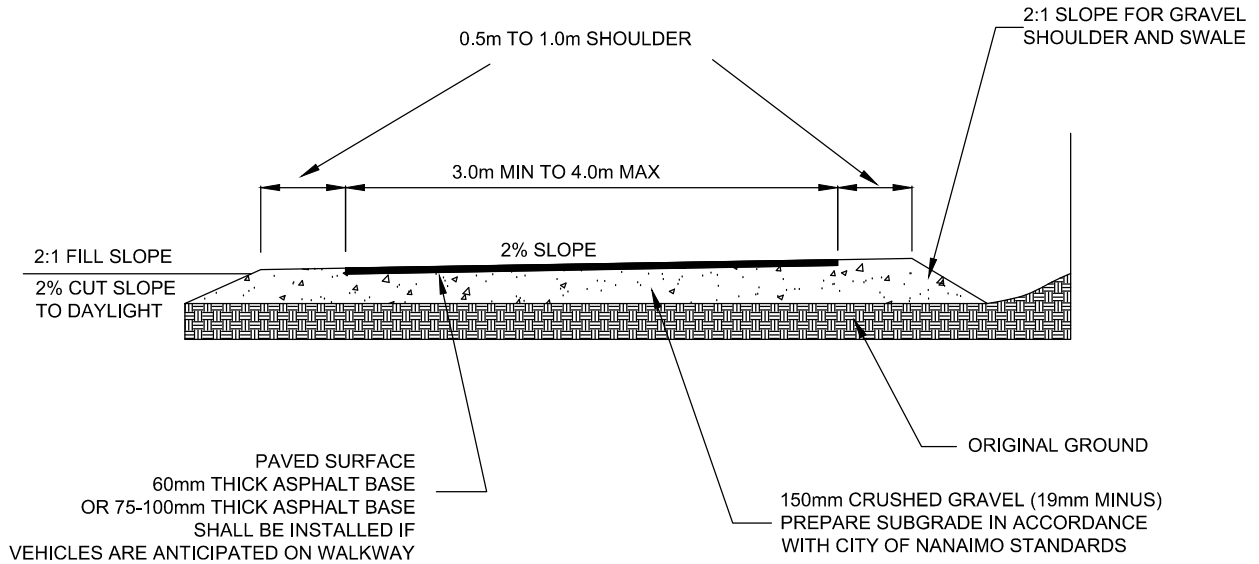


NOTES:

1. "D"=DEPTH OF CURB EXTENSION SHOULD BE SIMILAR TO THE WIDTH OF THE PARKING LANE (TYPICALLY 2.4m); EXCEPT ON LOCAL STREETS WHERE THE MINIMUM CURB EXTENSION DEPTH MAY BE REDUCED, WHERE REQUIRED, TO MAINTAIN A MINIMUM THROAT WIDTH OF 7.0m.
2. IF THE START OF THE PARKING LANE IS MORE THAN 75m IN ADVANCE OF THE CURB EXTENSION OR WHERE THE CURB EXTENSION MAY BE A HAZARD TO VEHICLE IN THE ADJACENT TRAVEL LANE INCLUDE AN OBJECT MARKER (WA-36R) ON THE CURB EXTENSION.
3. INCLUDE A TANGENT AT 45° TO THE CURB FACE BETWEEN RADII WHERE "D" IS GREATER THAN 2.4m.
4. STREET DESIGN REQUIRED FOR DRAINAGE.
5. NO STREET TREES IN THE FRONT BOULEVARD WITHIN CURB EXTENSION.
6. FOR COMPLEX DESIGNS, WITH NON LOCAL ROAD CLASSIFICATIONS AND/OR BUS ROUTE STATUS THE CITY ENGINEER SHALL BE CONSULTED PRIOR TO DESIGN STAGE.
7. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE NOTED.

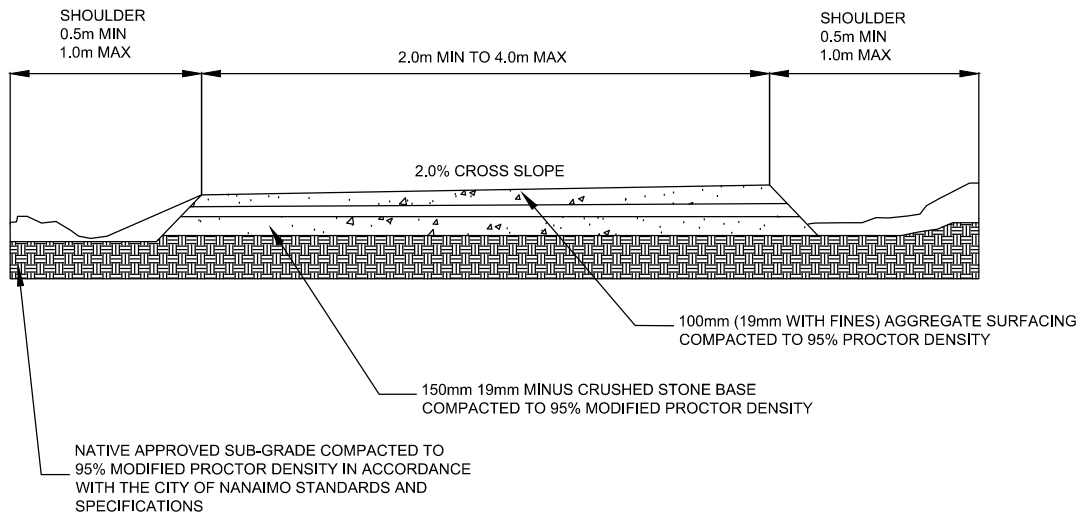


NOTE:
THIS STANDARD APPLIES ONLY WHEN THERE IS A 3.0m RIGHT-OF-WAY CREATED AS A RESULT OF EARLIER SUBDIVISION.



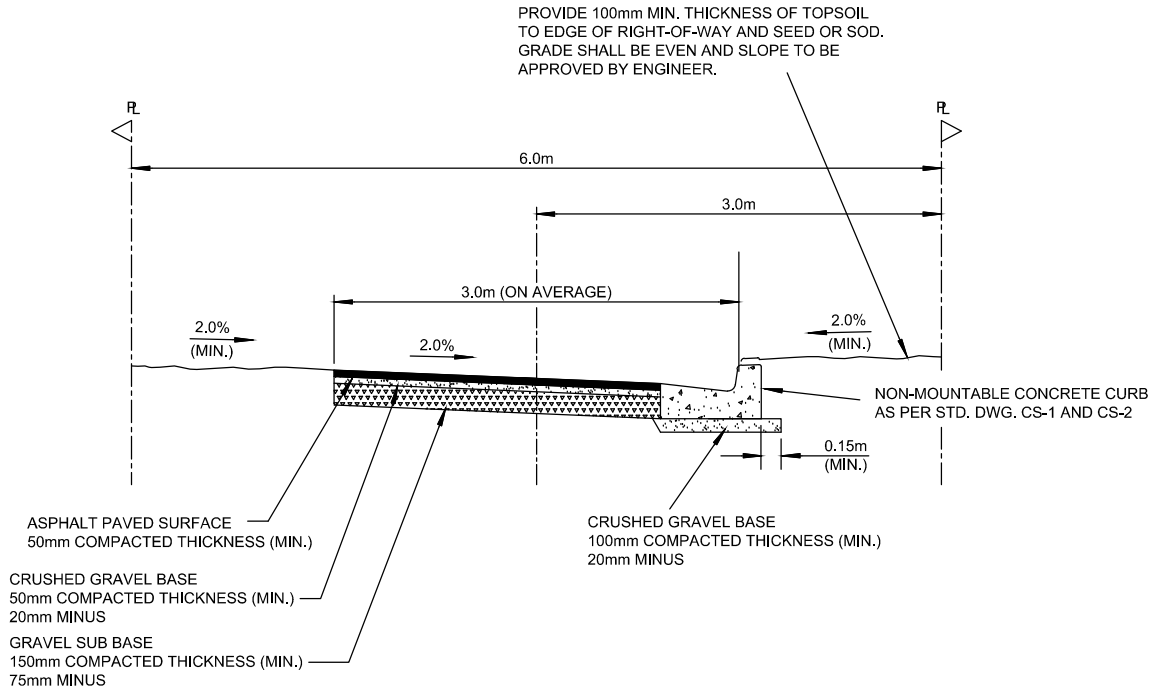
NOTES:

1. WALKWAY SURFACE TREATMENT - ASPHALT
2. WALKWAY SURFACE WIDTH TO BE A MINIMUM 3.0m WIDE TO A MAXIMUM 4.0m WIDE.
3. WALKWAY SURFACE CROSS SLOPE SHALL BE 2%.
4. 2:1 CUT/FILL SLOPE FOR GRAVEL SHOULDERS AND SWALE.
5. SHOULDERS/CLEAR ZONES SHALL BE A MINIMUM 0.5m WIDE TO A MAXIMUM 1.0m WIDE.
6. VEGETATION CLEARANCE SHALL BE A MINIMUM VERTICAL CLEARANCE OF 2.5m AND A MINIMUM 0.5m HORIZONTAL CLEARANCE.
7. MAXIMUM TRAIL GRADES:
 - 3% SUSTAINED GRADE
 - 5% GRADE FOR DISTANCES 30m OR LESS
 - 10% GRADE FOR DISTANCES 15m OR LESS
8. MINIMIZE HORIZONTAL CURVES AND ENSURE ADEQUATE SITE LINES ON CORNERS. REFER TO BICYCLE FACILITY DESIGN GUIDELINES (2.3 - 2.4).
9. RESIDENTIAL BUFFER SHALL BE A MINIMUM OF 2.0m TO A MAXIMUM 5.0m.
10. REFER TO CITY OF NANAIMO - TRAIL PLAN - DESIGN GUIDELINES (MAY 2007) FOR ADDITIONAL DESIGN INFORMATION.



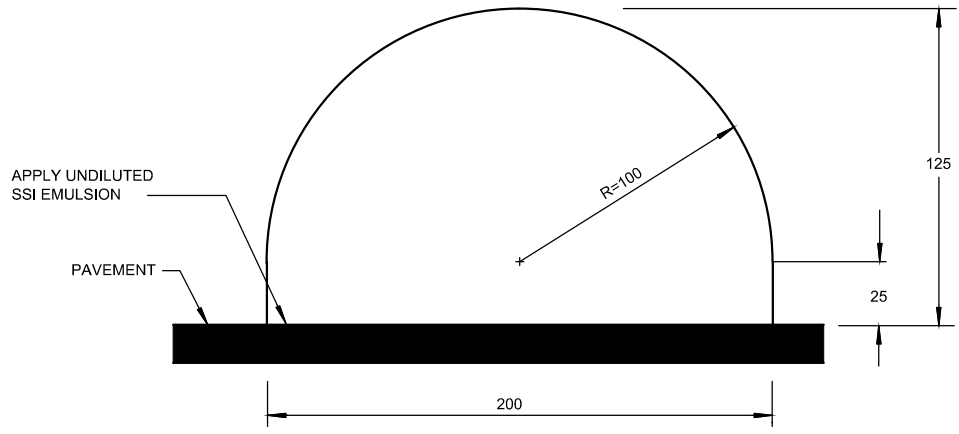
NOTES:

1. WALKWAY SURFACE TREATMENT - CRUSH AND/OR 50/50 HOG FUEL/ROAD MULCH.
2. WALKWAY SURFACE WIDTH TO BE A MINIMUM 2.0m WIDE (VERY LOW LOCAL USE) TO A MAXIMUM 4.0m WIDE (HIGH USE).
3. WALKWAY SURFACE CROSS SLOPE SHALL BE 2%.
4. 2:1 CUT/FILL SLOPE FOR GRAVEL SHOULDERS AND SWALE.
5. SHOULDERS/CLEAR ZONES SHALL BE A MINIMUM 0.5m WIDE TO A MAXIMUM 1.0m WIDE.
6. VEGETATION CLEARANCE SHALL BE A MINIMUM VERTICAL CLEARANCE OF 2.5m AND A MINIMUM 0.5m HORIZONTAL CLEARANCE.
7. MAXIMUM TRAIL GRADES:
 - 3% SUSTAINED GRADE
 - 5% GRADE FOR DISTANCES 30m OR LESS
 - 10% GRADE FOR DISTANCES 15m OR LESS
 - SOME STAIRS ALLOWED
8. ENSURE ADEQUATE SITE LINES ON CORNERS. REFER TO BICYCLE FACILITY DESIGN GUIDELINES (2.3 - 2.4).
9. RESIDENTIAL BUFFER SHALL BE A MINIMUM OF 2.0m TO A MAXIMUM 5.0m.
10. REFER TO CITY OF NANAIMO - TRAIL PLAN - DESIGN GUIDELINES (MAY 2007) FOR ADDITIONAL DESIGN INFORMATION.

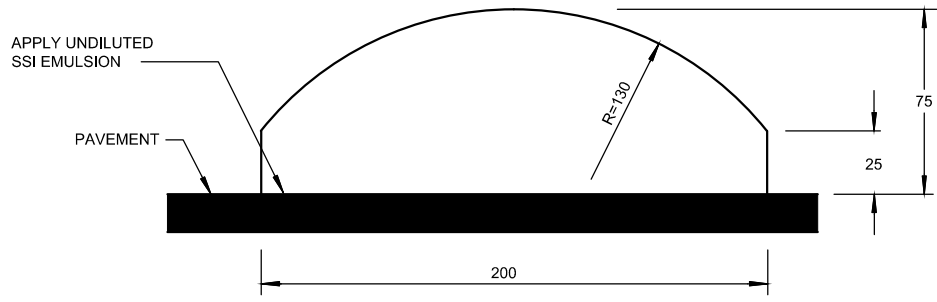


NOTES:

1. WALKWAY SURFACE TREATMENT - TO MATCH PARK AND NEARBY TRAILS. TYPICALLY ASPHALT PAVED SURFACE
2. WALKWAY SURFACE WIDTH TO BE 2.0m ON AVERAGE IN 6.0m ROW.
3. WALKWAY SURFACE CROSS SLOPE SHALL BE 2%.
4. 2:1 CUT/FILL SLOPE FOR GRAVEL SHOULDERS AND SWALE.
5. SHOULDERS/CLEAR ZONES SHALL BE A MINIMUM 0.5m WIDE TO A MAXIMUM 0.75m WIDE WITH LANDSCAPE OR BUFFER ZONE OF 1.25m.
6. VEGETATION CLEARANCE SHALL BE A MINIMUM VERTICAL CLEARANCE OF 2.5m AND A MINIMUM 0.5m HORIZONTAL CLEARANCE.
7. MAXIMUM TRAIL GRADES:
-PREFERRED MAXIMUM 10%
-MAXIMUM 30%
8. MINIMIZE HORIZONTAL CURVES AND ENSURE ADEQUATE SITE LINES ON CORNERS.
9. RESIDENTIAL BUFFER IS THE 1.25m LANDSCAPE/BUFFER ZONE.



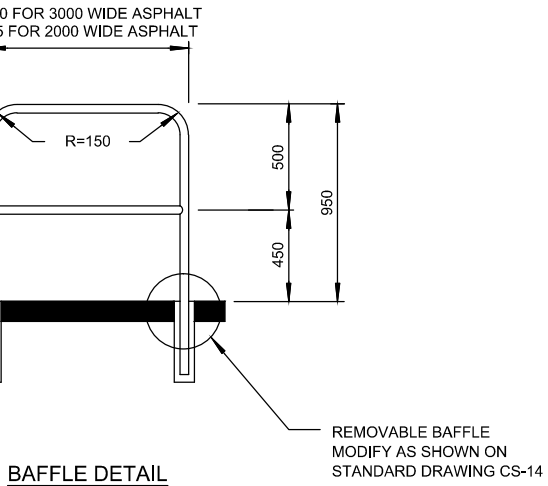
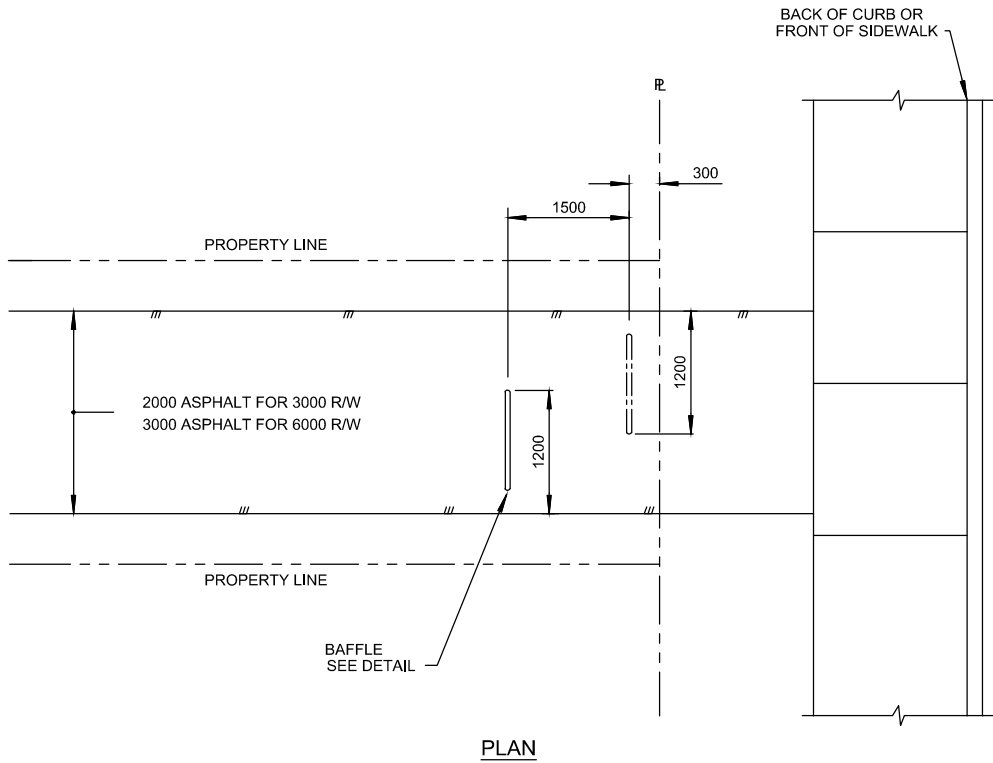
100mm ASPHALT CURB
MACHINE PLACED



75mm ASPHALT CURB
MACHINE PLACED

- NOTES
1. CURBS SHALL BE INSTALLED ON PAVED SURFACES
 2. DROP CURB, 75 HIGH REQUIRED AT ALL DRIVEWAY AND LANE CROSSINGS
 3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.



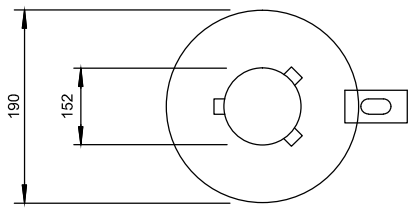


NOTE
 1. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.
 2. NOT FOR USE ON MULTI-USE PATHWAYS

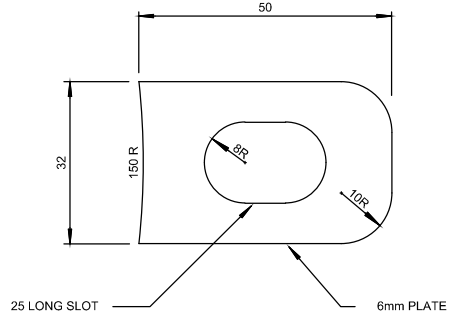


WALKWAY BARRIER

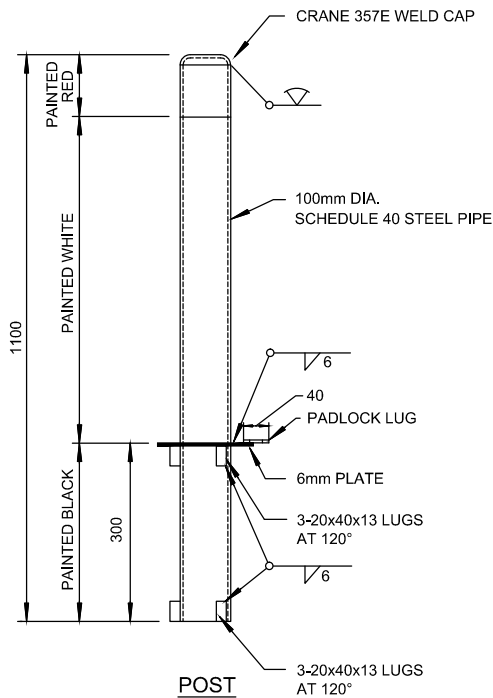
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Created:	SEPT 2012
Rev Date:	NOV 2016
Dwg No:	CS-13



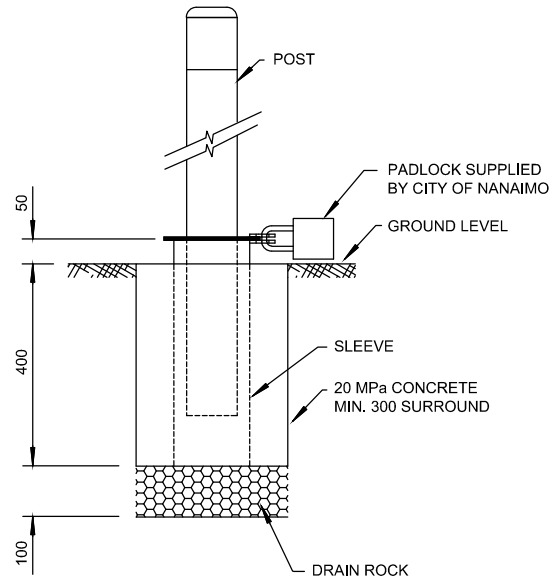
PLAN



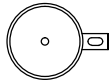
LUGS FOR PADLOCK



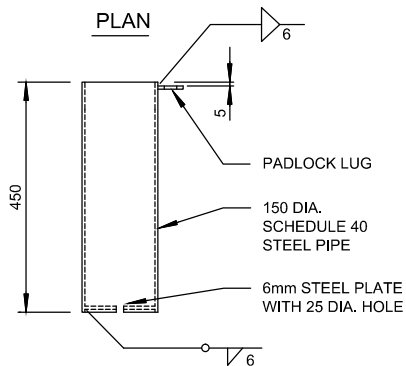
POST



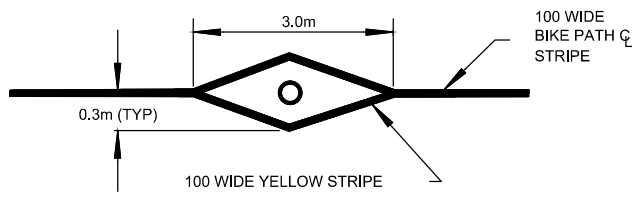
ASSEMBLY



PLAN



SLEEVE



**CENTRE BARRIER POST
PAVEMENT MARKING**

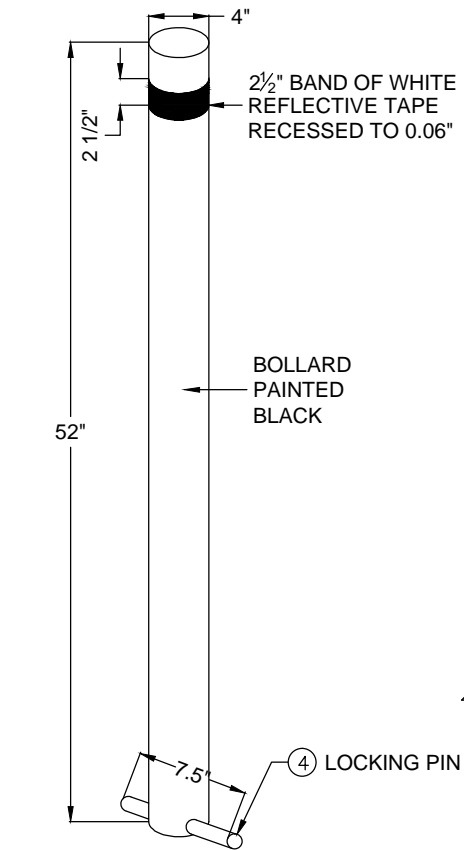
NOTES:

- 1) FOR USE ON MULTI-USE PATHWAYS WHEN NECESSARY TO PREVENT VEHICLE ACCESS.
- 2) REFER TO DESIGN CRITERIA SECTION 8.03.

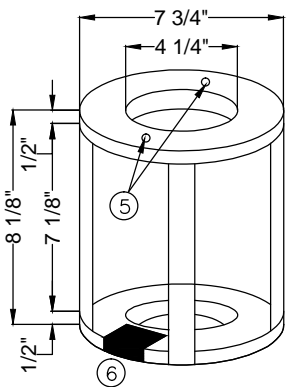


REMOVABLE BARRIER POST

Scale:	N.T.S.
Created:	MAY 2001
Rev Date:	NOV 2016
Dwg No:	CS-14



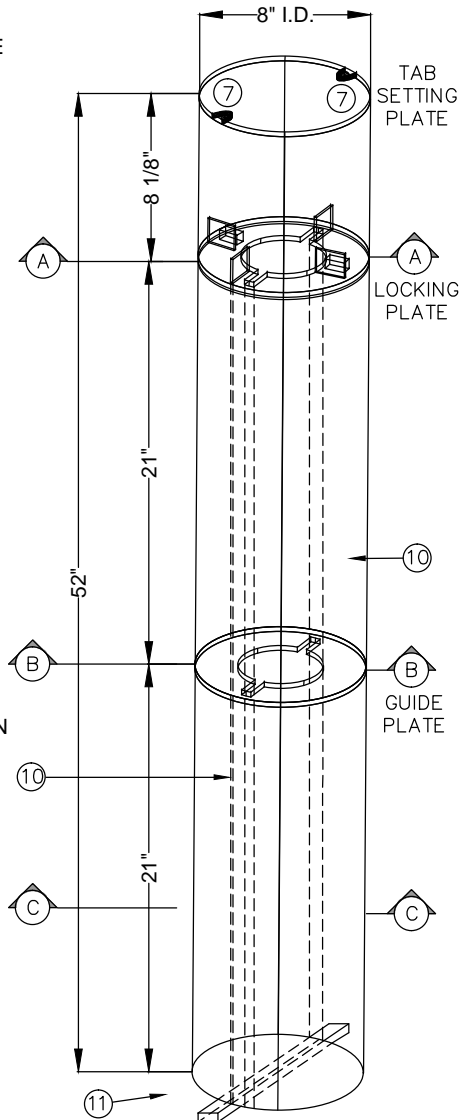
① STREET BOLLARD DETAIL



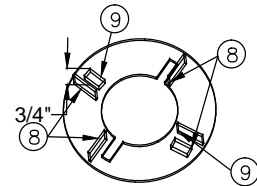
② ALUMINUM GUIDE CASING DETAIL

NOTES:

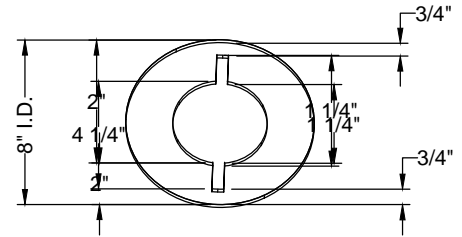
1. IN THE BELOW GRADE POSITION THE BOLLARD SITS AT THE BOTTOM OF THE STEEL BASE
2. IN THE UPRIGHT POSITION THE BOLLARD SITS IN THE ALUMINUM GUIDE CASING LOCKED WITH THE LOCKING PLATES. REFER TO CROSS SECTION A-A.
3. BOLLARDS ARE TO BE SPACED 1.0m ON CENTER AT ENTRANCE TO A FIRE LANE.
4. DIMENSIONS OF LOCKING AND GUIDE PLATES ARE EQUAL C/W TAPPED EDGES AND ARE TO BE 1/4" THICK
5. REFER TO DESIGN CRITERIA SECTION 8.03.



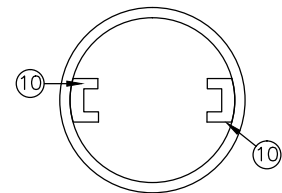
③ STEEL BASE DETAIL



SECTION A-A
LOCKING PLATE DETAIL



SECTION B-B
GUIDE PLATE DETAIL

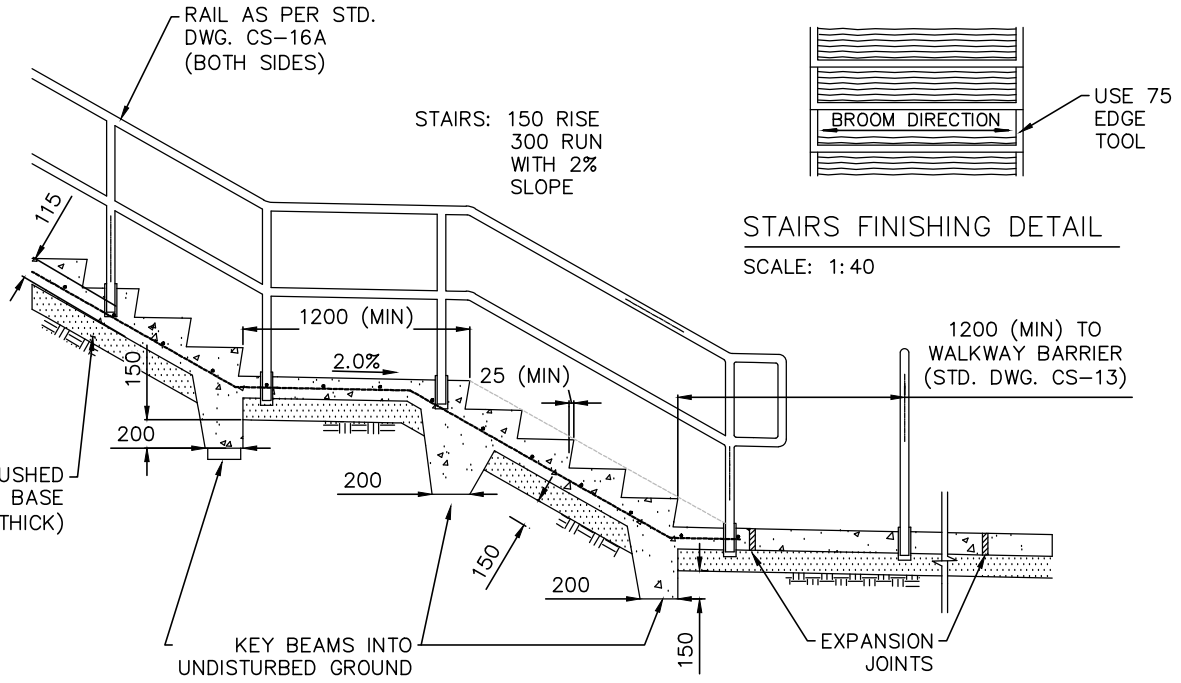


SECTION C-C
CHANNEL GUIDE FOR
LOCKING PIN

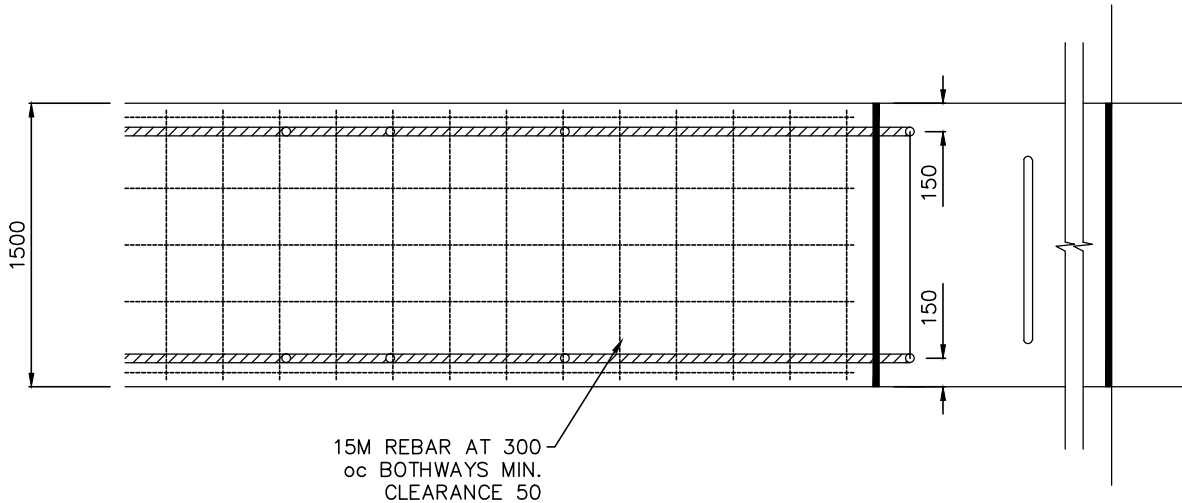
ITEM LIST

- ① STREET BOLLARD DETAIL
- ② ALUMINUM GUIDE CASING DETAIL
- ③ STEEL BASE DETAIL
- ④ 7 1/2" LONG 5/8" Ø ROD DRILLED AND WELDED LOCKING PIN
- ⑤ 5/16" O/S LOCKING HOLES
- ⑥ TAB GUIDE 1 1/2" WIDE X 1" DEEP
- ⑦ TABS 3/4" X 3/4" ARE TO BE SET 1/2" FROM TOP OF STEEL BASE FOR 5/16" Ø SCREWS
- ⑧ 1 1/2" LONG X 1/8" WIDE X 1/4" HIGH LOCKING PLATES (4)
- ⑨ 1" LONG X 1/2" WIDE X 1/2" HIGH LOCKING PLATES (2)
- ⑩ 3/4" X 1" X 42" LONG CHANNEL GUIDE FORMED WITH 14 GAUGE STEEL (2 PCS)
- ⑪ 10" LONG X 2" WIDE X 1/4" HIGH STABILIZING STOP BAR

G:\INFRASTRUCTURE PLANNING\STANDARDS & PRODUCTS\MOESS\EDITION N011\FINAL DRAFT FOR PUBLISHING\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 8 DWGS\CS-16



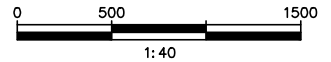
CONCRETE STAIRWAY ELEVATION
SCALE: 1:40



CONCRETE STAIRWAY PLAN
SCALE: 1:40

NOTES:

1. MAXIMUM OF 12 RISERS PER FLIGHT BETWEEN LANDINGS.
2. MAXIMUM WALKWAY GRADIENT IS 12%.
3. FOR CONCRETE MIX DESIGN CRITERIA REFER TO SECTION 8.
4. REINFORCING BARS TO CSA G30.18 GRADE 400.
5. FOR HANDRAIL DETAILS SEE STD. DWG CS-16A.
6. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

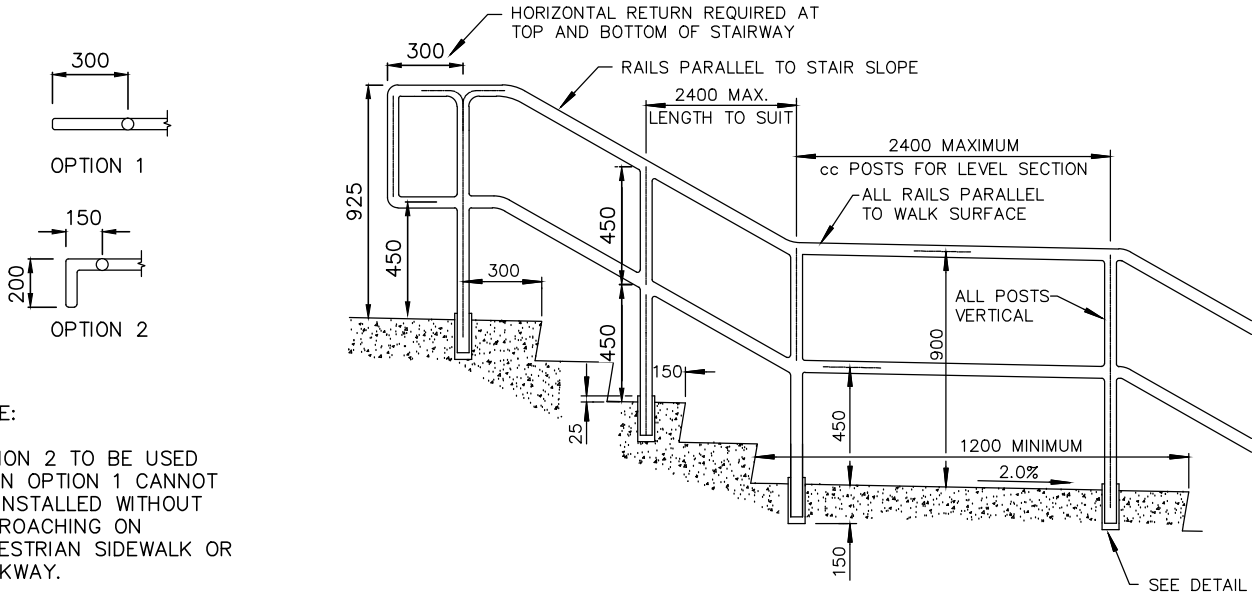


6.16.2016



CONCRETE STAIRWAY
AND LANDING

Scale: 1:40
Created: NOV 2016
Rev Date: NOV 2016
Dwg No: CS-16



NOTE:

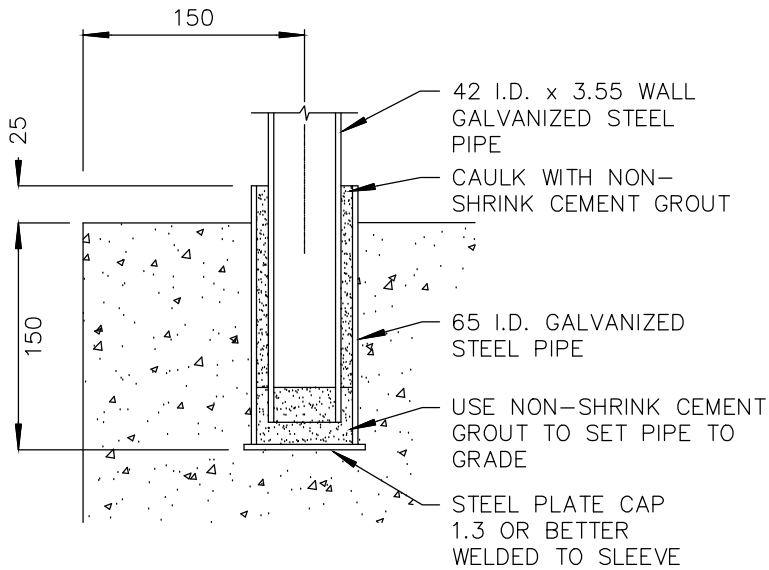
OPTION 2 TO BE USED WHEN OPTION 1 CANNOT BE INSTALLED WITHOUT ENCROACHING ON PEDESTRIAN SIDEWALK OR WALKWAY.

HANDRAIL END PLAN VIEW
OPTIONS 1 & 2

SCALE: 1:30

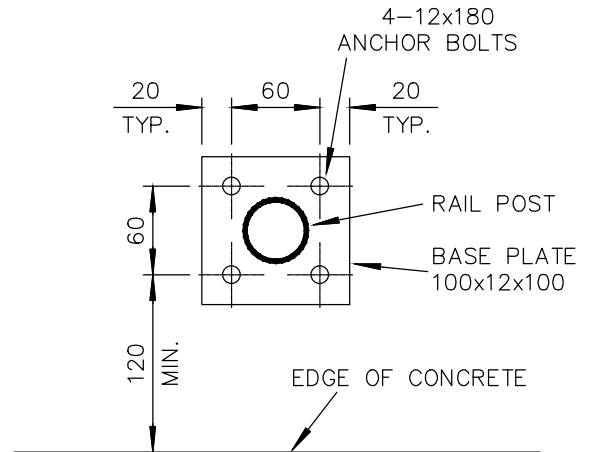
TYPICAL HANDRAIL FOR STAIRWAY

SCALE: 1:30



EMBEDDED MOUNTING

SCALE: 1:5

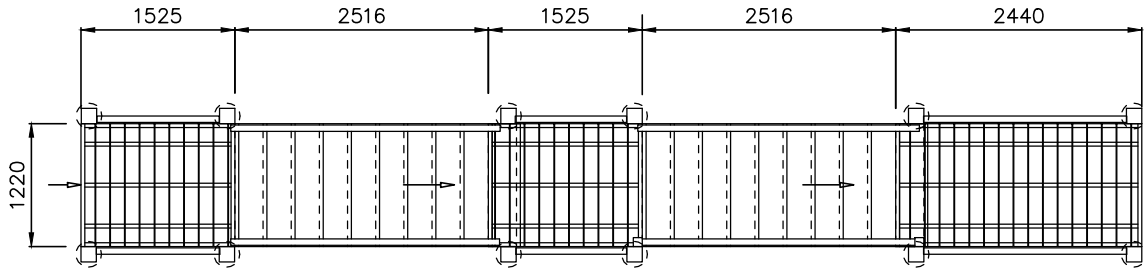


ATTACHED MOUNTING

SCALE: 1:5

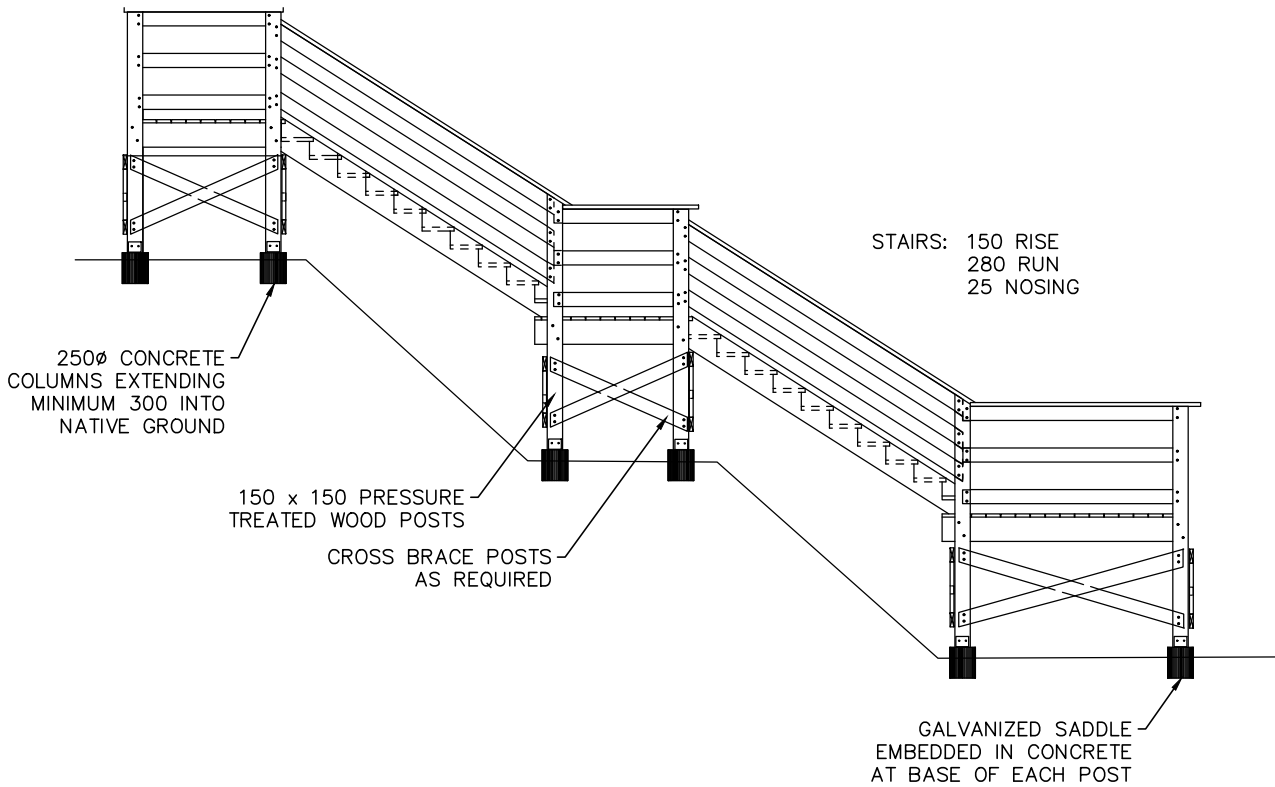
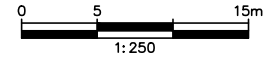
NOTES:

1. ALL HANDRAILS SHALL BE FABRICATED FROM 42 I.D. x 3.55 WALL STEEL PIPE.
2. ALL JOINTS SHALL BE MITRED, WELDED ALL AROUND AND FILED SMOOTH.
3. ALL BENDS SHALL BE SMOOTH CIRCULAR CURVES.
4. ALL COMPONENTS SHALL BE HOT-DIP GALVANIZED AFTER FABRICATION TO CSA - 6164.
5. HANDRAILS REQUIRED ON BOTH SIDES OF STAIRWAY.
6. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.



WOODEN STAIRWAY PLAN

SCALE: 1:100

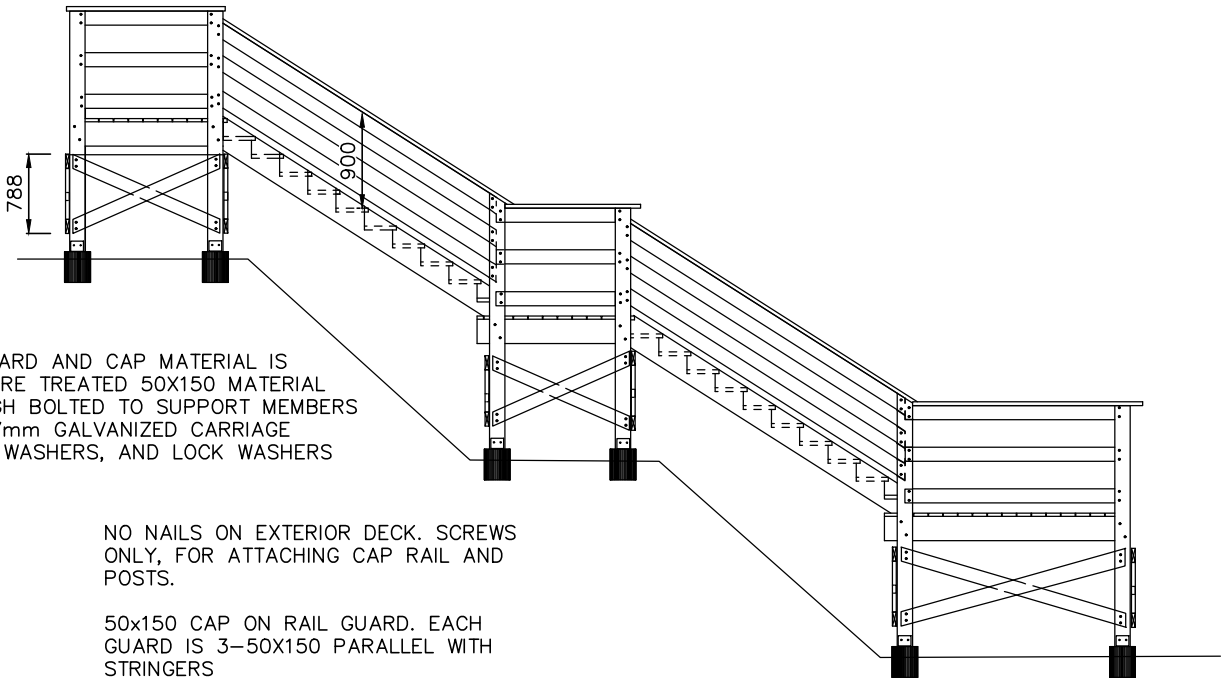


WOODEN STAIRWAY ELEVATION

SCALE: NTS

NOTES:

1. ALL JOISTS PRESSURE TREATED.
2. VEGETATION CLEARANCE TO BE 0.5m MINIMUM HORIZONTAL AND 2.0m VERTICAL.
3. ENSURE ADEQUATE SIGHTLINES ON CORNERS.
4. RESIDENTIAL BUFFER TO BE 5.0m.
5. REFER TO CITY OF NANAIMO – TRAIL PLAN – DESIGN GUIDELINES (MAY 2007) FOR ADDITIONAL DESIGN INFORMATION.
6. FOR HANDRAIL DETAILS REFER TO STD. DWG. CS-17A
7. STRUCTURAL CERTIFICATION REQUIRED WITH STAIR DESIGN SUBMISSION.



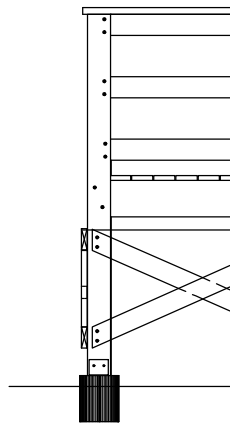
ALL GUARD AND CAP MATERIAL IS PRESSURE TREATED 50X150 MATERIAL THROUGH BOLTED TO SUPPORT MEMBERS BY 12.7mm GALVANIZED CARRIAGE BOLTS, WASHERS, AND LOCK WASHERS

NO NAILS ON EXTERIOR DECK. SCREWS ONLY, FOR ATTACHING CAP RAIL AND POSTS.

50x150 CAP ON RAIL GUARD. EACH GUARD IS 3-50X150 PARALLEL WITH STRINGERS

WOODEN STAIRWAY ELEVATION

SCALE: 1:75



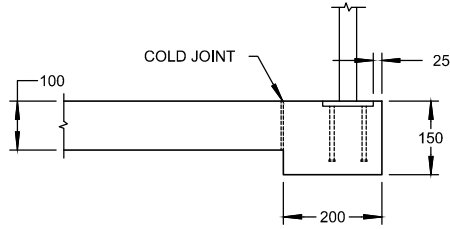
2 (5X300) SEMI HOUSED STRINGERS
 GLUED WITH PL 400 GLUE AND 75MM ELECTROPLATED SCREWS
 CENTER STRINGER FOR STAIRS OVER 900 WIDTH
 50x150 CAP RAIL ON GUARD

EACH GUARD IS 3 50x150 PARALLEL WITH STRINGERS

GRIP SPANNING
 METAL THREADS MAY BE USED IN AREAS THAT ARE HEAVILY
 TREED AND PRONE TO SLIPPAGE

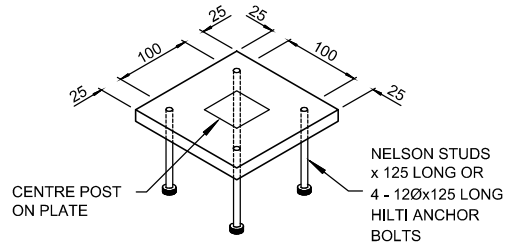
NOTES:

1. ALL HANDRAILS TO BE CONSTRUCTED AS SHOWN.
2. HANDRAILS REQUIRED ON BOTH SIDES OF STAIRWAY.
3. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.



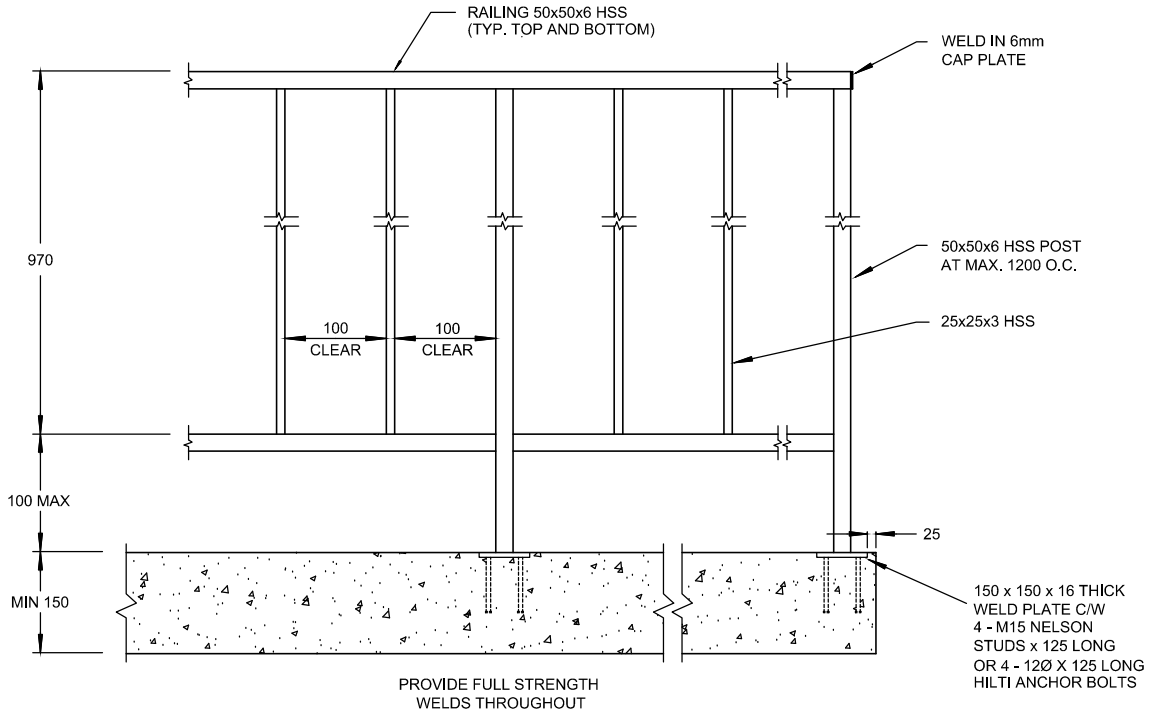
**DETAIL FOR LOCATIONS WITH
100mm THICK SIDEWALK ADJACENT**

NTS



**DETAIL- WELD PLATE
FOR RAILING POST**

NTS

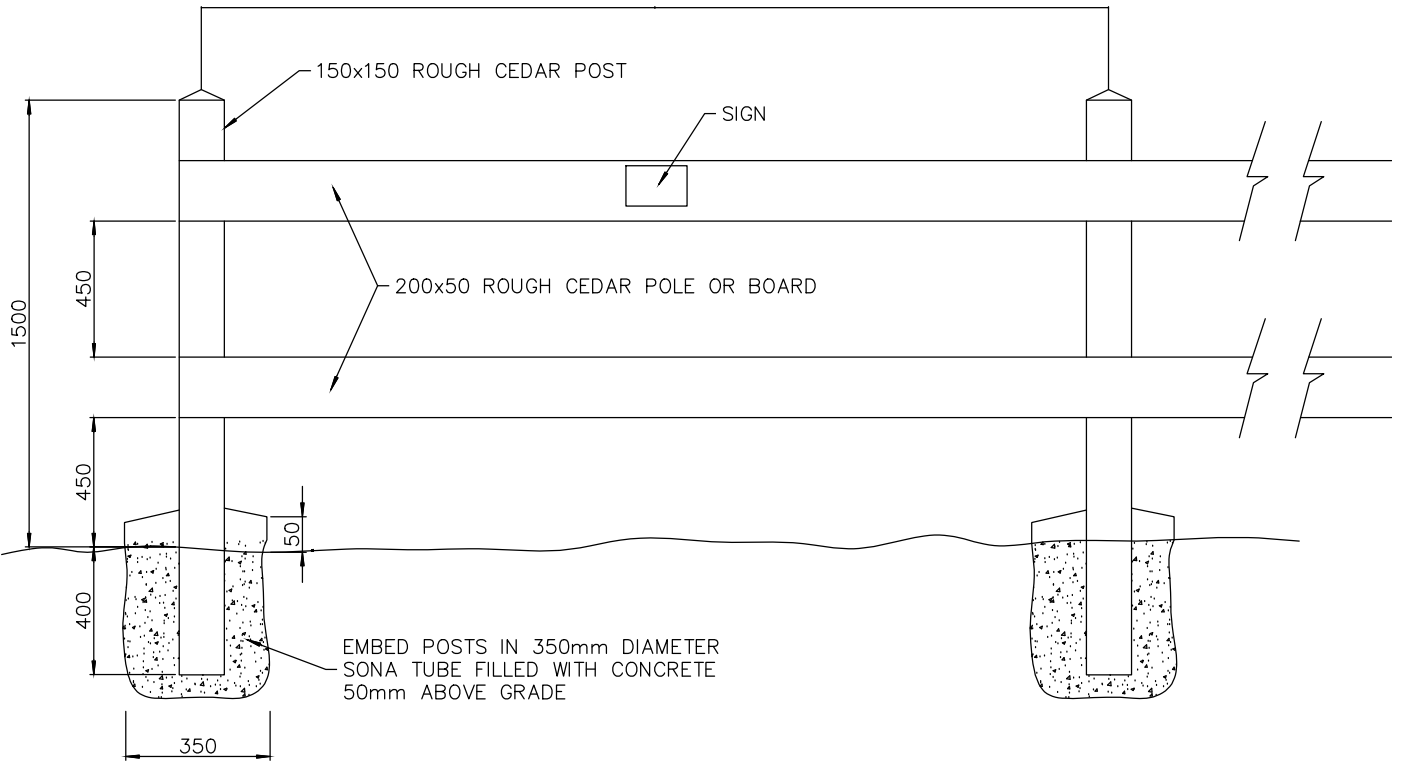


ELEVATION OF RAILING

NTS

NOTES:

1. SUPPLY, FABRICATION, ERECTION, STRUCTURAL DESIGN AND DETAILING OF ALL MISCELLANEOUS STEEL ARE TO BE IN ACCORDANCE WITH CSA S16.
2. ALL WELDING IS TO CONFORM TO CSA W59 AND TO BE PERFORMED ONLY BY FABRICATION SHOPS APPROVED BY THE CANADIAN WELDING BUREAU TO CSA W47.1 FOR DIVISION 1 OR 2 REQUIREMENTS. PROVIDE FULL STRENGTH WELDS AND ALL WELDS ARE TO BE CONTINUOUS FOR THE LENGTH OF EACH JOINT. GRIND AND FILE WELDS SMOOTH AND FLUSH.
3. ALL STEEL IS TO CONFORM TO THE REQUIREMENTS OF THE FOLLOWING STANDARDS:
 - 1) ROLLED SECTIONS AND PLATE: CAN/CSA-G40.21, GRADE 300W.
 - 2) HSS SECTIONS: CAN/CSA-G40.21, GRADE 350W, CLASS C OR CLASS H.
 - 3) WELDING ELECTRODES: CSA W48 SERIES AND APPLICABLE AWS-A5 SERIES.
4. ALL STEEL IS TO BE HOT DIPPED GALVANIZED WITH ZINC COATING OF 600 GRAMS PER SQUARE METRE TO CSA G164 STANDARDS.
5. DAMAGED SURFACES SHALL BE THOROUGHLY CLEANED AND PAINTED WITH 2 COATS OF ORGANIC ZINC RICH PAINT.
6. ALUMINUM MAY BE SUBSTITUTED IN PLACE OF STEEL AS AN ALTERNATE.

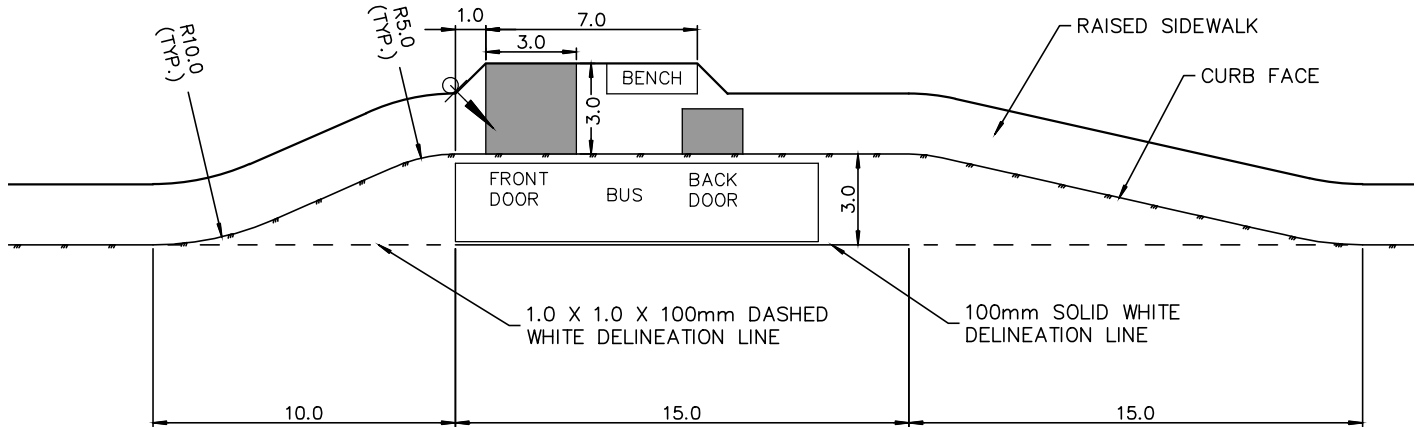


NOTES:

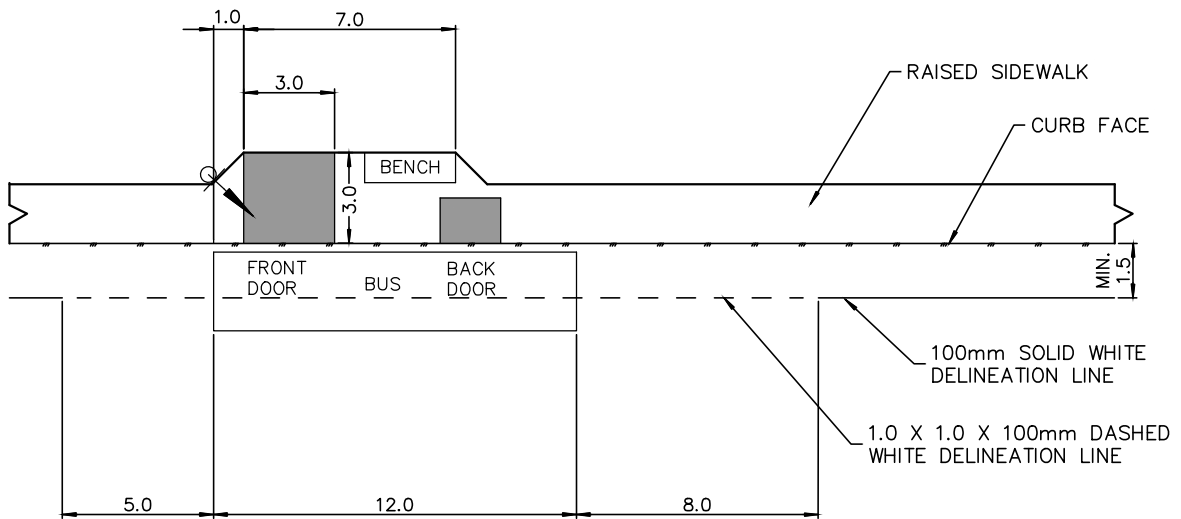
1. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
2. TO BE INSTALLED AT EDGE OF SLOPE, 0.5M FROM EDGE OF PATHWAY
3. WHEN INSTALLED AS AN AQUATIC SETBACK FENCE, THE FOLLOWING MUST BE COMPLETED:
 - A) TO BE INSTALLED AT THE EDGE OF ALL AQUATIC SETBACK BOUNDARIES TO ENSURE THE SETBACK IS DELINIATED.
 - B) SIGN TO BE MOUNTED TO FENCE TO ENSURE THE SETBACK AREA IS PROTECTED.
 - C) SIGN TO BE INSTALL AT THE REAR OF EVERY LOT BACKING ONTO THE SETBACK AREA OR AT A 30m SPACING.



ENVIRONMENTALLY PROTECTED AREA SIGN



BUS PULLOUT AT RAISED SIDEWALK



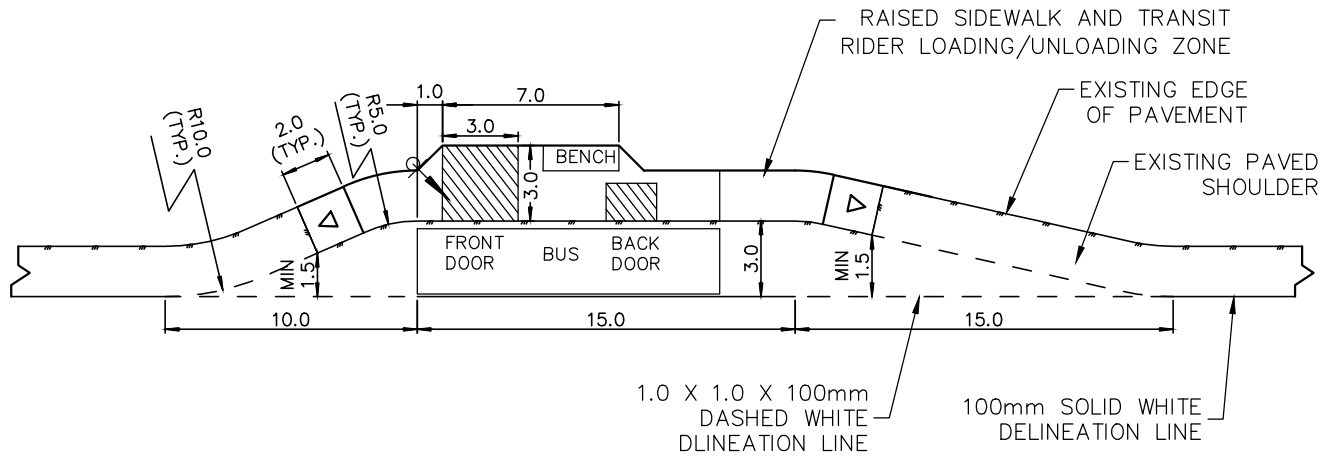
BUS STOP AT RAISED SIDEWALK

NOTES:

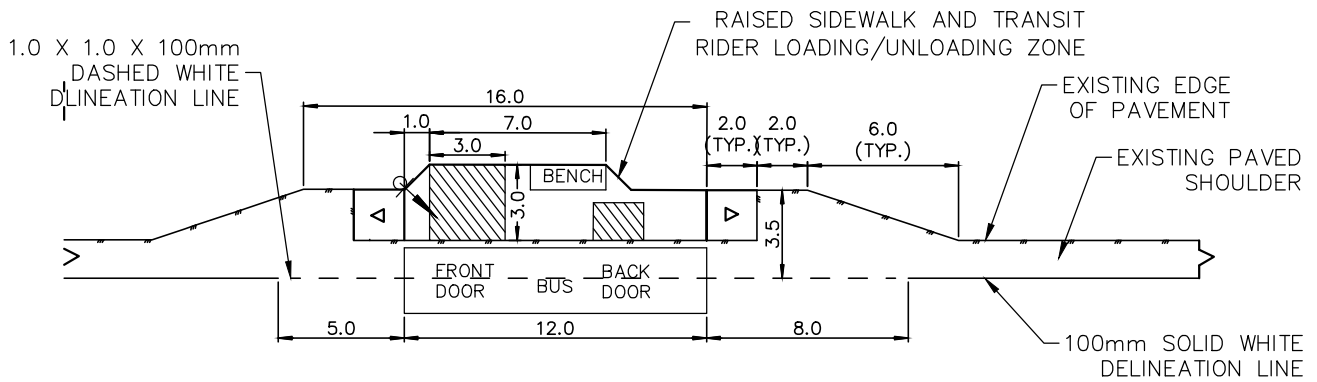


TRANSIT RIDER LOADING/UNLOADING ZONE; KEEP FREE OF OBSTACLES

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE NOTED.



BUS PULLOUT WITH PAVED SHOULDER AND RAISED PAD



BUS STOP WITH PAVED SHOULDER AND RAISED PAD

NOTES:

 TRANSIT RIDER LOADING/UNLOADING ZONE; KEEP FREE OF OBSTACLES

1. ALL DIMENSIONS ARE IN METERS UNLESS OTHERWISE NOTED.

SECTION 8 - CURBS AND SIDEWALKS

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT

Curbs	8.70
Cutting and Removal of Existing Asphaltic and Concrete Sidewalk Pavement	8.71

SECTION 8 - CURBS AND SIDEWALKS

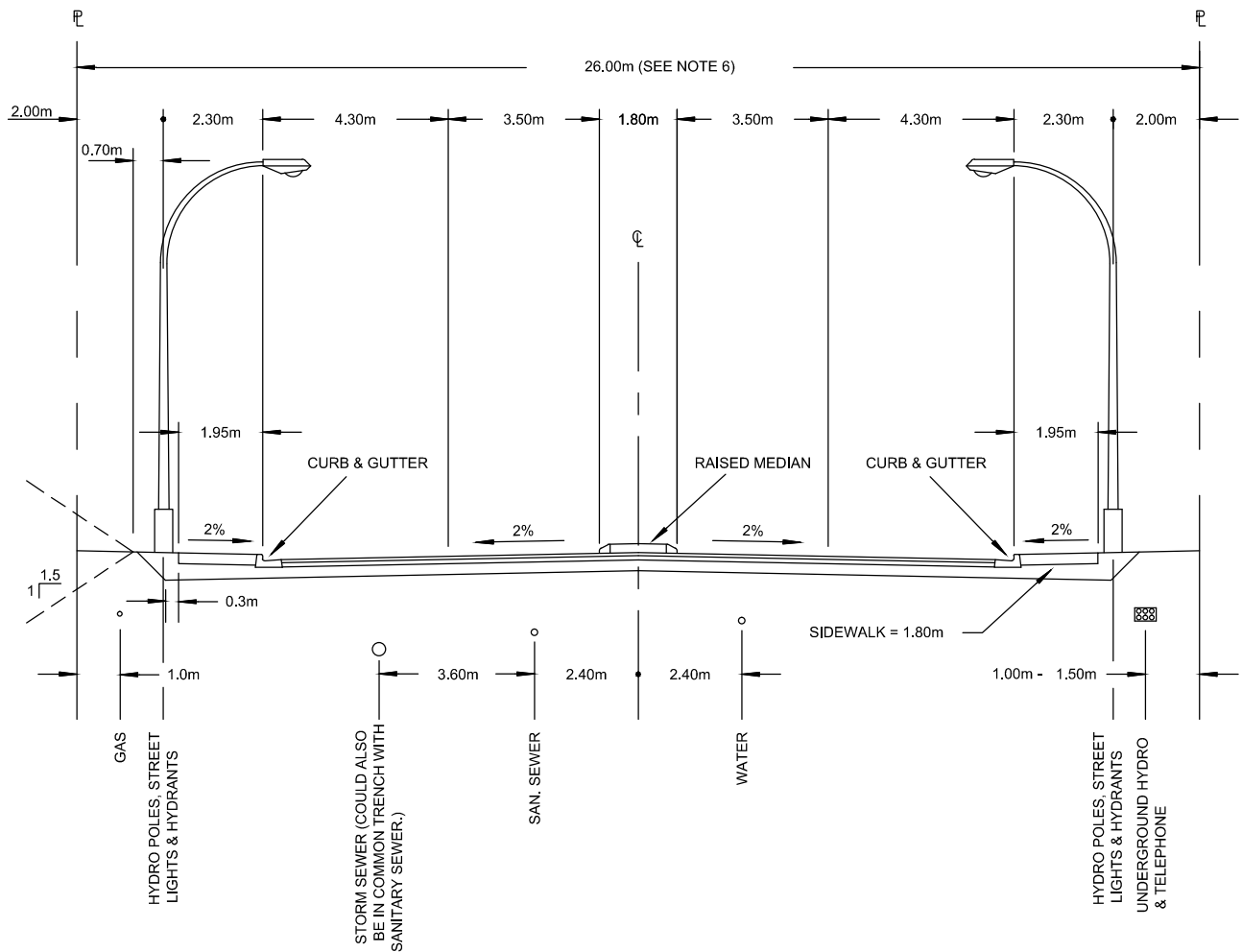
MEASUREMENT AND PAYMENT

8.70 CURBS Section 8.20.1

Payment for curbs will be made at the unit price per linear metre per curb type shown in the Tender Form. Linear measurement will be made along the centreline of the curbs. This price shall include materials, base preparation, forming, jointing, reinforcing, finishing, curing, driveway letdowns, curb and all work incidental to the completed installation. Payment for granular base materials will be made at the unit price per material type shown in the Tender Form.

8.71 CUTTING AND REMOVAL OF EXISTING ASPHALTIC AND CONCRETE SIDEWALK PAVEMENT Section 8.42

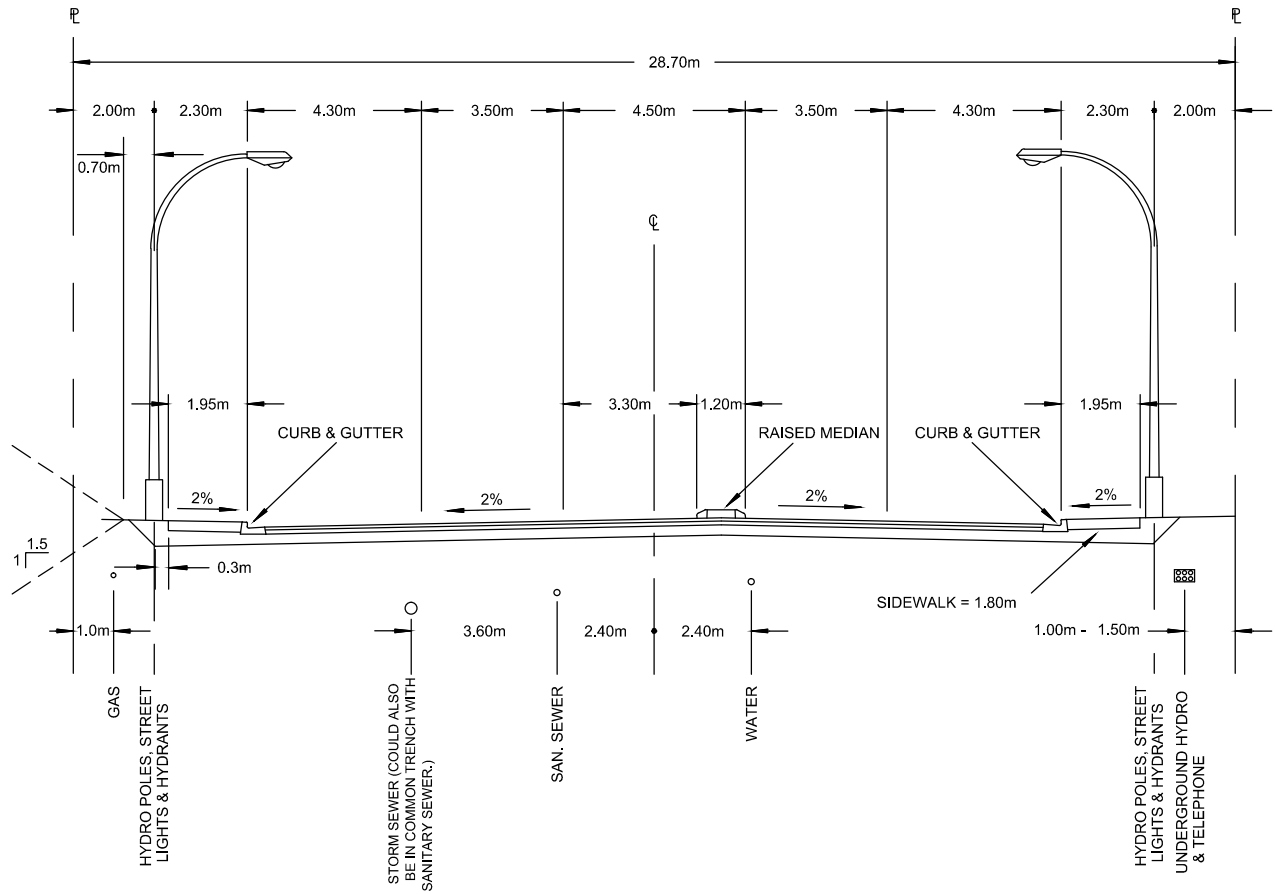
- (a) Payment for cutting of existing asphaltic and concrete sidewalk pavement will be made at the unit price per linear metre of sidewalk cut, regardless of thickness, shown in the Tender Form.
- (b) Payment for removal of existing asphaltic and concrete sidewalk pavement will be made at the unit price per square metre of pavement and sidewalk removed including the adjacent asphalt curb, regardless of thickness, shown in the Tender Form. This price shall include loading, hauling, and disposal of all unwanted material.



NOTES:

1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.
6. HIGH VOLUME URBAN ARTERIALS SHALL HAVE A MINIMUM RIGHTS-OF-WAY WIDTH OF 28.7m TO ACCOMMODATE TURNING LANES AT MAJOR INTERSECTIONS IN ACCORDANCE WITH STANDARD DWG. R1-XS2 URBAN ARTERIAL (FIVE LANES)

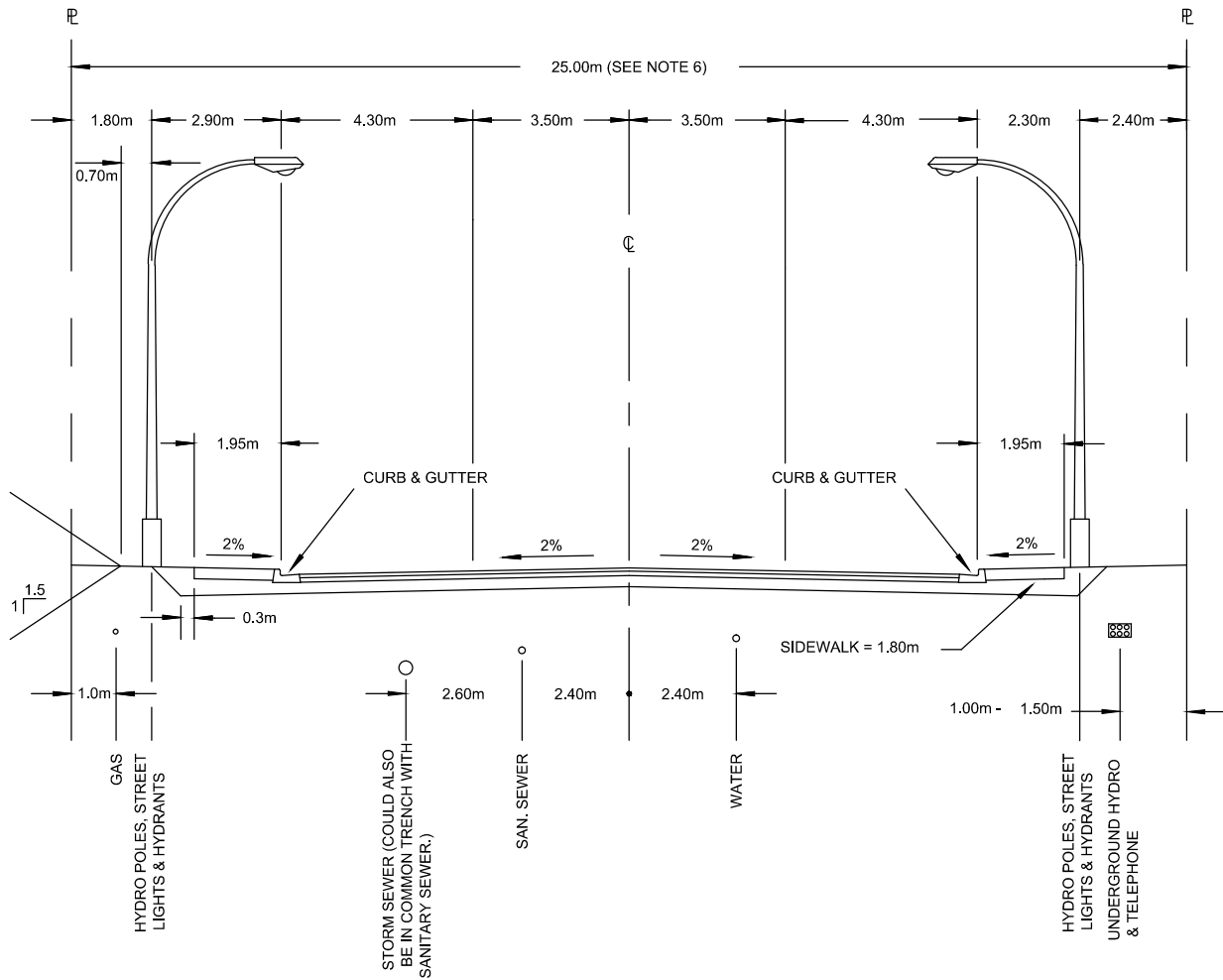




NOTES:

1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.





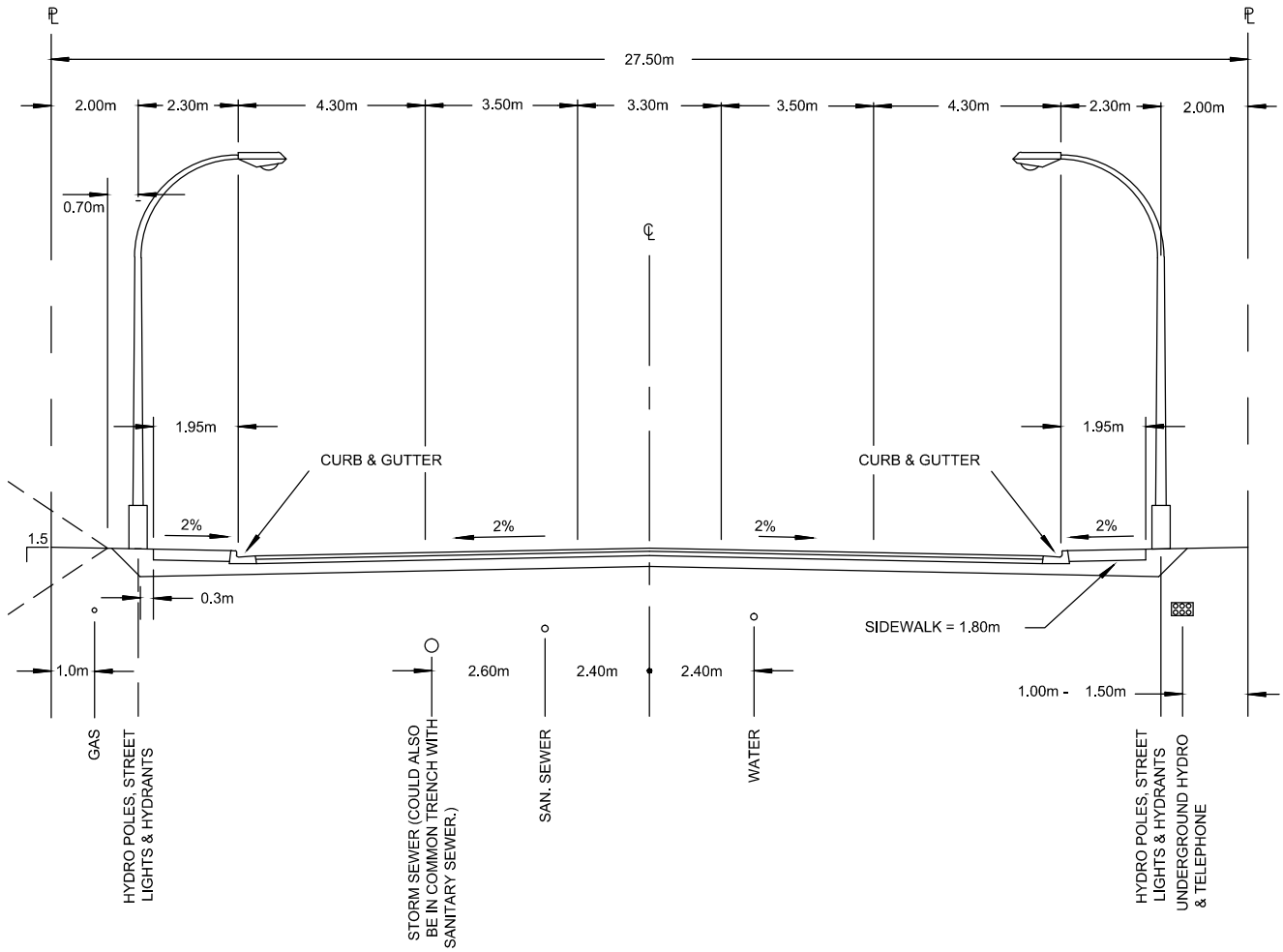
NOTES:

1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.
6. HIGH VOLUME URBAN COLLECTORS SHALL HAVE A MINIMUM RIGHT-OF-WAY WIDTH OF 27.5m TO ACCOMMODATE TURNING LANES AT MAJOR INTERSECTIONS. AS PER R2-XS2 MAJOR COLLECTOR (5 LANES)



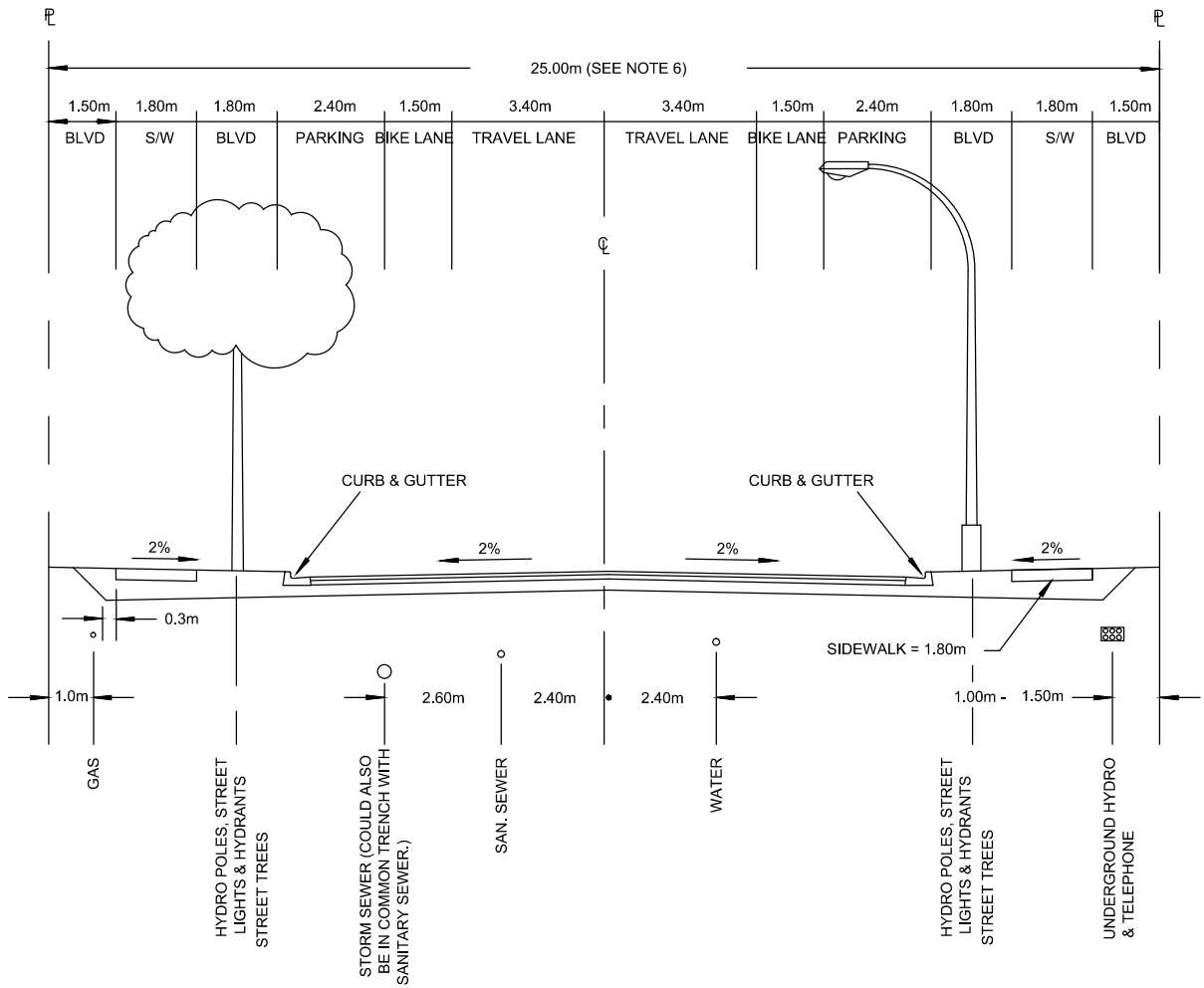
**MAJOR COLLECTOR
(FOUR LANES)**

Scale:	N.T.S.
Created:	MAY 2013
Rev Date:	NOV 2016
Dwg No:	R2-XS1



NOTES:

1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.



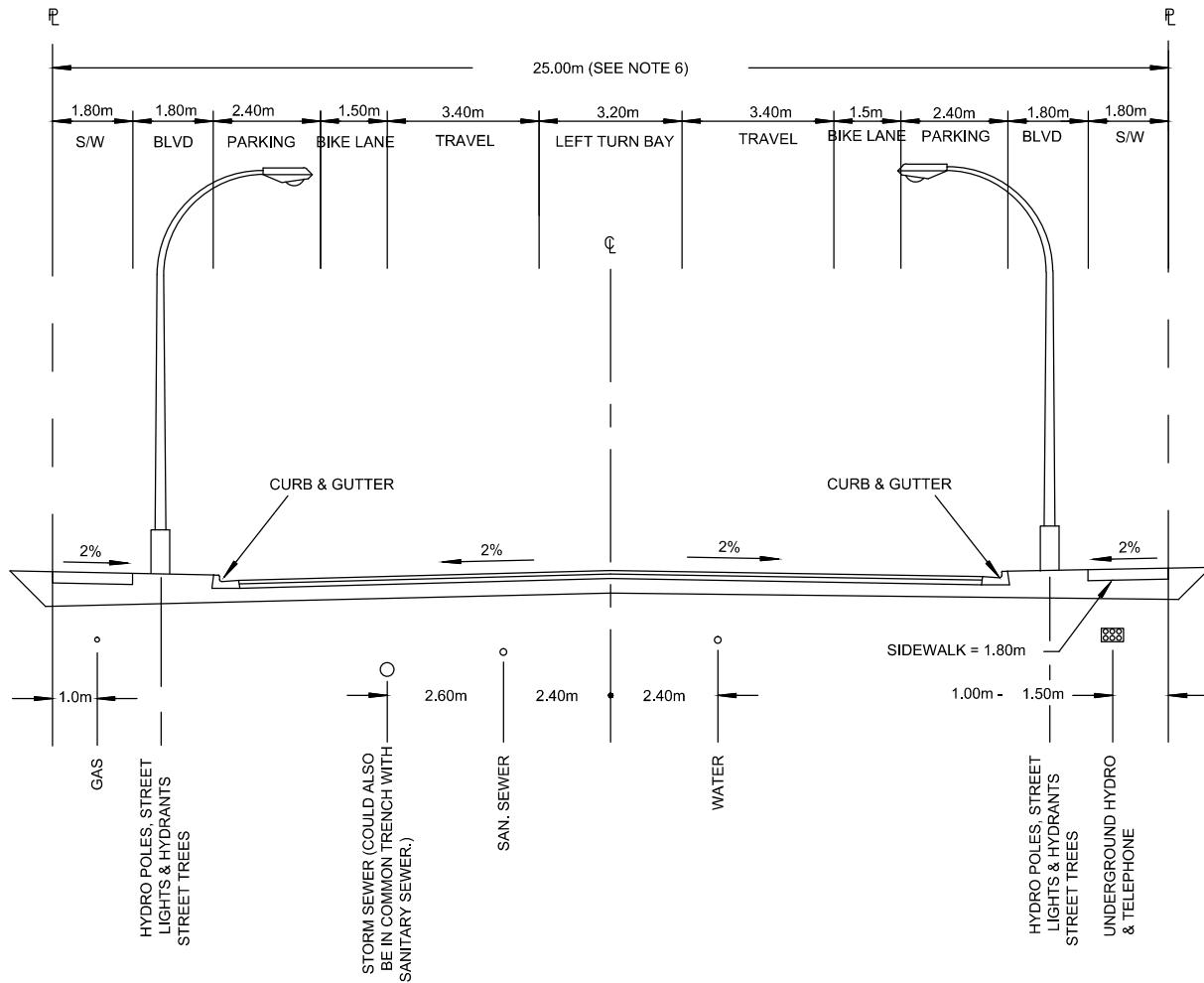
NOTES:

1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.
6. HIGH VOLUME URBAN COLLECTORS SHALL BE IN ACCORDANCE WITH STANDARD DWG. R2-XS1 MAJOR COLLECTOR (FOUR LANES)



**MINOR COLLECTOR
(TWO LANES)**

Scale:	N.T.S.
Created:	MAY 2013
Rev Date:	NOV 2016
Dwg No:	R3-XS1



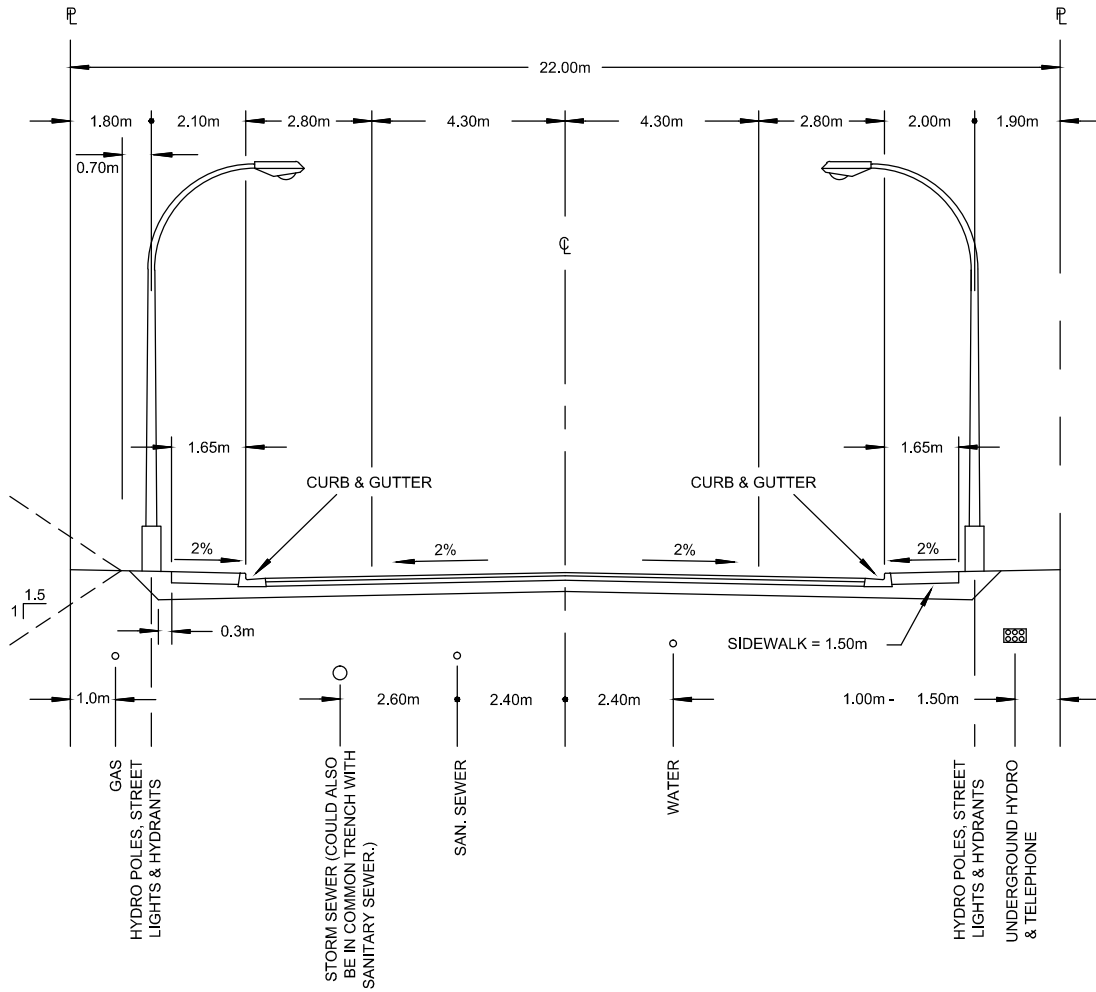
NOTES:

1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.
6. HIGH VOLUME URBAN COLLECTORS SHALL BE IN ACCORDANCE WITH STANDARD DWG, R2-XS1 MAJOR COLLECTOR (FOUR LANES)



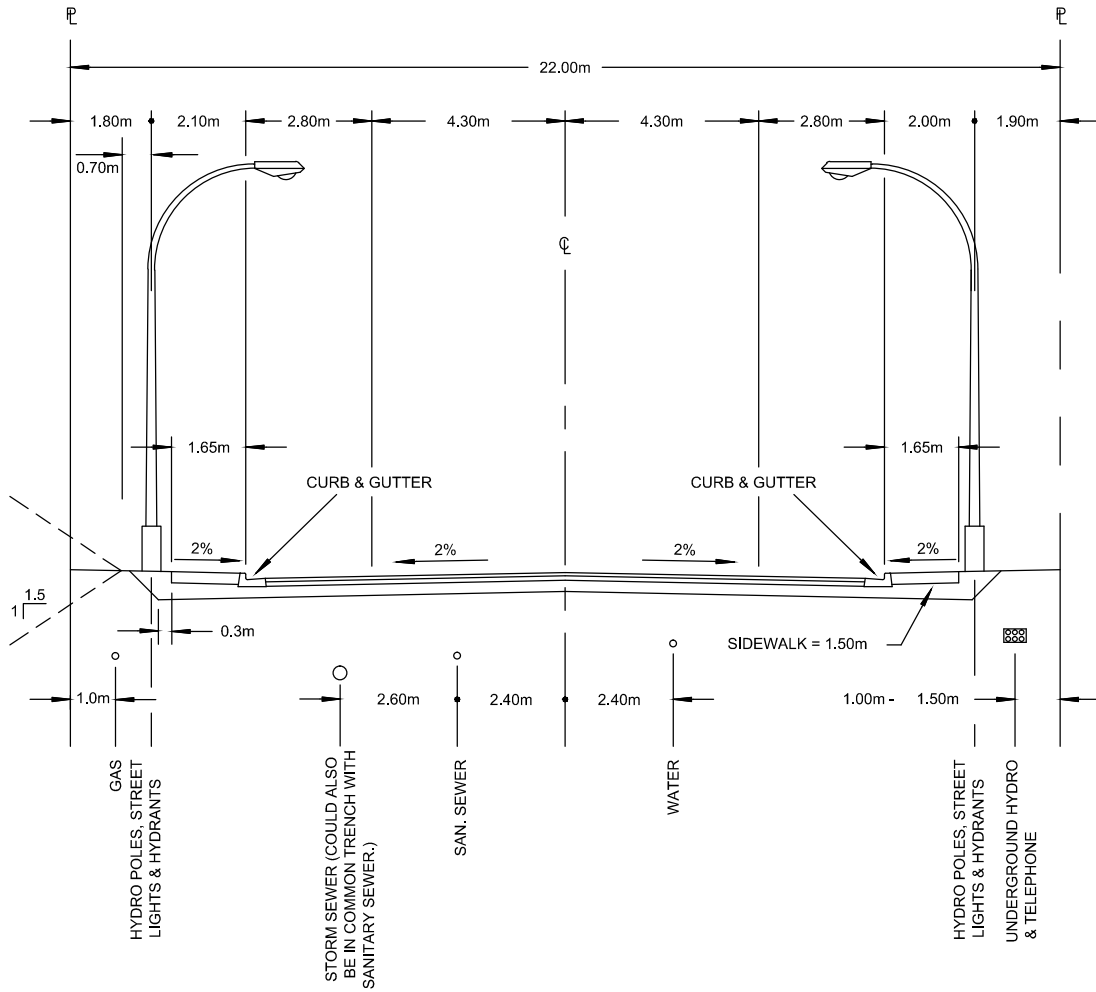
MINOR COLLECTOR
(TWO LANES, TURN LANE)

Scale:	N.T.S.
Created:	MAY 2013
Rev Date:	NOV 2016
Dwg No:	R3-XS2



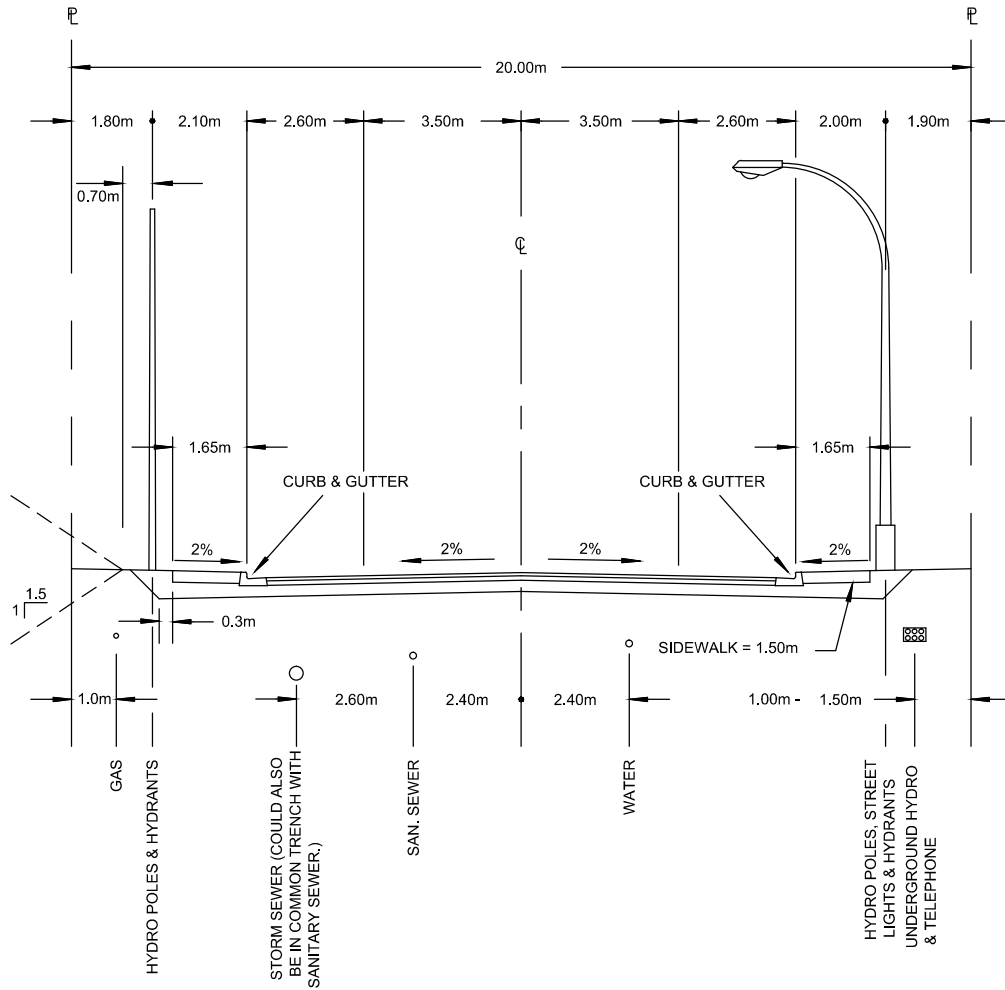
NOTES:

1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.



