SCARP
School of Community
And Regional Planning

COST MENU

for Climate Change Adaptation Measures

Submitted to
West Coast Environmental Law and Kerr Wood Leidal

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Produced Spring 2021

Acknowledgement

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Background

BC communities have made admirable progress in adapting to climate change however, many other communities in the province are still in the early stages of climate change adaptation. While lists of adaptation options exist, oftentimes these lists leave out costs, making it more challenging for communities to weigh the options.

West Coast Environmental Law (WCEL) and Kerr Wood Leidal (KWL) identified this need, and from the fall of 2020 to the spring of 2021, they engaged a team of three master's students in the School of Community and Regional Planning as part of a studio course.

The project aims to create a "menu" of climate change adaptation options with associated costs, based on the actual experiences of communities that have implemented the adaptations. The team narrowed the scope of the menu to wildfires and stormwater flooding, based on the team's interests and partners' assessment of community needs.

While processing interviews, the team chose to present the adaptations with relatively more complete content. They also made an effort to include a range of adaptations, including structural ones and policy ones.

The team conducted a five-stage process:

1.  **Literature Review:** Reviewing the grey literature in BC on these risks
2.  **Practitioner Interviews:** Interviewing seven practitioners in the field
3.  **Community Interviews:** Interviewed staff from 11 local governments in BC
4.  **Review Workshops:** Conducting two workshops to review sample menu items
5.  **Menu Creation:** Using the information from interviews to create a full menu

User Information

This cost menu provides high-level and sample community costs for various adaptations to climate change risk events in BC. Cost figures are indicative and not definitive.

Who is this menu for?

- The primary audience are planners and staff in local government in BC
- Residents may find it a useful reference for participating in municipal conversations

What can this menu be used for?

- Exploring climate change adaptations other communities in BC have undertaken
- As a foundation or starting point in deciding which adaptations to pursue
- Learning about the experiences other communities in implementing those adaptations
- Identifying other communities to speak with (see introductory pages for each risk)

When should this menu be used?

- The menu may be more useful once your community knows the climate change risks it faces or wants to adapt to
- Ideally, detailed studies/analyses would follow the selection of adaptations before taking action

Limitations of this menu

- There is an overlap in climate change adaptations and general management practices it is not easy to distinguish between them
- Adapting to climate change involves more than local government actions, such as political will or public awareness
- There are more aspects to adaptations than those we have listed, such as costs to other parties or ease of implementation
- The adaptations shown are not exhaustive, nor is the information complete or definitive. In fact, your community may have lessons to share.

Potential Next Steps

- Expanding the menu to include other risk events.
- Obtaining more cost information from communities to obtain cost ranges for more adaptations
- Providing more detail and breakdown of costs and benefits per adaptation
- Adding case studies

Glossary of Key Terms

Risk event: “Occurrence or change of a particular set of circumstances that could occur, due at least in part to climate change, and would have a significant impact on provincial objectives.”

> *Source:* Ministry of Environment and Climate Change Strategy, 2019. *Preliminary Strategic Climate Risk Assessment for British Columbia.*

Adaptations: “Adjustments to natural or human systems in response to actual or expected climate change.” This menu focuses on adaptations that local governments can do.

> *Source:* United States Government Accountability Office, 2016. “Climate change: Selected governments have approached adaptation through laws and long-term plans.”

For the purpose of this menu we have grouped adaptations into two broad categories:

Structural Adaptations: Adaptations involving changes to the built or natural environment done by local government staff or its contractors. Example: fuel management.

Policy Adaptations: All other adaptations, including regulatory changes, price structuring, running activities/programs, making plans, etc, which do not involve local government staff or contractors making direct changes to the environment. Example: Community Wildfire Protection Plans.

Co-benefits: Positive effects of an adaptation besides adapting to the risk event. Example: Stormwater ponds adding recreational space in an local area.

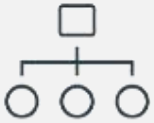
Reading a Menu Item

The risk event the adaptation is for

Name of adaptation

Description of adaptation

Picture(s) related to the adaptation



The broad “type” of adaptation, whether structural or policy

Whether the adaptation applies to public or private land

The land uses that this adaptation applies to

Reading a Menu Item

The risk event the adaptation is for

Adaptation Name

Start-up Costs to Municipality

- These are initial costs to implementing the adaptation.
- These costs are to the municipality and do not include costs to private actors, senior governments, etc.
- Sample community costs are provided to serve as reference figures. Communities are not named, but the region and population are provided.
- We attempt to list cost components to account for differing costs of good/services throughout the province.
- Where available, cost ranges are provided, but these are general estimates, not hard limits.

Ongoing Costs to Municipality

- These are ongoing costs to maintain the adaptation.
- These costs are to the municipality and do not include costs to private actors, senior governments, etc.
- Sample community costs are provided to serve as reference figures.

Local Conditions Influencing Cost

- These are factors that can increase or decrease costs, either for start-up or ongoing costs.

Funding Sources

- Here are funding sources used by at least one community towards this adaptation.
- Amounts are omitted because they can vary by community and year.
- Funding sources change frequently. Note the date the menu was produced (on bottom-right of page)

Benefits & Co-benefits

- Here are benefits and co-benefits experienced or expected from the adaptation.

Challenges

- Here are challenges communities we interviewed faced in implementing the adaptation.

Tips & Advice

- Here are tips and advice interviewed communities gave to other communities considering this adaptation.

Key Resources

- Here are documents or webpages where you can get more information.

Year the menu item was produced

Wildfire Adaptation Measures

Wildfire Definition

'An unplanned fire - including unauthorized human-caused fires - occurring on forest or range lands, burning forest vegetation, grass, brush, scrub, peat lands, or a prescribed fire set under regulation which spreads beyond the area authorized for burning.' (Wildfire Service BC, n.d.)

