January 17, 2019 – BCBEC

BUILDINGSMART

With Site and Foundation Drainage

Presenters:

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Acknowledgements

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Aviva Insurance
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Building Knowledge Inc.
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City of North Vancouver
City of Richmond
City of Surrey
City of Vancouver
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District of North Vancouver
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Institute of Catastrophic Loss Reduction
National Research Council
Norton Engineering Inc.
RDH Building Science Inc.
Township of Langley
Travelers Insurance
University of Toronto
WSP Group

Speaker

HORIZON ENGINEERING INC

www.horizoneng.ca

Established in 1997; 20 staff / 14 engineers; 4,500 projects

Consulting for new construction and renovations/retrofits

- Drainage consulting and remediation
- Geotechnical assessments
- Slope stability analyses
- Excavation shoring design
- Retaining wall design

Speaker

RDH BUILDING SCIENCE www.rdh.com

- New Construction
- Existing Buildings - Repair, Renewal, and Rehabilitation
- Research, Energy & Forensics (Building Science Laboratories)

James Higgins

- Building Science Technologist
- 6+ years with RDH
- Building enclosure design, forensic investigations, building monitoring, thermal analysis, field review, and testing services
- Industry education and guideline development

Key Drainage Topics

I. Geology and Ambient Groundwater Conditions

II. Lines of Defence
- Site Drainage
- Foundation Drainage
- Building Envelope

III. Guide Order Follows Construction Stages

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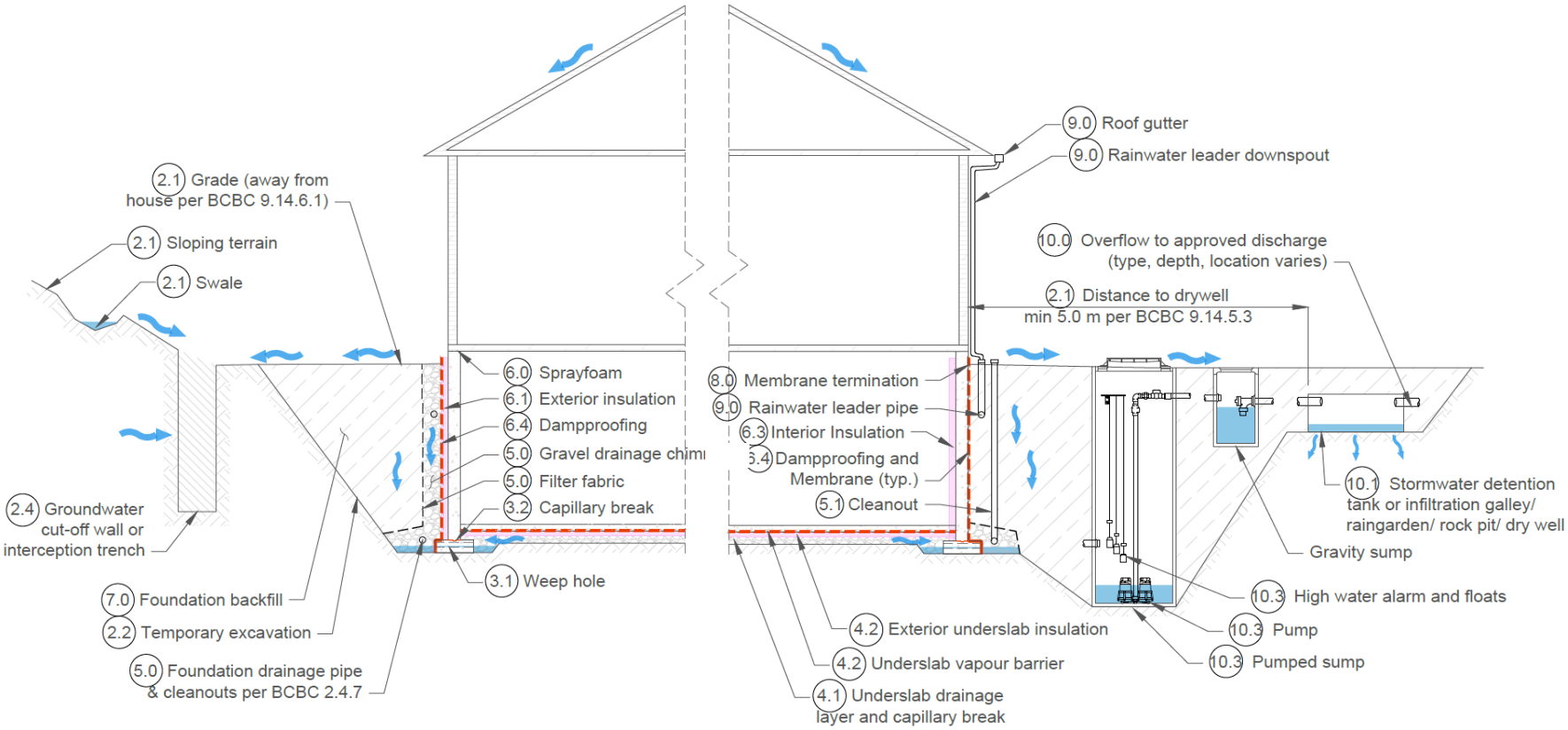
Guide Wayfinder



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Key Enclosure Topics

Foundation wall and slab

- **Moisture Barrier**
- Insulation
- Air Barrier

Transitions/details

- Footing to foundation wall
- Below-grade to above grade
- Concrete slab

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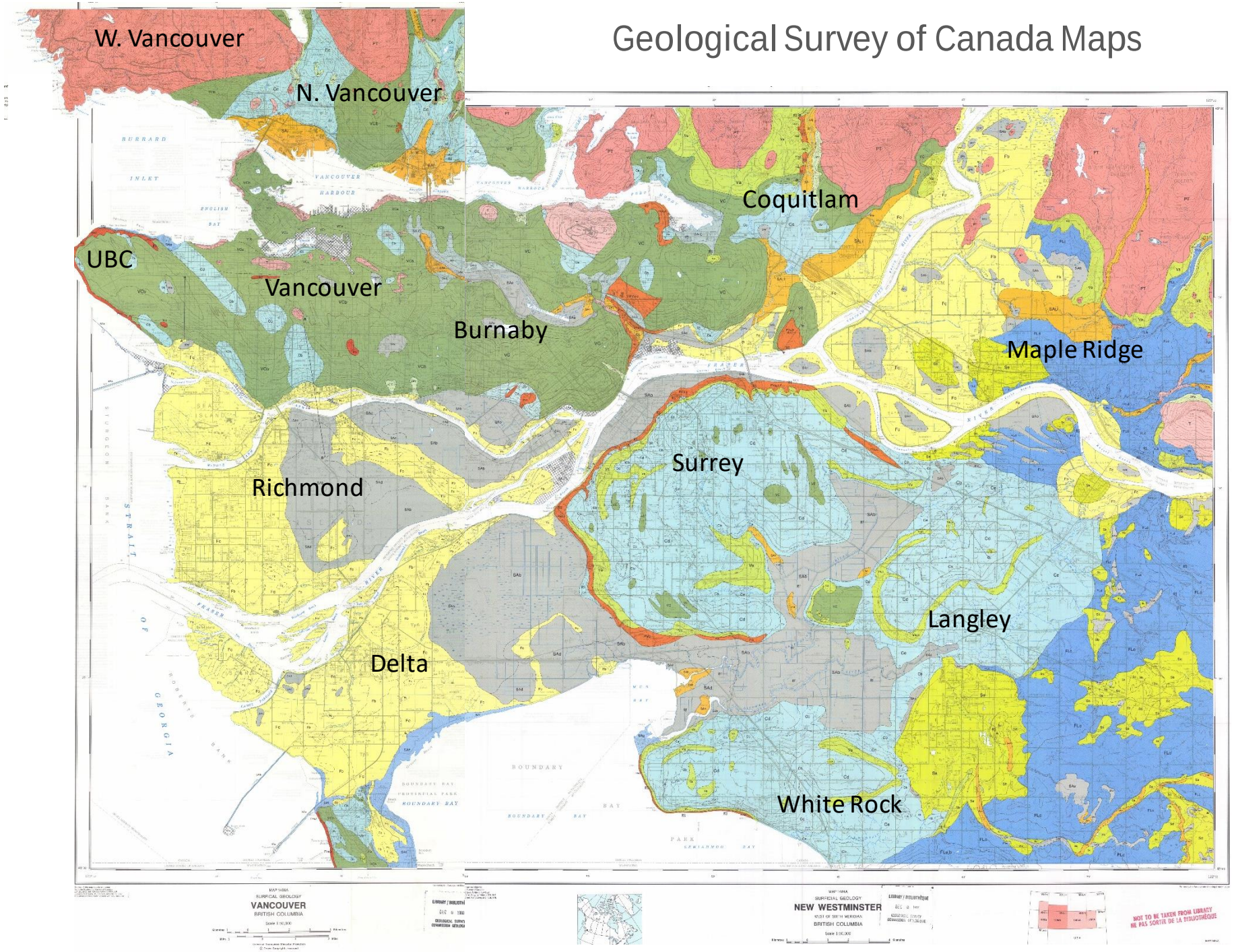
Failure Investigations

Question:

"Where is the water and what is it doing?"

not adequately addressed

Geological Survey of Canada Maps



VANCOUVER'S OLD STREAMS

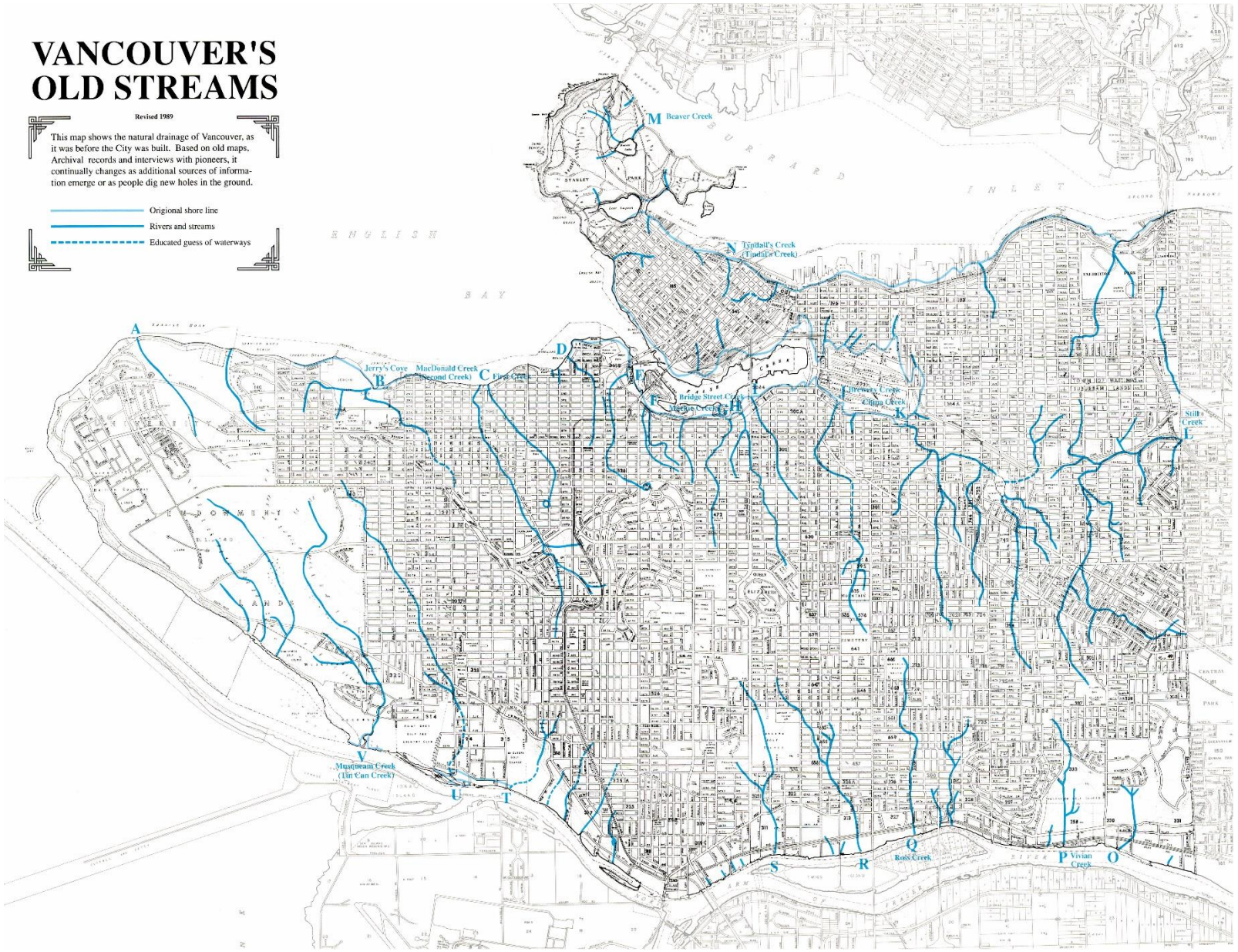
Revised 1989

This map shows the natural drainage of Vancouver, as it was before the City was built. Based on old maps, Archival records and interviews with pioneers, it continually changes as additional sources of information emerge or as people dig new holes in the ground.

Origional shore line

Rivers and streams

Educated guess of waterways



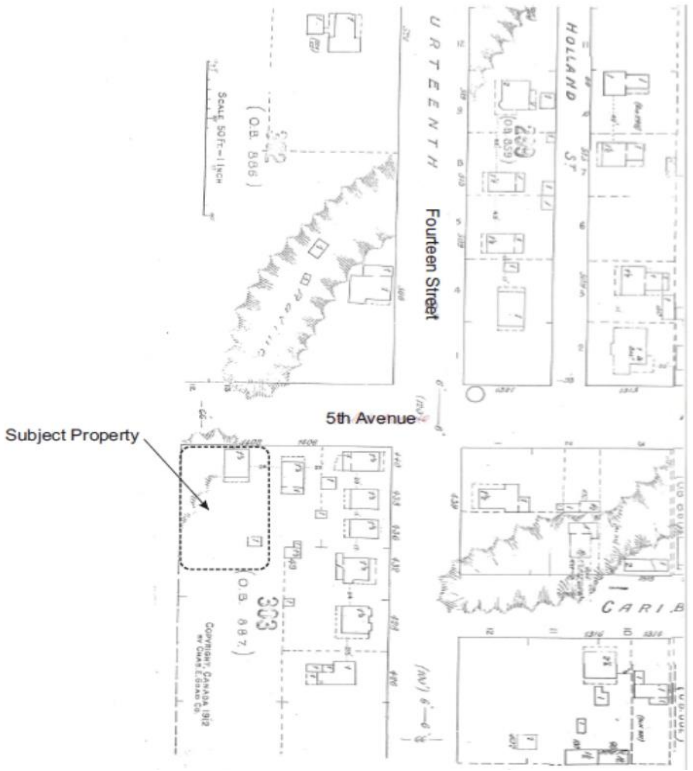
Other Maps

Engineers with local experience

Historical aerial photos

Maps

- Topographic
- Geological
- Old streams
- Fire insurance



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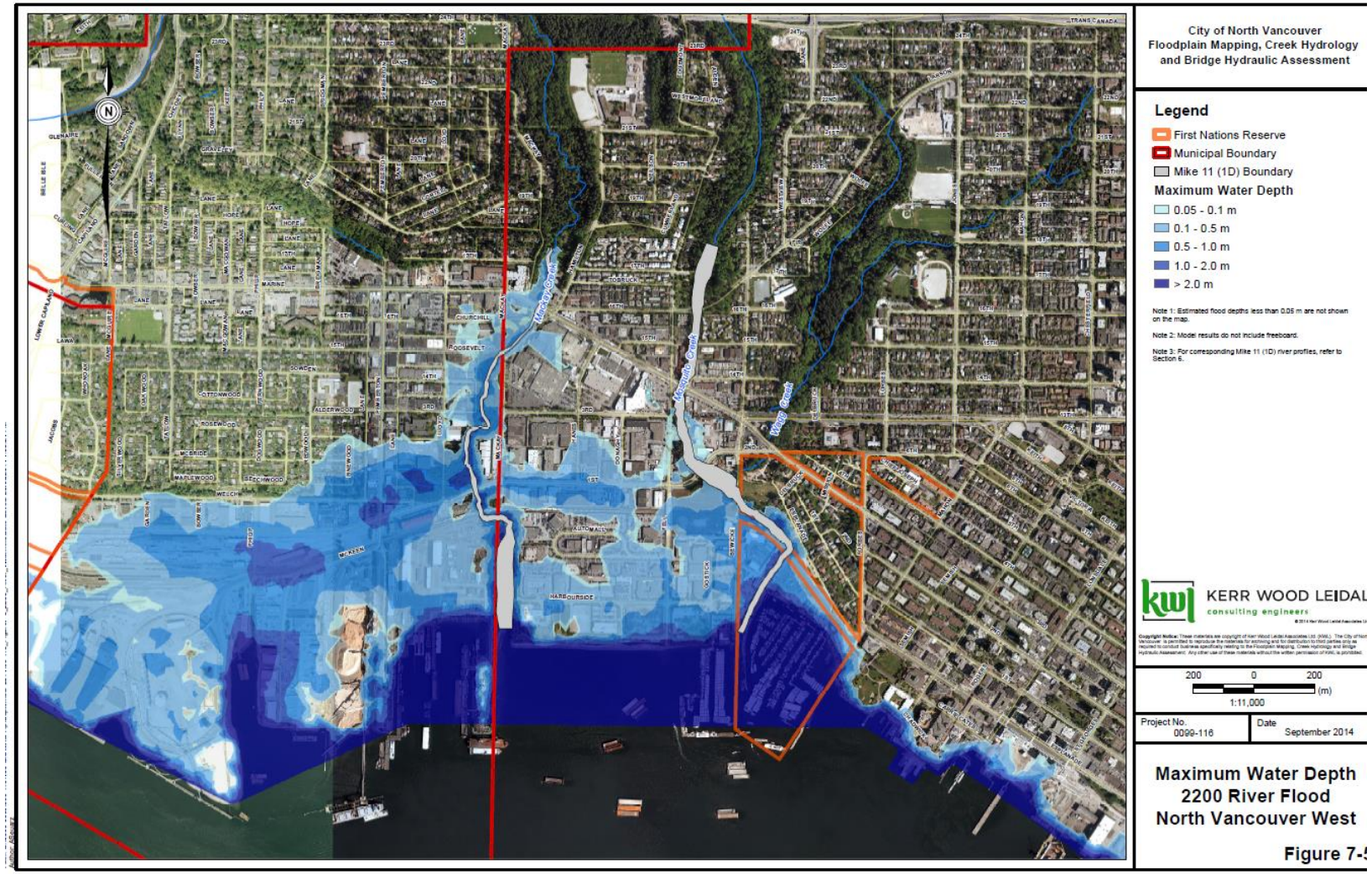
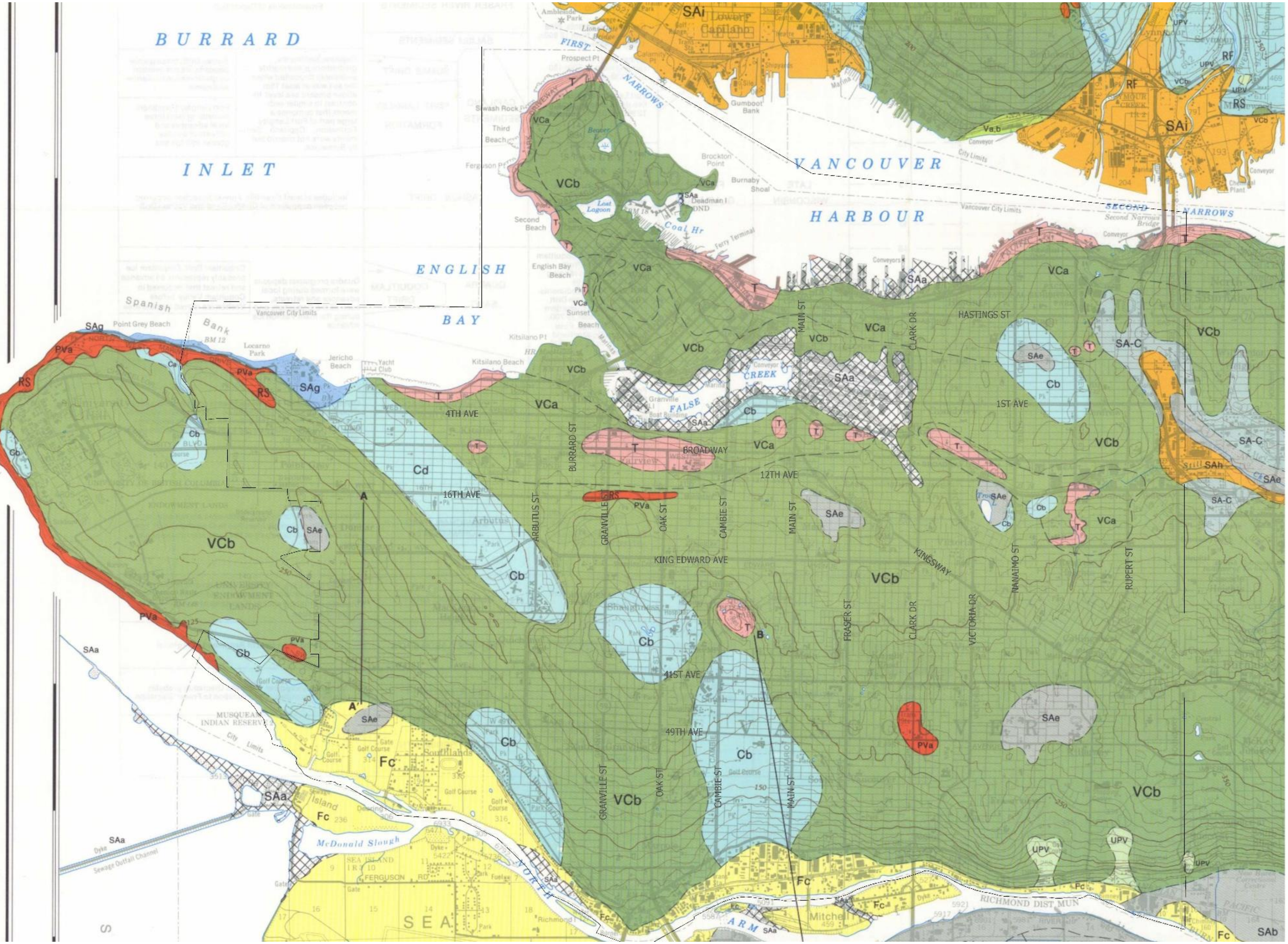
Flood Elevations & Q200