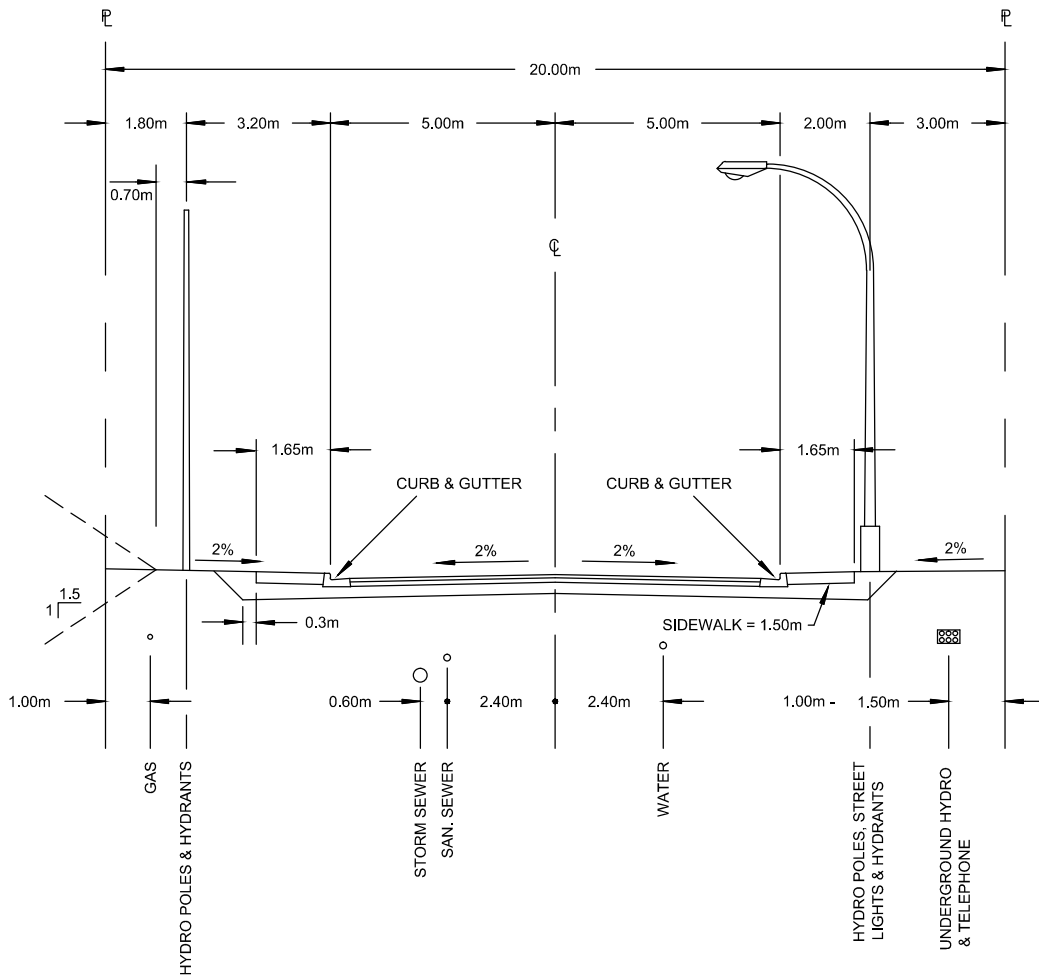
NOTES:

1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.



NOTES:

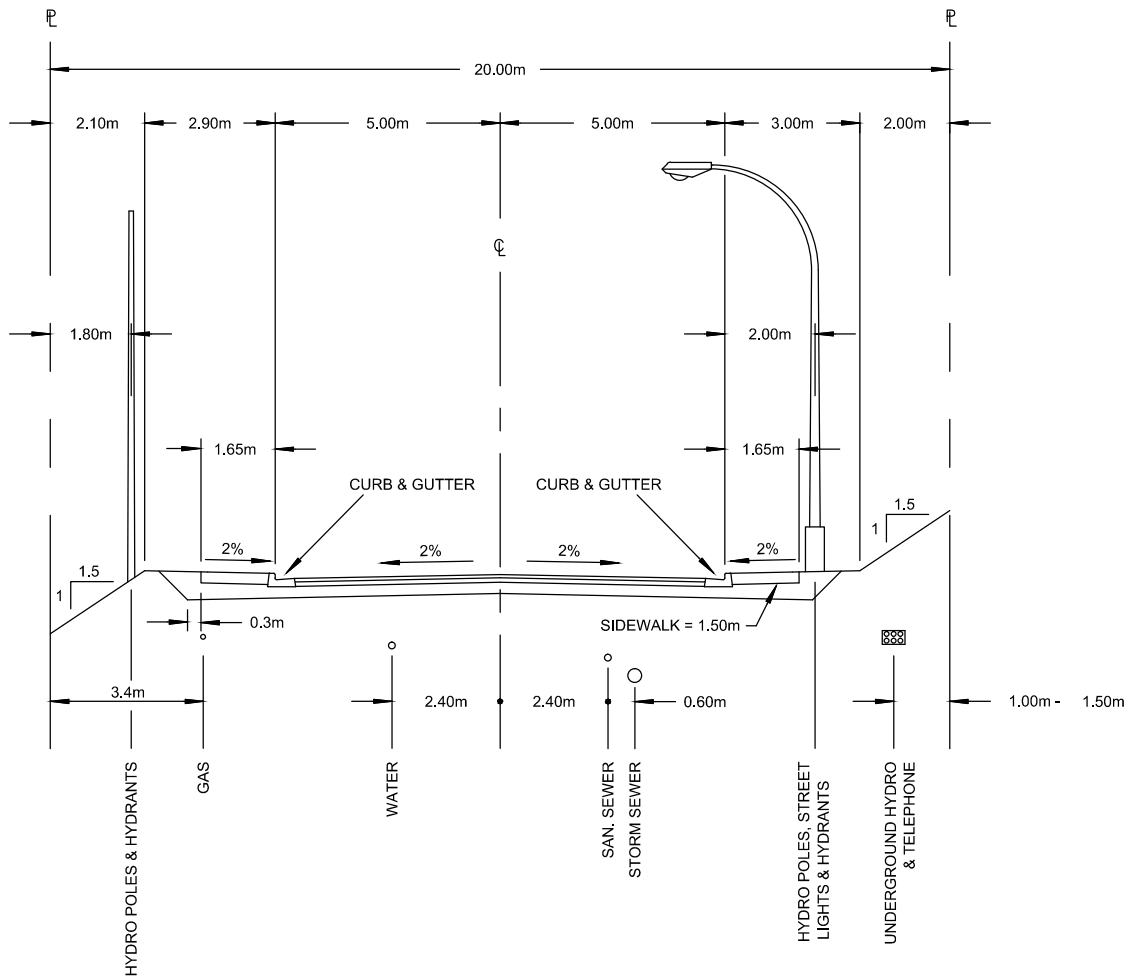
1. PAVED SURFACE - 75mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.



NOTES:

1. PAVED SURFACE - 50mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.

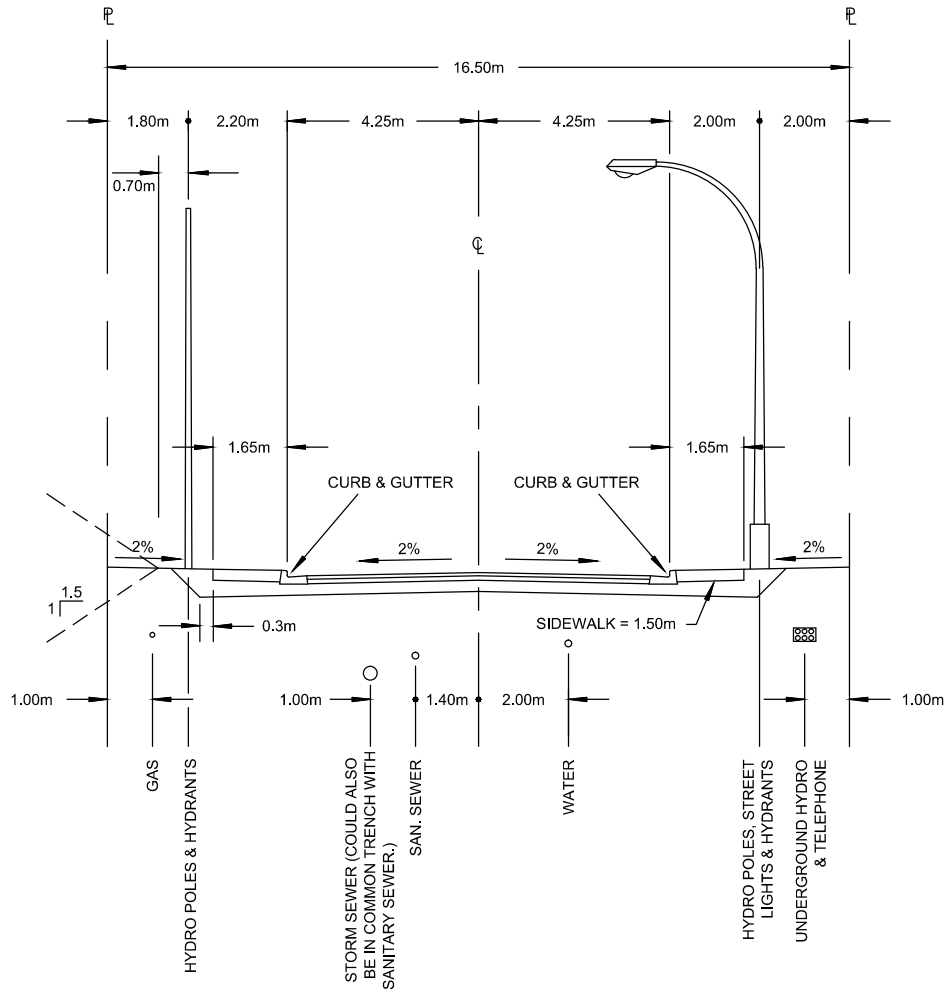




NOTES:

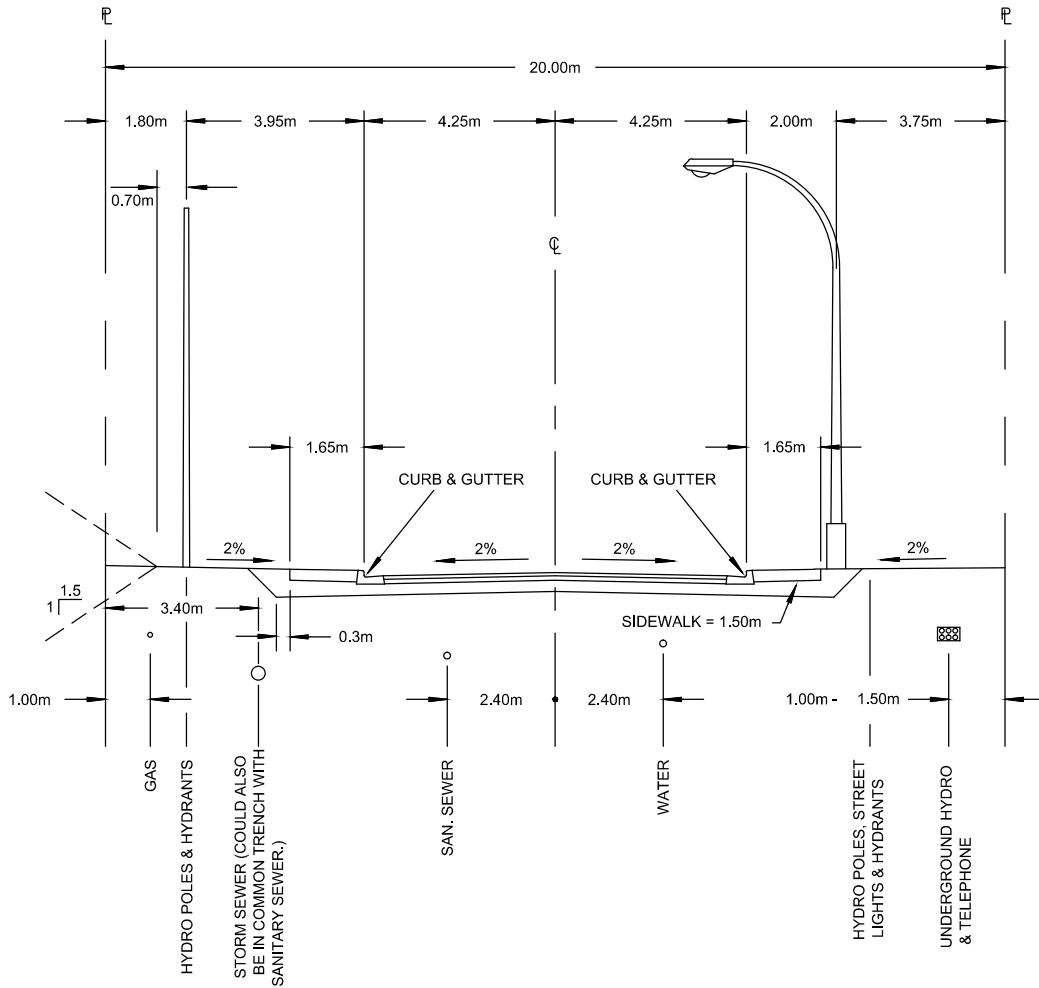
1. PAVED SURFACE - 50mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.





NOTES:

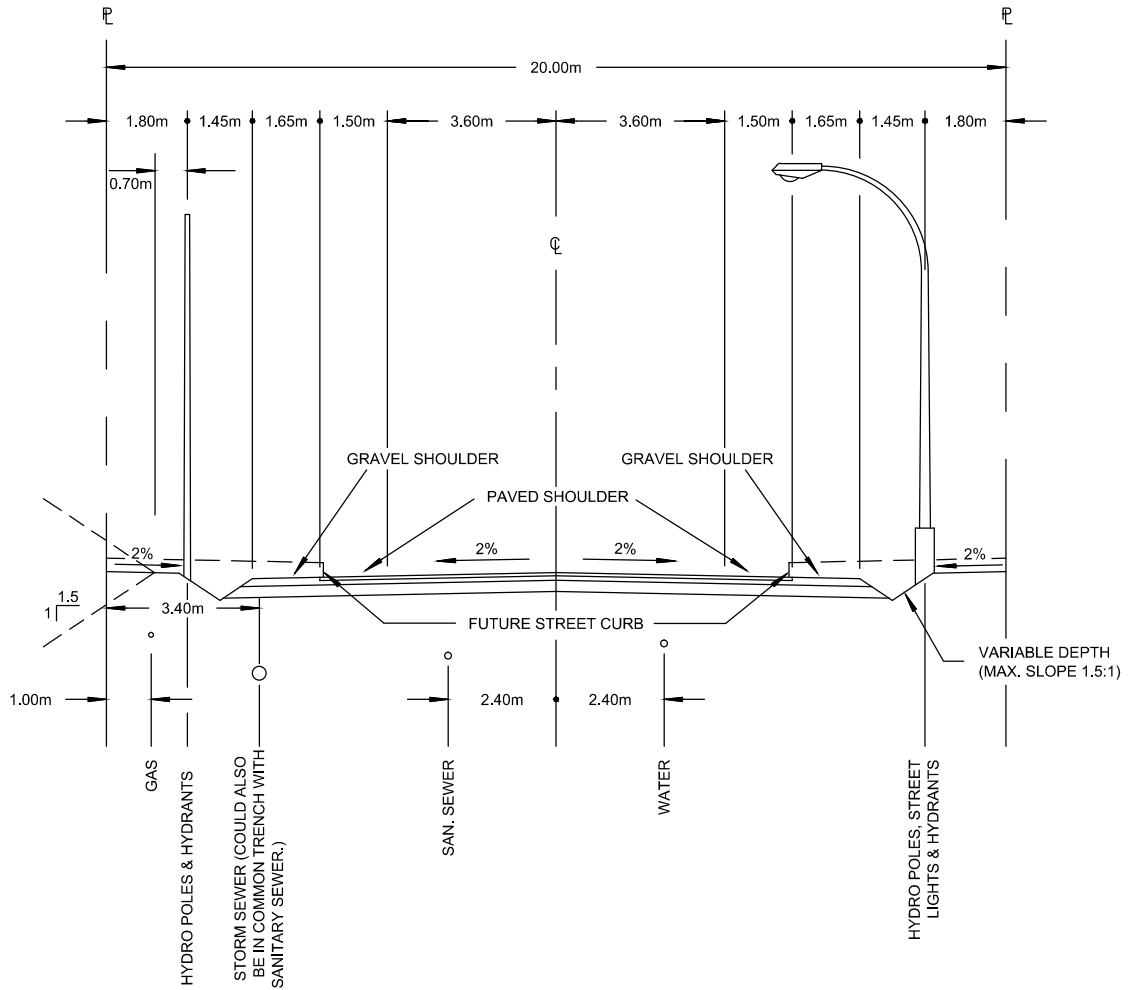
1. PAVED SURFACE - 50mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.



NOTES:

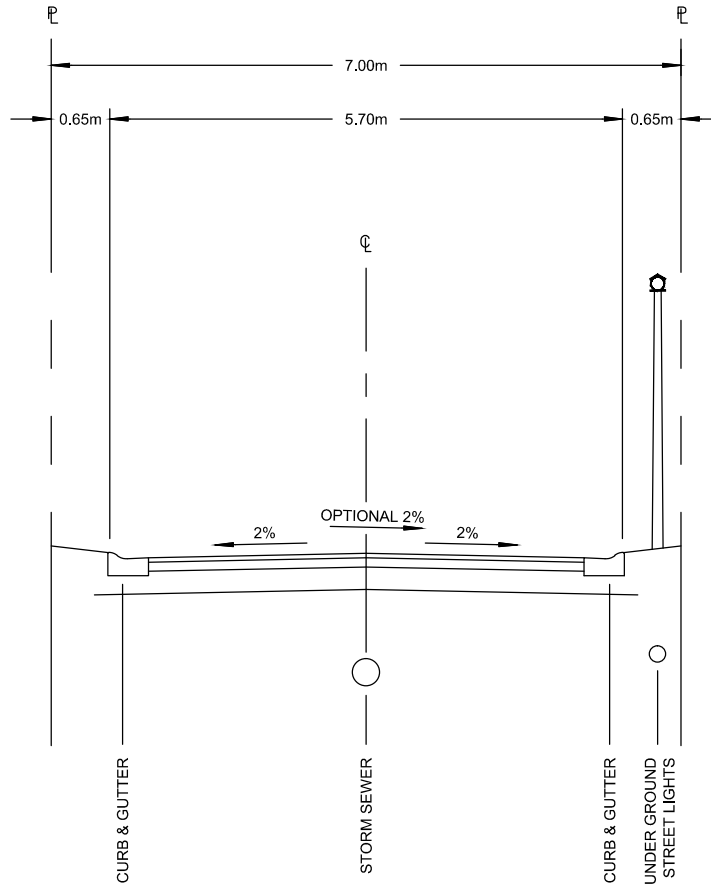
1. PAVED SURFACE - 50mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-1.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.
6. THIS STANDARD APPLIES TO URBAN LOCAL (LOW VOLUME) ROADS CONSTRUCTED IN EXISTING 20.0m RIGHTS-OF-WAYS OR IN HILLSIDE SITUATIONS WHERE ADDITIONAL RIGHTS-OF-WAY WIDTH IS REQUIRED TO ACCOMMODATE CUTS AND FILLS.





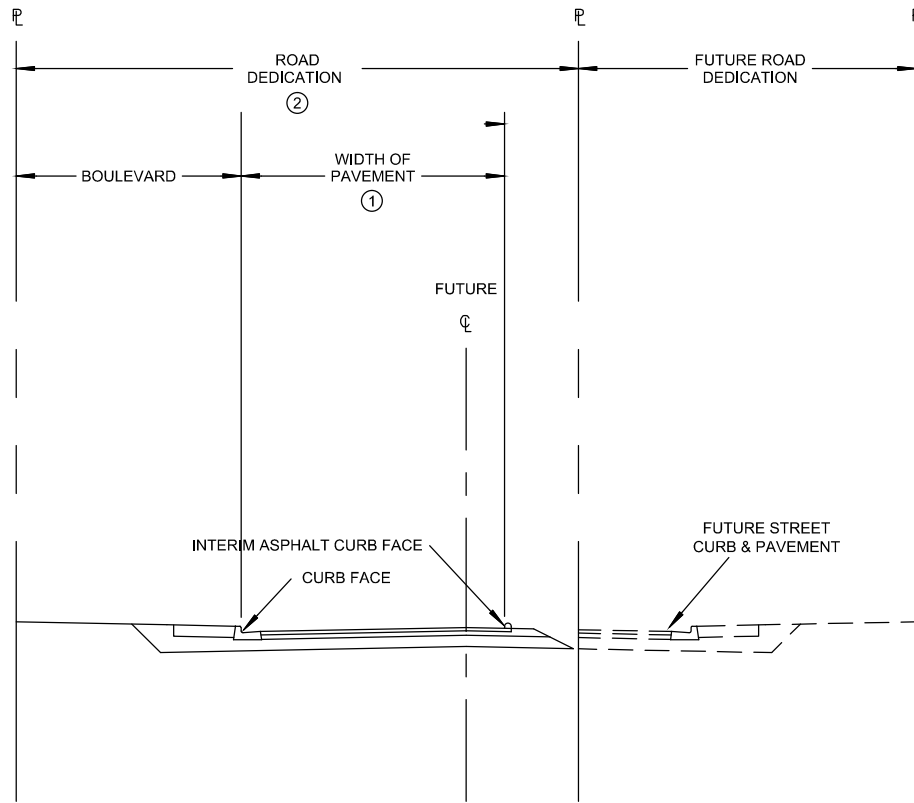
NOTES:

1. PAVED SURFACE - 50mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. SHOULDER - CRUSHED GRAVEL (20mm MINUS)
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.



NOTES:

1. PAVED SURFACE - 50mm ASPHALT (COMPACTED THICKNESS)
2. BASE - 100mm CRUSHED GRAVEL (20mm MINUS)
3. SUB-BASE - 250mm PIT RUN GRAVEL (75mm MINUS)
4. NON-MOUNTABLE MONOLITHIC CURB AND GUTTER IN ACCORDANCE WITH STANDARD DRAWING CS-4.
5. DEPTHS OF SURFACING AND BASE GRAVELS ARE MINIMUM AND IN SOME CASES WILL HAVE TO BE INCREASED TO MEET MAXIMUM ALLOWABLE BENKELMAN BEAM DEFLECTION.



ROAD CLASS	① PAVEMENT	② DEDICATION	PARKING
ARTERIAL	UNDER DIRECTION OF CITY ENGINEER		
MAJOR COLLECTOR			
MINOR COLLECTOR (LT BAY)	15.4	20.0	ONE SIDE
MINOR COLLECTOR	12.2	18.4	ONE SIDE
NEIGHBOURHOOD COLLECTOR	10.2	15.0	ONE SIDE
LOCAL (ULT 20m ROW)	8.0	14.0	ONE SIDE
LOCAL LOW VOL. (ULT 16.5 ROW)	7.0	12.0	ONE SIDE*
LANE**	4.0	5.0	N/A
COMMERCIAL	11.4	16.3	ONE SIDE
INDUSTRIAL	11.4	16.3	ONE SIDE

NOTES

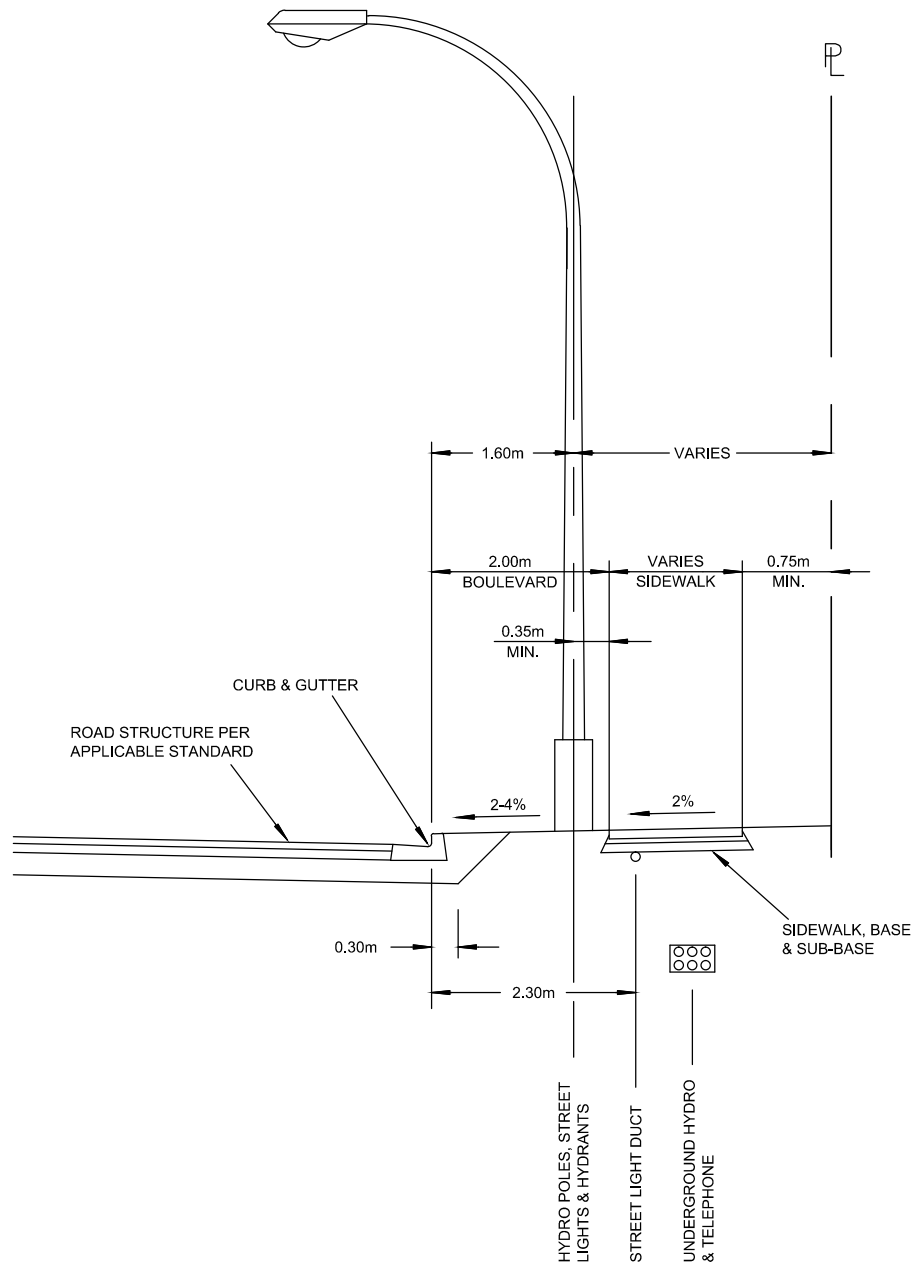
1. THIS STANDARD SHALL BE LIMITED TO SITUATIONS WHERE FUTURE DEVELOPMENT OF SURROUNDING PROPERTIES WILL RESULT IN DEDICATION AND CONSTRUCTION OF FULL ROAD.
2. ALL DESIGN PARAMETERS NOT SHOWN SHALL MATCH THOSE FOR THE ROAD CLASSIFICATION.
3. DRAINAGE MUST BE CONTAINED AND CONVEYED TO THE STORM SYSTEM WITHIN THE PAVEMENT SURFACE. OPEN CHANNEL DRAINAGE MAY BE CONSIDERED ALONG THE INTERIM ROAD EDGE WITH ADDITIONAL DEDICATION FOR DRAINAGE SWALE.
4. PARKING MUST BE RESTRICTED THROUGH SIGNAGE WHERE NOT ACCOMMODATED.

* PARKING NOT SUPPORTED WHERE ULTIMATE WEEKDAY TRAFFIC VOLUMES ANTICIPATED TO EXCEED 300 VEH/DAY.
 ** HALF ROAD STANDARD FOR LANES GENERALLY NOT SUPPORTED IN NEW DEVELOPMENT.



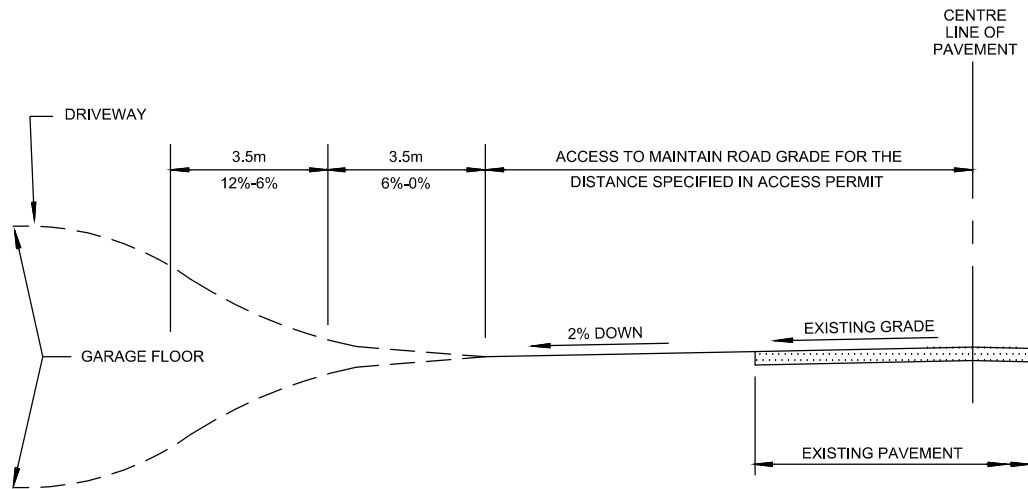
HALF ROAD SECTION

Scale: N.T.S.
 Created: MAR 2016
 Rev Date: NOV 2016
 Dwg No: R9-XS1



NOTES:

- 1 THIS STANDARD SHALL BE USED IN CONJUNCTION WITH OVERALL APPROVED LANDSCAPING SCHEME.
- 2 APPLICATION OF THIS STANDARD AT THE DISCRETION OF THE CITY ENGINEER.
- 3 DEPTHS OF SURFACING, BASE GRAVELS AND PAVEMENT WIDTHS AS PER APPLICABLE STANDARD FOR ROAD SECTION.



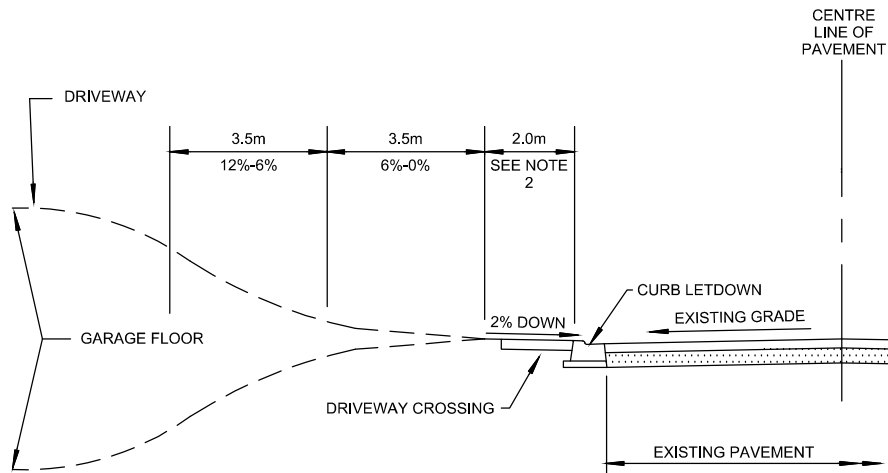
NOTES:

1. FOR ACCESS TO DRIVEWAYS FRONTING ARTERIAL, COLLECTOR AND NEIGHBOURHOOD COLLECTOR ROADS WITHOUT CONCRETE CURBS.
2. TO ALLOW FOR FUTURE ROAD WIDENING AND SIDEWALK CONSTRUCTION, THE DRIVEWAY AND FINISHED BOULEVARD MUST FOLLOW THE SAME GRADE AS THE EXISTING PAVEMENT, MEASURED FROM THE PAVEMENT CENTRE LINE FOR DISTANCE SPECIFIED IN THE ACCESS PERMIT.

IN GENERAL, THESE DISTANCES ARE AS FOLLOWS:

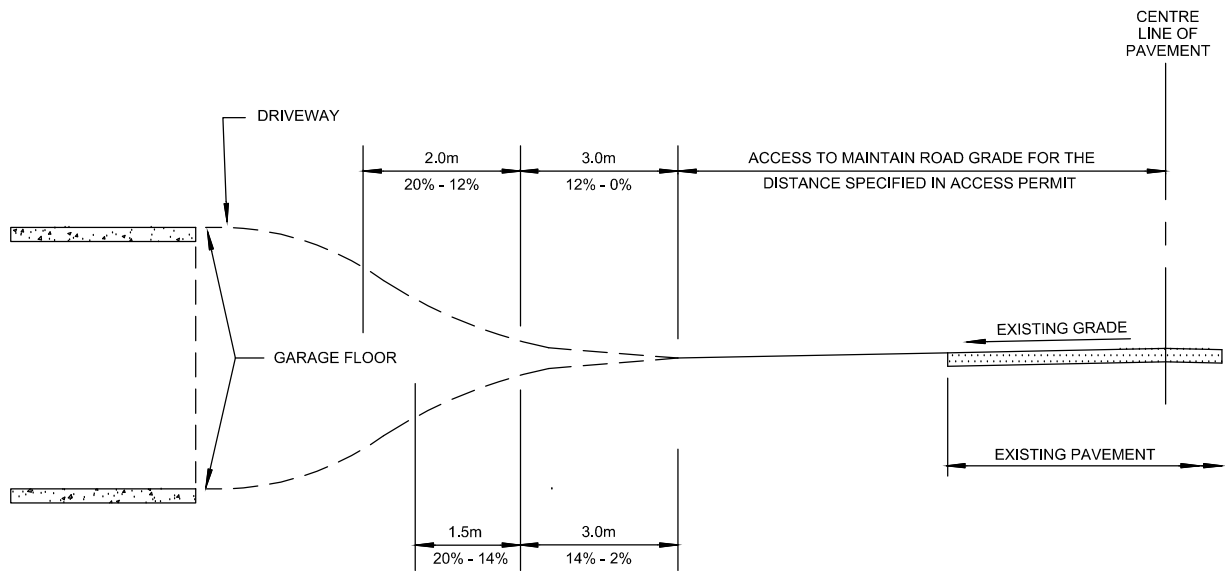
- (a) COLLECTOR ROADS - 9.0m
- (b) ARTERIAL ROADS - 12.0m

3. WHERE THE CENTRE OF THE EXISTING PAVEMENT IS MORE THAN 1.5m OFF THE CENTRE OF THE ROAD RIGHT-OF-WAY, THE HORIZONTAL DISTANCE AS SPECIFIED IN THE ACCESS PERMIT SHALL BE MEASURED FROM THE CENTRE OF THE ROAD RIGHT-OF-WAY.
4. THE MAXIMUM GRADE OF THE DRIVEWAY SHALL BE 20% WITH A CHANGE IN RISE OR FALL NOT EXCEEDING 6% FOR EACH HORIZONTAL 3.5m.
5. THE SLOPE OF THE EDGES OF THE DRIVEWAY IN CUT AND FILL SHALL BE A MAXIMUM OF 1 VERTICAL TO 1.5 HORIZONTAL ROCK SLOPES SHALL BE CUT WITH A MAXIMUM OF 4 VERTICAL TO 1 HORIZONTAL.
6. IN THE CASE OF SUBDIVISION WHERE A DRIVEWAY WILL PROVIDE ACCESS TO THREE OR MORE PARCELS, THE DRIVEWAY SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER; AS PER CITY OF NANAIMO GUIDELINES FOR THE APPROVAL, THE DESIGN AND THE CONSTRUCTION OF PRIVATELY OWNED COMMON ACCESS DRIVEWAYS.



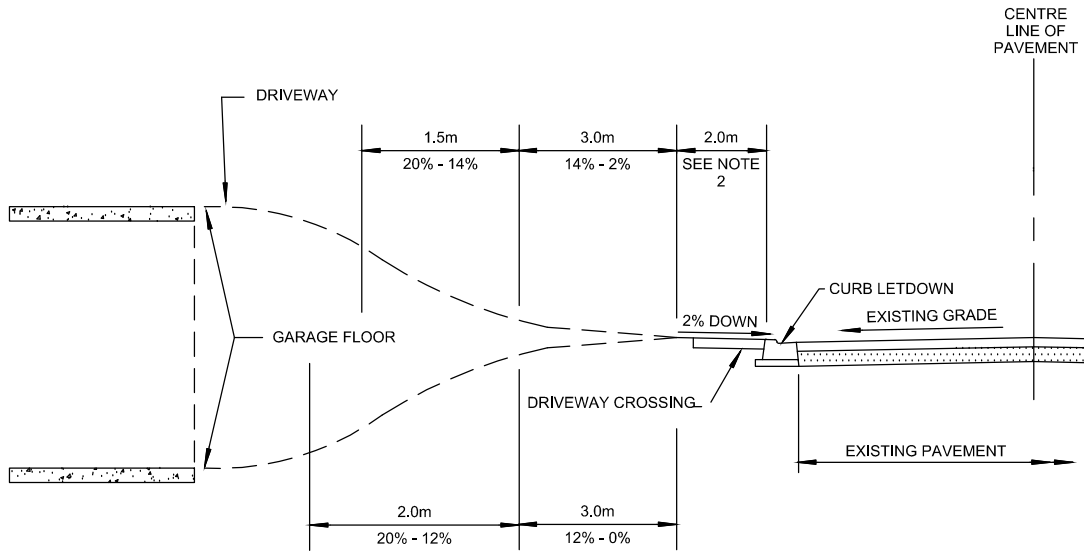
NOTES:

1. FOR ACCESS TO DRIVEWAYS FRONTING ARTERIAL, COLLECTOR AND NEIGHBOURHOOD COLLECTOR ROADS WITH CONCRETE CURBS.
2. THE MAXIMUM GRADE OF THE DRIVEWAY SHALL BE 20% WITH A CHANGE IN RISE OR FALL NOT EXCEEDING 6% FOR EACH HORIZONTAL 3.5m. THE RISE OR FALL OF THE DRIVEWAY SHALL BEGIN 2.0m BEHIND THE CURB TOWARDS THE PROPERTY.
3. THE SLOPE OF THE EDGES OF THE DRIVEWAY IN CUT AND FILL SHALL BE A MAXIMUM OF 1 VERTICAL TO 1.5 HORIZONTAL ROCK SLOPES SHALL BE CUT WITH A MAXIMUM OF 4 VERTICAL TO 1 HORIZONTAL.
4. IN THE CASE OF SUBDIVISION WHERE A DRIVEWAY WILL PROVIDE ACCESS TO THREE OR MORE PARCELS, THE DRIVEWAY SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER; AS PER CITY OF NANAIMO GUIDELINES FOR THE APPROVAL, THE DESIGN AND THE CONSTRUCTION OF PRIVATELY OWNED COMMON ACCESS DRIVEWAYS.



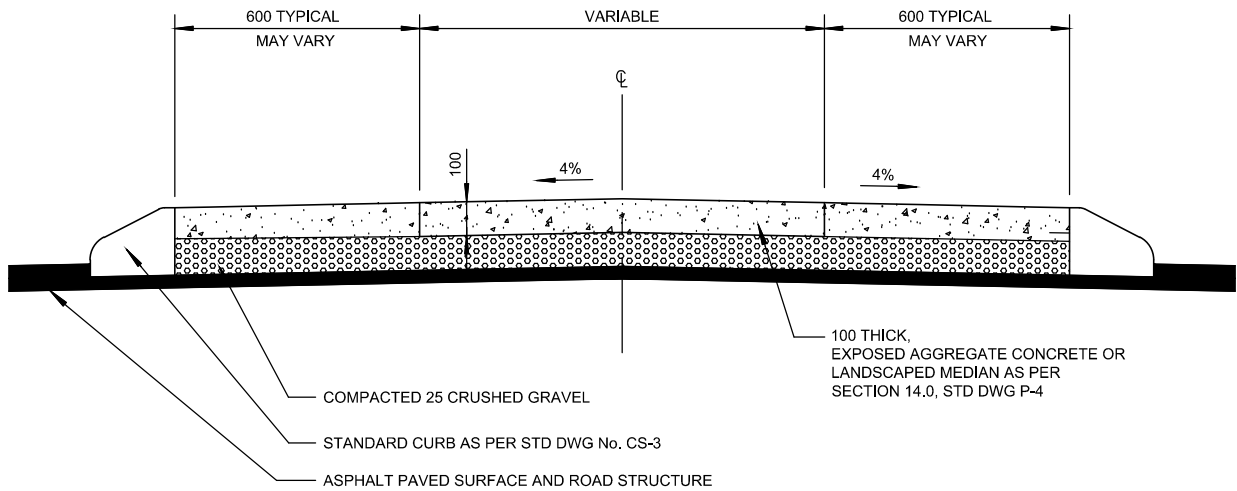
NOTES:

1. FOR ACCESS DRIVEWAYS FRONTING URBAN LOCAL AND RURAL LOCAL ROADS WITHOUT CONCRETE CURBS.
2. TO ALLOW FOR FUTURE ROAD WIDENING AND SIDEWALK CONSTRUCTION, THE DRIVEWAY AND FINISHED BOULEVARD MUST FOLLOW THE SAME GRADE AS THE EXISTING PAVEMENT, MEASURED FROM THE PAVEMENT CENTRE LINE, FOR DISTANCE SPECIFIED IN THE ACCESS PERMIT. IN GENERAL, THE DISTANCE FOR LOCAL ROADS IS 6.7m.
3. WHERE THE CENTRE OF THE EXISTING PAVEMENT IS MORE THAN 1.5m OFF THE CENTRE OF THE ROAD RIGHT-OF-WAY, THE HORIZONTAL DISTANCE AS SPECIFIED IN THE ACCESS PERMIT SHALL BE MEASURED FROM THE CENTRE OF THE ROAD RIGHT-OF-WAY.
4. THE CHANGE IN GRADE, RISE OR FALL, SHALL NOT EXCEED 12% FOR EACH HORIZONTAL 3.0m DISTANCE, TO A MAXIMUM GRADE OF 20%.
5. THE SLOPE OF THE EDGES OF THE DRIVEWAY IN CUT AND FILL SHALL BE A MAXIMUM OF 1 VERTICAL TO 1.5 HORIZONTAL. ROCK SLOPES SHALL BE CUT WITH A MAXIMUM OF 4 VERTICAL TO 1 HORIZONTAL.
6. IN THE CASE OF SUBDIVISION WHERE A DRIVEWAY WILL PROVIDE ACCESS TO THREE OR MORE PARCELS, THE DRIVEWAY SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER; AS PER CITY OF NANAIMO GUIDELINES FOR THE APPROVAL, THE DESIGN AND THE CONSTRUCTION OF PRIVATELY OWNED COMMON ACCESS DRIVEWAYS.

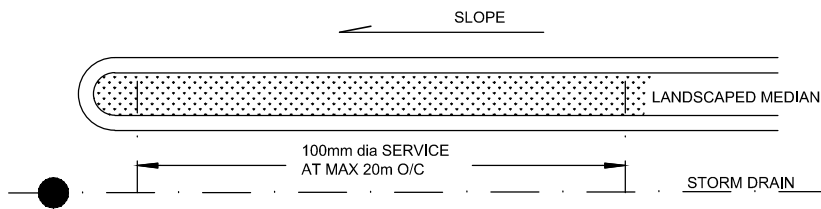


NOTES:

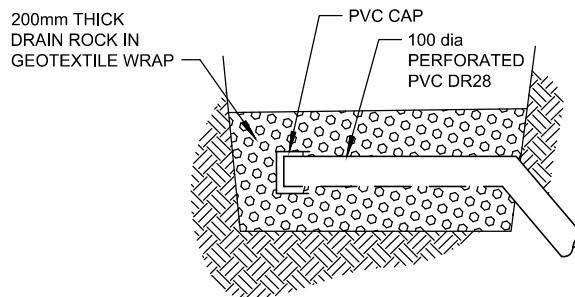
1. FOR ACCESS DRIVEWAYS FRONTING URBAN LOCAL AND RURAL LOCAL ROADS WITH CONCRETE CURBS.
2. THE CHANGE IN GRADE, RISE OR FALL, SHALL NOT EXCEED 12% FOR EACH HORIZONTAL 3.0m DISTANCE, TO A MAXIMUM GRADE OF 20%. THE RISE OR FALL OF THE DRIVEWAY SHALL BEGIN 2.0m BEHIND THE CURB TOWARDS THE PROPERTY.
3. THE SLOPE OF THE EDGES OF THE DRIVEWAY OR FILL SHALL BE A MAXIMUM OF 1 VERTICAL TO 1.5 HORIZONTAL ROCK SLOPES AND CUTS SHALL BE A MAXIMUM OF 4 VERTICAL TO 1 HORIZONTAL.
4. IN THE CASE OF SUBDIVISION WHERE A DRIVEWAY WILL PROVIDE ACCESS TO THREE OR MORE PARCELS, THE DRIVEWAYS SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER; AS PER CITY OF NANAIMO GUIDELINES FOR THE APPROVAL, THE DESIGN AND OF THE CONSTRUCTION OF PRIVATELY OWNED COMMON ACCESS DRIVEWAYS.



SECTION



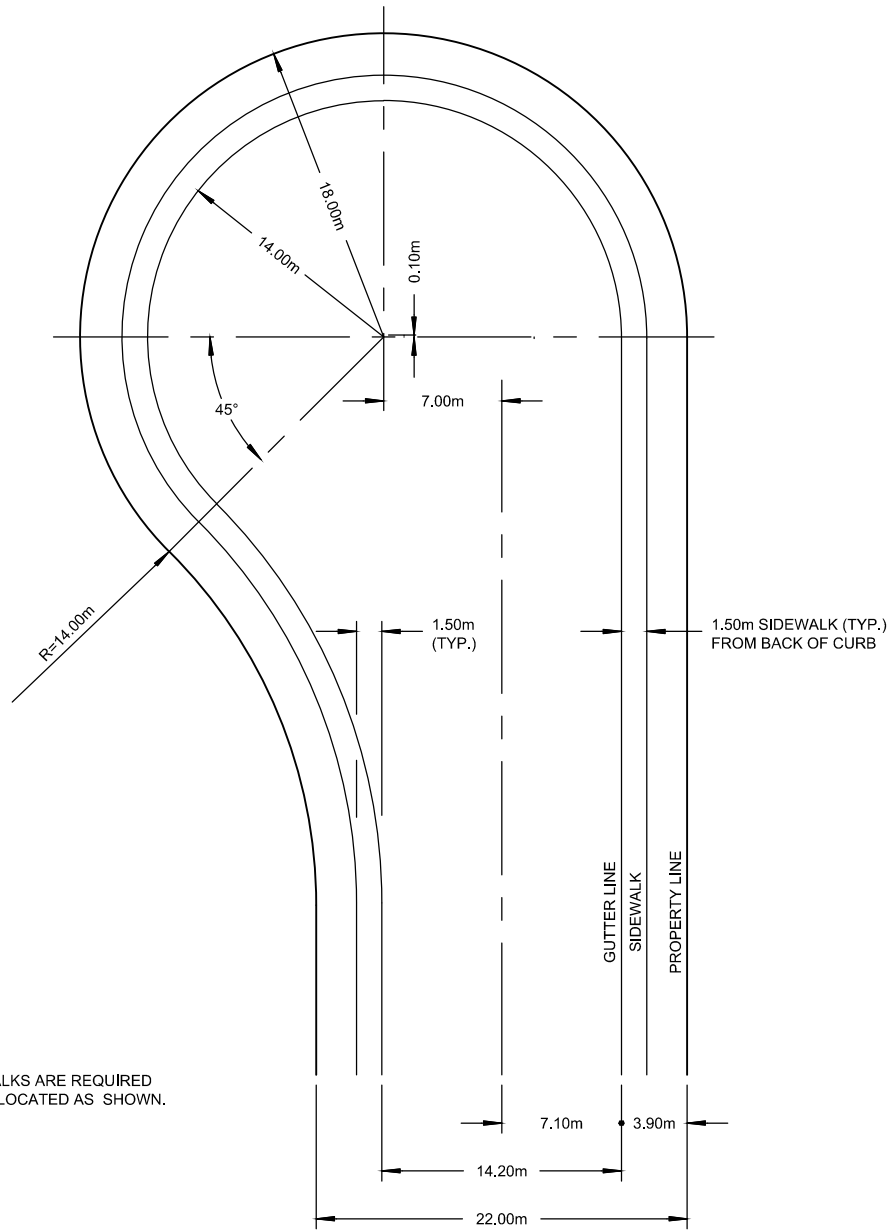
SERVICE LOCATION PLAN - SCHEMATIC



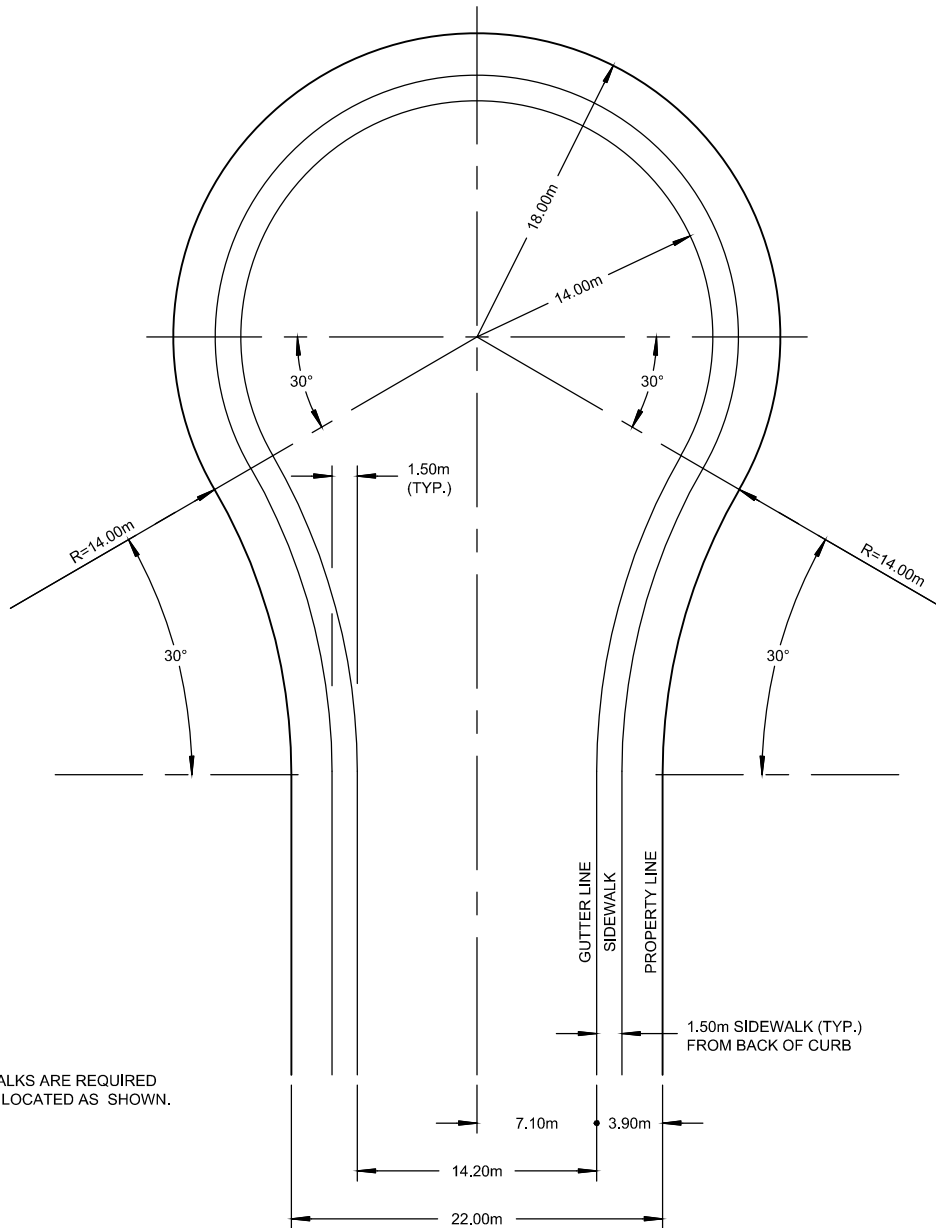
**STORM SERVICE
TERMINATION DETAIL**

NOTES:

1. PROVIDE STORM DRAIN CONNECTION AT LOW END OF ISLAND.
2. INSTALLATION OF THE EXPOSED AGGREGATE CONCRETE SHALL BE COMPLETED UNDER BEST PRACTICES TO ENSURE THE WASH-OFF EFFLUENT DOES NOT ENTER THE STORM SEWER SYSTEM.
3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.
4. FOR CONCRETE DETAILS SEE SECTION 8 - CURBS, SIDEWALKS AND WALKWAYS.
5. FOR LANDSCAPE DETAILS SEE SECTION 14 - LANDSCAPE.



NOTE
1. WHERE SIDEWALKS ARE REQUIRED
THEY SHALL BE LOCATED AS SHOWN.

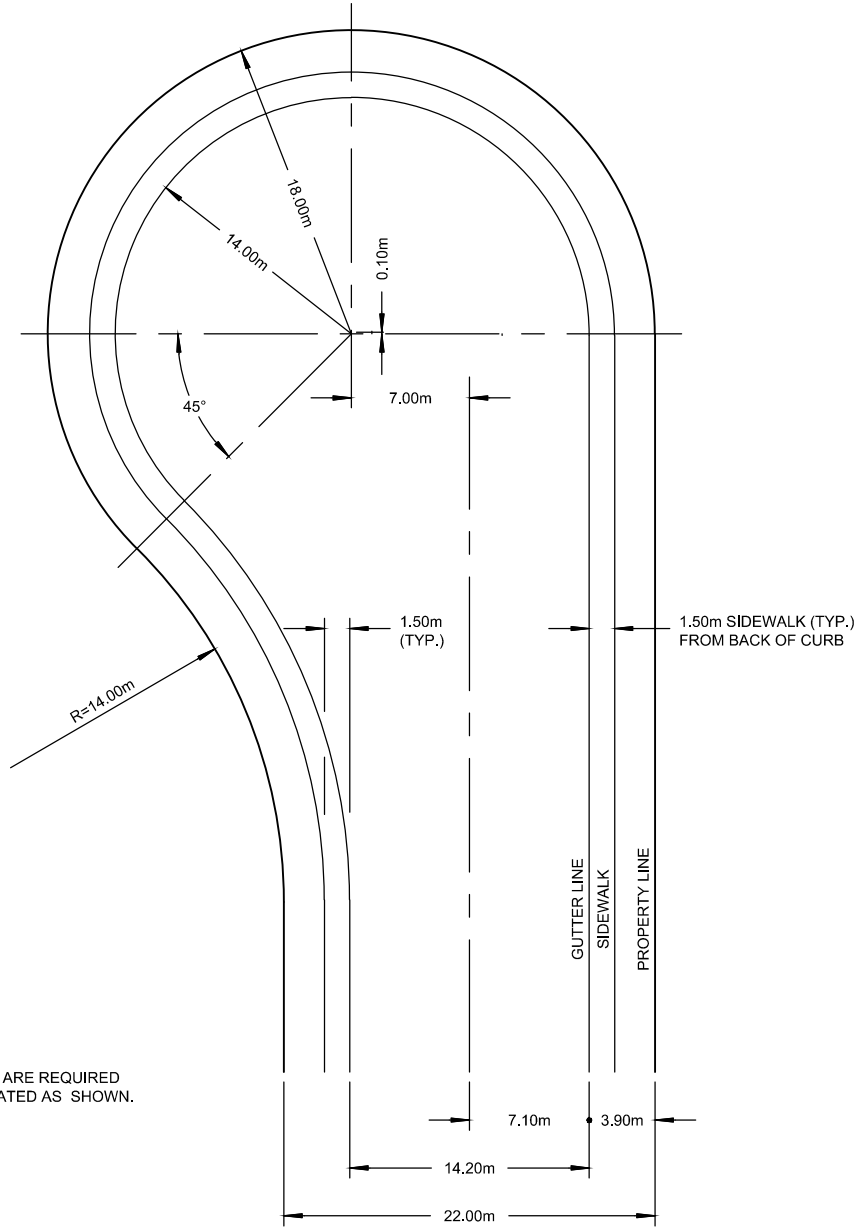


NOTE
 1. WHERE SIDEWALKS ARE REQUIRED
 THEY SHALL BE LOCATED AS SHOWN.

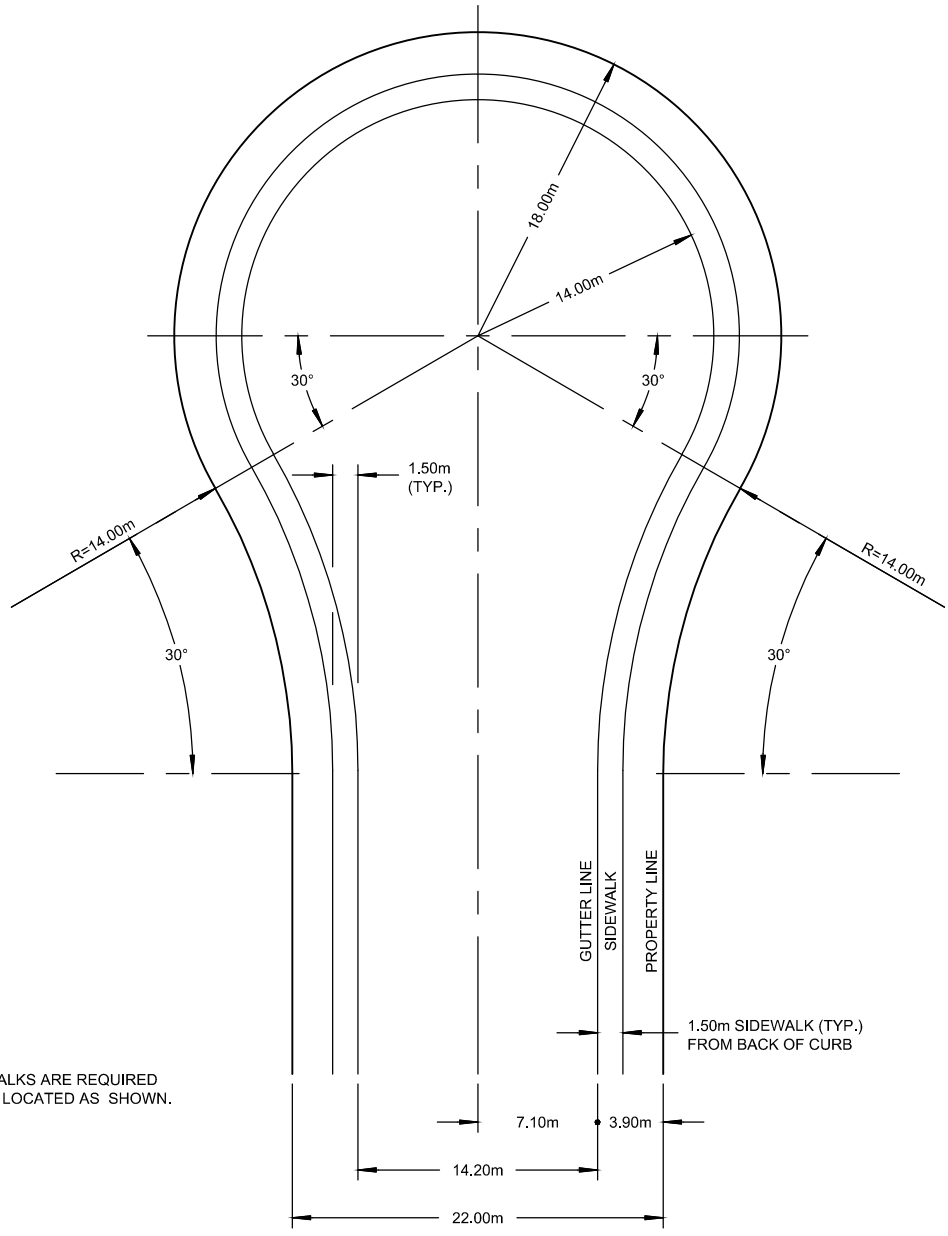


COMMERCIAL STANDARD
 CUL-DE-SAC

Scale: N.T.S.
 Created: MAY 2013
 Rev Date: NOV 2016
 Dwg No: R4-CU2



NOTE
1. WHERE SIDEWALKS ARE REQUIRED
THEY SHALL BE LOCATED AS SHOWN.

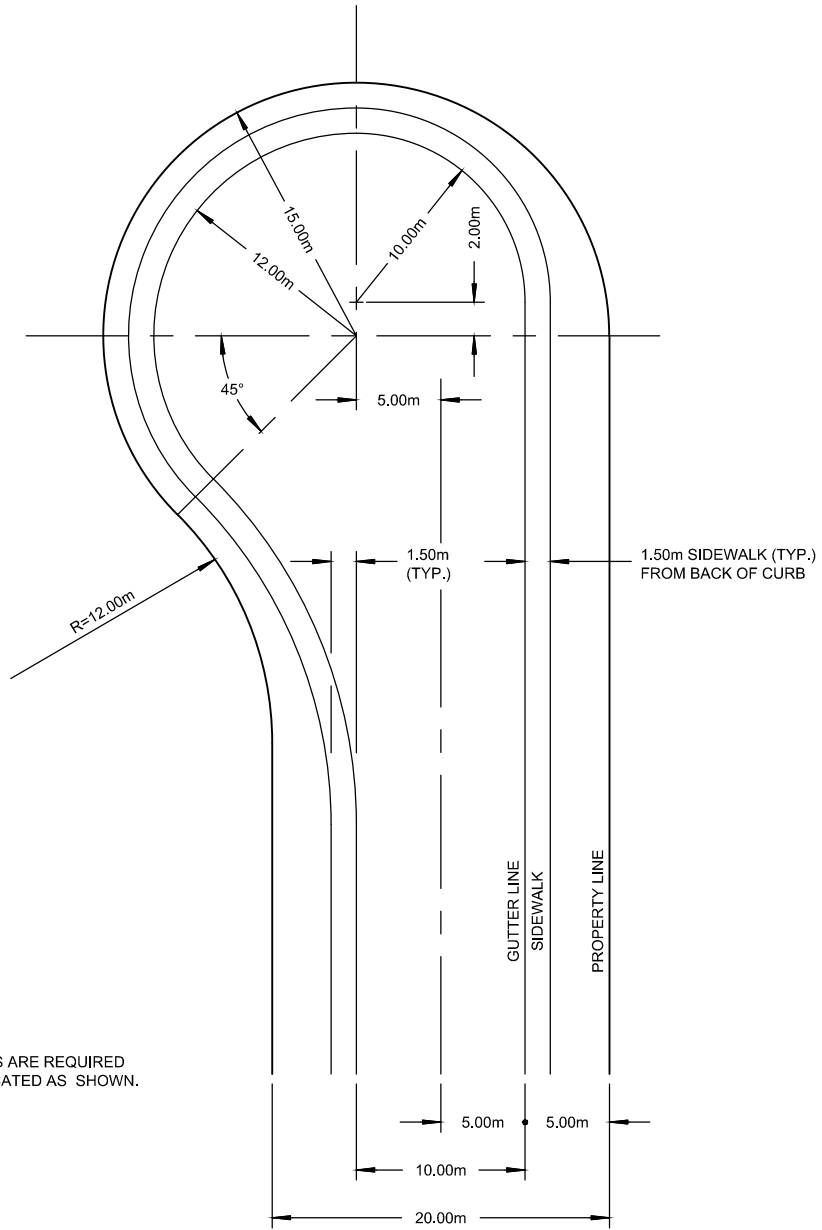


NOTE
1. WHERE SIDEWALKS ARE REQUIRED
THEY SHALL BE LOCATED AS SHOWN.

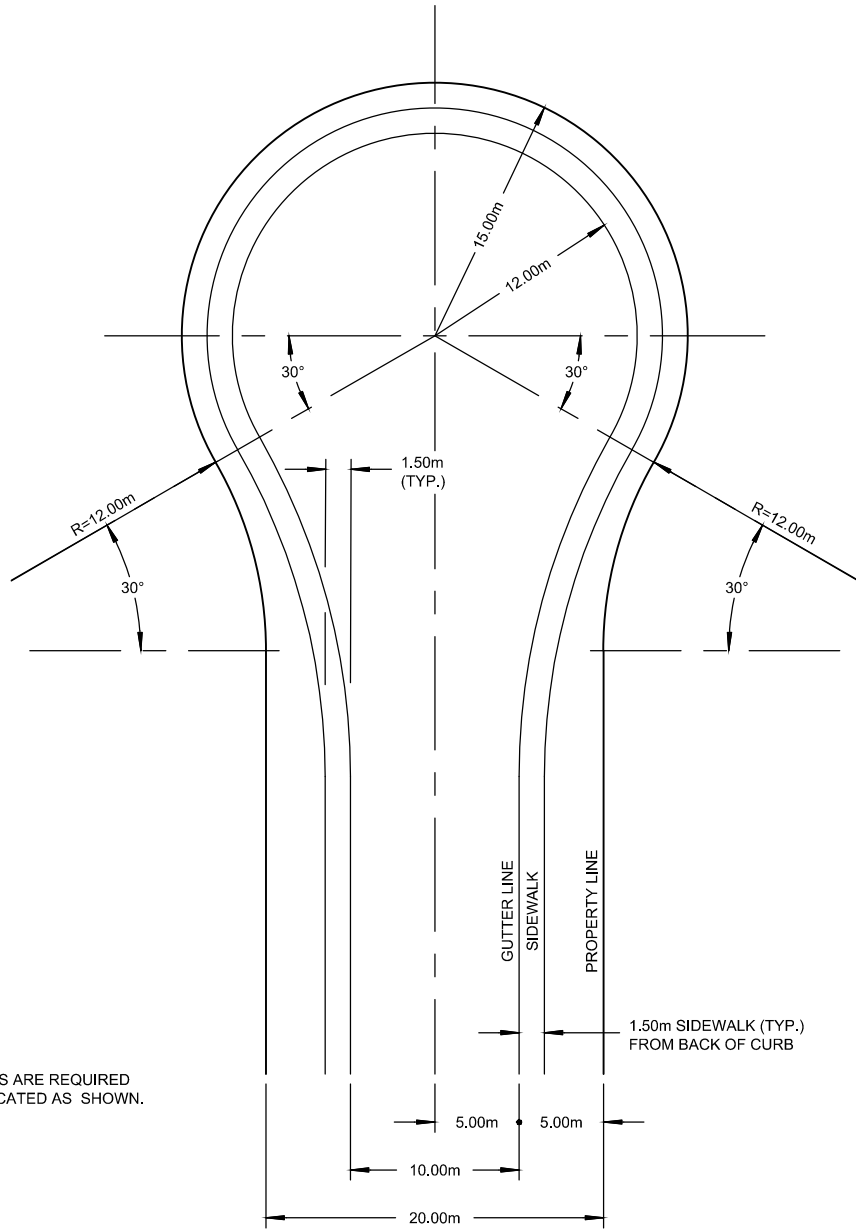


INDUSTRIAL STANDARD
CUL-DE-SAC

Scale:	N.T.S.
Created:	MAY 2013
Rev Date:	NOV 2016
Dwg No:	R5-CU2



NOTE
 1. WHERE SIDEWALKS ARE REQUIRED
 THEY SHALL BE LOCATED AS SHOWN.

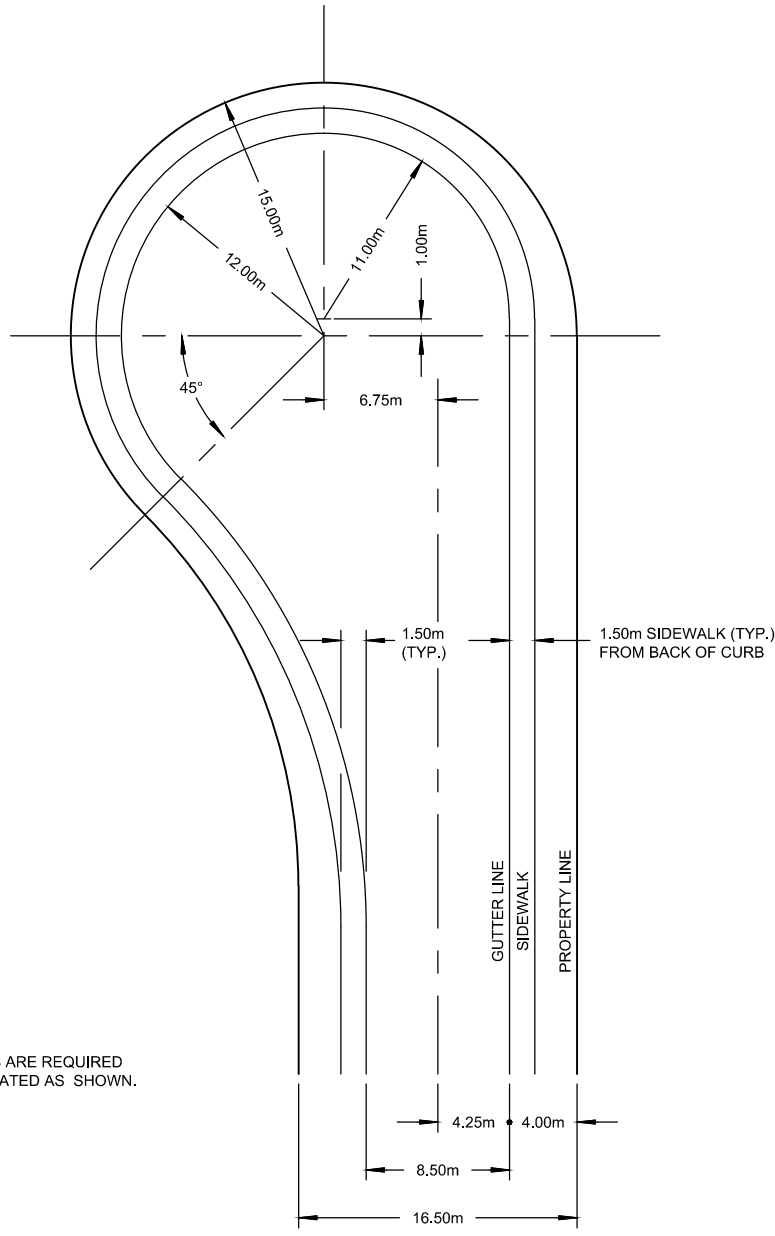


NOTE
 1. WHERE SIDEWALKS ARE REQUIRED
 THEY SHALL BE LOCATED AS SHOWN.



URBAN LOCAL STANDARD
 CUL-DE-SAC

Scale: N.T.S.
 Created: MAY 2013
 Rev Date: NOV 2016
 Dwg No: R7-CU2

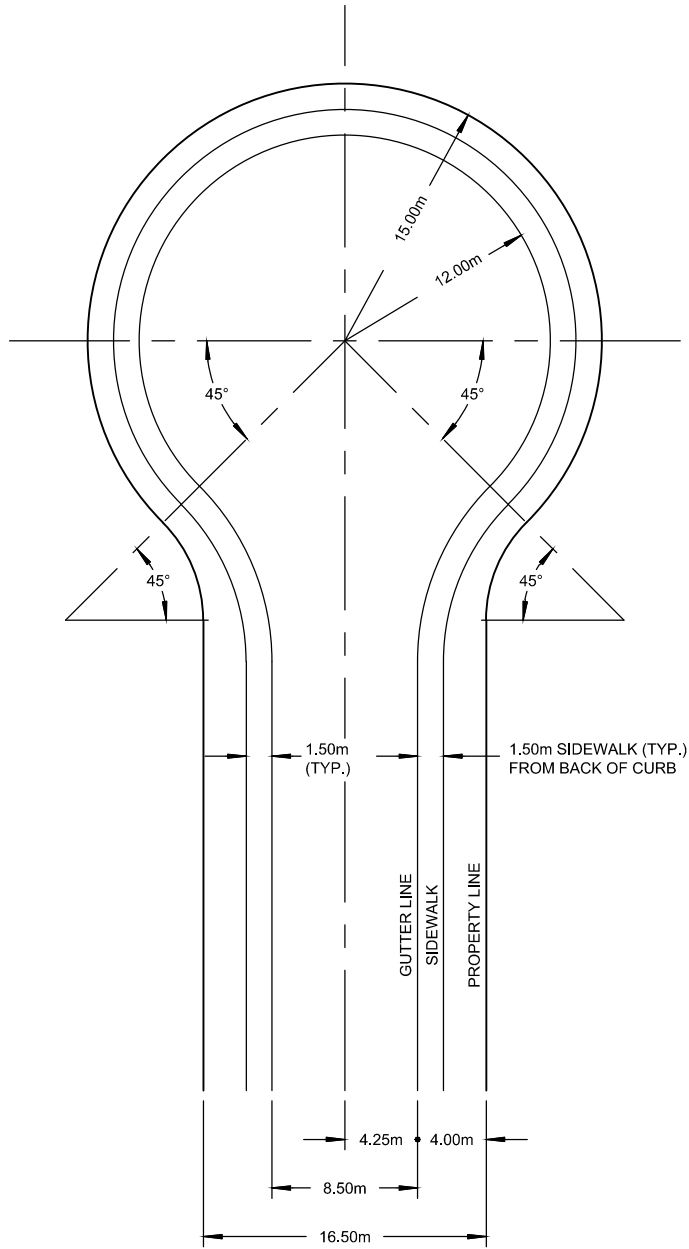


NOTE
 1. WHERE SIDEWALKS ARE REQUIRED
 THEY SHALL BE LOCATED AS SHOWN.

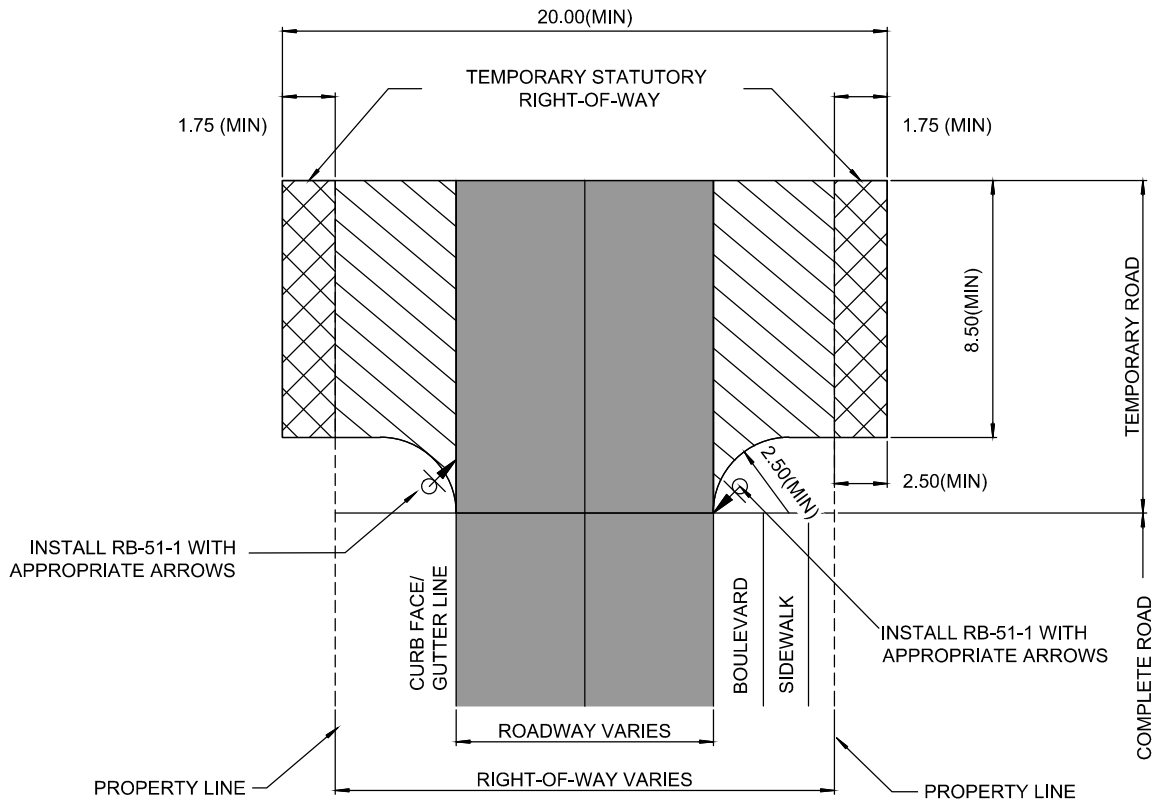


URBAN LOCAL (LOW VOLUME)
 OFFSET CUL-DE-SAC




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 Created: NOV 2009
 Rev Date: NOV 2016
 Dwg No: R7-CU3



NOTE
1. WHERE SIDEWALKS ARE REQUIRED
THEY SHALL BE LOCATED AS SHOWN.



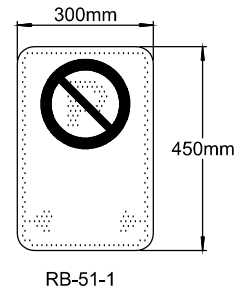
LEGEND

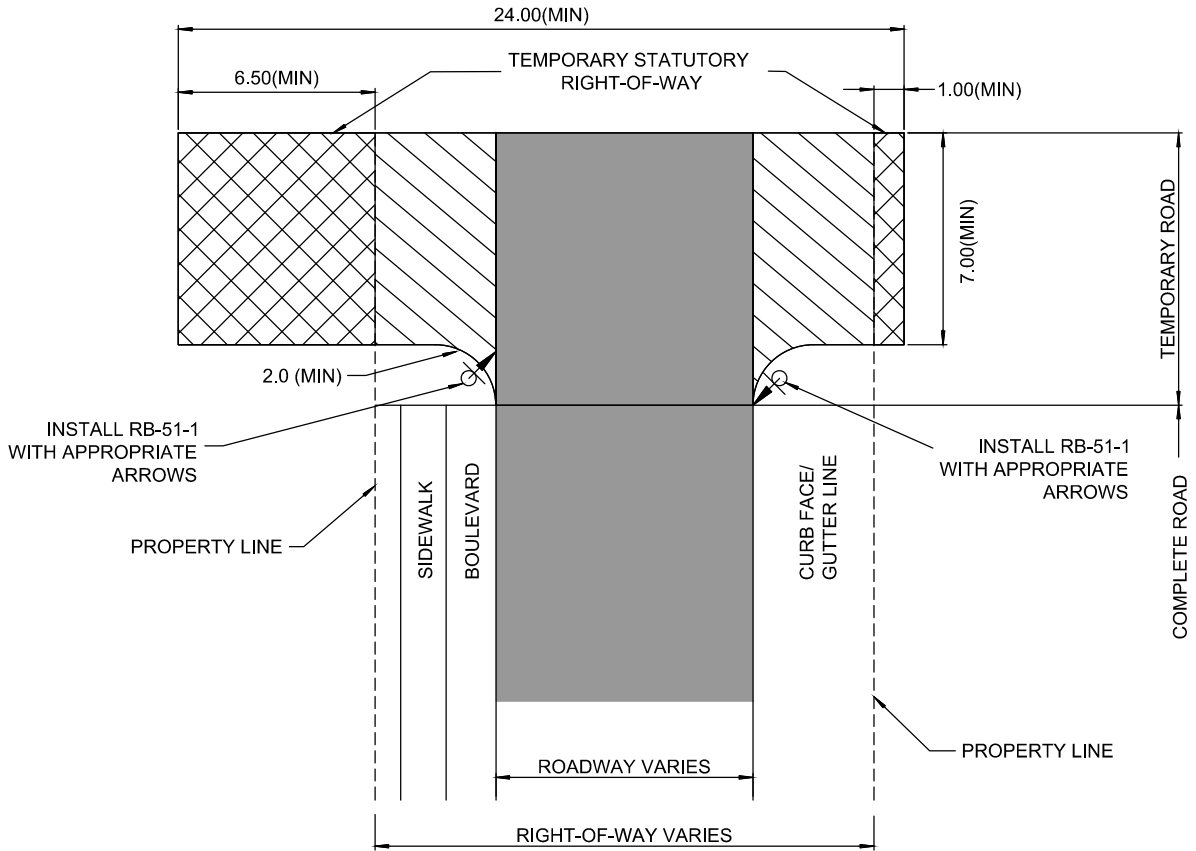
-  TEMPORARY ROAD WITH FULL DEPTH ROAD STRUCTURE
-  COMPLETE ROAD
-  TEMPORARY STATUTORY RIGHT-OF-WAY OR TEMPORARY ROAD DEDICATION, WILL BE RELEASED WHEN ROAD IS CONNECTED.

LOCAL LOW VOLUME ROAD




NOTES:

1. STANDARD TEMPORARY TURNAROUND SHALL BE USED FOR LOCAL LOW VOLUME ROADS AND A TEMPORARY STATUTORY RIGHT-OF-WAY SHALL BE APPLIED UNTIL THE ROAD IS CONNECTED. A TEMPORARY ROAD DEDICATION SHALL BE APPLIED UNTIL THE ROAD IS CONNECTED WHEN SUITABLE.
2. PARKING IS NOT PERMITTED WITHIN THE TEMPORARY TURNAROUND, REGULATORY SIGNAGE SHALL BE INSTALLED.
3. ALL DIMENSIONS IN METERS UNLESS OTHERWISE SHOWN.





LEGEND

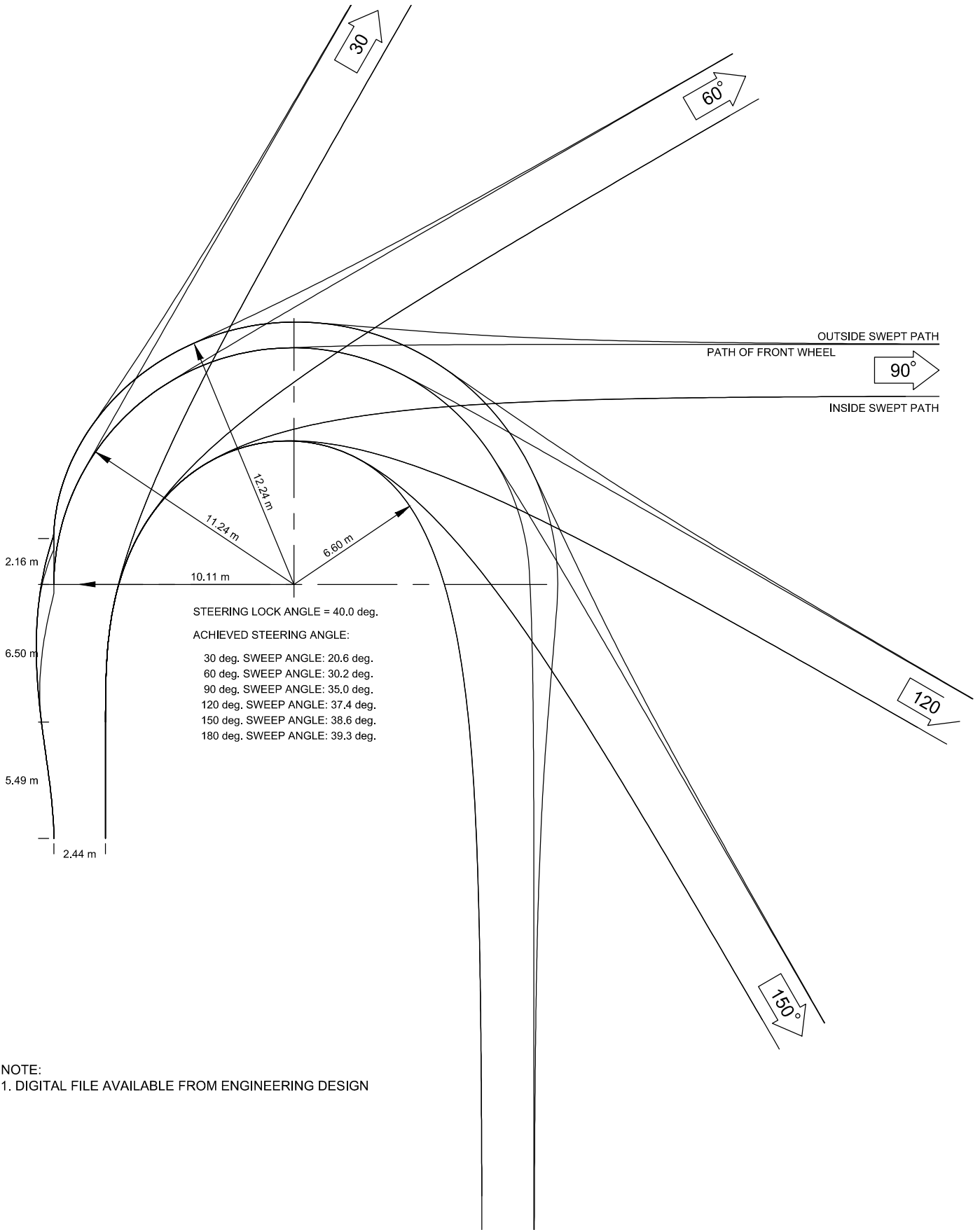
-  TEMPORARY ROAD WITH FULL DEPTH ROAD STRUCTURE
-  COMPLETE ROAD
-  TEMPORARY STATUTORY RIGHT-OF-WAY OR TEMPORARY ROAD DEDICATION, WILL BE RELEASED WHEN ROAD IS CONNECTED.

LOCAL LOW VOLUME ROAD

NOTES:

1. STANDARD TEMPORARY TURNAROUND SHALL BE USED FOR LOCAL LOW VOLUME ROADS AND A TEMPORARY STATUTORY RIGHT-OF-WAY SHALL BE APPLIED UNTIL THE ROAD IS CONNECTED. A TEMPORARY ROAD DEDICATION SHALL BE APPLIED UNTIL THE ROAD IS CONNECTED WHEN SUITABLE.
2. PARKING IS NOT PERMITTED WITHIN THE TEMPORARY TURNAROUND, REGULATORY SIGNAGE SHALL BE INSTALLED.
3. ALL DIMENSIONS IN METERS UNLESS OTHERWISE SHOWN.

UTENT&PWINFRASTRUCTURE PLANNING STANDARDS & PRODUCTS\W02\SS\EDITION NOT\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 9 DWGS\RT-2



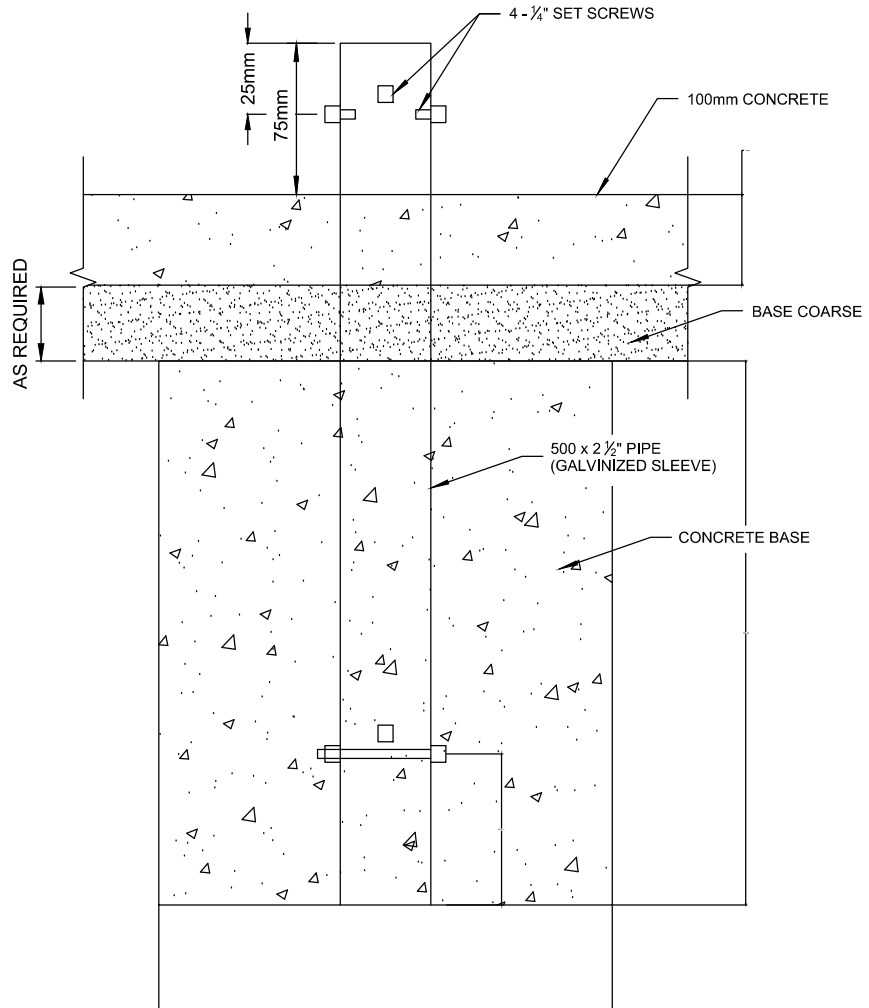
NOTE:
 1. DIGITAL FILE AVAILABLE FROM ENGINEERING DESIGN

4.14.2016



CITY OF NANAIMO CUSTOM FIRE TRUCK TURNING TEMPLATE

Scale: 1:250
 Created: SEPT 2012
 Rev Date: NOV 2016
 Dwg No: RT-2

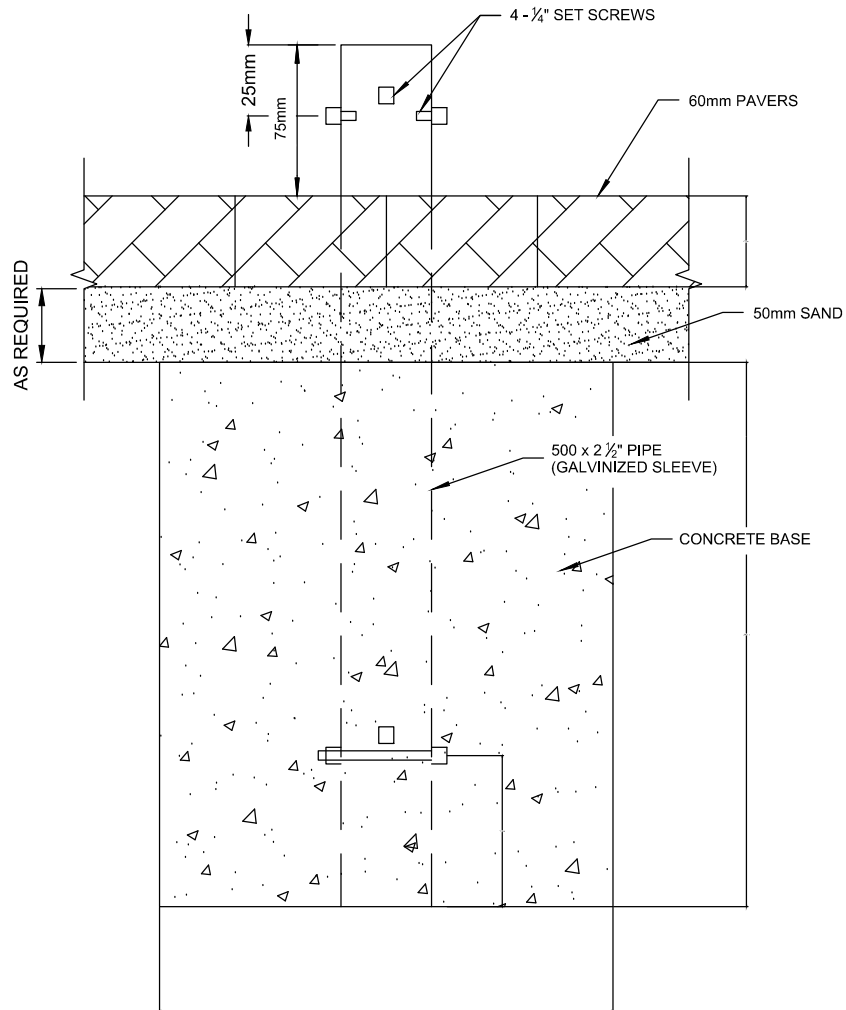


- NOTES:
1. TO BE USED WHEN SIGN IS INSTALLED IN CONCRETE.
 2. ALL DIMENSIONS ARE mm UNLESS SHOWN OTHERWISE



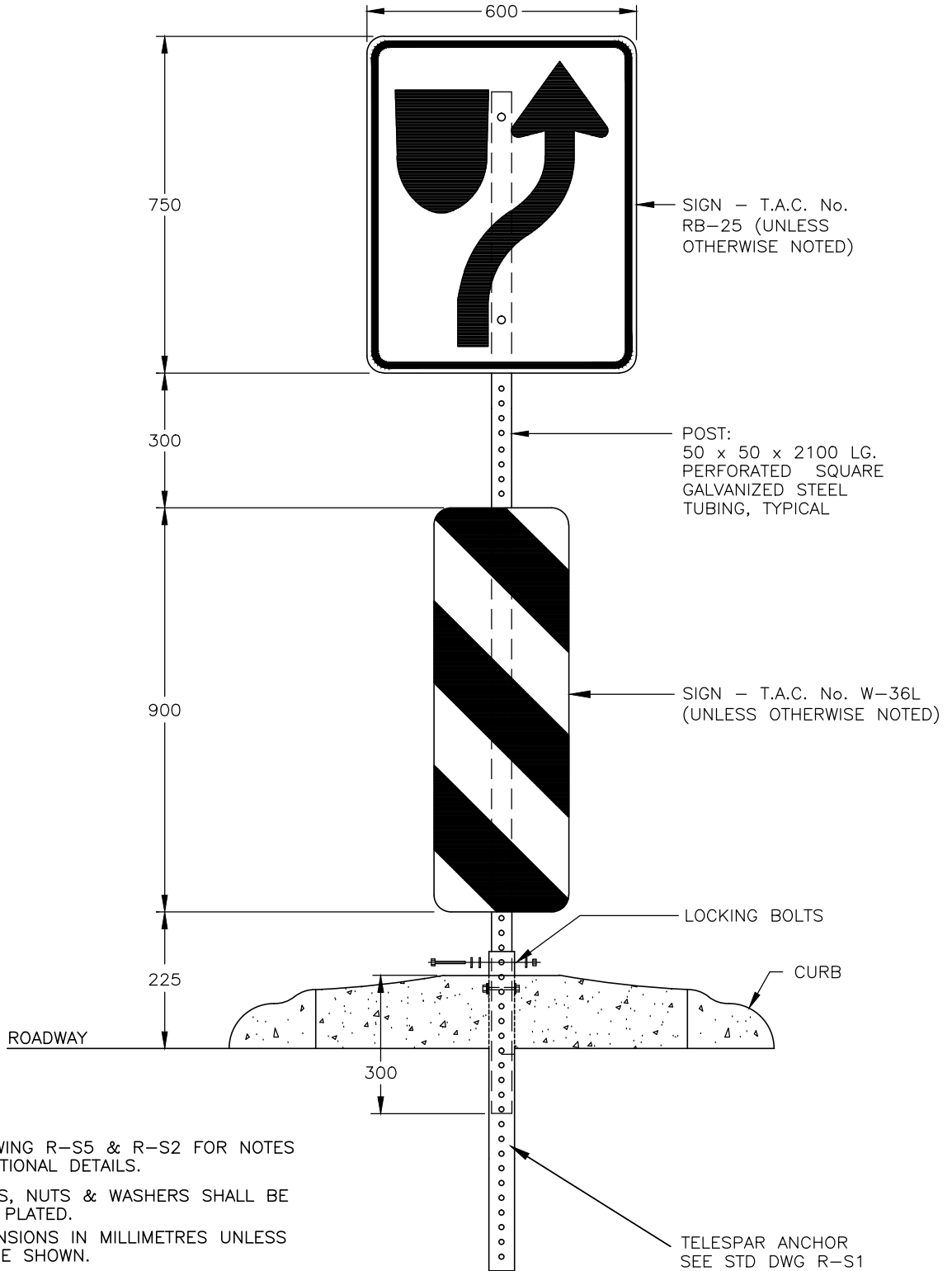
ROUND STOCK SIGN BASE
DETAIL IN CONCRETE

Scale:	N.T.S.
Created:	FEB 2012
Rev Date:	NOV 2016
Dwg No:	R-S2



ROUND STOCK SIGN BASE
DETAIL IN PAVERS

Scale:	N.T.S.
Created:	FEB 2012
Rev Date:	NOV 2016
Dwg No:	R-S3

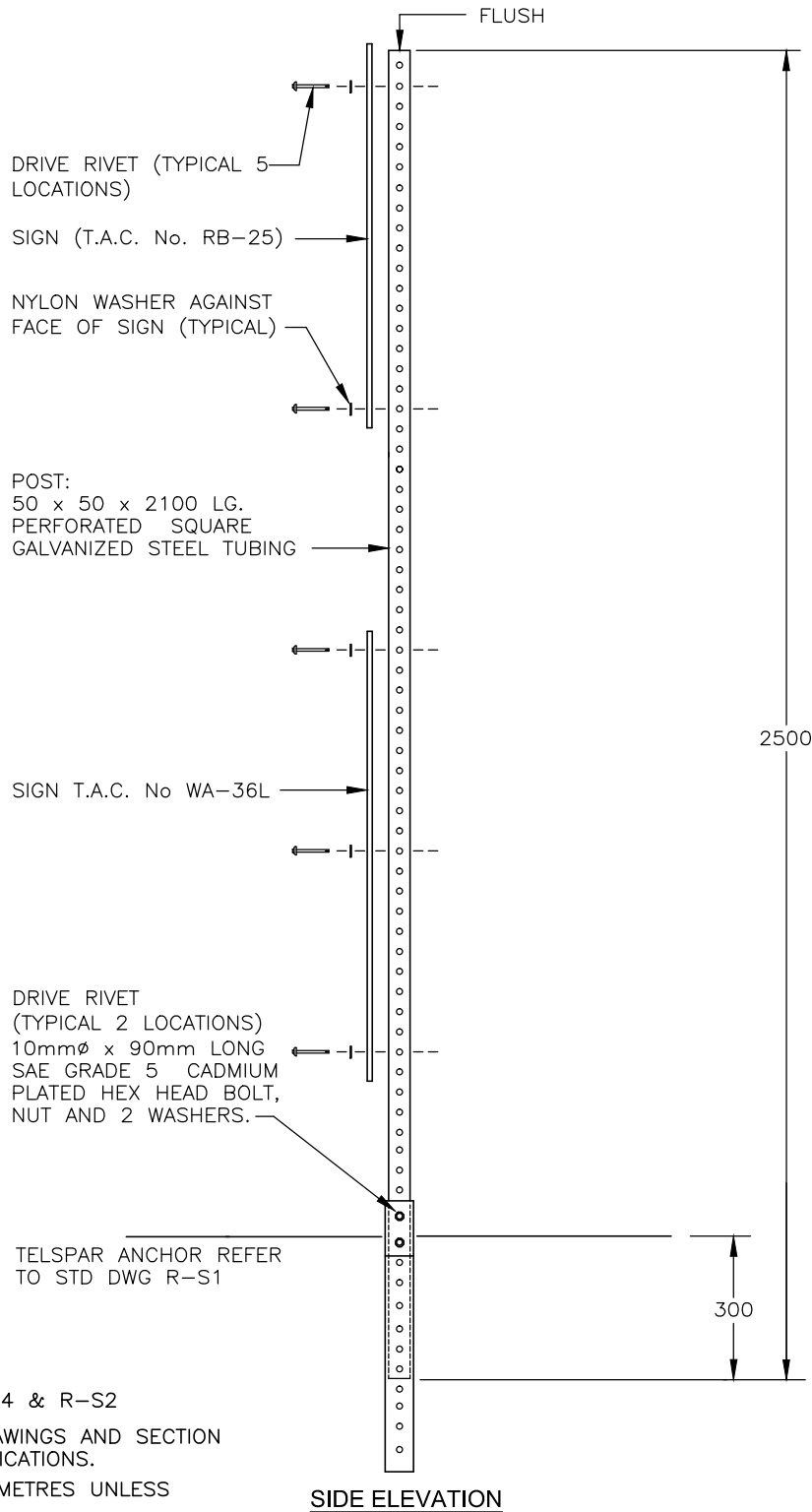


NOTES

1. SEE DRAWING R-S5 & R-S2 FOR NOTES AND ADDITIONAL DETAILS.
2. ALL BOLTS, NUTS & WASHERS SHALL BE CADMIUM PLATED.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE SHOWN.