Wildfire in British Columbia

- Wildfire is a naturally occurring event in BC, however climate change has exacerbated the frequency of wildfires.
- Wildfires have engulfed an average of 2.5 million hectares per year in Canada (NRCAN,2020).
- In the past decade, BC experienced particularly severe wildfires in 2018, 2017, and 2014. Reasons for wildfire include lightening, human intervention, warmer climates, mountain pine beetle infestation, accumulation of forest fuel etc.
- In 2018, 2117 fires were recorded in BC, which burnt 1,354,284 hectares of area and costed the province $ 615 million

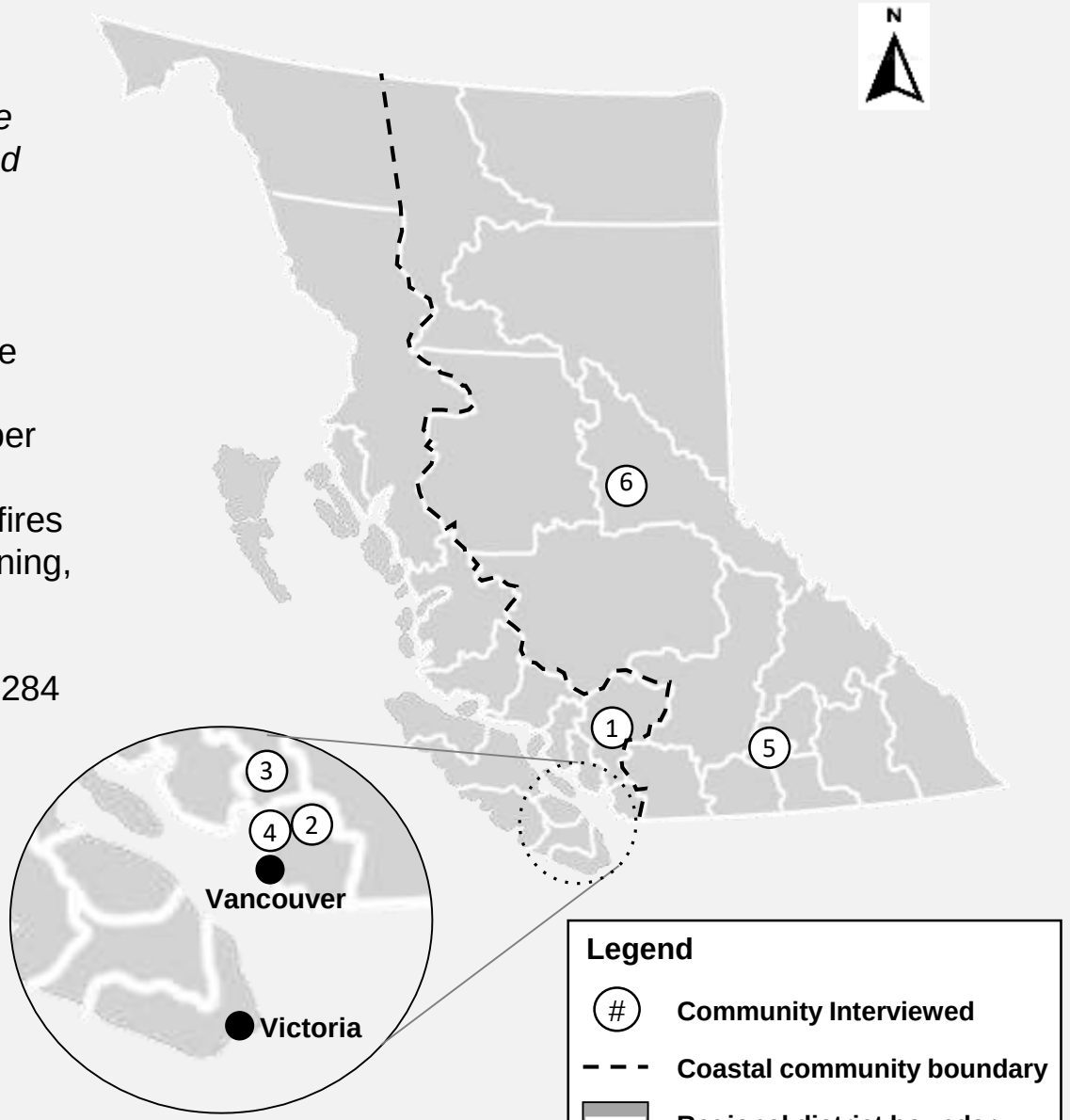
Communities interviewed

1. Resort Municipality of Whistler
2. Corporation of the District of North Vancouver
3. District of Squamish
4. District of West Vancouver
5. City of Kelowna
6. City of Prince George

Note: Regional Districts having a coast line are assumed as coastal communities

**NRCAN – Natural Resources Canada*

Communities Interviewed



Refer the list for community numbers

Community Wildfire Protection Plans (CWPPs)

It helps local governments identify wildfire risk within and surrounding the community and the opportunities available to reduce and mitigate the risk. Community Resiliency Investment program of the BC government which is responsible for funding wildfire adaptations, provides a template for the CWPP, which consists of the mandatory content and structure. As per the template the 4 risk reduction strategies that should be addressed by municipalities include,

- **Fuel Management:** identifies and prioritize actions
- **Community Education:** engagement for community support and education & outreach
- **FireSmart Planning:** current FireSmart implementation and future scenario
- **Other measures:** local strategies and actions to reduce risk

This is a **policy** adaptation

This adaptation applies to **public & private land**

This adaptation applies to **many land uses**

Trees infected by Mountain Pine Beetle infestation

Picture Source: *Mountain pine beetle*. (n.d.). https://wiki.bugwood.org/HPIPM:Mountain_Pine_Beetle

Community Wildfire Protection Plans (CWPPs)

Start-up Costs to Municipality

SAMPLE COST

- A community in the interior of about 70,000 residents and 300 sq. km. spent **$67,000** on a consultant and around **200 hours** by the staff person leading the project

COST RANGE

- **Plan:** prepared by a consultant, **$20,000 – 70,000** is usual, depending on the community size.
- **Staff Time:** Engaging with community and other departments of municipality including Planning, Fire, Parks etc.

Ongoing Costs to Municipality

- Updating the CWPP carries a cost we did not obtain a figure for this.

Local Conditions Influencing Cost

- A larger population size of the community would require more outreach and hence increase the cost

Funding Sources

- Community Resiliency Investment (CRI) Program- UBCM
- Community tax revenue

Benefits & Co-benefits

- Helps identify and prioritise potential risks within and around the community as well.
- Helps strategize actions.
- Provides opportunity to establish the Wildland Urban Interface (WUI) boundary using local knowledge

Challenges

- Co-ordination between internal departments of municipality
- Implementation can be time-consuming

Tips & Advice

- No specific advice was provided for this adaptation measure by practitioners and municipal staff

Key Resources

Example CWPPs

City of Kelowna

City of Prince George

Fuel Management

The aim of fuel management is to reduce the potential wildfire risk posed by the fuel formation in the forest. Forest fuel is dead organic matter consisting of vegetation and biomass. Mountain Pine Beetle and other pest infestations is also responsible for the formation of forest fuel. Rising temperatures due to climate change further aggravates beetle infestations increasing the fuel formation.