Flood Elevations & Q200

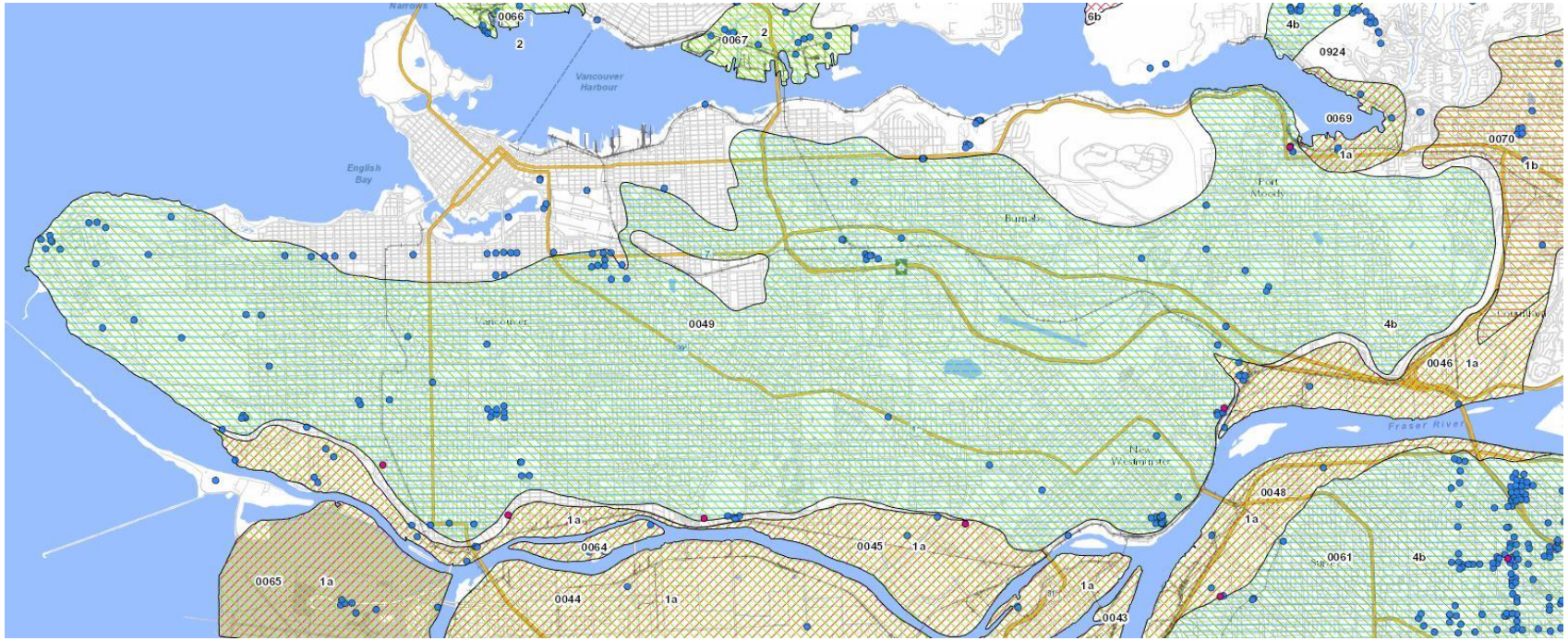
- Karen's blog
  - http://www.horizoneng.ca/wordpress/resources/karens-blog/flood-elevations/

- Ministry of Environment

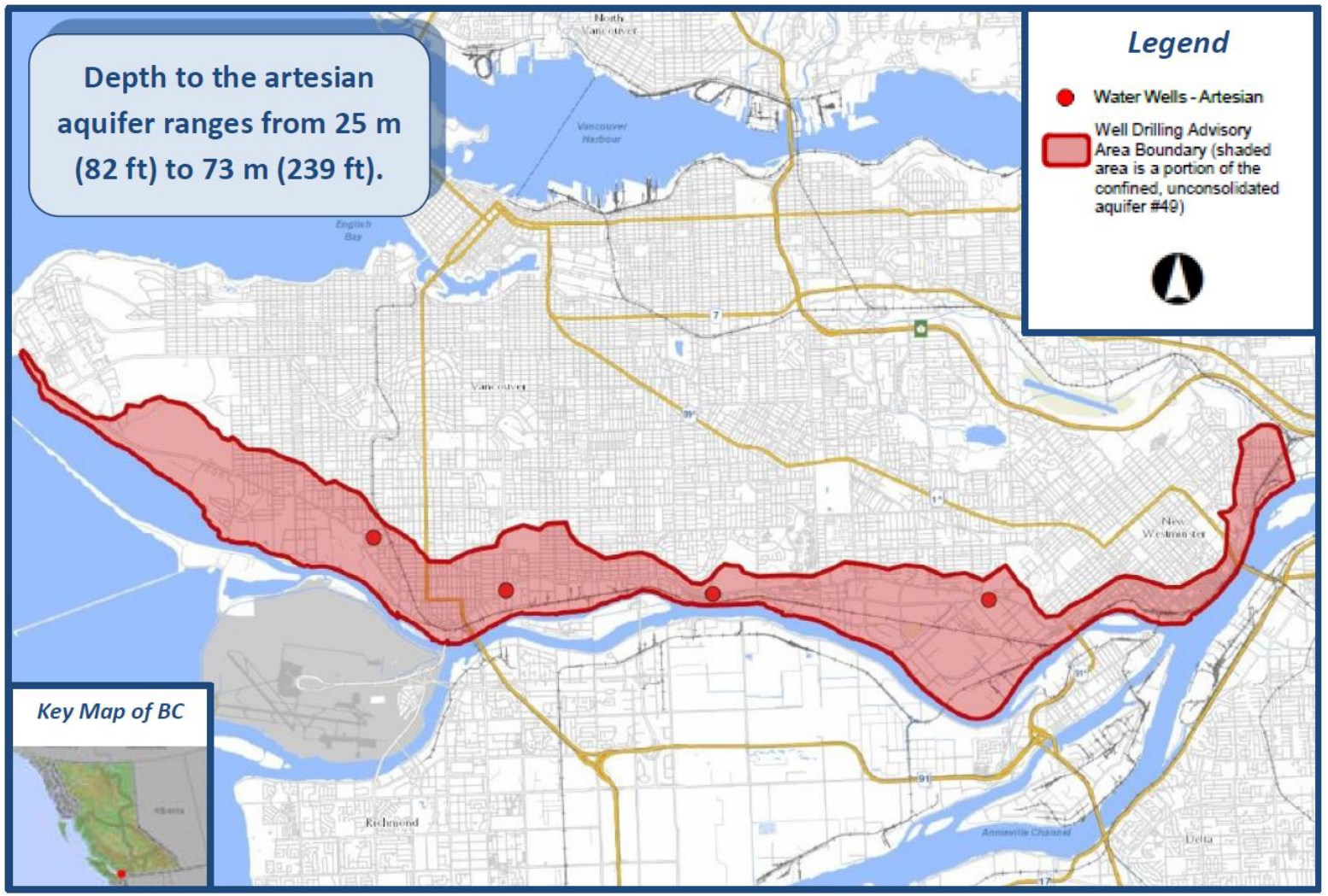


BURRARD
INLET
ENGLISH BAY
VANCOUVER
HARBOUR
FIRST NARROWS
SECOND NARROWS
FALSE CREEK
Coal Hr
Lost Lagoon
McDonald Slough
NORTH ARM
SEA
Spanish Bank
Point Grey Beach
Locarno Park
Jericho Beach
Kitsilano Beach
Kitsilano Pt
English Bay Beach
Sunset Beach
Second Beach
Third Beach
Ferguson Pt
Siwash Rock
Prospect Pt
Brockton Point
Burnaby Shoal
Deadman I
Ambleside Park
Lower Capilano
Gumboot Bank
Vancouver City Limits
MUSQUEAM INDIAN RESERVE
Sea Island
RICHMOND DIST MUN
Mitchell
FERGUSON RD
Southlands
4TH AVE
BROADWAY
12TH AVE
16TH AVE
KING EDWARD AVE
41ST AVE
49TH AVE
1ST AVE
HASTINGS ST
KINGSWAY
BURRARD ST
ARBUTUS ST
GRANVILLE ST
OAK ST
CAMBIE ST
MAIN ST
FRASER ST
CLARK DR
VICTORIA DR
NANAIMO ST
RUPERT ST
A
A'
B
VCa
VCb
Cb
Cd
SAe
SAa
SAg
SAi
SAh
SAb
SA-C
PVa
RS
RF
T
Fc
UPV
Va,b
Ca

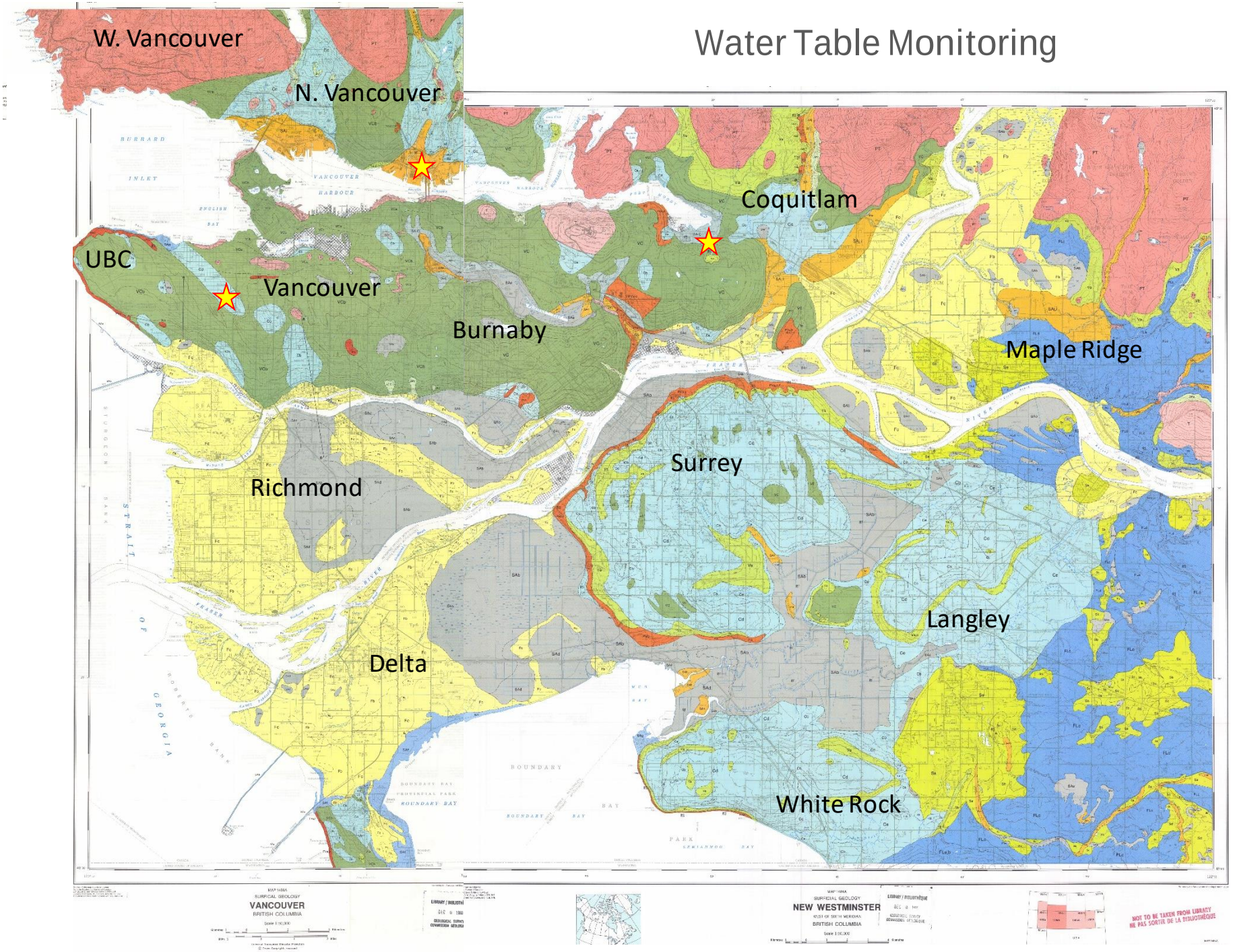
Quadra Sand Aquifer

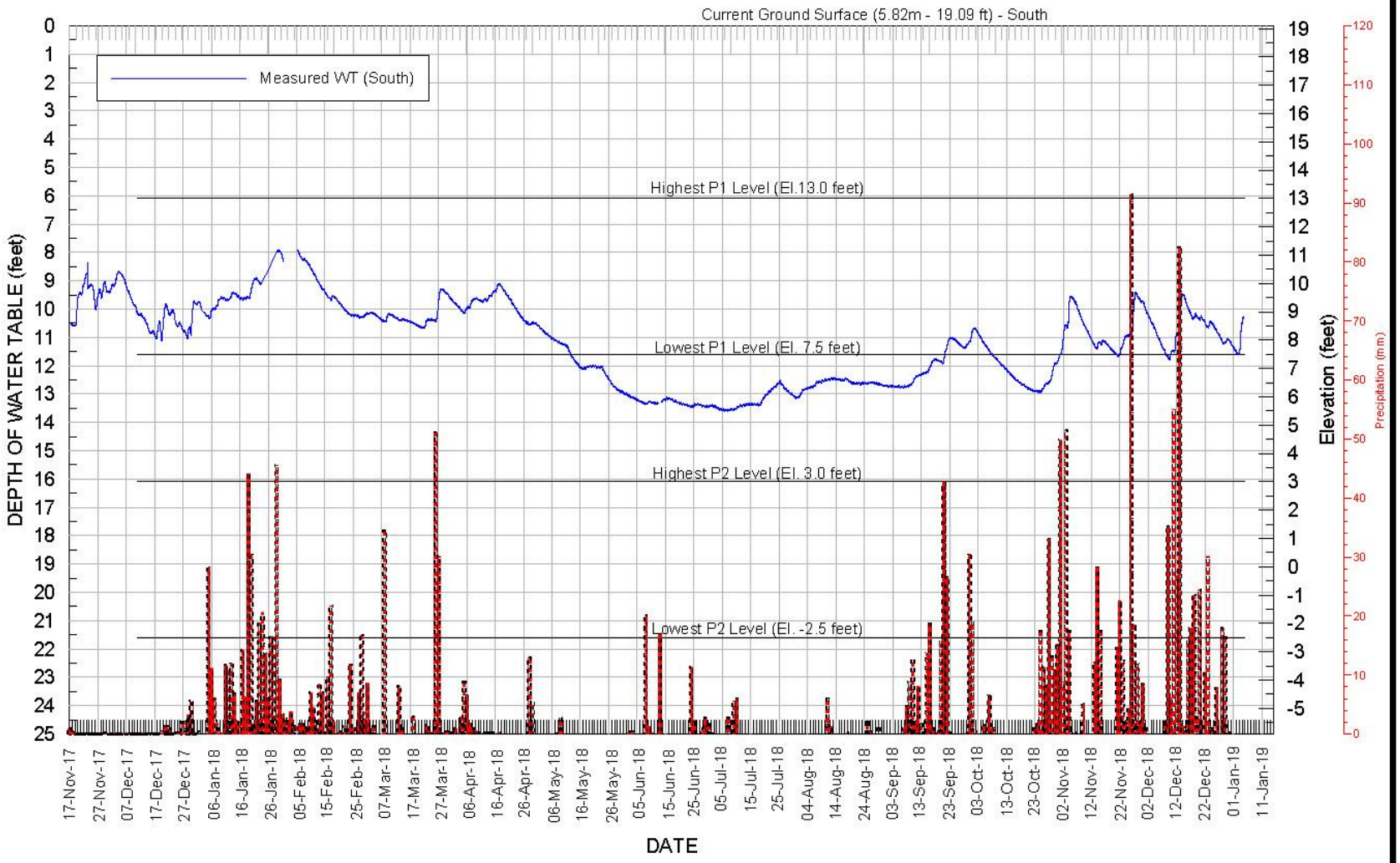


Artesian Well Drilling Advisory



Water Table Monitoring





N:\2014 Projects\114-9552 BC Housing Drainage Bulletin\Standpipe Piezometers\117-4268 Water Level Monitoring Reversed Y Scale File7 Draft.grf

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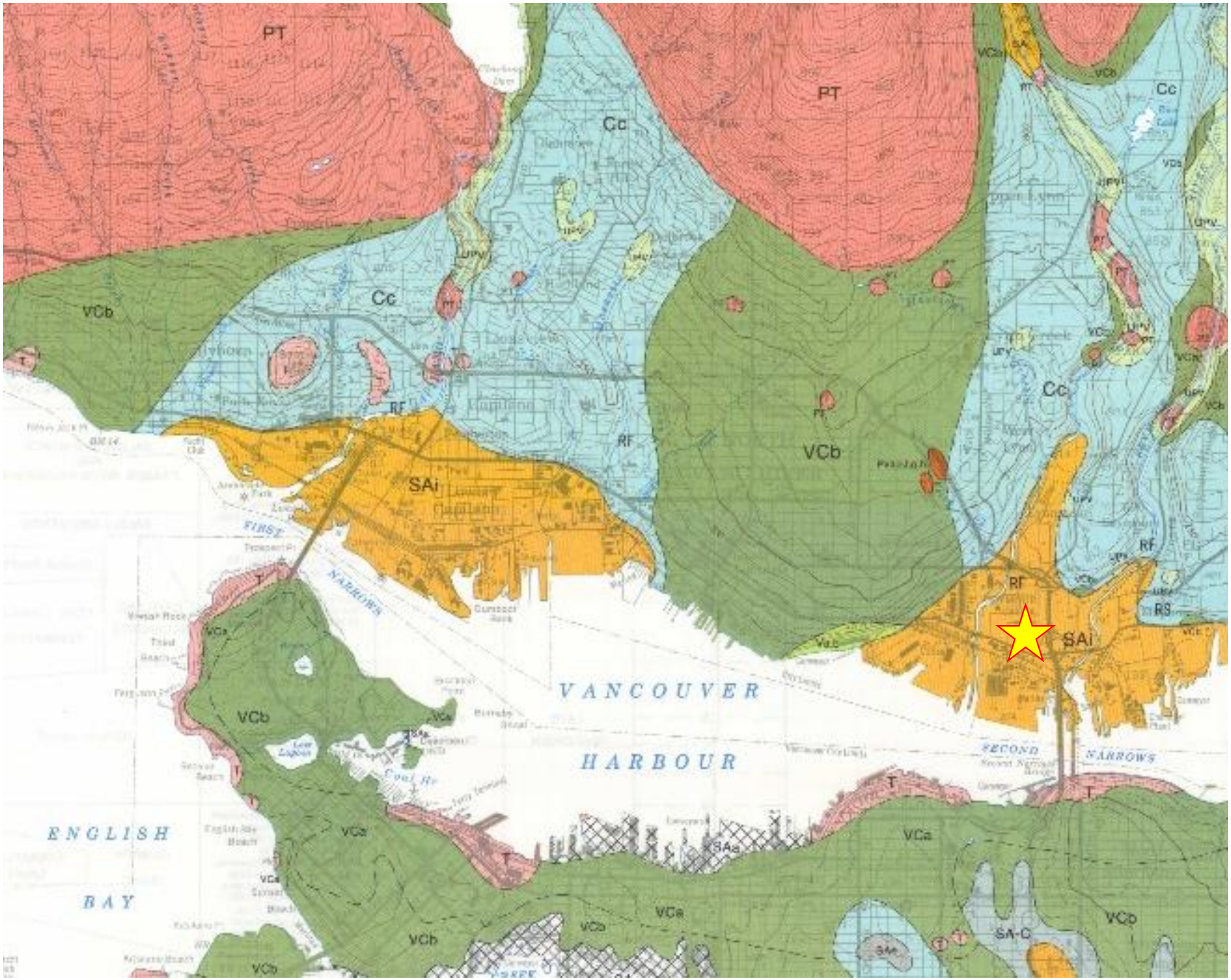
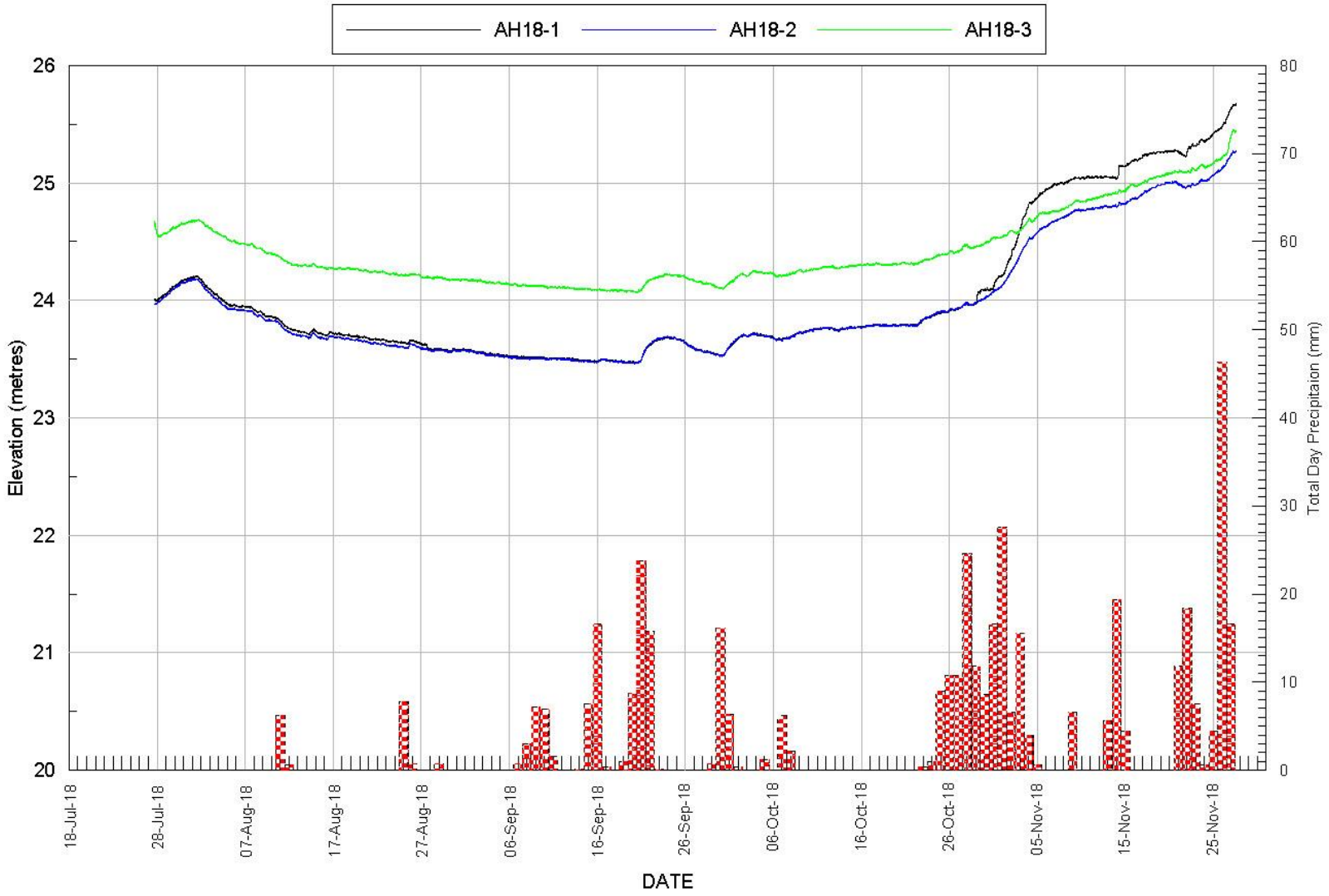
PROPOSED RESIDENTIAL DEVELOPMENT
Lynn/Seymour Flood Plain
WATER LEVEL MONITORING PROGRAM

WATER LEVEL MONITORING DATA

Scale:	File No:	Date:	FIGURE:
NTS	117-4268	SEP/18	
Des: JT/HS	Dwn: JT/HS	Chk:	Rev:


PT
Cc
VCb
RF
SAi
VANCOUVER
HARBOUR
ENGLISH
BAY
FIRST
NARROWS
SECOND
NARROWS
VCa
SA-C
RS



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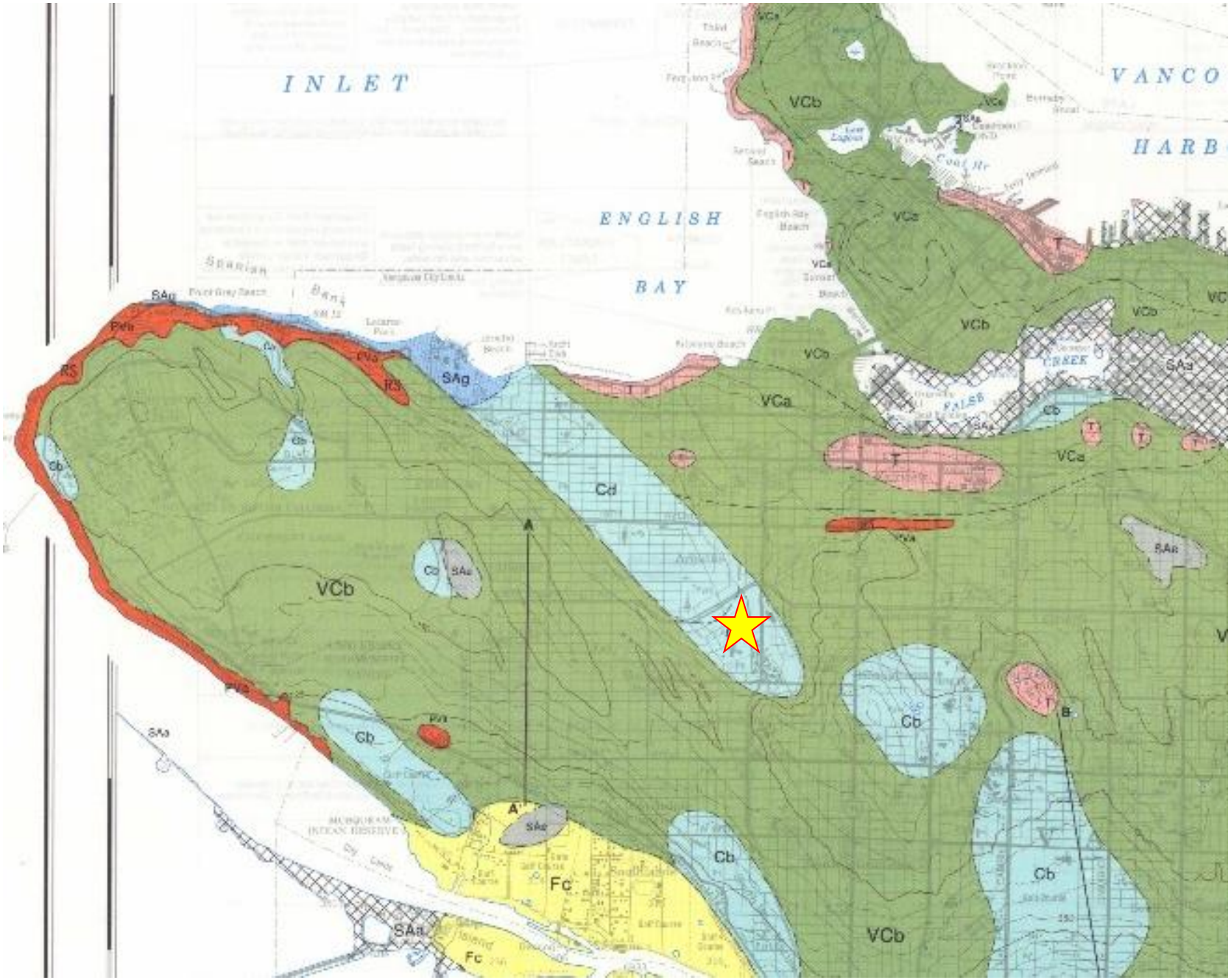
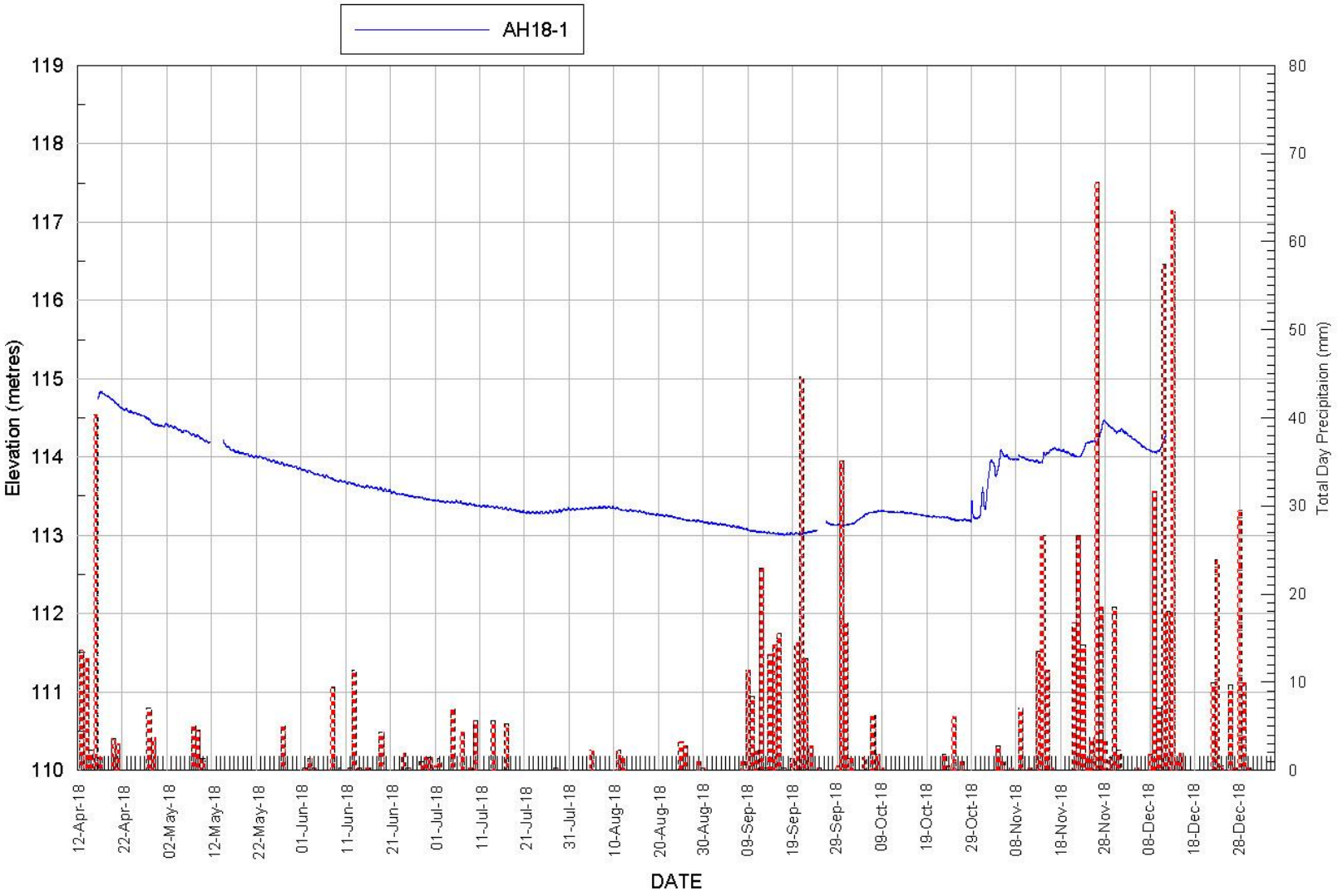
PROPOSED RESIDENTIAL DEVELOPMENT
Arbutus Village
WATER LEVEL MONITORING PROGRAM

WATER LEVEL MONITORING DATA

Scale:	File No:	Date:	FIGURE:
NTS	-	JAN/19	

Des:	Dwn:	Chk:	Rev:
HB/HS	HS		


INLET
ENGLISH
BAY
VANCO
HARB
VCb
VCa
SAg
SAa
Cb
Cd
Fc
A
A'



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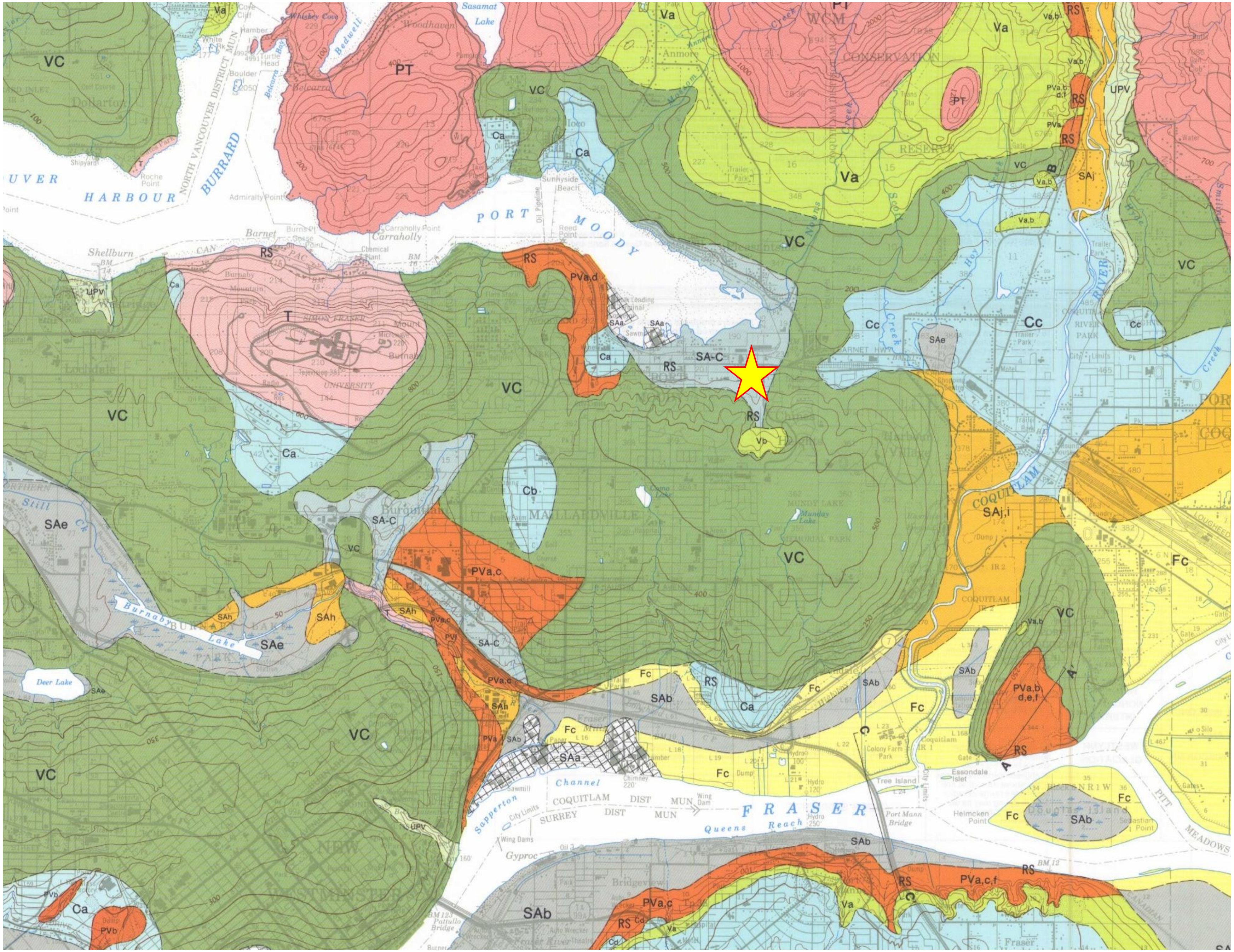
PROPOSED RESIDENTIAL DEVELOPMENT
Coquitlam
WATER LEVEL MONITORING PROGRAM

WATER LEVEL MONITORING DATA

Scale:	File No:	Date:	FIGURE:
NTS	-	JAN/19	

Des:	Dwn:	Chk:	Rev:
HS	HS		



VC
PT
Va
WCM
CONSERVATION
RESERVE
Anmore
UPV
RS
Ca
Cc
SAj
SAe
SA-C
SAa
SAb
SAh
PVa,d
PVa,c
PVa,b d,e,f
PVa,c,f
Vb
Cb
Fc
SAj,i
T
PORT MOODY
BURRARD
HARBOUR
Burnaby Lake
Deer Lake
FRASER
Queens Reach
Sapperton Channel
COQUITLAM
MAILLARDVILLE
Port Mann Bridge
Pattullo Bridge

Table A1.1. Grain size identification (consistent with the *Canadian Foundation Engineering Manual*).

Soil Groups	Soil Type Name		Size Limits of Particles	Familiar Size Example
Coarse-grained soils	Boulders		200 mm (8 in) or larger	Larger than bowling ball
	Cobbles		60 mm (2½ in) – 200 mm (8 in)	Grapefruit
	Gravels	Coarse gravel Medium gravel Fine gravel	20 – 60 mm 6.0 – 20.0 mm 2.0 – 6.0 mm	Orange or lemon Grape or pea Rock salt
	Sands	Coarse sand Medium sand Fine sand	0.60 – 2.0 mm 0.20 – 0.60 mm 0.06 – 0.20 mm	Sugar Table salt Icing sugar
Fine-grained soils	Silts		0.02 – 0.06 mm	Cannot be discerned with naked eye at a distance of 200 mm (8 in)
	Clays		Less than 0.02 mm	Use simple field tests to distinguish between silts and clays (e.g., stickiness, dilatancy)

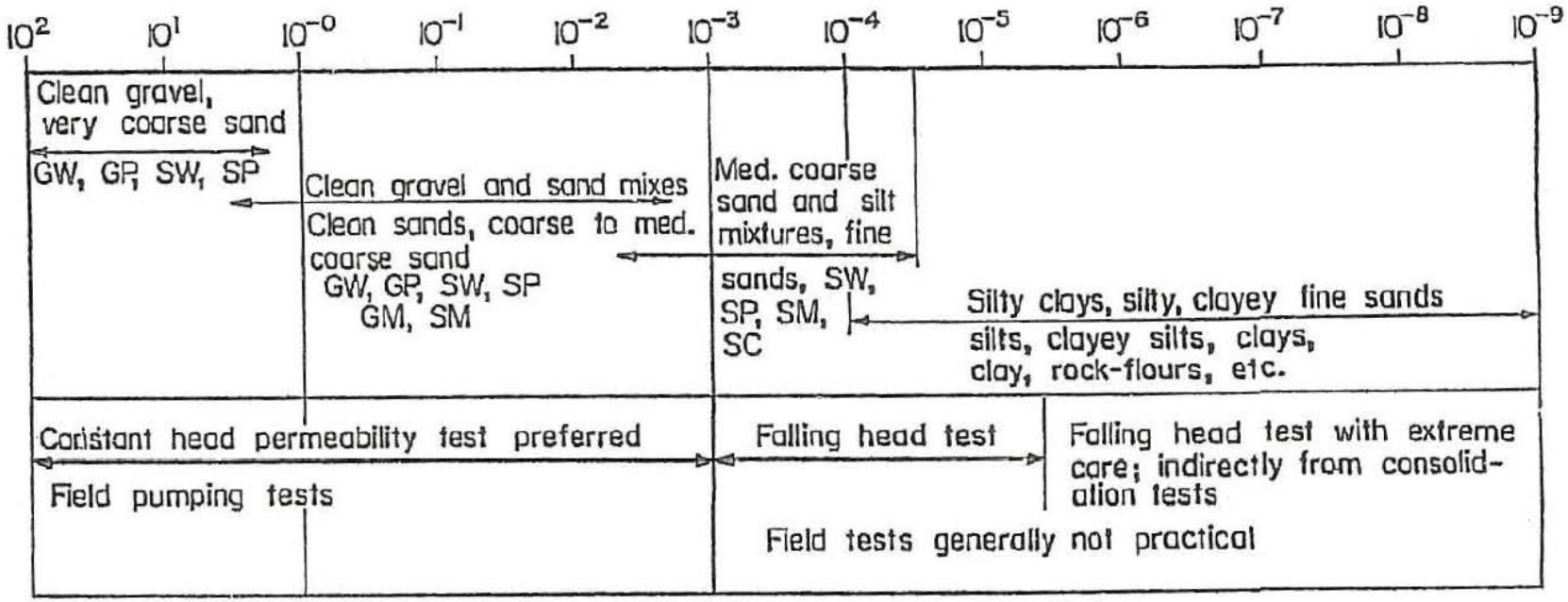
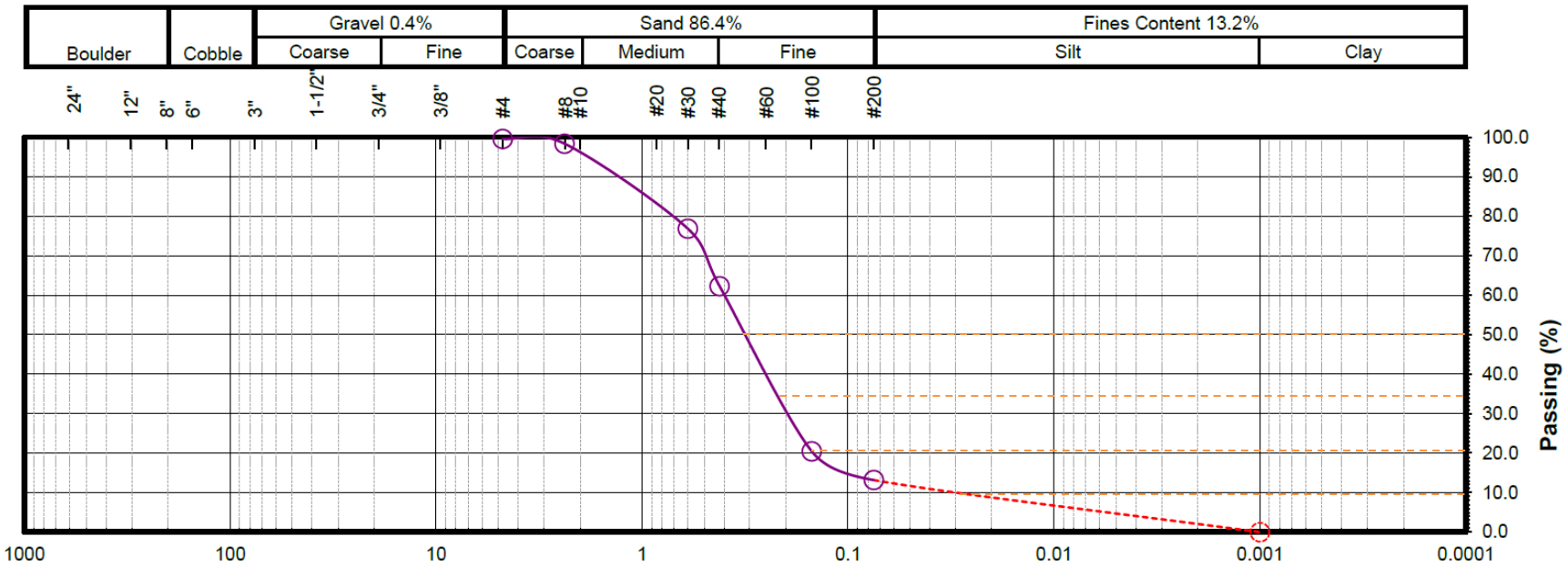


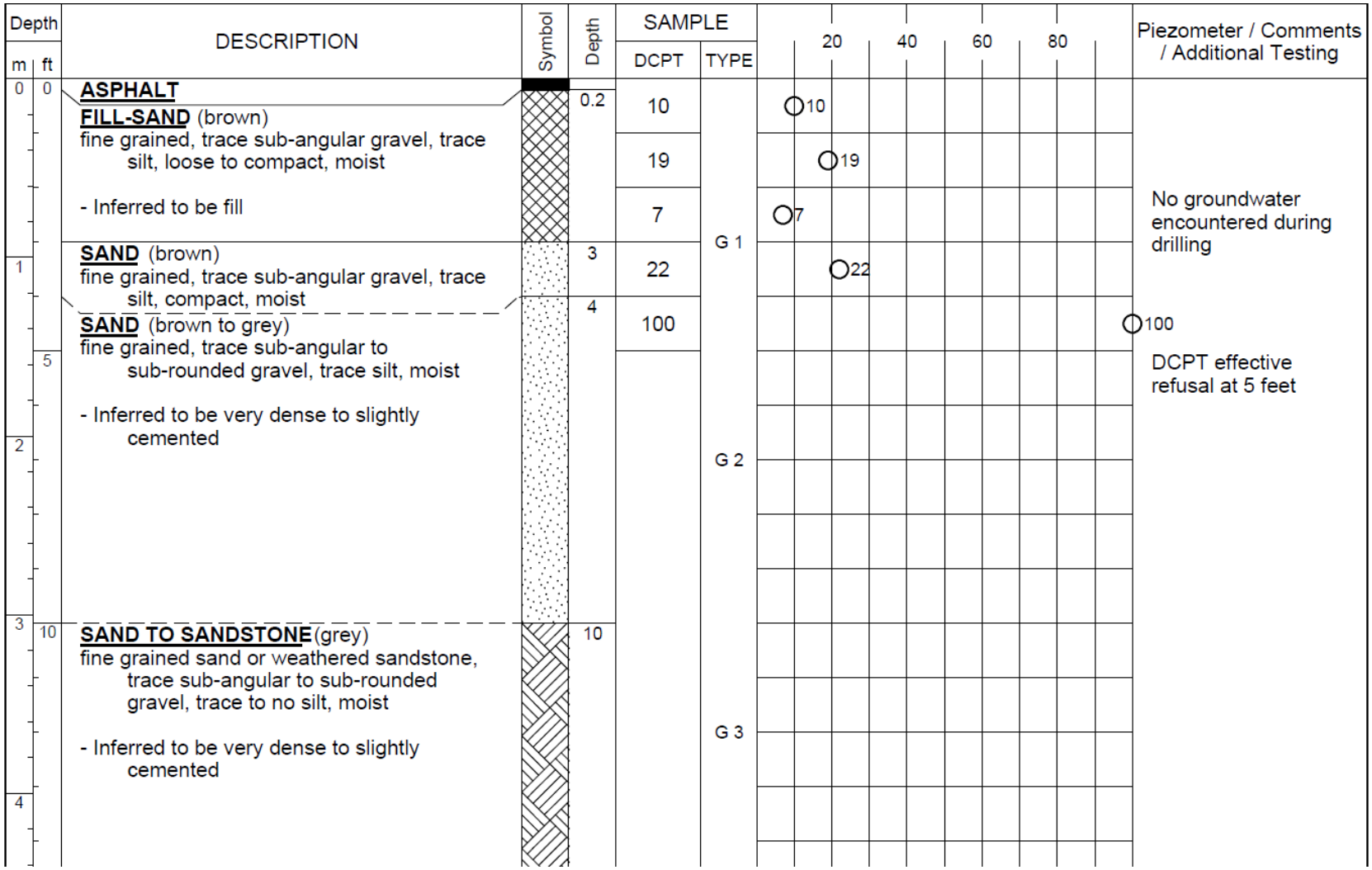
Figure 8-6 Typical ranges of permeability coefficients in cm/s and suggested test methods.