FRONT ELEVATION





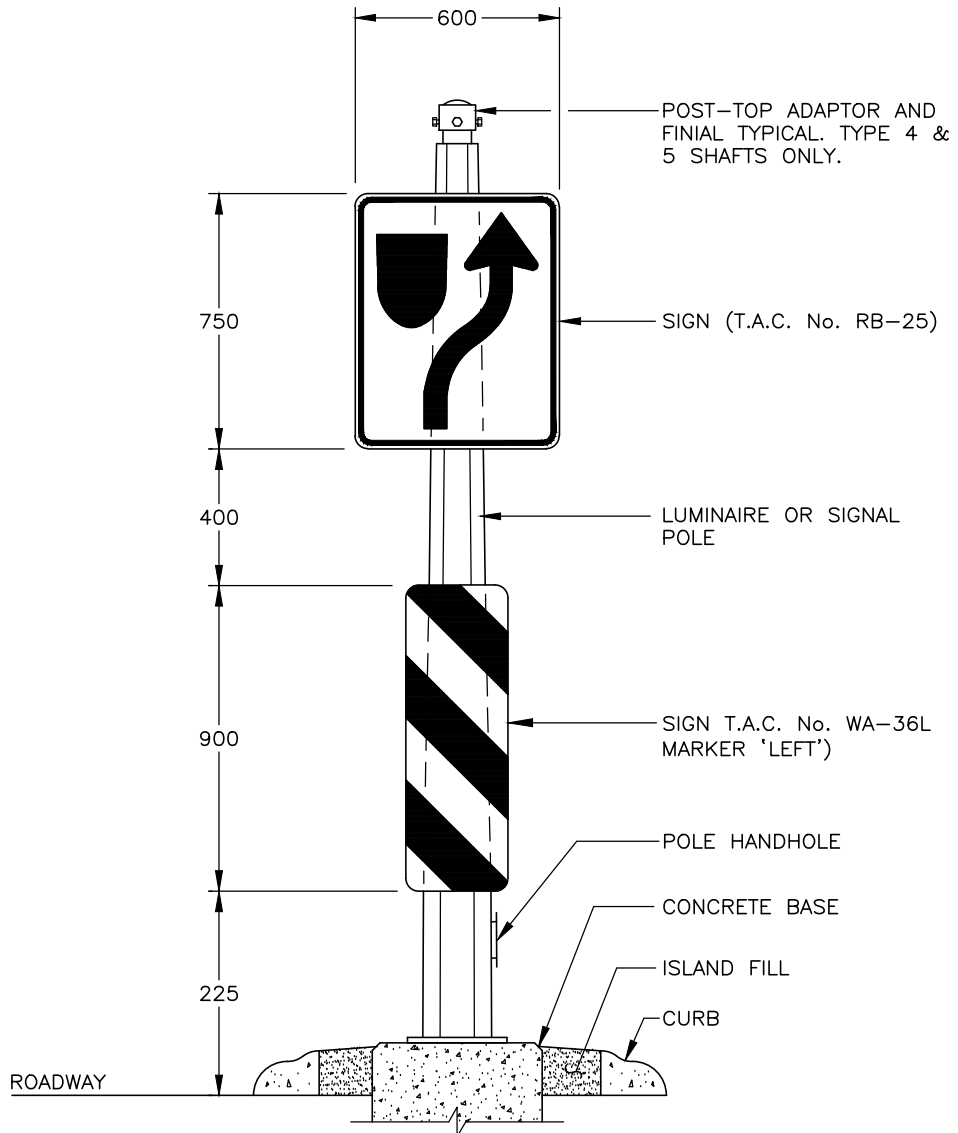
NOTES

1. REFER TO STD DWG R-S4 & R-S2
2. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



**SIGNS ON PERFORATED
STEEL TUBING SHEET 2**

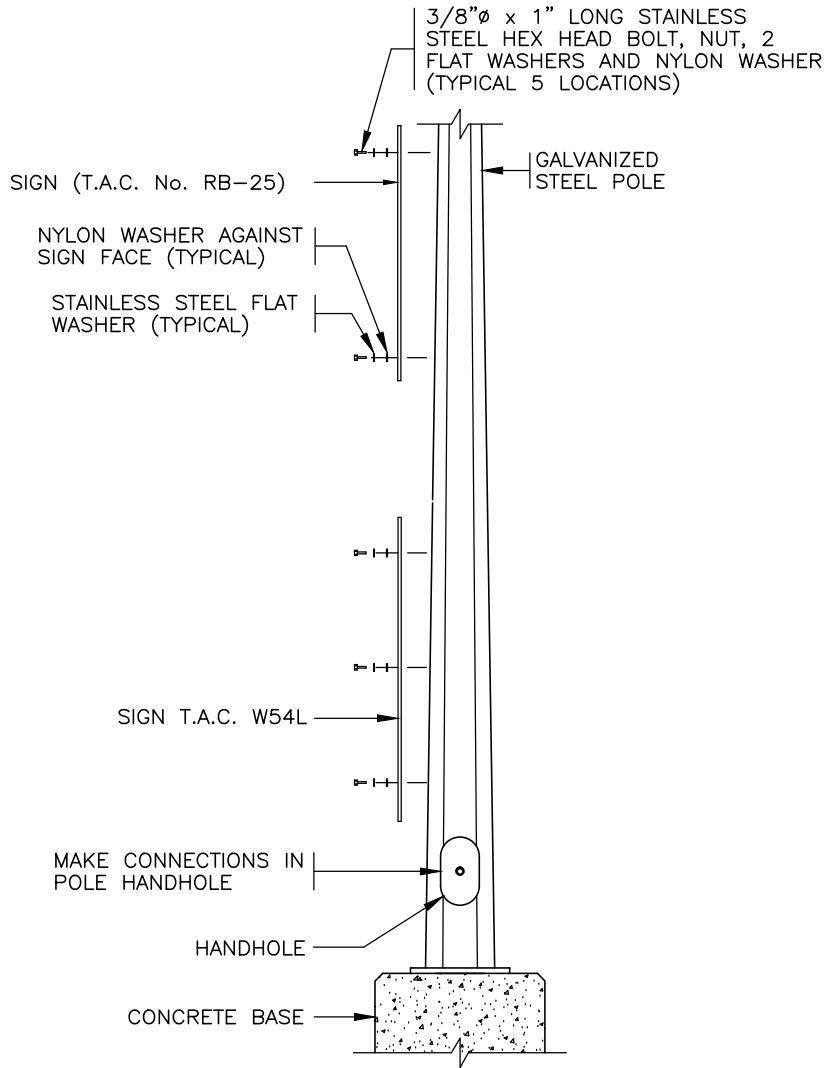
Scale:	N.T.S.
Created:	MAY 2013
Rev Date:	NOV 2016
Dwg No:	R-S5



FRONT ELEVATION

NOTES

- 1. SEE DRAWING R-S8 FOR NOTES AND ADDITIONAL DETAILS.



SIDE VIEW

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.

SECTION 9 - STREETS
MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT

Stripping and Common Excavation	9.70
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Authorized Overexcavation	9.72
Sub-Grade Preparation	9.73
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Borrow Pits, Crushing and Stockpiling	9.76
Ditches	9.77
Street Name and Traffic Signs	9.78
Street Markings	9.79

SECTION 9 - STREETS

MEASUREMENT AND PAYMENT

9.70 **STRIPPING AND COMMON EXCAVATION** Section 9.44 and 9.45

Payment for stripping and common excavation will be made at the unit price per cubic metre shown in the Tender Form. Excavated volume will be computed as the difference between the original cross sections and the subgrade cross section using the average end area method. Cross sections will be taken every 20 m along the centreline, or at such lesser interval as the Engineer may deem necessary. This Tender Form price shall include excavating material, placing and compacting as earth fill or rock fill. Offsite disposal of surplus material will be made at the unit price per cubic metre shown in the Tender Form.

9.71 **ROCK EXCAVATION** Section 9.46

Payment for rock excavation will be made as shown in the Tender Form.

- a) **By Volume Measurement:** Payment will be made for excavation of single boulders exceeding one metre in volume. Where solid rock is excavated, the volume of rock for payment will be calculated on the basis of the average end area method measured at 5 metre intervals along the grade to the design subgrade. This price shall include excavation, disposal of unsuitable material and grading of subgrade. No additional payment will be made for backfill material required to achieve subgrade elevations due to over break.

9.72 **AUTHORIZED OVEREXCAVATION** Section 9.47

Payment for authorized over-excavation and placement of import material will be made:

- (a) At the applicable unit rates for common excavation and import materials, as shown on the Tender Form, when the authorized over-excavation occurs in conjunction with the Contractor's common excavation operation.
- (b) At the unit price per tonne of import material placed, as shown in the Tender Form for authorized over-excavation, when the authorized over-excavation occurs independent of the Contractor's common excavation operation. This price shall include over-excavation, disposal of unsuitable material, supply and placement and compaction of specified imported material, and all work incidental thereto.

Payment for this work will only be made when, in the opinion of the Engineer, it is necessitated by the natural existence of unsatisfactory soil conditions. No payment will be made for unauthorized over-excavation which has resulted from acts, neglects or delays of the Contractor.

9.73 **SUBGRADE PREPARATION** Section 9.50

Payment for the subgrade preparation will be made at the unit price per square metre shown in the Tender Form. The area will be computed using the nominal design width of the finished subgrade and the length measured horizontally along the centreline of the finished roadway, with due allowance made for increased areas at intersections. This price shall include scarifying, windrowing, watering and dewatering, shaping, compacting, proof rolling and all work incidental thereto. Payment will not be made in areas where an earth or rock fill in excess of 150 mm has been placed. No additional payment will be made for reworking the subgrade because of damage from weather conditions or improper management and protection of the surface by the Contractor.

SECTION 9 - STREETS
MEASUREMENT AND PAYMENT

9.74 **SUBBASE** Section 9.54

Payment for subbase will be made at the unit price per tonne shown in the Tender Form. This price shall include materials, materials handling, placing, watering, shaping, compacting, proof rolling, and all work incidental thereto. Payment by weight will be based on weigh certificates for material actually incorporated into the work unless otherwise approved by Engineer. No additional payment will be made for reworking the subbase because of damage from weather conditions or improper management and protection of the surface by the Contractor.

9.75 **BASE COURSE** Section 9.54

Payment for base course will be made at the unit price per tonne shown in the Tender Form. This price shall include materials, materials handling, placing, watering, shaping, compacting, and all work incidental thereto. Payment by weight will be based on weigh certificates for material actually incorporated into the work unless otherwise approved by Engineer. No additional payment will be made for reworking the subbase because of damage from weather conditions or improper management and protection of the surface by the Contractor.

9.76 **BORROW PITS, CRUSHING AND STOCKPILING** Section 9.40 and 9.41

No payment will be made for acquisition, royalties, clearing and grubbing, stripping, access, crushing or any other costs incurred in developing or operating borrow pits. Related costs for acquisition, handling and stockpiling of borrow material shall be included in the applicable tendered prices.

9.77 **DITCHES**

No separate payment will be made for excavation of drainage ditches unless otherwise shown in the Tender Form. Material excavated will be classified as common excavation, except in rock, and payment made in accordance with 9.70 except rock payment shall be made in accordance with 9.71.

9.78 **STREET NAME AND TRAFFIC SIGNS** Section 9.61

Payment for street name and traffic signs will be made at the unit price per sign shown in the Tender Form for the various signs. This price shall include all materials, erection of the sign post and sign and all work incidental thereto.

9.79 **STREET MARKINGS** Section 9.62

Payment for street markings will be made as a lump sum as shown in the Tender Form. These prices will include all materials, pre-marking, preparation, application and all work incidental thereto.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS CONTENTS

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Minimum Width of Pavement	9.03
Design Cross Sections	9.04
Description of Road Classes	9.05
Minimum Base and Pavement Strengths	9.06
Standard Longitudinal Grade	9.07
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Geometrics	9.09
Earthwork	9.10
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(REVISED NOVEMBER 2016)

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Street Markings	9.62

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS CONTENTS

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Urban Arterial (five lanes)	R1-XS2
Major Collector (four lanes)	R2-XS1
Major Collector (five lanes)	R2-XS2
Minor Collector (two lanes)	R3-XS1
Minor Collector (two lanes, turn lane)	R3-XS2
Commercial (two lanes + parking)	R4-XS1
Industrial (two lanes + parking)	R5-XS1
Neighbourhood Collector (two lanes + parking)	R6-XS1
Urban Local	R7-XS1
Urban Local (hillside cross section)	R7-XS2
Urban Local (low volume)	R7-XS3
Urban Local (low volume in existing 20.0m R/W)	R7-XS4
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Access Fronting Roads without Concrete Curbs – Type 1	R11-DW1
Access Fronting Roads with Concrete Curbs – Type 1	R11-DW2
Access Fronting Roads without Concrete Curbs – Type 2	R11-DW3
Access Fronting Roads with Concrete Curbs – Type 2	R11-DW4
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SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS DESIGN CRITERIA

9.01 SCOPE

- .1 Streets, Traffic Signs and Marking design shall be designed in accordance with the following design criteria. Deviations from these design criteria require approval by the City Engineer. **(REVISED NOVEMBER 2016)**
- .2 When particular design criteria are not specified in this section, the most current version of the Geometric Design Guide for Canadian Roads, distributed by the Transportation Association of Canada (TAC) shall be used. All design criteria from the Geometric Design Guide for Canadian Roads must be approved by the City Engineer prior to design stage. **(REVISED NOVEMBER 2016)**

9.02 MINIMUM WIDTH OF RIGHT-OF-WAY

.1	<u>Road Class</u>	<u>Min R/W Width (m)</u>	<u>STD. DWG No.</u>
	Urban Arterial	26.0 to 28.7	R1-XS1, R1-XS2
	Major Collector	25.0 to 27.5	R2-XS1, R2-XS2
	Minor Collector	25.0	R3-XS1
	Commercial/Cul-de-sac	22.0	R4-XS1, R4-CU1, R4-CU2
	Industrial/Cul-de-sac	22.0	R5-XS1, R5-CU1, R5-CU2
	Neighbourhood Collector	20.0	R6-XS1
	Urban/Rural Local/Cul-de-sac	16.5 to 20.0	R7-XS1 to R7-XS5, R7-CU1 to R7-CU4
	Lane	7.0	R8-XS1
	Half Road Section	>12.0	R9-XS1

(REVISED NOVEMBER 2016)

- .2 Where urban local roads are constructed in a half road right-of-way, the right-of-way shall be not less than 12.0m wide. **(REVISED NOVEMBER 2016)**
- .3 In hillside locations where the land slope exceeds ten percent (10%) the minimum width of right-of-way shall be 20m. Refer to the City of Nanaimo Development Services Steep Slope Guidelines.
- .4 For all other Road Classes, the minimum rights-of-way shall be as per the respective Standard Drawing unless otherwise approved by the City Engineer.

9.03 MINIMUM WIDTH OF PAVEMENT

.1	<u>Road Class</u>	<u>Min Width of Pavement(m)</u>	<u>STD. DWG No.</u>
	Urban Arterial	17.4 to 20.1	R1-XS1, R1-XS2
	Major Collector	15.6 to 18.9	R2-XS1, R2-XS2
	Minor Collector	14.2	R3-XS1
	Commercial/Cul-de-sac	14.2	R4-XS1, R4-CU1, R4-CU2
	Industrial/Cul-de-sac	14.2	R5-XS1, R5-CU1, R5-CU2
	Neighbourhood Collector	12.2	R6-XS1
	Urban /Rural Local/ Cul-de-sac	8.5 to 10.2	R7-XS1 to R7-XS5, R7-CU1 to R7-CU4
	Lane	5.7	R8-XS1
	Half Road Section	Depends on specific cross section	R9-XS1

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS DESIGN CRITERIA

- .2 Where urban local roads are constructed in a reduced road right-of-way, in no case shall the pavement width be less than 7.5m with concrete curb along at least one side of the right-of-way. On pavement edges where concrete curb is not required, a temporary 100mm asphalt curb shall be provided for drainage and traffic control.
- .3 For all road classes, the minimum width of pavement shall be as per the Standard Drawings unless otherwise approved by the City Engineer.

9.04 DESIGN CROSS SECTIONS

- .1 All road cross sections shall conform to the Standard Drawings unless otherwise approved by the City Engineer.
- .2 Centre medians for divided roads shall conform to Standard Drawing No. R12-ME1.
- .3 Alternate sidewalk location to provide a boulevard shall conform to Standard Drawing No. R10-XS1.

9.05 DESCRIPTION OF ROAD CLASSES

.1 Rural Local:

The rural local roads classification applies to roads serving rural parcels of land (0.8 ha or larger) and not designated as an arterial or collector road.

.2 Urban Local:

Urban local streets are not intended to move large volumes of traffic. A local street primarily carries traffic with an origin and/or destination along its length. It is not intended to carry through traffic other than to immediately adjoining streets. Normally, urban local streets serve only residential areas.

.3 Urban Local (Low Volume):

The urban local (low volume) street classification has similar requirements to urban local streets but is to be applied to short cul-de-sacs and crescents serving residential areas.

.4 Neighbourhood Collector:

The neighbourhood collector provides traffic and land service to connect local roads to urban collectors. This classification provides the same service as local roads but provides for higher volumes of traffic by providing more width to reduce conflict with on-street parking.

.5 Minor Collector:

Minor collector streets provide traffic and land service. The function of this type of street is to carry traffic from local roads to major roads. Urban minor collector roads include two vehicle through lanes and may include turning lanes. Full access to adjacent properties is generally allowed on minor collectors with some restrictions at intersections.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS DESIGN CRITERIA

.6 Major Collector:

Major collector streets provide traffic and land service. The function of this type of street is to carry traffic from local roads to arterial roads. Urban major collector roads include up to four vehicle through lanes, and may include turning lanes. Direct access to adjacent properties is minimized with adequate separation from intersections.

.7 Urban Arterial

Urban arterial streets carry traffic between the principle areas of traffic generation. They are intended to carry large volumes of all types of traffic. Urban arterial streets shall be designed to minimize direct access to development. Access will be provided by adjoining streets, lanes, and rights-of-way.

.8 Commercial and Industrial:

This classification applies to roads serving commercial or industrial lands. The road is intended to carry a higher percentage of truck traffic and provide for on-street parking.

9.06 MINIMUM BASE AND PAVEMENT STRENGTHS

- .1 The minimum standards shall be as shown. Pavement and road structure design shall be based on Benkelman Beam rebound values as outlined in the most current edition of the "Pavement Design and Management Guide", distributed by the Transportation Association of Canada. The maximum Benkelman Beam deflection tested shall be corrected for seasonal variation. If required, the minimum standards shall be increased to meet the maximum Benkelman Beam deflection. Proof of minimum strengths shall be required.

	<u>Local</u>	<u>Collector</u>	<u>Arterial, Industrial & Commercial</u>
Coarse Gravel Sub-base, compacted 75mm minus	250mm	250mm	250mm
Crushed Gravel Base, compacted 20mm minus	100mm	100mm	100mm
Hot plant-mix asphalt pavement, compacted	50mm	75mm	75mm
Asphalt prime coat	As directed	-	-
Maximum Benkelman Beam deflection	1.5mm	1.25mm	0.75mm
Minimum compaction of subgrade and gravel	95% modified proctor	95% modified proctor	95% modified proctor

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS DESIGN CRITERIA

- .2 Where works are to be constructed in and/or adjacent to existing streets and existing pavements do not meet the maximum Benkelman Beam deflection, the City of Nanaimo may require its removal and replacement with new road and pavement structure to meet the current standard.

9.07 STANDARD LONGITUDINAL GRADE

.1	Minimum desirable for concrete gutter	0.50%
	Minimum absolute for concrete gutter	0.40%
	Maximum desirable local streets	8%
	*Maximum absolute local streets	12%
	Maximum collector or arterial streets	8%
	Maximum cul-de-sac bulb	6%
	Minimum lanes	0.5%
	*Maximum lanes	12%
	*Maximum desirable approach to intersection	5%
	*Maximum desirable approach to T-intersection	3%

*Unless otherwise approved by the City Engineer.

.2 Vertical Curvature at Intersections (K Values):

Providing the minor intersecting street is marked as a STOP, the following K Values may be used for the minor street:

<u>Classification</u>	Crest Curves		Sag Curves	
	<u>Min</u>	<u>Pref</u>	<u>Min</u>	<u>Pref</u>
Collector	4	6	4	6
Local	2	4	1.5	4

Minimum K Values for sag curves may be used where street lighting is provided.

9.08 STANDARD CROWN AND CROSSFALL GRADES

- | | | |
|----|--------------------------|----|
| .1 | Street pavements minimum | 2% |
| | Street pavements maximum | 6% |
- .2 All roads shall normally be a crown section. Crossfalls shall require prior approval from the City Engineer.

9.09 GEOMETRICS

- .1 Vertical curves, super elevation, spirals and intersection geometrics shall be designed in accordance with the most current standards in the Geometric Design Guide for Canadian Roads, distributed by the Transportation Association of Canada (TAC).
- .2 Reverse curves shall have a minimum tangent length of 30m between curves where one of the curves has a centerline radius less than 100m. This shall apply to all classifications of roads.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS DESIGN CRITERIA

9.12 ACCESS DRIVEWAYS

- .1 Driveway approaches shall be a minimum 4.25m wide and paved to the edge of the road right-of-way. Gravel and earthwork slopes in cut and fill shall be a maximum 1.5H:1V on private property.
- .2 Rock slopes in cut shall be a maximum 1H:4V.
- .3 The grade of a residential driveway shall not exceed 20%.
- .4 For access driveways fronting arterial and collector roads.
 - (a) The vertical transition curves shall not exceed a grade change of 6% for each horizontal 3.5m distance, with proper vision clearance being provided at the street. The vertical transition curve shall begin 2.0m behind the curb or future curb location towards the property. Refer to Standard Drawings No. R11-DW1 and R11-DW2 for driveway profiles fronting arterial and collector roads.
- .5 For Access Driveways Fronting Urban Local, Rural Local Roads, and neighbourhood collectors:
 - (a) The vertical transition curves, shall not exceed 12% for each horizontal 3.0m distance, with proper vision clearance being provided at the street. The vertical transition curve shall begin 2.0m behind the curb or future curb location towards the property. Refer to Standard Drawings No. R11-DW3 and R11-DW4 for driveway profiles fronting urban local and rural local roads.
- .6 Access driveways shall conform to the City's Crossing Control Bylaw.

9.13 - NOT USED -

9.14 STREET NAME AND TRAFFIC SIGNS

- .1 The design and construction of all roads shall include the design and installation of traffic signs (regulatory and warning), and traffic signals, in accordance with the most current standards contained in the "Manual of Uniform Traffic Control Devices for Canada" distributed by the Transportation Association of Canada (TAC).
- .2 Street name signs shall be provided at all intersections, where possible, the street name sign shall be located above a traffic sign at one corner of the intersection.
- .3 Sign installation shall provide a minimum of 2.0m vertical clearance from the ground to the bottom of the sign.
- .4 Signs shall not be located in sidewalks unless approved by City Engineer.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS DESIGN CRITERIA

9.15 STREET MARKINGS

- .1 The design and construction of all roads shall include the design and application of pavement markings and hazard and delineation markings in accordance with the most current standards contained in the Manual of Uniform Traffic Control Devices in Canada distributed by the Transportation Association of Canada (TAC). When particular design criteria are not specified in that document, the Manual of Standard Traffic Signs and Pavement Markings distributed by the Ministry of Transportation and Infrastructure may be considered. **(REVISED NOVEMBER 2016)**
- .2 Crosswalk locations shall be determined in accordance with the City of Nanaimo Traffic and Highway Installation Guidelines, and the Manual of Standard Traffic Signs and Pavement Markings distributed by the Ministry of Transportation and Infrastructure or as required by the City Engineer. **(REVISED NOVEMBER 2016)**
- .3 Refer to Section 9.38 for Street Marking Specifications.

9.16 TEMPORARY TURN-A-ROUNDS

- .1 Temporary asphalt turn-a-rounds shall be required for all temporary dead end streets. Extent of works to be determined on a site specific basis and approved by the City Engineer.
- .2 Refer to Standard Drawing No. R7-CU5 and Standard Drawing No. R7-CU6 for temporary turn-arounds.

9.17 ROUNDBABOUTS AND TRAFFIC CIRCLES

Roundabouts and traffic circles shall be used as directed by the Nanaimo Transportation Master Plan and at the discretion of the City Engineer. When a roundabout or traffic circle is required, the extent of the works shall be determined on a site specific basis and approved by the City Engineer. **(REVISED NOVEMBER 2016)**

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS SPECIFICATIONS

9.20 SCOPE

- .1 This specification refers to preparation and construction of the road subgrade, sub-base, and base course. Only those products approved by the City Engineer and listed in the City of Nanaimo Approved Products List will be accepted for installation. When the City of Nanaimo Approved Product List does not list a product, the Ministry of Transportation and Infrastructure's Recognized Product List shall be referenced. Only those products approved by the City Engineer will be accepted for an installation. **(REVISED NOVEMBER 2016)**

9.21 TESTING

- .1 The Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates non-compliance with the specifications, additional testing shall be required at the Contractor's expense.
- .2 The Contractor as directed by the Engineer shall supply specimens or samples for testing.
- .3 The types of tests listed below may be required.
 - (a) Regular sieve analysis of aggregate gradation during the crushing operation and during the delivery of aggregate to the project site in accordance with ASTM C136.
 - (b) Determination of optimum moisture content and Modified Proctor Density (ASTM D1557) on all materials to be used for subgrade, sub-base and base course construction.
 - (c) Determination of moisture content and Modified Proctor Density on the remolded subgrade, sub-base and base course materials in place during construction shall be as per ASTM D1557 or ASTM D6938 Standard Test Methods. A minimum of one field density test of subgrade or granular base per 1000m² for roads and per 50lm for sidewalks, will be performed. **(REVISED NOVEMBER 2016)**
 - (d) Benkelman beam tests on the prepared subgrade, sub-base, base and pavement.
 - (e) Other testing as required by the Engineer.

9.22 DESIGN SUBGRADE CROSS SECTION

- .1 Design subgrade cross section shall mean the surface of the finished subgrade upon which select granular sub-base material is to be placed.

9.23 OVERBURDEN

- .1 Overburden shall mean the surface material which, in the opinion of the Engineer, is not suitable for classifying as topsoil or earth fill.

9.24 TOPSOIL

- .1 Topsoil is surface material containing organic components and which, in the opinion of the Engineer, is suitable for landscaping.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS SPECIFICATIONS

9.24A STRIPPING

- .1 Stripping is the excavation of topsoil and overburden including the stockpiling of topsoil at a location approved by the Engineer and disposal of overburden as specified in Section 4.11 - Disposal of Excavated Material.

9.25 COMMON EXCAVATION

- .1 Common excavation is the excavation and removal of all material encountered which is not classified as rock.

9.25A ROCK EXCAVATION

- .1 Rock excavation is the removal of solid rock which requires drilling and blasting or breaking with a power-operated tool for its removal, or is detached masses of rock having individual volumes in excess of 1.0m³. Detached masses of rock include boulders and pieces of concrete or masonry.
- .2 Removal of soft or disintegrated rock which can be removed with a hand pick or power-operated excavator or shovel, or previously blasted or broken stone in rock fills or elsewhere with individual volumes less than 1.0m³, or boulders or pieces of fractured rock which do not occur naturally within the excavated volume but fall into the excavation from the adjacent area, will not be classified as rock excavation. Hard pan (glacial till) will not be classified as rock excavation.
- .3 Overbreak, is that portion of solid rock which is excavated, displaced or loosened outside the limits used to calculate the volume of rock excavation and will be classified as unauthorized overexcavation.

9.26 AUTHORIZED OVEREXCAVATION

- .1 Authorized overexcavation is that excavation required by the Engineer as a result of unsuitable foundation conditions not resulting from the Contractor's operation.

9.26A UNAUTHORIZED OVEREXCAVATION

- .1 Unauthorized overexcavation is that excavation required as a result of the Contractor's operation as determined by the Engineer.

9.27 EARTH FILL

- .1 Earth fill shall include all fills comprised of common excavation containing less than 15% by volume of rock larger than 150mm in size, free of organic and deleterious matter and frozen earth lumps and shall be approved by the Engineer prior to placement.

9.27A IMPORTED EARTH FILL

- .1 Imported earth fill is defined as material imported from outside the project site to meet the specifications for earth fill.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS SPECIFICATIONS

9.28 ROCK FILL

Rock fill shall include all fills comprised of material containing more than 85% by volume of rock larger than 150mm in size, free of organic and deleterious matter. Rock fill shall not contain rocks greater than 600mm in diameter and be approved by the Engineer prior to placement.

9.28A IMPORTED GRANULAR FILL

- .1 Imported granular fill shall consist of well graded granular material, with not more than 8% passing the 0.075mm sieve, which contains no stones larger than 150mm in diameter and contains no stumps, roots, organic or other deleterious material.
- .2 All imported granular fill shall require approval by the Engineer prior to placement.
 - (a) A wet sieve analysis (ASTM C117) may be required by the Engineer to confirm the fines content of the imported granular fill material.
- .3 The use of quarried or blast rock as import granular fill requires specific approval by the City Engineer unless listed in the City of Nanaimo Approved Product List. Quarried or blast rock shall be hard and durable, well graded, with not more than 8% passing the 0.075mm sieve, which contains; no stones larger than 150mm in diameter and no stumps, roots, organic or other deleterious material.

9.29 ROAD SUB-BASE GRAVEL COURSE

- .1 Sub-base shall be a pit run gravel, screened if necessary, composed of inert, durable aggregate, uniform in quality and free from soft or disintegrated particles, clay and silt balls and other deleterious material, and shall conform to the following gradation limits when tested in accordance with ASTM C136:

US Standard Sieve Size	Gradation Limits (Percent by Weight Passing)
75mm	100
25mm	50 - 85
0.15mm	0 – 16
0.075mm	0 - 5

9.30 ROAD BASE GRAVEL COURSE

- .1 The base course shall be composed of inert, clean, tough, durable, crushed aggregate, uniform in quality and free from soft or disintegrated pieces. The aggregate particles shall be uniform in quality and free from an excess of flat or elongated particles. In the absence of satisfactory performance records over a 5-year period of the particular source of aggregate, its soundness shall be tested in accordance with ASTM C88 using magnesium sulfate. Maximum weighted average losses for coarse aggregate shall be 20% and for fine aggregate, 25%. The sand equivalent value when tested in accordance with ASTM D2419 shall not be less than 40. The Los Angeles abrasion value when tested in accordance ASTM C131 shall have a maximum loss by mass of 25%.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS SPECIFICATIONS

The aggregate gradation shall fall within the following limits when tested in accordance with ASTM C136:

US Standard Sieve Size	Gradation Limits (Percent by Weight Passing)
25mm	100
19mm	80 – 100
9.5mm	50 – 85
4.75mm	35 – 70
2.36mm	25 – 50
1.18mm	15 – 35
0.3mm	5 – 20
0.075mm	0 - 5

(REVISED NOVEMBER 2016)

- .2 The Contractor shall submit to the Engineer for approval his proposed base course gradation for the project. Upon approval, this gradation curve shall become the project gradation. All samples of base course aggregate used on the project shall conform to the following requirements:

- (a) Deviation between samples and the project gradation shall not exceed the following limits:

US Standard Sieve Size	Gradation Limits (Percent by Weight Passing)
Larger than 2.36mm	±3.5%
1.18mm – 2.36mm	±3.5%
0.3mm – 0.6mm	±2%
0.075mm – 0.15mm	±1%

- (b) All sample gradations shall fall within the gradation limits.
 (c) A minimum of 50% of all material retained on the 4.75mm sieve shall have at least one fractured face. The percentage shall be determined by particle count.

9.31 RECLAIMED ASPHALT PRODUCT

- .1 Reclaimed Asphalt Product (RAP), sourced from excavated road mix, may be used in conjunction with crushed aggregate to produce a blended product conforming to Section 9.30 - Road Base Gravel Course for the following applications: **(REVISED NOVEMBER 2016)**

- (a) Road base gravel course on low volume roads. (Urban Local, Rural Local, Cul-de-Sac and Lane) RAP shall be uniformly crushed, screened and blended. Maximum RAP content shall be 10% by volume of the finished product. **(REVISED NOVEMBER 2016)**
- (b) Road Gravel for gravel shoulders and gravel parking areas RAP shall be uniformly crushed, screened and blended. Minimum RAP content shall be 10% and the Maximum RAP content shall be 30% measured by volume of the finished product. **(REVISED NOVEMBER 2016)**

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS SPECIFICATIONS

9.32 - NOT USED -

9.33 - NOT USED -

9.34 STREET NAME SIGNS

- .1 Street name signs shall be double sided and constructed of 3mm x 200mm flat sign grade aluminum with rounded corners. **(REVISED NOVEMBER 2016)**
- .2 The sign shall consist of diamond grade reflective sheeting with transparent blue Electro Cut vinyl. Letters shall be 150mm Helvetian Med font and shall be upper and lower case. **(REVISED NOVEMBER 2016)**
- .3 The abbreviations St., Dr., Pl., Rd., etc., are to be the same height as the street name.

9.35 TRAFFIC SIGNS

- .1 Traffic sign shapes, colours, dimensions, symbols and wording shall be in accordance with the standards detailed in the most current Motor Vehicle Act Regulations.
- .2 Illumination or reflectorization of signs shall also be in accordance with the standards detailed in the most current Motor Vehicle Act.
 - (a) Signs shall be made on 12 gauge (3mm) sign grade aluminum.
 - (b) Reflective sheeting shall be diamond grade. Signs for Parking Restrictions, Loading Zones, Bus Stops and No Stopping shall be engineering grade and no more than 300mm wide. **(REVISED NOVEMBER 2016)**

9.36 FASTENERS - STREET NAME AND TRAFFIC SIGNS

- .1 Non-corrosive metal fasteners shall be used for attaching all signs to their supports to avoid discolouration.

9.37 STREET NAME AND TRAFFIC SIGN POSTS

- .1 Street name and traffic sign posts and anchors shall be roll formed from strip steel (structural quality) in accordance with ASTM A653, Grade 33. **(REVISED NOVEMBER 2016)**
- .2 Sign posts shall be 50mm x 50mm 12 gauge (3mm) galvanized with perforations. (12mm diameter holes at 50mm O.C. on four sides)
- .3 Anchor bases shall be double sleeve consisting of a 0.90m base and a 0.45m sleeve. Anchor bases shall be 57mm x 57mm 12 gauge (3mm) galvanized square tubing with perforations. (12mm diameter holes at 50mm O.C. on four sides)

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS SPECIFICATIONS

9.38 STREET MARKINGS

- .1 Paint for curb markings delineating "Bus Stops" shall be red, "No Parking" yellow, and "Loading Zones" white.
- .2 All marking paint shall be pre-qualified according to the Province of British Columbia Ministry of Transportation and Infrastructure (MOTI) qualification procedures and test methods. Marking paint shall be suitable for spray application at a temperature of $50^{\circ}\text{C} \pm 5^{\circ}$ to asphalt or concrete pavements and shall meet the MOTI General Specifications for Highway Construction Section 321 - Traffic Paint.
- .3 The paint shall be used with overlay glass reflectorizing beads. Paint shall not have any "Premix" beads.
- .4 Reflectorizing glass beads shall conform to the MOTI Specifications for Glass Beads.
- .5 All crosswalks, stop bars, dashed lane lines, white solid storage bay lane lines, continuity lines, guiding lines and traffic arrows shall be thermoplastic with a minimum thickness of 3mm.
- .6 Refer to Section 9.15 for street marking design criteria and Section 9.62 for street marking installation.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS INSTALLATION

9.40 BORROW PIT DEVELOPMENT

- .1 Prior to removal of any material from a borrow pit, the entire site to be excavated shall be cleared and grubbed and stripped of all unsuitable overburden. Combustible material shall be disposed of as directed by the Engineer. Overburden shall be removed to suitable locations approved by the Engineer.
- .2 Borrow pits shall be excavated such that they will be free draining to the lowest corner or to such other location as determined by the Engineer. Reject material from the pit operation shall be removed from the pit area and disposed of as specified for overburden.

9.41 STOCKPILING

- .1 All aggregate materials shall be stockpiled prior to use at either the crushing site or such other location on the jobsite subject to the approval of the Engineer. Stockpile sites shall be cleared of all vegetation, trees, brush, rocks and other debris and covered with a uniform layer of pit run gravel prior to deposition of the material.
- .2 Stockpiles shall be built up in layers not exceeding 1.0m in thickness to a minimum height of 3m in such a manner as to prevent any appreciable segregation. End dumping over the edge of the stockpile will not be permitted.
- .3 Planks or protected runways for vehicles shall be provided as necessary to prevent contamination of the stockpile.

9.42 ROAD ALIGNMENT AND GRADE

- .1 The streets shall be constructed to the alignment and grade specified on the drawings. The Contractor's methods to maintain alignment and grade shall be approved by the Engineer.

9.43 ROADWAY CONSTRUCTION CONDITIONS

- .1 Construction shall not be undertaken during snow, heavy rain, freezing, or other unsuitable conditions. Aggregate shall not be placed upon a frozen, wet, muddy or rutted subgrade or sub-base surface, unless otherwise directed by the Engineer.

9.44 STRIPPING

- .1 Prior to commencing excavation operations, those areas designated by the Engineer shall be stripped of all overburden and topsoil. Overburden shall be disposed of as specified in Section 4.11 - Disposal of Excavated Material. Topsoil shall be stockpiled at locations approved by the Engineer. Stumps, boulders and other deleterious matter shall be removed from the topsoil and disposed of as specified in Section 4.11 - Disposal of Excavated Material.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS INSTALLATION

9.45 COMMON EXCAVATION

- .1 All material classified as common excavation shall be removed, to the design subgrade cross section, or as otherwise established by the Engineer.
- .2 Material which, in the opinion of the Engineer, is not suitable for use as earth fill or rock fill or not required for the works as shown on the construction drawings shall be disposed of as specified in Section 4.11 - Disposal of Excavated Material.
- .3 Material which is suitable for earth fill or rock fill shall be placed and compacted in those areas requiring filling to the design subgrade cross section.
- .4 The Contractor may strip and salvage existing surface gravel from roadways to be regraded. This material may be reused as sub-base if, in the opinion of the Engineer, it conforms to this specification. However, in no case shall it be reused as base course.

9.46 ROCK EXCAVATION

- .1 Rock excavation shall be carried out to the design subgrade cross section. No points or pinnacles of rock shall be left protruding above the rock cut cross section. Subgrade rock shall be shattered at least 300mm below the subgrade.
- .2 In rock cuts, care shall be exercised to ensure no damage is caused to the supporting rock below the roadway. Damage so caused shall be repaired to a condition acceptable to the Engineer at no additional cost to the Owner.
- .3 Overbreak shall be removed as directed by the Engineer and replaced with sub-base material placed and compacted as specified herein at no additional cost to the Owner.

9.47 AUTHORIZED OVEREXCAVATION

- .1 Authorized overexcavation shall be replaced with earth fill, rock fill, imported granular fill, sub-base material or base course as directed by the Engineer. Replacement fill shall be placed as specified elsewhere herein.

9.48 UNAUTHORIZED OVEREXCAVATION

- .1 Replacement of unauthorized excavation shall be as specified in Section 9.47 - Authorized Overexcavation and shall be at no additional cost to the Owner.

9.49 - NOT USED -

9.50 SUBGRADE PREPARATION

- .1 In areas where, after stripping, a fill in excess of 150mm is required to bring the finished subgrade to the design subgrade elevation, earth fill or rock fill shall be placed as specified elsewhere herein.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS INSTALLATION

- .2 In areas where after stripping, a cut or a fill of 150mm or less is required to bring the finished subgrade to the design subgrade elevation, the subgrade shall be scarified to a minimum depth of 150mm below the design subgrade elevation and all material windrowed to one side. The exposed surface shall then be compacted to 90% of Modified Proctor Density (ASTM D1557), the windrowed material moved, and the compaction repeated on the other side. Windrowed material shall then be brought to its optimum moisture content, shaped to line and grade, and compacted to 95% of Modified Proctor Density (ASTM D1557).
- .3 At transitions between cut and fill areas, the subgrade in the cut area shall be scarified and recompacted as specified above to a depth of 150mm for a distance of 20m beyond the transition from a fill.
- .4 The subgrade in cut areas shall be prepared 600mm wider on each side than the required width of the finished base course. In fill areas embankments shall be constructed to the required width of the finished base course as shown on the drawings with the specified side slopes. The finished subgrade shall be crowned and sloped as required to prevent ponding of water on the roadway.
- .5 Soft or unstable subgrade material shall be excavated and replaced as specified in Section 9.47 - Authorized Overexcavation. If, in the opinion of the Engineer, the overexcavation is necessitated as a result of the Contractor's operations it will be classified as unauthorized overexcavation.

9.51 WATERING FOR COMPACTION AND DUST CONTROL

- .1 If weather conditions and construction materials are such that watering may be required, upon direction from the Engineer, the Contractor shall maintain suitable watering equipment on the site. Watering shall be performed as directed by the Engineer to control dust and to ensure optimum moisture conditions for earth fill compaction, subgrade preparation and placing sub-base and base course materials.
- .2 Water in excess of that required for optimum moisture conditions may be used only with the Engineer's approval, to obtain the specified density.
- .3 Water shall be supplied uniformly from a pressure type distributor equipped with suitable control apparatus and a spray bar and nozzles similar to those used on asphalt distributors. Splash plate type distributors or distributors with spray bars which discharge jets of water require approval by the Engineer.

9.52 EARTH FILLS

- .1 Earth fills shall be constructed in such a manner that they will be completely stable at all times during construction. Silts and clays shall not be used without proper aeration and drying. Placing of frozen material in fill areas will not be permitted.
- .2 Earth fills not exceeding 600mm (compacted thickness) shall be constructed in layers not exceeding 150mm (uncompacted thickness). Each layer shall be compacted to 95% Modified Proctor Density (ASTM D1557).

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS INSTALLATION

- .3 Earth fills exceeding 600mm (compacted thickness) shall be constructed in layers not exceeding 200mm (uncompacted thickness). Each layer shall be compacted to 95% Modified Proctor Density, except the top 600mm (compacted thickness) which shall be constructed as per Section 9.52.2.
- .4 Where shown on the construction drawings, or as directed by the Engineer, the existing side slopes shall be scarified or terraced to ensure a proper bond between existing and fill materials. Methods shall be approved by the Engineer prior to commencing work.
- .5 Should any soft spots develop during the process of compaction, such areas shall be excavated and replaced as specified in Section 9.47 - Authorized Overexcavation. If in the opinion of the Engineer, the excavation is necessitated as a result of the Contractor's operations, it will be classified as unauthorized overexcavation.

9.53 ROCK FILLS

- .1 Rock fills shall be constructed in layers equal in thickness to the largest average size of the material, but not exceeding 600mm. Material shall be placed and spread in such a manner that the larger rocks are well distributed and the intervening void spaces are filled with sufficient amounts of smaller rocks and fines to create a stable structure. Fill surface voids at the subgrade level to prevent migration of sub-base gravels into the rock fill.

9.54 PLACING AND COMPACTING SUB-BASE AND BASE COURSE

- .1 The subgrade shall be approved prior to placement of the sub-base course.
- .2 Sub-base and base course materials shall be approved by the Engineer prior to being delivered to the project site. Approval shall require testing as per Section 9.21 - Testing.
- .3 Sub-base and base course shall be placed on the approved subgrade in those locations and to the compacted thicknesses and dimensions shown on the drawings or as otherwise directed by the Engineer. Testing shall be in accordance with Section 9.21 - Testing, Section 9.56 – Proof Rolling and Section 9.57 – Benkelman Beam Testing.
- .4 Sub-base and base courses shall be placed in maximum 150mm lifts, and shall be spread in an approved manner such that the aggregate is neither segregated nor contaminated with foreign material. Segregated materials shall be remixed until uniform. The sub-base course shall be approved prior to placement of the base course.
- .5 Immediately following spreading, the sub-base and base courses shall be graded and compacted at optimum moisture content to 95% of Modified Proctor Density (ASTM D1557).

9.55 FINISHED GRADE

- .1 The finished grade surface of the compacted subgrade shall be within 15mm of the design grade and cross section, but not uniformly high or low, when measured with a 3.0m straightedge parallel or perpendicular to the road centreline.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS INSTALLATION

- .2 The finished grade surface of the compacted sub-base course shall be within 15mm of the design grade and cross section, but not uniformly high or low, when measured with a 3.0m straightedge parallel or perpendicular to the road centre line.
- .3 The finished grade surface of the compacted base course shall be within 10mm of the design grade and cross section, but not uniformly high or low, when measured with a 3.0m straightedge parallel or perpendicular to the road centre line.

9.56 PROOF ROLLING

- .1 Before proceeding further with the work, each finished layer of subgrade, and sub-base and base course shall be proof rolled by receiving complete coverage using a single axle truck having an 8000 kg rear axle load and a tire pressure of 550kPa. Benkelman Beam testing may be required in conjunction with proof rolling. Should any areas of rutting or displacement result, they shall be excavated and refilled as specified in Section 9.47 Authorized Overexcavation. If, in the opinion of the Engineer, the excavation is necessitated as a result of the Contractor's operations it will be classified as unauthorized excavation. Excavated and refilled areas shall be retested to confirm rutting and/or displacement has been eliminated.
- .2 Intermediate tests will be conducted on the sub-base prior to placement of road base material, and on the road base immediately prior to paving. Results of the intermediate tests will be supplied to the Contractor as a quality control guide, but will not constitute acceptance or rejection of the work.
- .3 It shall be the Contractor's responsibility to provide a single axle, dual wheel truck and driver for the tests. The truck shall be equipped with 250 x 500mm, 12-ply tires inflated to a pressure of 550kPa. The truck shall have an 8000kg rear axle load distribution on both wheels.
- .4 Where proof rolling is likely to damage works or access is limited, determination of moisture content and Modified Proctor Density on the re-molded subgrade, sub-base and base materials shall be performed as per Section 9.21 – Testing, Clause 3(c).

9.57 BENKELMAN BEAM TESTING

- .1 Prior to paving, the finished base course shall be checked by the Engineer for deflections utilizing a Benkelman Beam or other approved testing device.
- .2 Results of the test will be used to determine the final pavement strength resulting from the placement of the specified thickness of asphaltic concrete.
- .3 If the calculated deflections are in excess of the maximum Benkelman Beam deflections, as outlined in Section 9.06 – Minimum Base and Pavement Strengths, measures shall be taken to strengthen the road base and pavement structure prior to paving. Paving shall not proceed until the test results meet the minimum requirements.
- .4 Benkelman Beam test procedures, and the estimation of pavement strength shall be as outlined by "A Guide to the Structural Design of Flexible and Rigid Pavement in Canada" and the "Pavement Design and Management Guide", distributed by the Transportation Association of Canada.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS INSTALLATION

9.58 - NOT USED -

9.59 CLEANUP

- .1 Prior to completion of construction, all existing and newly constructed drainage ditches, waterways, and culverts shall be cleaned to restore their full effectiveness. Boulevards and all other areas affected by the construction operation shall be cleaned of all loose rock, boulders and the debris and in all respects prepared suitable for placement of topsoil or as otherwise directed by the Engineer.

9.60 BOULEVARD GRADING

- .1 Boulevard areas and other areas within the road allowance or right-of-way shall be sloped, graded with 100mm of topsoil and seeded with grass as shown on the drawings. The requirement for placement of topsoil and grass seeding shall be determined by the Engineer. As a general statement, top soil placement and grass seeding is not required in boulevards fronting undeveloped lots. **(REVISED NOVEMBER 2016)**

9.61 STREET NAME AND TRAFFIC SIGNS

- .1 Street name and traffic signs shall be located as shown on the drawings and as directed by the Engineer. All signs shall be mounted approximately at right angles to the direction of and facing the traffic they are intended to serve except in the case of No Parking and No Stopping signs. All signs to conform to the most current standards in the Canadian Manual of Uniform Traffic Control Devices (MUTCD).
- .2 Reflectorized signs shall be placed at a slight angle away from approaching traffic.
- .3 Sign post bases shall be installed in accordance with the City of Nanaimo Manual of Engineering Standards and Specifications. Refer to the Standard Drawings No. R-S1 to No. R-S6.
- .4 Anchor posts shall be provided for sign base installations where native soils are unable to hold the sign rigidly in its proper and permanent position and to prevent it from swaying in the wind, from being turned or otherwise displaced.
- .5 Median signage shall be as shown on Standard Drawing No. R-S4 to No. R-S7.
- .6 Unless otherwise specified, street signs shall be supplied by the City of Nanaimo at the Developer's expense.

9.62 STREET MARKINGS

- .1 Layout works as shown on the construction drawings.
- .2 Pavement surface shall be free from surface water, frost, ice, dust, oil, grease and other foreign materials. In areas designated by the Engineer, clean pavement surface by method approved by the Engineer.
- .3 Apply paint only when air temperature is above 10°C and no rain is forecast.

SECTION 9 - STREETS, TRAFFIC SIGNS AND MARKINGS INSTALLATION

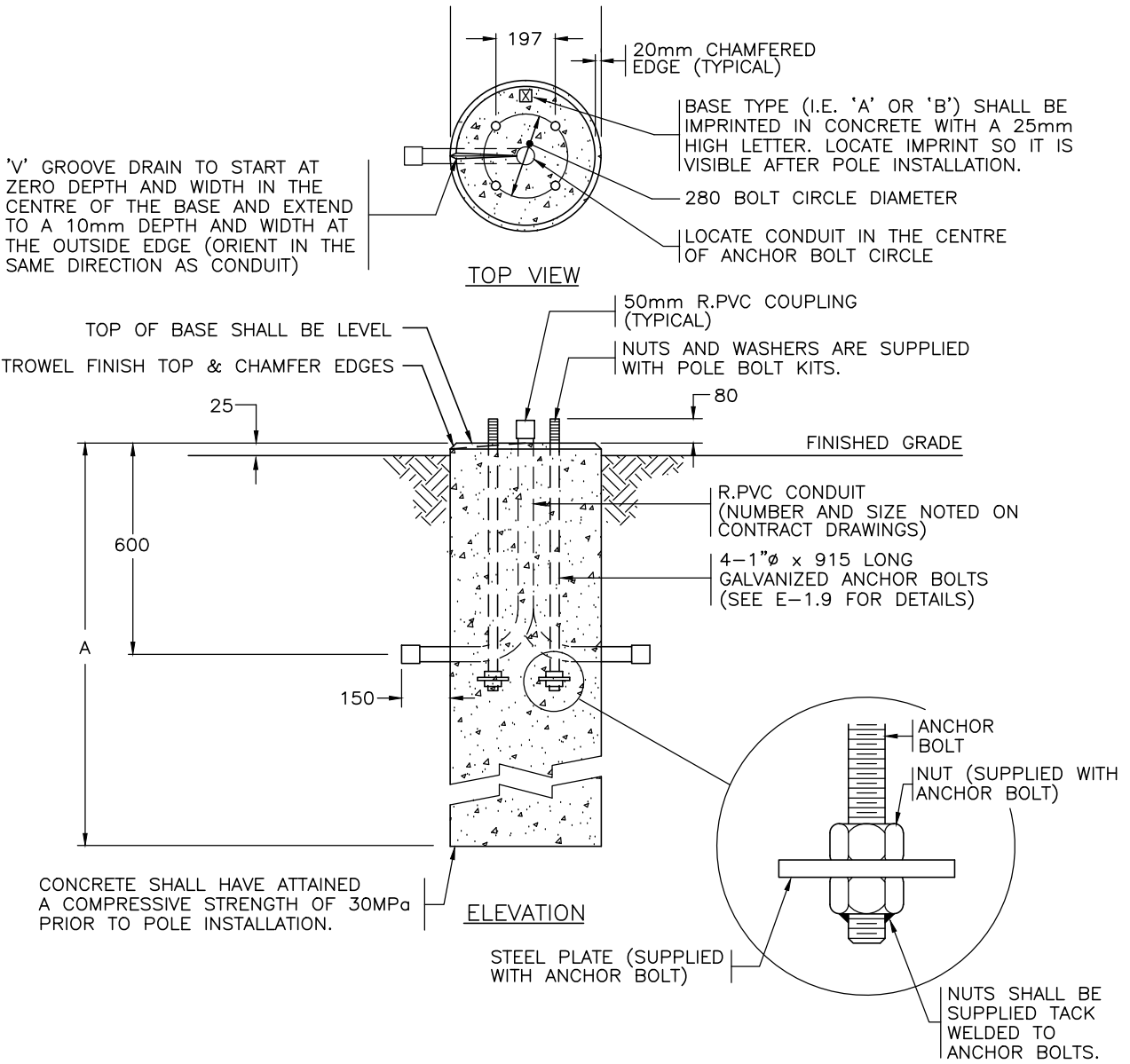
- .4 Apply paint evenly at 3m²/ litre.
- .5 Do not thin paint unless approved by the Engineer.
- .6 Paint lines to be of uniform colour and density. No overspray will be allowed.
- .7 Thoroughly clean distributor tank before refilling with a different colour paint.
- .8 Apply glass beads at a specified rate.
- .9 Paint markings shall be within ± 10 mm of specified dimensions.
- .10 Protect pavement markings until they are dry.
- .11 Thermoplastic shall be applied in accordance with the manufacturer's recommendations.
- .12 Refer to Section 9.38 for street marking specifications.

BASE INDEX		
TYPE	DRAWING	POLE TYPES
A	E-1.2	TYPE 4 SIGNAL POST
B	E-1.2	TYPE 4A & 5 SIGNAL POST & 4.0m, 6.0m & 7.5m POST TOP LUMINAIRE POLES.
C	E-1.3 & E-1.4	7.5m, 9.0m & 11.0m DAVIT LUMINAIRE POLES
C1	E-1.3 & E-1.4	6.6m, 8.1m & 10.1m LUMINAIRE POLES & 3.1m, 5.1m & 6.6m POST TOP LUMINAIRE ON 0.9m HIGH SERVICE BASE
E2	E-1.5 & E-1.6	TYPE 1 AND 3 SIGNAL POLES
F2	E-1.7 & E-1.8	TYPE 6 AND 7 SIGNAL POLES
L2	E-1.7 & E-1.8	TYPE L SIGNAL POLE
-	SECTION 9.0 R-S4 & R-S5	POST MOUNTED FLASHER CONCRETE BASE

NOTES

1. REFER TO SECTION 10 – ROADWAY LIGHTING AND TRAFFIC SIGNALS FOR SPECIFICATIONS





BASE TYPE	POLE TYPE	APPROXIMATE MASS	VOLUME OF CONCRETE	DIM A
A	TYPE 4 SIGNAL POST (2.5m)	600 kg	0.24 m ³	1200
B	TYPE 4A SHAFTS & 4.0m & 6.0m POST TOP LUMINAIRE POLES	760 kg	0.30 m	1500

- NOTES**
- REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
 - ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
 - SEE DRAWINGS E-1.13 & E-1.14 FOR BACKFILL REQUIREMENTS.



TYPE A & B SONOTUBE CONCRETE BASES

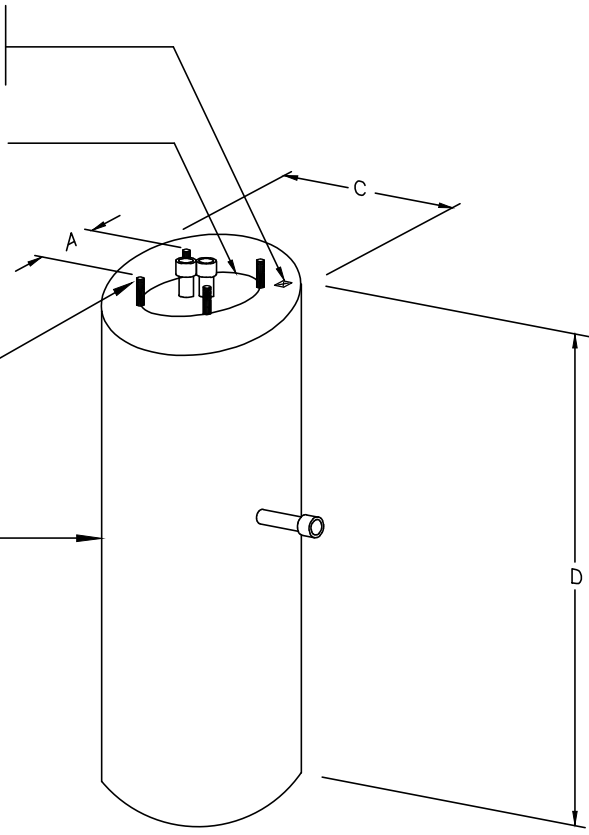
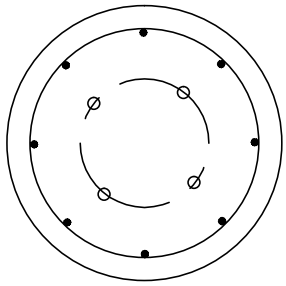
Scale: N.T.S.
 Created: MAY 2006
 Rev Date: NOV 2016
 Dwg No: E-1.2

BASE TYPE (I.E. 'D' OR 'D1') SHALL BE INPRINTED IN CONCRETE WITH A 25mm HIGH LETTER(S). LOCATE IMPRINT SO IT IS VISIBLE AFTER POLE INSTALLATION.

B (ANCHOR BOLT CIRCLE)

4-1"Ø x 915mm LONG GALVANIZED ANCHOR BOLTS (SEE E1.9 FOR DETAILS)

CONCRETE SHALL HAVE ATTAINED A COMPRESSIVE STRENGTH OF 30MPa PRIOR TO POLE INSTALLATION



PRECAST OR CAST IN PLACE CONCRETE BASES

BASE TYPE	POLE TYPE	APPROXIMATE MASS	VOLUME OF CONCRETE	A	B	C	D	REINFORCING
D	7.5m, SINGLE LUMINAIRE	2000 kg	0.39m ³	197	250	500	2200	6-15M VERTS 10M SPIRAL @ 150
D1	9.1m, DOUBLE LUMINAIRE	2000 kg	0.62m ³	269	380	600	2200	8-15M VERTS 10M SPIRAL @ 150

NOTES

- REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
- SEE DRAWING E-1.4 FOR ADDITIONAL DETAILS.
- SEE DRAWINGS E-1.13 & E-1.14 FOR BACKFILL REQUIREMENTS.
- CLEAR COVER TO REINFORCING 50mm.



TYPE D & D1 SONOTUBE PRECAST OR CAST-IN-PLACE CONCRETE BASES

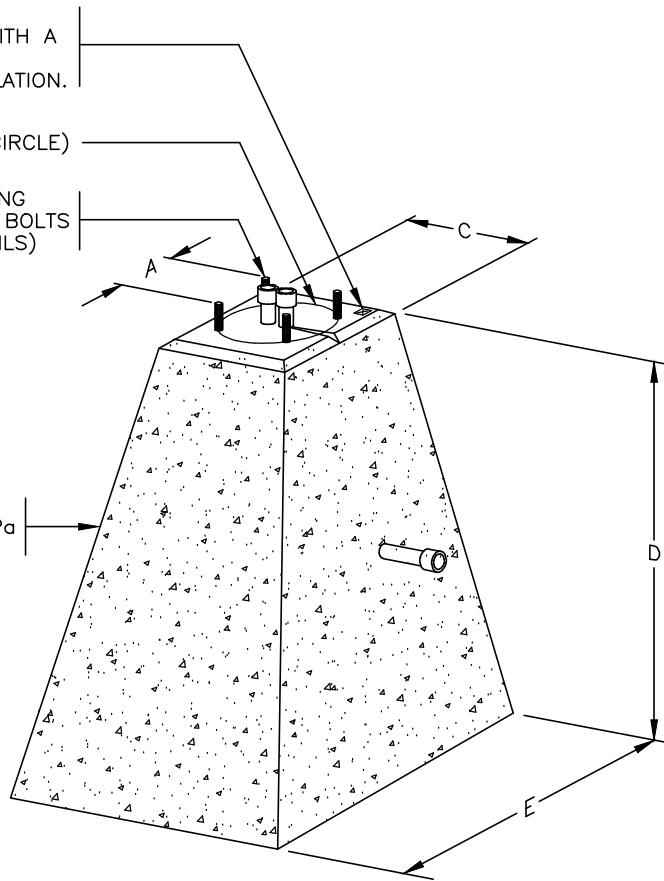
Scale: N.T.S.
Created: NOV 2012
Rev Date: NOV 2016
Dwg No: E-1.2A

BASE TYPE (I.E. 'C' OR 'C1') SHALL BE IMPRINTED IN CONCRETE WITH A 25mm HIGH LETTER. LOCATE IMPRINT SO IT IS VISIBLE AFTER POLE INSTALLATION.

B (ANCHOR BOLT CIRCLE)

4-1"φ x 915mm LONG GALVANIZED ANCHOR BOLTS (SEE E1.9 FOR DETAILS)

CONCRETE SHALL HAVE ATTAINED A COMPRESSIVE STRENGTH OF 30MPa PRIOR TO POLE INSTALLATION

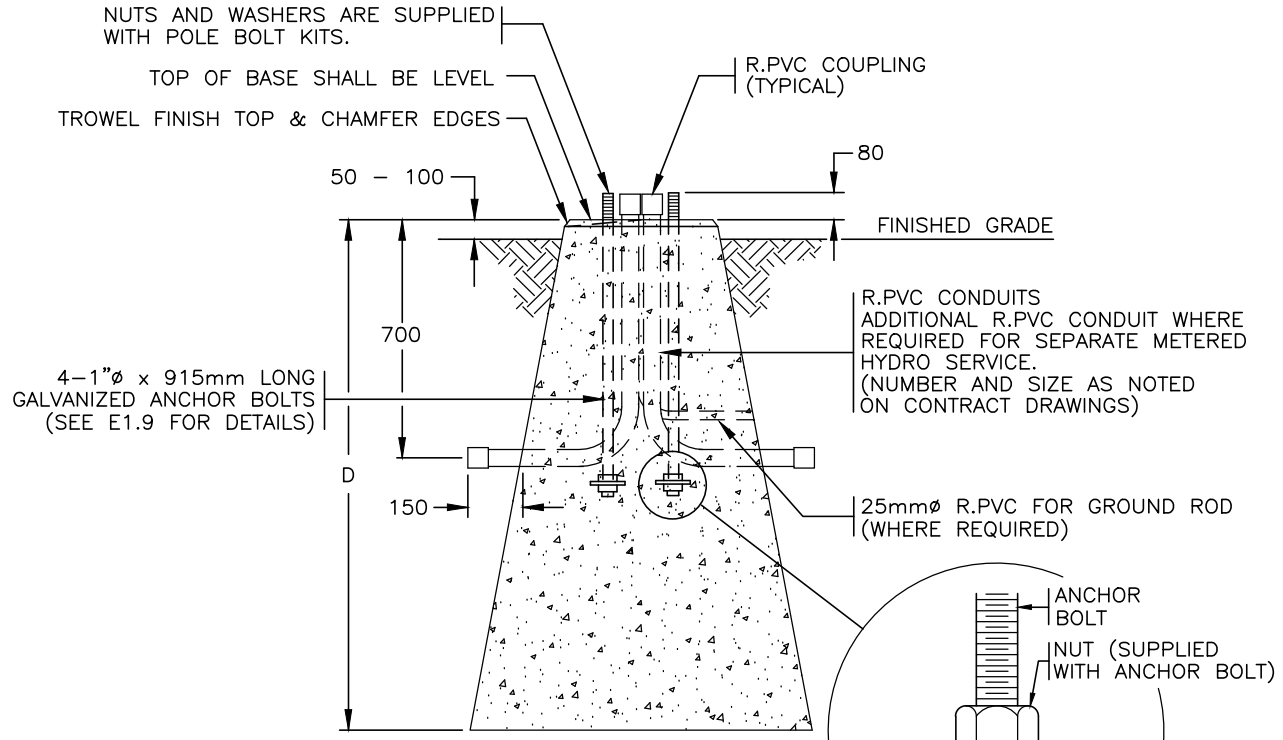
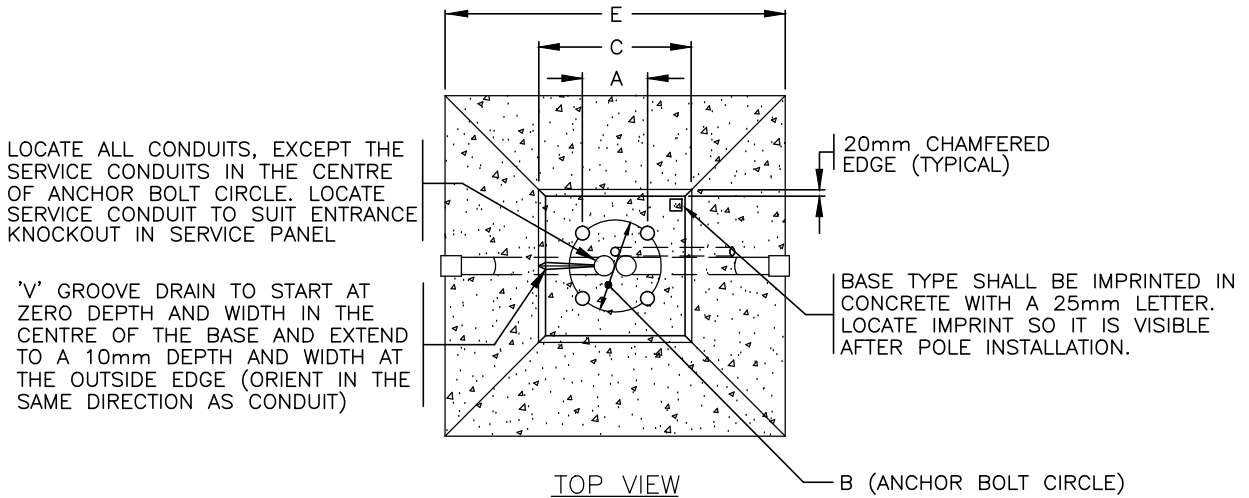


PRECAST CONCRETE BASES

BASE TYPE	POLE TYPE	APPROXIMATE MASS	VOLUME OF CONCRETE	A	B	C	D	E
C	7.5m, 9.0m & 11.0m DAVIT LUMINAIRE POLES	2000 kg	0.83m ³	197	280	450	1500	1000
C1	6.6m, 8.1m & 10.1m DAVIT LUMINAIRE & 3.1m, 5.1m & 6.6m POST TOP LUMINAIRE ON 0.9m HIGH SERVICE BASE	2000 kg	0.83m ³	269	380	450	1500	1000

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
3. SEE DRAWING E-1.4 & E-1.4A FOR ADDITIONAL DETAILS.
4. SEE DRAWING E-1.4A & E-1.14 FOR BACKFILL REQUIREMENTS.



SEE DRAWING E-1.3 FOR NOTES AND ADDITIONAL DETAILS

NUTS SHALL BE SUPPLIED TACK WELDED TO ANCHOR BOLTS.

ELEVATION

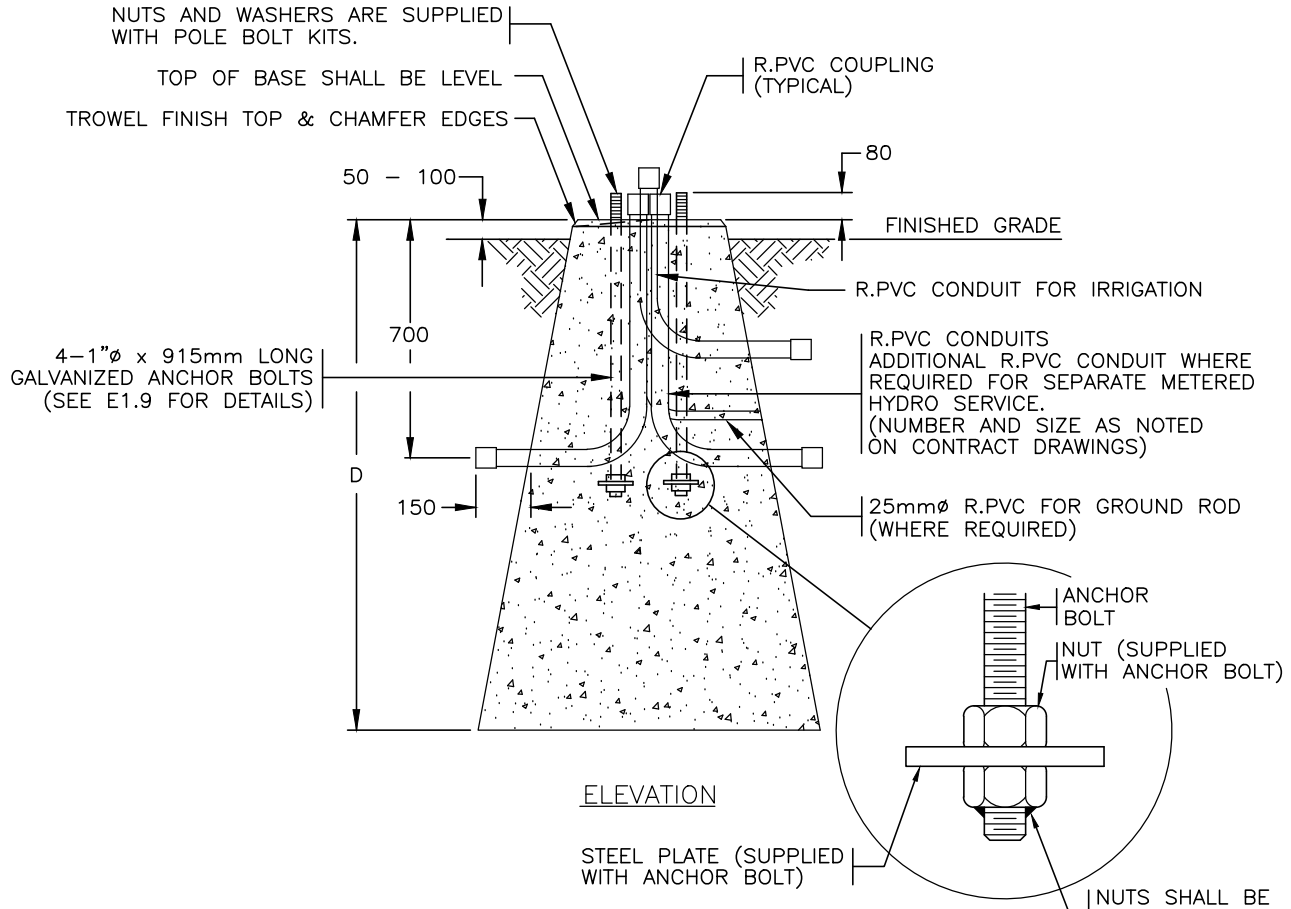
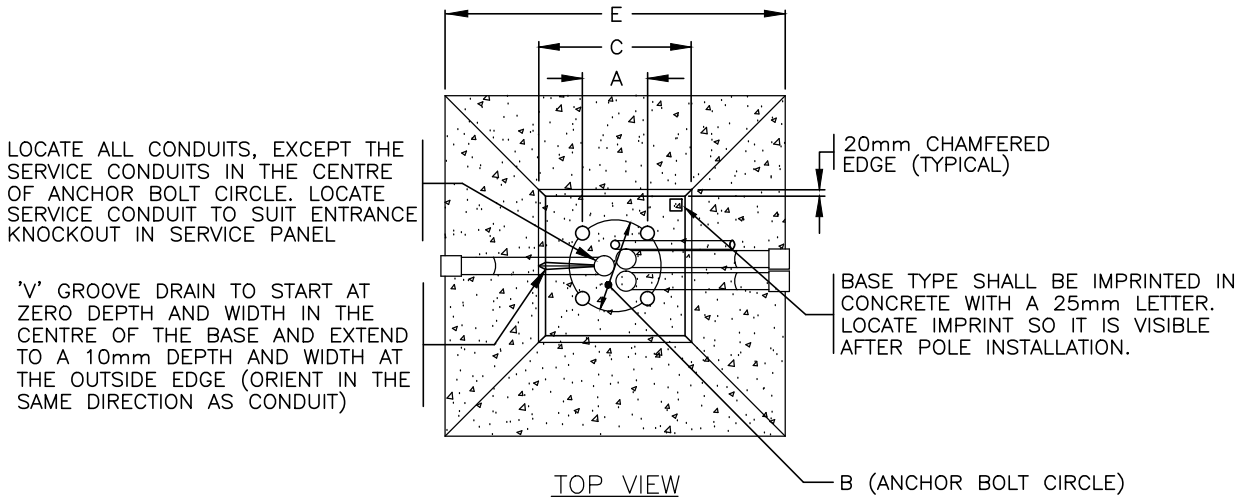
STEEL PLATE (SUPPLIED WITH ANCHOR BOLT)



TYPE C & C1 TRAPEZOIDAL SHAPE CONCRETE BASES

Scale: N.T.S.
Created: JUNE 2013
Rev Date: NOV 2016
Dwg No: E-1.4

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SEE DRAWING E-1.3 FOR NOTES AND ADDITIONAL DETAILS



TYPE C & TYPE C1 TRAPEZOIDAL SHAPE CONCRETE BASES WITH IRRIGATION

Scale: N.T.S.
Created: JUNE 2013
Rev Date: NOV 2016
Dwg No: E-1.4A

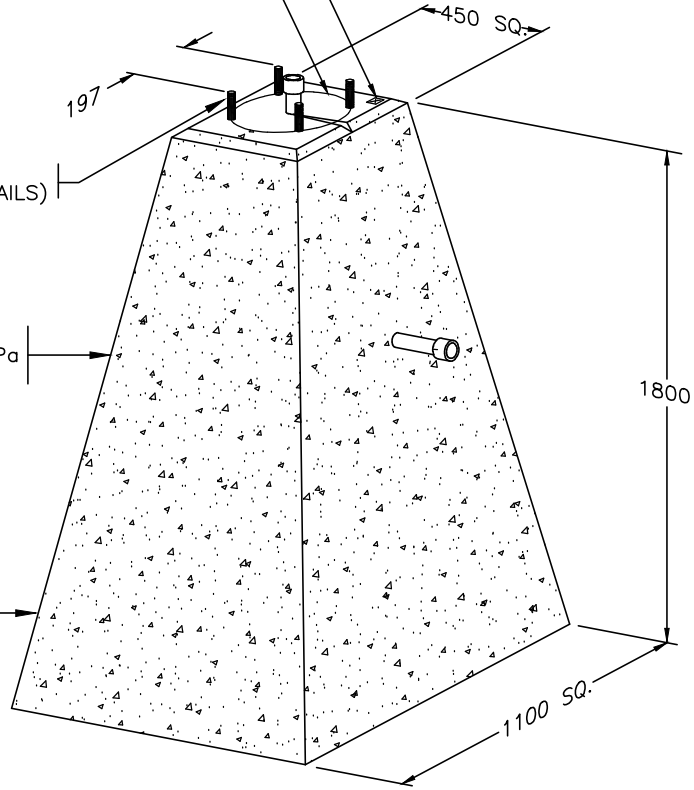
BASE TYPE (I.E. 'E2') SHALL BE INPRINTED IN CONCRETE WITH A 25mm HIGH LETTER(S). LOCATE IMPRINT SO IT IS VISIBLE AFTER POLE INSTALLATION.

280 (ANCHOR BOLT CIRCLE)

4-1"Ø x 915mm LONG GALVANIZED ANCHOR BOLTS (SEE E1.9 FOR DETAILS)

CONCRETE SHALL HAVE ATTAINED A COMPRESSIVE STRENGTH OF 30MPa PRIOR TO POLE INSTALLATION

SEE DRAWING E-1.6 FOR REBAR DETAILS

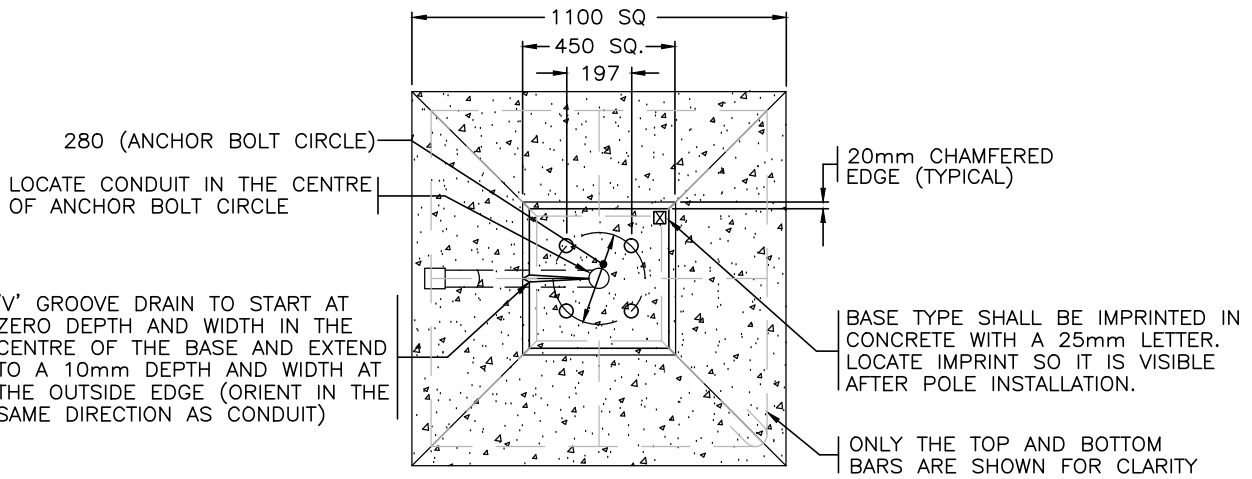


PRECAST CONCRETE BASES

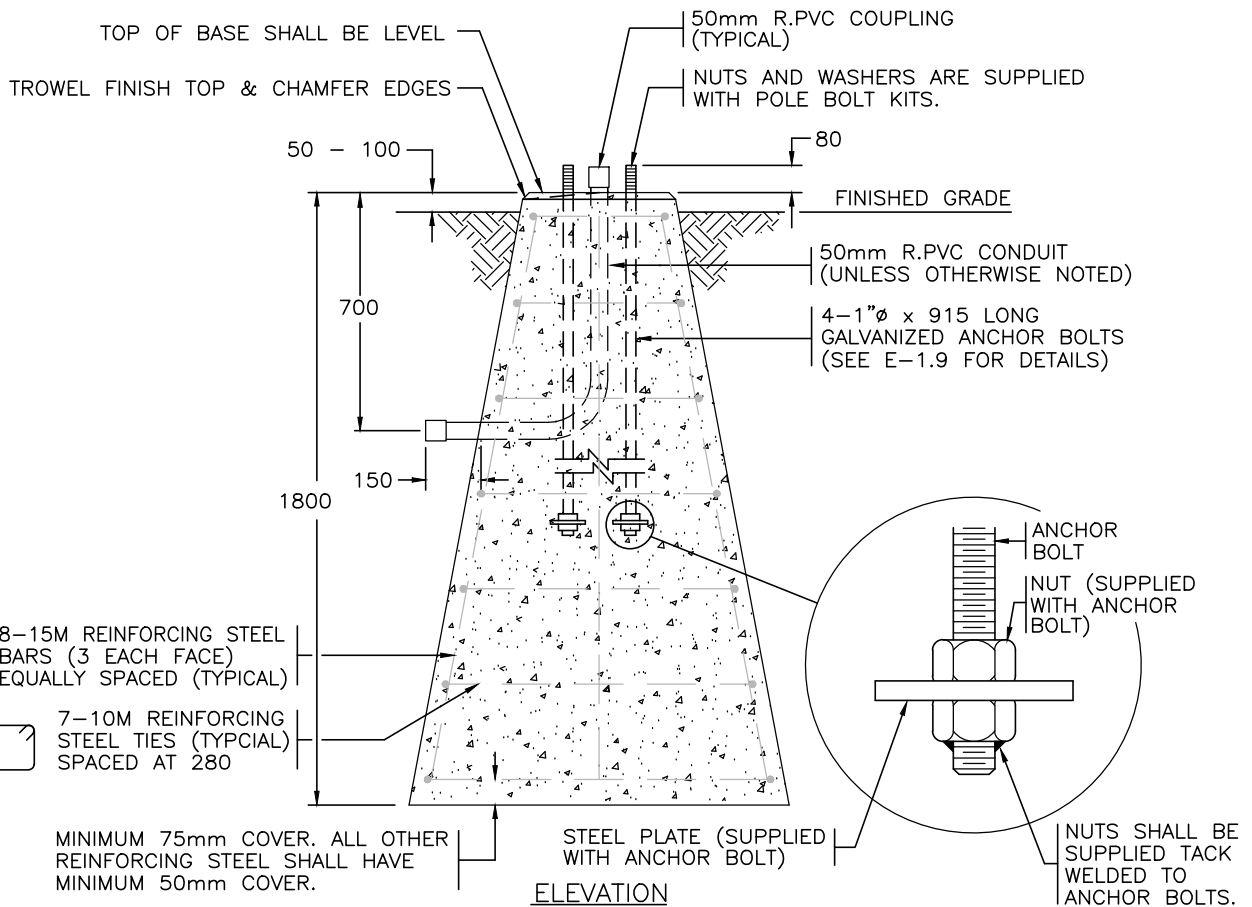
BASE TYPE	POLE TYPE	APPROXIMATE MASS	VOLUME OF CONCRETE
E2	TYPE 1 AND 3 SIGNAL POLES	2450 kg	1.0m ³

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
3. SEE DRAWING E-1.6 FOR ADDITIONAL DETAILS.
4. SEE DRAWINGS E-1.13 & E-1.14 FOR BACKFILL REQUIREMENTS.

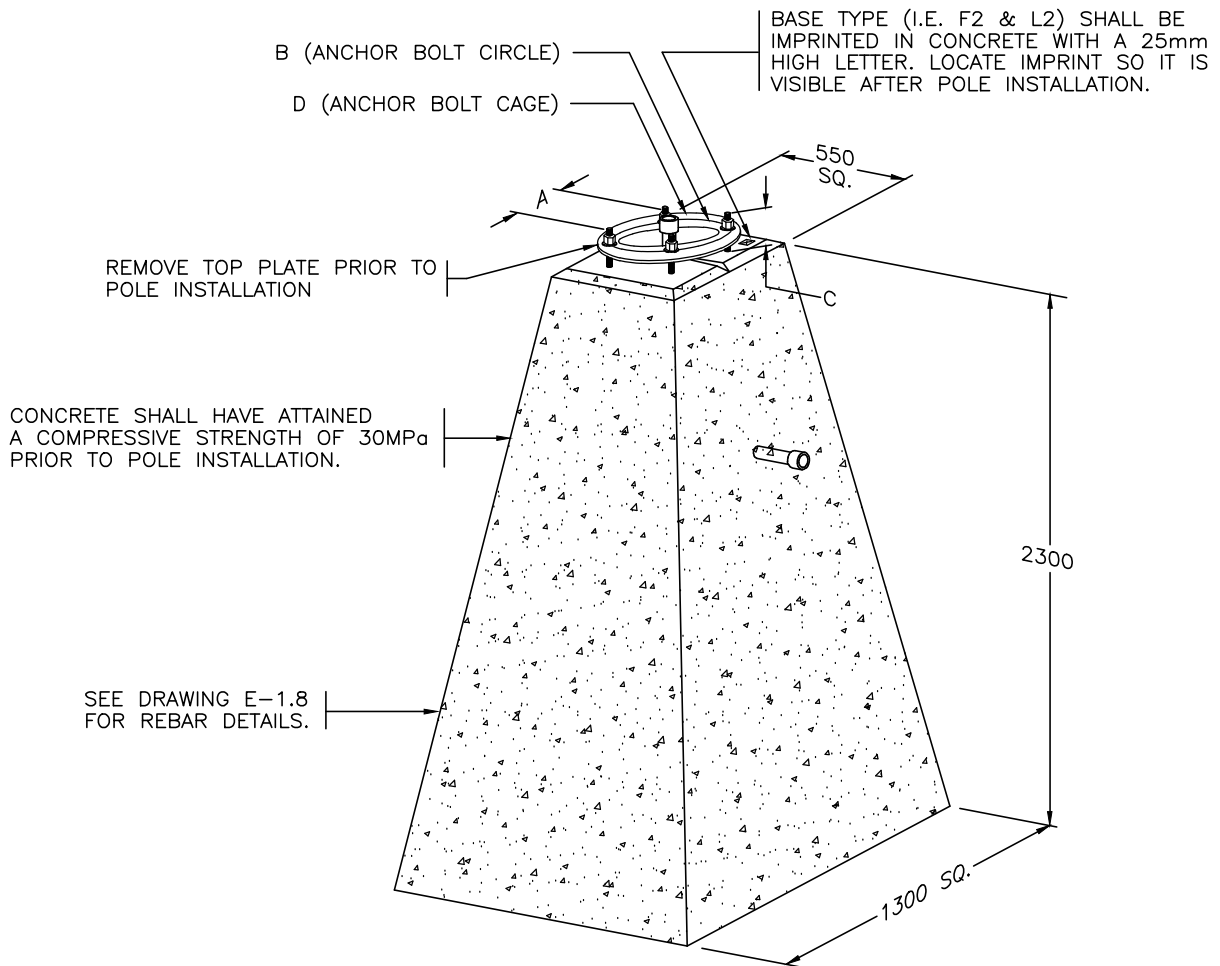


TOP VIEW



ELEVATION

SEE DRAWING E-1.5 FOR NOTES AND ADDITIONAL DETAILS



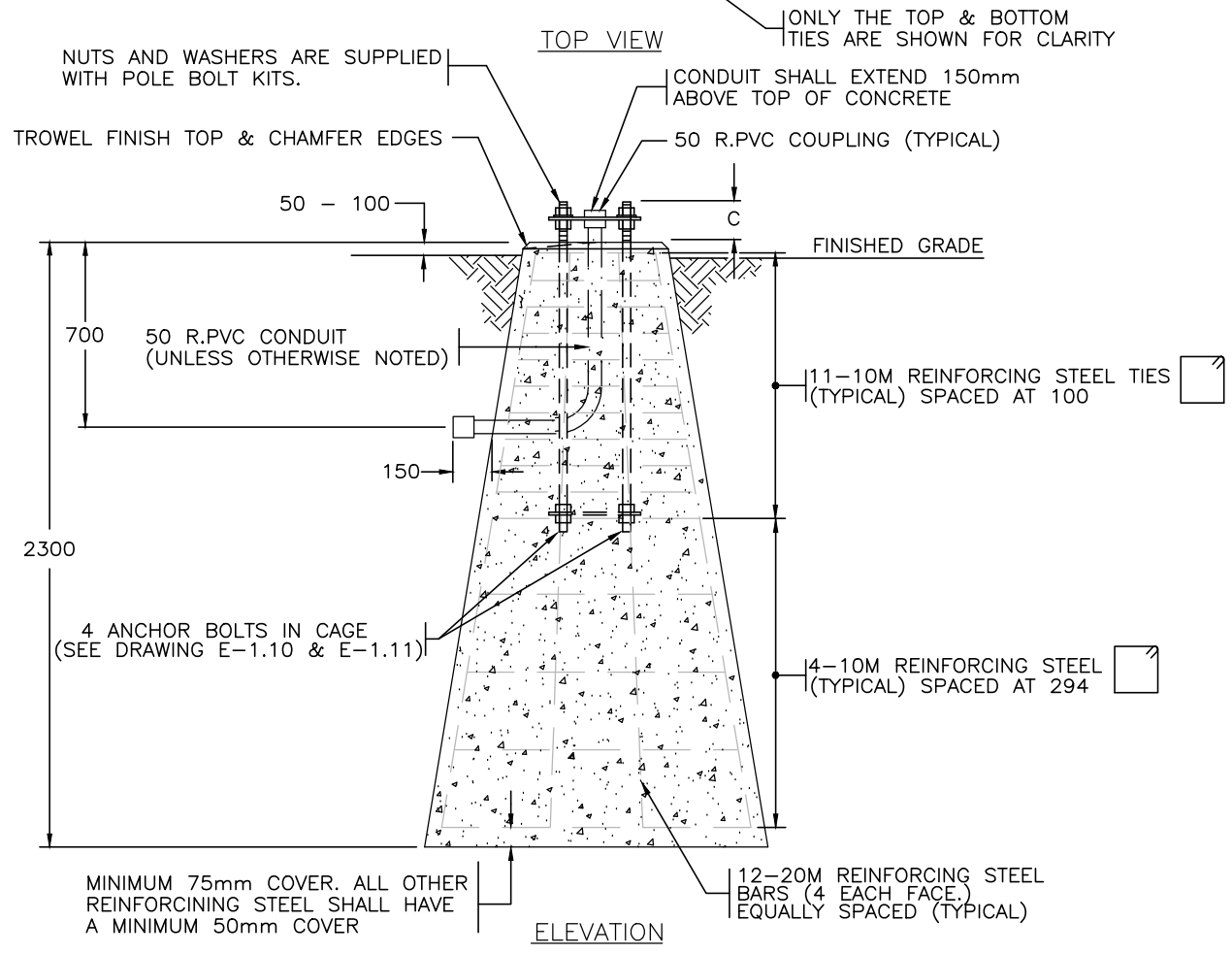
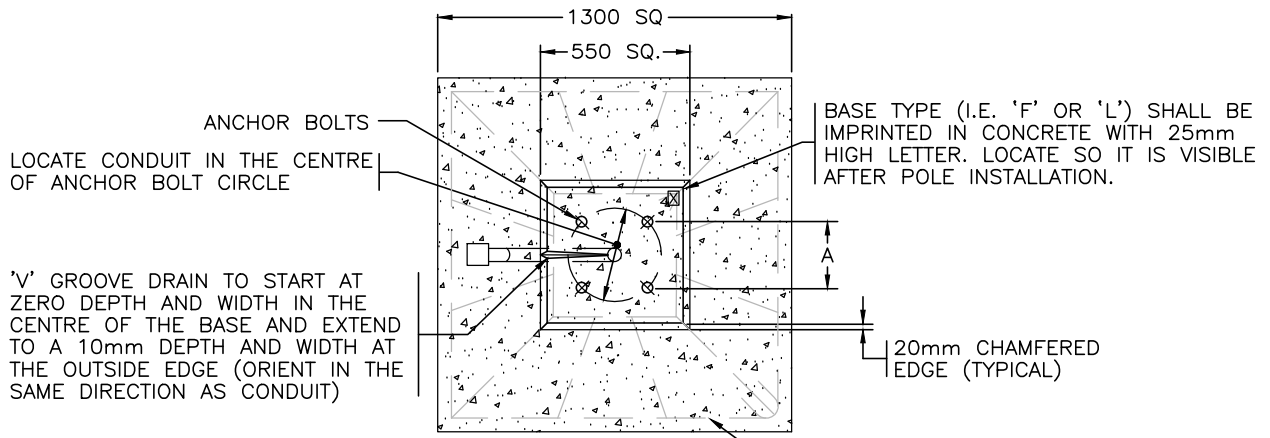
PRECAST CONCRETE BASES

BASE TYPE	POLE TYPE	APPROXIMATE MASS	VOLUME OF CONCRETE	A	B	C	D (ANCHOR BOLTS)
F2	TYPE 6 AND 7 SHAFTS	5000 kg	2.0 m ³	243	343	160	4-1"Ø x 1220 GALVANIZED ANCHOR BOLTS PRE-ASSEMBLED IN A CAGE
L2	TYPE L POLES	5040 kg	2.0 m ³	276	390	140	4-1 1/2"Ø x 1370 GALVANIZED ANCHOR BOLTS PRE-ASSEMBLED IN A CAGE

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
3. SEE DRAWING E-1.8 FOR ADDITIONAL DETAILS.
4. SEE DRAWINGS E-1.13 & E-1.14 FOR BACKFILL REQUIREMENTS.

