10th Street Recreational Wave Viability Report – FINAL

October 28, 2024

Executive Summary

The City of Calgary's River Engineering Team was requested to assess the feasibility of including a recreational wave park as part of the 10th Street Gravel Bar Flood Mitigation Project. A conceptual design report for the wave park was developed by the Alberta River Surfing Association (Surf Anywhere, 2019) which suggested the wave could conservatively provide up to $1.8M/year in economic benefit to Calgary's economy as well as have numerous social benefits for the area and downtown in general.

This report reviewed the efficacy of a recreational wave at this location by assessing the potential wave for:

- The safety of recreational waves in general and compared to other recreational activities;
- Whether a recreational wave would hydrologically/hydraulically function at this location;
- The potential morphologic and sediment transport maintenance concerns;
- The geotechnical considerations;
- Water quality concerns related to river use in general and at this location specifically;
- Archeological or cultural impacts;
- Material management and constructability considerations;
- Regulatory approvals and navigation concerns in particular;
- The ecological impacts from a wave particularly on fish and their movement;
- How the wave would be operated and maintained in the long term;
- Impacts to existing utilities; and,
- Public support or concerns for the wave, and alignment with the adjacent Sunnyside barrier, Lot 6, and River Walk West Projects.

Based on the review of these factors, there does not appear to be any technical, regulatory, or safety reasons to exclude a recreational wave from the project. From a technical perspective, this location is ideal for this type of feature due to the hydraulic and geotechnical conditions.

The potential economic and social benefits also appear to be robust based on the performed literature review which found the economic benefits to recreational waves ranged between $50CAD-$100CAD per user per day. The ARSA (2019) estimated usage of 30,000 user visits per year also appears valid considering the usage seen at other similar recreational waves, usage of other similar recreational features in Calgary (i.e. Glenmore Canoe Club and Harvie Passage), and the number of pedestrians using the regional pathway along that stretch of river.

The preliminary design for the gravel bar project incorporating a potential recreational wave is nearing completion (see Figures 25-30) and the resulting design can mitigate the flood risk while also creating a successful riverfront and recreational wave feature. The current Class 5 (+100%, -50%) project cost estimate is approximately $10M, of which $6M is for the flood mitigation component and $4M is for the in-

river recreational wave components. The $4M recreational component is proposed to be paid for from a combination of City funding, Provincial and Federal grants, and public donations.

The project aligns well with City's overall strategic direction of creating a "great place to live" as well as numerous other business unit goals including the Downtown Strategy, the Recreation Master Plan, the River Access Strategy, the Riparian Program, and The Eventful City Strategy.

Acknowledgements

This project and report specifically have benefited from the input from numerous individuals and subject matter experts. Their contributions and thoughtful comments have ensured the report is as accurate and considerate as possible. In no particular order, the individuals and organizations that helped contribute to this project review include:

- The National Research Council's Ocean, Coastal and River Engineering Division and specifically Ivana Vouk, Mitch Provan, and Sean Ferguson;
- Dr. Colin Rennie and Dr. Qingcheng Yu from the University of Ottawa;
- Mary Quinlan from Arts and Culture;
- Jia Cheng from Project Spaces Public Development;
- Amber Ashford and Carolyn Tooth from Partnerships;
- Katherine Hikita and Mark Schultes from the Transportation Public Delivery team;
- Erica Goth and Anne Breckenridge from Climate and Environment;
- Maggie Burlington and Neil Barss from Law;
- Norma Ruecker and Eric Camm from Water Services;
- Laureen Bryant and Michelle Reid from Cultural Landscapes;
- Tamara Lamb from Regulatory Compliance; and of course,
- The entire consulting team led by O2 Planning and Design.

Table of Contents

Executive Summary ii

Acknowledgements iv

1 Introduction 1

2 Wave Park Efficacy 5

2.1 Safety 5

2.2 Hydrologic/Hydraulic Consideration 6

2.3 Morphodynamic Considerations 8

2.4 Geotechnical Condition 11

2.5 Water Quality 12

2.6 Material Management 12

2.7 Navigation 13

2.8 Fish Habitat/Migration Impacts 14

2.9 Environmental Impact 14

2.10 Archeology/Cultural Concerns 15

2.11 Regulatory Approvals 16

2.12 Indigenous Engagement 16

2.13 Utilities (Enmax line and Outfall B52A) 16

2.14 Partnership and Operation 17

2.15 Public Engagement 18

2.16 Public Access and Parking 19

2.17 Efficacy Conclusion 20

3 Business Case 20

3.1 Social Benefits 20

3.1.1 Additional Social Benefits 21
3.2 Environmental Benefits 22
3.3 Economic Benefits 22
3.3.1 Non-Market Benefits 24
3.4 Past Communication 25
3.5 Cost/Funding 25
3.6 Collaboration with RWW, Lot 6, and Sunnyside Barrier 25
3.7 Improved River Access 25
3.8 Business Case Conclusion 25

4 Design 26

4.1 Louise Bar 27
4.2 South Slopes 27
4.3 North Channel 28
4.4 The Wave 30
4.5 The Landing 31

5 Conclusions 31

6 Closure 32

7 References 33

Appendix A 36

Appendix B 37

Table of Figures

Figure 1: Image of the project area demonstrating the bridge spans that are being hydraulically impacted. 1
Figure 2: 1:100-year flood mapping of the area of concern. 1
Figure 3: Image of the standing wave that formed just downstream of the tenth street gravel bar (Daily Hive, 2022) 2
Figure 4: Conceptual design of a river surf park at tenth street in Calgary (Alberta River Surfing Association, 2019) 3
Figure 5: Images of some of the recreational waves located throughout the world including in Kananaskis, Canada. ... 3
Figure 6: Images of the project Area in 1953 (left) and 2022 (right) 4
Figure 7: Open Water Flow Duration Curve for the Bow River for the past 32 years 7
Figure 8: 2D HECRAS plan and profile results for the existing geometry 7
Figure 9: Aerial images of the reach of interest from 2001 and 2005 8
Figure 10: Cumulative deposition (red) and erosion (blue) map of different bar management plans 9
Figure 11: Image of the physical model at the NRC laboratory in Ottawa 10
Figure 12: Physical Model Results showing bed level changes 10
Figure 13: Typical geological cross section near the proposed recreational wave location 11
Figure 14: Enterococcus concentrations from weekly grab samples taken at the surf wave location 12
Figure 15: Image looking upstream at the existing wave and the sharp bend 13
Figure 16: Image showing trees within the project area and their approximate size 15
Figure 17: Looking downstream from below Louise Bridge at the light “sentinel” 15
Figure 18: Utilities in the project area. Enmax 138 KV underground line in Red and City storm line in green 17
Figure 19: Example Image of a supporting facility that would provide rentals, lessons, and sales 18
Figure 20: Word cloud derived from RWW engagement comments 19
Figure 21: Findings from the 2023 Perspectives on Calgary Survey: Downtown (CoC, 2024B) 22
Figure 22: The Wave (a) and Lee Valley Whitewater Centre (b) 23
Figure 23: A mural of the tenth street wave at the Calgary international airport departure lounge 24
Figure 24: 2022 Airphoto of existing conditions with the 5 project areas shown 26
Figure 25: Plan image of the project area 26
Figure 26: Louise Bar Design 27
Figure 27: South Slopes Section with Access Point 28
Figure 28: South Slopes and North Channel 29
Figure 29: Rendering of The Wave location looking downstream from near Louise Bridge 30
Figure 30: The Landing 31

Table of Tables

Table 1 Whitewater and Similar Recreational Sport Fatality rates (Fiore, 2003) 5
Table 2 Operating Budget Overview from ARSA (2019) 18
Table 3: Surfer versus non surfer profiles From Wagner et. al. (2011) 23

1 Introduction

Over the past several decades, a gravel bar has been forming in the Bow River under the 10 Street SW Bridge (Louise Bridge). The 2013 flood resulted in a dramatic increase in size of the gravel bar which has since become vegetated with native poplar trees. The bar is expected to continue vegetating and growing in size, impacting the hydraulic capacity of three of the five bridge spans (see Figure 1). This is a flood risk concern due to the impact of increased water levels on the communities of Hillhurst, Kensington, and Sunnyside (See Figure 2). In addition, reliance on just two of the five bridge spans would cause increased scour and erosion under the functioning spans putting the bridge piers and other infrastructure at risk.

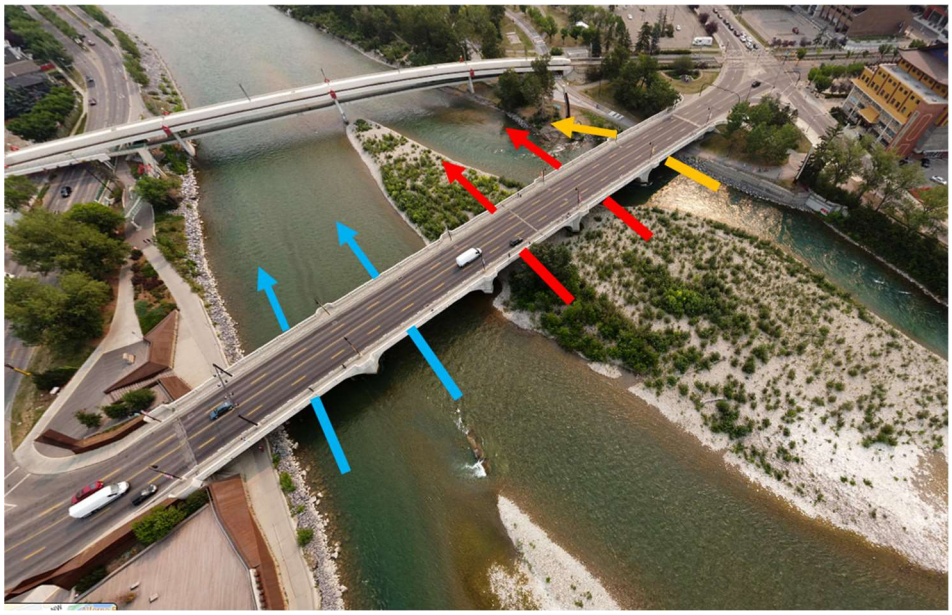


Figure 1: Image of the project area demonstrating the bridge spans that are being hydraulically impacted by the gravel bar formation.

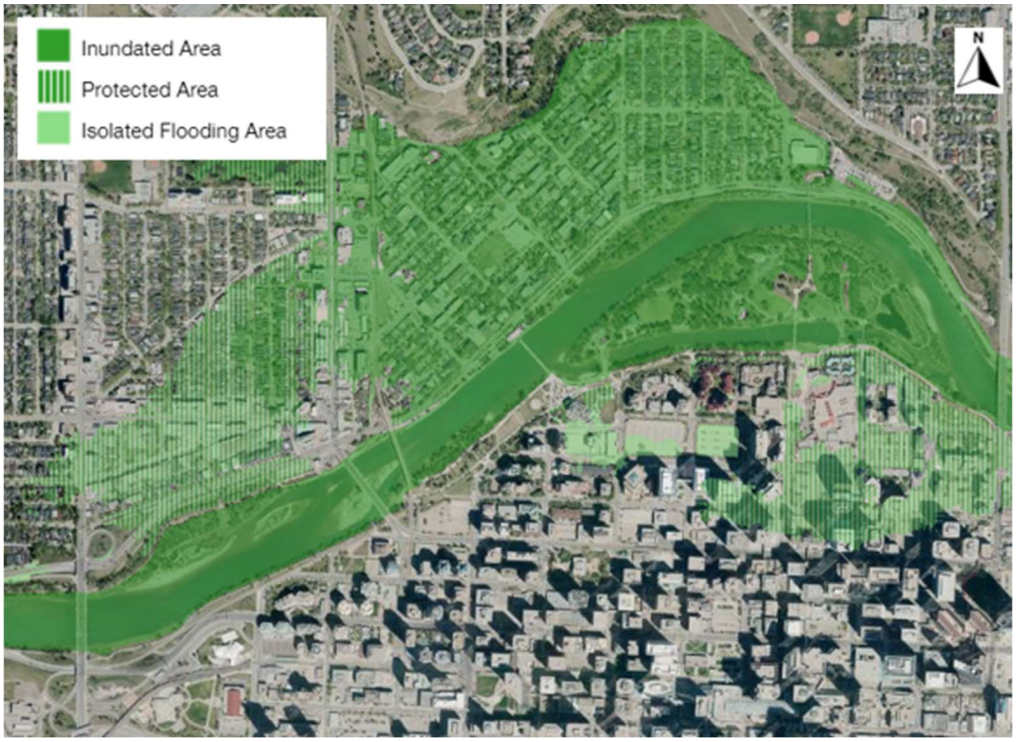


Figure 2: 1:100-year flood mapping of the area of concern.

The bars removal was assessed as part of the “Calgary Rivers Morphology Study (KCBL, 2017). The study recommended realigning the gravel bar to reduce this risk and developed a conceptual design for this work. They showed a benefit to cost ratio of 4:1 for mitigation of the flood risk. The City’s Flood Resilience Plan was approved by Council in 2017 and included modification of gravel bars in Calgary such as the 10th St gravel bar. Other gravel bars realigned under the flood mitigation program since 2017 include Elbow Island (Mission) and Centre Street gravel bar. The 10th St gravel bar realignment project is in the preliminary design phase.

The 2013 flood also resulted in a naturally formed standing wave adjacent to the gravel bar which has been used for recreation such as river surfing and kayaking (Figure 3). This natural wave’s functionality has been decreasing in recent years as the sediment transport (gravel deposition) continues to impact the local hydraulics. The area is also hazardous for river rafters and floaters that need to navigate around the gravel bar and can get stuck on the boulders where the river makes a hard turn after the bridge.

Figure 3: Image of the standing wave that formed just downstream of the tenth street gravel bar (Daily Hive, 2022)

Since 2016, The Alberta River Surfing Association (ARSA) and Alberta Whitewater Association (AWA) have been advocating for an improved/expanded recreation wave park at this location (see Figure 4). In 2019, they developed a conceptual design report (attached as Appendix A) that demonstrated the benefits and feasibility of an adjustable wave park at this location and estimated a yearly economic return to The City of $1.8M annually from the facility (Surf Anywhere, 2019).

Because the gravel bar realignment could not be completed without impacting the existing wave, *River Engineering* in Partnership with *Capital Priorities and Investments* was asked in Q4 of 2022 to assess the viability of including an adjustable wave park in this location as part of the gravel bar realignment project. This report describes the findings of the wave parks efficacy at this location as well as reviews the business case provided in the ARSA conceptual design report (Surf Anywhere, 2019).

Though the concept of recreational river waves appears novel, there are hundreds of existing recreational river waves in operation throughout the world (see Figure 5) and that number is growing as several new waves have been constructed over the past few years. In southern Alberta three recreational river wave systems already exist on the Spray River, Kananaskis River, and at Harvie Passage on The Bow in Calgary.

Figure 4: Conceptual design of a river surf park at tenth street in Calgary (Alberta River Surfing Association, 2019)

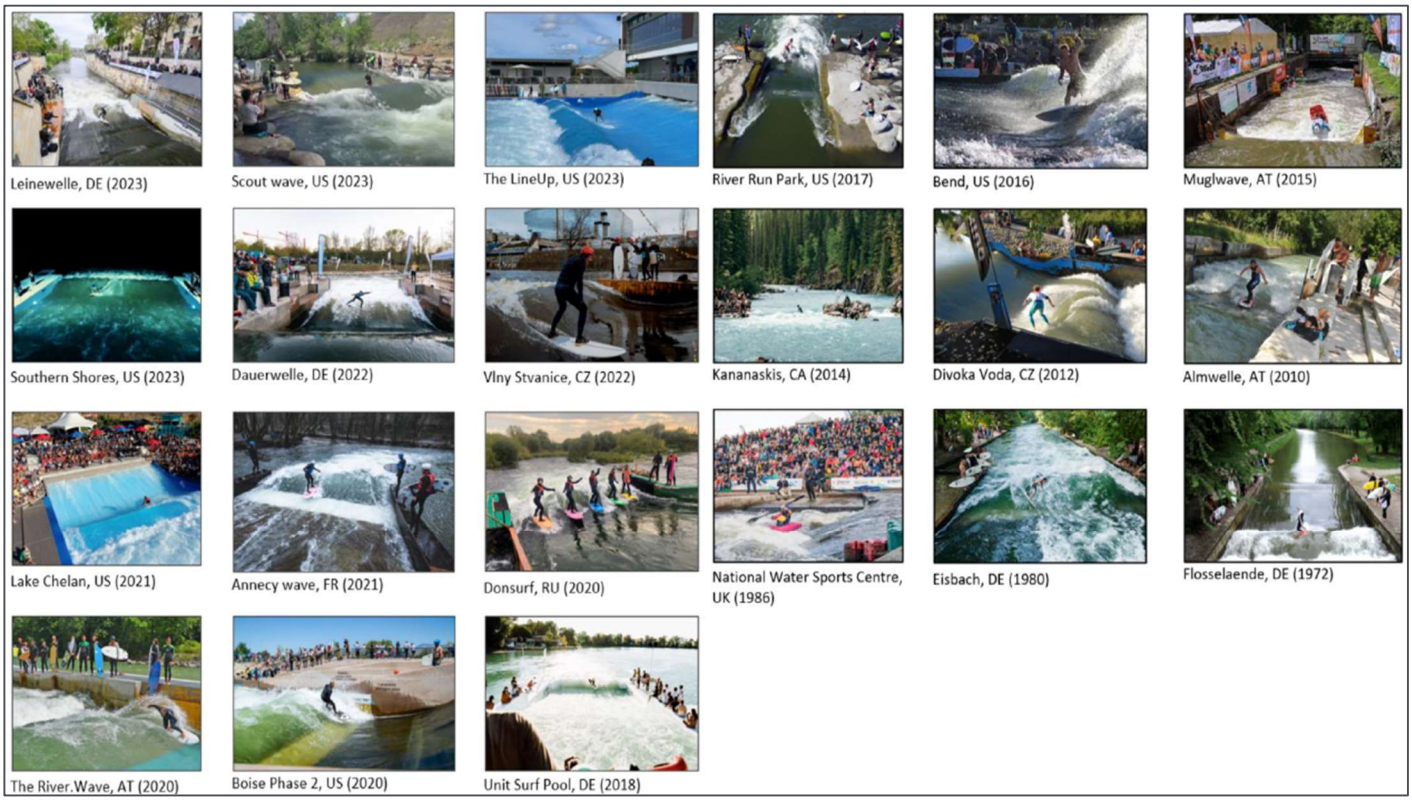


Figure 5: Images of some of the recreational waves located throughout the world including in Kananaskis, Canada.

Recreational waves can be created in numerous ways and can be either static concrete structures (e.g. Harvie Passage) or adjustable through the use of mechanical or pneumatic steel plates that can be raised or lowered. Adjustable waves are safer because they can be “turned off” and can adjust to different flow conditions. They also create better waves that are more usable by a range of river users (i.e. kayakers, surfers, body boarders) or different skill levels, for a larger range of flows. One of the major public complaints of Harvie Passage is that the resulting waves are not very usable for river surfers, boarders, or kayakers. The right type of wave is very important for this type of recreation (Cohen, 2017)

It is proposed that any recreational wave in this location would be adjustable such that it would not impact flood levels and could be turned off at night or in the winter when it is not safe to use. This means when the wave is not formally activated, river users should not be able to tell there is any wave infrastructure present at this location. Furthermore, as this project’s main goal is to mitigate flood risk, it would not be appropriate to install infrastructure that would increase water levels, even locally, during flood conditions.

The ARSA (Surf Anywhere, 2019) conceptual design (Figure 4) was utilized in this analysis. It splits the river into a south (recreational) channel and a north (navigable) channel with a longitudinal bar. The proposed design somewhat matches how the river was used historically (see Figure 6) in that there were also two channels split by a dividing island (reinforced with wooden piles). Historically, the south channel was used to drive logs into the Eau Claire sawmill. At some point in the 1960’s the historic side channel was infilled, and this land was turned into the current City park which had the unfortunate impact of reducing the river’s wetted width by approximately half. The current recreational wave is in fact partially created by the old wooden piers being impacted by fast moving water. The most important observation from this historical analysis is that this reach of river has been heavily anthropogenically modified to the point it is no longer natural and no longer has a natural flow or gravel regime. This is an important consideration as we move into the next section on a potential wave's efficacy.

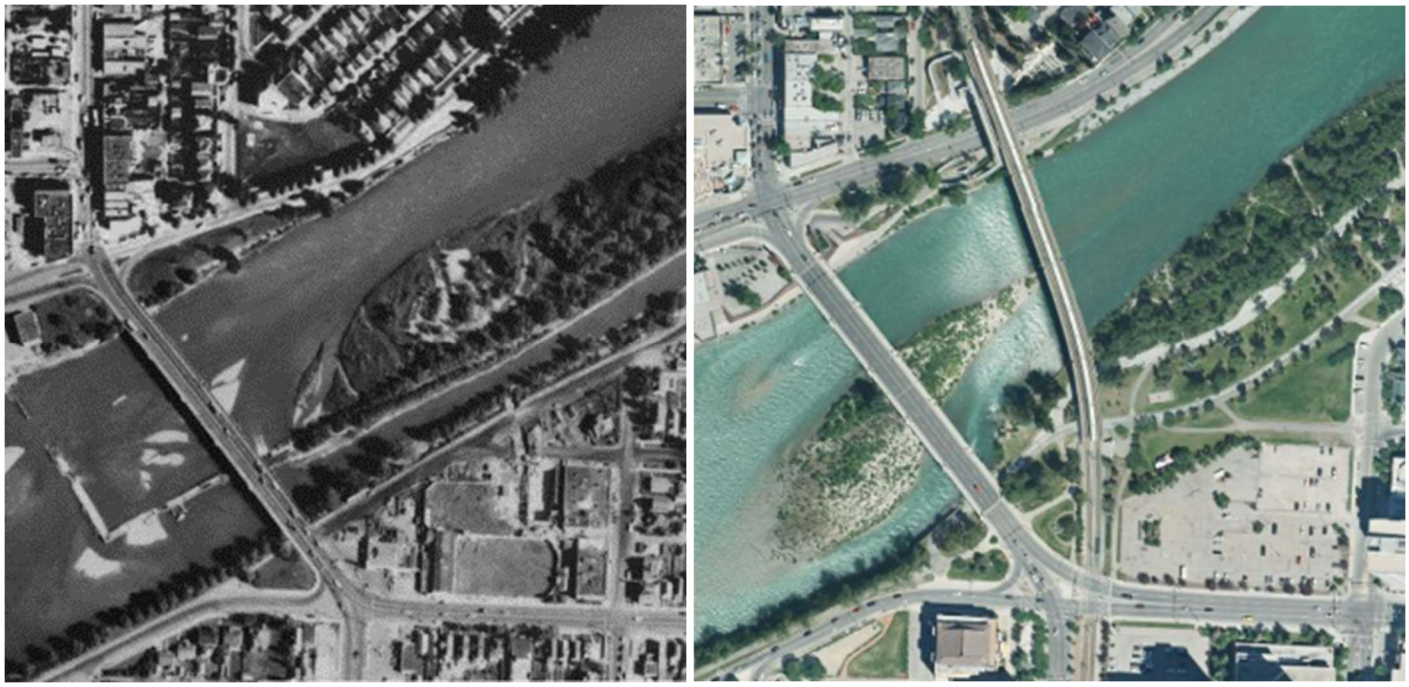


Figure 6: Images of the project Area in 1953 (left) and 2022 (right). Note the historic side channel that was infilled to create more Park Land.

2 Wave Park Efficacy

Confirming the efficacy of a wave park requires a multi-element approach as there are numerous factors that could impact the viability of a wave park in general, or at this location specifically. The following sub-sections describe each factor considered in the analysis and their ability to impact the waves' viability as part of the flood mitigation project.

2.1 Safety

Concern has been raised as to the safety of recreational river waves compared to other recreational activities. A detailed review of the literature was performed to assess the user risk from this activity. The most pertinent study by Fiore (2003) showed that the fatality rate is in line with similar activities like hiking and skiing. Also, whitewater rafting has a higher fatality rate than kayaking/surfing and is already a popular activity along The Bow with much higher usership than expected for the proposed wave. Most interesting, is how all activities are an order of magnitude safer than driving.

Table 1 Whitewater and Similar Recreational Sport Fatality rates (Fiore, 2003)

Activity	Fatality rate per million participant days
Kayaking*1	5.4
Rafting	6.6
Trekking/Hiking	10
Scuba diving	3.1
Downhill Skiing	4.5*2
Driving	152

*1 – It is considered that river surfing and kayaking have similar risk profiles
*2 - Updated from Niedermeier et. al., 2019

Other more recent studies have confirmed Fiore's findings though utilizing different metrics. Franklin and Leggat (2012) found a fatality rate of 0.64 per 100,000 participants for kayaking, while Spittler et. at (2020) found the fatality rate to be 1.5 per 100,000 participants for kayaking. These rates are in line with football at 1 fatality per 100,000 participants (Boden et. al., 2013) or alpine skiing at 3.6 per 100,000 participants (Niedermeier et. al., 2019).

Fiore (2003) also noted a pertinent observation amongst the case studies of the fatalities associated with rafting and kayaking. He noted the deaths were primarily amongst two user groups:

The first, which has been an issue for many years, is the inexperienced rafter, canoeist, and, less frequently, kayaker who gets caught in a situation above his or her capability. The second most common type of whitewater fatality involves highly accomplished boaters, usually kayakers, attempting extremely dangerous whitewater.

Injury rates were also determined to be fairly low at 5 injuries per 1000 activity days for kayaking (Fiore, 2003). This injury rate is lower or in line with many other sports such as soccer (19), basketball (10), and volleyball (4.5) (Hootman et. al., 2007).

In should also be noted that most of the above whitewater data is derived from "natural" river whitewater as opposed to engineered recreational waves as is being proposed. The fatality rate is expected to be even lower for engineered waves designed and operated to be as safe as possible. To date, the anecdotal safety record of constructed river waves (single wave and then flat water) is favourable with only one known death

due to a tragic design flaw which caused leg entrapment between gate panels in Boise, Idaho. This design flaw has been corrected and would not be replicated at a proposed Calgary wave.

It is possible that there is added apprehension to constructed recreational waves due to their apparent novelty. However, as noted previously, there are hundreds of recreational river waves in operation throughout the world that have informed best safety practices that would be required at any proposed Calgary wave including:

- Mandatory personal floatation devices;
- Mandatory helmets to minimize head injuries;
- No leashes or use of ropes which can get caught on boulders or in-river debris;
- No inflatable rafts allowed due to the risk of folding entrapment;
- River lifeguards that have swift water rescue training at high use time;
- Wave size and type aligned with lifeguard staffing;
- Regular safe river usage education;
- Instructors and leaders are required to be trained in swiftwater safety/rescue with regular river rescue education;
- Image based river safety signage to pass language barriers;
- Safety equipment lending station;
- Wave does not operate at night;
- Video feed of wave and surrounding area;
- Wave operations team trains on emergency responses; and,
- Canoe/Kayak Canada's Code of Safety followed.

2.2 Hydrologic/Hydraulic Consideration

A wave park on The Bow River would be required to be functional for flows between the safe boating advisory (280 m3/s) and extreme low summer flows (35 m3/s). Based on the flow duration curve for the Bow River (Figure 7), “recreational” flows are available approximately 95% of the time making the wave park usable most of the time during the open water season. It is currently suggested that the wave park not be usable during the ice affected season due to the safety risk associated with winter river use.

Good waves also require approximately 2-3 m^3/s per linear meter (Surf Anywhere, 2019). Assuming a minimum wave width of 5 m results in the wave requiring approximately 10-15 m3/s of flow which represents about 1/3 of the Bow Rivers flow at extreme low flows (35-45 m3/s) which is a feasible diversion rate into the south channel. This demonstrates that from a flow perspective, there is adequate flow in The Bow to facilitate a recreational wave at this location.

The other hydraulic requirement is a minimum 1 m water elevation drop across the wave to ensure the wave is of appropriate quality. To confirm this requirement, The City developed a 2D Hydraulic Model (HEC-RAS) based on the existing underwater LiDAR data set and calibrated it using surveyed water levels for flows of 142 and 92 m3/s that were captured in the summer of 2023. Based on the modelling, there is over a 1 m water elevation drop from the upstream end of the existing bar to the downstream end through the south “recreational” channel for the entire recreational flow band (33- 280 m3/s) (Figure 8).

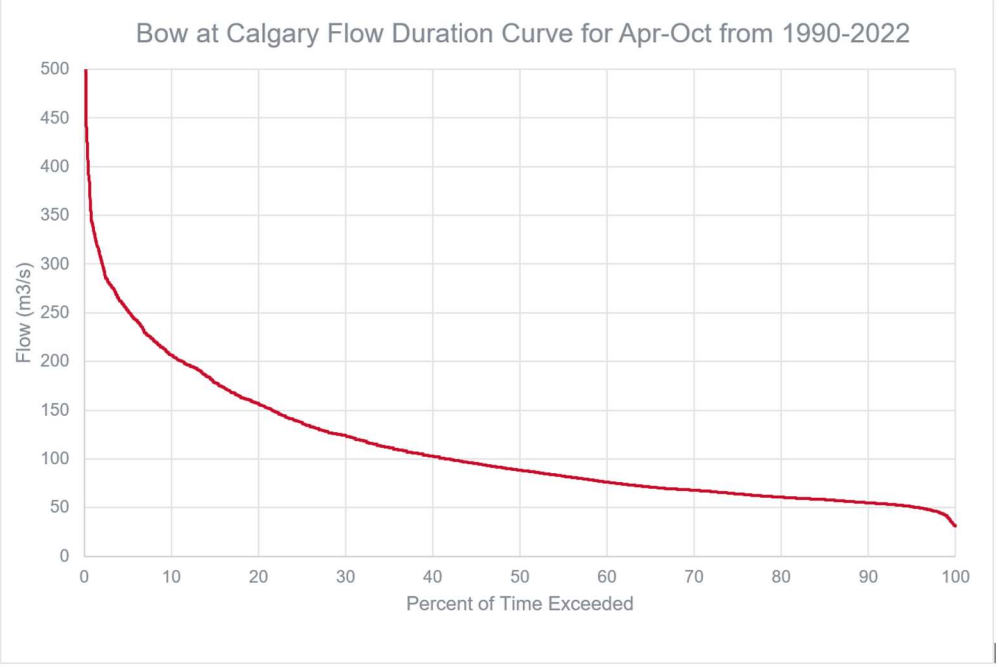


Figure 7: Open Water Flow Duration Curve for the Bow River for the past 32 years

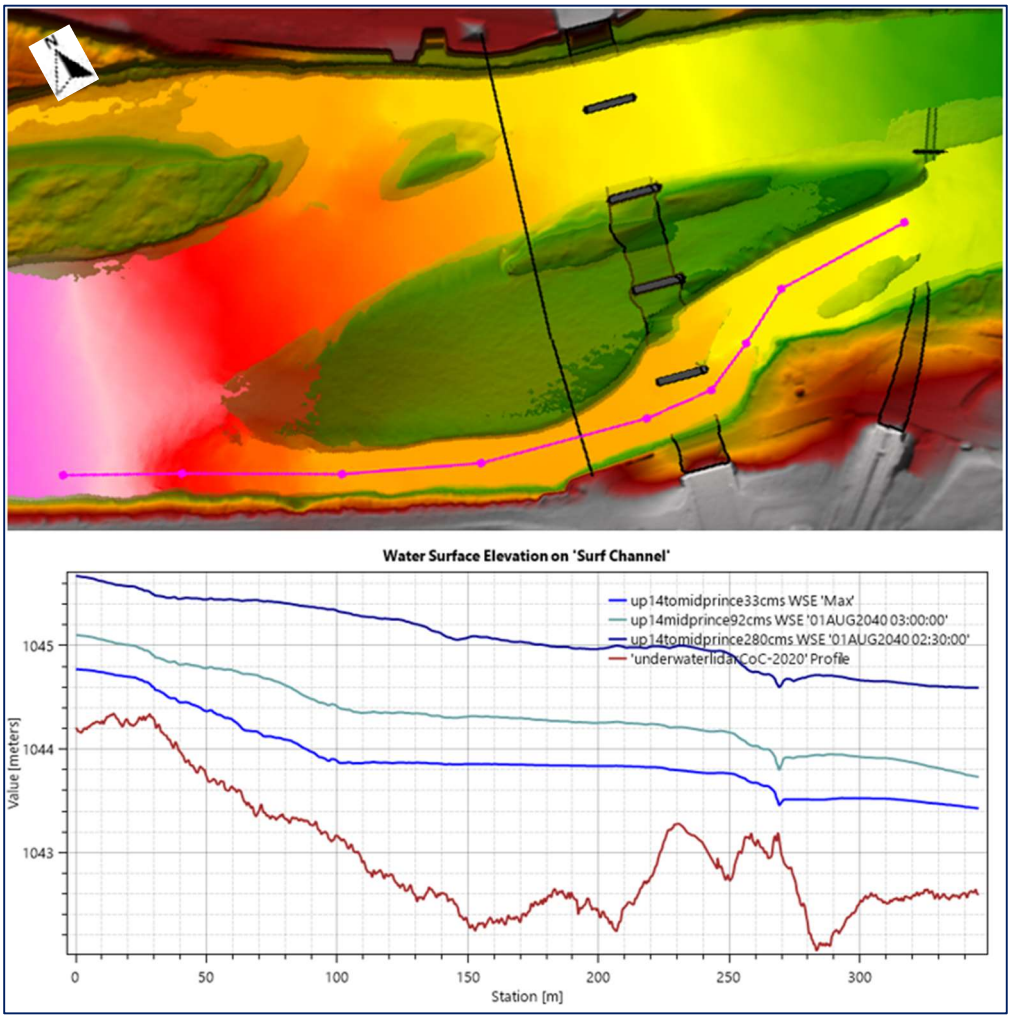


Figure 8: 2D HECRAS plan and profile results for the existing geometry that demonstrates that there is over 1 m of elevation drop across this reach for the recreational flow band

2.3 Morphodynamic Considerations

The largest risk to the functionality of a recreational wave at this location, and to the larger flood mitigation project in general, is likely from sediment transport/morphologic changes. For example, if a moderate flood occurs after construction and the wave infrastructure becomes buried under 3 m of river gravel the maintenance costs would be significant. To assess this risk, we relied on the results of the Calgary Rivers Morphology study (KCBL, 2017) as well as partnered with both The University of Ottawa and the National Research Council of Canada to perform both computational and physical morphodynamic modelling of this reach of river.

The Calgary Morphology Study utilized sediment transport formulas for the Bow River and determined that significant sediment movement only begins at about the 1:10 year flood (845 m3/s). This corresponds to the historical observations and the observed changes from the 2005 flood (791 m3/s) which shows only moderate changes through this reach of river (Figure 9). As such, any proposed recreational infrastructure would not be significantly impacted by sediment transport for most normal summer high flows.

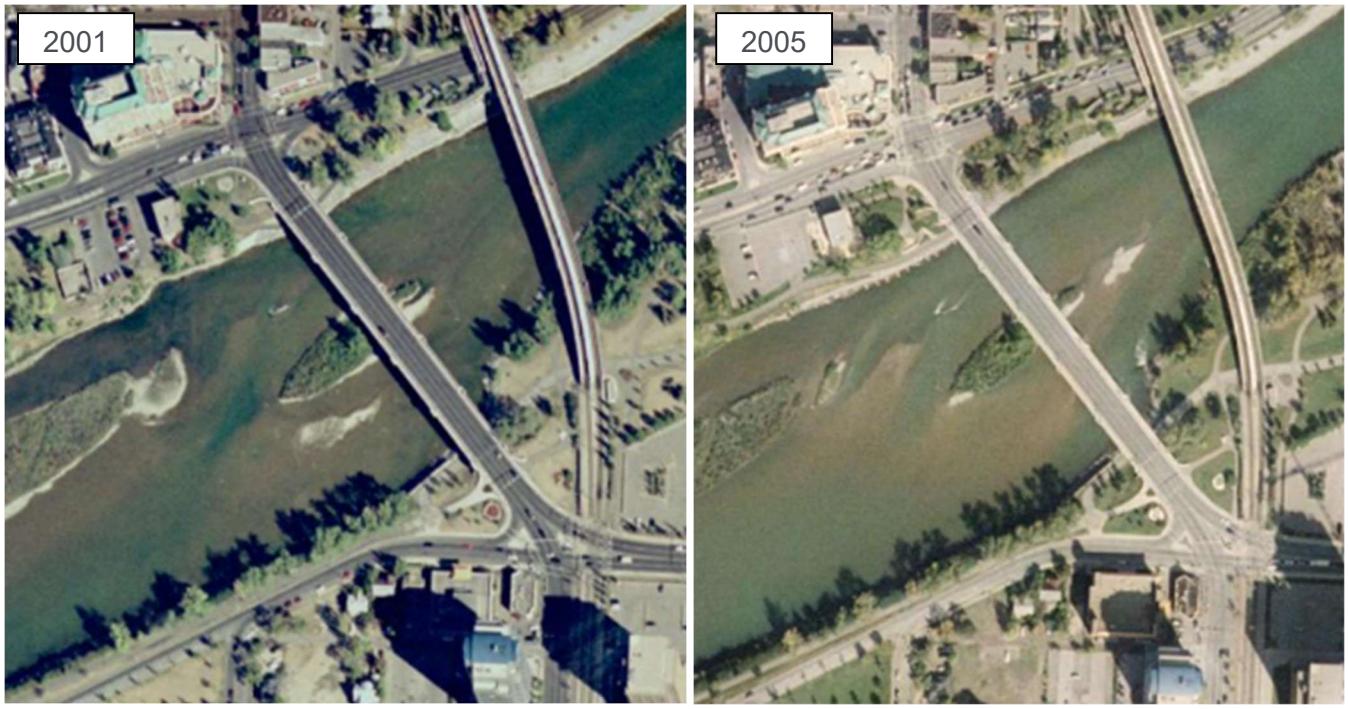


Figure 9: Aerial images of the reach of interest from 2001 and 2005

To assess the impact from higher flows, The University of Ottawa utilized a computational morphodynamic model to assess three scenarios by running an additional 1:100 flood through this reach of river (Yu et. al., 2022). The scenarios were:

1. **Do Nothing**: in which the bar is left in place and not modified in any way – This resulted in increased deposition on the bar and in the south (recreational) channel. Downcutting on the north bridge spans was also observed which could put the bridge at risk (See Figure 10).

2. **Full Removal**: In which the bar is fully removed which would impact the existing recreational waves' functionality plus the additional ecological and cost concerns – This resulted in the bar reforming at the approximate same location requiring future gravel bar removals (See Figure 10).

3. **Bar Realignment**: In which the bar is realigned in a similar way to the recreational concept to maintain consistent shear stresses through this reach of river – This option resulted in a relatively stable sediment transport regime with the majority of sediment moving through this reach with only minimal deposition at the upstream end of the realigned bar (See Figure 10).

To confirm the results of the computational model, The City partnered with the National Research Council's (NRC) "nature-based solutions" program to perform physical modelling of the realignment option. Physical models are scaled versions of a reach of interest that can more accurately replicate the complex three-dimensional flows and sediment transport that occurs in the real world (See Figure 11).

Figure 12 below shows the results of the proposed design after consecutive 1:10, 1:35, and 1:100 flow has been run through the physical model. As can be seen, the proposed location of the recreational wave can be designed to be an erosional zone, meaning that deposition is unlikely to impact the wave even after three significant floods.

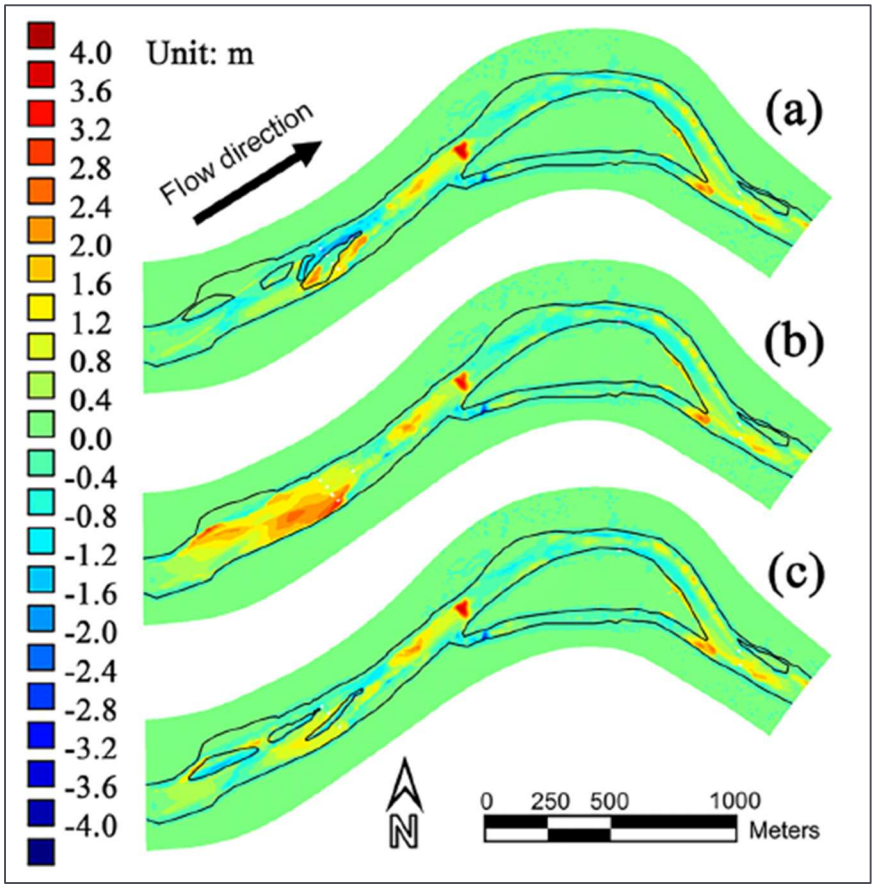


Figure 10: Cumulative deposition (red) and erosion (blue) map of different bar management plans after the long-term simulation: (a) Do nothing; (b) bar removal; (c) bar realignment. (Yu et.al, 2022)

Figure 11: Image of the physical model at the NRC laboratory in Ottawa. Note the tenth street bridge in the center of the image with its identifiable curved arches. The Yellow blocks at the upstream end are sediment spreaders that introduce bedload into the model at the upstream boundary condition

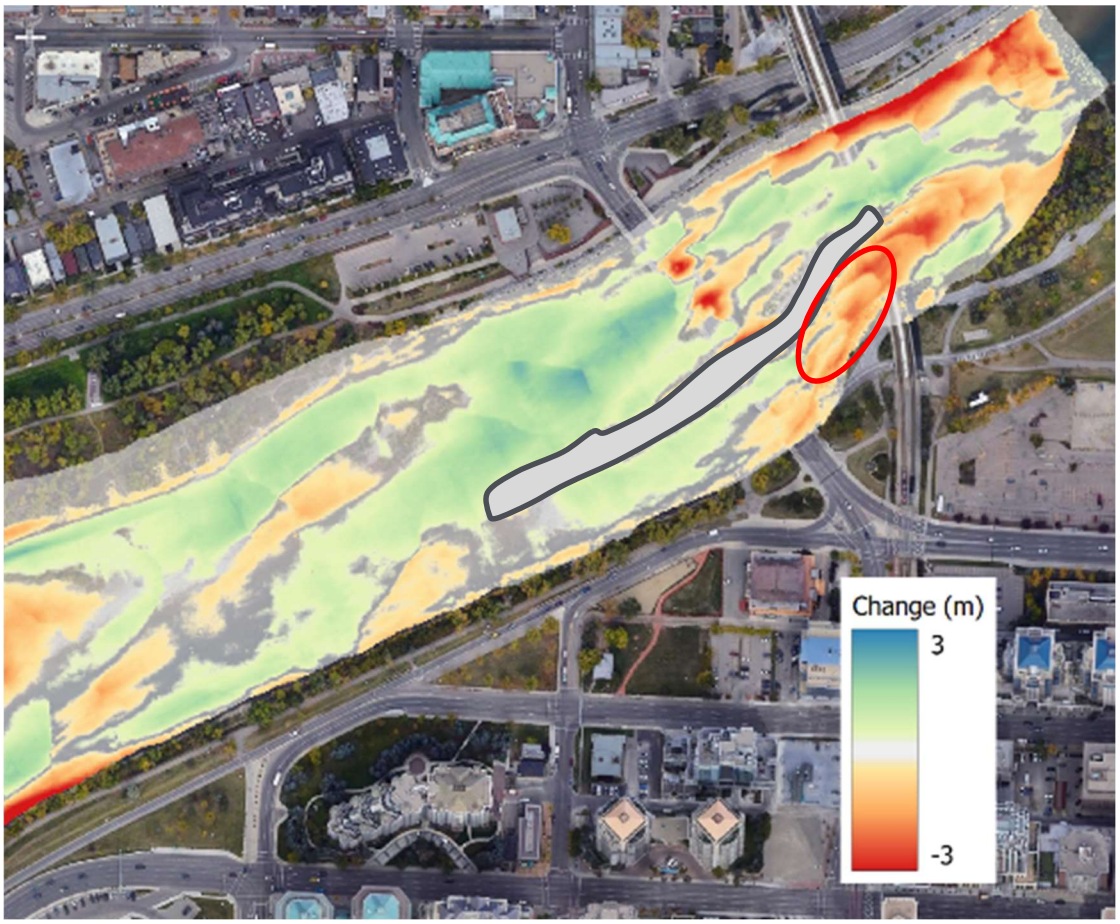


Figure 12: Physical Model Results showing bed level changes after consecutive 1:10, 1:35 and 1:100 year flood flows. The recreational wave location is circled in Red

The use of a computational model as well as a physical model is the highest level of analysis that can be performed for hydraulic structures and is usually reserved for high consequence facilities such as dams. As such, there is confidence that the proposed structure should not experience significant operational impacts due to sediment transport. However, even with this level of analysis there remains some risk due to the uncertainty surrounding natural systems and especially sediment transport.

2.4 Geotechnical Condition

Past geological reports along this reach of river were compiled to produce the Lithology Mapping. The mapping (see Figure 13) demonstrated that most of the project's excavation will be of native river gravels that can be efficiently realigned within the project footprint. It also noted the existence of a ±7 m thick band of the Spy Hill Glacial Clay Till (Moran, 1986) relatively close to the surface which has the following project benefits:

1. Clay Tills are generally non-erodible which will help limit downcutting through this reach improving the stability of any recreational structure and the project in general.
2. Clay Tills have very low hydraulic conductivity which will benefit the constructability of any hydraulic structures within the wetted area. Tying the isolation berm into that clay layer will effectively cutoff groundwater intrusion which is often a significant construction challenge with instream structures.

One drawback for consideration is that clay can have weak bearing capacity and so the foundations of a hydraulic structure would have to be designed to accommodate this either through geotechnical testing of the clay layers bearing capacity or through the use of structural piles into the bedrock layer.

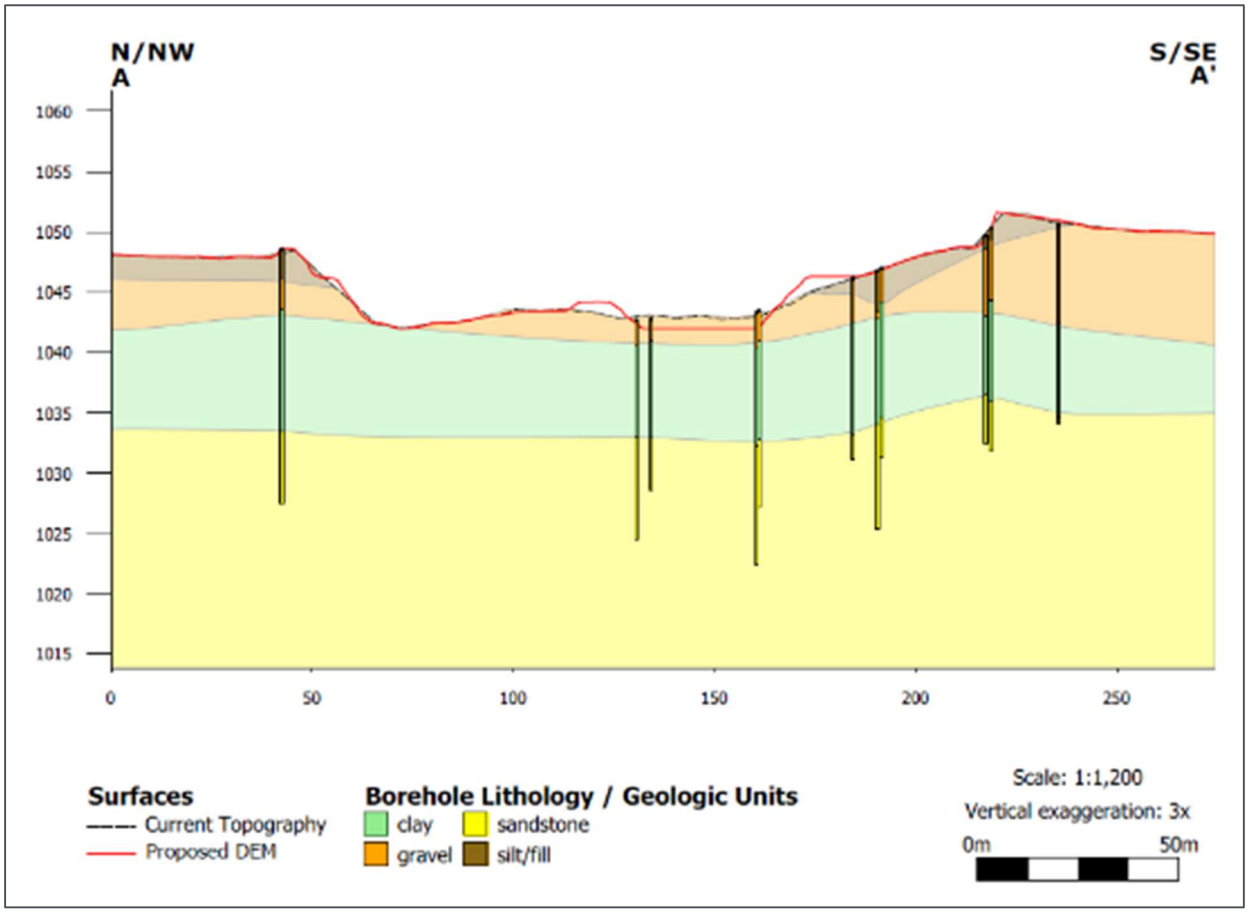


Figure 13: Typical geological cross section near the proposed recreational wave location showing the existence of a substantial clay layer. The red line represents the preliminary design extents.

2.5 Water Quality

The Environmental Quality Guidelines for Alberta Surface Waters (Government of Alberta, 2018) includes guidelines for recreational users. These guidelines apply to any untreated surface waters that are used for recreation and are designed to minimize the health risks to the average recreational water user.

The biological indicator for recreation that is most closely linked to public health outcomes (illness) is *Enterococcus spp.* The City's *Water Quality and Regulatory Assurance* team performed weekly monitoring in the summer of 2023 of *Enterococcus spp.* at the project site as well as other locations along The Bow River to assess the recreational water quality in the area and the river in general.

The results in Figure 14 show that at the proposed location no single sample exceeded the 1280 cce/100 mL guideline, however the rolling geometric mean of weekly samples over a 30 day period exceeded the geometric mean limit of 300 cce/100mL in some periods. It was also noted that the water quality at the proposed wave location was generally better than other locations on the Bow including Harvie Passage where active recreation is already occurring.

The concentrations of *Enterococcus spp.* are known to be highly variable across both space and time within the Bow River and water quality in general can vary quickly in natural systems due to upstream inputs. Therefore, it is recommended to continue monitoring at this location and include proactive water quality communication and signage should a recreational wave move forward at this location.

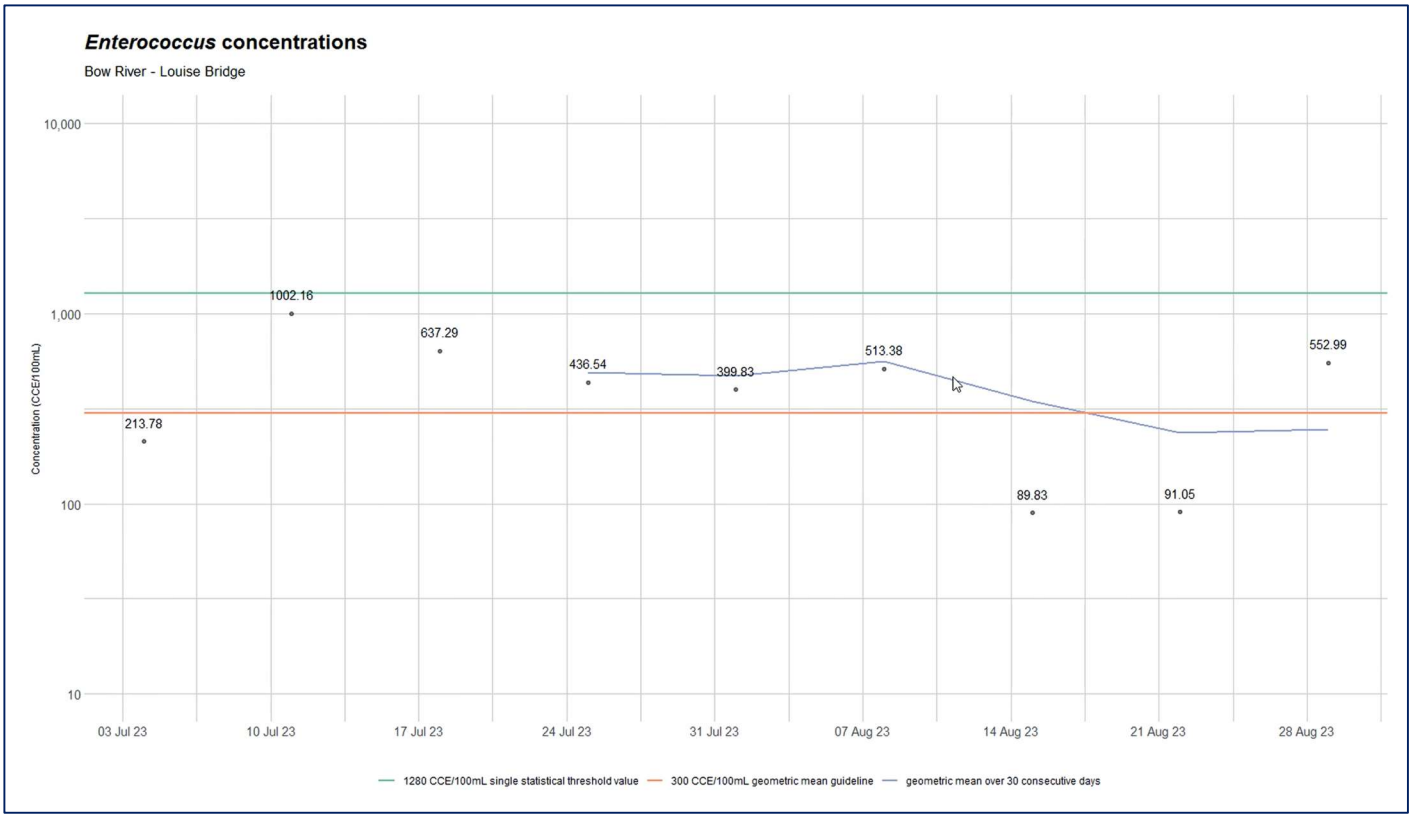


Figure 14: Enterococcus concentrations from weekly grab samples taken at the surf wave location over the summer of 2023. Note they all fall below the 1280 cce/100ml threshold value indicated in the "Safe Beach Protocol" (Alberta Government, 2022)

2.6 Material Management

Though no specific contamination sources are known at this location, there is concern that background hydrocarbons may be present in the gravel matrix from the following sources:

1. Natural coal seams in the upper catchment;
2. Runoff from the asphalt roads and pathways; and/or,
3. Historical refinery effluent being released into the river.

Other similar gravel bar projects have faced challenges with reusing gravels that were deemed contaminated by background hydrocarbons (i.e. Center Street Gravel Bar Project) as their reuse requires provincial approval. This is a project risk for the larger flood mitigation project component as well as the recreational wave component and is being mitigated by performing early and directed engagement with the regulator on what is a fair and representative method of assessing the gravels for potential contamination.

If required, it would be possible to remove and import new gravel though this would increase project costs by approximately 30%. Should this undesirable circumstance occur it is not expected to impact the total projects viability as the most recent benefit to cost ratio was estimated at 9:1 (CoC, 2021).

2.7 Navigation

Currently the south “recreational” channel is hazardous to river users such as rafters as there is a sharp bend in the river just downstream of Louise Bridge where rafters can impact existing riprap or wooden piles against the bank (see Figure 15). In addition, the existing standing (recreational) wave can result in rafts/boats capsizing or taking on water. This project is expected to improve navigation through this route both when the recreational wave is active and when it is inactive by formally splitting the river into a north “normal” navigation channel and the south “recreational wave” channel. The flow split for all recreational flows is expected to be about 2/3 and 1/3 for the north and south (recreational) channels, respectively.

Figure 15: Image looking upstream at the existing wave and the sharp bend that must be navigated through the south channel to not impact riprap and wooden piles

Formally splitting these channels will make it safer for traditional river users (rafters). These users will be guided to the north channel with signage and with a potential boom line to prevent them entering the south (recreational) channel. Furthermore, many river egress points will be provided on both sides of the river including on the dividing bar, which is proposed to be accessible from a staircase from tenth street bridge.

This formal split is expected to satisfy Transport Canada Navigable Waters regulatory requirements to maintain continuous navigation along the Bow. Both the Calgary Fire and Police boats would also not be hindered moving upstream or downstream through this reach due to the project. To further benefit these important operational groups, the project will include “hitching points” where jet boats can be safely tied off downstream of the dividing island in case boat access to the island is required.

Should rafters still choose to enter the south (recreational) channel there will be numerous egress points allowing users to climb out of the river without having to navigate the wave. As the wave will be non-retentive, any user that enters the facility will be washed downstream into a lower-velocity shallow beach area.

2.8 Fish Habitat/Migration Impacts

This project is expected to result in a net increase in fish habitat and as such, the only remaining concern is related to migration or movement should the recreational wave act as a barrier. Like the navigation concern, approximately 2/3 of the river will not be impacted by this project and so any migration/movement impacts are considered low. Furthermore, most movement of the target fish species (Brown Trout, Rainbow Trout, and Mountain Whitefish) occurs at night, dawn, and dusk (Thurow, 2016). By not having the wave functional during these times, movement within the recreational channel itself should not be significantly impacted.

As such, the project is not expected to impact the fishery and conversely is expected to result in a net benefit for the population by providing increased habitat area and diversity.

2.9 Environmental Impact

No rare species or species of concern were noted during the environmental assessment for the proposed recreational wave area. However, a snake hibernacula assessment is still to be conducted in the spring though it is not expected to result in any added information due to this being such a heavily used section of the river.

Much of the riparian health through the recreational wave project area is in poor condition due to heavy use by the public and the prevalence of non-native turf grass. This project's recreational wave component would help improve the overall riparian health by providing hard river access paths and native riparian planting pockets in all other locations.

Up to 5 trees (poplars) will have to be removed as part of this project (see Figure 16) however it is likely that these trees would have required removal as part of the larger flood mitigation component of the project regardless. Tree compensation will be provided for all removed trees with a 4:1 ratio using large caliper native trees.

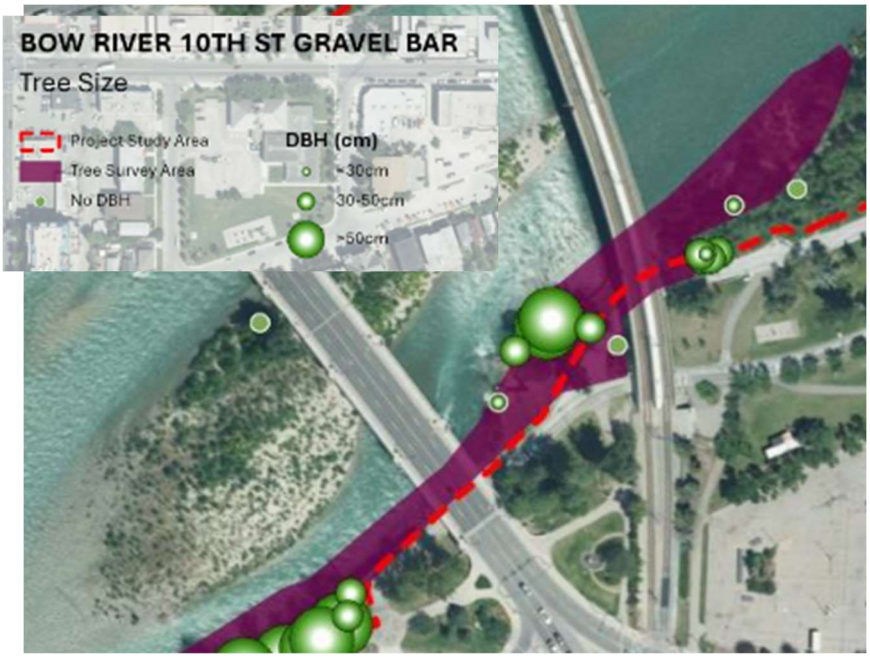


Figure 16: Image showing trees within the project area and their approximate size

2.10 Archeology/Cultural Concerns

Because of the noted historic use of the area, there was concern as to the historic significance of the proposed recreational wave location. To confirm the risk, Alberta Culture was approached and a Historical Resource Act approval with conditions was obtained which indicated no significant concerns but does require an archeologist to be present during excavation of the recreational wave area as mitigation.

In addition to the Archeological concerns, there were also concerns with the cultural significance of the area due to the presence of the large light tower “sentinel” on the south side of the river (Figure 17). After discussions with the City’s Cultural Landscape team, no significant concerns relating to the relocation or removal of the light tower were noted and the project in general did not present any significant cultural concerns.

Figure 17: Looking downstream from below Louise Bridge at the light “sentinel”.

2.11 Regulatory Approvals

Regulatory approvals are challenging for river engineering projects, but no additional challenges are expected due to the recreational structure. The following provides a brief overview of the main regulatory approvals that will be required for this project to move forward and a brief description of the implications of a recreational wave:

- **Fisheries and Oceans Canada (DFO) – Fisheries Act:** The project will be assessed both with the wave active and inactive using the City's Habitat Suitability Index (HSI) Model which was developed in partnership with The Province and DFO after the 2013 flood to assess impacts from City flood restoration projects. The overall project is expected to result in a net increase in fish habitat and does not significantly affect fish movement so no significant concerns from DFO are expected.

- **Government of Alberta – Public Lands Act:** The project will be constructed on the "Bed and Shore" of the river which is provincially stewarded land. As such, a "License of Occupation" from The Province will be required. Licenses of occupation are also required for other City Infrastructure built in the river such as Stormwater Outfalls and Bridges. As other recreational facilities have been allowed to be constructed on public lands (Harvie Passage, Kananaskis Wave) it is not expected that there will be significant concern.

- **Government of Alberta – Water Act:** The Water Act is primarily concerned about water quality and flood impacts. As the project will not impact water quality in the long term and will use best management practices during construction, no water quality concerns should arise. From a flood mitigation perspective, the project will reduce water levels through this reach of river and most importantly will mitigate flood risk in the long term by addressing the problematic gravel bar. The surf wave would not be activated during flood flows and as such will not impact water levels.

- **Transport Canada – Navigable Water Act:** As previously discussed, the river will be split into two channels with approximately 2/3 of the flow being directed into the north (navigable) channel are un-impacted by the proposed project and will remain available for safe navigation through this reach of river. Provided that appropriate navigation signage is included in the project, it is not expected that Transport Canada will have significant concerns with the project.

Other regulatory acts may have to be considered as part of the larger general project; however, they would not influence the inclusion of a recreational wave. Based on the above, regulatory approvals should not impact the recreational waves inclusion into the overall project.

2.12 Indigenous Engagement

Indigenous Engagement will be required as part of both the Provincial and Federal regulatory process. However, it is recommended to engage the Nations earlier than required to inform them of the upcoming project. Early engagement will allow for meaningful feedback prior to the regulatory phase when it is much harder to modify the project design. It is also likely to speed up the regulatory process as the Nations will already be aware of the project. The project will also incorporate learnings from the Calgary River Valleys projects extensive indigenous engagement.

2.13 Utilities (Enmax line and Outfall B52A)

There are two utilities adjacent to the proposed recreational wave area that may need to be addressed as part of detailed design (Figure 18). The first is a 300 mm stormwater outfall that should be easy to realign to

facilitate a recreational structure if needed. The other is a 138 KV underground Enmax power line that crosses the river at this location. The power line is approximately 2 m below the existing riverbed and would not be impacted directly during construction though work along the dividing island would be required to occur over it requiring an easement from Enmax.

Based on initial discussions with Enmax on this line, it is nearing the end of its lifecycle and it is proposed to be shut down in the next few years which could simplify the easement. Neither utility is expected to impact the overall project feasibility.

Figure 18: Utilities in the project area. Enmax 138 KV underground line in Red and City storm line in green

2.14 Partnership and Operation

The ARSA conceptual design report (Surf Anywhere, 2019) provides information on an operational model for the recreational wave with a third-party partnership as recommended by Law (Section 2.2). In the suggested operational model, the wave would remain publicly available except during competitive events with the operators responsible for activities including wave adjustments, providing safety management, providing lessons, and renting equipment. The operator will remain responsible for operation at all times regardless of the users.

A key aspect of their business plan would be the inclusion of a supporting facility out of which lessons and rentals could be provided. This facility would preferably be a permanent structure near the wave or included as part of the Lot 6 redevelopment. Less ideal due to its location on the opposite side of the river, Old Firehall #6 could potentially be utilized and would provide a desired cultural hub for that community. The report also documents the estimated operating budget (provided as Table 2) which shows that the facility results in a marginal profit even with high insurance and lifecycle costs. The values utilized in Table 2 are based on the estimated usership which is discussed in Section 3.

Figure 19: Example Image of a supporting facility that would provide rentals, lessons, and sales

Table 2 Operating Budget Overview from ARSA (2019)

Description	Revenue	Expense	Profit
Revenues			
Lessons	$164,720	$98,832	$65,888
Events	$113,000	$80,800	$32,200
Membership	$100,000	$10,000	$90,000
Facility Rental	$108,800	$31,840	$76,960
Interest & Sponsorship	$90,000	$0	$90,000
Food & Drink	$126,000	$75,600	$50,400
Grants	$85,000	$0	$85,000
Revenues Subtotal	**$787,520**	**$297,072**	**$490,448**
Additional Expenses (Insurance emergency fund, life cycle, etc.)		$480,000	($480,000)
Total	**$787,520**	**$777,072**	**$10,448**

The City's Partnership Business Unit has been integrated into the project team and is reviewing how a partnership with a third-party organization could be facilitated for the structure. Various operational models have been successful at other recreational waves in North America and Europe (https://www.ottawariverrunners.com/the-pumphouse/ and https://www.enercity-leinewelle.de/).

This model is similar to how many of the City's other water recreation facilities like the Sailing Club and Canoe and Rowing Club are operated. As part of detailed design process, an open expression of interest for operators will be conducted to confirm the feasibility of this business model. The actual operator would be selected through an open RFP type procurement process, and the operator's viability duly assessed.

2.15 Public Engagement

The proposed recreational wave is adjacent to the project area of the ongoing Riverwalk West (RWW) Project. The goal of Riverwalk West is to improve the river promenade along the south side of the Bow River between Peace Bridge and 14th street.

As part of RWW's Phase 1 engagement process ("*Inspire*"), an online engagement opportunity was available from July 10 – 31, 2023. Participants were asked to share their ideas to improve amenities, activation, and recreation opportunities through the RWW area. A total of 457 contributions of feedback were submitted and numerous ideas were documented in the "what we heard" report including:

- Make it a destination area that people want to visit;
- Add food and beverage service options (e.g., restaurants, cafés) and small retail shops/stalls and markets;
- More activation/programming/events/entertainment;
- Include amenities such as seating/benches, picnic tables/areas washrooms, and water fountains/stations;
- Add opportunities and suitable spaces for recreation (e.g., outdoor gym equipment, playground, beach areas, land-based recreation such as volleyball, and on-water recreation such as a **surf/river wave park**, boating and swimming); and,
- Create places from which to view the river (e.g., balconies/ platforms over the water, piers).

The support for a recreational wave at this location was well captured in the report, but to further assess the support for it, the below word cloud (Figure 20) was developed from the 457 raw engagement comments. By observing the frequency of comments and words related to the proposed wave amenity, we observe a trend in public support.

Figure 20: Word cloud derived from RWW engagement comments

This support was further demonstrated by the Phase 2 ("design") engagement which asked the public which of 5 different design concepts should move forward. The winning design was one of the only designs that incorporated a recreational wave and supporting facilities. Based on the official "what we heard" report findings and Figure 20, it appears that there is strong public support for this type of amenity at this location.

2.16 Public Access and Parking

In addition to the numerous public transportation routes to this site there is also ample parking downtown and in Kensington that could support user access to the site. The availability of pedestrian walkways both upstream of the proposed wave along 10th street and downstream along the C-Train bridge will also help facilitate access across the river. There is some concern between the interaction between wave users carrying boards or kayaks and the regional pathway that will require consideration in the design. Based on

discussions with Festivals and Events, there is interest in moving the regional pathway north of the river during large public events which could help minimize impacts.

2.17 Efficacy Conclusion

Of the 17 factors considered, there does not appear to be any technical, regulatory, or policy challenges that would preclude the inclusion of a recreational wave as part of the overall gravel bar realignment project provided the wave design followed the approximate design considered in this report. The inclusion of the wave would create additional project complexity and potential long-term liability for The City though it would be similar to those associated with other similar recreational structures.

This section only reviewed the efficacy of a potential wave but not its value to The City and its citizens. The business case for a potential wave is discussed in the following section.

3 Business Case

The business case for a recreational wave in Calgary is documented in detail in the same ARSA conceptual design report (Surf Anywhere, 2019). The report was Funded by the Province of Alberta and the Alberta River Surfing Association to demonstrate the viability and operational model of a wave at this location. This section reviews the suggested benefits noted in the report related to the wave.

3.1 Social Benefits

The ARSA (2019) report details the social benefits of the wave as being:

- Providing a free and public wave for a very accessible and safe sport will provide both a physical and mental health benefits to Citizens that actively use the wave;
- Activation of a cultural hub and gathering space. Spectators of similar river surfing waves in Munich, Germany and Bend, Oregon see over 100,000 visits by users and spectators per year;
- Holding world class surfing events will provide opportunities for Calgary Events to benefit from the increase usership of the area;
- Surfing became an Olympic sport in 2020. The wave will help train future Canadian Olympic Athletes. Surf kayaking and freestyle kayaking are not yet Olympic level sports, but global competitions do exist in which Canada participates;
- River safety culture will be improved as all wave users will have to complete an online safety orientation and formal lessons will be provided for new users; and,
- Educational opportunities on river recreation specifically and river health in general will be provided due to the number of spectators and focus provided on the river.

The claimed social benefits appear to be reasonable and align well with City goals such as the Recreation Master Plan (CoC, 2010). However, the benefits are dependent on the stated usership and spectator numbers. To confirm these values a review of other existing facilities was conducted. The two most similar recreational wave parks for which information exists are “Kelly’s Whitewater Park” in Cascade, Idaho and “Bend Whitewater Park” in Bend, Oregon. Braak (2012) documented the economic impact from the construction of a whitewater park in Cascade, a town of 1012+ people. The closest major urban center is Boise, Idaho (pop. 237,000) approximately 113 km (1 hr 42 min drive) away. The study found that usership of the Cascade whitewater park was approximately 20,000 in the first year after construction and 50,000 in the second year. ECONorthwest (2017) estimated higher usage of the Bend whitewater park at 235,000 users in its first year of operation.

Another reference point for which data exists is the “Bristol Wave” (The Wave, 2024) which is a constructed hydraulic recreational wave facility in Bristol, England. In 2020, the first year of its operation, it saw more

than 90,000 users and 50,000 spectators. This facility is a private paid facility with the average entrance fee being around $100 CAD to use the facility.

Though not an exact surrogate, the usage on the Glenmore Reservoir also provides a reasonable reference for potential usage of a recreational wave. The 2022 reservoir usage report (City of Calgary 2023) indicated that there were approximately 35,000 individuals using the reservoir in a variety of boats (sailing, canoe, kayak, rowing, and Dragon boats) over that summer. If spectators or onshore visitors were also considered in the count, the total usership would be much higher.

Harvie's Passage or the Kananaskis wave would be ideal surrogates for potential wave usage in Calgary, unfortunately no formal counts have been conducted at either location. At Harvie Passage anecdotally observed usership over a typical summer day is up to 1000 people observed on shore and on the surrounding pathways, and up to 100 people in the water and waves. Assuming 50 typical warm summer days puts the usage around 55,000 users/spectators. At the Kananaskis wave the only reported numbers are from white water rafter usage at about 20,000 participants. River Surfing and Kayaking would all be in addition to this indicating that the wave sees substantial use in its relatively short season.

Membership of the ARSA and AWA clubs also provide an indication on potential usership. Both clubs have a combined membership of approximately 2000 individuals. If each of the members used the wave 10 times in a season then we would quickly reach 20,000 uses. It is estimated that there are approximately 3 times more surfers or kayakers in the province that are not members of the two clubs indicating that the usage from existing white water enthusiasts would be substantial.