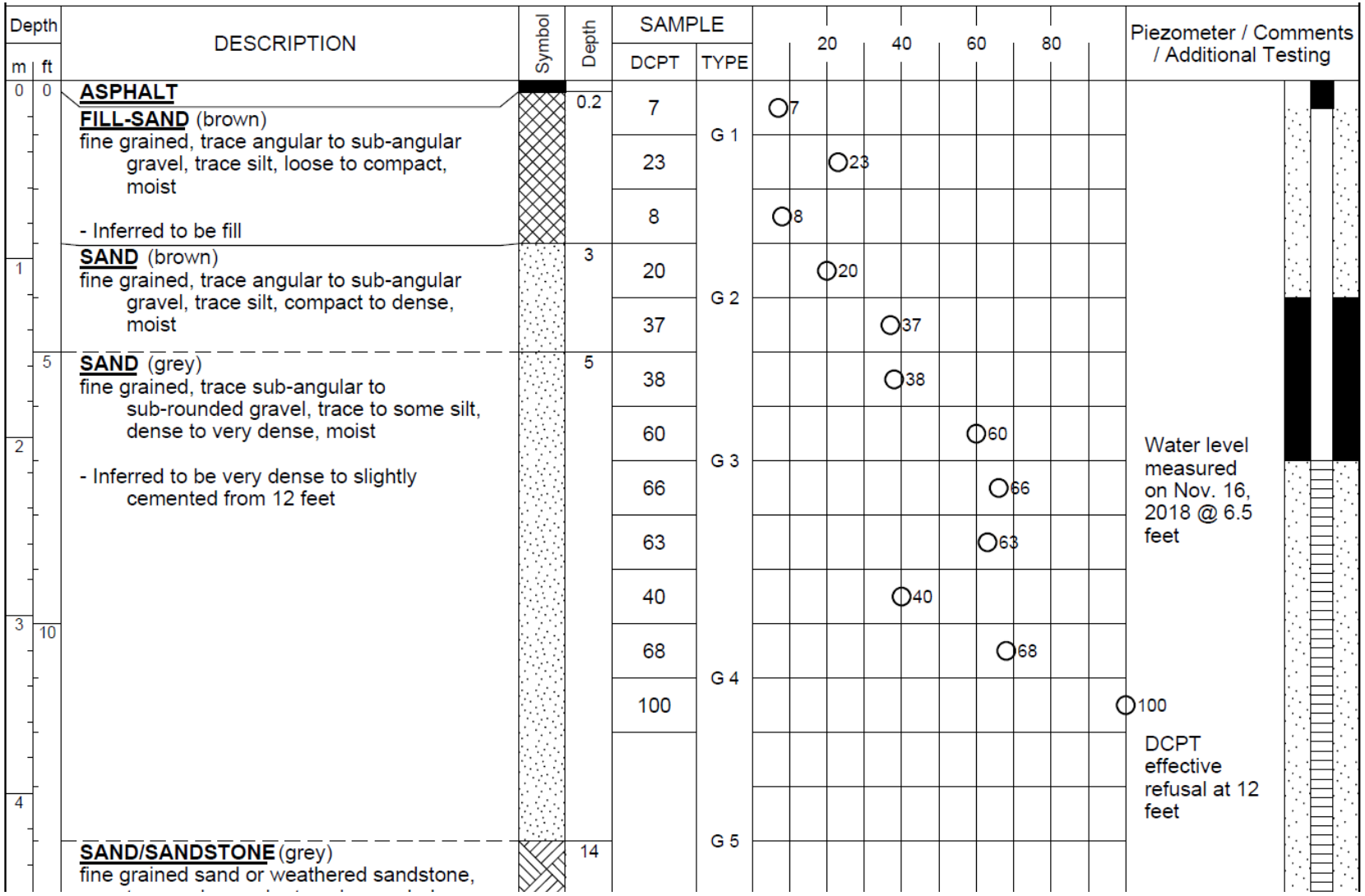
Descriptive Term	Example by Weight	Proportion
NOUN	GRAVEL, SAND, SILT, CLAY	>50%
"and"	and gravel, and silt, etc.	>35%
ADJECTIVE	gravelly, sandy, silty, clayey, etc.	20–35%
"Some"	Some sand, some silt, etc.	10–20%
"Trace"	Trace sand, trace silt, etc.	1–10%

fine to medium grained SAND, some silt

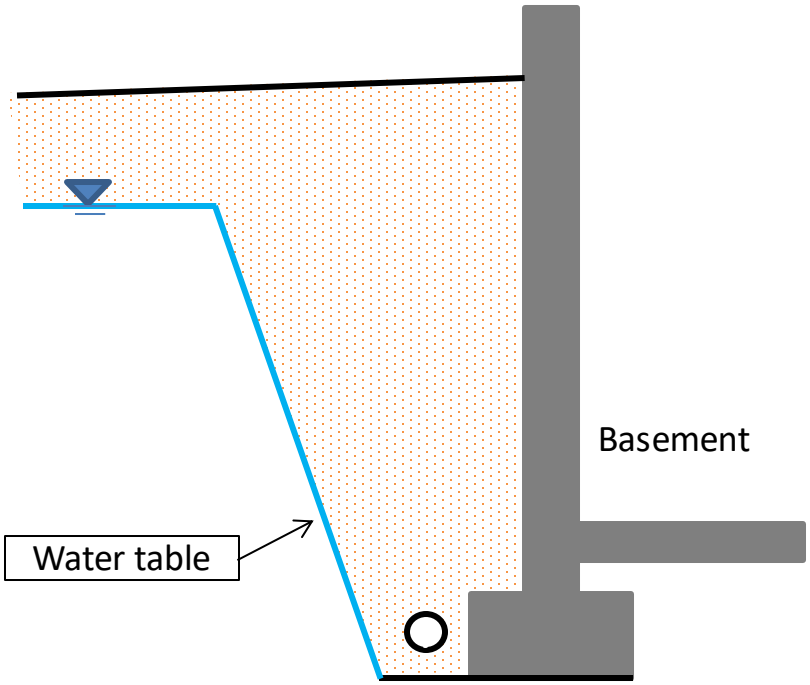
Test Hole Logs



Test Hole Logs

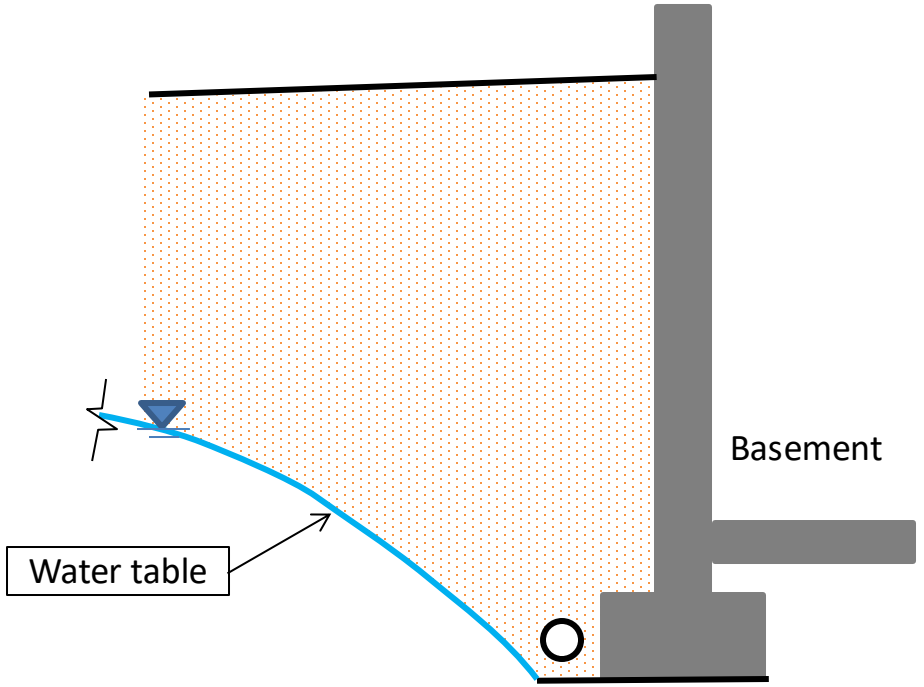


Dewatering - Drawdown



Water table perched on low permeability soil

Negligible offsite effects



(High) water table in high permeability soils

Offsite effects possible

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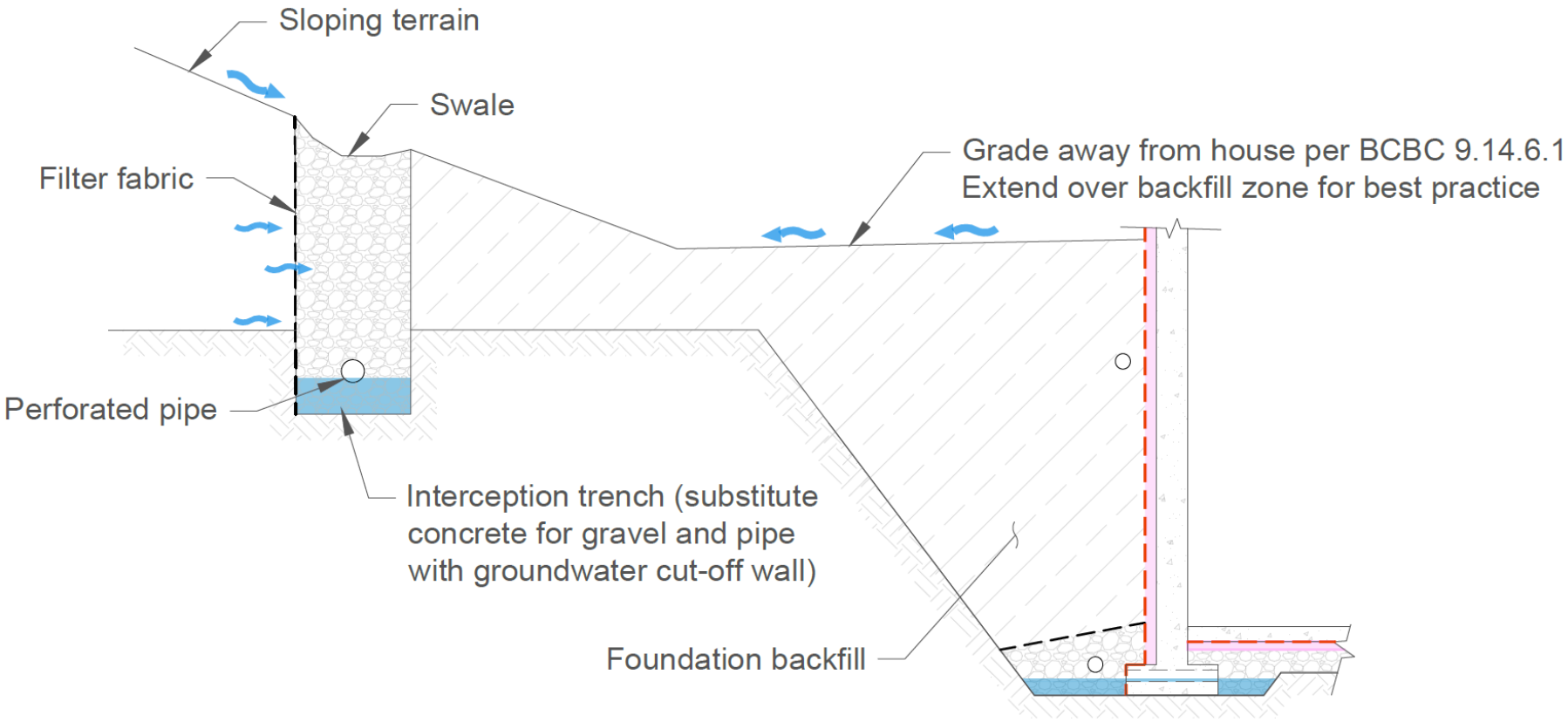
BC Building Code

4.2.4.9. Groundwater Level Change

1) Where proposed construction will result in a temporary or permanent change in the *groundwater level*, the effects of this change on adjacent *buildings* shall be fully investigated and provided for in the design.

Site Drainage



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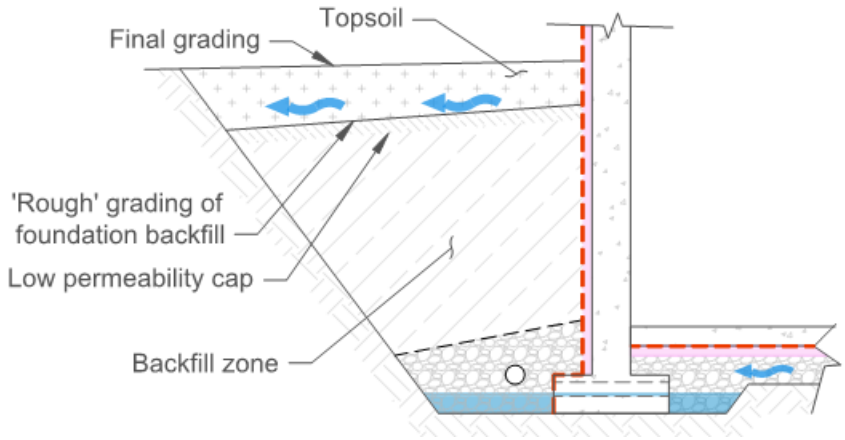
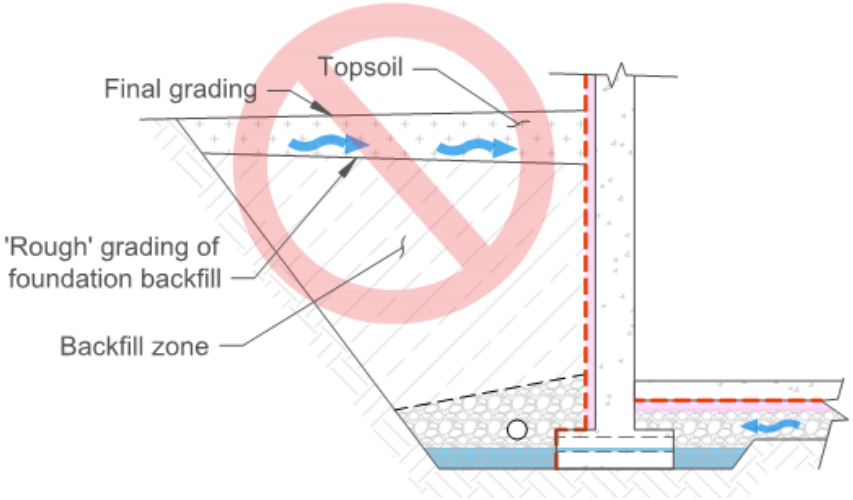
Site Drainage

Ground surface **graded to slope down and away from buildings** (*9.14.6.1.(1)*) and surface water should be directed to suitable disposal

‘Rough’ grading should slope down and away from the building location

Grade the building excavation and utility trenches to promote drainage away from the building





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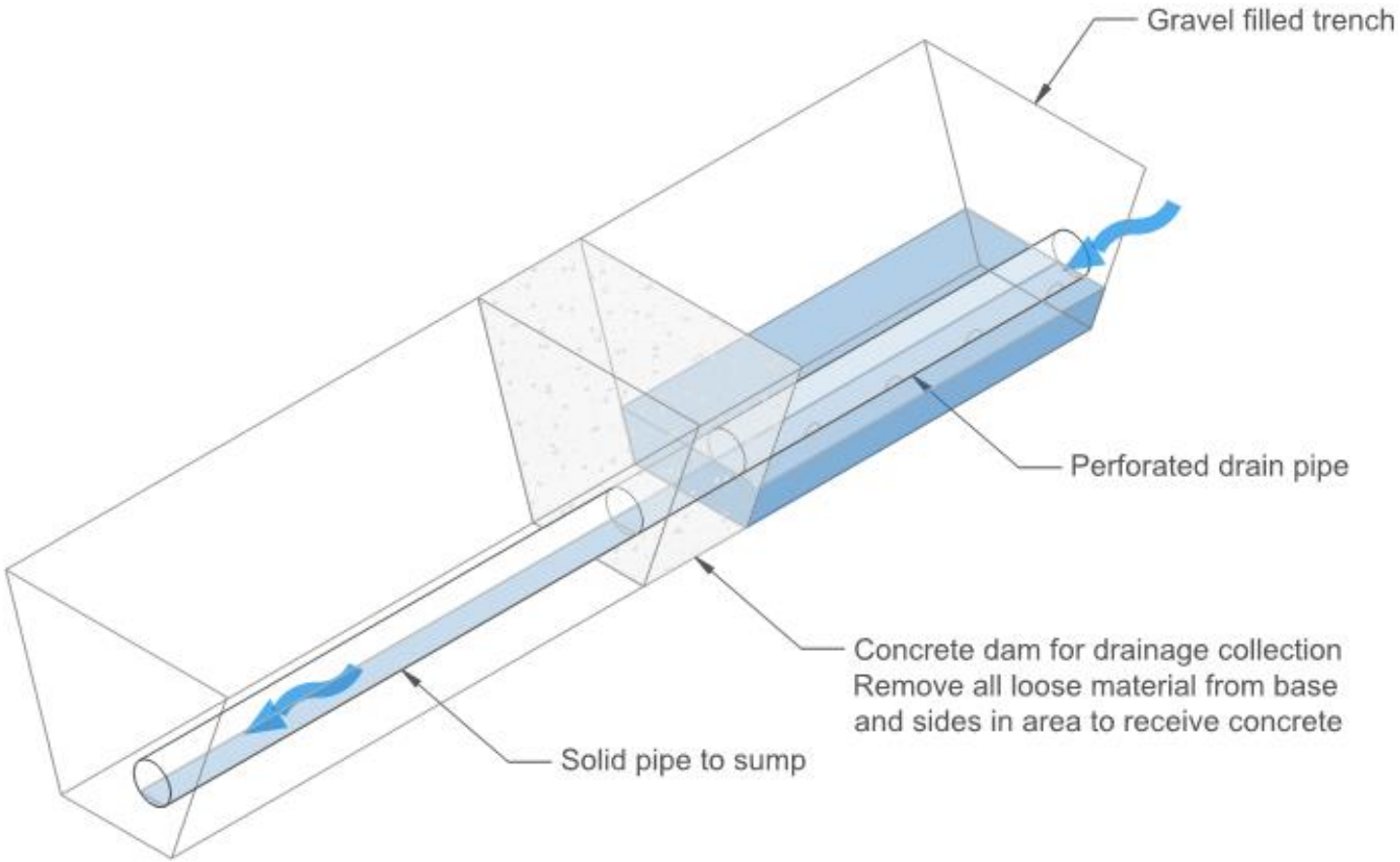
Site Drainage – Interception Trench (Geotechnical Engineer Recommended)



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Case Study: Water Ingress Through Utility Trenches

Interior sealing was attempted by owner (unsuccessfully)

Required costly/invasive utility relocation and exterior wall remediation

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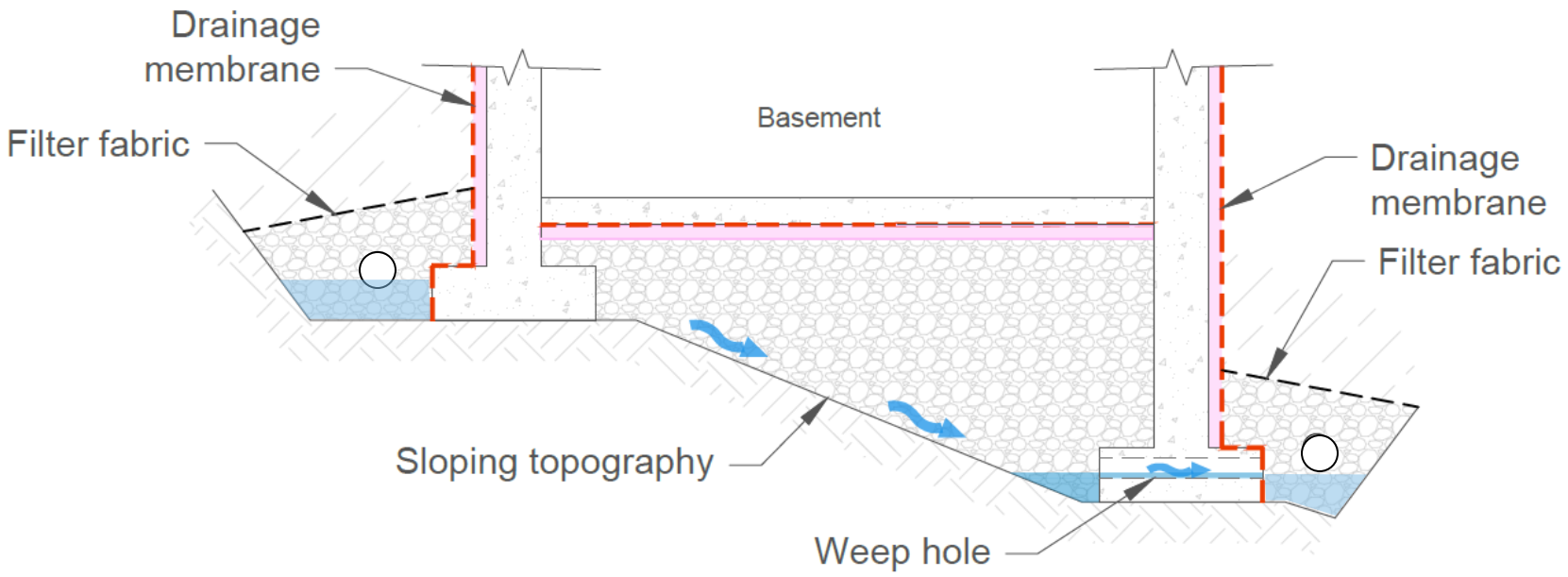
Foundation – Footing Weepholes



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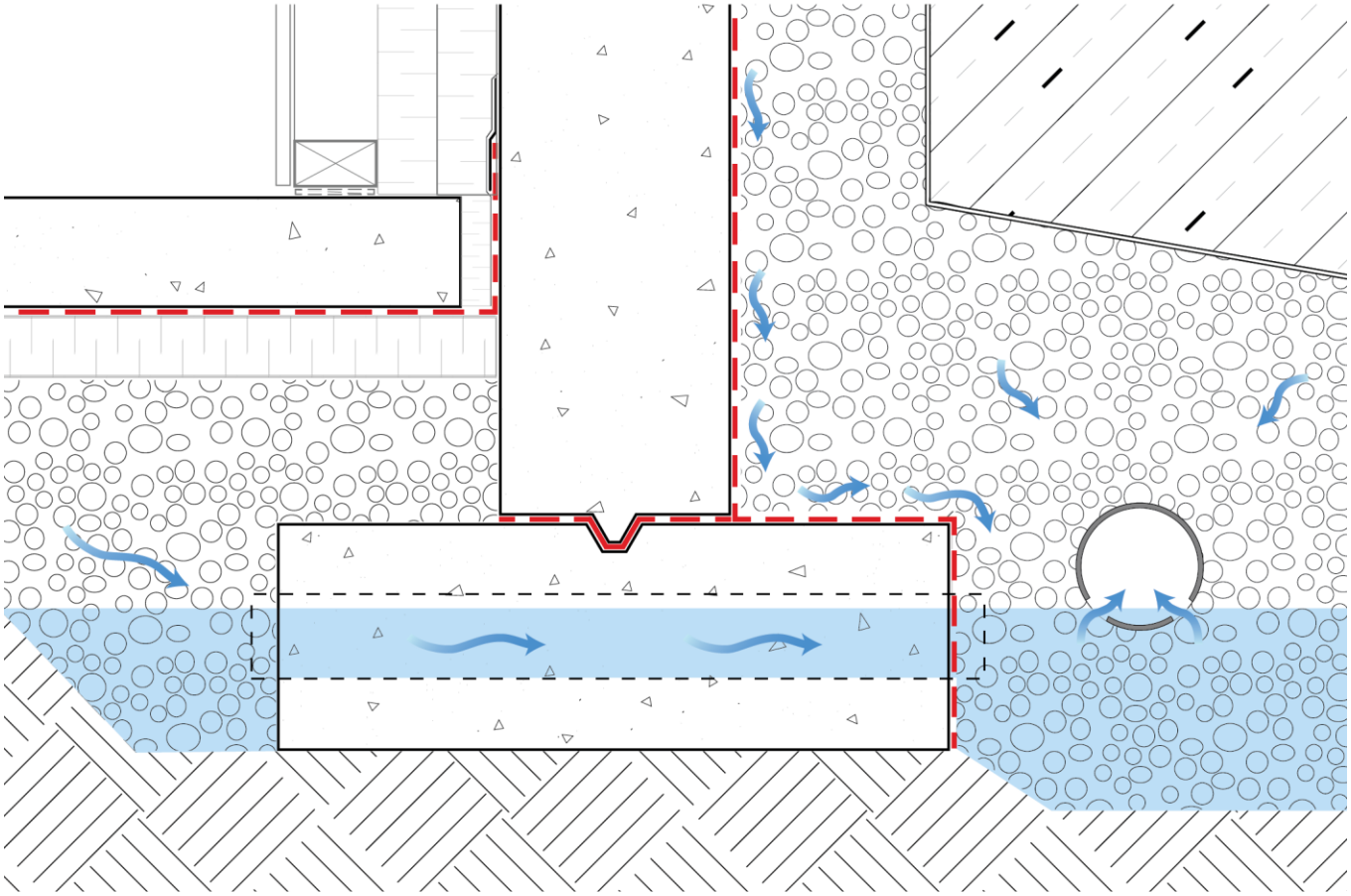
Foundation – Footing Weepholes