UTENT&PW\INFRASTRUCTURE PLANNING\STANDARDS & PRODUCTS\SWISS\SECTION NOT\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 10 DWGSE-1.8



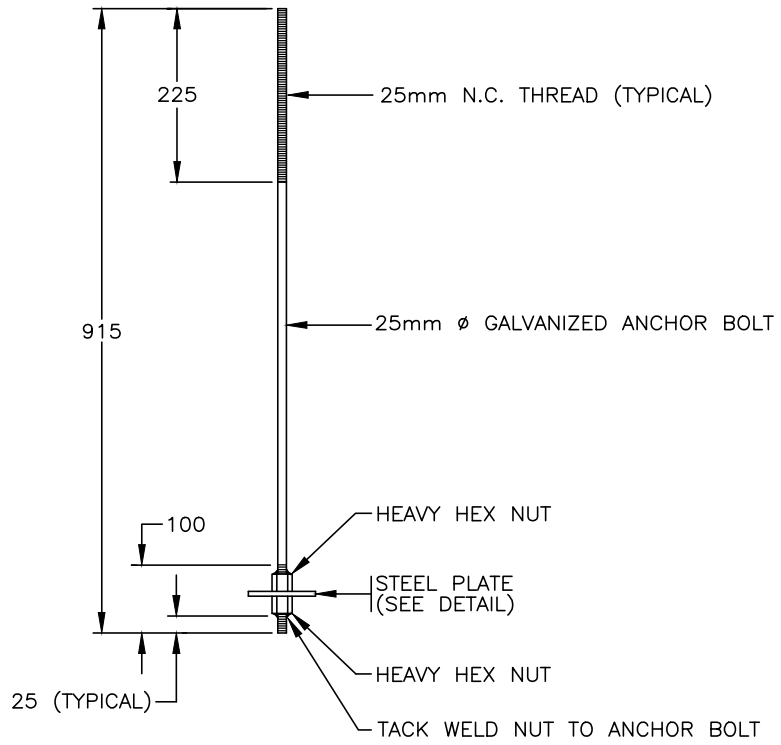
SEE DRAWING E-1.7 FOR NOTES AND ADDITIONAL DETAILS

4.13.2016



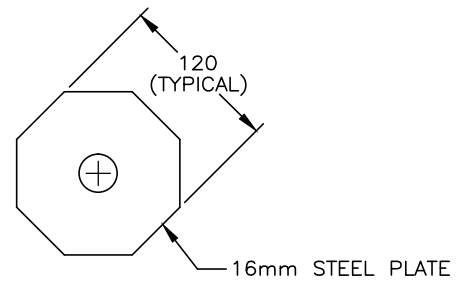
TYPE F2 & L2 TRAPEZOIDAL SHAPE CONCRETE BASES

Scale: N.T.S.
Created: JAN. 1998
Rev Date: NOV 2016
Dwg No: E-1.8



ANCHOR BOLT
4 PER SET

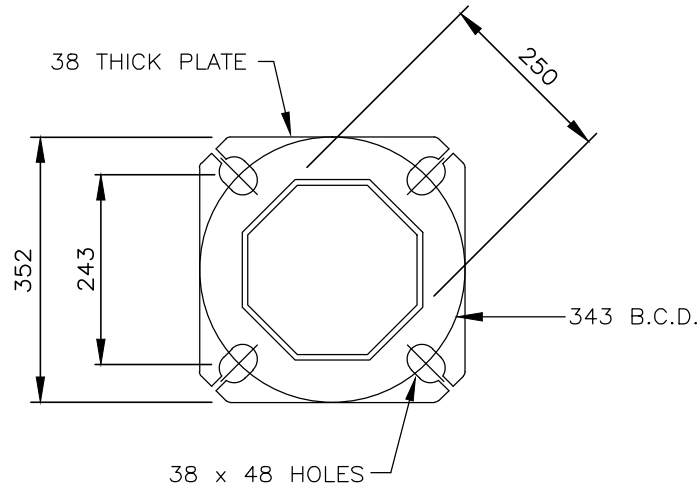
APPROXIMATE MASS (PER SET)
21 kg



STEEL PLATE

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

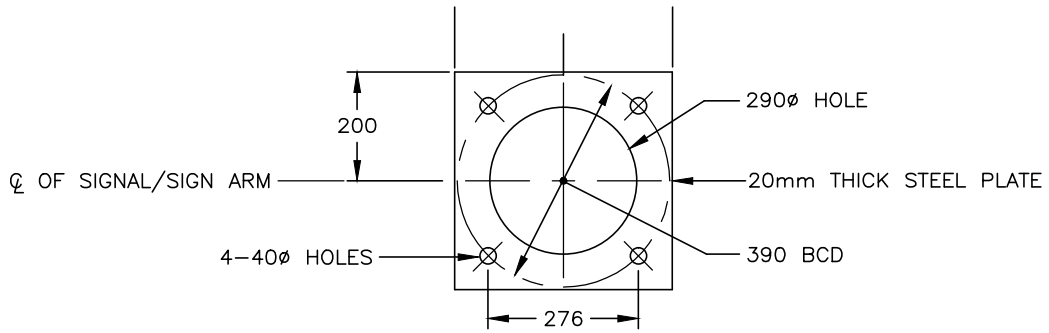


TYPE S POLE BASE PLATE
1:10

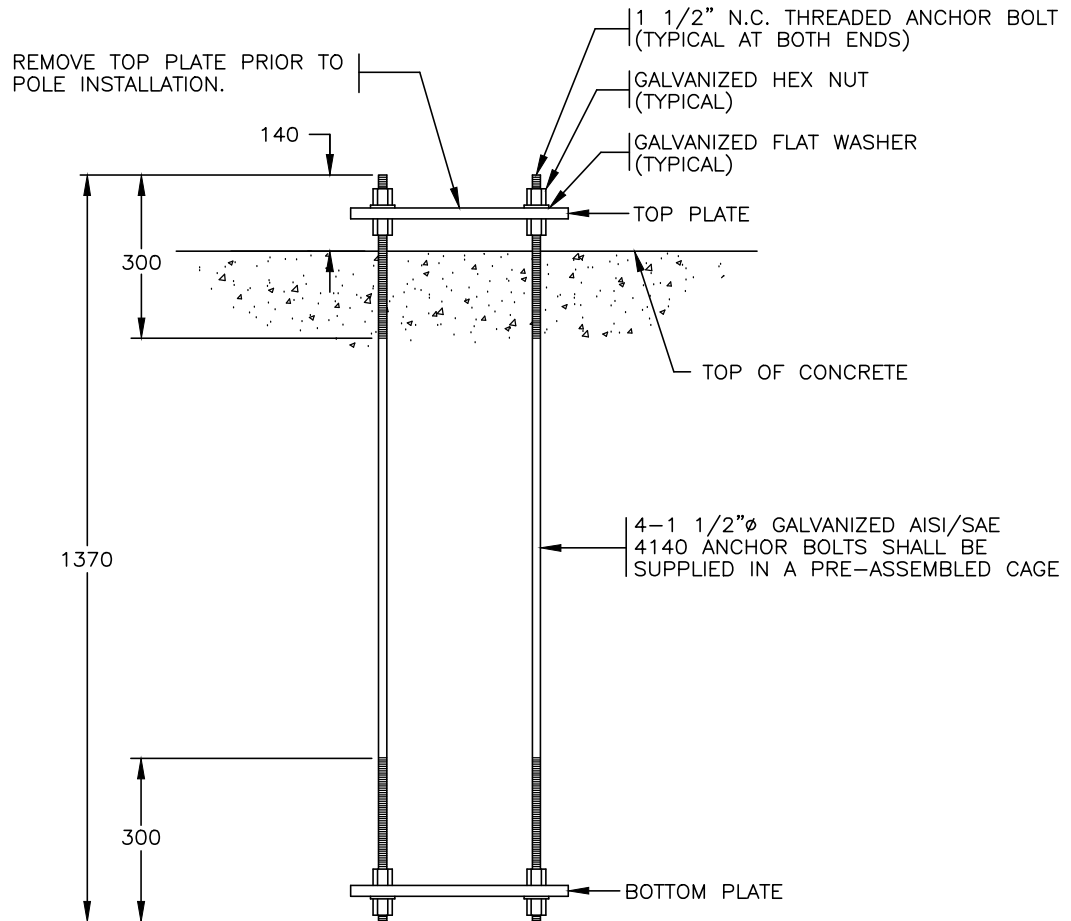
PARTS LIST FOR TYPE S SIGNAL POLE		
PART	MINISTRY STOCK NUMBER	MASS (kg)
TYPE [S] POLE SHAFT	SN3152	385
TYPE [5S] SIGNAL ARM – 5.0m	SN3150	104
TYPE [5.5S] SIGNAL ARM – 5.5m	SN3155	111
TYPE [6S] SIGNAL ARM – 6.0m	SN3160	118
TYPE [6.5S] SIGNAL ARM – 6.5m	SN3165	125
TYPE [7S] SIGNAL ARM – 7.0m	SN3170	132
TYPE [7.5S] SIGNAL ARM – 7.5m	SN3175	192
TYPE [8S] SIGNAL ARM – 8.0m	SN3180	204
TYPE [8.5S] SIGNAL ARM – 8.5m	SN3185	214
TYPE [9S] SIGNAL ARM – 9.0m	SN3190	224
TYPE [9.5S] SIGNAL ARM – 9.5m	SN3195	292
TYPE [10S] SIGNAL ARM – 10.0m	SN3100	306
TYPE [10.5S] SIGNAL ARM – 10.5m	SN3105	320
TYPE [11S] SIGNAL ARM – 11.0m	SN3110	340
TYPE [1.75L] LUMINAIRE ARM EXTENSION – 1.75m	SN2063	29
TYPE [0.25L] LUMINAIRE ARM EXTENSION – 0.25m	SN2064	10
TYPE [2A] LUMINAIRE ARM	SN1832	35
TYPE 1 FLANGE COVER PLATE [1 FCP]	SN1367	1.5
TYPE S FLANGE COVER PLATE [S FCP]	SN1368	3
TYPE 3 FLANGE COVER PLATE [3 FCP]	SN2084	4
POST TOP TENON [PTT]	SN1831	5

* [] I.D. LABEL ON POLE

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TOP AND BOTTOM PLATES



ANCHOR BOLT CAGE

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

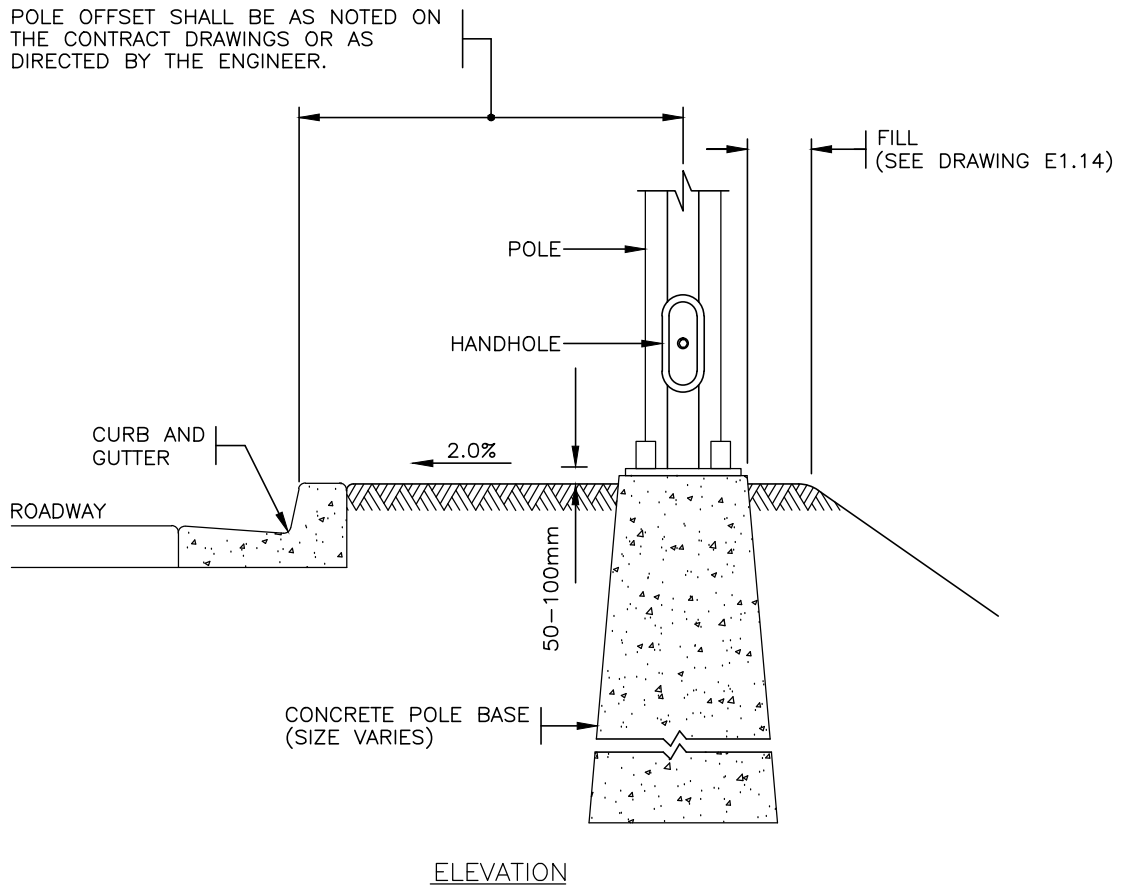
APPROXIMATE MASS
95 kg

4.13.2016



ANCHOR BOLT CAGE FOR TYPE L POLES

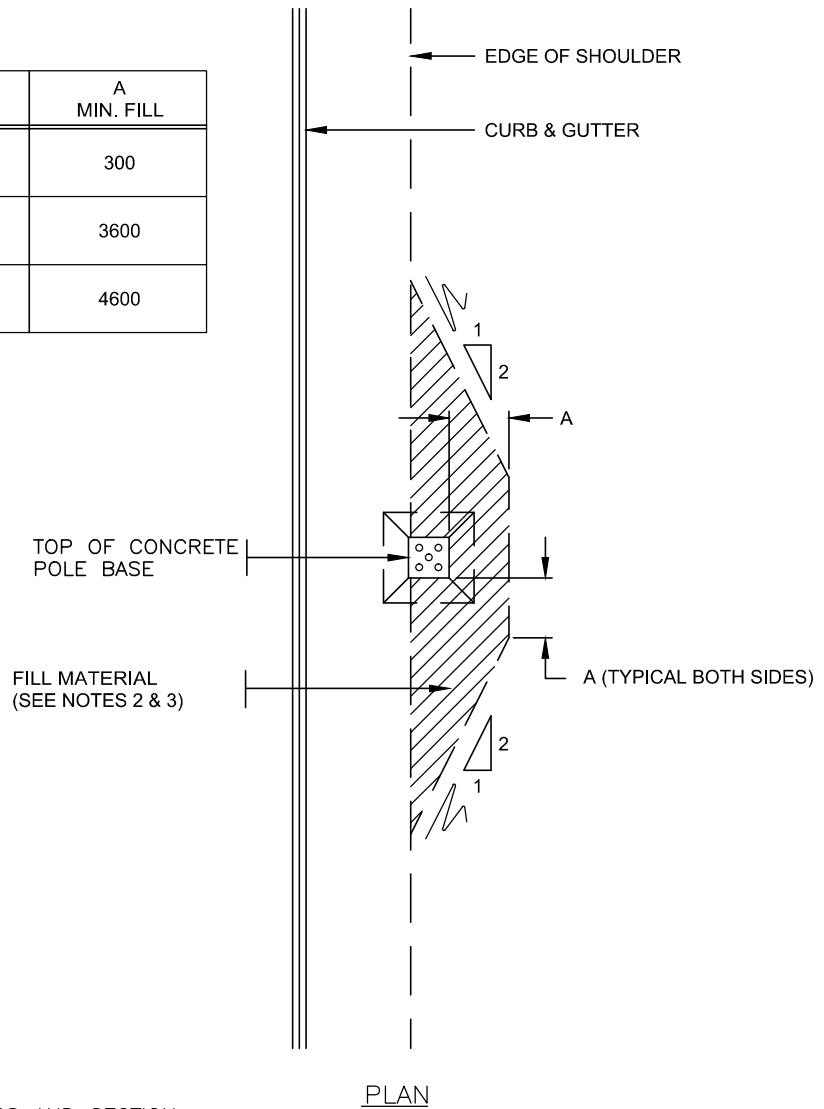
Scale: N.T.S.
 Created: JAN. 1998
 Rev Date: NOV 2016
 Dwg No: E-1.11



NOTES

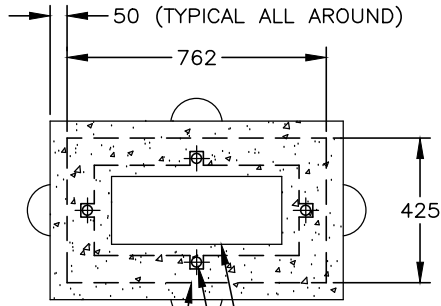
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

BASE TYPES	A MIN. FILL
TYPES A, B AND C CONCRETE BASES	300
TYPE E2 CONCRETE BASES	3600
TYPES F2 AND L2 CONCRETE BASES	4600



NOTES

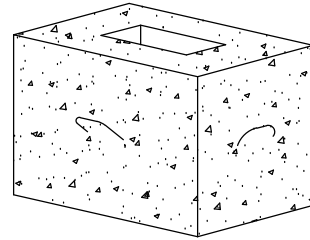
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. FILL MATERIAL SHALL CONSIST OF CLEAN WELL GRADED GRANULAR SOIL HAVING A MAXIMUM FINES CONTENT OF 8% (SILT AND CLAY SIZE PARTICLES) AND A MAXIMUM AGGREGATE SIZE OF 100mm.
3. FILL MATERIAL SHALL BE SUPPLIED, INSTALLED AND FULLY COMPACTED IN ACCORDANCE WITH SECTION 4 FOR THE MINIMUM AREA ALL AROUND THE BASE AS SHOWN ABOVE.
4. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.



TYPE M1, MSX AND MXX
CONTROLLER CABINET
BASE OUTLINE

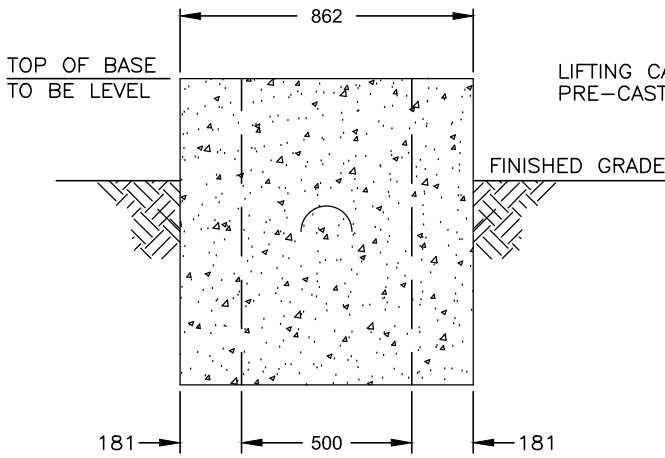
CONDUIT ENTRY (TYPICAL)
HILTI RED RING KWIK BOLT ANCHORS
(10Ø x 90 LONG)
TYPICAL 4 LOCATIONS

TOP VIEW



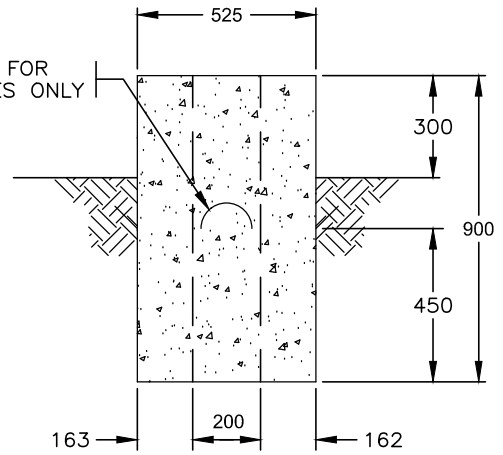
PICTORIAL VIEW

APPROXIMATE MASS
800 kg



FRONT VIEW

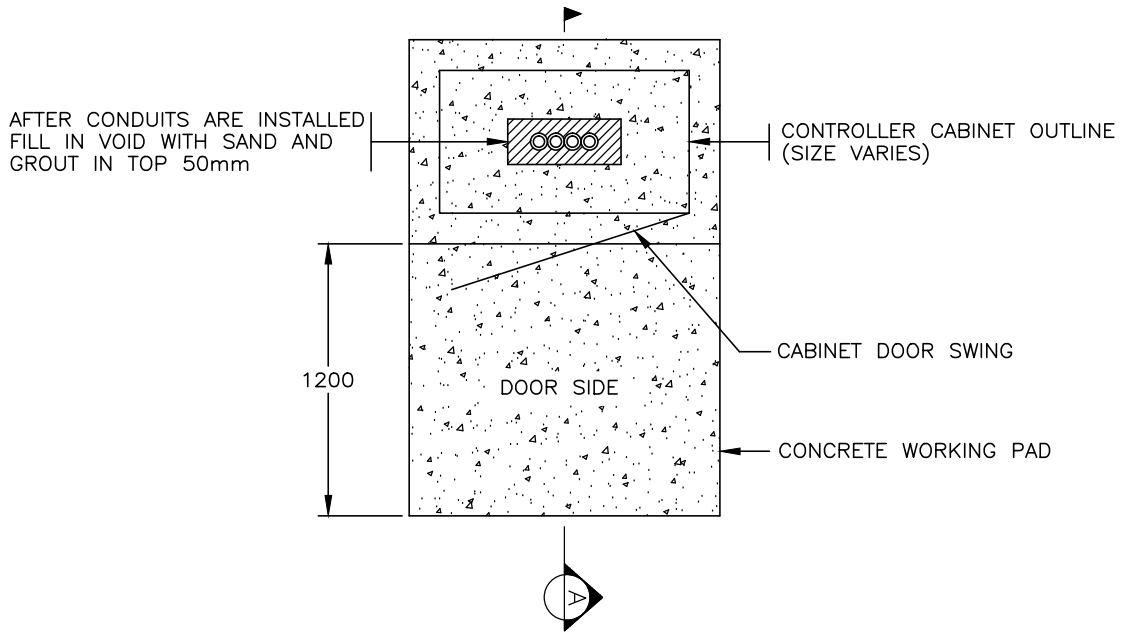
LIFTING CABLES FOR
PRE-CAST BASES ONLY



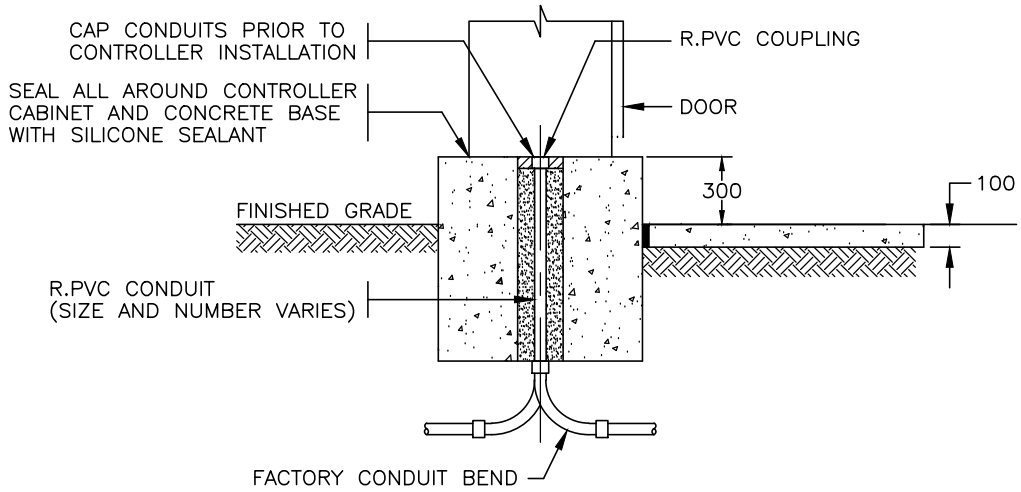
SIDE VIEW

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
3. BASES TO BE PRE-CAST OR CAST-IN-PLACE.



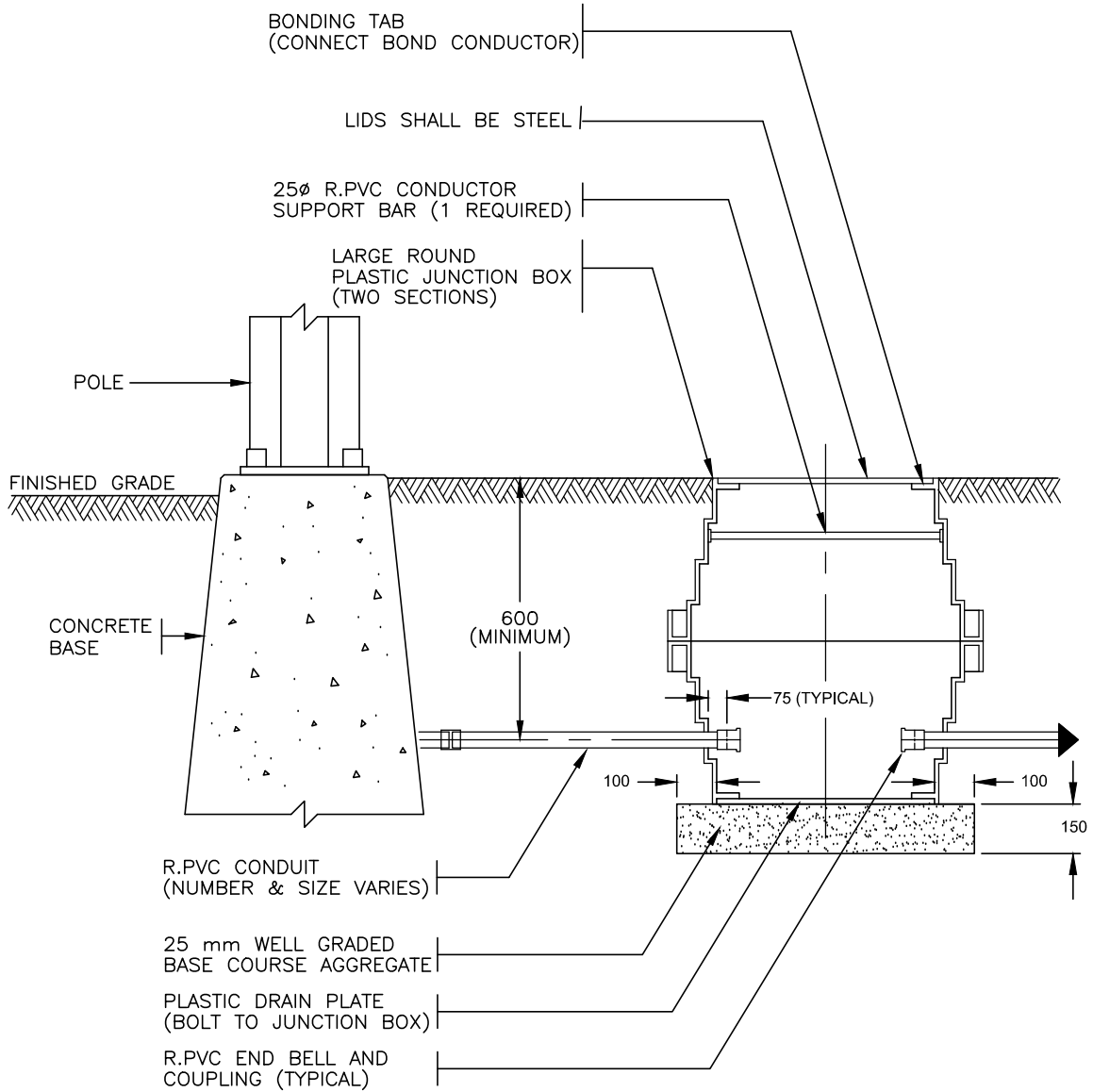
TOP VIEW



SECTION (A)

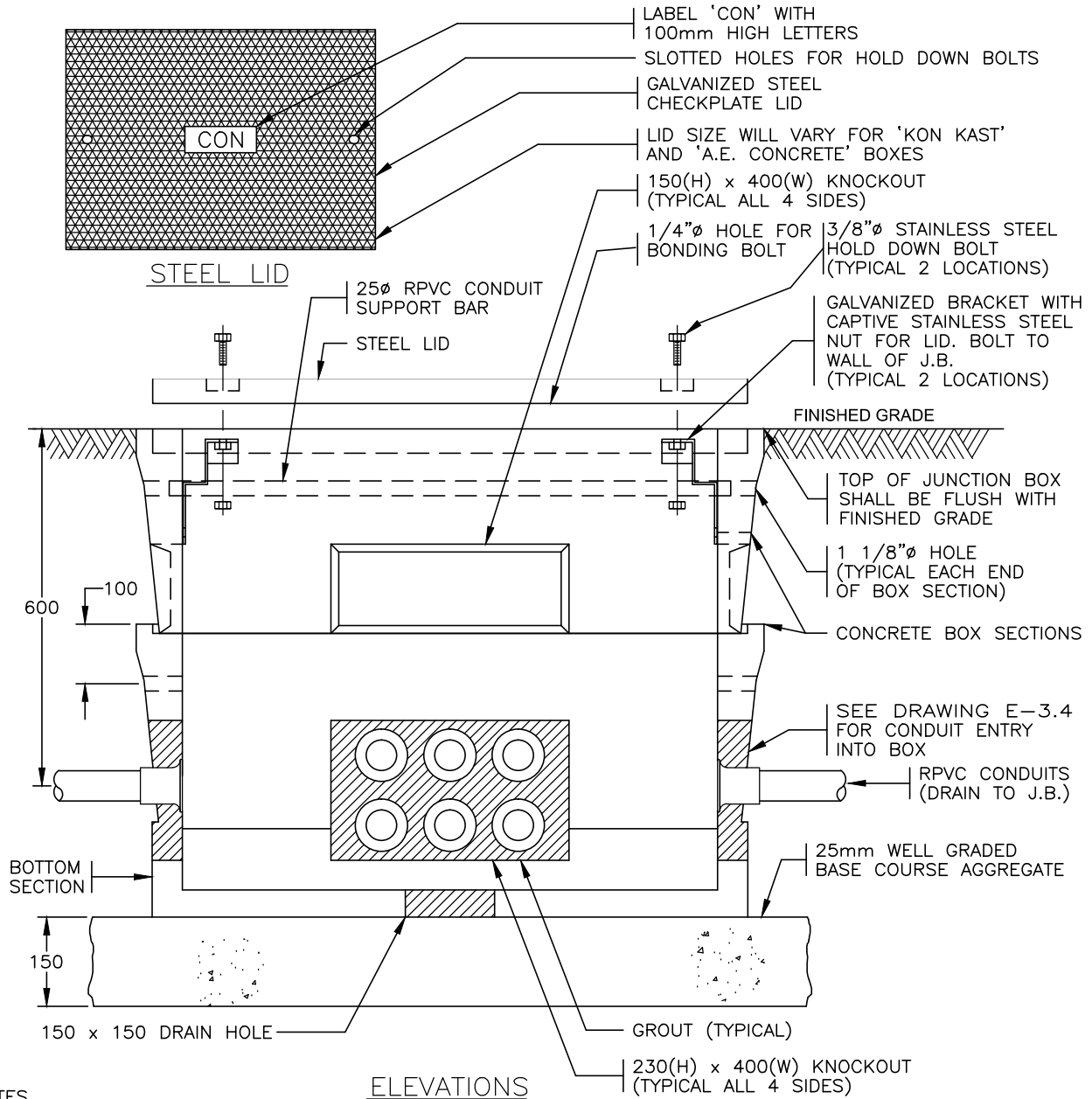
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. INSTALL LID ON PLASTIC JUNCTION BOX BEFORE BACKFILLING, TAMPING & PAVING OPERATIONS.
3. INSTALL TOP OF JUNCTION BOX FLUSH WITH FINISHED GRADE.
4. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
5. CONCRETE JUNCTION BOX INSTALLATION SIMILAR.
6. NUMBER OF CONDUITS ENTERING JUNCTION BOX NOT TO EXCEED 10 (UNLESS OTHERWISE NOTED).



NOTES

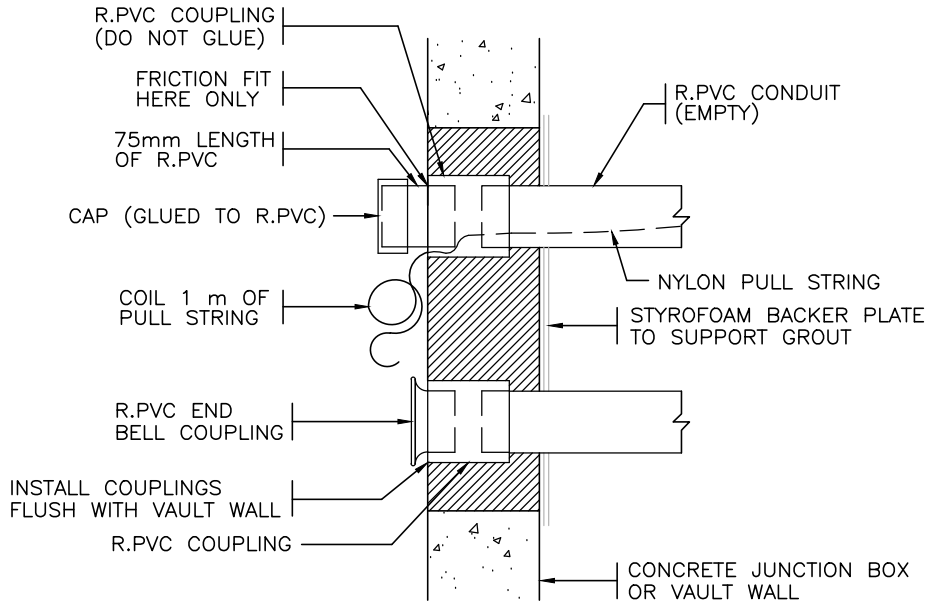
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS
2. ONLY PRODUCTS WITHIN THE CITY OF NANAIMO'S APPROVED PRODUCTS LIST, AND APPROVED BY THE CITY ENGINEER SHALL BE USED.
3. JUNCTION BOX SHALL BE DESIGNED FOR 5000kg STATIC LOADING.
4. VAULTS SHALL BE PRE-CAST CONCRETE WITH A MINIMUM COMPRESSIVE STRENGTH OF 35 MP_a AT 28 DAYS.
5. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

ELEVATIONS



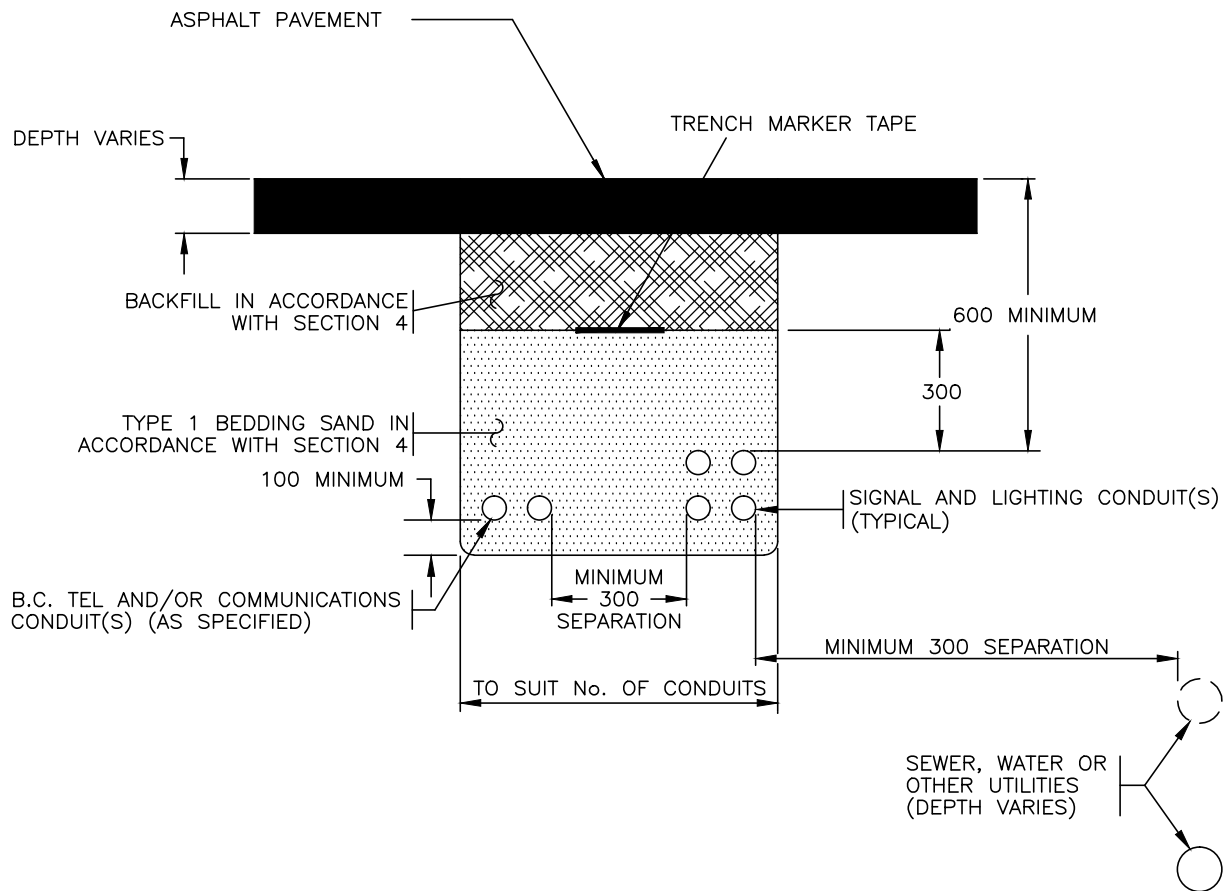
CONCRETE JUNCTION BOX DETAILS

Scale:	N.T.S.
Created:	JAN. 1998
Rev Date:	NOV 2016
Dwg No:	E-3.2



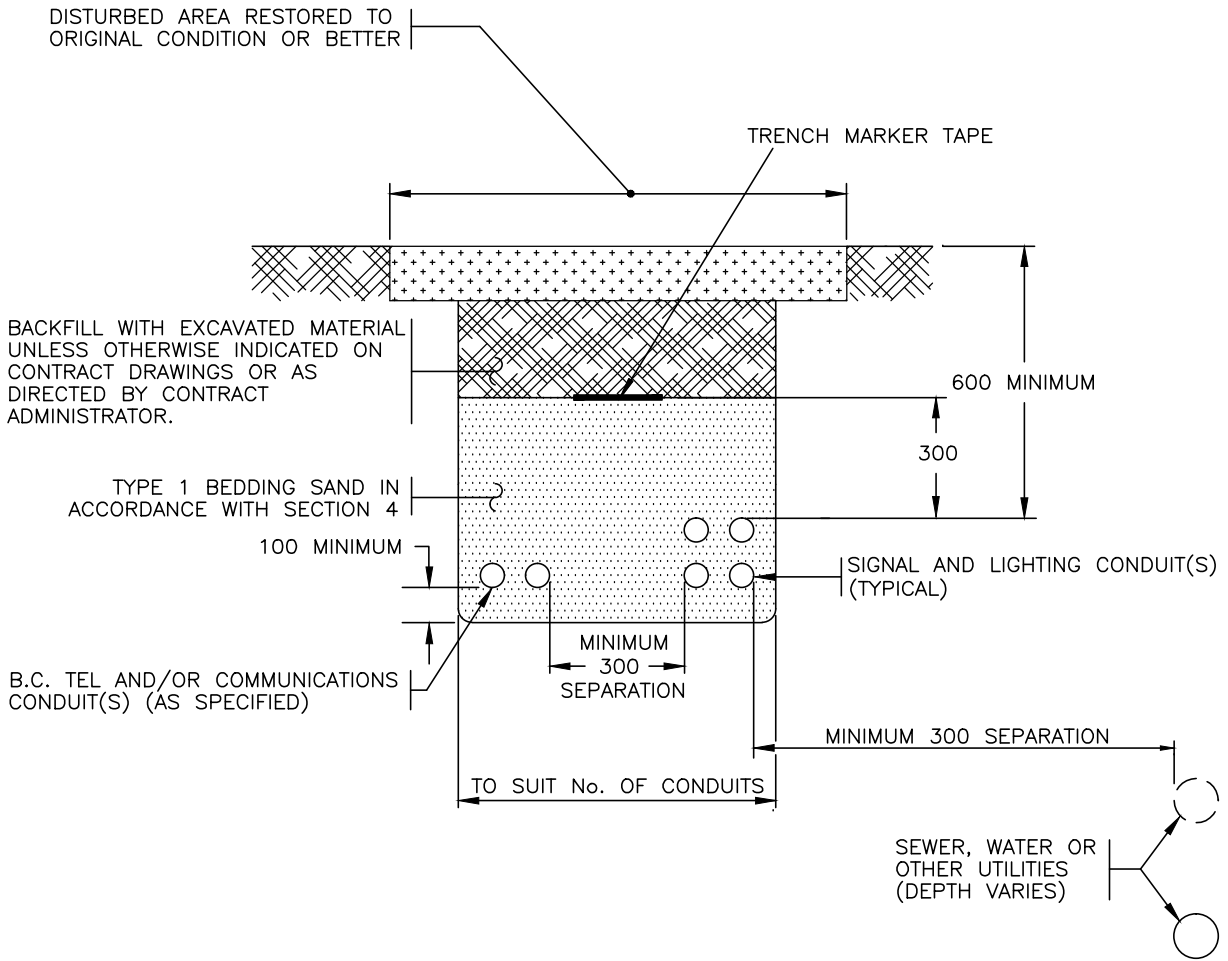
CONDUIT ENTRY TO VAULT OR CONCRETE JUNCTION BOX

SEE DRAWINGS E-3.2 & E-3.3
FOR NOTES AND ADDITIONAL DETAILS.



NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



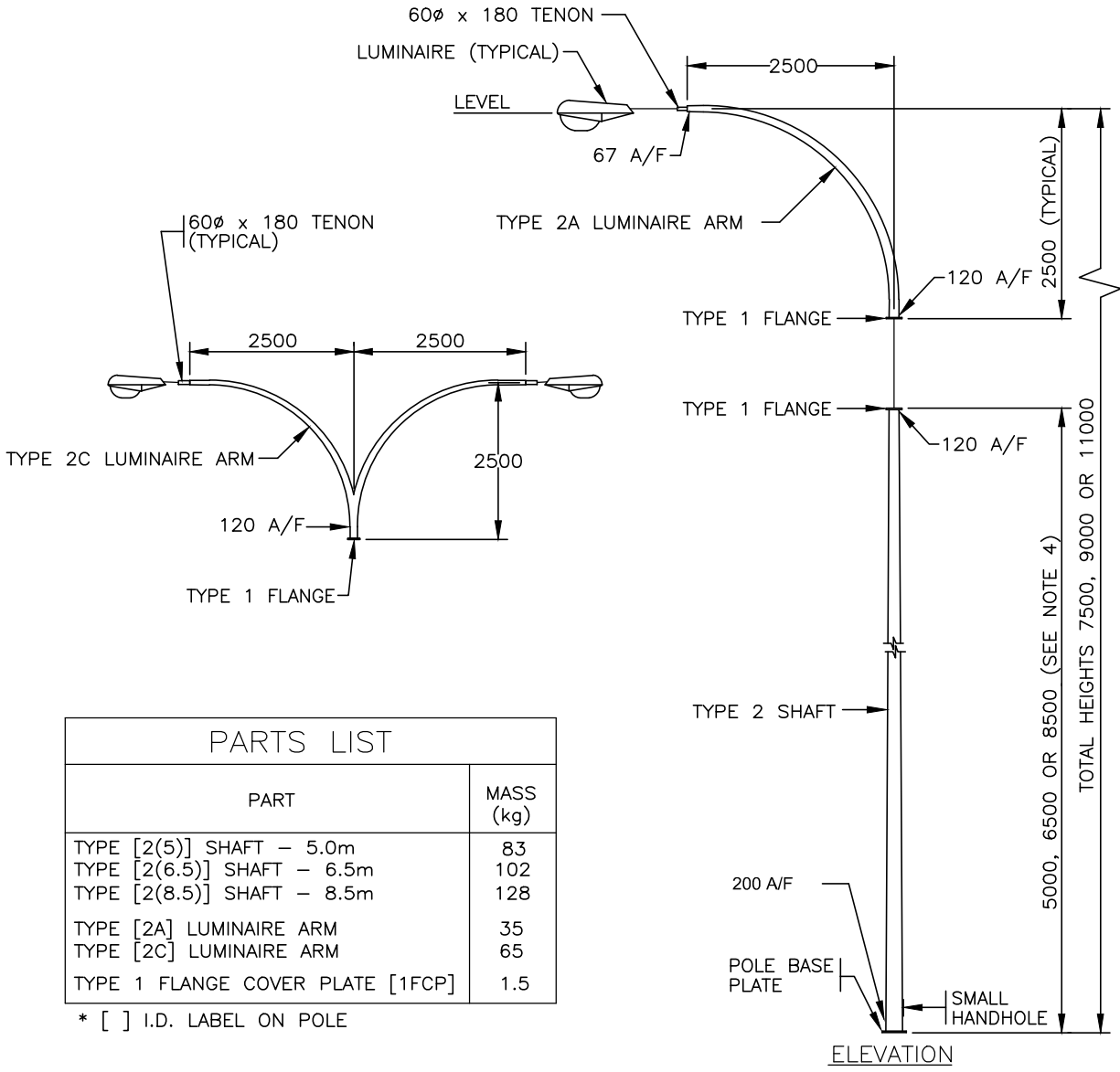
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



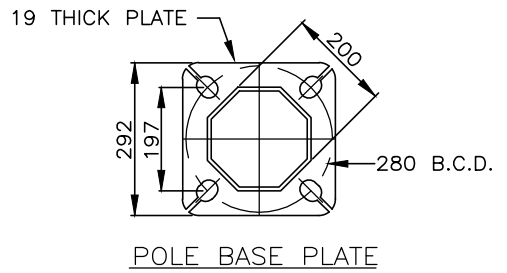
UNDERGROUND CONDUIT IN NON-PAVED AREAS

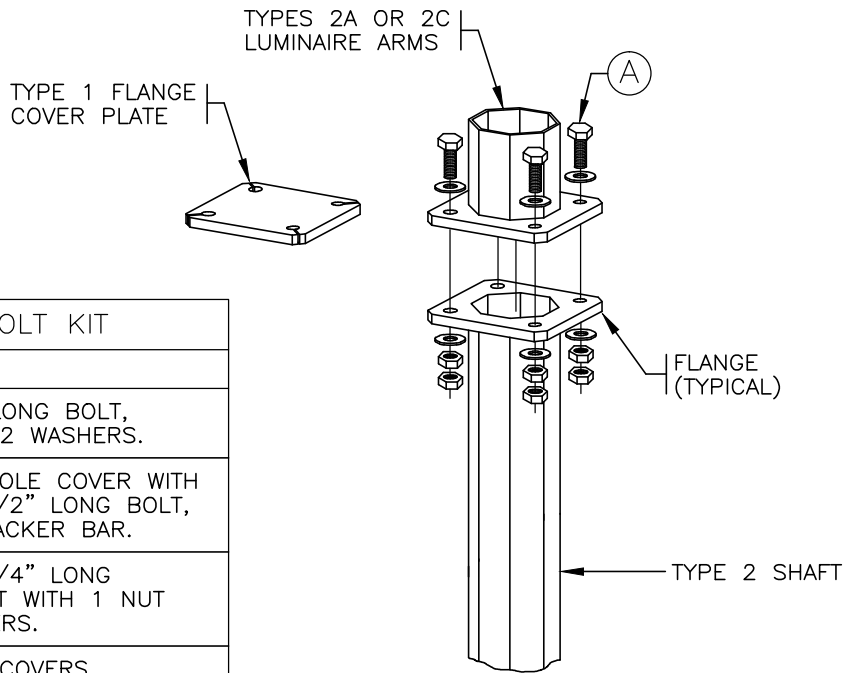
Scale:	N.T.S.
Created:	MAY 1999
Rev Date:	NOV 2016
Dwg No:	E-4.2



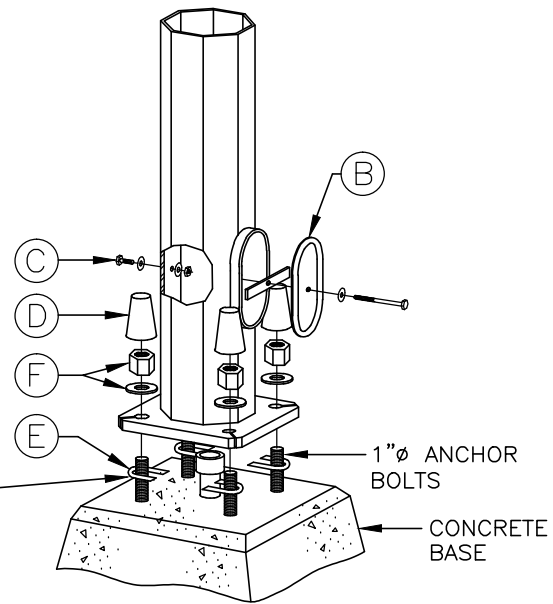
NOTES

- REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
- SEE DRAWING E-5.2 FOR TYPE 2 SHAFT, BOLT KITS AND POLE ASSEMBLY DETAILS.
- ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
- POLE SHAFTS TO BE SUPPLIED 0.9m SHORTER WHERE BEING INSTALLED ON SERVICE BASE.





TYPE 2 SHAFT BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
A	4	5/8"Ø x 3" LONG BOLT, 2 NUTS AND 2 WASHERS.
B	1	SMALL HANDHOLE COVER WITH 3/8"Ø x 2 1/2" LONG BOLT, WASHER & BACKER BAR.
C	1	3/8"Ø x 1 1/4" LONG BONDING BOLT WITH 1 NUT AND 2 WASHERS.
D	4	PLASTIC NUT COVERS FOR 1" NUTS.
E	4	LEVELLING SHIMS.
F	4	1"Ø NUTS AND WASHERS.

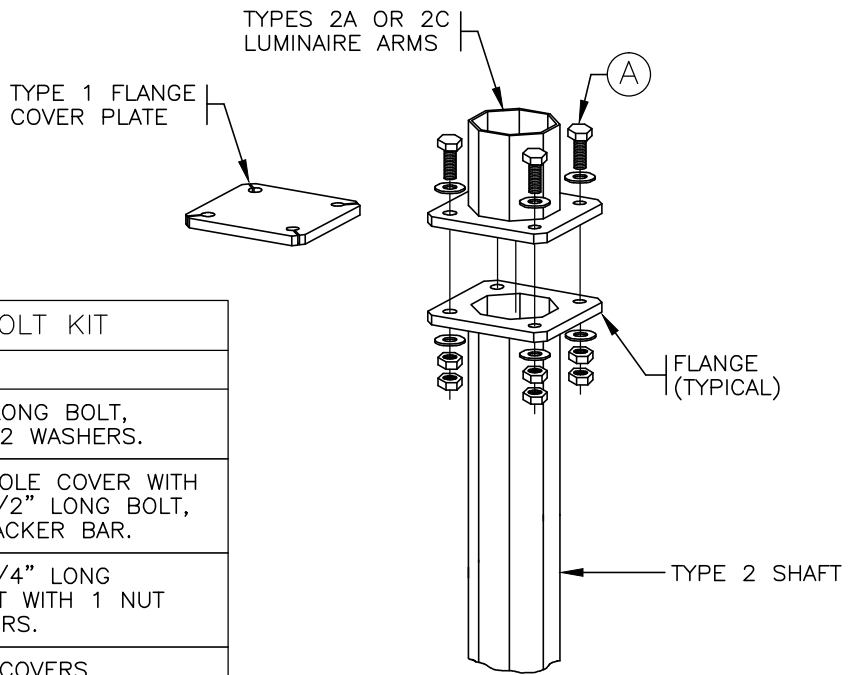


POLE ASSEMBLY DETAIL

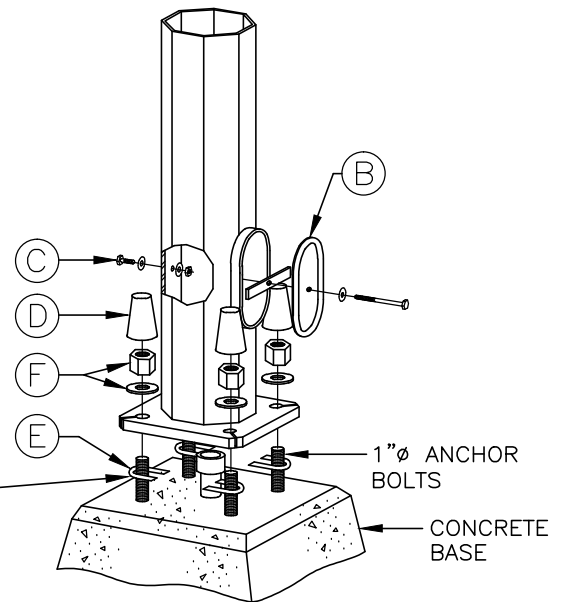
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SHAFTS TO BE INSTALLED PLUMB.
3. ALL SHAFTS, ARMS AND EXTENSIONS TO BE SUPPLIED WITH A GALVANIZED FINISH, UNLESS OTHERWISE NOTED.
4. APPLY GREASE TO ANCHOR BOLT THREADS.
5. TOUCH UP ANY SCRATCHES IN GALVANIZED SURFACES WITH COLD GALVANIZING COMPOUND.

MAXIMUM 4 SHIMS PER BOLT



TYPE 2 SHAFT BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
A	4	5/8"φ x 3" LONG BOLT, 2 NUTS AND 2 WASHERS.
B	1	SMALL HANDHOLE COVER WITH 3/8"φ x 2 1/2" LONG BOLT, WASHER & BACKER BAR.
C	1	3/8"φ x 1 1/4" LONG BONDING BOLT WITH 1 NUT AND 2 WASHERS.
D	4	PLASTIC NUT COVERS FOR 1" NUTS.
E	4	LEVELLING SHIMS.
F	4	1"φ NUTS AND WASHERS.



POLE ASSEMBLY DETAIL

NOTES

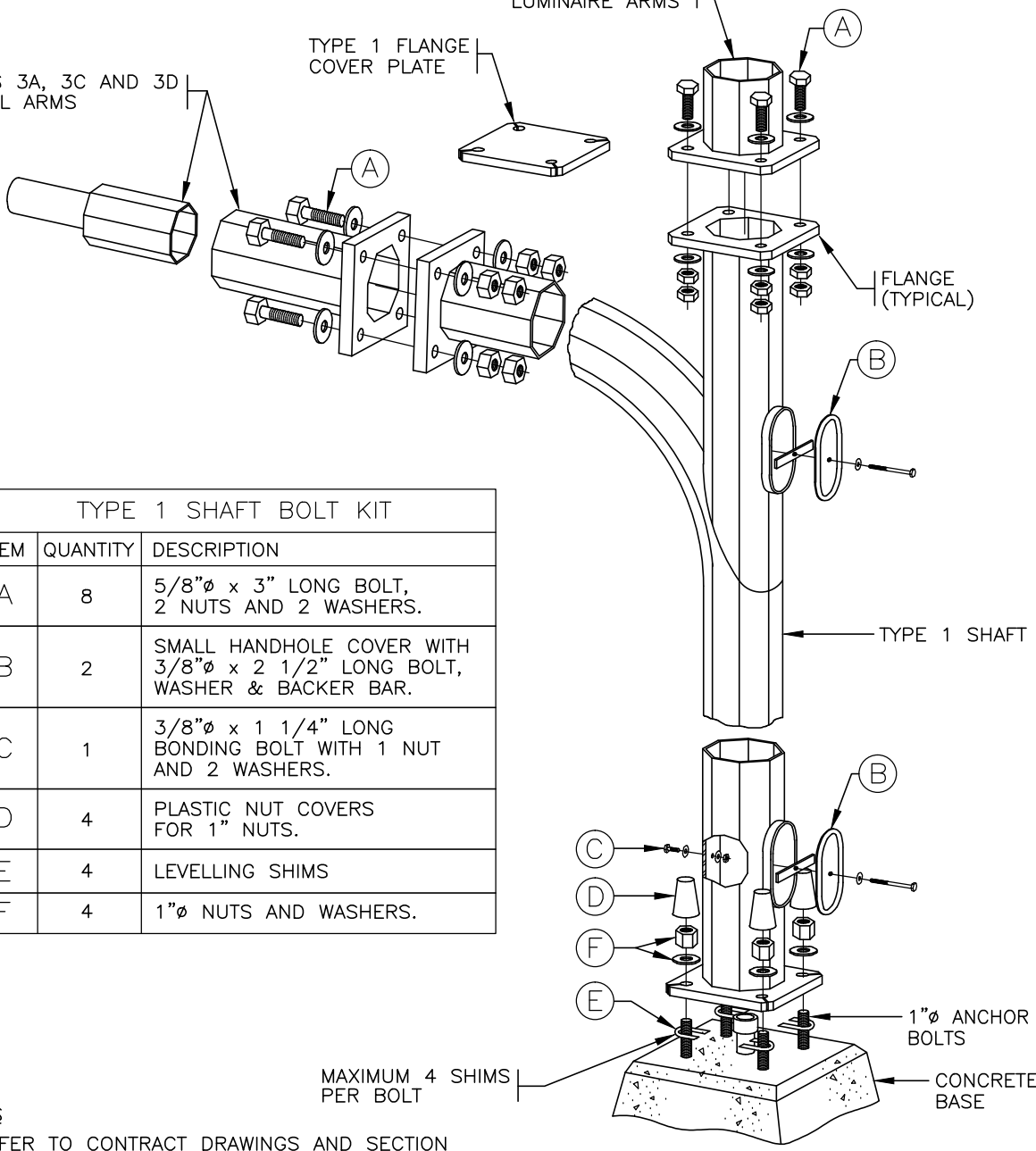
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SHAFTS TO BE INSTALLED PLUMB.
3. ALL SHAFTS, ARMS AND EXTENSIONS TO BE SUPPLIED WITH A GALVANIZED FINISH, UNLESS OTHERWISE NOTED.
4. APPLY GREASE TO ANCHOR BOLT THREADS.
5. TOUCH UP ANY SCRATCHES IN GALVANIZED SURFACES WITH COLD GALVANIZING COMPOUND.

MAXIMUM 4 SHIMS PER BOLT

TYPES 3A, 3C AND 3D
SIGNAL ARMS

TYPE 1 FLANGE
COVER PLATE

TYPES 2A OR 2C
LUMINAIRE ARMS



TYPE 1 SHAFT BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
A	8	5/8"Ø x 3" LONG BOLT, 2 NUTS AND 2 WASHERS.
B	2	SMALL HANDHOLE COVER WITH 3/8"Ø x 2 1/2" LONG BOLT, WASHER & BACKER BAR.
C	1	3/8"Ø x 1 1/4" LONG BONDING BOLT WITH 1 NUT AND 2 WASHERS.
D	4	PLASTIC NUT COVERS FOR 1" NUTS.
E	4	LEVELLING SHIMS
F	4	1"Ø NUTS AND WASHERS.

NOTES

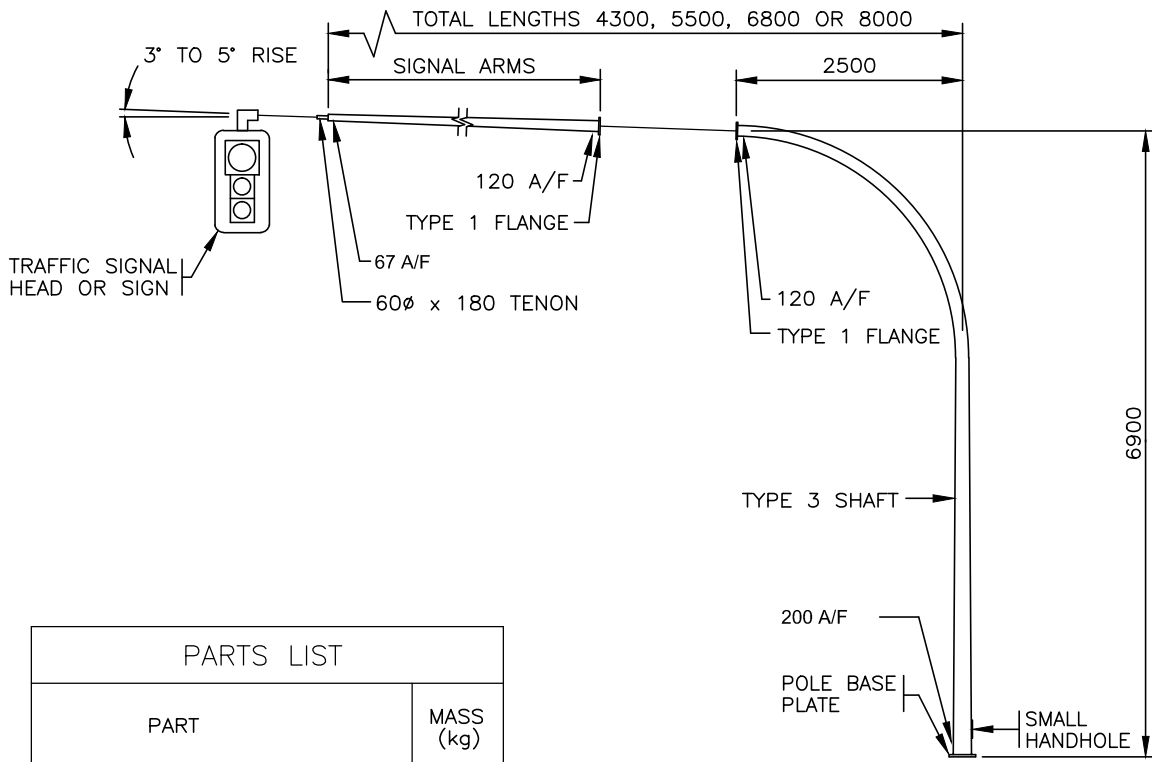
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SHAFTS TO BE INSTALLED PLUMB.
3. ALL SHAFTS, ARMS AND EXTENSIONS TO BE SUPPLIED WITH A GALVANIZED FINISH, UNLESS OTHERWISE NOTED.
4. APPLY GREASE TO ANCHOR BOLT THREADS.
5. TOUCH UP ANY SCRATCHES IN GALVANIZED SURFACES WITH COLD GALVANIZING COMPOUND.

POLE ASSEMBLY DETAIL



SIGNAL POLE (HIGHWAYS TYPE 1 SHAFT)

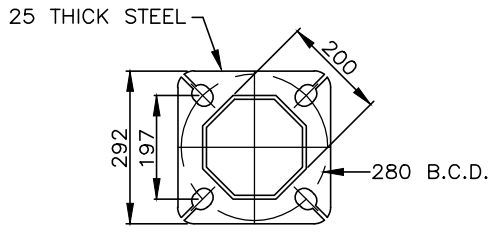
Scale: N.T.S.
Created: JAN. 1998
Rev Date: NOV 2016
Dwg No: E-5.4



ELEVATION

PARTS LIST	
PART	MASS (kg)
TYPE [3] SHAFT	186
TYPE [3C] SIGNAL ARM - 1.8m	18
TYPE [3A] SIGNAL ARM - 3.0m	27
TYPE [3D] SIGNAL ARM - 4.3m	54
TYPE [3E] SIGNAL ARM - 5.5m	68

* [] I.D. LABEL ON POLE



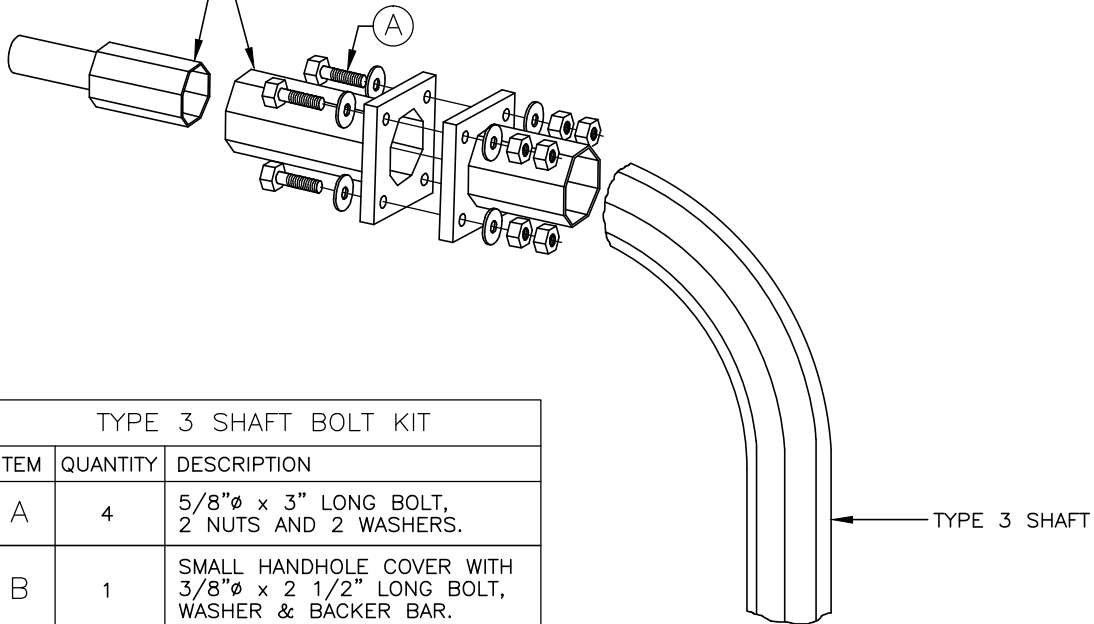
POLE BASE PLATE

NOTES

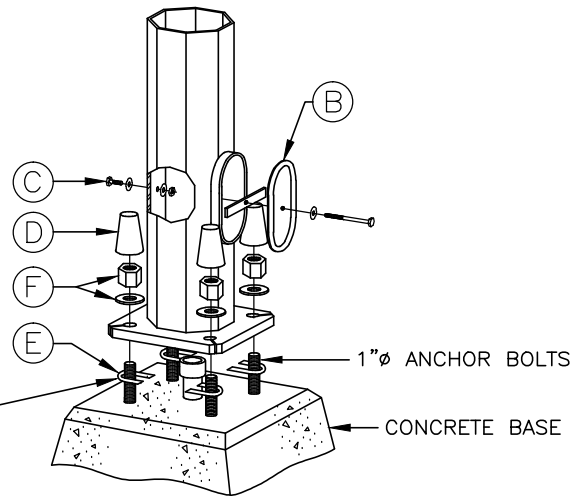
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SEE DRAWING E-5.6 FOR TYPE 3 SHAFT, BOLT KITS AND POLE ASSEMBLY DETAILS.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



TYPES 3A, 3C AND 3D
SIGNAL ARMS



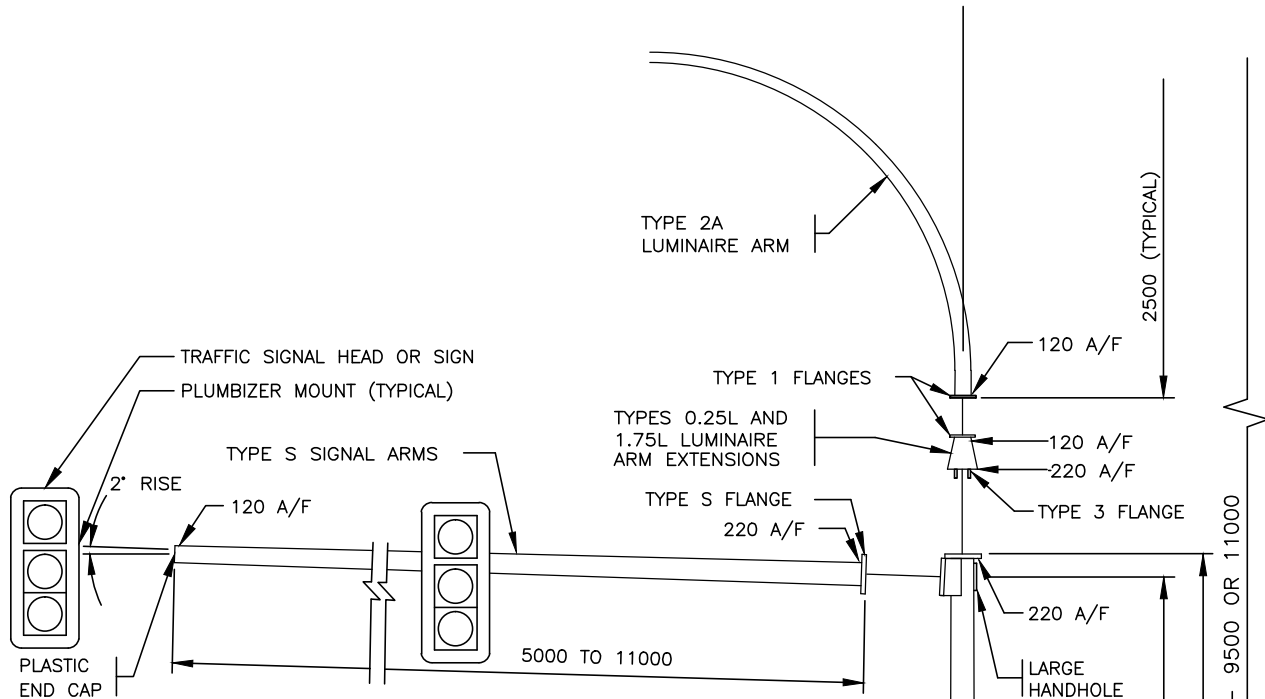
TYPE 3 SHAFT BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
A	4	5/8"φ x 3" LONG BOLT, 2 NUTS AND 2 WASHERS.
B	1	SMALL HANDHOLE COVER WITH 3/8"φ x 2 1/2" LONG BOLT, WASHER & BACKER BAR.
C	1	3/8"φ x 1 1/4" LONG BONDING BOLT WITH 1 NUT AND 2 WASHERS.
D	4	PLASTIC NUT COVERS FOR 1"φ NUTS.
E	4	LEVELLING SHIMS.
F	4	1"φ NUTS AND WASHERS.



POLE ASSEMBLY DETAIL

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SHAFTS TO BE INSTALLED PLUMB.
3. ALL SHAFTS, ARMS AND EXTENSIONS TO BE SUPPLIED WITH A GALVANIZED FINISH, UNLESS OTHERWISE NOTED.
4. APPLY GREASE TO ANCHOR BOLT THREADS.
5. TOUCH UP ANY SCRATCHES IN GALVANIZED SURFACES WITH COLD GALVANIZING COMPOUND.



PARTS LIST	
PART	MASS (kg)
TYPE [6] SHAFT	412
TYPE [3C] SIGNAL ARM - 1.8m	18
TYPE [3A] SIGNAL ARM - 3.0m	27
TYPE [3D] SIGNAL ARM - 4.3m	54
TYPE [3E] SIGNAL ARM - 5.5m	68
TYPE [7A] EXTENSION - 0.24m	20
TYPE [7B] EXTENSION - 1.8m	69
TYPE [7C] EXTENSION - 2.5m	86
TYPE [7D] EXTENSION - 4.8m	154
TYPE 1 FLANGE COVER PLATE [1FCP]	1.5
TYPE 8 FLANGE COVER PLATE [8FCP]	2.5

* [] I.D. LABEL ON POLE

NOTES

1. SEE STANDARD SPECIFICATIONS & SPECIAL PROVISIONS FOR ADDITIONAL INFORMATION.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.

POLE BASE PLATE (SEE DRAWING E5.12))

TYPE S SHAFT

250 A/F

6541

6750

TOTAL HEIGHTS - 9500 OR 11000

2500 (TYPICAL)

120 A/F

TYPE 1 FLANGES

TYPES 0.25L AND 1.75L LUMINAIRE ARM EXTENSIONS

120 A/F

220 A/F

TYPE 3 FLANGE

TYPE S FLANGE 220 A/F

220 A/F

LARGE HANDHOLE

LARGE HANDHOLE

5000 TO 11000

PLASTIC END CAP

2" RISE

TYPE S SIGNAL ARMS

TRAFFIC SIGNAL HEAD OR SIGN
PLUMBIZER MOUNT (TYPICAL)

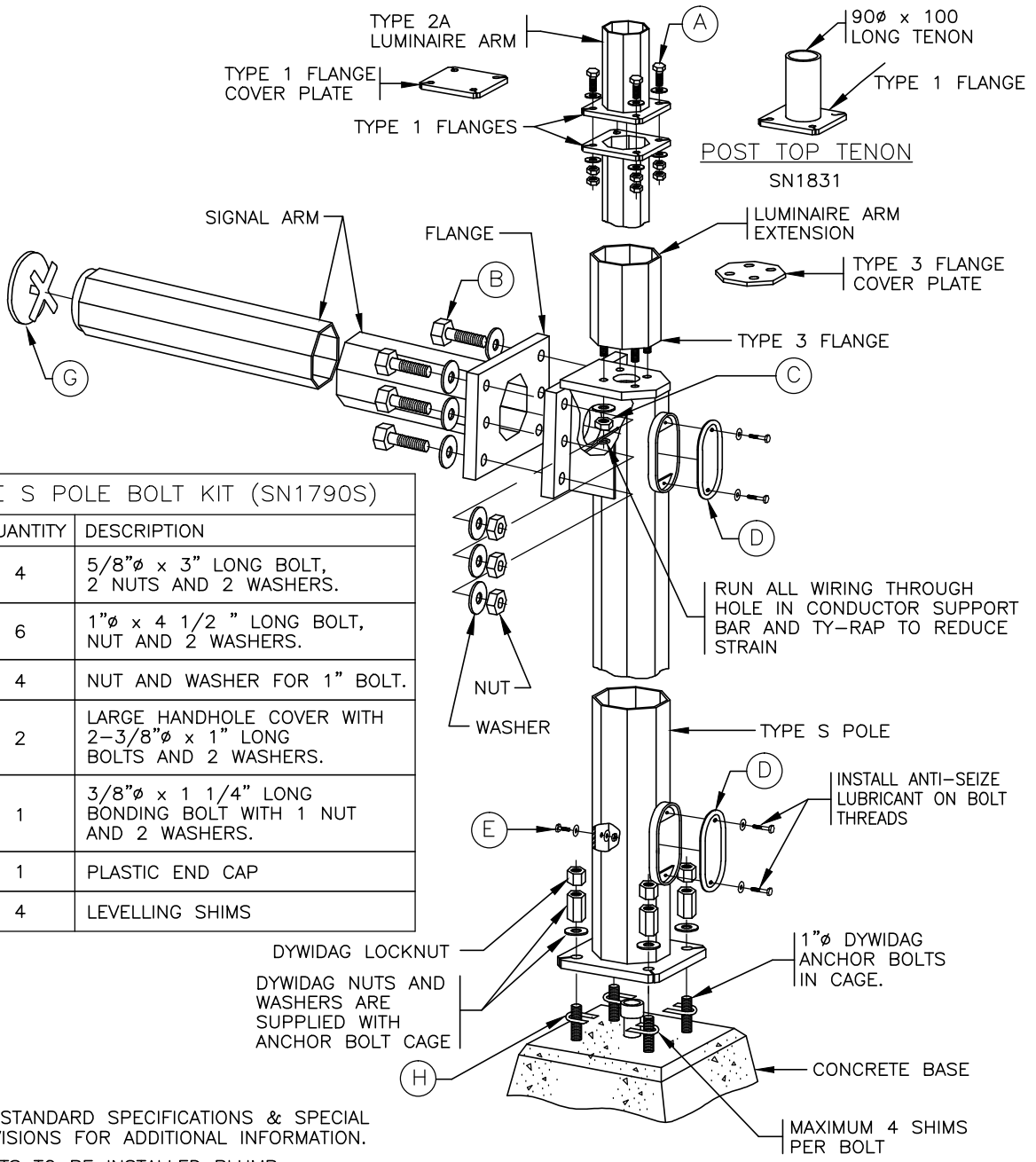
120 A/F

PLASTIC END CAP



SIGNAL POLE (TYPE S SHAFT) INSTALLATION DETAILS

Scale: N.T.S.
Created: MAY 2013
Rev Date: NOV 2016
Dwg No: E-5.7



TYPE S POLE BOLT KIT (SN1790S)

ITEM	QUANTITY	DESCRIPTION
A	4	5/8"φ x 3" LONG BOLT, 2 NUTS AND 2 WASHERS.
B	6	1"φ x 4 1/2" LONG BOLT, NUT AND 2 WASHERS.
C	4	NUT AND WASHER FOR 1" BOLT.
D	2	LARGE HANDHOLE COVER WITH 2-3/8"φ x 1" LONG BOLTS AND 2 WASHERS.
E	1	3/8"φ x 1 1/4" LONG BONDING BOLT WITH 1 NUT AND 2 WASHERS.
G	1	PLASTIC END CAP
H	4	LEVELLING SHIMS

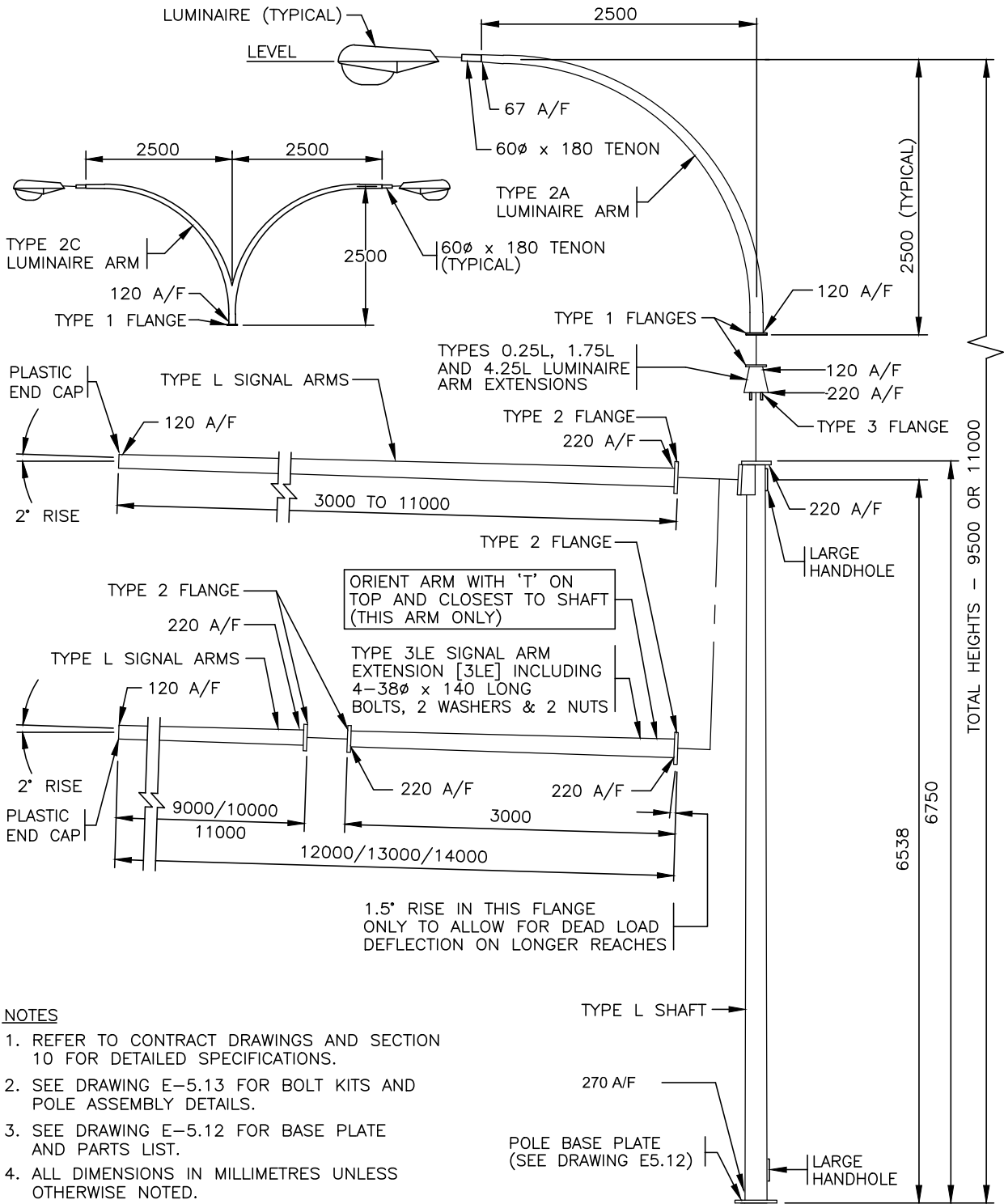
- NOTES**
1. SEE STANDARD SPECIFICATIONS & SPECIAL PROVISIONS FOR ADDITIONAL INFORMATION.
 2. SHAFTS TO BE INSTALLED PLUMB.
 3. ALL SHAFTS, ARMS AND EXTENSIONS TO BE SUPPLIED WITH A GALVANIZED FINISH.
 4. APPLY GREASE TO ANCHOR BOLT THREADS.
 5. TOUCH UP ANY SCRATCHES IN GALVANIZED SURFACES WITH COLD GALVANIZING COMPOUND.

POLE ASSEMBLY DETAIL



SIGNAL POLE (TYPE S SHAFT) INSTALLATION DETAILS

Scale: N.T.S.
 Created: JAN. 1998
 Rev Date: NOV 2016
 Dwg No: E-5.8



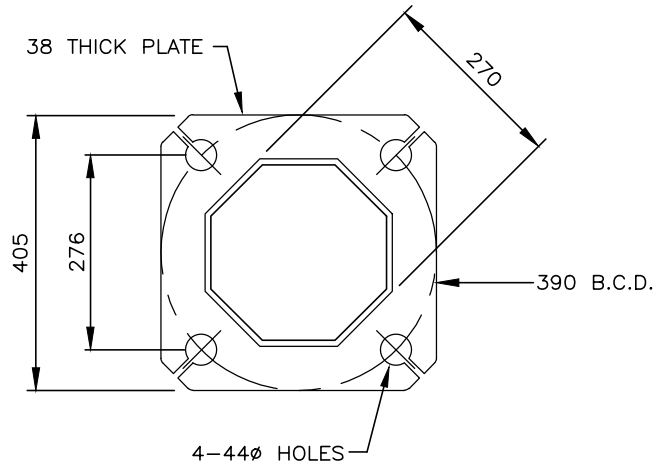
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SEE DRAWING E-5.13 FOR BOLT KITS AND POLE ASSEMBLY DETAILS.
3. SEE DRAWING E-5.12 FOR BASE PLATE AND PARTS LIST.
4. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



SIGNAL POLE (HIGHWAYS TYPE L SHAFT)

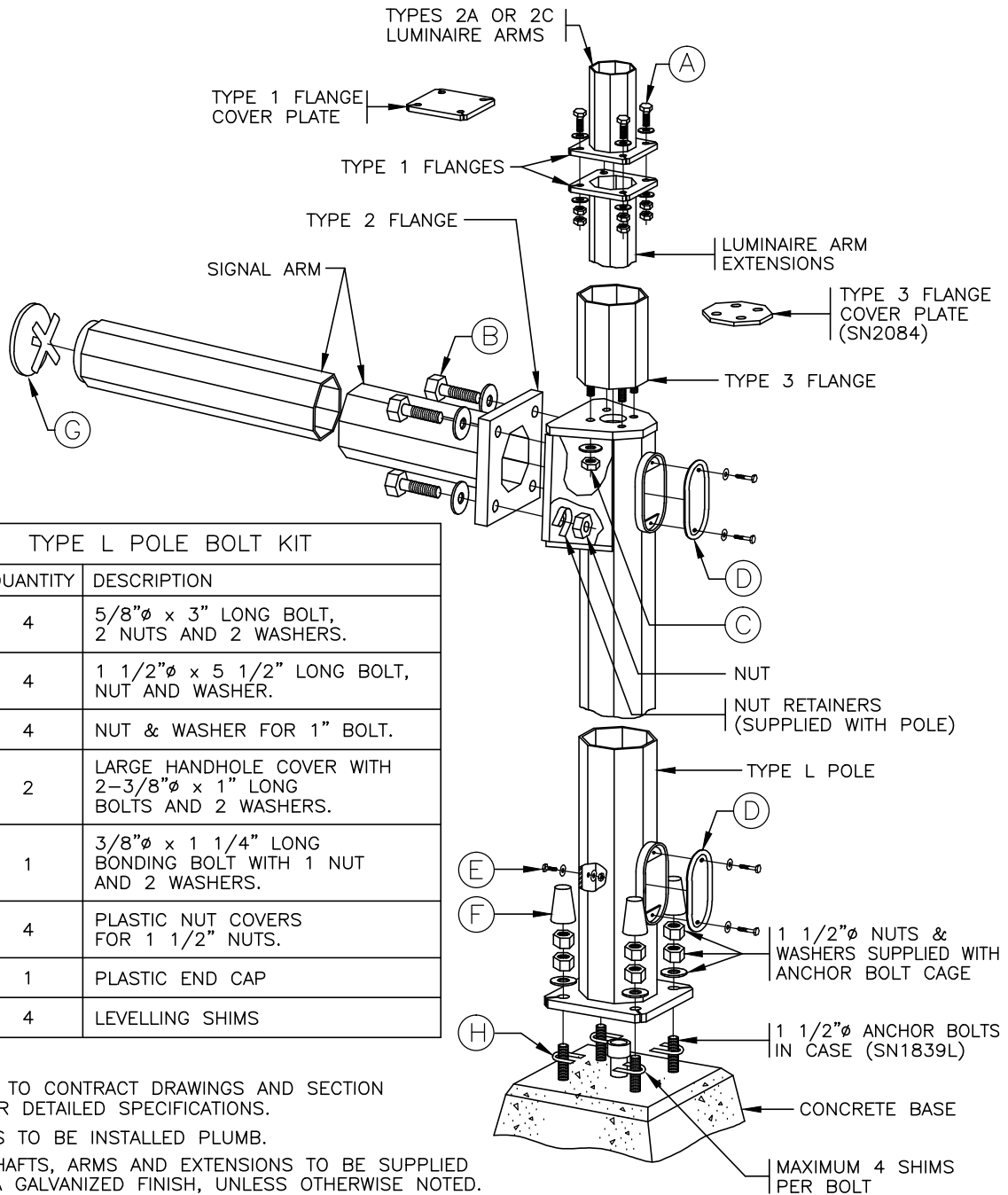
Scale: N.T.S.
 Created: MAY 2013
 Rev Date: NOV 2016
 Dwg No: E-5.11



TYPE L POLE BASE PLATE

PARTS LIST FOR TYPE L SIGNAL POLE		
PART		MASS (kg)
TYPE [L]	POLE SHAFT	442
TYPE [3L]	SIGNAL ARM - 3.0m	97
TYPE [4L]	SIGNAL ARM - 4.0m	118
TYPE [5L]	SIGNAL ARM - 5.0m	173
TYPE [6L]	SIGNAL ARM - 6.0m	201
TYPE [7L]	SIGNAL ARM - 7.0m	229
TYPE [8L]	SIGNAL ARM - 8.0m	259
TYPE [9L]	SIGNAL ARM - 9.0m	284
TYPE [10L]	SIGNAL ARM - 10.0m	377
TYPE [11L]	SIGNAL ARM - 11.0m	410
TYPE [3LE]	SIGNAL ARM EXTENSION - 3.0m	114
TYPE [4.25L]	LUMINAIRE ARM EXTENSION - 4.25m	82
TYPE [1.75L]	LUMINAIRE ARM EXTENSION - 1.75m	29
TYPE [0.25L]	LUMINAIRE ARM EXTENSION - 0.25m	10
TYPE [2A]	LUMINAIRE ARM	35
TYPE [2C]	LUMINAIRE ARM	65
TYPE 1	FLANGE COVER PLATE [1 FCP]	1.5
TYPE 2	FLANGE COVER PLATE [2 FCP]	4
TYPE 3	FLANGE COVER PLATE [3 FCP]	4

* [] I.D. LABEL ON POLE

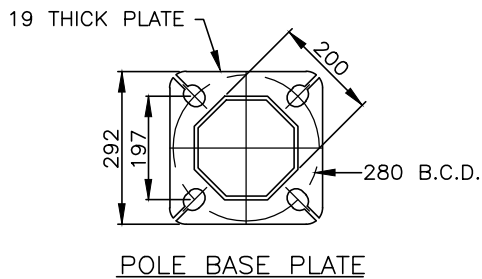
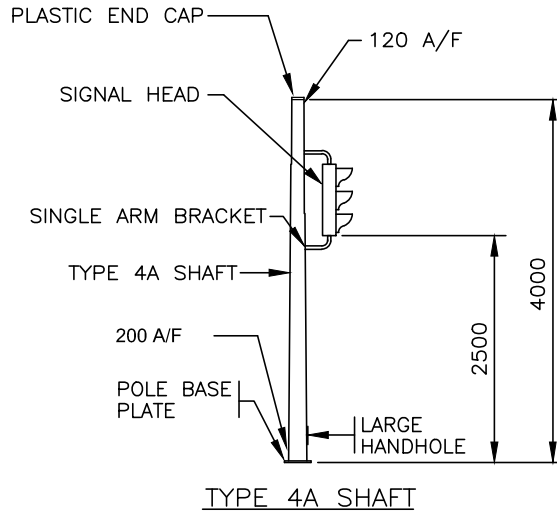


TYPE L POLE BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
A	4	5/8"ø x 3" LONG BOLT, 2 NUTS AND 2 WASHERS.
B	4	1 1/2"ø x 5 1/2" LONG BOLT, NUT AND WASHER.
C	4	NUT & WASHER FOR 1" BOLT.
D	2	LARGE HANDHOLE COVER WITH 2-3/8"ø x 1" LONG BOLTS AND 2 WASHERS.
E	1	3/8"ø x 1 1/4" LONG BONDING BOLT WITH 1 NUT AND 2 WASHERS.
F	4	PLASTIC NUT COVERS FOR 1 1/2" NUTS.
G	1	PLASTIC END CAP
H	4	LEVELLING SHIMS

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SHAFTS TO BE INSTALLED PLUMB.
3. ALL SHAFTS, ARMS AND EXTENSIONS TO BE SUPPLIED WITH A GALVANIZED FINISH, UNLESS OTHERWISE NOTED.
4. APPLY GREASE TO ANCHOR BOLT THREADS.
5. TOUCH UP ANY SCRATCHES IN GALVANIZED SURFACES WITH COLD GALVANIZING COMPOUND.

POLE ASSEMBLY DETAIL

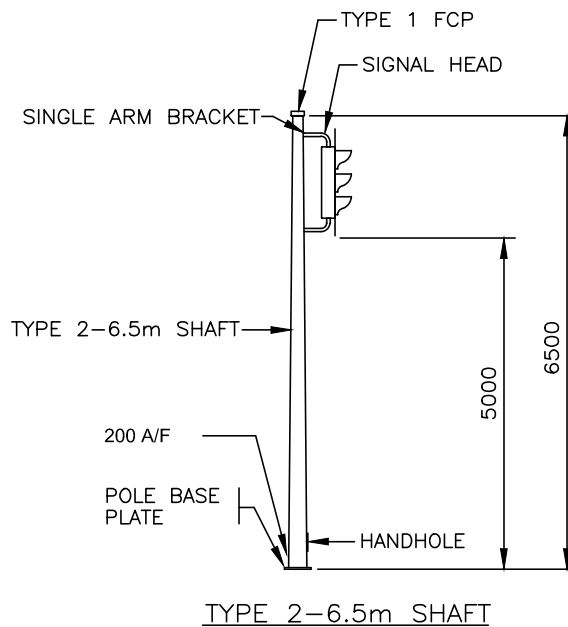


PARTS LIST	
PART	MASS (kg)
TYPE [2] SHAFT	102
TYPE [4A] SHAFT	66

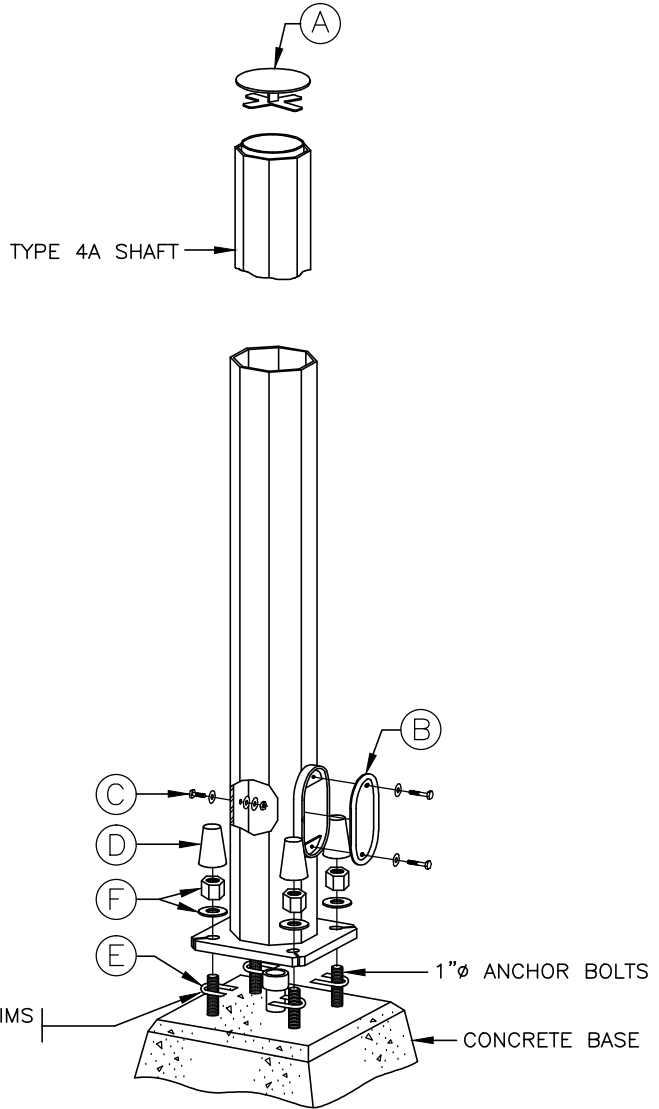
* [] I.D. LABEL ON POLE

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SEE DRAWING E-5.15 FOR TYPE 4A SHAFT, BOLT KITS AND POLE ASSEMBLY DETAILS.
3. ALL DIMENSION IN MILLIMETRES UNLESS OTHERWISE NOTED.
4. POLE SHAFTS TO BE SUPPLIED 0.9m SHORTER WHERE BEING INSTALLED ON SERVICE BASE.



TYPE 4A SHAFT BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
A	1	PLASTIC END CAP
B	1	LARGE HANDHOLE COVER WITH 2-3/8"φ x 1 1/4" LONG BOLTS AND 2 WASHERS.
C	1	3/8"φ x 1" LONG BONDING BOLT WITH 1 NUT AND 2 WASHERS.
D	4	PLASTIC NUT COVERS FOR 1"φ NUTS.
E	4	LEVELING SHIMS.
F	4	1"φ NUTS AND WASHERS.

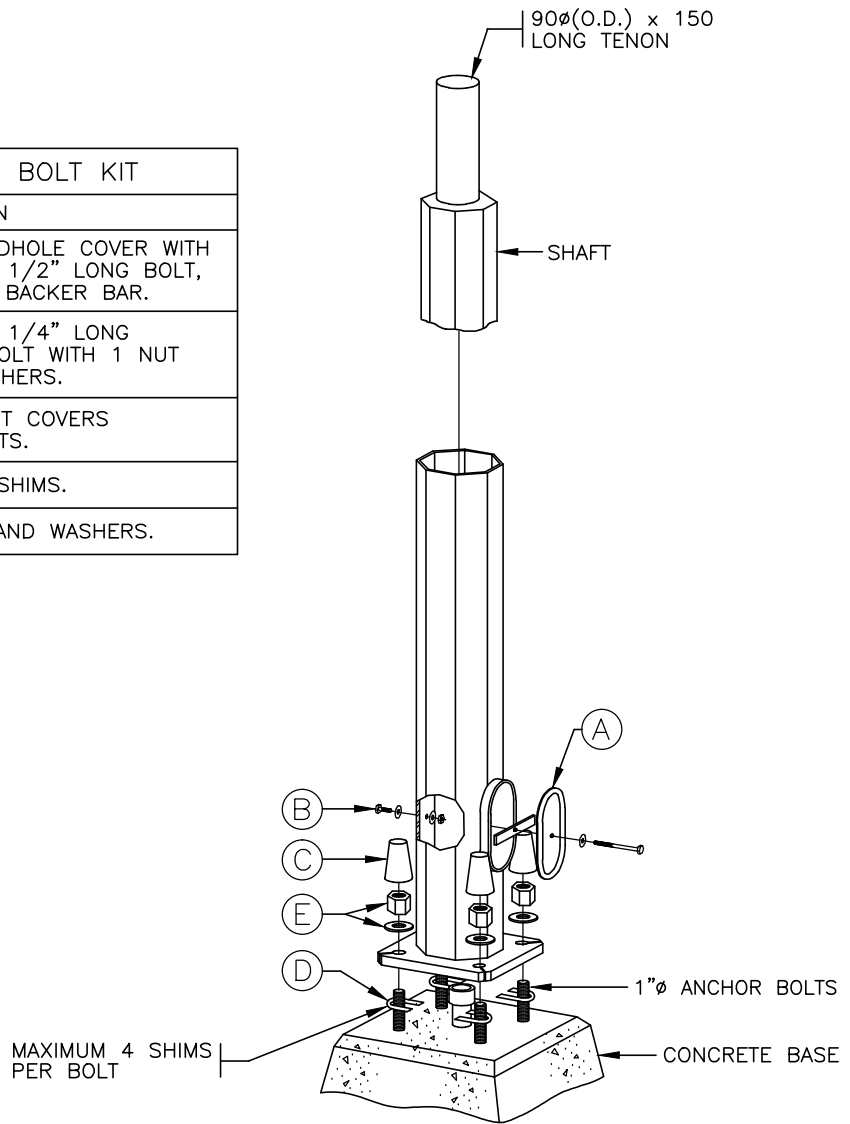


POLE ASSEMBLY DETAIL

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SHAFTS TO BE INSTALLED PLUMB.
3. ALL SHAFTS, ARMS AND EXTENSIONS TO BE SUPPLIED WITH A GALVANIZED FINISH, UNLESS OTHERWISE NOTED.
4. APPLY GREASE TO ANCHOR BOLT THREADS.
5. TOUCH UP ANY SCRATCHES IN GALVANIZED SURFACES WITH COLD GALVANIZING COMPOUND.

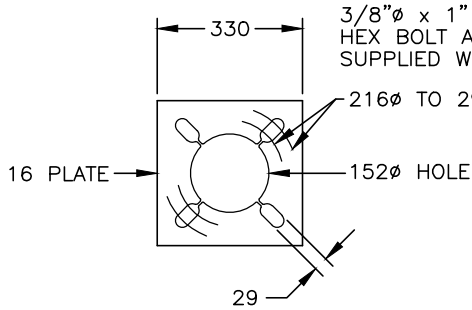
POST TOP POLE BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
A	1	SMALL HANDHOLE COVER WITH 3/8"Ø x 2 1/2" LONG BOLT, WASHER & BACKER BAR.
B	1	3/8"Ø x 1 1/4" LONG BONDING BOLT WITH 1 NUT AND 3 WASHERS.
C	4	PLASTIC NUT COVERS FOR 1" NUTS.
D	4	LEVELLING SHIMS.
E	4	1"Ø NUTS AND WASHERS.



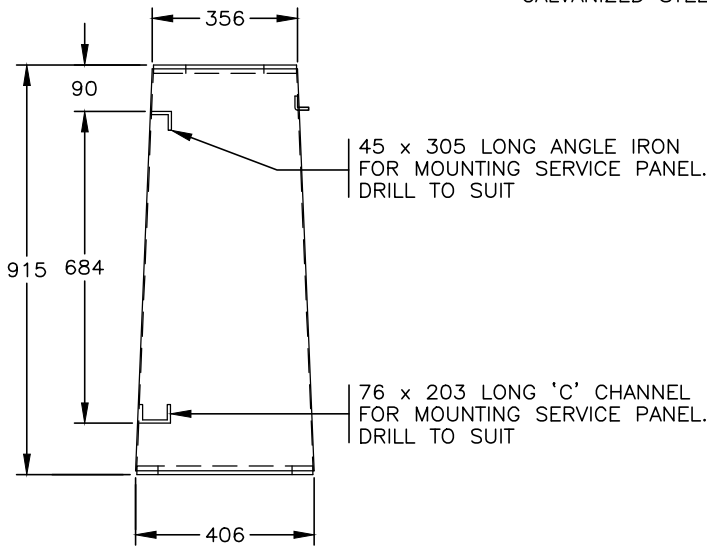
POLE ASSEMBLY DETAIL

NOTES

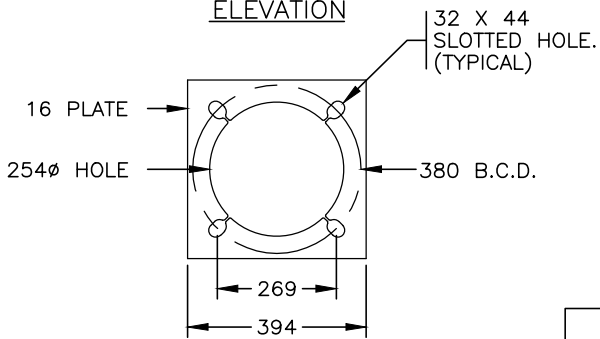
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SHAFTS TO BE INSTALLED PLUMB.
3. ALL SHAFTS, ARMS AND EXTENSIONS TO BE SUPPLIED WITH A GALVANIZED FINISH, UNLESS OTHERWISE NOTED.
4. APPLY GREASE TO ANCHOR BOLT THREADS.
5. TOUCH UP ANY SCRATCHES IN GALVANIZED SURFACES WITH COLD GALVANIZING COMPOUND.



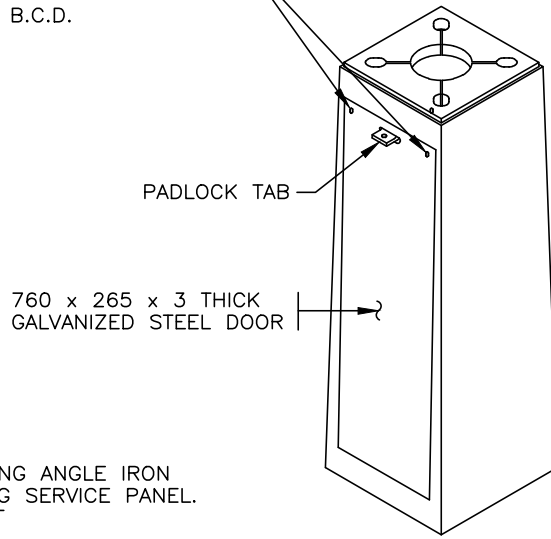
TOP VIEW



ELEVATION



BOTTOM VIEW

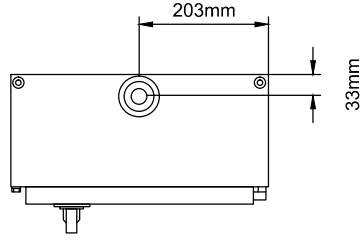


PICTORIAL VIEW

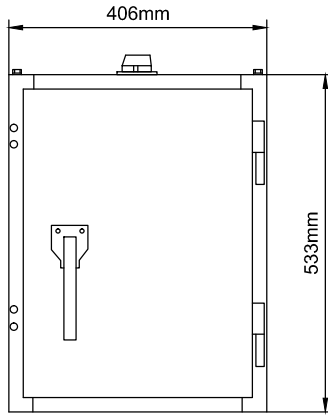
NOTES

- 1 REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SERVICE BASE TO BE USED WITH TYPE 2 SHAFTS AND POST TOP POLES ONLY.
3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.

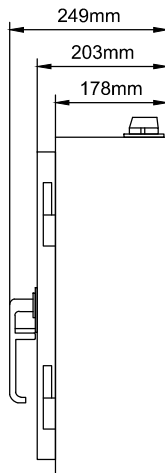
SERVICE BASE BOLT KIT		
ITEM	QUANTITY	DESCRIPTION
POLE CONNECTION BOLTS	4	1"ø x 3" LONG GALVANIZED SAE GRADE 5 BOLT, NUT AND 2 WASHERS.