One last reference, regarding the number of potential spectators, are the pathway users adjacent to that space. The City regional pathway usership tracking for 2019 indicated that between 650,000 to 1,000,000 people walk or commute past the proposed wave location every year. Not considering new spectators being drawn to the site, if 5% of pathway users stopped to watch the recreational wave for any length of time, it would result in 32,500-50,000 spectators.

3.1.1 Additional Social Benefits

One additional benefit to the project not discussed in the ARSA report is the social benefit from increased activation of this downtown space. The Downtown Strategy is a program to "…capitalize on opportunities that will create jobs, drive economic recovery, and revitalize and transform the downtown" (CoC, 2024A). One of their four major strategies is to invest in "Downtown Vibrancy Capital Projects". The recreational feature as is being proposed appears to align well with this strategy.

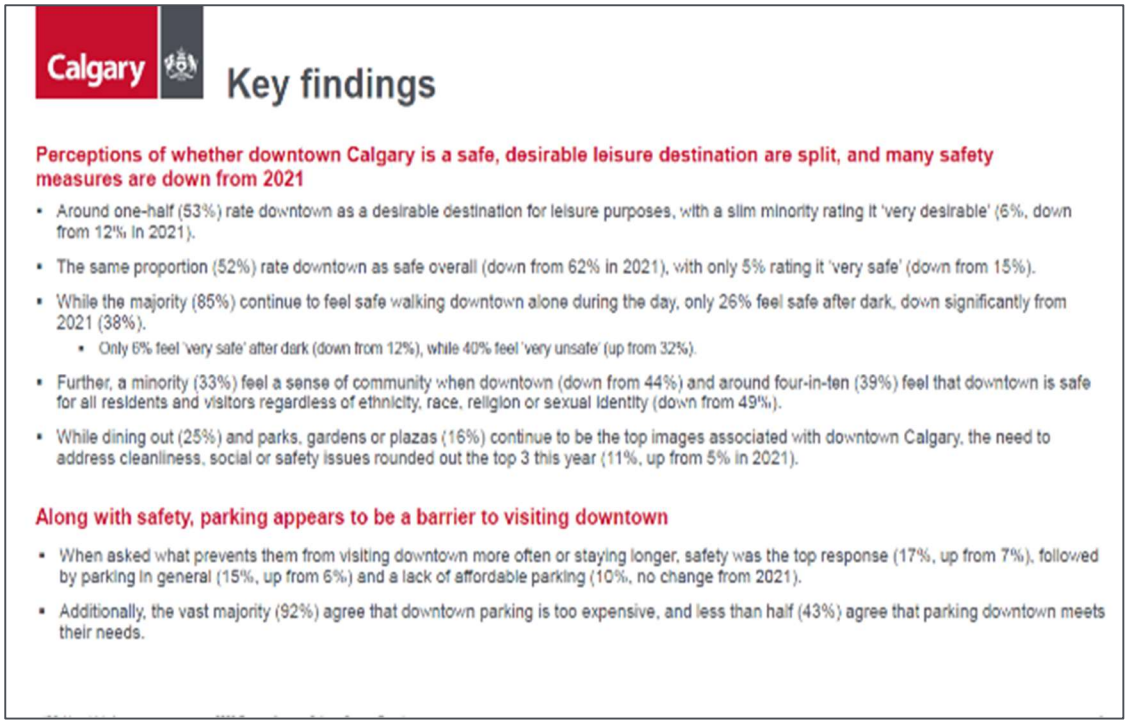


Figure 21: Findings from the 2023 Perspectives on Calgary Survey: Downtown (CoC, 2024B)

3.2 Environmental Benefits

The environmental benefit of the recreational wave is primarily educational in nature. The ARSA report specifically notes that the project will result in:

- An increased awareness of water quality by spectators and users;
- An increased awareness of river and riparian habitat by spectators and users;
- A reduction in carbon emissions as local recreational wave users will not have to travel to engage in this activity.

The proposed environmental benefits seem plausible and meaningful considering the number of users and spectators that are expected to utilize the wave and surrounding area. Educating the public on these items are key aspects of The City's business related to the riparian strategy and storm water quality. (CoC, 2017 and CoC, 2018)

3.3 Economic Benefits

The ARSA conceptual design report (Surf Anywhere, 2019) indicates that the proposed recreational wave will provide approximately $1,816,000 in annual economic return from wave usership. This was determined by assuming the average spending of a wave user would be $62.50 per use multiplied by the expected yearly usership of 29,059 yearly users. Both of these values were taken from the ARSA report.

Section 3.1 noted that the expected usership numbers appear reasonable and potentially conservative and so the remaining uncertainty would be the noted $62.50 in average spending. This value is not a user fee, but rather considers all the associated market benefits from people traveling to and using the wave. It includes recreational equipment costs (i.e. board/wetsuit), travel costs (i.e. gas, transit, car rental), food/beverages, accommodation for out-of-town visitors, lessons, etc. This does not include additional economic benefit from events, or the more intangible non-market benefits.

The estimated economic benefit of $62.50/use appears reasonable based on a brief review of the literature. Coffman and Burnett (2009) noted an economic benefit of $56.7USD per use for an ocean wave in Half Moon Bay, California. Morrissey et. al. (2012) noted that there is a 371.55 Euro benefit per use for water-based activities (i.e. surfing and kayaking) in west Ireland. The study location is remote, so this number is higher, as most users would need to stay overnight. Leon et. al. (2023) estimated $50Aus ($44 CAD) per session for an ocean wave located in the Noosa world surfing reserve outside of Brisbane.

Wagner et. al. (2011) performed a detailed socioeconomic review of recreational surfers in the US and found that approximately $66USD ($90 CAD) was spent per session. The paper also interestingly found that many biases towards surfers as being a lower income fringe group may be outdated. Their study found that the median surfer is well educated with a higher-than-average income (Table 3).

Table 3: Surfer versus non surfer profiles From Wagner et. al. (2011)

Subject	Median Age	Education (% college and above)	Employment (% full time)	Income, USD (median individual)
Surfers	35	63%	65%	$75,000
Beach Users	39	54%	69%	$52,682
Regular Citizens	35	29%	-	$61,154

The predicted $1.8M in economic benefits is also in line with ECONorthwest (2017) review of the Bend Oregon recreational wave park. They estimated that the park provided $3.6M USD in economic benefit to the town in 2017.

Perhaps the greatest confirmation of the assumed benefit per user comes from the number of commercial pumped/mechanical wave facilities that are in operation. These facilities charge users for access but must power their wave generation through energy intensive pumping systems. Some examples include:

- The Wave (Bristol, England) - $103CAD/session
- Montgomery Whitewater (Montgomery, Alabama) - $74CAD/session
- The Lineup (Oahu, Hawaii) - $80CAD/session

Figure 22: The Wave (a) and Lee Valley Whitewater Centre (b) are both private, mechanical, whitewater recreational parks

These facilities demonstrate that there is a significant willingness to pay for these types of activities, and that though these facilities have much higher capital, operational, and maintenance costs they are still able to maintain a viable business. The most interesting example from above is “The Lineup” in Hawaii. Though surrounded by numerous free and natural surfing locations, a constructed wave business is still viable demonstrating the desire for safe, stationary waves.

One final consideration for the direct market benefit value from the wave comes from its ability to attract users from outside of Calgary. Mills and Cummings (2013) found that surfers in the UK spend approximately 1,497BP ($2,550 CAD) on foreign surf trips each year. If only 1% of the expected users come from outside of Calgary and have similar spending habits, then this provides close to a $750k/year benefit.

3.3.1 Non-Market Benefits

The business case presented above is based on the market benefits from usership of the wave only and does not consider the less tangible, non-market benefits from the project. These non-market benefits can also be of significant value. Two of the most pertinent include the waves impact on the City’s brand and the ability of the wave to activate this area of downtown.

River Surfing is already featured in the City’s main tourism video which places it on par (based on video time) with fine dining, the Stampede, the Rocky Mountains, and a Calgary Flames game. (https://youtu.be/mLJHaew9wYE (CoC, 2024C)). The tenth street wave, in particular, has also been featured in a mural at the Calgary airport's international departures wing (Figure 23). Unfortunately, the existing tenth street wave has lost much of its functionality and Harvie Passage only provides poor “surf” type waves impacting the viability of Calgary as a surf destination. The construction of a dedicated adjustable recreational wave park at tenth street would solidify this activity as a core component of Calgary’s brand and could help improve tourism and immigration of young, educated individuals to Calgary.

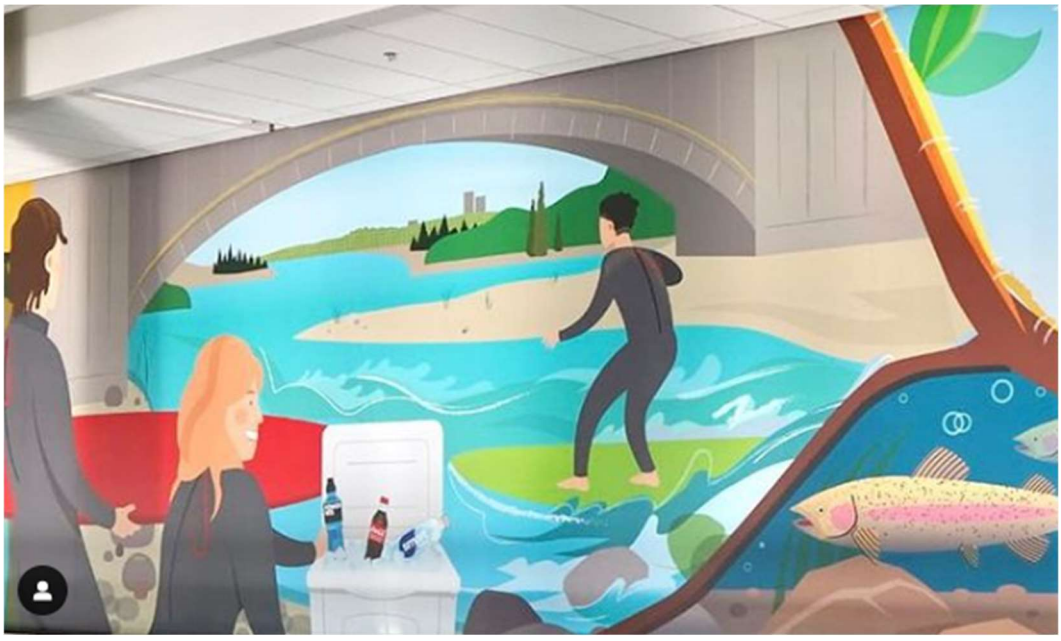


Figure 23: A mural of the tenth street wave at the Calgary international airport departure lounge

In addition to the wave users, spectators will also be utilizing this space. The ARSA report estimates up to 100,000 users/spectators but a ratio of up to 9:1 spectators per user has also been observed at other locations (ARSA, 2019) meaning that up to 200,000 spectators could be drawn to this location over a given year. This level of activation would result in a substantial improvement to the general downtown area and

would provide several non-market benefits. Some benefits previously discussed include improved safety and education, but an increase in economic activity at local businesses would also be expected. The project appears to align well with the goals of the downtown strategy.

3.4 Past Communication

Both ARSA and AWA have been effective proponents for a recreational wave at this location and have engaged with numerous City business units and councillors over the past 5 years. In response to their request, The City provided a letter of support in principle for the project in September 2020 (attached as Appendix B).

The letter of support recognizes the need for further study at this location and supported the creation of a Parks Foundation funding model to support the design and potential construction of the recreational wave. It also requested that the City develop a communication strategy that would be beneficial to all parties.

3.5 Cost/Funding

The conceptual design cost estimate (Class 5, -50% to +100%) for the combined Gravel Bar Realignment and River Recreational Wave is approximately $10M of which $6M is associated with the Flood Mitigation Component and $4M is associated with the recreational wave. The $6M flood mitigation component has been integrated into the WIIP for the coming years, however the $4M for the recreational wave is currently unfunded. It is proposed that funding for the recreation component will be paid for from a combination of City funding, Provincial and Federal grants, and public donations.

3.6 Collaboration with RWW, Lot 6, and Sunnyside Barrier

This project site is adjacent to both the River Walk West, Lot 6, and the Sunnyside Barrier Projects. Collaboration meetings with these projects have been occurring since project kickoff to ensure there is alignment and a consistent theme between the projects. RWW and Lot 6 have been asked to review how recreational wave support facilities could be better integrated into their projects. All three projects have been supportive of the recreational wave and proposed gathering spaces the project would support.

3.7 Improved River Access

In 2016, The Calgary River Users Alliance (CRUA) provided The City with a report that demonstrated that the combined economic benefit from all river recreation on the Bow and Elbow provides The City with over $50M in annual economic benefits (CRUA, 2016). This value aligns well with the previous discussed benefits from a potential recreational wave. One of CRUA's main goals was to improve river access so these activities can be accessed safely and efficiently. In addition to providing a recreational wave, this project will provide multiple river access locations both upstream and downstream of the wave. One of the access points will also be a mobility ramp which will benefit this underserved population.

3.8 Business Case Conclusion

There appears to be a viable business case for the recreational wave to be included in the overall flood mitigation project. An estimated yearly economic benefit from wave users alone of $1.8M is expected though this does not consider the numerous other non-market social and environmental benefits from the proposed project. Based on the current cost estimate and expected economic benefits, the payback period for the investment would be three years for the recreation wave component of the project.

4 Design

The proposed project has 5 distinct areas as shown in Figure 24 which are further discussed below. The provided design incorporates the recreational wave into the flood mitigation design, but also creates fish habitat and riparian area improvements which will convert this impacted reach of river into an accessible and enjoyable riverfront. It should be noted that the provided schematics are based on the preliminary design and there may be modifications and changes as we move into detailed design.

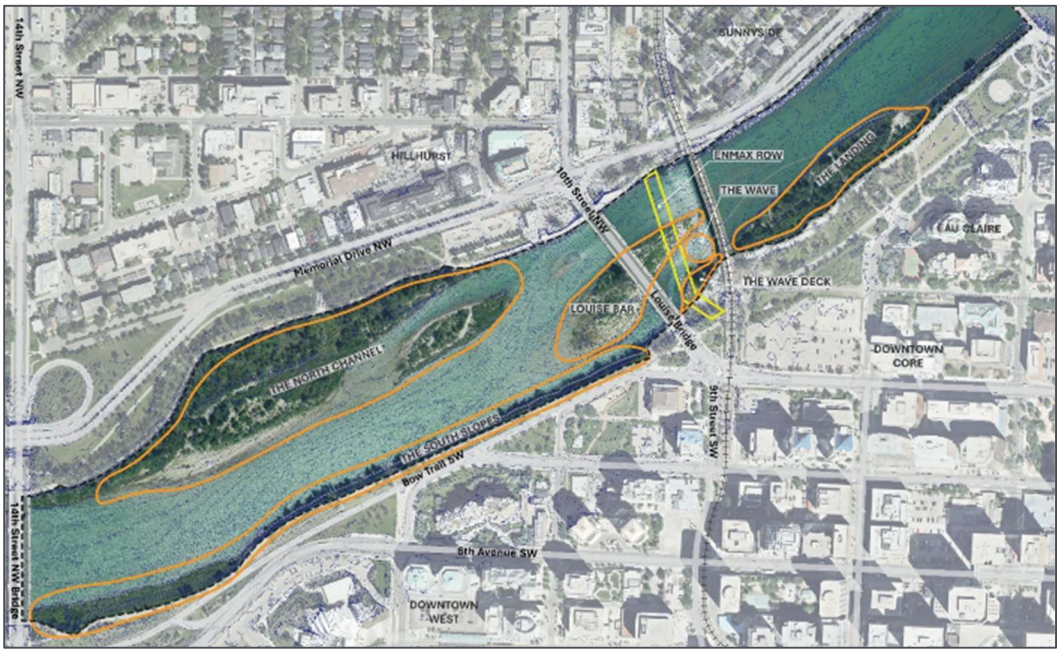


Figure 24: 2022 Airphoto of existing conditions with the 5 project areas shown

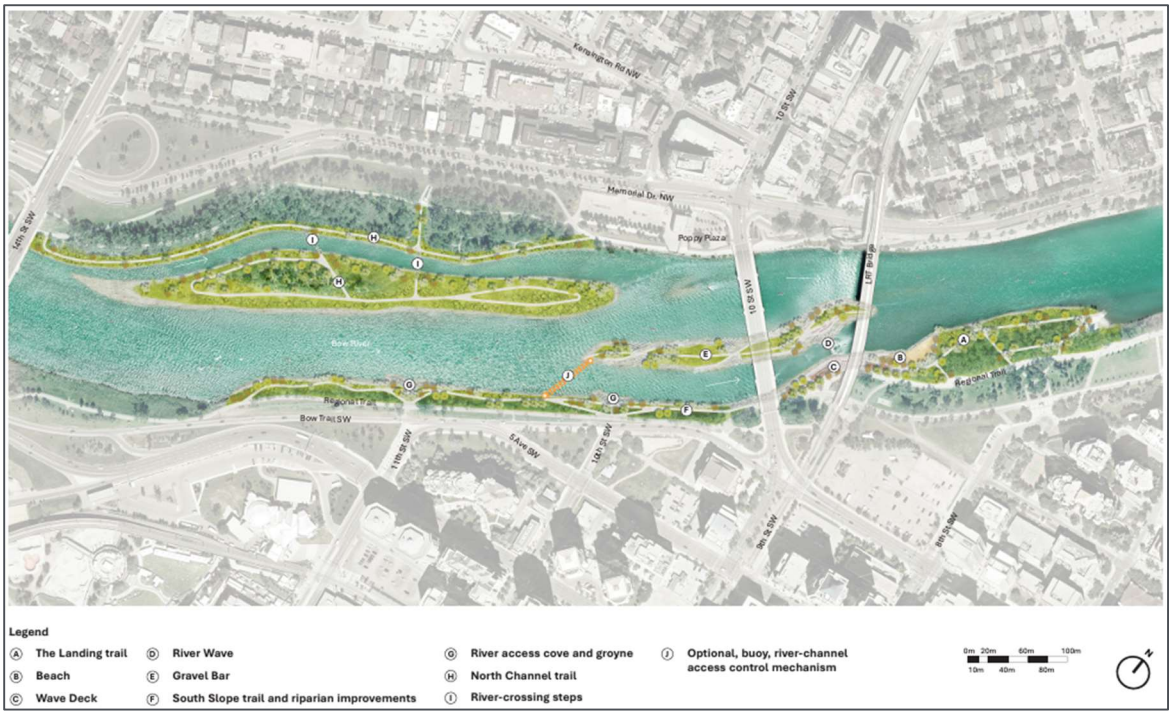


Figure 25: Plan image of the project area

4.1 Louise Bar

Louise Bar is proposed to be realigned to mitigate the flood risk posed by the existing bar alignment, pending approval of capital funding. The realigned bar has several functions and features including:

1. Balancing shear stresses throughout the reach so that sediment deposition does not occur to the same degree as it has in the past during large floods;
2. Providing hydraulic separation between the south recreational channel and the north navigable channel;
3. Providing an emergency helicopter landing pad as requested by Mobility Operations in support of the downtown Helipad re-activation;
4. Providing a safe and accessible gathering space with stairs down from Louise Bridge and informal seating along the banks of the bar for people to observe the wave but also to recreate in the upstream recreational channel;
5. Restoring riparian and fish habitat by planting native shrub and tree species on the island and using boulder cluster to provide diverse hydraulics and habitat along the banks.

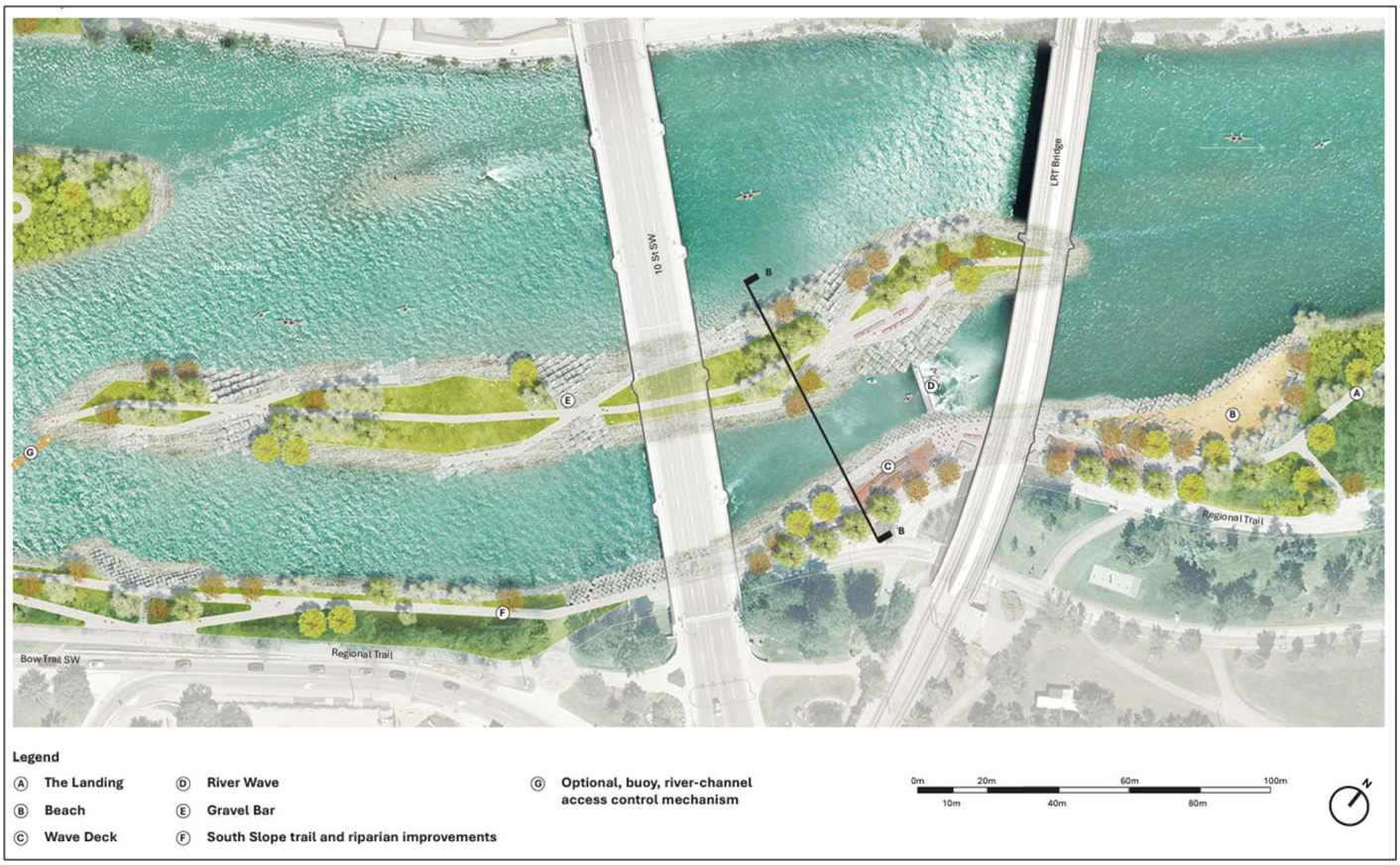


Figure 26: Louise Bar Design

4.2 South Slopes

The gravel that is removed from Louise Bar will be placed along the toe of the South Slopes which will minimize transport costs, maintain the gravel balance within the river, and provide improved river access. This bank is currently very steep with dense sections of non-native caragana. No safe river access is available along this bank. By placing the gravel along the toe of the slope and hardening it with designed bedrock hardpoints, access will be improved, and a separate pedestrian trail and regional pathway will be

possible. The hydraulically complex bank along with the proposed plantings of native shrubs and trees will provide a diverse and healthy ecosystem. This will also provide an improved wildlife corridor separating the blue/green corridor from Bow Trail.

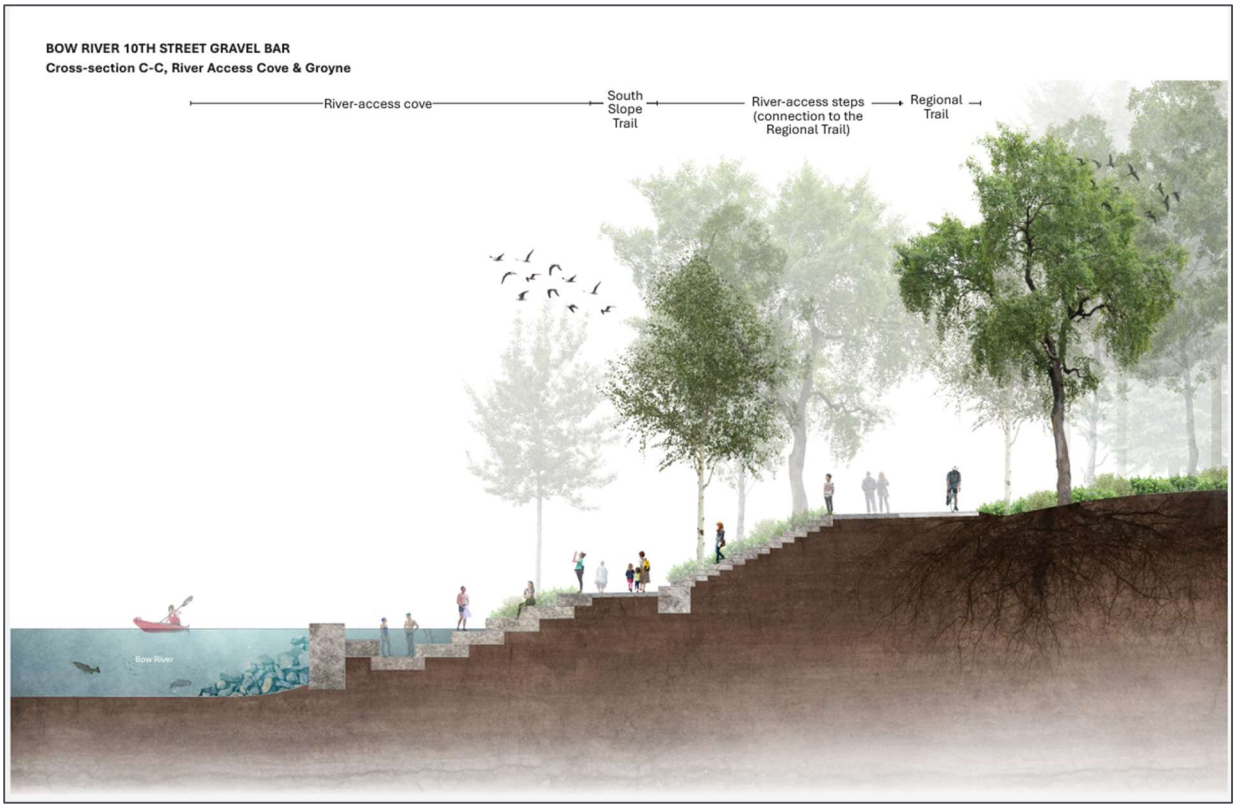


Figure 27: South Slopes Section with Access Point

4.3 North Channel

To further balance the shear stresses and hydraulics through this reach as well as to compensate for any potential fish habitat lost from the flood mitigation and recreational project components, a side channel will be constructed along the north bank of the river upstream of Louise Bridge. Side channel habitat has been shown to be critical spawning habitat for Brown Trout and there has been a loss of this type of habitat over the past 100 years (KCBL, 2016) making this type of compensation ideal for the fishery. The side channel will be designed to provide a range of habitat types and will benefit from the large diversity of mature vegetation that already exists along the banks.

The adjacent riverbank provides good riparian habitat but contains large unsheltered populations impacting the usability of the park by the general public. New trails are proposed to be developed along the bar that will connect with those being suggested as part of the Sunnyside barrier project. The trails will lead pedestrians through the riparian area to hardened river access points along the new side channel to protect the existing habitat. The increase in usability of the area by the public will help mitigate undesirable uses and will provide opportunities to relocate people experiencing vulnerabilities to intact housing.

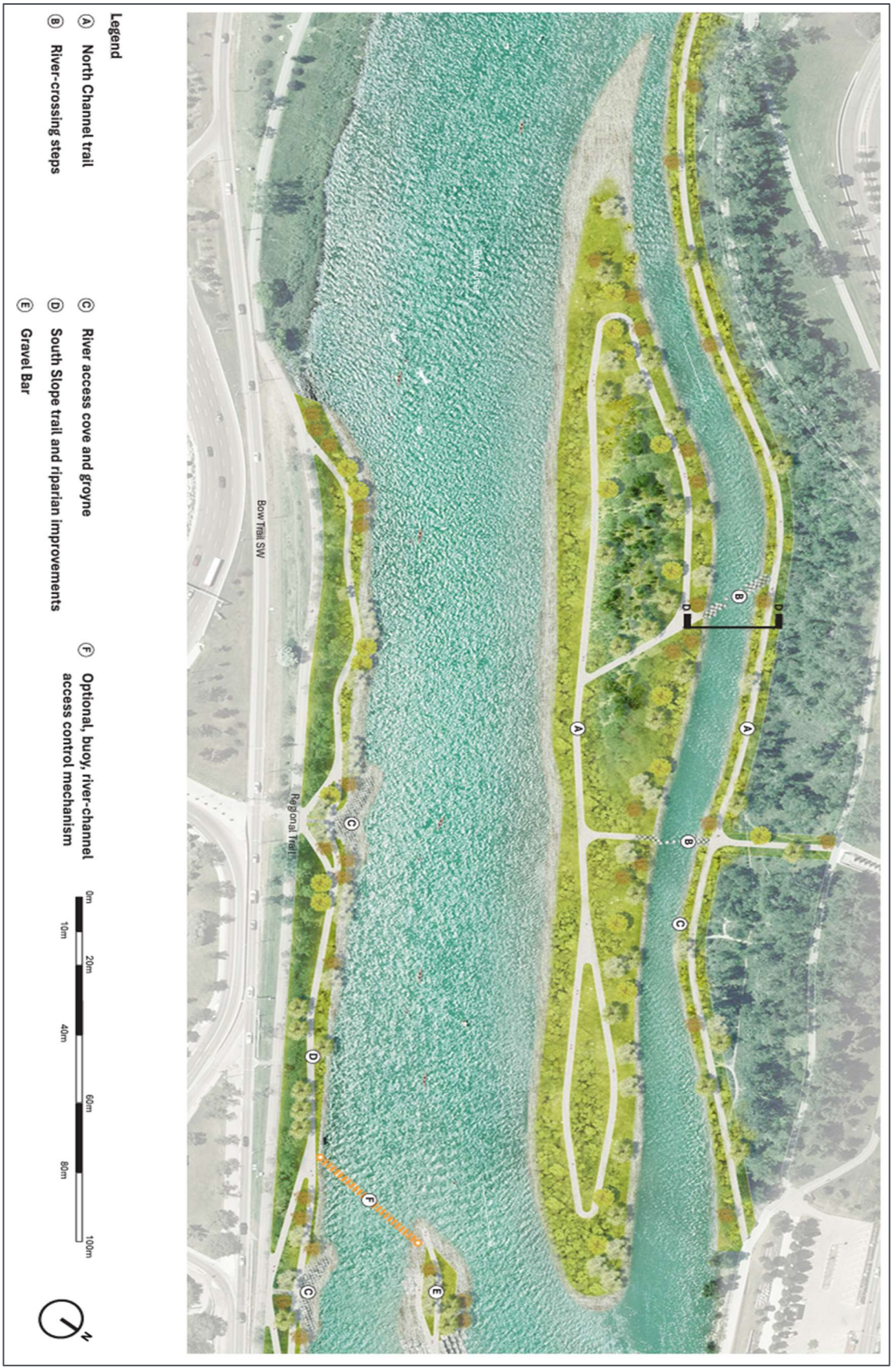


Figure 28: South Slopes and North Channel

4.4 The Wave

The recreational wave will be located between Louise Bridge and the Ctrain bridge and as discussed will only be present when intentionally activated. The bank adjacent to the wave on both sides will be hardened using natural stone or concrete steps to provide safe access and egress from the wave. The wave will be comprised of at least three different “wave gates” so that depending on the river flow rate, the wave can remain functional. When river flows are high, all three gates will be able to provide a recreational wave. When flows are low, only one gate will provide a recreational wave. The wave will either be pneumatic or mechanically activated and will be supported by a large cast in place concrete foundation. A deep pool will be provided on the downstream side to minimize impacts with the ground during wave egresses.

Spectators will be able to view the wave from both banks and bridges. A continuous pedestrian trail from the wave upstream to the south slopes will be provided and separated from the regional pathway to avoid conflicts between river users and pathway commuters. Fenced planting pockets with native trees and shrubs will also be provided along the banks adjacent to the wave. These plantings will provide riparian habitat and shade for spectators.

Figure 29: Rendering of The Wave location looking downstream from near Louise Bridge

4.5 The Landing

Downstream of the wave a large access/egress cobble beach is proposed. This will allow recreational wave users that “wash out” from the wave to quickly return to shore as needed. It will also provide an ideal location for spectators and less formal recreational activities to interact with the water. Additional river access/egress locations will be provided further downstream with trails that connect back to the wave in case a user washes out farther down the reach.

Figure 30: The Landing

5 Conclusions

The proposed recreational wave is anticipated to provide significant economic and social benefits to The City with an economic payback in as little as 3 years. Based on the potential economic benefits and the number of private recreational waves being constructed, there is a potential for The City to “lose out” should other groups move forward with other similar projects (i.e. Cochrane).

The proposed location is ideal for a recreational wave based on the local hydraulic, geotechnical, water quality, and existing morphologic condition. Furthermore, this reach has already been so heavily impacted by historic anthropogenic interventions that the inclusion of a wave structure will have no significant impact on its natural ecology or morphology.

After reviewing a range of different factors that could impact the waves efficacy ranging from safety to morphology, no clear reasons were identified why a recreational wave would not be successful. Further work is required to confirm how the wave would be operated in a partnership however, a public/private partnership model is likely the best means to operate the wave and maintain its fee free status.

The project aligns well with City's overall strategic direction of creating a "great place to live" as well as numerous other business unit goals including the Downtown Strategy, the Recreation Master Plan, the River Access Strategy, the Riparian Program, and The Eventful City Strategy.

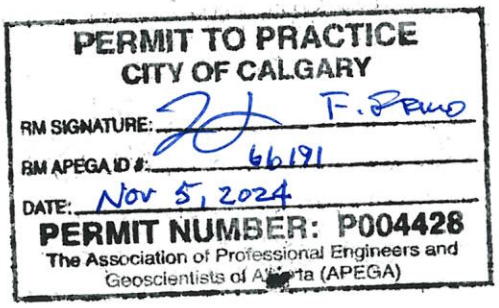
Though the inclusion of the wave into the overall flood mitigation project will increase its complexity it is recommended that it be included due to the positive economic and social benefits. The resulting design can mitigate the flood risk while also creating an objectively successful riverfront recreational space. The current Class 5 (+100%, -50%) project cost estimate is approximately $10M, of which $6M is for the flood mitigation component and $4M is for the recreational wave. The $4M recreational component is suggested to be paid for from a combination of Parks Foundation, grants, and potentially other City business units. Should the project be corporately approved, implementation of both the flood mitigation and recreational wave components of the project will depend on approval of capital funds.

6 Closure

The report has been prepared for the exclusive use of the City of Calgary for planning purposes. The report's contents should not be relied upon by any other party without due consideration and authorization.

Jonathan Slaney, M.A.Sc., P. Eng.
Planning Engineer, River Engineering
City of Calgary

Reviewed by: Sandra Davis, M.Sc., P.Eng
Team Lead, River Engineering
City of Calgary



APEGA Permit to Practice

7 References

Alberta Government. (2018). Environmental Quality Guidelines for Alberta Surface Waters. ISBN (PDF) 978-1-4601-3873-1. Water Policy Branch. March 28, 2018.

Alberta Government. (2022). Alberta Safe Beach Protocol. [2022 edition]. | ISBN 978-1-4601-5439-7. Alberta Health. May 19, 2022.

Braak, W. (2012), 2011 Economic Impact of Kelly's Whitewater Park in Cascade Idaho. University of Idaho Extension in Valley County. University of Idaho. October 2012.

Boden BP., Breit I., Beachler J., Williams A., Mueller F. (2013) Fatalities in high school and college football players. Am J Sports Med. 2013 May;41(5):1108-16. doi: 10.1177/0363546513478572. Epub 2013 Mar 11. PMID: 23477766.

Calgary River Users Alliance (2016). The Economic Importance of Recreational River Use to the City of Calgary. May 20, 2016

City of Calgary (2010), Recreation Master Plan 2010-2020. The City of Calgary Recreation

City of Calgary (2017), The Riparian Action Program – A blueprint for resilience. City of Calgary. March 2017.

City of Calgary (2018), Homeowner Water Guide. Stormwater Management Systems. ISB 18-01036238

City of Calgary (2023), Glenmore Reservoir 2022 - Public, Private and City usage on the Reservoir. Demographics and Research Community Strategies. The City of Calgary. March 2023

City of Calgary (2024A), Calgary's Downtown Strategy. Website (https://www.calgary.ca/planning/downtown-strategy.html). Accessed 20240312

City of Calgary (2024B), 2023 Perspectives on Calgary Survey: Downtown – Final Report. The Corporate Research Team, City of Calgary. February 2024.

City of Calgary (2024C) Tourism Calgary – A Visit to Calgary in 60 Seconds. https://www.youtube.com/watch?v=mLJHaew9wYE&ab_channel=TourismCalgary. Accessed 20240315

Cohen, J. (2017), The perfect wave. Science 358, 711-713 (2017). DOI:10.1126/science.358.6364.711

Coffman, M. & Burnett, K. (2009) An Analysis of the Mavericks Wave from an Ecotourism Perspective,www.savethewaves.org/sites/default/files/Mavericks_Wave_Valuation_Report_0.pdf, 1/9/2013

ECONorthwest (2017) Economic Contributions of Bend Park and Recreation District- Benefits and Impacts. Prepared for: Bend Park and Recreation District. November 2017.

Fiore DC. (2003) Injuries Associated with Whitewater Rafting and Kayaking. Wilderness & Environmental Medicine. 2003;14(4):255-260. doi:10.1580/1080-6032(2003)14[255:IAWWRA]2.0.CO;2

Franklin RC, Leggat PA. (2012) The epidemiology of injury in canoeing, kayaking and rafting. Med Sport Sci. 2012;58:98-111. doi: 10.1159/000338698. Epub 2012 Jul 18. PMID: 22824841.

Hootman JM, Dick R, Agel J. (2007) Epidemiology of collegiate injuries for 15 sports: summary and recommendations for injury prevention initiatives. J Athl Train. 2007 Apr-Jun;42(2):311-9. PMID: 17710181; PMCID: PMC1941297.

Klohn Crippen Berger Ltd (2017), Calgary Rivers Morphology Study – Main Report. Report Number A03311B01

Klohn Crippen Berger Ltd (2016), Calgary Rivers Fish Habitat Study – Fish Habitat Study. Report Number A03311B02

Leon J.X., Manero A., Lazarow N., Spencer-Cotton A., Wegener T., Jarratt P., Pearce T. (2023) Estimating the economic value of recreational surfing at the Noosa World Surfing Reserve: a direct expenditure and travel cost analysis. Working Paper. The University of Western Australia. 2023

Mills B., and Cummings A. (2013) The economic impact of domestic surfing on the United Kingdom. Surfers against Sewage. October 2013

Morrissey, Karyn & Semru, J & Cairnes, & Moron, Ms. (2012). The Market and Non-Market Value of Water-based Activities in the West of Ireland.

Moran S.R. (1986) Surficial Geology of the Calgary Urban Area. Bulletin No 53. Alberta Research Council.

Niedermeier M, Gatterer H, Pocecco E, Frühauf A, Faulhaber M, Menz V, Burtscher J, Posch M, Ruedl G, Burtscher M. (2019) Mortality in Different Mountain Sports Activities Primarily Practiced in the Winter Season - A Narrative Review. Int J Environ Res Public Health. 2019 Dec 30;17(1):259. doi: 10.3390/ijerph17010259. PMID: 31905912; PMCID: PMC6981978.

Rood, B, Stewart. and Kaluthota, Soba. (2006). Riparian Woodlands along the Middle Bow River through Calgary: Patterns and Processes, including Plant Colonization and Succession Chinook Environmental Resources and University of Lethbridge. Sub-Report for: Calgary Rivers Morphology and Fish Habitat Study, Klohn Crippen Berger and City of Calgary May 2016

Rood, B.S., Kaluthota, S., Philipsen. J.L., Zanewich P.K., (2016) Analyzing and Projecting Post-Flood Vegetation Colonization along the Bow River through Calgary, Alberta. Chinook Environmental Resources, RR9 Site 1 Box 1, Lethbridge, AB T1J 4R9, and Environmental Science Program, University of Lethbridge, AB

Spittler, J., Gillum R., DeSanto K. (2020) Common Injuries in Whitewater Rafting, Kayaking, Canoeing, and Stand-Up Paddle Boarding. Current Sports Medicine Reports 19(10):p 422-429, October 2020. | DOI: 10.1249/JSR.0000000000000763

Surf Anywhere (2019) Initial Design Report for Calgary River Wave Park (SA-2018-009-R1). December 15, 2019. Modifed Mar 24 2024.

The Wave. (2024), The Wave – The Year We've Had. Website(https://www.thewave.com/the-year-weve-had/) accessed 20240312

The Daily Hive (2024) – People are actually surfing on the Bow River. Website (https://dailyhive.com/calgary/calgary-people-surfing-bow-river-photos-videos) . accessed 20240319

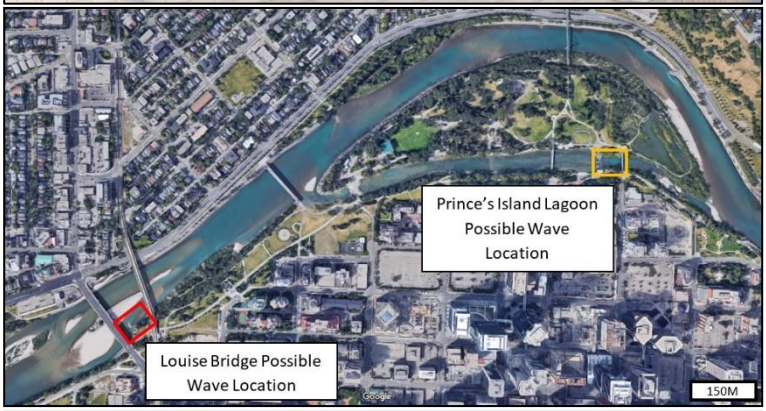
Thurow, (2016): Life histories of potamodromous fishes. In: P. Morais & F. Daverat, eds. Introduction to Fish Migration.

Wagner, S., Nelson, C., Walker, M., (2011) A Socioeconomic and Recreational Profile of Surfers in the United States. Surf First and the Surfrider Foundation. July 2011.

Yu Q., Rennie C., Slaney J., Parsapour-Moghaddam P. (2022) Impact evaluation of instream bar management using morphodynamic modelling. J Environ Manage. 2022 Sep 15;318:115564. doi: 10.1016/j.jenvman.2022.115564. Epub 2022 Jun 27. PMID: 35772276.

Appendix A

Conceptual Design Report for the Calgary River Wave Park at Calgary Alberta



Initial Design Report for the Calgary River Wave Park

at

Calgary Alberta

SA-2018-009-R1
December 15, 2019

Updated
March 24, 2024

Presented by

SURF ANYWHERE

Funded by

Alberta

ALBERTA RIVER SURF

Calgary

City of Calgary, Alberta

Attn: Alberta River Surfing Association Board

Re: SA-2018-009-R1, Initial Design Report for Surf Beach and River Waves in Calgary, AB

Dear Board Members,

Surf Anywhere offers river wave design, construction and operation consulting services for development of successful river waves. We specialize in creating and supporting excellent river waves, surroundings, communities, education and events that result in substantial economic, culture and environmental returns. Good river waves are accessible, allow for a wide range abilities and high level of performance. River waves can be low hazard, reduce flood risks, create a substantial spectator draw, become a central cultural space and capture part of the $50B USD a year wave tourism market.

This initial design report provides extensive details on all key aspects of the Calgary River Waves and Urban Beach project. The report is based on the results of stakeholder consultation, experience building other waves & river recreation areas, analysis of successful existing waves and river recreation areas and substantial additional research. The creation of good river waves will have substantial positive economic, cultural and environmental impacts in Calgary while reducing area flood risks and improving daily river safety.

The proposed waves and urban beach in Calgary are projected to draw about $1,800,000 each year in annual spending by wave users alone based on conservative estimates. This number does not include additional yearly spending from spectators, events, new businesses locating in Calgary and high earning wave users staying in or moving to Calgary. Budgetary estimates show the project cost to be around $9,600,000 with a 6-year payback based on conservative increased economic activity.

We look forward to working with you and helping create a successful river wave and river recreation resource in Calgary. Please contact me with any questions.

Sincerely,

Neil Egsgard
President
Surf Anywhere

TABLE OF CONTENTS

1 Executive Summary 13
1.1 River Wave Area 16
1.2 Supporting Facility 18
1.3 Area Plan 19
1.4 Initial Design 20
2 Benefits of Good Recreational River Waves 21
2.1 Triple Bottom Line Report on Surfing in Calgary 21
2.1.1 Cultural Impact Summary 21
2.1.2 Economic Impact Summary 22
2.1.3 Environmental Impact Summary 22
2.2 Common Areas of Concern 23
2.2.1 Impact on Flood Risk 23
2.2.2 Impact on Fish Passage 23
2.2.3 Impact on Aquatic Habitat and Riparian Habitat 23
2.2.4 Impact on Navigation 23
2.2.5 Adjustability, Wave Type and Usage Time 23
2.2.6 Wave Technology Choice 23
2.2.7 Community Programming 23
2.2.8 Liability 23
2.2.9 Controlled Increase in Tourism and Activity 24
2.2.10 Durability 24
2.2.11 Maintenance 24
2.2.12 Operations 24
2.3 Examples of Waves Creating Cultural Benefits 24
2.3.1 Photos of Waves Creating Cultural Benefits 25
2.4 Photos of Waves with Environmental Benefits 26
2.5 Photo of Waves as part of Water Diversion 27
3 Basic Wave Construction 28
3.1 Minimum Wave Conditions 28
3.2 World Class Wave Conditions 28
3.3 Calgary Wave Target 28

3.4 Ideal Wave Location 28
4 Possible Locations 29
4.1 Possible Wave Locations 29
4.2 Louise Bridge 30
4.3 Prince's Island – East End of Lagoon 31
4.4 Historical River Conditions 33
4.4.1 Summary of River Changes since 1926 33
4.5 River changes due to floods 44
5 Flow Analysis 48
5.1 Summary of Flow Analysis 48
5.2 Full Bow River Flow 49
5.3 Louise Bridge Wave Flow @ 40% of Full Flow 50
5.4 Lagoon Wave Flow 51
6 Drop Analysis 56
6.1 Summary of Drop Analysis 56
6.2 Drop at Louise Bridge Location 57
6.2.1 Louise Bridge – Water Surface & River Bottom Elevation Profile 58
6.2.2 Louise Bridge – Drop from West of Louise Bridge to Ctrain Bridge 58
6.2.3 Louise Bridge – Water Surface Elevations & Drops at 48 m^3/s 59
6.2.4 Louise Bridge – Water Surface Elevations & Drops at 95 m^3/s 60
6.2.5 Louise Bridge – Water Surface Elevations & Drops at 124 m^3/s 61
6.3 Drop at Prince's Island Lagoon Location 62
6.3.1 Lagoon – Drop at Existing Channels 62
7 Environmental Self Compensation 63
7.1 Louise Bridge Environmental Self Compensation 63
7.2 Lagoon Environmental Self Compensation 67
8 High flow events, ice jams and sediment deposition 68
8.1 High flow event 68
8.2 Ice jams 69
8.3 Sediment deposition 69
9 Land Ownership 70
9.1 Land Ownership of Wave Structures and Bank Structures 71

9.2 Land Ownership of Supporting Facility 71
9.3 Land Titles 72
9.4 ROW Bridge 73
9.5 ROW Enmax 74
9.6 ROW Transit 75
10 Operations & Maintenance 76
10.1 Facility Operating Organizations 76
10.1.1 Alberta River Surfing Association and Alberta Whitewater Association Organization and Responsibilities 76
10.1.2 Calgary Parks Responsibilities 77
10.2 Facility Ownership 77
10.3 Wave Structure Control & Operation 78
10.3.1 Duration of Raising and Lowering 78
10.3.2 In-River Wave Components 79
10.3.3 On Shore Wave Components 80
10.4 Flow Level Wave Operations Plan 81
10.4.1 Bow River Unsafe Boating Advisory Level – Bow River Flow > 280 m^3/s 81
10.4.2 Bow River Flow < 280 m^3/s 81
10.5 Daily Wave Operations Plan 81
10.6 Seasonal Wave Operations Plan 81
10.7 Response to Sudden Events 83
10.7.1 Channel Flow Isolation 83
10.7.2 Upstream Water Level Lowering 83
10.7.3 Emergency Services and Control of Adjustable Structures 83
10.8 User Conflicts 83
10.8.1 Avoiding Conflict 83
10.8.2 Dangerous or Inappropriate Wave Usage 84
10.8.3 Fixed Rope Use 84
10.8.4 Violent or Aggressive Behavior 84
10.9 Events 84
10.9.1 Alcohol / Cannabis at Events and River Wave Usage 84
10.10 Safety Plan 85

10.10.1 Risks and Risk Management 85
10.10.2 Signage 90
10.10.3 Safety Personnel & Scheduling 91
10.10.4 Junior River Surf & Safety Program 91
10.10.5 Wave Scheduling 91
10.10.6 River Safety Equipment 92
10.10.7 Video Monitoring of Area 92
10.10.8 Area Video Feed Users 92
10.10.9 Safety Map 93
10.11 Emergency Response Plan 94
10.11.1 Emergency Action Plan for Calgary Surf Beach 95
10.12 Wave Inspection & Maintenance 98
10.12.1 Design Assisting Inspections & Maintenance 98
10.12.2 Inspections 98
10.12.3 Maintenance 99
10.13 Park Land Maintenance 99
11 Design 100
11.1 Concept drawing 100
11.1.1 Wave park areas 100
11.1.2 Natural channel for boat and fish bypass 101
11.1.3 Deep, slow pool 101
11.1.4 River exit and entrance 102
11.2 Examples of Whitewater Parks and Adjustable Waves with Capital Costs 104
11.3 Critical Design Considerations 109
11.3.1 Flooding Risk 109
11.3.2 Float Through Boater Traffic 109
11.3.3 Fish Passage 109
11.3.4 Environmentally Self Compensating 109
11.3.5 Wave Quality 109
11.3.6 Safety 109
11.3.7 Durability & Maintenance 109
11.3.8 Broad Public Usage & Benefit 109

11.3.9 Adjustability....109
11.3.10 Wave Channel Dewatering & Flow Bypass....110
11.3.11 Liability....110
11.3.12 Operating Organization....110
11.4 General Concept Design....111
11.4.1 Reducing Flood Risk....111
11.4.2 Water Surface Elevation Control....112
11.4.3 Flow Through Boater Traffic....112
11.4.4 Upstream Fish Passage....112
11.4.5 Fire & Police Boat Passage....112
11.4.6 Adjustable Wave Features....112
11.4.7 Durability & Maintenance....112
11.4.8 Wave Quality at Each Possible Location....112
11.4.9 Environmentally Self-Compensating....113
11.4.10 Broad Public Usage....113
11.4.11 River Education....113
11.4.12 Examples of Waves that operate from 20 m^3/s to 45 m^3/s....113
11.5 Louise Bridge Specific Concept Design....114
11.5.1 Overview....114
11.5.2 Key Adjustments....114
11.5.3 Reducing Flood Risk....114
11.5.4 Effect on Water Surface Elevation....115
11.5.5 High Water Response....115
11.5.6 Environmental Enhancements....115
11.5.7 River Access and Egress....115
11.5.8 Spectating....115
11.5.9 Design Flows....115
11.5.10 Louise Bridge – Concept Design....117
11.5.11 Louise Bridge – Concept Drawing....118
11.6 Lagoon Specific Concept Design....119
11.6.1 Overview....119
11.6.2 Key Adjustments....119

11.6.3 Effect on Water Surface Elevation 119
11.6.4 Environmental Impacts 119
11.6.5 Design Flows 119
11.6.6 Lagoon – Concept Design 120
12 Recommended Wave Location 121
12.1 Location Evaluation 121
13 Initial Design 123
13.1 Overview 123
13.1.1 Wave area at 120 m^3/s – Wave structure raised 125
13.1.2 Wave area at 200 m^3/s – Wave structure lowered 127
13.1.3 Wave structure motion concepts 128
13.1.4 Wave Structure Motion Technology 130
13.1.5 Physical / Computer Modelling of Wave Structure 130
13.1.6 Supporting Facility 131
13.2 Reducing Flood Risks 132
13.2.1 HEC-RAS 1D model of water elevations 132
13.2.2 Waves funding ongoing flood risk minimization 133
13.2.3 Collapsible River Control Structures 133
13.2.4 Engineering Report 133
13.2.5 Gravel Bar Island Adjustments 134
13.3 Protecting Infrastructure 136
13.3.1 Louise Bridge 136
13.3.2 C-Train Bridge 137
13.3.3 Enmax 138 kV line 138
13.3.4 Storm Sewer 138
13.4 User Safety 139
13.4.1 User River Risk Table 139
13.4.2 User Riverbank Risks 142
13.4.3 Safety Monitoring & Response 143
13.5 Boat Passage 145
13.5.1 Down river boat passage 145
13.5.2 Upriver boat passage 145

13.5.3 Emergency boat passage 146
13.5.4 Drift Boats 146
13.5.5 Families and Low Skill Rafters 147
13.6 Fish Passage 147
13.6.1 North channel 147
13.6.2 South channel when waves are not operating 147
13.6.3 South channel when waves are operating 147
13.7 River Access & Egress 148
13.8 Area Usage 149
13.8.1 Spectators 149
13.8.2 River Users 151
13.8.3 Wave Users 153
13.9 Area Design 155
13.9.1 On Shore 155
13.9.2 In River 157
13.9.3 Habitat Enhancement 158
13.10 Area Access, Parking and Transportation 159
13.10.1 Parking & Car Access 159
13.10.2 Bike, Foot and Pathway Access 161
13.10.3 Transit Access 162
13.11 Life span 163
13.12 Planned major interventions 163
14 River Wave Formation 164
14.1 Terminology 164
14.2 Basic concepts 166
14.3 Key factors in good wave formation 167
15 Wave Technology 168
15.1 Key wave technology features 169
15.2 Existing and Planned Wave technology 172
15.2.1 Bend – Existing 173
15.2.2 Boise Phase 1 – Waveshaper 2 – Existing 175
15.2.3 Boise Phase 1 – Waveshaper 3 – Existing 177

15.2.4 Boise Phase 2 – Surf Wave 179
15.2.5 The.Riverwave, Austria 181
15.2.6 Vertical Lift Slope – Planned 185
15.2.7 Hinged Lift Slope – Planned 185
15.3 New Wave Technology 186
15.3.1 Oblique waves 186
15.3.2 Attachment Points 187
15.3.3 Changeable Wave Structure Position 187
15.3.4 Replaceable Wave Structure 187
15.3.5 Flow By-Pass / Wave Dewatering 188
15.3.6 Modelling Flume for Education & Research 188
15.4 Installation 189
15.5 Maintenance & Inspection 189
15.6 Life Span 189
16 Liability 190
16.1 Insurance 190
16.1.1 Industry Standard Insurance 190
16.1.2 Participants 190
16.1.3 City of Calgary 190
16.1.4 Operating Organizations 191
16.1.5 Limits, endorsements and exclusions 191
16.1.6 Meeting obligations in the event of a claim 191
16.2 Previous incidents, accidents & lawsuits 191
16.2.1 Risk and Risk Management 191
16.2.2 Lawsuits in Alberta 191
16.3 Incident prevention plan 191
16.4 Emergency Response Plan 192
16.5 Waivers 193
17 Permitting requirements 196
17.1 Federal 196
17.1.1 Fisheries and Oceans Canada 196
17.1.2 Transport Canada – Navigation Protection Program 196

17.2 Provincial 197
17.2.1 Alberta Environment & Parks – Water Act 197
17.2.2 Alberta Environment & Parks – Environmental Impact Assessment 197
17.2.3 Alberta Environment & Parks – Public Lands 197
17.2.4 Historical Resources Management Branch – Historic Resource Impact Assessment 198
17.3 Local 199
17.3.1 City of Calgary 199
18 Weather, Demographics and Economic Impact 200
18.1 Ideal Wave Usage Months 200
18.2 Access to Calgary and Waves 200
18.3 Demographics Overview 201
18.3.1 Calgary and Surrounding Surfer Area 201
19 Economic impact of surf waves in Calgary 202
19.1 Whitewater park economic impacts 202
19.2 Market value of wave sessions 202
19.3 River wave economic impacts 202
19.4 Total Available Spending by potential wave user households 203
19.5 Spending and visits by wave users at the Project 204
19.5.1 Conditions and calculations 205
19.6 Competing wave locations 206
19.7 Major powered wave facilities 207
19.8 Private river wave and indoor wave facilities 207
19.8.1 Additional Economic Impact Opportunities 208
19.8.2 Maximizing Returns 208
20 Budget 209
20.1 Capital Budget 209
20.2 Return on Investment 211
20.2.1 Cultural 211
20.2.2 Environmental 211
20.2.3 Economic 211
20.3 Operational Budget 212

20.3.1 Operational Budget Overview 212
20.3.2 Revenues and associated expenses 213
20.3.3 Additional expenses 214
20.4 Capital Funding 215
20.4.1 Initial Capital Plan 215
20.4.2 Community / Not for Profit 216
20.4.3 Grants 216
20.4.4 Corporate Donations 216
20.4.5 Private Individuals / Families Donations 216
20.4.6 City of Calgary 216
20.4.7 Province of Alberta 216
20.4.8 Federal Government 216
21 Process of Building Waves 217
21.1 Project Timeline 218
21.2 218
21.3 Next Steps 219
22 Conclusion 220
23 Surf Anywhere Team 221
23.1 Neil Egsgard – President 221
23.2 Jacob Kelly Quinlan – Director of Communications & Culture 222
24 Bibliography 223
25 Appendices 226
A. Louise Island in the Bow River at Calgary Mitigation of a Growing Flood Hazard and Prospective Environmental Impacts from the Urban Surf Beach and River Waves Project 227
B. Boise and Bend River Wave Review by Ryan Richard 228
C. Stakeholder Consultation for Calgary River Waves and Urban Beach 229

1 Executive Summary

Calgary can become one of the best river recreation destinations in the world. The proposed river wave recreation facility with high quality adjustable waves and supporting infrastructure ("the Project") on the Bow River in downtown Calgary will generate immediate, lasting and substantial economic, cultural and environmental benefits for the surrounding area. This document details the benefits, requirements, costs and next steps of creating the Project.

Key Benefits and Impacts

The main benefits of the Project are:

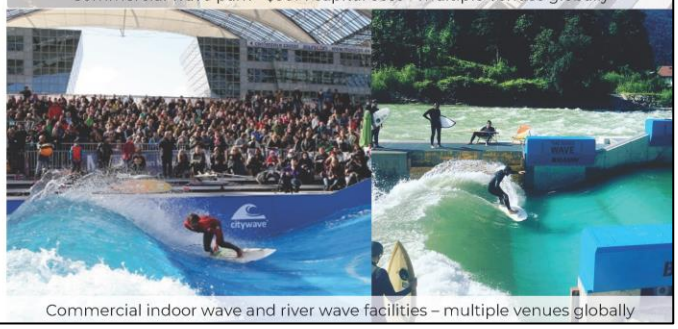
- Reduced flood risk
- Over $5 million each year in new economic activity.
- Return on investment of 6 years.
- Self-funding for all project operational, maintenance and life cycle costs.
- Increased daily river safety .
- Vitalization of derelict and eroding downtown river front.
- Cultural anchor connecting Eau Claire, Downtown West and Kensington.
- Improved riparian and aquatic habitat.
- Attraction and retention of Calgary businesses, families and students.
- River trail encouraging people to do multiple casual floats through downtown Calgary.

PROJECT PLAN

The Alberta RSA proposes this plan to advance the Calgary River Wave Park project.

- Lease or other agreement with the City allowing surf facility year-round structure and year-round operation to support the existing wave.
- Surf YYC facility supporting existing surf area:
  - Summer: youth camp, safety lessons, surf lessons, rentals, seating at wave, changing area, events and more.
  - Winter: board shaping classes, board shaping space, gear repair classes, safety gear upgrading and more.
- Establish framework for partnership with City to combine public, grant and private funding.
- Raise funds based on framework.
- Engineering RFP that leverages Calgary River Wave Park Initial Design Report.
- Standard design and construction process.

Commercial wave park - $50M capital cost – multiple venues globally



Commercial indoor wave and river wave facilities – multiple venues globally

HISTORY OF SUCCESS

Since 2013 the Alberta RSA has developed the 10th Street Wave into a widely recognized tourist attraction. The Alberta RSA has laid extensive ground work for the Calgary River Wave Park including:

- Slam Festival: Annual surf, skate and music festival at 10th Street Wave that draws thousands of people to the space and millions online.
- Calgary River Wave Park Initial Design Report: 310+ page comprehensive report on project..
- Surf lessons, equipment supply and equipment rental.
- Seasonal area enhancements including seating, board racks, changing deck, informational signage and more.
- Project support from local people, businesses, organizations and government.
- The Mountain wave in Kananaskis: Good river wave constructed and upgraded by Alberta RSA and Surf Anywhere.

Slam Festival 2017 to 2019

EXAMPLES OF RIVER WAVES
Global wave tourism is valued at $50B a year. There is a long history of successful river wave projects creating millions of dollars each year in new economic activity. These images are examples of manufactured river waves from North America and Europe. Good river waves projects are immediately and constantly filled with users and spectators.
Kananaskis Surf Wave – $450k capital cost over two builds – Built in 2014 and upgraded in 2019
Boise Whitewater Park – $5.3M capital cost – Built in 2012
Bend whitewater park – $13M capital cost – Built in 2016 – Annual economic impact $4.8M
The.RiverWave, Austria – Built in 2020

1.1 River Wave Area

Huge numbers of spectators and river users of all types and skill will regularly come to the wave area.

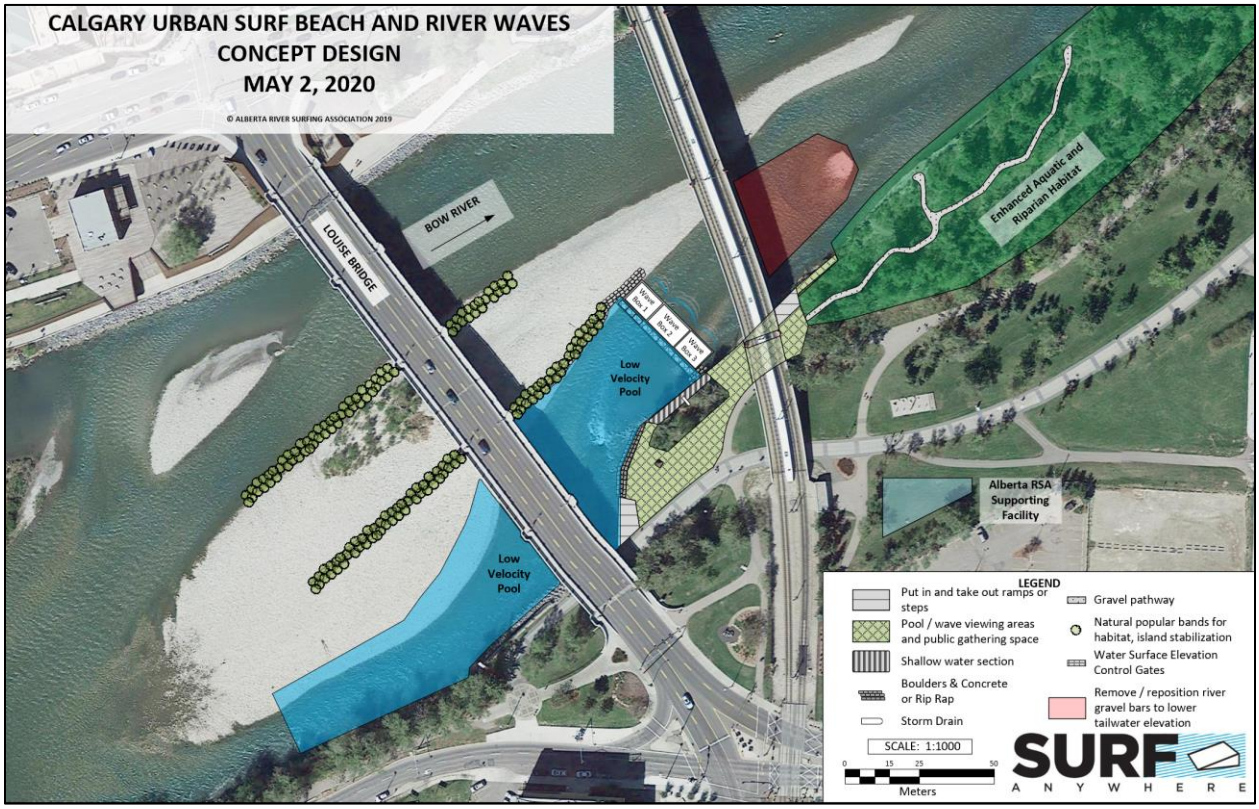
DESIGN
SURF ANYWHERE
DRAWING
THE RAPID EYE MOVEMENT
PARTNERS
ALBERTA RIVER SURF
AWA
Alberta Whitewater Association
Alberta
Parks Foundation Calgary
Calgary
v. Jan 28, 2022

1.2 Supporting Facility

The building is out of the flood zone and has all amenities for a stylish & vibrant community river space. The first and small version of the Support Facility will be operational in 2020.

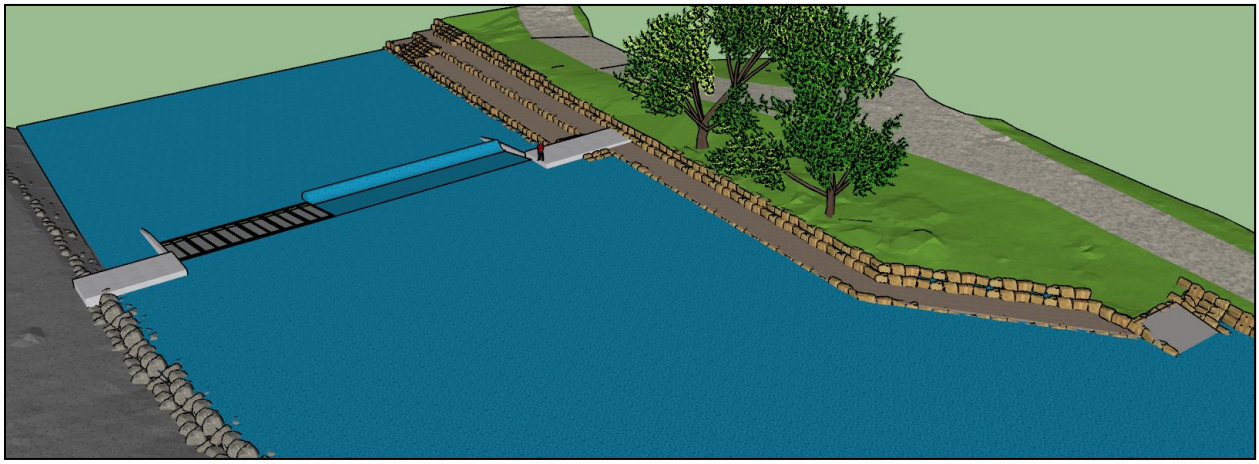
1.3 Area Plan

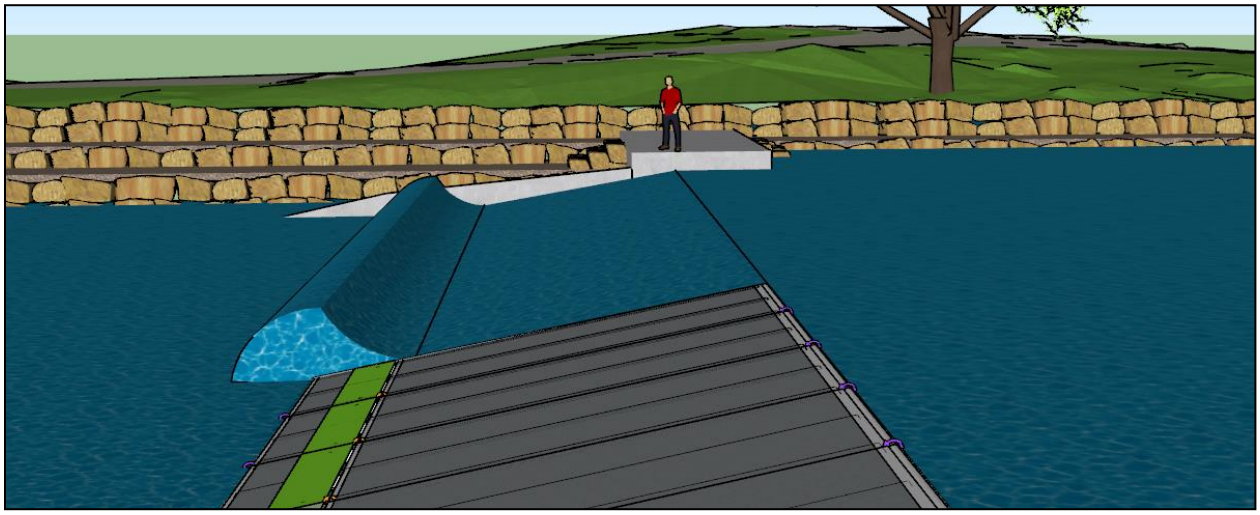
The wave area will vitalize the riverfront between Louise Bridge and the CTrain bridge and is on Crown Land. The supporting facility is just east of the CTrain line on City of Calgary Park land.

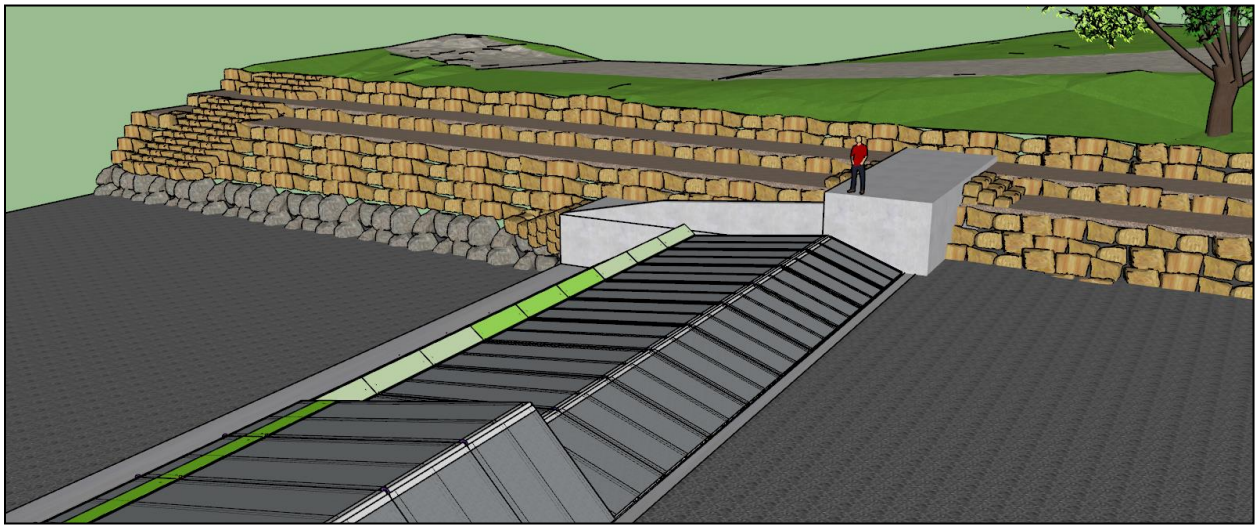


1.4 Initial Design

Preliminary rendering of the wave area and adjustable wave structure. The person is 182 cm / 6'2" tall. Images below are conceptual. **Wave structure design and motion will be determined during preliminary and detailed engineering.**







2 Benefits of Good Recreational River Waves

Good river waves create strong positive economic, social and environmental impacts. Recreational river wave use is a significant untapped resource for Calgary that can only be tapped with the creation of good waves and river access.

2.1 Triple Bottom Line Report on Surfing in Calgary

Surf Anywhere has completed a Triple Bottom Line Report on Surfing in Calgary based on the City of Calgary published criteria.

2.1.1 Cultural Impact Summary

- Creation of major general cultural hubs at river waves
    - The waves create a destination for river users and become a gathering point for the hundreds of thousands of people who drive through and past Calgary each year
    - The areas near the wave become a natural gathering point for community events
- Community Programming and Engagement
    - River waves provides a new and desired way for youth and other age groups to engage in a low risk and no impact sport with a low entry cost
    - River wave use and river waves can be included in general recreational programming and educational programming
- Holding of river wave competitions, events and festivals
    - Festivals can be combined with music and other cultural events
    - If desired, the waves can be used to draw participants and spectators from around Alberta, Canada and the globe

2.1.2 Economic Impact Summary

- Increased spending at adjustable river wave location and increased tourism
    - Global wave tourism has $50B USD annual value[1]
    - On average, wave users spend $62.50 each day including gas, food and equipment[2] [3]
    - A review by Surf Anywhere of 6 studies covering 14 rivers and whitewater parks from 1984 to 2011 revealed that medium quality whitewater parks result in $500,000 a year increased local spending and high-quality whitewater parks result in over $1,500,000 a year in increased local spending[4]
    - The increased spending is driven by:
        - Wave and river users coming to the area and staying for a few hours
        - Spectators coming to watch the wave and river users
        - Events drawing large numbers of spectators & participants over a few days
- Unique attraction for people & families to live in Calgary
- Communities choose how to balance the size of the economic impact and limiting the number of new people coming to the area for the surf wave. The balance is based on how the waves are marketed and how accessible they are to people who live outside the area.

