Groundwater & Flooding

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Objectives

- Understand the differences of surface and groundwater flooding
- Understand the mechanisms of groundwater flooding
- Statutory responsibilities for flood protection (WSA* and GPR**, others)
- Understand how to reduce flooding risks to water supply wells

WSA* - *Water Sustainability Act;* GPR**- Groundwater Protection Regulation

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When we think of flooding…

- River scouring it's banks and piling debris

Photo by Mike Noseworthy

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When we think of flooding…

- Rivers overtopping their banks

Photo by John Pogson

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When we think of flooding…

- Streets and fields inundated with murky brown waters

Photos by John Pogson

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We Think of a) Pluvial Flooding

Surface Water Flood

- Extreme rainfall event
- Independent of a water body being nearby
- occurs slower, with more time to evacuate
- Damage can be great

Flash Flood

- rapid torrent of water, short time of onset, potentially dangerous and destructive from water and debris
- Atmospheric rivers?

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… or b) Fluvial/River Flooding

- Usually from snowmelt or heavy rainfall
- Water level rise in river/lake
- Overflowing banks to otherwise dry land
- May damage dams and dikes
- Back areas may become swamped

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… Risks are Generally Understood

- Risks are long recognized
- Land use policies and hazard mapping
- Insurance risk assessments
- Build structures to mitigate
- Climate change?

….Groundwater flooding less understood

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What is Groundwater Flooding?

"The inundation of subsurface structures (i.e. basements) by groundwater, without a necessary water table rise to ground surface."

Abboud et al. 2018

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What is Groundwater Flooding?

"Flooding that occurs when groundwater tables are high (usually as a result of nearby riverine, coastal and/or pluvial flooding) and water is pushed up to the surface."

Definition from Floodwise in BC's Lower Mainland

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Why does the water table rise?

1) Excess recharge to an aquifer with already low storage capacity

2) Propagation into an aquifer due to rising river or lake stages

3) Reduction in artificial storage (e.g. significant reduction in extraction/pumping)

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1) Recharge to aquifer with low storage

- Extreme precipitation or spring snowmelt events
- High infiltration
- Elevated groundwater level prior to event?

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1) Characteristics

- Delayed (days or weeks) after heavy/protracted precipitation or infiltration of spring snowmelt
- Effects can last a long time
- Not restricted to valley bottoms
- Emergence on hillsides (controlled by geology)*

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1) Characteristics

- Damaging to underground infrastructure
- Can create surface flooding
- Risks are not easily mapped

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2) Propagation due to rising river stage

- River stage rises
- Water moves into the adjacent high-conductivity aquifer, or from stream losses on an alluvial fan
- Available storage in aquifer decreases
- Level of the water table increases

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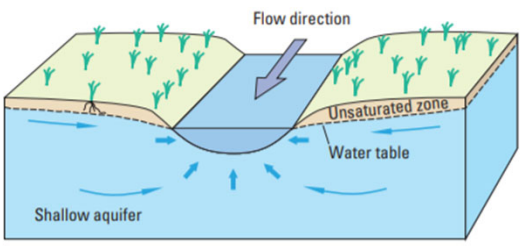
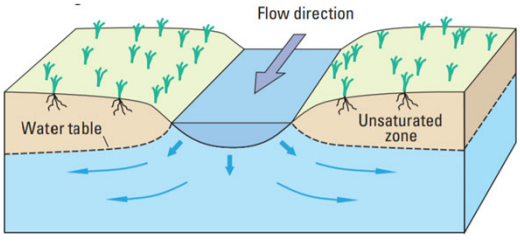
Gaining and losing streams



Gaining stream



Losing stream

Figures from Barlow, P.M. and Leake, S.A., 2012

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2) Example

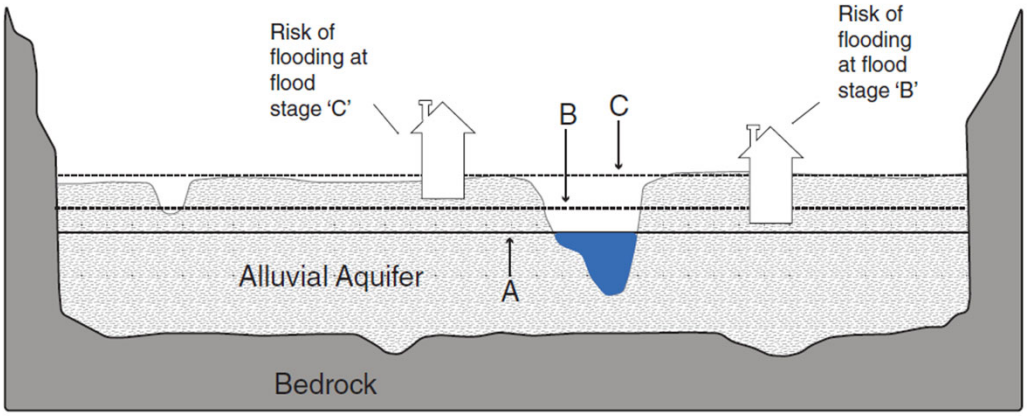

Figure from Abboud et al. 2018

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2) Characteristics

- May occur in the absence of surface flooding
- Commonly an alluvial aquifer adjacent to stream or lake
- Can extend beyond mapped flood zone
- Damaging to underground infrastructure
- Levees/berms may not prevent these impacts
- Risks are not easily mapped