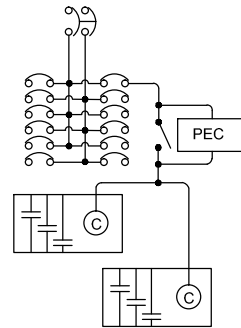
TOP VIEW



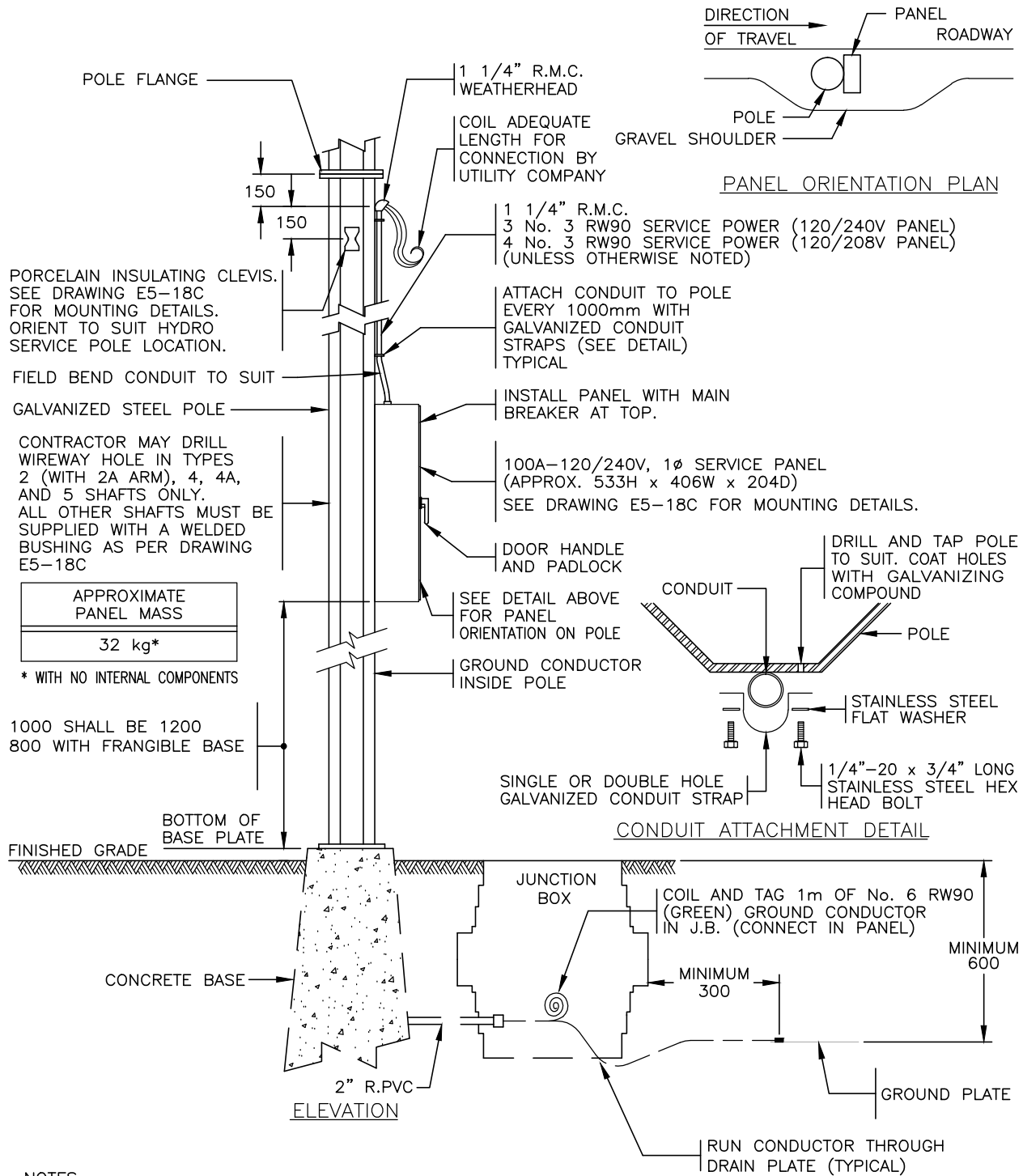
FRONT VIEW

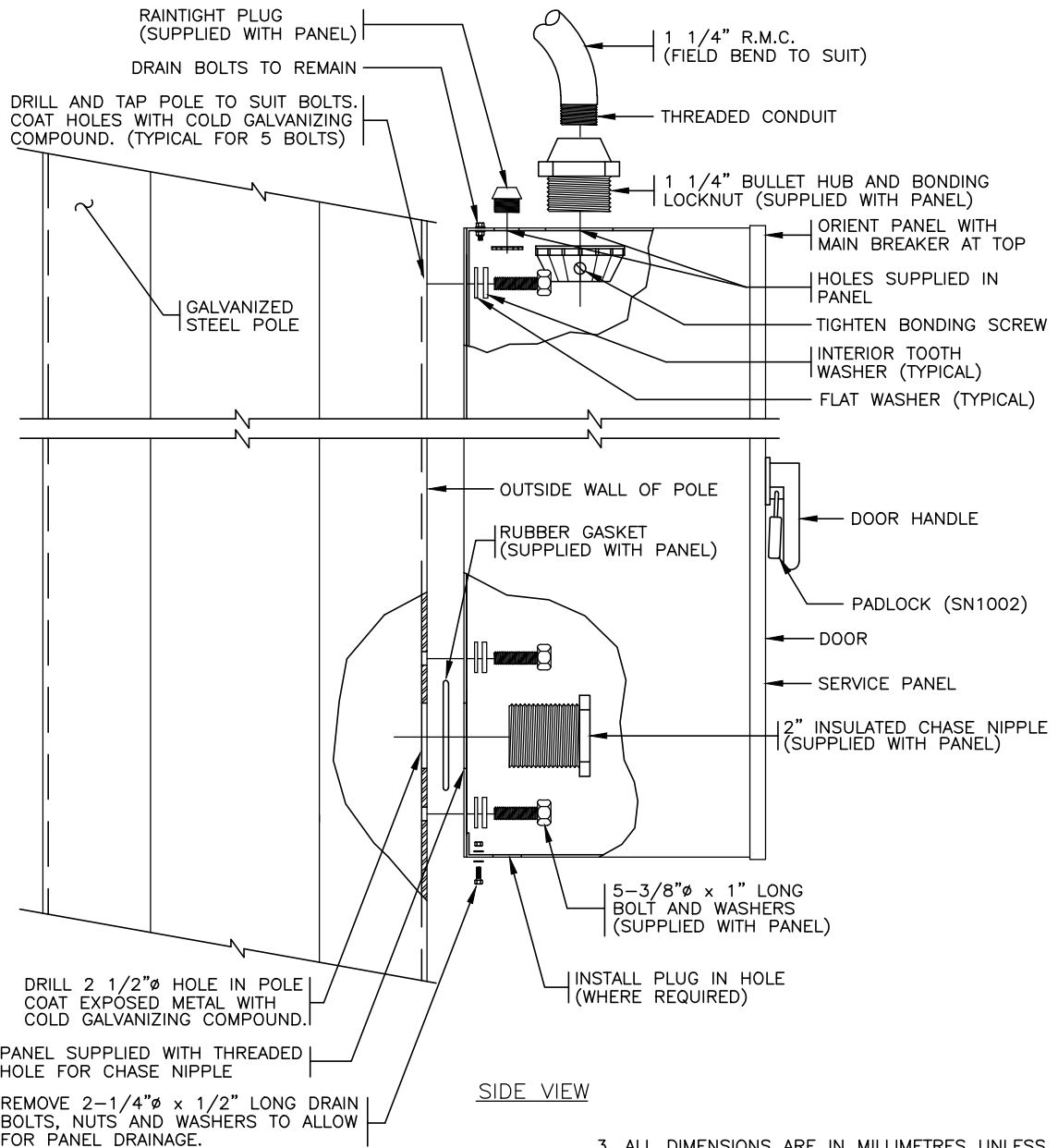


SIDE VIEW



UTILITY & INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS / ISSUE EDITION NOT FINAL DRAFT FINAL DRAFT STANDARD CAD DRAWINGS SECTION 10 DWGSE-5.18B

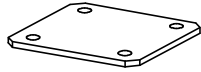




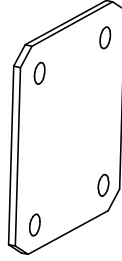
NOTES

1. SEE STANDARD SPECIFICATIONS & SPECIAL PROVISIONS FOR ADDITIONAL INFORMATION.

3. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.
4. PANEL ASSEMBLY AND INSTALLATION INSTRUCTIONS SUPPLIED WITH PANEL.

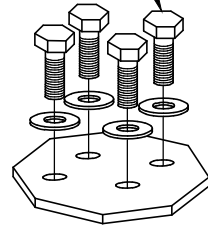


TYPE 1 FLANGE
COVER PLATE

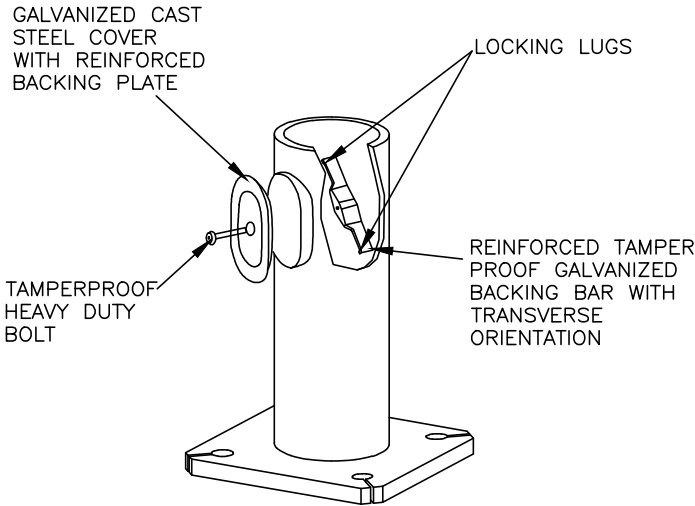


TYPE 2 FLANGE
COVER PLATE

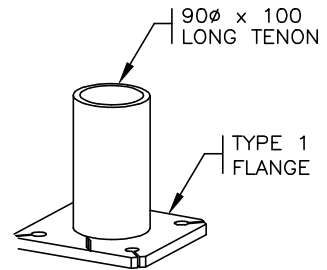
4-1"Ø x 2 1/2" LONG
BOLTS AND WASHERS



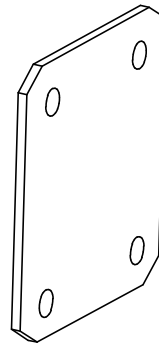
TYPE 3 FLANGE
COVER PLATE



SECURITY 4 X 7 HANDHOLE
COVER KIT



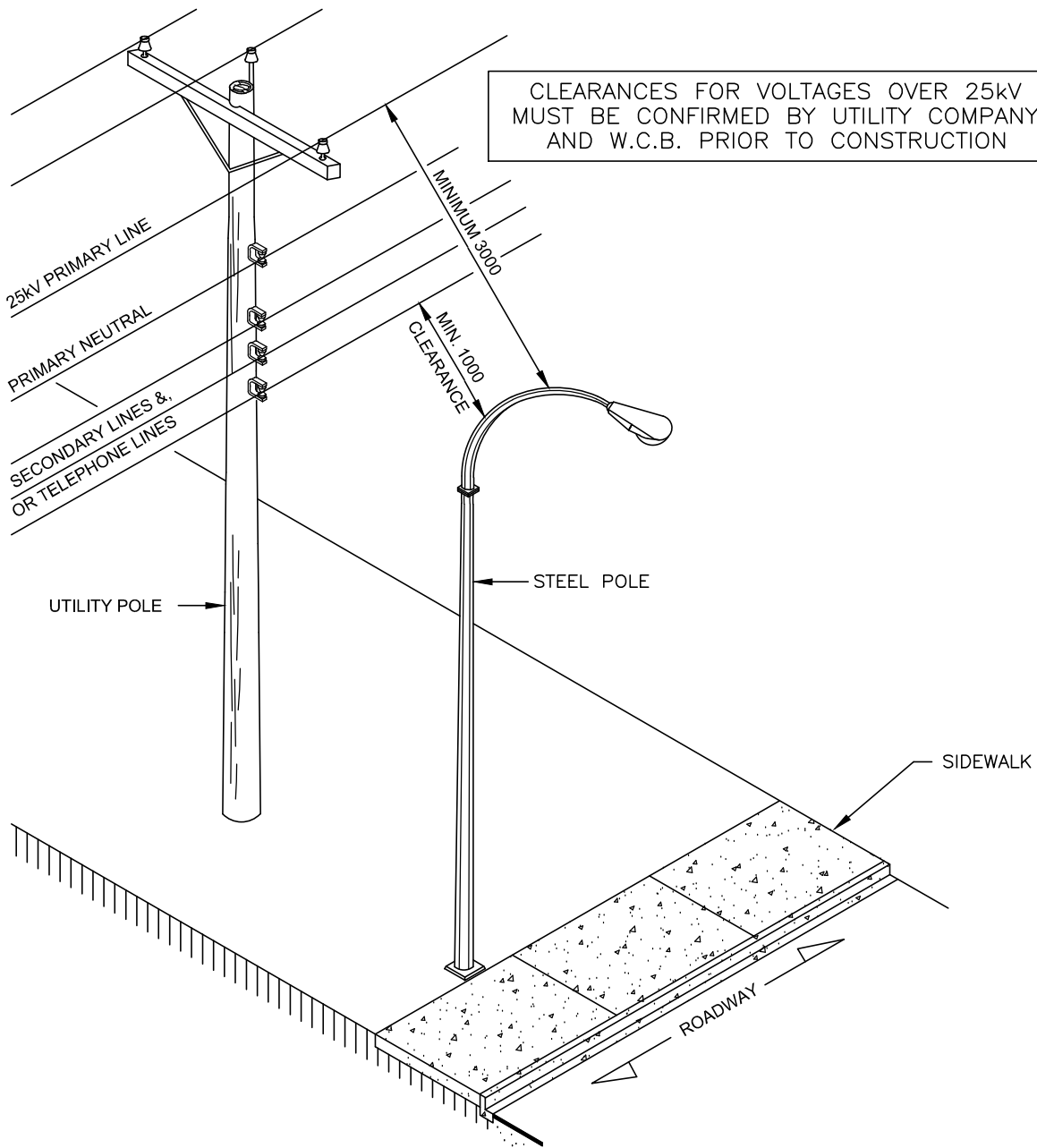
POST TOP
TENON



TYPE 8 FLANGE
COVER PLATE

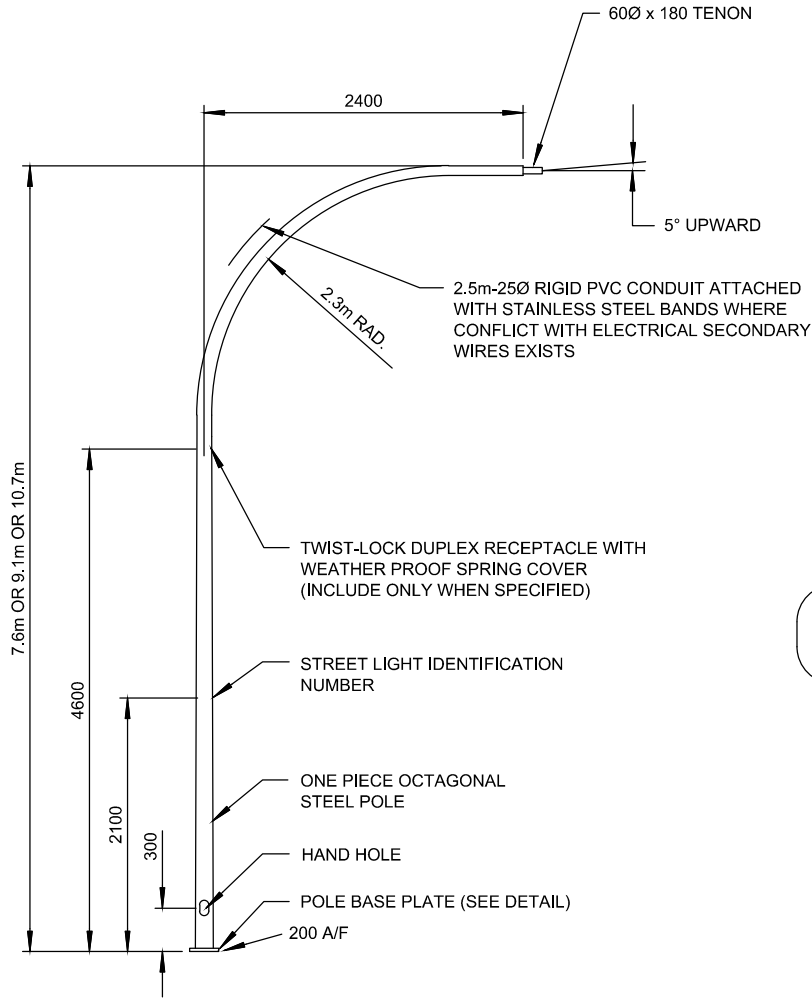
NOTES

- 1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.

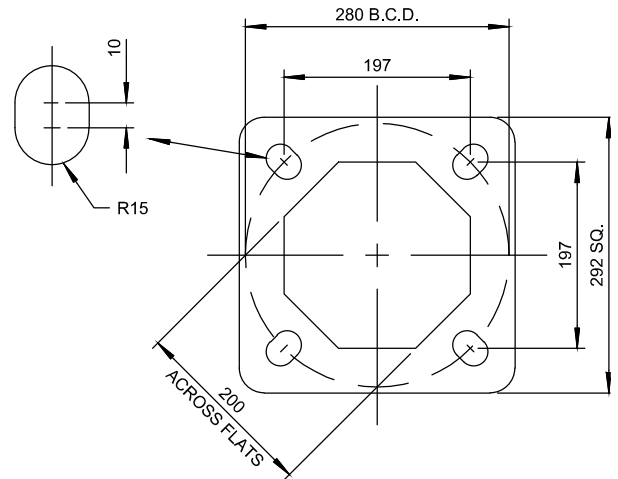


NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. CLEARANCES LISTED ABOVE ARE TO BE USED AS A GUIDELINE ONLY. EXACT REQUIRED CLEARANCES MAY VARY AND MUST BE CONFIRMED BY CONTRACTOR PRIOR TO CONSTRUCTION. AS PER THE REQUIREMENTS OF THE UTILITY COMPANY.
3. FOR CLEARANCES LESS THAN 3.0m CONTRACTOR TO OBTAIN APPROVAL FROM UTILITY COMPANY AND WORKERS COMPENSATION BOARD PRIOR TO INSTALLATION.



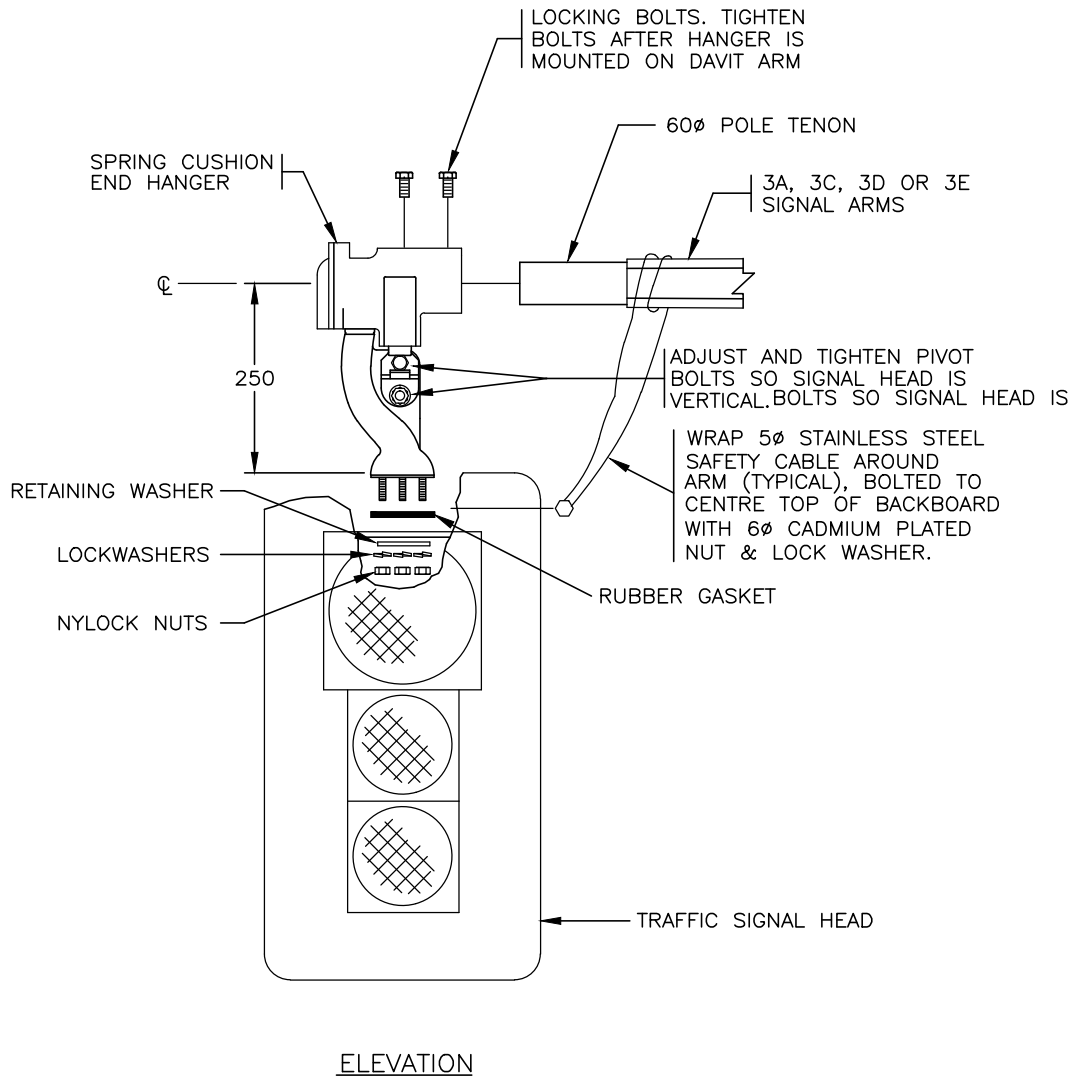
ELEVATION



POLE BASE PLATE

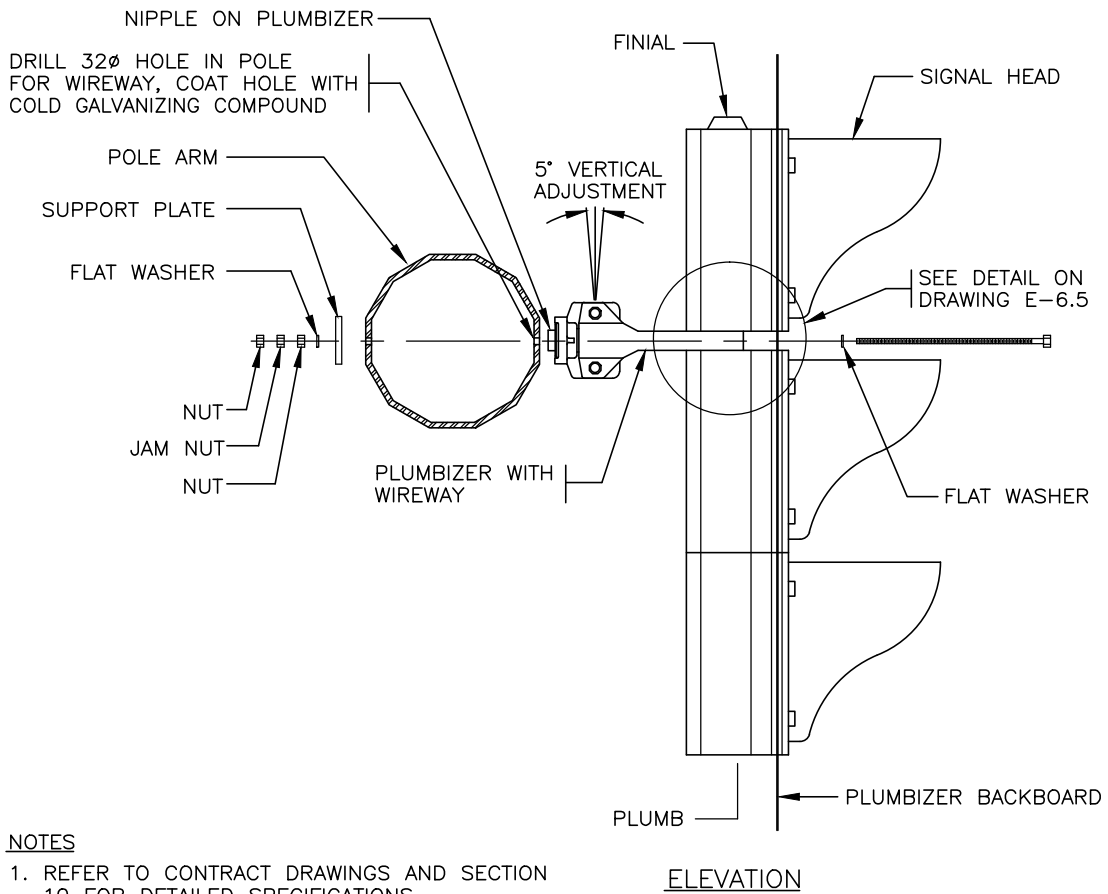
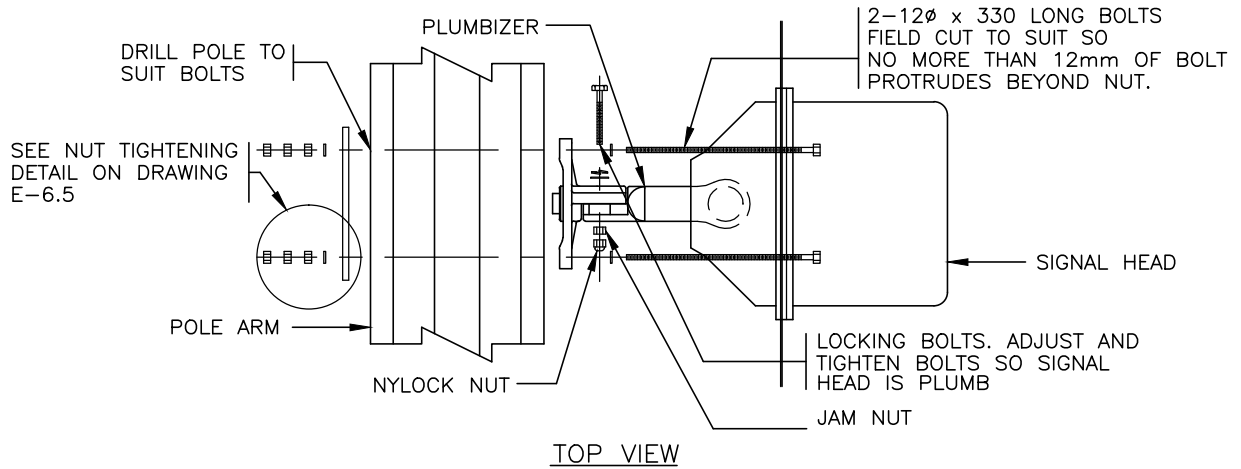
NOTES:

1. STRICT ADHERANCE TO CLEARANCES FROM HIGH VOLTAGE POWER AS SPECIFIED IN THE CANADIAN ELECTRICAL CODE IS REQUIRED
2. ALL DIMENSIONS IN MILLIMETERS UNLESS SHOWN OTHERWISE
3. POLE TO BE SUPPLIED 0.9m SHORTER WHERE BEING INSTALLED ON SERVICE BASE.



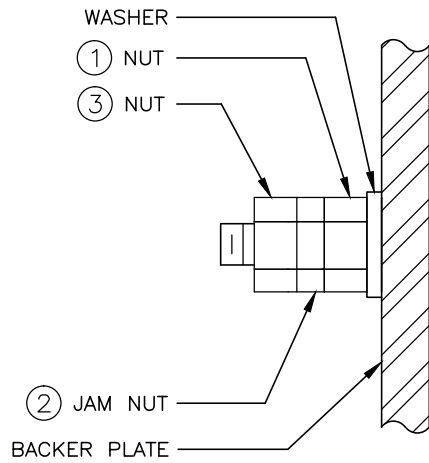
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. AIM SIGNAL HEADS AS DIRECTED BY THE CITY ENGINEER.
3. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



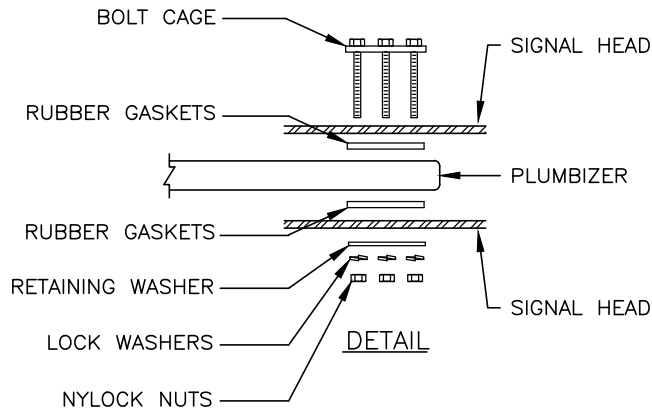
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. AIM SIGNAL HEADS AS DIRECTED BY THE CITY ENGINEER.



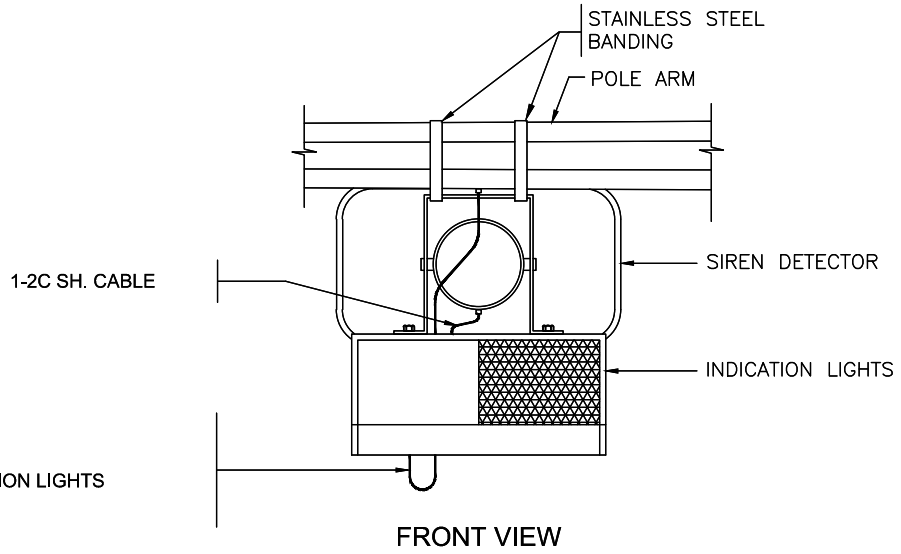
- TIGHTEN NUT ① AGAINST WASHER,
- TIGHTEN JAM NUT ② AGAINST NUT,
- SNUG NUT ③ AGAINST JAM NUT ② AND THEN TIGHTEN NUT ③ AND JAM NUT ② INTO EACH OTHER.

DETAIL



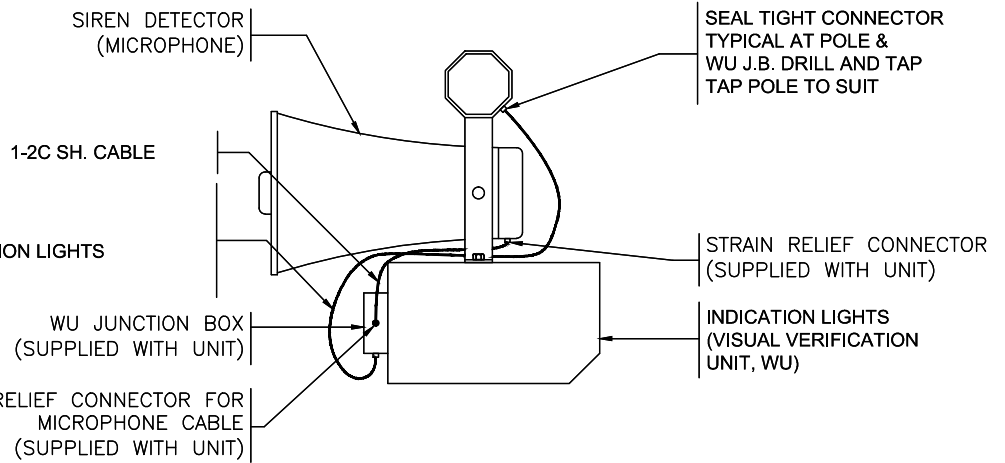
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. AIM SIGNAL HEADS AS DIRECTED BY THE CITY ENGINEER.



FRONT VIEW

- 1-3/4" FMC
- 1-2C SH. CABLE
- 3 No. 14 RW90 INDICATION LIGHTS
- 1 No. 14 RW90 BOND

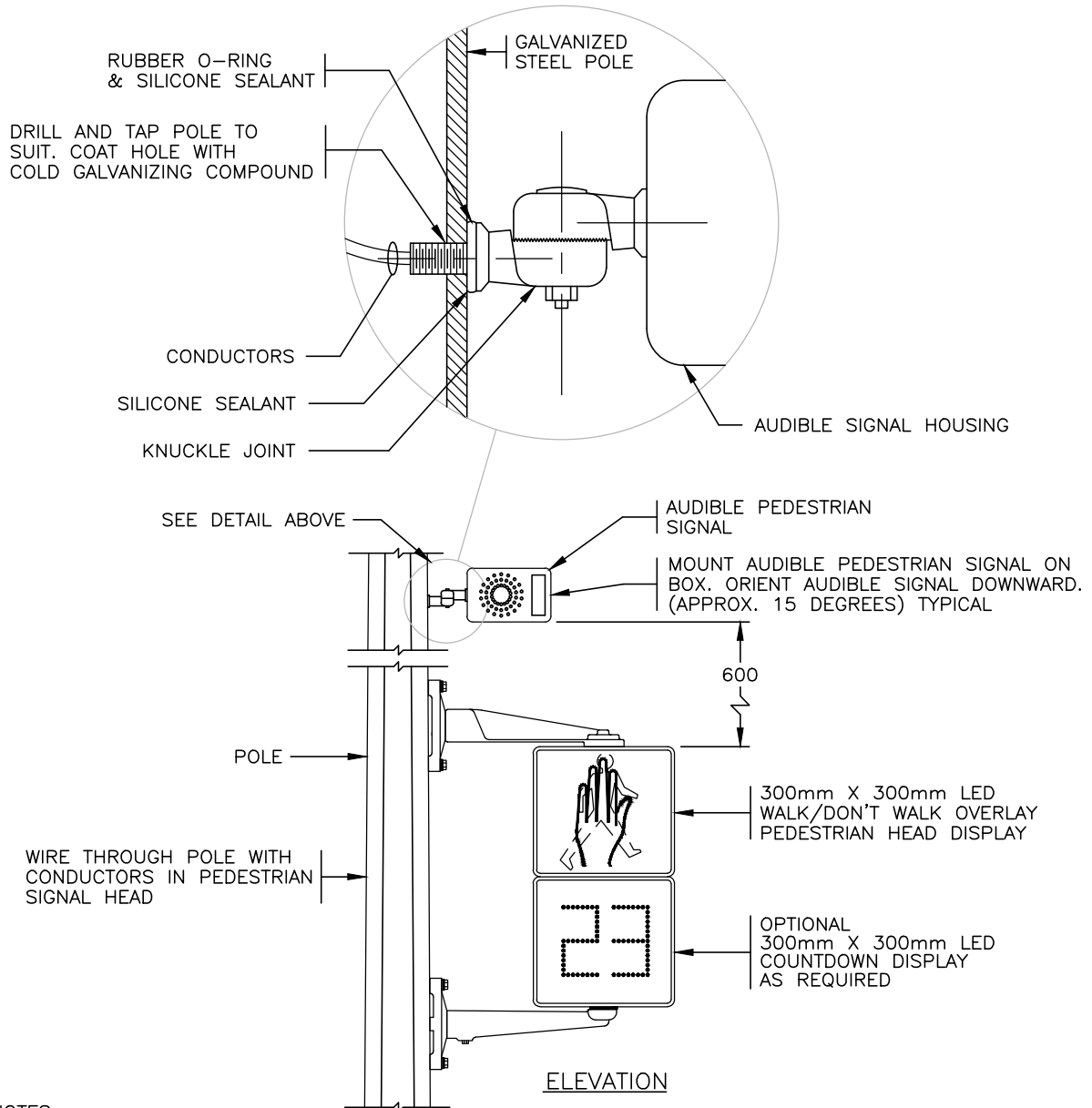


SIDE VIEW

- 1-3/4" FMC
- 1-2C SH. CABLE
- 3 No. 14 RW90 INDICATION LIGHTS
- 1 No. 14 RW90 BOND

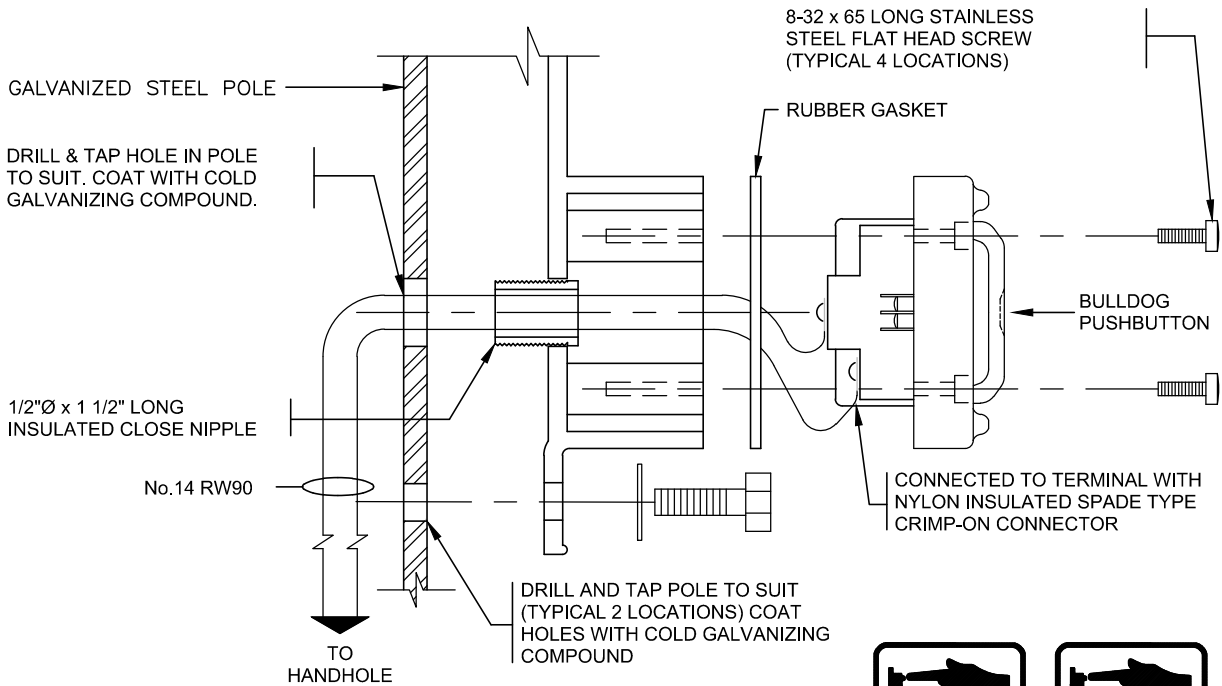
NOTES:

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. PRE-EMPTION UNIT IS TO BE SUPPLIED BY THE CITY OF NANAIMO AND INSTALLED BY THIS CONTRACTOR.
3. AIM, ADJUST SIREN PRE-EMPTION UNIT AS DIRECTED BY THE CITY ENGINEER.

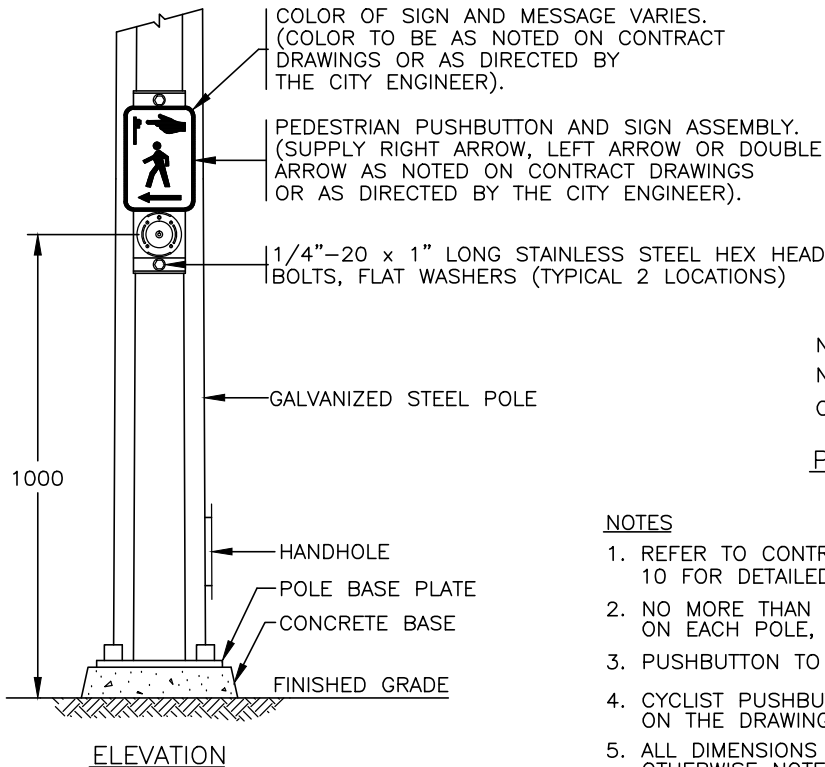


NOTES

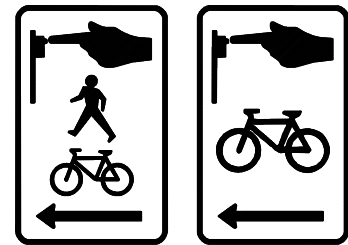
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. AIM, ADJUST AND CONNECT AUDIBLE SIGNAL AS PER MANUFACTURERS INSTRUCTIONS TO SATISFACTION THE CITY ENGINEER.
3. AUDIBLE SIGNAL TO 'CHIRP' FOR EAST TO WEST CROSSINGS & 'CUCKOO' FOR NORTH TO SOUTH CROSSINGS. AT INTERSECTIONS WHERE NORTH/SOUTH AND EAST/WEST ARE NOT EASILY DEFINED CONTACT CITY ENGINEER FOR DIRECTION.
4. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
5. ORDER AUDIBLE SIGNAL HEAD WITH MINIMUM 3.0m OF CONDUCTORS



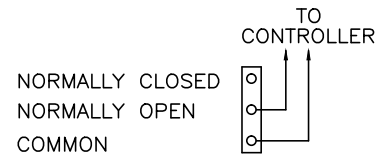
SIDE VIEW



ELEVATION



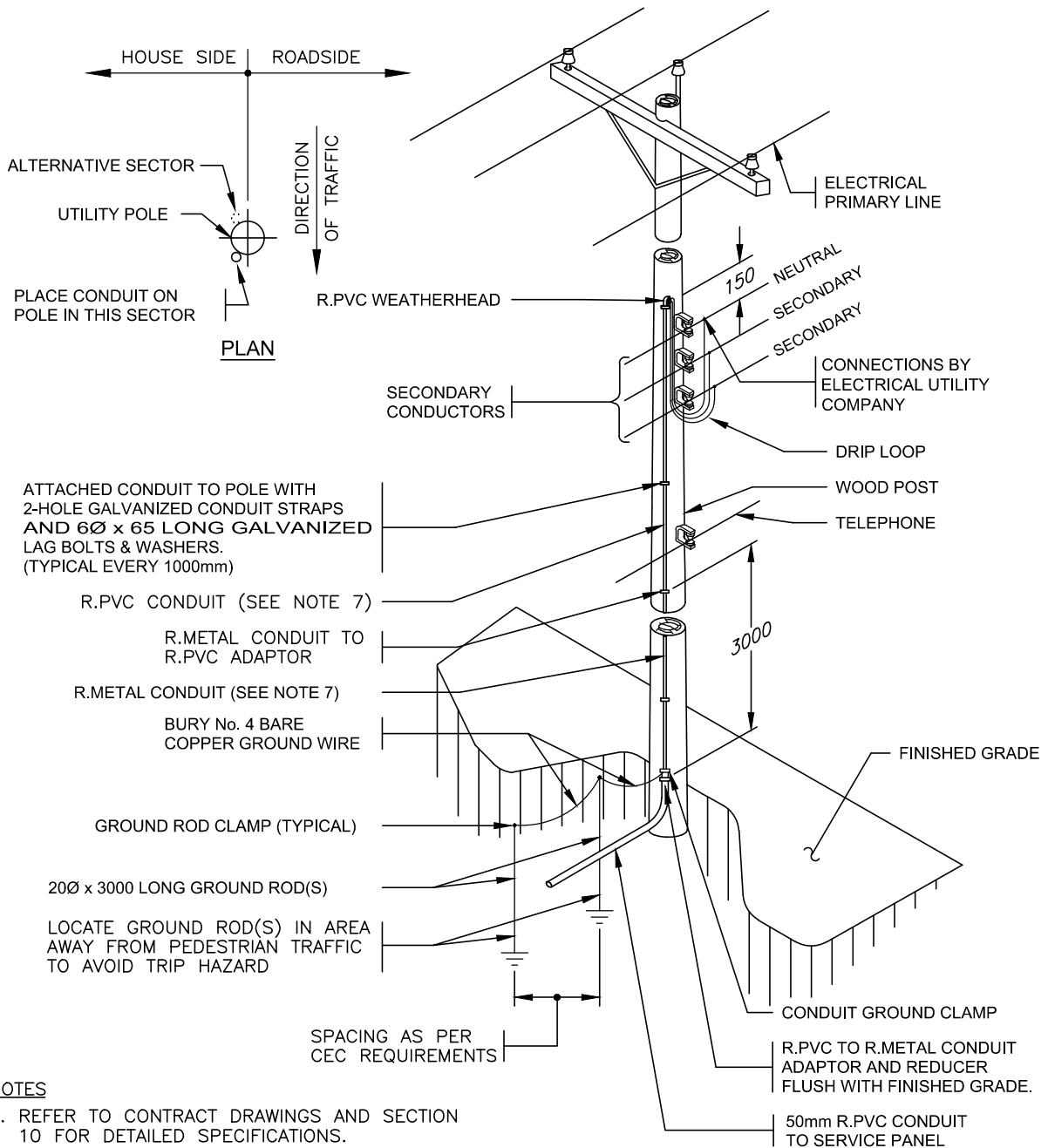
ALTERNATE PEDESTRIAN PUSHBUTTON SIGNS



PEDESTRIAN PUSHBUTTON CONNECTIONS

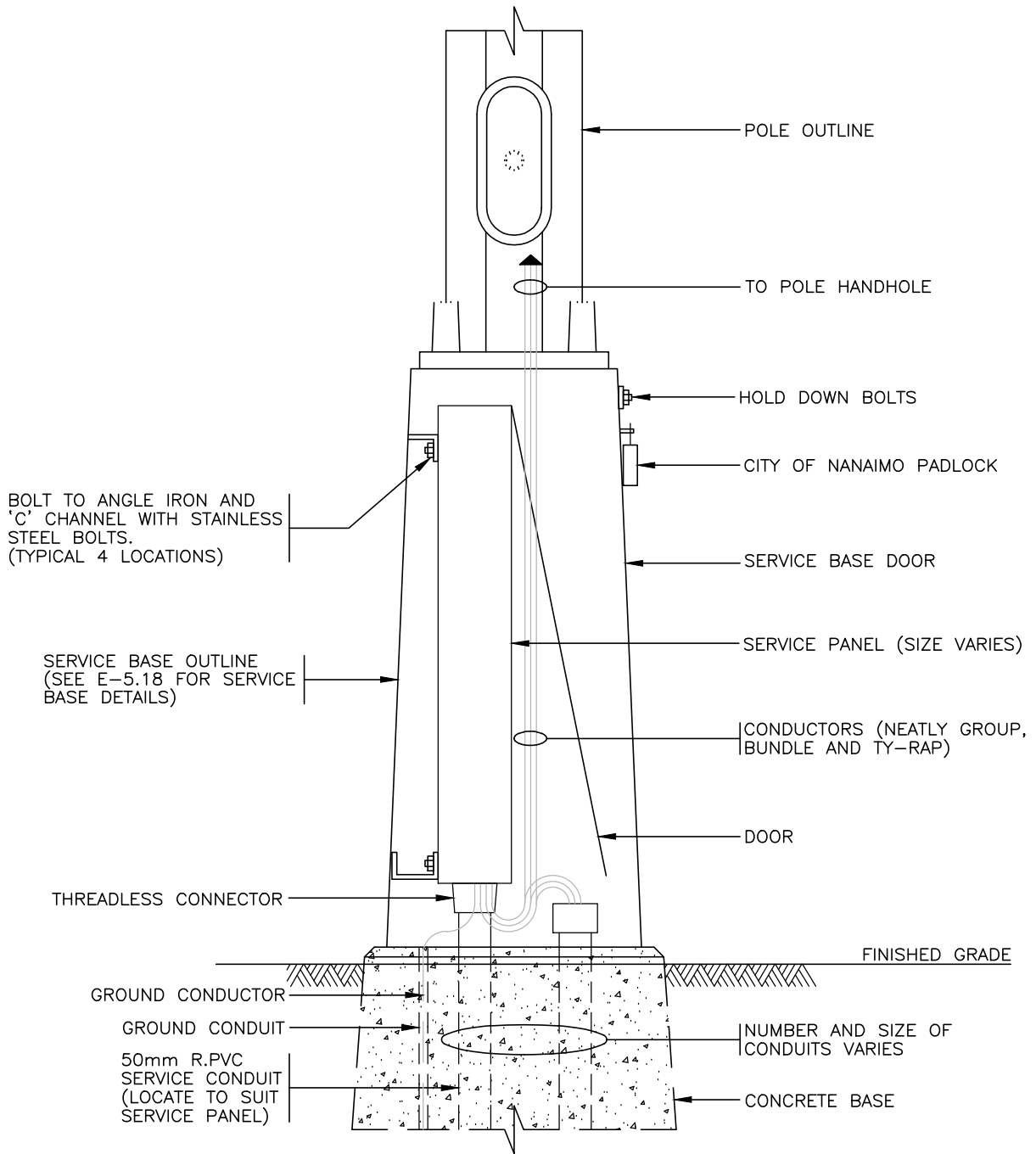
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. NO MORE THAN 2 PUSHBUTTONS TO BE INSTALLED ON EACH POLE, UNLESS OTHERWISE NOTED.
3. PUSHBUTTON TO HAVE NORMALLY OPEN CONTACTS.
4. CYCLIST PUSHBUTTON TO BE INSTALLED AS DIRECTED ON THE DRAWINGS OR BY THE CITY ENGINEER.
5. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



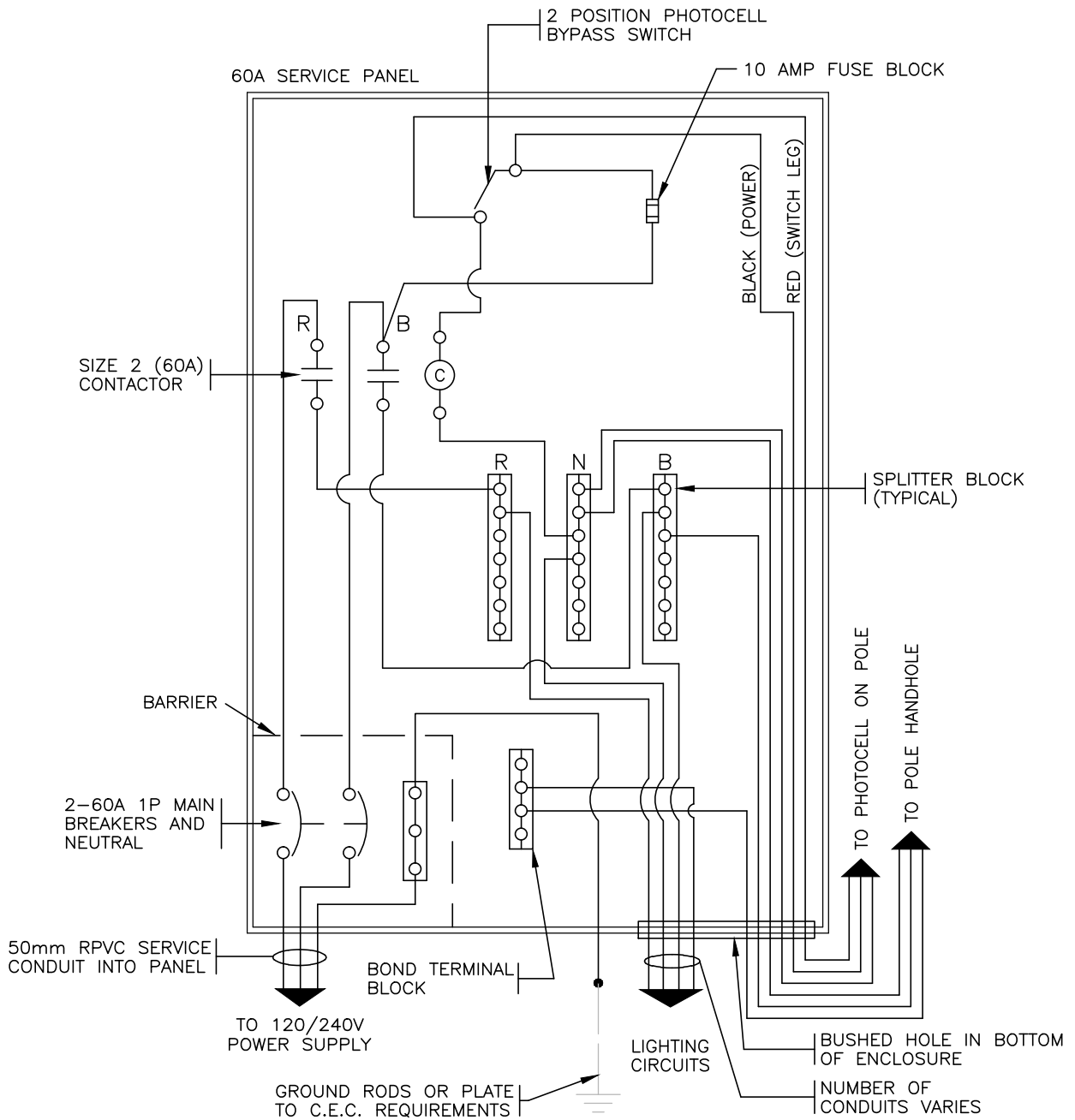
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. CONTRACTOR RESPONSIBLE FOR INSTALLATION OF SERVICE CONDUCTORS. CONNECTION BY ELECTRICAL UTILITY COMPANY UNLESS OTHERWISE NOTED.
3. CONTRACTOR TO OBTAIN PERMISSION FROM UTILITY COMPANY PRIOR TO INSTALLING CONDUIT ON THEIR POLE.
4. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.
5. SERVICE CONDUCTORS AS DETAILED ON CONTRACT DRAWINGS.
6. MOUNT CONDUIT ON CONCRETE POLE WITH 19mm STAINLESS STEEL BANDING.
7. CONDUIT UP POLE TO SUIT SERVICE CONDUCTORS (MINIMUM 30mmØ)



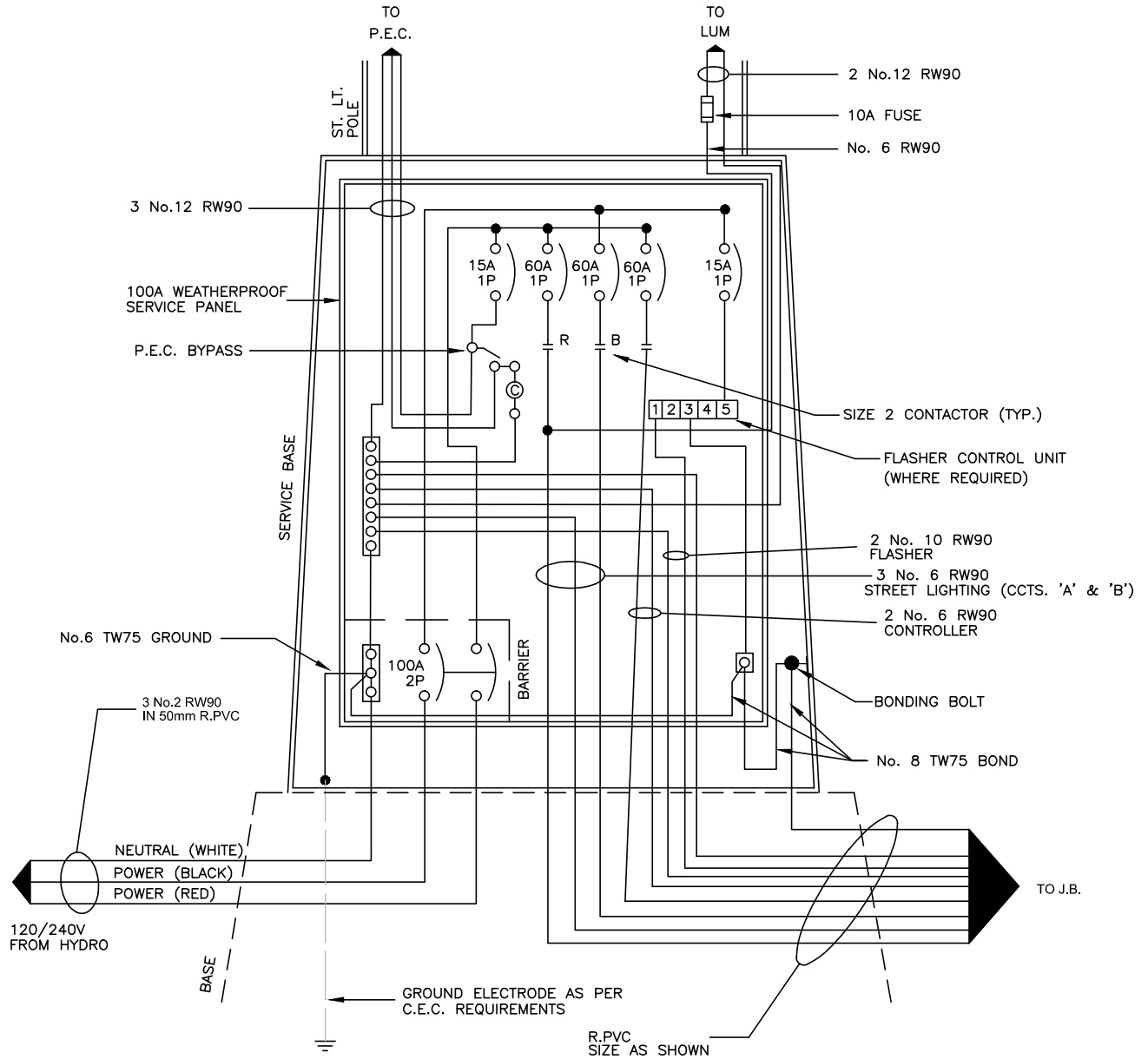
NOTES

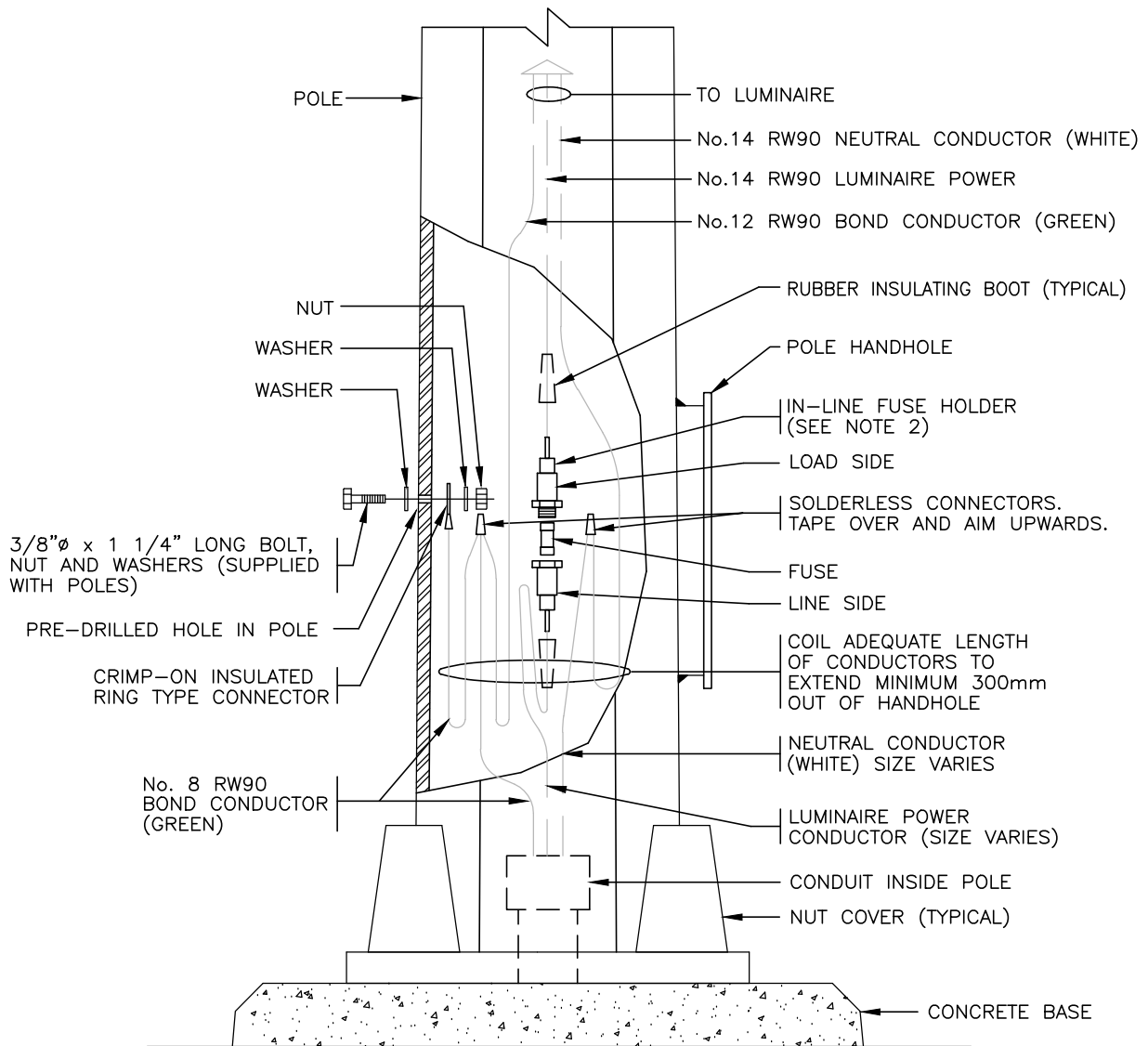
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.



TYPICAL 60A STREET LIGHTING WIRING
DIAGRAM (FOR USE IN SERVICE BASE)

Scale:	N.T.S.
Created:	NOV. 2012
Rev Date:	NOV 2016
Dwg No:	E-10.3

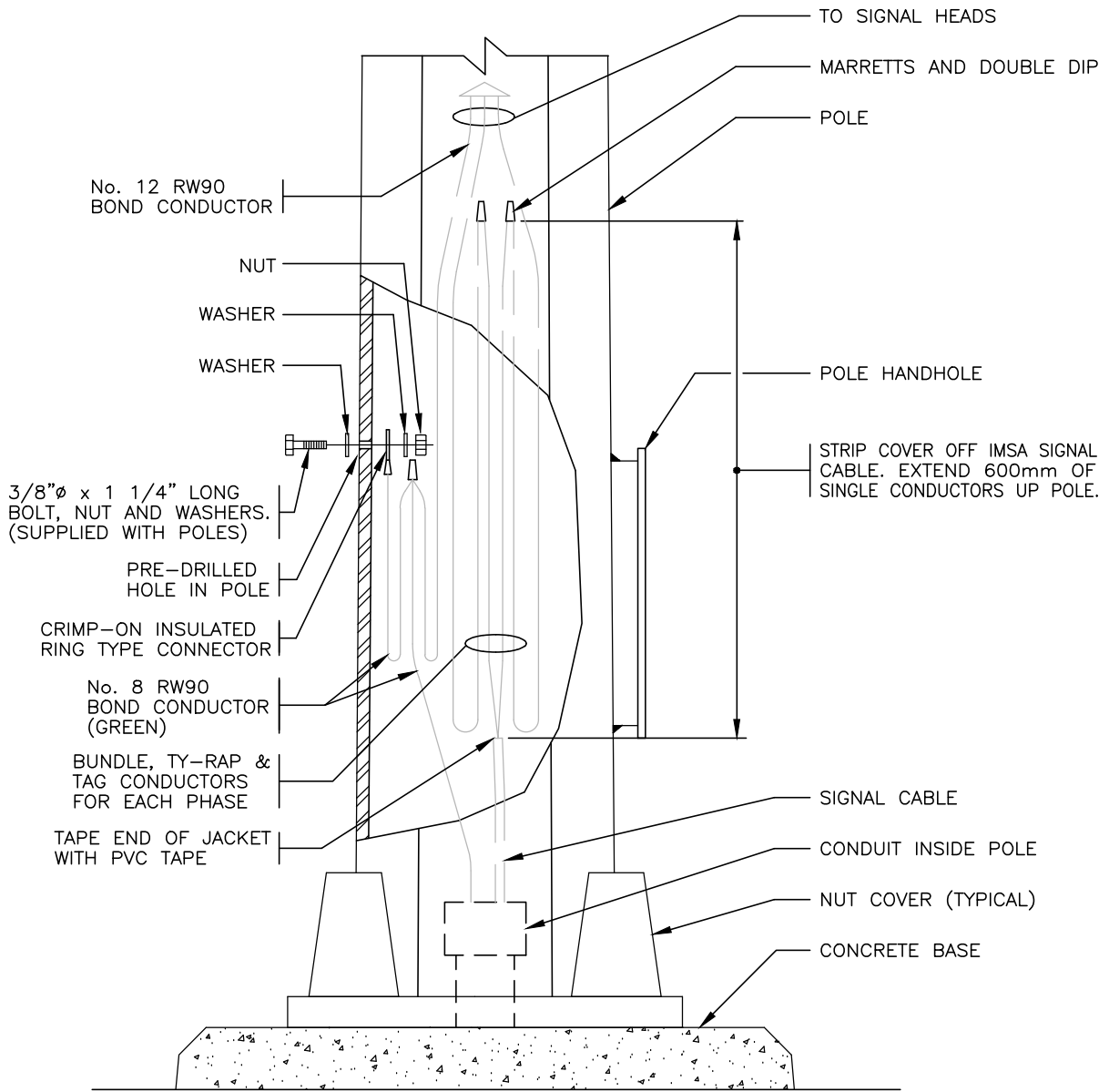




ELEVATION

NOTES

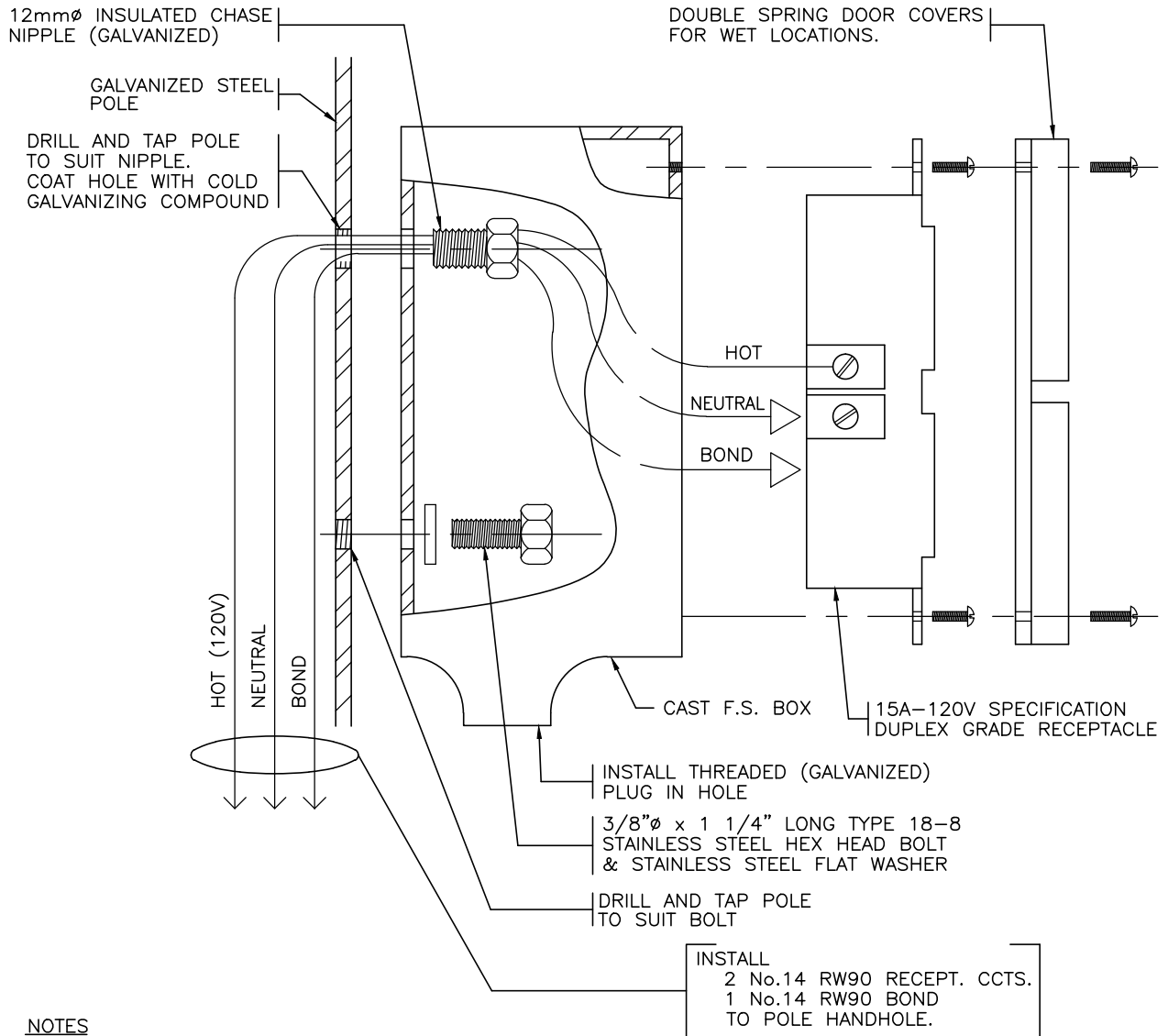
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. FUSE INSTALLATION IN JUNCTION BOXES SIMILAR.



ELEVATION

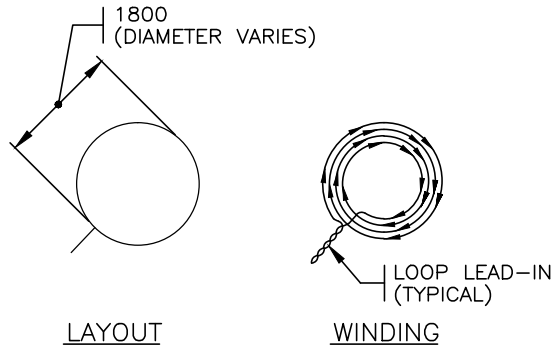
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.

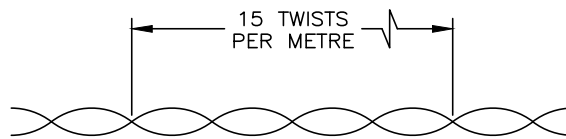


NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. RECEPTACLE MOUNTING HEIGHT AND ORIENTATION ON POLE TO BE NOTED ON CONTRACT DRAWING.
3. FUSE RECEPTACLE CIRCUITS, WITH A 10AMP FUSE, IN HANDHOLE AT BASE OF POLE AS PER DRAWING E12-1
4. RECEPTACLES TO NOT BE INSTALLED ON POLES WITHIN 50m OF A SIGNALIZED INTERSECTION AND NOT UNDER ANY CIRCUMSTANCES TO BE INSTALLED ON TRAFFIC SIGNAL OR SIGN POLES.



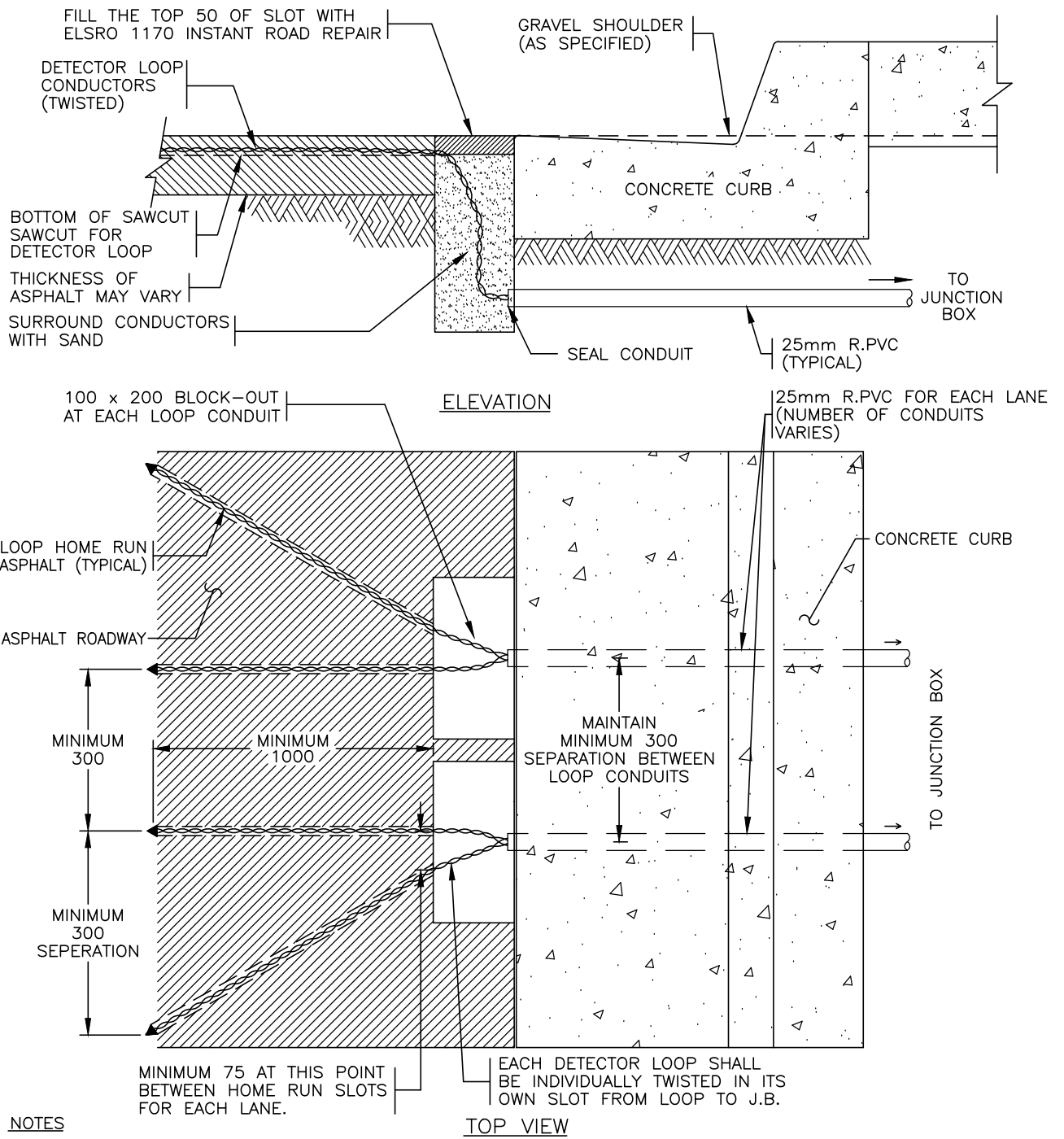
ROUND LOOP



LOOP LEAD-IN CONDUCTORS (TYPICAL FROM LOOP TO SHIELDED CABLE SPLICE IN JUNCTION BOX)

NOTES

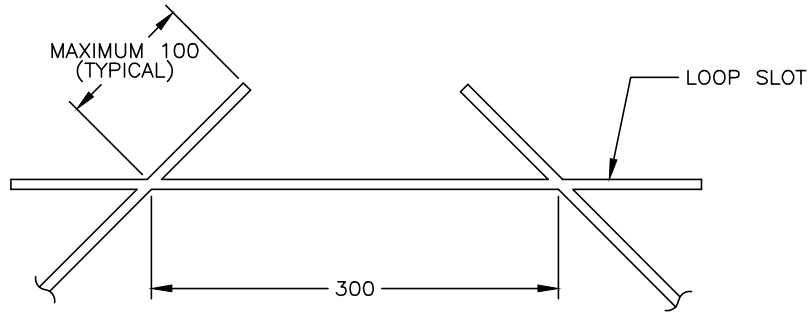
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
3. LOOP INDUCTANCE TO BE EQUAL TO OR GREATER THAN SHIELDED CABLE INDUCTANCE. (A 2:1 RATIO IS PREFERABLE) SHIELDED CABLE INDUCTANCE IS 0.72 μ H PER METRE



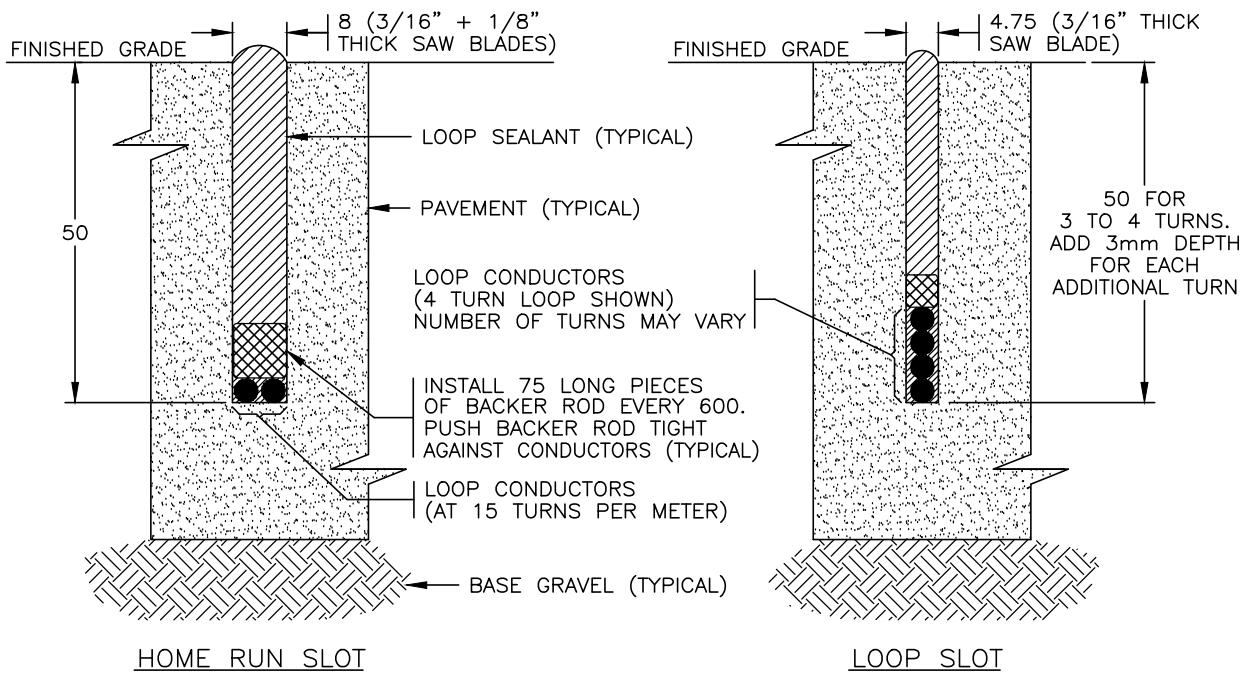
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.

TOP VIEW



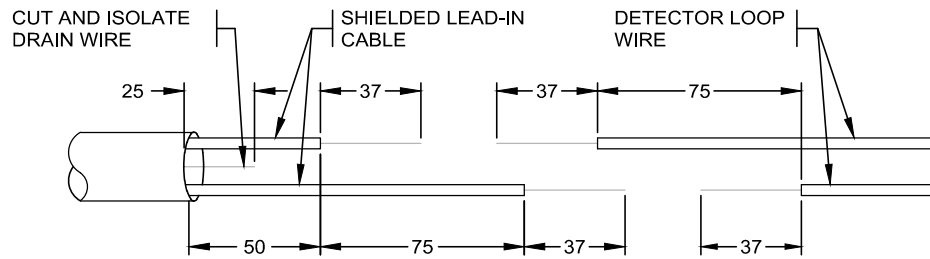
TYPICAL LOOP CORNER DETAIL



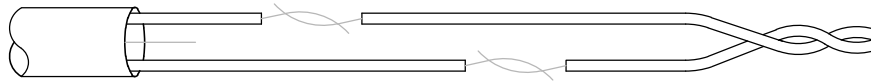
NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.
3. LOOP SLOT SEALANTS SHALL BE ELSRO HOT POUR CRACK FILLER No. 1190 OR B.P. BURFALT 16607 170, TYPE 2 OR APPROVED EQUAL.
4. BACKER RODS SHALL BE DETECTOR SYSTEMS BR-625 OR APPROVED ALTERNATE.
5. ONLY ONE LOOP SHALL BE INSTALLED IN EACH HOME RUN SLOT.

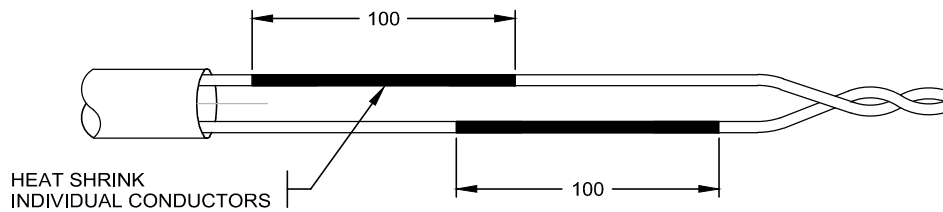
STEP 1. STRIP LOOP WIRES AND LEAD-IN CABLE AND SLIDE ON HEAT SHRINKS



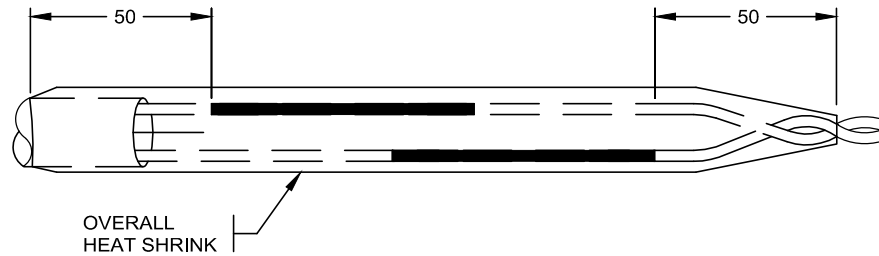
STEP 2. CONNECT AND SOLDER. TWIST BARE CONDUCTORS TOGETHER AND SOLDER WITH 60/40 (TIN/LEAD) RESIN SOLDER.



STEP 3. INSULATE EACH SOLDER JOINT SEPARATELY



STEP 4. ENVIRONMENTALLY SEAL TOTAL SPLICE.



NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
3. HEAT SHRINK SHALL BE PREMIER CLEAR-SEAL (6mm I.D. INDIVIDUAL CONDUCTORS & 10mm I.D. FOR OVERALL)

STEP BY STEP LOOP INSTALLATION PROCEDURES AND RULES ARE AS FOLLOWS:

STEP 1 LAYOUT DETECTOR LOOPS AND REVIEW LOCATIONS WITH THE ENGINEER PRIOR TO SAWCUTTING THE ROADWAY. THE GENERAL LAYOUT OF THE DETECTOR LOOPS IS INDICATED ON DRAWINGS E-14.7. STOP BARS AND LANE LINES MUST BE LAID OUT PRIOR TO LOCATING DETECTOR LOOPS.

RULE 1

DETECTOR LOOPS SHALL NOT BE INSTALLED WHEN THE ROAD IS WET OR WHEN THE AMBIENT (AIR) TEMPERATURE IS LOWER THAN 5°C, UNLESS APPROVED IN WRITING BY THE CITY ENGINEER. SEALANTS DO NOT ADHERE PROPERLY IN WET CONDITIONS. SHOULD THE CONTRACTOR BE ASKED IN WRITING BY THE ENGINEER TO INSTALL LOOPS IN THE WET AND/OR WHEN THE AIR TEMPERATURE IS BELOW 5°C, THE INSTALLATION WARRANTY WILL NOT BE ENFORCED.

RULE 2

DETECTOR LOOPS SHALL NOT BE INSTALLED WHEN THE PAVEMENT IS CRACKED OR BADLY RUTTED UNLESS THE INSTALLATION IS APPROVED BY THE CITY ENGINEER. SAW CUTS CAN OFTEN CAUSE PAVEMENT CONDITIONS TO DETERIORATE FURTHER. IF RE-SURFACING OF THE INTERSECTION IS NOT PLANNED THEN PHOTOGRAPHS SHOULD BE TAKEN TO DOCUMENT THE PAVEMENT CONDITIONS BEFORE AND AFTER THE LOOP INSTALLATION.

STEP 2 CUT LOOP AND HOME RUN SLOTS IN ASPHALT. ALL LOOP AND HOME RUN SLOTS SHALL BE CUT TO THE SAME DEPTH, WITH A PAVEMENT SAW. SLOTS SHALL NOT PASS THROUGH PAVEMENT INTO THE BASE GRAVEL.

RULE 3

LOOP AND HOME RUN SLOT MUST BE INSTALLED AT LEAST 300mm FROM ANY OTHER LOOP AND EACH LEAD-IN SLOTS, EXCEPT WHERE THE LEAD-IN CONDUCTORS ENTER THE 1" RPVC CONDUIT. THIS WILL REDUCE THE PROBABILITY OF INTERFERENCE BETWEEN LOOPS.

RULE 4

WHEN REPLACING LOOPS, CUT THROUGH TWICE ON EACH SIDE OF EXISTING LOOP. THIS MAY REQUIRE ADDITIONAL SAW CUTS, IF THE EXISTING LOOP IS NOT LOCATED IN THE SAW CUT PATH OF THE NEW LOOP. THIS WILL ELIMINATE THE POSSIBILITY OF INTERFERENCE BETWEEN THE OLD AND THE NEW LOOP.

STEP 3 CLEAN THE SLOT WITH A PROFESSIONAL GRADE PRESSURIZED WATER SYSTEM. REMOVE ALL WATER AND DIRT OUT OF THE SLOT CUT AND THE SURROUNDING 100mm OF ROAD SURFACE USING COMPRESSED AIR. SLOT MUST REMAIN COMPLETELY CLEAN AND DRY UNTIL THE SLOT IS SEALED.

STEP 4 INSTALL THE LOOP CONDUCTOR INTO THE LOOP SLOT. ENSURE CONDUCTORS ARE TIGHTLY WOUND AND PUSHED INTO THE BOTTOM OF THE SLOT. TWIST CONDUCTOR HOME RUN AT 15 TURNS PER METRE. INSTALL 75mm STRIPS OF BACKER ROD EVERY 600mm TO HOLD CONDUCTORS INTO SLOT.

RULE 5

ONLY ONE CONTINUOUS CONDUCTOR SHALL BE INSTALLED IN EACH LOOP AND HOME RUN SLOT TO THE JUNCTION BOX.

RULE 6

LOOP CONDUCTORS MUST BE INSTALLED IMMEDIATELY AFTER THE LOOP AND HOMERUN SLOTS ARE CUT.

STEP 5 INSTALL LOOP SEALANT AFTER CONDUCTORS HAVE BEEN INSTALLED. LOOP SEALANTS SHALL BE HEATED AS PER MANUFACTURER'S INSTRUCTIONS AND NEATLY APPLIED USING A FUNNEL WITH A NARROW SPOUT. ANY EXCESS SEALANT ON ROAD SURFACE SHALL BE REMOVED. AN ADDITIONAL APPLICATION OF LOOP SEALANT MAY BE REQUIRED WHERE THE SEALANT IS NOT UP TO THE PAVEMENT GRADE.

NOTES

1. SEE DRAWING E-14.6 FOR CONTINUATION OF PROCEDURES AND RULES.



CONTINUED FROM DRAWING E-14.5

STEP 6 ONCE THE SEALING OF THE SLOT HAS BEEN PROPERLY COMPLETED, A DUST SUCH AS PORTLAND CEMENT SHALL BE SPRINKLED ONTO THE SEALANT TO PREVENT TRACKING BY ROADWAY TRAFFIC. ANY EXCESS DUST SHALL BE SWEEPED OFF THE ROADWAY PRIOR TO ALLOWING TRAFFIC TO PASS OVER THE SEALED SLOT.

RULE 7

SPLICES WILL NOT BE ALLOWED IN LOOP CONDUCTORS OR SHIELDED CABLES.

STEP 7 THE SPLICES BETWEEN DETECTOR LOOP CONDUCTORS AND THE SHIELDED CABLE ARE TO BE SOLDERED AND SEALED WITH HEAT SHRINK IN ACCORDANCE WITH DRAWING E-14.4

STEP 8 REPEAT STEP 8 AT THE JUNCTION BOX OR VAULT NEAREST CONTROLLER.

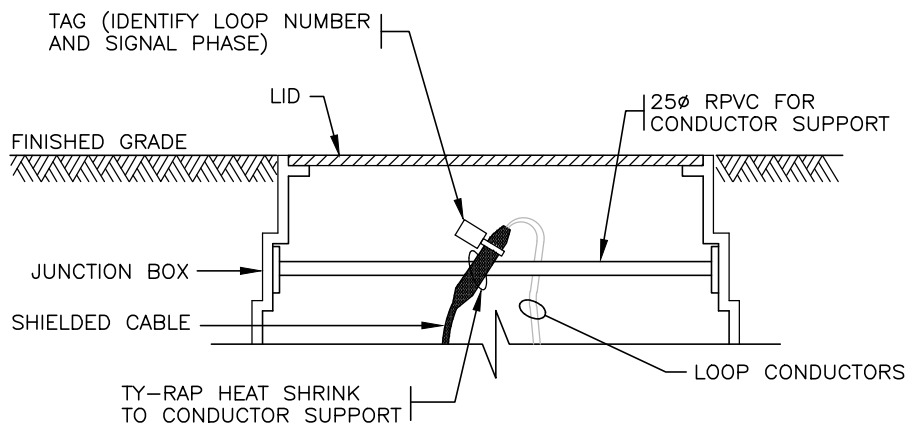
RULE 8

LOOP DETECTOR RESISTANCE TO GROUND SHALL BE GREATER THAN 1 MEGOHM, & LOOP INDUCTANCE SHALL BE WITHIN 25% OF THE VALUES SHOWN ON THE CONTRACT DRAWINGS.

STEP 9 TAG EACH LOOP CABLE AS INDICATED BELOW.

RULE 9

MAINTAIN THE MAXIMUM SEPARATION POSSIBLE IN THE JUNCTION BETWEEN THE LOOP CONDUCTORS AND POWER CONDUCTORS.



LOOP DETECTOR CONDUCTORS IN JUNCTION BOX

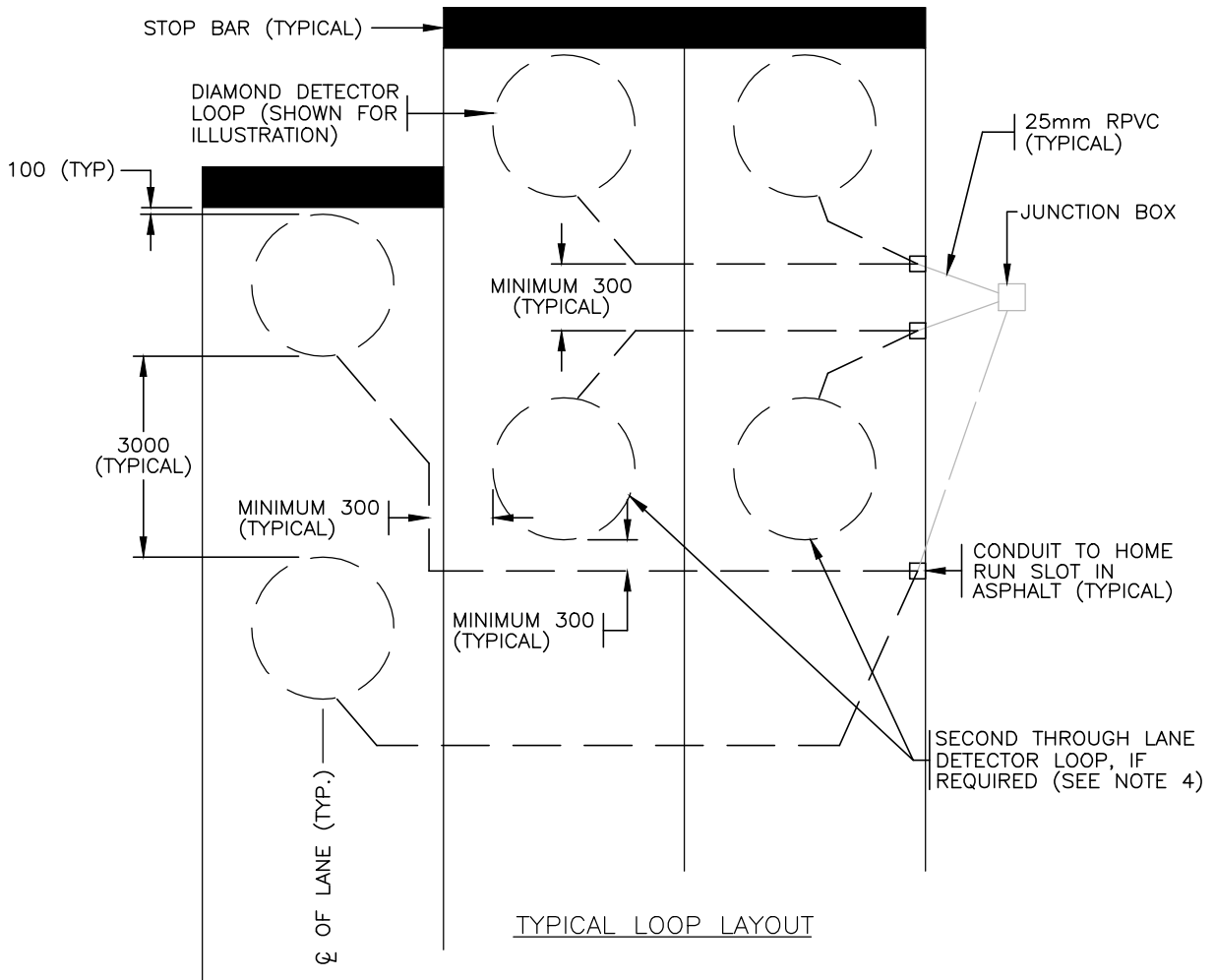
\\TENTATIVE\INFRASTRUCTURE PLANNING\STANDARDS & PRODUCTS\IWO\SESS\EDITION NOV1\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 10 DWGS\E-14.6

4.26.2016

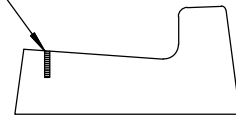


DETECTOR LOOP PROCEDURES & RULES
(CONTINUED)

Scale: N.T.S.
Created: NOV. 2009
Rev Date: NOV 2016
Dwg No: E-14.6



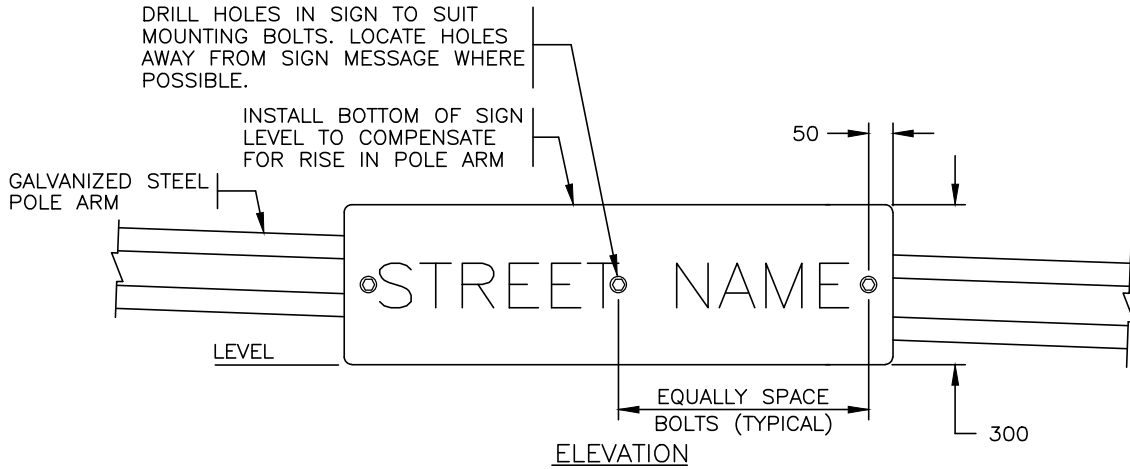
MARK CONDUIT LOCATION IN CONCRETE CURB WITH 12mm dia DROP-IN ANCHOR



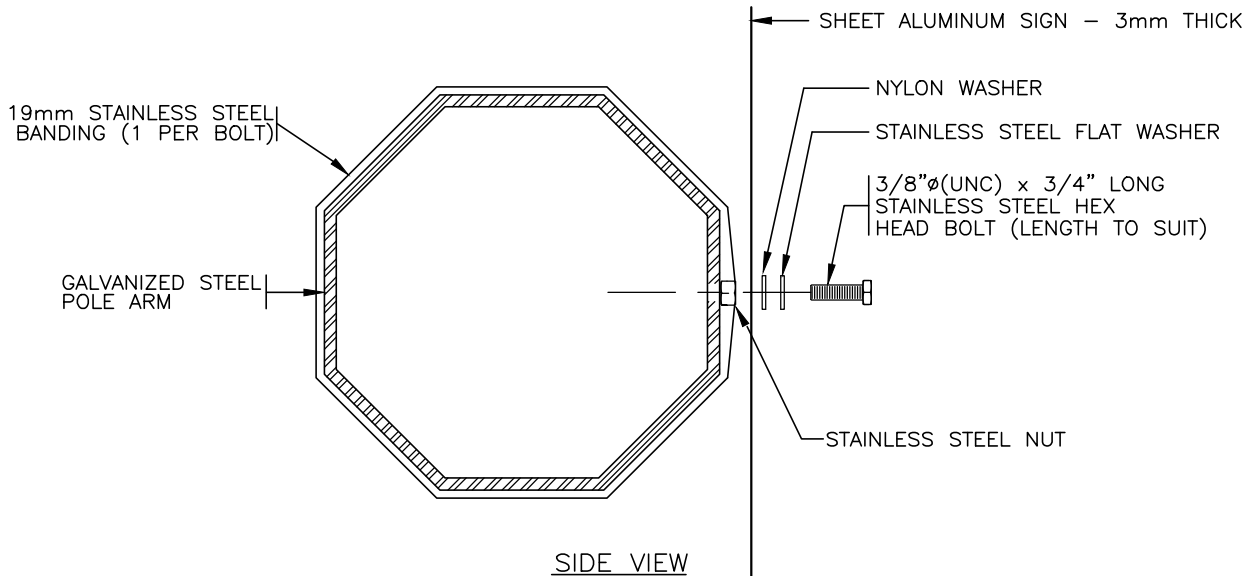
LOOP CROSSING AT CURB (DETAIL)

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.
3. LOCATE LOOP CONDUITS IN ASPHALT TO SUIT LOOP LOCATIONS & MINIMIZE THE LENGTHS OF HOME RUN SLOTS IN THE ASPHALT.
4. NORMALLY NOT REQUIRED WHERE THROUGH PHASE IS RECALLED TO GREEN.