2.1.3 Environmental Impact Summary

River wave projects provide opportunities to improve habitat, create new habitat and increase awareness. The awareness comes from people being close to and immersed in the river. The more positive interactions people have with rivers and river ecosystems, the more they understand the value of protecting and preserving the rivers. Some of the positive environmental impacts of river surfing waves are:

- Improvement of existing in-river and riverbank habitat
- Construction of new in-river and riverbank habitat
- Dramatically increased awareness of water quality by spectators and surfers
- Dramatically increased awareness of river habitat by spectators and surfers

[1] (McGregor, 2016)
[2] (Mills, Dr Bryan and Cummins, Andy, 2013)
[3] (Wagner, Nelson, Walker, 2011)
[4] (Egsgard, Neil, 2019)

2.2 Common Areas of Concern

There are a few areas of concern that are regularly raised with respect to adjustable river wave projects.

2.2.1 Impact on Flood Risk

For areas with flooding concerns, adjustable river waves can be constructed to reduce flood risk. During high flows the wave creating structures flatten to the river bottom.

2.2.2 Impact on Fish Passage

Many river waves have been designed to allow fish to safely move upstream and downstream through or past the wave.

2.2.3 Impact on Aquatic Habitat and Riparian Habitat

River wave construction is an opportunity to create additional or improve existing riparian and aquatic habitat for animals on the riverbank and in the water.

2.2.4 Impact on Navigation

River waves can be designed and built to allow safe passage of all watercraft including boats and tubes.

2.2.5 Adjustability, Wave Type and Usage Time

River waves can be adjustable. Adjustable waves to be easily shaped for different users and over a range of flows. The wave can be a good surfing wave then quickly become a good kayak feature. The adjustability means that high quality waves can be available for most of the year when there is enough flow.

2.2.6 Wave Technology Choice

All wave projects require custom wave solutions for the site conditions. There are a range of available wave technologies from very expensive patented wave systems to simpler not patented systems. River wave technologies are constantly improving. The basics of river wave creation cannot be patented. Wave technology is chosen after all detailed local conditions have been determined and as part of later stage budgeting.

2.2.7 Community Programming

Surf Anywhere can provide detailed programming to engage locals in using the wave and the surrounding space.

2.2.8 Liability

Liability at adjustable river waves is typically handled very similar to skate parks. Both skate parks and adjustable river waves are free to use and public recreational infrastructure. The waves are adjustable and can be made to disappear when needed such as at night, during high flow events and during ice events. There will safety and usage signage.

2.2.9 Controlled Increase in Tourism and Activity

Adjustable river waves will bring in tourists who want to use the area and see the spectacle of people using the area. The community has strong controls on the increase in tourism and activity by adjusting marketing, hours of operation and amenities.

2.2.10 Durability

Adjustable river waves have survived major floods in rivers with high sediment transfer and remained operational afterwards. The life span of the boulder and concrete portions of the river waves can be over 50 years. The life span of the adjustable waves is at least 15 years.

2.2.11 Maintenance

Adjustable river waves and the related technology require very minimal annual maintenance. Costs of area maintenance can be covered by a supporting facility that is operated by a not for profit dedicated to the area.

2.2.12 Operations

Adjustable river waves are normally operated by trained volunteers from the river community or by municipality parks and/or recreation staff. The area does not require constant monitoring. Costs of area operations can be covered by a supporting facility that is operated by a not for profit dedicated to the area.

2.3 Examples of Waves Creating Cultural Benefits

Bend, Oregon, USA: Created a heavily used surfing wave that draws users and spectators. Usage of the park is over 1000 users per day.

Missoula, Montana, USA: Built a good river wave and became travel destination for wave users and the focus of a number of short films

Kananakis & Calgary, Alberta, Canada: Constructed good waves and created a cultural gathering point in the middle of the City and in the mountains. The waves with surfers draw hundreds of spectators a day who stop and spend time at the wave. The waves have been incorporated into the City of Calgary tourism department marketing.

Munich, Germany: Surfer constructed wave is featured in city travel guides and pulls in thousands of spectators every nice day.

Sheridan, Colorado, USA: Built a river park and the waves were filled with happy users

2.3.1 Photos of Waves Creating Cultural Benefits

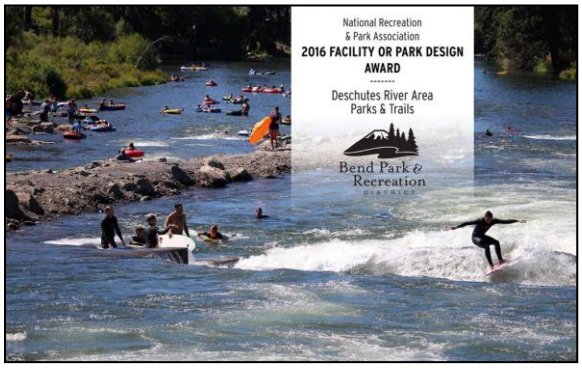


Figure 1 Bend, Oregon, USA

Figure 2 Missoula, Montana, USA

Figure 3 Kananaskis, Alberta, Canada

Figure 4 Munich, Germany

Figure 5 Kananaskis, Alberta, Canada

Figure 6 Vail, Colorado, USA

Figure 7 Cunovo, Bratislave, Slovakia

Figure 8 Cascade, Idaho, USA

2.4 Photos of Waves with Environmental Benefits

Figure 9: Bremgarten - Fish passage on left and surf wave on right

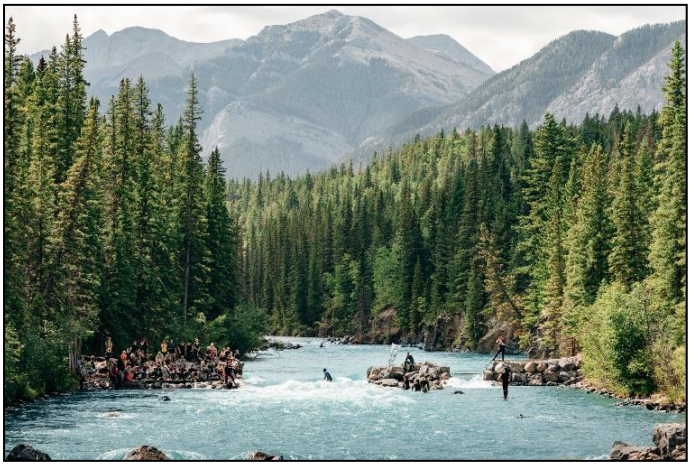


Figure 10: The Mountain Wave in the Kananaskis

Figure 11: Bend – Habitat on left, Waves in middle, Tuber Passage on right. Replaced hazardous dam.

2.5 Photo of Waves as part of Water Diversion

Figure 12: Boise – Diversion channel entrance on top left of image, waves in middle of image

Figure 13: Boise – Surf wave and surf line-up

3 Basic Wave Construction

Good river waves can be constructed over a wide variety of flow ranges and drops. Good waves can be created with much higher flows than listed below but here are some basic requirements for two wave types:

3.1 Minimum Wave Conditions

This wave is rideable but requires precisely sculpted features with adjustable components.

- Flow: 5 m^3/s
- Drop: 0.9 m

3.2 World Class Wave Conditions

These conditions allow the creation of a world class wave. Some adjustability is strongly recommended. Can be constructed with rough materials such as boulders or concrete blocks.

- Flow: 26 m^3/s
- Drop: 1.2 m

3.3 Calgary Wave Target

To maximize the benefit of the large potential user population and nature of the construction, the Calgary wave project should aim for as close to 1m drop as possible or more.

3.4 Ideal Wave Location

The best wave locations allow for easy access, usage that compliments existing businesses and amenities and has a low construction cost. The following factors make for a great wave location.

- Close to commercial core
- Close to existing amenities
- Good parking or space for new parking
- Narrow river width
- Shallow river depth
- Large water surface elevation change over a short length of river
- High riverbanks
- Easy construction access

Typical wave locations will be strong in some of the above areas and weak in others.

4 Possible Locations

The two fundamental requirements for a river wave are enough river flow and enough drop in water surface elevation. There is enough flow in the Bow River at Calgary to allow for good river surfing waves all year. There are two possible wave locations in downtown Calgary: Louise Bridge and Prince's Island Lagoon. There is enough drop at the both Louise Bridge location and the Prince's Island Lagoon location for the creation of good river surfing waves.

4.1 Possible Wave Locations

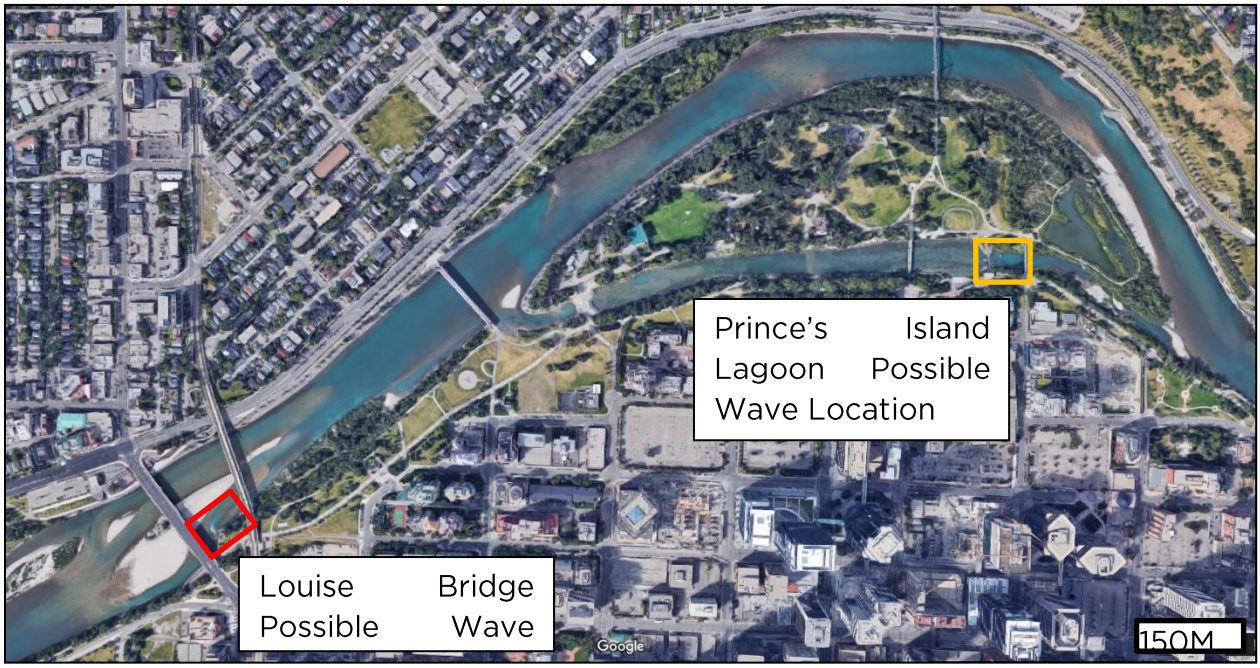


Figure 14: Map of possible wave locations in downtown Calgary

4.2 Louise Bridge

One possible wave location is on the south side of the Bow River between the Louise Bridge and the CTrain Bridge. This is the site of the existing 10th Street Surf Wave. The red outline indicates the in-river wave development area. The south bank is already being developed as part of the West Eau Claire project and will include development for surfer and spectator needs. This space is currently primarily used for surfing the existing 10th Street wave and for spectators watching the surfers. When surfers are not present almost no one stays in this area. The City of Calgary has plans to adjust the gravel bar in the middle of the river as part of a future flood mitigation and river improvement project. Building a wave in this location would require substantial in river work within the area marked in red below.

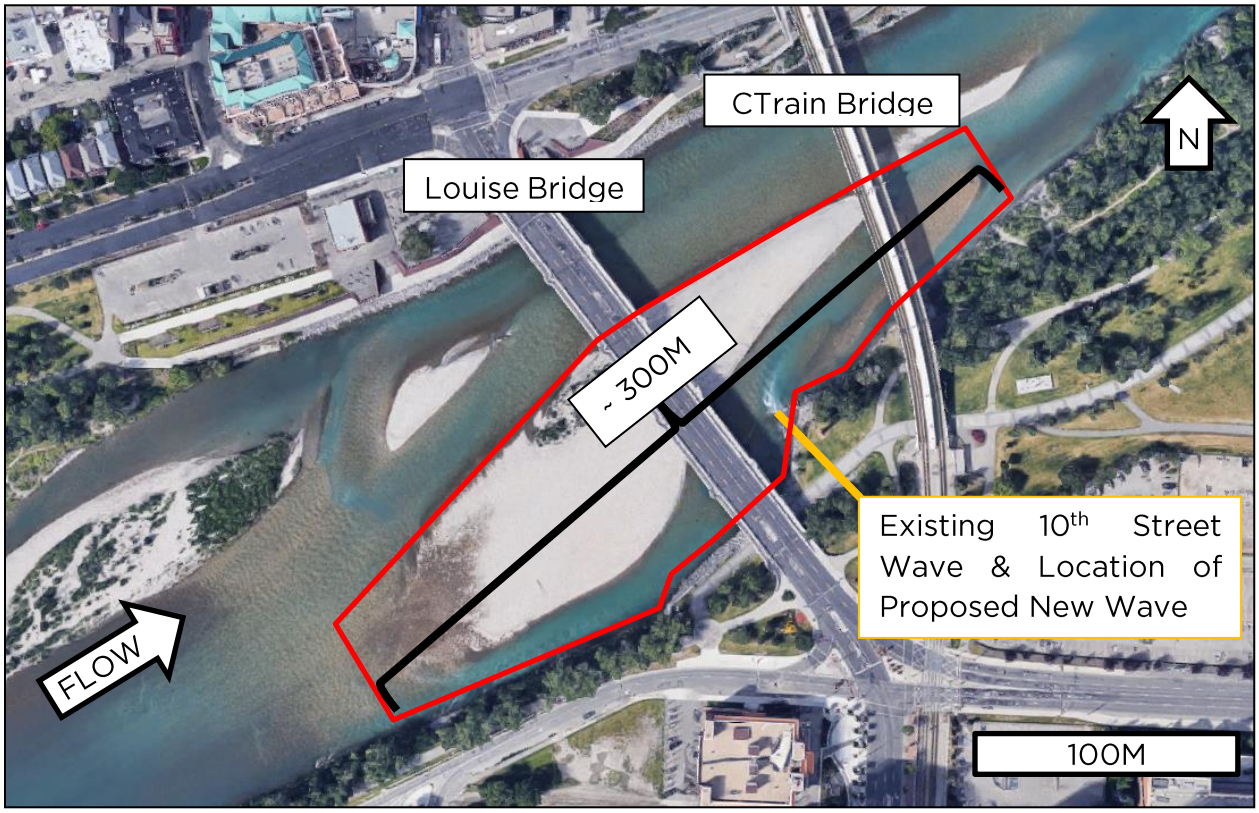


Figure 15: Map of 10th Street Wave project area

Figure 16: Existing 10th Street Surf Wave – Picture taken from Louise Bridge looking East

4.3 Prince's Island – East End of Lagoon

Another possible wave location is at the East End of the Lagoon on the south side of Prince's Island. There are existing concrete channels that could be adjusted to form surf waves. The land in this area is currently heavily used as part of Prince's Island Park. Upstream of the potential wave location is the Prince's Island Lagoon and downstream is a natural area. Building a wave at this location would require substantially increasing the flow through the Lagoon and would require work at the Lagoon inflow, the channels and the Lagoon outflow. The Green outline below indicates the inflow area, the Red outline below indicates the channel & new wave area and the Blue outline below indicates the outflow area.

Figure 17: Map of Prince's Island Lagoon wave area

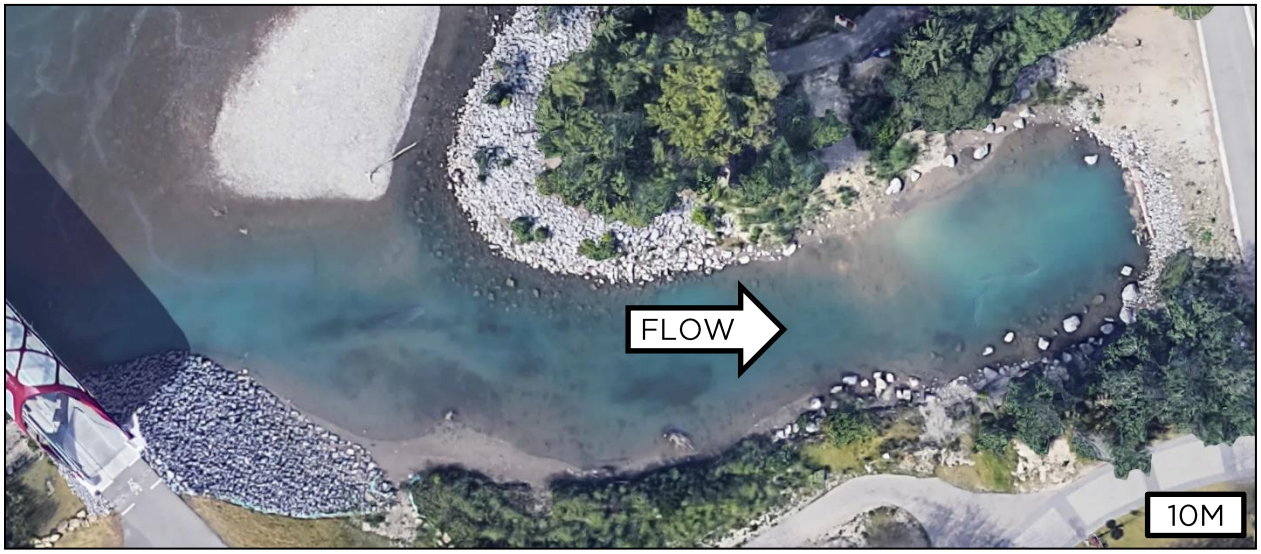


Figure 18: Inflow to Prince's Island lagoon

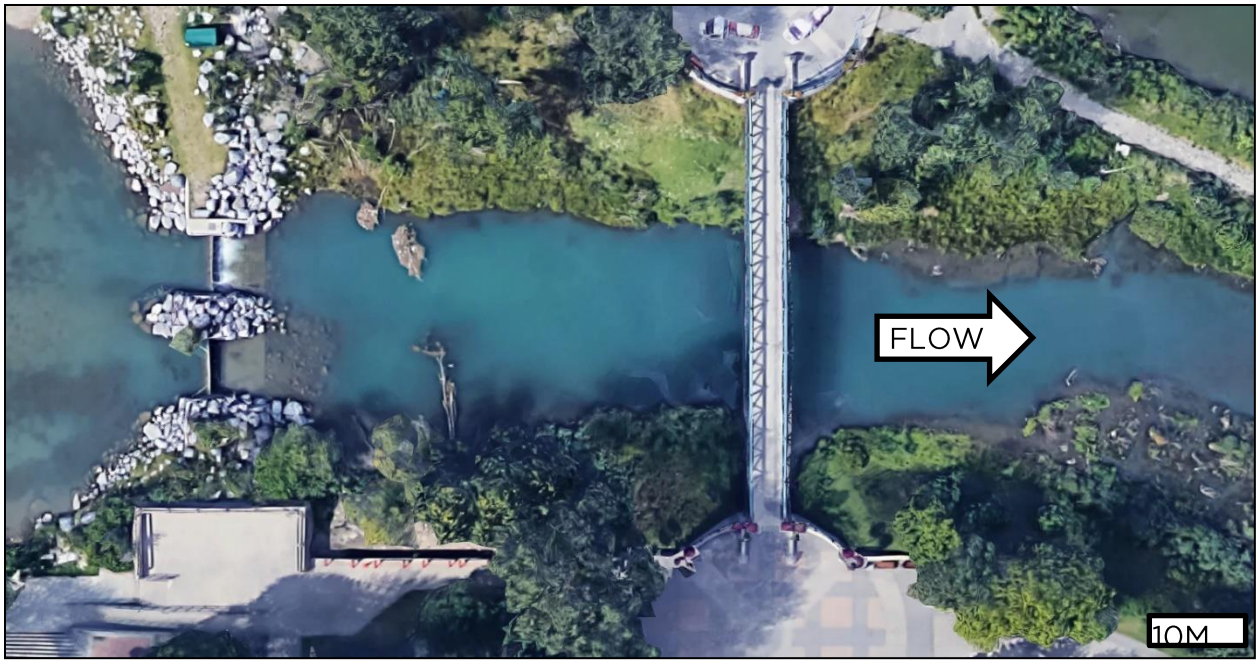


Figure 19: Channel and Wave Area

Figure 20: Outflow Area

4.4 Historical River Conditions

An important consideration for building waves in a river is how the river has changed over time. The Bow River in Calgary has a lot of sediment movement particularly during large flood events. The critical issues are whether the river will move away from the proposed wave location and whether the drop required for a feature will be maintained. At the proposed wave locations, the development and armoring of the riverbanks has constrained the Bow river to the same general channel for the past century. The following are pictures of the Bow River at Louise Bridge wave location from 1926 until 2017. Historical pictures of Princes Island are not shown because that location is a highly controlled separate channel from the main river and there is no opportunity for significant change due to high flow events. Additional historical details are available in the Appendix in the Environmental Impact Report.

4.4.1 Summary of River Changes since 1926

Since at least 1926 the river has split into two channels at Louise Bridge. On the north side of the river is a broader and shallower channel through the north two bridge openings. On the south side of the river there is are narrower and deeper channels through the south two bridge opening. The river in the middle opening of the Louise Bridge has always been shallow or an island including upstream, at the bridge and downstream of the bridge.

Until the 1950s or 1960s there was a channel on the south side of the river that was originally used to bring logs to the Eau Claire sawmill. The channel was lined with vertical timber posts that were deeply driven into the riverbed. Between 1955 and 1966 the log channel was filled in. These buried timber posts just downstream of Louise Bridge are what forms the drop for the current 10th Street Wave and are substantially protecting the bank in that area from major erosion.

By 1966 the shallow sections and island at Louise Bridge were significantly vegetated. Following the 2013 flood, the island was dramatically expanded in size with a gravel bar and the vegetation substantially reduced. Since 2013 the gravel bar island has remained similar in size with ever increasing vegetation.

Since at least 1926 the south bank of the Bow River downstream of the Louise Bridge has been riparian habitat. The only exception is the area around the 10th Street Wave, which is part of the regional pathway, is grassed with minimal cover and is used as a public park. Following the closing of the logging channel, the south bank of the Bow River downstream of the Louise Bridge is rapidly eroding with major riparian habitat loss following large flood events.

Key Points

- Since at least 1926 there has always been substantial amounts of water flowing over the Louise Bridge Wave Location

- The Bow river has always split into two channels starting above the Louise Bridge and rejoining below the Louise Bridge
- There has always been a substantial drop in water surface elevation around Louise Bridge
- The middle of the river at Louise Bridge has always been shallow, an island or a gravel bar
- The south bank downstream of the Louise Bridge is rapidly eroding riparian habitat

Figure 21: Louise Bridge 1926[5]

[5] (Bow River Calgary 1924 (CA 112 32), 2019)

Figure 22: Louise Bridge 1951[6]

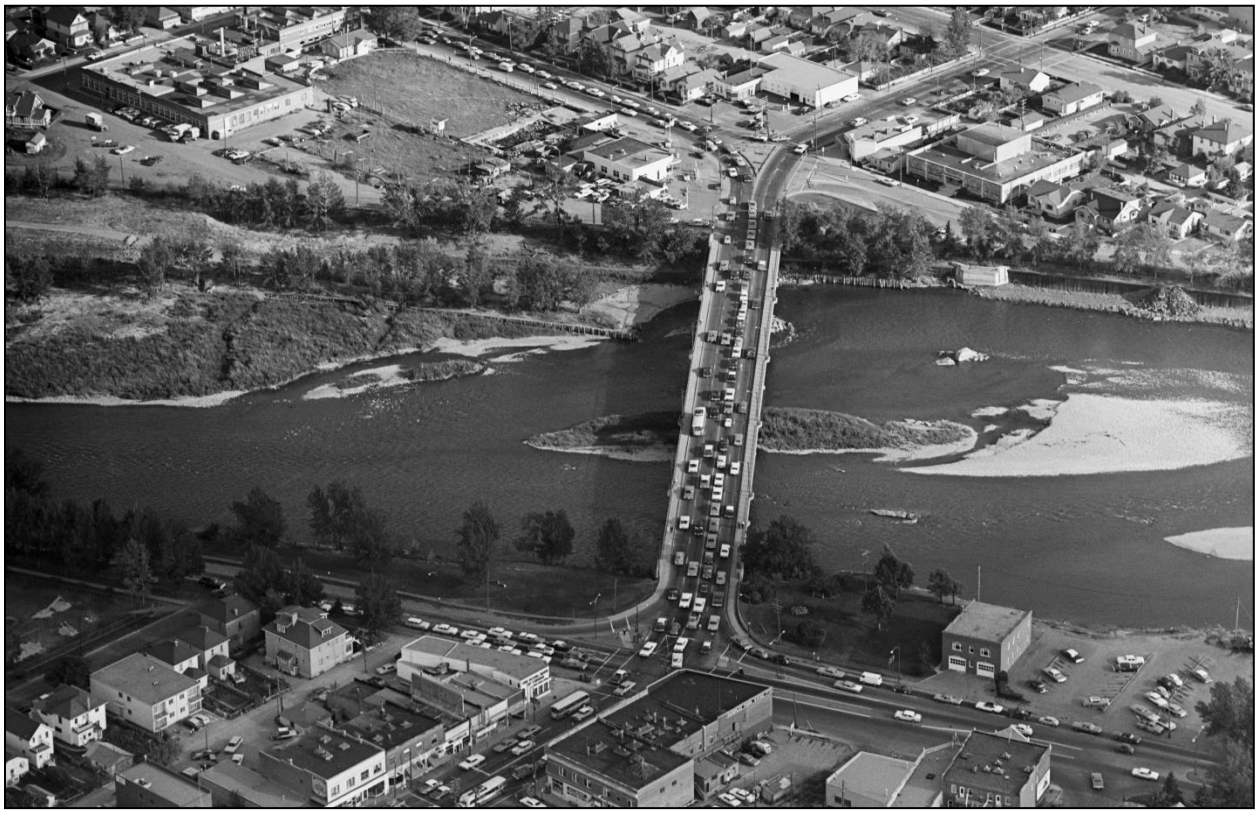


Figure 23: Louise Bridge 1966 September[7]

[6] (Calgary Bow River 1951, 1951)
[7] (Glenbow Archives na-2864-477b, 1966)

Figure 24: Louise Bridge 1970s[8]

Figure 25: Louise Bridge 1973 October[9]

[8] (R1_031.jpg, 1970s)
[9] (Glenbow Archives na-2864-23932, 1973)

Figure 26: Louise Bridge 1991

Figure 27: Louise Bridge 2002 April 29[10]

[10] (Google and Maxar Technologies, 2002)

Figure 28: Louise Bridge 2005 July 30[11]

Figure 29: Louise Bridge 2007 October 21[12]

[11] (Google and Maxar Technologies, 2005)
[12] (Google and Maxar Technologies, 2007)

Figure 30: Louise Bridge 2008 September 13[13]

Figure 31: Louise Bridge 2011 August 20[14]

[13] (Google and Maxar Technologies, 2008)
[14] (Google and Maxar Technologies, 2011)

Figure 32: Louise Bridge 2012 September 22[15]

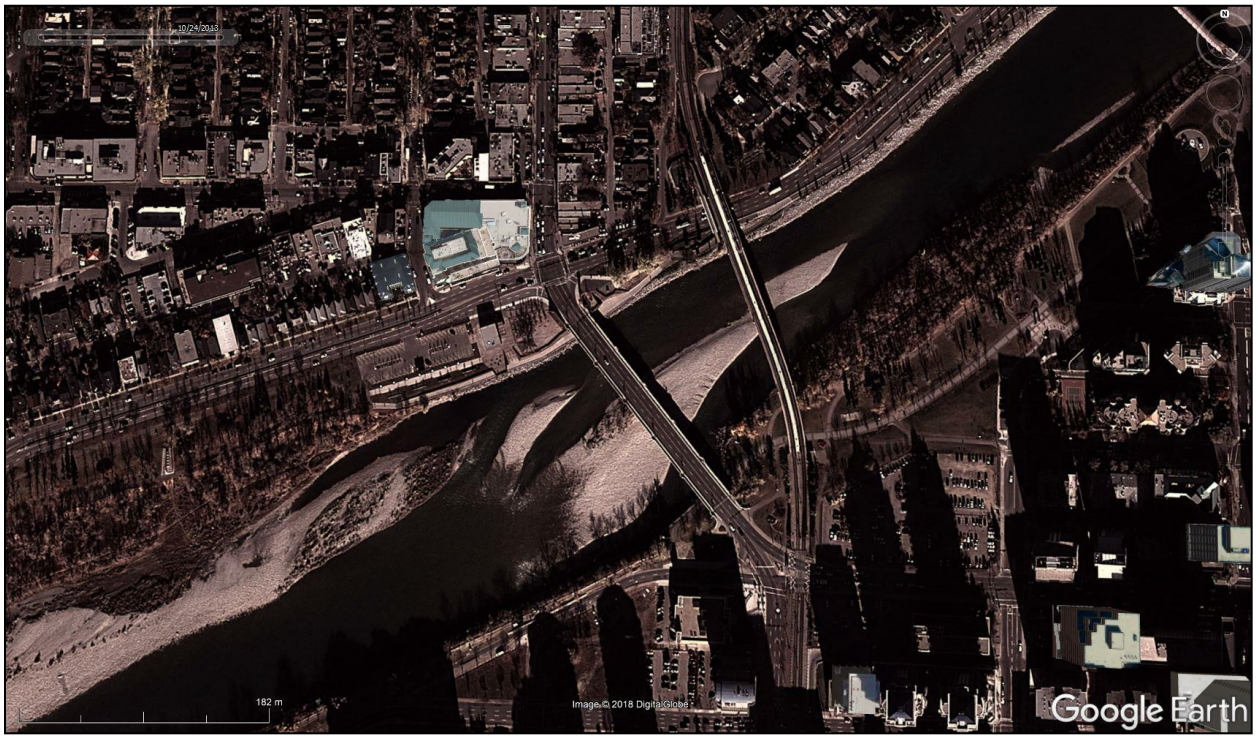


Figure 33: Louise Bridge 2013 October 24[16]

[15] (Google and Maxar Technologies, 2012)
[16] (Google and Maxar Technologies, 2013)

Figure 34: Louise Bridge 2014 August 11[17]

Figure 35: Louise Bridge 2015 August 8[18]

[17] (Google and Maxar Technologies, 2014)
[18] (Google and Maxar Technologies, 2015)

Figure 36: Louise Bridge 2016 August 8[19]

Figure 37: Louise Bridge 2017 October 17[20]

[19] (Google and Maxar Technologies, 2016)
[20] (Google and Maxar Technologies, 2017)

Figure 38: Louise Bridge 2018 July 07[21]

Figure 39: Louise Bridge 2019 June 30[22]

[21] (Google and Maxar Technologies, 2018)
[22] (Google and Maxar Technologies, 2019)

4.5 River changes due to floods[23]

The 2013 flood caused significant changes to the area. Additional details are in the Environmental Impact Report in the Appendix.

Figure 40: An aerial photograph of the Bow River around the Louise Bridge, June 22, 2013. The green lines provide tracings of the shorelines or vegetation margin in an aerial photograph from Sept. 23, 2012. Image from Klohn Crippen Berger (2017b.)

[23] (Rood, 2020)

Figure 41: Pre-flood (top, Sept. 22, 2012, 61 m3/s)

Figure 42: Post-flood (bottom, Aug. 31, 2017, 65 m3/s)

Shoreline loss in 2013 flood. Red line is the 2012 shoreline and the yellow line is the 2015 shoreline.

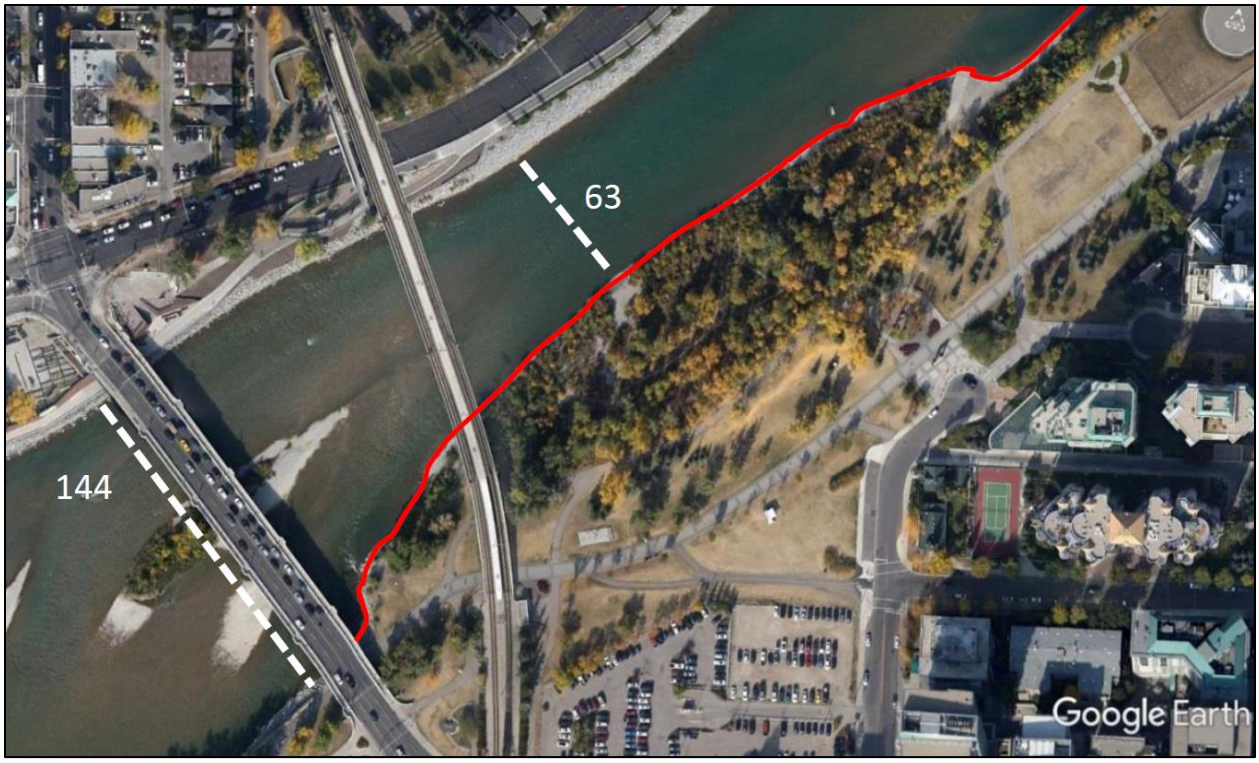


Figure 43: Pre-flood (top, Sept 22, 2012, 61 m3/s)

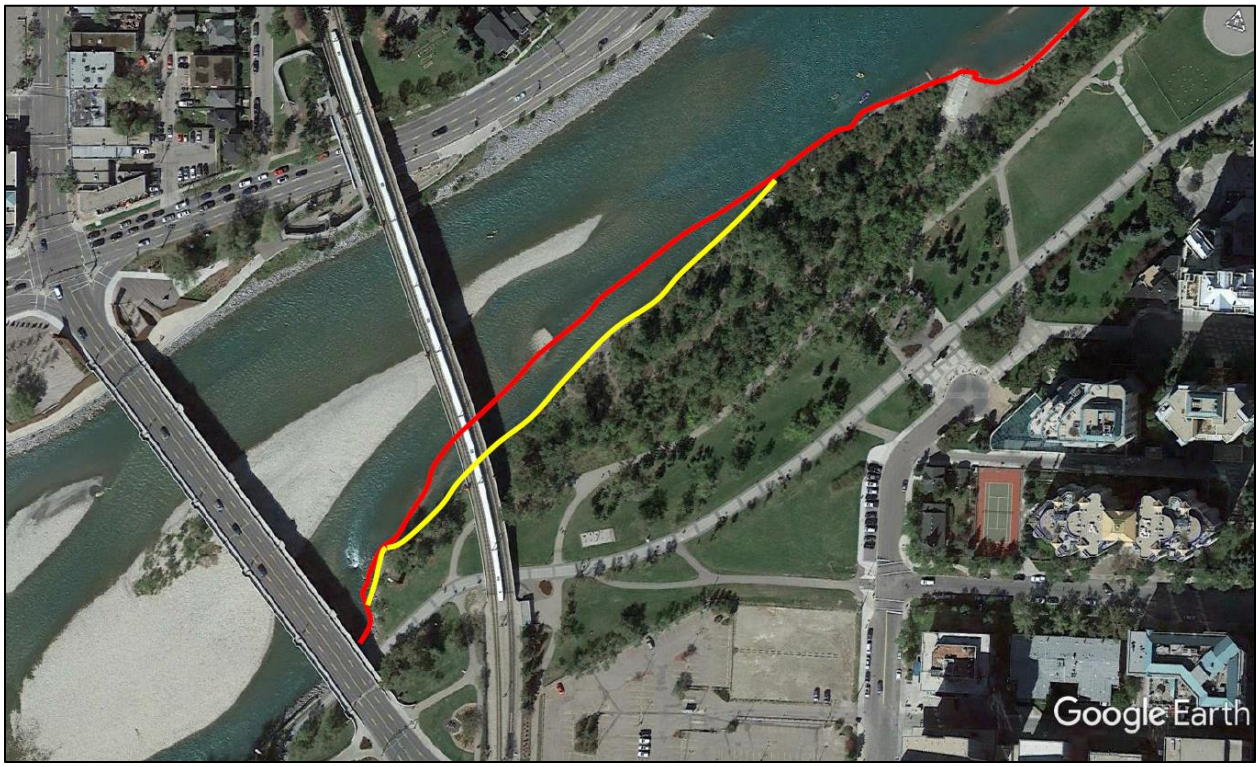


Figure 44: Post-flood (bottom, Aug. 22, 2015, 67 m3/s)

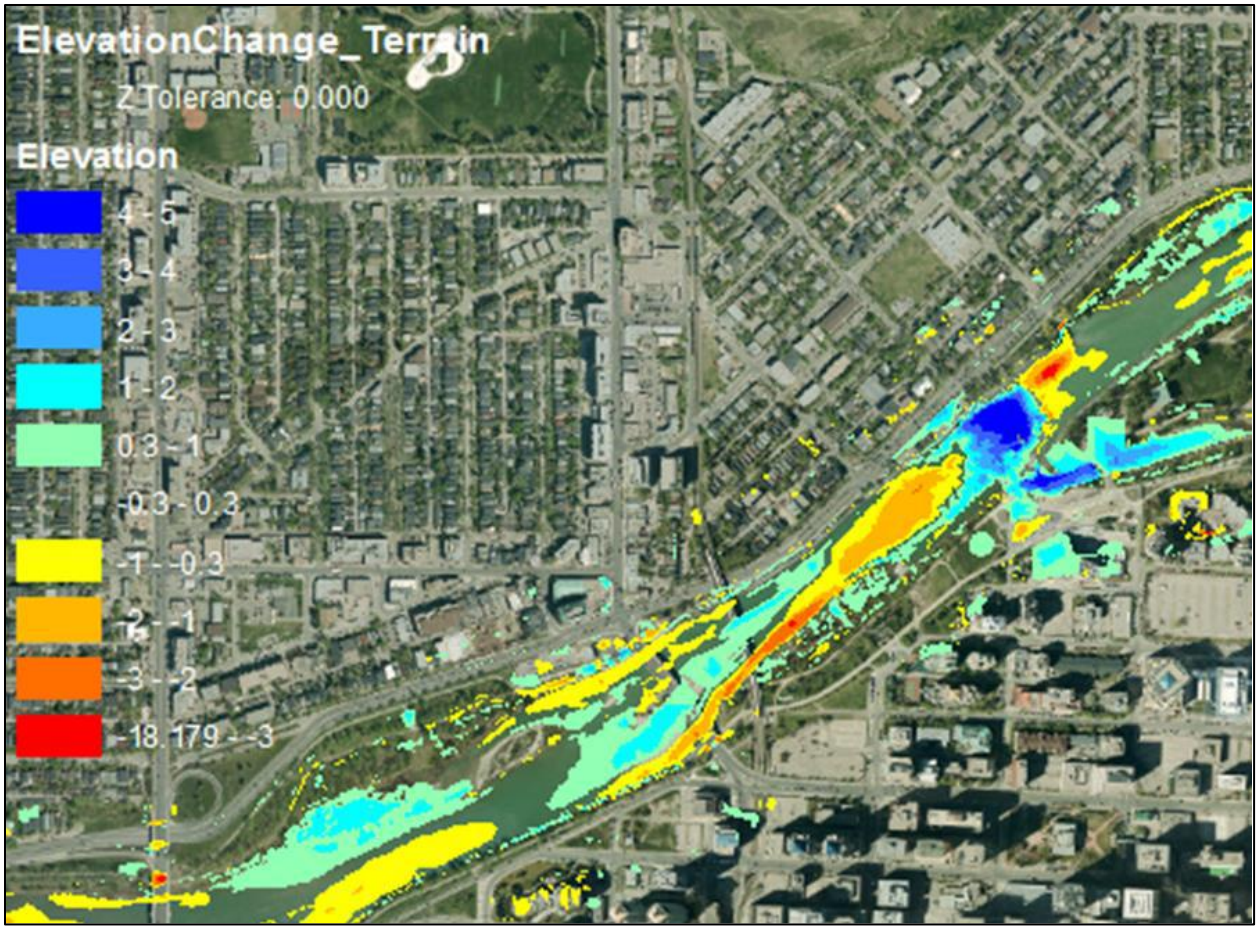


Figure 45: Subtraction digital elevation model (DEM, m) from topo-bathymetric surveys along the Bow River channel in 2010 (pre-flood) versus 2013 (post-flood).

Locations above: (1) Louise Bridge and Louise Island, island deposition and channel scour, (2) Riparian woodland zone downstream of the C-Train Bridge, bank and channel scour, (3). Below boat ramp, broad scour zone, (4). Prince's Island and lagoon channel: extensive deposition (from Slaney et al. (2019) Figure 2).

5 Flow Analysis

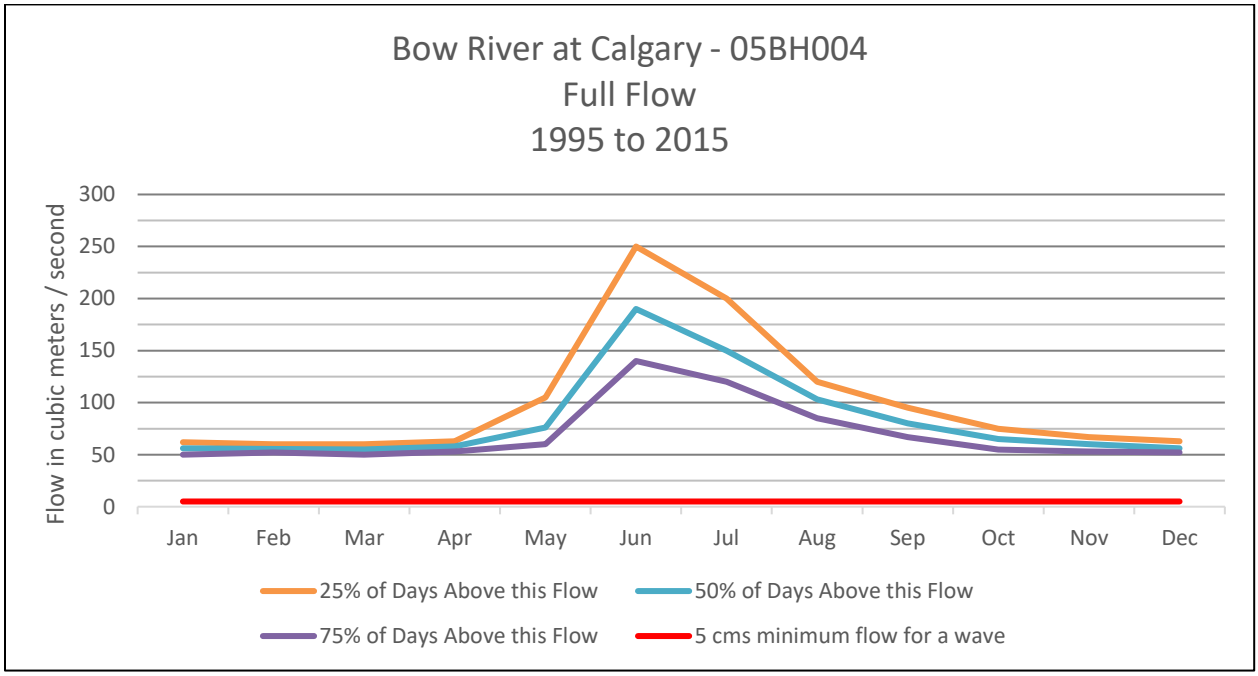
Based on federal Water Office data from the Bow River gauge at Calgary (05BH004) there is enough flow to create good river surfing waves all year. Both the Louise Bridge location and the Princes Island Lagoon location have flow limitations. World class waves require at least 26 m^3/s of flow

5.1 Summary of Flow Analysis

The Louise Bridge has enough flow for good waves all year except for during winter ice coverage and spring high flows and world class waves 6 months per year. The Princes Island Lagoon only has enough flow for a small wave during high water conditions in June, July and part of August.

5.2 Full Bow River Flow[24]

The charts below are for the full flow of the Bow River. Only part of the Bow River will flow through the either surfing wave area. Current modelling shows about 40% of the Bow River will flow through the Louise Bridge wave location. The Lagoon inflow and outflow would be designed to allow the minimum needed flow to form a wave.

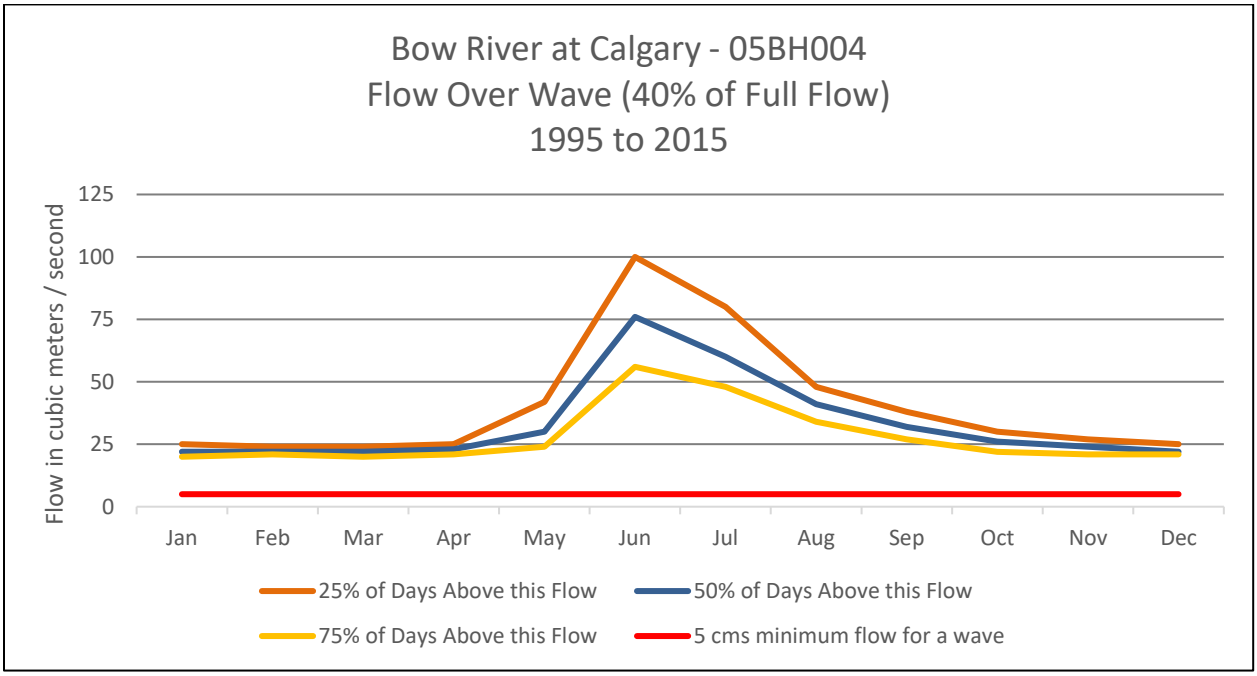


Bow River at Calgary Gauge 05BH004 1995 to 2015	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
25% of Days Above this Flow	62	60	60	63	105	250	200	120	95	75	67	63
50% of Days Above this Flow	56	55.5	55	58	76	190	150	103	80	65	60	56
75% of Days Above this Flow	50	52	50	53	60	140	120	85	67	55	53	52

[24] (Water Office, 2017)

5.3 Louise Bridge Wave Flow @ 40% of Full Flow[25]

This figure and table show the flow going over the wave. The flow going over the wave is about 40% of the full flow of the Bow River. There is enough flow all year to have good surfing waves. At lower flows there will be a single wave. At higher flows there will be multiple waves.



Bow River at Calgary - 05BH004 Flow Over Wave 40% of river 1995 to 2015	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
25% of Days Above this Flow	25	24	24	25	42	100	80	48	38	30	27	25
50% of Days Above this Flow	22	22	22	23	30	76	60	41	32	26	24	22
75% of Days Above this Flow	20	21	20	21	24	56	48	34	27	22	21	21

[25] (Water Office, 2017)

5.4 Lagoon Wave Flow

Only a small portion of the full flow of the Bow can flow through the Lagoon. There are a few key limitations on the flow through the Lagoon.

- Flow into the Lagoon is limited by three concrete culverts with a gate in the middle of the length of the culverts.
    - The elevation of these culverts means the Bow must be at high flows to have enough flow through the Lagoon to create a wave.
    - The river bed upstream of the culverts and in the lagoon is 0.2m higher than the bottom of the culvert and this restricts flow through the culverts
- Flow through the Lagoon is limited by the elevation of the Lagoon bottom.
    - The lagoon bottom is about 0.6m higher than the bottom of the culverts and this restricts flow through the lagoon

Figure 46: Lagoon inflow area and culverts

Lagoon Bottom Cross Sections[26]

The Lagoon Bottom is flat across the Lagoon. This means the Lagoon bottom elevation points shown on the next page are showing the bottom of the lagoon.

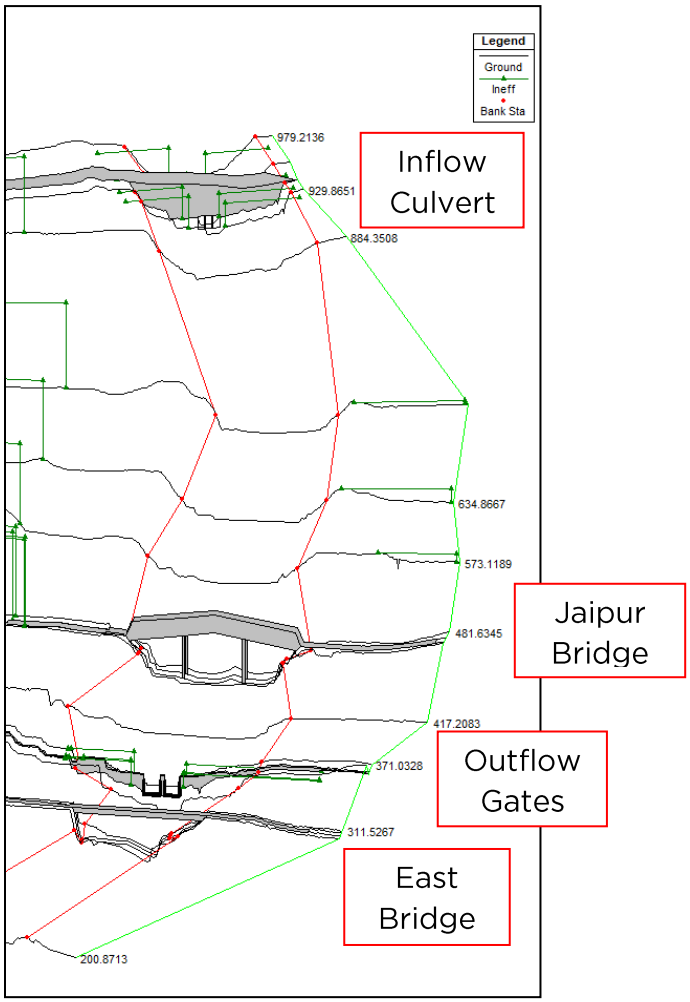
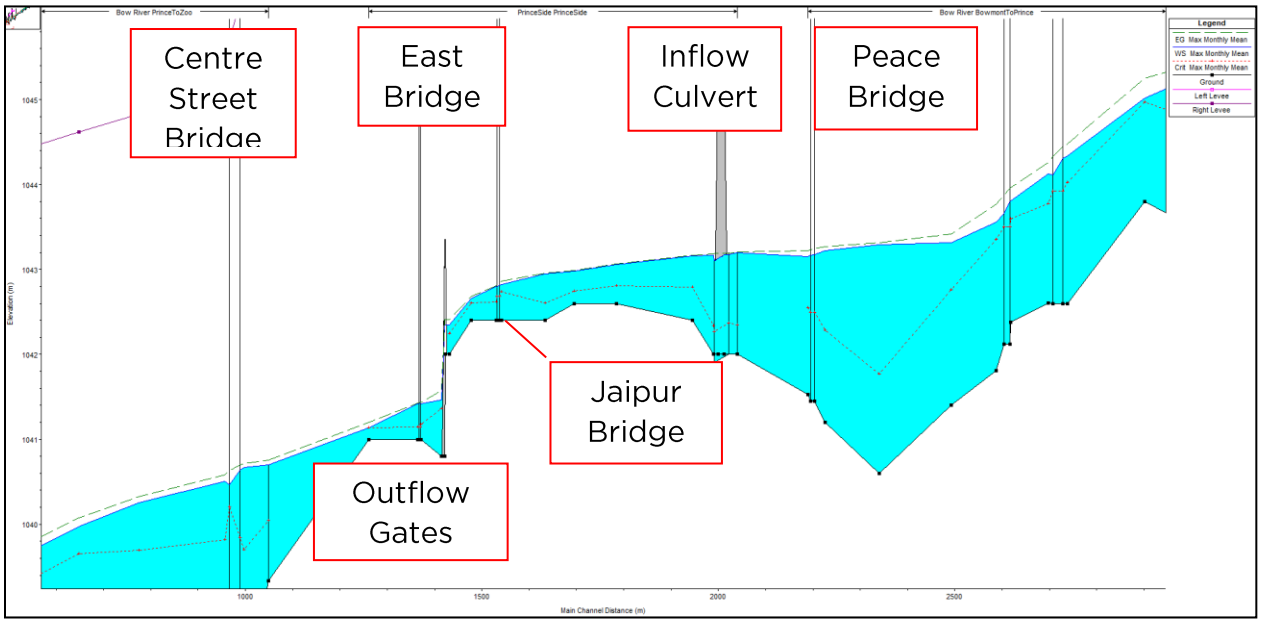


Figure 47: Lagoon Cross Sections

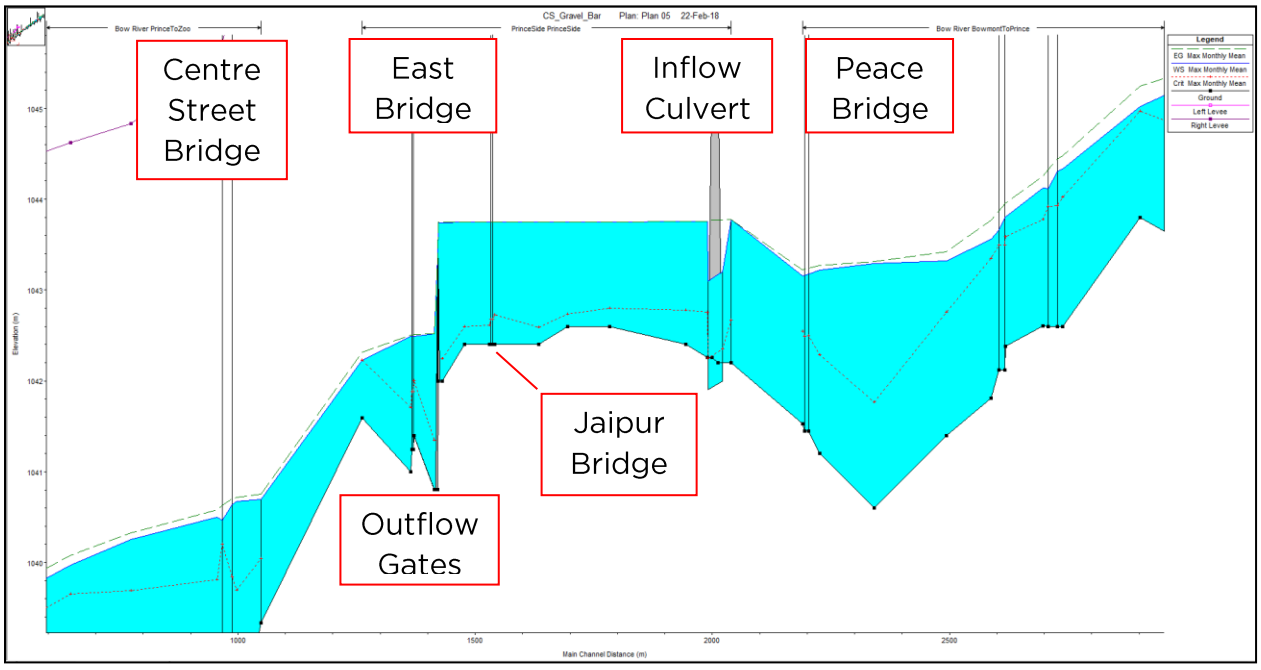
[26] (Golder Associates Ltd., 2015)

Profile of Water Surface Elevations in Lagoon @ Full Bow River Flow of 124 m^3/s[27]

Outflow Gates Lowered, Inflow & Outflow have been adjusted to maximize flow. Full Bow River Flow is 124 m^3/s. Flow through Lagoon is 4.7 m^3/s.



Outflow Gates Raised. No modifications to Inflow or Outflow. Full Bow River Flow is 124 m^3/s. Flow through Lagoon is 4.7 m^3/s.



These water surface elevation profiles are based on a full Bow River Flow of 124 m^3/s. The flow through the lagoon is 5 m^3/s with the gates fully lowered and the flow around

[27] (Golder Associates Ltd., 2015)

Princes Island is not shown. In the top profile HEC-RAS modelling shown on this page, the river bottom upstream and immediately downstream of the culverts has been made the same elevation as the culvert bottom and river bottom downstream of gates has been lowered. These are the conditions for the maximum possible inflow at full Bow River flow of 124 m^3/s without very complex & expensive culvert and lagoon bottom adjustments.

Figure 48: Raised Gates at Downstream End of Lagoon

Green indicates best surf temperature months.

Bow River at Calgary Gauge 05BH004 1995 to 2015	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
25% of Days Above this Flow	62	60	60	63	105	250	200	120	95	75	67	63
50% of Days Above this Flow	56	55.5	55	58	76	190	150	103	80	65	60	56
75% of Days Above this Flow	50	52	50	53	60	140	120	85	67	55	53	52

Bow River at Calgary Gauge 05BH004 Flows with over 5 m^3/s going through Lagoon	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
25% of Days Above this Flow	-	-	-	-	-	250	200	120	-	-	-	-
50% of Days Above this Flow	-	-	-	-	-	190	150	-	-	-	-	-
75% of Days Above this Flow	-	-	-	-	-	140	120	-	-	-	-	-

The Lagoon could only have enough flow for a wave during June, July and part of August unless very expensive and complex modifications were made to the culvert and the lagoon bottom.

6 Drop Analysis

Both the Louise Bridge location and the Lagoon location have enough drop to form a good surf wave. This analysis is based on site observations by Surf Anywhere, survey data and HEC-RAS modelling data provided by the City of Calgary.

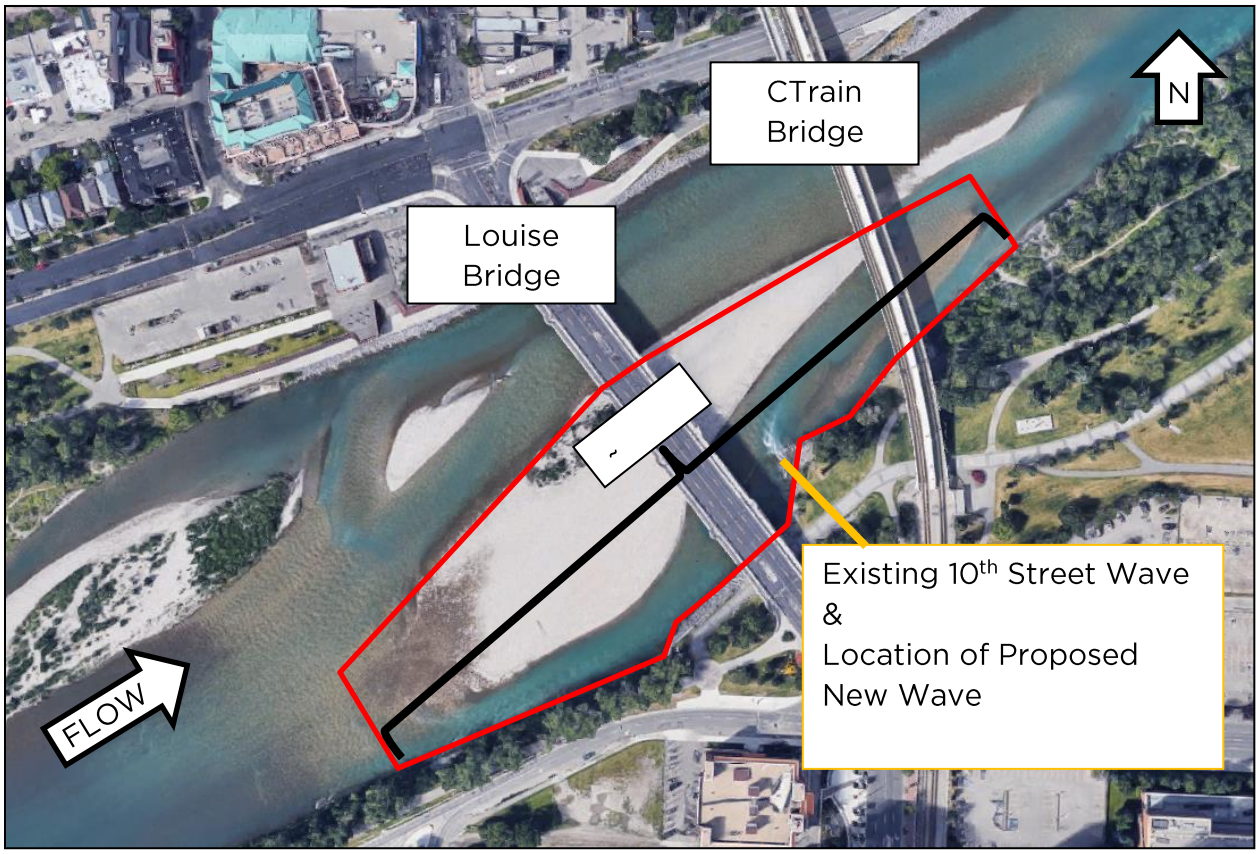
World class waves require at least 1.2m drop.

6.1 Summary of Drop Analysis

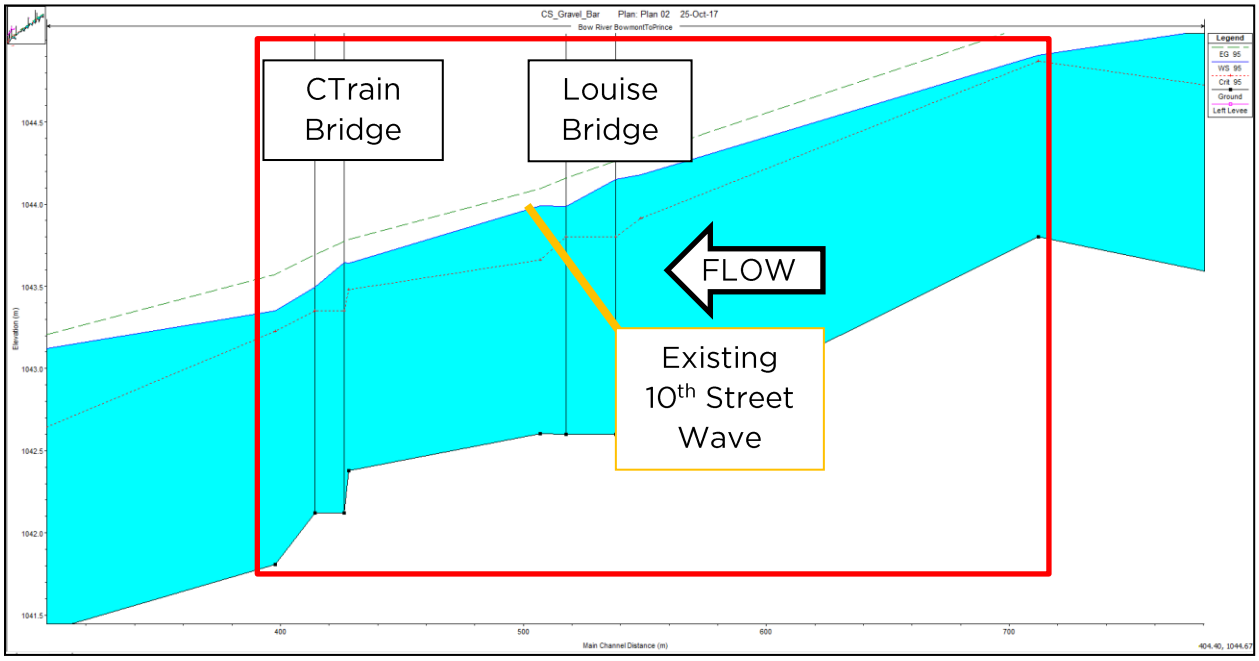
At flows 124 m^3/s there is over 1.47m in drop at the Louise Bridge Wave location. Lower flows have a higher available drop. There can be about 1.45m of drop at the Lagoon Wave location.

6.2 Drop at Louise Bridge Location

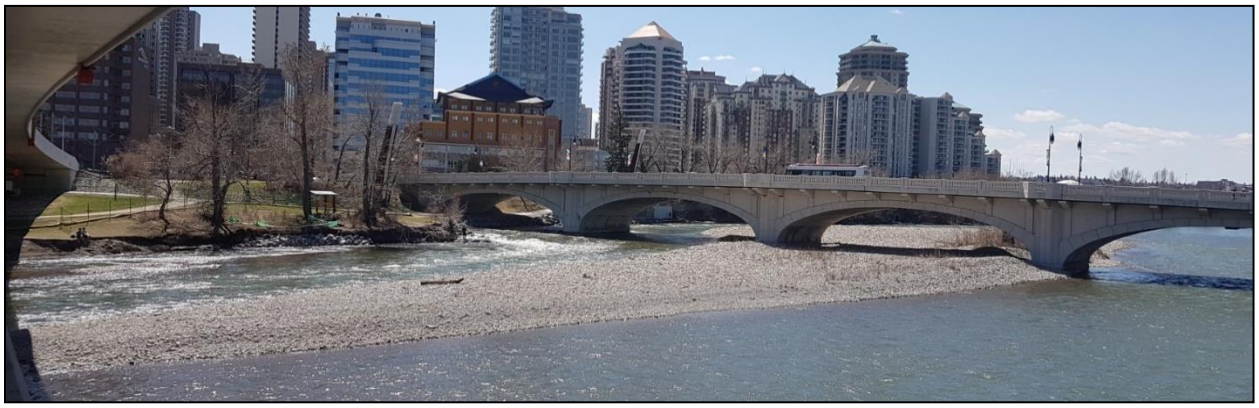
The red outline in both images indicates the wave development area.



6.2.1 Louise Bridge – Water Surface & River Bottom Elevation Profile [28]

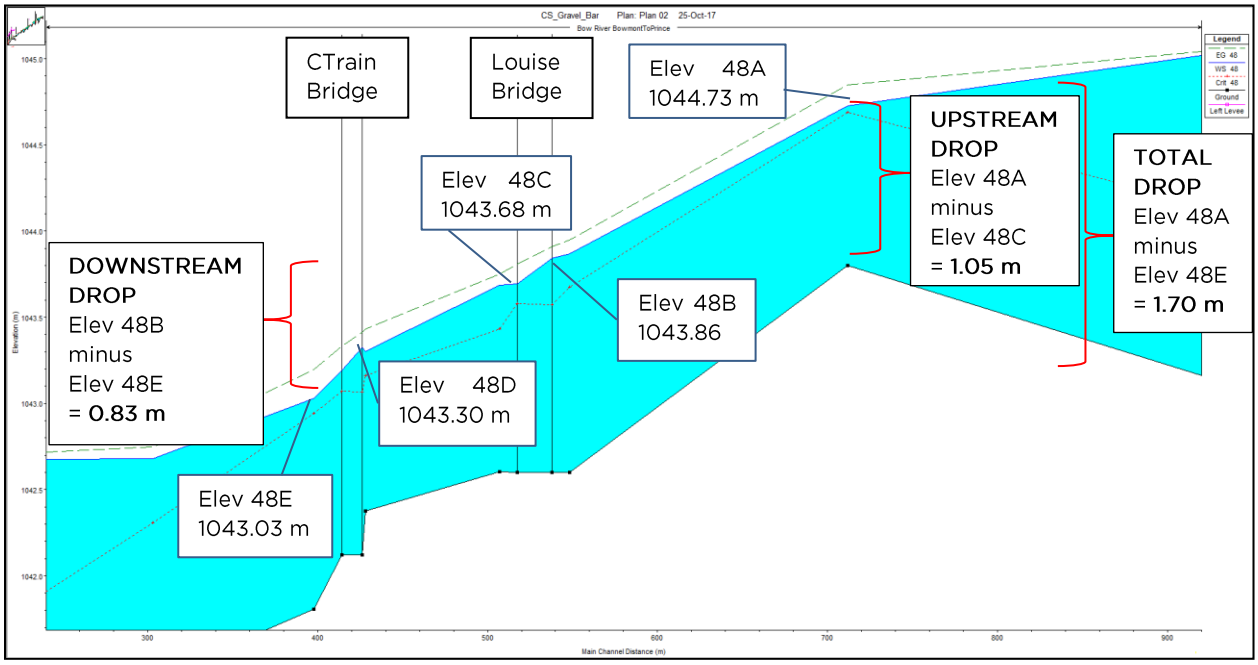


6.2.2 Louise Bridge – Drop from West of Louise Bridge to Ctrain Bridge



[28] (Golder Associates Ltd., 2015)

6.2.3 Louise Bridge – Water Surface Elevations & Drops at 48 m^3/s [29]



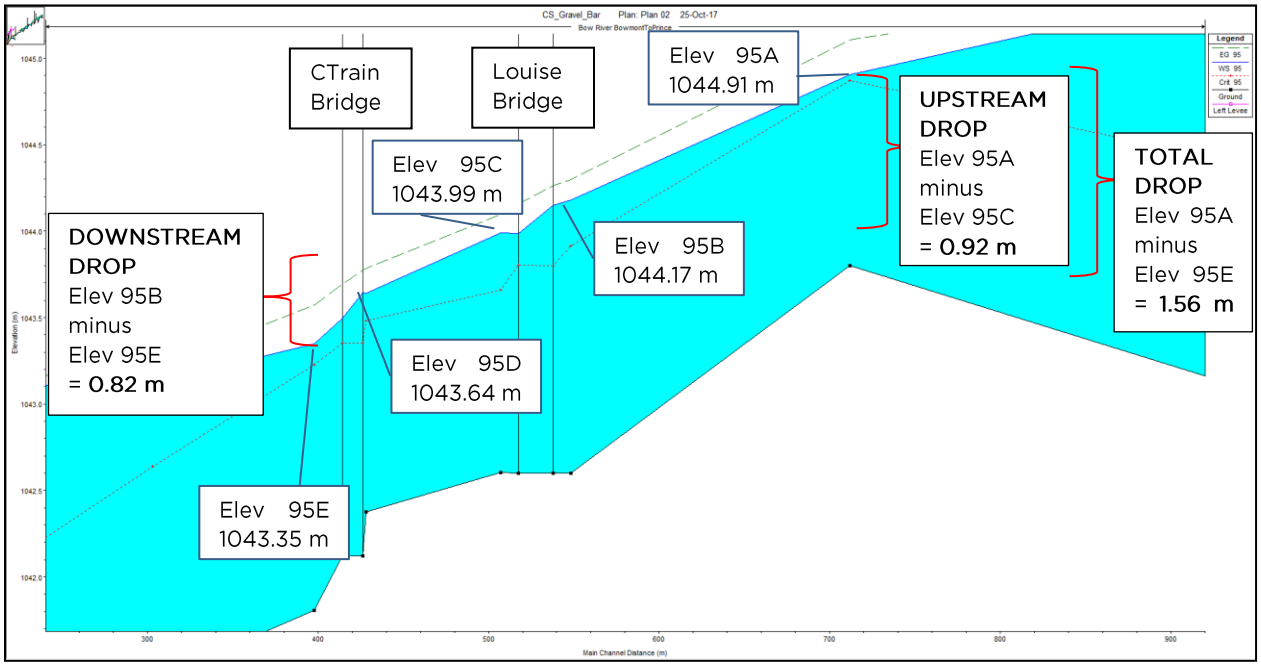
At a flow of 48 m^3/s, there is enough drop in the wave development area to create a good wave. If the drop will be consolidated from downstream of the CTRAIN Bridge then the consolidation will need to extend a short distance upstream of the Louise Bridge. The drop from downstream of the CTRAIN Bridge to just upstream of the Louise Bridge is 0.83m. A little additional drop would be necessary from upstream of the Louise Bridge.