Fuel treatment helps to reduce the wildfire intensity to a level which is manageable by fire fighters through direct suppression measures like establishment of sprinklers etc. In addition to lowered fire intensity, it would also reduce crown fire ignition & spread, sustained ignition and the rate of wildfire spread (Fuel Management Prescription, BC, 2020). It is focused on Wildland Urban Interface (WUI), where the human settlements and the wildland interacts but could be applied to large parks to protect natural assets and critical infrastructure, depending upon the community risk reduction objectives (Fuel Management Prescription, BC, 2020).

This is a **structural** adaptation

This adaptation applies to **public land**

This adaptation applies to **parks & forests**

Forest fuel

Forest fuel treatment

Picture 1 source: Parris, R. A. (2018, January 17). *Putting 2017 in the rear-view.* The Prepper Journal. https://theprepperjournal.com/2018/01/17/putting-2017-rear-view/
Picture 2 source: *Fuel reduction*. (2021, March 9). Resort Municipality of Whistler. https://www.whistler.ca/services/emergency/fire/wildfire-protection-strategy/Fuel-Thinning-Projects

Fuel Management

Start-up Costs to Municipality

SAMPLE COSTS

- A community in the interior of about 70,000 residents: **$10,000-11,000/hectare**
- A community on the southwest coast of about 20,000: **$32,000-35,000/hectare**

COST RANGE

- **Treatment**
  Interior: **$4,000 – 11,000/ha** is usual
  Coast: **$12,000 – 50,000/ha** is usual
- **Equipment:** e.g. wood chipper, fire hoses

Ongoing Costs to Municipality

- Although there are costs to re-treating areas, the communities interviewed have not gotten to this stage yet

Local Conditions Influencing Cost

- Denser forests, steeper slopes and environmental sensitivities on the coast compared to the interior increase costs
- Limited ability to burn debris due to regulations and proximity of homes increases costs

Funding Sources

- Community Resiliency Investment (CRI) Program- UBCM
- Canada Infrastructure Program: COVID-19 Resilience stream
- Community tax revenue

Benefits & Co-benefits

- Reduces the chance that lives or property will be lost
- Improves the efficiency and safety of wildfire suppression

Challenges

- Lack of adequate community support (e.g. opposition to cutting down trees)
- Absence of professional foresters on staff.
- Labour shortage in the northern communities
- Limited time and other hazards to address
- Securing funding from council takes a long time
- Long time to implement the measures

Tips & Advice

- Communicate early and thoroughly with the public
- Consult a professional forester for accessing and managing grant funding.
- Complete a Community Wildfire Resiliency Plan to prioritize efforts
- Contact UBCM and apply for funding

Key Resources

UBCM CRI funding

FireSmart

FireSmart is a multi-faceted program aiming to reduce the risk of property damage in the Wildfire Urban Interface areas. It comprises seven disciplines:

1. **Education:** spreading awareness amongst community members
2. **Vegetation Management:** managing type and location of vegetation in fire prone areas to reduce vulnerability
3. **Legislation & Planning:** development of policies and legislation on forestry management practices integrated land use planning compliance and enforcement programs and legal orders.
4. **Development Considerations:** at design /construction/renovation stages to reduce the vulnerability to wildfire
5. **Interagency Cooperation:** encouraging partnership at different levels of government
6. **Cross-training:** structural and wildfire firefighters for improved emergency response performance
7. **Emergency Planning:** combing local knowledge and wildfire management techniques for better emergency response

This is a **policy** adaptation

This adaptation applies to **private land**

This adaptation applies to **residential**

FireSmart Home Ignition Zone prescription

Vegetation around properties

Picture 1 Source: *Home ignition zone*. (2019, October 23). FireSmart. https://firesmartcanada.ca/what-is-firesmart/understanding-firesmart/home-ignition-zone/
Picture 2 Source: Ferrell, R. (2020, January 7). *The wildland-urban interface: Wildfire risk at your doorstep | WSRB blog*. WSRB. https://www1.wsrb.com/blog/wildland-urban-interface-washington-state

FireSmart

Start-up Costs to Municipality

- **Equipment/Materials -** depends on the specific measures, but could include information handouts, door hangers, a free-to-use community wood chipper, etc.

Ongoing Costs to Municipality

- **Staff time:** Time spent by the members in the emergency program, the fire department, and local community volunteers (e.g. public presentations and Q&As, door-knocking)

SAMPLE:

- A community located on the coast of about 80,000 residents involves 10 to 20 staff members at a time

Local Conditions Influencing Cost

- A larger population size of the community would require more outreach and hence increase the cost

Funding Sources

- UBCM Union of BC municipalities (UBCM) Community Resiliency Investment program
- Community tax revenue

Benefits & Co-benefits

- Increases public understanding and awareness of wildfire risks
- Allows firefighters to concentrate on fighting wildfires (rather than town fires)
- Stops the domino effect - fire spreading from one house to another
- Reduces the risk of houses being ignited by embers/ burning debris from other houses or the forest

Challenges

- Community support required since onus on community to implement
- Communication issues, such as conflicting FireSmart and subdivision rules

Tips & Advice

- It's difficult for the community to continually fund this, so it's important residents come on board
- Provide incentives like free chipping where possible

Key Resources

Resources from FireSmart BC

FireSmart Community Funding & Supports, Union of BC Municipalities

Development Permit Areas (DPAs)

It is a set of development standards for regulating development in an area demarcated as DPA under the Official Community Plan (OCP). DPA implementation regulations are set out under the Local Government Act, Sections 919.1 and 920. These areas are met with special treatment as compared to other areas for certain purpose. The purpose of Wildfire DPAs is to protect development and other natural assets from wildfire hazards. DPAs could be implemented through OCP and neighbourhood plans. It is implemented in alignment with the zoning bylaw when applied on a development site (BC Climate Action Toolkit, n.d.). A property owner needs to apply for a DPA for site when they are constructing/ renovating a building or subdividing.