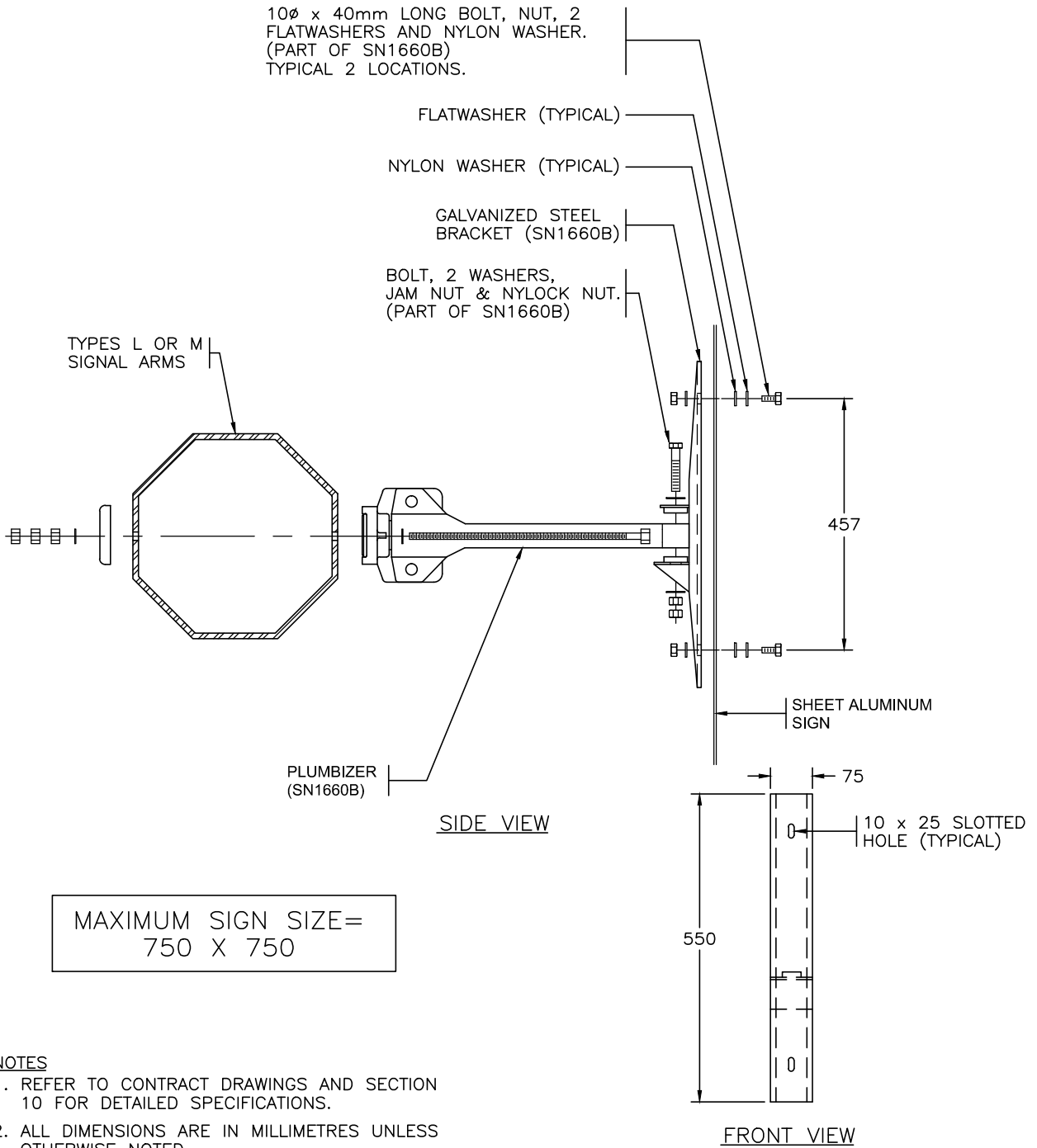


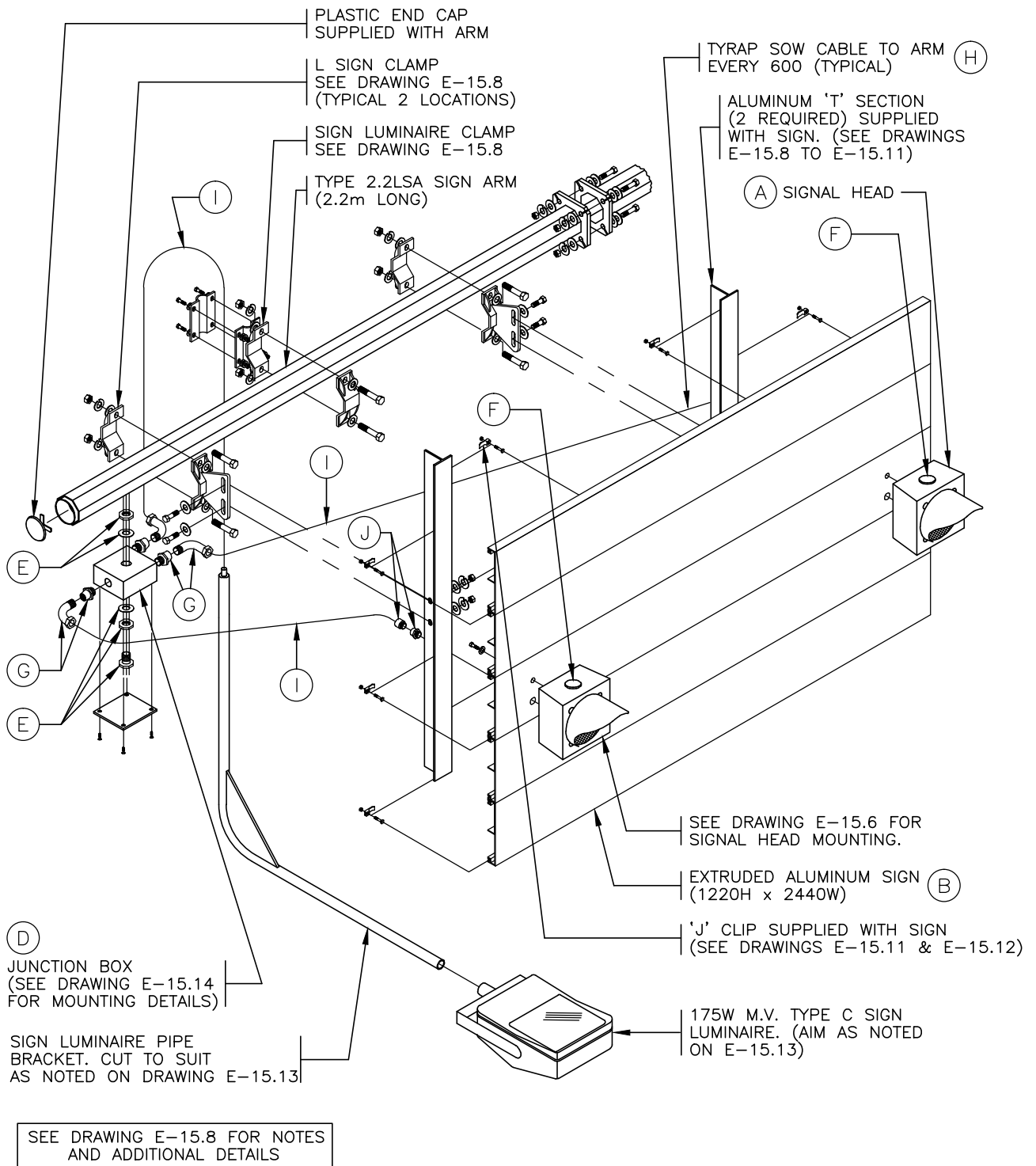
SIGN WIDTH	NUMBER OF BOLTS
900 WIDE	3
1200 WIDE	4
1500 WIDE	5
1800 WIDE	6
2100 WIDE	7

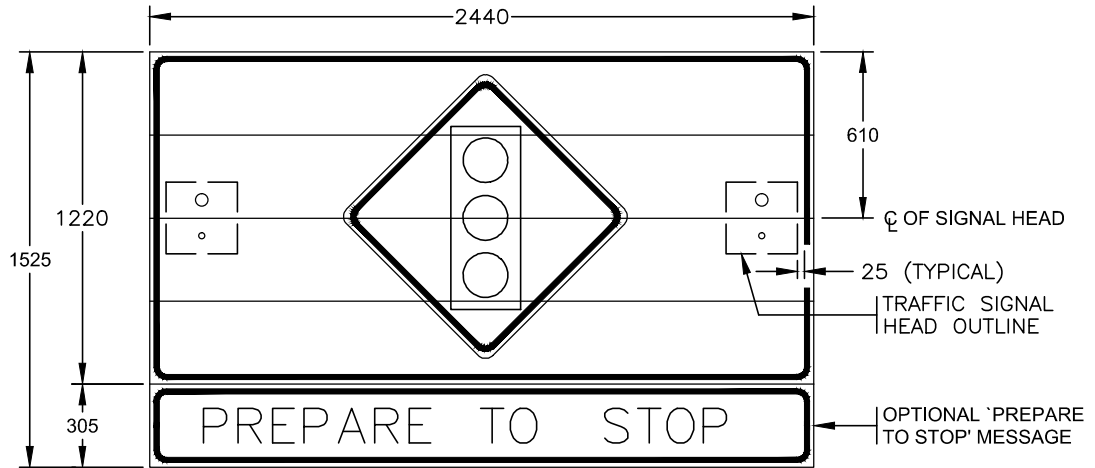


NOTES

- REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
- POSITION SIGN ON POLE ARM AS INDICATED ON THE PLANS OR AS DIRECTED BY THE CITY ENGINEER.
- ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.



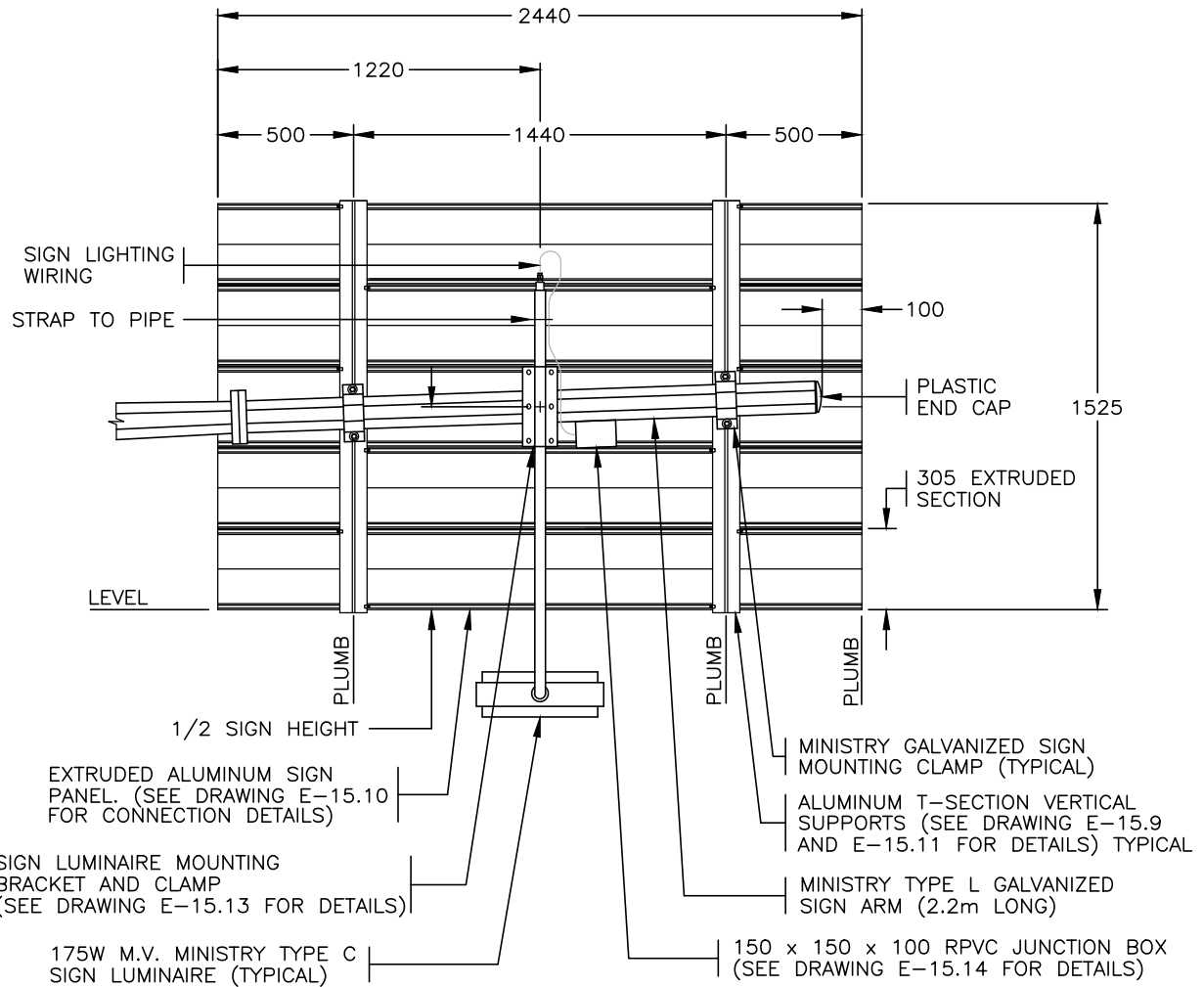




TRAFFIC SIGNAL ADVANCE WARNING SIGN

TRAFFIC SIGNAL ADVANCE WARNING SIGN KIT PARTS LIST	
ITEM	DESCRIPTION
A	200mm SIGNAL HEAD SECTION C/W YELLOW LENS, LAMP AND COWL VISOR
B	TRAFFIC SIGNAL EXTRUDED ALUMINUM ADVANCE WARNING SIGN
C	10 ϕ x 25mm LONG STAINLESS STEEL HEX HEAD BOLT, NUT, 2 FLAT WASHERS AND 1 LOCKWASHER
D	150 x 150 x 100 PVC J.B.
E	INSULATED CHASE NIPPLE, 2 LOCKNUTS AND 2 FLAT WASHERS
F	FINIAL
G	12mm BULLET HUB AND 90° STRAIN RELIEF CONNECTOR AND LOCKNUT
H	LARGE TY-RAP
I	3c No. 14 S.O.W. CABLE
J	12mm BULLET HUB AND STRAIN RELIEF CONNECTOR AND LOCKNUT

SEE DRAWING E-15.8 FOR NOTES AND ADDITIONAL DETAILS



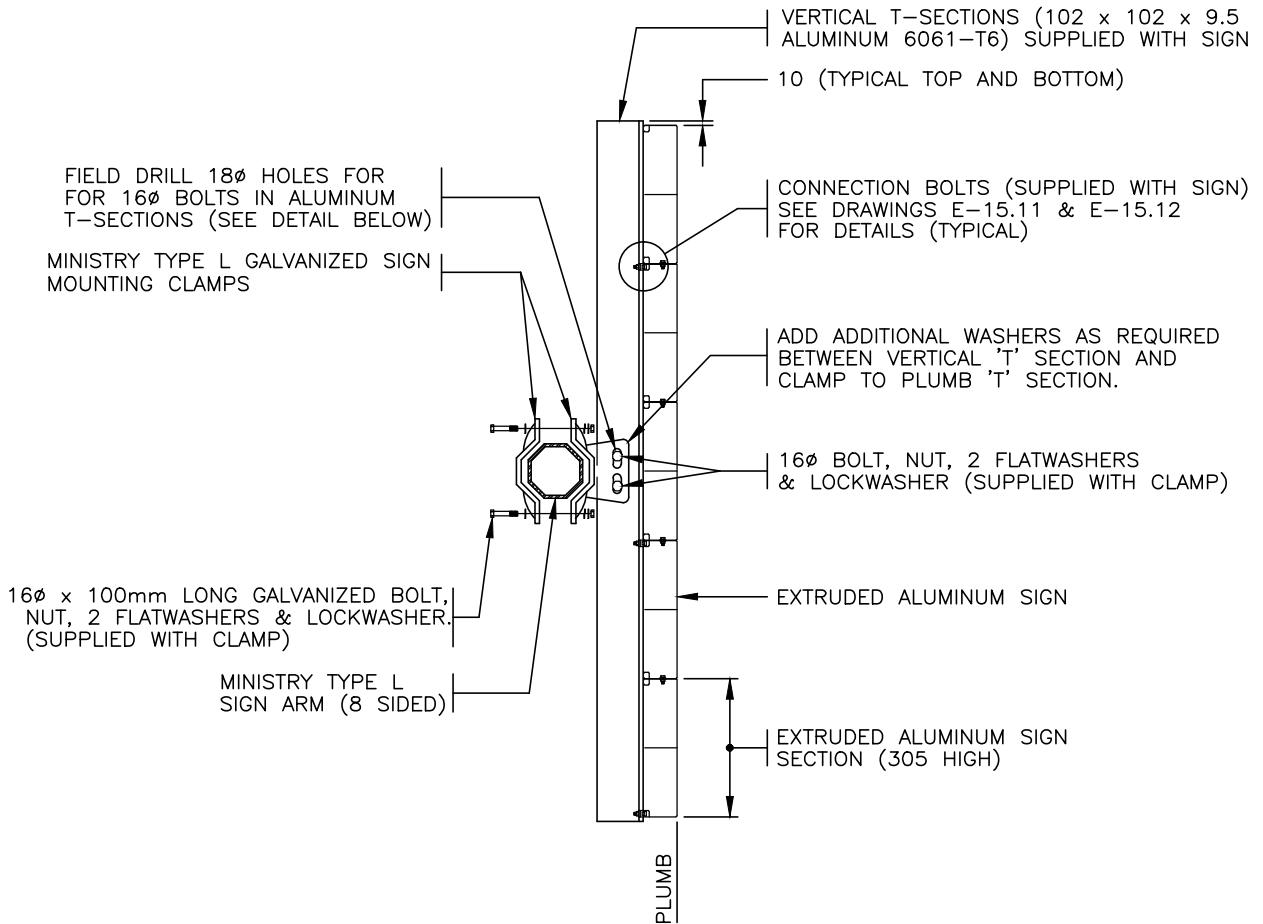
REAR ELEVATION

TOTAL MASS
EXTRUDED ALUMINUM SIGN = 48 kg

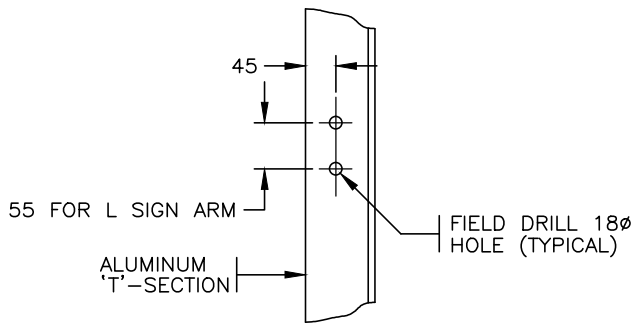
SEE DRAWING E-15.13 FOR SIGN LIGHTING DETAILS.

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. SEE DRAWING E-15.5 FOR SIGN ASSEMBLY DETAILS.
3. FUSE SIGN LUMINAIRES IN POLE HANDHOLE.
4. SIGN LUMINAIRE, MOUNTING PIPE, CLAMP AND CABLE ARE NOT REQUIRED FOR NON-ILLUMINATED SIGN.
5. ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE NOTED.



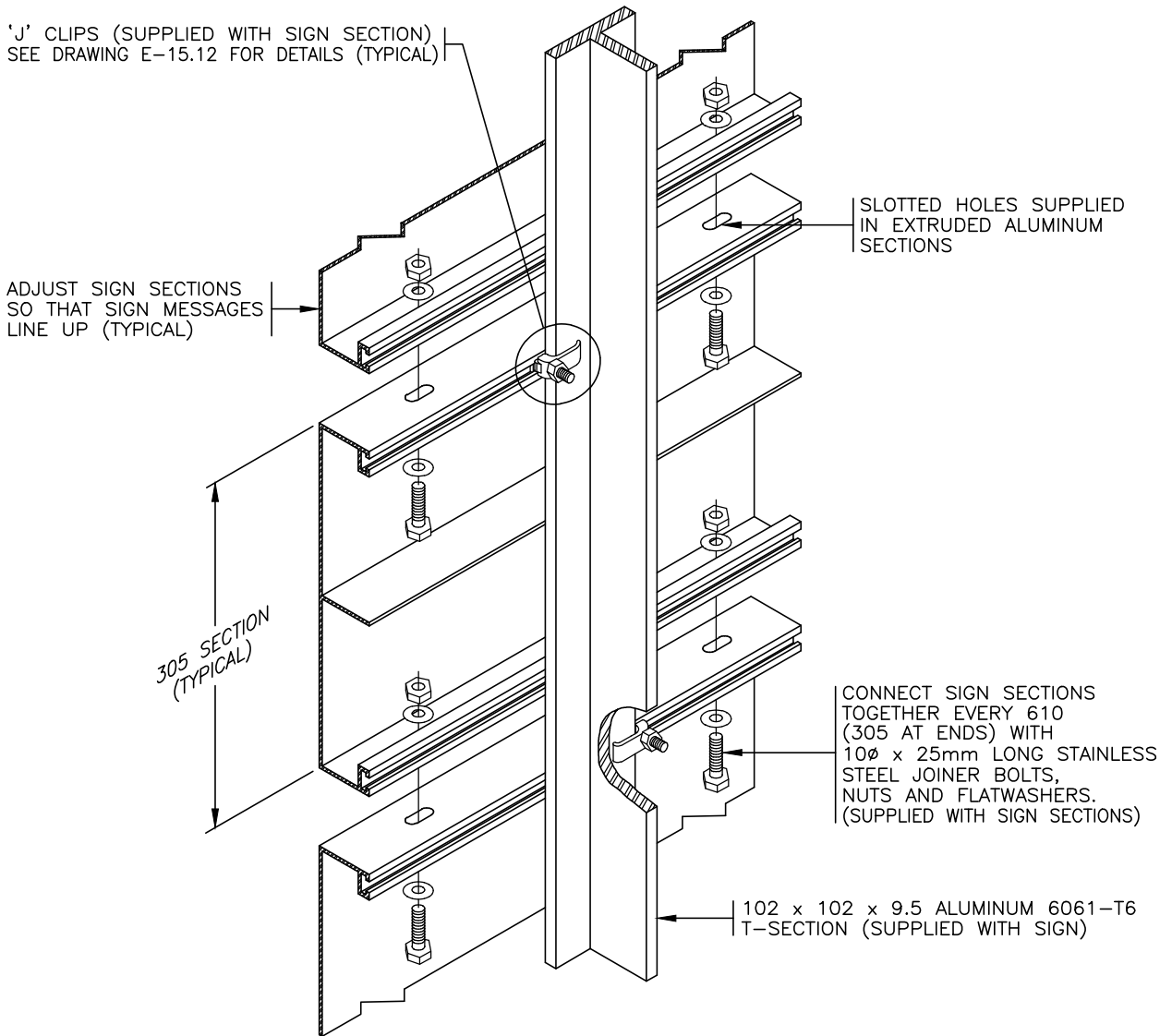
SIGN BRACKET ASSEMBLY
SIDE VIEW



'T'-SECTION HOLE DETAIL

SEE DRAWING E-15.8 FOR NOTES AND ADDITIONAL DETAILS.

SIGN LIGHTING NOT SHOWN. SEE DRAWING E-15.13 FOR SIGN LIGHTING DETAILS.

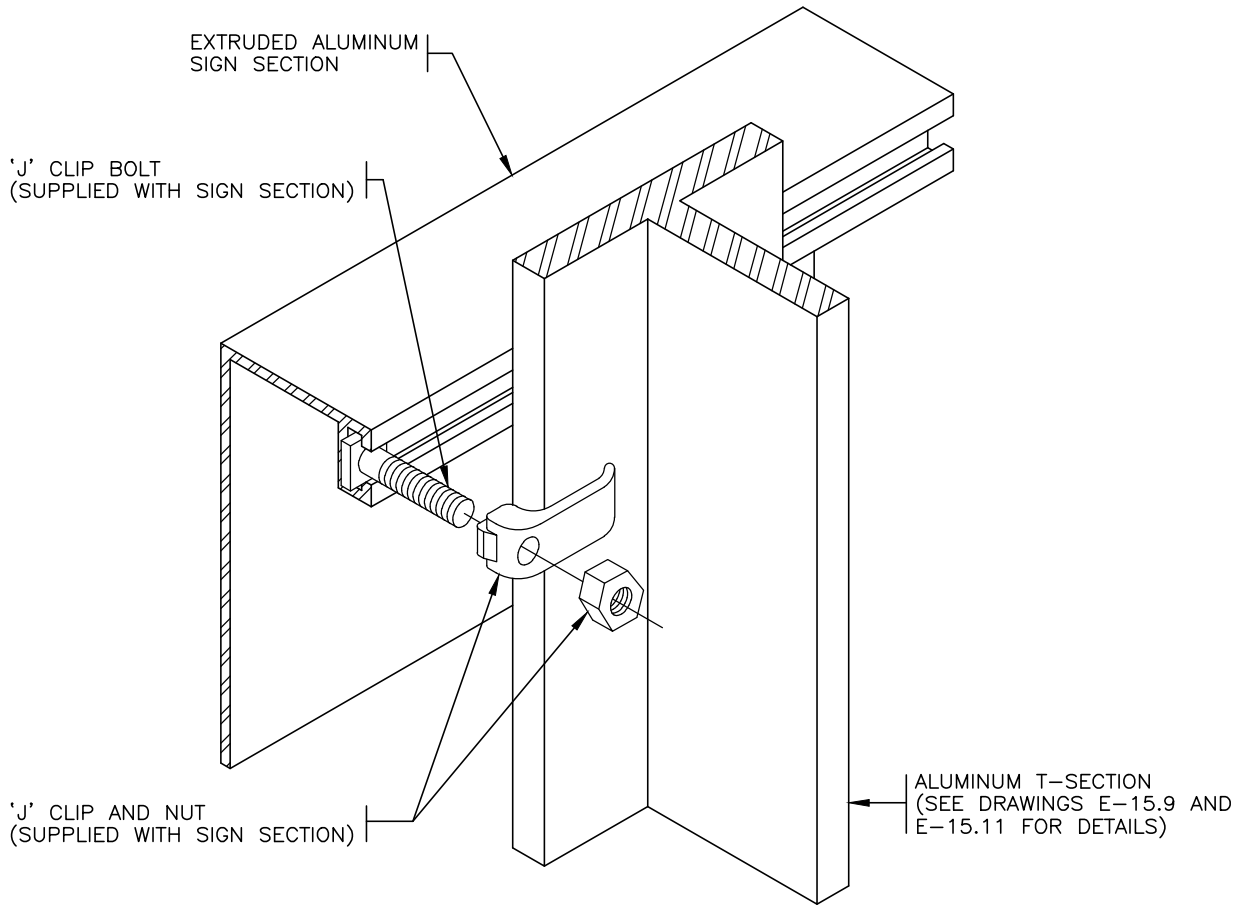


ASSEMBLY VIEW

SEE DRAWING E-15.8 FOR
NOTES AND ADDITIONAL DETAILS.

TORQUE JOINER BOLTS AND
'J' CLIPS TO 19 ft. lbs.

\\TENT&P\INFRASTRUCTURE\PLANNING\STANDARDS & PRODUCTS\WORKS\EDITION NOT FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 10 DWGS\E-15.12



ASSEMBLY VIEW

SEE DRAWING E-15.8 FOR NOTES AND ADDITIONAL DETAILS.

TORQUE JOINER BOLTS AND 'J' CLIPS TO 19 ft. lbs.

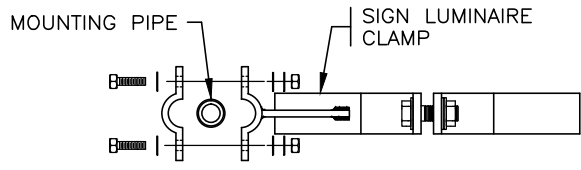
5.4.2016



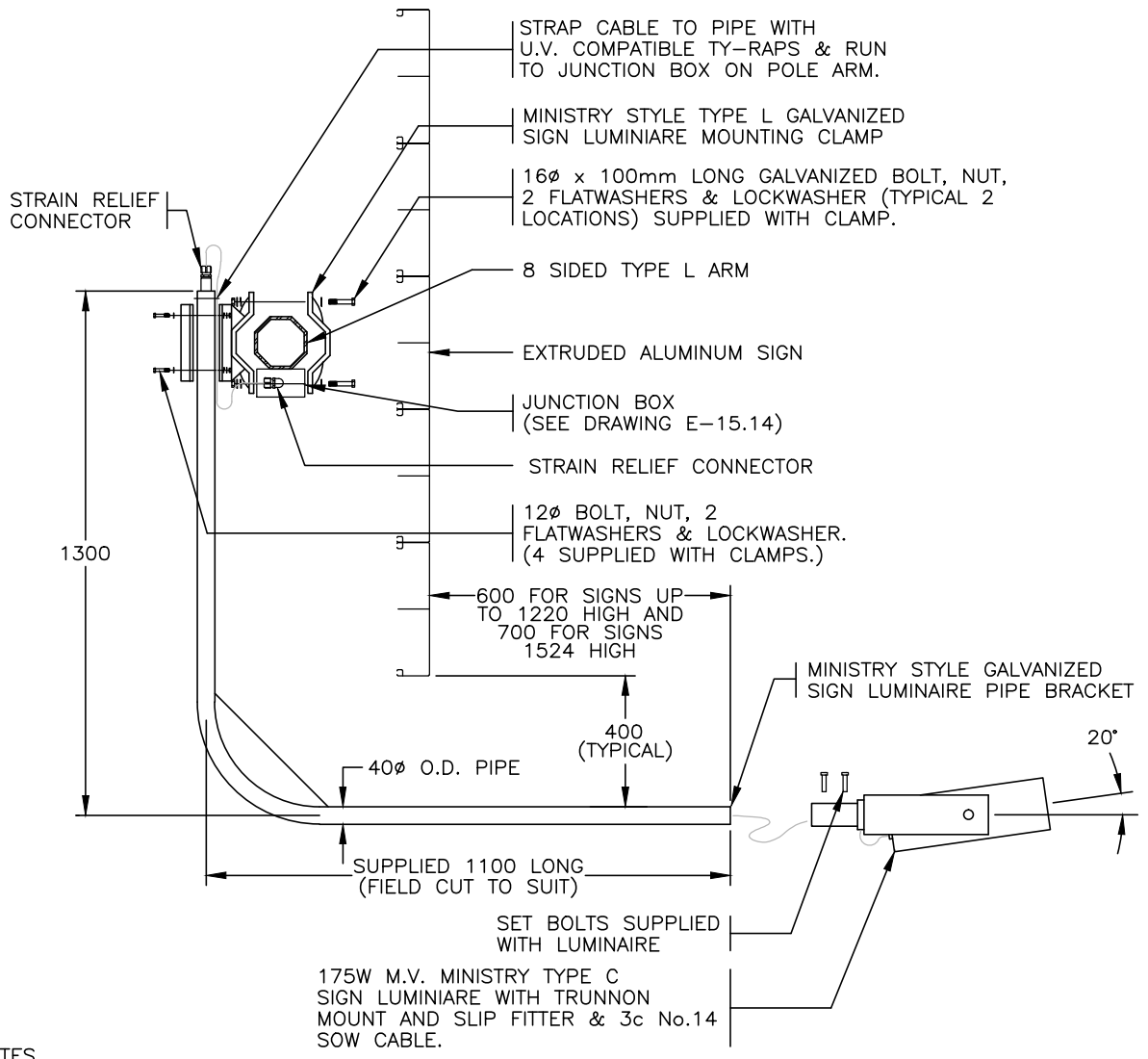
OVERHEAD EXTRUDED ALUMINUM SIGN ASSEMBLY DETAILS

Scale: N.T.S.
 Created: JAN. 1998
 Rev Date: NOV 2016
 Dwg No: E-15.12

TENTATIVE/INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS/ISSUE EDITION NOT FINAL DRAFT FINAL DRAFT STANDARD CAD DRAWING SECTION 10 DWGSE-15.13



LUMINAIRE MOUNTING CLAMP



NOTES

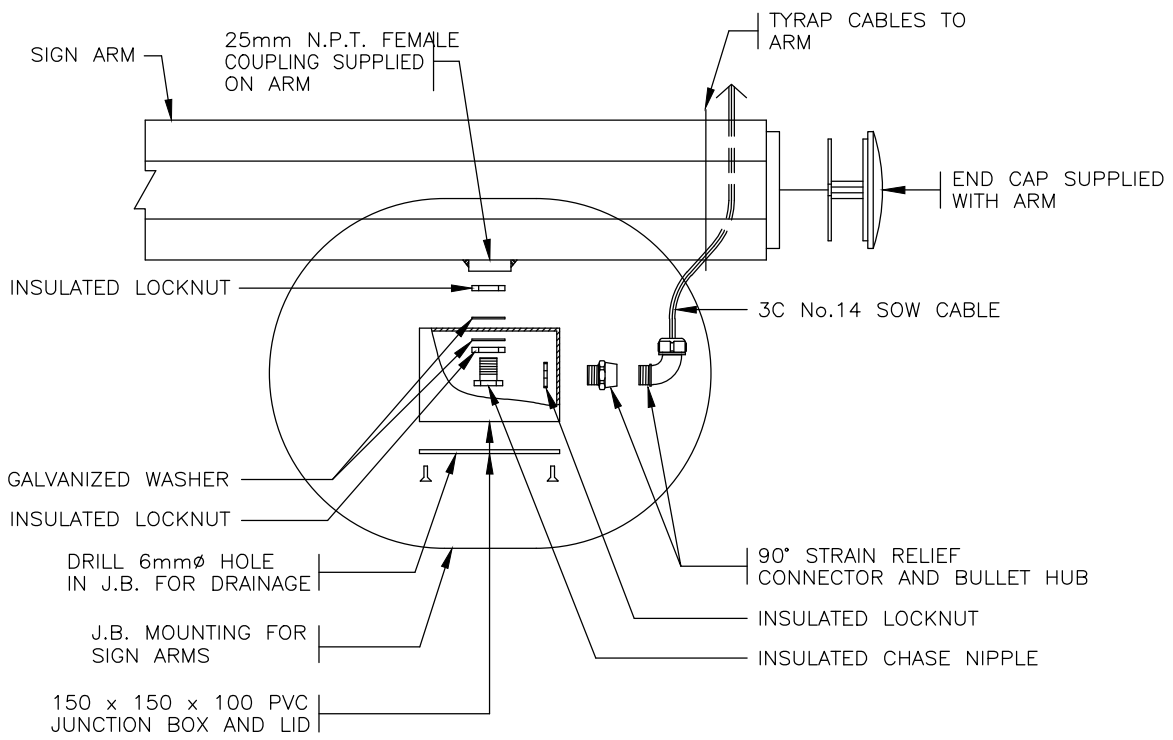
1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

SIGN LIGHTING
SIDE VIEW



OVERHEAD EXTRUDED ALUMINUM SIGN LUMINAIRE INSTALLATION DETAILS

Scale:	N.T.S.
Created:	JAN. 1998
Rev Date:	NOV 2016
Dwg No:	E-15.13



J.B. MOUNTING DETAIL

NOTES

1. REFER TO CONTRACT DRAWINGS AND SECTION 10 FOR DETAILED SPECIFICATIONS.
2. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE NOTED.

SECTION 10 - ROADWAY LIGHTING

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT

Conduit and Wiring	10.90
Poles and Luminaires	10.91
Junction Boxes	10.92

SECTION 10 - ROADWAY LIGHTING

MEASUREMENT AND PAYMENT

10.90 CONDUIT AND WIRING Section 10.68 and 10.78

Payment for conduit and wiring will be made at the unit prices per linear metre shown in the Tender Form. Measurement will be made longitudinally along the road and transversely across the road of conduit and wiring runs (feeders). The price shall include; trench excavation, bedding and backfill, all above, equipment, conduit, installation of feeder, wiring as specified, warning tape, and all work incidental thereto.

10.91 POLES AND LUMINAIRES Section 10.70 and 10.74

Payment for poles and luminaires will be made at the unit price per specified pole and luminaire type shown in the Tender Form. The price shall include materials, assembly, installation of the assembly and all work incidental thereto.

10.92 JUNCTION BOXES Section 10.67

Payment for junction boxes will be made at the unit price see box type specified in the Tender Form. The price shall include materials, installation, and work incidental thereto.

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS CONTENTS

<u>DESIGN CRITERIA</u>	<u>SECTION NO.</u>
Roadway Lighting	10.01
Traffic Signals	10.02
Conduit	10.03
Junction Boxes	10.04
Conductors	10.05
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(REVISED NOVEMBER 2016)	

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS DESIGN CRITERIA

10.01 ROADWAY LIGHTING

.1 Lighting Levels:

- (a) Roadways, bikeways and pedestrian walkways shall be illuminated for nighttime safety and comfort of motorists, cyclists and pedestrians.
- (b) Required roadway illuminance levels and uniformity ratios are listed in Table 1 below. Illuminance levels and uniformity ratios listed in Table 1 are based on the most current edition of the ANSI/IESNA RP-8 - Roadway Lighting standard practices. Road classifications are described in Section 9 - Streets, Traffic Signs and Markings Design Criteria. **(REVISED NOVEMBER 2016)**
- (c) Required sign illuminance levels and uniformity ratios shall be in accordance with the most current edition of the ANSI/IESNA RP-19 - Roadway Sign Lighting. **(REVISED NOVEMBER 2016)**
- (d) Illumination levels for intersecting roadways shall be the sum of each roadway.
- (e) The maintained average horizontal illuminance level, average to minimum uniformity ratios and roadway classification for each roadway shall be noted on the Design Drawings.
- (f) The designer shall calculate all illuminance levels and uniformity ratios as noted under 10.01.4 Lighting Calculations.

TABLE 1		
Road Classification	Maintained (*) average horizontal illumination level to meet or exceed	Average to minimum uniformity ratio not to exceed
Urban Arterial	17 Lux	3 : 1
Major Collector / Minor Collector	12 Lux	3 : 1
Industrial/Commercial	12 Lux	3 : 1
Neighbourhood Collector	9 Lux	4 : 1
Urban Local	4 Lux	6 : 1
Rural Local	4 Lux	6 : 1
Lane	4 Lux	6 : 1
Walkway	4 Lux	6 : 1

(*) Maintained levels shall include a total Light Loss Factor (LLF) of 0.79 as discussed in Table 4.

(REVISED NOVEMBER 2016)

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS DESIGN CRITERIA

.2 Pole Spacings:

- (a) Spacing and location of poles shall be governed by road width, road configuration, intersecting property lines, luminaire photometrics, mounting heights and required illumination levels. In addition maintaining clearances to overhead BC Hydro power lines in accordance with the *Canadian Electrical Code*, *WorkSafeBC* and the *BC Electrical Safety Act* shall also govern pole spacing.
- (b) Generally, poles shall be arranged in a one sided or staggered spacing based on the road classifications listed in Table 2. In circumstances where overhead BC Hydro power lines are in conflict with streetlight poles, one sided spacings may be considered if the required illumination levels and uniformity ratios can be achieved. Alternate pole spacings shall meet the approval of the City Engineer.
- (c) Where possible locate poles on property lines to avoid driveway conflicts.
- (d) Streetlight poles shall be offset as shown on the "Typical Cross Section Standard Drawings" in Section 9 - Streets, Traffic Signs and Markings.

TABLE 2	
Road Classification	Pole Arrangement
Urban Arterial	Staggered
Major Collector / Minor Collector	Staggered
Industrial / Commercial	Staggered
Neighbourhood Collector	One Sided
Urban Local	One Sided
Rural Local	One Sided
Lane	One Sided
Walkway	One Sided

(REVISED NOVEMBER 2016)

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS DESIGN CRITERIA

.3 Luminaire types, Pole types and Wattages:

- (a) Luminaire types, pole types and wattages are as listed in *Table 3*.
- (b) Where tying into an existing system or area luminaire types, wattages and mounting heights should match those previously installed.
- (c) Luminaire wattages, distributions, voltage, Northing, Easting and elevation shall be noted on the Design Drawings. Refer to Section 1.0 Standard Drawing No. G-7.
- (d) Post top and flat glass luminaires shall be listed on the City of Nanaimo Approved Product List.

TABLE 3				
Road Classification	11.0m High Davit Pole with Flat Glass Luminaire	9.0m High Davit Pole with Flat Glass Luminaire	7.5m High Davit Pole (*) with Flat Glass Luminaire	4.5m High Post Top Pole with Post Top Luminaire
Urban Arterial	250W	150W		-
Major Collector / Minor Collector	250W	150W		-
Industrial / Commercial		150W		
Neighbourhood Collector		150W		
Urban Local		100W	100W (*)	
Rural Local		100W	100W (*)	100W
Lane		100W	100W (*)	100W
Walkway				100W

(REVISED NOVEMBER 2016)

- (*) For use to avoid conflicts with overhead powerlines or on local streets or lanes. In all cases the use of 7.5m high davit poles must meet the approval of the City Engineer.

The Cobra Head Luminaire with semi-cutoff optics (drop refractor) may be used in special cases as directed by the City Engineer.

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS DESIGN CRITERIA

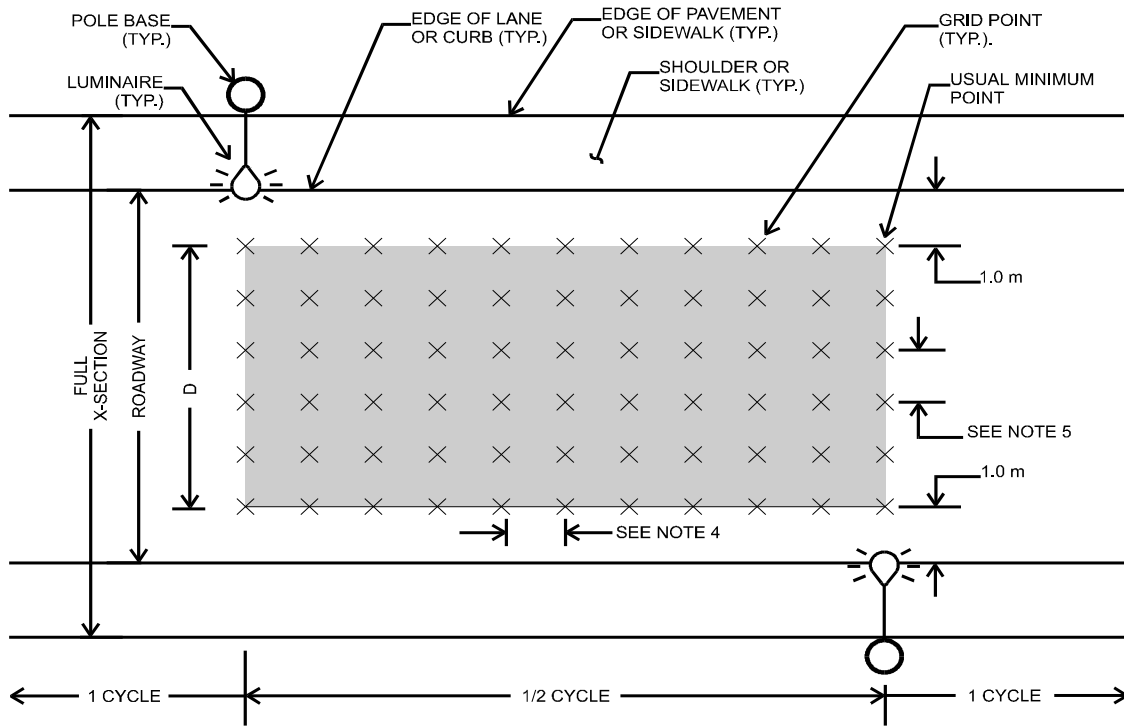
.4 Lighting Calculations:

- (a) Lighting calculations are based on the illuminance methods described in *ANSI/IESNA RP-8 Roadway Lighting*, lighting calculations shall be done using a computer lighting program designed to carry out the required calculations and the luminaire manufacturers IES formatted photometrics. The IES photometric files for the City approved luminaires are available in electronic format, through the luminaire manufacturers. **(REVISED NOVEMBER 2016)**
- (b) Computer lighting calculation shall be performed using the grid spacing shown on Figures 1 – Grid Spacing for Calculating Point of Minimum Illuminance and Figure 2 – Grid Spacing for Calculating Average Illuminance. The traveled roadway x-section shown shaded on Figure 1, shall be used for calculating the minimum illuminance. The full roadway x-section shown shaded on Figure 2, shall be used for calculating the average illuminance. The average to minimum uniformity ratio shall be calculated using the minimum illuminance calculation from Figure 1 divided by the average illuminance calculation from Figure 2. For example, if the lowest point of illuminance within the shaded area shown on Figure 1 is 4 Lux and the average illuminance of all the points within the shaded area shown on Figure 2 is 12 Lux, then the average to minimum uniformity ratio would be 3:1.
- (c) Grid spacing for walkways or bikeways shall be maximum 1m.
- (d) Lighting calculations shall be based on maintained levels using initial rated lamp lumens and the total light loss factor (LLF) of 0.79. Refer to *Table 4* for the factors included in the LLF. The LLF shall be considered as the total maintenance factor.

TABLE 4				
Lamp Lumen Depreciation (LLD)⁽¹⁾	Lamp Dirt Depreciation (LDD)⁽¹⁾	Luminaire Component Depreciation (LCD)⁽²⁾	Equipment Factor (EF)⁽³⁾	Total Light Loss Factor (LLF)
0.90	0.94	0.98	0.95	0.79
<u>Notes</u> ⁽¹⁾ Based on a 4 year maintenance cycle ⁽²⁾ Degradation of the reflector and refractor ⁽³⁾ Effect of ambient temperature on the lamp including the ballast and lamp factors LLF = LLD x LDD x LCD x EF				

- (e) A hardcopy of the lighting calculations shall be submitted to the City along with the Design Drawings. Refer to Section 1.07 Ornamental Street Lighting Traffic Control Signals, Hydro, Phone, Gas and Cablevision Fibre Optics (Commercial and Private) for design drawing requirements. **(REVISED NOVEMBER 2016)**

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS DESIGN CRITERIA



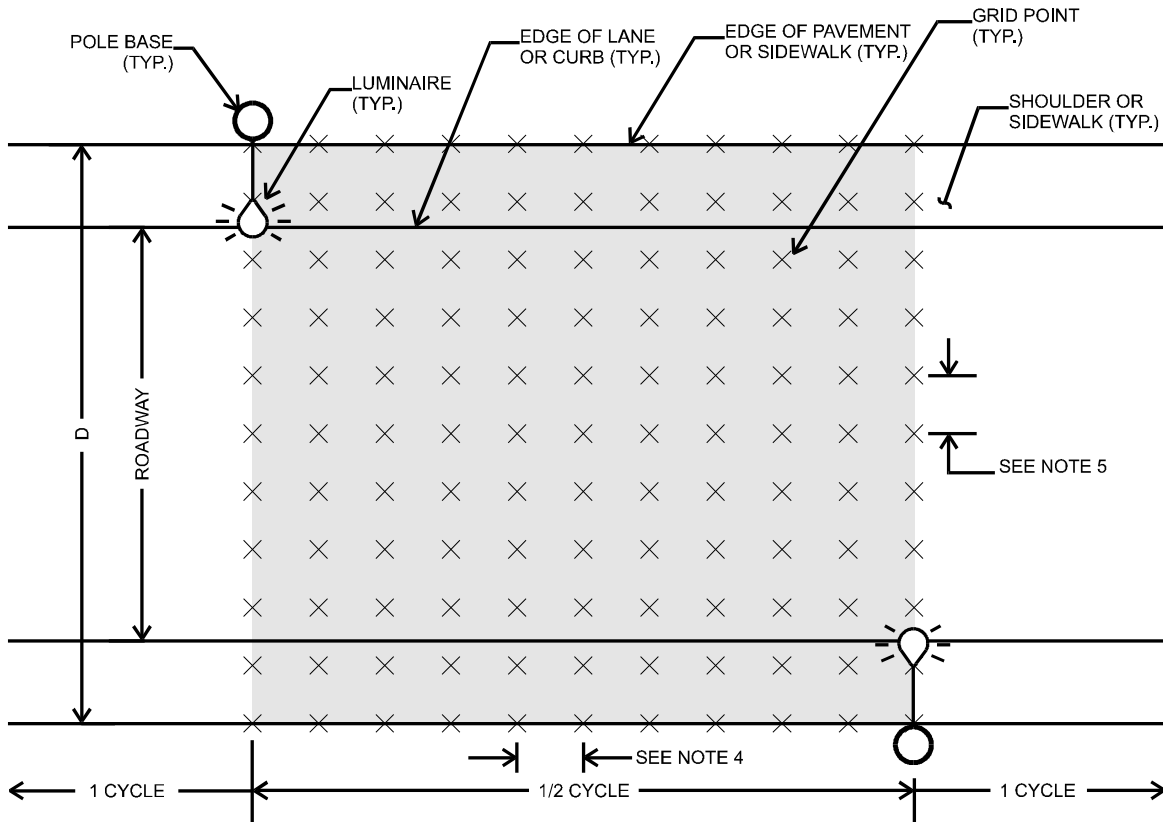
GRID SPACING FOR CALCULATING POINT OF MINIMUM ILLUMINANCE

NOTES:

1. ONE LUMINAIRE CYCLE IS DEFINED AS THE DISTANCE BETWEEN TWO CONSECUTIVE LUMINAIRES WHICH ARE LOCATED ALONG ONE SIDE OF THE ROAD.
2. CALCULATION AREA IS DEFINED AS THE AREA BOUNDED BY THE GRID POINTS CONTAINED WITHIN A 1/2 CYCLE.
3. CALCULATION SHALL TAKE INTO ACCOUNT 1 CYCLE ON EACH SIDE OF THE CALCULATION AREA. (TOTAL 6 LUMINAIRES)
4. LONGITUDINAL GRID SPACING EQUALS LUMINAIRE SPACING (1/2 CYCLE) DIVIDED BY 10, NOT TO EXCEED 5 METRES.
5. TO OBTAIN THE GRID POINTS ACROSS THE ROADWAY DIVIDE THE DISTANCE "D" BY THE NEXT INTEGER (WHOLE NUMBER) GREATER THAN "D". (EG. IF D=10.8m THEN THE GRID SPACING = $10.8/11 = 0.98\text{m}$).
6. THIS CALCULATION SHALL BE USED TO DETERMINE THE POINT OF MINIMUM ILLUMINANCE WITHIN THE SHADED AREA.

Figure 1

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS DESIGN CRITERIA



GRID SPACING FOR CALCULATING AVERAGE ILLUMINANCE

NOTES:

1. ONE LUMINAIRE CYCLE IS DEFINED AS THE DISTANCE BETWEEN TWO CONSECUTIVE LUMINAIRES WHICH ARE LOCATED ALONG ONE SIDE OF THE ROAD
2. CALCULATION AREA IS DEFINED AS THE AREA BOUNDED BY THE GRID POINTS CONTAINED WITHIN A 1/2 CYCLE.
3. CALCULATION SHALL TAKE INTO ACCOUNT 1 CYCLE ON EACH SIDE OF THE CALCULATION AREA. (TOTAL 6 LUMINAIRES)
4. LONGITUDINAL GRID SPACING EQUALS LUMINAIRE SPACING (1/2 CYCLE) DIVIDED BY 10, NOT TO EXCEED 5 METRES.
5. TO OBTAIN THE GRID POINTS ACROSS THE ROADWAY DIVIDE THE DISTANCE "D" BY THE NEXT INTEGER (WHOLE NUMBER) GREATER THAN "D". (EG. IF D=10.8m THEN THE GRID SPACING = $10.8/11 = 0.98\text{m}$).
6. THIS CALCULATION SHALL BE USED TO DETERMINE THE AVERAGE ILLUMINANCE WITHIN THE SHADED AREA.

Figure 2

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS DESIGN CRITERIA

10.02 TRAFFIC SIGNALS

- .1 Traffic signal controllers and cabinets and siren pre-emption equipment shall be supplied through the City of Nanaimo.
- .2 For development projects requiring traffic signals the cost for the design and the supply of traffic controllers, signs and siren pre-emption equipment shall be borne by the Developer.
- .3 Traffic signals shall be designed in general accordance with Sections 402.6 of the Ministry of Transportation and Infrastructure Electrical and Traffic Engineering Manual. Contrary to this manual the City of Nanaimo uses NEMA phase designations as opposed to the Ministry movement designations (i.e.; A1, A2, B1 etc.)
- .4 Traffic signal designs shall also conform to the British Columbia Motor Vehicle Act and the Uniform Traffic Control Devices for Canada.

10.03 CONDUIT

- .1 Conduits shall be parallel or perpendicular to the roadway, and routed to run in a direct line between adjacent poles or junction boxes. Street lighting conduits shall be run under sidewalks, unless otherwise noted.
- .2 There shall be a maximum 2 - 90° bends in a conduit run. Where this can not be avoided junction boxes shall be used as noted under Section 10.04 - Junction Boxes.
- .3 Street lighting conduit shall be minimum 38mm diameter.
- .4 Where conduit(s) cross an existing road, they shall be installed by horizontal directional drilling to avoid cutting pavement and interrupting traffic. Prior to specifying drilling confirm soil condition will accommodate drilling.

10.04 JUNCTION BOXES

- .1 Large round plastic junction boxes shall generally be used as follows:
 - (a) where the maximum number of 90° bends in a conduit run is exceeded
 - (b) where branch conduit runs are required
 - (c) in conduit runs over 100m
 - (d) at service panels
 - (e) at post mounted flashers
- .2 Rectangular plastic junction boxes shall be used in narrow traffic islands where a round box will not fit.
- .3 Concrete junction boxes shall be used for traffic signals only.

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS DESIGN CRITERIA

10.05 CONDUCTORS

- .1 For the purpose of standardization and to accommodate future expansion, street lighting conductors shall be No. 6 RW90. The use of alternate conductor sizes will require the approval of the City Engineer.

10.06 SERVICE EQUIPMENT

- .1 The designer shall confirm service locations with BC Hydro.
- .2 Street lighting systems are controlled with a lighting contactor and photocell. The photocell shall be located on the luminaire nearest the service panel.
- .3 Service panels for street lighting systems shall have a 60A - 2P breaker, contactor and photocell bypass switch and shall be mounted in a service base as shown on Standard Drawing No. E-10.1 and wired as shown on Standard Drawing No. E-10.3.
- .4 Where possible traffic signal and street lighting systems shall be fed from the same service panel. The combination street lighting and traffic signal service panel shall have a 100A -2P main breaker, sub-breakers, contactor, photocell by-pass switch and where required a flasher control unit. The service panel shall be mounted in a service base or on the side of the traffic controller refer to Standard Drawings No. E-10.1, E-10.3, E-10.4 and E-10.5 for details.
- .5 All services shall be 120/240V single phase, 3 wire. Alternate service voltage must meet the approval of the City Engineer.

10.07 CONCRETE BASES

- .1 The Engineer shall assess the existing soil conditions at the proposed concrete base installations to determine if modifications to the standard drawings are required.
- .2 The Engineer shall submit for approval by the City Engineer, the design modifications to the standard drawings that are required to meet the existing soil conditions.
- .3 Avoid running more than two conduits into a streetlight pole base. Where this situation can not be avoided a junction box shall be used.
- .4 When selecting pole base locations search out proposed or existing utility locations to avoid conflicts.

10.08 -NOT USED-

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS SPECIFICATIONS

10.20 SCOPE

- .1 This specification refers to the materials for street lighting and traffic signal installations. Only those products approved by the City Engineer and listed on the City of Nanaimo Approved Product List will be accepted for an installation. When the City of Nanaimo Approved Product List does not list a product, the Ministry of Transportation and Infrastructure's Recognized Product List shall be referenced. Only those products approved by the City Engineer will be accepted for an installation. **(REVISED NOVEMBER 2016)**
- .2 All materials shall be new unless otherwise noted.
- .3 All materials shall meet or exceed the Canadian Electrical Code Requirements and the Canadian Standards Association Standards, where applicable, and are subject to the approval of the Electrical Safety Branch Inspector prior to installation.
- .4 All similar items of materials shall be of one type and from the same manufacturer.
- .5 Unless otherwise noted, the following materials shall be supplied by the City of Nanaimo at the Developers expense:
 - (a) Traffic Controllers/Cabinets;
 - (b) Padlocks;
 - (c) Siren pre-emption systems;

10.21 CONDUIT

- .1 Exposed Conduit:
 - (a) All exposed conduit shall be rigid steel unless otherwise noted on the Standard Drawings.
 - (b) Rigid steel conduit shall be hot-dipped galvanized and shall conform to CSA C22.2 No. 45.
 - (c) Rigid steel conduit clamps and fitting shall be hot dip galvanized.
 - (d) All rigid conduit ends shall be reamed and all necessary bushings, locknuts, elbow and bends shall be provided.
 - (e) All joints shall be made with threaded couplers.
- .2 Buried Conduit:
 - (a) Buried conduit couplings, adaptors, bends and fittings shall be rigid unplasticized PVC.
 - (b) Rigid PVC conduit shall conform to CSA C22.2 No. 211.2.
 - (c) Rigid PVC couplings , adaptors, bends and fittings shall conform to CSA C22.2 No. 85.
 - (d) Only factory conduit bends are acceptable.
 - (e) Conduit cement shall be CSA certified type.
 - (f) Each standard length of conduit, couplings, adaptors, bends and fittings shall bear a CSA certification label.

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS SPECIFICATIONS

- .3 Concrete for conduit encasement shall have a minimum compressive strength of 15 MPa at twenty-eight (28) days and be in accordance with Section 11 - Plain and Reinforced Concrete Works. Concrete encasement will only be required where specially noted on the Contract Drawings or where directed by the Engineer.
- .4 In locations where concrete encasement is not required, bedding sand shall be used in accordance with Section 4 – Trench Excavation, Bedding and Backfill.

10.22 TRENCH MARKER TAPE

- .1 Trench marker tape shall be 150 mm wide yellow and shall be labeled "CAUTION - ELECTRICAL LINE BURIED BELOW".
- .2 Tape shall be minimum 3.5 mils thick heavy duty polyethylene material.

10.23 JUNCTION BOXES

- .1 Large round and rectangular plastic junction boxes and lids shall be manufactured in accordance with the Ministry of Transportation and Infrastructure Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**
- .2 Concrete junction boxes shall be in accordance with Standard Drawing No. E-3.2 and Standard Drawing No. E-3.3.
- .3 All junction boxes shall have steel lids.

10.24 CONCRETE BASES

- .1 Concrete bases shall be in accordance with the Standard Drawings.
- .2 Concrete bases shall be pre-cast. Poured in place concrete bases shall meet the approval of the City Engineer.
- .3 Concrete and rebar shall meet the requirements of Section 11 - Reinforced and Plain Concrete Works with the exception of the following:
 - (a) Concrete shall develop a minimum compressive strength of 30Mpa at 28 days.
 - (b) Concrete strength tests will only be required for poured in place pole bases.
- .4 Top of concrete bases shall be trowelled smooth and level with beveled edges. Top surface shall not vary by more than 3mm in depth as measured across the widest surface.
- .5 All concrete shall be fully vibrated.
- .6 Anchor bolts shall be as shown on Standard Drawing No. E-1.9 to Standard Drawing No. E-1.11. Anchor bolts shall be manufactured in accordance with the Ministry of Transportation and Infrastructure Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS SPECIFICATIONS

10.25 POLES AND RELATED EQUIPMENT

- .1 Poles, arms, extensions, brackets and clamps shall be as shown on Standard Drawing No. E-5.1 to Standard Drawing No. E-5.19 and Standard Drawing No. E-5.21. This material shall be manufactured in accordance with the Ministry of Transportation and Infrastructure Electrical and Traffic Engineering Manual. The nominal height of a pole on a service base shall be 0.9m shorter to allow for the height of the service base. **(REVISED NOVEMBER 2016)**
- .2 Service bases shall be designed to meet or exceed the capacity of the pole. Service bases shall meet or exceed the Ministry of Transportation and Infrastructure material standards for the fabrication of poles as per the Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**
- .3 Post top poles shall meet or exceed the Ministry of Transportation and Infrastructure Material standards for the fabrication of poles as per the Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**
- .4 All poles, arms, extensions, brackets, clamps and service bases shall be hot dip galvanized.

10.26 CONDUCTORS

- .1 Single conductors shall be stranded copper with type RW90 XLPE insulation unless otherwise noted on the Contract Drawings.
- .2 Multi-conductor traffic signal cable shall be 19 conductor IMSA specification 19-1 (stranded copper) unless otherwise noted on the Contract Drawings. **(REVISED NOVEMBER 2016)**
- .3 Colour coding and gauges (AWG) shall be as noted on the Contract Drawings.
- .4 Shielded detector loop cable shall be 2 conductor No. 16 stranded copper and shall meet California Type B Lead in Cable specifications or IMSA specification 50-2 (1984).

10.27 LOOP SEALANTS AND BACKEROD

- .1 Loop sealants shall be hot tar.
- .2 Backerod shall be foam material. Backerod shall be sized to hold down conductor in loop slot and to resist melting during the pouring of hot tar.

10.28 TRAFFIC AND PEDESTRIAN SIGNAL HEADS AND LAMPS

- .1 Traffic and pedestrian signal heads and lamps including backboards and visors shall be manufactured in accordance with the Ministry of Transportation and Infrastructure material standards as per the Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS SPECIFICATIONS

- .2 Signal head layout, size and lamp requirements shall be as follows.

ITEM	LENS	REQUIRED DIAMETER	LAMP
PRIMARY HEADS (Overhead mount)	Red	300mm	LED
	Yellow	300mm	LED
	Green	300mm	LED
	Left Turn (Gr, Yell)	300mm	LED
SECONDARY HEADS (Side mount)	Red	200mm	LED
	Yellow	200mm	LED
	Green	200mm	LED
	Left Turn (Gr, Yell)	300mm	LED
PEDESTRIAN HEADS	Combination Walk/Don't Walk Overlay Graphic	300mm square	LED
PEDESTRIAN COUNTDOWN DISPLAY	Countdown Graphic	300mm square	LED
Notes: 1. All heads shall be mounted vertically. 2. All primary heads shall have backboards with fluorescent yellow reflective sheeting as per the approved product list.			

10.29 SIGNAL HEAD AND SIGN MOUNTING HARDWARE

- .1 Signal and sign mounting hardware shall be manufactured in accordance with the Ministry of Transportation and Infrastructure material standards as per the Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**

10.30 -NOT USED-

10.31 -NOT USED-

10.32 AUDIBLE SIGNALS

- .1 Audible signals shall be manufactured in accordance with the Ministry of Transportation and Infrastructure material standards as per the Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**

10.33 CONNECTORS

- .1 Conductor connections shall be screw on type solderless connectors sized to suit conductor size with the exception of those used inside traffic controllers which shall be compression type spade connectors.
- .2 Ground clamps shall be copper with bolt down compression connection.

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10.34 CONDUCTOR TAGS

- .1 Conductor tags in traffic controllers and pole handholes shall be sleeve type markers. Tags shall be designed so they can snapped onto a conductor.
- .2 Conductor tags in junction boxes shall be yellow and shall be a minimum of 60mm x 50mm x 0.5mm thick . Tags shall be rigid and waterproof. Tags shall be supplied with a ty-rap to connect to bundle of conductors. Tags shall be designed to be permanently labeled with a black indelible pen.

10.35 FUSES AND FUSE HOLDERS

- .1 Fuses shall be a 10 amp ferrule type to suit fuse holder.
- .2 Fuse holders to be inline type with 2 'L' type rubber insulating boots.

10.36 GROUNDING RODS

- .1 Ground Rods shall be 20mm Ø x 3000mm long steel with hot forged point, hot-dipped galvanized full length.

10.37 PEDESTRIAN PUSHBUTTONS

- .1 Pedestrian pushbuttons shall have an integral sign with a raised walk symbol.
- .2 Pushbutton unit shall be white with black tactile actuation hand walking symbol and directional arrow. Pushbutton symbols and arrows shall be available in both left and right hand directions.
- .3 Pushbutton housing shall be designed to mount against a flat surface and shall be supplied with a rubber gasket for a watertight seal to the pole.
- .4 Pushbutton head shall be ultra-high molecular weight polyethylene.
- .5 Pushbutton shall be supplied with 2 - 3/8" stainless steel head mounting bolts and stainless steel flat washers for mounting to the pole.
- .6 Pushbutton shall be **actuated** via a magnetic proximity switch. A 2200mm length of purple No. 14 RW90 stranded copper conductor shall be supplied soldered to each switch terminal. Contacts shall be hermetically sealed.
- .7 Extend sidewalk to pushbutton, (wheelchair accessible).

10.38 RECEPTACLES

- .1 Receptacles shall be 15A-120V corrosion resistant spec grade duplex mounted in cast F.S. box.
- .2 Covers shall be double spring door type for wet location

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS SPECIFICATIONS

10.39 LUMINAIRES

- .1 Flat glass and sign luminaires shall be manufactured in accordance with the Ministry of Transportation and Highways Material Standards.
- .2 Post top luminaires shall be:
 - (a) 100 W high pressure sodium with IES type 2 distribution;
 - (b) Cast aluminum with a glass or polycarbonate refractor;
 - (c) Vandal proof;
 - (d) Equipped with a integral CWA or CWI type ballast;
 - (e) Equipped with a quick disconnect ballast starter and capacitor unit;
 - (f) Equipped with a knockout for photocell;
 - (g) Powder paint finished;
- .3 Luminaire wattage and distribution type shall be as noted on the Contract Drawings.
- .4 Luminaire voltage, wattage and distribution type to shall as noted on the Contract Drawings.

10.40 SERVICE PANELS

- .1 Service panels shall be as follows:
 - (a) 60A - 120/240V street lighting;
 - (b) 100A - 120/240V street lighting and traffic signal;
- .2 Service wiring shall contain equipment shown on Standard Drawing No. E-10.3 to Standard Drawing No. E-10.4.
- .3 Service panel enclosures shall be stainless steel or powder coated aluminum and shall be waterproof with a EEMAC 3 rating.
- .4 Service panels shall be designed to fit into a standard service base. Refer to Standard Drawing No. E-5.18 or as shown on Standard Drawing No. E-5.18A to Standard Drawing No. 5.18C.
- .5 Service panels shall be designed for long life and easy maintenance.

10.41 POST MOUNTED FLASHER LUMINAIRES

- .1 Post mounted flasher luminaires shall be manufactured in accordance with the Ministry of Transportation and Infrastructure material standards as per the Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**

10.42 PHOTOCELL AND RECEPTACLE

- .1 Photocells shall be manufactured in accordance with the Ministry of Transportation and Infrastructure material standards as per the Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS SPECIFICATIONS

10.43 HID LAMPS

- .1 Lamps shall be manufactured in accordance with the Ministry of Transportation and Infrastructure material standards as per the Electrical and Traffic Engineering Manual. **(REVISED NOVEMBER 2016)**
- .2 HID lamps shall be high pressure sodium with the exception of 175W sign luminaires which shall be mercury vapor.

10.44 NUTS, BOLTS AND WASHERS

- .1 Nuts, bolts and washers 3/8" Ø or smaller shall be type 18-8 or 316 stainless steel hex head.
- .2 Nuts, bolts and washers larger than 3/8" Ø shall be as follows:
 - (a) Nuts to be galvanized SAE grade 2 heavy hex.
 - (b) Bolts to be galvanized SAE grade 5.
 - (c) Washers to be galvanized.
- .3 Screws shall be stainless steel Robertson No. 10.

10.45 COLD GALVANIZING COMPOUND

- .1 Cold galvanizing compound shall be spray type and shall contain a minimum of 93% zinc in the finished film.

10.46 -NOT USED-

10.47 TRAFFIC CONTROLLERS

- .1 Traffic controllers shall be designed to operate signalized intersections
- .2 Traffic Controller Unit (CU) and assembly shall be Type-1 as per *National Electrical Manufacturers Association (NEMA) Standards Publication No. TS-2*. CU and assembly shall be capable of a minimum 12 fully-actuated phases, and siren pre-emption in all directions.
- .3 Malfunction Management Unit (MMU) shall be TS2-Type16 and shall be configured for the required signal phasing.

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS SPECIFICATIONS

- .4 The controller cabinet shall be base mount, size 6, made of sheet aluminum in accordance with *Section 7 of NEMA Standards Publication No. TS2-1992, "Traffic Controller Assemblies"*. The controller cabinet shall be supplied complete with all mounting hardware and shall be fully wired for the required signal phasing. Cabinets shall be equipped with a GFI receptacle, a heater, a fan, thermostat controls, a light and a 40A-1P breaker for the power supply feeders. Cabinets shall be primed and finished inside and out with a finish coat of a polyester baked enamel paint, Munsel 70 in color. A durable waterproof document pouch shall be located on the cabinet door, containing as built cabinet wiring diagrams and user manuals for the controller and all auxiliary equipment. The cabinet shall be equipped with a police door with key lock access for the following switches:
- Signals on/off switch
 - Manual/automatic switch
 - Flash/automatic switch
 - Extendible police cord to 2 metres
- .5 All auxiliary devices such as Bus Interface Units (BIU's), Cabinet Power Supply, loadswitches, flash switches, shall be *NEMA TS-2 Standard*. Detector modules shall be rack mount type.
- .6 All traffic signal controller assemblies shall be shop tested prior to delivery and come with a minimum two year warranty on all parts and labor.
- .7 The traffic controller manufacturer shall enter all signal timings. In addition the manufacturer shall have technician on site to check all field wiring connections and put the controller into operation during the signal start-up.

10.48 SIREN PRE-EMPTION SYSTEM

- .1 Siren pre-emption systems shall be designed to provide exclusive right of way for police, fire, or ambulance vehicles in lieu of the regular sequence of phases. Siren detectors mounted on the signal pole arms shall detect the sound of the siren send a signal to the traffic controller through a hard wire connection. Lights on digital detectors indicate direction of pre-emption to the drivers.
- .2 A siren pre-emption system shall consist of sound-based detectors with indication lights, shielded cables and rack mount interface cards. Refer to Standard Drawing No. E-6.6.
- .3 Sound-based detectors shall be supplied with suitable hardware to mount on signal pole arms.
- .4 Rack mount interface cards shall be installed inside the traffic controller cabinet

SECTION 10 - ROADWAY LIGHTING AND TRAFFIC SIGNALS INSTALLATION

10.60 CONTRACTOR QUALIFICATIONS

- .1 All electrical work to be performed by Registered Electrical and Inspection Contractor under provisions of *British Columbia Safety Standards Act*. **(REVISED NOVEMBER 2016)**

10.61 PERMITS

- .1 The Contractor shall obtain and pay for all permits, arrange for electrical inspections covering all work, pay all other fees and charges, and make all deposits that are in any way connected with the installation. The Contractor shall give all necessary notices to authorities having jurisdiction and shall be responsible for complying with all applicable public ordinances.

10.62 CODES AND REGULATIONS

- .1 Electrical work shall conform to the latest edition of Canadian Electrical Code. In addition, any bulletins published by the Ministry of Natural Gas Development, Building and Safety Standards Branch, shall also apply. **(REVISED NOVEMBER 2016)**
- .2 All work shall conform to all applicable regulations of WorkSafeBC and if required, a Notice of Project Form 52E49 must be submitted prior to commencing construction. The Contractor shall ensure compliance with the following sections:
 - (a) WorkSafeBC form 30M33 must be completed prior to working in vicinity of overhead power lines.
 - (b) Notice of construction projects, WorkSafeBC Industrial Health and Safety Regulations, Section 34.16(3).

10.63 CERTIFICATE OF INSPECTION

- .1 Prior to requesting final inspection the Contractor shall submit to the Engineer the Certificate of Inspection signed by the local Safety Officer of the British Columbia Safety Authority. **(REVISED NOVEMBER 2016)**

10.64 ELECTRICAL POWER SUPPLY

- .1 Power shall be supplied from the BC Hydro secondary distribution system at location(s) shown on the Drawings.
- .2 Prior to construction the Contractor shall confirm the exact service location(s) with BC Hydro.
- .3 The Contractor shall arrange with BC Hydro for connection and disconnection of service, through BC Hydro Street Light Information Management System (SLIM) online at www.bchydro.com/ex/streetlight. For sample forms of SLIM, refer to Appendix J. All connections and disconnections to be made by BC Hydro.

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10.65 TRENCH EXCAVATION, BEDDING AND BACKFILL

- .1 Refer to Section 4 - Trench Excavating, Bedding and Backfill for installation requirements.
- .2 Backfill in accordance with Section 4.19 - Backfill and Compaction.
- .3 Where soil conditions and/or foundations are unstable, the Contractor shall notify the Engineer in order that a special pole base design change can be considered.

10.66 CONCRETE BASES

- .1 Concrete bases shall be installed as shown on Standard Drawing No. E-1.1 to Standard Drawing No. E-1.14 and Standard Drawing No. E-2.1 to Standard Drawing No. E-2.3.
- .2 Minimize disturbance to surrounding soil when excavating.
- .3 Concrete base installation tolerances to be as follows:
 - (a) Horizontal location to be within 150mm of specified.
 - (b) Vertical elevation to be within 10mm of specified.
 - (c) Top surface variation from level shall not exceed 3mm.
- .4 Where poured in place are proposed the Contractor shall provide details of how they plan to carry out the work. In all cases wooden formwork shall be removed prior to poured in place backfilling bases. Where sonotube foundations have been utilized, round sonotube forms may be buried.
- .5 Concrete bases shall have a compressive strength of 30MPa and all backfill shall be fully compacted prior to pole installation.
- .6 No concrete base shall be installed closer than 3m from a fire hydrant.

10.67 JUNCTION BOXES

- .1 Install junction boxes in accordance with the Standard Drawings No. E-3.1 through to Standard Drawing No. E-3.4. Only concrete junction boxes shall be installed in driveways, roadways, sidewalks or other travelled surfaces.

10.68 CONDUITS

- .1 Underground conduits shall be installed in an open trench as shown on Standard Drawing No. E-4.1 and Standard Drawing No. E-4.2 unless otherwise noted on the Contract Drawings.
- .2 Minimum cover over conduits shall be 600mm, except that cover for street light conduits placed under concrete sidewalk may be reduced to 300mm.
- .3 Where indicated on the Contract Drawings conduits to be installed through a hole drilled under the pavement. Drilling equipment to be fully directional.
- .4 Empty conduits shall be provided with a nylon pull string and capped.

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- .5 Conduits laid near underground shall maintain the required minimum clearances.
- .6 Crossing over of conduits shall be kept to a minimum.

10.69 TRENCH MARKER TAPE

- .1 Trench marker tape shall be installed above and directly over the conduit as shown on Standard Drawing No. E-4.1 and Standard Drawing No. E-4.2.

10.70 POLES

- .1 Install poles and related equipment as shown on the Standard Drawings.
- .2 Poles shall be erected plumb.
- .3 Where minimum pole to powerline clearances as shown on Standard Drawing No. E-5.20 cannot be maintained advise the Engineer and defer further work pending instruction.
- .4 Take all precautions necessary to ensure adequate protection of existing works and personnel during installation of poles.
- .5 Install davit pole arms at right angles to the street centreline unless otherwise noted on the Contract Drawings.
- .6 Confirm pushbutton and signal head locations prior to drilling and assembling poles.
- .7 Field drilling of holes larger than 33mm diameter are not allowed in type 1, 3, 6, 7, & L shafts, and all arms and extensions. Where larger holes are required, they shall be reinforced with a welded bushing prior to galvanizing.
- .8 All poles and related hardware to be handled with care to prevent stress to components through bending or twisting. Use nylon slings to transport and erect components. Use of steel chains as slings are not permitted. The Contractor shall repair or replace any damage to the components through overstress, scratching or denting to the satisfaction of the Engineer.
- .9 Tighten all nuts and bolts to 1/3 past snug tight. "Snug-tight" is tightness attained by a few impacts of an impact wrench or full effort of a person using a spud wrench.
- .10 All scratches in poles and field drilled holes shall be coated with cold galvanizing compound.
- .11 Poles shall be cleaned after erection.

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10.71 TRAFFIC AND PEDESTRIAN SIGNAL HEADS

- .1 Install traffic and pedestrian signal heads as shown on Standard Drawing No. E-6.1 to Standard Drawing No. E-6.5.
- .2 Securely attach traffic and pedestrian signal heads and mounting hardware to the pole.
- .3 Confirm final traffic and pedestrian signal head aiming on site with Engineer.
- .4 Completely cover all traffic and pedestrian signal heads with burlap sacking from the time they are installed until system startup.

10.72 AUDIBLE SIGNALS

- .1 Install audible signals as shown on Standard Drawing No. E-7.1.
- .2 Aim, tune and adjust audible signal as per manufacturers instructions.
- .3 Wire each audible pedestrian signal through the pole and connect into the pedestrian signal head which controls the audible signal.
- .4 Audible tones and decibel levels should meet the recommended tones as outlined in the Canadian National Institute for the Blind – CNIB Position for Accessible Pedestrian Signals in Canada (www.cnib.ca/en/about/who/believe/documents/cnib) and then go to **Accessible Pedestrian Signals - CNIB.doc**.

10.73 PEDESTRIAN PUSHBUTTONS

- .1 Install pedestrian pushbuttons as shown on Standard Drawing No. E-8.1.
- .2 Securely attach pedestrian pushbuttons and signs to the pole.
- .3 Completely cover pushbutton signs with burlap sacking from time they are installed until system start-up.
- .4 Extend sidewalk to pushbutton, (wheelchair accessible).

10.74 LUMINAIRES AND PHOTOCELLS

- .1 Install luminaires and photocells in accordance with manufacturers instructions.
- .2 Luminaires shall be cleaned after pole erection and plumbing is complete.
- .3 Securely attach the luminaire to the pole.
- .4 Install cobra head luminaire levels.
- .5 Aim photocells north.

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10.75 MEDIAN SIGNAGE AND POST MOUNTED FLASHERS

- .1 Install median signage as shown on the Standard Drawings.
- .2 Install post mounted flashers as shown on the Standard Drawings.

10.76 UNDERGROUND DIP SERVICE

- .1 Install underground dip service as shown on Standard Drawing No. E-9.1.

10.77 SERVICE PANELS

- .1 Service panels shall be mounted in a service base as shown on the Standard Drawings.
- .2 Wiring shall be in accordance with Standard Drawing No. E-10.3 to Standard Drawing No. E-10.4.
- .3 Service panels and the electrical equipment inside shall be protected against the entrance of dust, dirt, moisture, and mechanical damage during construction.
- .4 Unused openings in the sheet steel panels shall be plugged with suitable corrosion resistant plugs.
- .5 Securely attach service panels inside the service base or on the side of the controller.

10.78 WIRING

- .1 Before pulling conductors through the conduit, the conduit shall be blown out with compressed air from both ends and then swabbed out to remove all stones, dirt, water and other foreign material from the conduit.
- .2 No conductor shall be drawn into any raceway until all work of any nature that may cause damage to the conductor or its insulation has been completed. During pulling, the conductors shall be fed carefully into the raceway to prevent stretching, twisting, kinking or looping. Only talc or other CSA approved lubricants shall be used to assist in the pulling operations. Grease type lubricants shall not be permitted.
- .3 Wiring to conform to requirements of the Canadian Electrical Code.
- .4 Wiring shall be installed in pole handholes as shown on Standard Drawing No. E-12.1 and Standard Drawing No. E-12.2.
- .5 With exception of detector loop conductor to shielded cable splices, all conductor splices shall be made in pole handholes. Splices of detector loop conductor to shielded cable shall be made in junction boxes. See Standard Drawing No. E-14.4 for detector loop splice details.
- .6 Signal cable colour coding shall be as shown on the Contract Drawings.
- .7 Shielded cables shall run with no splices from controller to the respective loop.

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- .8 Single conductor sizes and colours shall be as shown on the Contract Drawings.
- .9 With the exception of detector loop cables, bundle and label conductors in junction boxes with tags specified in Section 10.34 – Conductor Tags, *clause 10.34.2*. Labels shall be as follows:
 - (a) Street Lighting - STLTG
 - (b) Photocell - PEC
 - (c) Controller Power - CONT PWR
 - (d) Signal Cable - SIGNAL CABLE No. 1, No. 2, ETC.
 - (e) Post Mounted Flasher - FLASH
 - (f) Advance Warning Sign - AWS1, AWS2, ETC.
- .10 Label individual conductors in controllers and pole handholes with sleeve type markers as specified in Section 10.34 – Conductor Tags, *clause 10.34.1*. Labels shall be as follows:
 - (a) Street Lighting - STLTG
 - (b) Photocell - PEC
 - (c) Controller Power - CONT PWR
 - (d) Signal Phase - 2R, 2Y, 2G, 2N (where '2' indicates the Signal Phase and 'R' indicates Red, 'Y' indicates Yellow, 'G' indicates Green and 'N' indicates Neutral).
 - (e) Pedestrian Phase - P2W, P2DW, P2N (where 'P2' indicates the Pedestrian Phase, 'W' indicates Walk, 'DW' indicates Don't Walk and 'N' indicates Neutral).
 - (f) Detector Loop - L1, L2, ETC.
 - (g) Post Mounted Flasher - FLASH
 - (h) Advance Warning Sign - AWS1, AWS2, ETC.
- .11 Wire each traffic signal and pedestrian signal head separately from base of pole. Run a separate neutral and bonding conductor from base of pole to each signal head or luminaire.
- .12 Neatly arrange, bundle and ty-rap wiring in the traffic controller, junction boxes, vaults, pole handholes and service panels to satisfaction of the Engineer.
- .13 Secure conductor splices with the exception of detector loop to shielded cable with solderless type connectors. Where number and/or size of conductors exceeds the capacity of the solderless connector use split bolt connectors.
- .14 Sealing of connections, with exception of detector loop to shielded cable splices, shall be performed using one of the following methods:
 - (a) Double dipping the connection in an approved liquid product as referenced in the City of Nanaimo's Approved Products List. Dipping shall be performed strictly adhering to the Manufacturer's specification.
 - (b) Each conductor shall have a wrap of the self-holding tape conforming to products listed in the City of Nanaimo's Approved Products List, then the complete splice shall be wrapped. PVC Tape shall then be applied to cover the complete splice.
- .15 Seal detector loop to shielded cable splices in accordance with Standard Drawing No. E-14.4.

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- .16 If conductor connections require use of split bolts or similar style devices due to wire size, completely cover splice with tape then Duct Seal to form a ball over connection. Duct Seal shall be thick enough to prevent the sharp ends of the conductors and/or points of the connector from protruding through the taped connection. Once the Duct Seal has been applied, the splice shall to be taped with self-holding and PVC tape.
- .17 Bond all luminaires, signal heads, steel junction box lids and vault lids with a No. 12 RW90 conductor.
- .18 Bundle ty-rapped conductors every 75mm and route neatly inside the controller. Tag the conductors at the terminal blocks. Wiring inside of controller shall generally consist of:
 - (a) Connection of the traffic controller power to the terminals supplied.
 - (b) Connection of all the traffic and pedestrian phases to the terminals supplied.
 - (c) Connection of the detector loops to the terminal supplied.
 - (d) Connection of the bond conductor.
- .19 Make connections in traffic controller with insulated spade type crimp-on connectors.
- .20 Flash-out and check all signal and pedestrian heads at the terminal block in controller cabinet prior to system start-up.

10.79 TRAFFIC CONTROLLER

- .1 Install the traffic controller as shown on the Standard Drawings.
- .2 The type of traffic controller shall be indicated on the Contract Drawings.

10.80 POLE MOUNTED RECEPTACLES

- .1 Pole mounted receptacles shall be installed as shown on Standard Drawing No. E-13.1.
- .2 Receptacles shall be installed to the elevation and orientation shown on the Contract Drawings.

10.81 DETECTOR LOOPS

- .1 Detector loops shall be installed in accordance with Standard Drawing No. E-14.1 to Standard Drawing No. E-14.7.

10.82 GROUNDING

- .1 All grounding shall conform to the Canadian Electrical Code and latest Electrical Safety Branch Amendments.
- .2 Connect all ground rods, conductors, and galvanized steel conduits together. Connect only one wire to any one ground bushing.
- .3 Ground rigid steel conduits.

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10.83 COLD GALVANIZING COMPOUND

- .1 Repair damage to the galvanized surfaces with cold galvanizing compound. Application of cold galvanizing compound shall conform to manufacturer's instructions and the following:
 - (a) Surface to be mechanically cleaned with a wire brush or grinder and chemically cleaned to remove all welding flux, paint, grease, oil, rust, scale or other detrimental foreign matter.
 - (b) Surface shall be absolutely dry and the ambient temperature shall be over 10°C.
 - (c) Apply uniform coats as thick as possible without causing runs on the finished surface.

10.84 OVERHEAD SIGNS

- .1 Overhead street name signs mounted on signal poles shall be bolted to the arms in accordance with Standard Drawing No. E-15.1.
- .2 Overhead regulatory and warning signs 750mm X 750mm or smaller shall be mounted on signal poles in accordance with Standard Drawing No. E-15.2 to Standard Drawing No. E-15.4.
- .3 Extruded aluminum signs 1220mm(H) X 2440mm(W) such as advance warning signs or guide signs shall be mounted on sign poles in accordance with Standard Drawing No. E-15.5 to Standard Drawing No. E-15.14.
- .4 Signs shall be securely attached to the pole.
- .5 Temporary signs shall be plywood, unless otherwise noted.

10.85 TESTING AND COMMISSIONING

- .1 The Contractor shall carry out all adjustments and tests necessary to ensure that the entire electrical installation and all its equipment, material and components are in satisfactory physical condition and perform the intended function and operations. Any adjustments required to make the system operate in the manner intended by the Engineer shall be made by the Contractor.
- .2 At the completion of the job, proper system operation shall be demonstrated to the Engineer and the City of Nanaimo.
- .3 Traffic signal startup shall be carried out as follows:
 - (a) Upon completion of the installation, prior to start-up, the Contractor shall advise the Engineer and the City of Nanaimo to carry out their final inspection. After the final inspection is completed a written list of deficiencies will be sent to the contractor.
 - (b) All deficiencies noted during the final inspection shall be corrected to the satisfaction of the Engineer and the City of Nanaimo prior to signal start-up.
 - (c) After the deficiencies are corrected (prior to the signal start-up) the contractor shall put the signal into flash for a period of seven (7) days.
 - (d) The contractor shall provide the City with the proposed signal start-up date and time. Upon approval from the City the Contractor shall advise the Engineer and the controller manufacturer a minimum of 72 hours in advance of the approved start-up

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date and time. Where a siren pre-emption system is installed the Contractor shall arrange to have the manufacturer test the operation of their system prior to start-up. The fire chief shall all be present during the final testing of the siren pre-emption system.

- (e) The controller manufacturer's representative shall inspect all field wiring connections and controller operation on site prior to signal start-up.
- (f) In the presence of the Engineer, the controller manufacturer and the City the contractor shall put the signal into full operation.
- (g) The contractor shall supply all the necessary traffic control personnel required during the signal start-up. A minimum of 2 qualified flag persons are required.
- (h) The signal start-up shall be done during non-peak traffic periods.

10.86 CLEANUP

- .1 Any areas where work has been performed shall be restored to original condition, or better.
- .2 Existing equipment designated as being removed shall be returned to the City of Nanaimo works yard or disposed off-site as noted on the Contract Drawings.
- .3 The interior of enclosures, pole handholes and wiring areas shall be cleaned of dust, dirt and loose materials, vacuum-cleaned and all water and moisture removed.
- .4 All fastening screw holes provided in enclosures shall have a fastening screw installed.
- .5 Any spots where the galvanizing is damaged due to drilling, tapping, reaming, welding, or surface damage during transportation and erection, shall be refinished with cold galvanizing compound in accordance with Section 10.83 – Cold Galvanizing Compound.

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SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS SPECIFICATIONS

11.20 SCOPE

- .1 This specification refers to reinforced and plain concrete works for the construction of pavements, sidewalks, curbs and gutters, manholes, catchbasins, concrete works associated with the installation of watermains and sewers and other works incidental to municipal services construction.
- .2 This specification shall not be used for structural facilities such as buildings, bridges or other structure requiring site specific structural design.

11.21 CODES AND STANDARDS

- .1 Concrete work shall conform to the following codes and standards:
 - (a) Local codes and bylaws
 - (b) Workers' Compensation Board Regulations
 - (c) NBC
 - (d) CSA Specification CAN/CSA A23.1 - Concrete Materials and Methods of Concrete Construction, and CAN/CSA A23.2 - Methods of Tests for Concrete
 - (e) ACI Standards
 - (f) AASHTO (**REVISED NOVEMBER 2016**)
- .2 The codes and standards shall take precedence and govern in the order shown, unless otherwise specified.
- .3 The concrete supplier's plant, equipment and materials, used for production of concrete, shall comply with the requirements of CAN/CSA A23.1 and be certified by a Professional Engineer.
- .4 Selected concrete mix proportions shall be certified by a Professional Engineer to produce concrete of specified quality, durability, yield and strength complying with CAN/CSA A23.1.

11.22 FORM RELEASE AGENT

- .1 Form release agent shall be approved by the Engineer prior to use and shall be a non-staining, mineral type, with chemically active release agents containing compounds that react with free lime to produce water soluble soap.

11.23 SUPPORTS, CHAIRS AND SPACERS

- .1 Bolsters, supports, chairs and spacers shall conform to CAN/CSA A23.1.

11.24 REINFORCEMENT

- .1 Reinforcing steel shall be intermediate grade billet steel conforming to CSA G30.18 Grade 400 unless otherwise specified on the construction drawings.
- .2 Reinforcing weldable low alloy steel deformed bars shall conform to CSA G30.18.
- .3 Cold drawn annealed steel wire ties shall conform to CSA G30.3.

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- .4 Deformed steel wire shall conform to CSA G30.14.
- .5 Welded steel wire fabric shall conform to CSA G30.5.
- .6 Welded deformed steel wire fabric shall conform to CSA G30.15, and supplied in flat sheets only.
- .7 Epoxy coating of non-prestressed reinforcement shall conform to ASTM A775 and A775M.
- .8 Galvanizing of non-prestressed reinforcement shall conform to CSA G164 with a minimum zinc coating of 610 g/m².

11.25 FORMS

- .1 All forms shall conform to CAN/CSA A23.1 and shall be free of surface defects for all concrete faces exposed to view. (**REVISED NOVEMBER 2016**)
- .2 Form ties shall be metal and of the type such that no metal is left within 25mm from the concrete surface when the forms are removed.

11.26 PREMOULDED JOINT FILLER

- .1 Premoulded joint fillers shall be bituminous impregnated fiber board in accordance with ASTM D1751.

11.27 CEMENT

- .1 Cement shall conform to CAN/CSA A3000. (**REVISED NOVEMBER 2016**)
- .2 Cement shall be Type 10 Portland cement for all concrete work.
- .3 Other types of cement will only be permitted with the Engineer's approval.

11.28 AGGREGATE

- .1 Aggregates shall consist of crushed stone, gravel or natural sand in conformance with CAN/CSA A23.1.

The maximum size of aggregate shall not exceed the following limits:

- (a) 40mm for footings.
- (b) 13mm for concrete patching and grout.
- (c) 20mm for other concrete work.

SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS SPECIFICATIONS

11.29 MIXING AND CURING WATER

- .1 Mixing and curing water shall conform to CAN/CSA A23.1.

11.30 ADMIXTURES

- .1 Admixtures other than air-entraining admixtures and water-reducing admixtures shall not be added unless authorized by the Engineer.
- .2 Air-entraining and water reducing admixtures shall conform to CAN/CSA A266.1 and A266.2.

11.31 CONCRETE

Concrete shall meet the following minimum requirements except for concrete used for curbs and sidewalks, and stairways which shall be as specified in Section 8.21 Curb and Sidewalk Concrete.

.1 Compressive Strength:

As specified in Tables 1 and 2 of CSA A23.1 for exterior walls and columns. Concrete shall develop a minimum compressive strength of 25 MPa at 28 days. **(REVISED NOVEMBER 2016)**

.2 Slump:

- (a) Slump shall be maintained at the minimum possible while permitting efficient placing and providing an homogeneous mass.
- (b) Maximum slumps shall be as indicated in CAN/CSA A23.1

.3 Temperature:

- (a) Concrete when placed shall be at least 10°C, but shall not exceed 25°C.

.4 Entrained Air:

- (a) Entrained air shall be 5% + 1% by volume. All concrete, except that used for plain, interior concrete slabs, shall contain entrained air.

.5 Grout:

- (a) Grout shall be approved by the Engineer.
- (b) Grout shall be used in accordance with the manufacturer's recommendations.

SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS SPECIFICATIONS

(c) Grout shall be prepared from the constituent materials in the following proportions:

Cement	1 part
Sand	2-1/2 parts
Admixture	0.45kg per sac of cement shall be used to reduce grout shrinkage and improve bond strength.
Water	Minimum mixing water shall be used to obtain desired workability and flowability. If dry pack grout is desired, sufficient water shall be used to pack by ramming. A minimum of 15 litres per 40kg sack of cement shall be used.

11.32 CONCRETE ACCESSORIES

- .1 All concrete accessories shall be as indicated on the drawings or as approved in writing by the Engineer.

SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS INSTALLATION

11.40 GENERAL

- .1 Install reinforced and plain concrete works, including surface tolerances, finishing and field quality control in accordance with CAN/CSA A23.1 except where specifically stated otherwise.

11.41 NOTIFICATION TO THE ENGINEER

- .1 The Engineer shall be given twenty-four (24) hours notice in advance of placing concrete by the Contractor.

11.42 CONCRETE TESTING

- .1 The Engineer will arrange for a CSA certified testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates non-compliance with the specifications additional testing shall be required at the contractor's expense.
- .2 The Contractor as directed by the Engineer shall supply specimens or samples for testing.
- .3 Concrete samples shall be taken in conformance with CAN/CSAA23.2. Cure cylinders on the job site under the same conditions as the concrete they represent.
- .4 The types of tests listed below are the minimum testing requirements. The Engineer shall determine if additional testing is required.

(a) Compressive Strength Test:

- (i) Compressive strength shall be determined from compression tests performed in conformance with CAN/CSAA23.2.
- (ii) One strength test shall consist of 3 - 150mm x 300mm cylinders; one tested at 7 days, 2 tested at 28 days.
- (iii) At least one strength test shall be made from each 20 cubic metres of concrete placed, with a minimum of one test for each pour of a specified concrete strength placed each day.
- (iv) The average of all 28-day strength tests shall exceed the specified strength. When 3 or more tests of the same class of concrete are available, the average of any 3 consecutive tests shall be equal to or greater than the specified strength. No strength test shall fall below 85% of the specified strength.

(b) Slump Test:

- (i) Slump tests shall be made in conformance with CAN/CSA A23.2.
- (ii) At least one slump test shall be made for each strength test.
- (iii) The slump test is not required for machine extruded concrete using a no-slump mix design.

SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS INSTALLATION

- (c) Air Content Test:
 - (i) Air content tests shall be made in conformance with CAN/CSA A23.2.
 - (ii) At least one air content test shall be made for each strength test.
 - (d) Temperature:
 - (i) Temperature measurement shall be made for each strength test.
- .5 All concrete trucks shall supply a copy of the delivery slip to the Engineer containing the following information:
- (a) Minimum Compressive Strength
 - (b) Maximum Slump
 - (c) Air Content by Percent of Volume
 - (d) Batch Time
 - (e) Maximum Size of Aggregate
 - (f) List of Admixtures
 - (g) Date
 - (h) Name of Supplier
- .6 Inspection and testing by the Engineer shall not relieve the contractor of his responsibility for quality control.
- .7 Concrete found to be in non-compliance with these specifications, shall be repaired or replaced by the Contractor at no additional cost to the Owner. The Contractor shall submit to the Engineer for approval, his proposed method to correct the noted deficiencies, prior to commencing the work.

11.43 FORMWORK

- .1 Forms shall be so constructed that the finished concrete will conform to the shape, dimensions and finish specified.
- .2 Forms shall be constructed in conformance with the WorkSafeBC regulations.
- .3 Forms and falsework shall be built sufficiently strong and rigid to maintain correct alignment and elevation and retain concrete pressures without deflection. Forms shall be sufficiently tight to prevent leakage of concrete.
- .4 Forms shall be treated with form release agent prior to placing of reinforcement.
- .5 Forms for surfaces which are to receive a plaster finish shall not be treated with form release agent.
- .6 Forms shall not be stripped until concrete has attained sufficient strength to support safely its own weight and all loads to which it may be subjected.
- .7 Forms shall be removed without damaging the concrete.

SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS INSTALLATION

11.44 HOOKS AND BENDS IN REINFORCEMENT

- .1 Fabrication of hooks and bends in reinforcing steel shall be in accordance with CAN/CSA A23.1.
- .2 Bars shall be cold bent, unless otherwise authorized by the Engineer. Bars that are partially embedded in concrete shall not be field bent unless shown on the drawings or authorized by the Engineer.
- .3 Replace bars which develop cracks or splits.

11.45 CLEANING REINFORCEMENT

- .1 Bars shall be free from loose rust, mud, oil or other bond-reducing coating.
- .2 Bars shall, if necessary, be recleaned prior to resumption of pouring if concrete placing is delayed during the course of a pour.
- .3 Touch up damaged parts and cut ends of epoxy coated or galvanized reinforcing steel with compatible finish to provide continuous coating.

11.46 PLACING REINFORCEMENT

- .1 Fabricate reinforcing steel in accordance with CAN/CSA A23.1, ANSI/ACI 315 and 315R. Upon approval by the Engineer weld reinforcement in accordance with CSA W186.
- .2 Reinforcement shall be placed accurately and securely supported by chairs, spacers and ties in accordance with the construction drawings.

11.47 SPLICES

- .1 Bars shall be spliced only where shown on the construction drawings or as authorized by the Engineer. Splicing shall be carried out in conformance with CAN/CSAA23.1.
- .2 Welding of reinforcement, where authorized by the Engineer, shall conform to CSA W186.

11.48 COVER FOR REINFORCEMENT

- .1 Supports, chairs and spacers shall be provided to ensure the specified cover.
- .2 A minimum of 75mm of cover for reinforcement shall be provided for concrete placed against the ground.
- .3 For surfaces to be exposed to the weather or in contact with the ground after removal of forms, the concrete cover shall be at least 50mm.
- .4 A minimum of 20mm concrete cover shall be provided for surfaces not exposed to earth or weather:

SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS INSTALLATION

11.49 - NOT USED -

11.50 CONSTRUCTION JOINTS

- .1 Construction joints not shown on the drawings shall be approved by the Engineer prior to construction of formwork and placement of reinforcement. The interface between concrete pours is classified as a construction joint if fresh concrete cannot be incorporated integrally by vibration with that previously placed.
- .2 Joints shall be perpendicular to main steel.
- .3 Reinforcing steel and/or welded wire fabric shall be continuous across joints.
- .4 Before placing new concrete on hardened concrete, forms shall be re-tightened, the surface of concrete adequately roughened, laitance removed and the surface saturated with water in advance of concreting.
- .5 Joint preparation and installation of jointing materials shall be in accordance with the manufacturer's instructions.
- .6 Furnish filler for each joint in a single piece for the depth and width required for the joint, unless authorized by the Engineer. When more than one piece is authorized for a joint, fasten abutting ends and hold securely to shape by stapling or other positive fastening methods.

11.51 SLEEVES AND OPENINGS

- .1 Pipes, castings or conduits passing through walls or floors shall, wherever possible, be placed in forms before pouring concrete. Boxes may be built into forms to make form openings for subsequent insertion of such items only with the Engineer's approval.
- .2 Continuous keyways shall be provided throughout the perimeter of the opening and shall be flared slightly to facilitate the escape of entrapped air during grouting.

11.52 EMBEDDED ITEMS

- .1 Items that are to be embedded in concrete shall be properly set, held, leveled and aligned in forms.
- .2 Anchor bolts or other inserts shall be accurately set, held, leveled and aligned using templates.
- .3 Suitable nailing blocks, plugs, strips and other items required for attachment of architectural trim and finish shall be placed such that there is no visible distortion or defacement of the completed installation.

SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS INSTALLATION

11.53 COLD WEATHER REQUIREMENTS

- .1 Procedures used for the protection of concrete and concreting operations during cold weather shall conform to the requirements specified in CAN/CSAA23.1.