The drop could be consolidated almost entirely from upstream of the Louise Bridge. enough drop near the Parkhill Bridge to build an excellent wave at the start of the deep channel. The drop from well upstream of the Louise Bridge to just downstream of the Louise Bridge is 1.05m.

The full drop across the wave development area at 48 m^3/s is 1.70m.

[29] (Golder Associates Ltd., 2015)

6.2.4 Louise Bridge – Water Surface Elevations & Drops at 95 m^3/s [30]



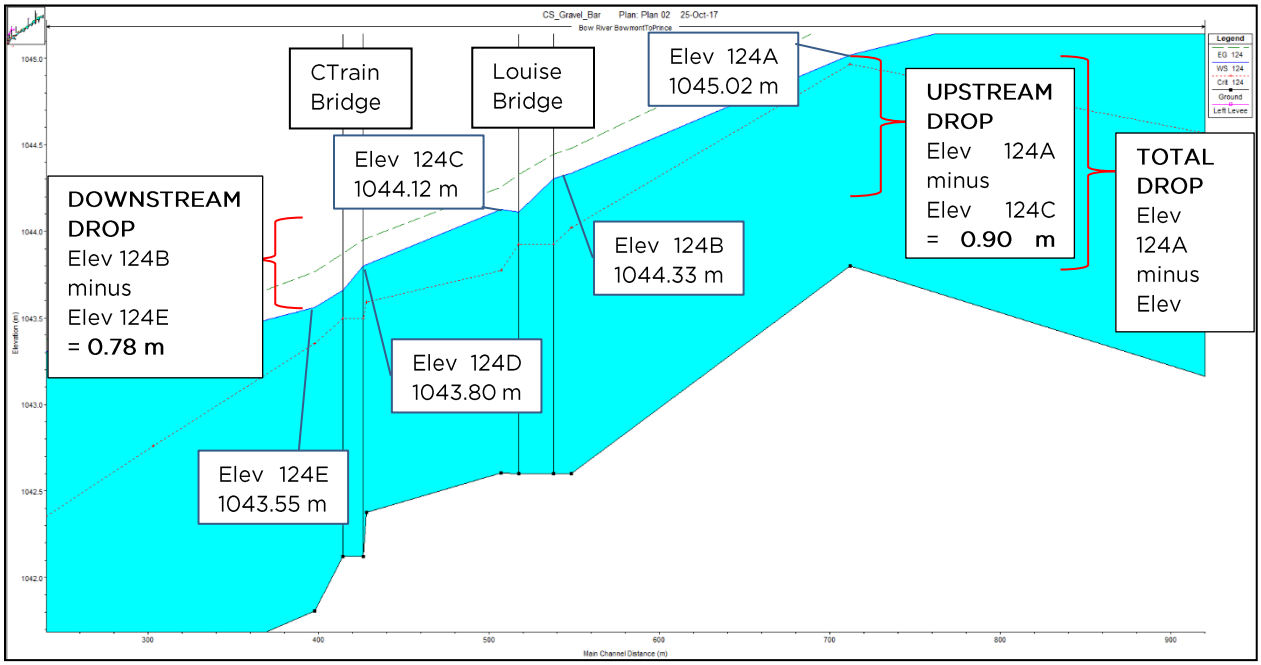
At a flow of 95 m^3/s, there is enough drop in the wave development area to create a good wave. If the drop will be consolidated from downstream of the CTRAIN Bridge then the consolidation will need to extend a short distance upstream of the Louise Bridge. The drop from downstream of the CTRAIN Bridge to just upstream of the Louise Bridge is 0.82m. A little additional drop would be necessary from upstream of the Louise Bridge.

The drop could be consolidated almost entirely from upstream of the Louise Bridge. enough drop near the Parkhill Bridge to build an excellent wave at the start of the deep channel. The drop from well upstream of the Louise Bridge to just downstream of the Louise Bridge is 0.92m.

The full drop across the wave development area at 95 m^3/s is 1.56m.

[30] (Golder Associates Ltd., 2015)

6.2.5 Louise Bridge – Water Surface Elevations & Drops at 124 m^3/s [31]



At a flow of 124 m^3/s, there is enough drop in the wave development area to create a good wave. If the drop will be consolidated from downstream of the CTRAIN Bridge then the consolidation will need to extend a short distance upstream of the Louise Bridge. The drop from downstream of the CTRAIN Bridge to just upstream of the Louise Bridge is 0.78m. A little additional drop would be necessary from upstream of the Louise Bridge.

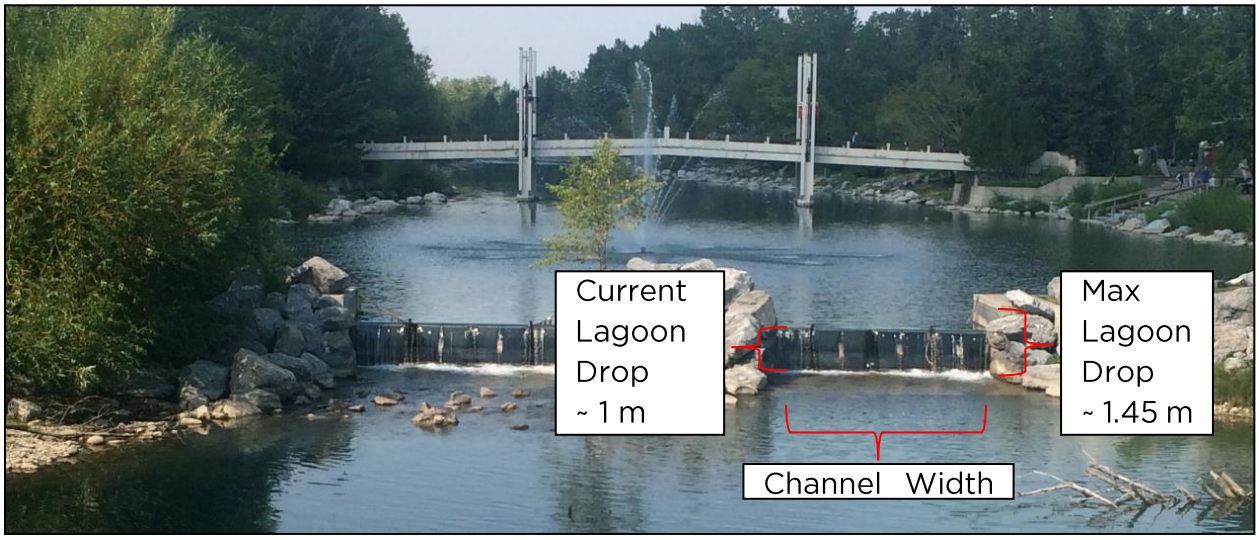
The drop could be consolidated almost entirely from upstream of the Louise Bridge. enough drop near the Parkhill Bridge to build an excellent wave at the start of the deep channel. The drop from well upstream of the Louise Bridge to just downstream of the Louise Bridge is 0.90m.

The full drop across the wave development area at 124 m^3/s is 1.47m.

[31] (Golder Associates Ltd., 2015)

6.3 Drop at Prince's Island Lagoon Location

6.3.1 Lagoon – Drop at Existing Channels



Under current conditions, the Lagoon wave location can have a drop up to 1.45m. The height of the drop will be affected by the water surface elevation needed in the Lagoon and the water surface elevation downstream when higher flows are going through. Likely, the downstream water surface elevation will increase with higher flows making the drop smaller than 1.45m. The Lagoon Outflow can be reshaped to keep the downstream water surface elevation low and the drop large enough for a good wave.

7 Environmental Self Compensation

The Louise Bridge location provides much better options for environmental self-compensation than the Princes Island Lagoon. The riverbanks around the Louise Bridge wave area are eroding or roughly armoured with riprap. Improvements to aquatic and riparian habitat could easily be made as part of the project.

7.1 Louise Bridge Environmental Self Compensation

There are excellent opportunities to improve the aquatic and riparian habitat near the wave. Good areas for habitat enhancement include the south bank of Bow both upstream and downstream of the wave area. The riverbanks around Louise Bridge are either heavily riprapped, lightly riprapped or eroding and the riverbed is medium sized cobble. Sections of the gravel island can be developed as riparian habitat.[32] Red indicates wave & urban beach area, orange indicates areas for riparian and aquatic improvements and blue indicates improvement areas on the island.

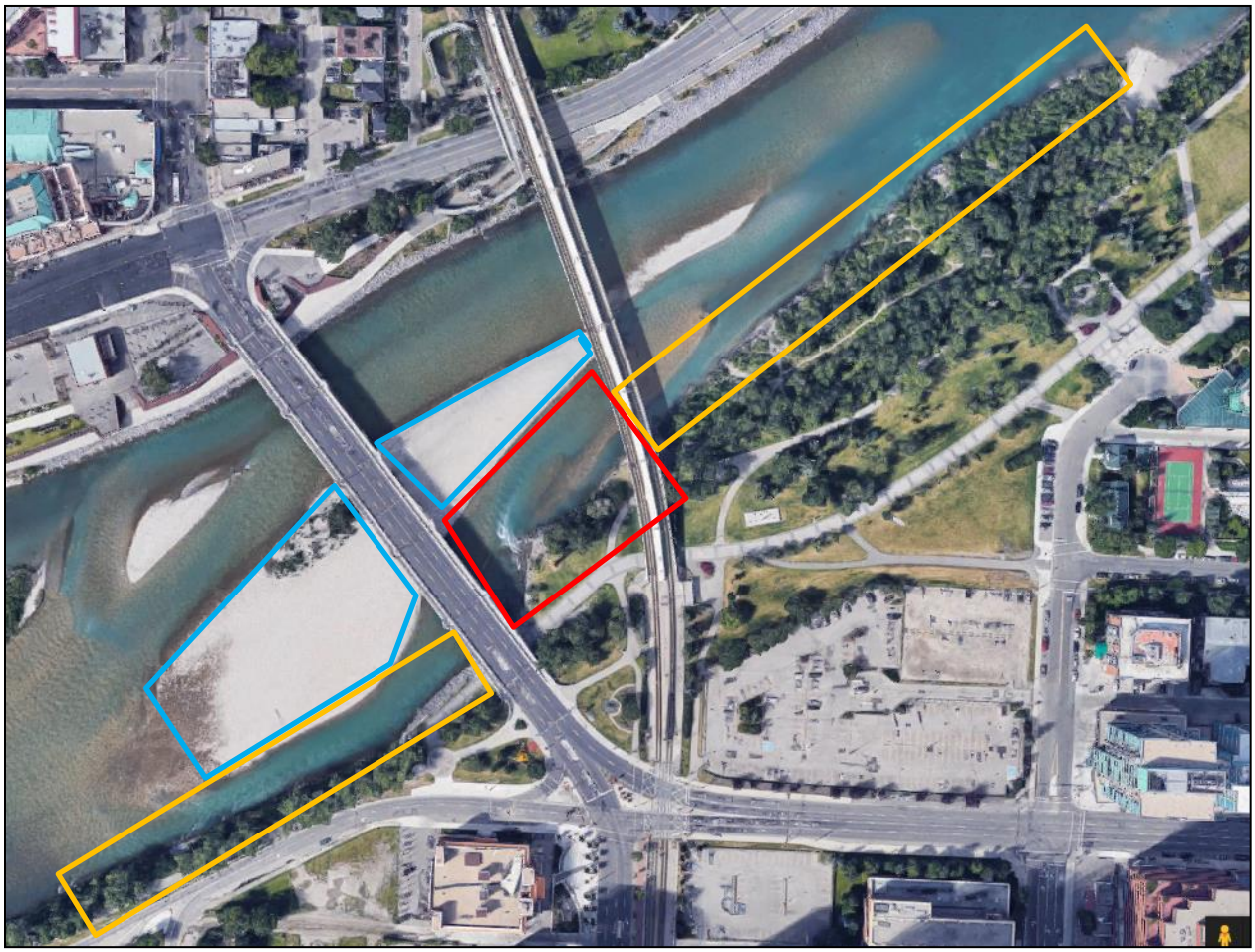


Figure 49: 10th Street wave environmental compensation area

[32] (Rood, 2020)

Figure 50: North Side of Bow – Entirely Riprapped – Poor Habitat – Difficult to Improve – August 2017

Figure 51: South Side of Bow at 10th Street Wave– Eroding and will become beach – August 2017

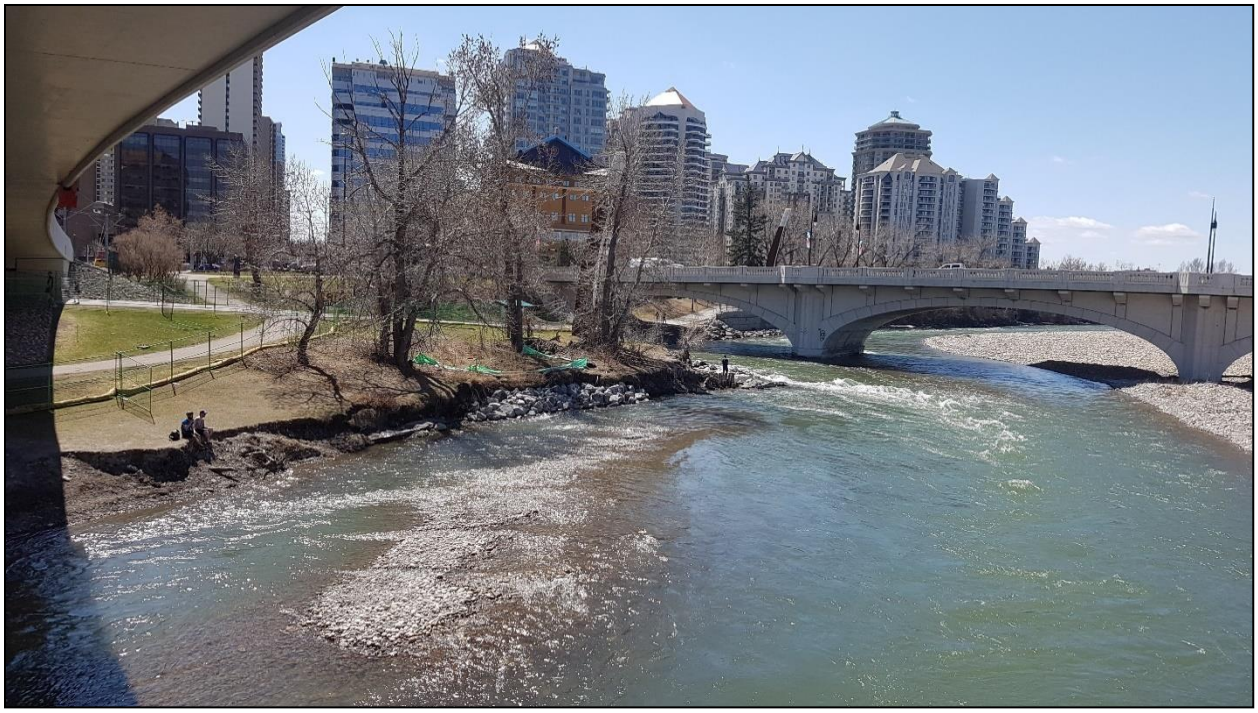


Figure 52: South Side of Bow at 10th Street Wave taken from Ctrain Bridge – Eroding and will become beach – May 2018

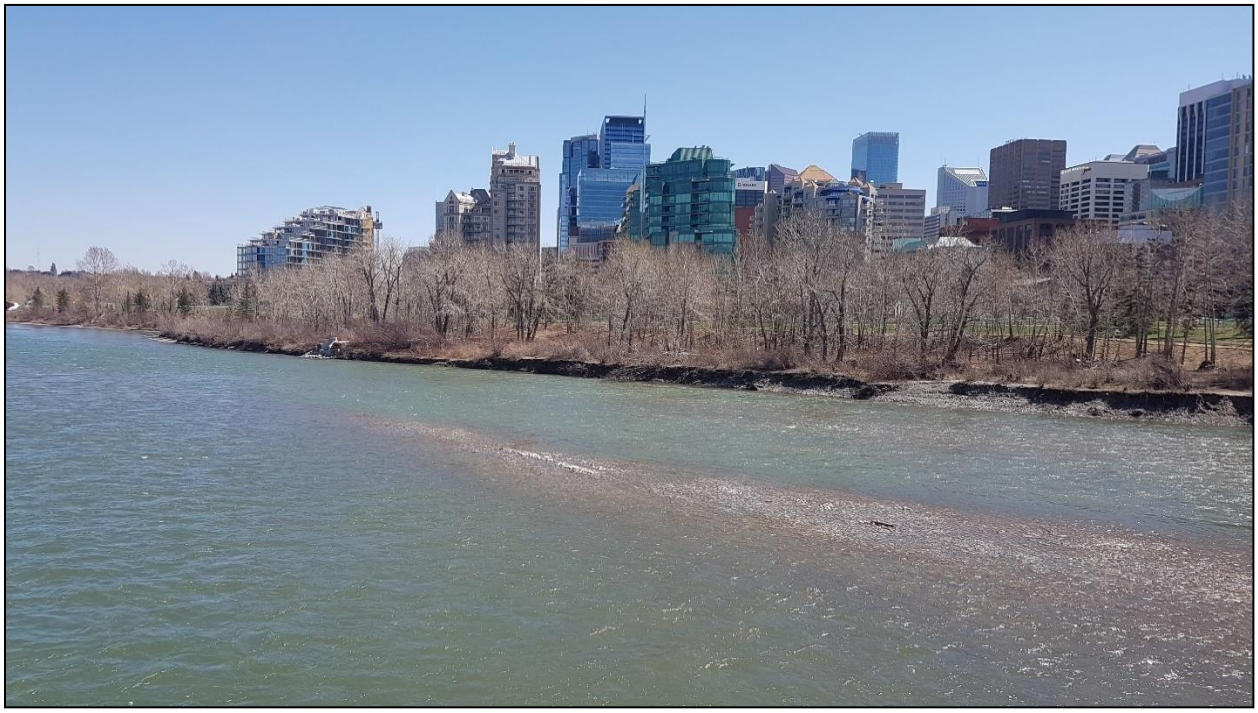


Figure 53: South Side of Bow East of Ctrain Bridge – Eroding and will be improved aquatic and riparian habitat – May 2018

Figure 54: South Side of Bow East of Ctrain Bridge – Eroding and will be improved aquatic and riparian habitat – May 2018

Figure 55: Photographs of Louise Island, Aug 2019 (S.Rood).[33]

[33] (Rood, 2020)

7.2 Lagoon Environmental Self Compensation

The Princes Island Lagoon has less opportunity for environmental compensation as the areas are already visible habitats during summer months.

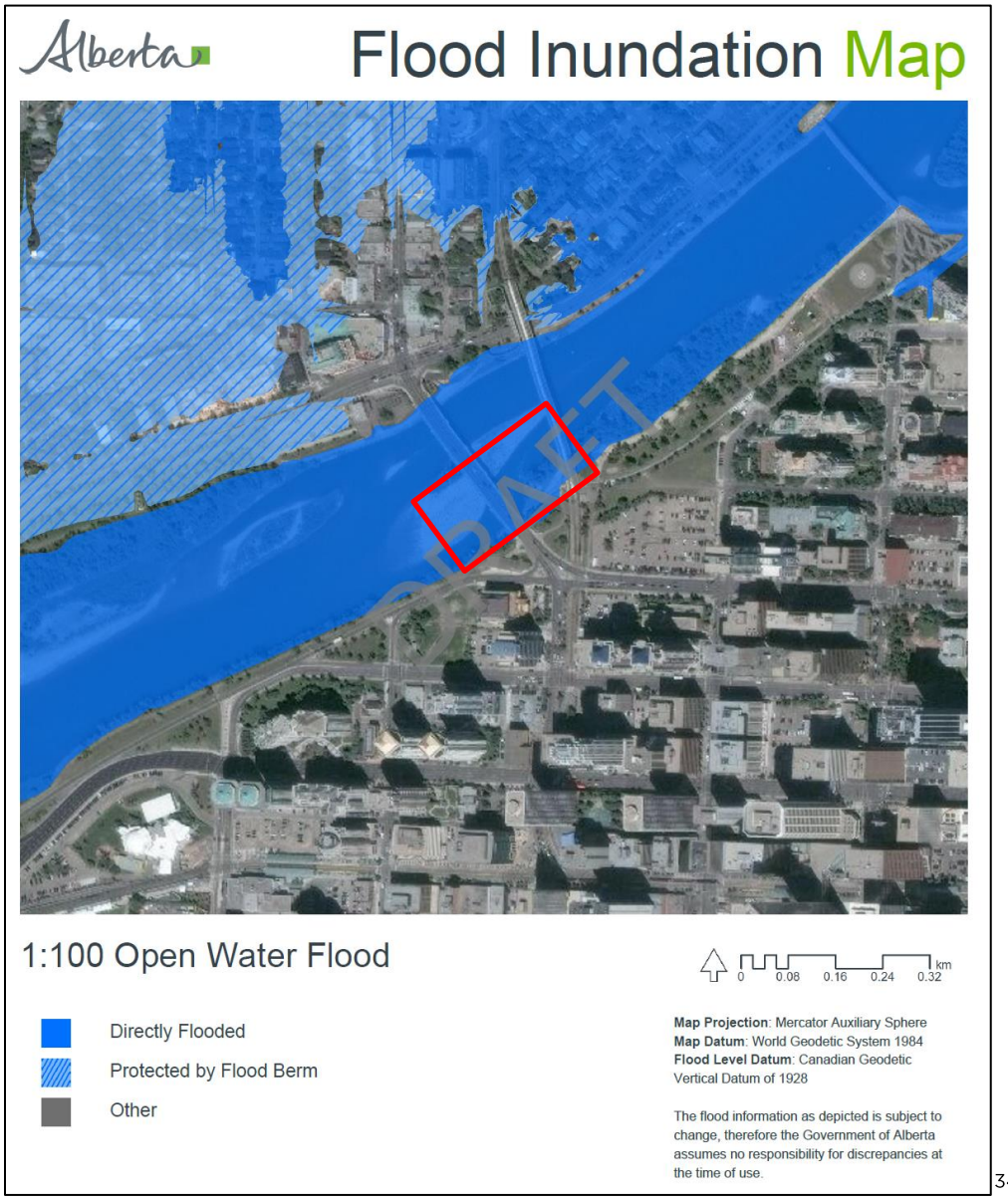
Figure 56: View looking downstream from Lagoon Outflow Gates – August 2017

8 High flow events, ice jams and sediment deposition

The three biggest concerns with river projects in the area are floods, ice jams and sediment deposition. All three concerns can result in flooding. The Project river section need detailed modelling during the preliminary engineering and detailed design to ensure the Calgary River Wave Park will reduce flood risks.

8.1 High flow event

The Project will use collapsible wave creating structures that will ensure the Project does not impact flood risk. Project area is outlined in red below.

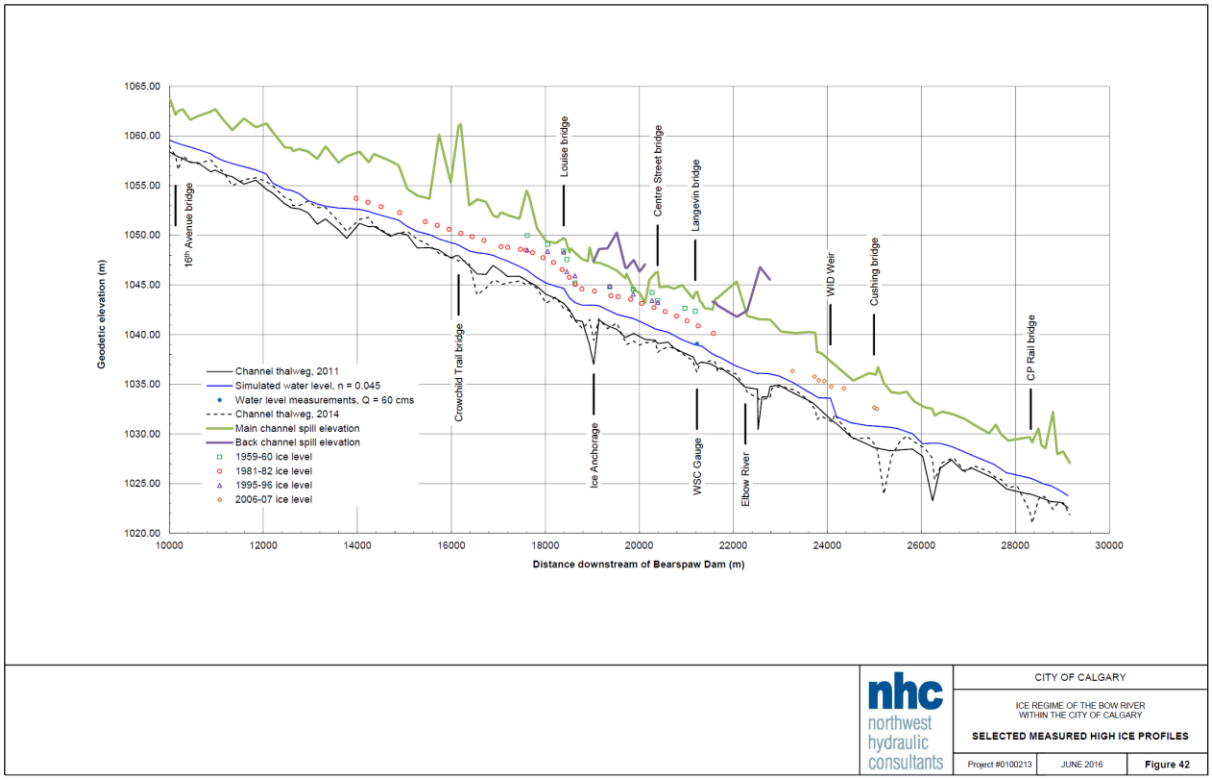


[34]

[34] (Alberta Floods, 2020)

8.2 Ice jams

The Project area has a history of ice jams. The Project design must minimize the formation of ice jams and avoid flooding cause by ice jams. The collapsible wave structures will assist in the reduction of ice jam formation. There has been extensive study of ice jam formation on the Bow River through Calgary.



[35]

8.3 Sediment deposition

Sediment deposition has led to the formation of the Louise Bridge gravel island which is considered a significant flood risk. The Project must be designed to avoid or minimize formation of gravel islands that create flood risks. The adjustable wave structures will allow fine control of river flows that can help control sediment deposition patterns.

[35] (The Ice Regime of the Bow River within the City of Calgary, Alberta, 2017)

9 Land Ownership

The land around the Project area has a few owners, rights of way and easements as detailed below.[36] [37] [38] [39]

Description	Owner & Manager	Plan #	Title #	LINC	Short Legal
Riverbank Land Title	Crown – Alberta Ministry of Lands and Forest of Natural Resources. Managed by Calgary Parks.	357LK	149 U 174	0021 135 786	5;1;24;16;NW,NE
ROW Bridge		881 1094			
ROW Enmax		771 1342			
ROW Transit		741 0447			
Supporting Facility Land Title	City of Calgary. Managed by Calgary Parks.	851 0908	851 214 731 A	0014 537 162	851 0908;B

[36] (Registrar of Land Titles, 2019)
[37] (Soutern Alberta Land Registration District, 1988)
[38] (South Alberta Land Registration District, 1977)
[39] (South Alberta Land Registration District, 1974)

9.1 Land Ownership of Wave Structures and Bank Structures

The riverbed and riverbank are Crown land. There are three rights of way (ROW) in the area. The ROWs are:

- Enmax ROW for a 138 kV electrical line. The wave structures are downstream of the ROW. The riverbank structures cross the ROW.
- Calgary Transit ROW for CTrain line. The wave structures are upstream of the CTrain ROW.
- Bridge ROW. The bridge will not be developed anytime soon if ever. There are too many additional developments that prevent a good bridge alignment. The wave structures and riverbank structures are in this ROW.

The project can be completed without interfering with current or future Enmax and Calgary Transit usage.

9.2 Land Ownership of Supporting Facility

The land under the Supporting of Facility is owned by the City of Calgary and managed by Calgary Parks.

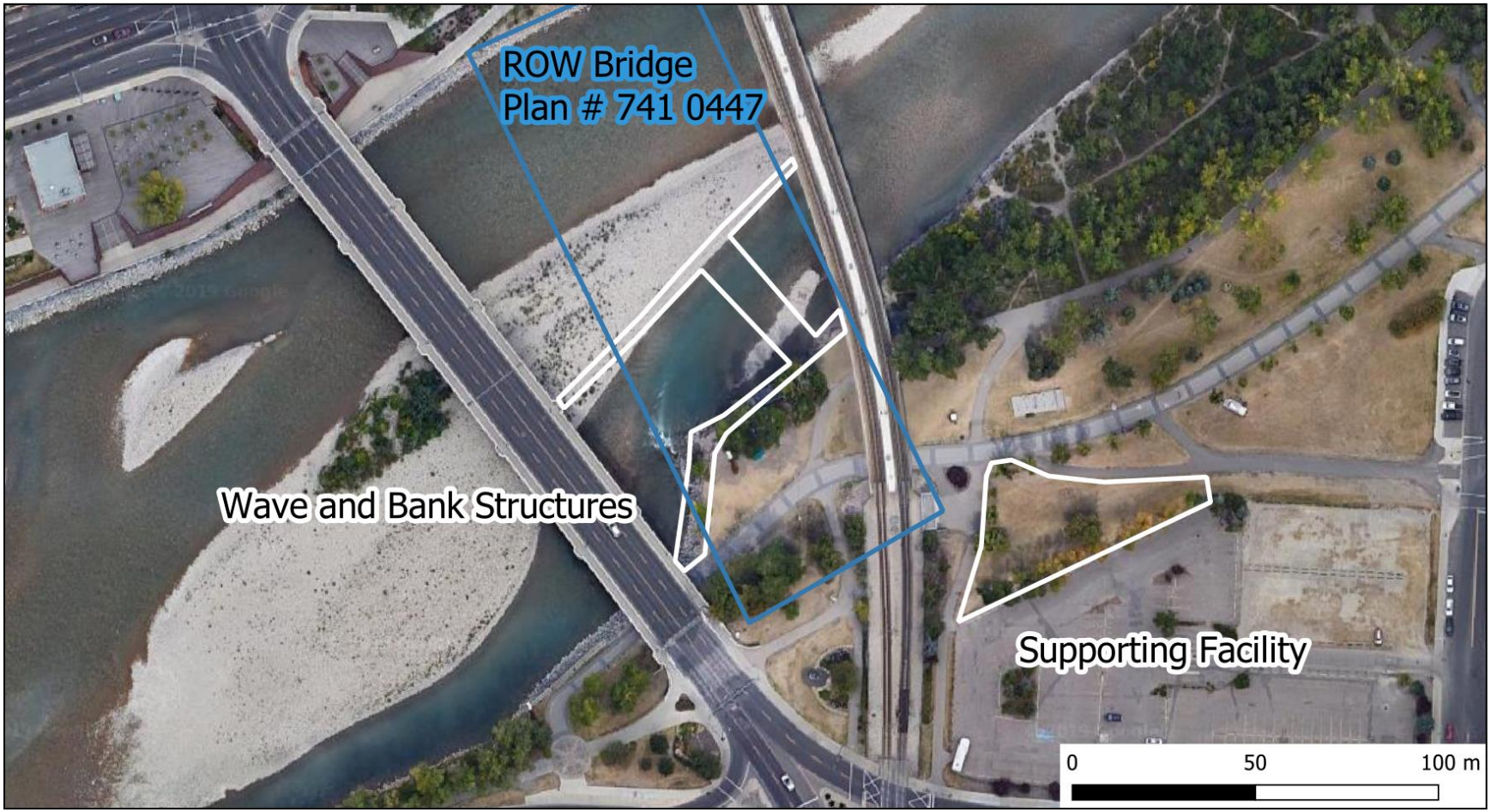
9.3 Land Titles[40] [41]

The Crown owns the riverbank and riverbanks which covers the wave area. The City owns the land for the supporting facility.

[40] (City of Calgary, 2011)
[41] (Registrar of Land Titles, 2019)

9.4 ROW Bridge[42] [43]

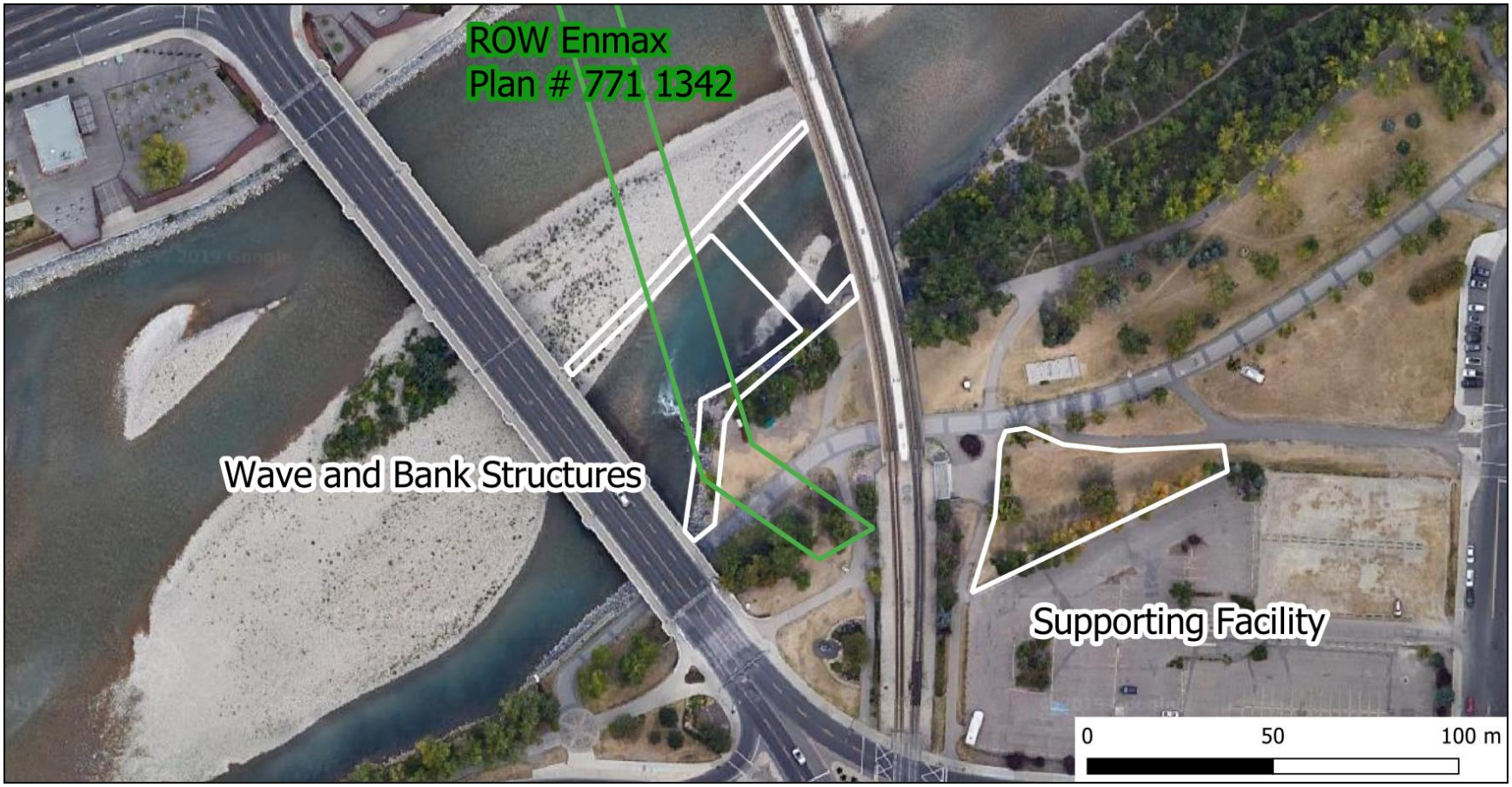
This ROW was for a bridge that will not be built anytime soon if ever. There is too much development preventing good bridge alignment.



[42] (City of Calgary, 2011)
[43] (South Alberta Land Registration District, 1974)

9.5 ROW Enmax[44] [45] [46]

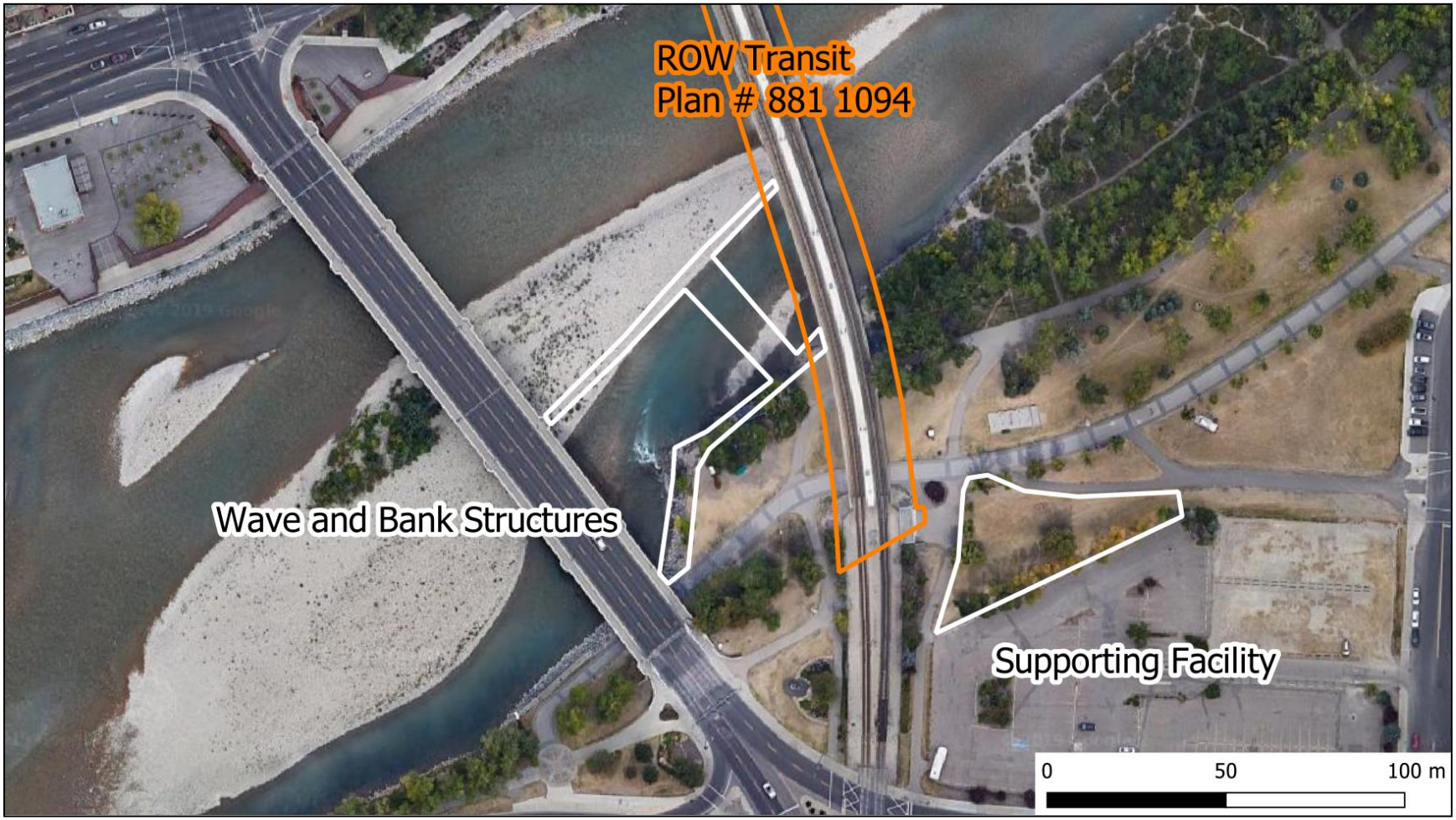
This ROW is for an existing 138 kV line. This project has been discussed with Enmax. The wave structures are outside of the Enmax ROW.



[44] (Enmax Corporation, 2019)
[45] (City of Calgary, 2011)
[46] (South Alberta Land Registration District, 1977)

9.6 ROW Transit[47] [48]

This ROW is for the existing Calgary Transit CTrain bridge. The Project will not negatively impact the C Train bridge or the ROW.



[47] (City of Calgary, 2011)
[48] (Soutern Alberta Land Registration District, 1988)

10 Operations & Maintenance

This section details how the wave will be operated and maintained.

10.1 Facility Operating Organizations

There are three key organizations involved with the facility: the Alberta River Surfing Association, Alberta Whitewater Association, and Calgary Parks. The Alberta River Surfing Association and Alberta Whitewater Association operate the facility, will handle wave management and maintenance, area safety and supporting area services. Alberta Parks is the landowner, excluding the river, and will be responsible for general land maintenance.

10.1.1 Alberta River Surfing Association and Alberta Whitewater Association Organization and Responsibilities

Facility responsibilities will include:

- Wave management and scheduling
- Wave structure safety inspections and maintenance
- Area river safety
- Supporting facility operations and services
- Land area urban beach activations

10.1.2 Calgary Parks Responsibilities

Calgary Parks key details:

- Municipal government department

Responsibilities will include:

- Land area maintenance

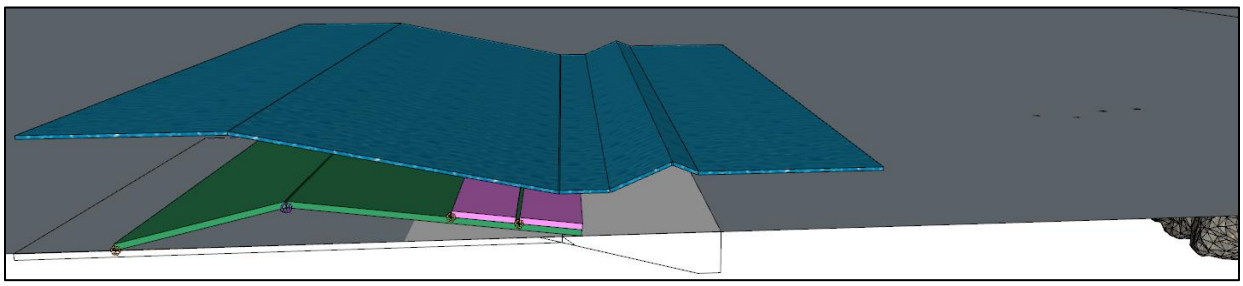
10.2 Facility Ownership

The facility will be owned and operated by the Alberta River Surfing Association and Alberta Whitewater Association. Disposition(s) and leases will be required as the area is Crown Land with ROWs and City of Calgary Land. The wave structure and bank structure area is on land owned by the Crown. This land has an Enmax ROW and a Calgary Transit ROW. The Enmax ROW is for a 138-kW line and the Calgary Transit ROW is for the northwest C-Train line of Calgary Transit. The work can be completed without interfering with current or future area usage by Enmax or Calgary Transit. Alternatively, the City of Calgary could own and operate the facility. The benefit of the Alberta River Surfing Association and Alberta Whitewater Association owning and operating the facility is that funds generated by the facility will cover operating, improving and maintaining the area with no additional funds needed from the City.

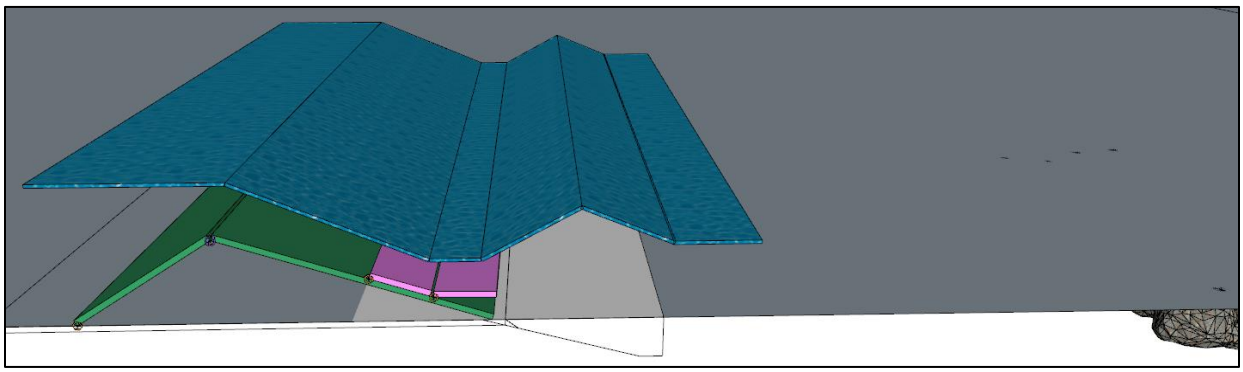
10.3 Wave Structure Control & Operation

The wave structure uses hydraulics and/or pneumatics moving steel plates to adjust the contours of the river bottom. The wave structure has in-water and riverbank components. The in-water components are the structures that control the shape of the river bottom. The riverbank components are the control systems for the structures.

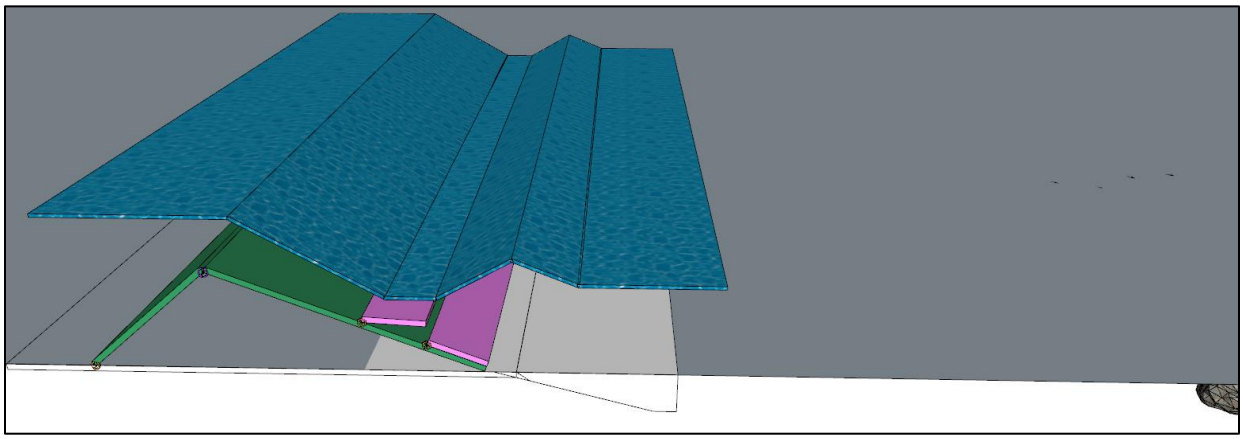
Low tailwater and fixed horizonal transition forms wave



Medium tailwater and first adjustable kicker forms wave



High tailwater and second adjustable kicker forms wave



10.3.1 Duration of Raising and Lowering

The structure can fully raise of lower within a few minutes. The structure is capable of fully raising or lowering in well under a minute in case of emergency. Rapid, large position adjustments will be avoided to prevent sudden flow changes downstream.

10.3.2 In-River Wave Components

The in-river wave components are:

10.3.2.1 Concrete foundation

Provides base for adjustable structures

10.3.2.2 Upstream Water Surface Elevation Control

Controls:

- Upstream water surface elevation
- The amount of flow in each channel

The water level control technology will be part of the wave box structure. The gates consist of large plates anchored to a concrete foundation. The plates are raised and lowered by large bladders or hydraulics or pneumatics. We will be able to mechanically and manually raise the gates should there be any equipment problems. The technology makes it easy for future inspection and maintenance by allowing on demand dewatering of any channel and allowing minimal water velocity upstream of any channel. An example Obermeyer water level control gates and a different surf water control structure are shown below. The water level control technology is part of the Wave Box.

Figure 57: Lower Obermeyer Gate

Figure 58: Raised water control surf structure

Figure 59: Raised Obermeyer Gate

Figure 60: Partially lowered water control surf structure

10.3.2.3 Wave Box – Wave Creating Structure

Controls:

- Shape of waves
- Direction of water flow in channels
- Elevation of water in channels

The wave creating technology is an adjustable river bottom that is anchored to the concrete foundation. The adjustable bottom can collapse completely flat against the river bottom. The wave creating technology can shape a variety of different waves and can change the wave shape while a user is riding the wave. The wave creating technology is moved by pneumatics or hydraulics and is connected to the appropriate lines in the concrete foundation. The wave creating technology can be completely removed and replaced with improved technology or for repairs. There are a variety of wave shaping technologies available including both patented and not patented.

10.3.2.4 Education & Testing Flume

The education and testing flume is a small separate channel on the bank side of the wave structure. This channel allows for small scale modelling of rivers and river waves. The flume is used for educational programming, to model different wave shaping technology and to test changes to the Wave Box structures.

10.3.3 On Shore Wave Components

The wave components on the riverbanks are the control systems for the in-water wave structures. The components included the motors, compressors and controls. All riverbank components are located outside of the flood zone.

10.3.3.1 Compressors

The compressors provide the pressure that is used to move the Wave box components.

10.3.3.2 Controls

The controls are the computer system that operates the compressors and other equipment.

10.3.3.3 Wave Control & Operation

The upstream water level and wave box is control by equipment in the control room outside of the flood zone. The equipment is operated remotely via wife or via internet. The control interface will be a tablet. The wave operator can be onsite or offsite and connects via internet.

10.4 Flow Level Wave Operations Plan

The Upstream Water Level Control Structures and the Wave Control Structures are highly adjustable and will be configured differently based on river flows.

10.4.1 Bow River Unsafe Boating Advisory Level – Bow River Flow > 280 m^3/s

The Water Level Control Structures and the Wave Control Structures will be flattened against the concrete foundation when flows are anticipated to exceed 280 m^3/s in the next 12 hours and when flows exceed 280 m^3/s.

10.4.2 Bow River Flow < 280 m^3/s

When the Bow River Flow is under 280 m^3/s the wave(s) will be operational except for the conditions listed above. Flows will be directed through each channel as per the chart below. Each individual channel can be narrowed to ensure a safe water depth.

Bow River Flow (m^3/s)	% of Bow Flow entering wave area	Flow entering wave area (m^3/s)	Flow through channel 1 (m^3/s)	Flow through channel 2 (m^3/s)	Flow through channel 3 (m^3/s)
>280	In river structures flattened to concrete foundation				
250	40%	100	30	40	30
150	40%	60	20	30	10
100	40%	40	20	20	0
50	40%	20	10	10	0

10.5 Daily Wave Operations Plan

The waves will be operational during daylight hours and non-existent at night. The adjustable water level control and wave control structures will be flattened against the bottom at night and will provide no incentive for people to enter the river.

Daytime:Waves are operational
Nighttime: Waves are non-existent. Water Level Control Structures and Wave Control Structures are lowered.

10.6 Seasonal Wave Operations Plan

The waves will be operational from approximately March to November. The waves will not be operation during very high flows and during ice coverage. The waves will not be operational for portions of June and July during spring run-off if the Bow River flow if above 280 m^3/s. If flows are expected to exceed 280 m^3/s in the next 12 hours the

waves will not be operational. The waves will not be operational from November to March when there is ice coverage.

10.7 Response to Sudden Events

In case of sudden events, the water level and wave control structures can be lowered or raised.

10.7.1 Channel Flow Isolation

If a channel needs to be isolated from flow, the water level control structures can be quickly raised to block all flow through that channel. This can be used to dewater a channel or to reduce flow in part of the river immediately downstream.

10.7.2 Upstream Water Level Lowering

If the upstream water level needs to be lowered, the water level control structures and wave control structures can be lowered. Lowering the structures will be slower than raising the structures to avoid a rush of water downstream.

10.7.3 Emergency Services and Control of Adjustable Structures

Emergency services will have two ways to control the adjustable structures. Both methods will have training and clear procedures for both the Alberta RSA and the emergency services.

10.7.3.1 Alberta RSA Control of Adjustable Structures

Emergency services contacts the Alberta RSA operator with their need to adjust the structures. The operator clears the structures and performs the necessary adjustments. There will be video feeds of the area to allow for safe remote structure operation.

10.7.3.2 Emergency Services Control of Adjustable Structures

In the event of immediate life danger, emergency services will be able to control the structures. There will be video feeds of the area to allow for safe remote structure operation. Local manual controls will also be available.

10.8 User Conflicts

User conflicts at river waves are normally very rare. The river wave community is very positive, supportive, welcoming and leads with good example. This established community attitude prevents most conflicts. Usage is naturally community regulated with people lining up and taking turns. Area staff is there for safety, area management and minor conflict resolution. In the case of significant conflicts, area staff will notify 311 and/or the appropriate emergency service. Notification will be done via cell phone or the nearby emergency call station. There will be a few strategies used to avoid and resolve conflicts and some responses to specific problems.

10.8.1 Avoiding Conflict

Image based signage will be posted on site showing best practices and expected etiquette. The regular river wave community will lead by example and be friendly,

supportive and welcoming. The combination of signage and positive community attitude avoids most conflicts. The wave will also be flattened at night to avoid issues.

10.8.2 Dangerous or Inappropriate Wave Usage

If someone is using the wave in a dangerous manner, is cutting lines or otherwise causing problems on the wave, the wave will be adjusted so the user washes downstream. Once the user is off the wave, the wave will be restored to normal operating conditions.

10.8.3 Fixed Rope Use

Using fixed ropes, ropes attached to shore, in a river is very dangerous especially where there is heavy river usage. In the event of fixed rope use attached to Louise Bridge, City of Calgary Bylaw and Calgary Fire Department will respond to educate the offenders. In the event of fixed rope use attached to shore, Calgary Fire Department will respond to educate the offenders. Bylaw will educate the people regarding the Bylaw and apply fines if they deem necessary and the Calgary Fire Department will educate the people on river safety.

The relevant bylaw is Street Bylaw 20M 88, section 17(4) No person shall place, dispose, direct or allow to be placed, directed or disposed, any Material belonging to that person or over which that person exercises control on a portion of a Street unless authorized to do so. Definition of Street under the Street Bylaw: "Street" means any thoroughfare, highway, road, trail, avenue, parkway, driveway, viaduct, lane, alley, square, bridge, causeway, trestle way, or other place, whether publicly or privately owned, any part of which the public is ordinarily entitled or permitted to use for the passage or parking of vehicles.

10.8.4 Violent or Aggressive Behavior

In the event of violent or aggressive behavior Calgary Police Services will be notified.

10.9 Events

The Alberta RSA holds events through spring, summer and fall at the existing 10th Street Wave and will hold larger events when the Project is complete. The events have their own safety plans, operations plans and insurance in addition to the plans in this document.

10.9.1 Alcohol / Cannabis at Events and River Wave Usage

The Alberta RSA prohibits event participants from using the river wave if they have consumed alcohol or cannabis. All event participants are required to sign their name indicating they will not consume impairing substances prior to using the wave. People who are noticeably impaired will not be allowed to use the wave as per Section 10.8.2 Dangerous or Inappropriate Wave Usage.

10.10 Safety Plan

The safety plan consists of three key parts: avoiding risk, minimizing risk and responding to incidents. Each part has passive components that are part of the area design and active components that involve action by Alberta RSA staff, volunteers and/or the public.

10.10.1 Risks and Risk Management

Good river waves and urban beaches are low risk. River waves usage does result in occasional injury and there have been multiple studies done on the types of injuries and injury rates. The whitewater paddling injury rate is 3.5 to 6.0 injuries per 1,000 exposures[49]. Whitewater kayaking fatality rates at managed whitewater facilities was found to be 2.9 per 100,000 participants[50]. River surfing does not have a published study relating to injury or fatality rates but there is the Surf Anywhere Accident and Incident Database that collects reports of accidents and incidents related to river surfing from around the world[51].

[49] (David C. Fiore, 2003)
[50] (Iain Wilson, 2013)
[51] (Egsgard, 2019)

Risk	Avoidance through Design	Minimize through Education	Response to Problem
Impact with river bottom	Avoid high impact risk areas with design. Maintain deep water over wave structure. Use controllable flow patterns to minimize sediment build up. Add impact absorbing layers to high impact areas. Offer floatation equipment.	Signage and lessons on proper equipment and best practices. Leadership by example to maintain low risk culture.	Get injured person out of water. See emergency response plan.
Impact with equipment	Offer appropriate equipment that helps avoid impact with equipment.	Signage and lessons on proper equipment and best practices. Leadership by example to maintain low risk culture.	Get injured person out of water. See emergency response plan.
Muscle of ligament strains or tears	Provide areas for proper stretching for warm-up and cooldown. Provide drinking water and healthy food.	Signage and lessons on proper training and best practices. Leadership by example to maintain low risk culture.	Get injured person out of water. See emergency response plan.
Repetitive stress	Provide areas for proper stretching for warm-up and cooldown. Provide drinking water and healthy food.	Signage and lessons on proper training and technique. Leadership by example to maintain low risk culture.	Get injured person out of water. See emergency response plan.

Risk	Avoidance through Design	Minimize through Education	Response to Problem
Choking on water	N/A. Risk is user controlled.	Signage and lessons on proper technique and best practices. Leadership by example to maintain low risk culture.	Get injured person out of water. See emergency response plan.
Numbness due to cold water exposure	Offer appropriate wetsuits and other thermal gear. Display water and air temperature measurements.	Signage and lessons on proper equipment selection and use. Leadership by example.	Get injured person out of water and into warm location. See emergency response plan.
Leash entrapment	Avoid leash entrapment risk areas in design. Offer body quick release leashes and other good solutions.	Signage and lessons on leash dangers, equipment selection and best practices. Leadership by example.	Keep head above water. Pull user in opposite of entrapment. Release or cut leash. See emergency response plan.
Limb entrapment	Avoid limb entrapment risk areas in design. Offer floatation equipment.	Signage and lessons on limb entrapment, equipment selection and best practices. Leadership by example.	Keep head above water. Pull user in opposite of entrapment. Ropes maybe needed to free person. See emergency response plan
Rope entanglement	Ban rope use and remove any ropes that are setup.	Signage and lessons on risks of rope use. Leadership by example.	Keep head above water. Cut rope. See emergency response plan

Risk	Avoidance through Design	Minimize through Education	Response to Problem
Pinning against object of bank	Avoid pinning risk areas in design. Offer floatation equipment.	Signage and lessons on pinning, equipment selection and best practices. Leadership by example.	Keep head above water. Use lever to loosen pin. Pull user perpendicular to pinning force. opposite of entrapment. Ropes maybe needed to free person. See emergency response plan
Impact with debris coming from upstream	Provide clear sightlines to upstream for people waiting to use wave.	Signage and lessons on upstream debris and best practices. Leadership by example.	Get injured person out of water. See emergency response plan.
Impact with user coming from upstream	Provide clear sightlines to upstream for people waiting to use wave.	Signage and lessons on upstream debris and best practices. Leadership by example.	Get injured person out of water. See emergency response plan.
Entrapment under ice	Lower wave structures when there is any ice cover so there are no usable recreational features.	Signage and lessons on ice coverage risk and best practices. Leadership by example.	Break ice. Get injured person out of water. Try to extract in direction of water flow. See emergency response plan.

Risk	Avoidance through Design	Minimize through Education	Response to Problem
Hypothermia	Offer appropriate wetsuits and other thermal gear. Display water and air temperature measurements. Lower wave structures when very cold so there are no usable recreational features.	Signage and lessons on hypothermia risk and best practices. Leadership by example.	Get injured person out of water and into cool location for slow warming. See emergency response plan.
Drowning	Avoid retentive hydraulics in design. Offer floatation gear.	Signage and lessons on drowning risk and best practices. Leadership by example.	Get injured person out of water and start CPR. See emergency response plan.
Dangerous area usage	N/A. Cannot prevent stupid / ignorant people.	Safety signage and lessons on proper area usage. Leadership by example.	Inform dangerous person of risks and ask they stop. Notify By-law Services, Calgary Fire Department and Calgary Police Services.

10.10.2Signage

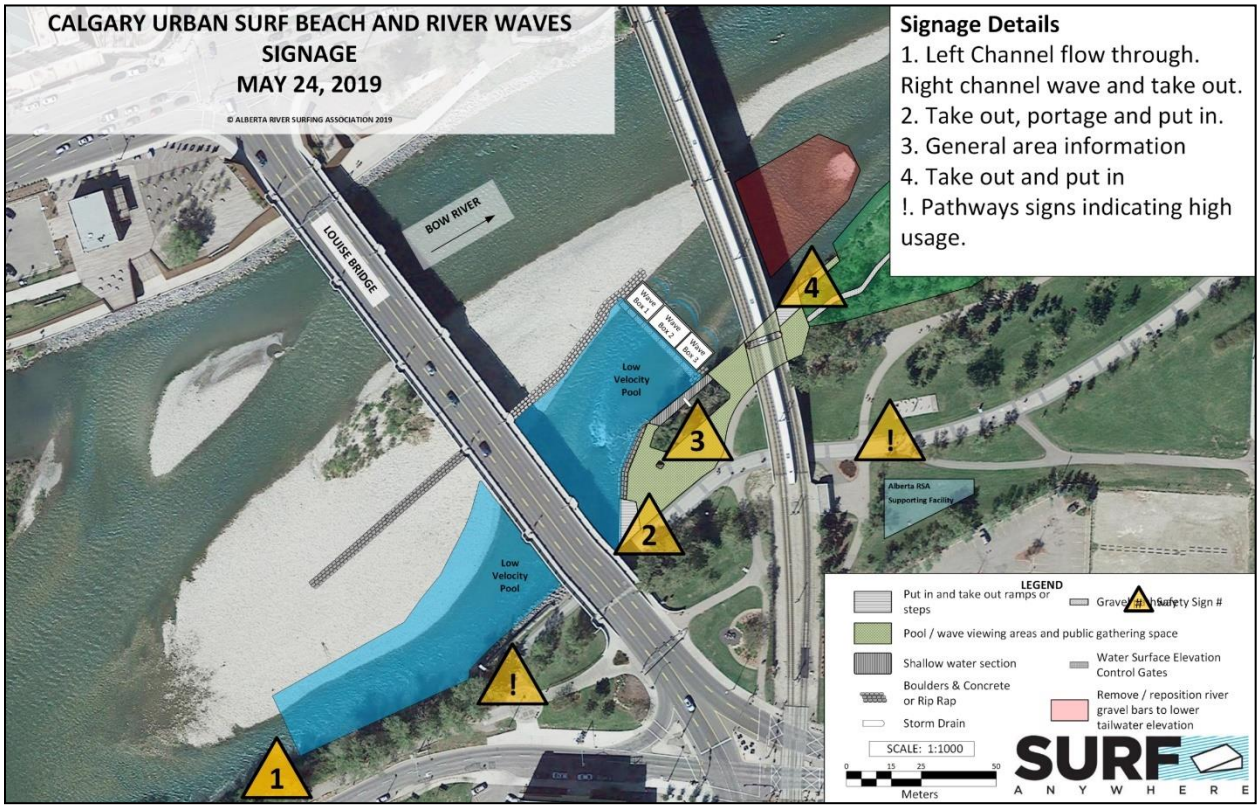


Figure 61: Map of safety signage locations

10.10.2.1 Riverbank Signage

There will be signage on the area access points explaining the area, the key features, best practices and how to respond in case of emergency. Signage will be visual and language free as much as possible.

River access and egress points will be clearly marked.

Surf Anywhere and the Alberta River Surfing Association worked with the City of Calgary to develop the exiting signage at 10th Street Wave. The new signage would have additional information and, wherever possible, key points would be made using images.

10.10.2.2 Upstream River User Signage

There will be signage upstream of the area notifying river users about the area and their route options. Upstream river users can:

- Take the north channel and avoid the wave area
- Portage around the wave area using the gravel island or the river ramp / stairs
- Exit the river using the river ramp / stairs
- Travel over the waves

There will be signage identifying egress points upstream of the features and downstream of the features.

10.10.3Safety Personnel & Scheduling

The Alberta River Surfing Association will be providing onsite safety personnel. The safety operation of the area will be like a beach. The Alberta RSA is developing a modified urban surf beach safety training program with the Life Saving Society. The training program will be a modification of the existing LSS Waterfront and LSS Surf programs. The Alberta RSA safety personnel will have completed the LSS River Surf Beach training program. The safety personnel will consist of a few paid lifeguards and a larger number of volunteer life savers. Lifeguards are paid professionals who provide river safety services. Life savers are volunteers who patrol the area, provide river safety services but avoid personal risk. Safety personnel will only be onsite during key hours. Presence or lack of safety personnel will be clearly posted.

10.10.3.1 Rescuing Dangerous People in Water

Some people in need of rescue will be dangerous to rescuers due to panic or other issues. Rescuers will keep a safe distance from the person being rescued while bringing them to shore. The two primary tools are:

1. Throw bags: Bags with lines throwing from shore. The struggling person grabs the line, holds on and the current swings the struggling person to shore.
2. Rescue surf board: A long, high floatation surf board with handles on the top. The rescuer paddles the board to the struggling person and offers the board as a floatation aid. The rescuer stays out of reach from the struggling person.

As needed, the Calgary Fire Department and Calgary Police Services will be notified.

10.10.3.2 Safety Personnel Scheduling

Safety personnel will be scheduled for weekday evenings and weekends during the summer months.

10.10.4 Junior River Surf & Safety Program

The Junior River Surf & Safety program is a week-long program for youth from ages 10 to 17. The program will run for 8 weeks during the summer with 10 to 20 youth per week. The programs trains youth in river rescue & safety practices, the use of river waves and the surrounding river areas and river ecology. The Junior River Surf & Safety program develops groups of skilled youth who can assist with providing river safety for the area. Some youth from the program will become professional river life safety personnel and will be hired by the Alberta RSA.

10.10.5Wave Scheduling

During regular operations waves will be active during daylight hours and will not be active at night.

10.10.6 River Safety Equipment

There will be permanent and deployed river safety equipment in the area. Permanent equipment will be there all the time and deployed equipment will be there when river safety personnel are on site.

- Permanent River Safety Equipment
  - Throw bags down stream of waves. Allow safety personnel on shore to safely pull conscious river user to shore.
  - Call station on pathway downstream of wave. Provides direct link to City of Calgary emergency personnel.
- Deployed River Safety Equipment
  - Surf rescue board at river safety station. Allows safety personnel to enter water and rescue unconscious or conscious river users with minimal risk.
  - First aid kit at rafter take out and downstream of wave. Provides supplies for all major first aid issues.

10.10.7 Video Monitoring of Area

There will be live video feeds from multiple angles covering the urban beach and river wave areas. The video feeds will have a high-resolution private version for safety services and a lower resolution version for public view.

10.10.8 Area Video Feed Users

Group	Usage	High Resolution Video Feed Access	Low Resolution Video Feed Access
Calgary Fire Department	River safety monitoring	Yes	Yes
Calgary Police Services	Public safety monitoring	Yes	Yes
Alberta River Surfing Association	Wave adjustment and safety monitoring	Yes	Yes
Public	Viewing of area	No	Yes

10.10.9 Safety Map

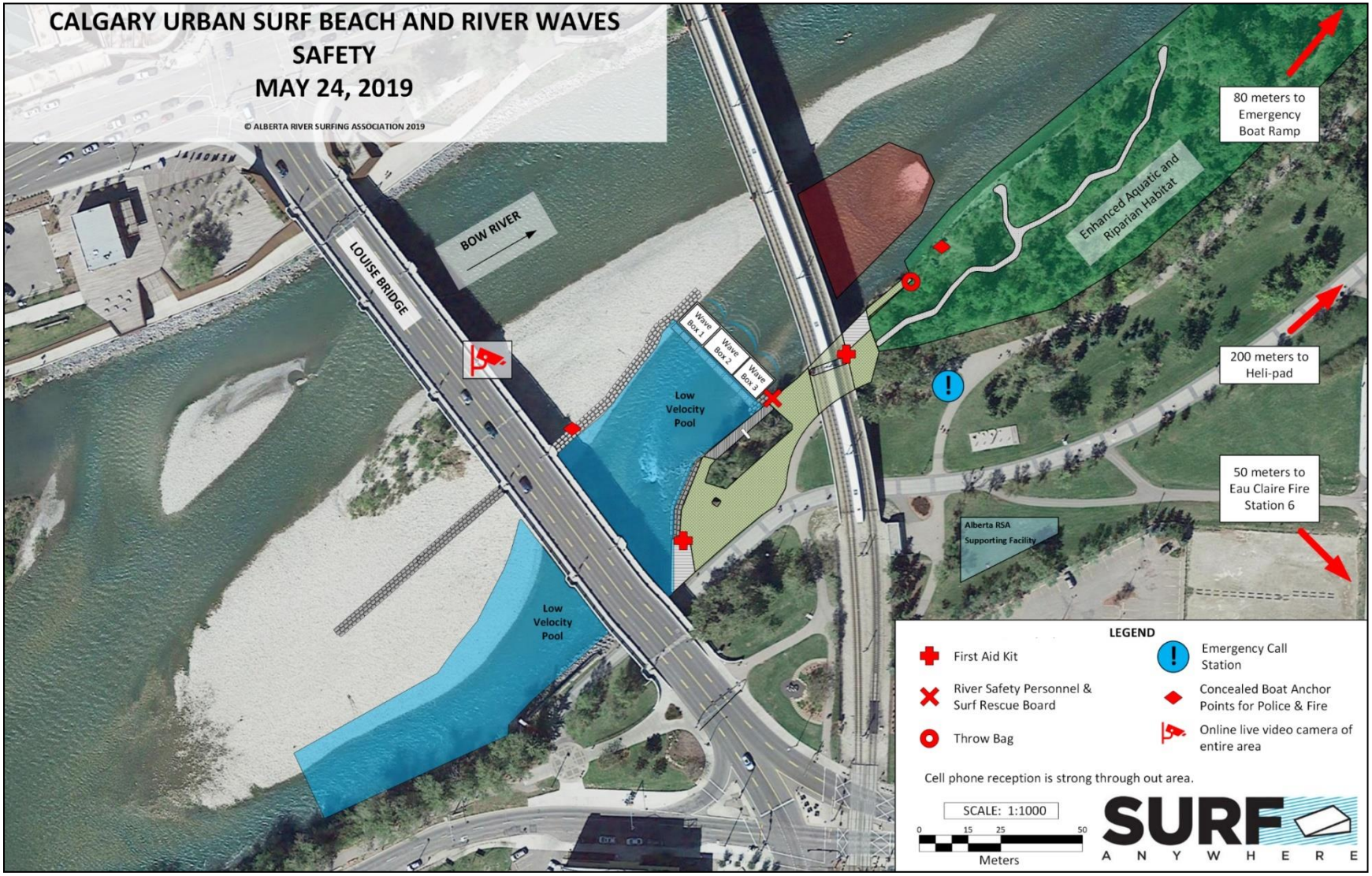


Figure 62: Map of safety equipment

10.11 Emergency Response Plan

In the event of an in-water emergency, the following safety measures will be taken.

1. If area safety personnel are on-duty
    a. Blowing of whistle to notify everyone of emergency and to get them to clear the river
    b. Rescue procedures based on situation
        i. Notification of City of Calgary emergency personnel
        ii. Throw bag if victim is responsive and able to grab throw bag
        iii. Surf rescue board if victim is unresponsive or unable to grab throw bag
    c. Emergency Action Plan
2. If area safety personnel are not on-duty, there will be safety equipment and instructions including:
    a. Instructions to notify City of Calgary emergency personnel via 9-1-1 or Call Station
    b. Throw bags

10.11.1 Emergency Action Plan for Calgary Surf Beach

Emergency Action Plan for Calgary Surf Beach

This EAP form is a quick visual reminder of the steps to follow during an emergency. All river safety personnel, instructors and leaders and should understand the EAP for the Calgary Surf Beach and should practice emergency situations. This emergency action plan is not a substitute for prudent planning or proper risk management while on or off the river.

Steps to Follow When an Injury Occurs

Note: Not all injuries require activation of EAP. It is important that instructors properly assess the situation to ensure the safety of all surfers involved.

Step 1: Control the environment so that no further harm occurs

☐ Ensure you are immobilised in a safe area

☐ Stop all other surfers in a safe area (ideally an eddy with on land access)

☐ Extraction of injured surfer may be required. If so, do an initial assessment before activating EAP.

☐ Extraction of dangerously pinned or entrapped and submerged surfers automatically activates EAP

Step 2: Do an initial assessment of the situation

Activate EAP if any of the following is true. If the surfer:

☐ Is not breathing

☐ Does not have a pulse

☐ Is bleeding profusely

☐ Has impaired consciousness

☐ Has injured the back, neck, or head

☐ Has a visible major trauma to a limb

☐ Cannot move his or her arms or legs or has lost feeling in them

If the surfer does not show the signs above, proceed to Step 3.

Step 3: Do a second assessment of the situation

☐ Gather the facts by talking to the injured surfer as well as anyone who witnessed the incident

☐ Stay with the injured surfer and try to calm him or her; your tone of voice and body language are critical

Step 4: Assess the injury

☐ Have someone with first-aid training complete an assessment of the injury and decide how to proceed.