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Groundwater flooding in the News

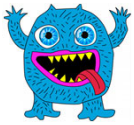
Some Chilliwack residents dealing with water on land and underground

City reminds homeowners to be ready for basement floods as Fraser River and water table rises

JESSICA PETERS / Jul. 7, 2020 3:02 p.m. / LOCAL NEWS / NEWS

Some basements in the Fairfield Island area have been getting wet this week, as the water table rises in north Chilliwack.

The city put a statement on their Fraser River Flood Preparations page, July 2, advising those with basements to prepare for the possibility, due to significantly high water levels. Because while the water isn't forecasted to get high enough to breach the city's dike system, it can creep up into homes from the bottom up.



"… it can creep into homes from the bottom up."

https://www.publicdomainpictures.net/en/view-image.php?image=155188&picture=blue-monster
https://www.theprogress.com/news/some-chilliwack-residents-dealing-with-water-on-land-and-underground/ accessed: March 24, 2021

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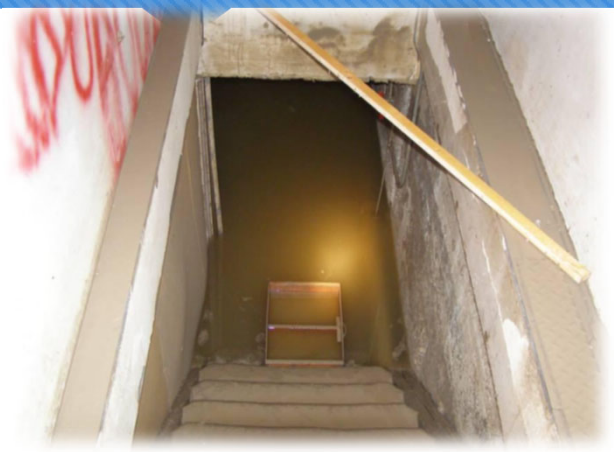
Groundwater flooding in the News



Basement flooding at the Avalanche Institute of Contemporary Art Building, 2013

https://canadianart.ca/news/alberta-floods-art-scene/ accessed: March 23, 2021

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OW296 Merritt

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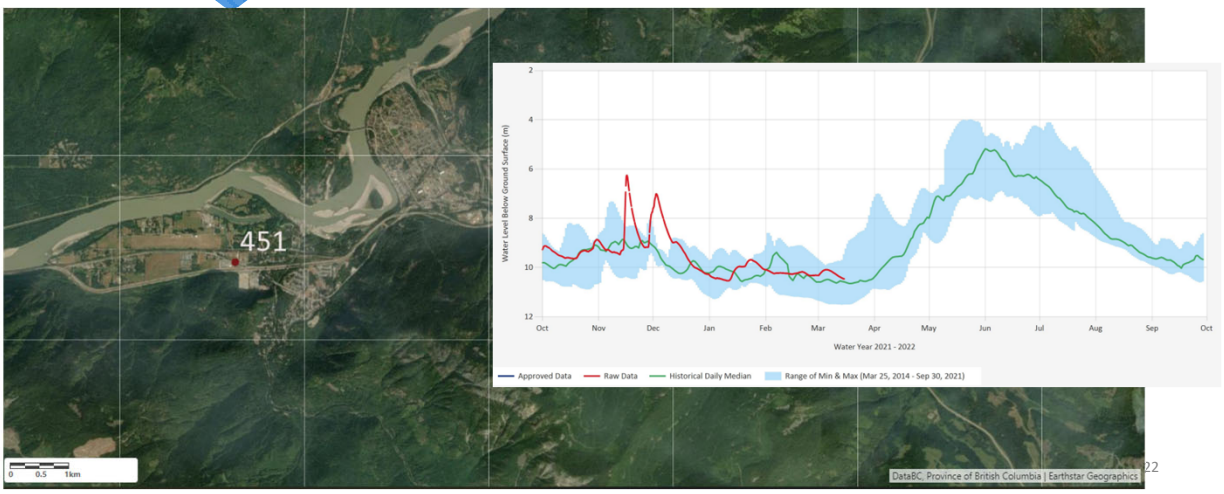
OW451 Hope



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Mitigating Flood Impacts & the Groundwater Protection Regulation

- Maintain the integrity of a surface seal (Sec 64)
- Maintain casing stick-up min. 30 cm (12 inches) (Sec 65)
- Securely install well cap/cover that prevents entry of water at the surface of the ground, including floodwater and ponded water; and any foreign matter (Part 4)
- Other legislation and tools: Drinking Water Protection Reg., GARP assessment, Health Hazard Reg.