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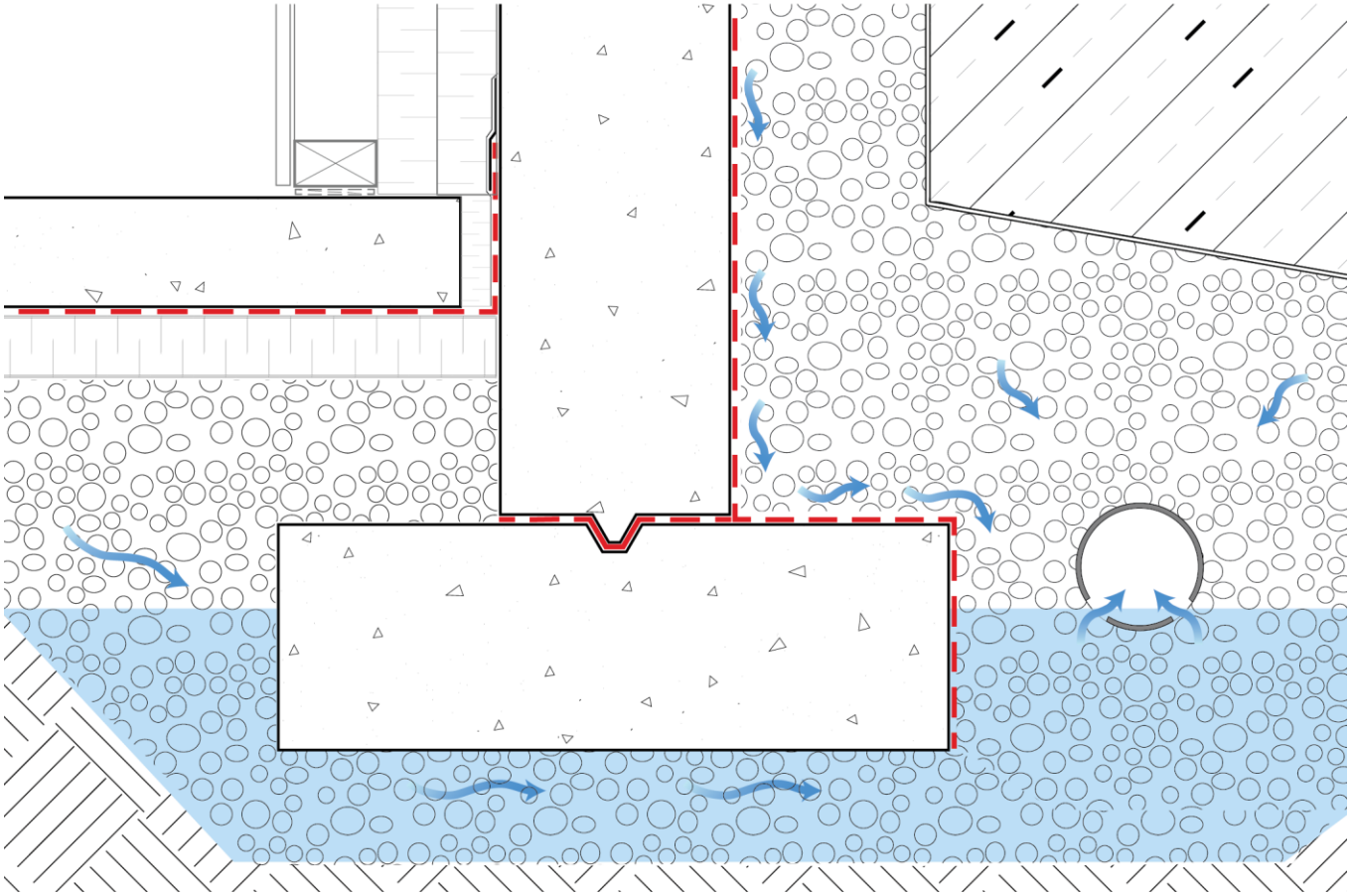
Foundation – Footing Weepholes



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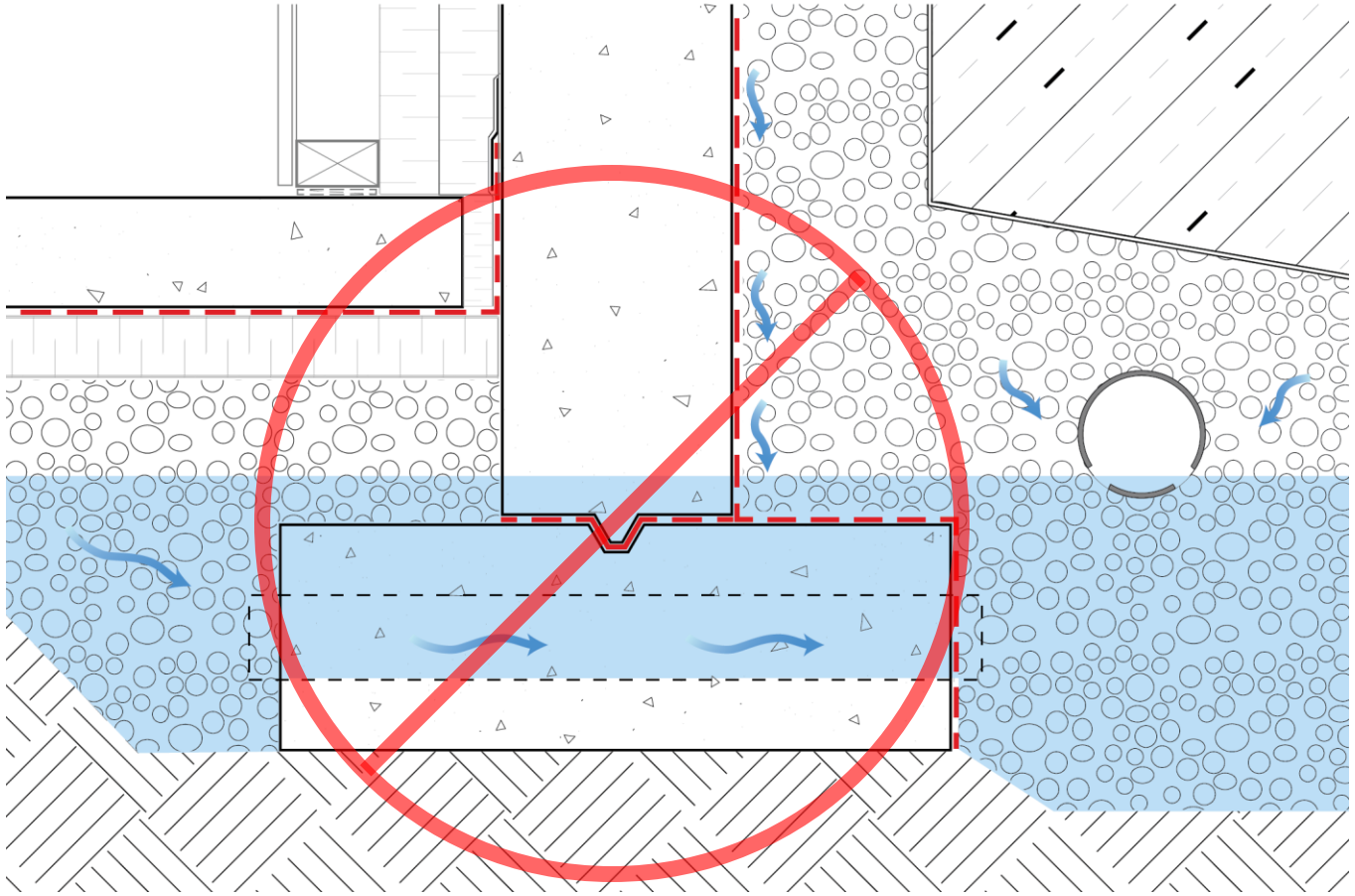
Foundation – Footing Weepholes



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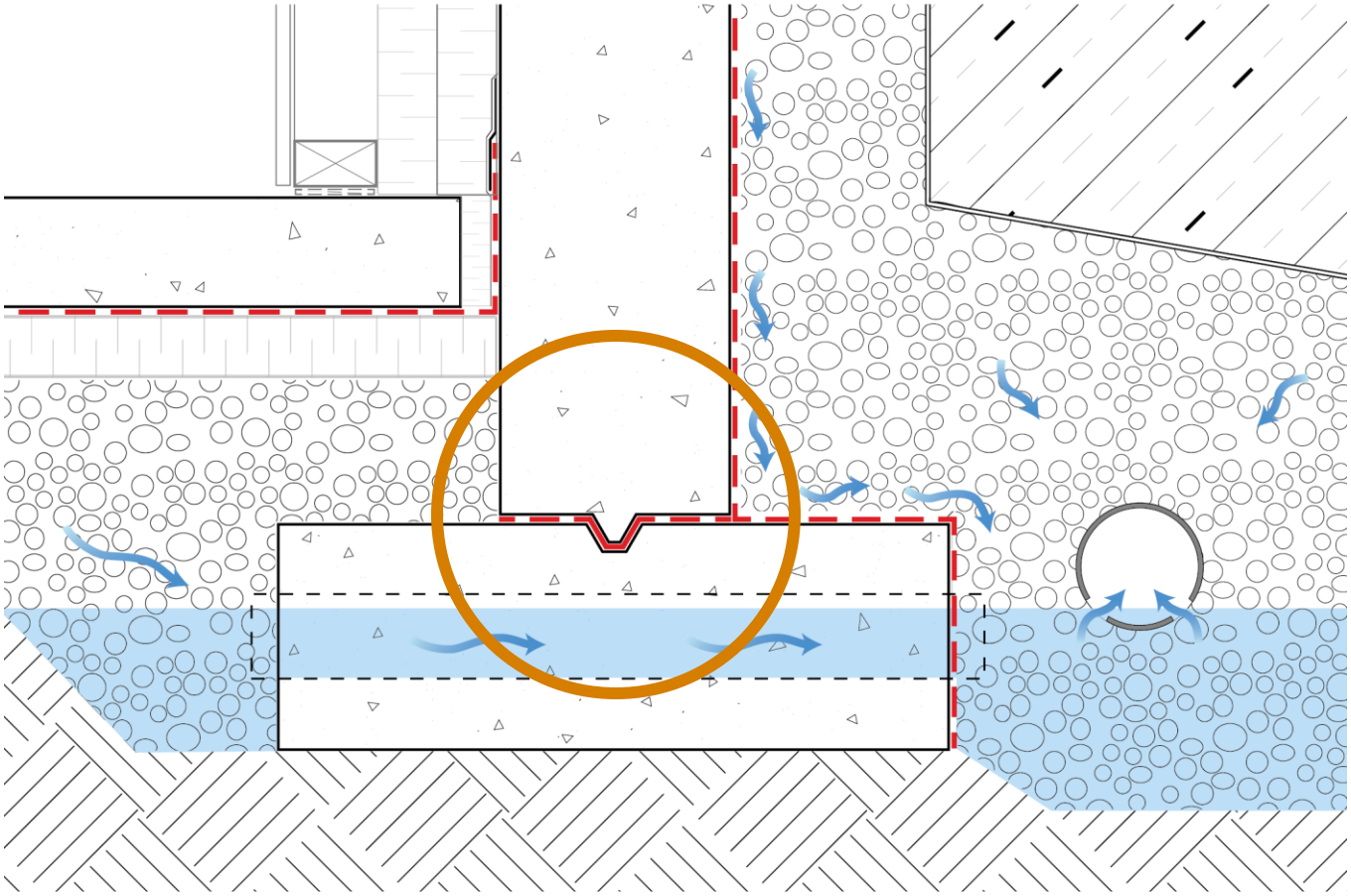
Foundation – Footing Capillary Break



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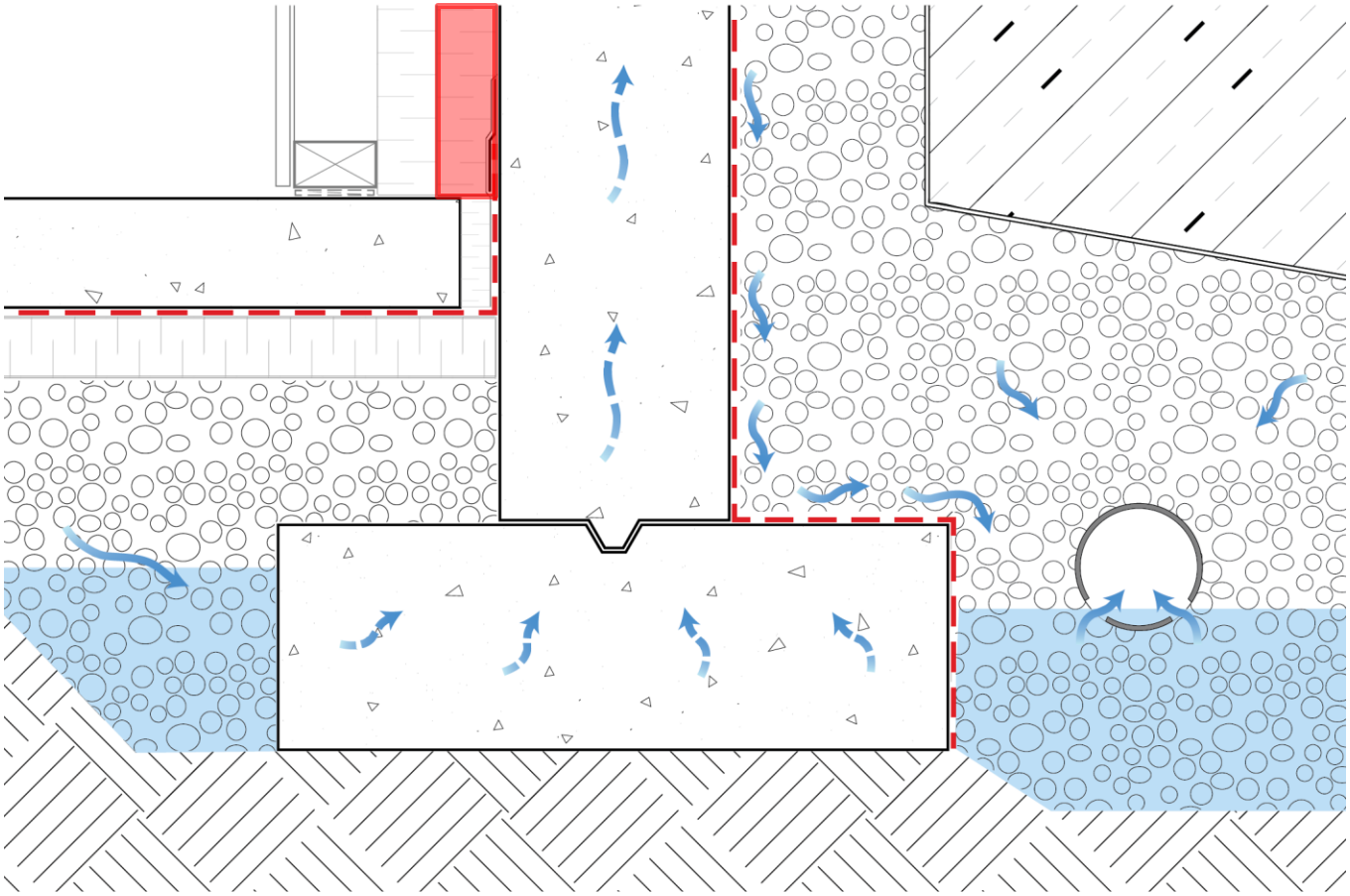
Foundation – Footing Capillary Break



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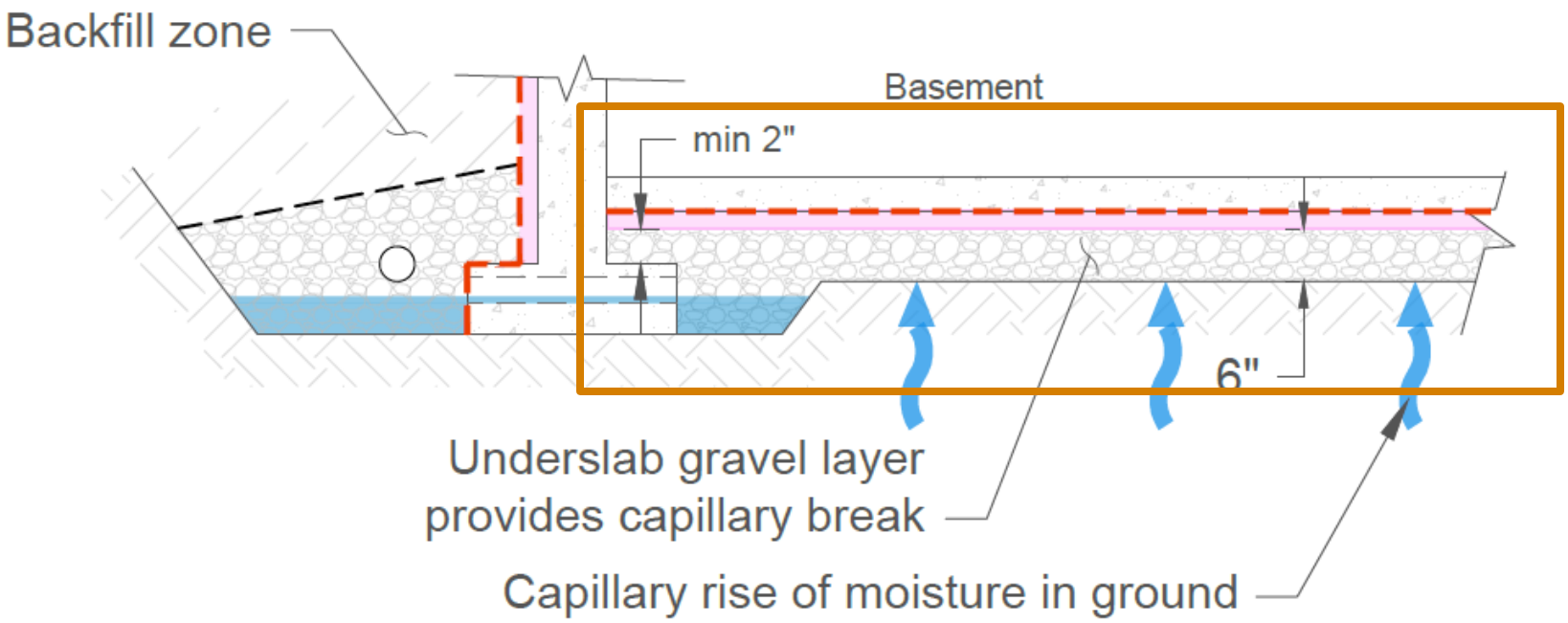
Slab-on-Grade – Underslab Drainage

Use clear gravel under slab for capillary break and drainage layer (9.16.2.1)

Don’t sit slab directly on footing; allow for some gravel separation



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Slab-on-Grade – Underslab Drainage

Use clear gravel under slab for capillary break and drainage layer (9.16.2.1)

Do not use sand

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Slab-on-Grade – Air Barrier / Soil Gas Control

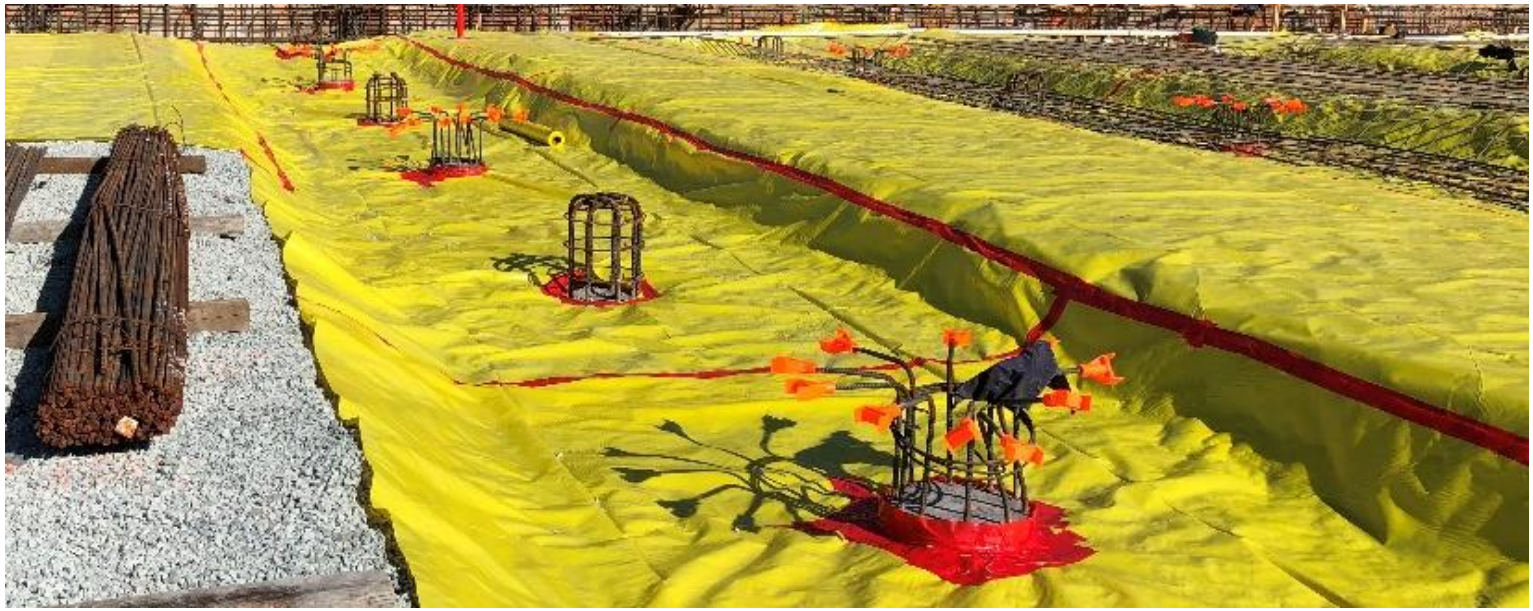
Methane

→ Anaerobic decomposition of organics: **organic-rich soil below slab**

→ Commonly structure is pile-supported with utilities suspended from the slab

→ **LOTS of penetrations** through the vapour/soil gas barrier **require sealing**

→ Think about weight of membrane hanging off of penetrations as settlement occurs below building: will it compromise the membrane?