☐ If the person trained in first aid is not sure of the severity of the injury or no one present has first aid training, activate EAP.

If the assessor is sure the injury is minor, proceed to Step 5.

Step 5: Control the return to activity

Allow surfer to return to activity after a minor injury only if there is no:

☐ Swelling

☐ Deformity

☐ Continued bleeding

☐ Reduced range of motion

☐ Pain when using the injured part

Step 6: Record the injury on an accident report form and inform the parents/guardians if the surfer is less than 18.

Emergency Action Plan for Calgary Surf Beach

Map of River and Surroundings

IN CASE OF EMERGENCY

1. Ensure self safe
2. Ensure no others in danger
3. All river users exit river
    a. Extract victim
4. Stabilise victim
    a. Level of consciousness
    b. Breathing
    c. Circulation
    d. C-Spine
    e. Disability (Neurological)
    f. Extremity Trauma & Exposure
5. First aid kits (Treat victim as needed)
6. Emergency contact – 911 or Emergency Call Station
7. Evacuation – preparation of:
    a. Victim in need of care
    b. Equipment

Alberta River Surfing Association 3 of 3

10.12 Wave Inspection & Maintenance

The Alberta RSA will inspect and maintain the wave. Inspections will occur twice each year: after the final winter ice flows but before spring high water and after spring high water. Maintenance will be performed during the inspections and after inspections if additional maintenance needs are identified. Normal inspection and maintenance do not require dewatering the structures. The design of the waves makes it easy & cost effective to perform inspections and maintenance.

10.12.1 Design Assisting Inspections & Maintenance

There are a few components of the wave design that make inspections and maintenance easy and cost effective.

10.12.1.1 Manual Gate Control

The water level control gates can be manually raised using winches between fixed anchor points and connection points on the gates. This allows water flows and levels to be controlled even if there is failure with gate operation.

10.12.1.2 Channel isolation

Each channel can be isolated from river flow using the water level control gates and temporary downstream barriers. This allows for no water velocity condition in any channel and allows the channel to be drained if needed.

10.12.1.3 Flow Control

Flow at the top of each channel can be controlled by opening and closing different water level control gates. This allows for low velocity conditions at any gate.

10.12.1.4 Ongoing Permission to Dewater

During the permitting process, the facility will request permission to dewater the channels at any time when needed for facility improvements or maintenance.

10.12.2 Inspections

Inspections will regularly check that key components of the river wave structures are operating properly.

10.12.2.1 Timing

Inspections will happen twice a year after the seasonal events that put the most stress on the river wave structures.

- Post Ice Flow Inspection: After the final winter ice flows and before the spring runoff. Typically performed in April or May.
- Post High Flow Inspection: After the peak spring runoff. Typically performed in late June or early July.

10.12.2.2 Actions

The following actions will be performed during each inspection.

- Anchor review: Review of all anchor points to confirm tightness and proper connect.
- Structure review: Review of all structure connections and spans to ensure proper stability
- Obstruction review: Review of all areas with moving components for obstructions such as cobble, woody debris, etc.
- Hazards review: Review of area for new and existing hazards
- Reporting: Report on results of all inspections

Reviews will be performed by a combination of dewatering via flow path control and a dive team.

10.12.3 Maintenance

Maintenance will be regular small adjustments to ensure wave structure systems continue to work properly.

10.12.3.1 Timing

Maintenance will be performed at the same time as inspections.

10.12.3.2 Actions

The following actions will be performed as part of regular wave structure maintenance.

- Anchor tightening: All anchor bolts will be tightened
- Obstruction removal: All obstructions in the wave structure will be removed such as cobble, woody debris, etc.

10.13 Park Land Maintenance

Calgary parks will handle general maintenance of the Park area on shore. The Alberta River Surfing Association will provide regular monitoring, cleaning of the area and maintenance of the Urban Beach deployable infrastructure.

11 Design

This section provides design details for the Calgary Urban Surf Beach and River Waves project.

11.1 Concept drawing

11.1.1 Wave park areas

The wave is the spectacle and main attraction that brings tourism and locals to the area. The wave is adjustable and will be used by all levels and types of river wave users. There will be river wave riding and river safety instruction classes in the water and on the river banks. Spectators will gather on the river banks and the surrounding bridges.

11.1.2 Natural channel for boat and fish bypass

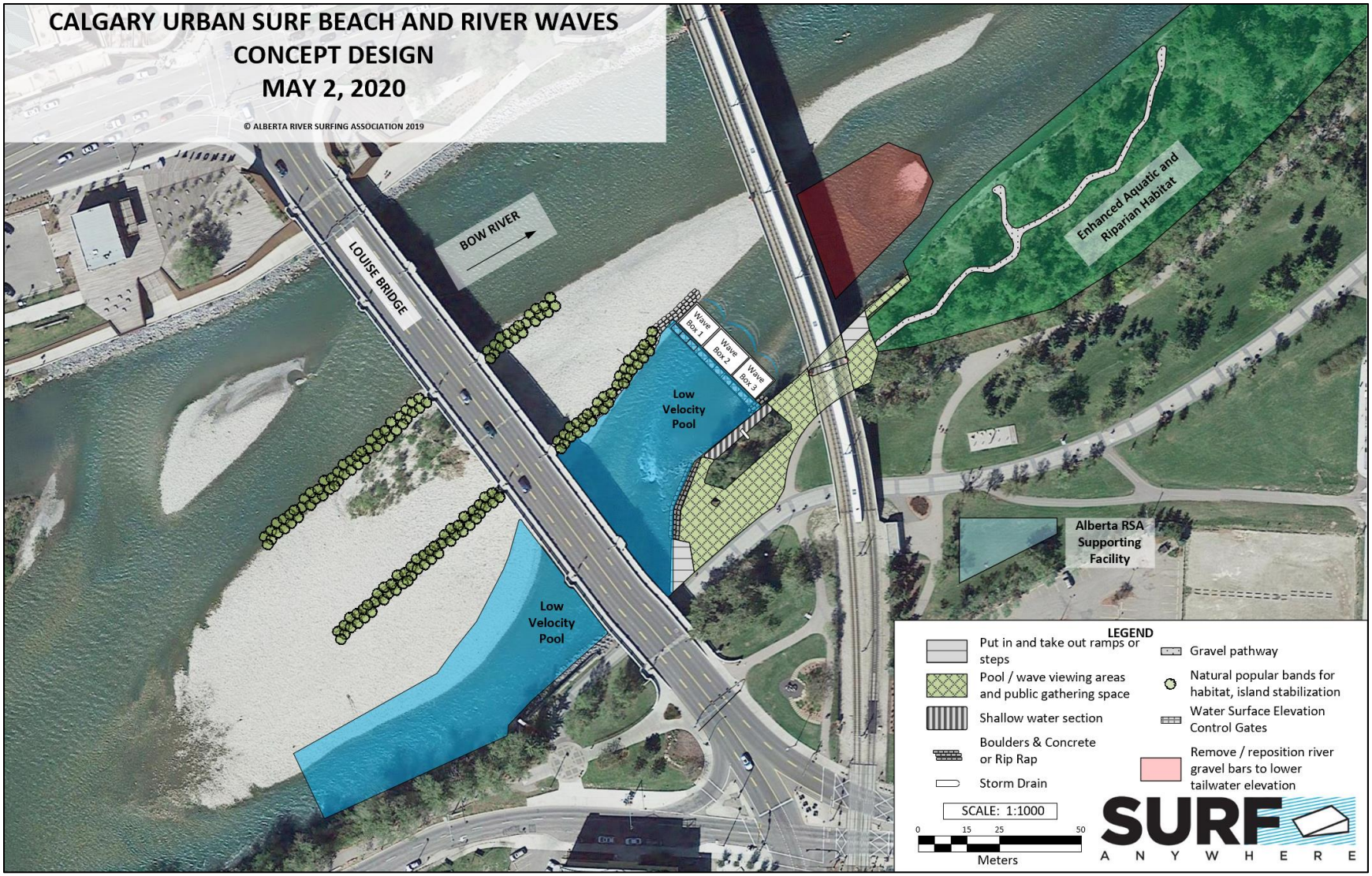
The north channel will remain natural and allow for easy bypass by drift boats, rafts and other users floating downstream, and fish. There will be clear river signage directing users to the natural channel or the wave channel. If floaters end up in the wave channel, there will be many easy exit points before the wave. When floaters go over the wave, it will be exciting and they may tip but they will pass through the wave and continue downstream.

11.1.3 Deep, slow pool

Upstream of the wave there will be a deep slow pool. The pool will be good for swimming, wading flatwater paddling and floating. The water in the pool will slowly move towards the wave and then quickly pickup speed just upstream of the wave.

11.1.4 River exit and entrance

There will be an improve and easy river exit and entrance point just past the Louise Bridge. This ramp will allow rafters and others to safely leave the river or launch upstream of the wave. This river access point will be accessible and create a short water trail through downtown Calgary that encourages visitors and locals to repeatedly float the trail and stay longer in the area. The entire south river bank will allow for low risk access.


CALGARY URBAN SURF BEACH AND RIVER WAVES
CONCEPT DESIGN
MAY 2, 2020
© ALBERTA RIVER SURFING ASSOCIATION 2019
BOW RIVER
LOUISE BRIDGE
Wave Box 1
Wave Box 2
Wave Box 3
Low Velocity Pool
Low Velocity Pool
Enhanced Aquatic and Riparian Habitat
Alberta RSA Supporting Facility
LEGEND
Put in and take out ramps or steps
Pool / wave viewing areas and public gathering space
Shallow water section
Boulders & Concrete or Rip Rap
Storm Drain
Gravel pathway
Natural popular bands for habitat, island stabilization
Water Surface Elevation Control Gates
Remove / reposition river gravel bars to lower tailwater elevation
SCALE: 1:1000
0 15 25 50
Meters
SURF ANYWHERE

11.2 Examples of Whitewater Parks and Adjustable Waves with Capital Costs

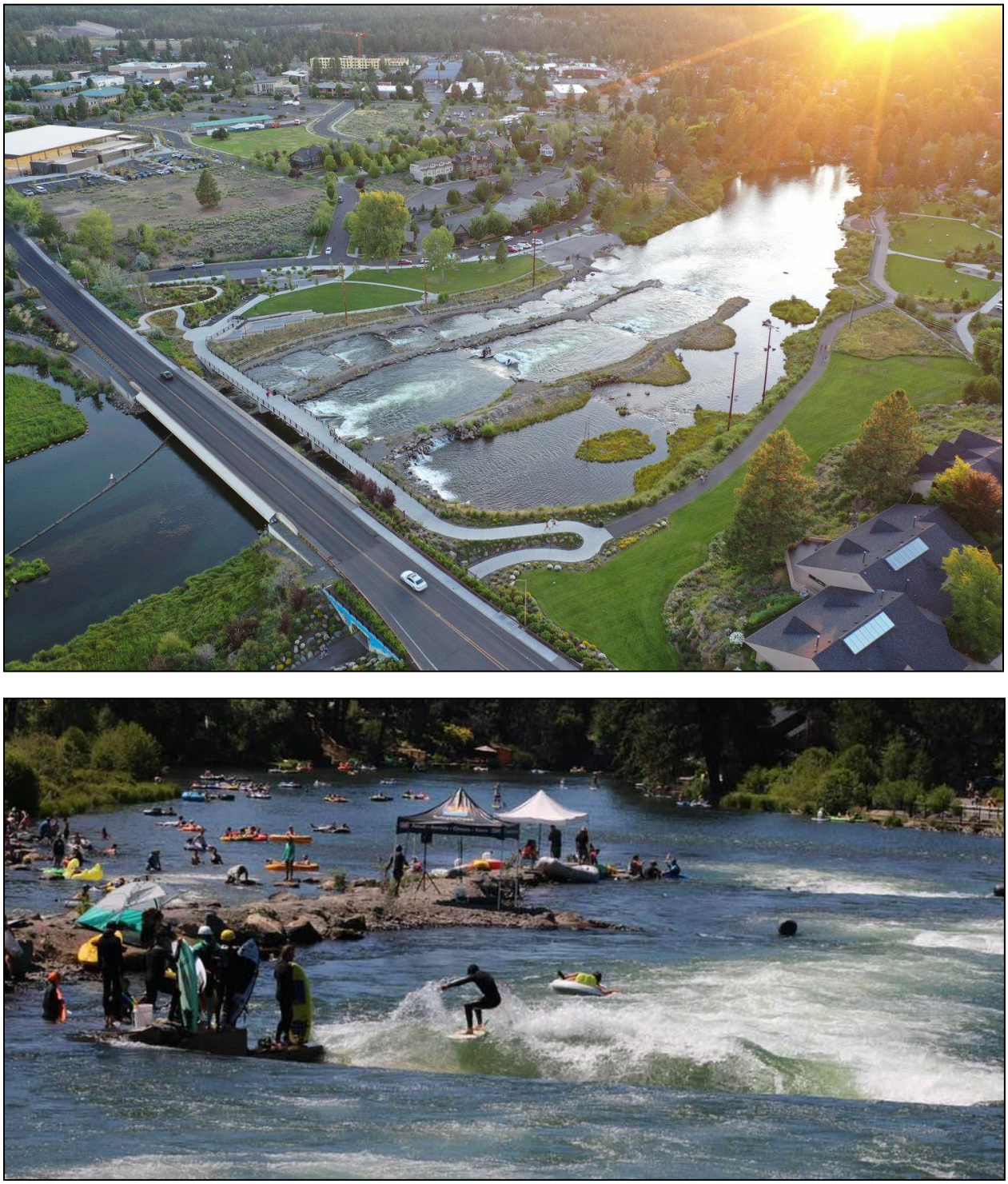


Figure 63: Whitewater Park in Bend, Oregon. Concrete, boulder construction with adjustable pneumatic plates. Surf wave design by Surf Anywhere. Capital cost $13M CAD ($10M USD). Built in 2016

Figure 64: Whitewater area in Kananaskis Alberta. Boulder construction with no moving parts. Entire project by Surf Anywhere. Capital cost $450,000 CAD over two builds. Built in 2014 and upgraded in 2019.

Figure 65: Whitewater park phase 1 in Boise, ID. Construction is boulder & concrete with pneumatic and bladder adjustable components. Capital cost $5.3M CAD ($4M USD). Built in 2012.

Figure 66: Ebensee, Austria. Private artificial river wave. Capital cost $3 to $5M CAD (2M€ to 3.3M€.) Built in 2020.

Figure 67: Munich Airport, Munich, Germany. Pumped wave. Capital cost $6M for a retrofit facility.

Figure 68: London, UK. Artificial whitewater park. Capital cost $51M CAD (£30M GBP). Built in 2012.

Figure 69: The Wave - Bristol. Artificial surf park. Capital cost over $42M CAD (£25M GBP). Built in 2019.

11.3 Critical Design Considerations

11.3.1 Flooding Risk

The proposed river surfing wave must either reduce flooding risk or have no effect on flooding risk. The Bow River through Calgary regularly experiences flood events.

11.3.2 Float Through Boater Traffic

There is extensive river usage by float through boaters during summer months. The float through traffic primarily consists of low skilled users on basic rafts. Other float through users included SUPers, kayakers and canoers. Any feature would need to allow passage of floating traffic.

11.3.3 Fish Passage

The wave features must allow for the upstream passage of local fish.

11.3.4 Environmentally Self Compensating

The design will require an environmental review to determine if the effects of building a river surfing wave pose environmental concerns at the locations. The design should be environmentally self-compensating and result in a net improvement in aquatic and riparian habitat.

11.3.5 Wave Quality

The cultural, economic and environmental return on investment is directly tied to wave quality. The better the wave the better the returns. A great wave will provide excellent return on investment while a project with no wave will provide little to no return on investment.

11.3.6 Safety

River waves can be designed to be low risk and designed as a good location to educate people on river safety. Users will require appropriate river knowledge, equipment and swimming ability.

11.3.7 Durability & Maintenance

The design must survive large flood events and remain operational. The design must last a long time and require minimal maintenance to remain operational.

11.3.8 Broad Public Usage & Benefit

The design of the wave and surrounding area must provide benefits to a wide range of the public.

11.3.9 Adjustability

The wave shape and water levels controls must be adjustable to allow high quality waves for the widest range of flow conditions

11.3.10 Wave Channel Dewatering & Flow Bypass

The wave channels must be easy to dewater using a flow bypass. This allows for easy future improvements to the waves as technology improves after the initial construction.

11.3.11 Liability

Liability at public access and free-to-use surf waves is typically handled the same was as liability at local skate parks.

11.3.11.1 Link to City of Calgary Skatepark Site

http://www.calgary.ca/CSPS/Recreation/Pages/Skateparks/Home.aspx

11.3.12 Operating Organization

River surfing waves are public recreational infrastructure primarily used by locals. The local municipality receives most of the substantial cultural, social and economic benefits. Ideally, the Alberta River Surfing Association will become the operating organization. The operating costs and requirements are quite minimal. The most complicated systems have a single staff member associated with the facility.

11.4 General Concept Design

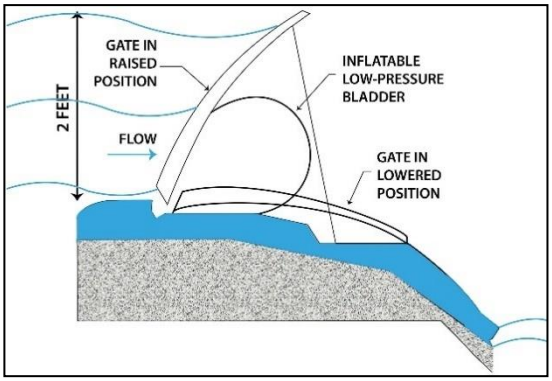
The basic concept for the river wave design is similar in all potential locations.

11.4.1 Reducing Flood Risk

The Project will significantly reduce flood risks. The Project will make more space under the Louise Bridge spans by lowering the gravel bar height and increasing the space for high flow events. Every year, the Alberta RSA will remove growth on the island inline with spans to prevent the growth from holding material and increasing flood risk during a high water event. During construction, the river bottom will be slightly excavated, a concrete and rock foundation installed and then the wave and water level controls installed on the foundation. The wave features and water level controls will be fully collapsible during flood events. The resulting river bottom will provide more room for flood waters than before construction and will provide precise control of upstream water elevation. The suggested controls will use Obermeyer gates.

Obermeyer Gate Collapsed

Obermeyer Gate Engaged



Obermeyer Gate Diagram

11.4.2 Water Surface Elevation Control

The Obermeyer Gate solution shown above will also provide precise water surface elevation control.

11.4.3 Flow Through Boater Traffic

At both locations, there are alternate routes for flow through boater traffic down unmodified sections of the Bow River. The wave designs will allow safe passage of flow through float traffic.

11.4.4 Upstream Fish Passage

Both locations have alternate unmodified river passages that allow for upstream passage of fish.

11.4.5 Fire & Police Boat Passage

Both locations have alternate unmodified river passages that allow for easy upstream & downstream passage of fire boats and police boats.

11.4.6 Adjustable Wave Features

Adjustable wave features are critical to allow usage of the wave and all the associated benefits for most of the year. There will be two or three wave channels with adjustable features that provide the following benefits:

- At least one wave can be active all year
- Other waves become active as flow levels rise
- All channels have adjustable surf wave features allowing for a good wave at a range of flows
- During very high flows, the adjustable features flatten and remove any impediment to flow

11.4.7 Durability & Maintenance

Well designed and built river waves regularly survive major flood events and continue to be operational. The waves will not require structural maintenance. Depending on sediment deposition some adjustment might be require in the wave canals to improve or change the function. Adjusting the sediment deposition would be a very low cost and would be relatively easy since each channel could be easily isolated from river flow.

11.4.8 Wave Quality at Each Possible Location

Good waves are possible at both locations. The Louise Bridge location can create the best river surfing waves in the world, be the site of major regional, national and international competitions and be excellent for all skill levels. The Lagoon location can create good river surfing waves.

11.4.9 Environmentally Self-Compensating

The wave project can be environmentally self-compensating by improving fish and riparian both upstream and downstream of the wave location.

11.4.10 Broad Public Usage

River surfing waves draw large amounts of spectators and users. The area around the wave should be designed to encourage families to stop and watch and enjoy the space. The area should be designed to encourage usage by other users included raft take-out / launch, SUP and other flat-water paddling, swimming / wading, stretching, spectating, river safety training and events related to the river.

11.4.11 River Education

River surfing waves are excellent opportunities to educate the public about and connect the public to the river ecosystem. There area should include educational features about the wave, how rivers change and the aquatic / riparian habitat.

11.4.12 Examples of Waves that operate from 20 m^3/s to 45 m^3/s

Concrete, Boulder Construction with Pneumatic Plates

Boulder Construction

Obermeyer Gates, Boulder & Concrete

11.5 Louise Bridge Specific Concept Design

11.5.1 Overview

The Louise Bridge location will have an adjustable wave structure that spans the south channel. Different sections of the wave structure can be lowered to make different flow paths for different flow conditions. At lower flows, there would be less flow paths and more of the south channel would be blocked. The ability to direct water away from any part of the wave structure allows for easy ongoing improvements and adjustments to the wave making equipment.

11.5.2 Key Adjustments

The second bridge pier from the south bank will be extended downstream. A line of large boulders will be place in the gravel bar between the second bridge pier and the third bridge pier. The extended second pier and the line of boulders is necessary to ensure the drop remains consolidated at the wave location even after high floods. foundation will connect the south bank and the extended bridge pier. The foundation will be flood proof by either anchoring to the bedrock or being deep and massive. The channels, gates and wave making equipment will be built on top of the foundations. The gravel island under the Louise Bridge span will be lowered to increase space for high flow events.

11.5.3 Reducing Flood Risk

The Project will significantly reduce flood risks. The Project will make more space under the Louise Bridge spans by lowering the gravel bar height and increasing the space for high flow events. Every year, the Alberta RSA will remove growth on the island in-line with spans to prevent the growth from holding material and increasing

flood risk during a high water event.[52] The adjustable structure installation will slightly reduce flood risk by slightly lowering water elevation during high flow events.

11.5.4 Effect on Water Surface Elevation

At the Louise Bridge Location, the water surface elevation upstream of the wave will increase and will be controlled by the Obermeyer gates and adjustable wave structure. The water surface elevation downstream of the wave will decrease because the river bottom will be excavated, and the waves will create deeper river sections after the wave.

11.5.5 High Water Response

In the event of a high-water advisory, the Obermeyer gates and adjustable wave structures can be lowered allowing free flow of water and removing the increase in water surface elevation.

11.5.6 Environmental Enhancements[53]

Building a wave at the Louise Bridge location can have net positive environmental impacts. The environmental impacts are detailed in the Environmental Impact report in the Appendix. There is a major second channel on the north side of the river that will not be adjusted allowing easy passage for fish. The shore sections within the wave development area are either already armored with riprap or are heavily eroding. This project should include riparian and aquatic habitat improvements both upstream and downstream of the wave and on the Louise Island.

11.5.7 River Access and Egress

River access points will be built upstream and downstream of the wave to encourage take-out/launch of by river users, river access by swimmers and waders and allow easy wave cycling by surfers.

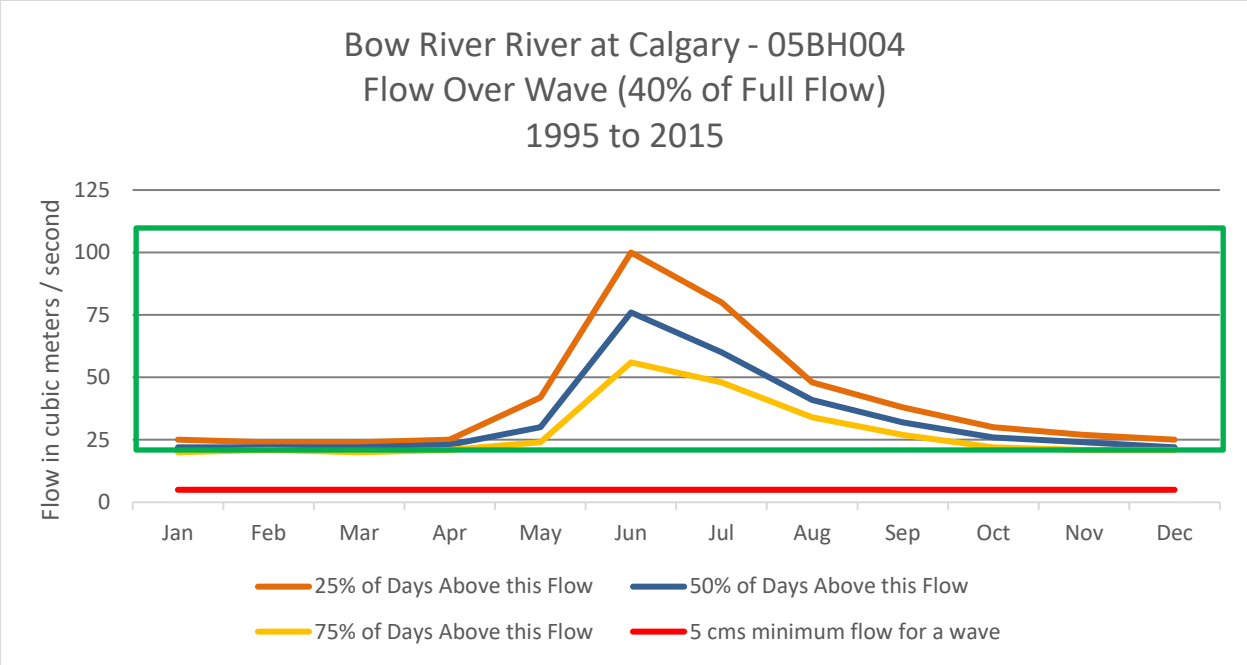
11.5.8 Spectating

The south bank will be developed as a spectator location and hardened to protect against further flood damage.

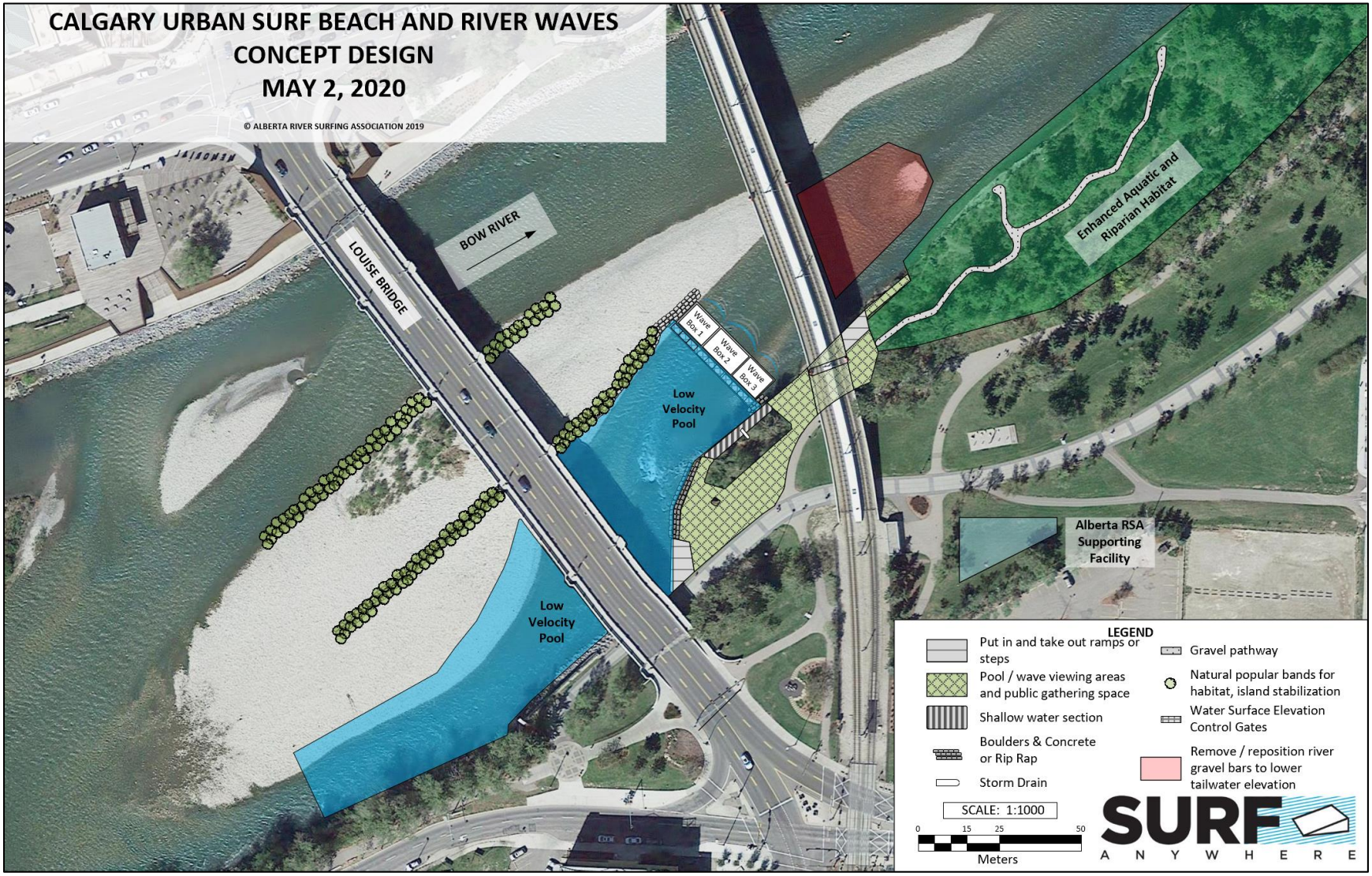
11.5.9 Design Flows

The design flow range is from 20 m^3/s to 110 m^3/s with 40% of the Bow River going over the waves. The full Bow flow equivalent is from 50 m^3/s to 275 m^3/s. This range provides good surfable waves all year except for during floods and when river is frozen. The wide range of flows is possible because of the multiple wave channels. The green box below shows the design flow range on the predicted flow graph.

[52] (Rood, 2020)
[53] (Rood, 2020)


Bow River River at Calgary - 05BH004
Flow Over Wave (40% of Full Flow)
1995 to 2015
Flow in cubic meters / second
125
100
75
50
25
0
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
25% of Days Above this Flow
50% of Days Above this Flow
75% of Days Above this Flow
5 cms minimum flow for a wave

11.5.10 Louise Bridge – Concept Design



11.5.11 Louise Bridge – Concept Drawing

11.6 Lagoon Specific Concept Design

11.6.1 Overview

The Lagoon location would two wave channels. The existing channels would be retrofitted with wave making equipment. Due to the limited flows possible through the Lagoon due to high bottom elevation and the complexity of adjusting the Lagoon bottom, this is not a recommended location.

11.6.2 Key Adjustments

The inflow area will need adjustment to allow a controlled flow of at least 5 m^3/s from June through August. This will require deepening the inflow channel to match the bottom of the culverts that feed the Lagoon. The outflow area will need adjustment to ensure the necessary drop at 5 m^3/s of flow. The outflow gates will be replaced with wave shaping structures.

11.6.3 Effect on Water Surface Elevation

At the Lagoon location, the water surface elevation upstream will remain similar and be controlled by the Obermeyer gates and the adjustable wave structure. The water surface elevation downstream will likely increase as more water will be flowing through.

11.6.4 Environmental Impacts

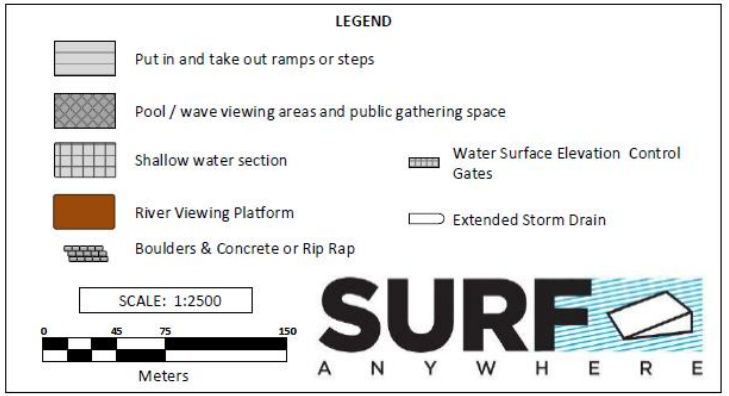
Building a wave at the Lagoon location will have some environmental impacts. To create a surfing wave the flows through this area will need to be increased and will require a higher flow channel. This channel can be created while minimizing impact to the surrounding area. The flow through the Lagoon will also substantially increase.

11.6.5 Design Flows

The design flow range is 5 m^3/s which is the maximum expected flow through the culverts. This range provides good surfable waves during June, July and part of August.

11.6.6 Lagoon – Concept Design

DRAFT FOR ALBERTA RIVER SURFING ASSOCIATION
FEBRUARY 23, 2018
PRINCE'S ISLAND LAGOON SURF WAVES AND URBAN BEACH
CONFIDENTIAL



12 Recommended Wave Location

The recommended Wave Location is near Louise Bridge.

12.1 Location Evaluation

Each location is ranked based on the criteria from 1 to 5. Lower numbers are better.

Criteria	Louise Bridge	Princes Island Park	Notes
Low Cost	3	5	Both locations require significant funds. Princes Island requires adjustment to large portions of the Lagoon, to the river entry and to the river exit from the Lagoon
Minimal Environmental Impact	1	3	Louise Bridge location is eroding into the river and can be substantially environmentally improved. Princes Island has a lush low flow river and riverbank habitat in the summer.
Wave Quality	1	4	At Louise Bridge, there is enough water all year for world class waves. At Princes Island there is enough water for part of the year for medium quality waves.
Economic & Cultural Benefit	1	4	Louise Bridge is currently barely unused and a world class wave and beach would create a new cultural anchor and new economic activity. Princes Island area is already heavily used and the wave quality would be lower resulting in less of an impact.
River Safety Improvement	2	4	Louise Bridge is currently a hazardous area for rafters. The wave and beach would dramatically reduce the hazard. There is no river hazard at Princes Island.
Minimal conflict with existing usage	1	3	Louise Bridge area is currently barely used and primarily used by wave users and spectators. Princes Island area is heavily used by a wide range of users.

Criteria	Louise Bridge	Princes Island Park	Notes
Small Size of Construction Area	2	4	Louise Bridge area footprint is just at the wave and beach location and environmental enhancements downstream. Princes Island area footprint covers the entire lagoon and the river exit and river entry of the Lagoon
Minimal Upstream Area Affected by Water Level Rise	2	2	Both locations would have minimal impact upstream due to increased water levels.
Easy Construction Access	2	2	Both locations have relatively easy construction access
Easy Access for users	1	1	Both locations are easy for users to access.
Proximity to Downtown	2	1	Louise Bridge area is on the edge of downtown. Princes Island is beside the downtown core.
Total	18	33	

13 Initial Design

This section provides details on the initial design. The initial design an expansion of the concept design informed by stakeholder consultation, experience building river waves and areas, review of other wave designs and review of other river wave areas.

13.1 Overview

The Calgary Urban Surf Beach has a few overlapping design priorities including:

- Reducing and minimizing area flood risk
- Protecting existing infrastructure (ex. Bridges)
- Area user safety
- Good durability and minimal maintenance costs
- Minimizing capital costs
- Excellent recreational river waves
- Excellent urban beach
- Boat Passage
- Fish Passage
- River Access & Egress
- Environmental education

Figure 70: Render of initial design of surf wave area at summer flows

Figure 71: Concept drawing of support facility. First version starting in 2020.

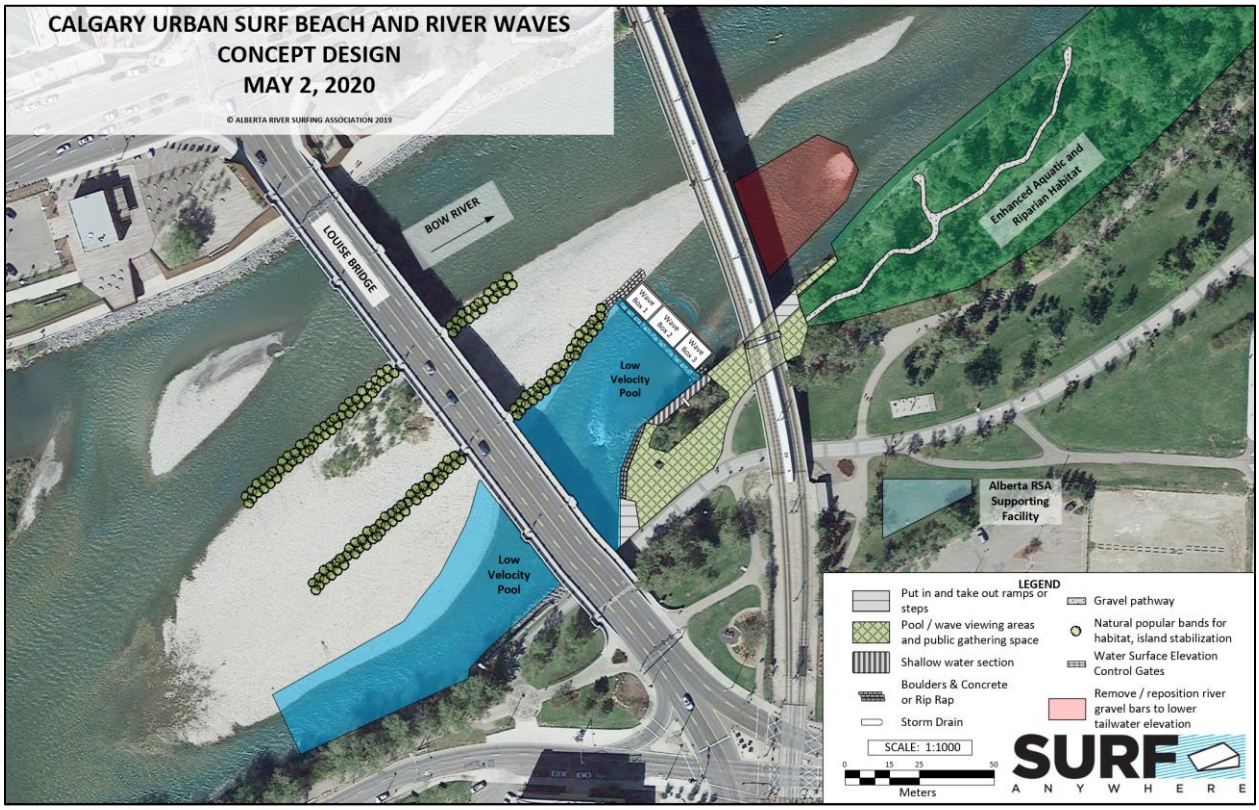
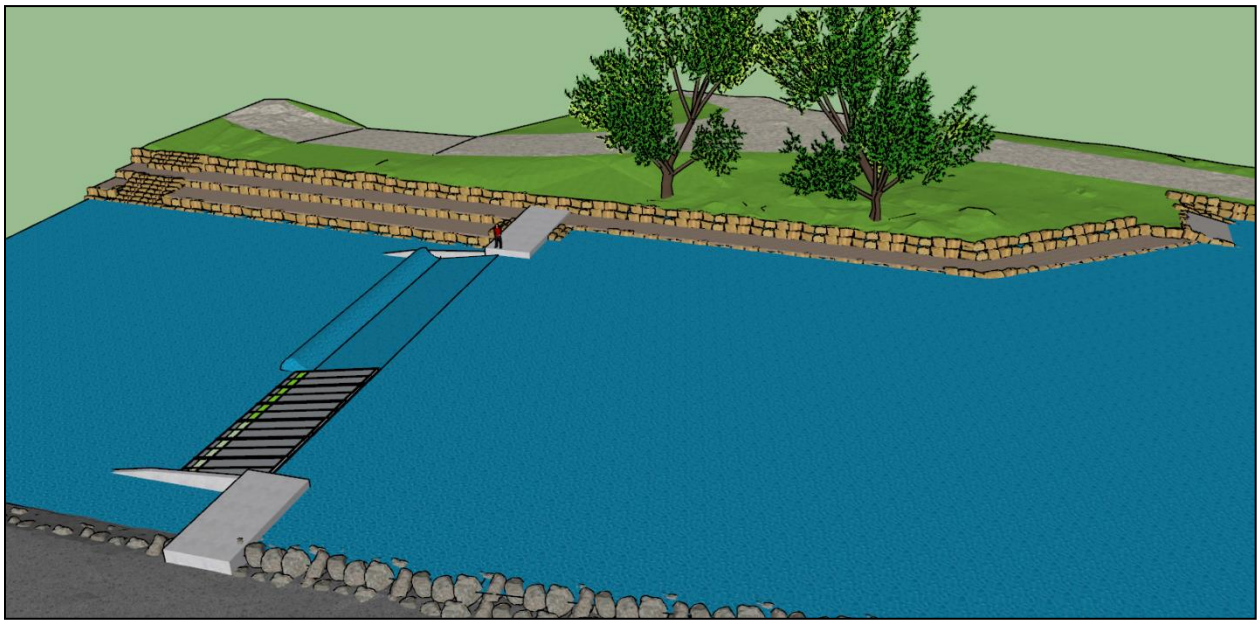
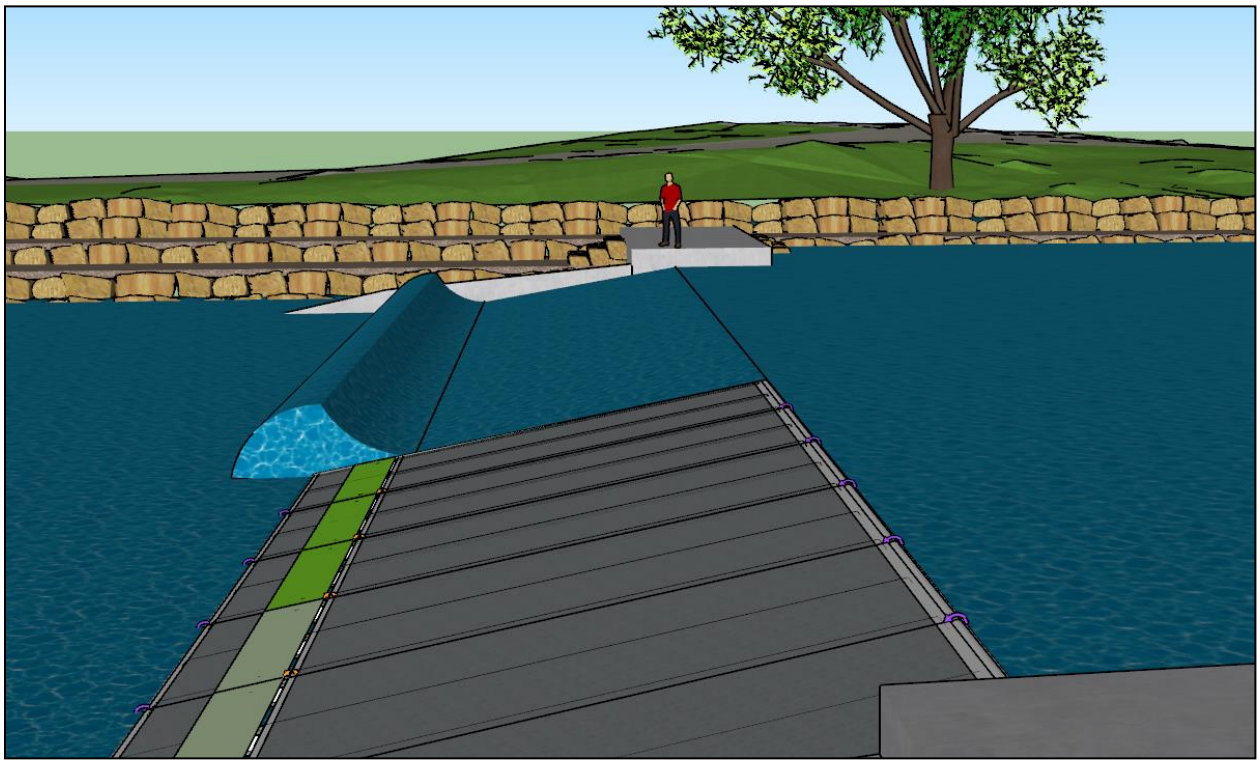


Figure 72: Area layout

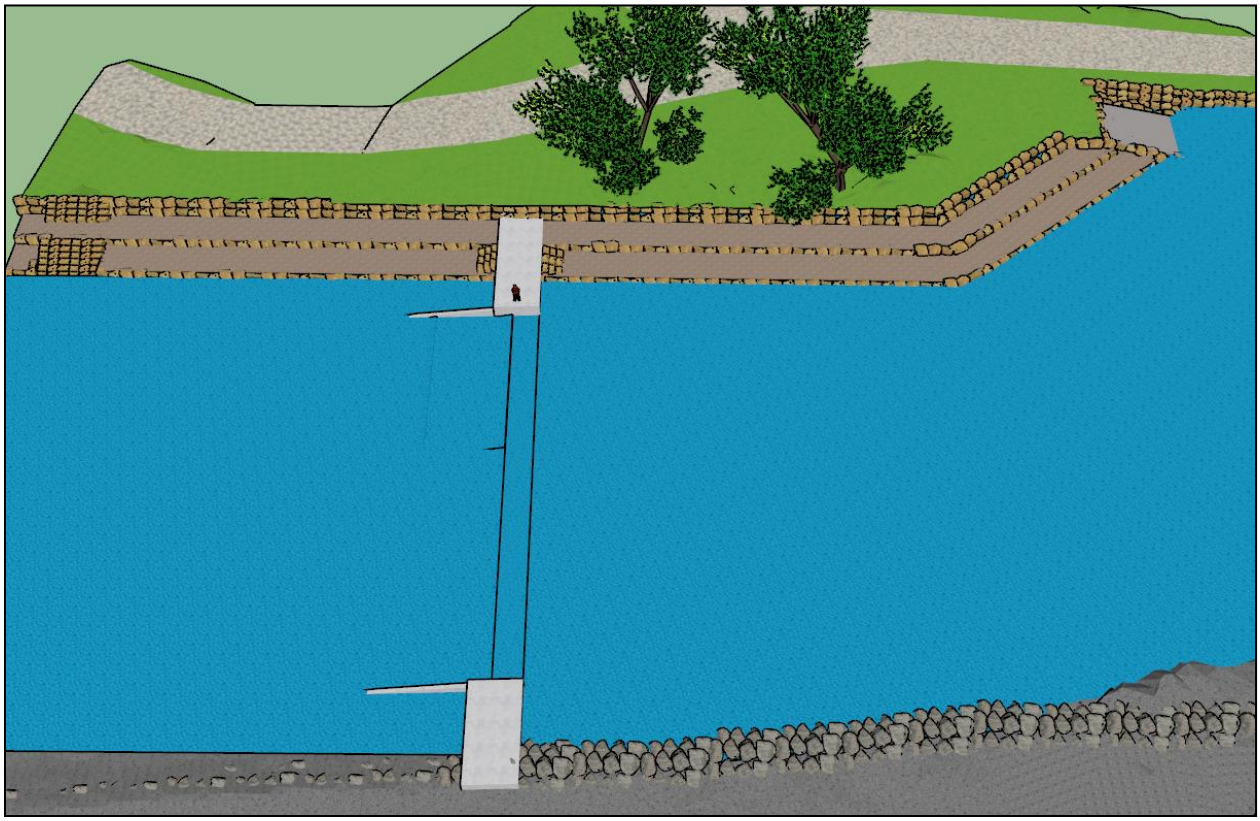
13.1.1 Wave area at 120 m^3/s – Wave structure raised

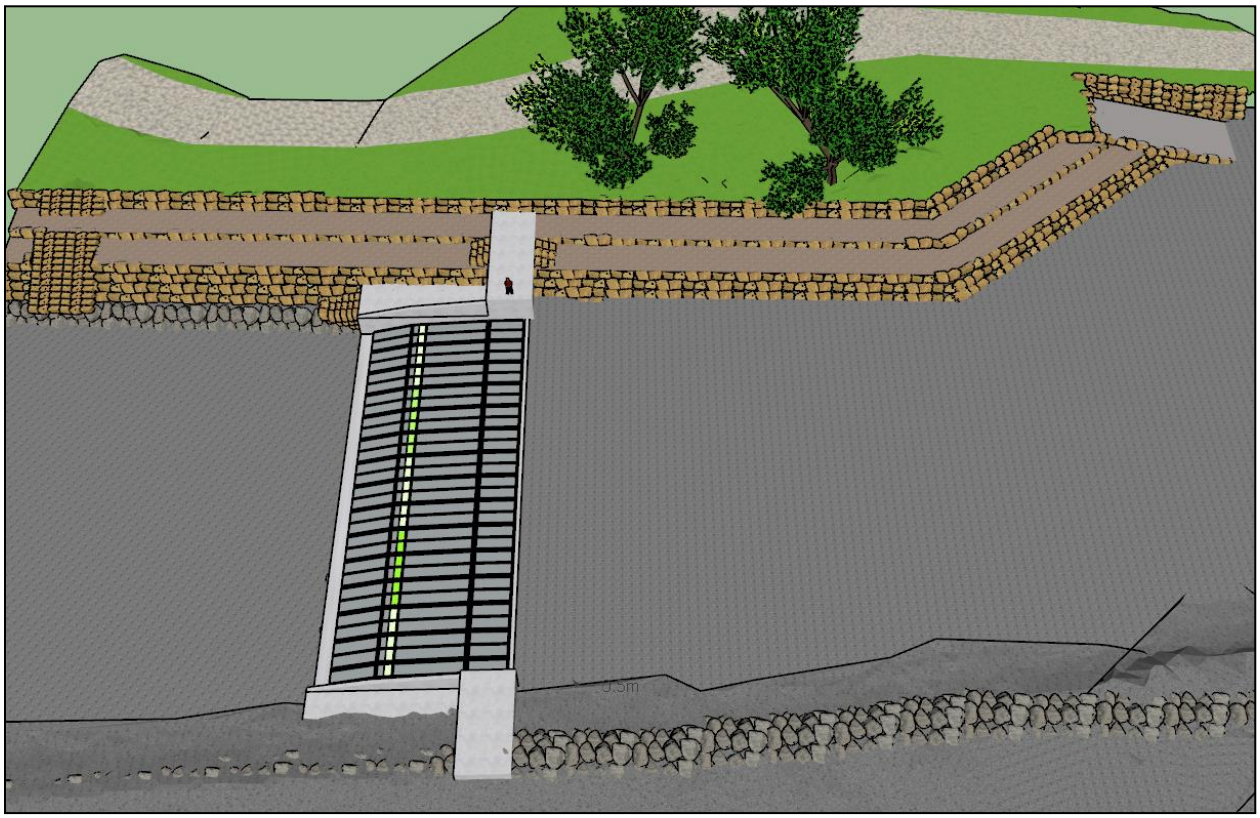
These designs are conceptual. **Actual wave structure and method of movement will be determined during detailed engineering.**





13.1.2 Wave area at 200 m^3/s – Wave structure lowered





13.1.3 Wave structure motion concepts

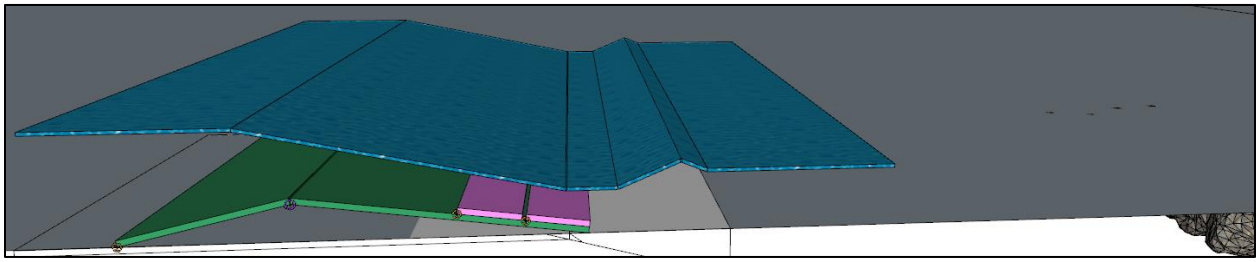
These designs are conceptual. **Actual wave structure and method of movement will be determined during detailed engineering.**

13.1.3.1 Multi section slope that lowers flat

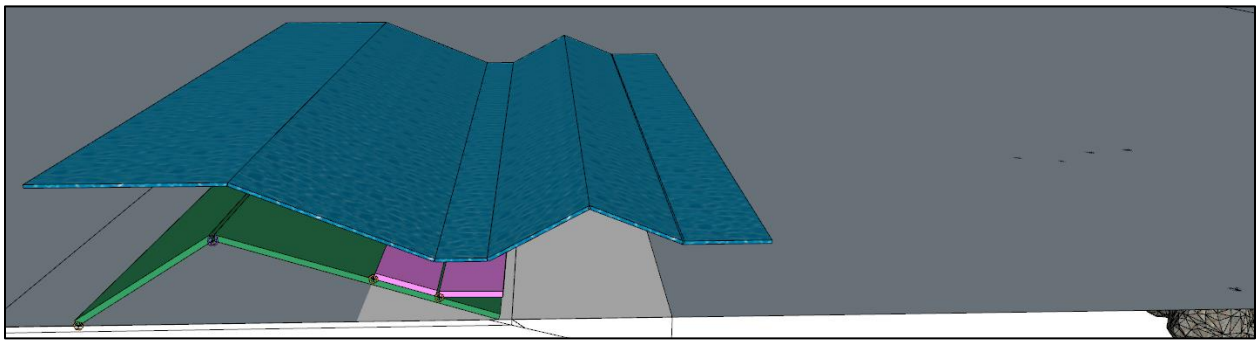
The key design components are:

- Adjustable headwater gate and slope in green.
  - Controls headwater elevation, creates drop, and sets slope angle.
  - Prevents flow over part of channel to keep wave quality in low flow conditions and to make maintenance easier.
- Adjustable kickers in purple.
  - Redirects the flow to form a wave. Allows for waves to form at widely different tailwater elevations. Prevents retentive hydraulic formation.

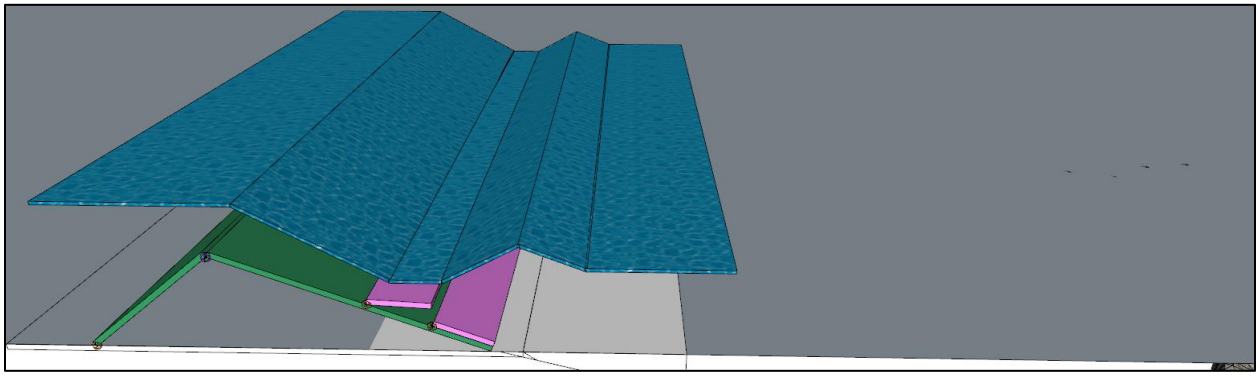
Low tailwater and fixed horizonal transition forms wave



Medium tailwater and first adjustable kicker forms wave



High tailwater and second adjustable kicker forms wave

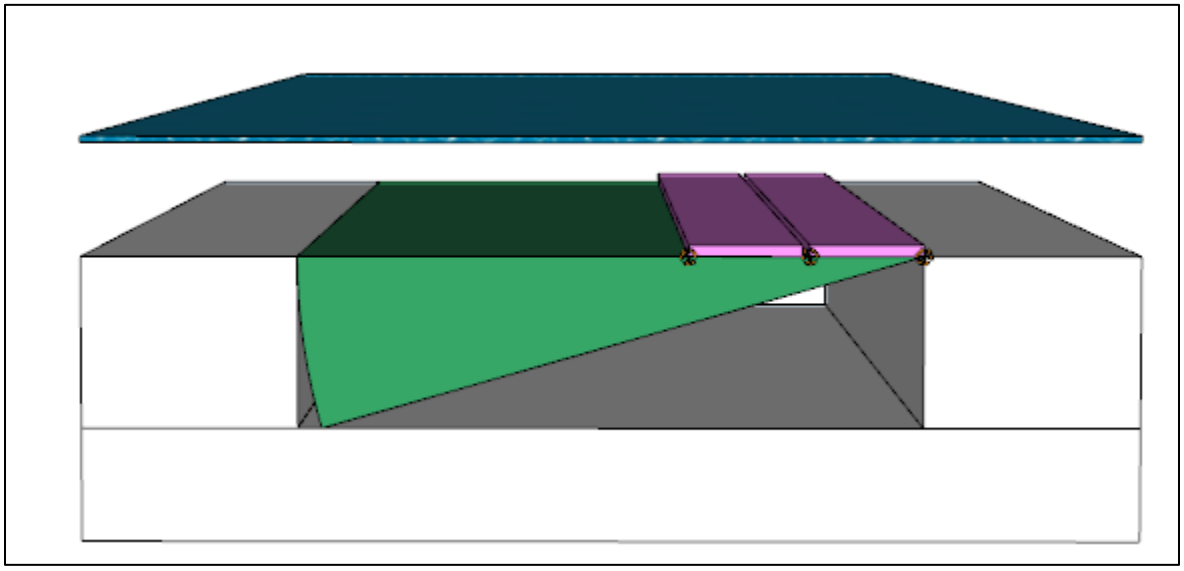


13.1.3.2 Rotating slope that lowers flat

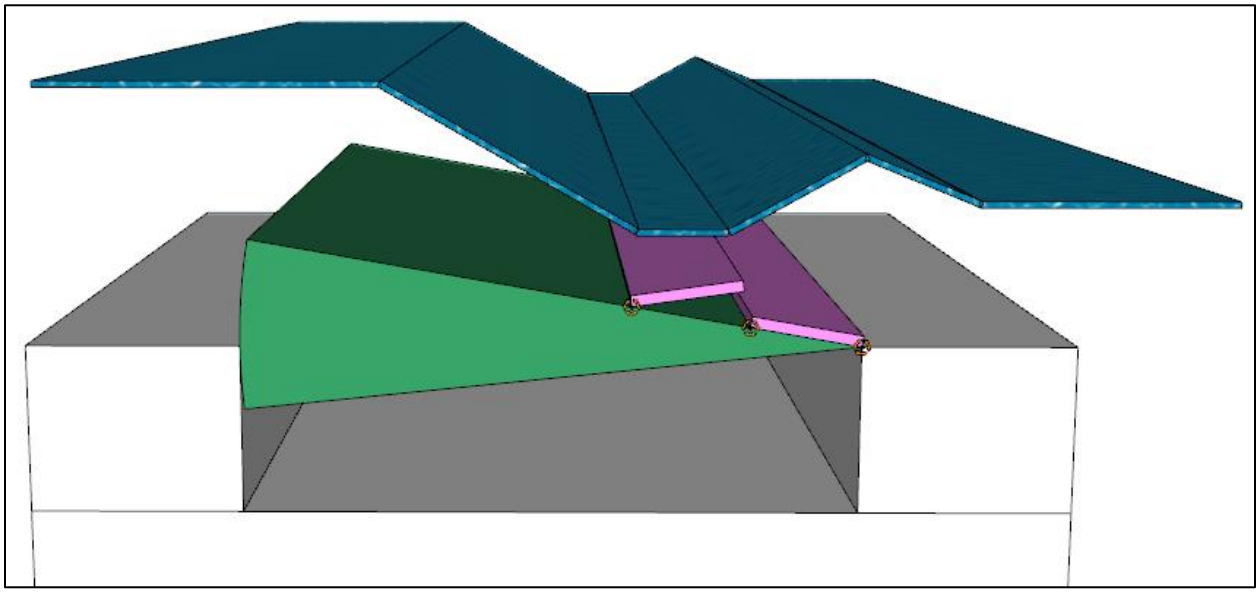
The key design components are:

- Rotating slope in green.
  - Controls headwater elevation, creates drop, and sets slope angle.
  - Prevents flow over part of channel to keep wave quality in low flow conditions and to make maintenance easier.
- Adjustable kickers in purple.
  - Redirects the flow to form a wave. Allows for waves to form at widely different tailwater elevations. Prevents retentive hydraulic formation.

Lowered to flat



Slope rotated up and kicker rotated to form wave



13.1.4 Wave Structure Motion Technology

Currently, the plan is to use hydraulic cylinders with environmentally friendly hydraulic fluid or pneumatic bladders to move the structures. There are hydraulic cylinders and pneumatic bladders proven to work in rivers that can provide the necessary force and control. Alternative technologies are possible.

13.1.5 Physical / Computer Modelling of Wave Structure

The Alberta River Surfing Association, Surf Anywhere, and the Alberta Whitewater Association conducted physical and computer modelling with the University of Ottawa over 1.5 years to determine ideal wave structure designs that will be easy to control, minimize costs and create excellent river waves.

13.1.6 Supporting Facility

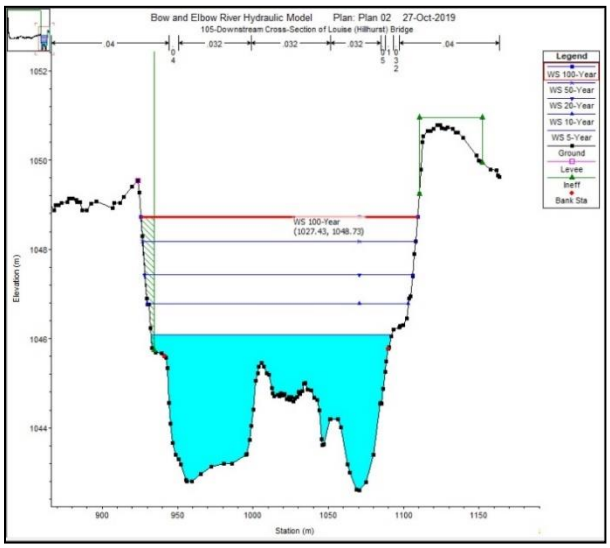
The first and small version of the supporting facility will be constructed in 2020 to provide much needed services to the area and generate revenue for the area. The facility will be removable, will not break ground and will consists of a deck with railing and a small adjacent structure for storage. The deck and structure will look good. Each year the supporting facility will expand until it reaches the final version. The Alberta RSA is in the process of getting a lease for this land. There are long term plans to develop the CPA Lot 6 and adjacent land but there are no firm plans. The supporting facility will use the space until the development will advocate strongly for a space in the development when it happens.

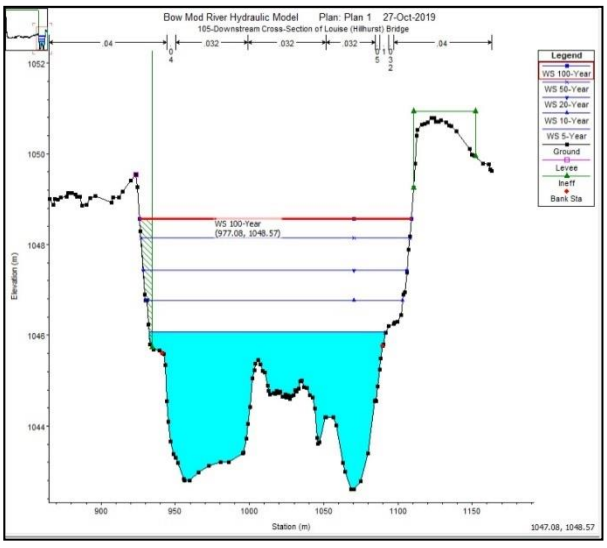
13.2 Reducing Flood Risks

The construction of the River Waves and Urban Beach will lower flood risks at all levels. Modelling of the new river configuration shows water levels are reduced at all flows. The river section containing the 10th Street Wave area has been identified as a major flood risk for Calgary. The source of the risk is the 10th Street gravel bar island that stretches from the upstream of Louise Bridge to downstream of the C-Train bridge. The 10th Street gravel bar island currently occupies the two middle spans of the five Louise Bridge archways. There is increasing vegetation on the 10th Street island which, as the vegetation expands, will further increase future flood risk. The City of Calgary plans to reshape the 10th Street Gravel Bar Island and has completed a conceptual design for the project.[54] The Calgary Surf Beach and River Waves project can turn a major flood risk in to major benefit for Calgary and can provide ongoing funding for future flood mitigation projects in the area.

13.2.1 HEC-RAS 1D model of water elevations

The cross sections below are just upstream of the wave location. The left image shows the water levels from the 2015 Bow River HEC-RAS Model. The right images show the water levels after the wave structure has been added downstream.





[54] Klohn Crippen Berger. Tenth Street Gravel Bar Reshaping and Fish Habitat Enhancement Project – Conceptual Design. City of Calgary. 2017.

	2015 Model Original	2015 Model with Wave	
Flood Return (years)	Water Surface Elevation (m)	Water Surface Elevation (m)	Difference (m)
100	1048.73	1048.57	-0.16
50	1048.18	1048.15	-0.03
20	1047.44	1047.43	-0.01
10	1046.78	1046.77	-0.01
5	1046.09	1046.07	-0.02

13.2.2 Waves funding ongoing flood risk minimization

The Calgary Surf Beach and River Waves will reduce the risk of future floods and will provide funding for future flood mitigation in the area. This project will generate substantial ongoing revenue and provide major area economic & cultural benefits. A significant portion of the ongoing revenues will be allocated to future flood mitigation work. Part of the capital cost of the project will include a large future flood risk mitigation fund. The revenues, initial fund and area benefits will ensure that any future area flood mitigation projects will be funded and happen quickly.

13.2.3 Collapsible River Control Structures

The in-river water level control and wave control structures are fully collapsible. The control structures are built on a concrete foundation. When the control structures are collapsed, they will allow more flow through than the current cobble river bottom and there will be a reduction in flood risk. The control structures will be fully collapsed prior to and during high water events.

13.2.4 Engineering Report

Engineering reports will be completed confirming the designs will minimize flood risk. Designs will be adjusted as needed during the project to ensure food risk is minimized.

13.2.5 Gravel Bar Island Adjustments[55]

The River Waves requires maintaining the existing separate south channel from the top of the existing gravel bar island to the Ctrain bridge. The channel will be formed by installing a combination of boulders and using existing vegetation along the south side of the gravel bar island. The gravel bar island in-line with the Louise Bridge spans will be lowered and the problem vegetation removed will be removed annually by the Alberta RSA. This gravel bar adjustment will allow a higher volume of flows to pass through the area without causing flooding. The vegetation removal will prevent vegetation from capturing debris during a high water event that will block water flow and increase flood risk.

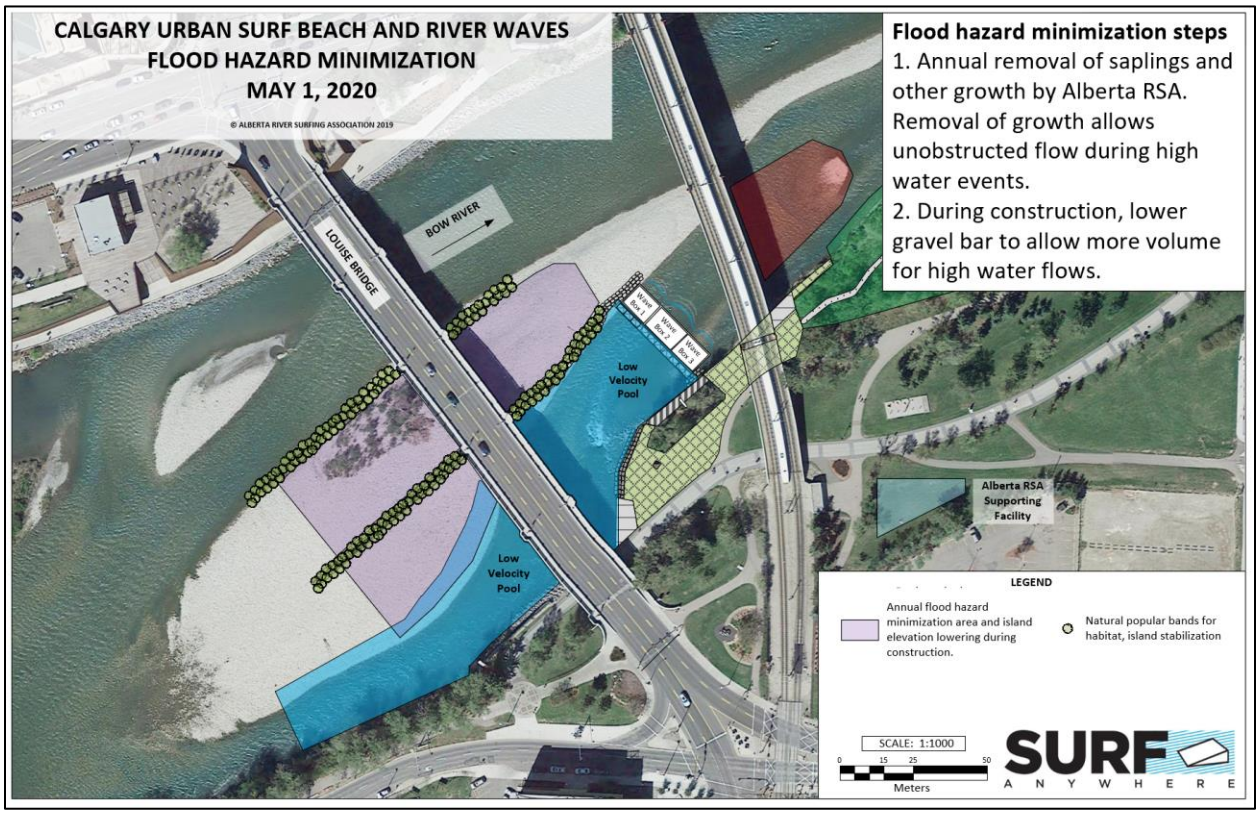


Figure 73: Flood hazard minimization concept design

[55] (Rood, 2020)

Figure 2. The Louise Island Park concept

(1) Clear poplar saplings to avoid woodland development that would impede flood flows,

(2) Leave shoreline poplar bands for habitat, island stabilization and the aquatic food-web,

(3) Allow a pier-aligned mid-island poplar band to provide wildlife habitat, and

(4) The Urban Surf Beach and River Waves project

Arrows indicate the flood flow path (aerial orthophoto, Aug 2019, S.Rood).

3

Figure 74: Flood hazard minimization plan[56]

[56] (Rood, 2020)

13.3 Protecting Infrastructure

There are four main existing infrastructure pieces in the area: Louise Bridge, C-Train Bridge, Enmax 130kV line and storm sewer.

13.3.1 Louise Bridge

Louise Bridge is located upstream of most of the Calgary Surf Beach and River Wave project. The key concerns with respect to the Louise Bridge are scour at or damage to the bridge piles and the ability to inspect the piles.

13.3.1.1 Effect on Louise Bridge

Most of the Surf Beach and River Waves project will be downstream of Louise Bridge. The project will have the following effects around Louise Bridge:

13.3.1.1.1 Higher water surface elevation

The water surface elevation on the south channel bridge piles will be high when the waves are operating.

13.3.1.1.2 Deeper and slower water

The water will be deeper and slower on the south channel bridge piles when the waves are operating.

13.3.1.1.3 Lower gravel bar island

The elevation of gravel bar island will be lower under the central spans of Louise Bridge.

13.3.1.1.4 Minimum river cobble elevation

The concrete control structure foundations will maintain minimum river cobble elevation upstream of the control structure foundations.

13.3.1.1.5 Channel walls near bridge

There will be channel walls near the Louise Bridge piles. There will be enough space between the walls and the piles to allow for necessary pile inspections. The walls will be a combination of large boulders and vegetation.

13.3.1.2 Avoiding scour damage

Since the river upstream of Louise Bridge will be slower and the concrete wave foundation will maintain a minimum river cobble elevation, there will be a decreased risk of scour around the south channel bridge piles. The north channel and the north channel bridge piles will not be significantly affected by this project.

13.3.1.3 Pile inspection

Pile inspection requires access to the base of the bridge piles. The project will leave enough space around each bridge pile for proper inspection.

13.3.1.4 Engineering Report

Engineering reports will be completed confirming the designs will have no negative impacts on Louise Bridge. Designs will be adjusted as needed during the project to ensure there are no negative impacts on Louise Bridge.

13.3.2 C-Train Bridge

The C-Train bridge is located downstream of most of the Calgary Surf Beach and River waves project. The key concerns with respect to the C-Train bridge are scour or damage to the piles and the ability to inspect the piles.

13.3.2.1 Effect on C-Train Bridge

Most of the Surf Beach and River Waves project will be upstream of the C-Train Bridge. The project will have the following effects around the C-Train Bridge:

13.3.2.1.1 Higher water surface elevation

The water surface elevation on the south channel bridge piles will be high when the waves are operating.

13.3.2.1.2 Faster water

The water will be faster under the south span when the waves are operating.

13.3.2.1.3 Lower river cobble elevation

The river cobble elevation will be lower for a distance downstream of each wave location.

13.3.2.1.4 Channel walls near bridge

There will be channel walls near the C-Train piles. There will be enough space between the walls and the piles to allow for necessary pile inspections. The channel walls will provide scour protection to the piles. The walls will be a combination of large boulders and vegetation.