This is a **policy** adaptation

This adaptation applies to **private land**

This adaptation applies to **residential**

Vegetation and Development

Wildland Urban Interface (WUI)

Picture 1 source: District of West Vancouver. (n.d.). *Development permits*. https://westvancouver.ca/home-building-property/development-applications/other-development/development-permits
Picture 2 source: *Not your grandpa's wildfires*. (2019, July 4). Focus on Victoria. https://www.focusonvictoria.ca/focus-magazine-july-august-2019/not-your-grandpas-wildfires-r7/

Development Permit Areas (DPAs)

Start-up Costs to Municipality

SAMPLE COST for a community on the southwest coast of about 40,000 residents over 90 sq km:

- **Mapping –** done by staff otherwise outsourced to consultants which costs **$11-12,000**
- **Staff time –** Initial public outreach to gauge community sentiment to the change. Reproducing the mapping done by consultant for distribution to internal departments took the GIS team of 2 people 2 weeks.

Ongoing Costs to Municipality

- **Staff time** – to process DPA applications

Local Conditions Influencing Cost

- A larger population size of the community would require more outreach and hence increase the cost

Funding Sources

- Community tax revenue
- Application fees charged by municipalities

SAMPLE FEE

- a community on the southwest coast of about 40,000 residents over 90 sq km charges **$2500 per DPA application.**

Benefits & Co-benefits

- Prevents domino effect, fire spreading from one house to another
- Minimize threat of post-wildfire erosion and landslide
- Addresses environmental issues along with reducing wildfire impacts
- Costs borne by property owners instead of municipality

Challenges

- Difficulty for the public to understand DPA rules
- Conflicting DPA areas (natural hazards, creek, wildfire).
- Co-ordination between internal departments of municipality
- Public could be reluctant since onus on property owners

Tips & Advice

- Make DPAs easy to understand to reduce confusion and thereby staff time in revising applications
- Allocate appropriate staff time to review applications
- Align DPA areas
- Hire a consultant to streamline the process
- Learn from other municipalities and don't hesitate to ask for information.

Key Resources

Example communities:

DPA Portal District Corporation of North Vancouver

DPA Guide for District of North Vancouver

References for Wildfire Adaptations

- **CWPP Description:**

  Community wildfire protection plans. (2021, March 23). https://rdck.ca/EN/main/services/emergency-management/wildfires/community-wildfire-protection-plans.html

- **Fuel Management Description:**

  BC Wildfire Service. (2020). *BCWS Fuel Management Prescription Guidance 2020*. Province of British Columbia. https://www2.gov.bc.ca/assets/gov/public-safety-and-emergency-services/wildfire-status/prevention/fire-fuel-management/fuels-management/2020_fuel_management_prescription_guidance_final.pdf

- **Fire Smart Description:**

  FireSmart. (2021, March 15). FireSmart BC. https://firesmartbc.ca/

  Understanding FireSmart. (2019, November 6). FireSmart. https://firesmartcanada.ca/what-is-firesmart/understanding-firesmart/

- **DPA Description:**

  Development permit area guidelines. (n.d.). BC Climate Action Toolkit | climate solutions for BC local governments. https://www.toolkit.bc.ca/dpa

Stormwater Flooding Adaptation Measures

Stormwater Flooding Definition

“The inundation of property in a built environment, particularly in more densely populated areas, caused by rain falling on increased amounts of impervious surfaces and overwhelming the capacity of drainage systems.” (University of Maryland, Center for Disaster Resilience & Texas A&M University, Galveston Campus, Center for Texas Beaches and Shores, 2018).

Stormwater Flooding in British Columbia

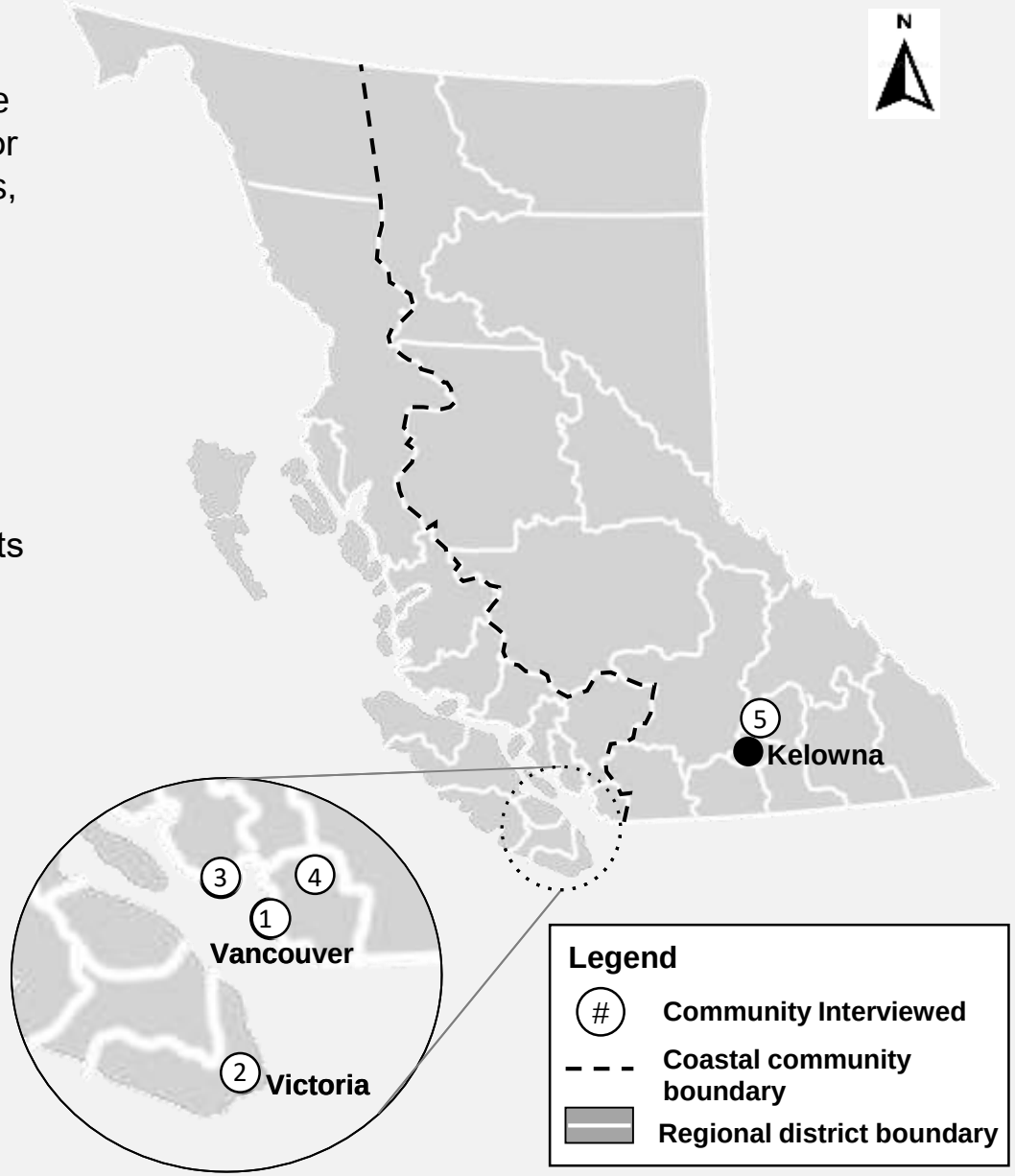
- Stormwater flooding is most common form of flooding in Canadian municipalities (King-Scobie, 2020).
- In case of BC, more frequent flooding can be expected in the future due to human-caused climate change (Kirchmeier-Young & Zhang, 2020). Vancouver expects “heavy rain events [to] become 35 per cent more intense by 2050” (City of Vancouver, 2018)
- Stormwater flooding has impacts on economy (e.g. spoiled crops, damage to streets, loss of employer hours etc. human health (e.g. deaths, sickness, injuries), environmental (e.g. pollution, damaged natural habitats), and political.