11.54 HOT WEATHER REQUIREMENTS

- .1 Procedures used for the protection of concrete and concreting operations during hot weather shall conform to the requirements specified in CAN/CSAA23.1.

11.55 MIXING, PLACING AND COMPACTING

- .1 Prior to placing concrete, obtain Engineer's approval of reinforcing material and placement.
- .2 Mixing, placing and compacting of concrete shall conform to CAN/CSA A23.1 and to the approval of the Engineer.
- .3 Pumping of concrete shall require approval by the Engineer.
- .4 Placement and compacting of concrete shall not disturb reinforcement and inserts.
- .5 The Engineer, shall maintain accurate records of poured concrete to indicate date, location of pour, quality, air temperature and test samples taken.

11.56 SCREEDING

- .1 Suitable wood or metal screed strips shall be placed and aligned to the contours of the slab. The slab shall be screeded with compacting type screeds or strike-off templates with a sawing motion on screed strips. Power screeds shall be used wherever possible.

11.57 TYPES OF FINISHES AND TOLERANCES

.1 Float Finish:

Surfaces receiving a wood float finish shall be screeded in conformance with CAN/CSA A23.1 and then the concrete surface shall be worked with a long-handled darby or float to remove high spots and ridges and to fill voids and hollows left in the concrete surface by screeding.

.2 Broom Finish:

After float finishing, surfaces to be broom-finished shall be slightly roughed by light brooming with a stiff brush or broom to a uniform non-skid surface to the satisfaction of the Engineer. Finished surfaces shall be true in all planes within 8mm in 3.0m as determined by a 3.0m straightedge placed anywhere on the concrete.

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.3 Trowel Finish:

After float finishing, surfaces to be trowel-finished shall be power-trowelled and finally hand-trowelled once the surface has hardened sufficiently. Finished surfaces shall be true in all planes within 5mm in 3.0m as determined by a 3.0m straightedge placed anywhere on the slab. The surface shall have a smooth, even, dense texture free from blemishes.

.4 Common Finish:

For a common finish formed surfaces shall have fins and protrusions exceeding 5mm ground off. Honeycombed or defective concrete shall be removed to sound concrete, an approved bonding agent applied and patched with mortar of cement and sand mixed in the same proportions as the concrete patches. Damp burlap curing shall be applied. Tieholes shall be cut back 25mm from the face and filled.

.5 Rubbed Finish:

- (a) Forms shall be removed and any necessary patching completed as soon as possible after placement of the concrete without damage to the structure. The rubbed finish shall be undertaken when the surfaces are completed and accessible.
- (b) The concrete surfaces shall be thoroughly saturated with water and maintained wet for at least one hour before finishing operations are begun. All free water on the surface shall be removed prior to the application of the finishing mortar.
- (c) The mortar shall consist of one part cement and two parts sand (passing a 1.18mm sieve) by volume. The mortar shall be preshrunk by mixing at least one hour before it is used and then remixed without the addition of water prior to its use.
- (d) The sand and cement shall be the same materials as those used in the concrete.
- (e) The mortar shall be rubbed thoroughly over sections of the prepared concrete surfaces with clean burlap pads or other suitable materials so that all surface voids are filled. While the application mortar is still plastic, the surfaces shall be rubbed with the sack pads using a mixture of mortar of the same proportions as previously specified, except that no mixing water shall be used. The final rubbing shall be performed in such a manner that the filled voids are left flush with the surface of the surrounding concrete.
- (f) On exposed form surfaces, it may be necessary to blend white cement with the job cement in order to obtain a finish colour that will match the surrounding concrete surfaces. Trial batches of mortar should be made prior to application on the job surface to determine the correct mix proportions to be used.
- (g) The finished surface shall be cured continuously in accordance with CAN/CSA A23.1.

SECTION 11 - REINFORCED AND PLAIN CONCRETE WORKS INSTALLATION

11.58 SURFACE FINISHING

- .1 Unformed surfaces not exposed to view shall receive a float finish.
- .2 Unformed surfaces exposed to view, or receiving a floor covering, shall receive a trowel finish.
- .3 Sidewalks shall receive a uniform broom finish in accordance with Section 8.51 – Curb and Sidewalk Edging and Finishing.
- .4 Formed surfaces not exposed to view shall receive a common finish.
- .5 Formed surfaces exposed to view shall receive a rubbed finish.
- .6 Surface finishing may be noted on the drawings or, if not clear, shall be as directed by the Engineer.

11.59 PROTECTION

- .1 Freshly placed concrete shall be protected from damage caused by weather, construction operations and vandalism.

11.60 CURING

- .1 Concrete curing procedures shall take into account weather and temperature conditions.
- .2 Concrete surfaces shall be kept moist by continuous light sprinkling, ponding, a wet absorptive cover such as sand, sawdust, or fabric or by sealing the surface with a waterproof barrier, adequately lapped and sealed with waterproof tape.
- .3 Moist curing shall commence immediately following the final set and shall continue uninterrupted for at least 7 days.
- .4 Curing compounds shall not be used unless expressly authorized by the Engineer.
- .5 Do not place load on the new concrete until authorized by the Engineer.

SECTION 12 - ASPHALTIC CONCRETE PAVING CONTENTS

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SECTION 12 - ASPHALTIC CONCRETE PAVING SPECIFICATIONS

12.20 SCOPE

- .1 This specification outlines the requirements for the production, placing and compaction of hot mix, hot laid asphalt concrete for pavement construction and other uses.

12.21 SPECIAL MIXES

- .1 For general purposes, such as road pavement, the requirements of this specification, and the 19mm aggregate gradation shall apply unless otherwise approved by the City Engineer.
- .2 For special purposes, such as patching, the paving of shoulders, boulevards walkways and sidewalks, and the construction of curb, gutter or combination curb and gutter, the requirements of this specification, particularly in respect to the mix design aggregate requirements, and the level of testing, shall be subject to amendment by the Engineer.

12.22 - NOT USED -

12.23 AGGREGATE

- .1 Aggregate for asphaltic concrete shall be composed of hard, angular, durable, crushed gravel free from silt or clay lumps, cementation, organic material, frozen material and other deleterious materials.
- .2 The aggregate gradation shall fall within the following limits when tested in accordance with ASTM C136 and ASTM C117.

Gradation Limits (% Passing by Weight)

<u>Size</u>	<u>19mm</u>	<u>12mm</u>	<u>10mm</u>	<u>12.5mm Superpave</u>
19 mm	100	100	100	100
12.5 mm	70-100	90-100	100	90-100
9.5 mm	55-90	75-95	90-100	
4.75 mm	35-70	45-75	55-85	
2.36 mm	25-57	30-60	35-70	28-58
1.18 mm	18-45	20-45	25-55	
0.60 mm	13-34	15-35	15-40	
0.30 mm	8-26	6-20	8-25	
0.15 mm	5-17	4-15	5-18	
0.075 mm	2-8	2-10	2-10	2-10

(REVISED NOVEMBER 2016)

.3 Recycled Asphalt Pavement (RAP):

- (a) RAP is sourced from asphalt millings or excavated road mix. Suitable RAP shall not contain any other additives including, but not limited to, sulphur, crumb rubber, asphalt rubber, asbestos, produced sand, paving fabrics and reinforcement grids. Crush and screen so that 100% of the reclaimed asphalt pavement materials passes the 19mm screen before mixing. **(REVISED NOVEMBER 2016)**

SECTION 12 - ASPHALTIC CONCRETE PAVING SPECIFICATIONS

- (b) RAP must be fed to the plant by separate feed systems capable of being sampled and metering at the design rate. **(REVISED NOVEMBER 2016)**
- .4 All sample gradations shall fall within the gradation limits, and any deviations between the samples and the project gradation curve, based on the mix design, shall not exceed the following limits:

Sieve Size (mm)	Maximum Permissible Tolerance % by Weight Passing
4.75 - 19.0	± 4.5
1.18 - 2.36	± 4.0
0.60	± 3.5
0.30	±3.0
0.15	± 2.0
0.075	± 1.0

- .5 A minimum 75% of the material retained on a 4.75 sieve shall have at least 2 fractured faces. Percentages shall be determined by particle mass. **(REVISED NOVEMBER 2016)**
- .6 (a) Deleterious material (clay lumps, soft shale, coal wood or mica) by weight shall not exceed 3% in the lower course nor 1.5% in the surface course. **(REVISED NOVEMBER 2016)**
- (b) The maximum percentage of flat and elongated particles shall be 10% by mass for coarse aggregates.
- (i) Flat particles are defined as those particles with a ratio of width to thickness greater than three (3).
- (ii) Elongated particles are defined as those particles with a ratio of length to width greater than three (3).
- .7 Aggregate deficient of material passing the 0.075mm sieve shall have approved mineral filler added. Mineral filler shall be only material passing the 0.075mm sieve and shall be finely ground particles of limestone, hydrated lime, Portland cement or other approved non-plastic materials when tested in accordance with ASTM D4318.
- .8 The moisture content of the aggregate after leaving the drier and before mixing shall not be more than 0.5% by weight.
- .9 The following tests may be required to confirm the gravel source is suitable for use in the production of aggregate for asphaltic concrete:
- (a) Soundness of Aggregates to ASTM C88
- (i) Maximum loss by mass after 5 cycles with MgSO₄
- Coarse aggregate = 15%
 - Fine aggregate = 18%

SECTION 12 - ASPHALTIC CONCRETE PAVING SPECIFICATIONS

- (b) Micro-Deval Abrasion to ASTM D6928 **(REVISED NOVEMBER 2016)**
 - (i) Maximum loss factor = 18% **(REVISED NOVEMBER 2016)**
 - (c) Sand Equivalent to ASTM D2419
 - (i) Minimum = 40
 - (d) Absorption of Aggregate to ASTM C127
 - (i) Maximum absorption by mass = 2%
 - (e) Petrographic Examination to ASTM C295.
10. Additional Requirements for Superpave Aggregates: **(REVISED NOVEMBER 2016)**
- (a) Aggregates for Superpave mixes shall have properties and the gradation limits as specified below and in accordance with the latest version of the Asphalt Institute's *Superpave Series Publication – Superpave Mix Design (current verison)*. Changes and/or variations from these limits shall be outlined within the Contract Special Provisions. **(REVISED NOVEMBER 2016)**
 - (i) 90% fractured aggregate with a 12.5mm nominal maximum size, including sufficient manufactured fines to provide fine aggregate angularity. **(REVISED NOVEMBER 2016)**
 - (ii) The aggregates must meet all the requirements for angularity, toughness deleterious materials, clay content, and flat and elongated particles. **(REVISED NOVEMBER 2016)**
 - (iii) Design ESAL's will be 10 – 30 million. **(REVISED NOVEMBER 2016)**

12.24 ASPHALT CEMENT

- .1 Performance grade 64-22 or penetration grade 80–100 asphalt cement shall be in accordance with MOTI SS 952. Asphalt cement shall be prepared from the refining of petroleum oils and be homogenous, free from water and shall not foam when heated to 175°C. Vacuum Tower Asphalt Extender (VTAE) shall not be incorporated into the binder. **(REVISED NOVEMBER 2016)**
- .2 The Contractor shall inform the Engineer of the name of his asphalt supplier and shall ensure that each load of asphalt is accompanied with a flow sheet showing compliance with the preceding requirements. Such flow sheets shall be submitted to the Engineer.

SECTION 12 - ASPHALTIC CONCRETE PAVING SPECIFICATIONS

12.25 ASPHALTIC CONCRETE MIX DESIGN CRITERIA

.1 Marshall Mixes: **(REVISED NOVEMBER 2016)**

- (a) The asphalt mix design for pavements shall be carried out under Marshall design criteria using the designated equipment and procedures as contained in the Asphalt Institute's *Mix Design Methods for Asphalt Concrete MS-2*, latest edition. **(REVISED NOVEMBER 2016)**
- (b) If requested by the Engineer, the Contractor shall supply an asphaltic concrete mix design conforming to the following specifications as based on the Marshall method of design (Asphalt Institute Manual series No. 2 (MS-2) for approval: **(REVISED NOVEMBER 2016)**

	<u>Local</u>	<u>Collector</u>	<u>Arterial</u>	<u>Special Mixes</u>
(a) Number of blows each face of test specimen	75	75	75	50
(b) Minimum % voids in mineral aggregate (VMA), based on Bulk SG				
25 mm Aggregate	-	-	-	-
19 mm Aggregate	13	13	13	13
12 mm Aggregate	14	14	14	14
10 mm Aggregate	16	16	16	16
(c) % air voids in compacted mixture, surface and lower course	3-5	3-5	3-5	3-5
(d) Minimum modified Marshall load, N @ 60°C	5000	7000	7000	4500
(e) Flow index, (mm)	2-4	2-4	2-4	2-4
(f) Minimum asphalt film thickness (µm)	8	8	8	
(g) Minimum index of retained stability after immersion in water @ 60°C for 24 hours	75%	75%	75%	75%
(h) Asphalt content in the mix shall be as specified in the mix design ±0.3%				

(REVISED NOVEMBER 2016)

SECTION 12 - ASPHALTIC CONCRETE PAVING SPECIFICATIONS

.2 Superpave Mixes: **(REVISED NOVEMBER 2016)**

- (a) The Superpave asphalt mix design shall be carried out in accordance with the latest edition of the Asphalt Institute's Superpave Mix Design, Superpave Series No. 2 (current version) and these Standard Specifications. **(REVISED NOVEMBER 2016)**
- (b) If requested by the Engineer, the Contractor shall supply an asphaltic concrete mix design conforming to the following specification for approval: **(REVISED NOVEMBER 2016)**

CRITERIA PROPERTY OF LABORATORY COMPACTED PAVING MIXTURE For Design ESAL's = 10 – 30 million, at N _{Design} = 100 gyrations	SUPERPAVE nominal 12.5mm
% voids in the Mineral Aggregate, minimum	14
Required density: % of Theoretical Maximum Specific Gravity in a laboratory compacted mix: <ul style="list-style-type: none"> • at N_{max} = 160 gyrations • at N_{Design} = 100 gyrations • at N_{Initial} = 8 gyrations 	98 maximum 95–97 89 maximum
% voids filled with Asphalt Cement	65-75
Dust to Binder ratio ¹	0.6-1.2

(REVISED NOVEMBER 2016)

.3 Reclaimed Asphalt Product (RAP):

- (a) The maximum RAP allowed in the asphalt mix shall be determined by the contribution of the RAP Asphalt Cement (AC) towards the total AC content in the mix by weight as per the percentages shall be 15%. Contractor shall notify the City Representative, 14 days in advance of Paving if RAP will be used in the project. **(REVISED NOVEMBER 2016)**
- (b) The amount of total AC replaced by the AC in the RAP will be calculated as follows:

$$\% \text{ AC Replacement} = (axb)/c$$

Where:

a = AC content of RAP

b = RAP percent in mixture by total weight of mix

c = Total percent AC content in mixture

(REVISED NOVEMBER 2016)

12.26 JOB MIX AND PLANT CALIBRATION

- .1 If requested by the Engineer, a job mix formula shall be provided by the Contractor and shall contain the following information:
 - (a) Sieve analysis of combined aggregate in mix.
 - (b) Aggregate size range in each bin separation to be used.
 - (c) Weight of aggregate to be used from each bin for one batch of mix.

¹ Consideration shall be given to increasing the dust to binder ratio to 0.8 – 1.6

SECTION 12 - ASPHALTIC CONCRETE PAVING SPECIFICATIONS

- (d) Weight of asphalt cement to be used for one batch of mix.
 - (e) Optimum mixing and compacting temperatures.
- .2 If requested by the Engineer, a plant calibration for continuous mix plants shall be provided by the Contractor.

12.27 TACK COAT

- .1 Bituminous tack coat shall be Grade SS-1 or SS-1h asphalt emulsion, in accordance with MOTI SS 952 (or the latest AASHTO M140-13 or the latest ASTM D977) or as approved. Manufacturer's laboratory analysis of each tack coat shipment shall be submitted to the Engineer for approval. **(REVISED NOVEMBER 2016)**

SECTION 12 - ASPHALTIC CONCRETE PAVING INSTALLATION

12.40 RESPONSIBILITY FOR ALIGNMENT, GRADE AND BASE

- .1 The contractor shall examine the base, existing surface and tack coat to ensure they conform to the specifications, and the grade and alignment conform to the construction drawings, prior to commencing paving operations. The contractor shall be satisfied that the base is properly prepared for the placement of asphaltic concrete and shall notify the Engineer of any observed deficiencies prior to paving. The contractor's responsibility for pavement failures shall include those caused by base failure, misalignment or incorrect grade.
- .2 Prior to delivery of the asphaltic concrete to the job site, the prepared base shall be cleaned of all loose or foreign material.

12.41 TRAFFIC CONTROL

- .1 The Contractor shall be responsible for traffic control during all operations in accordance with Sections 3.61 – Control of Public Traffic – General, Section 3.62 – Use of Flagperson and Section 3.63 – Use of Traffic Control Devices
- .2 Traffic shall not be permitted on the finished pavement until it has cooled to atmospheric temperature.

12.42 CUTTING AND REMOVAL OF EXISTING PAVEMENT

- .1 The Contractor shall cut, remove and dispose of existing pavement as directed by the Engineer. Pavement cutting shall be in accordance with Section 4.29 – Final Cutting Paved Surfaces.

12.43 ADJUSTMENT OF SERVICES

- .1 The Contractor shall adjust manholes, catchbasins, valves, etc. to the proper finished grade at least 48 hours prior to paving in accordance with Section 6.53 - Frames and Covers and Section 6.54 – Manhole Steps.

12.44 TESTING

- .1 The Engineer will arrange for a testing firm to carry out tests to determine whether the applicable standards and specifications have been met. Where initial testing indicates non-compliance with the specifications, additional testing shall be required at the Contractor's expense.
- .2 The Contractor as directed by the Engineer shall supply specimens or samples for testing.
- .3 The test programs listed below are the minimum testing requirements. The Engineer shall determine if additional testing is required.
 - (a) Aggregates:
 - (i) One aggregate gradation test shall be carried out either for each 300 tonnes of production or a minimum of once per day (ASTM C136 and ASTM C117).
(REVISED NOVEMBER 2016)

SECTION 12 - ASPHALTIC CONCRETE PAVING INSTALLATION

(ii) Additional testing as outlined in Section 12.23 as required by the Engineer.

(b) Asphaltic Concrete:

One Marshall test consisting of three briquettes for every three hundred tonnes of production, or a minimum of one test per day shall be performed to determine the following: **(REVISED NOVEMBER 2016)**

- (i) Marshall stability
- (ii) Specific gravity
- (iii) Air voids and voids in mineral aggregate (VMA)
- (iv) Flow index
- (v) Asphalt content extraction
- (vi) Gradation of Asphalt aggregate

Testing shall use the 75 Blow Marshall test method. The 50 Blow Marshall test method may be used for walkways, sidewalks, driveways or other City Engineer approved locations.

(c) Compaction:

- (i) Upon completion of the asphalt paving operation, one core from each 400 m² of pavement with a minimum of three (3) cores shall be obtained at locations determined by the Engineer for the purpose of determining the asphaltic concrete density in accordance with ASTM D2726, and the asphaltic concrete thickness. **(REVISED NOVEMBER 2016)**
- (ii) Final compaction results shall be expressed as a percentage compacted density which is defined as follows:

$$\text{Percentage compacted density} = \frac{\text{Density of sample}}{\text{Marshall density}} \times 100$$

- (iii) Test result data will be subjected to statistical analysis and the final compaction shall not be considered satisfactory unless the mean and the standard deviation of the test result data is in accordance with Section 12.51 - Asphaltic Concrete Acceptance Requirements.

(d) Other testing as may be required to confirm conformance of materials and workmanship to the specifications.

.4 The test programs outlined above are minimum requirements and may be modified by the Engineer. Full testing may be required during the first few days of paving to determine quality control and construction procedures. As paving progresses sufficient tests to maintain uniformity will be required.

.5 Inspection and testing by the Engineer shall not relieve the contractor of his responsibility for quality control.

SECTION 12 - ASPHALTIC CONCRETE PAVING INSTALLATION

- .6 Asphaltic concrete found to be in non-compliance with the specifications shall be repaired or replaced by the contractor at no additional cost to the Owner in accordance with Section 2.03 – Materials and Workmanship, Article 26 – Testing, Rejected Work and Materials and Article 27 – Owner’s Right to Correct Deficiencies. The contractor shall submit to the Engineer for approval, the proposed method to correct the noted deficiencies and work schedule, prior to commencing the work.

12.45 TACK COAT

- .1 The existing asphaltic concrete surface shall be thoroughly cleaned by a power-driven sweeper immediately prior to applying the tack coat.
- .2 Tack coat shall be applied to all existing asphaltic concrete which is to be overlaid. Tack coat shall be applied to the edge of existing asphaltic concrete, curbs and structures where these surfaces will be in contact with the new asphaltic concrete pavement.
- .3 Tack coat shall be applied only when the surface is dry and clean, and the air temperature is over 10°C.
- .4 Tack coat shall not be diluted unless directed by the Engineer.
- .5 Tack coat shall be uniformly applied with an approved pressure distributor at a rate of 0.25 litres per square metre. The temperature of the material shall be maintained between 32°C and 38°C.
- .6 Traffic shall, where possible, be kept off tack coat areas. Where traffic has been allowed on the tack coat, these areas shall be thoroughly cleaned by a power-driven sweeper immediately prior to laying asphaltic concrete.
- .7 No hot mix shall be placed upon the tack coat until it has dried to a proper condition of tackiness, as determined by the Engineer.
- .8 Tack coat shall be placed only on the area being paved. Work shall be planned so that no more tack coat than is necessary for the days operation is placed on the surface.
- .9 Any damage to persons, vehicles or private property during the application and curing of the tack coat is the Contractor’s responsibility.

12.46 TRANSPORTATION OF HOT PLANT MIX

- .1 Trucks used for the transport of hot mix shall be equipped with tarpaulins and, where required, with insulated boxes. Trucks shall not leak fuel, lubrication oils or hydraulic oil.
- .2 Inside surfaces of truck boxes shall be free of all deleterious materials and lubricated with suitable thin soap, but excessive use of lubricant will not be permitted.
- .3 The mixture shall be transported from the paving plant to the job site utilizing City of Nanaimo designated truck routes where possible, and shall use local streets only to obtain local access.

SECTION 12 - ASPHALTIC CONCRETE PAVING INSTALLATION

- .4 Loads shall be delivered continuously in covered trucks to provide a uniform, non-stop paving operation.
- .5 Delivery of the mix shall be scheduled to permit completion of the paving operation in daylight hours unless otherwise approved by the Engineer.

12.47 PLACEMENT

- .1 Surfaces onto which asphaltic concrete pavement is placed shall be dry, above 5°C, and cleaned of all loose and foreign materials. Mixtures shall normally not be laid when the atmospheric temperature is less than 5°C and falling.
 - (a) Bottom lift shall be placed onto surfaces above 5°C and rising.
 - (b) Top lift shall be placed onto surfaces above 10° C and rising.
- .2 The mixture at time of placing shall be not less than 120°C or greater than 160°C or as required by the mix design and requires approval by the City Engineer.
- .3 An approved, self-propelled mechanical paver shall be used to spread the mixture to the specified thickness. The paver speed shall be adjusted to correspond to the rate of delivery to provide a uniform, non-stop paving operation.
- .4 The Contractor may use such methods as approved by the Engineer in narrow areas, irregular sections, intersections, turnouts or driveways, where it is impractical to spread with a paver.
- .5 Minor inequalities in spreading and shaping the paved surface adjacent to existing structures such as manholes, catchbasins or valves shall be performed to a condition satisfactory to the City Engineer.

12.48 COMPACTION

- .1 Equipment:
 - (a) Unless otherwise directed by the Engineer, the Contractor shall furnish a minimum of two (2) self-propelled rollers to roll and compact the asphaltic concrete mixture. All rollers shall be in good condition and capable of reversing without backlash.

SECTION 12 - ASPHALTIC CONCRETE PAVING INSTALLATION

.2 General:

- (a) Compaction shall commence immediately after the bearing capacity of the asphalt mat is adequate to support compaction equipment without undesirable displacement or cracking.
- (b) Maximum speed for initial rolling shall not exceed 5 km/hr, and subsequent rolling, 8 km/hr. Speeds shall be maintained at all times such that displacement of asphaltic concrete does not occur. **(REVISED NOVEMBER 2016)**
- (c) During the rolling operation, roller wheels shall be kept moist with only enough water to avoid picking up material. Fuel oil, lubricating oil, or kerosene shall not be permitted as lubricants for the surface of the roller wheels.
- (d) The line of rolling shall not be suddenly changed nor the direction of rolling suddenly reversed. Pronounced changes in direction shall be made on stable material.
- (e) Heavy equipment including rollers shall not be permitted to stand on the finished surface.
- (f) Where rolling causes displacement of material, loosen affected areas immediately with lutes or shovels and restore to original grade of loose material before re-rolling.
- (g) Should the testing results or the Contractor's quality control indicate compaction requirements are not being met, the Contractor shall immediately modify his compaction procedure to satisfy the compaction requirements.

.3 Breakdown Rolling:

Breakdown rolling shall immediately follow the rolling of transverse and longitudinal joint and edges. Rollers shall be operated as close to the paver as necessary to obtain adequate density without causing undue displacement. Initial rolling shall be performed by steel wheel rollers with the drive roll or wheel forward in the direction of paving. Rolling shall commence on the low side of the mat and progress to the high side.

.4 Secondary Rolling:

Secondary rolling shall follow the initial rolling as closely as possible, and shall be continuous until the mix has been thoroughly compacted. **(REVISED NOVEMBER 2016)**

.5 Finish Rolling:

Finish rolling shall be by steel wheel roller to remove all marks left by pneumatic rolling. Finish rolling shall be accomplished with the minimum number of passes required to produce a satisfactory surface.

12.49 JOINTS

.1 General:

- (a) All transverse and longitudinal joints shall be painted with a thin tack coat immediately prior to paving. Application of tack coat to longitudinal joints may be omitted if the previously laid pavement has not cooled to less than 50°C.
- (b) Transverse joints in succeeding courses shall be offset a minimum of 600mm. In adjacent lanes they shall be offset a minimum of 3.0m.
- (c) Longitudinal joints in succeeding courses shall be offset 150 - 200mm.

SECTION 12 - ASPHALTIC CONCRETE PAVING INSTALLATION

(d) Wherever possible, longitudinal joints shall be offset 100mm from future traffic markings (paint lines).

.2 Transverse Joints:

Transverse joints shall have a vertical face and shall be carefully constructed and thoroughly compacted to provide a smooth riding surface over the joint. Horizontal alignment of joints shall be straight-edged to ensure smoothness. Rolling of transverse joints shall be performed immediately after raking is completed.

.3 Longitudinal Joints:

Longitudinal joints shall have a vertical face and shall be rolled directly behind the paving operation. Joints shall be rolled by passing the roller on the previously compacted lane letting one wheel project 100mm to 150mm on the new lane. A minimum of 2 passes shall be required to thoroughly compact this narrow strip down to and even with the existing lane.

.4 Edges:

Pavement edges shall be rolled concurrently with the longitudinal joints and shall not be exposed more than 15 minutes before rolling. After longitudinal joints and edges have been compacted, longitudinal rolling shall start at the edge and progress to the centre of the pavement, overlapping at least one-half the width of the roller with each successive pass. On super-elevated curves, rolling shall begin on the low side and progress to the high side.

12.50 CLEANING

.1 The contractor shall thoroughly remove from all culverts, catchbasins, curbs, gutters and other structures such contamination by asphaltic or other materials as may have occurred during the performance of the work.

12.51 ASPHALTIC CONCRETE ACCEPTANCE REQUIREMENTS

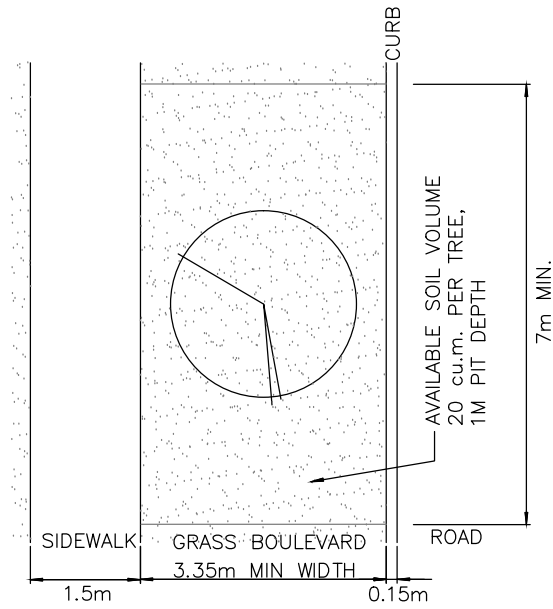
.1 The finished grade surface shall be free from bumps, depressions or other irregularities and shall be within 6mm of the design grade and cross-section, but not uniformly high or low, when measured with a 3.0m straight edge in any direction.

.2 The finished elevation of the compacted asphaltic concrete shall be 0 - 6mm above the finish elevation of structures, including but not limited to curbs, gutters, manhole lids, catch basins, valve boxes and survey monuments.

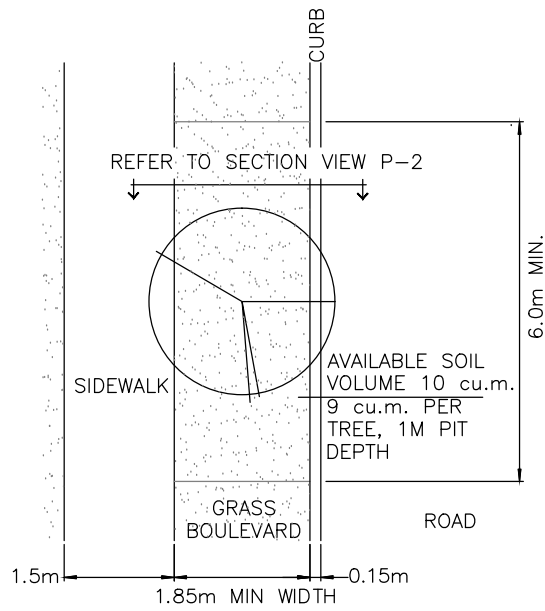
.3 The finished surface of the asphaltic concrete shall be homogenous, free from segregation and consistently uniform in surface texture.

.4 Asphaltic concrete shall be compacted to 97% mean compacted density when tested in accordance with Section 12.44 - Testing. Maximum acceptable standard deviation of test data shall be 1.5%, with no individual test results less than 95% compacted density.

.5 Asphaltic concrete thickness, as measured in accordance with ASTM D3549, shall not be less than the specified thickness for all test cores.



TREE PLANTING WITH 20cu.m ROOT ZONE
PLAN VIEW



TREE PLANTING WITH 10 cu.M ROOT ZONE
PLAN VIEW

NOTES:

1. REFER TO SPECIFICATIONS CLAUSE 14.06 FOR STREET TREE SPACING, LOCATION, AND SIZE.

TENTATIVE/INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS/ISSUES SECTION NOT FINAL DRAFT/FINAL DRAFT STANDARD CAD DRAWING/SECTION 14 DWGSP-2

APPROVED TREE SPECIES
AS PER PLANTING PLAN
PRUNE FOR CLEARANCE AND FOR
TREE HEALTH AS PER SECTION 14.0

NOTE: PLANT TREE WITH NURSERY SOIL LINE
AT 50mm ABOVE FINISH GRADE. FORM
50mm DEEP SAUCER AT BASE OF TREE.

75mm DEPTH BARK MULCH TO
600mm RADIUS AT TREE.

SOD ON 150mm DEPTH TOPSOIL
AS PER SPECIFICATION.

150mm MIN. DEPTH "A HORIZON"
AMENDED TOPSOIL PER SPECIFICATIONS.

PROVIDE 12mm FREEBOARD
BETWEEN FINISHED GRADE AND
ADJACENT PAVED SURFACES.

300mm MIN DEPTH IRRIGATION
TRENCH

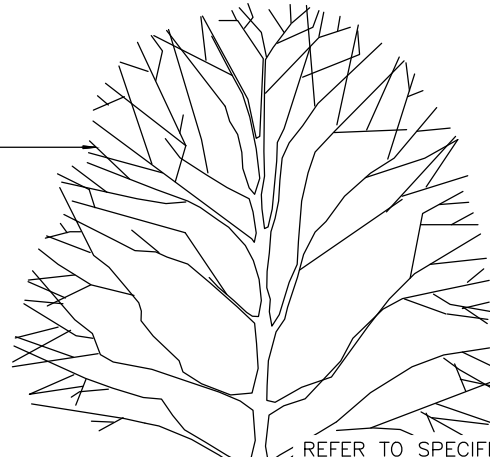
UNTIE AND REMOVE TOP 1/3 OF BURLAP
FROM ROOTBALL.
NOTE: BALLED AND BURLAP TREE IS
ILLUSTRATED. IF CONTAINER OR BAG
GROWN TREES ARE USED, COMPLETELY
REMOVE IMPERISHABLE CONTAINERS.

SUBSOIL (REFER TO CLAUSE 14.17
OF SPECIFICATIONS).

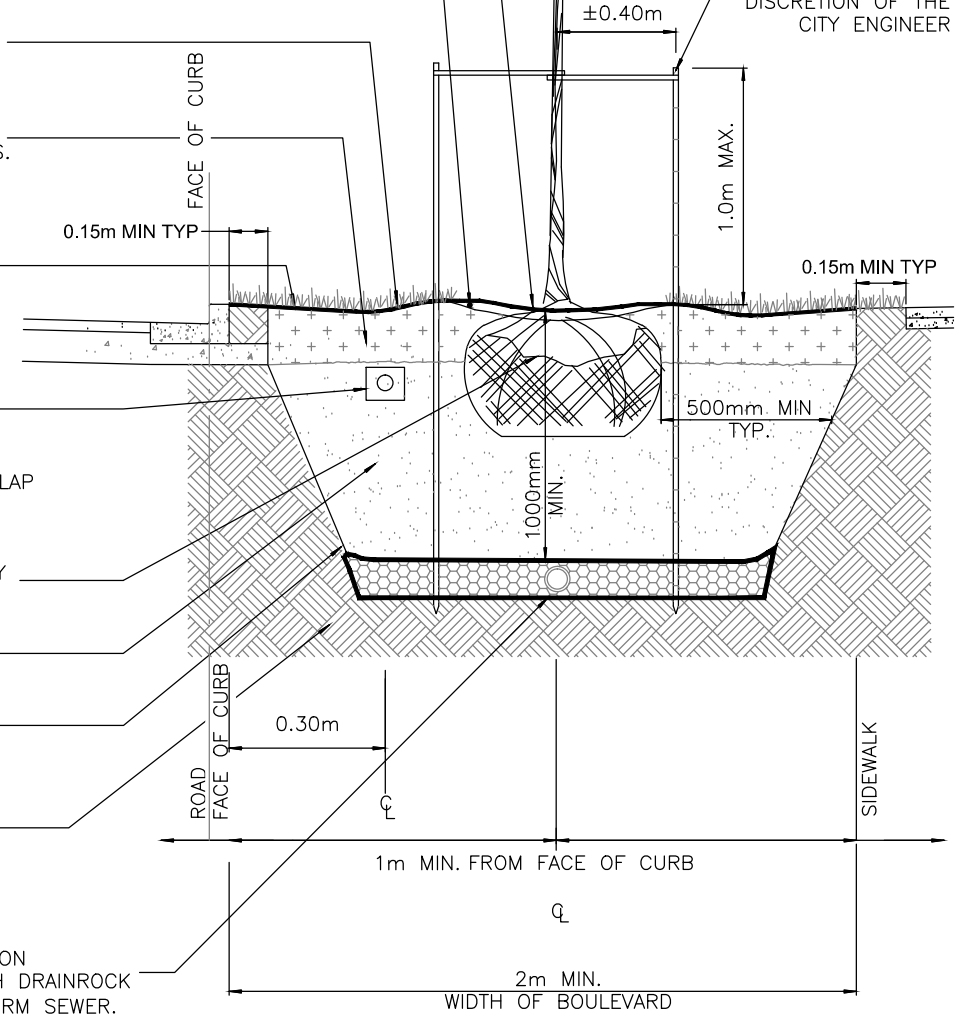
ROUGHEN PIT BOTTOM AND SIDES
TO REMOVE GLAZING.

UNDISTURBED NATIVE SOILS OR
COMPACTED SUBGRADE.

AS PER THE CITY ENGINEERS DIRECTION
INSTALL PVC DRAIN IN 150mm DEPTH DRAINROCK
C/W FILTERCLOTH AND DRAIN TO STORM SEWER.



REFER TO SPECIFICATION CLAUSE
14.30.1 AND 14.59 FOR STAKING
MATERIALS AND INSTALLATION.
STAKING SHALL BE
DONE AT THE
DISCRETION OF THE
CITY ENGINEER



CITY OF NANAIMO
THE HARBOUR CITY



TREE PLANTING IN GRASS
BOULEVARD OR MEDIAN

Scale: N.T.S.
Created: MAY 2013
Rev Date: NOV 2016
Dwg No: P-2

REMOVE DEAD, DAMAGED
OR WEAK GROWTH

FORM WATERING BASIN AT SHRUB BASE.
NOTE: ENSURE THE SOIL LEVEL DOES
NOT EXCEED THE ORIGINAL NURSERY
SOIL LINE AND THAT ROOTS ARE
COMPLETELY COVERED IN SOIL.

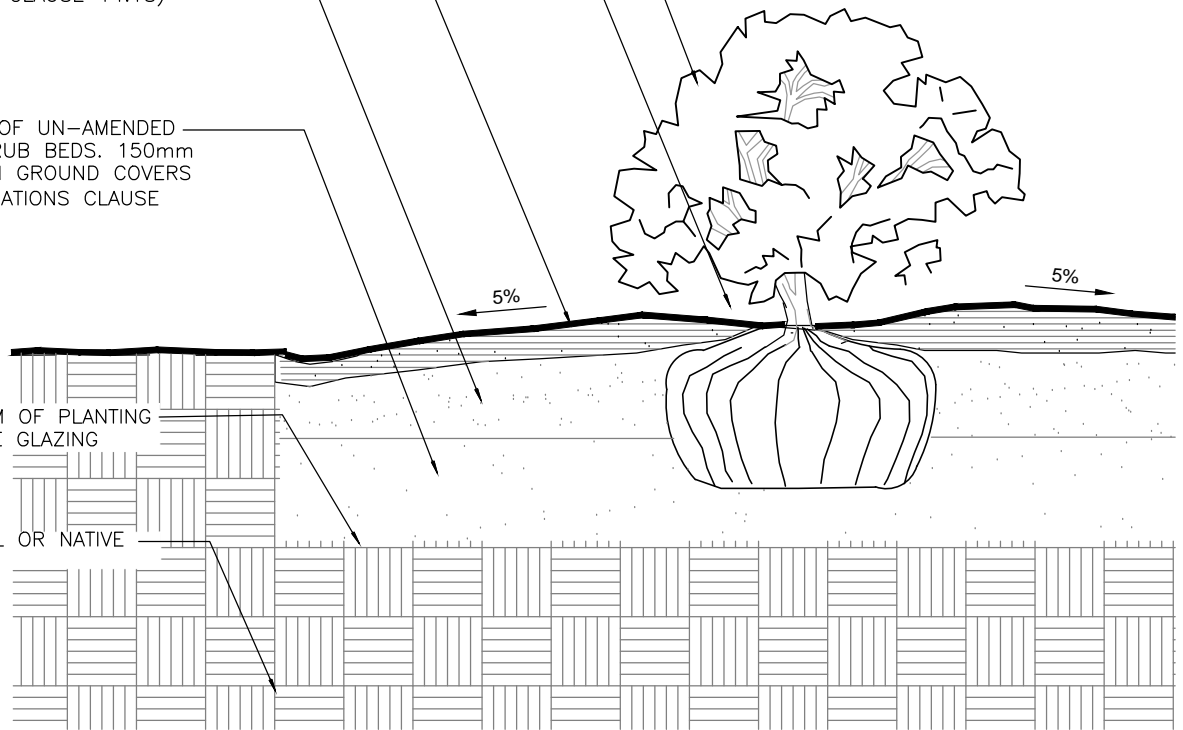
50mm DEPTH BARK MULCH.

150mm LAYER OF 'A HORIZON' SOIL MIX.
(SPECIFICATIONS CLAUSE 14.18)

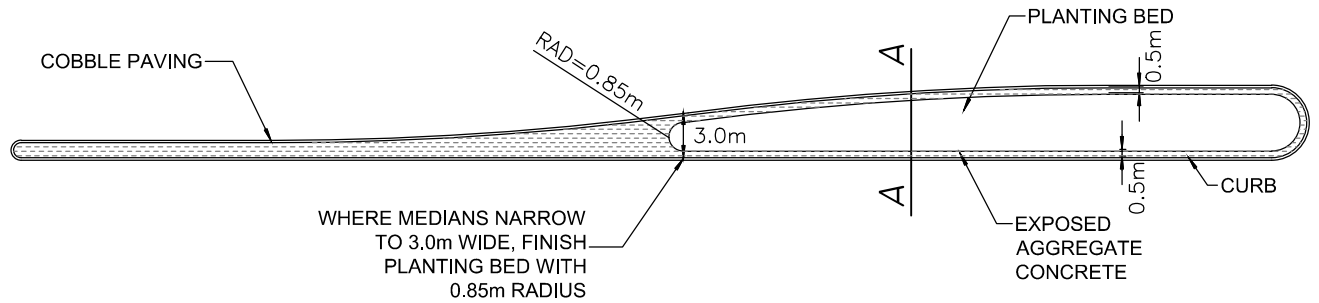
300mm LAYER OF UN-AMENDED
TOPSOIL IN SHRUB BEDS. 150mm
LAYER DEPTH IN GROUND COVERS
BEDS. (SPECIFICATIONS CLAUSE
14.16)

SCARIFY BOTTOM OF PLANTING
BED TO REMOVE GLAZING

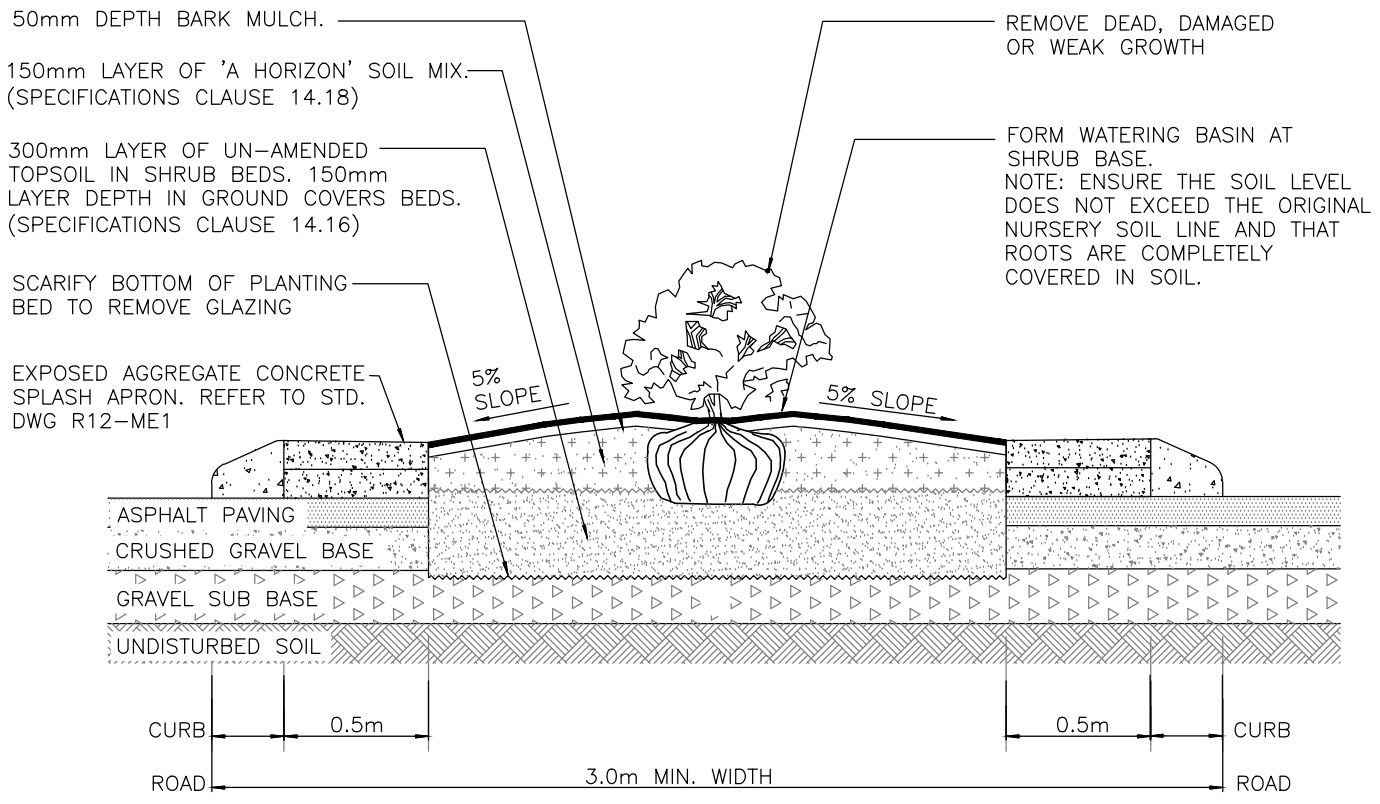
COMPACTED FILL OR NATIVE
MATERIAL



TENTATIVE INFRASTRUCTURE PLANNING STANDARDS & PRODUCTS / W05SEDITION NOT FINAL DRAFT STANDARD CAD DRAWINGS SECTION 14 DWGSP-4



PLAN VIEW



SECTION VIEW A

- NOTES:
1. MEDIANS NARROWER THAN 3m FROM CURB FACE TO CURB FACE SHALL BE EXPOSED AGGREGATE CONCRETE. REFER TO SECTION 9.0, STANDARD. DRAWING R12-ME1
 2. INSTALLATION OF THE EXPOSED AGGREGATE CONCRETE SHALL BE COMPLETED UNDER THE BEST PRACTICES TO ENSURE THE WASH-OFF EFFLUENT DOES NOT ENTER THE STORMWATER MANAGEMENT SYSTEM.
 3. FOR CONCRETE DETAILS SEE SECTION 8 - CURBS & SIDEWALKS.



SHRUB PLANTING IN MEDIAN

Scale: N.T.S.
 Created: MAY 2013
 Rev Date: NOV 2016
 Dwg No: P-4

APPROVED TREE SPECIES
AS PER SECTION.
PRUNE FOR CLEARANCE (REFER TO
SECTION) AND FOR TREE HEALTH
(CLAUSE 14.62).

NOTE: PLANT TREE WITH NURSERY
SOIL LINE AT 50mm ABOVE FINISH
GRADE. FORM 50mm DEEP EARTH
SAUCER AT BASE OF TREE.
75mm DEPTH OF BARK MULCH.

PREPARE ROOTBALL
PER CLAUSE 14.59.5

CONCRETE SIDEWALK
BASE

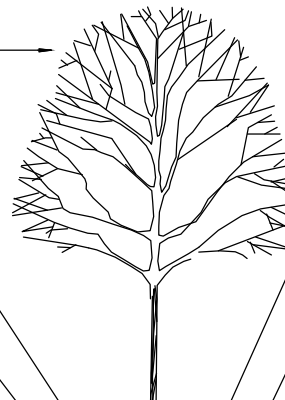
150mm DEPTH "A HORIZON"
AMENDED TOPSOIL PER
CLAUSE 14.18

SUBSOIL (REFER TO CLAUSE
14.7 OF SPECIFICATIONS).

ROUGHEN PIT BOTTOM AND
SIDE TO REMOVE GLAZING.

UNDISTURBED NATIVE SOILS
OR COMPACTED SUBGRADE.

AS PER THE CITY ENGINEERS DIRECTION
INSTALL PVC DRAIN IN 150mm DEPTH DRAIN ROCK
C/W FILTER CLOTH AND DRAIN TO STORM SEWER.



METAL TREEGRATE
REFER TO SECTION 14.30

AIR SPACE, 50mm DEPTH

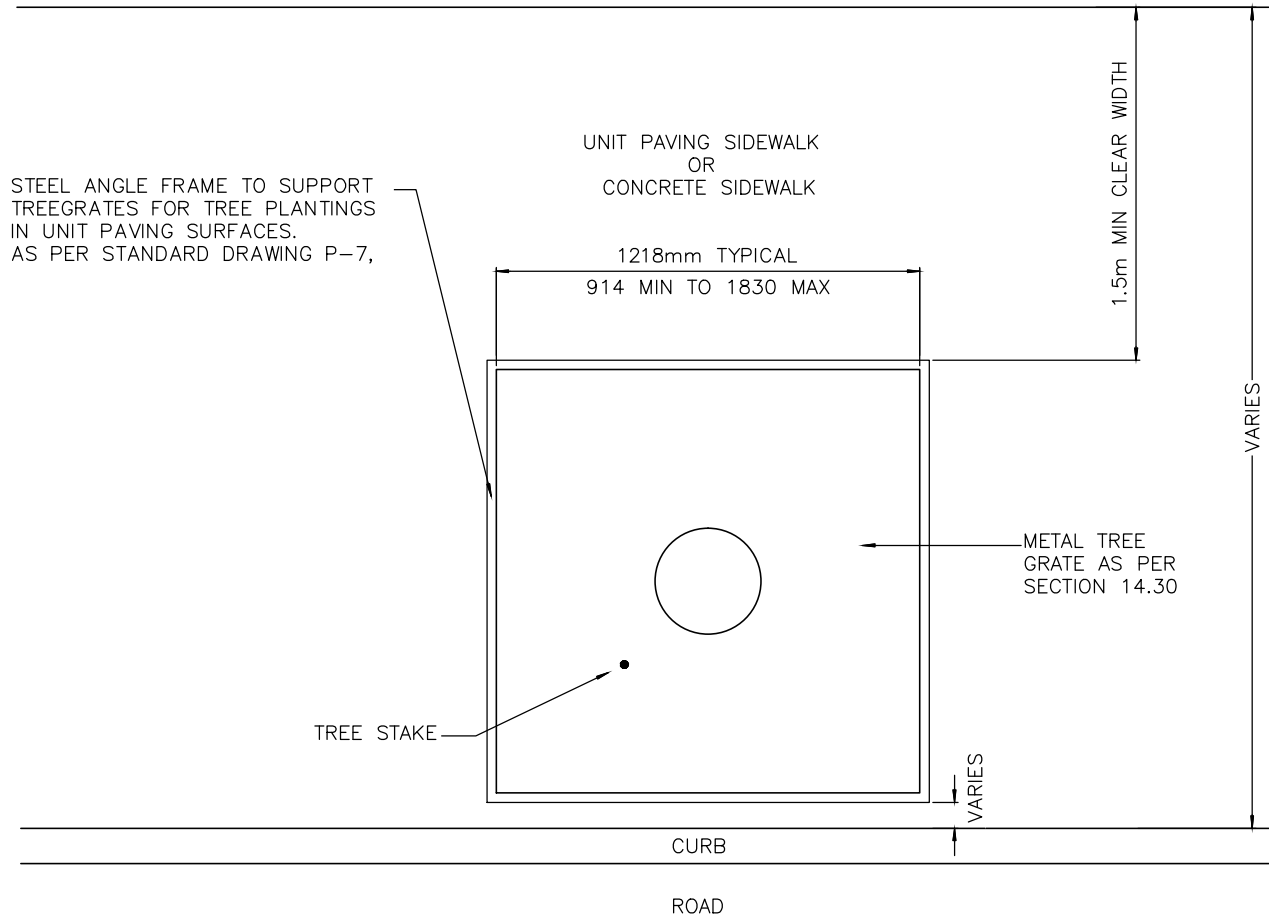
CONCRETE BENCHING FOR METAL
TREE GRATE INSTALLATION.
REFER TO SECTION 14.59.

SIDEWALK
BASE

SECTION VIEW

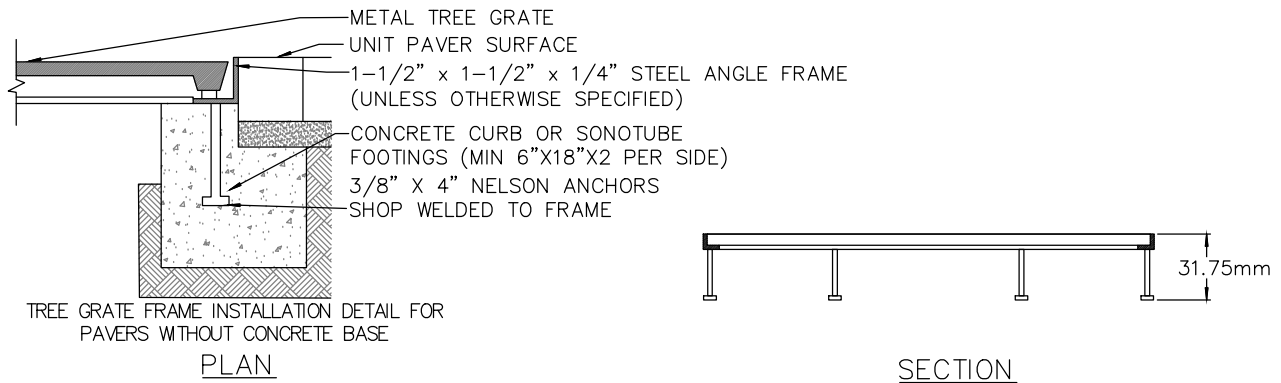
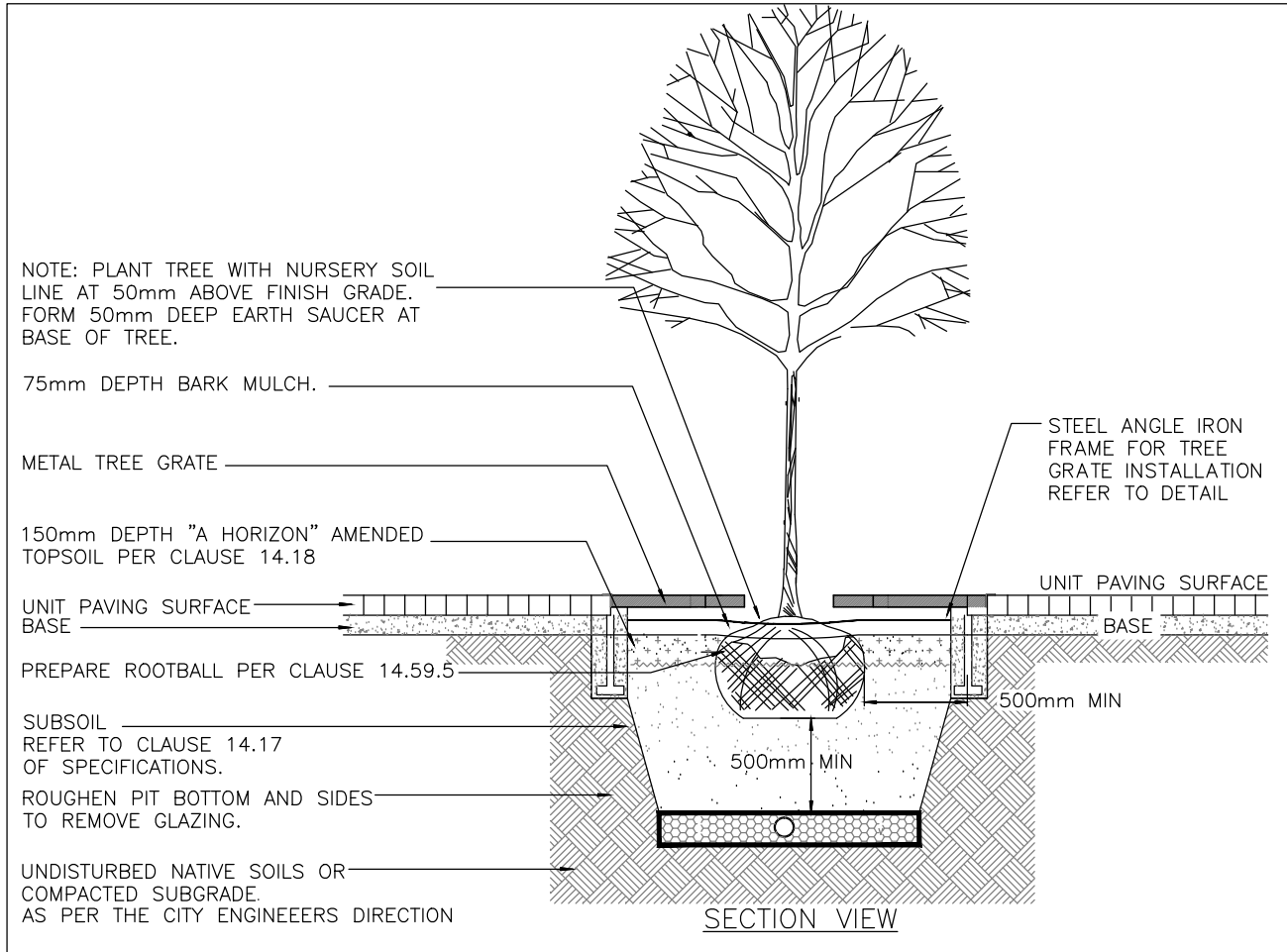
NOTES:

1. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.



NOTE:

1. REFER TO SECTION 14.30 FOR SPECIFICATIONS AND 14.59 FOR INSTALLATIONS.
2. ALLOWABLE TREE GRATE SIZE SHALL BE 1219mm x 1219mm WITH A MINIMUM SIZE OF 914mm AND A MAXIMUM SIZE OF 1830mm.
3. INSTALL TREES TO MINIMIZE CONFLICTS WITH UTILITIES, BUILDING, STRUCTURES, PEDESTRIAN, AND VEHICULAR TRAFFIC.
4. INSTALL TREE STAKES AS PER CITY ENGINEERS DIRECTION. REFER TO SECTIONS 14.30 AND 14.59 FOR MATERIALS AND INSTALLATION SPECIFICATIONS.
5. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

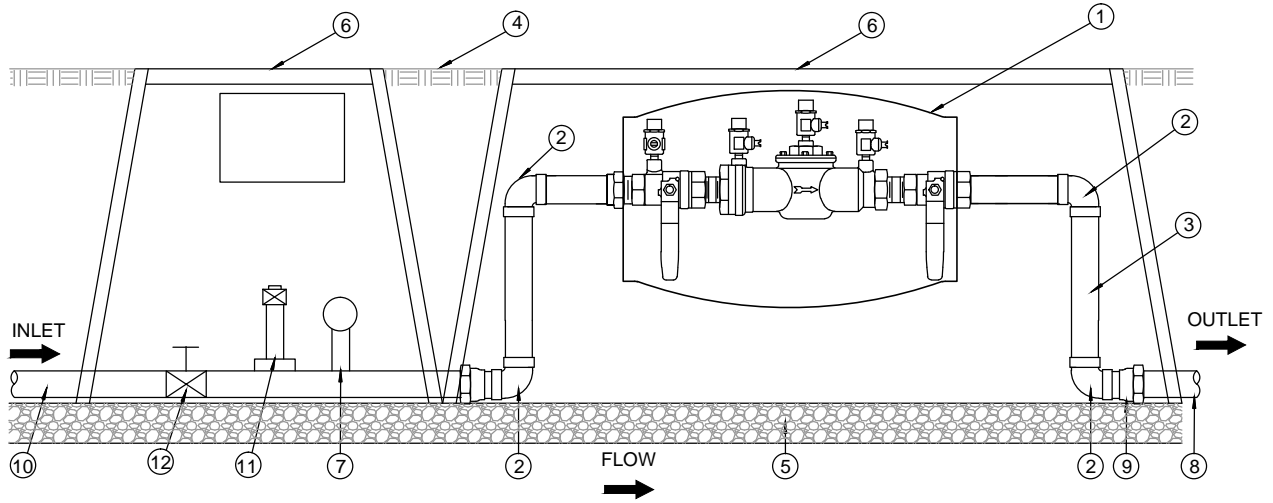


TREE GRATE STEEL ANGLE IRON FRAME DETAIL

NOTE:

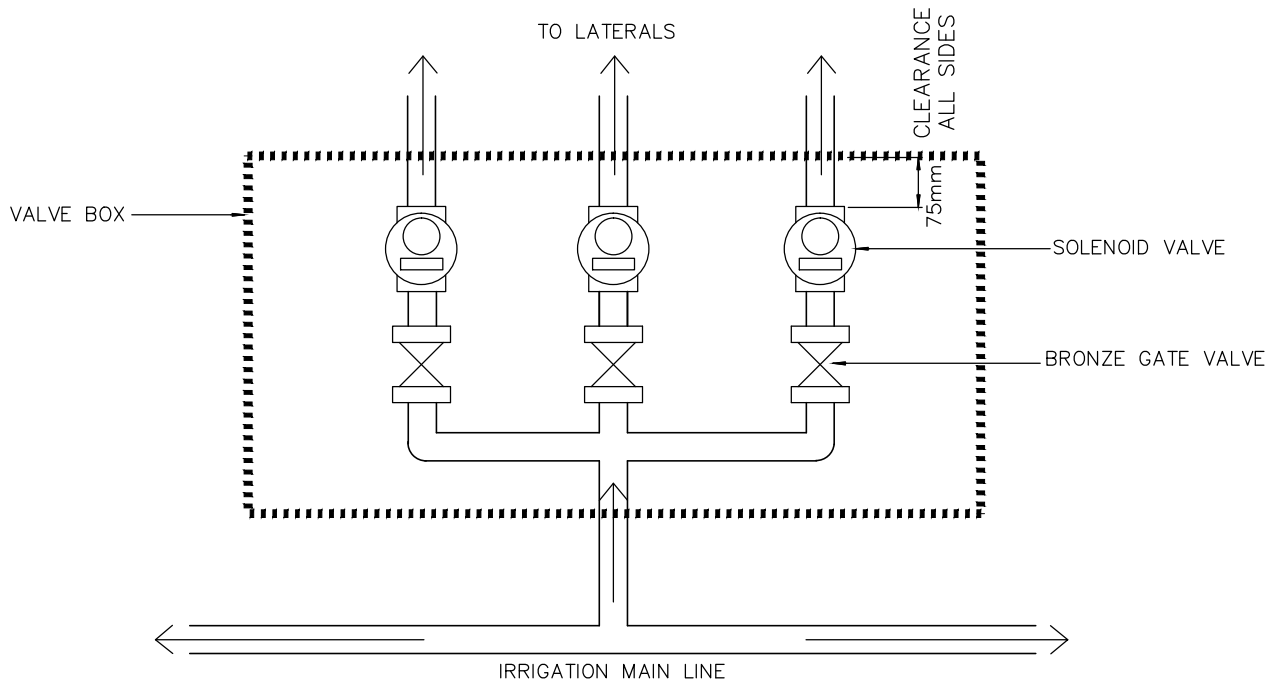
1. AS PER THE CITY ENGINEERS DIRECTION INSTALL PVC DRAIN IN 150mm DEPTH DRAIN ROCK C/W FILTER CLOTH AND DRAIN TO STORM SEWER.
2. PRUNE APPROVED TREE SPECIES FOR CLEARANCE AND FOR TREE HEALTH AS PER SECTION 14.0.
3. TREE GRATE INSTALLATION SHALL BE AS PER THE MANUFACTURERS SPECIFICATION

- | | |
|--|---|
| <ul style="list-style-type: none"> ① DOUBLE CHECK BACKFLOW PREVENTER SIZED ACCORDING TO THE WATER SERVICE ② BRASS 90° ELL (1 OF 4) ③ BRASS NIPPLE ④ FINISH GRADE ⑤ 50mm DEPTH 19mm MINUS GRAVEL ⑥ VALVE BOX C/W BOLTED LID ⑦ LIQUID FILLED PRESSURE GAUGE | <ul style="list-style-type: none"> ⑧ 19mm - 50mmØ SCHEDULE 40 PVC IRRIGATION MAIN (¾"-2"Ø) ⑨ SCHEDULE 40 PVC MALE ADAPTER ⑩ TYPE K ANNEALED COPPER PIPE OR CLASS 200 POLYETHYLENE TUBING FROM CITY OF NANAIMO WATER METER AS PER SECTION 5.30 ⑪ 19mm BRONZE QUICK COUPLER ON RISER ⑫ BRONZE GATE VALVE |
|--|---|



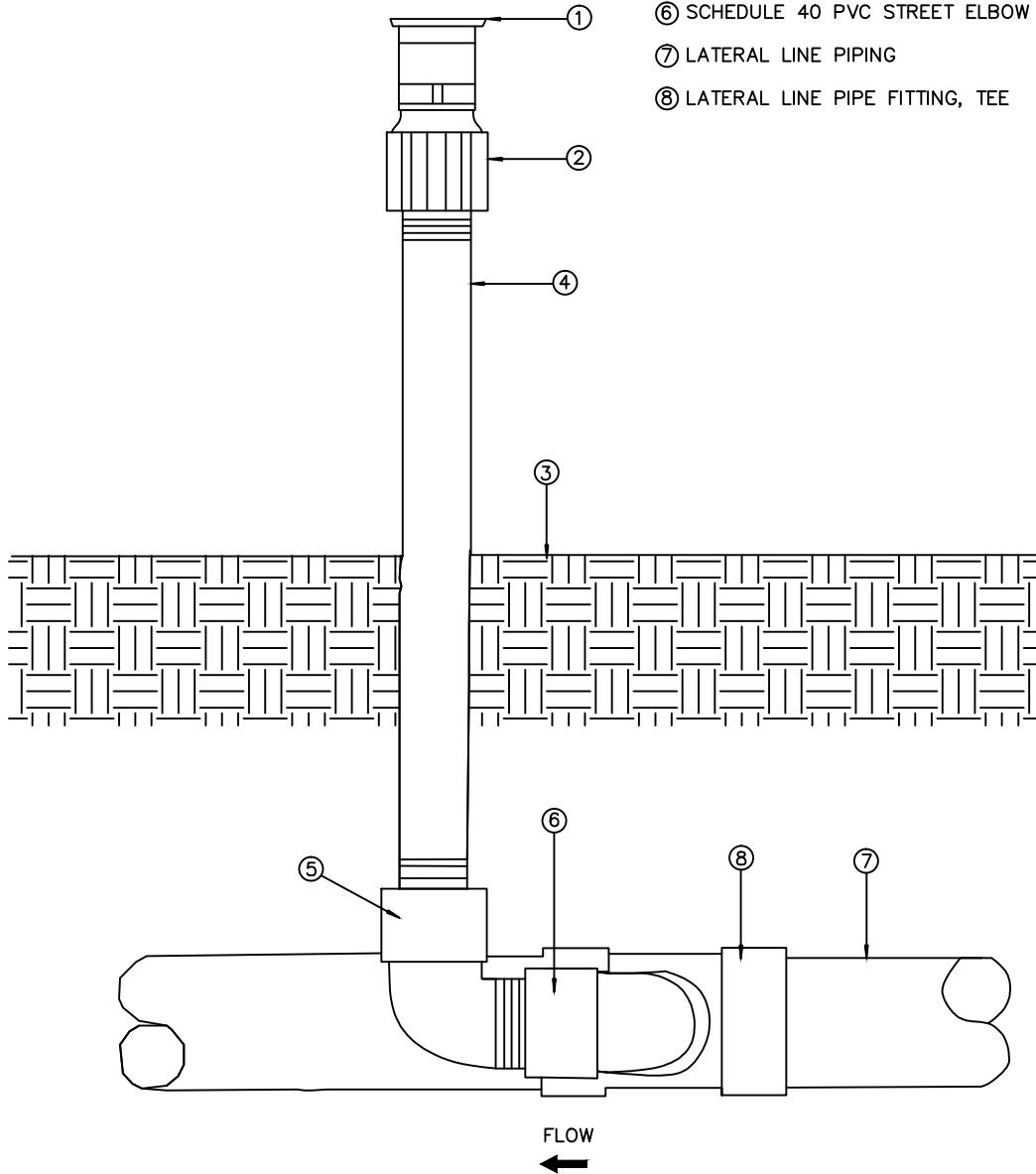
NOTE:

1. SUPPLY CONNECTION FROM MAIN TO WATER METER TO CITY OF NANAIMO ENGINEERING STANDARDS AND SPECIFICATIONS BY CITY FORCES AT OWNERS EXPENSE.
2. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED ON THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
3. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.



\\TENT\EA&PW\INFRASTRUCTURE\PLANNING\STANDARDS & PRODUCTS\MOESS\EDITION NOV1\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 14 DWGS\I-4

- ① SPRAY NOZZLE
- ② SHRUB ADAPTER
- ③ FINISH GRADE
- ④ SCHEDULE 80 PVC NIPPLE, LENGTH TO SUIT, 300mm.
- ⑤ SCHEDULE 40 PVC STREET ELBOW
- ⑥ SCHEDULE 40 PVC STREET ELBOW
- ⑦ LATERAL LINE PIPING
- ⑧ LATERAL LINE PIPE FITTING, TEE



NOTE:

- 1. THREAD SEAL TAPE (PTFE TAPE) ALL THREADED JOINTS
- 2. FOR DESIGN CRITERIA, SPECIFICATION AND INSTALLATION REFER TO SECTION 14.0 WRITTEN SPECIFICATIONS.
- 3. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED ON THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.

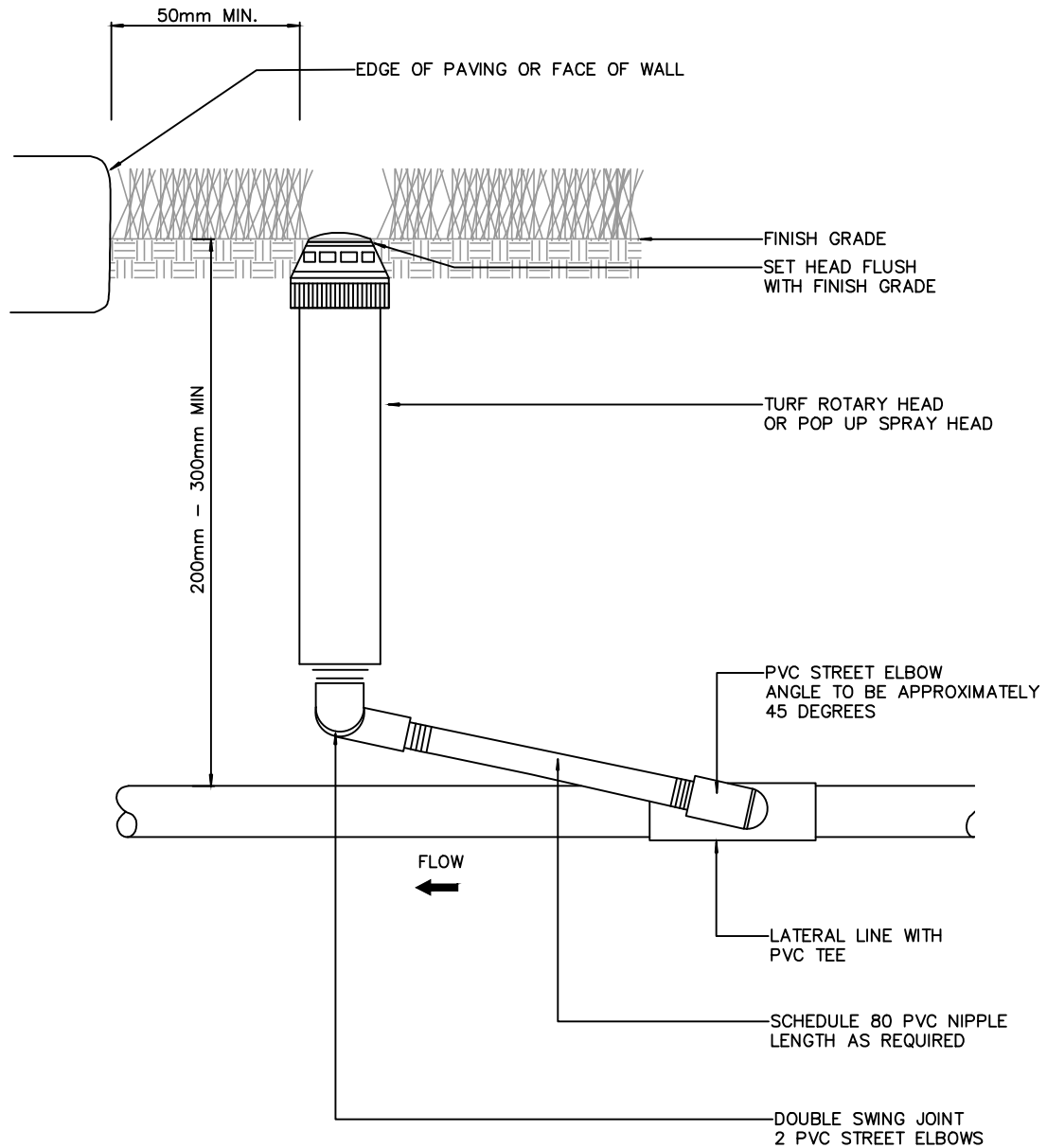
4.27.2016



SHRUB RISER
SPRAY HEAD

Scale: N.T.S.
 Created: SEPT 2012
 Rev Date NOV 2016
 Dwg No: I-4

\\TENT\EPW\INFRASTRUCTURE\PLANNING\STANDARDS & PRODUCTS\MOESS\EDITION NO11\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 14 DWG5-5



NOTES:

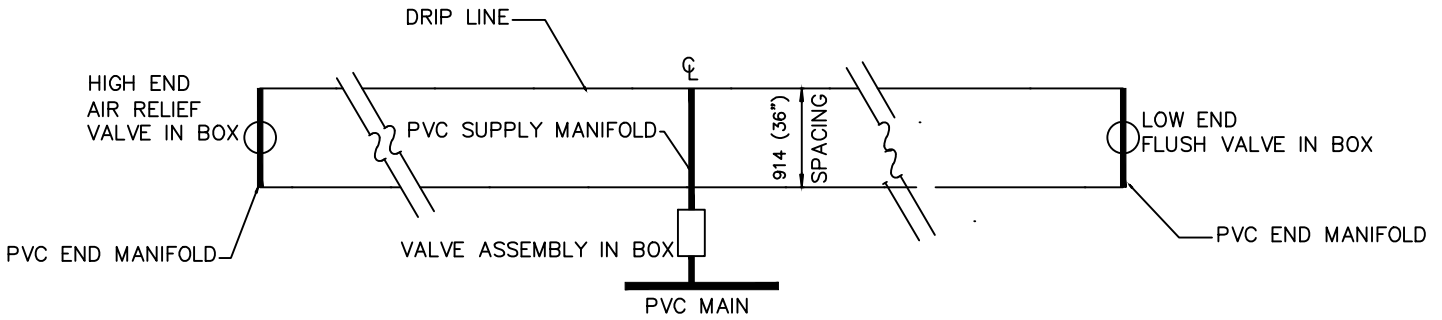
1. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED ON THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
2. FOR DESIGN CRITERIA SPECIFICATIONS AND INSTALLATIONS REFER TO SECTION 14.0 WRITTEN SPECIFICATIONS.
3. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.

6.20.2016

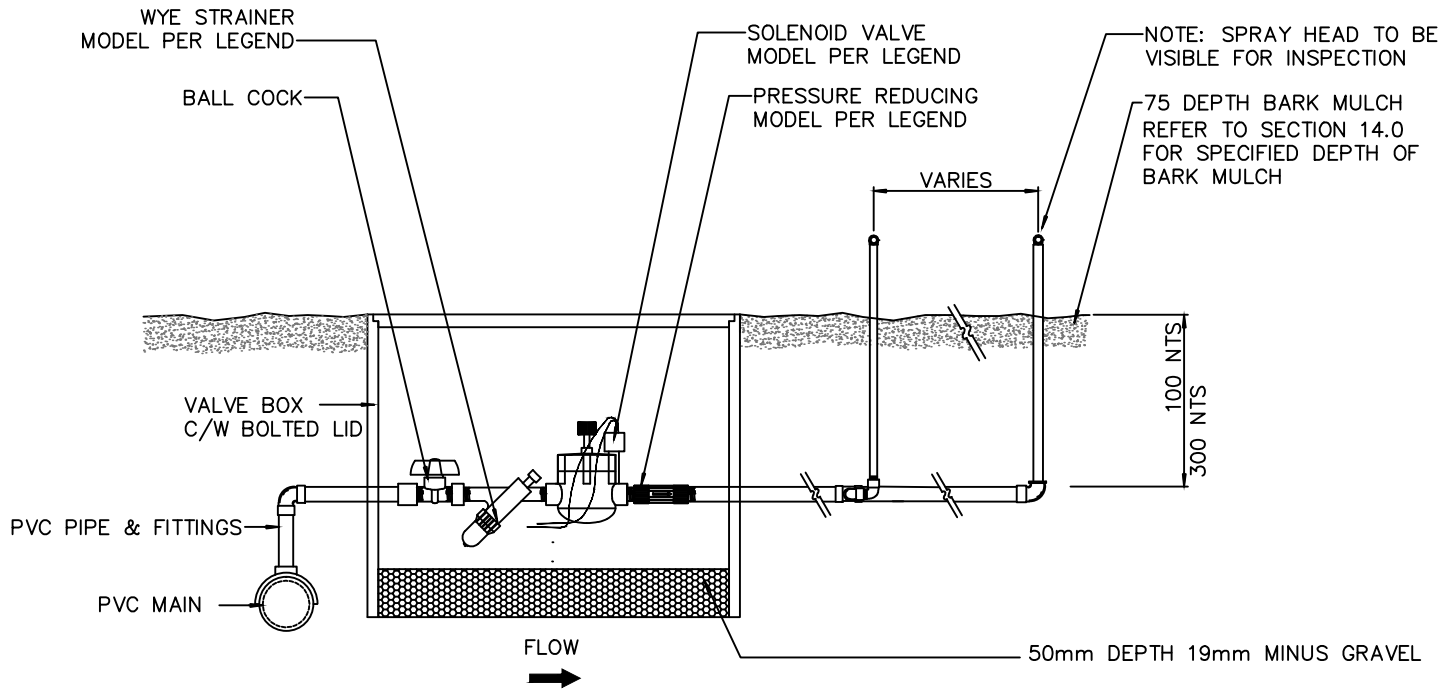


POPUK SPRAY HEAD
TURF ROTARY HEAD

Scale: N.T.S.
 Created: SEPT 2012
 Rev Date NOV 2016
 Dwg No: I-5

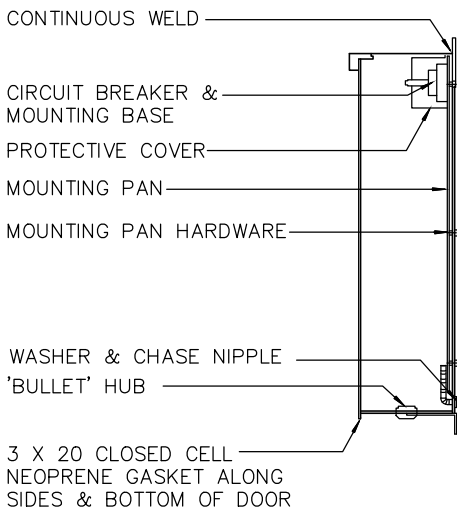


DRIP CIRCUIT SCHEMATIC LAYOUT

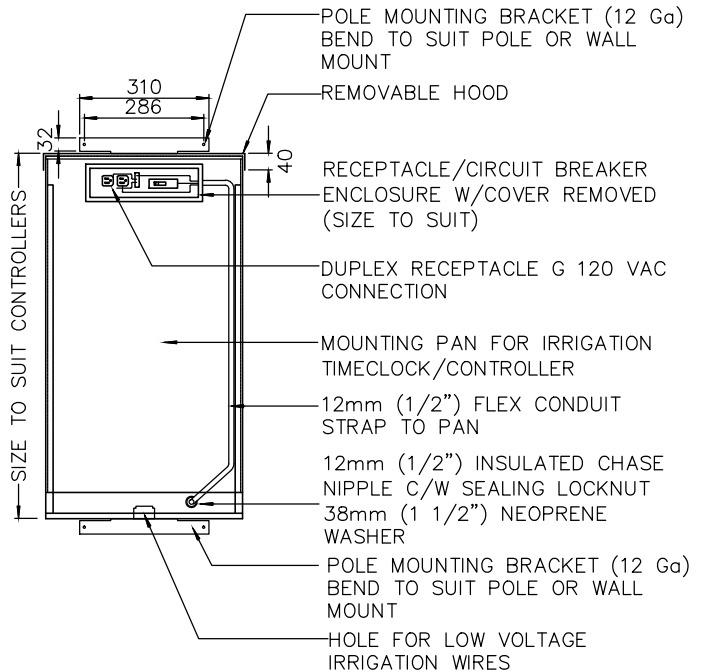


TYPICAL DRIP VALVE ASSEMBLY AND MANIFOLD

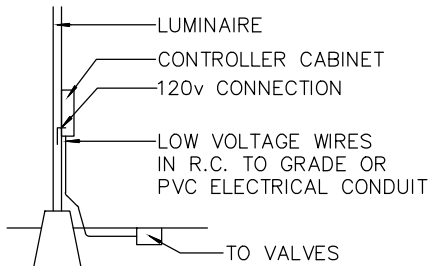
- NOTES:
 1. FOR DESIGN CRITERIA, SPECIFICATIONS AND INSTALLATIONS REFER TO SECTION 14.0 WRITTEN SPECIFICATIONS.



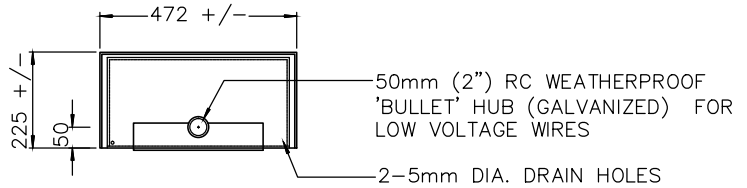
CROSS SECTION



FRONT VIEW WITH DOOR REMOVED



MOUNTING DETAIL



BOTTOM VIEW

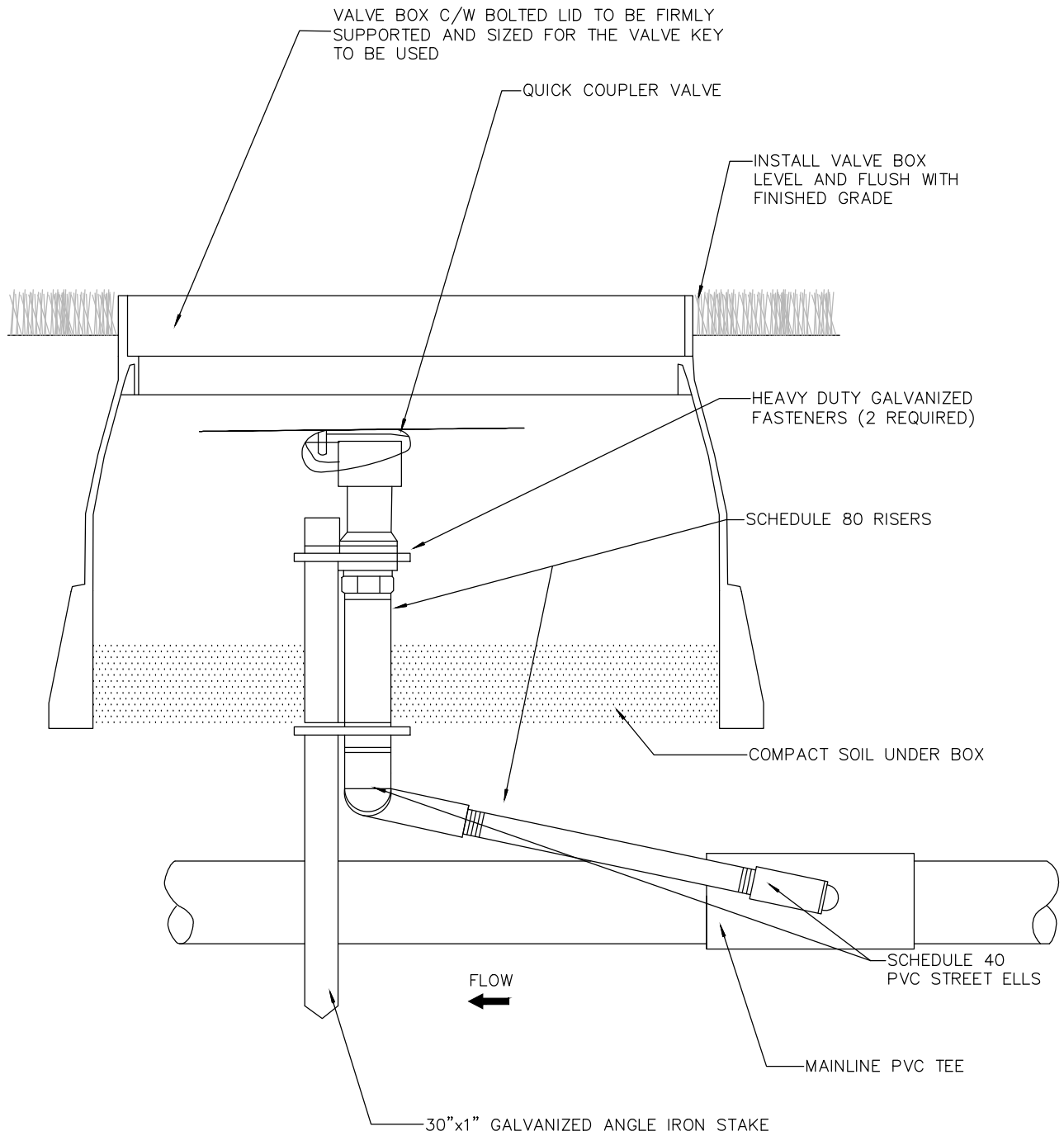
NOTES:

- 1) ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED ON THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
- 2) ENTIRE ENCLOSURE TO BE 16 GAUGE MILD STEEL OR ALUMINUM WITH THE EXCEPTION OF THE RECEPTACLE ENCLOSURE & MOUNTING PAN WHICH SHALL BE 14 GAUGE. STEEL FINISHED WITH GREY ENAMEL, ALUMINUM CLEAR ANODIZED. ALL SEAMS SHALL BE CONTINUOUSLY WELDED.
- 3) THE ENCLOSURE SHALL BE MANUFACTURED TO CONFORM TO C.S.A. ENCLOSURE 3 SPECIFICATIONS & SHALL BEAR APPROVAL FROM THE PROVINCIAL SAFETY BRANCH INSPECTOR.
- 4) ALL HARDWARE (SCREWS, NUTS, ETC.) SHALL BE STAINLESS STEEL.
- 5) DOOR TO BE FULLY GASKETTED & WITH PADLOCKING FACILITY.
- 6) THE PANEL SHALL BEAR THE MANUFACTURER & THE PROVINCIAL APPROVAL LABELS INSIDE THE PANEL.
- 7) ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.



IRRIGATION CONTROLLER CABINET DETAILS

Scale: N.T.S.
Created: MAY 2013
Rev Date NOV 2016
Dwg No: I-7



NOTES:

1. TEFLON TAPE TO BE USED ON THREADED JOINTS
2. VALVE BOW TO BE INSTALLED FLUSH WITH FINISHED GRADE, AND IN A SHRUB AREA WHERE POSSIBLE.
3. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND USED ON THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.



QUICK COUPLER VALVE DETAIL

Scale: N.T.S.
 Created: MAY 2013
 Rev Date NOV 2016
 Dwg No: I-8

\\TENTY&PW\INFRASTRUCTURE\PLANNING\STANDARDS & PRODUCTS\MOESS\EDITION NOT1\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 14 DWGS\I-9

VALVE BOX C/W BOLTED LID TO BE FIRMLY SUPPORTED AND SIZED FOR THE VALVE KEY TO BE USED.

NEATLY COIL EXTRA WIRE TO LIFT SPLICE OUT OF VALVE BOX

WATER TIGHT CONNECTORS

MAIN LINE

COMPACTED SOIL

BRASS ISOLATION VALVE

LATERAL LINE

FLOW



NOTES:

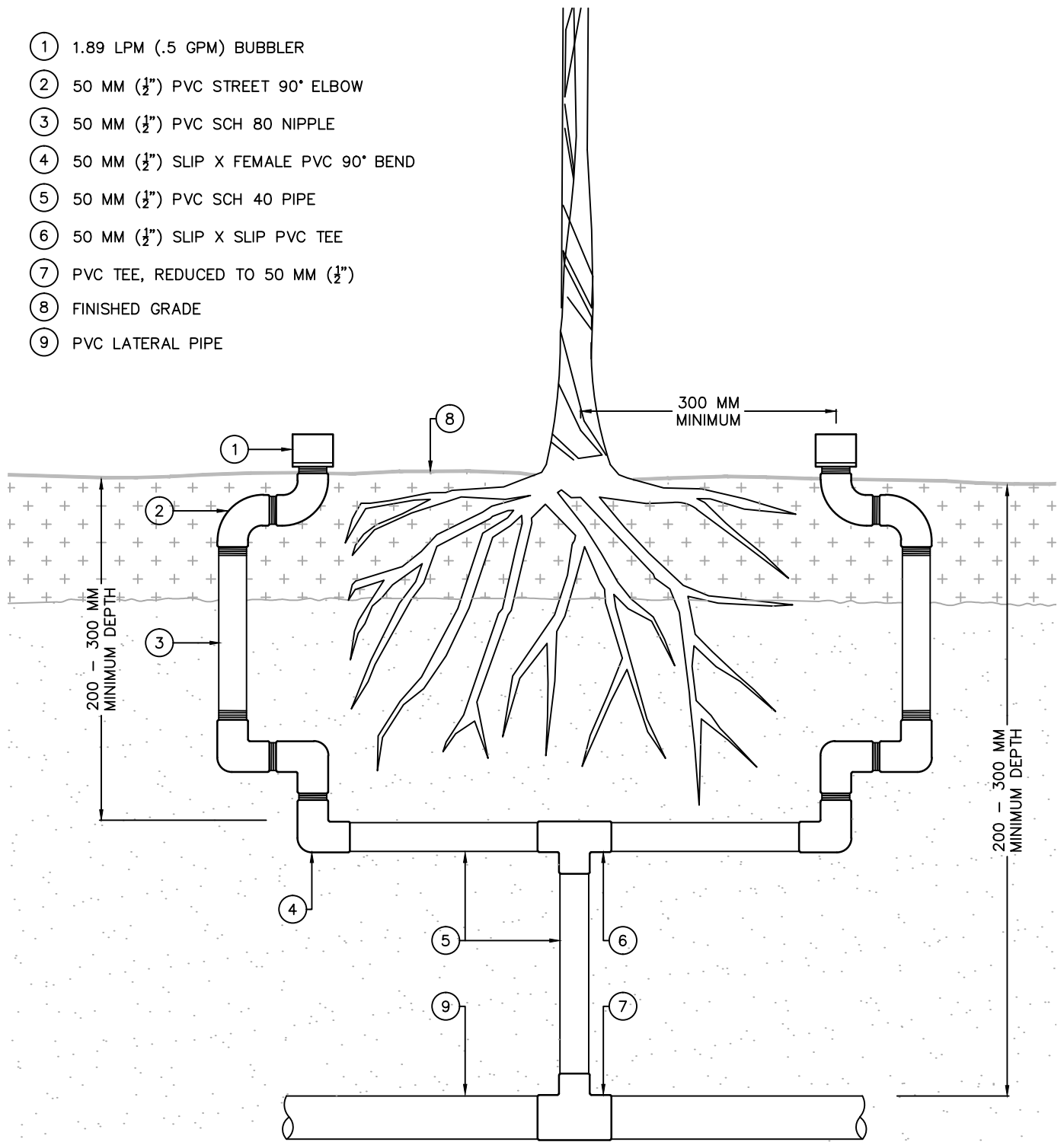
1. VALVE BOX TO BE INSTALLED FLUSH WITH FINISHED GRADE, AND IN A SHRUB AREA WHERE POSSIBLE.
2. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED IN THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.



ELECTRIC VALVE DETAIL

Scale: N.T.S.
 Created: MAY 2013
 Rev Date NOV 2016
 Dwg No: I-9

- ① 1.89 LPM (.5 GPM) BUBBLER
- ② 50 MM (1/2") PVC STREET 90° ELBOW
- ③ 50 MM (1/2") PVC SCH 80 NIPPLE
- ④ 50 MM (1/2") SLIP X FEMALE PVC 90° BEND
- ⑤ 50 MM (1/2") PVC SCH 40 PIPE
- ⑥ 50 MM (1/2") SLIP X SLIP PVC TEE
- ⑦ PVC TEE, REDUCED TO 50 MM (1/2")
- ⑧ FINISHED GRADE
- ⑨ PVC LATERAL PIPE



IRRIGATION BUBBLER SECTION

SCALE: 1:10

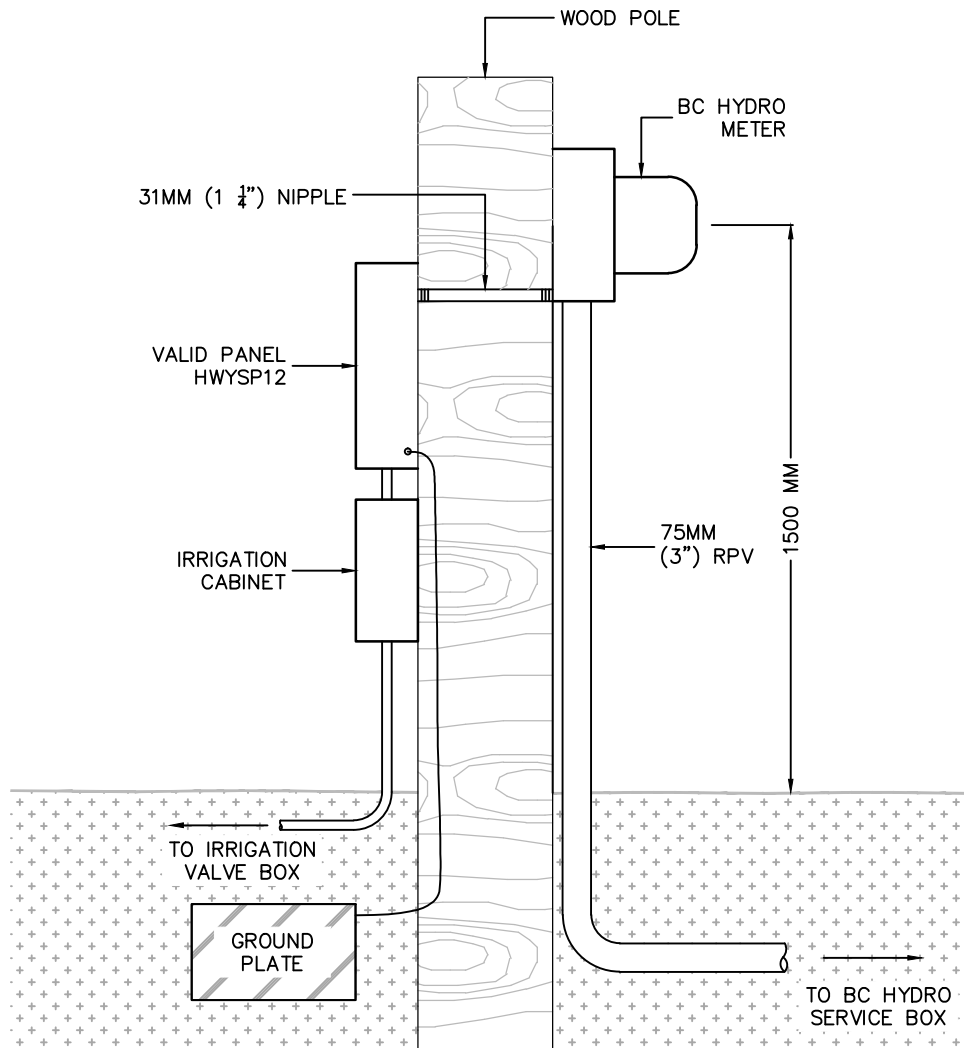
NOTES:

- 1. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER WILL BE APPROVED FOR INSTALLATION.
- 2. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN.



Scale:	N.T.S.
Created:	MAR 2016
Rev Date:	NOV 2016
Dwg No:	I-10

\\TENT\E&PW\INFRASTRUCTURE PLANNING\STANDARDS & PRODUCTS\MOESSEDITION NO11\FINAL DRAFT\FINAL DRAFT STANDARD CAD DRAWINGS\SECTION 1 4 DWGSI-11



SECTION

SCALE: 1:20

NOTES:

1. ONLY PRODUCTS APPROVED BY THE CITY ENGINEER AND LISTED ON THE CITY OF NANAIMO APPROVED PRODUCTS LIST WILL BE ACCEPTED FOR INSTALLATION.
2. INSTALLATION SHALL BE DONE FOR DESIGNATED PARK LAND.
3. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE SHOWN.

4.27.2016



IRRIGATION UNDERGROUND
ELECTRICAL SERVICE WITH POLE

Scale:	N.T.S.
Created:	MAR 2016
Rev Date:	NOV 2016
Dwg No:	I-11

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(REVISED NOVEMBER 2016)

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(REVISED NOVEMBER 2016)

SECTION 14 - LANDSCAPE DESIGN CRITERIA

14.01 SCOPE

- .1 These landscape standards and specifications shall apply to all new parkland and trailways acquired through subdivision development as well as to all landscape areas within the rights-of-way (R.O.W.) of roadways in the City of Nanaimo including: medians, soft landscape areas between the curbs and the R.O.W. lines, and plantings in urban plaza and sidewalk areas. Safety for utility lines, drivers and pedestrians must be ensured when developing treed boulevards. **(REVISED NOVEMBER 2016)**
- .2 The general design and construction of the landscape shall be in accordance with the standards set out in this section. All standards and specifications must be followed. Specific projects may warrant amendments to the standards herein but those amendments must be approved in writing by the City Engineer.
- .3 During Pre-Construction Stage, the following must be completed:
 - (a) Submission of a landscape plan complete with restoration planting, tree locations and irrigation design completed by a Landscape Architect following the standards and specifications herein. **(REVISED NOVEMBER 2016)**
 - (b) Installation of landscaping may be completed with the exception of the trees once the plan is accepted and only if timing is appropriate for planting.
- .4 During Construction Stage the City Engineer must be notified of the following:
 - (a) Inspection of all pipe in ground (if required) to ensure it is exposed with bedding material prior to back fill.
 - (b) Inspection of the back-flow prevention and point of connection as per Standard Drawing I-1 if required before back fill.
 - (c) Inspections to ensure T-joint couplings are installed (if required) before back fill at the location where future trees will be planted.
 - (d) Inspection of the irrigation controller installed (if required).
 - (e) Completion of soil samples and testing to be done in accordance with Section 14.14. A copy of the report must be sent to the City Engineer prior to installation.
 - (f) Inspection of the seed, turf and plantings must be done by the City Engineer when installed by the developer. **(REVISED NOVEMBER 2016)**
- .5 At the End of Maintenance Inspection Prior to Bond Release, the following must be completed:
 - (a) Final inspection of irrigation and all landscaping.
 - (b) Where a final inspection includes a parkland acquisition, the inspection shall ensure all requirements have been completed as per the request of the City Engineer.
 - (c) Testing of irrigation after installation. All lines are to be charged to ensure there are no breaks or leaks in the system.
 - (d) As-built drawings (with any revisions noted) must be provided to the City Engineer.
 - (e) If not already installed, the City of Nanaimo Parks Operations Department will install boulevard trees in planned locations when the majority of build out has occurred and maintain with irrigation, watering truck or adopt a tree program.

SECTION 14 - LANDSCAPE DESIGN CRITERIA

PLANTING

14.02 DRIVER VISIBILITY AND CLEARANCE

- .1 Do not obstruct the line of vision at intersections within the triangular area bounded by the intersection of lot lines and a line joining each lot line 7 metres from their intersection.
- .2 The maximum mature maintained height for plant materials located within sight distance triangles at intersections shall be 300mm above finish grade.
- .3 Specify trees near approaches to left turn slots, driveways or pedestrian crosswalks which can be pruned up from the base to a minimum height of 1.5m. Shrubs in these areas shall not exceed 300mm in mature height.
- .4 Locate trees a minimum of 1.0m distance from the pavement or curb face, unless planted in accordance with Standard Drawing P-5 or P-6.
- .5 Tree branch clearances requirements are: 5m the over traveled portion of road and 2m over the sidewalk.