13.3.2.2 Avoiding scour damage

The river going under the C-Train bridge below the south span will have a higher velocity when the waves are in operation. The wave structures can be adjusted to direct the flow and the flow will be directed far enough away from the piles to avoid scour. The channel walls will also be positioned to protect the piles from high velocity flows and from scour. The north channel and the north channel bridge piles will not be significantly affected by this project.

13.3.2.3 Pile inspection

Pile inspection requires access to the base of the bridge piles. The project will leave enough space around each bridge pile for proper inspection.

13.3.2.4 Engineering report

Engineering reports will be completed confirming the designs will have no negative impacts on the C-Train Bridge. Designs will be adjusted as needed during the project to ensure there are no negative impacts on the C-Train Bridge.

13.3.3 Enmax 138 kV line

The Enmax 138 kV line runs in the riverbed upstream of most of the Surf Beach and River Waves project and between the Louise Bridge and the wave control structure foundations. The wave control structure foundation will be at least 10m from the Enmax 138 kV line. The key concerns with respect to the Enmax 138 kV line are disturbing the line during construction and scour.

13.3.3.1 Effect on Enmax 138 kV line

Most of the Surf Beach and River Waves project will be downstream of the Enmax 138 kV line. The project will have the following effects around the Enmax 138 kV line:

13.3.3.1.1 Higher or same cobble elevation

The cobble over the 138 kV line will be deeper or the same because the foundations are downstream of the line and will maintain the existing cobble bed elevation.

13.3.3.1.2 Slower or same water velocity

The water going over the 138 kV line position will be slower because of increased water surface elevation upstream of the wave or the same when the waves are not active.

13.3.3.2 No possibility of scour

The waves will be downstream of the 138 kV line and there will be no possibility of scour from the waves affecting the 138 kV line.

13.3.3.3 Engineering report

Engineering reports will be completed confirming the designs will have no negative impacts on the 138 kV line.

13.3.4 Storm Sewer

There is a storm sewer that empties from the south bank of the Bow River into the area of the Surf Beach and River Waves project. The foundations will be downstream of the storm sewer and can be built around the storm sewer, so the sewer outflow is not impeded by raised river levels upstream of the wave.

13.3.4.1 Engineering report

Engineering reports will be completed confirming the designs will have no negative impacts on the storm sewer.

13.4 User Safety

The design of the river waves and surf beach will minimize risk and maximize safety while creating an excellent river recreation resource. See additional information on safety in Section 10.10 Safety Plan.

13.4.1 User River Risk Table

The following table details river risks to users.

Name	Description	Mitigation
Impact	Striking river bottom, banks or wave structure	Ensure a good depth and velocity of water over wave structure using the water level control gates. Good water depth and velocity combination minimize the risk of users striking the structure because the water quickly moves them downstream. Moving the user quickly downstream both avoids impact and minimizes the force of any impact. Provide stable and flat entry points for accessing river waves that have traction when wet. Encourage use of floatation vests to further minimize risk of impact and to provide protection in case of impact.
Recirculation in a hydraulic	Held in a river feature that cycles around and does not release user	Use the wave control structure to only create low risk river features like waves. Through modelling prior to build, testing after build and ongoing testing & monitoring will ensure only slow risk river features will exist.

Name	Description	Mitigation
Body part entrapment	Limb wedged into a narrow space in the river and user is not able to get free	Ensure any gaps on riverbank or in river structures are too small to entrap a body part.
Leash entrapment	Leash is wedged into a narrow space in the river and user is not able to get free	Ensure there are no catch points on the wave structure for leashes or ropes. Encourage use of low risk river safety gear.
Pinning	Water flow pushing user against an object and user is not able to get free	Model river flow from waves, observe river flows patterns during commissioning and monitor flow patterns during use. Ensure there are no fast flows against objects that could hold a river user.
Hypothermia	Bottom temperature of user drops dangerously low	Encourage appropriate river gear and clothing.
Being swept downstream	Current takes user downstream away from planned takeout area	Include multiple exit points along riverbank. Exits will include a boulder at rivers edge to provide an eddy and an easy way to exit the river.
Debris coming from upstream	Wood or other floating debris can strike users on the wave.	Onsite signage to educate users about risks coming from upstream.
River users coming from upstream	Rafters, SUPers, kayakers and other river users can strike users on the wave.	Onsite signage to educate users about risks coming from upstream.
Upstream users exiting the river before the wave	River floaters will want to exit the river in the pool upstream of the wave because this is the first good exit point of downtown and to enjoy the area.	Signage on the river indicating take out upstream of the exit and at the exit. Make the exit easy to access, big enough for multiple vessels and have minimal water velocity.

Name	Description	Mitigation
	Unaware floaters could try to cross the river at the last moment to get to the exit. River elevations. vary substantially depending on flows and take out point will be different at different levels	Provide long exit ramp or steps that will work at high and low river elevations.
Vessels and swimmers unintentionally going through wave	Vessels and swimmers could accidentally go through the wave and not be prepared. Boaters will likely fall out of their vessel.	Signage on the river indicating take out upstream of the exit and at the exit. Curve edges of upstream end of channel to allow vessels and swimmers to enter the channel at the last moment. Make channel walls smooth so they are safe for users who bounce against them if they try and fail to cross the channel upstream. Ensure there are no retentive hydraulics so people who fall out of there vessel will move downstream.

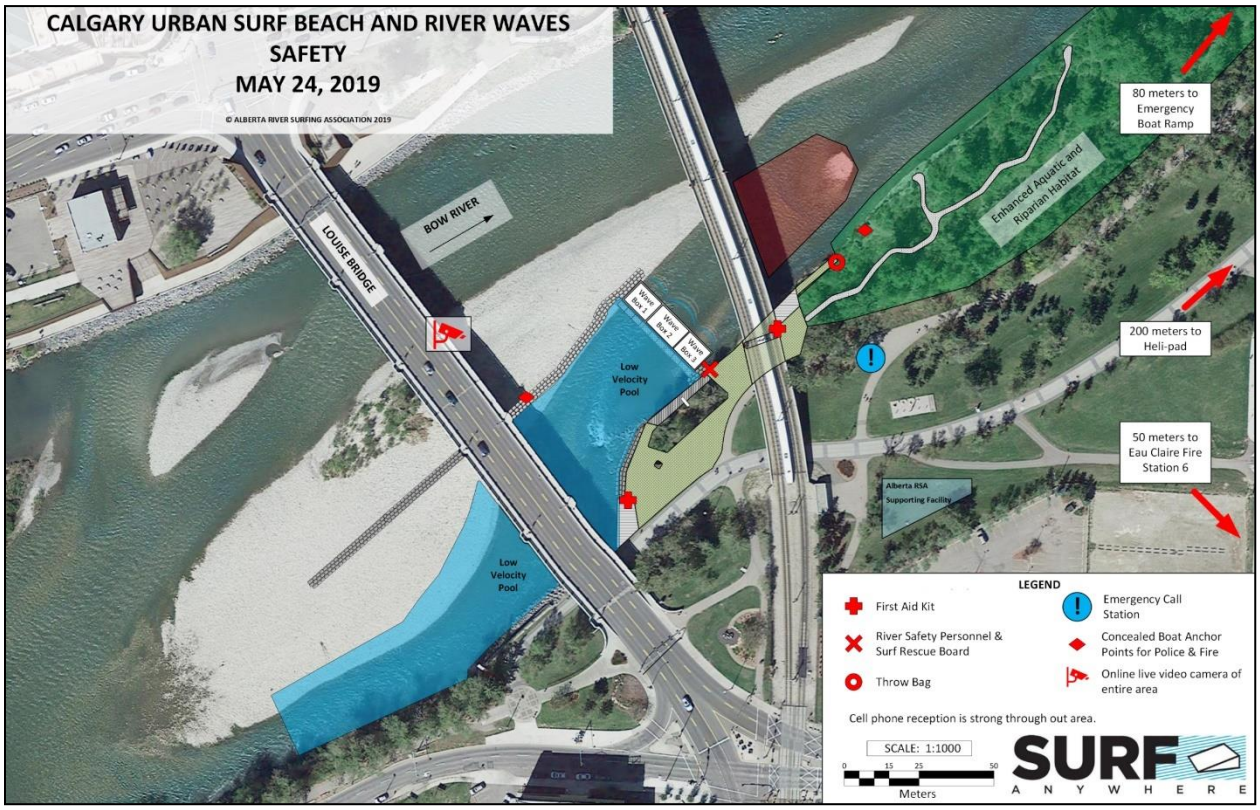
13.4.2 User Riverbank Risks

The following table details riverbank risks to users.

Name	Description	Mitigation
Falling off edge	Falling off or down the edge of the riverbank	Provide clear indication of riverbank edge using change in material such as boulders. Built a tiered river's edge to allow easy movement from top of bank to river.
Tripping over obstruction	Tripping over an obstruction on the ground	Create obvious river access and exit routes with minimal to no tripping hazards.
Slipping on wet surface	Slipping on the riverbank	Use materials for the riverbank that will provide traction even when wet.
Portage exit	Slipping on the riverbank	Use materials for the riverbank that will provide traction even when wet.
Pathway traffic	Collision with traffic on pathway	Signage on pathways before surf beach location warning of high traffic area & pedestrian crossing

13.4.3 Safety Monitoring & Response

The Surf beach and river waves design includes a variety of safety monitoring components to allow effective response to any issues.



13.4.3.1 Video Stream

There will be a video camera(s) that provide online live stream(s) of the area to emergency services, wave operations personnel, the public and other groups requiring the access. Emergency services and wave operations personnel will have access to a private high-resolution feed. The public will have access to a lower resolution feed to protect privacy.

13.4.3.2 Safety personnel stations

River safety personnel stations will be included in the design. The stations will make it easy for volunteer and professional river safety personnel to quickly and effectively setup and monitor during their monitoring periods.

13.4.3.3 Fire and police service boat anchor points

There will be a few hidden riverbank and island anchor points for fire and police service boats. These anchors points will allow for increased safety and effectiveness if an emergency response is needed and will allow for easier training in the area.

13.4.3.4 Emergency services training

Emergency services will be able to train for various water emergencies at this location. This will make the area safer and the rest of the Bow River safer.

13.5 Boat Passage

A variety of different river vessels will need to navigate around or through the river waves. When the wave structures are lowered, the river will be like the current situation with no waves but safer.

13.5.1 Down river boat passage

All types of Bow river vessels will be able to pass the river waves. There are three options for passing the river waves going downstream. There are many, very clearly marked and easily accessible opportunities for vessels to by-pass the waves until just before the waves. Going through the waves has low risk.

13.5.1.1 Avoiding the wave channel

River vessels will be able to take the north channel of the Bow upstream of Louise Bridge. The north channel will be untouched by the Surf Beach and River Waves projects and will have the existing gradual slope.

13.5.1.2 Portage around the wave

River vessels that take south channel of the Bow river upstream of the Louise Bridge will enter the Surf Beach and River Waves area. The river section immediately upstream of the waves will be deep and slow with clearly marked and easy to use exit points. The exit points will allow river users to portage their vessel around the river waves with minimal risk.

13.5.1.3 Going through the waves

River vessels that do not exit the pool upstream of the wave will go through the river waves. Going through the waves will be exhilarating and will likely capsize inexperienced users. Vessels that capsize can be collected downstream when they reach an eddy or when users swim to their vessel. Vessels that do not capsize can continue downstream or enter an eddy.

13.5.2 Upriver boat passage

Only two types of boats will be going upriver because going upriver requires a motor and only police & fire service vessels are allowed motors on the Bow river in Calgary. There are two options for going upriver either through the wave channel or through the unchanged north channel.

13.5.2.1 Upriver passage when wave is operating

When the wave is operating it is not recommended to go upriver through the wave channel and over the waves. The wave creating structures and the resulting wave shapes mean that a boat going upriver could strike the adjustable parts of the structure and possibly damage the structures of the boat. There will also be a lot of users in the water that may not notice the boat(s). The wave structures can be quickly lowered to a configuration that allows low risk upriver boat passage. Upriver passage is always possible through the north channel.

13.5.2.2 Upriver passage when wave is not operating

When the wave is not operating it is easy for boats to travel upstream through the wave channel over the lowered wave control structures and water elevation control structures.

13.5.3 Emergency boat passage

The area will allow for effective emergency boat passage by the:

- Ability to quickly change configuration of wave and river level control structures to allow upriver boat passage
- Clear communications and action plan for quickly changing configuration of wave and river level control structures when requested by police or fire services. Emergency services will be able to lower control the waves if an operator is not available.
- Training of police and fire service boat crews on navigating the wave channel and responding to emergencies

13.5.4 Drift Boats

Drift boats will be able to pass through the wave area. The boats can take the north channel and avoid the waves entirely. If they take the south channel they can go over the waves, portage, take out or the waves can be temporarily adjusted or lowered to allow easy passage.

Figure 75: Drift boat going through low water channel at Harvie Passage[57]

[57] (Harvie Passage- A Challenge For Drift Boat Use, 2019)

13.5.5 Families and Low Skill Rafters

Low skill rafters and families and others will have lots of time to avoid the wave channel and get to shore before reaching the wave channel. The river upstream of the waves will be flat and slow allowing for easy navigation. There will be obvious and easy to use exit points allowing low skill river users to exit before the waves. The features are not retentive and people going through the waves will float downstream. During high usage periods there will be river life safety personnel onsite.

13.6 Fish Passage[58]

There are a variety of ways for fish to pass the river waves. The project will have minimal effect on fish passage. There is detailed study of the effects on fish passage in the Appendix in the Environmental Impact report.

13.6.1 North channel

The north channel will be unchanged and fish will be able to swim up and down the river along the north channel at any time.

13.6.2 South channel when waves are not operating

When the waves are not operating in the south channel and the wave and water level control structures are lower than fish will be able to easily pass up and down the south channel. Wave and water level control structures can easily be lowered at critical times for fish passage. The control structures will be lowered at night, during high flow periods and during ice coverage.

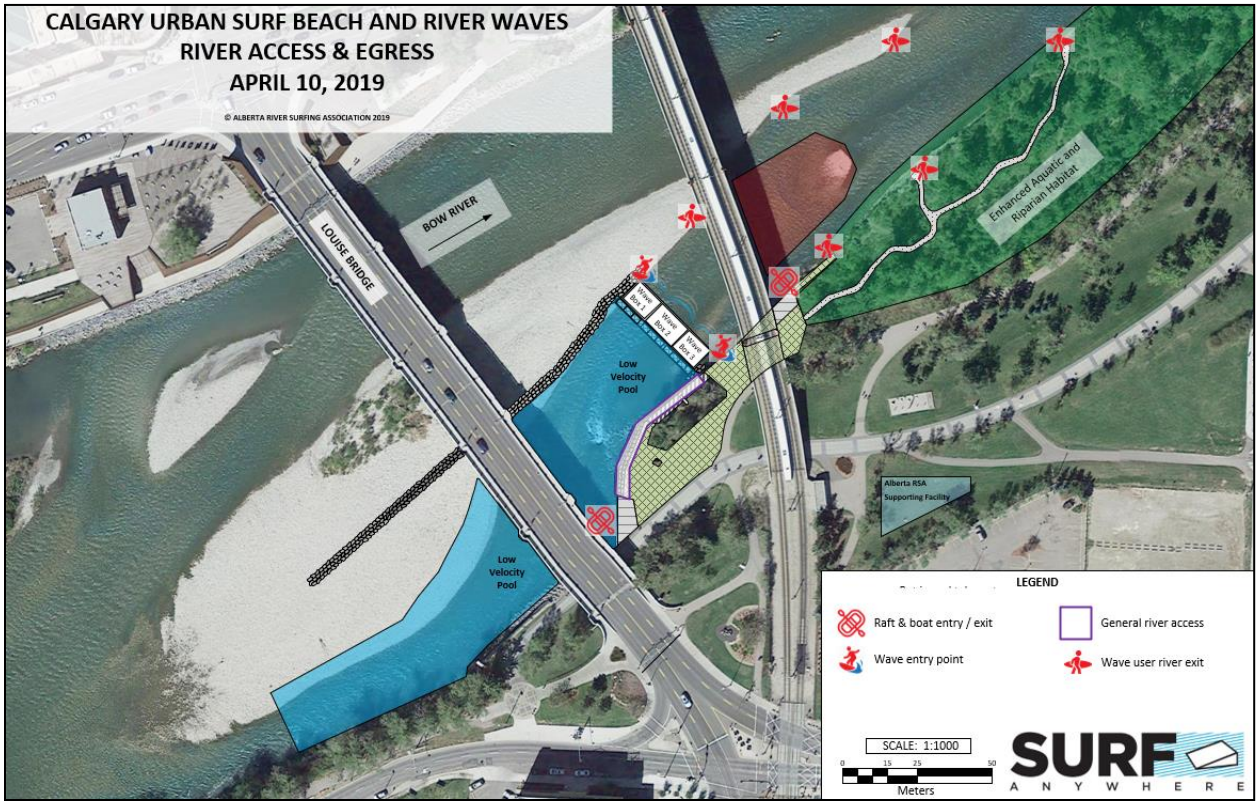
13.6.3 South channel when waves are operating

When the waves are operating in the south channel, some fish will not be able to pass upriver. Fish will be able to pass down river.

[58] (Rood, 2020)

13.7 River Access & Egress

The Surf Beach and River Waves will provide excellent and much needed river access & egress. The beach and waves are the first downtown river location and will be a gateway from the river to the communities and from the communities to the river.

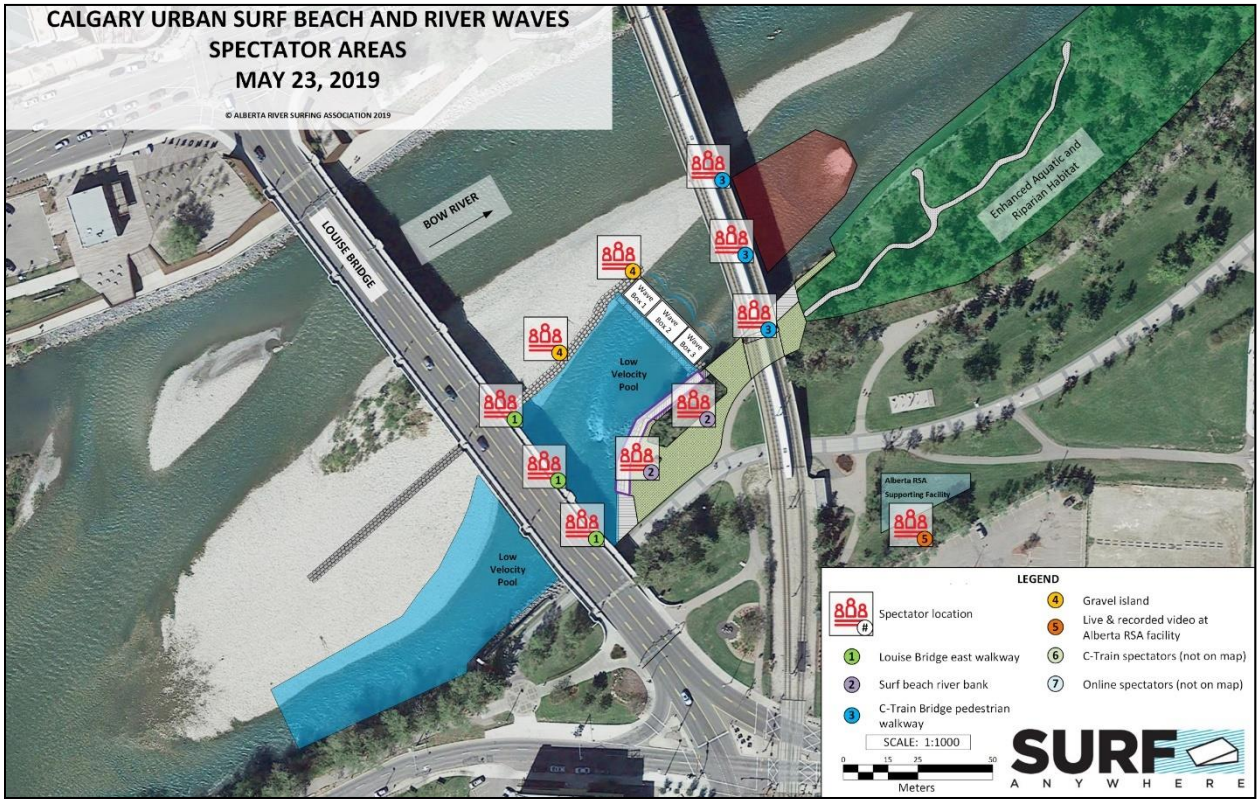


13.8 Area Usage

There are three main user group of the Surf Beach and River Waves area: spectators, river users and wave users. This section details how each group will interact with the space.

13.8.1 Spectators

Spectators come to the area to enjoy the surf beach and the spectacle of surfers on the river waves. Spectators come intentionally to the area or stop as they are passing by. The area will be made comfortable for spectators through permanent features and urban beach components deployed by the Alberta RSA. The length of time spectators stay in the area depends on the quality of the surfing and the comfort of any spectating location. The locations listed below are all regularly used spectators at the existing wave except for the gravel island (#4), the Alberta RSA facility (#5) and online spectators (#7).



13.8.1.1 Louise Bridge east walkway spectators

This spectator location is a dedicated pedestrian walkway on Louise Bridge that is separated from traffic by a waist high barrier. This location provides excellent views of the surf waves for the entire length of the bridge and includes turrets that can fit more people out of the way of people passing through. Spectators typically stand, lined-up against the bridge railing to watch surfing. This will be a very popular location for taking photos and videos because the wave looks very good from the Louise

Bridge. Spectators here can easily be drawn to the communities on either end of Louise Bridge.

13.8.1.2 Surf beach riverbank spectators

This spectator location is a landscaped and flood proof riverbank designed for spectators to comfortably watch the river, waves, surfers and to access the water. The location is a preferred spot for families, older people and for those who want to spend a longer time in the area. Spectators on the surf beach tend to sit on the ground, banks or seating provided by the Alberta RSA. The Alberta RSA will provide extensive deployable surf beach infrastructure to make the area more comfortable for spectators.

13.8.1.3 C-Train Bridge spectators

This spectator location is the dedicated pedestrian walkway on the C-Train Bridge. The location provides good views of the surf waves from the entire length of the bridge. Spectators typically lean on the west railing to watch the surfers.

13.8.1.4 Gravel island spectators

This spectator location is the gravel island and the inlaid boulder wall in the middle of the Bow river between Louise Bridge and the C-Train Bridge. This location will be popular with rafters, swimmers, wave users and others floating down the river.

13.8.1.5 Alberta RSA Facility spectators

This spectator location is the Alberta RSA Facility on the west side of the C-Train tracks. This location will be popular with a wide range of people because it will have seating, shade, washrooms, change rooms for wave users, food & drink and screens with a live feed of the surf wave and of high-quality surf films.

13.8.1.6 C-Train Spectators

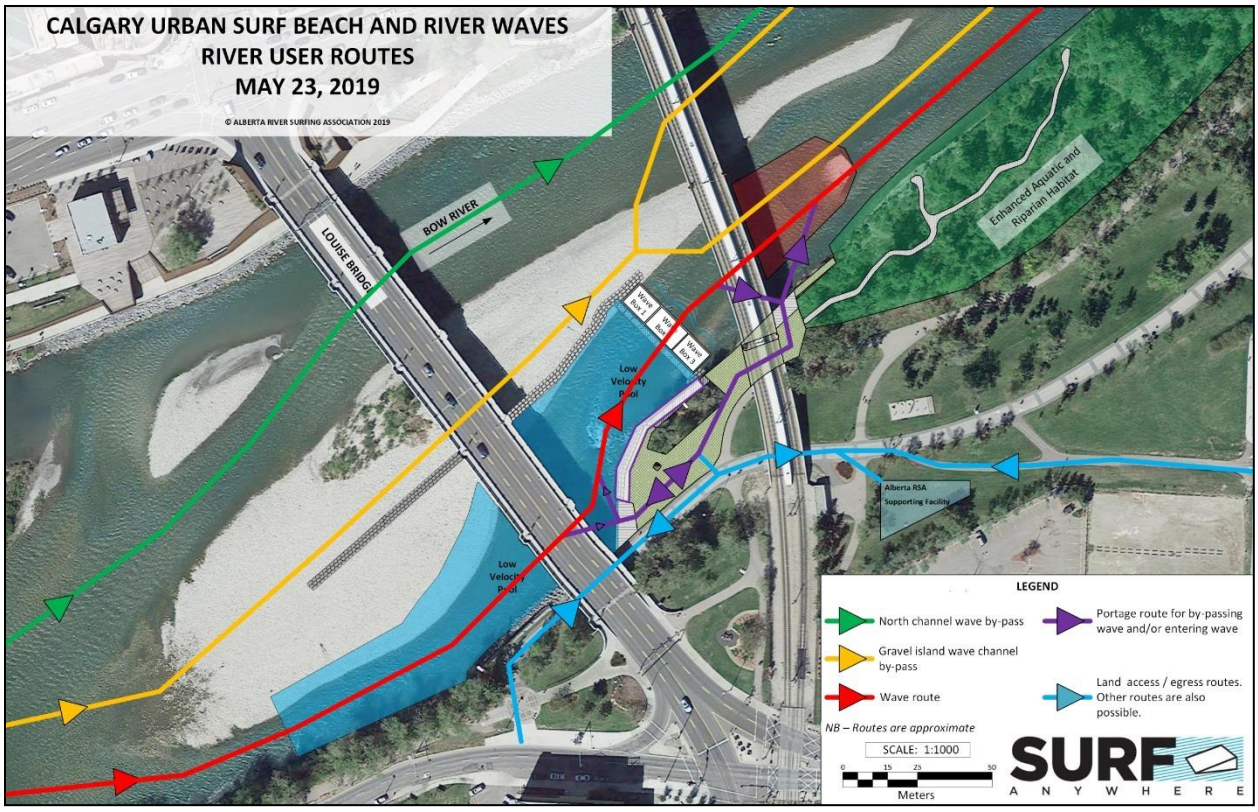
This spectator location is on the C-Train going south. There are about 40,000 people a day who ride the C-Train and who will be able to see the surfing as they enter downtown Calgary.

13.8.1.7 On-line spectators

There will be a substantial number of people from around the world watching the surf wave via the online feed.

13.8.2 River Users

River users will enjoy the Surf Beach and River Waves by floating through the waves, stopping on the gravel island, exiting the river, entering the river, repeatedly going through the wave by walking up the surf beach, using the pool upstream of the wave and by-passing the area using the north channel or portages. River users encompass everyone using the river except for those riding the waves. The area will be made much safer for river users including dedicated and permanent river access and egress points. The slow pool upstream of the wave will become a popular location as a rare deep and calm river section. All these routes are used with the existing wave.



13.8.2.1 North channel wave by-pass

The north channel by-pass is the easiest way to go around the river waves. The north channel will remain unchanged and will continue to be a long, gradual slope. This channel is easy to choose when floating downstream.

13.8.2.2 Gravel island portage

The gravel island portage provides river users a way to enjoy a river island, watching the waves from a unique perspective and a method to by-pass the river waves. The gravel island can easily access anywhere upstream of the wave.

13.8.2.3 Wave route

The wave route provides a low risk thrill for river users. The users take the south channel, stay on the river and ride over the waves. Many inexperienced river users will

fall out of their boats going over the waves. The river downstream slows and the users can swim to or wade to their boat. Some river users will repeatedly take the wave route by either walking back up the gravel island or walking up the surf beach.

13.8.2.4 Surf beach portage

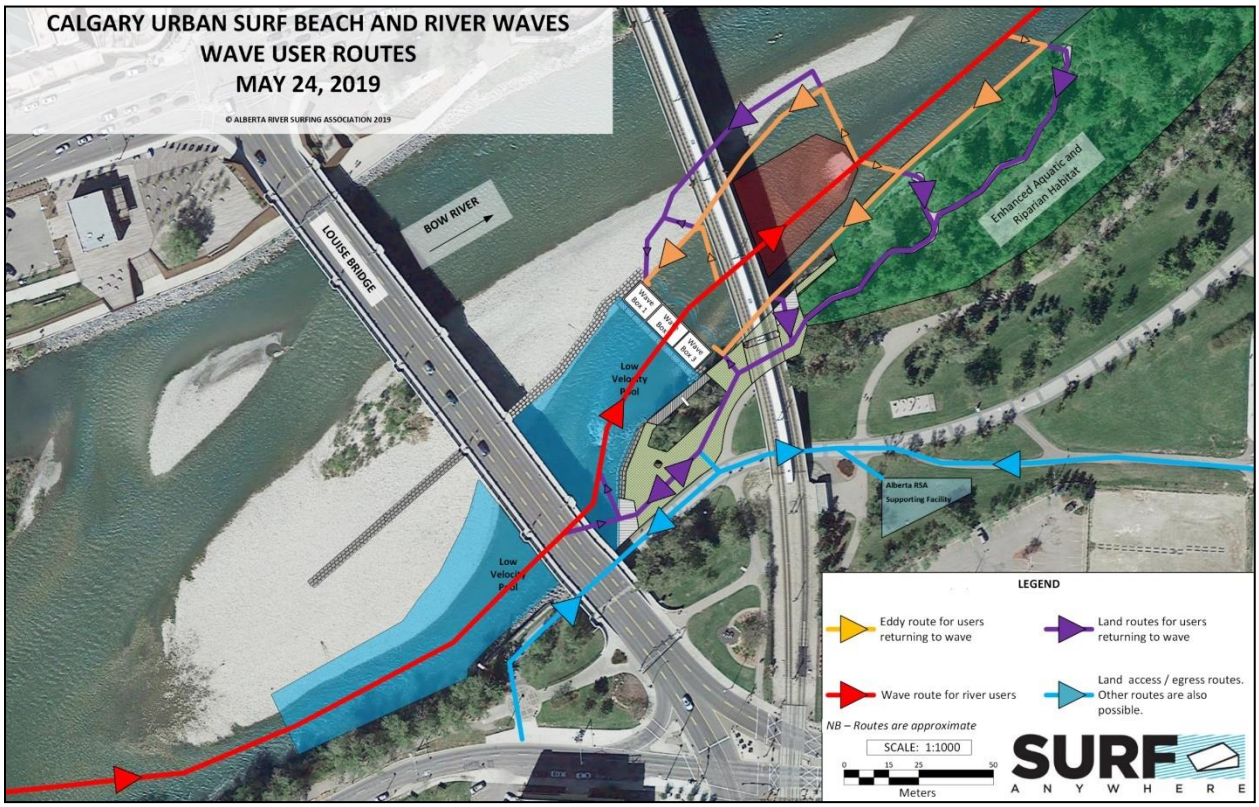
The surf beach portage allows river users to go around the wave from just upstream of the wave. River users will have a new and low risk exit on the south bank and be able to easily carry their vessel to below the new put-in downstream of the wave. The portage will also be used in the opposite direction allowing river users to float through the wave again by walking back up the portage after going through the wave. The downstream put-in also provides a new and low risk river access at the upstream end of downtown Calgary.

13.8.2.5 Access / Egress Routes

The access and egress routes are how river users will leave the area or enter the area by land. River users will be able to drop off certain vessels at the Alberta RSA facility.

13.8.3 Wave Users

Wave users will be locals and those travelling longs distances to ride the waves. Wave users will be repeatedly riding the wave, floating a short distance downstream and then paddling up the eddies or walking up the banks to return to the wave. Wave users typically spend between 30 minutes to many hours in the area. Wave users will be of all ages from youth to seniors.



13.8.3.1 Eddy route for returning to wave

This is one of the main ways wave users will return to the wave. The current coming from the wave will form eddies on the side of the river and river users will be able to enter those eddies and paddle back to the wave. The in-river components of the area will be designed to provide good eddy systems

13.8.3.2 Wave route for river users

Some of the wave users will be arriving from upstream and will depart downstream after their session on the wave.

13.8.3.3 Land route for returning to wave

The land route will be a common path for returning to the wave. On the south bank, wave users will exit at the pathways and then walk back to the wave along the paths. On the gravel island, wave users will exit where they reach the island a walk back along the island to the wave.

13.8.3.4 Land access and egress routes

Most wave users will arrive and leave the area using the existing access and egress routes.

13.8.3.5 Alberta RSA Supporting Facility

The Alberta RSA supporting facility will provide change rooms, gear storage, washrooms, food, drink, shade, surf videos and a community gathering place. Wave users will regularly use the supporting facility before, during and after their surf sessions.

13.9 Area Design

There are three main areas of design for this project: On-shore, in-river and habitat enhancement. The riverbank design covers the south bank, integration with existing riverbank infrastructure and will be the most heavily used area. The in-river area includes the wave structures and the gravel bar island modifications. The habitat enhancement includes the wild area east of the C-Train bridge.

13.9.1 On Shore

The riverbank components create the high value urban beach experience of the space. The components need to encourage low risk and family friendly enjoyment of the area, provide clear direction for area users and integrate well with the existing pathway system.

13.9.1.1 Urban Beach

The urban beach area encourages people to relax by river. The area will be level, comfortable, free from obstructions and will have durable surface.

13.9.1.2 Pathway Integration

There is a major regional pathway beside the area that is heavily used with over 2,500 users per day. In 2018, there were substantial upgrades to the existing pathways. The Project will expand on these improvements. The Project will include signage on the pathways indication a high traffic area and signage for area users indicating the pathway.

13.9.1.3 Preparation and Wrap-Up Areas

There is a lot of space in the area for river use preparation and wrap-up. Changing stalls and equipment lockers will be located at the Supporting Facility. Raft deflation areas will be on the river side of the bike pathway. Signage will remind people of pathway, to cross quickly and to keep bike paths clear.

13.9.1.4 River Hall

In 2020, the Alberta RSA will construct the first parts of the River Hall. The River Hall will be the supporting building for the area and be the base for all the services. The River Hall will provide changing facilities, washrooms, food, drink and a licensed gathering/meeting space. Revenue generated from the River Hall will pay for the maintenance and operations of the river waves and urban beach.

13.9.1.5 Signage

A variety of signage and visual communication is needed for the area to manage users. Signage needs to cover area safety, liability, location and more.

13.9.1.6 Amenities

Amenities will be provided through a combination of City of Calgary provided services and services provided by the Alberta RSA through the River Hall. City of Calgary provided amenities are expected to be the existing trash & recycle bins on the

pathway. The Alberta RSA will be providing change rooms, washrooms, food, drink, gear storage, equipment rental and a licensed gathering / meeting space.

13.9.1.7 Community Gateway

The Calgary Urban Beach and Surf Waves area is the gateway into three communities: Eau Claire, Downtown West & Hillhurst-Sunnyside. The area should have gateway features welcoming to and from people to each neighbourhood.

13.9.2 In River

The in-river components create the high value waves and river experience of the space. The components need to great a low risk and high-quality waves with clear and easy river exits / entrances that smoothly integrate with the onshore area.

13.9.2.1 Access & egress

There are many river access and egress points in the area. The needs at each point vary and they need to reflect the planned usage for that point. Boat access and egress should have ramps. Surfer and SUP and swimmer access / egress should be steps to the river bottom.

13.9.2.2 Riverbanks

The armored and developed riverbanks have a few main purposes:

- stabilize the banks against ice / flood,
- provide excellent seating and viewing for area spectators and
- provide low risk river access / egress.

13.9.2.3 Boulder / concrete berms

The boulder and concrete berms are the foundations of the in-river area. The berms need to:

- direct water flow,
- prevent water undercutting the banks, berms and wave structures,
- control sediment deposition
- provide foundation and protection for the wave control structure and systems
- provide viewing areas for spectators and staging areas for wave users

13.9.2.4 Wave structures

The adjustable wave structures precisely create different waves and make good waves under a wide range of flow conditions. In order to ensure high quality waves and very long-term value, the wave structures need to have the following characteristics:

- Removable / replaceable components allowing for new wave systems to be installed in the future
- High strength attachment points such as bolt holes for adding wave shaping contours to the surface of the wave structure
- Collapsible to avoid ice and flood forces
- Adjustable structure elevation to allow operation during a wide range of flows
- Adjustable angles on wave slope and wave kicker
- Adjustable headwater elevation independent of structure elevation
- Constructed in sections to allow different wave shapes across the wave
- Adjustable position in flow direction to allow angled wave shapes
- Hydraulically or pneumatically moved

13.9.2.5 Signage

In-river signage is needed to clearly communicate river travel options and best practices for river users.

13.9.2.6 Flume for research and education

The flume is a small, controlled channel that allows testing of wave shapes and river effects on a small scale. The flume is located between the wave structures and the riverbank.

13.9.3 Habitat Enhancement[59]

The Calgary Urban Beach and River Waves project is an excellent opportunity to improve the river habitat in the area. Both aquatic habitat and riparian habitat can be enhanced. More details on habitat enhancement are in the Environmental Impact report in the Appendix.

13.9.3.1 Aquatic Habitat Enhancement

Aquatic habitat is habitat in the river. The habitat enhancements will be downstream of the wave area and along the riverbank. These enhancements will provide more areas for spawning, resting and hunting for aquatic animals. The river area around the wave features may also be used by animals.

13.9.3.2 Riparian Habitat Enhancement

Riparian habitat is habitat beside the river and on the riverbanks. The habitat enhancements will be downstream of the wave area in the wild are between the river and paved pathway system. These enhancements will provide more nesting, resting and hunting areas for riparian animals. The riparian habitat enhancement area will feature small but maintained pathways to encourage positive human interactions with the area. There Louise Bridge island will also include improved habitat.

[59] (Rood, 2020)

13.10 Area Access, Parking and Transportation

People will access the area by car, bike, transit, foot, river and other methods of transportation.

13.10.1 Parking & Car Access

There is ample parking in the area including the CPA Lot 6, multiple other parking lots and on street parking. Eventually, the CPA Lot 6 will be developed and, likely, that development will also include parking. In addition, there is lots of parking near CTrain stations and the Project is within easy walking distance of three CTrain stations.

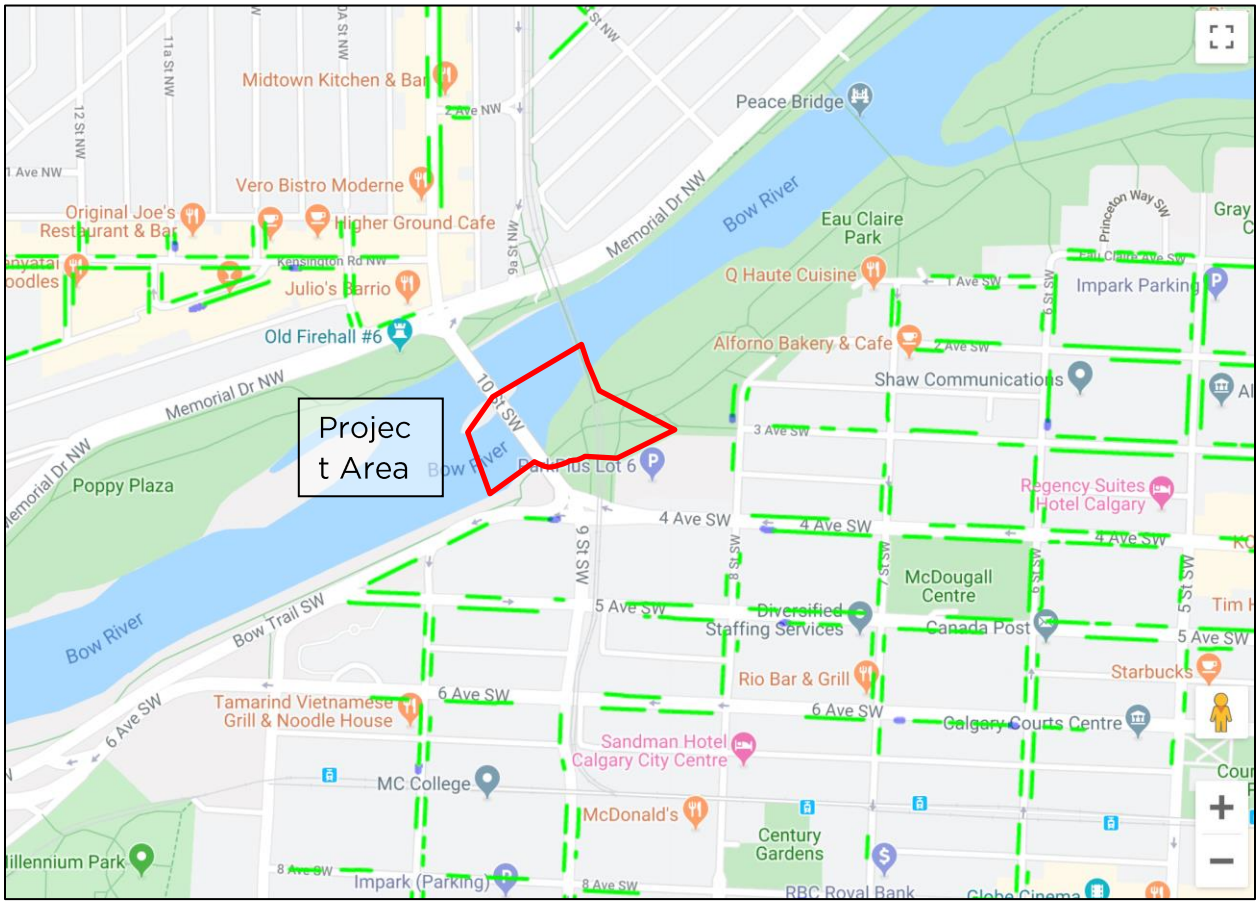


Figure 76: On street parking near the Project area.[60]

[60] (Calgary Parking Authority, 2019)

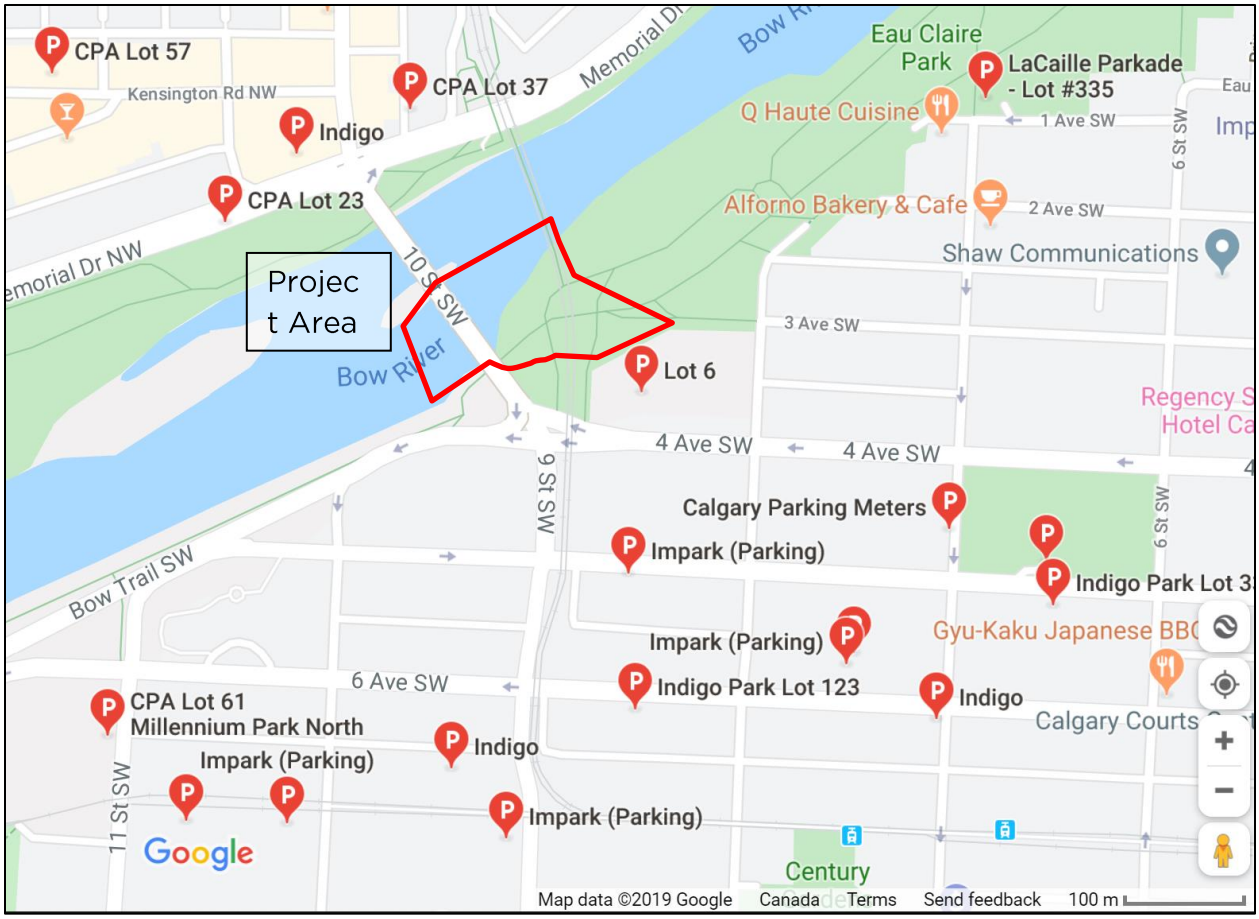


Figure 77: Parking lots near the Project area.[61]

[61] (Google Maps, 2019)

13.10.2 Bike, Foot and Pathway Access

There is excellent pathway access to the Project area. Pathways provide easy access for travelling by bike, foot, scooter and other pathway transportation modes.

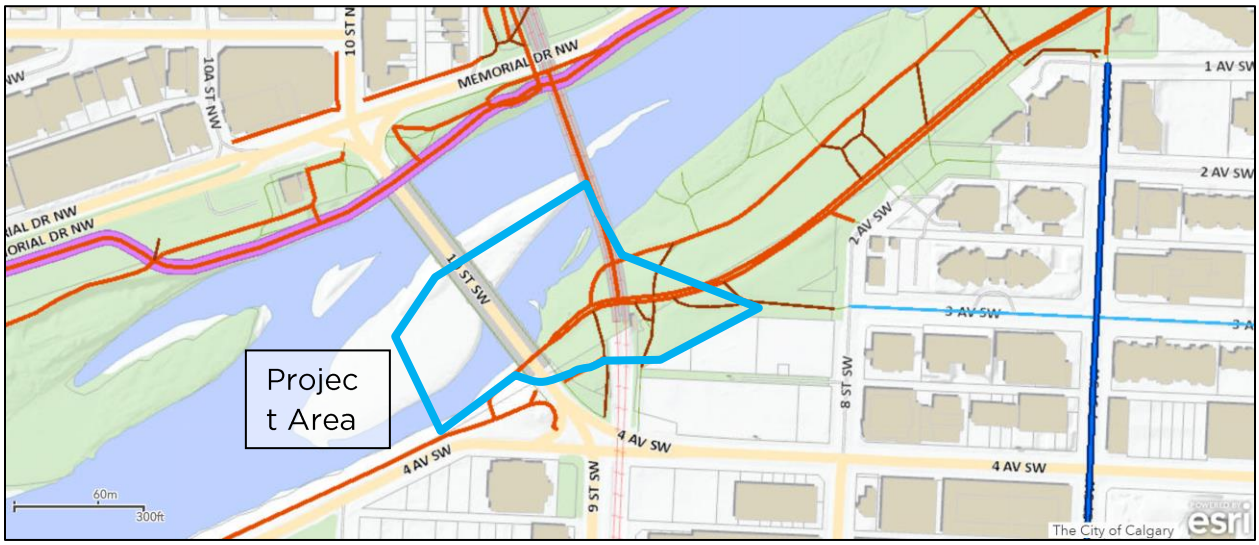


Figure 78: Map of regional and local pathways providing access to the Project area.[62]

[62] (City of Calgary, 2019)

13.10.3 Transit Access[63]

There is lots of transit access options for the Project Area including three nearby CTrain stations covering both main CTrain lines.

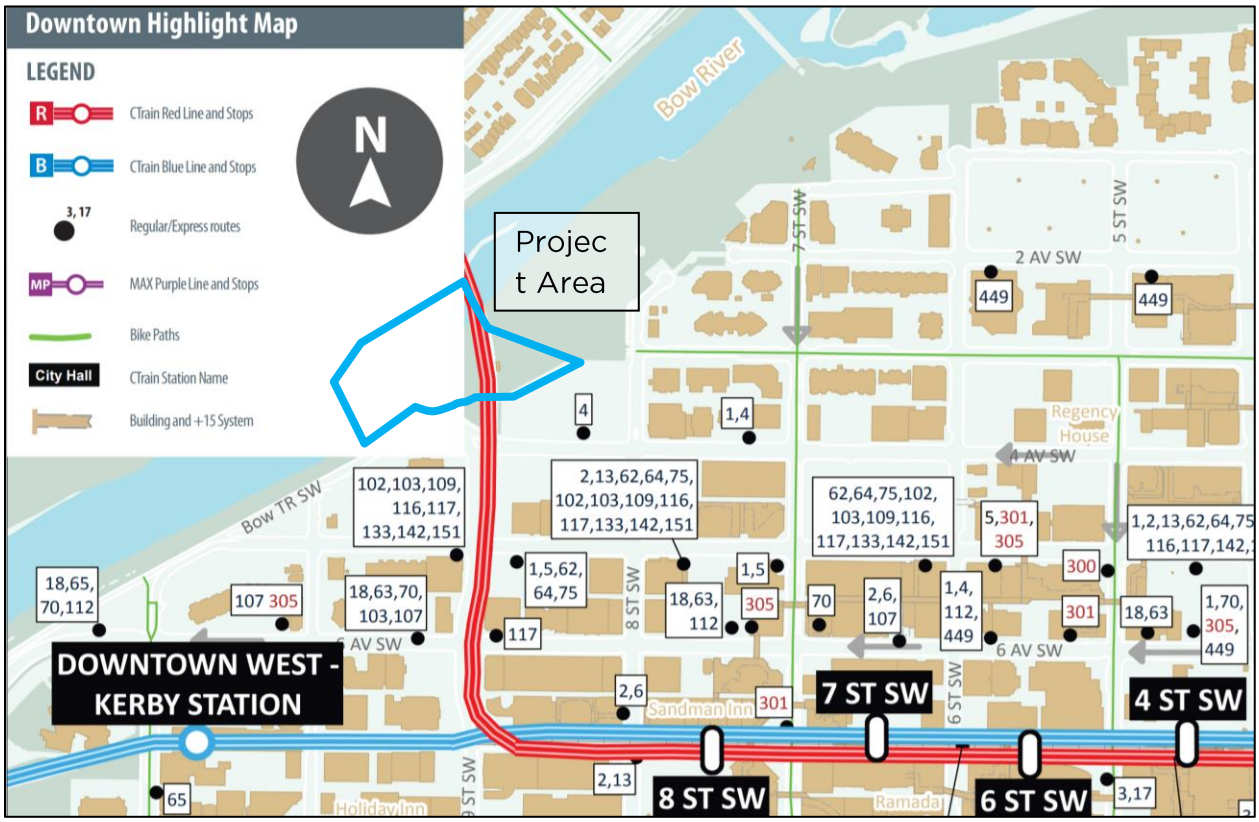


Figure 79: Transit route map for downtown near Project area.

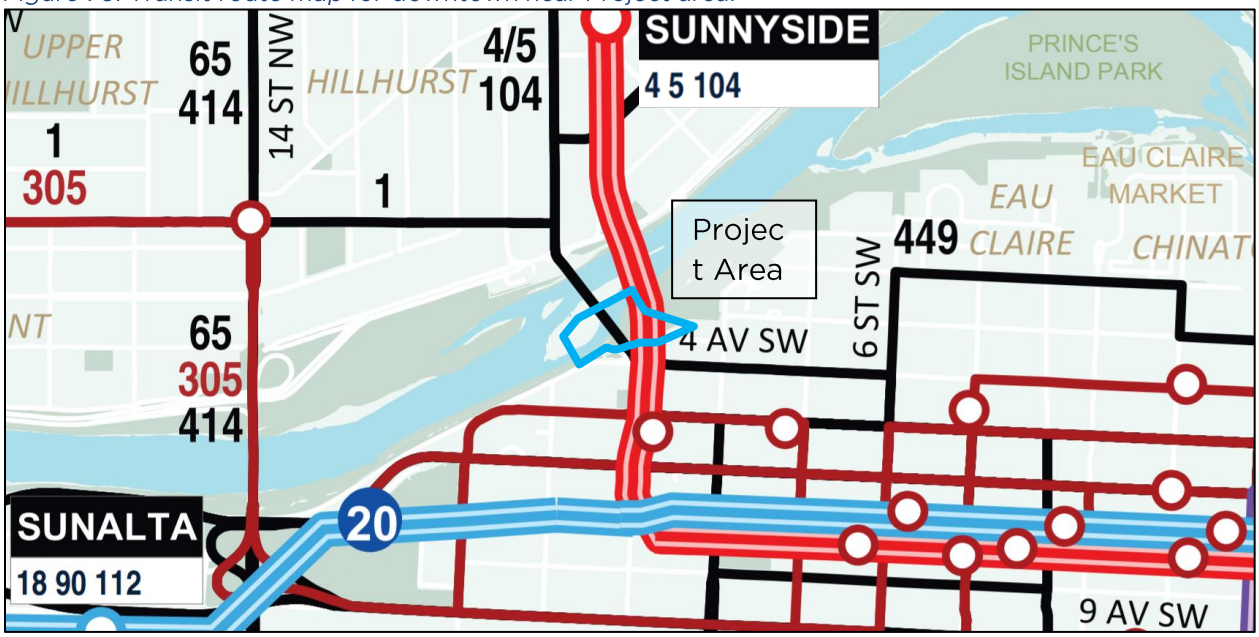


Figure 80: Transit route for regions surrounding Project area.

[63] (Calgary Transit, 2019)

13.11 Life span

Properly built river waves have very long-life spans. There are operating whitewater parks that are over 40 years old. The existing adjustable waves exposed to full river flows are in Bend and Boise and the adjustable components have a life span of at least 15 - 20 years. Obermeyer gates, which are one way to control water levels, have a life span of 25 years without maintenance. The Calgary Surf Beach and River Waves berms are expected to last at least 40 years. The adjustable components are expected to last at least 15 years. Regular maintenance and improvement and long-term replacement will be heavily self-funded by the supporting facility and events. The design and construction of the features is critical to durable river waves that require minimal maintenance. Critical design and construction considerations that will extend life span are:

- Armoring all sides of berms and foundation to withstand ice flows, debris and floods and prevent undercutting or piping
- Building berms and wave structure foundations deep enough to prevent water from flowing under the berm
- Wave structure foundations that will protect wave structure components from ice and debris forces when the wave structure is retracted.
- Berm and wave structure foundation layout to:
    - Minimize sediment deposition on wave foundation and downstream of wave
    - Prevent or minimize scour immediately downstream
- Minimize size and amount sedimentation under wave structure and in wave structure range of motion
- Ability for controlled jets of water under wave structures to clean out deposition
- Access under wave structures
- Ability to jet water downstream to move or adjust deposition
- Ability to shut off water flow and easily dewater each channel
- Maximize hydraulic / pneumatic line durability. Minimize connection points, ensure connections are very secure and ensure lines are very durable.

13.12 Planned major interventions

There are a few planned major interventions to extend the life of the area. All major interventions will be heavily fund by the Alberta RSA via the supporting facility and major events.

- Wave structure upgrades and repairs
- Cleaning sedimentation and deposition from under structure
- Possible dredging following major flood events
- Replacement of hydraulic system components
- Replacement of adjustable wave system
- Rebuild at end of life

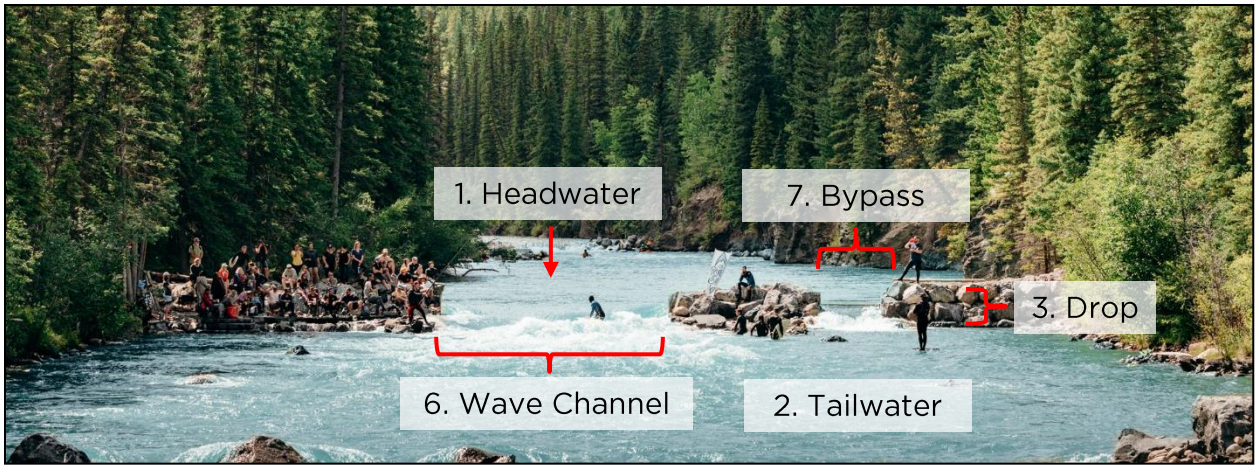
14 River Wave Formation

This section discusses river wave concepts and existing river waves.

14.1 Terminology

There are important terms to understand when discussing and planning river waves.

1. Headwater: Water upstream of the wave
2. Tailwater: Water downstream of the wave
3. Drop: Difference in elevation between headwater elevation and tailwater elevation
4. Slope: The fixed or adjustable slope between the headwater and tailwater
5. Kicker: The fixed or adjustable piece that helps redirect water and shape the wave after going down the slope
6. Trough: The lowest elevation of water at the transition from slope to wave
7. Wave: The surfable feature that is formed by water going over the slope and kicker
8. Wave Channel: Channel between headwater and tailwater where the wave forms and consisting of slope and kicker.
9. Bypass Channel: Channel allowing water to go from headwater to tailwater without going down the slope
10. Adjustability: Wave components **must** be adjustable for high wave quality over large flow range


1. Headwater
7. Bypass
3. Drop
6. Wave Channel
2. Tailwater

7. Wave
4. Slope
6. Trough
5. Kicker

14.2 Basic concepts[64]

The best existing river waves are formed by:

- fast moving, smooth and relatively shallow water entering a deep pool
- pool surface is higher than the surface of the fast water entering the pool
- a kicker assisting in the wave formation

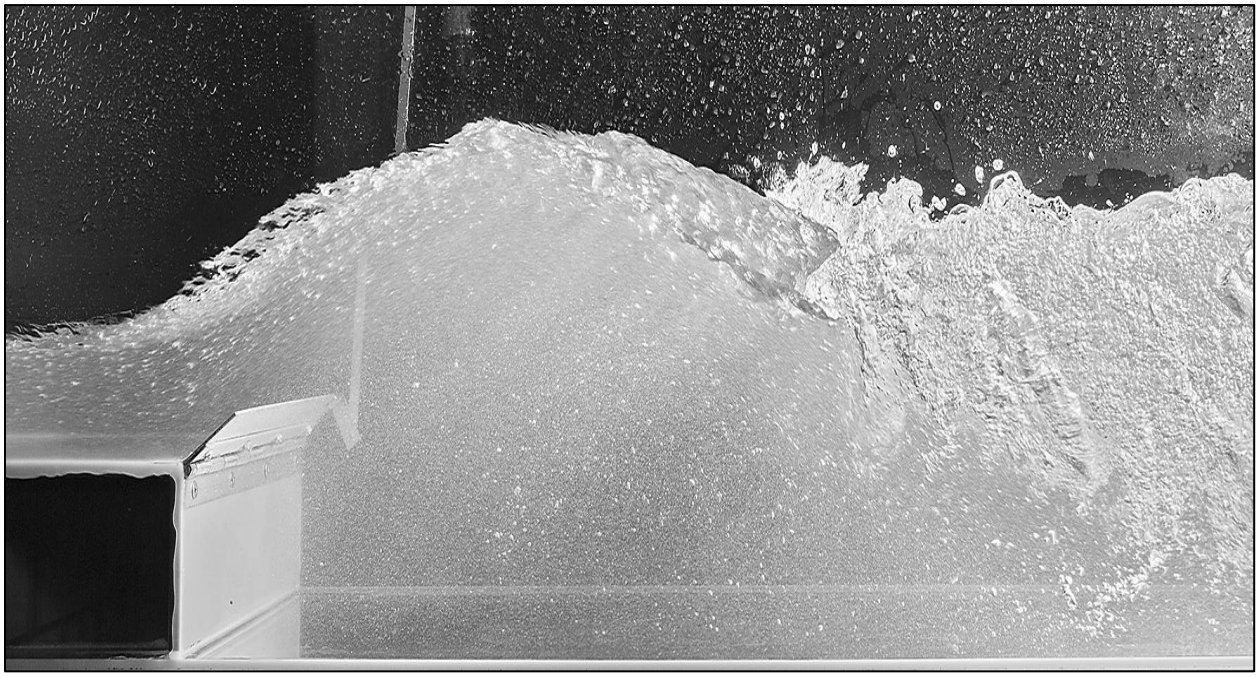


Figure 81: Model of good river surf wave

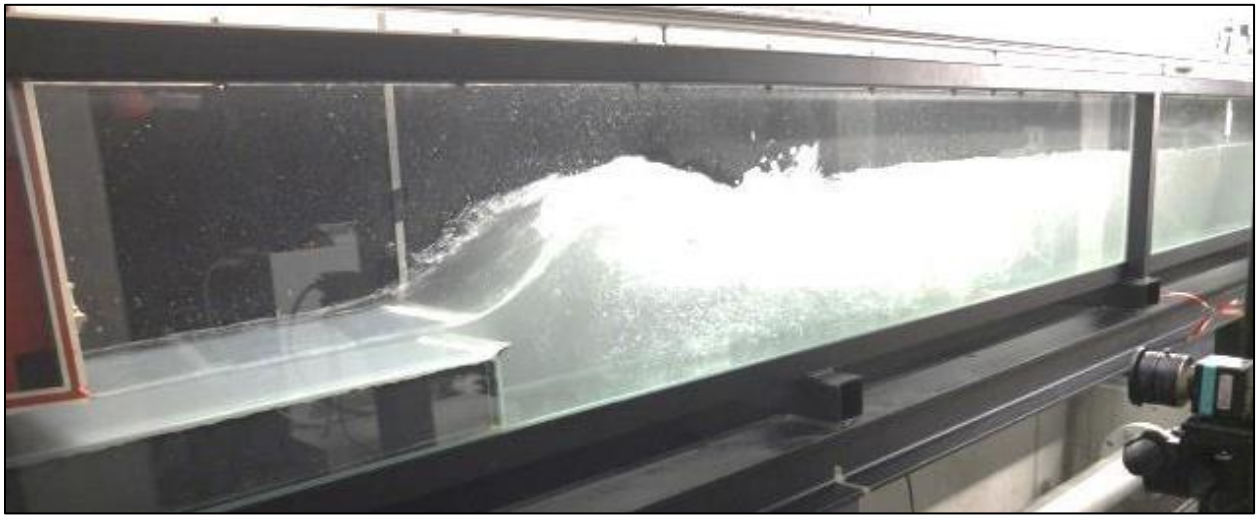


Figure 82: Flume from Wyl's experiments with a good wave

[64] (Wyl, 2015)

14.3 Key factors in good wave formation[65]

The following factors have major impacts on wave formation and quality.

Symbol	Name	Description	Controlled by
v_0	Water velocity	Velocity of water entering the wave area	Headwater elevation
h_0	Depth of approaching water	Depth of water flow entering the wave area	Channel width, bypass channel and water velocity
h_u	Depth of tailwater	Depth of water downstream of wave area	Downstream constriction
k	Kicker length	Length of kicker	Kicker design
k°	Kicker angle	Angle of kicker	Kicker design

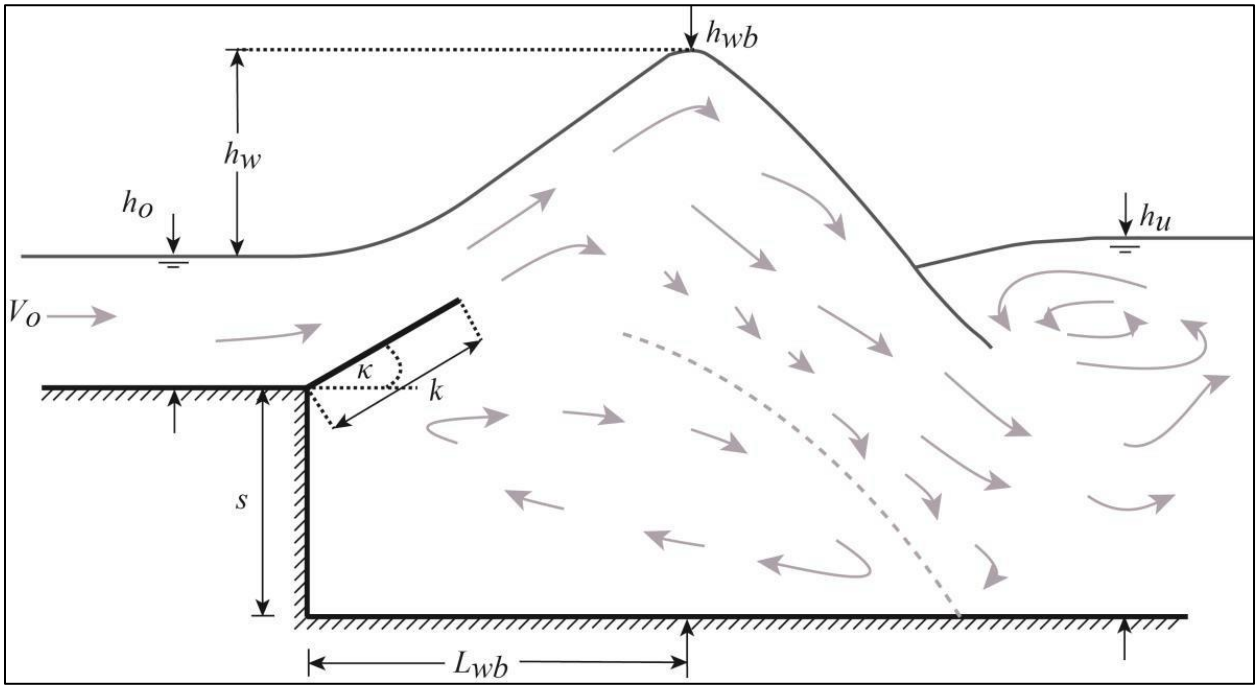


Figure 83: Diagram of flows in good river surf wave

[65] (Wyl, 2015)

15 Wave Technology

River wave technology is still in its' infancy. There are a mix of unpatented systems, patented systems and many options that have not yet been developed. None of the existing systems will create the ideal waves for the Calgary Surf Beach and River Waves project. All river wave projects are customized. The Calgary river waves need to work with local company Surf Anywhere, the Alberta River Surfing Association and the chosen project team to develop a new custom wave solution. The new wave system will:

- Allow an exceptional level of adjustability,
- Create a wide variety of different waves
- Provide high quality waves over a wide range of flows,
- Be easy to inspect and maintain and
- Allow for ongoing system improvements

This section provides key details on how to develop and design the new wave technology including:

- Key technology features
- Existing wave technologies
- New wave technology
- Installation
- Maintenance
- Life span

15.1 Key wave technology features

The key wave technology factors are:

1. Ranges of motion:
    a. Headwater elevation
    b. Slope angle
    c. Slope elevation
    d. Kicker angle
    e. Kicker elevation with respect to tailwater
    f. Slope position along direction of flow
    g. Kicker position along direction of flow
    h. Prevention of backflow under structure

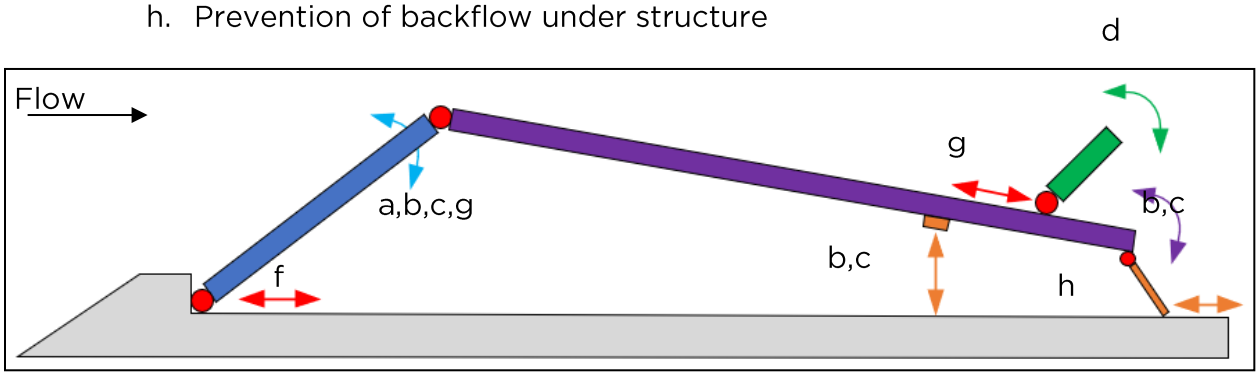


Figure 84: Hinged slope

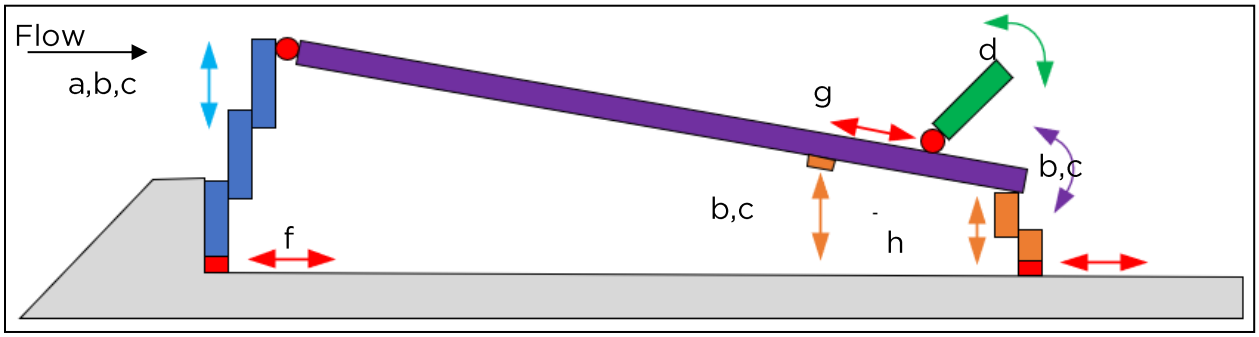


Figure 85: Vertical lift slope

2. Hydraulic / pneumatic adjustability allowing fast, precise and powerful adjustment
3. Removable / replaceable components allowing for new wave systems to be installed in the future or existing system to be upgraded
4. High strength attachment points such as bolt holts on slope, kicker and walls for adding wave shaping contours to the surface of the wave structure
5. Collapsible to avoid / minimize ice and flood forces
6. Adjustable structure elevation to allow during a wide range of flows
7. Adjustable angles on wave slope and wave kicker
8. Adjustable headwater elevation independent of structure elevation

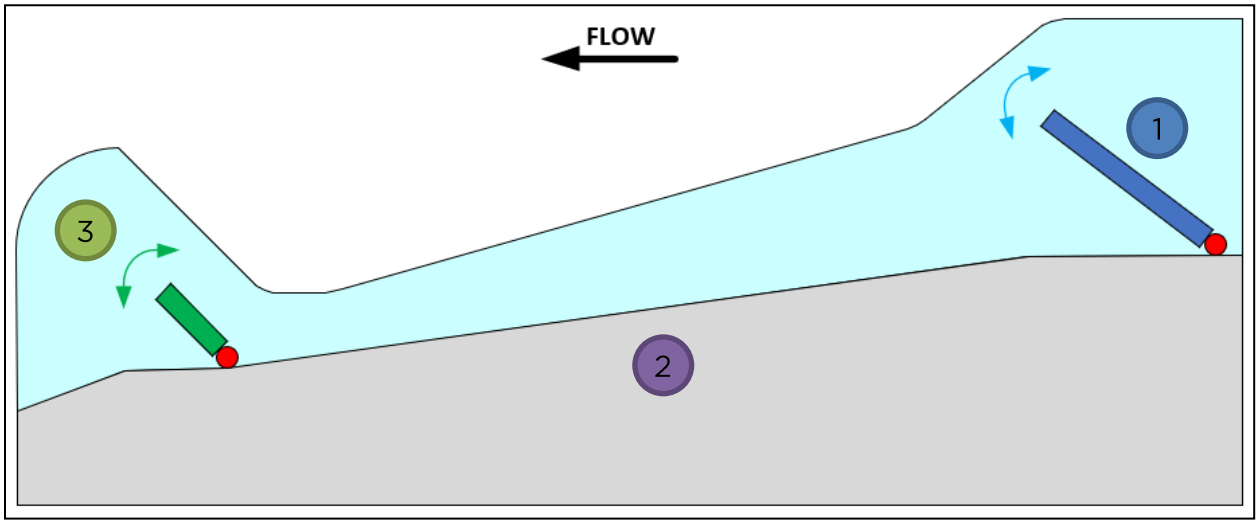
9. Constructed in sections across flow so each section can move independently to allow oblique wave sections across the wave
10. Adjustable position in flow direction to allow angled wave shapes
11. Minimizing deposition of sediment and debris under structure
12. Easy access under structure for cleaning of sediment / debris and inspections / maintenance
13. Ability to move structure externally if lifting mechanism stop working
14. Ability to affect / control sediment deposition downstream
15. Smooth surfaces, faces and transitions
16. Straight channel section before start of drop
17. Rounded entrance to channel
18. Smooth concrete to avoid friction burns
19. Holes covered / plugged with low profile covers / plugs to prevent catching fingers or equipment

Area of Adjustment	Purpose of adjustment	How is it can be adjusted
Headwater Elevation	Change wave power	1. Raising / lowering structure 2. Raising / lowering headwater control flap at upstream end of structure 3. Raising / lowering by-pass flow control 4. Narrowing or widening wave channel
Elevation of kicker with respect to tailwater	Change wave type & shape	1. Raising / lowering structure 2. Moving kicker up / down slope 3. Raising / lower tailwater elevation a. Requires additional structure downstream 4. Changing angle of slope
Slope angle	Change wave type & shape	1. Raising / lowering upstream end of structure 2. Raising / lower downstream end of structure
Kicker Angle	Change wave type & shape	1. Raising / lowering downstream end of kicker
Slope section position with respect to flow	Create oblique waves and complex angled waves	1. Move entire slope section upstream / downstream a. Elevation of slope section remains unchanged 2. Hinge slope section upstream / downstream a. Elevation of slope section changes
Kicker section position with respect to flow	Create oblique waves and complex angled waves	1. Move kicker up / down slope

15.2 Existing and Planned Wave technology

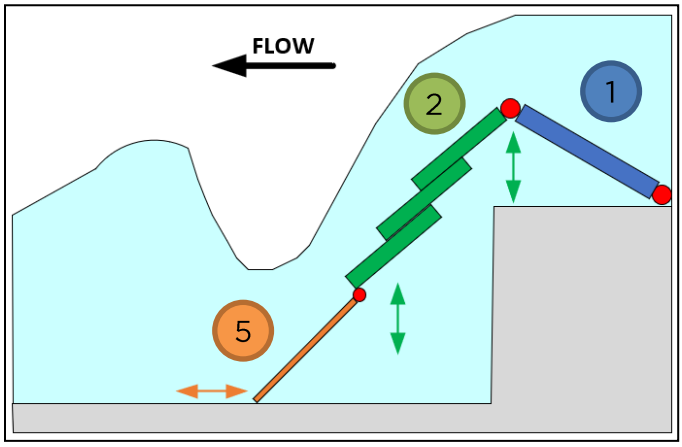
There are a variety of existing wave technologies available. All wave technologies must be customized for their locations. River wave technology is still in heavy development and the technology for Calgary will be an improvement on existing technologies. The following section details existing & operating good river waves designs and planned good river wave designs.