Communities Interviewed

1. City of Vancouver
2. City of Victoria
3. Town of Gibsons
4. City of North Vancouver
5. City of Vernon

Note: Regional Districts having a coast line are assumed as coastal communities

Communities Interviewed



Refer the list for community numbers

Integrated Stormwater Management Plans (ISMPs)

An Integrated Stormwater Management Plan (ISMP) identifies a set of stormwater management strategies to operate together in an integrated way. ISMPs often include a combination of strategies, including traditional "hard infrastructure" structural approaches such as ditches and culverts, green infrastructure structural approaches such as rain gardens and tree trenches, and policy and planning approaches such as stormwater management bylaws. ISMPs are typically developed at a watershed level for urban watersheds.

This is a **policy** adaptation

This adaptation applies to **public & private land**

This adaptation applies to **all land uses**

Integrated Stormwater Management Plan Example

source： https://vancouver.ca/files/cov/rain-city-strategy.pdf

Integrated Stormwater Management Plan (ISMPs)

Start-up Costs to Municipality

SAMPLE COSTS An average cost of a well-developed ISMP for a single watershed would be about $200,000 for the planning. The total cost depends on the number of watersheds covered, whether they are developed and other factors.

Costs of ISMP implementation will vary widely depending on the issues, upgrades, and restoration identified in the ISMP. One community of about 700,000 residents expects to spend **$10 million** on long range ISMP planning and implementation.

Ongoing Costs to Municipality

- Ongoing costs of future planning and plan implementation were not obtained

Local Conditions Influencing Cost

- Size of community
- Extent of the stormwater system
- Form or condition of existing stormwater infrastructure
- Desired level of community engagement
- ISMPs typically focus on urban/developed watersheds

Funding Sources

- Property tax

Benefits & Co-benefits

- Improve the quality of the treatment of stormwater
- Monitor pipe system helps to handle a certain volume of water
- Improve water quality, resilience, and livability through creating healthy urban ecosystems
- Cost savings by managing water closer to where it falls rather than further away

Challenges

- Challenges with cross-connections within their system that result in combined sewage connections from private properties being connected to the city's separated storm pipe system and eventually the city's receiving waters

Tips & Advice

- Have infrastructure that's easier to change over time, and has a shorter lifespan so that we can replace it with updated infrastructure
- Think differently and do more effective long term financial planning for the full lifecycle and service outcomes

Key Resources

- Integrated Stormwater Management Plan
- Rain City Strategy, City of Vancouver, 2019

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Green Stormwater Infrastructure: Tree Trenches

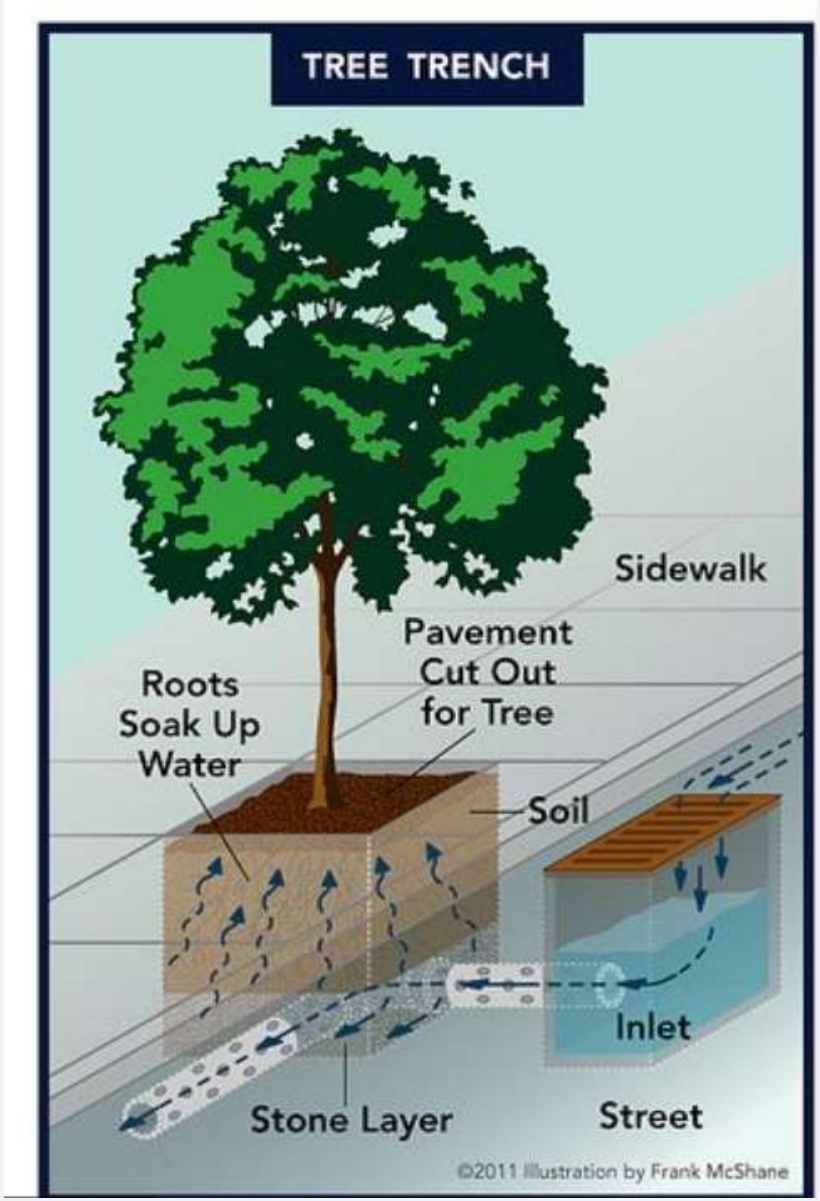
Green stormwater infrastructure (GSI) mimics natural water processes. It works with plants, soils, trees, and buildings to capture and clean stormwater before releasing it into pipes or nature.