14.03 MINIMUM SETBACKS FOR TREES

- .1 Setbacks for trees to objects shall be as follows:

Table 14-1

SETBACK TREES FROM:	DISTANCE
Underground street light conduit or irrigation main	0.6m
Other underground utilities	1.2m
Lamp standards	6.0m
Steel and wooden utility poles	3.0m
Driveways	2.0m
Catch basins	2.0m
Manholes, valve boxes, services	1.2m
Sewer service boxes	1.5m
Fire hydrants	2.0m
Road intersection	7.0m
Curb face	1.0m
Sidewalk	0.85m
Buildings - fastigate (columnar) tree	2.0m
Buildings - regular crown tree	3.0-5.0m

SECTION 14 - LANDSCAPE DESIGN CRITERIA

14.04 MINIMUM LANDSCAPE AREA DIMENSIONS AND MAXIMUM GRADES

- .1 The minimum width for grass boulevard shall be 1.0m, 1.5m or greater preferable. Maximum slope for lawns to be 3:1.
- .2 The minimum width for shrub or ground cover beds shall be 0.6m, 1.0m or greater is preferred. Maximum slope for shrub or ground cover beds to be 2:1.
- .3 Median areas narrower than 3m from curb face to curb face shall be paved with an exposed aggregate concrete finish, to be approved by the City Engineer. **(REVISED NOVEMBER 2016)**
- .4 Landscaped median areas wider than 3.0m shall have a 0.5m width exposed aggregate splash apron to be constructed in accordance with Standard Drawing No. P-4. **(REVISED NOVEMBER 2016)**
- .5 The minimum width of boulevards for tree planting shall be 1.85m measured from face of curb.

14.05 PLANT MATERIAL SELECTION

- .1 All plant materials shall meet the following criteria:
 - (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) Plants shall be hardy to Zone 7 or colder.
 - (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 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 14.02 – Driver Visibility and Clearance.
- .2 Lawns/Fine Grass, Rough Grass and Wildflowers:
 - (a) Sod shall be used on all lawn/fine grass areas. Seeding shall require approval of the City Engineer.
 - (b) Rough grass and wildflowers areas shall be seeded. Seeding method shall be noted on drawings.
 - (c) Areas to be seeded with grades greater than 4:1 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.

SECTION 14 - LANDSCAPE DESIGN CRITERIA

- .3 Trees shall be selected such that:
 - (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 trees species shall vary between intersecting streets.

- .4 All street trees shall meet the following criteria:
 - (a) Compact or upward branching structure.
 - (b) Ability to withstand pruning for pedestrian, vehicle and/or building clearance without compromise to tree health or form.
 - (c) Absence of species/variety characteristics of structural weakness, susceptibility to wind damage, or thin, easily damaged bark.

- .5 Select street trees according to proposed site conditions either from: Table 14-2, or
 - (a) An alternative source provided that the proposed trees meet the site criteria contained within the relevant Parts of Table 14-2 and all other criteria contained in this section.
 - (b) Obtain written approval from the City Engineer for tree selections not taken from Table 14-2.

TABLE 14-2

PART 1 – Trees For Directly Under Hydro Lines

Minimum allowable soil volume per tree 4cu.m. with 1m depth pit.

Selection criterion for alternative trees not listed in Part 1: Mature height not greater than 7.62m.

SCIENTIFIC NAME	COMMON NAME
Acer griseum	Paperbark Maple
Acer ginnala	Amur Maple (tree form)
Acer platinoides 'Globosom'	Globe Norway Maple
Prunus yedoensis	Akebono Cherry
Prunus serrulata 'Kwanzan'	Kwanzan Cherry
Prunus serrulata 'Pink Perfection'	Pink Perfection Cherry
Cornus Eddie's White Wonder	Eddie's White Wonder Dogwood
Prunus pissardi Nigra	Purple Plum
Pyrus calleryana Redspire	Ornamental Pear

(REVISED NOVEMBER 2016)

SECTION 14 - LANDSCAPE DESIGN CRITERIA

PART 2 – Trees For Beside Hydro Lines (Min. 2.75m Lateral Distance from Nearest Line)

Minimum allowable soil volume per tree 4cu.m. with 1m depth pit.

Trees listed in Part 1 may also be used.

Selection criterion for alternative trees not listed in Part 2: Mature spread not greater than 5m.

SCIENTIFIC NAME	COMMON NAME
Acer platanoides 'Columnare'	Columnar Norway Maple
Acer platanoides 'Crimson Sentry'	Crimson Sentry Norway maple
Acer rubrum 'Bowhall'	Bowhall Red Maple
Carpinus betulus 'Fastigiata'	Fastigate Hornbeam
Ginkgo biloba 'Princeton Sentinel'	Princeton Sentinel Ginkgo
Fagus sylvatica 'Fastigiata' ('Dawyckii')	Fastigate Beech
Prunus sargentii 'Columnaris'	Columnar Sargent's Cherry
Quercus robur 'Fastigiata'	Fastigate English Oak
Sorbus aucuparia 'Rosedale'	Rosedale Mountain Ash
Tilia cordata 'Corzam'	Corinthian Linden

PART 3 - Trees For Limited Available Soil Volume (Min. 4cu.m. per Tree, 1m pit Depth)

Trees listed in Parts 1 or 2 may also be used.

Selection criterion for alternative trees not listed in Part 3: Mature height not greater than 10m.

SCIENTIFIC NAME	COMMON NAME
Acer campestre (tree form)	Hedge Maple
Acer circinatum (tree form)	Vine Maple
Acer platanoides x truncatum cv.	Norwegian and Pacific Sunset Maples
Fraxinus oxycarpa 'Raywood'	Raywood Ash

(REVISED NOVEMBER 2016)

PART 4 - Trees For Available Soil Volumes of 9cu.m. per Tree or More, 1m pit Depth

Trees listed in Parts 1-3 may also be used.

Selection criterion for alternative trees not listed in Part 3: Mature height not greater than 20m.

SCIENTIFIC NAME	COMMON NAME
Acer rubrum cvs.	Red Maple cultivars
Quercus coccinea	Scarlet Oak
Quercus rubra	Red Oak
Tilia x euchlora	Crimean Linden
Robinia pseudoacacia	Black Locust
Robinia pseudoacacia cvs	Black Locust cultivars
Cercidiphyllum japonicum	Katsura

(REVISED NOVEMBER 2016)

SECTION 14 - LANDSCAPE DESIGN CRITERIA

PART 5 - Trees For Wide Boulevard or Wide Median Use Only

Trees listed in Parts 1-4 may also be used.

Trees in this Part require a minimum available root zone of 20cu.m. per tree with a minimum width of 3.5m.

SCIENTIFIC NAME	COMMON NAME
All non-dwarf coniferous spp.	
Fagus sylvatica (sp., & full size cultivars)	European beech
Liquidambar styraciflua	Sweetgum
Liriodendron tulipifera	Tulip tree
Platanus acerifolia	London Planetree
Quercus palustris	Pin Oak
Zelkova serrata cv.	Japanese Zelkova
Quercus robur	English Oak

(REVISED NOVEMBER 2016)

14.06 STREET TREE SIZE, SPACING AND LOCATION

- .1 Trees shall be minimum 5cm caliper measured at 1.4m above the rootball at the time of planting, and of uniform size if planted in a boulevard row. **(REVISED NOVEMBER 2016)**
- .2 Minimum number of boulevard trees shall be calculated as follows:

Tree Size	Single Family Residential
Medium Trees (\pm 10 - 20m ht.)	Greater of 1 per lot or 15m
Small Trees (Under 10m ht.)	Greater of 1 per lot or 10m

(REVISED NOVEMBER 2016)

- .3 Plantings of trees closer than 6m on centre shall require the written approval of the City Engineer.
- .4 Locate trees at least 1m offset from the curb face.
- .5 Locate trees fronting on single family lots at the center of the lot frontage unless otherwise approved by the City Engineer.

14.07 URBAN TREES IN PAVEMENT

- .1 Select urban trees in pavement in accordance with Table 14-2.
- .2 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.
- .3 Urban Trees in Pavement shall be referenced to City of Nanaimo Standard Drawing P-5, P-6 or P-7, or when alternates are proposed, the drawings shall include project-specific tree planting details showing, by plan and cross section:
 - (a) Typical view of surrounding pavements, curbs, above and below ground utilities, light standards, and adjacent buildings and structures.

SECTION 14 - LANDSCAPE DESIGN CRITERIA

- (b) Typical details of proposed rooting environment including tree pit dimensions, subgrade scarification, drainage structure if required, topsoil mix layers or 'horizons', root deflecting structure location and type if required, location and type of irrigation device and pipe, and soil surface treatment such as tree grate, porous pavement or other; and
- (c) Typical above ground details such as staking, special appurtenances, pruning for headroom etc.

14.07A STRUCTURAL SOILS

- .1 Structural soils shall be used with the approval of the City Engineer.

IRRIGATION

14.08 GENERAL IRRIGATION DESIGN REQUIREMENTS

- .1 Design irrigation in industry-standard metric units on standard metric sheets.
- .2 Irrigation design requirements shall be identified by the Road Classification as per Section 9.0 – Streets, Traffic Signs and Markings as summarized below:

<u>Road Type</u>	<u>Irrigation Requirements</u>
Rural Local Urban Local Urban Local (Low Volume) Neighbourhood Collector	Watering truck for specified time period, followed by adopt-a-tree program, above ground donuts and bags around trees. Consider front yard trees and trees in boulevard.
Minor Collector Major Collector Urban Arterial	Fully irrigated boulevards and/or medians attached to central control for the waterwise program.
Commercial Industrial	Supportive of irrigated landscaping with maintenance under private landowner's control. If landscaping is on city ROW, then fully irrigated boulevards and/or medians attached to central control for the waterwise program.

(REVISED NOVEMBER 2016)

- .3 An automatic irrigation system is required where boulevard trees, shrubs and ground covers are to be irrigated.
- .4 Each urban tree shall be irrigated with at least two visible 0.5gpm bubblers in accordance with the City of Nanaimo Standard Drawing No. I-10. **(REVISED NOVEMBER 2016)**
- .5 Irrigation systems shall be designed to supply water on a demand basis by employing a soil moisture probe to override the controller during periods of adequate soil moisture.

SECTION 14 - LANDSCAPE DESIGN CRITERIA

- .6 In grassed boulevards fronting institutional, commercial and residential uses with potential for heavy pedestrian traffic between the curb and sidewalk, grass areas shall be irrigated. Low traffic grassed boulevards may be installed without irrigation, but manual watering for establishment and maintenance is required. The City Engineer's decision on irrigation requirements for grass areas shall be final.

14.09 IRRIGATION SERVICE CONNECTIONS

- .1 Design service connections from City of Nanaimo water main to, and including, water meter chamber, to be in accordance with Section 5 - Water Distribution System.
- .2 Required backflow prevention in accordance with the City of Nanaimo Standard Drawing No. I-1.
- .3 Measure static water pressure at or near the point of connection and include with irrigation system design.

14.10 IRRIGATION SYSTEM PARAMETERS

- .1 Maximum design flow velocity to be 1.5 m/sec.
- .2 Size pipes and valves for minimum friction loss.
- .3 Specify all irrigation components from a coordinated manufacturer's line listed in the Approved Products List.
- .4 Design head-to-head coverage for turf and shrub areas.
- .5 Design sprinkler circuits with matched precipitation heads. Do not mix heads with varied precipitation rates on the same circuit.
- .6 Specify low flow heads for sloping areas.
- .7 Where surface sprinklers are used, ensure unobstructed sprinkler coverage to tree bases from at least two sides.
- .8 Every drip circuit 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.
- .9 Minimize overspray on paved surfaces.

SECTION 14 - LANDSCAPE SPECIFICATIONS

PLANTING

14.11 SUBSTITUTIONS

- .1 Requests for substitutions in plant material species shall be submitted to the Engineer in writing, with proof of a plant search area that extends throughout BC wholesale nurseries, and may only be submitted after the Contract has been awarded to the successful bidder.

14.12 REFERENCE STANDARDS

- .1 Unless otherwise specified, all planting, sodding, and seeding procedures to be in accordance with BCNTA/BCSLA Landscape Standard latest edition.
- 2 Do all pruning to International Society of Arboriculture (ISA) Best Management Practices Tree Pruning 2008.
- .3 Reference standards for landscape maintenance shall include project specifications and the most recently amended version of the following:
 - (a) B.C.S.L.A./B.C.N.T.A. British Columbia Landscape Standard
 - (b) International Society of Arboriculture Guide for Establishing Values of Trees and Other Plants, a Guide to Plant Appraisal and Best Management Practices.
 - (c) Canadian Fertilizer Act
 - (d) Canadian Fertilizer Quality Assurance Program
 - (e) Canadian Nursery and Landscape Association – Standards for Nursery Stock
 - (f) Seeds Act
 - (g) Canadian Soil Conservation Act
 - (h) BC Landscape Standard
 - (i) Bylaw No. 4695 – Nanaimo Tree Protection
 - (j) Bylaw No. 7102 – Pesticide Use
 - (k) ANSIA300 Tree Care Operations – Tree, Shrub and other Woody Plant Maintenance – Standard Practices
 - (l) Field Guide to Noxious Weeds and other Selected Invasive Plants of British Columbia, Ministry of Agriculture and Lands.
 - (m) Guide to Weeds in BC and Seven Steps to Managing your Weeds, Weeds BC
 - (n) Federal Pest Control Products Act
 - (o) Federal Plant Quarantine Act
 - (p) Federal Fisheries Act
 - (q) Federal Migratory Bird Regulations
 - (r) Federal Food and Drug Act
 - (s) Federal Pesticide Residue Compensation Act
 - (t) Provincial Integrated Pest Management Act
 - (u) Provincial Plant Protection Act
 - (v) Provincial Wildlife Act
 - (w) Federal and Provincial Weed Control Act
 - (x) Handbook for Pesticide Applicators and Pesticide Dispensers, Ministry of Environment
 - (y) IPM Manual for Landscape Pests, Ministry of Environment
 - (z) Ministry of Environment, Pesticide Control Branch: 810 Blanshard Street, Victoria, BC, V8W 3E1
 - (aa) WorkSafeBC: Standard Practices for Pesticide Applicators

SECTION 14 - LANDSCAPE SPECIFICATIONS

- (bb) BC Ministry of Transport Guidelines for Maintenance
- (cc) Invasive Plant Alerts, Ministry of Agriculture and Lands

The intent of the supplemental documents is to provide additional information. Information provided in the supplemental documents does not replace or supersede the MoESS requirements.

14.13 PROTECTION

- .1 Prevent damage to all existing curbs, sidewalks, pavement, utilities and structures, plants, etc. Refer to Section 3 – Existing Structures and Utility Works for conditions affecting work around existing structures and utilities.

14.14 SOIL SAMPLES AND TESTING

- .1 City Engineer's approval of topsoil, sub-soil and bulk organic amendments at source, or for re-use of on-site native soils, is required. A reference sample of topsoil taken from the same source pile as the analysis sample shall be delivered to the Engineer, accompanied by a memorandum of assurance from the Contractor that the soil so delivered shall be the soil used in the Contract. On-site soils used shall be tested before the landscape work is tendered to establish suitability. Copies of test results and required modification reports shall be included in the bid documents.
- .2 All soils and bulk organic amendments supplied by the Contractor shall be tested by a soil testing laboratory agreed to by both the Contractor and the City Engineer, at the Contractor's expense. The Contractor shall arrange for such testing in a timely fashion to meet the requirements set out in Section 14.14.4.
- .3 Except where otherwise indicated in the drawings or specifications, the recommendations of the soil testing laboratory shall be the basis of requirements for soil amendments.
- .4 The Contractor shall submit the soil analysis report to the City Engineer 48 hours prior to commencement of work.
- .5 The submission for soil analysis shall include:
 - (a) Minimum 1 kg. sample of each: top soil, native sub-soil intended for re-use, and bulk organic amendments.
 - (b) Project planting details and information regarding intended landscape applications for the soil.

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- .6 The soil analytical requirements shall include:
- (a) pH
 - (b) lime requirement to achieve a pH of 6.5
 - (c) soluble salts or electrical conductivity (E.C.)
 - (d) % Sands + % Fines(Silt and Clay) + % Organic Matter = 100%
 - (e) % Total Nitrogen
 - (f) Available levels of phosphorous, potassium, calcium and magnesium.

- .7 The laboratory analysis shall include recommendations for:

Soil amendments to bring soil attributes to acceptable levels as outlined in this specification. Fertilizer applications, by category of plant type, to bring topsoil mix fertility to levels outlined in this specification.

14.15 TOP SOIL FOR GRASS AREAS

- .1 Top soil for lawn and fine grass areas shall be unamended top soil.
- .2 Top soil for rough grass and wildflower areas shall be unamended top soil or native subsoil.

14.16 UN-AMENDED TOP SOIL

- .1 All supplied top soil shall be fertile, friable natural loam containing minimum 4% organic matter for clay loams and 2% organic matter for sandy loams. When modified according to the recommendations of the soil testing laboratory, top soil shall be capable of sustaining vigorous plant growth.
- .2 Top soil shall be free from any inclusions of sub-soil, lumps of clay, stones and roots over 50mm diameter, toxic materials, crabgrass, couch grass, blackberry, morning glory, horsetail, or other noxious weeds and weed seeds.
- .3 Un-amended top soil shall have a texture falling within the following allowable ranges for percentage dry-weight mineral fraction:

Gravel	>2mm & <75mm	0-10%
Sand	>0.05mm & <2mm	50-70%
Silt	>0.002mm & <0.05mm	10-25%
Clay		0-15%

- .4 Un-amended top soil shall have the following chemical properties:

pH	5.5 - 7.0	
salinity	sat. extract conductivity	<3.0 millimhos/cm @ 25°C
boron	concentration in saturated extract	<1.0 ppm

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14.17 SUB-SOIL

- .1 Sub-soil shall be either:
 - (a) native sub-soil, free of stones larger than 75mm, and having the chemical and physical properties falling within the acceptable ranges specified in Section 14.16.3 and Section 14.16.4 for un-amended topsoil, or
 - (b) un-amended topsoil
- .2 Native sub-soil not meeting the criteria specified in Section 14.17.1(a) shall be removed from site and legally disposed of.
- .3 Sub-soil shall be free of any toxic materials, pavements, construction debris, deleterious materials, (crabgrass, couch grass, blackberry, morning glory, horsetail, or other noxious weeds and weed seeds).
- .4 On-site subsoil intended as a component of growing medium shall be protected against contamination from plants, plant parts, invasive and noxious species, insect pests, plant pathogenic organisms and other extraneous organic and non-organic materials and toxins. Refer to the following regulations:
 - (a) WorkSafeBC – Occupational Health and Safety Regulations
 - (b) BC Ministry of Environment Regulations
 - (c) Canadian Environmental Protection Act
 - (d) Weed Control Act (Federal and Provincial)
 - (e) BC Ministry of Agriculture and Lands Regulations
 - (f) Canadian Master Specifications, Construction Specifications Canada
 - (g) National Master Specifications, Construction Specifications Canada
- .5 Submit sub-soil for testing as required in Section 14.14.1.

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14.17A GROWING MEDIUM PROPERTIES

- .1 Growing medium properties are based on different levels of maintenance and irrigation in accordance to the British Columbia Landscaping Standard as follows:

- (a) Properties of Growing Medium for Level 1 “Well Groomed” Area:

Level 1 areas: intensive, high standard of maintenance is anticipated. Irrigation is recommended in all instances and is necessary in all areas, “on-slab” or under cover. The textural classification for these growing media by the Canadian System of Soil Classification is “Sand” to “Loamy Sand”. Plant selection, irrigation requirements and maintenance intensity should consistently respond to the exceptional nature of the growing medium.			
<i>Growing Medium Types:</i>	<i>1L</i>	<i>1H</i>	<i>1P</i>
<i>Applications:</i>	Low traffic Lawn Areas Trees and Large Shrubs	High Traffic Lawn Areas	Planting Areas
<i>Texture:</i>	Percentage of Dry Weight of Total Growing Medium		
Coarse Gravel <ul style="list-style-type: none">• Larger than 19mm• Smaller than 40mm	0 – 1%	0 – 1%	0 – 1%
All Gravel <ul style="list-style-type: none">• Larger than 2mm• Smaller than 40mm	0 – 5%	0 – 5%	0 – 5%
Sand: <ul style="list-style-type: none">• Larger than 0.05mm• Smaller than 2mm	50 – 70%	80 – 90%	50 – 70%
	Percentage of Dry Weight of Total Growing Medium Excluding Gravel		
Silt: <ul style="list-style-type: none">• Larger than 0.002mm• Smaller than 0.05mm	10 – 25%	5 – 15%	10 – 25%
Clay: <ul style="list-style-type: none">• Smaller than .002mm	0 - 20%	0 - 5%	0 – 20%
Clay and Silt Combined	Maximum 25%	Maximum 15%	Maximum 25%
Organic Content	3 – 10%	3 – 5%	10 – 20%
Acidity (pH):	6.0 – 7.0	6.0 – 7.0	5.5 – 6.5
Drainage:	Percolation shall be such that no standing water is visible 60 minutes after at least 10 minutes of moderate to heavy rain or irrigation.		

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(b) Properties of Growing Medium for Level 2 “Groomed” and Level 3 “Moderate” Areas:

Level 2 and 3 areas: routine, high to moderate standard of maintenance is anticipated. Automatic irrigation is recommended, however such areas can be adequately irrigated through consistent use of manual irrigation equipment. The textural classification for these growing media by the Canadian System of Soil Classification is “Loamy Sand” to “Sandy Loam”. These growing media accommodate a wide selection of plants; they create a balance between good drainage and water retention and are suited to moderate, normal maintenance practices. “On-slab” areas should be treated as Level 1 areas, with corresponding increase in sand content and decrease in silts and clays.			
<i>Growing Medium Types:</i>	<i>1L</i>	<i>1H</i>	<i>1P</i>
<i>Applications:</i>	Low traffic Lawn Areas Trees and Large Shrubs	High Traffic Lawn Areas	Planting Areas
<i>Texture:</i>	Percentage of Dry Weight of Total Growing Medium		
Coarse Gravel <ul style="list-style-type: none">• Larger than 19mm• Smaller than 40mm	0 – 1%	0 – 1%	0 – 1%
All Gravel <ul style="list-style-type: none">• Larger than 2mm• Smaller than 40mm	0 – 5%	0 – 5%	0 – 5%
	Percentage of Dry Weight of Total Growing Medium Excluding Gravel		
Sand: <ul style="list-style-type: none">• Larger than 0.05mm• Smaller than 2mm	50 – 80%	70 – 90%	40 – 80%
Silt: <ul style="list-style-type: none">• Larger than 0.002mm• Smaller than 0.05mm	10 – 25%	0 – 15%	10 – 25%
Clay: <ul style="list-style-type: none">• Smaller than .002mm	0 - 25%	0 - 15%	0 – 25%
Clay and Silt Combined	Maximum 35%	Maximum 15%	Maximum 35%
Organic Content	3 – 10%	3 – 5%	10 – 20%
Acidity (pH):	6.0 – 7.0	6.0 – 7.0	4.5 – 6.5
Drainage:	Percolation shall be such that no standing water is visible 60 minutes after at least 10 minutes of moderate to heavy rain or irrigation.		

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- (c) Properties of Growing Medium for Level 4 “Open Space/Play”, Level 5 “Background and Natural Areas”, and Level 6 “Service & Industrial” Areas:

Level 4, 5, and 6 areas: high standard of maintenance is neither anticipated nor required. Irrigation may be provided, but more frequently only temporary watering is done for establishment maintenance. The textural classification for this growing medium by the Canadian System of Soil Classification is “Sandy Loam” to “Loam”. These soils provide a quality growing medium, albeit with reduced percolation and resistance to compaction. These may be imported soils, however existing soils may meet these requirements or it may be possible to amend them to meet the requirements. Plant selections must respond to the limitations of the growing medium and to modest maintenance expectations. If soil must be imported to augment existing site topsoil (due to insufficient volumes on-site or damage to on-site topsoil by construction activities), the imported growing medium should be similar to the on-site soil and should be mixed with it. Different soil types should not be layered. Where the growing medium has reduced percolation characteristics additional drainage measures may be required.			
<i>Growing Medium Types:</i>	<i>3L</i>		<i>3H</i>
<i>Applications:</i>	All Lawn Areas, Trees & Large Shrubs	Planting Areas	
<i>Texture:</i>	Percentage of Dry Weight of Total Growing Medium		
Coarse Gravel	0 – 3%	0 – 3%	
<ul style="list-style-type: none"> • Larger than 19mm • Smaller than 40mm 			
All Gravel	0 – 10%	0 – 10%	
<ul style="list-style-type: none"> • Larger than 2mm • Smaller than 40mm 			
	Percentage of Dry Weight of Total Growing Medium Excluding Gravel		
Sand:	30 – 70%	30 - 70%	
<ul style="list-style-type: none"> • Larger than 0.05mm • Smaller than 2mm 			
Silt:	15 – 50%	15 – 50%	
<ul style="list-style-type: none"> • Larger than 0.002mm • Smaller than 0.05mm 			
Clay:	15 – 30%	15 – 30%	
<ul style="list-style-type: none"> • Smaller than .002mm 			
Clay and Silt Combined	Maximum 60%	Maximum 60%	
Organic Content	2 – 10%	5 – 20%	
Acidity (pH):	6.0 – 7.0	4.5 – 7.0	

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14.18 'A HORIZON' SOIL MIX

- .1 'A horizon' soil mix shall be topsoil amended as recommended by the soil testing lab to have the following properties, in addition to the physical and chemical properties of un-amended topsoil:
 - (a) Dry weight not to exceed 1350 kg/cu.m.
 - (b) Saturated weight not to exceed 1600 kg/cu.m.
 - (c) Total nitrogen to be between 0.2% & 0.6% by weight.
 - (d) Available phosphorous to be 20-250 ppm.
 - (e) Available potassium to be 50-1000 ppm.
 - (f) Percentage by dry weight of organic matter to be:
 - (i) 3-5 % for high traffic lawn areas
 - (ii) 3-10% for low traffic lawn areas, trees and large shrubs
 - (iii) 10-20% for planting areas
 - (iv) 5-20% for natural areas
 - (g) Carbon to Nitrogen Ratio shall not exceed 40:1.
 - (h) Fertility (nitrogen, phosphorus and potassium) and pH may be modified either during mixing and screening, or after growing medium is placed.
 - (i) Salinity – the saturation extract conductivity shall not exceed 3.0 milliohms/cm at 25°C (77°F). If higher, it shall be leached with fresh water through irrigation or precipitation prior to planting.
 - (j) Boron – the concentration in the saturation extract shall not exceed 1.0ppm.
 - (k) Sodium – the sodium adsorption ratio (SAR) as calculated by analysis of the saturation extract shall not exceed 8.0.
- .2 Stripping of topsoil shall commence only after the area has been cleared of all scrub, plant material, invasive and noxious plants and their reproductive parts, grass, stumps, rocks 100mm (4in) or greater, and other extraneous organic and non-organic materials and contaminants.
- .3 Where testing shows topsoil suitable for use in its present condition or as a component of a growing medium, it shall be stockpiled where shown on the drawings or in areas designated for stockpiling as approved by the City Engineer and it must be protected from adverse weather conditions as well as other contaminants.
- .4 Onsite topsoil used as a growing medium shall have an acidity range of pH 6.0-7.5 and shall contain a dry weight percentage of organic matter as referred to in Section 14.18.1(f).
- .5 Onsite topsoil shall have a salt conductivity of less than 3.0 milliohms/cm at 25°C (77°F). If higher, it shall be leached with clean water through irrigation or precipitation prior to planting.
- .6 Death of plants during the first year that can be attributed to plant pathogenic organisms or toxic materials in the growing medium may be an indication that the growing medium did not meet the City of Nanaimo's Standards and Specifications at the time of installation may result in a requirement that the contractor remove and replace affected plants and faulty growing medium at no additional cost to the Owner.

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- .7 Excessive weed and invasive plant growth in a growing medium during the first year may be an indication that unacceptable levels of invasive plant seeds or parts were present in the growing medium at the time of installation. Such a determination may result in a requirement that the contractor remove all weeds and invasive plant roots and reduce the growth to acceptable levels at no additional cost to the Owner.

14.19 PEAT MOSS

- .1 Soil Amendments shall be virtually free from sub-soil, sawdust, commercial wood products, stones, lumps, plants or their roots, building materials, invasive or noxious plants and their reproductive parts, non composted wood, wood waste, insect pests, plant pathogenic organisms, chemical pollutants or substances at levels toxic to plants, and other extraneous materials that detract from the desirable physical and chemical properties required for landscaping purposes.
- .2 Peat moss shall be Horticultural grade, partially decomposed fibrous or cellular stems and leaves of Sphagnum Mosses with a texture varying from porous to spongy fibrous, fairly elastic and substantially homogeneous with a pH value of not less than 3.5 and not greater than 6.5. It shall be brown in colour and medium to coarse shredded, particles 10mm size or less.
 - (a) Salinity: the saturation extract conductivity <2.0millimhos/cm @ 25°C.
 - (b) Nitrogen content shall be >0.8% based on dry weight.

14.20 MANURE

- .1 Manure shall be well-rotted farm animal manure or mushroom manure, such that liquids have been eliminated, and the material is crumbly, free from weed seeds, rocks, sticks and other deleterious material and contain not more than 40% by volume of sawdust, straw, or shavings.
 - (a) Manure shall be free of harmful chemicals, and shall have salt content that gives an electrical conductivity reading of between .5 and .6mmhos/cm.
 - (b) Manure shall contain not less than 1.0% nitrogen based on dry weight.
 - (c) All particles in manure shall pass a 6.35mm standard sieve.
 - (d) Manure shall be virtually free from weed and invasive plants and their seeds and reproductive parts, coliform, pathogens, rocks, sticks and rubble.

14.21 COMPOSTED LEAF OR WOOD WASTES

- .1 Submit samples of composted wood waste or leaf mould for chemical analysis to soil testing lab for consideration for use as an organic amendment in the 'A horizon' topsoil mix.
- .2 The total carbon to total nitrogen ratio in the composted leaf or wood waste shall not exceed 40:1.
- .3 Uncomposted wood wastes or leaves shall not be present in the topsoil mix.
- .4 Composted leaf or wood wastes must be virtually free from all viable weed and invasive plants and their seeds or other plant reproductive parts, coliform, pathogens and chemical or organic contaminants that may be detrimental to plant or animal health.

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- .5 Composted leaf or wood wastes must contain less than 0.5% by volume of contaminants such as rocks, plastic, metal or glass.
- .6 Refer to Section 14.29 for mulch specifications.

14.22 FERTILIZERS

- .1 Fertilizers shall meet the requirements of the Canada Fertilizer Act.
- .2 Types, formulations and rates of application of fertilizers and liming agents shall be as recommended by a laboratory soil specialist and based on test results of the growing medium.
- .3 Fertilizers shall be in granular, pellet or prill and must be dry and free flowing and have a guaranteed N-P-K analysis and be in manufacturer's original packaging, stored in waterproof containers clearly marked with the name of the manufacturer, weight and analysis.
- .4 Fertilizers shall be spread evenly over the placed growing medium with an appropriate mechanical spreader and incorporated into the grow medium.
- .5 There should be a minimum of at least three (3) weeks separation between the application of lime and fertilizers.
- .6 Lime may be added to the growing medium at the time of screening or cultivated into the top 100mm (4in) of growing medium after it is in place.

14.23 -NOT USED-

14.24 LIME

- .1 Lime shall be applied as per soil analysis recommendations.
- .2 Growing medium shall require not more than 0.5kg/m² (0.10lb/ft²) of dolomite lime to reach the required pH level.

14.25 WATER

- .1 Water for landscape installation shall be free from organic or chemical contaminants detrimental to healthy plant growth.

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14.26 PLANT MATERIALS

- .1 All plant materials shall meet or exceed the standards identified on the landscape construction drawings with respect to size, grading and quality.
- .2 Plants shall be characteristic of the genus, species and cultivar as indicated on the construction drawings and specified herein.
- .3 All plants shall be nursery grown under similar climatic conditions to the project site. Plants shall not be pruned prior to delivery unless pre-approved by the Engineer. Container stock shall have been established in the size of container specified for at least six (6) months prior to delivery. The roots shall not have grown beyond the limits of the container.
- .4 It is the Contractor's responsibility to verify and comply with all regulations regarding the inter-regional movement of plant material, including nursery stock, within the Province of British Columbia. Imported plant materials must be accompanied by copies of the necessary permits and import licences required by Federal and Provincial regulations.
- .5 Plants shall be properly proportioned; not weak, thin or elongated.
- .6 Plants shall have normal, well-developed branches and vigorous, fibrous root systems. They shall be healthy and free from defects, decay, girdling roots, sunscald injuries, abrasions of the bark, and plant diseases insect pests eggs, borers and all forms of infestation.
- .7 Trees shall have straight stems unless uncharacteristic for the species/cultivar. Pruning wounds shall show healthy callous growth at the branch collar without bark tearing or fungal growth. Cambium tissue shall be moist and exhibit the correct colouration for the species. Plants exhibiting fungal staining shall be rejected.
- .8 All plant materials shall conform to the measurements specified in the drawings except that plants larger than specified may be used if approved by the Engineer. The use of such plants shall not increase the contract price. If larger plants are used, the ball of earth shall be increased in proportion to the size of the plant. All plants shall be measured when the branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch tip to root base or from branch tip to branch tip. Where trees are measured by caliper (cal.), reference is made to the diameter of the trunk measured 300mm above ground as the tree stands in the nursery.
- .9 Native plants shall be propagated in nurseries and not harvested from wild sites, except where salvaged from an area where the native vegetation will be destroyed and authorization for harvest has been obtained. All collected native plants shall be held and maintained in a nursery until new roots have formed through the burlap or other suitable packing material, or in the case of containerized plants, until such time that the roots grow to fill and hold the soil within the container.
- .10 Collected plants shall not be used without prior approval in writing by the Engineer.
- .11 Balled and burlapped conifers and trees in excess of 3 metres height must have been dug with a sufficiently large firm rootball to contain 75% of the fibrous and feeder root system. Rootballs shall be free of invasive weeds.

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- .12 All nursery grown plant materials shall conform with the most current versions of the Canadian Nursery Landscape Association/Canadian Standards for Nursery Stock and the BCNTA Standard for Container Grown Plants.
- .13 A comprehensive pest management system should be developed to protect plants and trees which may have been weakened or stressed and made susceptible to disease and insect pressure due to disturbance during transportation, storage and planting.
- .14 Rootballs and soil in containers shall be free of invasive and noxious plants.

14.27 SOD

- .1 The quality and source of nursery sod shall comply with standards outlined in 'British Columbia Standard for Turfgrass Sod' published by Canadian Nursery Trades Association, and the B.C. Society of Landscape Architects, latest edition. Quality Grade shall be No. 2 Standard unless shown otherwise on the drawings. The turfgrass sod shall be grown from a seed mixture containing Kentucky Bluegrass (*Poa pratense*) or Turf-type Perennial Ryegrass (*Lolium perenne*) and not less than 40% by weight of Creeping Red Fescue (*Festuca rubra*). At time of site delivery, the sod shall contain not more than 2% of other strains or species of grass or clovers, and no visible broadleaf weeds, and shall be of sufficient density that no surface soil is visible when mowed to a height of 38mm.
- .2 The source of the sod shall be pre-approved by the City Engineer. Source substitutions shall not be made without the written approval of the City Engineer.

14.28 GRASS AND WILDFLOWER SEED MIXTURES

- .1 Grass seed mixture quality and source to comply with standards for lawns and grass outlined in the 'British Columbia Landscape Standard' published by the Canadian Nursery Trades Association, and the B.C. Society of Landscape Architects, latest edition. Seed mixtures are to be suited to the climate, terrain, establishment and maintenance conditions under which they are to grow. All seed mixtures are to meet the requirements of:
 - (a) Seeds Act
 - (b) The Provincial Weed Control Act
- .2 Fine grass seed mixture quality grade shall be Certified Canada No. 1, or as specified No. 2 Standard. Seed mixture shall contain the following: Perennial Turf Type Ryegrass (*Lolium perenne*) and/or Kentucky Bluegrass (*Poa pratense*), and not less than 40% by weight of Creeping Red Fescue (*Festuca rubra*) and/or Chewings Fescue (*Festuca rubra commutata*).

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- .3 Rough grass seed mix shall contain the following: less than 10% by weight Kentucky Blue (Poa pratense) grass and/or Turf-type Perennial Ryegrass Ryegrass (Lolium perenne), and not less than 50% by weight of Creeping Red Fescue (Festuca rubra) and/or Chewings Fescue (Festuca rubra commutata).
- .4 The wildflower seed mix shall be such that it meets the requirements of the Seeds Act and be free of any invasive plant species or potentially invasive species.
- .5 Nurse crop – Annual Rye grass (Lolium multiflorum).
- .6 The following invasive species must be removed from all sites:
- Bamboo - (Bambusa sp.)
 - Morning Glory - (Convolvulus arvensis)
 - Scotch Broom - (Cytisus scoparius)
 - English Ivy - (Hedera helix)
 - Giant Hogweed - (Heracleum mantegazzianum)
 - English Holly - (Ilex aquafolium)
 - Policemen's Helmet/Himalayan Balsam - (Impatiens glandulifera)
 - Dead-nettle Lamium - (Lamiastrum gleubdolon)
 - Purple Loosestrife - (Lythrum salicaria)
 - Himalayan Blackberry - (Rubus armeniacus) (discolour)
 - Evergreen Blackberry - (Rubus laciniatus)
 - Tansy - (Tanacetum vulgare)
 - Periwinkle Species - (Vinca major, Vinca minor)
 - Butterfly Bush – (Buddleja davidii)
 - Carpet Burweed – (Soliva sessilis)
 - Daphne/Spurge-Laurel – (Daphne laureola)
 - Eurasian Water-milfoil – (Myriophyllum spicatum)
 - Garden/Yellow Loosestrife – (Lysimachia vulgaris)
 - Lamium – (Aegopodium podagraria)
 - Burdock Species – (Arctium lappa, A. minus)
 - Common Tansy – (Tanacetum vulgare)
 - English Hawthorne – (Crataegus monogyna)
 - Hairy Cat's Ear – (Hypochaeris radicata)
 - Orchardgrass – (Dactylis glomerata)
 - St. John's Wort – (Hypericum perforatum)
- (REVISED NOVEMBER 2016)**
- .7 The following noxious species must be removed from all sites:
- Annual Sowthistle - (Sonchus oleraceus)
 - Bohemian Knotweed - (*Fallopia x bohemica*)
 - Bur Chervil - (*Anthriscus caucalis*)
 - Canada Thistle - (Cirsium arvense)
 - Common Reed - (*Phragmites australis* subsp. *australis*)
 - Crupina - (*Crupina vulgaris*)
 - Dalmatian Toadflax - (*Linaria dalmatica*)
 - Dense-flowered Cordgrass - (*Spartina densiflora*)
 - Diffuse Knapweed - (Centaurea diffusa)

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- Dodder - (*Cuscuta* spp.)
- English Cordgrass - (*Spartina anglica*)
- Flowering Rush - (*Butomus umbellatus*)
- Garlic Mustard - (*Alliaria petiolata*)
- Giant Hogweed - (*Heracleum mantegazzianum*)
- Giant Knotweed - (*Fallopia sachalinensis*)
- Giant Mannagrass / Reed Sweetgrass - (*Glyceria maxima*)
- Gorse - (*Ulex europaeus*)
- Himalayan Knotweed - (*Polygonum polystachyum*)
- Hound's-tongue - (*Cynoglossum officinale*)
- Japanese Knotweed - (*Fallopia japonica*)
- Jointed Goatgrass - (*Aegilops cylindrica*)
- Leafy Spurge - (*Euphorbia esula*)
- Milk Thistle - (*Silybum marianum*)
- North Africa Grass - (*Ventenata dubia*)
- Perennial Sowthistle - (*Sonchus arvensis*)
- Purple Loosestrife - (*Lythrum salicaria*)
- Purple Nutsedge - (*Cyperus rotundus*)
- Rush Skeletonweed - (*Chondrilla juncea*)
- Saltmeadow Cordgrass - (*Spartina patens*)
- Scentless Chamomile - (*Matricaria maritima*)
- Smooth Cordgrass - (*Spartina alterniflora*)
- Spotted Knapweed - (*Centaurea maculosa*)
- Tansy Ragwort - (*Senecio jacobaea*)
- Velvetleaf - (*Abutilon theophrasti*)
- Wild Oats - (*Avena fatua*)
- Yellow Flag Iris - (*Iris pseudacorus*)
- Yellow Nutsedge - (*Cyperus esculentus*)
- Yellow Starthistle - (*Centaurea solstitialis*)
- Yellow Toadflax - (*Linaria vulgaris*)
- Common Crupina – (*Crupina vulgaris*)
- Giant Reed – (*Arundo donax*)
- Kudzu – (*Pueraria Montana*)
- Poison Hemlock – (*Conium Maculatum*)
- Russian Knapweed – (*Acroptilon repens*)
- Jimsonweed/Devil's Apple – (*Datura stramonium*)
- Orange Hawkweed – (*Hieracium aurantiacum*)
- Saltwater Cordgrass – (*Spartina patens*)
- Wild Chervil – (*Anthriscus sylvestris*)

(REVISED NOVEMBER 2016)

14.29 MULCH

- .1 Bark mulch shall be 50mm and minus Douglas Fir/ Hemlock bark chips, dark brown in colour and shall be virtually free of invasive and noxious seeds and reproductive parts, soil, stones, salts or other harmful chemicals, or other extraneous matter that would prohibit seed germination or the healthy development of plant material.
- .2 Other mulch materials shall only be used when indicated in the drawings.

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- .3 Do not store bark mulch on paved sidewalks.
- .4 Mulch is not intended to replace vegetation as a sole ground cover, nor is it to be used as a growing medium in landscape applications.

14.30 PLANTING ACCESSORIES

- .1 The following products shall only be installed when indicated in the construction drawings.
 - (a) TREE STAKES - shall be nominal 50mm by 50mm wood or 75mm round pressure-treated wood, or equivalent to be pre-approved by the City Engineer.
 - (b) TENSIONING DEVICE – 19mm wide flat woven polypropylene or nylon webbing.
 - (c) ROOT DEFLECTING BARRIER - 61cm x 61cm copolymer polypropylene of 2.16mm thickness, 50% post consumer recycled plastic, with 12.7mm raised moulded root directing ribs c/w anti lift tabs.
 - (d) TREE GRATES - must be cast iron, aluminum or bronze and the safety standards of the castings are to meet the requirements as per ASTM A48. Tree grates shall be square or round in shape. Tree grates must be installed in a proper perimeter frame with non-tamper attachments and must allow for incremental enlargement to accommodate the tree growth and to protect the tree from injury. Patterns can vary to pertain to the project or neighbourhood aesthetics, however the opening dimensions of the decorative designs shall be less than 12mm in width or diameter. **(REVISED NOVEMBER 2016)**

14.31 REPLACEMENTS

- .1 All plant materials damaged or found not in a healthy satisfactory growing condition during the maintenance and guarantee period, or which, in any other way, do not meet the requirements of the specifications, shall be replaced at the Contractor's expense.
- .2 All required plant material replacements shall be by identical species/cultivar and size to the original, as indicated in the drawings.
- .3 Where identical replacements are not available, submit a written proposal to the City Engineer. Gain approval from the City Engineer prior to installation of the replacement plant materials.
- .4 Replacement shall be made at the next appropriate season to a maximum of four (4) months from identification of the requirement for plant replacement.
- .5 Replacement plants shall be maintained and guaranteed by the Contractor to the completion of the next full growing season, or the completion of the original maintenance and guarantee period whichever is later.

14.31A STRUCTURAL SOILS

- .1 Structural soils shall be used with the approval of the City Engineer.

SECTION 14 - LANDSCAPE SPECIFICATIONS

IRRIGATION

14.32 SCOPE

- .1 Irrigation work required includes supply of all materials, labor and equipment to install a complete and operational irrigation system as specified herein and as shown on the construction drawings including:
 - (a) Excavation, piping, valves, heads, drip emitters and devices, controller, and complete installation, testing, maintenance, adjustment and guarantee of the system.
 - (b) Water supply connection and backflow prevention including supply, excavation, installation, and testing in accordance to the B.C. Plumbing Code.
 - (c) 110 VAC and low voltage electrical wiring including supply, excavation and installation.
 - (d) Restoration of all existing landscape areas to condition prior to commencement of work on site, to the satisfaction of the Engineer.
 - (e) Inspection must be completed by the City Engineer during and after installation, and before the bond is released.
- .2 Only those products approved by the City Engineer and listed on the City of Nanaimo Approved Product List will be accepted for installation.

14.33 PERMITS AND FEES

- .1 Obtain all permits and pay required fees to any governmental agency having jurisdiction over the work. Inspections required by local ordinances during the course of construction shall be arranged as required. On completion of the work, satisfactory evidence shall be furnished to the City Engineer to show that all work has been installed in accordance with the ordinances and code requirements, including certificates from the Electrical Inspector.

14.34 STANDARDS

- .1 Work shall be in accordance with mechanical (plumbing) and electrical standards, codes and regulations including the following:
 - (a) The National Building Code of Canada and its supplements.
 - (b) Current C.S.A. and A.S.T.M. Specifications for pipe and fittings, including:

(i) copper pipe:	ASTM B42
(ii) PVC water pipe:	CSA B137.3 or ASTM D2241.
(iii) PVC fittings:	ASTM D2466 or ASTM D2467.
(iv) PVC solvent cement:	ASTM D2564.
 - (c) The B.C. Plumbing Code.

SECTION 14 - LANDSCAPE SPECIFICATIONS

- .2 Irrigation installers shall have the following qualifications:
 - (a) Irrigation Technicians Level 2 Certification,
 - (b) Low Voltage Electrical Certification and
 - (c) BCWWA Cross Connection Control Testers Certification.
- .3 All irrigation systems shall plan for future expansion. Sufficient wires, as requested by the City Engineer, shall be supplied at the time of installation from the controller to end of system where the potential for future expansion may exist. **(REVISED NOVEMBER 2016)**

14.35 ACCEPTABLE PRODUCTS

- .1 Acceptable products shall be in new condition with the size, manufacturer and features shown in the design. **(REVISED NOVEMBER 2016)**
- .2 If irrigation systems with products other than shown in the design are proposed, the Contractor shall undertake the following prior to commencing construction:
 - (a) Produce complete shop drawings showing the type and location of all heads and nozzle numbers, pipe location and sizes, and all part model numbers and specifications;
 - (b) Submit hydraulic calculation work sheets for the re-designed system to demonstrate that all parameters have been calculated;
 - (c) Submit the shop drawings in triplicate and gain the written approval of the Engineer.

14.36 IRRIGATION PLASTIC PIPING

- .1 Plastic pipe shall be semi-rigid, extruded from PVC resin type 1 grade 2 normal impact in accordance with applicable codes and standards.
- .2 All polyvinyl chloride (PVC) plastic pipe and fittings must be marked as to size and class and their pressure and strength rating must exceed that of one and one half times the working pressure of the system.
- .3 All PVC pipe shall be schedule 40 PVC.
- .4 Flow volumes and velocities shall always be considered to minimize head loss.
- .5 Flow velocities shall not be permitted to exceed 1.52 metres per second.
- .6 Specified pipes shall be rated at 1.5 times maximum operating pressure.

14.37 IRRIGATION PLASTIC FITTINGS

- .1 All plastic fittings shall be a minimum of schedule 40 PVC molded fittings.

SECTION 14 - LANDSCAPE SPECIFICATIONS

14.38 SWING JOINT ASSEMBLIES

- .1 Triple swing joint assemblies for all sprinklers shall consist of:
 - (a) 3 schedule 40 PVC street elbows (MIPT x FIPT)
 - (b) 1 schedule 80 PVC threaded nipple, length to suit (MIPT x MIPT)
 - (c) 1 schedule 40 PVC threaded tee (slip x slip x FIPT)
- .2 Triple swing joint assemblies for quick coupler valves shall consist of:
 - (a) 1 schedule 40 PVC threaded tee
 - (b) 2 brass threaded nipples, length to suit (MIPT x MIPT)
 - (c) 2 brass threaded elbows (FIPT x FIPT)
 - (d) 1 brass threaded street elbow (MIPT x FIPT)
 - (e) 1 brass threaded riser, 100mm (4") length, (MIPT x MIPT)

14.39 IRRIGATION METAL PIPE & FITTINGS

- .1 All metal pipe shall be copper except in quick coupler swing joint assemblies. All metal fittings shall be copper, brass or bronze as shown in the Standard Drawings.

14.40 SOLVENT CEMENT

- .1 Solvent cement and primer shall be of a type recommended for the PVC pipe class, schedule, and maximum size.
- .2 The Contractor shall ensure that the shelf life of the cement, as labeled by the manufacturer on the container, has not been exceeded.

14.41 SPRINKLER HEAD RISERS

- .1 Where risers are not of the pop-up type, sprinkler head risers shall be schedule 80 PVC pipe. Pipe shall be cut in a standard pipe cutting tool with sharp cutters. Ream only to full diameter of pipe and clean all rough edges or burrs. Cut all threads accurately with sharp dies. Not more than three (3) full threads shall show beyond fittings when pipe is made up. Use Teflon tape on all PVC threaded connections.

14.42 IRRIGATION BEDDING MATERIAL

- .1 Bedding within the pipe zone shall be in accordance with Section 4.17 – Bedding Within Pipe Zone, except that bedding material shall be well graded sand, with a minimum of 75mm on all sides of the irrigation pipe.

14.43 SPRINKLER HEADS

- .1 Sprinkler heads shall be as shown on irrigation construction plans. See legend and notes for correct model numbers and operating pressures.
- .2 Sprinklers shall perform to manufacturer's specifications including diameter of throw and gallonage at specified pressures.

SECTION 14 - LANDSCAPE SPECIFICATIONS

14.44 IRRIGATION VALVES

- .1 Valves are to be as shown on irrigation construction plans and shall have same size isolation gate valve. See legend and notes for correct model numbers.

14.45 IRRIGATION WATER SERVICE CONNECTIONS

- .1 All materials for water service connection including saddle, pipe, valves, water meter and chamber to be in accordance with Section 5 - Water Distribution System.

14.46 IRRIGATION CASING SLEEVES

- .1 Irrigation casing sleeves under sidewalks, driveways and road paving and/or through walls, shall be installed prior to the construction of the paved surfaces and/or walls. Sleeves to be SDR 35 PVC pipe, size as indicated on the drawings, with ends capped and staked until such time as irrigation pipe is installed.
- .2 The Contractor shall be responsible for locating all sleeves.
- .3 Irrigation sleeving to be between 300mm – 450mm below finished grade.

14.47 CONTROLLERS

- .1 Controller model numbers shall be as noted on the irrigation construction plans.
- .2 Automatic controllers shall provide all necessary features for programming as is shown on the irrigation design plan. Controllers shall be encased in a sturdy metal, lockable, weatherproof mounting box and must be easily accessible for maintenance. All electrical controllers shall be CSA approved or be of a type approved by local electrical authorities.
- .3 Refer to the City of Nanaimo Approved Product List for the controllers that are acceptable for installation.

14.48 MOUNTING LOCATION

- .1 Controller mounting shall be as noted on the irrigation construction plan.

14.49 VALVE BOXES

- .1 All in-line valves shall be grouped wherever possible and installed in plastic irrigation boxes with a solid lid marked "irrigation". Plastic shall have a minimum tensile strength of 45kPa as measured according to ASTM D 638 and shall be unaffected by moisture, light, corrosion and extreme temperatures. The valve box shall be sized to accommodate the number of valves grouped in the manifold with allowance for room to service the valves, minimum 75mm clearance. The valve boxes are to be bolted. Quantity as required; see irrigation construction plan. **(REVISED NOVEMBER 2016)**

SECTION 14 - LANDSCAPE SPECIFICATIONS

14.50 BACKFLOW PREVENTION DEVICE

- .1 Backflow prevention unit shall be supplied and installed where noted on the irrigation construction drawing. Such devices shall meet or exceed all local ordinances and requirements governing such a cross connection.
- .2 All cross connection control devices shall be successfully tested after installation by an active certified Cross Connection Control Specialist. A copy of the test results must be sent to the end user, City of Nanaimo Parks Operations.
- .3 Refer to the City of Nanaimo Approved Product List for the backflow prevention devices that are acceptable for installation. **(REVISED NOVEMBER 2016)**

14.51 24 VOLT CONTROL WIRING

- .1 24-volt electric control lines from controller to automatic valves shall be CSA approved direct burial minimum (#14 AWG TWU-40) wire of a different color than the 110-volt power to controllers.
- .2 Splicing shall be made with water-proof wiring kits. **(REVISED NOVEMBER 2016)**
- .3
 - (a) All wiring to be installed and tested in accordance to the most current B.C. Electrical Code.
 - (b) All wiring shall be protected by being bundled and taped at 3 meter intervals and installed beneath the irrigation line.
 - (c) All wire splices must be contained in a valve box.
 - (d) Sufficient extra wire shall be left in each valve box such that the splice may be lifted above grade. Wires shall be neatly coiled.
 - (e) White wire are only be used as the common wire and all other colors used shall be consistent from valve to controller.

14.52 POWER WIRING

- .1 All 110-volt AC wiring shall be installed in accordance Section 10 - Roadway Lighting and Traffic Signals.

14.53 GATE VALVES

- .1 Gate valves 50mm or larger shall be in accordance with Section 5.24 - Water Main Valves. Gate valves smaller than 50mm in size shall be bronze conforming to ASTM B62.
- .2 Gate valves or approved quarter turn ball valves shall also be used in any case where a manual drain valve is required.

14.54 QUICK COUPLING VALVES

- .1 Quick coupling valves, keys and valve boxes shall be as noted in the irrigation construction drawings.
- .2 Internal parts to be removable and with adjustable flow control.

SECTION 14 - LANDSCAPE INSTALLATION

PLANTING

14.55 SCHEDULING AND CO-ORDINATION

- .1 Topsoil shall not be handled in a wet or frozen condition or in any manner in which the soil structure is adversely affected.
- .2 Plant trees, shrubs, and ground covers only during periods that are normal for such work as determined by local weather conditions, and when seasonal conditions are conducive to successful adaptation of plants to their new location.

14.56 SHIPPING, STORAGE AND ON-SITE HANDLING OF PLANT MATERIALS

- .1 Co-ordinate shipping of plants and pre-planting preparation to minimize the time lapse between shipping and planting to ensure a maximum of (36) hours storage of plant material on-site.
- .2 Cover any plants not in a state of dormancy to prevent desiccation during transit.
- .3 During loading, transportation, off-loading, and planting, protect all trees against damage to stems and branches. Protect bark against chafing from chains, cables, equipment, or other trees by a wrapping of cardboard or burlap. Separate entangled tree branches without damage to branches.
- .4 Plants with broken or abraded trunks or major branches will not be accepted. Prune damaged twigs to ISA pruning guidelines using secateurs.
- .5 Unload and check all plants immediately upon arrival and water if necessary. Condition of plants should be documented by the contractor.
- .6 Immediately cover and protect bare root stock from damage to roots by frost, sun, and wind.
- .7 Handle material supplied in pots and containers by the container only to reduce breakage of branches and leaves.
- .8 Handle balled and burlapped plant materials with caution to maintain the firmness of the balls. No plants shall be used when the ball of earth surrounding the roots has been cracked or broken preparatory to or during the process of planting, or when the burlap, staves, and ropes required in connection with their transplanting have been removed.
- .9 Do not lift trees supplied in wire baskets by the trunk.
- .10 Keep plants in a moist condition at all times. Protect all plants against damage and/or drying out until they are planted on the site.
- .11 During the growing season, store all plants in containers, balled & burlapped or wire basket in an upright position if not planted immediately and take care to provide enough space between plants such that light reaches all portions of the plant in order to avoid burning when planted out.

SECTION 14 - LANDSCAPE INSTALLATION

- .12 Protect rootballs of balled and burlapped material by heeling in with material suitable to protect them from drying out (i.e., sawdust, peat moss, topsoil). Do not store containerized or balled & burlapped plants intended to be planted in the open in a building or in an area of low light intensity for a period exceeding 7 days. Keep all plants well-watered and protected from heat and frost.
- .13 Plants shall be acclimatized or “hardened off” against the environmental conditions of their final planting location and shall not be taken directly from shade houses or greenhouses and planted in drastically different environment. Preparation for the new environment should include an appropriate period of storage in an intermediate environment, managing fertilizer applications to avoid excessively lush growth and provision of a graduated watering regime.

14.57 PRE-PLANTING INSPECTIONS

- .1 Give 72 hours notice to the City Engineer for an inspection of plant material at a single plant material assembly point. The City Engineer must give approval of plant material in advance of commencement of planting work.
- .2 Acceptance of plant material by the City Engineer at its assembly point does not prevent rejection on-site prior to or after planting operation if, in the opinion of the City Engineer, the plant material has been damaged by the act or omission of the Contractor.
- .3 Give 24 hours prior notice to the City Engineer for each following required inspections:
 - (a) Prior to commencement of landscape work, give notice to the City Engineer and make the project landscape supervisor available for an on-site inspection of marked locations for planting and as-built conditions and site work by others. The City Engineer may alter the locations of plant material in the field.
 - (b) After excavation of plant locations, but prior to placement of sub-soil and installation of plant material, give notice to the City Engineer for inspection of the subgrades.
- .4 The City Engineer, at his discretion, may waive one or more of the pre-planting inspections, but this shall not impair the right to reject work or materials which have been damaged or in any way do not conform to the specifications.

14.58 EXCAVATION

- .1 The location of all planting pits shall be staked by the Contractor and approved by the City Engineer prior to excavation.
- .2 Tree pits, plantation beds and turf areas shall be tested for drainage by the following means: Dig a 250mm deep by 250mm wide hole at bottom of pit. Fill with water and allow to drain. Refill hole with water and time rate of fall of water. A rate of fall less than 25mm (1”) per hour indicates inadequate drainage for plant survival and shall be reported to the Engineer, prior to planting. No claim for poor drainage will be accepted after planting has taken place.
- .3 Tree planting pits shall be excavated to the dimensions indicated in the drawings. Pit sides wherever possible shall be dug with sloping sides at a preferred angle of 45°, scarified to

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remove glazing and provide a roughened soil interface. A minimum 300mm depth scarified layer of native soil shall be created in the bottom of the tree pit by such means that the layer remains uncompacted prior to the subgrade inspection by the Engineer. Remove all stones larger than 75mm.

- .4 Stockpile excavated soil near tree pit for use, if deemed suitable by testing of the soil testing laboratory.
- .5 Shrub beds shall be excavated to allow for a total of:
 - (a) 300mm layer of un-amended topsoil
 - (b) 150mm layer of 'A' horizon soil mix or as listed within Section 14.58.8, whichever is the greater depth.
 - (c) 50mm layer of bark mulch.
- .6 Areas of ground covers shall be excavated to allow for a total of:
 - (a) 150mm layer of un-amended topsoil.
 - (b) 150mm layer of 'A' horizon soil mix or as listed within Section 14.58.8, whichever is the greater depth.
 - (c) 50mm layer of bark mulch.
- .7 A minimum 150mm depth scarified layer of native soil shall be created in the bottoms of shrub or groundcover planting pits by such means that the layer remains uncompacted prior to the subgrade inspection by the City Engineer.

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- .8 Minimum depths of growing medium shall be in accordance to the British Columbia Landscaping Standards as followed:

	A	B	C
Application	Over prepared subgrade which retains some existing topsoil (which retains the "A" horizon)*	Over prepared subgrade where the subsoil drains rapidly	Over structures or where the subsoil drains poorly
<u>Low Traffic Lawn Areas:</u>			
Irrigated	100mm (4in)	150mm (6in)	150mm (6in)
Not Irrigated	100mm (4in)	150mm (6in)	230mm (9in)
<i>High Traffic Lawn Areas</i>	100mm (4in)	150mm (6in)	
<u>Planting Areas and Planters:</u>			
Ground cover areas	150mm (6in)	300mm (12in)	230mm (9in)
Small shrubs	300mm (12in)	450mm (18in)	300-500mm (12-20in)
Large shrubs	450mm (18in)	600mm (24in)	500-900mm (20-36in)
<u>Tree Planting Areas:</u>			
At each tree	1000mm (40in) deep for as large an area as possible around each tree. Recommended area 10m ² (108ft ²) or greater. The soil volume should reflect the severity of compaction and grading at the planting site.		
*The combined depth of the existing topsoil and the new growing medium shall meet the minimum depth requirements shown in column B and C.			

(REVISED NOVEMBER 2016)

14.59 TREE PLANTING

- .1 The Contractor shall examine the sub-grade before planting, and shall report any conditions or defects on-site which may adversely affect the performance of this section of the work to the Engineer prior to placing topsoil mix.
- .2 Root deflecting barrier shall only be installed when and as indicated on the construction drawings.
- .3 Soils to be placed in dry weather over relatively dry, approved, free-draining subgrade.

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- .4 Roughen bottom and sloping side surfaces of tree pit to remove glazing and provide a roughened soil interface prior to placement of tree and subsoil. Adjust elevation under where tree is to be placed so that the nursery soil line on the tree trunk will be 50mm above finish grade to allow for settlement.
- .5 Remove the upper third of the wire basket after placement in planting pit. With the tree in the planting pit untie and remove burlap and cord from top 1/3 portion of a balled & burlapped rootball. Completely remove, with care, imperishable containers from container-grown or bag -grown trees. **(REVISED NOVEMBER 2016)**
- .6 Prior to backfilling, the Contractor shall inspect the root system. Trees with the following defects shall be replaced at the Contractor's expense:
 - (a) Lack of root ball integrity,
 - (b) Broken or abraded structural or main roots,
 - (c) Presence of fungal mass or fruiting bodies and root discolouration,
 - (d) Poor root development with few fibrous roots, or
 - (e) Any other evidence of pathogenic or accidental injury.
- .7 Unwrap and spread out encircling roots and tease out roots growing at the outside of the rootball.
- .8 The tree shall be installed plumb and faced to provide the best appearance toward the primary viewing location, as determined by the City Engineer.
- .9 Place 2/3 depth of the sub-soil and water to remove air voids.
- .10 If indicated in the construction drawings, and prior to completion of backfilling, place tree stakes, avoiding penetration of the root system. Stakes shall be driven plumb and to a sufficient depth in the subgrade that the portion exposed above finish grade equals 1 metre height.
- .11 Place remaining 1/3 of sub-soil lightly boot tamping to remove air voids. Roughen surface prior to placement of 'A' horizon soil mix.
- .12 Place 150mm depth unamended topsoil then thoroughly till in all amendments specified in the soil analysis report to form the 'A' horizon. The Contractor shall not machine cultivate the soil above the root zone of the tree.
- .13 Ensure soil level does not exceed original nursery soil line. Form earth saucer to retain water over rootball and water in the tree.
- .14 Secure tree to stakes with counter-tensioned, non-twisted loops of 19mm polypropylene webbing stapled to the stakes, if required. **(REVISED NOVEMBER 2016)**
- .15 Unless otherwise indicated in the construction drawings, place 75mm bark mulch over soil surface.
- .16 Tree grate installation shall be as per the manufacturers specifications. Refer to Standard Drawing P-6.

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14.60 SHRUB AND GROUND COVER PLANTING

- .1 Shrub beds shall be a total of:
 - (a) 300mm layer of un-amended topsoil as specified in Section 14.16
 - (b) 150mm layer of 'A' horizon soil mix as specified in Section 14.18 or as listed within Section 14.58.8, whichever is the greater depth.
 - (c) 50mm layer of bark mulch.
- .2 Areas of ground covers shall be a total of:
 - (a) 150mm layer of un-amended topsoil as specified in Section 14.16
 - (b) 150mm layer of 'A' horizon soil mix as specified in Section 14.18 or as listed within Section 14.58.8, whichever is the greater depth.
 - (c) 50mm layer of bark mulch.
- .3 Compact unamended topsoil in shrub and groundcover beds to no greater than 80% of corrected maximum dry density. Roughen surface prior to placement of 'A horizon' soil mix.
- .4 For the 'A' horizon mix, place an additional 150mm lift of unamended topsoil over soil depths indicated in Section 14.60.1 or .2, then thoroughly till in all amendments specified in the soil analysis report. Lime, if required, may be added to the topsoil mix at the time of topsoil spreading. All other required fertilizers shall be added to the topsoil mix after it is in place. There should be at least one week between the time of application of lime and other types of fertilizer. Fertilizers shall be spread with a suitable mechanical spreader and be fully incorporated in to the topsoil mix to a minimum depth of 150mm.
- .5 Excavate individual pits in the placed topsoil mix for shrubs, to the same depth, and 1.5 times the width, of the container. Place shrubs to show the best side towards the primary viewpoint. Water shrubs in the pits prior to backfilling with the planting medium.
- .6 Rake shrub and ground cover beds to a smooth surface prior to placement of 50mm depth bark mulch layer.
- .7 Plant ground covers through bark mulch layer into the 'A' horizon layer below. The Contractor shall not plant ground covers into the mulch layer without full root burial in the soil.
- .8 Rake mulch layer to a smooth finish grade and water bed.

14.61 PRUNING

- .1 Trees which, at the time of planting, require the removal of damaged or diseased branches larger than 12mm diameter, that have broken leaders, or that have a damaged trunk, will be rejected by the City Engineer.
- .2 Pruning shall be limited to the minimum necessary to remove dead or damaged secondary branches or twigs, or to provide safe headroom adjacent to streets and sidewalks. Pruning shall be done in such a manner as to preserve the natural character of the plant.

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- .3 For pruning cuts 12mm diameter and smaller use clean sharp secateurs. The cut shall be perpendicular to the branch angle and located at the outside edge of the branch collar only, leaving no stub or bark tears.
- .4 Pruning cuts larger than 12mm shall be undertaken according to the current ISA Pruning Guidelines by a qualified person. The 3-cut method shall be employed using a clean sharp pruning saw.

14.62 CUTTING, SHIPPING, AND ON-SITE HANDLING OF SOD

- .1 Sod shall be in pieces approximately 0.84 sq.m. in area with the soil portion having a minimum depth of 19mm.
- .2 Co-ordinate shipping of sod to minimize the time lapse between shipping and laying. Co-ordinate with soil placement accordingly.
- .3 During transportation protect sod against drying.
- .4 Sod shall be installed 24 hours after delivery and within 36 hours after harvesting. Keep sod moist and cool if in the event of any delay in laying. The supplier shall provide, upon request, a label or statement certifying the quality grade, location of sod source and species of grass in the sod and that the sod meets the specifications for the stated grade.
- .5 During dry weather, water sod as necessary to ensure its vitality and prevent soil and root loss during handling.
- .6 During wet weather allow sod to dry sufficiently to prevent tearing during lifting and handling.
- .7 Roll or fold all sod prior to handling to avoid tearing or breakage.
- .8 Sod shall have a fibrous root system strong enough that a standard sized section can support its own weight without damage or tearing when suspended vertically by holding up the upper two corners.
- .9 Turfgrass sod shall not be harvested or transplanted when excessive moisture or dryness will result in damage to, or failure of the sod.
- .10 The height of the grass in the sod at the time of harvesting shall be between 40mm (1.15in) and 60mm (2.5in), except where otherwise specified.
- .11 Turfgrass sod shall be reasonably free from thatch. Up to 13mm (0.5in) of thatch (uncompressed) is acceptable. Commercial grade is exempt.
- .12 Turfgrass sod shall be free from visible diseases, detrimental fungi and damaging nematodes and soil-born insects, to the extent that with proper installation methods and initial maintenance, new turf will not deteriorate due to such causes.
- .13 All turfgrass sod shall be absolutely free from plants designated as noxious weeds, as per Section 14.28.7. Nursery turfgrass sod shall be free of broadleaf weeds, invasive species and undesirable grasses to the extent required for each quality grade. Field turfgrass sod shall contain not more than ten (10) weeds per 10m² (100ft²).

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- .14 Sod shall not be dropped or dumped from vehicles.
- .15 Sodded areas shall be protected with warning signs during rooting and the initial maintenance period.

14.63 SOD SCHEDULING AND WORKMANSHIP

- .1 Keep site well drained.
- .2 Do not lay sod during freezing temperatures or when the ground is frozen.
- .3 Sod placed between May 15 and September 15 shall require installation of an automatic irrigation system.
- .4 Clean up immediately soil or debris spilled onto pavement and dispose of deleterious materials.

14.64 LAYING OF SOD

- .1 Excavate and/or fill and prepare subgrade to a sufficient depth below finish grade to accommodate 150mm min. topsoil plus the thickness of the sod.
- .2 Scarify top 75mm surface of subgrade to produce an even loose-textured surface free of stones larger than 75mm. Remove and dispose of all roots and branches, and all plant parts of blackberry, horsetail, morning glory, Canada thistle or other noxious weeds. Remove and dispose of all paving materials, tar, building materials or other deleterious substances.
- .3 The Contractor shall inform the City Engineer of any existing sub-grade conditions which will adversely affect the work in this section.
- .4 The finished sub-grade shall be approved by the City Engineer prior to placement of topsoil.
- .5 Topsoil shall not be placed when in a wet or frozen condition.
- .6 Spread topsoil evenly over the approved sub-grade to a minimum depth of 150mm and compacted to maximum 85% modified dry density.
- .7 Where the soil analysis indicates the addition of granulated lime it shall be incorporated into the soil at the depth and rate specified by the soil testing laboratory at least 3 week prior to the application of fertilizer.
- .8 A turf starter fertilizer, as specified by the soil testing laboratory, shall be incorporated into the soil, at the depth and rate specified, a minimum of 48 hours prior to the laying of sod.
- .9 Immediately prior to sod placement, the finished topsoil grade shall be smooth, firm against footprints, with a fine loose-texture.

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- .10 Lay sod in rows, perpendicular to slope, smooth and even with adjacent areas and surfaces, and with joints staggered. Butt sections closely without overlapping or leaving open joints between pieces.
- .11 Water immediately after sod laying to obtain moisture penetration through sod into top 100mm (4") of topsoil mix.
- .12 When sod and soil has dried sufficiently to prevent damage, provide close contact between sod and soil by means of a 150 kg roller. Heavy rolling to correct irregularities in grade is not acceptable.
- .13 Provide adequate marking of sodded areas with warning signs, to be removed by the Contractor when sodding work has given a Notice of Acceptance.

14.65 SODDING INSPECTIONS

- .1 Give 24 hours prior notice to the City Engineer for each following required inspection:
 - (a) After excavation and preparation of the subgrade but prior to placement of topsoil give notice to the City Engineer for inspection of the subgrades.
 - (b) Notify the City Engineer when the sod is established for an inspection for acceptance.

14.66 SHIPPING, AND ON-SITE HANDLING OF SEED

- .1 Deliver and store grass seed in original container showing:
 - (a) Analysis of seed mixture and % of pure seed.
 - (b) Year of production and date and location when tagged.
 - (c) Net Mass.
 - (d) Percentage germination.
 - (e) Name and address of distributor.
- .2 All seeds to be stored in dry, weatherproof storage places and are to be protected from damage by heat, moisture, rodents or other causes until time of seeding.

14.67 SEEDING SCHEDULING AND WORKMANSHIP

- .1 Seed grass and/or wildflower mix during early spring or after the 15th of August to within two weeks of freeze-up.
- .2 Keep site well drained.
- .3 Perform work under optimum field conditions. Do not undertake seeding operation under adverse conditions including moisture, temperature, wind or scheduling related work.
- .4 Clean up immediately soil or debris spilled onto pavement and dispose of deleterious materials.

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14.68 SEEDING

- .1 Apply seed by Mechanical Dry Seeding method or Hydraulic Seeding method unless otherwise specified. Hand seeding shall only be carried out when site conditions preclude above methods and must be approved by the City Engineer.
- .2 Base application rates of fertilizers, seed mix, mulch and tackifier on analysis of season, climate, terrain, soil, and establishment and maintenance conditions affecting project.

14.69 MECHANICAL DRY SEEDING

- .1 Excavate or fill and grade smooth subgrade to within 150mm of finish grade in areas to be seeded with fine grass. Remove all deleterious and refuse materials. Place 150mm depth topsoil and fine grade removing humps and hollows. Rough grass/wildflower areas shall be seeded on the native sub-soil graded for drainage, and free of surface rocks and all deleterious materials.
- .2 Obtain Engineer's approval of topsoil grade and depth before starting seeding.
- .3 Sow during calm weather (winds less than 6mph) using equipment suitable for the area involved to the approval of the City Engineer. Sow half of the required seed in one direction and the remainder at right angles. Incorporate the seed into the soil a minimum depth of 6mm simultaneously or within one half hour after seeding operation. Mix carefully with light chain harrow or wire rake and roll area immediately afterward with water ballast type lawn or agricultural type roller.
- .4 Water with fine spray, avoiding washing out seed. Apply enough water to ensure penetration of a minimum of 50mm (2").
- .5 Re-seed at 2 week intervals where germination has failed.

14.70 HYDROSEEDING

- .1 Do not hydroseed fine grass areas without pre-approval from the City Engineer.
- .2 Thoroughly mix seed, fertilizer and hydraulic mulch in water slurry and distribute normally over surface area with approved hydraulic mulcher.
- .3 Measure quantities of each material to be charged into hydraulic seeder/mulch tank accurately either by mass or by common accepted system of mass-calibrated volume measurements. Add materials to tank while it is being filled with water and in following sequence: seed, fertilizer, and where applicable, mulch. Thoroughly mix materials into homogeneous water slurry and distribute uniformly over surface area with hydraulic seeder/mulcher.
- .4 Keep seeds for legumes in separate containers prior to seeding. If required, add legume seeds with standard product humus culture before mixing with grass/wildflower seed. Protect inoculated seed from exposure to sunlight for periods of over one-half hour. Use seed within eight hours from inoculation or to be re-inoculated.
- .5 After charging, do not add water or other materials to mixture in hydraulic mulcher.

SECTION 14 - LANDSCAPE INSTALLATION

- .6 Do not leave seed, fertilizer, mulch and water slurry in tank for more than 4 hours. Slurry left in tank over maximum time to not be used for seeding, dispose off-site.

14.71 HYDROSEEDING WITH MULCH

- .1 Prepare area to be seeded. Seed wildflowers/grasses and 25% of fibre mulch on the first pass, then seed the balance of mulch on the second pass.

14.72 EROSION CONTROL BLANKET

- .1 Prepare area and seed.
- .2 Apply blanket over designated areas in accordance with manufacturer's instructions.
- .3 Anchor blanket in accordance with manufacturer's recommendations which are to be used as minimum standard to ensure that blanket is held down to maintain firm contact.

14.72A STRUCTURAL SOILS

- .1 Structural soils shall be used with the approval of the City Engineer.

IRRIGATION

14.73 EXISTING CONDITIONS

- .1 Ensure that existing site features and improvement areas are disturbed as little as possible. Protect existing vegetation throughout installation and do not damage root systems. Return all areas to prior condition immediately after irrigation installation and testing.
- .2 Prior to excavation, the Contractor shall satisfy himself as to the finished grade elevations and density of compaction in existing lawn and planting areas, to ensure restoration of disturbed areas to grades and compaction matching existing.
- .3 Existing sod removed to accommodate irrigation installation shall be preserved in a healthy condition and replaced subsequent to installation and backfilling, or replaced with new sod.
- .4 Notify Engineer if trenching is required through paved areas. The Contractor shall saw-cut and remove paving to the width of the trench. Removal and replacement of paving to match existing shall be the responsibility of the Contractor.
- .5 Where trenching for piping or wiring is required through paved roadway areas, provide 150mm ID SDR 35 sleeve with minimum 600mm depth cover. Extend sleeve minimum 300mm into soft landscape areas.

SECTION 14 - LANDSCAPE INSTALLATION

14.74 DELIVERY AND STORAGE

- .1 Shipping and handling and installation of materials shall be to manufacturer's recommended instructions, and best workmanship. Particular care shall be taken to avoid scratches and nicks on the plastic pipe. Pipe must be properly stacked and stored in a clean place on the site, keeping dirt out of the pipe at all times.

14.75 WORKMANSHIP

- .1 Lay out work as accurately as possible to the construction drawings. Install swing joints, offsets and all fittings to bring the pipe and heads to the location shown.
- .2 If shop drawings or field adjustments to the design are made, the Contractor shall be responsible for full and complete irrigation distribution, and coverage of all irrigated areas and to add any changes made to the as-built drawings.

14.76 EXCAVATION AND TRENCHING

- .1 All trenching and backfilling to be in accordance with Section 4 - Trench Excavation, Bedding and Backfill, and in addition:
 - (a) Excavated materials shall be carefully placed adjacent to the trench in separate piles to avoid contamination of topsoil and excavated materials.
 - (b) Perform all excavations as required for the installation of the work included under this section, including shoring of earth banks to prevent cave-ins. Restore all surfaces, existing underground installations, etc., damaged or cut as a result of the excavations to their original condition and in a manner approved by the City Engineer.
 - (c) Excavations through existing landscape areas shall be carried out such that adjacent areas are not contaminated with excavated materials. Backfilling and replacement of topsoil shall be performed in accordance with the specifications such that all existing planting areas are restored to their original condition.
 - (d) Trenches shall be made wide enough to allow a minimum of 50mm between parallel pipe lines. Trenches for pipe lines shall be made of sufficient depths to provide the minimum cover from finish grade as follows:
 - (i) 45mm minimum cover over main lines
 - (ii) 300mm minimum cover over lateral lines to heads.
 - (iii) 100mm minimum over drip lines
- .2 Maintain all warning signs, barricades and other safety devices in accordance with the Section 3 – General Requirements.

14.77 WATER AND ELECTRICAL SERVICE CONNECTION

- .1 Water Service Connection shall be in accordance with Section 5 – Water Distribution System, and as shown on the construction drawings.
- .2 Contractor shall have a qualified Electrician connect the controllers to the electrical supply.

SECTION 14 - LANDSCAPE INSTALLATION

14.78 PIPE LINE ASSEMBLY AND INSTALLATION

- .1 Do not drag pipe along ground whether single lengths or assembled sections. Damaged pipe shall be rejected and replaced by new pipe and couplings.
- .2 Keep pipes clean at all times, blow out with compressed air or water on completion of assembly.
- .3 Plastic pipe shall be laid on sand to a compacted depth of 75mm. A further 75mm depth of sand shall be placed over plastic pipe prior to backfilling.
- .4 Plastic pipe and fittings shall be solvent welded using solvents and methods as recommended by manufacturer of the pipe, except where threaded connections are required. Pipe and fittings shall be thoroughly cleaned of dirt, dust and moisture before applying solvent with a non-synthetic bristle brush. All PVC pipe shall be installed in accordance to Section 5.0 – Water Distribution System.
- .5 Pipe may be assembled and welded on the surface. Snake pipe slightly from side to side to allow for expansion and contraction.
- .6 No irrigation line shall be installed so that it runs parallel and directly over another such line or utility.
- .7 Leave minimum clearance of 50mm between irrigation lines laid in a common trench.
- .8 Make all connections between plastic pipe and metal valves with threaded fittings using plastic male adapters.
 - (a) Screw fittings shall be carefully tightened with strap wrenches or by other means that do not mark the plastic pipe or plastic fittings.
 - (b) Pipe wrenches shall not be used on plastic fittings, unless the fittings are a type designed for use with a pipe wrench. Use teflon tape on all threaded fittings.

14.79 VALVES AND CONTROL WIRING

- .1 Install valve boxes such that top of structure is at finished grade, accessible for maintenance, in accordance with Section 5 – Water Distribution System
- .2 24-volt wiring of valves to controller shall be undertaken by a certified low energy systems tradesman.
- .3 All 24-volt wiring shall be a different color than the 110-volt power to controller and shall be buried a minimum of 300mm as per the amended B.C. Electrical Code.
- .4 Coil additional 600mm length of each electrical wire within valve box as extra material.
- .5 Splicing shall be minimized. Splices are to be made waterproof with the use of water-proof wiring kits and installed in a valve box as per Standard Drawing No. I-1. **(REVISED NOVEMBER 2016)**

SECTION 14 - LANDSCAPE INSTALLATION

14.80 SPRINKLER HEADS

- .1 Install all sprinklers according to manufacturer's specifications.

14.81 CLOSING OF PIPE AND FLUSHING LINES

- .1 Cap or plug all openings as soon as lines have been installed to prevent the entrance of materials that would obstruct the pipe. Leave in place until removal is necessary for completion of installation.
- .2 Thoroughly flush out all water lines before installing heads, valves and other hydrants.
- .3 Test in accordance with Section 14.83 – Backfill and Compacting.
- .4 Upon completion of the testing, the Contractor shall complete assembly and adjust sprinkler heads for proper distribution.

14.82 HYDROSTATIC TESTS

- .1 Request the presence of the City Engineer at least 48 hours in advance of testing.
- .2 Testing to be accomplished at the expense of the Contractor and in the presence of the City Engineer.
- .3 Center load piping with small amount of backfill to prevent arching or slipping under pressure.
- .4 After welded plastic joints have cured at least 24 hours, fill test section with water and expel all air and cap risers for an additional 24 hours prior to testing. Contractor shall pre-test the circuits, and call the City Engineer for a supervised test once the circuits to be demonstrated meet the test requirements. Contractor shall supply and temporarily install, until tests are approved, a pressure gauge and hosebib to each main and circuit to be tested. Tests to be conducted at 1.5 times the maximum operating pressure (continuous and static water pressure) in the presence of the City Engineer as follows:
 - (a) Main lines and sub-mains to be tested for 1 hour.
 - (b) Lateral lines to be tested for 15 minutes.
 - (c) Pressure loss on the pressure gauge shall not exceed 10% of the test pressure in the time period of the test.
- .5 Repair leaks resulting from tests by cutting out and replacing pipe or fittings. Leaks shall not be repaired by patching. Maintain test pressure for a minimum of one hour after replacement of defective parts and re-inspect as per Section 14.83 – Backfill and Compacting, clause 14.83.4.

SECTION 14 - LANDSCAPE INSTALLATION

- .6 After approval by the City Engineer, backfill excavations, maintaining pressure in the lines. If there is any indication of a leak, the defective section shall be located and replaced. Flush out the system to remove dirt and then attach the sprinklers using a thread seal tape (PTFE tape). **(REVISED NOVEMBER 2016)**

14.83 BACKFILL AND COMPACTING

- .1 After system is operating and required tests and inspections have been made, backfill excavations and trenches.
- .2 All sprinkler head excavations shall be backfilled with sand or topsoil up to within 50mm of finish grade.
- .3 Trenches to be backfilled in accordance with Section 4 – Trench Excavation, Bedding, and Backfill.
- .4 Ensure that existing lawn and planting areas are disturbed as little as possible.
- .5 Dress off all areas to finish grades.

14.84 CLEAN-UP

- .1 Remove from the site all debris and surplus material resulting from work of this section.

14.85 BALANCING AND ADJUSTMENTS

- .1 Balance and adjust all components of the system to achieve the most efficient system operation. Balancing and adjustment to include synchronization of controllers and soil moisture sensors, adjustments to pressure regulators, pressure relief valves, sprinkler heads and individual station adjustments on controllers.
- .2 Lawn sprinkler heads shall be set flush with the final turf grade by shortening or lengthening the riser as required. During the maintenance period, return and adjust the heads as required to be flush with the final turf grade.

14.86 DRIP COMPONENTS

- .1 Install according to the manufacturers' specifications.
- .2 Keep pipe ends and components absolutely clean during installation.
- .3 Check and clean filter one week after system start-up. Check and clean filter monthly thereafter during the operating season of the maintenance period.

SECTION 14 - LANDSCAPE MAINTENANCE

LANDSCAPE MAINTENANCE

14.87 SCOPE

- .1 The area of maintenance operations will be all constructed or altered landscape areas in this Contract.
- .2 Landscape maintenance operations shall meet the "Moderate" Maintenance Level in accordance with the BC Landscape Standard, 2008 Edition, unless otherwise specified herein or subject to a separate agreement.

Moderate Maintenance Level Definition (from BC Landscape Standard, 2008 Edition)	
<i>Objectives</i>	Main objective is a generally neat, moderately groomed appearance, with some tolerance for the effects of "wear and tear," moderate traffic and natural processes.
<i>Appearance Standard</i>	Plants and lawns are healthy, lawns kept within accepted height range for type; invasive plants, with the exception of listed noxious weeds and debris are acceptable within limits between regular visits. Invasive and noxious weeds shall be eradicated. Seasonal plantings in good condition and attractive at appropriate seasons.
<i>Typical Locations</i>	<ul style="list-style-type: none"> • Most residential, commercial and institutional sites, especially those of medium to large size • Publicly visible portions of industrial sites • Areas for occasional recreational use • Areas viewed from a medium distance
<i>Plant Characteristics</i>	Areas may include some native or naturalized planting; this may be modified for appearance or moderately intensive use.
<i>Traffic Activity Levels</i>	Moderate traffic tolerated; minor deterioration due to traffic is acceptable. Maintenance may include adjustments in response to such "wear and tear".
<i>Maintenance Practices</i>	Routine maintenance of moderate frequency and intensity, with regular monitoring to avoid serious deterioration.

- .3 Litter control and garbage pick-up, other than construction clean-up during and after work performed in this Contract, will be supplied by others, or will be subject to a separate agreement.
- .4 The maintenance period shall be from the time of planting until one year from the date of Notice of Acceptance of the landscape works or at the discretion of the City Engineer, or will be subject to a separate agreement.
- .5 Maintenance operations for trees, shrubs and ground covers shall include:
 - (a) Watering, weeding, pest and disease control, remedial pruning;
 - (b) Plant replacements as required;
 - (c) Supplemental fertilization as specified by the soil testing laboratory;
 - (d) Spring and fall clean-up;
 - (e) Planting beds shall be maintained to be weed-free.

SECTION 14 - LANDSCAPE MAINTENANCE

- .6 Maintenance operations for sodded and seeded lawn/fine grass areas shall include: watering, mowing, weeding, topdressing and reseeding as required to meet conditions set out in 14.99, throughout the maintenance and guarantee period.
- .7 Maintenance operations for rough grass, nurse crop, and wildflower areas shall include: mowing, weeding, topdressing and reseeding as required to meet conditions set out in 14.100 and 14.101, throughout the maintenance and guarantee period.
- .8 Maintenance operations for irrigation system shall include: monitoring and adjustment of system, repair as necessary, and winterization and spring startup of the system.
- .9 Maintenance operations should, where possible, follow ecologically sound practices such as:
 - (a) Integrated Pest Management (IPM)
 - (b) Plant Health Care (PHC)
 - (c) Composting
 - (d) Application of Organic Mulches

14.88 REFERENCE STANDARDS

- .1 Refer to Section 14.12 for reference standards for landscape maintenance.

14.89 QUALIFICATIONS AND WORKMANSHIP

- .1 A qualified professional, for this Section, refers to any individual who is trained as and is certified and recognized, such as:
 - (a) Diploma in Horticulture
 - (b) Landscape Horticultural Journeyman with a Certificate of Qualification by the Industry Training Authority of BC
 - (c) ISA Certified Arborist
- .2 All landscape maintenance personnel shall be skilled in the tasks assigned to them.
- .3 Supervisors for landscape crews shall be qualified professionals.
- .4 Pesticide handling and application shall be done only by applicators holding current certification within the comprehensive pest management system.

SECTION 14 - LANDSCAPE MAINTENANCE

14.90 PROTECTION

- .1 All existing and new plants, site services, curbs, paving, structures, finishes and all other features shall be protected against damage during the work. Refer to Section 3 of these specifications.
- .2 Appropriate measures shall be taken to ensure that no spillage of fuels, fertilizers, toxic construction materials, or other toxic wastes occurs, and where use of such materials is necessary, to ensure that adequate containment facilities and clean-up equipment are utilized.
- .3 No toxic or waste materials, fuels and fertilizers shall be stored adjacent to or dumped into water courses or any other water body either on or off the job site, or in a location where spillage could result in seepage into a watercourse.
- .4 All toxic wastes and other material shall be disposed of in a manner acceptable to the Owner and in accordance with municipal, provincial and federal regulations.

14.91 HANDLING AND STORAGE OF CHEMICALS

- .1 Chemicals used during the course of maintenance procedures shall be limited to those that are registered and meet all federal, provincial and regional/municipal regulations and bylaws.
- .2 Application, disposal and handling of all chemicals including, but not limited to, herbicides, pesticides, fungicides and insecticides shall comply to all applicable legislation and regulations, including, but not limited to, the federal Pest Control Products Act, Fisheries Act and Food and Drugs Act; and the provincial Integrated Pest Management Act, Wildlife Act, Weed Control Act, Plant Protection Act and Waste Management Act, the City of Nanaimo Pesticide Use Bylaw 7102 as well as any municipal or regional district legislation.

14.92 VANDALISM

- .1 Refer to Article 30 of the Section 2 - General Conditions.

14.93 END OF MAINTENANCE PERIOD

- .1 Notify the City Engineer, 30 days in advance of the end of the maintenance period.

14.94 PRODUCTS AND MATERIALS

- .1 Products and materials used in landscape maintenance operations shall meet the requirements of the specifications and referenced standards.

14.95 EQUIPMENT

- .1 The Contractor shall supply all equipment, materials and all other supplies necessary to maintain the Contract landscape area.

SECTION 14 - LANDSCAPE MAINTENANCE

- .2 Equipment shall be suited to the work at hand, and shall be in good condition. Mowers shall have clean, sharp blades. Safety devices shall be in place and functioning to Workers' Compensation Board requirements.
- .3 Pruning equipment shall be kept sharp and sterile to prevent the spread of plant diseases.
- .4 Equipment shall be such that the risk of spillage, inadvertent spraying or miss-direction of oil, gasoline, fertilizers or other chemicals is minimized.
- .5 Spray equipment shall be of a type which can be adjusted with respect to spray pattern and application rate. Do not use airblast, mist, or fog sprayers. Hose mounted sprayers shall be equipped with a check valve rated for the prevention of backflow, to be located within 1 metre of the water source shut off valve.

14.96 WATER

- .1 Water supply other than the irrigation system will be the responsibility of the Contractor or subject to separate agreement.
- .2 Base cost of this work on hand watering as required, and supplemental to the irrigation system if one is supplied, or in cases of breakdown.
- .3 Supply all equipment such as pumps, hose, portable sprinklers, tank trucks, etc. if required for watering operations.
- .4 Water used for landscape maintenance shall be free from organic or chemical contaminants detrimental to healthy plant growth.

14.97 SCHEDULING

- .1 Schedule operations to the type of plant materials being maintained, the intensity and pattern of use of the site, and the seasonal weather patterns.
- .2 Adjust maintenance frequency and intensity to the weather patterns of the particular year.
- .3 Schedule watering operations to meet the following criteria:
 - (a) To provide water just prior to, or during, early daylight hours for maximum plant uptake,
 - (b) To not impede the use of sidewalks or other paved areas during daylight hours, and
 - (c) In accordance with any watering restrictions in effect at the time.

14.98 TREES, SHRUBS AND GROUND COVERS

- .1 The Contractor shall undertake the following maintenance operations for trees shrubs and ground covers for the duration of the maintenance period:
 - (a) Monitor all plants at least once per month during the growing season for pest and disease signs: to ensure prompt treatment, minimum damage, and to minimize treatment intensity. Where the application of a pesticide is warranted, notify the City Engineer prior to treatment.

SECTION 14 - LANDSCAPE MAINTENANCE

- (b) (b)The Contractor shall be required to compensate the Owner for damage caused to non-target plants from the misapplication of herbicides.
- (c) The Contractor shall immediately notify the City Engineer, of any major insect, fungal or other pathogenic infestation or disease which will adversely affect the health of the plant materials. If, in the opinion of the Engineer and the City Engineer, the condition cannot be remedied prior to Acceptance, the affected plant materials shall be replaced by the Contractor, at no cost to the Owner.
- (d) Provide adequate water during the growing season to ensure healthy turgid growth. During the period from April 15 to September 15, the combined weekly total of natural precipitation and irrigation or water supplied by the Contractor shall be not less than the equivalent of 38mm of precipitation.
- (e) Maintain the mulched areas of shrub and ground cover beds, and at the bases of trees, in a clean, uncompacted, weed-free and grass-free condition. Ensure the total removal of all root parts of weeds. Do not mechanically cultivate over the root zone of any plant material.
- (f) Remove fallen leaves, twigs and trimmings in a timely fashion to prevent rot, damage to the surrounding landscape, impeded area drainage, or public inconvenience.
- (g) Pruning shall only be undertaken in accordance with 14.61. Except as indicated below, or as recommended for a particular species in the technical horticultural literature, prune plant materials during the late autumn after leaf drop or in early spring prior to bud break. Prune trees of the following genus' in autumn only: Betula, Cladastris, Laburnum, Liriodendron, Magnolia. Prune shrubs which bloom on the previous year's growth, shortly after blooming.
- (h) Do not fertilize trees planted in the spring until the following spring. Do not fertilize trees planted in the summer or fall until the following spring. Apply only a controlled release complete fertilizer, at the rate recommended by the soil testing laboratory.
- (i) Fertilize shrub and ground cover beds with a complete slow release fertilizer in accordance with the recommendations of the soil testing laboratory.
- (j) Trees which are staked shall be inspected periodically for state of repair, correct tensioning and for signs of stem abrasion or constriction. Unless otherwise instructed by the City Engineer, the stake shall be removed by the Contractor prior to, and as a condition of, final payment at the end of the maintenance period.

14.99 FINE GRASS AREAS

- .1 Maintain fine grass areas to the 'Moderate' standard set out in the BC Landscape Standard 2008 Edition .
- .2 Provide sufficient water to keep the sod root zone moist until firmly rooted.
- .3 If area was seeded, keep soil moist during germination period and adequately water grassed areas until accepted by the City Engineer. Apply water to ensure moisture penetration 75mm to 100mm. Control water to prevent washouts. Seeded areas to be adequately protected with warning signs, temporary wire or twine fences, or other necessary means.
- .4 Subsequent to rooting, program irrigation to provide alternate day watering for a total weekly precipitation rate of 38mm during the growing season.

SECTION 14 - LANDSCAPE MAINTENANCE

- .5 Topdress and reseed areas which are dead or bare and keep moist until fully established. Use a seed mix that matches the varieties found in the sod or original seed mix.
- .6 Weeding must be done when isolated small weed patches (no greater than 4 patches per 5 sq. m) have a width of 150mm. Weeding (mechanical or chemical) shall kill or remove 90% of weeds or the process shall be repeated within the next two site visits.
- .7 Mow at a time and frequency required to maintain the lawn at a height between 62mm and 38mm.
- .8 Remove and dispose of clippings at each mowing.
- .9 At each mowing, trim grass at interface with all non-turf elements such as curbs, pavement surfaces, walls, mulched areas beneath trees, and shrub beds. Do not allow the line on a string trimmer to come into contact with any plant material other than the sod.
- .10 Using a sharp edging tool, vertically cut an edge at the perimeter of all shrub beds and mulched areas under trees, three times during the growing season.
- .11 Fertilize sod in accordance with the recommendations of the soil testing laboratory at the prescribed interval and rate, and with the type of fertilizer appropriate to the stage of the growing season. Fertilize a minimum of twice during the growing season.
- .12 Fertilizer shall be spread with a mechanical spreader that can be calibrated for an even application of fertilizer at a controlled rate.

14.100 ROUGH GRASS AND WILDFLOWER

- .1 Mow rough grass once every thirty days. Mow to maximum height of 100mm. Wildflower mixes to be mowed once in the spring to a height of 150mm.
- .2 Maintain areas free of invasive and noxious species.
- .3 Refer to Section 14.28 for specifications.

14.101 NURSE CROPS

- .1 Mow crop once every 30 days. Mow to maximum height of 150mm.
- .2 Cut crop prior to going to seed to ensure the annual species do not reseed.

14.102 IRRIGATION SYSTEM

- .1 Maintenance of the irrigation system shall include:
 - (a) Monitoring of the irrigation controller functioning and scheduling;
 - (b) Adjustment of risers and nozzles for the designed coverage;
 - (c) Monitoring and cleaning of drip filters and emitters;
 - (d) Repair or replacement of defective or damaged components; and
 - (e) Winterization of the system at the end of the growing season, and spring startup.

SECTION 14 - LANDSCAPE MAINTENANCE

- .2 Winterization shall include flushing, draining, and shut-off of all system components.
- .3 Spring startup shall include filter cleaning, system charging, monitoring and adjustments.

SECTION 15 – VALVE & METERING ENCLOSURE

MEASUREMENT AND PAYMENT

MEASUREMENT AND PAYMENT

Piping and Fittings	6.70
Additional Excavation and Backfill	6.71
Rebench Existing Manhole	6.72
Abandon Existing Air Valve/Blowdown Chamber	6.73
Air Valve c/w Chamber	6.74
Blowdown c/w Chamber	6.75
Chase River Crossing	6.76

SECTION 15 – VALVE & METERING ENCLOSURE

MEASUREMENT AND PAYMENT

The Contractor will note that the tendered price for all items specified in this section will include all work to be completed within the Valve and Metering Enclosure.

15.1 VALVE CHAMBER DEMOLITION

Payment for demolition of the existing valve chamber at the Chase River Pump Station will be paid at the lump sum shown in the Tender Form. This price shall include removing all equipment and pipework, plugging existing pipes with concrete, supply and installation controlled density fill, removal of upper section of the manhole, backfill, compaction, site restoration and all related work shown on the Contract Drawings.

15.2 PRE-FABRICATED ENCLOSURE

Payment for the pre-fabricated Valve and Metering Enclosure will be paid at the lump sum shown in the Tender Form. This price will include the engineering, fabrication and installation of the enclosure and all related work, including but not limited to supply and installation of the gutter, drain spout, and splash pads as shown on the Contract Drawings and Specifications.

15.3 ENCLOSURE FOUNDATION AND SURFACE FINISHING

Payment for the Valve and Metering Enclosure foundation and surface finishing will be paid at the lump sum shown in the Tender Form. This price shall include excavation, backfill, grading, materials, structural fill base slab, reinforced concrete foundation including coating, penetrations and pipe sleeve installation, asphalt installation, surface finishing to align with adjacent grade, and all related work shown on the Contract Drawings.

15.4 PIPE, VALVE, FITTINGS & INSTRUMENTATION

Payment for the pipes, valves, fittings and instrumentation to be installed within the Chase River Pump Station boundary will be paid at the lump sum shown in the Tender Form. This price shall include supply and installation of the piping, valves, fittings and instrumentation (flowmeter and pressure transmitter), pipe supports within the above ground Valve and Metering Enclosure. The price shall also include below ground piping, valves, valve boxes, fitting, and thrust blocks for tie-in connections, drains, electrical conduits and the air valve release piping. The price shall include excavation, supply of materials, backfill, surface restoration and all related work as shown on the Contract Drawings. This price also include testing as specified, and all work incidental thereto.

15.5 RETAINING WALL

Payment for the pre-cast concrete block retaining wall for the Valve and Metering Enclosure will be paid at the lump sum shown in the Tender Form. This price shall include excavation, backfill, supply of materials, pre-cast concrete blocks and all related work shown on the Contract Drawings.

15.6 BOLLARDS

Payment for the bollards around the Valve and Metering Enclosure will be made at the unit price shown in the Tender Form. This price shall include excavation, backfill, supply of materials, and surface restoration and all related work shown on the Contract Drawings.

SECTION 15 – VALVE & METERING ENCLOSURE

MEASUREMENT AND PAYMENT

15.7 FENCING

Payment for the fencing around the Valve and Metering Enclosure will be made at the unit price per linear metre shown in the Tender Form. This price shall include supply and installation of a chain link fence to connect to the existing fence at the Chase River Pump Station and all related work shown on the Contract Drawings.