15.2.1 Bend – Existing



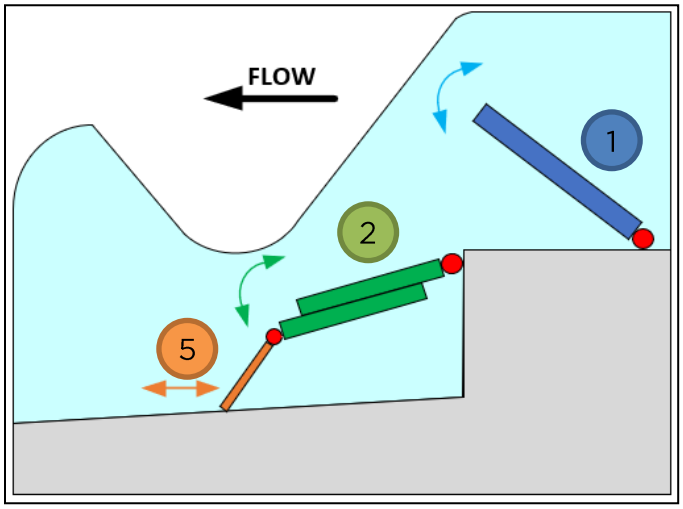
1. Headwater control via pneumatic crest gate type panels
2. Concrete slope
3. Hydraulic kicker pneumatic control
4. Tailwater control via pneumatic gate downstream (Not shown)

15.2.2 Boise Phase 1 – Waveshaper 2 – Existing



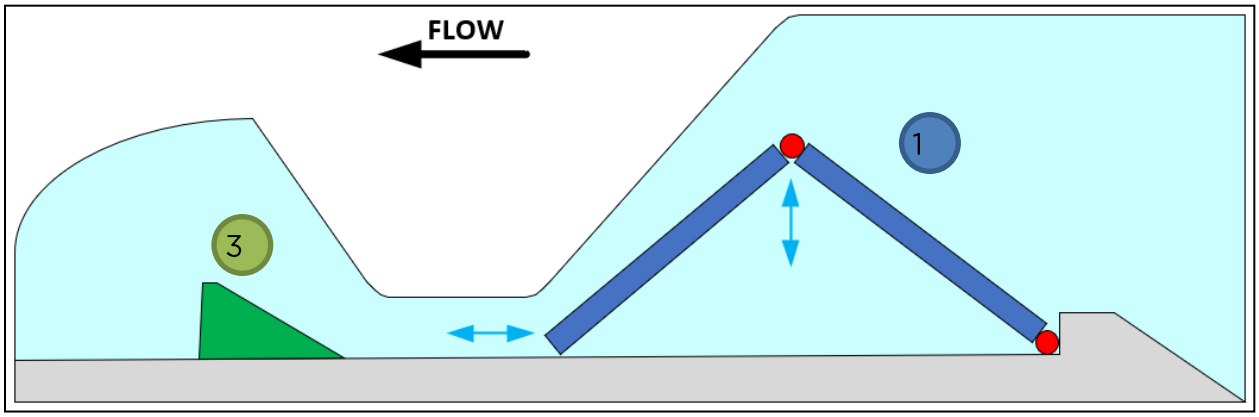
1. Headwater control via obermeyer crest gate
2. Tiered ramp angle and elevation controls wave shape
    a. Upstream end controlled by crest gate
    b. Downstream end controlled by hydraulics
    c. Upstream end and downstream end can be independently controlled
3. No kicker
4. No tailwater control
5. Trash gate to prevent material / people going under structure. Not intended to affect wave shape.

15.2.3 Boise Phase 1 – Waveshaper 3 – Existing



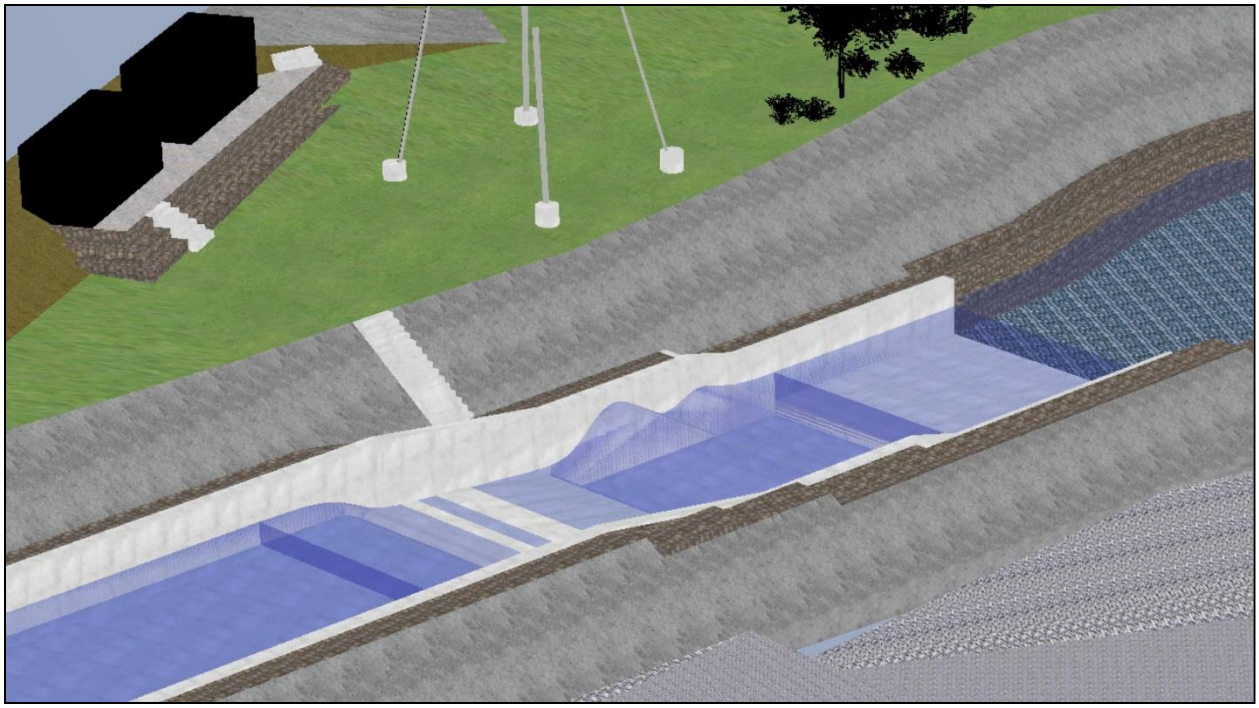
1. Headwater control via obermeyer crest gate
2. Tiered ramp with hydraulics controlling water slope and wave shape
3. No kicker
4. No tailwater control
5. Trash gate to prevent material / people going under structure. Not intended to affect wave shape.

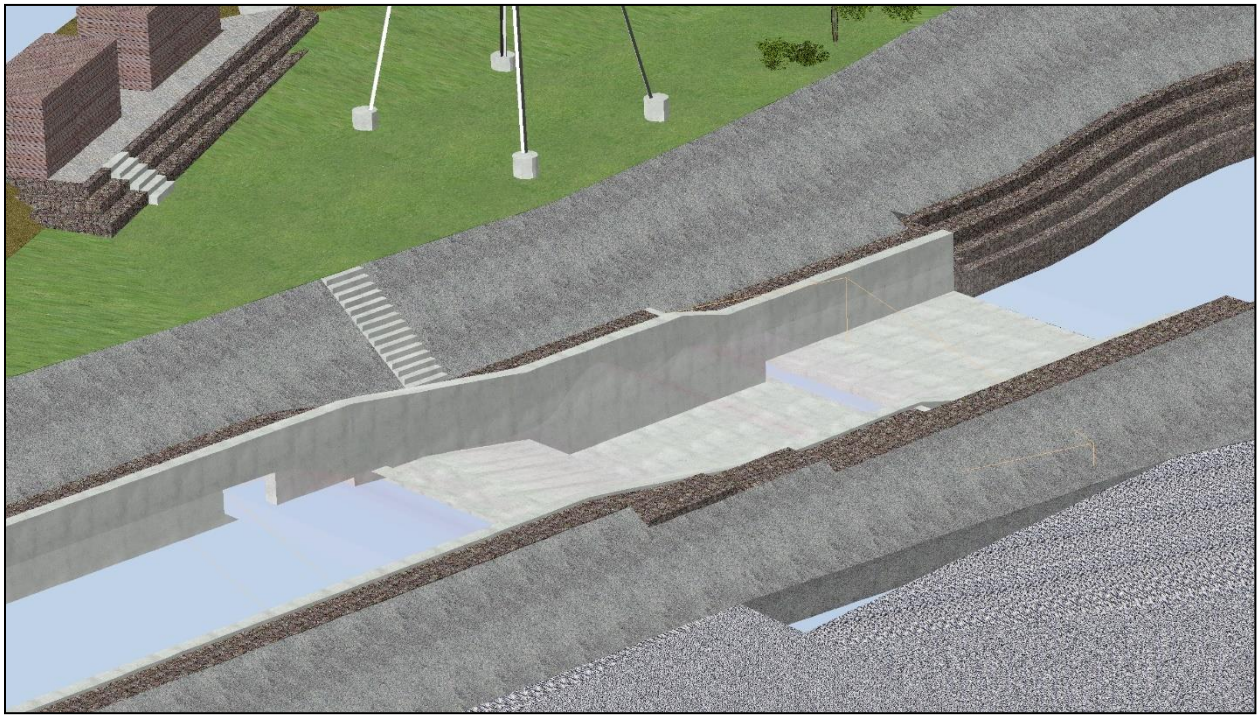
15.2.4 Boise Phase 2 – Surf Wave

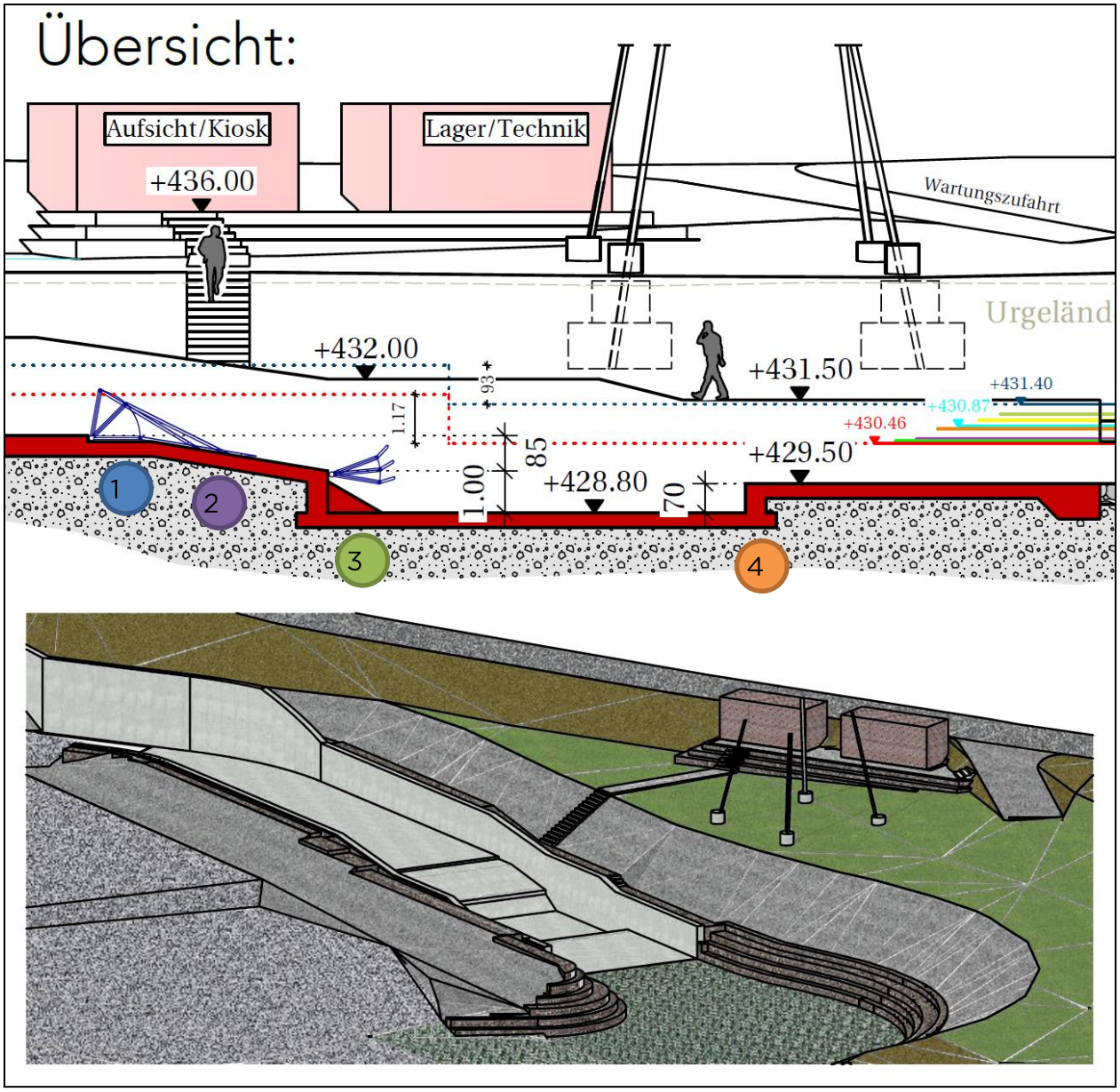


1. Headwater control and slope simultaneously controlled via bladder with hinged steel panel on upstream and downstream sides
2. See 1.
3. Fixed kicker that can be remove and adjusted when water is off
4. Tailwater control via gates on downstream feature (not shown)

15.2.5 The.Riverwave, Austria



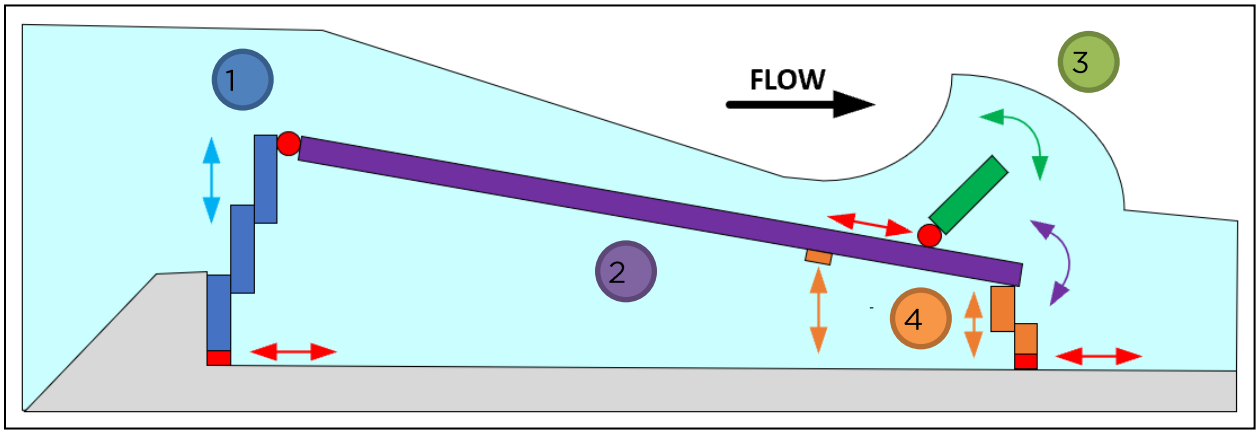




Drawing is not representative of actual design.

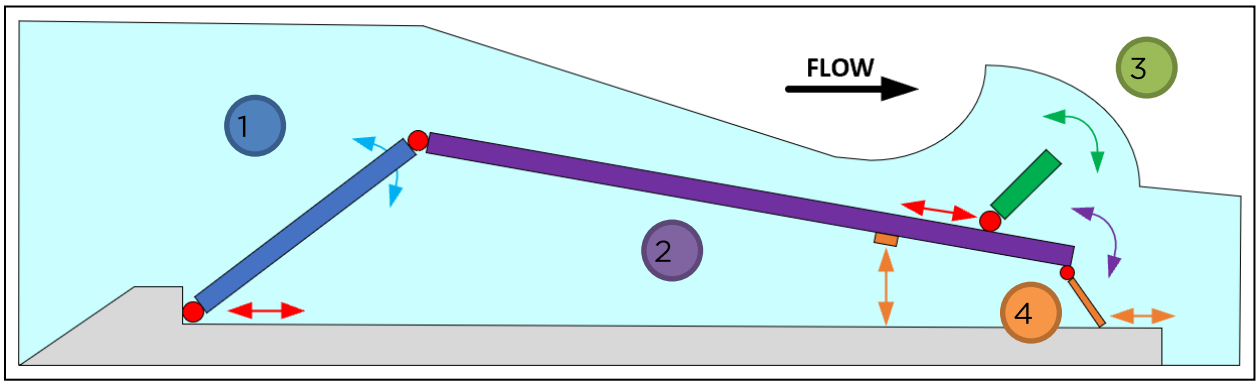
1. Headwater control via hinged up slope and down slope
2. Slope controlled by two sets of pistons. One set on upstream end and one set on downstream end.
3. Manually adjusted kicker when water is off.
4. Tailwater not controlled but depth deep after wave and then becomes shallower downstream.

15.2.6 Vertical Lift Slope – Planned



1. Headwater control via vertically raising/lowering structure
2. Hydraulic / pneumatic controlled metal slope that can raise/lower and change angle
3. Hydraulic / pneumatic kicker assembly
4. Trash gate to prevent material / people going under structure. Not intended to affect wave shape.

15.2.7 Hinged Lift Slope – Planned



1. Headwater control via raising/lowering upstream end of structure. Upstream end is a hinged-up slope and down slope.
2. Hydraulic / pneumatic controlled metal slope that can raise/lower and change angle
3. Hydraulic / pneumatic kicker assembly
4. Trash gate to prevent material / people going under structure. Not intended to affect wave shape.

15.3 New Wave Technology

There are a few new technologies and concepts that need to be implemented in the new waves to maximize the economic, cultural and environmental returns. These improvements will ensure the highest quality rivers for all conditions and allow the waves to change over time keeping the area very interesting and engaging.

15.3.1 Oblique waves

These waves form on angles. The angled wave changes what movements are possible on the wave. All existing manufactured waves are perpendicular to flow.

Figure 86: Examples of oblique waves

15.3.2 Attachment Points

The attachment points allow features to be added to the face of the slope and kicker to adjust the wave shape.

15.3.3 Changeable Wave Structure Position

Changing wave structure position in the direction of flow allows different waves to be created using the same structure. These changes can allow the creation of oblique and perpendicular waves on the same feature. The images below show wave structure position changes but does not show the surface of the wave structure.

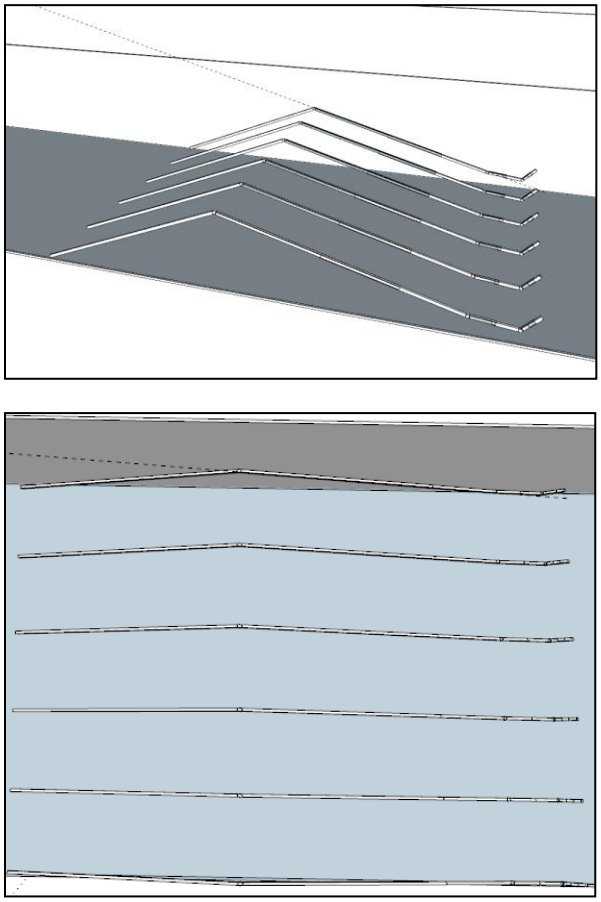


Figure 87: Wave frame showing perpendicular wave layout

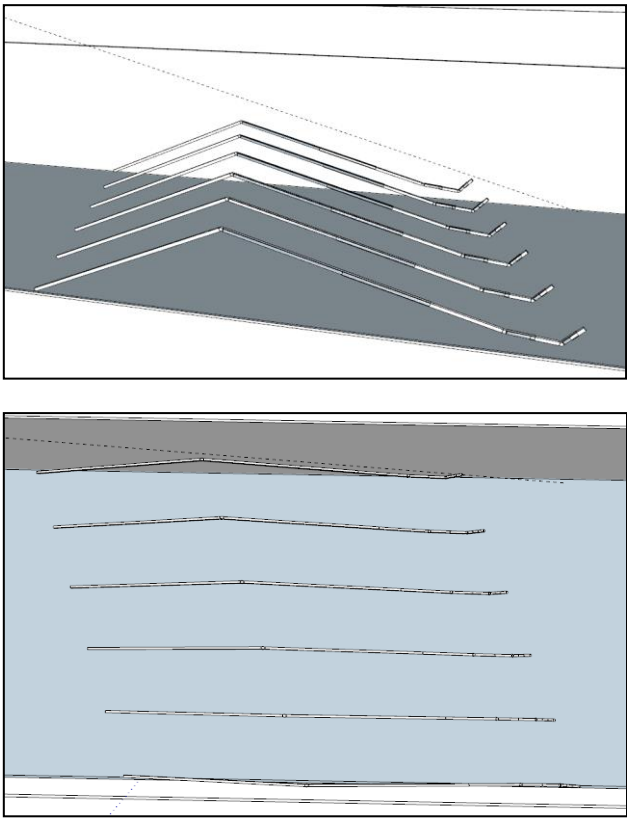


Figure 88: Wave frame showing oblique wave layout

15.3.4 Replaceable Wave Structure

A replaceable wave structure can be easily upgraded to new or improved technology

15.3.5 Flow By-Pass / Wave Dewatering

The structure must be able to easily create a 100% flow by-pass so all water flows around that section of the wave structure. This allows for cost effective maintenance, inspections and adjustments. The by-pass channel shown below is an example of a by-pass channel but it does not allow the wave to be dewatered.

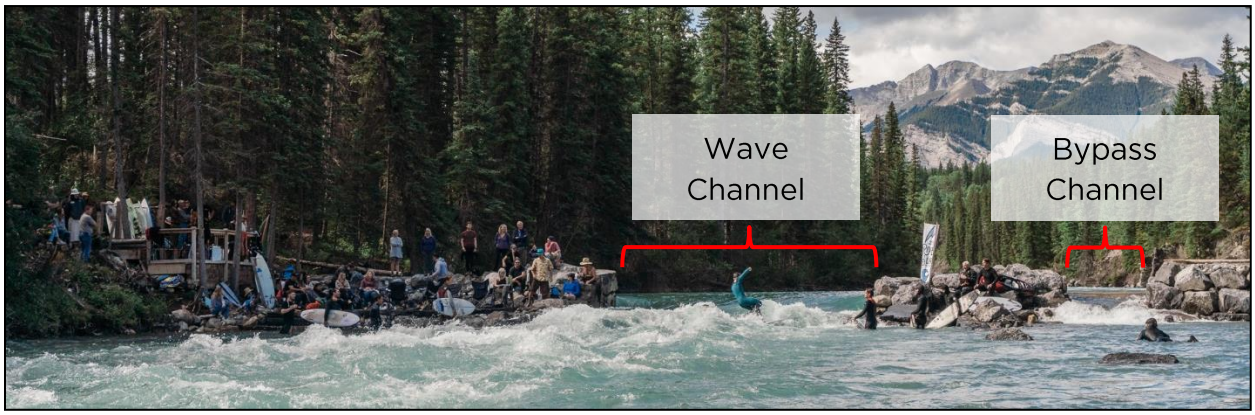


Figure 89: Example of bypass channel

15.3.6 Modelling Flume for Education & Research

A small channel at the wave dedicated to modelling rivers and river waves. The flume will be used to model new waves and river projects for research and provide hands-on river education.

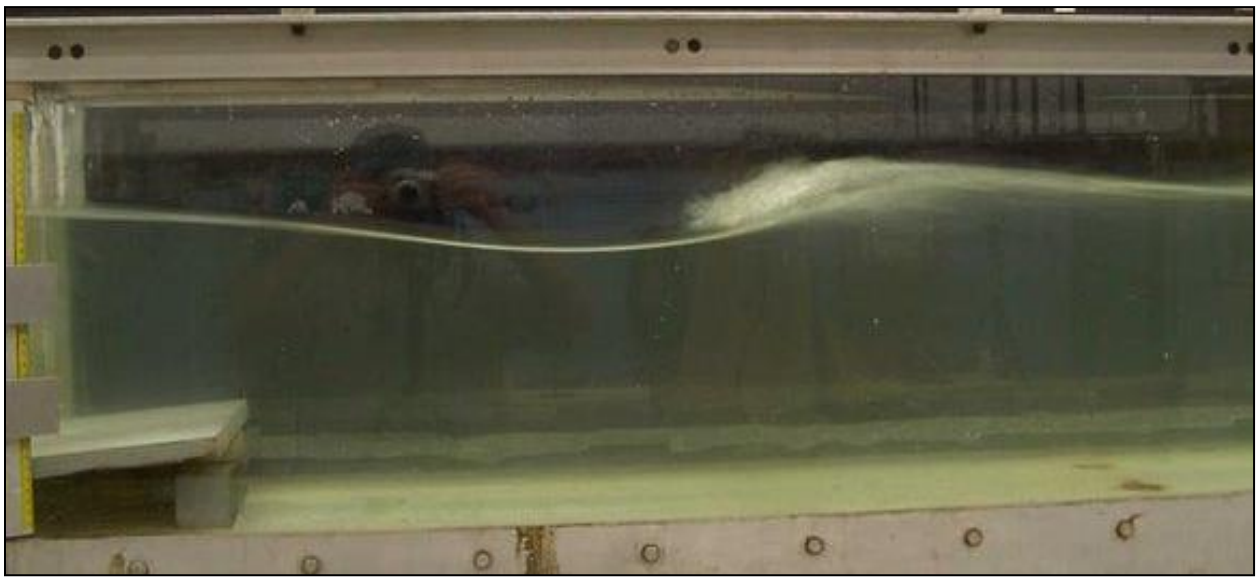


Figure 90: Example of river wave in a flume

15.4 Installation

Installation will require blocking of the river flow through the wave area. The wave structure foundation will consist of boulders and concrete with channels in the concrete for hydraulic / pneumatic lines. The berms will consist of large boulders or boulders / concrete.

15.5 Maintenance & Inspection

The Alberta RSA will inspect and maintain the wave. Inspections will occur twice each year: after the final winter ice flows but before spring high water and after spring high water. Maintenance will be performed during the inspections and after inspections if additional maintenance needs are identified. Normal inspection and maintenance do not require dewatering the structures. The design of the waves makes it easy & cost effective to perform inspections and maintenance.

More details are provided for in Section 10.12 Wave Inspection & Maintenance.

15.6 Life Span

Properly built river waves have very long-life spans. There are operating whitewater parks that are over 40 years old. The existing adjustable waves exposed to full river flows are in Bend and Boise and the adjustable components have a life span of at least 15 - 20 years. Obermeyer gates, which are one way to control water levels, have a life span of 25 years without maintenance. The Calgary Surf Beach and River Waves berms are expected to last at least 40 years. The adjustable components are expected to last at least 15 years. Regular maintenance and improvement and long-term replacement will be heavily self-funded by the supporting facility and events.

More details provided in Section 13.11 Life span.

16 Liability

Managing liability is an important part of a successful river wave project. River waves have several over lapping liability and insurance scenarios including:

- River is open to public with no control over usage
- Land is maintained and controlled by Calgary parks
- River wave area and beach is engineered and constructed
- Wave features are controllable by operator
- Area is operated by the Alberta River Surfing Association
- Area will be the site of special events

16.1 Insurance

Each organization involved in the river wave and urban beach area will need to carry appropriate insurance. This includes:

- Engineering company
- Construction company
- Landowner / controller / maintainer
- Wave operator (Alberta River Surfing Association)
- Special event users

16.1.1 Industry Standard Insurance

The normal practice for run of the river white water parks is to ensure all organizations above have appropriate insurance. A good example for insurance in Calgary is public access and outdoor skateparks. Skateparks have a much, much higher incident of injury and level of risk to users than river waves.

16.1.2 Participants

During general usage participants will either use at their own risk without specific coverage or access will be restricted to approved users. Controlling usage will allow waivers and improved insurance to cover area users but will be challenging to manage since that will require staff for all hours of operation and likely require a charge to use the wave. The normal scenario is use at your own risk without waivers or control of access. This normal scenario is like public access skate parks. Participants during events will be required to sign waivers and those events will be required to have insurance.

16.1.3 City of Calgary

The City of Calgary will need to include the area under insurance like what is used for river side parks and skateparks. Related and nearby City of Calgary facilities are:

- Shaw millennium skatepark
- Prince's Island, specifically the lagoon area
- River access points in East Village

- Harvie Passage
- Seton Recreational Facility, specifically the flowrider
- City of Calgary indoor water parks

16.1.4 Operating Organizations

The operating organization is currently planned to be the Alberta River Surfing Association. The operating organization will need to have Commercial General Liability. Ideally, the coverage will include operating the wave structures, lessons, rentals and life guarding. Similar facilities with operated recreational water machinery in Calgary include:

- Flowrider at the Seton Recreational Facility
- City of Calgary indoor water parks
- Private water parks

16.1.5 Limits, endorsements and exclusions

Examples of limits, endorsements and exclusions can be pulled from existing insurance for similar operations.

16.1.6 Meeting obligations in the event of a claim

All the organizations involved will be positioned to meet any obligations in the event a claim. The Alberta River Surfing Association will have organizational and funding stability due to operating the supporting facility.

16.2 Previous incidents, accidents & lawsuits

Good river waves and urban beaches are low risk. River waves usage does result in occasional injury and there have been multiple studies done on the types of injuries and injury rates. The whitewater paddling injury rate is 3.5 to 6.0 injuries per 1,000 exposures (David C. Fiore, 2003). Whitewater kayaking fatality rates at managed whitewater facilities was found to be 2.9 per 100,000 participants (Iain Wilson, 2013). River surfing does not have a published study relating to injury or fatality rates but there is the Surf Anywhere Accident and Incident Database that collects reports of accidents and incidents related to river surfing from around the world (Egsgard, 2019).

16.2.1 Risk and Risk Management

Please see details in Section 10.10.1 Risks and Risk Management

16.2.2 Lawsuits in Alberta

Searches for lawsuits on the Canadian Legal Information Institute (Canadian Legal Information Institute, 2019) relating to kayaking and surfing in Alberta turned up no results related by river users related to river use.

16.3 Incident prevention plan

Incident prevention is detailed in Section 10.10 Safety Plan.

16.4 Emergency Response Plan

Emergency response is detailed in Section 10.11 Emergency Response Plan.

16.5 Waivers

Below is the standard Alberta River Surfing Association waiver.

ALBERTA RIVER SURFING ASSOCIATION

WAIVER OF LIABILITY AGREEMENT
(FOR THOSE 18 YEARS OF AGE OR OLDER)

WARNING - BY SIGNING THIS FORM YOU GIVE UP IMPORTANT LEGAL RIGHTS !
PLEASE READ CAREFULLY!

Participant's Name: _____

DISCLAIMER CLAUSE

The Alberta River Surfing Association, it's clubs, affiliated discipline associations, members, leaders/instructors/coaches, directors, agents, employees, volunteers and representatives (hereafter referred to as the "Associations") are not responsible for any injury, loss or damage of any kind sustained by any person while participating in the Association's programs and activities for river surfing, including injury, loss or damage which might be caused by the negligence of the Associations.

DESCRIPTION OF RISKS

I acknowledge that I am aware of the possible risks, dangers and hazards associated with the water programs and activities for surfing in rivers, on land near rivers, and travel in vehicles, including the possible risk of severe or fatal injury to myself or others. These risks, dangers and hazards include, but are not limited to:

- The risk of drowning or near drowning including but not limited to: falling off of surfboard into the water, underwater entrapment by a water feature, equipment entanglement or being knocked unconscious in the water;
- Injuries resulting from your body hitting the surfboard, water surface, pool surface, shoreline embankments, underwater features or being hit by another water vessel or users
- Extremes of cold and hot weather and temperature which may result in hypothermia, hyperthermia, sunstroke, sunburns or heat exhaustion
- Prolonged or sudden exposure to cold water which may result in hypothermia or cardiac arrest
- Hazards related to windstorms, thunderstorms, lightning, hailstorms, or snowfall
- Hazards related to travel in and on rivers
- Remote locations in mountain terrain, river valleys and canyons with poor communications and inability to get rescue or medical assistance quickly or easily
- Medical problems arising before, during or after the trip
- Terrain where a slip, trip or fall may cause injury or death
- Other injuries (e.g. blisters, bruises, burns, cuts, sprains, strains, dislocations, fractures, concussions, acute or overuse injuries)
- Additional risks associated with travel to and from locations including transport by public or private motor vehicle
- Failure to follow directions from instructors or those in charge of outdoor trips, including those specifying
  a) staying with the group at all times unless those in charge are consulted and provide consent;
  b) wearing approved safety equipment;
  c) safe use of tools and other equipment where required
- Allergic reactions to natural substances in the environment (e.g.,poison plants, bee stings, bugbites, poison venom)
- Injuries related to encounters with animals and plants in the environment;
- Injuries related to equipment (poor fit, improper adjustment, malfunction, or becoming tangled)
- Injuries related to lifting, carrying, walking with, or putting down the surfboard and/or packs;
- Other risks normally associated with participation in the activity and environment.
- Loss of or damage to my surfboard, gear and other equipment before, during or after the activity

The use, retention, and disclosure of personal information collected from this form is done in compliance with privacy legislation (*Personal Information Protection Act*)

Page 1 of 3

CONSENT AND ACKNOWLEDGEMENT OF RISK

1. I acknowledge it is my duty and my right to obtain as much information as I require about this program or activity and associated risks and hazards, including information beyond that provided to me by the Associations.
2. I freely and voluntarily assume the risks/hazards inherent in the program/activity and understand and acknowledge that I may suffer personal and potentially serious injury arising from my participation.
3. I acknowledge that the Associations have the right to refuse to allow me to participate in any activity if, in the Associations' opinion, I am not adequately fit, not properly equipped, insufficiently skilled or otherwise not ready to participate safely.
4. I agree to abide by the rules and regulations, including directions and instructions from the Associations and/or service providers, administrators, instructors/coaches and supervisors over all phases of the program/activity.
5. I have read and agree to abide by the Code of Conduct and rules.
6. In the event that I fail to abide by the rules and regulations or Code of Conduct or rules, disciplinary action may require my exclusion from further participation and I will be responsible for any related costs associated.
7. I acknowledge that it is my duty to advise the Associations of any medical/health concerns (e.g., medical, physical, emotional, learning, and/or behavioural conditions) that may affect my participation.
8. I acknowledge that the Associations may cancel the activity if conditions are deemed unsafe (e.g., weather, health advisory). I accept that the board will not be liable for any costs associated with such a cancellation.
9. I acknowledge that the Associations may secure transport to emergency medical services as they deem necessary for my immediate health and safety, and that I shall be financially responsible for such services
10. Based on my understanding, acknowledgement, and consents as described herein, I agree to participate under these conditions throughout this calendar year.

INDEMNIFICATION AND RELEASE OF LIABILITY

In return for the Associations allowing me to voluntarily participate in its programs and activities, I agree:

1. TO ASSUME AND ACCEPT ALL RISKS arising out of, associated with or related to my participation in the Associations' programs and activities, even though such risks may have been caused by the NEGLIGENCE of the Associations;
2. TO BE SOLELY RESPONSIBLE FOR ANY INJURY, LOSS OR DAMAGE which I may sustain while participating in the Associations' programs and activities for kayaking and canoeing, even though such injury, loss or damage may have been caused by the NEGLIGENCE of the Associations;
3. TO IDEMNIFY AND HOLD HARMLESS the Associations, its officers, directors, agents, volunteers, employees and representatives from any and all claims, demands, actions and costs which might arise out of my participation in the Associations' water programs and activities for kayaking and canoeing, even though such claims, demands, actions and costs may have been caused by the NEGLIGENCE of the Associations.

ACKNOWLEDGEMENT

I UNDERSTAND THAT THIS IS A LEGAL AGREEMENT. It is binding upon myself as well as upon my heirs, next of kin, executors, administrators, assigns and representatives, in the event of my death or incapacity. I HAVE READ AND UNDERSTOOD ALL THE TERMS OF THIS AGREEMENT, and by signing this agreement voluntarily I am agreeing to abide by these terms.

Name of Participant_____Date of Birth _____

Address_____Town_____Postal Code _____

Phone #_____ Email _____

Signature:_____ Signed this_____day of_____, 20_____

Name of Witness_____Signature of Witness _____

Image Release

I grant permission to the Alberta River Surfing Association and it's Clubs the right to use, without payment of any fee or charge and without limitation on time or frequency, for nonprofit, educational, promotional or publicity purposes only, any photographs, video footage, audiotape or digital images of me.

☐ *Yes* ☐ *No* *Signature*_____*Date:* _____

The use, retention, and disclosure of personal information collected from this form is done in compliance with privacy legislation (*Personal Information Protection Act)*

Page 2 of 3

LACK OF HELMET ACKNOWLEDGEMENT OF RISK

1. I acknowledge that I understand the risks associated with not using a helmet including but not limited to impact of head against river bottom, impact of head against board, impact of head against other water vessels and other dangers.
2. I acknowledge that a lack of helmet could result in serious injury and/or death.
3. I confirm that I have the ability and experience necessary to safely participate in this Alberta RSA program without using a helmet.
4. I confirm that I have the necessary information and knowledge to make an informed decision not to wear a helmet.
5. I confirm that I am not wearing a helmet of my own choice and without pressure from others.

Name of Participant_____Date of Birth _____

Signature:_____ Signed this_____day of_____, 20_____

Name of Witness_____Signature of Witness _____

LACK OF PFD ACKNOWLEDGEMENT OF RISK

1. I acknowledge that I understand the risks associated with not using a personal flotation device (PFD) including but not limited to impact against river bottom, drowning and other dangers.
2. I acknowledge that a lack of PFD could result in serious injury and/or death.
3. I confirm that I have the ability and experience necessary to safely participate in this Alberta RSA program without using a PFD.
4. I confirm that I have the necessary information and knowledge to make an informed decision not to wear a PFD.
5. I confirm that I am not wearing a PFD of my own choice and without pressure from others.

Name of Participant_____Date of Birth _____

Signature:_____ Signed this_____day of_____, 20_____

Name of Witness_____Signature of Witness _____

The use, retention, and disclosure of personal information collected from this form is done in compliance with privacy legislation (*Personal Information Protection Act)*

Page 3 of 3

17 Permitting requirements

Several permits are required for work in the Bow River. The permitting information is accurate as per the date it was added to this report. Permitting requirements change without notice and should be reviewed prior to commencing any project. Additional permits, approvals or licenses may be required and will be confirmed when project moves forwards.

17.1 Federal

17.1.1 Fisheries and Oceans Canada

The Department of Fisheries and Oceans will require a Request for Review based on the current criteria in the Self-Assessment.

"The self-assessment should be used to determine whether or not you should submit your project for review."

"A project authorization may be required as a next step if you cannot avoid or mitigate serious harm to fish. It is recommended that an Application for Authorization only be pursued after a project review has been completed."[66]

Request for Review

http://www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/index-eng.html

17.1.2 Transport Canada – Navigation Protection Program

The Bow River in Calgary is a Scheduled Water as per Transport Canada. The Louise Bridge location is in a Scheduled Water. The Lagoon location may not be a Scheduled Water as it may not be considered part of the Bow River. A *Notice to the Minister of Transportation* is required.[67]

Guide

https://www.tc.gc.ca/eng/programs-673.html

List of Scheduled Waters

http://laws-lois.justice.gc.ca/eng/acts/N-22/FullText.html#h-27

[66] Request a Project Review. May 4, 2017. http://www.dfo-mpo.gc.ca/pnw-ppe/reviews-revues/index-eng.html

[67] A Guide to the Navigation Protection Program's Notification, Application and Review Requirements. May 4, 2017. https://www.tc.gc.ca/eng/programs-673.html#need

17.2 Provincial

17.2.1 Alberta Environment & Parks – Water Act

A Water Act Permit will be required. This permit is provided by the Alberta Environment and Parks (AEP). The details for this permitting are found on the Alberta government website below. This approval is likely to be very long with a lot of requirements. Similar recent projects resulted in an AEP Water Act Approval that was over 150 pages long.

Application Details

http://aep.alberta.ca/water/education-guidelines/documents/LicensingWaterDiversionProjects-Guide.pdf

17.2.2 Alberta Environment & Parks – Environmental Impact Assessment

An Environmental Impact Assessment (EIA) will be required and approval must be secured. The EIA is handled by Alberta Environment & Parks (AEP). Details for this approval are found on the Alberta government websites below.

Application Details

http://aep.alberta.ca/land/land-industrial/programs-and-services/environmental-assessment/default.aspx

17.2.3 Alberta Environment & Parks – Public Lands

A disposition under Public Lands will be required. Under the Public Lands Act: Section 3, the Government of Alberta owns the beds and shores of most permanent naturally occurring rivers, streams, watercourses, lakes, and other water bodies in the province (shorelands). Administration of public lands includes controlling "Rights of Access," "Surface Rights" and "Subsurface Rights" (mineral rights). Alberta Environment & Parks (AEP) and the Alberta Energy Regulator (AER) manage the use of public lands for all Albertans through the issuance of dispositions. A disposition must be obtained under the Public Lands Act for any access to or activity on public lands and in compliance with the Public Lands Administration Regulation.

Application Details

http://aep.alberta.ca/forms-maps-services/industry-online-services/public-lands-dispositions/default.aspx

17.2.4 Historical Resources Management Branch – Historic Resource Impact Assessment

A Historic Resource Impact Assessment may be required as there is a buried logging canal at this location. If an activity is likely to result in the alteration of, damage to or destruction of a historic resource, the person or company undertaking the activity may be required by the Province to:

- conduct a Historic Resources Impact Assessment (HRIA)
- submit a report of the HRIA results
- avoid any historic resources endangered by activity
- mitigate potential impacts by undertaking comprehensive studies
- document historic structures
- consult with First Nations

Project-specific requirements are issued in response to a Historic Resources Application, but all assessments must comply with some standard conditions.

See the following Standard Conditions document for details:

- Standard Conditions under the Historical Resources Act

In most cases, the assessment work must be completed before the onset of land disturbance, but occasionally studies can happen in conjunction with certain development activities.

HRIAs and mitigative studies are paid for by the person or company undertaking or proposing to undertake the development. Professional, private-sector archaeologists, paleontologists, historians, and traditional use consultants perform the required impact assessment work and prepare reports on the results of this work.

Application Details

https://www.alberta.ca/historic-resource-impact-assessment.aspx

17.3 Local

17.3.1 City of Calgary

Several permits will likely be required from the City of Calgary. The precise permits and any additional requirements will be determined through the City of Calgary planning process. The recommended first step is a *Pre-application* Meeting which is "a voluntary process where a prospective applicant may present a development proposal to The City for review and comment, prior to a formal application being submitted."[68] The development proposal will be circulated through all relevant City of Calgary departments for comment.

Pre-Application Details

http://www.calgary.ca/PDA/pd/Pages/Permits/Development-permits/Pre-application-meetings.aspx

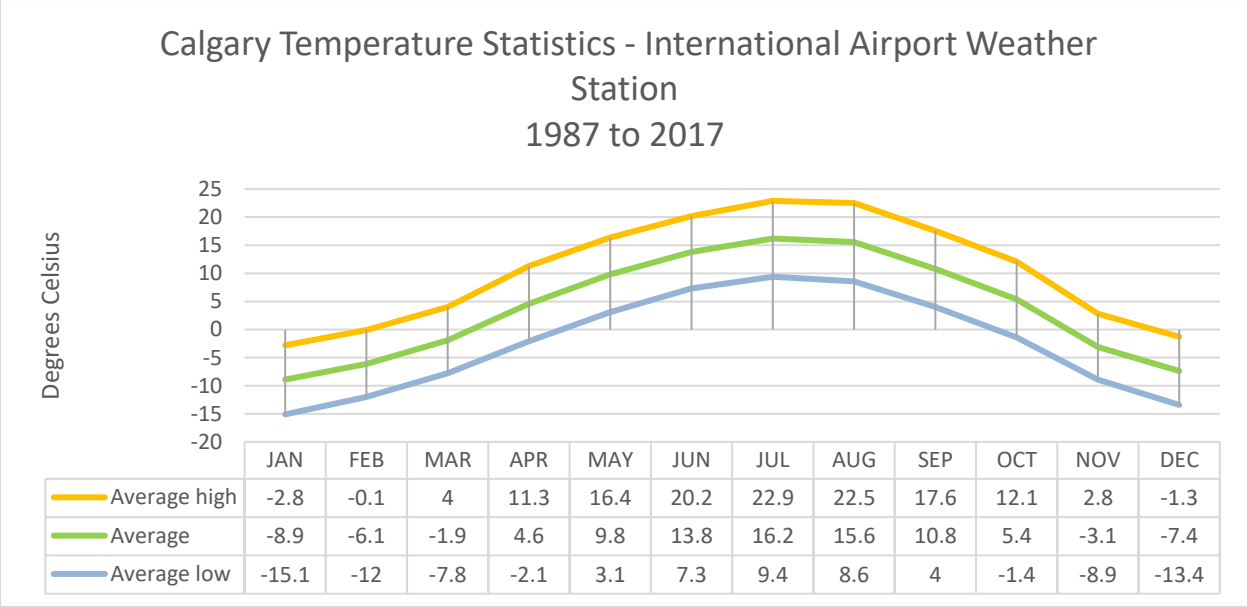
[68] Pre-application meetings. November 3, 2017. http://www.calgary.ca/PDA/pd/Pages/Permits/Development-permits/Pre-application-meetings.aspx

18 Weather, Demographics and Economic Impact

Calgary is excellently situated for a good river surfing wave. There are good periods of warm & sunny weather, a very large and nearby active population, a downtown that is beside the wave locations and good access via major highways and rail.

18.1 Ideal Wave Usage Months

Usage of river waves is strongly affected by the weather. The warmer and sunnier the weather, the more wave usage and spectators. The ideal months for Calgary, Alberta are from April through October (7 months). May to September are the best months and April and October are the shoulder season.



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Average high	-2.8	-0.1	4	11.3	16.4	20.2	22.9	22.5	17.6	12.1	2.8	-1.3
Average	-8.9	-6.1	-1.9	4.6	9.8	13.8	16.2	15.6	10.8	5.4	-3.1	-7.4
Average low	-15.1	-12	-7.8	-2.1	3.1	7.3	9.4	8.6	4	-1.4	-8.9	-13.4

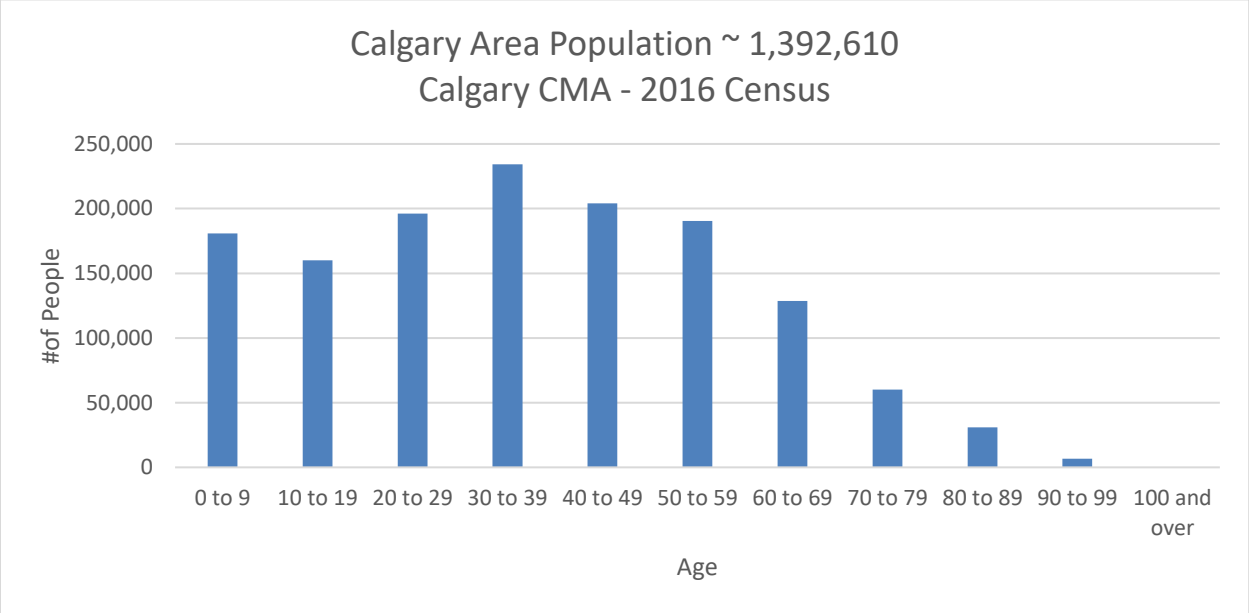
18.2 Access to Calgary and Waves

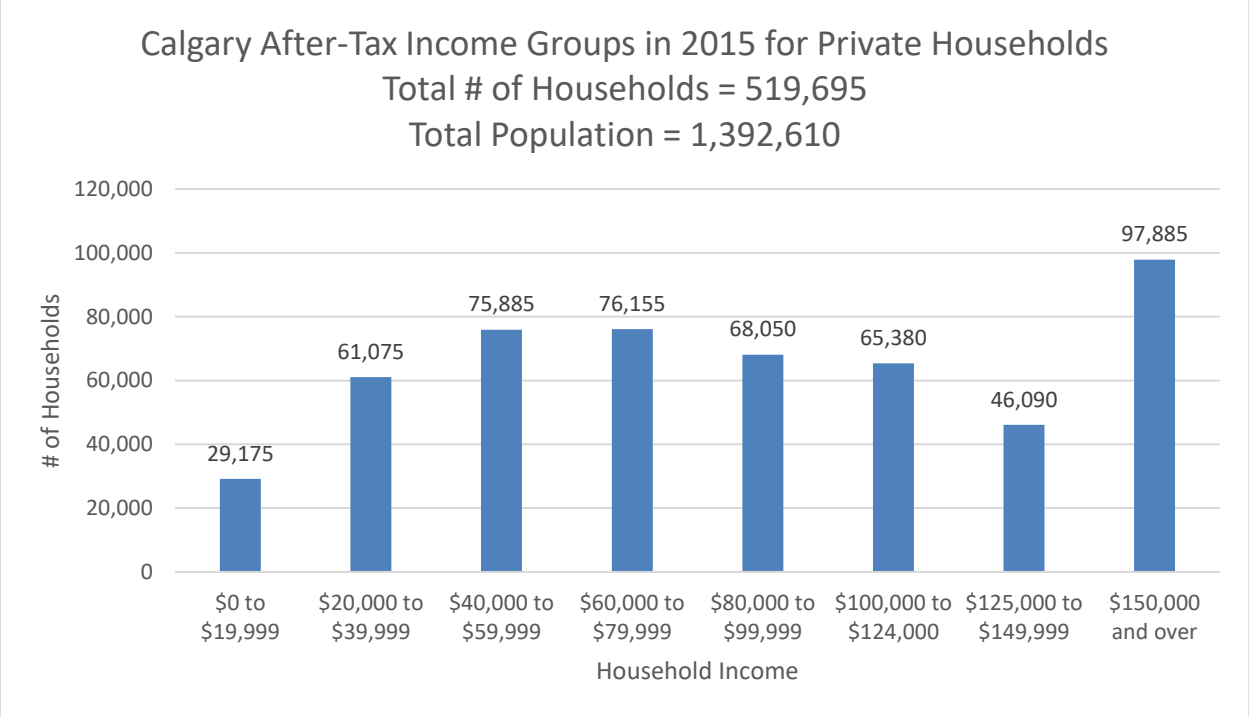
Calgary is easily access by all major forms of transportation including international air, automobiles and train. Calgary has a newly upgrade international airport, a passenger train station and is on the TransCanada highway. The proposed wave locations are in the centre of Calgary with excellent in city transportation options including buses, CTrain, biking, walking and driving. The waves are beside regional pathways, near CTrain stations, major bus routes and within walking distance of multiple high density residential neighbourhoods.

18.3 Demographics Overview

18.3.1 Calgary and Surrounding Surfer Area

The Calgary area population is about 1,392,610.





19 Economic impact of surf waves in Calgary

At 30% usage capacity, the Project will generate $1.8M a year in local economic activity from the wave users alone. At 100% capacity the Project generates $6.0M a year from waves users. Spectators and non-wave users will generate millions of dollars more each year. Global wave tourism is a $50 billion USD annual market[69]. Popular surf breaks are proven to generate millions to tens of millions each year in economic activity[70]. Surf waves are well proven economic drivers.

At 30% capacity, the Project can provide 29,060 wave sessions per year. There are 188,000 potential unique waves users each year including Albertans and tourists. At 100% capacity, the Project provides 98,860 wave sessions each year or about one session for every two wave users. The demand for surfing in Alberta and surrounding area is so large that Alberta cannot build enough waves to satisfy the demand.

19.1 Whitewater park economic impacts

There have been numerous studies on the economic impacts of whitewater parks since the mid-1980s. Medium quality whitewater parks generate a local annual economic impact of $500,000 USD. High quality whitewater parks generate millions USD in local annual economic impact.[71]

19.2 Market value of wave sessions

This is the market value of the wave sessions if they were pay to use like a typical powered wave facility. The typical pay to use wave session is about $1 per minute.[72] Each wave session is two hours.

Capacity	# of wave sessions per year Session length = 2hrs	Market value of one wave session $1 per minute	Total market value of waves sessions per year
30%	29,060	$120	$3,487,000
100%	98,860	$120	$11,623,000

19.3 River wave economic impacts

This information is based on national US[73] & UK[74] studies covering over 7,500 surfers and is supported by surveys from a variety of river surfing communities. A wave user spends an average of $62.50 per surf session. The average income of a surfer is $75,000. The numbers below are based on the regions around the wave location. Tourism will be a significant added economic benefit.

[69] (McGregor, 2016)
[70] (Thomas, 2012)
[71] (Egsgard, Neil, 2019)
[72] (A Dollar-by-Dollar Comparison of the World's Surf Parks, 2019)
[73] (Wagner, Nelson, Walker, 2011)
[74] (Mills, Dr. Bryan and Cummins, Andy, 2013)

19.4 Total Available Spending by potential wave user households[75] [76]

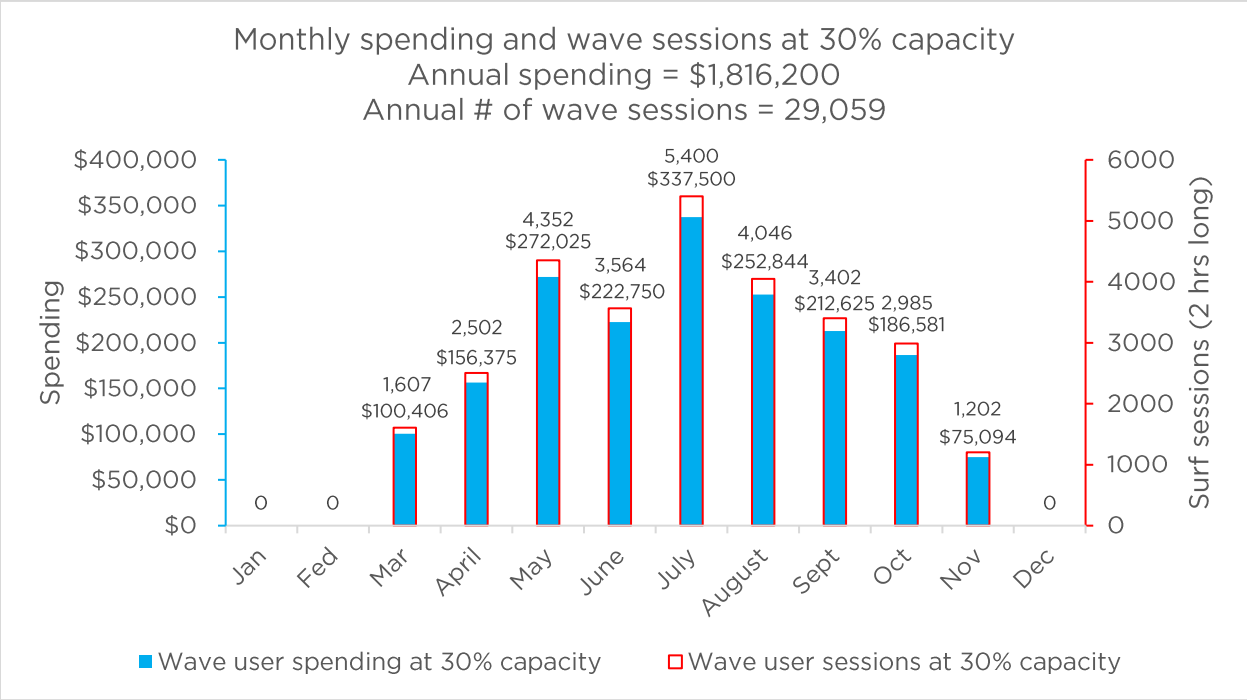
Wave user households near the Project spend about $50M a year on goods and services relevant to the Project. This number shows that the projected economic impact is reasonable especially when you include spending by tourists from out of the area, out of province and out of country. The spending and household number data is based on Calgary Census Metropolitan Area (CMA) households spending on areas relevant to the Project.

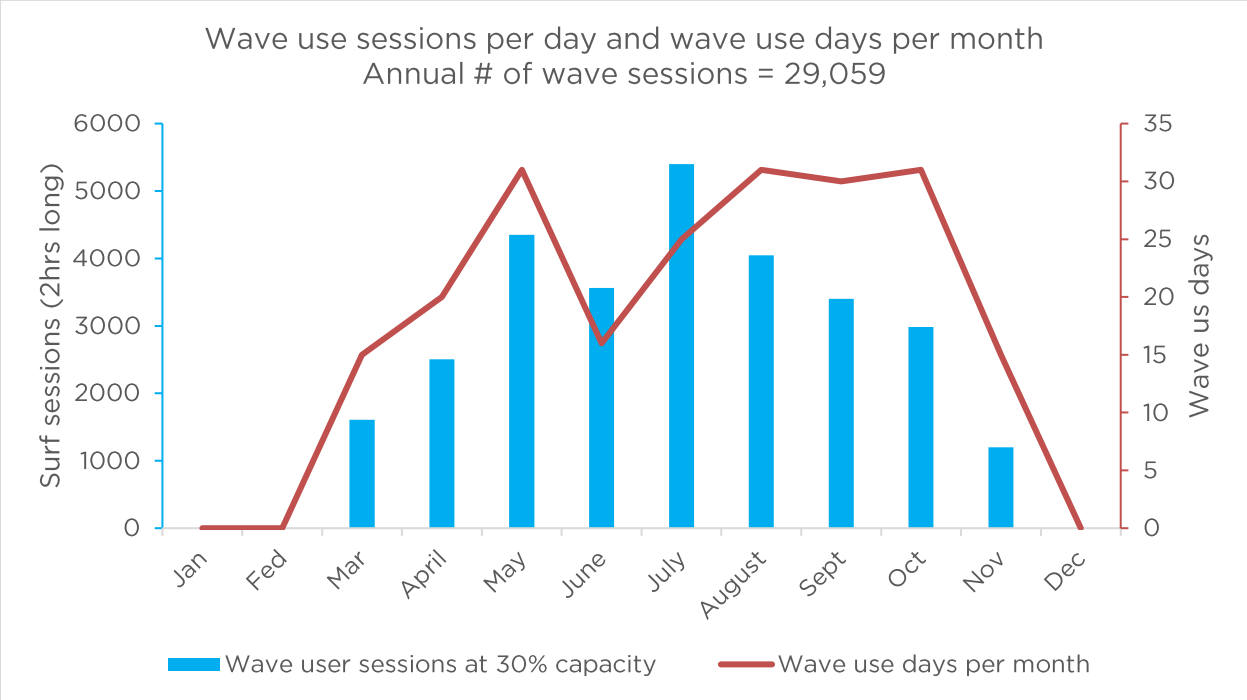
ID	Description	Value
A	Number of households in Calgary CMA	544,870
B	Wave users as percentage of population (Surfers @ 1% and whitewater kayakers @ 1%)	2%
C	Number of wave user households in Calgary CMA (A x B)	10,900
D	Relevant spending by wave user households per year (C x E)	$49,889,300
E	Relevant spending per household per year	$4,577
	Food purchased from restaurants	$2,668.00
	Sports, athletic and recreation equipment and related services	$183.00
	Dues and fees for sports and recreation facilities	$441.00
	Alcoholic beverages served on licensed premises and in restaurants	$568.00
	Alcoholic beverages purchased from stores	$717.00

[75] (Statistics Canada, 2016)
[76] (Statistics Canada, 2017)

19.5 Spending and visits by wave users at the Project

The Project will generate $1.8M to $6.0M a year in spending from wave users alone. These numbers do not include spectator spending, events and other sources of spending. These numbers adjust for wave user capacity, typical wave usage rates and weather conditions. The reduction of usage in June accounts for high flow events when river use could be suspended.





19.5.1 Conditions and calculations

- Conditions
  - Three Waves
    - Wave 1 and 2 are used 214 days of the year
    - Wave 3 is used 41 days of the year during higher flows
  - 9 months of usage: March to November
    - January, February and December are not included due ice coverage
    - November, March and April have reduced usage due to cold weather
    - June and July have reduced usage due to high water
- Wave use sessions
  - Each wave can have up to 30 simultaneous users with a few users on the wave and the rest in the line-up or returning to the line-up
  - A typical wave use session is two hours long
- Wave user income and spending
  - Average spending by wave users = $62.50 per session
  - Average wave user income = $75,000 per year
- Spending and wave user visits
  - 30% capacity
    - $1,816,200 annual spending by wave users
    - 29,059 wave user visits aka wave sessions
  - 100% capacity
    - $6,054,000 annual spending by wave users
    - 96,864 wave user visits aka wave sessions
- Not included
  - Spectator spending
  - Event spending
  - New businesses locating in area due to waves
  - High income people staying in or moving to area

19.6 Competing wave locations

There are no ideal waves within 1000 km of Calgary. The best wave is the Mountain wave in the Kananaskis built by the Alberta River Surfing Association and Surf Anywhere in 2014 and upgraded in 2019. The Mountain wave is very good but is remotely located and there are minimal opportunities to generate economic returns. There is a wave in Calgary at 10th Street bridge but it is the bare minimum for a surfable wave but still generates large and consistent crowds. The Harvie Passage has no surfable river waves.

The map below shows surf waves and is from MagicSeaweed (https://magicseaweed.com/). The light blue markers are ocean waves. The blue dots are consistent river waves. The red dot is the Project location.

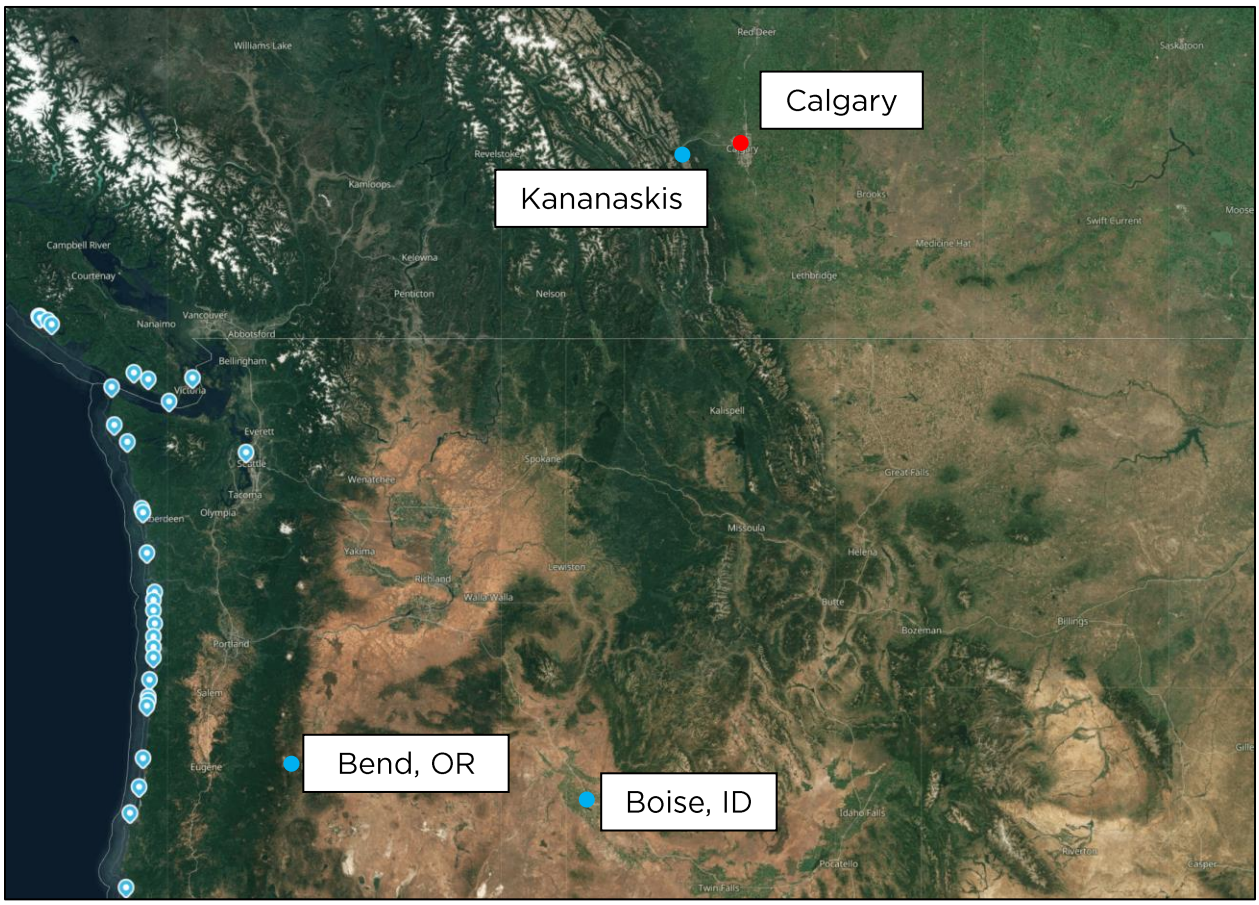


Figure 91: Map of regional surf waves[77]

[77] (Canada, west surf reports and surf forecasts, 2020)

19.7 Major powered wave facilities

In the last 5 years there has been an explosion of powered wave and whitewater facilities around the world. The capital cost of these facilities is over 40 million dollars, they have huge operating costs and high pay to use rates. The power wave / whitewater facilities are significantly privately funded because of the high returns on investment. These facilities provide high returns because they can guarantee predictable and high wave quality all the time. River waves offer similar opportunities but will much lower capital cost and minimal operating costs.

Figure 92: London, UK. Artificial whitewater park. Capital cost $51M CAD (£30M GBP). Built in 2012.

Figure 93: The Wave - Bristol. Artificial surf park. Capital cost over $42M CAD (£25M GBP). Built in 2019.

19.8 Private river wave and indoor wave facilities

In 2020, the first private facility dedicated to river surfing opened in Austria. Other private river wave or pumped standing wave facilities have been operating since 2010. The river waves have minimal operating costs and almost no energy usage. The pumped waves have very high operating costs and energy usage. These facilities are built because they make money.

Figure 94: Ebensee, Austria. Private artificial river wave. Capital cost $3 to $5M CAD (2M€ to 3.3M€. Built in 2020.

Figure 95: Munich Airport, Munich. Pumped wave. Capital cost $6M for a retrofit facility.

19.8.1 Additional Economic Impact Opportunities

Additional substantial economic impacts will derive from events around the waves and tourism by spectators. Events bring in thousands of participants and spectators over a few days. Good surf waves consistently have large number of spectators during good weather.

19.8.2 Maximizing Returns

Getting the highest value out of your surf wave requires using proper techniques and approach. Surf Anywhere has extensive successful experience creating vibrant communities and culture around river surfing waves. Surf Anywhere provides ongoing services after wave construction to ensure the wave provides your community exactly what you want.

20 Budget

20.1 Capital Budget

The rough pricing below is based on other river projects and input from local Southern Alberta river engineering firms. Only pricing for Louise Bridge location has been included.

Description	Unit	Quantity	Unit Cost	Cost	Notes
Design and permitting					
Engineering: Preliminary design and design development	Lump Sum	1	$268,972	$268,972	Based on quotes from Calgary engineering firms and APEGA guidelines on costs
Engineering: Construction drawings	Lump Sum	1	$537,944	$537,944	Based on quotes from Calgary engineering firms and APEGA guidelines on costs
Engineering: Contract administration, post construction service and other engineering services	Lump Sum	1	$268,972	$268,972	Based on quotes from Calgary engineering firms and APEGA guidelines on costs
Permitting	Lump Sum	1	$150,000	$150,000	Based on quotes from Calgary engineering firms and previous permitting work.
Design and permitting subtotal				$1,225,889	
Construction					
Access roads	Lump Sum	1	$200,000	$200,000	Based on comparing costs from other Calgary river construction projects
Excavation of banks, island and riverbed for boulder & concrete placement	m^3	1,347	$30	$40,410	Based on comparing costs from other Calgary river construction projects
Placement of excavated materials	m^3	1,347	$80	$107,760	Based on comparing costs from other Calgary river construction projects
Boulder supply and placement	Tonne	3,985	$240	$956,400	Based on comparing costs from other Calgary and area river construction projects and from past Alberta RSA projects.
Boulder concrete supply and placement	m^3	1,003	$500	$501,500	Based on comparing costs from other Calgary and area river construction projects and from past Alberta RSA projects.
Mobilization (20% of other construction costs)	Lump Sum	1	$896,574	$896,574	Based on comparing costs from other Calgary and area river construction projects and from past Alberta RSA projects.
Wave structure	m^2	330	$5,000	$1,650,000	Based on comparing pricing from water control structure manufacturers with costs for Alberta supplied materials
Care of water	Lump Sum	1	$750,000	$750,000	Based on comparing costs from other Calgary and area river construction projects

Description	Unit	Quantity	Unit Cost	Cost	Notes
Downstream riparian habitat enhancement	m	240	$320	$76,800	Based on comparing costs from other Calgary and area river construction projects
Signage and riverbank amenities	Lump Sum	1	$200,000	$200,000	Based on comparing costs from other Calgary and area river construction projects and from past Alberta RSA projects.
Construction Subtotal				$5,379,444	
Design & Construction Subtotal				$6,605,333	
Contingency (30%)				$1,981,600	
Flood recovery fund				$1,000,000	Funds for river adjustments to ensure high quality waves following a major flood (ex. 1:100 year)
Total				$9,586,933	

Notes

Completion of preliminary engineering with provide substantially more accurate cost estimates.