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Summary

- Groundwater flooding due is to water table rise
  - Excess infiltration into an aquifer with low storage capacity
  - Propagation into aquifer from increased stream/lake stages
  - Impacts can reach beyond mapped flood zones
  - Flood-proofing: proper siting, construction and maintenance of wells can mitigate against entrance of foreign matter to a well

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Monitoring and Regulation Resources

- Provincial Groundwater Level Interactive Map https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/groundwater-wells-aquifers/groundwater-observation-well-network/groundwater-level-data-interactive-map
- River Forecast Centre https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/drought-flooding-dikes-dams/river-forecast-centre
- Groundwater Protection Regulation https://www.bclaws.gov.bc.ca/civix/document/id/complete/statreg/39_2016
- Community volunteer groundwater monitoring programs

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References

- Abboud, J.M., Ryan, M.C., Osborn, G.D. Groundwater Flooding in a River-Connected Alluvial Aquifer. Journal of Flood Risk Management. 2018; e1234. Accessed March 23, 2021. https://doi.org/10.1111/jfr3.12334.
- AECOM, 2015. Oxfordshire County Council Mineral & Waste Level 1 Strategic Flood Risk Assessment. Accessed March 23, 2021. https://www2.oxfordshire.gov.uk/cms/sites/default/files/folders/documents/environmentandplanning/planning/mineralsandwaste/mw2016/5SupportingDocs/5.3-5.4/5.3a%20SFRA%20M%26W%20Core%20Strategy%20-%20Report%20August%202015.pdf
- Barlow, P.M., and Leake, S.A., 2012, Streamflow depletion by wells—Understanding and managing the effects of groundwater pumping on streamflow: U.S. Geological Survey Circular 1376, 84 p. Accessed March 29, 2021) http://pubs.usgs.gov/circ/1376/.
- Floodwise in BC's Lower Mainland. Hosted by Fraser Basin Council. https://floodwise.ca/

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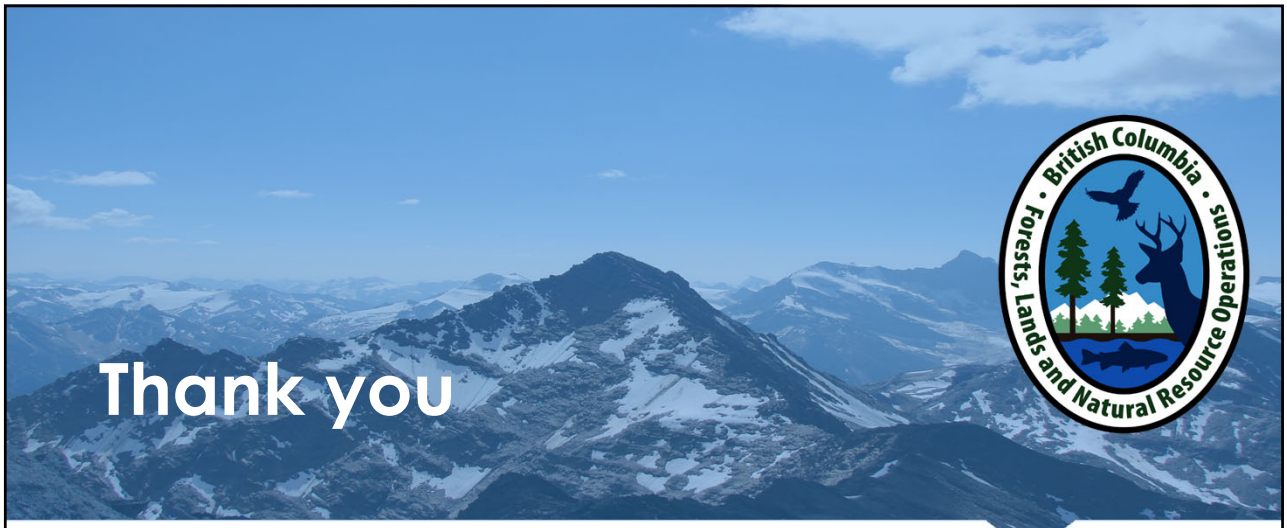

Thank you

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