Tree trenches are versatile GSI that are well suited for dense urban environment. Trees absorb rainwater through their roots and carry it to the sewer system. The rainwater runoff collected on streets is redirected into the tree trench through inlets and permeable pavers. Then, infiltration into the soil helps clean the runoff and reduces the amount of water into the sewers.

This is a **structural** adaptation

This adaptation applies to **public land**

This adaptation applies to **rights-of-way**



Tree Trench Model

Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.pinterest.com%2Fpin%2F428123508301653868%2F&psig=AOvVaw0MCZ-kbnTq1Y1bzhXl6X7L&ust=1617790251827000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCNiaiuOw6e8CFQAAAAAdAAAAABAD

Green Stormwater Infrastructure: Tree Trenches

Start-up Costs to Municipality

SAMPLE COSTS for a community on the southwest coast of about 700,000 residents. Full costs for design and installation vary by type and conditions.

- Areas with low complexity and local capture (local residential street) might be $100K-$150K for both sides of the street.
- Larger or more complex types of systems can run from $200K-$300K per block.
- **Total cost: $25 million** over 4 years

Ongoing Costs to Municipality

- Maintenance: roughly half a day a year of staff time per facility/infrastructure
- Without proactive maintenance, every 5-8 years, will need to spend around 50% of the initial capital costs to get things back in working order

SAMPLE COSTS for a community on the southwest coast of about 50,000 residents and about 100 facilities (not all trenches):

- minimum **150 hours/year**
- If it had 100% source controls: **$200,000-400,000/year**

Local Conditions Influencing Cost

- Dirtier streets or streets with more stores/population will carry higher maintenance costs
- If need to close down a lane or hire special equipment to build or maintain, will cost more

Funding Sources

- Property tax
- Developer financed through community benefit agreements

Benefits & Co-benefits

- Holds stormwater at the source and slows down the impact on pipes
- Protects some of the environmental function in the streams
- Collects and drop outs sediment and contaminants to help infiltrate runoff

Challenges

- Not making it clear and getting agreement from the beginning on who will maintain the facilities

Tips & Advice

- Have a long term plan
- Understand what kind of facilities are the best fit for the community, scale the level of effort to that
- Pick the adaptations that will pay off in the long term, because communities don't have the ability to rebuild these facilities every 10 years if they want to implement them everywhere

Key Resources

- International Stormwater Best Management Practices (BMP) Database
- Economic Framework and Tools for Quantifying and Monetizing the Triple Bottom Line Benefits of Green Stormwater Infrastructure, Water Research Foundation, 2020

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Stormwater Ponds

Build a stormwater pond along an existing creek can be planted to help settle out sediments and remove pollutants from stormwater.

Stormwater runoff flow into a catch basin, and the mixture of stormwater and pollutants flows from catch basins to storm sewers that lead to stormwater ponds. As the pond fills, sediment and pollutants settle down to the bottom. Then, treated stormwater from the pond is then slowly released into local waterways.

Stormwater Pond Model

This is a **structural** adaptation

This adaptation applies to **public land**

This adaptation applies to **parks & undeveloped areas**

Source: https://www.youtube.com/watch?v=850SUu0YQMQ

Stormwater Ponds

Start-up Costs to Municipality

- Land
- Design
- Construction
- Communications/Coordination

SAMPLE COSTS:

- A community in southwest coast of about 5,000 residents: **$1 million** for 1 pond
- A community in southern interior of about 40,000 residents: **$1.9 million** for 1 pond

Ongoing Costs to Municipality

- Dredging ponds / cleaning out sediment

SAMPLE COSTS:

- A community in southwest coast of about 4,500 residents: **$30,000 every 3 years**
- A community in southern interior of about 40,000 residents: **$50,000/year**

Local Conditions Influencing Cost

- More limited storage capacity in local streams/ponds and steeper channel gradients will allow for more sediment transport and can thereby reduce costs of dredging

Funding Sources

- Province of BC & Government of Canada - Rural and Northern Communities Infrastructure Stream (RNIS) of the Investing in Canada Plan
- Community Emergency Preparedness Fund
- Property tax

Benefits & Co-benefits

- Maybe adapts better than pipes to future increased rainfall
- Addresses long-term erosion and water quality impacts of past development
- Present a learning opportunity and the potential for involvement by a First Nation
- Provide access for sediment removal areas (maintenance)
- New sediment pond protects community from large-scale debris flow

Challenges

- Continual culvert dredging is costly and constrained highly by fish windows
- Emergency creek dredging is very expensive
- Requires regulatory approval

Tips & Advice

- Re-use existing designs when appropriate - a different design costs about twice as much
- Allow lead time for permitting
- Make agreements with the regional district