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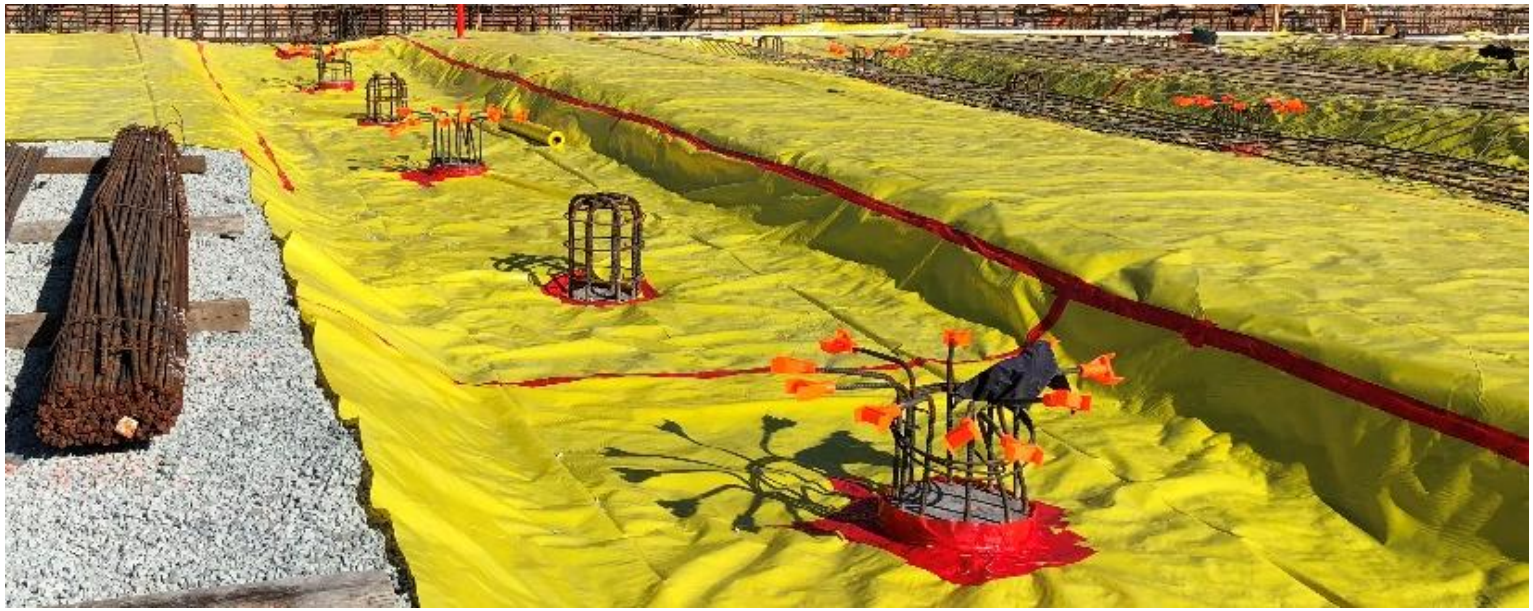
Slab-on-Grade – Air Barrier / Soil Gas Control

Radon

→ Code has some prescriptions
→ Testing ongoing, AHJs can set increased requirements
→ Health Canada estimates approximately 16% of lung cancer deaths are related to radon exposure in the home



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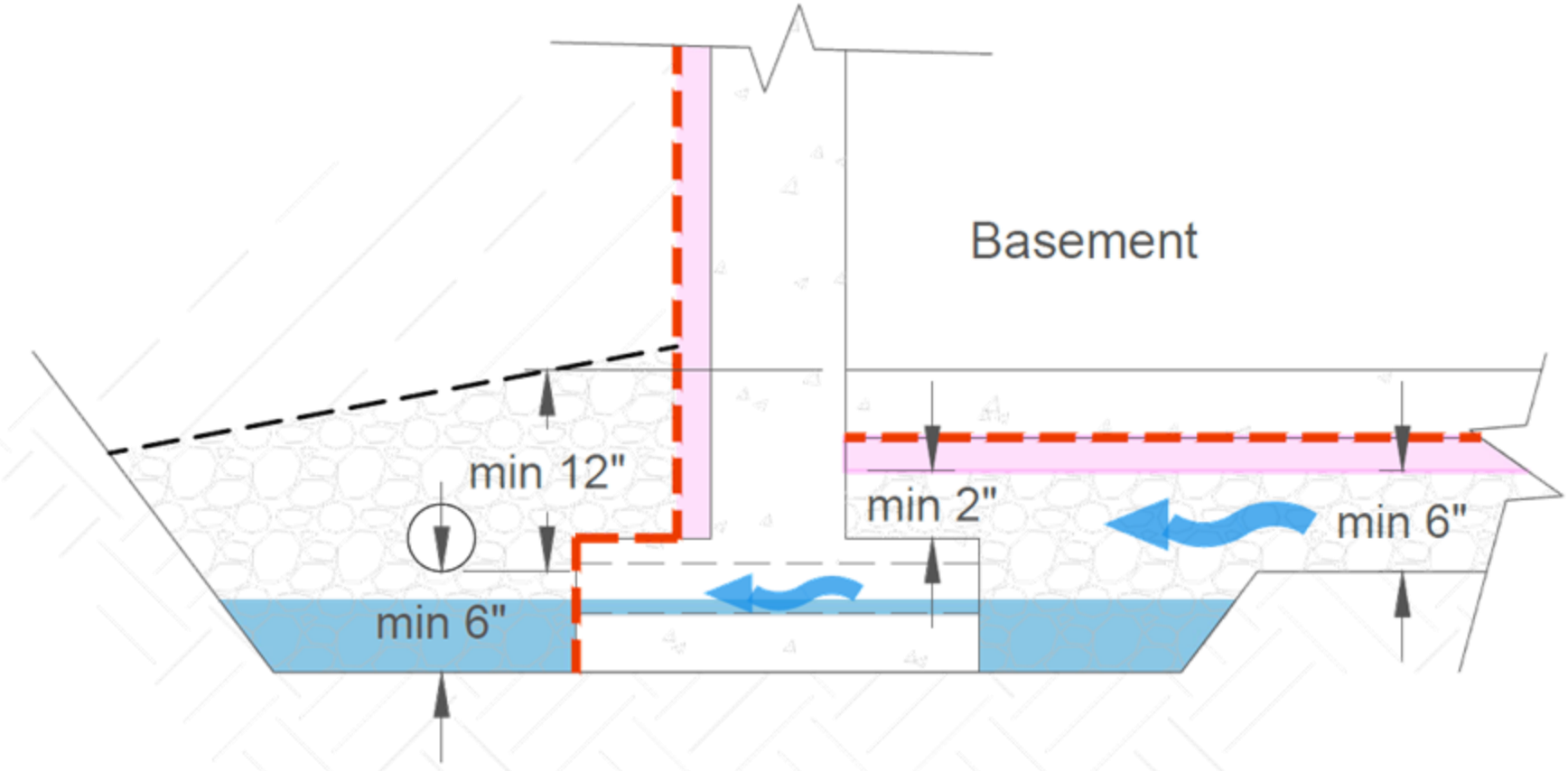
Foundation Drainage

Part 9 Best Practice:



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Foundation Drainage

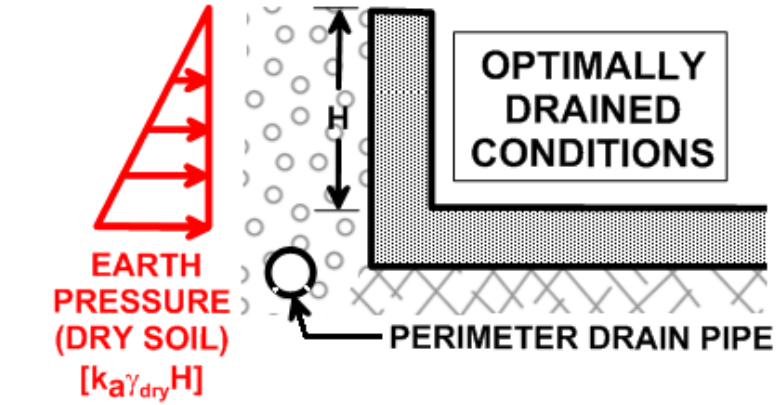
Some building types and excavation design make exterior foundation drainage infeasible

Recommend ‘interior’ foundation drainage in these scenarios (i.e., at the inside of the foundation)

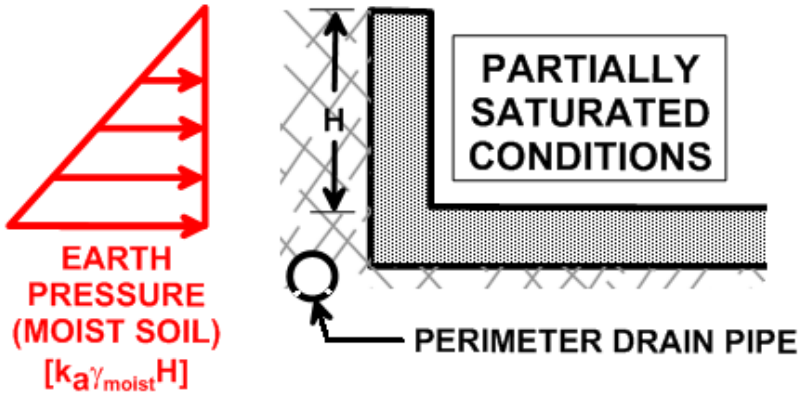
More common on commercial developments

Foundation Drainage

Influence of backfill conditions on lateral wall pressure



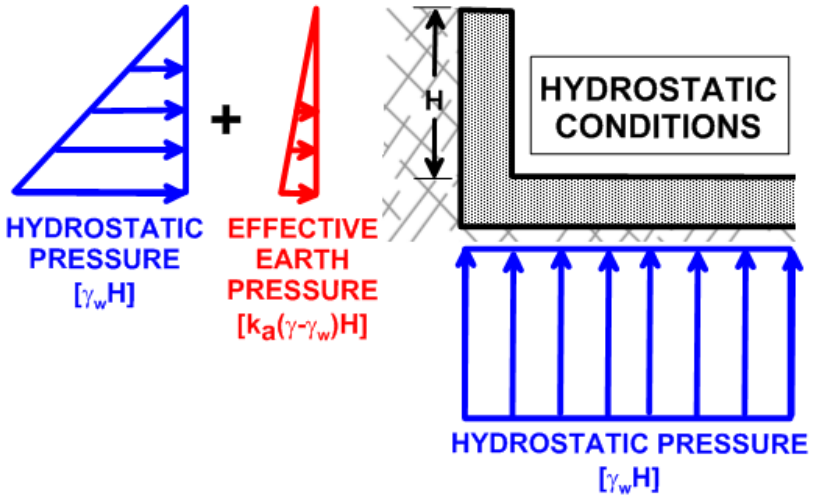
→ *Dry soil weight*
→ *Lower overall earth pressure*

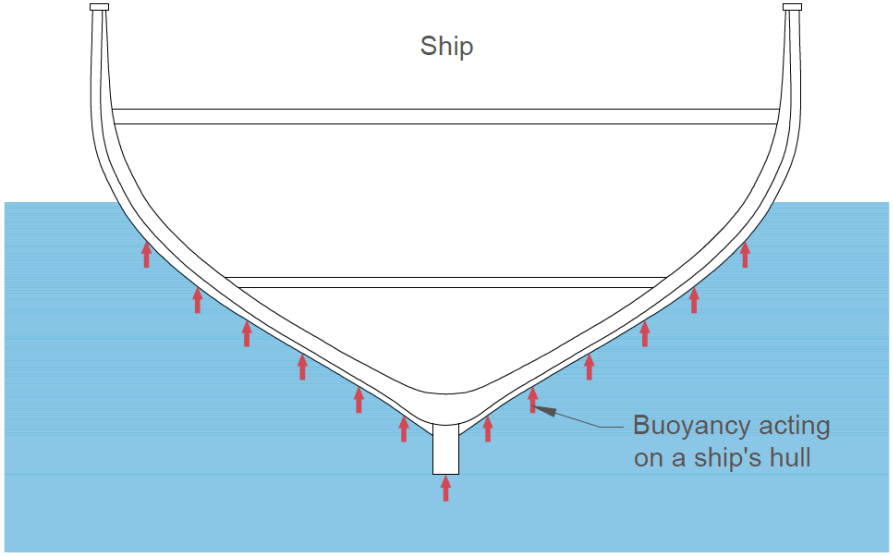


→ *'Moist' soil weight*
→ *Higher overall earth pressure*

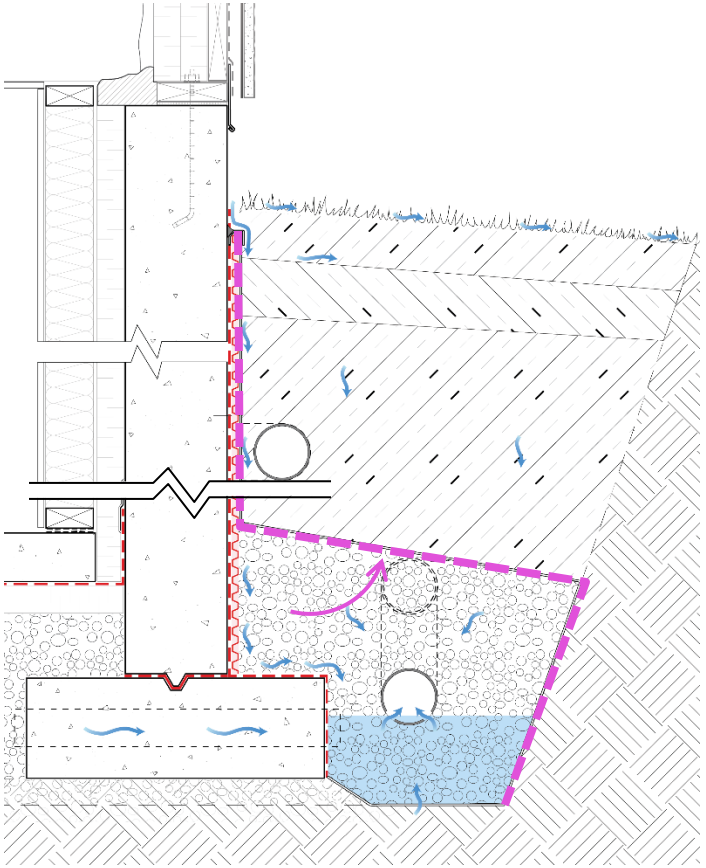
Foundation Drainage

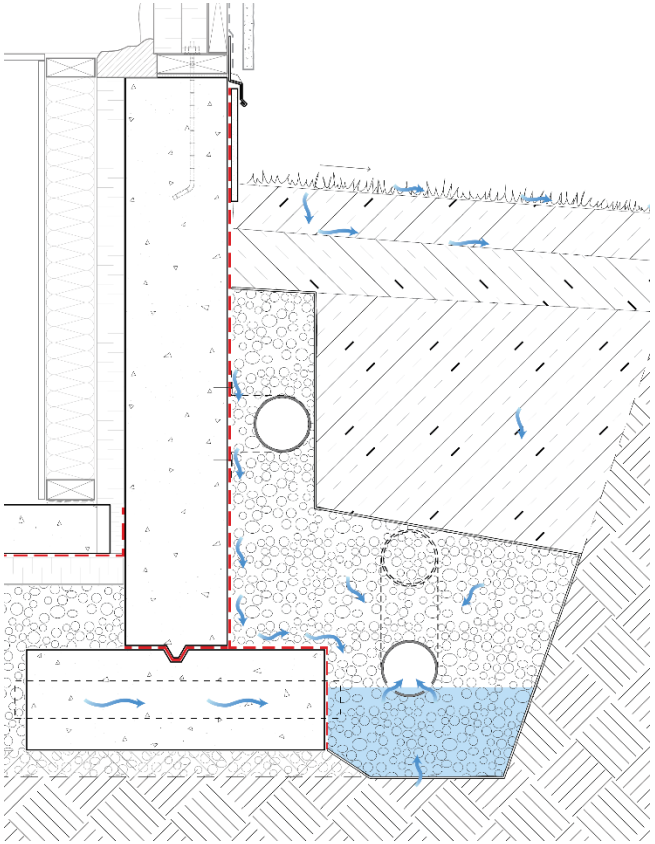
- → *Submerged conditions* occur when there is a high water table and high soil permeability (i.e., such as in gravels and sands)
  - → 'Tanking' of basements is required
  - → Tie-down structures may be required to resist upward buoyancy





Foundation Wall Filter Fabric





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Geotextiles – Filter Fabric

Nonwoven Geotextiles

- Apparent Opening Size (AOS) and Filtration Opening Size (FOS)

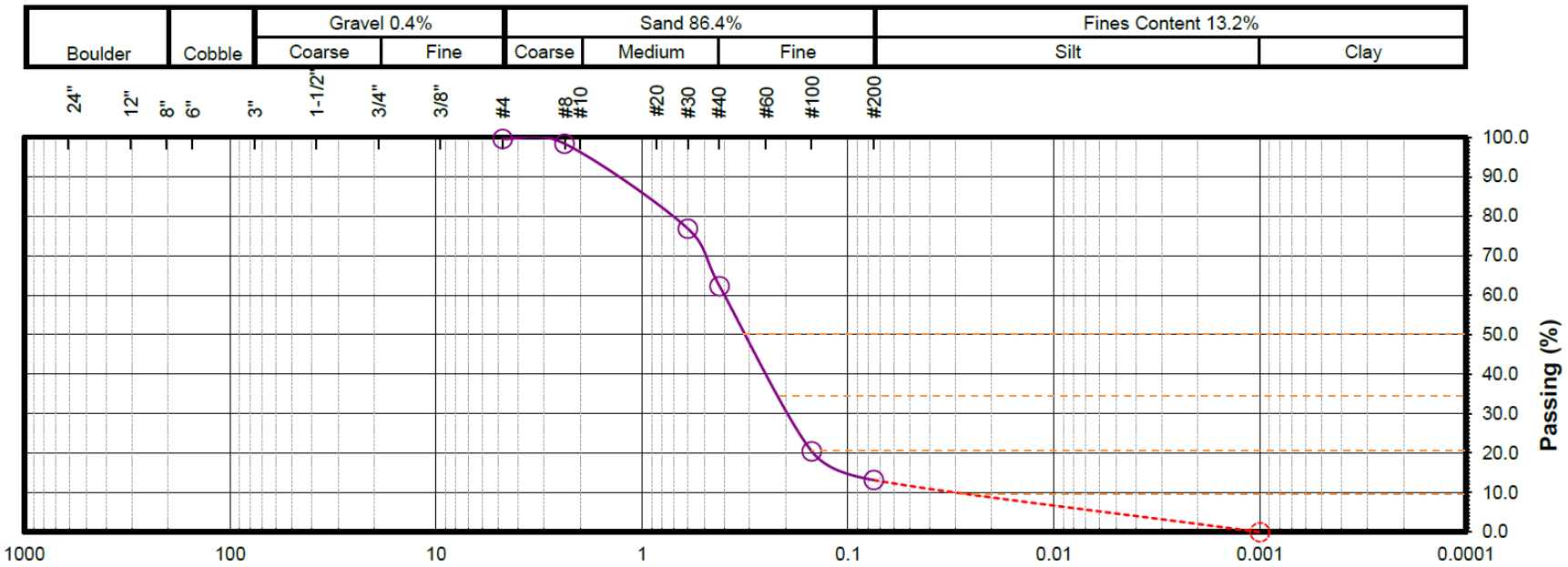
Woven Geotextiles

- Percent Open Area (POA)

From Canadian Foundations Engineering Manual (CFEM):

$$k_n = \frac{Q \times t_{GT}}{A \times H}$$

- k_n = hydraulic conductivity of geotextile
- Q = water flow rate through geotextile
- t_{GT} = thickness of geotextile
- A = area
- H = hydraulic head



Descriptive Term	Example by Weight	Proportion
NOUN	GRAVEL, SAND, SILT, CLAY	>50%
"and"	and gravel, and silt, etc.	>35%
ADJECTIVE	gravelly, sandy, silty, clayey, etc.	20–35%
"Some"	Some sand, some silt, etc.	10–20%
"Trace"	Trace sand, trace silt, etc.	1–10%

fine to medium grained SAND, some silt

Geotextiles – Nonwoven Filter Fabric

- Try to minimize migration of soil particles and prevent clogging

- Soil Retention:
  - $C_u = {}^{D_{60}}/_{D_{10}}$
  - $AOS\ or\ FOS\ <\ B\ \times D_I$

- C_u = coefficient of uniformity
- D_x = diameter at which x% of the soil sample is finer
- B, D_I = parameters defined in CFEM
- k_n = geotextile permeability
- k_s = soil permeability
- ψ = permittivity

- Permeability - Different requirements for fine grained soil or coarse grained soil
  - $k_n > 10 * k_s$ (retention of fines)
  - $k_n > k_s$ (retention of clean medium-coarse sands)
  - $\psi \geq 0.5, 0.2, or\ 0.1\ s^{-1}$ depending on grain size distribution

- Clogging
  - $AOS\ or\ FOS > 3 \times D_{15}$

- Other considerations for various applications

Foundation Wall Dampproofing/Waterproofing

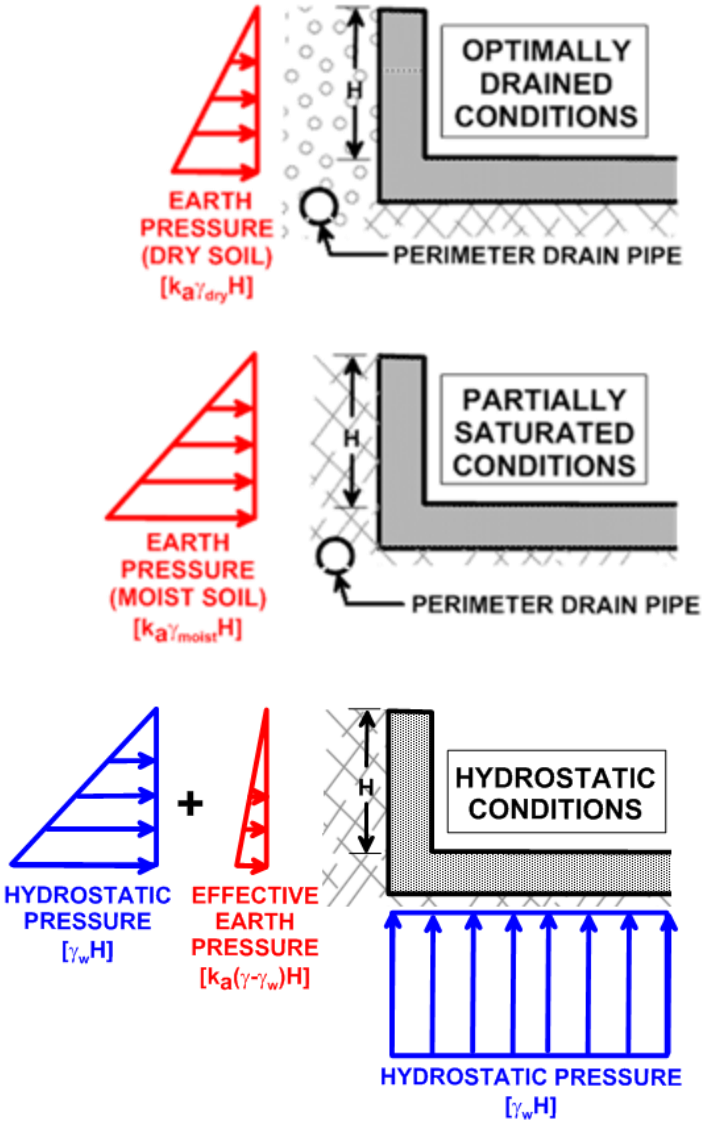
Optimally Drained sites use dampproofing

vs

Partially Saturated backfill requires non-tankable waterproofing

vs

Submerged/Fully Saturated sites with **hydrostatic pressure** use tankable waterproofing



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Foundation Wall Dampproofing/Waterproofing

	Optimally Drained		Partially Saturated			Submerged			
	Dampproofing		Non-Tankable Waterproofing			Tankable Waterproofing			
Product	**Asphalt Cutback**	**Asphalt Emulsion Dampproofing (Thin Application)**	**Liquid Applied**	**Self-Adhered Modified Bitumen Sheets**	**Asphalt Emulsion Waterproofing (Thick Application)**	**Asphalt Emulsion Waterproofing with HDPE Liner**	**Torch Applied Modified Bitumen Sheets**	**Bentonite Sheets**	**Pressure-Adhered Thick HDPE Membrane**
Description	Solvent based bituminous liquid membrane typically spray or roller applied	Bituminous liquid membrane suspended in water typically spray or roller applied	Liquid or spray applied bitumen membrane modified with polymers for elasticity and puncture resistance	Factory manufactured self-adhered bituminous sheet waterproofing modified with polymers for elasticity and puncture resistance	Asphalt emulsion applied thicker than the dampproofing application with reinforcement to meet waterproofing requirements	Asphalt emulsions waterproofing installed with continuous HDPE liner for additional water resistance	Factory manufactured heat welded bituminous sheet waterproofing modified with polymers for elasticity and puncture resistance	Clay composite sheet waterproofing which absorbs water and swells to form an impermeable layer	Fully adhered composite sheet membrane comprised of a thick HDPE liner and a pressure sensitive adhesive
Recommended Application	Relatively dry soil conditions with well drained backfill	Relatively dry soil conditions with well drained backfill	Moderate moisture environments	Moderate moisture environments	Moderate moisture environments	High moisture environments or temporary low intensity hydrostatic pressure anticipated	High moisture environments or sustained hydrostatic pressure anticipated	High moisture environments or sustained hydrostatic pressure anticipated	High moisture environments or sustained hydrostatic pressure anticipated
Thickness	10-30mils	30-50mils	+50mils recommended	60mils	60-80mils	80mils + liner	115mils	250mils	30-50mils
Concrete Application	Cast Backfill	Cast/Shotcrete Backfill/Blindside	Cast/Shotcrete Backfill/Blindside	Cast Backfill	Cast/Shotcrete Backfill/Blindside	Cast/Shotcrete Backfill/Blindside	Cast/Shotcrete Backfill/Blindside	Cast/Shotcrete Blindside	Cast/Shotcrete Blindside
Concrete Cure Time	0 days	0 days	Varies product to product	10-28 days	0 days	0 days	10-28 days	0 days	0 days
Reinforcement	Unreinforced	Unreinforced	Varies product to product	Integral reinforcement facer	Fully embeded reinforcing fabric recommended	Fully embeded reinforcing fabric recommended	Integral reinforcing within bitumen	Integral geotextile liner, HDPE liner recommended	Continuous HDPE sheet membrane
Benefits	• Can be installed below freezing	• Light crack bridging potential	• Cold weather application available • Light crack bridging potential when reinforced • Can transition onto penetrations	• Can bridge large cracks • Easier to install than head welded membrane • Factory manufactured sheets provide consistent membrane thickness	• Medium crack and bug hole bridging potential • Can transition onto penetrations	• High crack and bug hole bridging potential • HDPE liner is waterproofing layer • Can transition onto penetrations	• Fully Adhered, can bridge large cracks • Heat welded laps • Factory manufactured sheets provide consistent membrane thickness	• Factory manufactured sheets provide consistent membrane thickness	• Laps become continuous with pressure • Fully adhered, can bridge cracks • Factory manufactured sheets provide consistent membrane thickness
Limitations	• Solvent based, releases VOCs • Does not bridge cracks or bug holes in concrete • Required thickness sensitive to quality control during installation	• Must install above 5°C • Does not span bug holes in concrete • Required thickness sensitive to quality control during installation	• Performance varies significantly from product to product due to different chemical compositions • Required thickness sensitive to quality control during installation	• Attention to penetration detailing required • Must be applied on dry concrete	• Must install above 5°C • For backfill application, reinforcing fabric installation prone to applicator error • Required thickness sensitive to quality control during installation	• Must install above 5°C • Heat welded HDPE laps required, otherwise introduces weak points. • For backfill application, reinforcing fabric installation prone to applicator error • Required thickness sensitive to quality control during installation	• Attention to penetration detailing required • Commonly has adhesion issues due to complexity of torch applied vertical application	• Attention to penetration and lap detailing required • Skilled trade installation required • Shoring wall must be flat to prevent voiding and to contain membrane for shotcrete application	• Attention to penetration and lap detailing required
Where Required	Where exterior finished ground level is at a higher elevation than the ground level inside of the foundation walls (BCBC 9.13.2.1.(1))					Where hydrostatic pressure occurs, waterproofing is required for the exterior surfaces of floors-on-ground, and below ground foundation walls (BCBC 9.13.3.1.(1))			