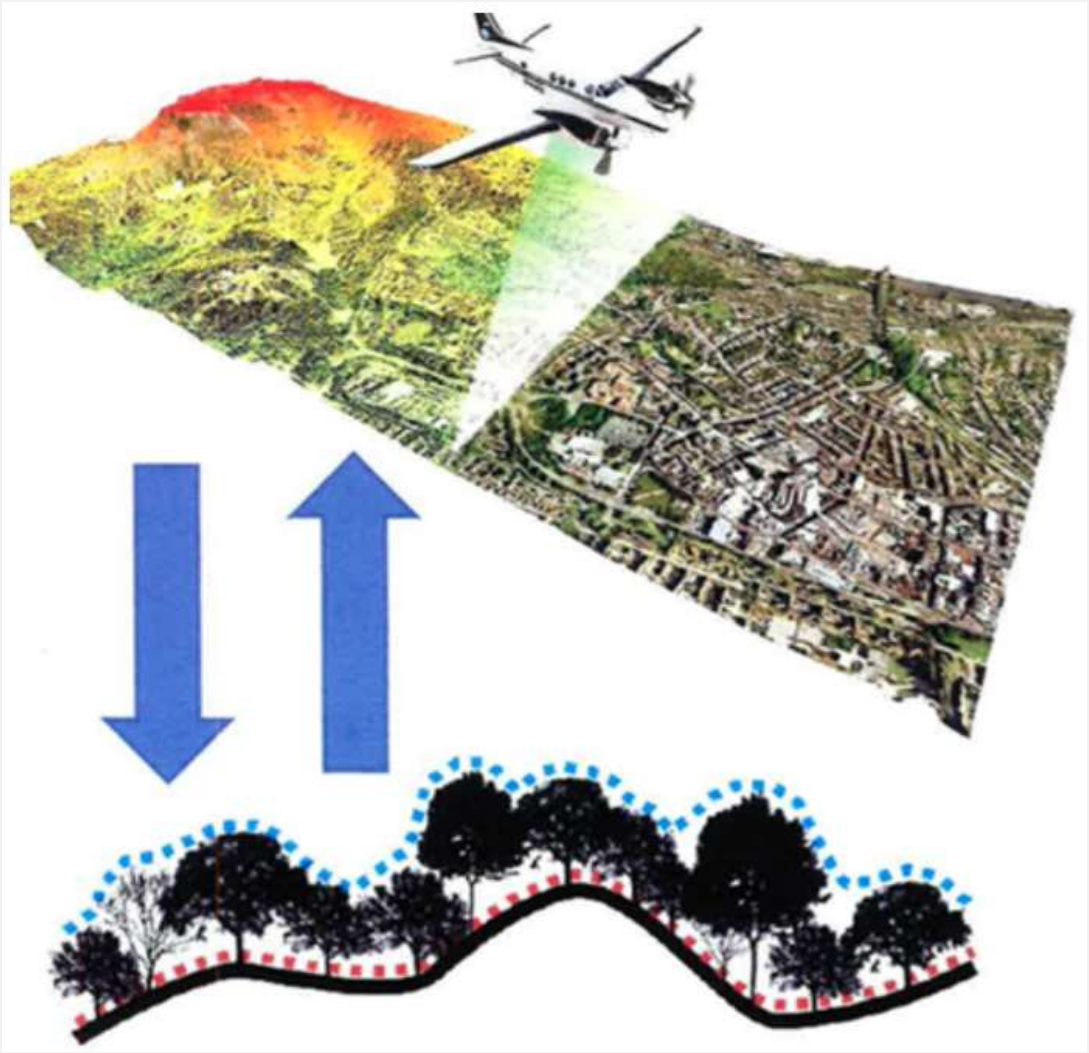
Key Resources

- Stormwater Pond

Produced Spring 2021

Prioritizing Drainage Infrastructure Using LiDAR

Fly a plane or drone over an area and bathe it in light beams. LiDAR is used to help calculate the path falling water would travel through the community, determine overland flow routes and community vulnerabilities. So, the collected LiDAR data shows where overland drainage would happen, which changes where buildings might be located.



LiDAR Scanning

Source: https://vernonmatters.ca/2021/02/07/vernon-storm-water-plan-is-the-envy-of-the-okanagan/

This is a **policy** adaptation

This adaptation applies to **public & private land**

This adaptation applies to **all land uses**

Prioritizing Drainage Infrastructure Using LiDAR

Start-up Costs to Municipality

- Quote for high density (30 points/sq.m) LIDAR is about **$500/km²**

SAMPLE COSTS for a community in southern interior of about 40,000 residents:

- LiDAR flight paths: **$17,000** onto a federal project of $1.5 million for the watershed (1% of which is the community in land area)
- Data analysis and report by consultant: **$110,000**
- Drainage infrastructure project afterwards: **$70,000 (**included **$12,000-15,000** if LIDAR**)**

Ongoing Costs to Municipality

- Ongoing maintenance is still unknown by the community, but one suggestion is to fly LIDAR every 5 years to update drainage routes

Local Conditions Influencing Cost

- Limited human resources to decrease cost (so have to do some open houses with some workshops bringing people)
- If didn't get LiDAR high resolution data then wouldn't be able to model the data and then make additional costs
- Capital cost depends on the number of the flight paths and the number of going back and forth

Funding Sources

- Federal Gas Tax
- Strategic Priorities Fund
- Property tax

Benefits & Co-benefits

- Guide future development - possible to use zoning, OCP designations, statutory right of ways
- Complete flood mapping studies and hazard assessments to help change the way that the community plan to put buildings and set bylaws related to construction levels

Challenges

- Managing large amounts of LiDAR data
- Finding topographic data that covered the study area

Tips & Advice

- Have to invest in high quality Lidar data, have the skills, have a skillful consultant to process the data into the overland flow routes

Key Resources

- *Okanagan Valley Receives $1.45M for Floodplain Mapping*. Okanagan Basin Water Board. April 10, 2018
- Understanding climate change impacts key to prioritizing drainage infrastructure projects

Flood Protection and Enhancement Projects

Flood protection and wetland enhancement projects are usually carried out in the lower reaches of the community's creek drainage basin. It can include the construction of culverts, flow diversion structures, channel like rip-rap channels, sedimentation/detention basins, and wetland areas for flow attenuation and bio-treatment.

Engineered wetlands in particular can increase the higher level of treatment of water (such as filtering out metals) in the basin.

Stormwater Flooding

This is a **structural** adaptation

This adaptation applies to **public land**

This adaptation applies to **parks & undeveloped areas**

Source: https://www.google.com/url?sa=i&url=https%3A%2F%2Fwater.unl.edu%2Farticle%2Fdrinking-water-wells%2Ffloodwater-and-stormwaters-can-contaminate-your-water-well&psig=AOvVaw2PP5THMrMXY2hhxweHwYJg&ust=1617460805048000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCICa-sbl3-8CFQAAAAAdAAAAABAD

Flood Protection and Enhancement Projects

Start-up Costs to Municipality

SAMPLE COSTS for a community in southern interior of about 40,000 residents:

- Capital Costs: **$960,000**

Ongoing Costs to Municipality

- Ongoing Maintenance is still unknown by the community

Local Conditions Influencing Cost

- Land acquisition
- Presence of species at risk
- Archaeological site

Funding Sources

- Building Canada Fund
- Development Cost Charges
- Property tax

Benefits & Co-benefits

- Improve flood protection and design to stormwater events
- Filter stormwater to improve water
- Provide varying water levels to support a variety of wetland and riparian species
- Address soil erosion concerns along the drainage channel
- Adds native plants to enhance local upland and aquatic habitats

Challenges

- Require parcel subdivision and purchase of land
- Require decommissioning existing weir upstream
- Regulatory approval
- Construction needs to be completed in fish window

Tips & Advice

- Lead time for permitting, archaeological findings, potential for grants, risk assessment, prioritization and studies prerequisites

Key Resources

OKANAGAN VALLEY RECEIVES $1.45 MILLION FOR FLOODPLAIN MAPPING, Okanagan Basin Water Board, 2018

Natural Asset Plans

Create a plan that accounts for the jurisdiction's natural assets such as parks and streams can include comparisons of alternatives, such as building pipes versus maintaining creeks. The plan also helps the community make strategic and operational decisions about municipal assets over their entire lifecycle to ensure that assets are maintained, repaired and replaced at appropriate times. Natural assets provide stormwater management services equivalent to engineered alternatives instead of only focusing on the engineering fields.