DRAFT Table from Guide

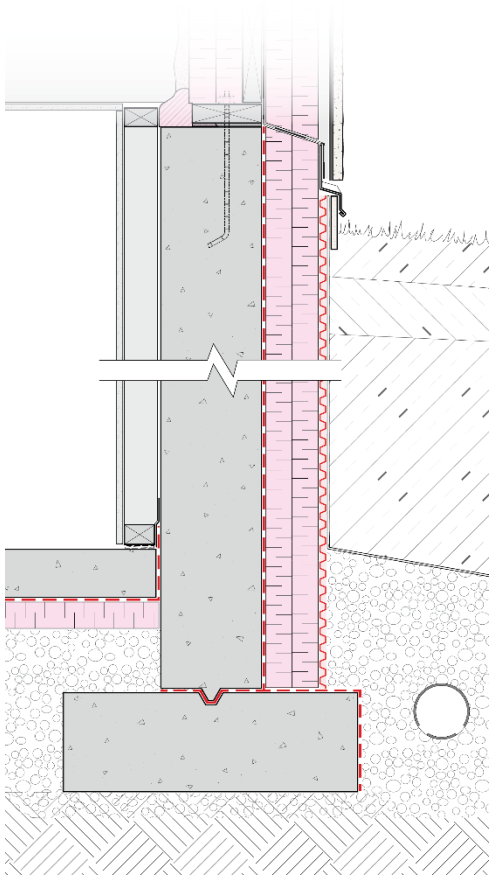
	Dampproofing Optimally Drained		Non-Tankable Waterproofing Partially Saturated Backfill		
Where Required	Where exterior finished ground level is at a higher elevation than the ground level inside of the foundation walls (Building Code 9.13.2.1.(1))		Where exterior finished ground level is at a higher elevation than the ground level inside of the foundation walls (Building Code 9.13.2.1.(1))		
Suitable Environment	Relatively dry soil conditions with well-drained backfill or moist soil conditions with clear gravel backfill		Moderate moisture environments		
Acceptable Foundation Types	Spread & strip footings; piles and grade beams; raft slab with or without piles.		Spread & strip footings; piles and grade beams; raft slab with or without piles.		
Product	**Asphalt Cutback**	**Asphalt Emulsion Dampproofing (Thin Application)**	**Liquid Applied**	**Self-Adhered Modified Bitumen Sheets**	**Asphalt Emulsion Waterproofing (Thick Application)**
Concrete Forming Application	Cast Backfill	Cast/ICF[1]/ Shotcrete Backfill/Blindside	Cast/ICF[1]/Shotcrete Backfill/Blindside	Cast/ICF[1] Backfill	Cast/ICF[1]/Shotcrete Backfill/Blindside
Concrete Cure Time	0 Days	0 Days	Varies product to product	10-28 Days	0 Days
Membrane Reinforcement	Unreinforced	Unreinforced	Varies product to product	Integral reinforcement facer	Fully embedded reinforcing fabric recommended
Description	Solvent based bituminous liquid membrane typically spray or roller applied	Bituminous liquid membrane suspended in water typically spray or roller applied	Liquid or spray applied bitumen membrane modified with polymers for elasticity and puncture resistance	Factory manufactured self-adhered bituminous sheet waterproofing modified with polymers for elasticity and puncture resistance	Asphalt emulsion applied thicker than the dampproofing application with reinforcement to meet waterproofing requirements
Thickness	10-30mils	30-50mils	+50mils recommended	60mils	60-80mils

Benefits	• Can be installed below freezing	• Light crack bridging potential	• Cold weather application available • Light crack bridging potential when reinforced • Can transition onto penetrations	• Can bridge large cracks • Easier to install than head welded membrane • Factory manufactured sheets provide consistent membrane thickness	• Medium crack and bug hole bridging potential • Can transition onto penetrations	•
Limitations	• Solvent based, releases VOCs • Bug holes and cracks should be sealed before installation • Required thickness sensitive to quality control during installation	• Must install above 5°C • Bug holes and cracks should be sealed before installation • Required thickness sensitive to quality control during installation	• Performance varies significantly from product to product due to different chemical compositions • Required thickness sensitive to quality control during installation • Bug holes and cracks should be sealed before installation	• Attention to penetration detailing required • Must be applied on dry concrete • Bug holes and large cracks should be filled with grout or sealant before installation to support membrane	• Must install above 5°C • Reinforcing fabric installation prone to applicator error Prone to inconsistent application • Required thickness sensitive to quality control during installation	•

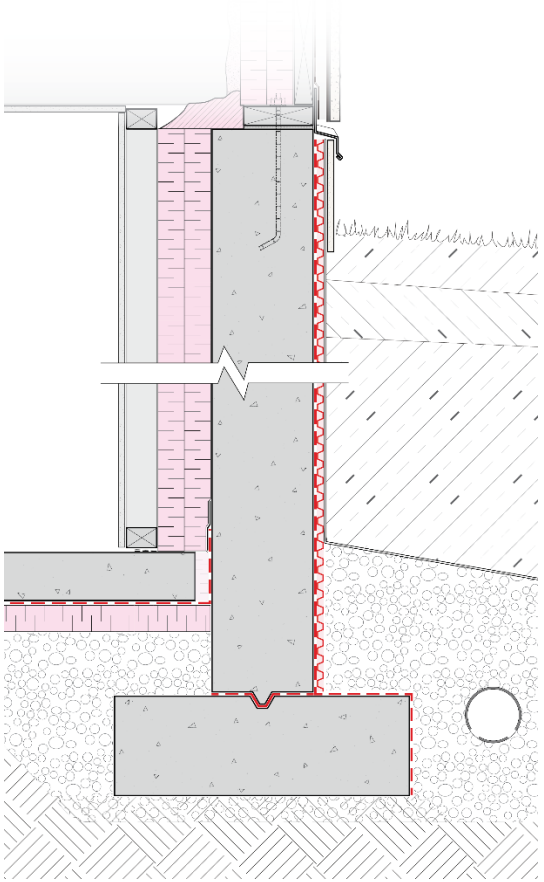
	Tankable Waterproofing – Submerged / Fully Saturated (REQUIRES PROFESSIONAL INVOLVEMENT)			
Where Required	Where hydrostatic pressure (including buoyancy) occurs, waterproofing is required for the exterior surfaces of floors-on-ground, and below ground foundation walls (Building Code *9.13.3.1.(1)*)			
Suitable Environment	High moisture environments or temporary low intensity hydrostatic pressure anticipated		High moisture environments or sustained hydrostatic pressure anticipated	
Acceptable Foundation Types	Spread & strip footings; piles and grade beams; raft slab with or without piles.			
Product	**Asphalt Emulsion Waterproofing with HDPE Liner**	**Torch Applied Modified Bitumen Sheets**	**Bentonite Sheets**	**Pressure-Adhered Thick HDPE Membrane**
Concrete Forming Application	Cast/ICF[1]/Shotcrete Backfill/Blindside	Cast/Shotcrete Backfill/Blindside	Cast / Shotcrete Blindside	Cast/Shotcrete Blindside
Concrete Cure Time	0 days	10-28 days	0 days	0 days
Membrane Reinforcement	Fully embedded reinforcing fabric recommended	Integral reinforcing within bitumen	Integral geotextile liner, HDPE liner recommended	Continuous HDPE sheet membrane
Description	Asphalt emulsions waterproofing installed with continuous HDPE liner for additional water resistance	Factory manufactured heat welded bituminous sheet waterproofing modified with polymers for elasticity and puncture resistance	Clay composite sheet waterproofing which absorbs water and swells to form an impermeable layer	Fully adhered composite sheet membrane comprised of a thick HDPE liner and a pressure sensitive adhesive
Thickness	80mils + liner	115mils	250mils	30-50mils

Benefits	• High crack and bug hole bridging potential • HDPE liner is waterproofing layer • Can transition onto penetrations	• Fully adhered, can bridge large cracks • Heat welded laps • Factory manufactured sheets provide consistent membrane thickness	• Factory manufactured sheets provide quality assurance	• Laps become continuous with pressure • Fully adhered, can bridge cracks • Factory manufactured sheets provide consistent membrane thickness
Limitations	• Must install above 5°C • Heat welded HDPE laps required, otherwise weak points. • For backfill application, reinforcing fabric installation prone to applicator error • Required thickness sensitive to quality control during installation	• Attention to penetration detailing required • Commonly has adhesion issues due to complexity of torch applied vertical application • Bug holes and large cracks should be filled with grout or sealant before installation to support membrane	• Attention to penetration and lap detailing required • Skilled trade installation required • Shoring wall must be flat to prevent voiding and to contain membrane for shotcrete application	• Attention to penetration and lap detailing required

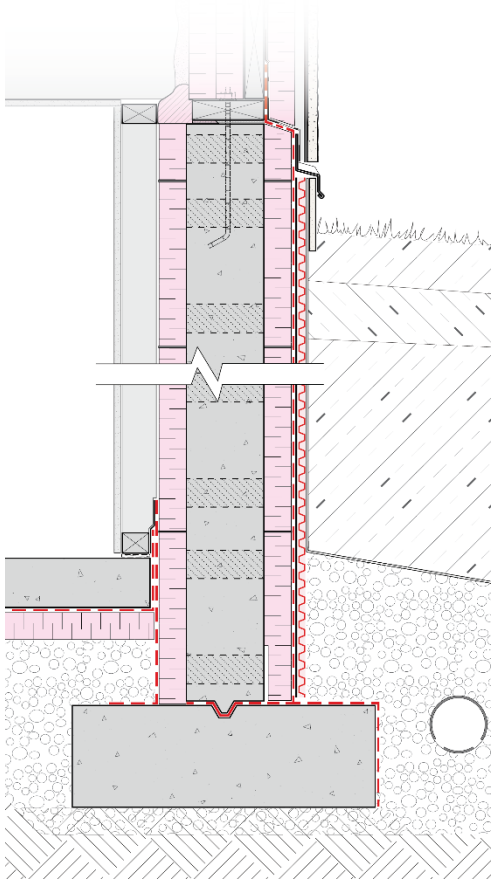
Foundation Wall Assemblies



Exterior Insulated



Interior Insulated



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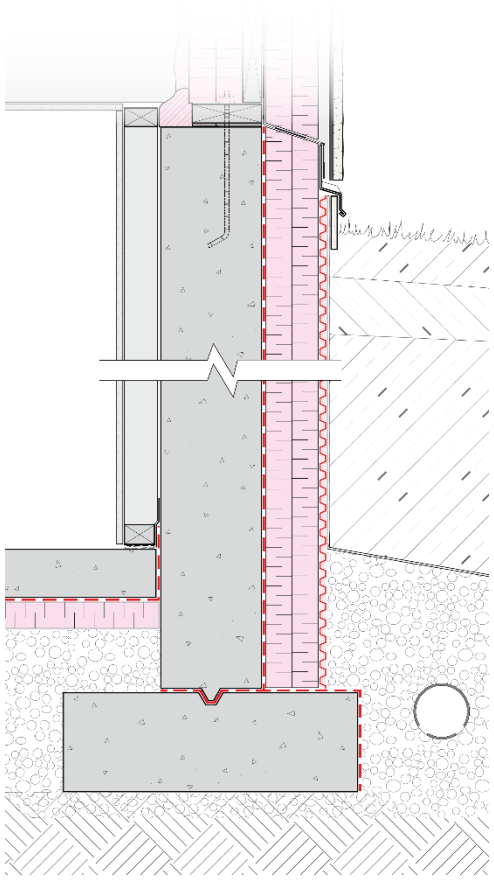
Foundation Wall Assemblies



Exterior Insulated

Recommended assembly type

Concrete is kept warm (and dry)

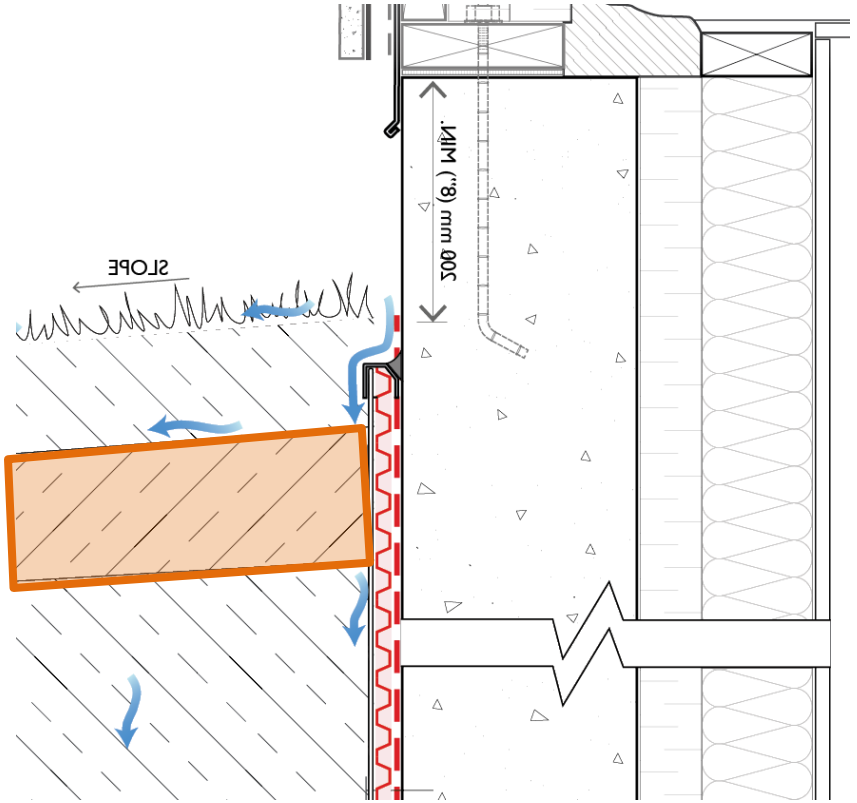
Insulation provides extra buffer against foundation wall

Careful attention is required above grade

Backfill

Use “clay cap” impermeable layer between backfill and topsoil/landscaping

Extend beyond backfill zone



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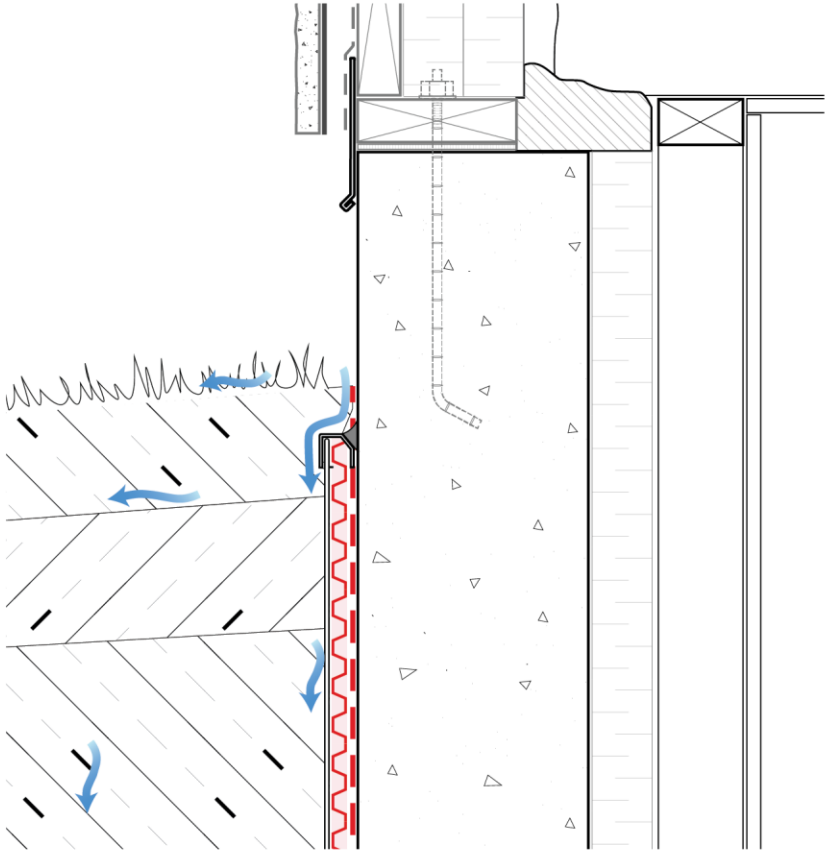
Below-Grade Membrane Termination

Terminate top of drain mat with retention strip/sealant

Parge coat exposed concrete above grade

Consider extending membrane up to top of wall



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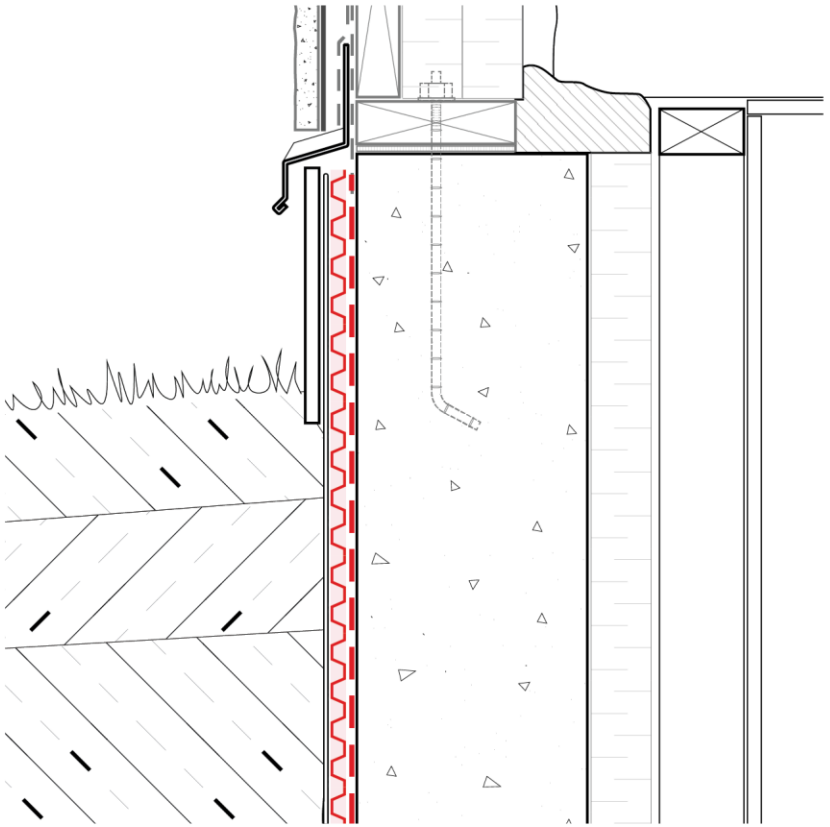
Above-Grade Membrane Termination

Protect drain mat, membrane, and exterior insulation above grade



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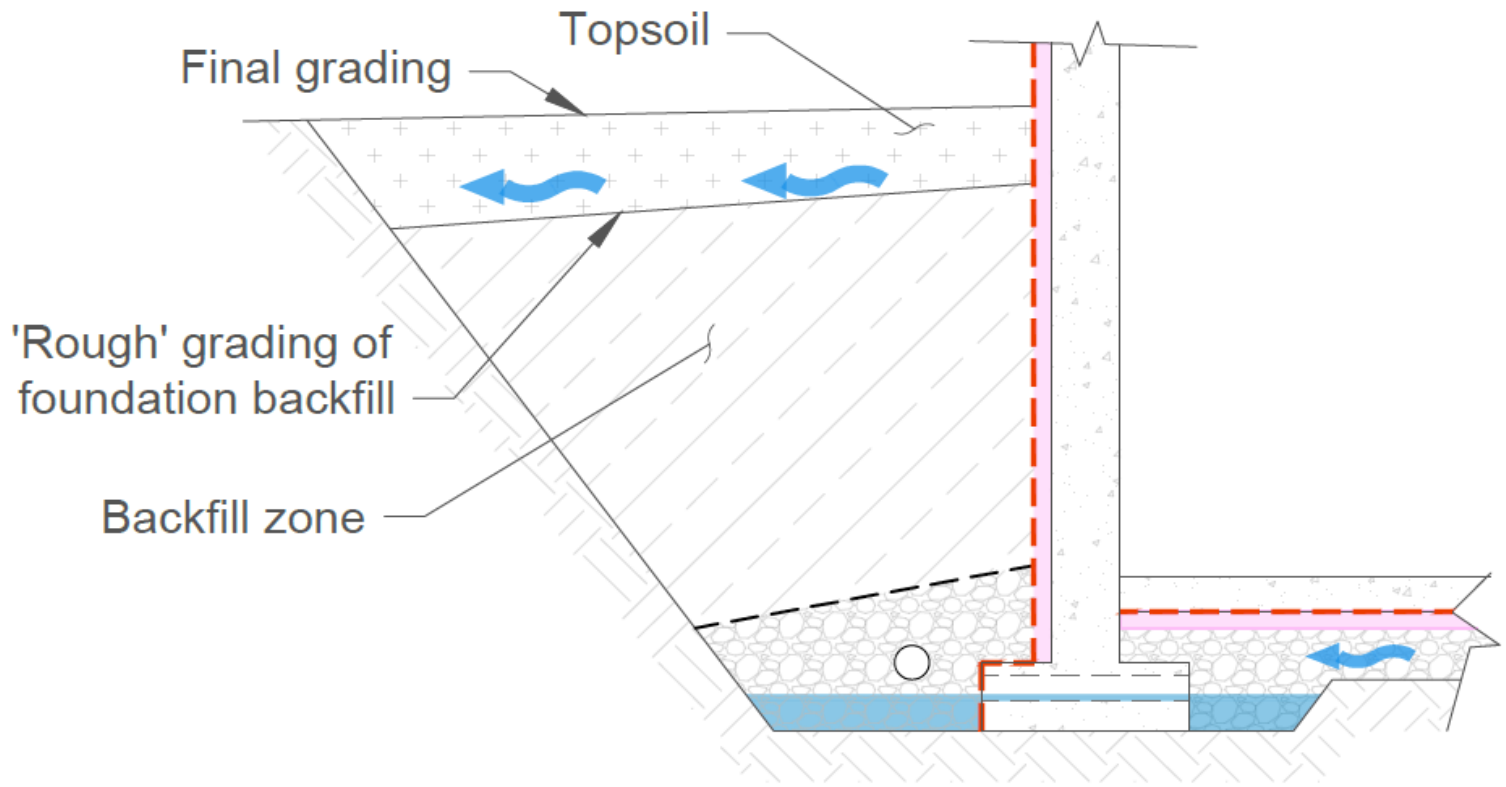
Backfill