Natural Asset

This is a **policy** adaptation

This adaptation applies to **public land**

This adaptation applies to **parks & undeveloped areas**

source: https://davidsuzuki.org/expert-article/natural-asset-management-is-proving-its-value-in-the-field/

Natural Asset Plans

Start-up Costs to Municipality

SAMPLE COSTS for a community in southwest coast of about 5,000 residents:

- Comparative analysis between concrete pipe vs restoring and expanding an existing park area and ponds: **$45,000**

Ongoing Costs to Municipality

- Variable: May involve hiring staff to collect data on natural assets and plan for the maintenance and monitoring of these assets
- Primarily to cover monitoring and the dredging of road sediment that accumulates in the ponds

Local Conditions Influencing Cost

- Communities with a larger area may take more resources to create a plan
- Communities with more natural assets may have more opportunities for cost savings

Funding Sources

- Municipal natural Assets Initiative (MNAI)
- Property tax

Benefits & Co-benefits

- Reveals more cost-effective options than traditional grey infrastructure
- Helps prioritize which assets to maintain first
- Cheaper to operate and maintain, if not degraded
- Does not depreciate if properly managed
- Carbon neutral or even carbon positive (carbon sequestration, carbon storage)
- Provides slope stabilization, water filtration, coastal protection

Challenges

- Lack of precedents (few examples of plans by BC communities)
- Limited funding options
- Culture of bias towards engineered option to address climate impacts
- Legislative and policy tools are needed to support nature-based solutions at a watershed scale

Tips & Advice

- Input your own GIS data for localized results
- Recognize dependencies & manage the whole system (e.g. creeks recharge aquifers)
- Have proper financial plan
- Consider nature-based solutions as an alternative to an engineered option, where possible
- Nature-based solutions have substantial financial advantages

Key Resources

- Natural Asset Management
- MNAI Land Awards Video, October 2018

Stormwater Utility & Rewards Program

Stormwater utility charges are based on the impervious area, street cleaning, intensity, and codes of practice program (a program to clean stormwater before it leaves a property) of the property.

Rainwater rewards credits and rebates (i.e., financial incentives) to properties to incorporate stormwater infrastructure practices (e.g., rain gardens, cisterns and permeable paved areas).

Stormwater Infrastructure Practice - Rain Garden

This is a **policy** adaptation

This adaptation applies to **private land**

This adaptation applies to **all land uses**

source: https://www.victoria.ca/EN/main/residents/water-sewer-stormwater/stormwater/rainwater_rewards_program.html

Stormwater Utility & Rewards Program

Start-up Costs to Municipality

SAMPLE COSTS for a community on the Island of about 85,000 residents:

- Community budget for infrastructure: **$6 million** and annually, increases about 2% per year
- Grants: **$8 million** annually

Ongoing Costs to Municipality

- Regular maintenance: clean up catch basin, replace the pipes

SAMPLE COSTS for a community on the Island of about 400,000 residents:

- **$300,000** or more per year, including staff positions etc.
- **Staff time** in engineering: one stormwater management specialist, junior stuff, and additional stuff depending on the type of needed work

Local Conditions Influencing Cost

- If all of the stormwater drains to a common point, there's a higher cost.

Funding Sources

- Stormwater utility generates revenue
- Property tax

Benefits & Co-benefits

- Encourages properties to incorporate green stormwater infrastructure on their buildings and landscapes, also to reduce footprint of impervious areas
- Addresses biodiversity, traffic etc.
- Financially sustainable

Challenges

- Limited green space and many competing priorities (the use of the space - roads, bike lanes, etc.)
- Difficulty in commuting a new and complex program to get public and political support
- In the beginning, public had trouble understanding the program staff got many questions
- Old data comes in different forms and are not consistent

Tips & Advice

- Ensure that the model of stormwater utility works well for the municipality, many attributes can be considered (flat fees, property size, property type, impervious area, or a combination)
- Be clear about the purpose of the stormwater utility
- Input and coordination from many departments across a municipality
- Have a database where the stormwater connections are identified properly

Key Resources

- Stormwater Utility
- Rainwater Rewards Program

References for Stormwater Adaptations

- **ISMP Description:**

  Rain City Strategy. (2019, Nov 5). City of Vancouver https://vancouver.ca/files/cov/rain-city-strategy.pdf

- **GSI - Tree Trenches:**

  Richards St. Blue-Green Network, Green Infrastructure Implementation. (n.d.). City of Vancouver.

- **Stormwater Pond:**

  Land Development Guidelines. (n.d.). http://www.rainwatermanagement.ca/wp-content/uploads/2014/04/Draft-BC-Land-Development-Guidelines-Section-4.pdf

- **Prioritize Drainage Infrastructure Using LiDAR Description:**

  Land Development Guidelines. (n.d.). https://vernonmatters.ca/2021/02/07/vernon-storm-water-plan-is-the-envy-of-the-okanagan/

References for Stormwater Adaptations

- **Flood Protection and Enhancement Description:**

  Vernon Stormwater Plan is the Envy of the Okanagan. (2021, Feb 7). Kevin Rothwell http://www.rainwatermanagement.ca/wp-content/uploads/2014/04/Draft-BC-Land-Development-Guidelines-Section-4.pdf

- **Natural Asset Plan Description:**

  Natural Asset Management. (n.d.). Town of Gibsons https://gibsons.ca/sustainability/natural-assets/#:~:text=GIBSONS%27%20NATURAL%20ASSETS&text=The%20Gibsons%20Aquifer%2C%20for%20example,acts%20as%20a%20natural%20seawall

- **Stormwater Utility & Rewards Program Description:**

  Stormwater Utility. (n.d.). City of Victoria http://www.rainwatermanagement.ca/wp-content/uploads/2014/04/Draft-BC-Land-Development-Guidelines-Section-4.pdf