Slope away from building



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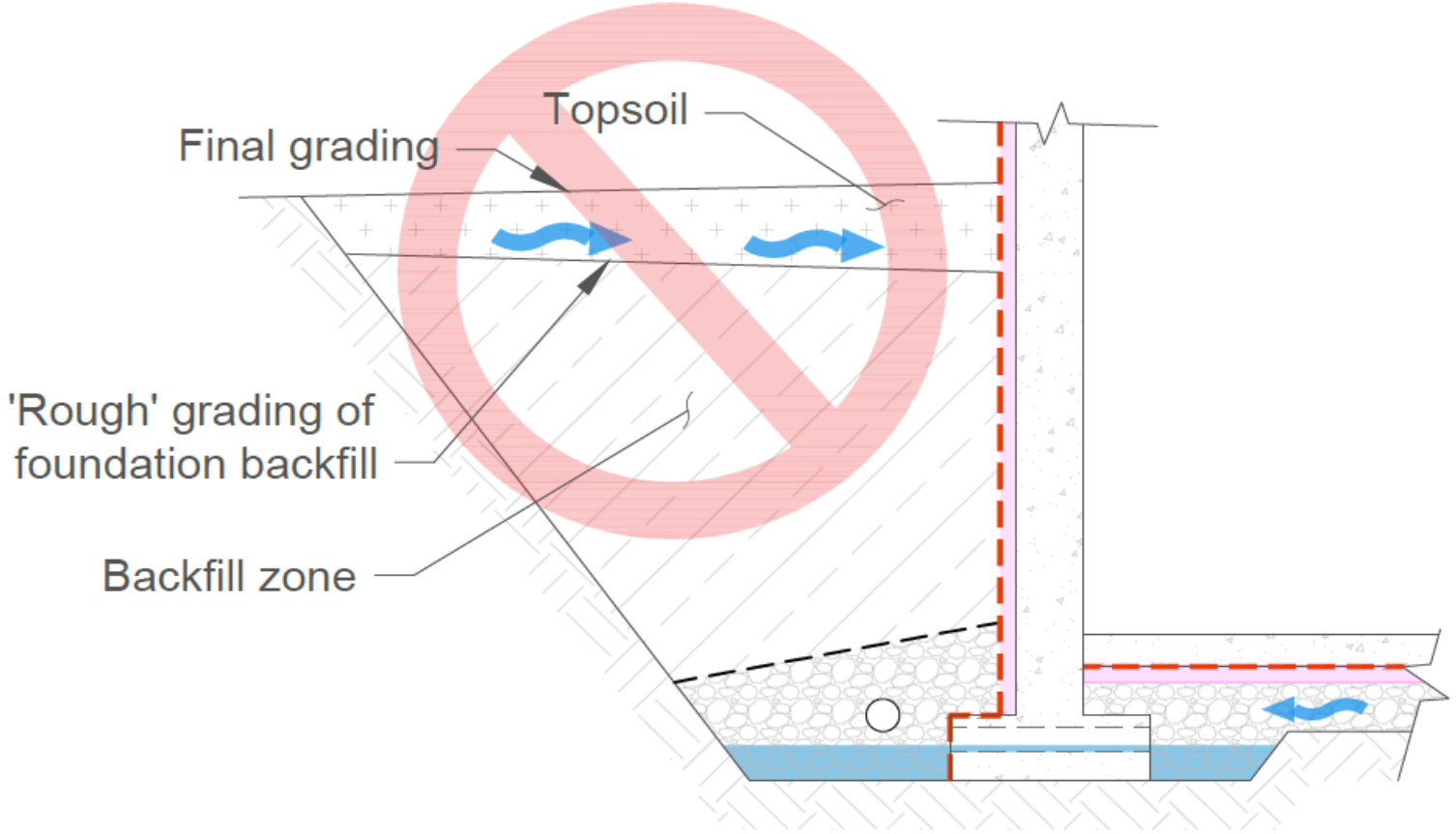
Backfill

Slope away from building (final and rough grading)



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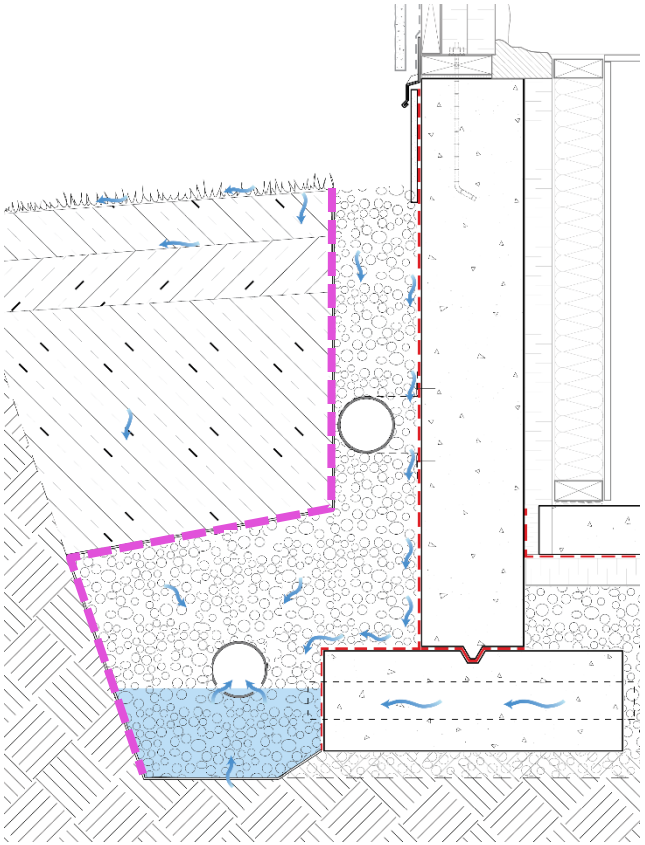
Backfill

OK: use “clean” (less than 8% silt) well-graded sand as backfill

Best practice: use chimney of clear gravel 0.5” – 1” as backfill



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BC Building Code

9.14.5.3. Dry Wells

1) Dry wells may be used only when located in areas where the natural *groundwater level* is below the bottom of the dry well.

2) Dry wells shall be not less than 5 m from the *building foundation* and located so that drainage is away from the *building*.

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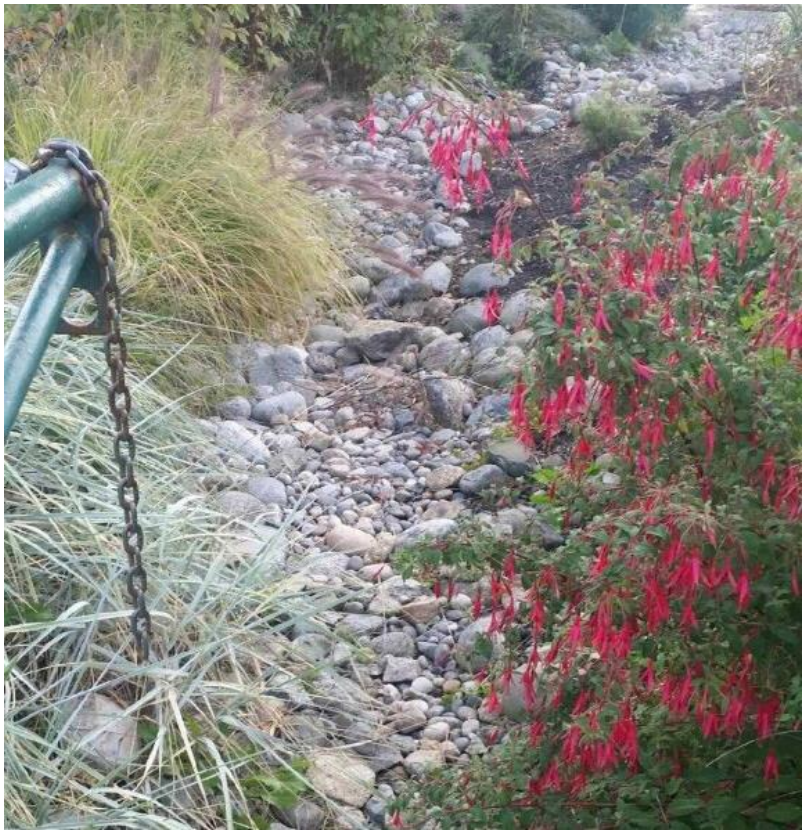
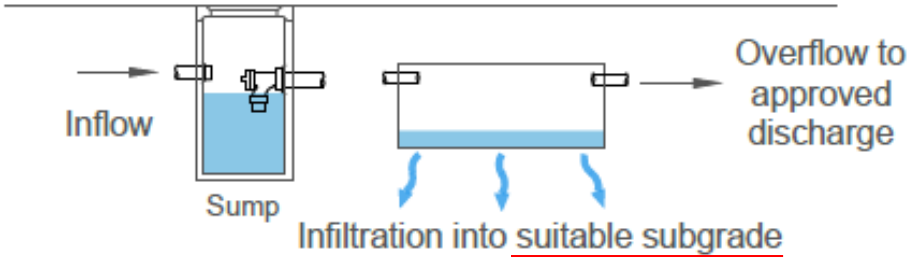
Landscaping
Raingardens
Silva Cells



Water Management & Drainage Discharge

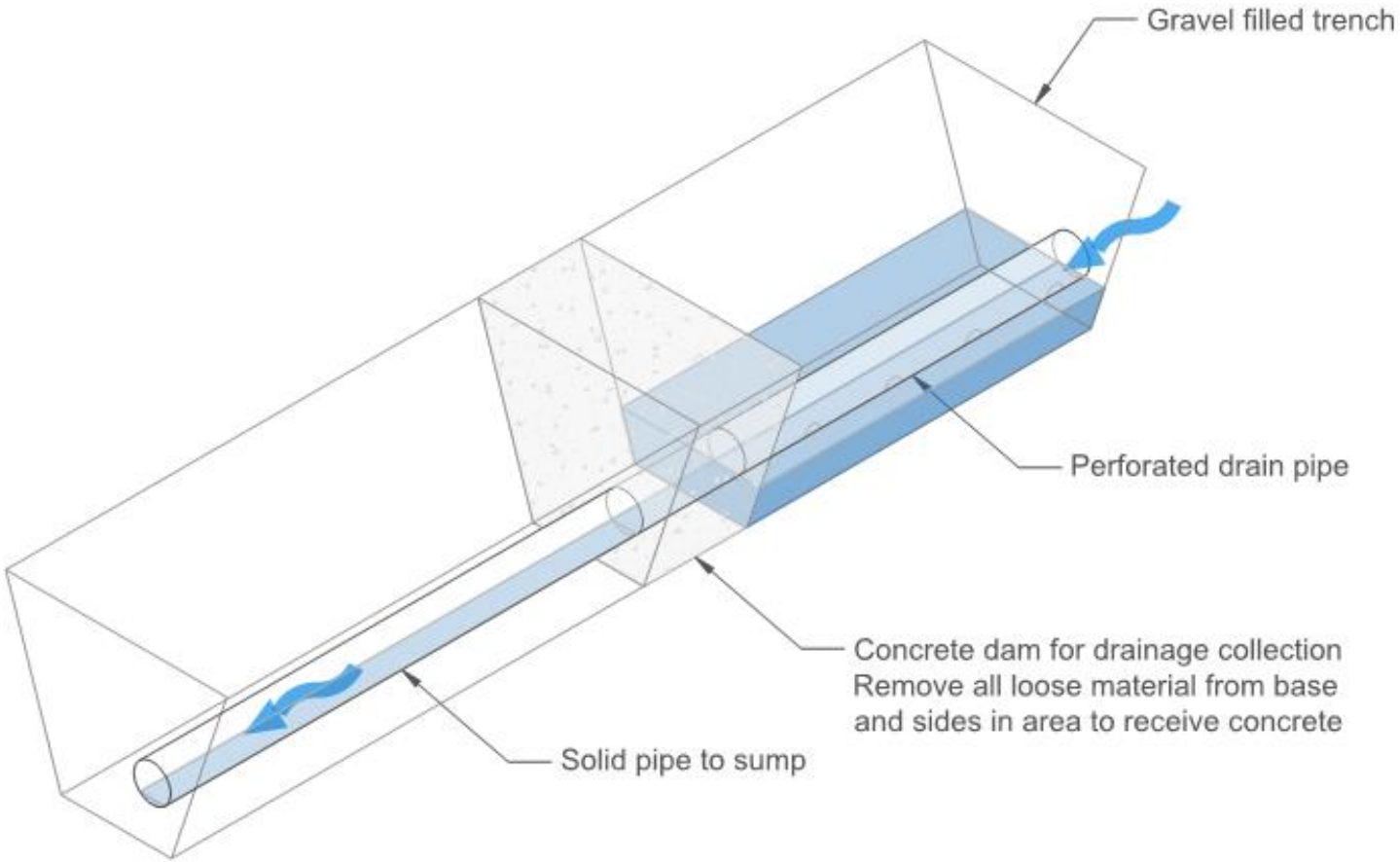
Infiltration field



Consider:

→ Proximity to basements (on and off property)

Site Drainage – Interception Trench (Geotechnical Engineer Recommended)



Common Sources of Drainage Problems

1. High groundwater table and high hydraulic conductivity (permeability) of adjacent natural soil, resulting in seepage into the backfill zone.
2. Moisture under slab fill with upward seepage capillary action if sand, rather than gravel, was used as an underslab support material.
3. Flow of perched groundwater into the backfill zone.
4. Flow of surface water into the backfill zone, including due to changes in upslope, off-site conditions.
5. Plugged drain pipes, including due to the effects of iron ochre.
6. Under-capacity drain pipes.
7. Under-capacity, poorly maintained, or inappropriately triggered pumps (including pumps that burn out because sump volumes are too small).

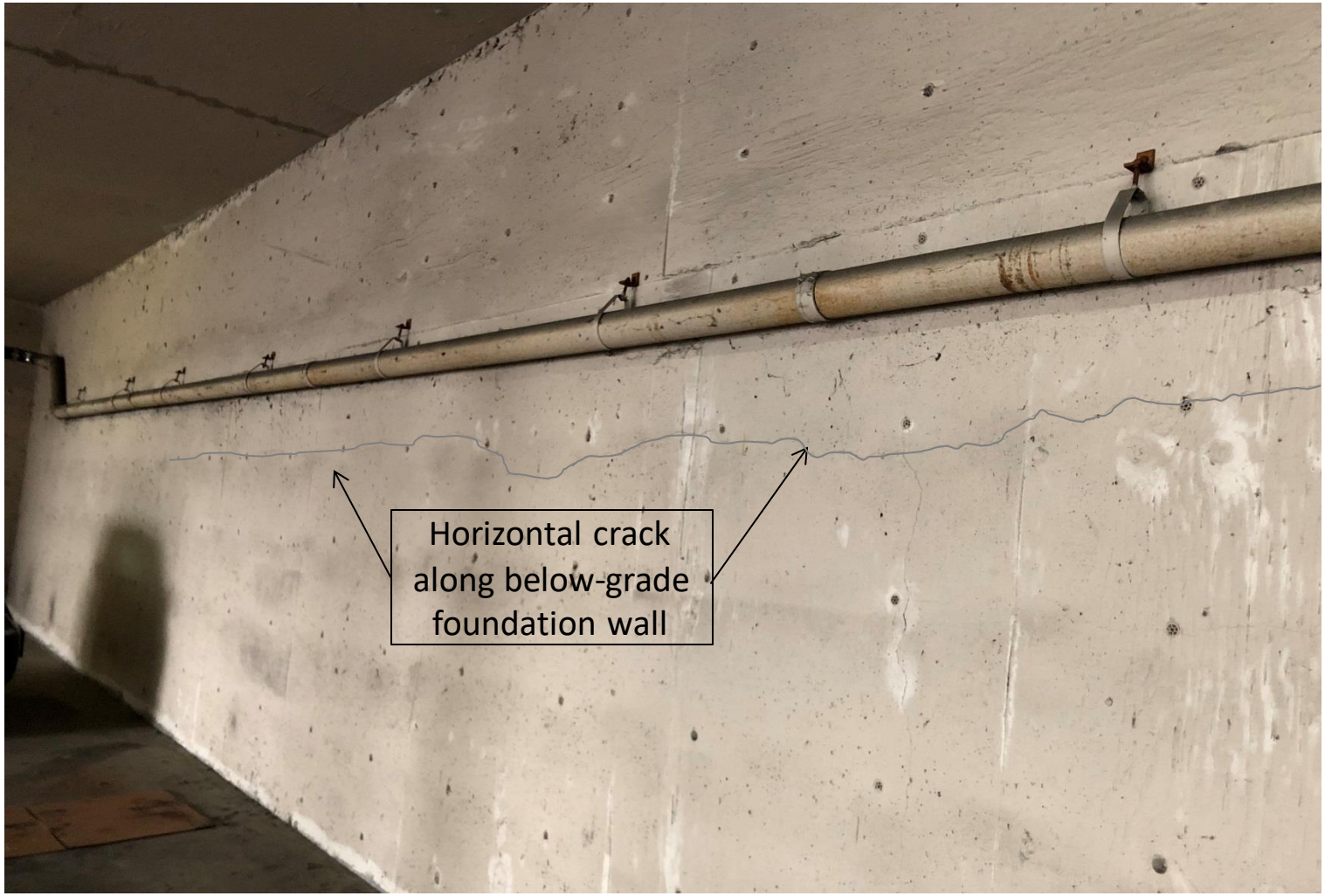
More Common Sources of Drainage Problems

8. Leaking plumbing fixtures in floors above.
9. Compromised above-grade building envelope.
10. A storm, tide, or flood event or combination of events that exceeds the maximum design event.
11. Collection of water vapour due to building envelope systems that are inappropriate.
12. Shallowly-sloping drainage systems with downstream inverts that are compromised by sedimentation, vegetation, ice, etc.
13. Off-site situations such as a poorly-served municipal sewer downstream of the site.

Most Important Drainage Considerations

- Accurately characterize geology, quantitatively assess soil, and monitor groundwater elevations in advance of (and continue during) design
- Drain by gravity where possible – avoid pumps
- Grade excavation to drain without pipes
- Intercept upslope water
- CLEAR GRAVEL UNDER SLAB
- Slope grade down and away from building

Drainage Remediation: Cracking



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Drainage Remediation

Concrete spalling

Epoxy injection

Note:

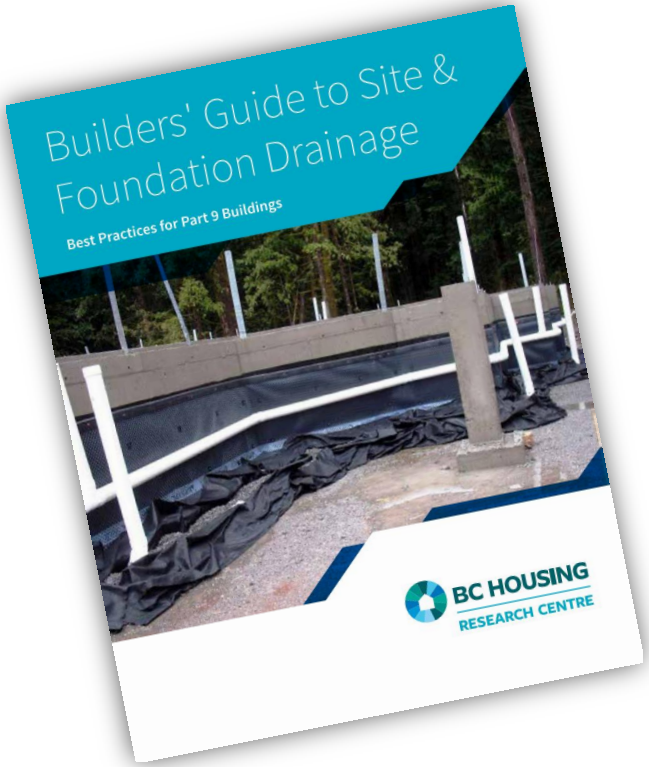
Epoxy injection may *temporarily* block water seepage, until hydrostatic pressures exceed wall capacity and re-cracking occurs.

Conclusion

- Many assemblies, components and systems used in below grade construction
- Current code minimums may not be most effective or common practice
- Current guidance may vary between code minimum, ok practice, better practice, and best practice
- Recommend using geotechnical/enclosure consultant for “wet” sites

Stay tuned for forthcoming guide from BC Housing:

Builder Guide to Site and Foundation Drainage: Best Practices for Part 9 Houses



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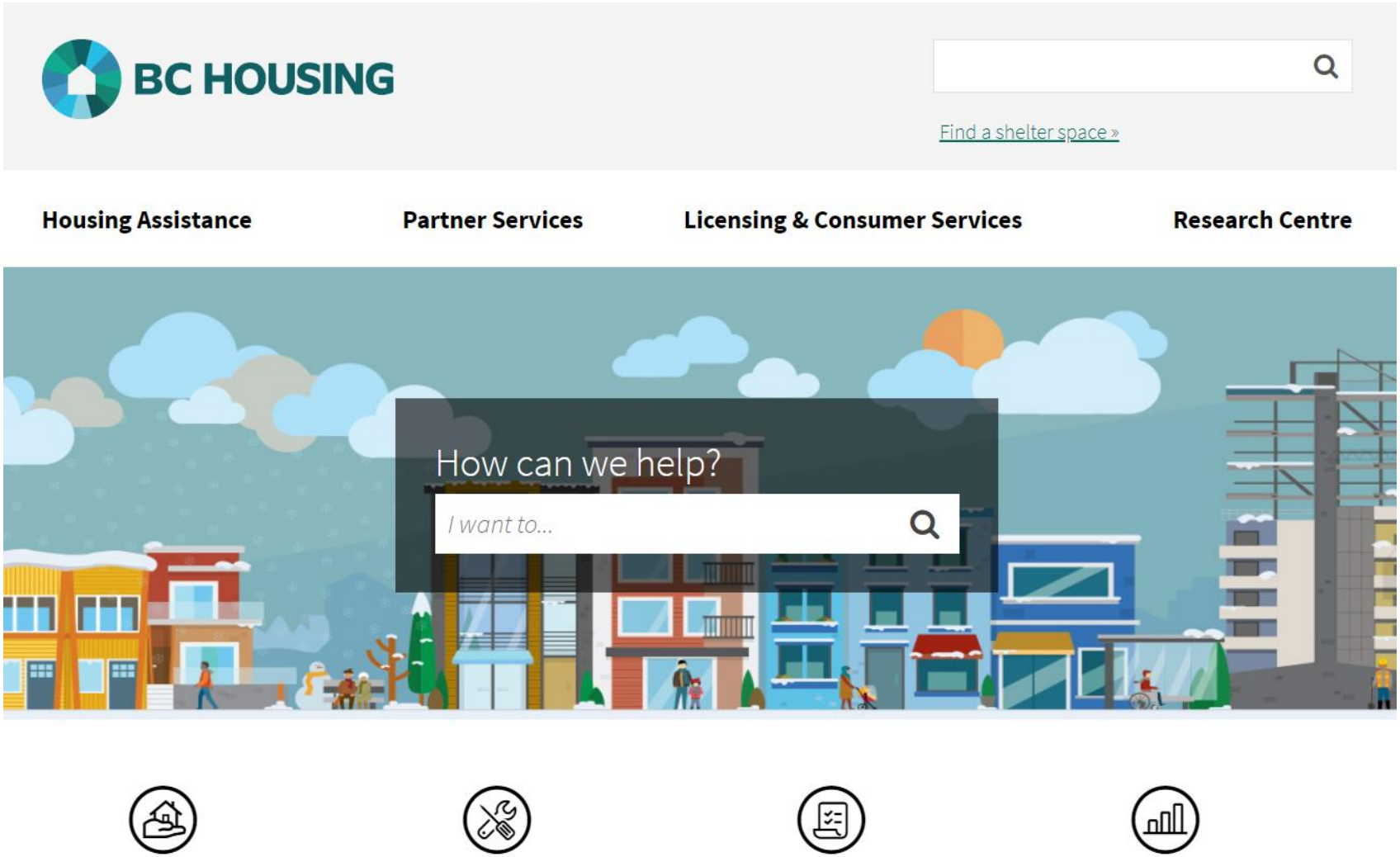
Other Resources – BC Housing



Question & Answer
Thank you for joining us

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Questions?
Email: technicalresearch@bchousing.org