20.2Return on Investment

20.2.1 Cultural

The waves will create a positive and vibrant gathering place. The area usage will increase with good usage by a wide range of the local population and visitors including youth and families. The surf waves can become part of municipal recreational programming and become a component of educational classes on science and physical education.

20.2.2 Environmental

The increased usage will develop a greater connection with the river ecosystem for a broader selection of the population. User groups will perform volunteer river clean-up operations to improve their own experience of the river. The area can be used as an environmental educational tool.

20.2.3 Economic

The expected return on investment is under 6 years and as fast as 3 years. The annual economic impact is expected to be $1,816,200.00 (30% capacity) to $6,054,000.00 (100% capacity) from wave user spending alone. Impact includes lodgings, food and other expenses while in the area. The budgetary cost of the wave at Louise Bridge is $9,586,933.

Additional sources of economic impact

These sources of economic impact are not included above: non-surfer tourism, major events, new businesses establishing in Calgary and people moving to or staying in Calgary.

ROI

		30% Capacity		100% Capacity	
Year	% of Annual Impact	$ of Annual Impact	Cumulative $	$ of Annual Impact	Cumulative $
1	50%	$908,100	$908,100	$3,027,000	$3,027,000
2	75%	$1,362,150	$2,270,250	$4,540,500	$7,567,500
3	100%	$1,816,200	$4,086,450	$6,054,000	$13,621,500
4	103%	$1,870,686	$5,957,136	$6,235,620	$19,857,120
5	106%	$1,925,172	$7,882,308	$6,417,240	$26,274,360
6	109%	$1,979,658	$9,861,966	$6,598,860	$32,873,220

Annual Impact Notes

- 9 months of usage with reduced usage on shoulder months and flood event months
- Three waves
    - Wave 1 and 2 operational 9 months of the year
    - Wave 3 operational 2 months of the year during high flows

20.3Operational Budget

This section details the annual operational costs including maintenance, area management, life cycle costs and emergency funds.

20.3.1 Operational Budget Overview

The summary table is based on the following tables.

Description	Revenue	Expense	Profit
Revenues			
Lessons	$164,720	$98,832	$65,888
Events	$113,000	$80,800	$32,200
Membership	$150,000	$15,000	$135,000
Facility Rental	$108,800	$31,840	$76,960
Interest & Sponsorship	$90,000	$0	$90,000
Food & Drink	$126,000	$75,600	$50,400
Grants	$85,000	$0	$85,000
Revenues Subtotal	**$988,720**	**$317,192**	**$671,528**
Additional Expenses Subtotal (ex. Insurance, life cycle, etc.)		$480,000	($480,000)
Total	**$988,720**	**$797,192**	**$191,528**

20.3.2 Revenues and associated expenses

Description	Qty	Unit Type	Unit $	Value	Freq-uency	Freq-uency Unit	Per Year	Value per Year	Expens e Ratio	Expens e	Profit
Lessons											
Youth Livesavers Program	40	Youth	$400	$16,000	1	per week	8	$128,000	60%	$76,800	$51,200
Lessons	6	People	$85	$510	3	per week	72	$36,720	60%	$22,032	$14,688
Subtotal								*$164,720*	*60%*	*$98,832*	*$65,888*
Events											
Annual festival	1	Festival	$65,000	$65,000	1	per year	1	$65,000	80%	$52,000	$13,000
Regular small event	1	Event	$2,000	$2,000	1	per week	24	$48,000	60%	$28,800	$19,200
Subtotal								*$113,000*	*72%*	*$80,800*	*$32,200*
Membership											
Memberships - Full	300	Member	$500	$150,000	1	per year	1	$150,000	10%	$15,000	$135,000
Subtotal								*$150,000*	10%	*$15,000*	*$135,000*
Pay to use											
Pay to use	30	User	$30	$900	7	per week	168	$151,200	10%	$15,120	$136,080
Subtotal								*$151,200*	10%	*$15,120*	*$136,080*
Rentals											
Wave Rental (Exclusive)	1	Rental	$600	$600	7	per week	168	$100,800	30%	$30,240	$70,560
Facility Rental	1	Facility	$1,000	$1,000	8	per year	8	$8,000	20%	$1,600	$6,400
Subtotal								*$108,800*	29%	*$31,840*	*$76,960*
Interest and Sponsorship											
Sponsorship	2	Sponsors	$20,000	$40,000	1	per year	1	$40,000	0%	$0	$40,000
Interest on flood fund	5%	Interest	$1,000,000	$50,000	1	per year	1	$50,000	0%	$0	$50,000
Subtotal								*$90,000*	0%	*$0*	*$90,000*
Food and Drink											
Food / Drink	50	Customers	$15	$750	1	per day	168	$126,000	60%	$75,600	$50,400
Subtotal								*$126,000*	60%	*$75,600*	*$50,400*
Grants											
Casino	1	Casino	$70,000	$70,000	1	per two years	0.5	$35,000	0%	$0	$35,000
Operating Grant	1	Grant	$50,000	$50,000	1	per year	1	$50,000	0%	$0	$50,000
Subtotal								*$85,000*	0%	*$0*	*$85,000*
Total								**$988,720**	32%	**$317,192**	**$671,528**

20.3.3 Additional expenses

The costs associated with revenues are covered under the previous table.

Expenses	# of Units	Unit $	Value	Frequency	Frequency Unit	Per Year	Value per Year	Notes
Annual Expenses								
Insurance	1	$50,000	$50,000	1	per year	1	$50,000	
Flood fund	1	$25,000	$25,000	1	per year	1	$25,000	
Wave structure replacement fund	1	$60,000	$60,000	1	per year	1	$60,000	$1,500,000 over 25 years
Inspections and maintenance	1	$20,000	$20,000	1	per year	1	$20,000	
Alberta RSA other initiatives	1	$50,000	$50,000	1	per year	1	$50,000	
Staffing	1	$200,000	$200,000	1	per year	1	$200,000	
Utilities and other services	1	$75,000	$75,000	1	per year	1	$75,000	
Total							$480,000	

20.4 Capital Funding

The capital plan is being developed through discussions will all groups listed below. River waves projects are funded by a variety of sources. The funding groups are typically a not-for-profit river community organization local business, government grants, private families/individuals and the municipality. The broad, high profile and lasting benefits of good river surfing waves make them excellent projects for corporate donations, as legacy projects for wealthy families and for government grants. River wave projects have been funded over 50% from corporations or private families.

20.4.1 Initial Capital Plan

This plan is based on initial discussions with potential funders and could change substantially. The project is uniquely beneficial, environmentally friendly and high profile. These characteristics will help earn funding.

Funding Source	Value	Notes
Alberta RSA, Corporations, Private Individuals & Families	$4,600,000	Funding sources are: • Alberta RSA funding from community and operations of surf facility. • Corporate funding through grants and community investment plans. • Private funding by people wishing to create a major and lasting and high profile public benefit.
City of Calgary	$2,000,000	Funding comes from: • River bank work through West Eau Claire to Crowchild Trail riverbank development. This is a multi-million dollar project. • Gravel island berm work through Louise Bridge gravel island flood mitigation and funds directed to project. This is a $6,400,000 project. • Additional funding will be specifically for the project Funding from above will be sharing costs and doing some of the necessary work as part of the project. Next funding 4 year funding cycle starts in 2022.
Alberta Government	$1,000,000	Funding via Community Facility Enhancement Plan matching grant
Federal Government	$2,000,000	Funding via future federal infrastructure programs
Total Funding	$9,600,000	
Project Capital Cost	$9,600,000	

20.4.2 Community / Not for Profit

The Alberta River Surfing Association builds up funds through events and donations every year. The events create great experiences for Alberta while educating people about the project benefits and building both support and funds. These funds are then used for matching grants

20.4.3 Grants

There a variety of regional and federal grants available for funding projects that create public sport, cultural and environmental spaces. These grants are typically matching grants that require cash, material or services equivalent to the dollar value of the grant.

20.4.4 Corporate Donations

The Alberta River Surfing Association has been very successful at securing substantial corporate donations. The Alberta RSA has received and continues to receive substantial donations of funds, professional services and materials. These donations are used for matching grants. All major donations can receive a tax receipt.

20.4.5 Private Individuals / Families Donations

The high profile, quick and lasting impact positive impacts make river surfing waves excellent legacy projects. Local individual and families have often provided major funding for river waves.

20.4.6 City of Calgary

The City of Calgary will be the primary beneficiary of the 10th Street Waves and Urban Beach project. The next stage of the project will be the creation of a report to convince the City of Calgary to invest in this project. The Alberta RSA will be asking the City of Calgary to allocate funds and staff towards the 10th Street Waves and Urban Beach. The Alberta RSA is asking the City of Calgary to adjust their two projects in the same area to support the 10th Street Waves and Urban Beach. The two existing City of Calgary projects are: the riverfront development from West Eau Claire Park to Crowchild Trail which covers the land beside the waves and the Louise Bridge gravel island adjustment which will lower the height of the gravel bar to reduce flood risk. The local municipality and the local population are the primary beneficiaries of the waves and recreation area. The municipality typically provides significant funds towards the project provided the other sources can provide substantial funding.

20.4.7 Province of Alberta

The Alberta RSA will be applying for Community Facility Enhancement Plan grants and other relevant grants from the Alberta government.

20.4.8 Federal Government

The Alberta RSA will be applying for federal grants. The grants available change from year to year and the Alberta RSA will continue applying until the project is successful.

21 Process of Building Waves

The process of building waves typically takes a few years depending on the availability of financing and difficulty of permitting. There general steps are:

1. Feasibility Study & Conceptual Design: Initial review to confirm good waves are possible and key supporting information. The includes an overview design of what could be built, a budget to complete the project, details on all the steps below and a visually appealing general layout to assist with the remaining stages.
2. Building Support: Building public and private support for the project. Typically, a local non-profit or a more informal group is started to support the project. This leverages the feasibility study and conceptual design. This is ongoing.
3. Permitting: Achieving the necessary permits from the various governing bodies. This process typically continues up to the construction stage
4. Fundraising: Raising funds and receiving grants to pay for project. This project typically continues up to the construction stage.
5. Stakeholder Consultation: Reaching out to stakeholders to present the project and get their feedback. The aim is to present the project positively and adjust the project based on the feedback to increase levels of support.
6. Initial Design Report and Support Building Plan: A detailed design plan for the municipality with a focus on making the plan easy to accept while maintaining high quality waves. The support building plan is for the wave association and details short- and long-term methods of creating deep and broad support.
7. Preliminary Engineering: Initial refinement of the design including detailed engineering that begins to cover site specific conditions such as hydraulics, environmental concerns, access, etc.
8. Final Engineering: Completion of engineering adjusting for issues identified during permitting and project development process
9. Construction & Bidding Documents: Creation of the documents necessary for bidding by contractors and for construction
10. Bidding: Bidding by contractors and contractor selection
11. Construction: Construction of the waves and surrounding amenities
12. Commissioning: Testing and activation of the waves and surrounding amenities
13. Adjustment: Adjustments to facilities following usage
14. Maximizing Return on Investment: Ongoing services to maximize return on investment by encouraging and assisting desired usage.

21.1 Project Timeline

The project timeline until completion is between 2 to 10 years with the variance due funding and permitting. The fastest the project could be complete is 2 years if it receives full funding in short order. The likely timeframe for the project is 5 to 10 years.

Description	Status	5-Year Timeline 2023 Build	10-Year Timeline 2028 Build
Build excellent river surfing wave in Kananaskis, Alberta.	Complete	2014	2014
Start conversations with City of Calgary about Urban Beach Surf Waves	Complete	2015	2015
Convince City of Calgary to include consideration to river recreation opportunities in all river projects	Complete	2016	2016
Hold first annual North American River Surfing Championship	Complete	2017	2017
Start Slam Festival to raise awareness and support for river surfing and to create events based in surf, skate, art and music	Complete	2017	2017
Feasibility Study, Concept Design and basic website for Surf Wave and Urban Beach. Multiple locations considered and 10th Street Bridge location selected.	Complete	2018	2018
Public outreach through major print/radio/video media with Concept Design, interviews and website	Complete	2018	2018
Initial Design Report, Initial Permitting Discussions, Engagement and Support Building	Complete	2019	2019
Building Public, Political and Governmental Support Building Funding & Partnerships.	Current Stage	Ongoing	Ongoing
Physical and computer wave modelling with the University of Ottawa	Incomplete	2020	2020
Presentation of initial design results	Incomplete	2020	2020
Project Delay Arranging Funding	Incomplete	1 Years	2 Years
Preliminary Engineering	Incomplete	2020	2021
Project Delay Arranging Funding	Incomplete	1 Year	3 Years
Begin Permitting Applications	Incomplete	2021	2024
Final Engineering	Incomplete	2022	2026
Construction Contractor Selection	Incomplete	2022	2026
Permitting Approval (Duration of Permit Process)	Incomplete	2023 (2 years)	2027 (3 years)
Begin Construction	Incomplete	2023	2027
Complete Construction	Incomplete	2023	2028
Commissioning	Incomplete	2023	2028
Open for public use	Incomplete	2023	2028

21.2

21.3 Next Steps

The next steps are to:

1. Present results of initial design report to stakeholders and potential funders
2. Develop capital plan
3. Complete physical and computer modelling of wave with University of Ottawa
4. Complete architectural imagery donated by The REM design studio

22 Conclusion

Calgary has a unique opportunity to create the first urban surfing waves & beach in Western Canada, build one of the best river facilities in the world and capture an exceptionally large and untapped market. The results of building good river surfing waves and an urban beach in Calgary will be a substantial increase in tourism and cultural activities. A good river surfing waves will provide substantial immediate & lasting economic, cultural and environmental benefits. The best location for the wave is near Louise Bridge.

23 Surf Anywhere Team

Surf Anywhere is the most experience river surfing wave designing & river surfing consulting team. We have a combined experience of over 20 years river surfing in communities and on waves across the world. We have been extensively involved in all aspects of river surfing from wave creation, to community management, to safety standards, to event creation, to media creation, to wave promotion and more. Surf Anywhere has helped raise hundreds of thousands in community, corporate and government funding for wave projects. Surf Anywhere has completed three successful river surfing waves in the past three years with more planned and has a 100% success rate. Surf Anywhere waves include the world's best manufactured river surfing wave in Bend, Oregon, and the best manufactured river surfing wave in Western Canada, in Kananaskis, Alberta. Surf Anywhere has completed critical surfing public safety projects including an international river surfing accident database, leash safety signage and details of river surfing hazards and safety equipment. In 2017, Surf Anywhere held the first North American River Surfing Championship and the first River Surf Summit.

23.1 Neil Egsgard – President

Neil Egsgard founded Surf Anywhere in 2008 and has extensive experience in wave building & design, operations, project management, grant applications, permitting, association creation & maintenance, safety information creation, surfer data collection & analysis, research and raising political support. Neil has successfully convinced multiple cities in different countries to build surfing waves. Neil started river surfing in 2005 and has traveled around the world researching wave building & surfing river waves. In 2006, Neil founded the Alberta River Surfing Association, one of the first river surfing associations and a model which many associations followed. In previous employment, Neil built a Calgary based regional office from nothing to millions a year in revenue. Neil holds a H.B.Sc. from the University of Toronto majoring in Physics and minoring in Mathematics and German.

23.2 Jacob Kelly Quinlan – Director of Communications & Culture

Jacob Kelly founded Surf Anywhere in 2008 and directs communications, media creation, fundraising, promotions, community management and has run a successful lessons and gear sales start-up. Jacob's surf events have become world renowned including the first ever North American Championships of River Surfing in 2017. Jacob is passing the torch for local business to concentrate on the international efforts of Surf Anywhere but still offers lots of coaching and development for surf lessons and event planning. Jacob has been river surfing since 2005 and has surfed over 100 river waves. Jacob is part of a network of river surfing's great pioneers, community leaders, wave engineers, athletes and business owners. This network shares information on all things river surfing and can offer a lot of insights to any project. Jacob holds a Bachelor of Psychology from the University of Lethbridge and a Bachelor of Applied Communications from Mount Royal University. Jacob is also certified with Swift Water Rescue and developed a recognized curriculum to teach river surfing.

24 Bibliography

(2019, October 7). Retrieved from Canadian Legal Information Institute: https://www.canlii.org/en/ab/abpc/#search/type=decision&jId=ab&text=kayak&origType=decision&origCcId=abpc

Alberta Floods. (2020, 12 14). Retrieved from Alberta Government: https://floods.alberta.ca/?N=&app_code=FI&BM=Satellite&Ext=%7B%22NE%22%3A%7B%22lat%22%3A%2251.053006%22%2C%22lng%22%3A%22-114.080977%22%7D%2C%22SW%22%3A%7B%22lat%22%3A%2251.048359%22%2C%22lng%22%3A%22-114.094024%22%7D%7D&Mrk=&center%5B%5D=54.8619336&cente

Bow River Calgary 1924 (CA 112 32). (2019, April 17). *Alberta Airphoto Collection*. Ottawa, Ontario, Canada: National Airphoto Library.

Calgary Bow River 1951. (n.d.). Department of Energy, Mines and Natural Resources.

Calgary Bow River 1951. (1951). *Airphotos*. Department of Energy, Mines and Natural Resources.

Calgary Parking Authority. (2019, November 30). *On-Street Occupancy*. Retrieved from CalgaryParking.com: https://www.calgaryparking.com/findparking/onstreet

Calgary Transit. (2019, November 30). *2019 Calgary Transit System Map.* Retrieved from Calgary Transit: http://www.calgarytransit.com/sites/default/files/content/PDF/18-00853891_-_2019_calgary_transit_system_map_web_dec_20_003.pdf

City of Calgary. (2011, 05 27). Legal Survey Fabric. City of Calgary.

City of Calgary. (2011, 05 27). Ownership Parcel Fabric. Calgary, Alberta, Canada: City of Calgary.

City of Calgary. (2019, November 30). *Calgary Pathways and Bikes*. Retrieved from The City of Calgary: https://maps.calgary.ca/PathwaysandBikeways/

David C. Fiore, M. (2003). Injuries Associated With Whitewater Rafting. *Wilderness and Environmental Medicine,,* 255-260.

Egsgard, N. (2019). *River Surfing Accident & Incident Database*. Retrieved from Surf Anywhere: https://www.surfanywhere.ca/project/river-surfing-accident-and-incident-database/

Egsgard, Neil. (2019). *Economic Incentives for Building River Waves.* Calgary: Surf Anywhere.

Enmax Corporation. (2019, September 09). *Utility Locate.* Calgary: Enmax Corporation.

Glenbow Archives na-2864-23932. (1973, October). *Glenbow Archives*. Calgary, Alberta, Canada: Glenbow Museum.

Glenbow Archives na-2864-477b. (1966, September). *Glenbow Archives*. Glenbow Museum.

Golder Associates Ltd. (2015). Bow River and Elbow River Hydraulic Mode. *HEC-RAS Model*. City of Calgary.

Google and Maxar Technologies. (2002, April 22). Calgary Bow River 2002.

Google and Maxar Technologies. (2005, July 30). Calgary Bow River 2005.

Google and Maxar Technologies. (2007, October 21). Calgary Bow River 2007.

Google and Maxar Technologies. (2008, September 13). Calgary Bow River 2008.

Google and Maxar Technologies. (2011, August 20). Calgary Bow River 2011.

Google and Maxar Technologies. (2012, September 22). Calgary Bow River 2012.

Google and Maxar Technologies. (2013, October 24). Calgary Bow River 2013.

Google and Maxar Technologies. (2014, August 11). Calgary Bow River 2014.

Google and Maxar Technologies. (2015, August 8). Calgary Bow River 2015.

Google and Maxar Technologies. (2016, August 8). Calgary Bow River 2016.

Google and Maxar Technologies. (2017, October 17). Calgary Bow River 2017.

Google and Maxar Technologies. (2018, July 7). Calgary Bow River 2018.

Google and Maxar Technologies. (2019, June 30). Calgary Bow River 2019.

Google Maps. (2019, November 30). *Search: Parking near Project*. Retrieved from Google Maps: https://www.google.com/maps/search/parking/@51.0513376,-114.0876454,16z

Harvie Passage- A Challenge For Drift Boat Use. (2019, December 1). Retrieved from Bow River Trout Foundation: https://bowrivertrout.org/2018/10/09/harvie-passage-a-challenge-for-drift-boat-use/

Iain Wilson, H. M. (2013). Injuries, Ill-Health and Fatalities in White Water Rafting and White Water Paddling. *Sports Med.*

McGregor, W. (2016). *Natural Assests: Surfing a wave of economic growth.* Oxford: University of Oxford.

Mills, Dr Bryan and Cummins, Andy. (2013). *The economi cimpact of domestic surfing on the United Kingdom.* Cornwall: Surfers Against Sewage.

Northwest Hydraulic Consultants. (2017). *The Ice Regime of the Bow River within the City of Calgary, Alberta.*

R1_031.jpg. (1970s). *MachAir Obliques*. Calgary, Alberta, Canada: University of Calgary.

Registrar of Land Titles. (2019, 11 25). Land Title Certificate. Alberta, Canada: Government of Alberta - Alberta Land Titles Spatial Information System.

Rood, S. (2020). *Louise Island in the Bow River at Calgary. Mitigation of a Growing Flood Hazard and Prospective Environmental Impacts from the Urban Surf Beach and River Waves Project.* Lethbridge: Chinook Environmental Resources and University of Lethbridge.

Soutern Alberta Land Registration District. (1988, September 12). Registered Survey Plan. Government of Alberta - Alberta Land Titles Spatial Information System.

South Alberta Land Registration District. (1974, May 29). Registered Survey Plan. Alberta: Government of Alberta - Alberta Land Titles Spatial Information System.

South Alberta Land Registration District. (1977, September 27). Registered Survey Plan. Government of Alberta - Alberta Land Titles Spatial Information System.

Wagner, Nelson, Walker. (2011). *A Socioeconomic and Recreational Profile of Surfers in the United States.* Surf-First and the Surf Rider Foundation.

Water Office. (2017, August 4). *Environment and Climate Change Canada Historical Hydrometric Data*. Retrieved from https://wateroffice.ec.gc.ca/mainmenu/historical_data_index_e.html

Wyl, R. v. (2015). *Einfluss einer Klappe auf die Surfbarkeit stehender Wellen.* Zürich: ETH Zürich.

25 Appendices

A. Louise Island in the Bow River at Calgary Mitigation of a Growing Flood Hazard and Prospective Environmental Impacts from the Urban Surf Beach and River Waves Project

B. Boise and Bend River Wave Review by Ryan Richard

C. Stakeholder Consultation for Calgary River Waves and Urban Beach

A. Louise Island in the Bow River at Calgary Mitigation of a Growing Flood Hazard and Prospective Environmental Impacts from the Urban Surf Beach and River Waves Project

B. Boise and Bend River Wave Review by Ryan Richard

C. Stakeholder Consultation for Calgary River Waves and Urban Beach

A. Louise Island in the Bow River at Calgary Mitigation of a Growing Flood Hazard and Prospective Environmental Impacts from the Urban Surf Beach and River Waves Project

Louise Island in the Bow River at Calgary

Mitigation of a Growing Flood Hazard and Prospective Environmental Impacts from the Urban Surf Beach and River Waves Project

(Figure 1. Aerial view of the Louise (10th St.) Island, Sept. 5, 2018 – S.Rood)

Stewart Rood
Chinook Environmental Resources and
University of Lethbridge, Alberta

April, 2020

Summary

A bridge over the Bow River at 10th St. in Calgary was first constructed in 1887, crossing a natural island. Shortly thereafter, a dam was constructed upstream of the bridge to raise the water level for diversion through an elevated and excavated channel that passed logs to the Eau Claire sawmill and water to the Calgary Water Power hydroelectric plant at Prince's Island. The bridge was twice reconstructed and the dam and log channel were removed around 1950. Subsequently, an island through the Louise (10th St.) Bridge reformed in a few years and has persisted since. The island was elevated and expanded with the 2013 flood, while scour deepened the adjacent main and side channels, limiting net change in the flood flow path. Following the flood, there was extensive colonization by balsam poplar seedlings, which have grown into saplings. If allowed to grow into trees, a riparian woodland would impede future flood flows through the Louise Bridge, increasing the flood hazard. To avoid woodland development, the saplings should be removed through uprooting or other measures. The poplars could be permitted to grow in narrow bands that are aligned with the bridge piers, providing environmental benefit without increasing the flood hazard.

A popular river surf wave occurs below the Louise Bridge. The proposal of the larger Urban Surf Beach and River Waves project would add a wave forming structure across the side channel along Louise Island. A gate would raise the water level and hinged flaps or spoilers would form side-by-side surf waves. Pneumatic or hydraulic controls would enable adjustments for different users or river flows, and the mechanism would be lowered nightly and with flood flows or ice. The environmental impacts of this project are assessed and there would be minimal impact on hydrology or geomorphology. The wave would impede upstream fish passage but with regular lowering and the unaltered larger main channel, fish movements would not be substantially hindered. The development could also include some beneficial shaping of the eroded shoreline downstream from the surf wave. Artificial river waves have been successfully developed elsewhere such as in the Kananaskis River west of Calgary and in Bend, Oregon and Boise, Idaho, and these contribute substantially to recreation and tourism. The Louise Island Park and River Waves projects are complementary and the pairing could provide economic, environmental and social benefits to the City of Calgary.

Figure 2. The Louise Island Park concept

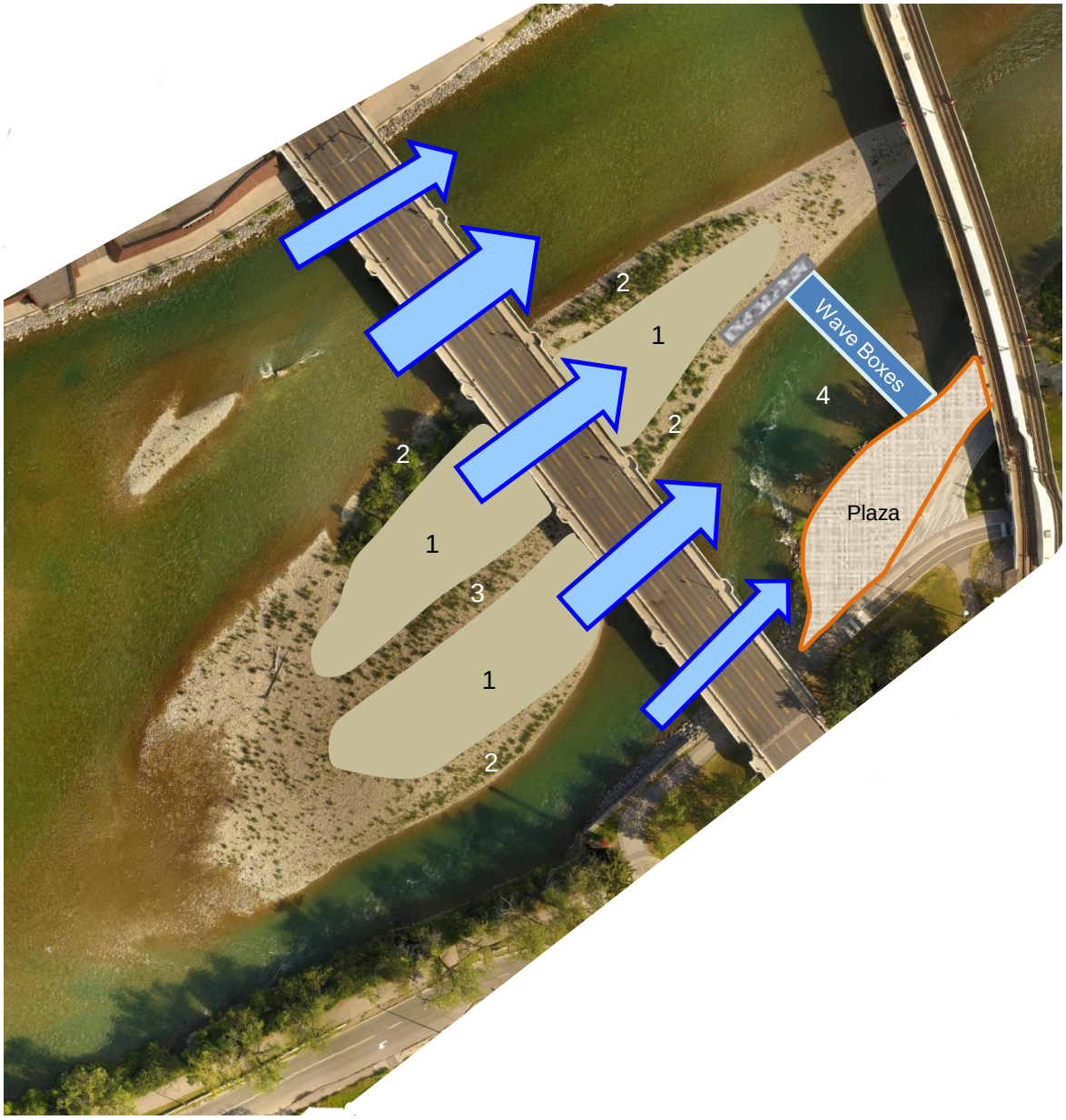
(1) Clear poplar saplings to avoid woodland development that would impede flood flows,

(2) Leave shoreline poplar bands for habitat, island stabilization and the aquatic food-web,

(3) Allow a pier-aligned mid-island poplar band to provide wildlife habitat, and

(4) The Urban Surf Beach and River Waves project

Arrows indicate the flood flow path (aerial orthophoto, Aug 2019, S.Rood).



Contents

Summary *2*
List of Figures *5*

I. Historical Background

1. The Extensively Regulated Bow River *6*
2. The Bow River through Calgary *6*
3. Bow River Developments in Calgary's Eau Claire District *7*
4. The Louise (10th St.) Bridges *9*
5. Louise Island *11*

II. After the Flood

6. The Bow River Flood of 2013 ..... *12*
7. Louise Island Expansion with the 2013 Flood *13*
8. Riparian Woodlands – Balsam Poplars *17*
9. Riparian Vegetation Colonization on Louise Island *18*
10. Measures to Exclude Woodland Development on Louise Island *20*
10.1 Vegetation Control *22*
10.2 Island Scraping and Shaping *23*
10.3 Water Management *23*

III. Urban Surf Beach and River Waves

11. The Proposed Surf Waves Project *24*
12. Environmental Impacts from the Surf Waves Project *26*
12.1 Hydrology – Flows, Floods, Groundwater, Ice – minor impacts *26*
12.2 Geomorphology minor alteration *28*
12.3 Aquatic Ecosystem – Slight impediment to fish passage *28*
12.4 Riparian Ecosystem – Eau Claire Woodland *31*
12.5 Navigation/Recreation – Deliberate Enhancement *34*

IV. Louise Island Park

13. Design Concepts for Louise Island *34*
13.1 Flood Hazard *34*
13.2 Concept Plan – Louise Island Park *36*

Acknowledgements *39*
References *40*

List of Figures

Figure 1. (Cover) Aerial view of Louise Island (Aug 2019). 1
Figure 2. Concept plan for Louise Island Park and the Surf Waves Project. 3
Figure 3. The Surf Wave in Boise, ID. 7
Figure 4. The Eau Claire sawmill and hydroelectric facility at Prince's Island. 7
Figure 5. The excavated and elevated Eau Claire Millstream (1912). 8
Figure 6. The overtopped Calgary Water Power dam (1915 flood). 8
Figure 7. Aerial view of the Bow River and Louise Bridge (1924). 9
Figure 8. The first 10th St. bridge, the Bow Marsh Bridge (1902 flood). 10
Figure 9. The steel Louise Bridge (no date, around 1910). 10
Figure 10. Upstream facing view of the Louise Bridge (Aug. 2019). 11
Figure 11. Aerial photos of Louise Bridge and Island, 1949 and 1957. ..... 11.
Figure 12. Partially blocked span of Mission Bridge over the Elbow River. 13
Figure 13. The Louise Bridge during the Bow River flood in June 2013. 14
Figure 14. Aerial photograph of the Bow River and Louise Bridge in flood, 2013. 14
Figure 15. Pre-flood (2012) and post-flood (2017) aerial photographs of Louise Island. 15
Figure 16. Deposition or erosion around Louise Island (Slaney et al., 2019). 16
Figure 17. Aerial overview of Louise Island with features designated. 17
Figure 18. Photographs of Louise Island (Aug 2019). 19
Figure 19. Approaches to avoid woodland development on Louise Island. 21
Figure 20. Calgary Urban Surf Beach and River Waves (SurfAnywhere). 24
Figure 21. Artist conception of the Surf Wave development (SurfAnywhere). 25
Figure 22. Aerial photograph of ice jamming around the Peace Bridge (March 2017). 27
Figure 23. The similarly engineered urban surf wave in Bend, OR (Aug 2019). 29
Figure 24. Pre-flood and Post-flood aerial photographs of the riparian woodland. 32
Figure 25. Photograph over Louise Island, of the C-Train Bridge and downstream bank. .. 33
Figure 26. Flood map around Louise Bridge (City of Calgary). 35
Figure 27. Concept plan for Louise Island Park and the Surf Waves Project. 37

I. Historical Background

1. The Extensively Regulated Bow River

With 15 dams on the mainstem and tributaries (Rood et al., 1999), the Bow River is the most extensively developed river in Alberta and one of the most managed rivers in Canada. The river commences in the pristine headwaters of Banff National Park and dams along the mainstem and mountain tributaries were developed from 1910 to 1954 for hydroelectric power generation.

Upstream from Calgary, Bearspaw Dam was the final hydroelectric dam and is also operated to reduce ice jamming and winter flooding through Calgary, and to reduce hydropeaking from Ghost Dam. Ghost Dam is the largest structure and following the flood of 2013, it is also operated to attenuate flooding. This involves greater reservoir draw-down to increase the storage capacity prior to the flood interval. The upstream dams are primarily for hydroelectric power generation, but increasingly incorporated into basin-wide water management (Sheer et al., 2013).

The extensive regulation has altered the seasonal flow regime of the Bow River through Calgary (Rood et al., 1999; 2019). Winter flows are augmented since this is the interval with the highest power demand. The spring peak is generally attenuated but as displayed in 2013, major floods can still occur (Pomeroy et al., 2016). Flows are augmented through the summer, allowing water delivery to the irrigation diversions. Following these diversions, summer flows are depleted along the lower river reach downstream of Bassano Dam and this prompted the Province to close the Bow River Basin to new water withdrawal licences in 2006.

2. The Bow River through Calgary

Through Calgary, the Bow River channel and banks were extensively modified over the past century (Klohn Crippen Berger, 2017a; Rood et al., 1999). Multiple bridges were built with riprap stabilization of the banks. There was channel simplification through the cut-off and infilling of side channels and the reach through downtown Calgary is now largely a single channel, flanked by armored banks (Figure 1).

Despite the extensive development, the Bow River through Calgary and downstream to Bassano Dam supports one of the most renowned trout fisheries in Canada, the ‘Blue-Ribbon Bow’ (MacLeannan, 1987). The introduced rainbow and brown trout thrive and benefit from some river developments. Instream flows are stabilized and augmented through the warm and dry interval of mid- to late summer, when cool water is released from Bearspaw Dams. Suspended sediments and fine sediments are depleted due to settling in the upstream reservoirs, and nutrient enrichment from Calgary wastewater promotes the aquatic food-web.

The Bow River provides Calgary's greatest natural asset and as for other river towns, there has been a 'river renaissance'. The river districts that used to be industrial zones 'out-back' now provide a focus for urban redevelopment (Kibel, 2007). Associated with these renewals, modifications of river channels for recreation have been successful in American cities with similarities to Calgary, including Reno, NV; Denver, CO; and Boise, ID (below).

Figure 3. The poplar, artificial surf wave in Boise, ID. With easy adjustments the wave shape can be modified for river surfers, kayakers or other users (image from public wavecam, Boise Whitewater Park).

3. Bow River Developments in Calgary's Eau Claire District

As reviewed by Armstrong et al. (2009) and Klohn Crippern Berger (2017b), the Bow River channel near the Louise Bridge has undergone major alterations. Around 1886, the Eau Claire and Bow River Lumber Company established a sawmill at the location that is now Prince's Island. The sawmill was supplied with logs floated down the Bow River from the forested Kananaskis and Bow River valleys. Near the Louise Bridge, guide fences directed the logs into an excavated side-channel, the 'Eau Claire Millstream'. With the managed water flow, the Calgary Water Power Company established a hydroelectric plant near the sawmill around 1890.

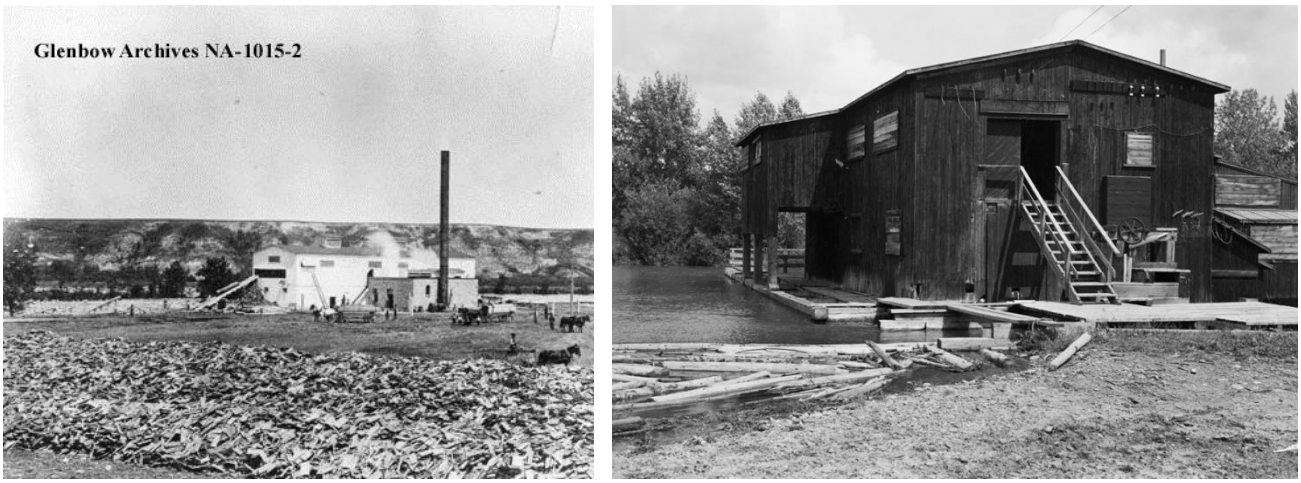


Figure 4. (*left*) Eau Claire sawmill at Prince's Island. (*right*) The Calgary Water Power Co. hydroelectric facility near the sawmill (no date, Glenbow Archives, NA-4477-44).

Associated with the channel and hydropower project, a 4 m high dam was constructed across about two-thirds of the Bow River. This was upstream of the Louise Bridge location and the dam extended from the north bank to a natural island (Armstrong et al., 2009). The dam raised the water level and wooden walls extended downstream to contain the elevated channel, which passed logs and water flow for power production (below).

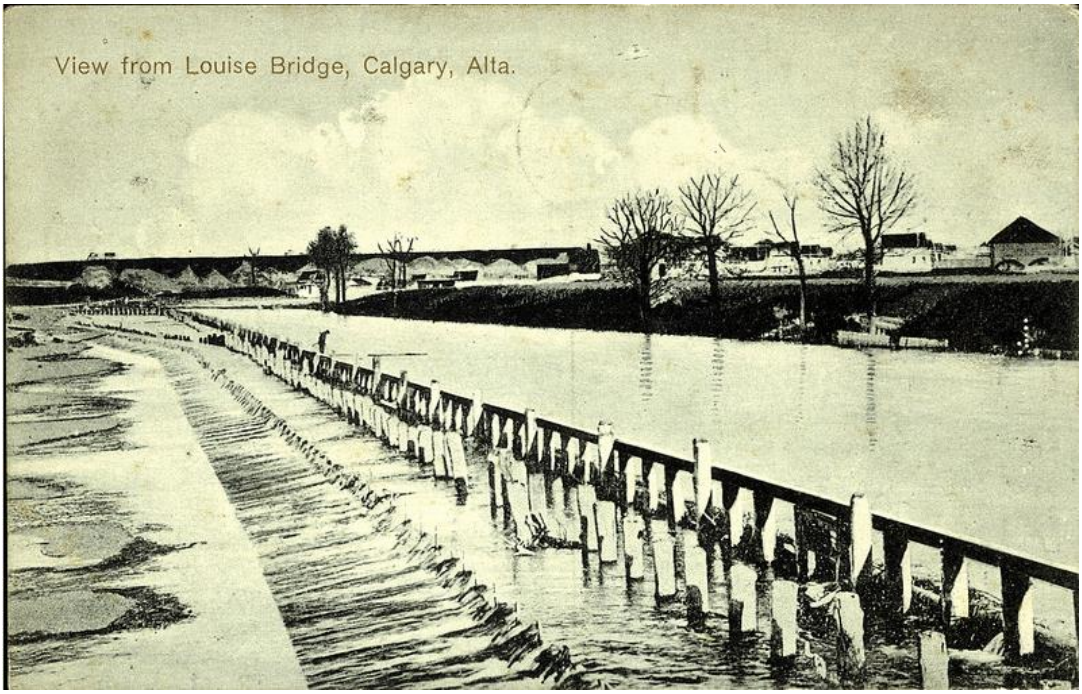


Figure 5. Downstream view from Louise Bridge of the 'Eau Claire Millstream' that passed logs to the Eau Claire sawmill and increased flow to the hydroelectric power plant at Prince's Island.(#10140 from Univ. Alberta Libraries, 'Prairie Postcards' collection, Feb 16, 1912.)

Figure 6. View upstream from the Louise Bridge during the 1915 flood. This apparently shows the wooden Calgary Water Power dam to the right of the walkway being overtopped (City of Calgary Archives, CA ccg-2077-is-ccg-3038).

Although challenged with a sequence of floods in the early 1900s (above), the wooden dam and side-walls of the millstream functioned for a half century (following).

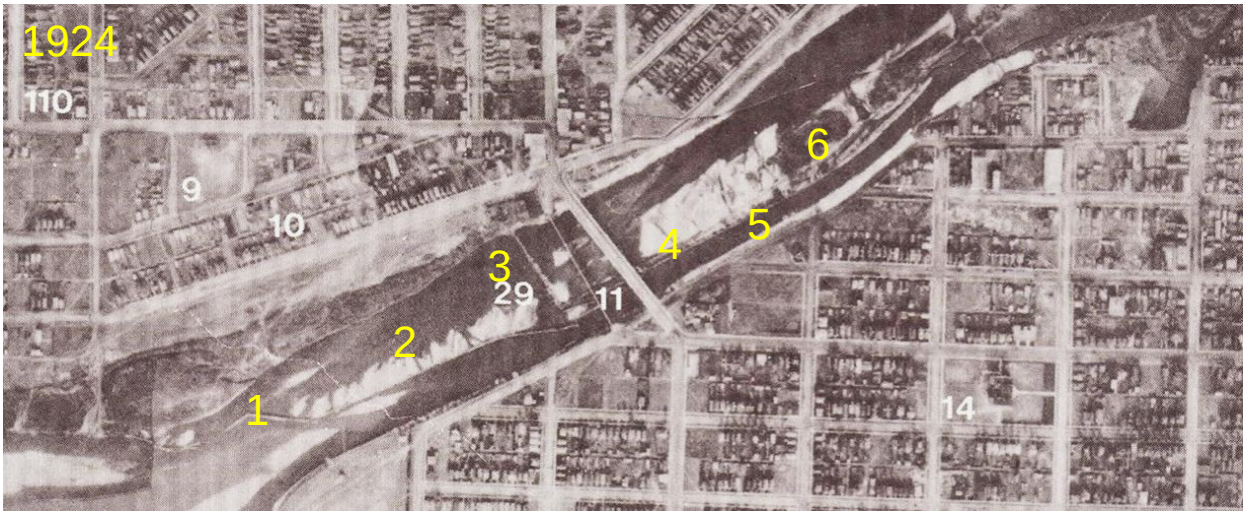


Figure 7. Aerial photograph of the Bow River and Louise Bridge, Oct 17 1924 (~ 50 m^3/s). Yellow numbers designate: (1) guide fence for floating logs, (2) gravel bars, (3) Calgary Water Power dam (4 m, 1889), (4) wooden side-wall to elevate channel, (5) excavated 'Eau Claire Millstream' to transport logs and water flow to the sawmill and hydroelectric plant, (6) wooded island that became part of the 'Eau Claire Woodland' downstream of the C-Train Bridge (Univ. Calgary Library, C3563.C3 A4 1924).

The sawmill was abandoned in 1945 and the dam was removed around 1950. The present side channel below the Louise Bridge is a remnant from the Eau Claire Millstream.The channel segment downstream from Louise Island to Prince's Island was infilled, and connected the prior wooded island that now contributes to the riparian woodland downstream from the C-Train Bridge (section 12.4). The final section of the Eau Clair Millstream log and power channel remains through Prince's Island, providing the lagoon.

4. The Louise (10th St.) Bridges

Three sequential bridges crossed the Bow River at 10th St. West. The Bow Marsh Bridge was constructed in 1887, with naming that suggests a riparian wetland complex. This site was probably chosen since a natural island simplified crossing. The island split the river flow, and the south channel provided the origin for the Eau Claire Millstream.

The primitive, wooden Bow Marsh Bridge was challenged by flooding (below) and weathering. It was replaced with the steel Louise Bridge in 1906, but the steel bridge was also short-lived, due to insufficient size as Calgary rapidly grew.

Figure 8. (left) Northward view of the Bow Marsh Bridge flooded in 1902 (City of Calgary Archives, CalA 2013-029-002). The Bow Marsh Bridge with an island revealed at the right edge of the photo, and the replacement steel Louise Bridge (background) (1906).

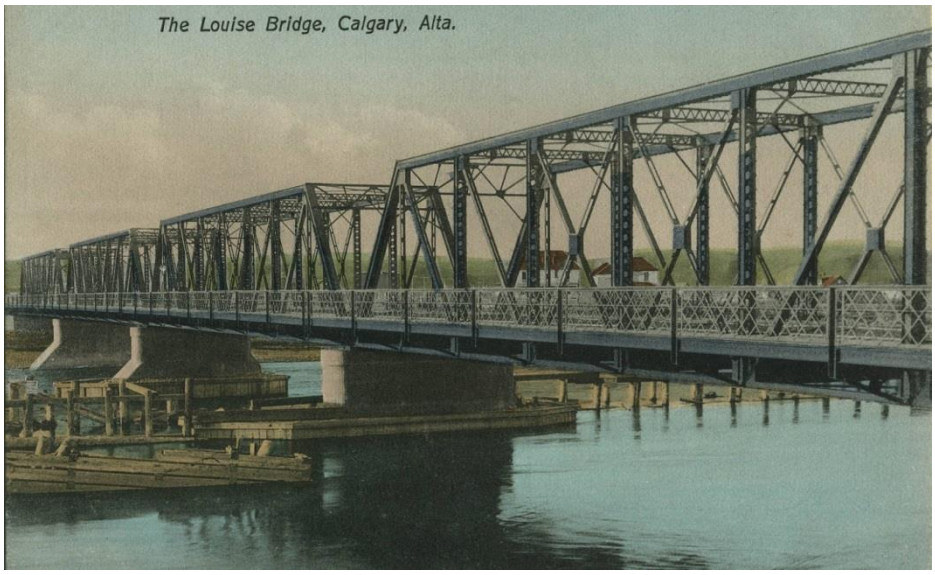


Figure 9. Downstream view of the steel Louise Bridge from the south bank. The Eau Claire Millstream is in the foreground, the channel side-wall is to the right of the bridge pier, and a log guide is in the left foreground (Calgary Public Library, 'Postcards From the Past' (pc_793), no date, between 1906 and 1920, hand-tinted photograph).

The steel Louise Bridge was replaced with the current Louise Bridge in 1921, with rehabilitation in 1995. This present Louise, 10t St. or Hillhurst Bridge is 172 m long with a ~20 m wide deck supported by four pillars, or piers. These create five wall-arched spans, or bays, each 32 m wide. Originally for electric street cars of the Calgary Municipal Railway and pedestrians, the bridge deck now provides four reversible traffic lanes. Pedestrian sidewalks are along both sides and architectural protrusions over each pillar allow viewing of the river and city. Underpasses for the popular Bow River Pathways extend from the abutments at each end of Louise Bridge, and slightly fill the end spans.

Figure 10. An upstream-facing view of the Louise or 10th St. Bridge over the Bow River, west of Downtown Calgary (Aug 2019, S.Rood).

5. Louise Island

The current Louise Island was reformed shortly after the breaching (below) and then removal of the small Calgary Water Power Dam in 1950. The Island had reformed by the mid-1950s with substantial vegetation by 1962. Larger trees were visible on Louise Island in an aerial photograph from 1979, and the island form subsequently appeared fairly consistent in aerial photographs up to 2012 (Section 7).

Thus, the 10th St. Bridge location was selected to incorporate a natural island. After removal of extensive developments around that bridge, the island reformed. This indicates that the Bow River channel dynamics will consistently create an island in this location.

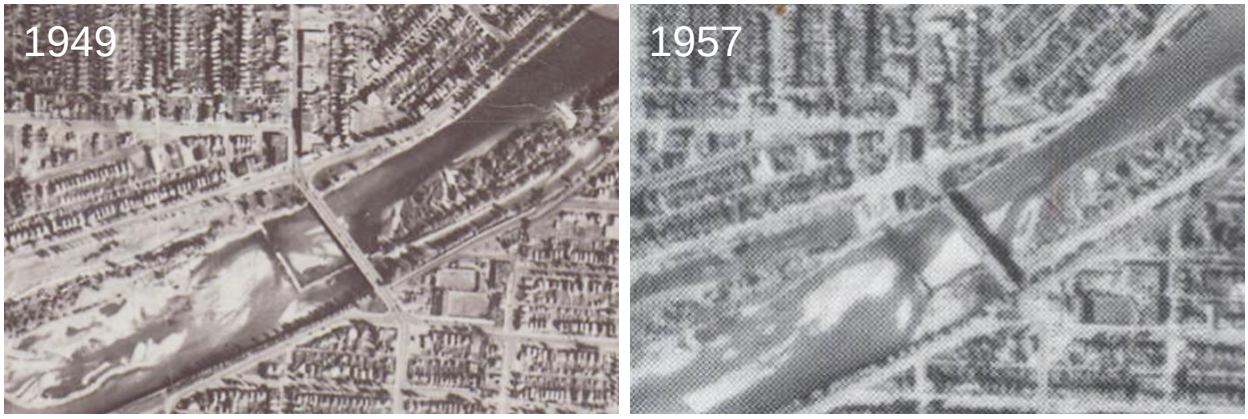


Figure 11. Aerial photographs from 1949 (left) with the water power dam breached, and 1957 (right) when the Louise Island had reformed. (Univ. Calgary Library, G3564 .C3 A4 32 1957).

II. After the Flood

6. The Bow River Flood of 2013

Following an intense, prolonged and widespread rainstorm over the foothills region of the Bow River watershed, the 2013 flood provided the flood-of-record (Pomeroy et al., 2016). The peak flow record is poorly fit with the common Log Pearson III distribution but as the highest flow in the 110 year record, the recurrence would be about a century for the Bow River at Calgary. The 2013 flood provided extensive and very costly damage through Calgary, with overbank flooding from the Bow River and especially the Elbow River, along with elevated groundwater that contributed to flooding of basements and below-ground developments. River banks were eroded and infrastructure such as bridges and riverside trails and roadways were damaged.

Contrasting with the devastation to artificial developments in the floodplain zones, the 2013 flood provided a major pulse of environmental rejuvenation along the Bow River valley. The flows provided extensive fluvial geomorphic disturbance, with erosion, transport and deposition of the sands, gravels and cobbles. Due to bank armoring, there was limited channel migration through Downtown Calgary but the there was extensive sediment redistribution between the banks. This created barren gravel bars and islands, and these are ideal nursery sites for seedling colonization of riparian plants. Consequently, the 2013 flood is enabling replenishment of the riparian woodlands, which were over mature with sparse juveniles (Rood et al., 1999; 2016).

While the geomorphic disturbance and ecological renewal is environmentally favorable at undeveloped locations along the Bow River, riparian woodland development would increase the future flood hazard in some locations through Calgary. With the Calgary Rivers Morphology project, we assessed the Bow and Elbow River corridors through Calgary to identify locations where changes in channel and bank forms could impede future floods and increase the risk to infrastructure (Klohn Crippen Berger, 2017a). A dozen hazard locations were identified, with the most serious challenges near bridges. Three specific hazard locations were recognized and these provide priorities for alterations to reduce the future flood risk (Klohn Crippen Berger, 2017a).

At the Centre St. Bridge, a gravel bar along the north bank extends from the bridge span downstream and this bar was raised and expanded through sediment deposition with the 2013 flood (Slaney et al., 2019). New vegetation is extensive with the finer substrate, and as the shrubs and especially trees grow, these would impede future flood flows (Rood et al., 2016). Upstream from the Crowchild Trail Bridge, a prior island was expanded and became connected with the west bank, creating a large gravel bar. The Louise Island through the 10th St Bridge provides the third hazard location.

With aggradation from sediment deposition, the flow path through bridges is slightly altered. Probably more seriously, the new gravel bars and islands have been colonized with balsam poplars and other native and introduced riparian plants (Rood et al., 2016). As these shrubs and trees grow, shrubland or woodland would rise from the bars and as these develop, there would be increasing impediment to future flood flows.

This flood hazard is displayed for the Mission (4th St.) Bridge over the Elbow River, where the Elbow Island Park woodland provides substantial blockage through a bridge span (Figure 12, right). The woodland impedes the river flow and has resulted in sediment deposition through the span. The blockage could have elevated the 2013 flood stage and to reduce the future risk, part of the Elbow Island may be cleared and shaped (Klohn Crippen and Berger, 2017, Appendix VIII-2).

The increasing risk from the development of shrubs and trees is recognized for the gravel bar below the Centre St. Bridge (Slaney et al., 2019). There is ongoing planning for possible scraping to lower the surface elevation. This could provide a more saturated surface that would exclude the inundation-intolerant poplars and other trees. Although the hazard from woodland development at the Centre St. Bridge might be lower than that at the Louise Island, the Centre St. bar is accessible to machinery from the bank along Memorial Drive, simplifying excavation.

7. Louise Island Expansion with the 2013 Flood

As indicated (Section 5), after the apparent reformation of Louise Island in the early 1950s, it displayed a fairly stable configuration for a half century. Subsequently, there was some downstream extension of island in 2005, following a minor flood flow of June 19 (602 m^3/s). The island change is displayed in Google Earth aerial photographs from May 29 (103 m^3/s) versus July 30, 2005 (126 m^3/s) but the imagery is poor. The aerial images from 2002 to 2012 also suggest the elevation of the bar upstream from the bridge pier to the south of Louise Island (Klohn Crippen Berger, 2017b; Figure 12 following, top).

With the 2013 flood, the Bow River rose towards the top of the Louise Bridge bays.Water rose up along the adjacent banks, including up the stairs and almost to the deck of Poppy Plaza at the north end of the Louise Bridge. Numerous images and videos of Louise Bridge are posted on the internet indicating that the river apparently rose slightly higher than in the following figure, but did not reach the bridge deck or overtop the adjacent banks.

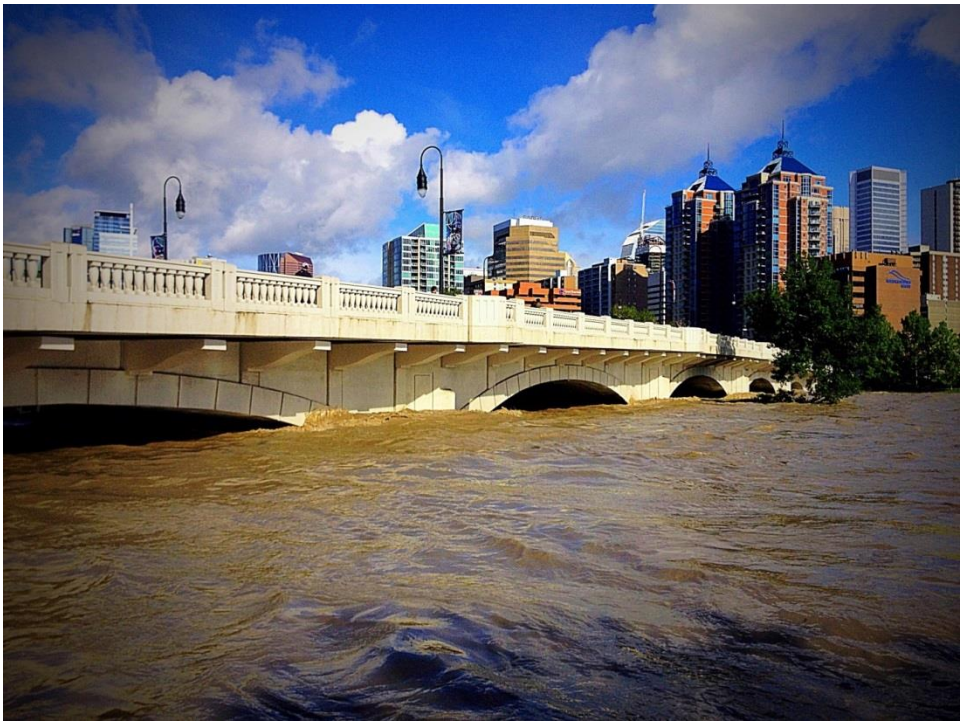


Figure 13. A downstream facing view of Louise Bridge during the 2013 flood (probably June 22, the day after the peak, photo by ‘jphreak’, licensed from Alamy Stock Photo)

The extent of flooding is apparent in the aerial photograph from June 22, 2013, the morning after the flood crest. There is apparently no standing water above the banks, such as along Memorial Drive, indicating that Bow River did not overtop its banks near the Louise Bridge.

Figure 14. An aerial photograph of the Bow River around the Louise Bridge, June 22, 2013. The green lines provide tracings of the shorelines or vegetation margin in an aerial photograph from Sept. 23, 2012 (displayed in Figure 15, top). (copied Figure 4.11 from Klohn Crippen Berger (2017b), which presents aerial imagery from the City of Calgary post-flood flight.)

After the 2013 flood, Louise Island and the adjacent shallow zones were elevated with sediment deposition and consequently, the island was substantially expanded (below). The clear water in the pre-flood photograph reveals portions of the shallow zones that were elevated to become exposed. This included a shallow ridge extending downstream to the C-Train Bridge pier, which matched the subsequent curve of the northern margin of the expanded island.

Figure 15. Pre-flood (top, Sept. 22, 2012, 61 m^3/s) and post-flood (bottom, Aug. 31, 2017, 65 m^3/s) aerial photographs of Louise Island with similar Bow River flows. Through sediment deposition, the island was elevated and expanded.

Fortunately, a bathymetric survey of the Bow River channel bed had been undertaken in 2010, shortly prior to the 2013 flood (Slaney et al., 2019). A post-flood survey was undertaken in 2013 and subtraction revealed the extent of deposition versus scour around Louise Bridge.

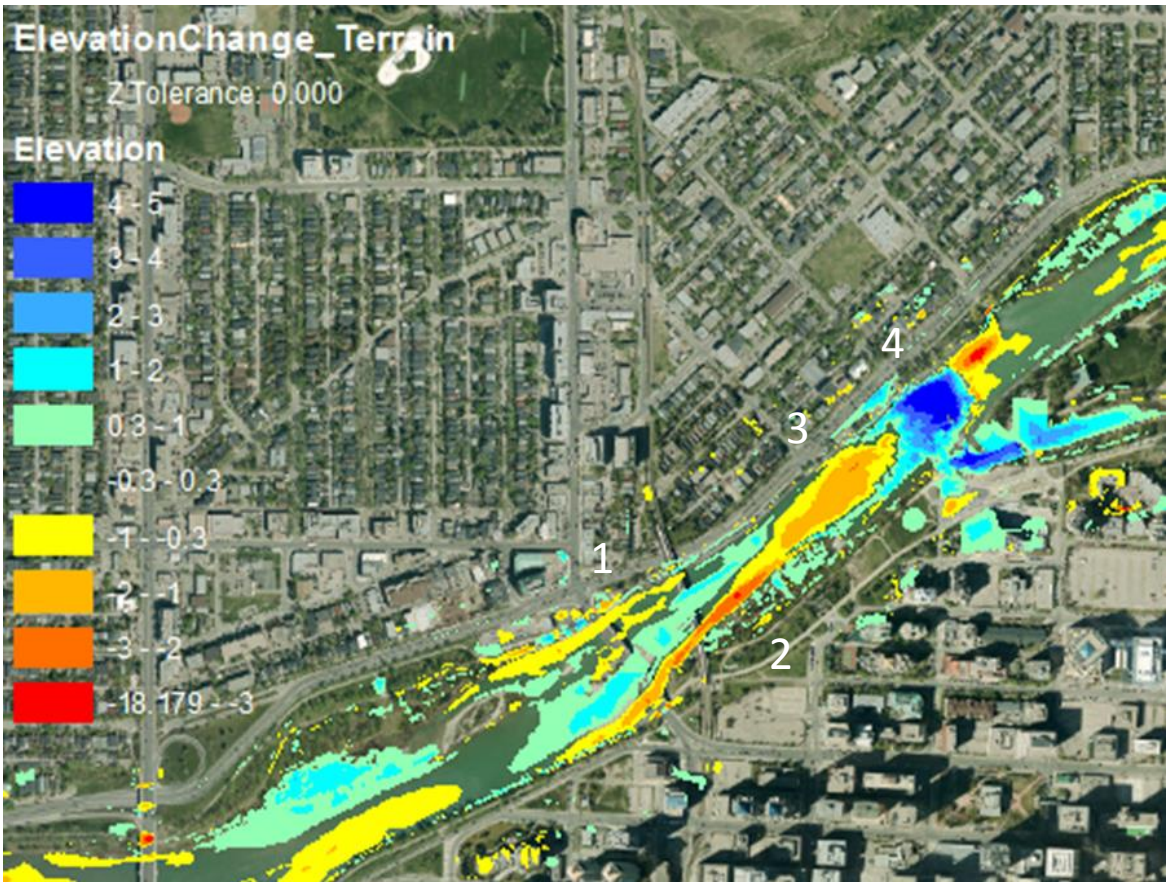


Figure 16. Subtraction digital elevation model (DEM, m) from topo-bathymetric surveys along the Bow River channel in 2010 (pre-flood) versus 2013 (post-flood). Locations: (1) Louise Bridge and Louise Island, island deposition and channel scour, (2) Riparian woodland zone downstream of the C-Train Bridge, bank and channel scour, (3). Below boat ramp, broad scour zone, (4). Prince's Island and lagoon channel: extensive deposition (from Slaney et al. (2019) Figure 2).

The substraction DEM revealed that the sediment deposition raised the Louise Island surface about 1 m. Conversely, scour slightly deepened the channel along the north bank and the side channel along the south bank was deepened around 2 m. With these opposing changes, the total flow path through the Louise Bridge spans was probably only slightly changed. Floods often result in leveling of river channels and the different response at this location would reflect influences from the bridge piers.

The post-flood configuration along the Bow River near the Louise Bridge is displayed in Figure 17, along with designations in this report.

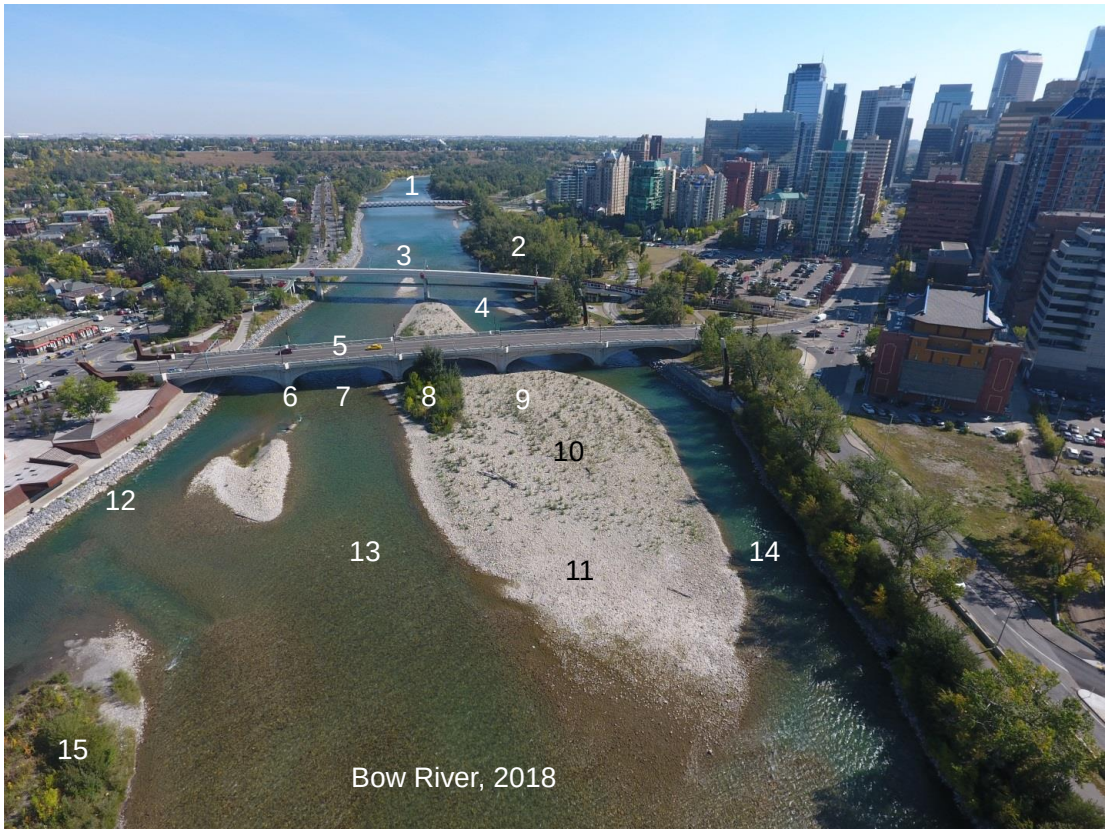


Figure 17. (1) Peace Bridge (2012), (2) 'Eau Claire Woodland', (3) Sunnyside C-Train Bridge (1987, pedestrian - lower deck), (4) Proposed surf wave feature, (5) Louise (10th St.) Bridge (1921), (6) Bridge pier or pillar (4 occur, numbered left-to-right facing downstream), (7) Bridge span or bay (5 occur), (8) Remnant grove, (9) Louise (10th St.) Island, (10) Extensve balsam poplar saplings, (11) Barren bar surface, (12) Armored bank, (13) Main Channel, (14) Side Channel (Wave Channel), (15) Shrub Island.

8. Riparian Woodlands – Balsam Poplars

Through Calgary and downstream, native trees were largely restricted to the riparian or streamside woodlands which are also referred to as floodplain forests. These are predominately balsam poplars (*Populus balsamifera*), which is closely related to the black cottonwood (*P. trichocarpa*) of the Pacific Northwest. The riparian poplar species have fairly similar ecophysiological requirements and life history traits. These trees are flood tolerant and dependent upon flood events to provide the geomorphic disturbance that creates barren gravel bars and islands that are suitable for seedling colonization.

Plains cottonwoods (*P. deltoides*) only naturally occur well downstream near the 'Bow Island' but there are a few apparently natural interspecific hybrids of *P. balsamifera x P. deltoides* (*P. x jackii*) in Calgary. These have intermediate characteristics between the two parents and increase the woodland biodiversity. Some selected or artificially-bred poplar hybrids are fast-growing and introduced poplar hybrids, including *P.* x *jackii*, were planted throughout Calgary. This includes the poplars planted along Memorial Drive and while the hybrid poplars are fast-growing, they are vulnerable to drought, pests and disease, and consequently short-lived.

Following the extensive river regulation and channel simplification, and also through an extended interval from 1932 to 2013 without a major natural flood that provides geomorphic disturbance, the riparian woodlands along the Bow River became static by the end of the twentieth century (Rood et al., 1999). This resulted in an over-mature poplar population that lacked saplings and younger trees. Prior to 2013, the established balsam poplar trees appeared relatively healthy but the population was unhealthy due to limited replenishment.

9. Riparian Vegetation Colonization on Louise Island

Following the 2013 flood, vegetation and surface substrate on the Louise Island were assessed in August 2015 (Rood et al., 2016). This revealed many new seeedlings on a coarse substrate with gravel and cobbles (Klohn Cripper and Berger, 2017b). The vast majority of the seedlings were balsam poplars, with a few seedlings of the shrub chokecherry (*Prunus virginiana*). The island vegetation was observed each summer from 2015 through 2019, revealing a few saplings of the small trees, water birch (*Betula occidentalis*) and box elder (or Manitoba maple, *Acer negundo*). Perennial herbaceous plants were relatively sparse, in contrast to some other gravel bars such as the Centre St. bar, which had much greater plant diversity due to a finer substrate. It is likely that over time willows will become established and these shrubs are capable of vigorous expansion through clonal reproduction. Over time, willows will probably become prevalent at lower positions on Louise Island, similar to the adjacent Shrub Island.

On the Louise Island, there were weedy introduced annual plants, including dandelion (*Taraxacum officinale*) and quackgrass (*Taraxacum officinale*). White sweetclover (*Melilotus albus*) became the predominant herbaceous plant after 2015, with substantial numbers and considerable size. Fortunately, invasive or noxious plants were almost absent, partly due to the blockage of floating seeds from upstream sources (hydrochory) by Bearspaw Dam. The absence of problem plants on Louise Island contrasts with gravel bars and islands downstream below Nose Creek and Fish Creek, where reed canarygrass (*Phalaris arundinacea*), is the primary plant of concern along the Bow River.

Stem bud scars indicated that the poplars had established in the flood year, 2013, and in 2014 and 2015, with densities averaging ~ 5/m^2 (Rood et al., 2016). These have thinned and sapling densities in 2019 were ~1/m^2. The surviving saplings are vigorous and many should survive. In 2019, the poplars were commonly 1 m tall, with some reaching 2 m. If unmanaged, the trees will grow in size, producing a woodland that would increasingly impede future flood flows.

Figure 18. Photographs of Louise Island, Aug 2019 (S.Rood).

(top pair) Upstream portion and most of the green plants are balsam poplar saplings, established as seedings after the major 2013 flood (left). (right) The Remnant Grove has larger shrubs and trees persists upstream of the middle pier.

(bottom pair) A downstream view of Louise Island from the Louise Bridge (left). The plants are primarily balsam poplar saplings with a few lighter chokecherry and box elder. (bottom) A view across the side channel to the island, with a river surfer on the present 10th St. wave.

10. Measures to Prevent Woodland Development

There are three components that interact to enable riparian woodland development: (1) the physical substrate surface, with particular composition and position, (2) the plant species and (3) water patterns or hydrology. The two physical factors of substrate surface and water combine to provide the hydrogeomorphic (HGM) context and different plant types have different HGM requirements. The physical factors are related especially through elevation since lower surfaces are wetter, while higher positions are dryer. The substrate texture or sediment particle size is relevant since coarse sediments drain and dry faster, while finer sediments retain moisture and enable capillary rise. This creates the semi-saturated capillary fringe above the alluvial groundwater table. That water table, the upper surface of the saturated phreatic zone, extends horizontally from the river surface, and the alluvial groundwater rises and falls in close association with the river stage, or level.

Across the plant species there are groupings or guilds that differ in the HGM requirements for establishment and survival. Along the Bow River through Calgary, there are two groupings of woody plants. The willows tolerate wetter conditions and even sustained inundation. These shrubs have aerenychma, specialized elongated cells that function like snorkels, enable oxygenation of the root zones even when inundated. The hydrophytic (water-loving) riparian willows are less tolerant of drought conditions and consequently these shrubs are limited to lower elevation zones that remain moist.

The other primary woody plant along the Bow River is the balsam poplar, which provides the predominant plant on Louise Island and is of primary concern relative to woodland development. Lacking aerenchyma, poplars are not inundation intolerant, in contrast to the willows. Conversely, the poplars are more drought-tolerant, partly due to the foliar physiology and also with more extensive root systems. As a consequence, the poplars occur in higher and drier positions. The substrate textures also directly relate, with willows favoring finer substrates while poplars occur on coarser substrates that drain more freely, increasing root oxygenation.

The differences in HGM requirements underly the spatial distribution within the floodplain zones along the Bow and other rivers. Following from field observations along the Bow River corridor, the particular HGM requirements were determined for local poplars and woodlands versus willows and shrublands and these reflected the water regime associated with Bow River flows. The elevational bands were defined relative to inundation patterns that reflected the river's instream flow regime. This was the basis for the 'camo-map' technique that projected shrubland and woodland distributions at different locations along the Bow River, including Louise Island.

Those vegetation projections appear fairly accurate but the woodland zones extend into slighty lower zones that were anticipated to develop into shrublands. This may result from low flow years after the poplar seedling colonization, which avoided inundation of those lower zones, which would have disfavored the small and vulnerable poplar seedlings.

With the ecophysiological foundation, there are management approaches that should exclude the development of an extensive riparian woodland on the Louise Island (below). Each of the three factors, plants, land and water, could offer a management strategy. These are not exclusive and management could involve combinations of alterations.

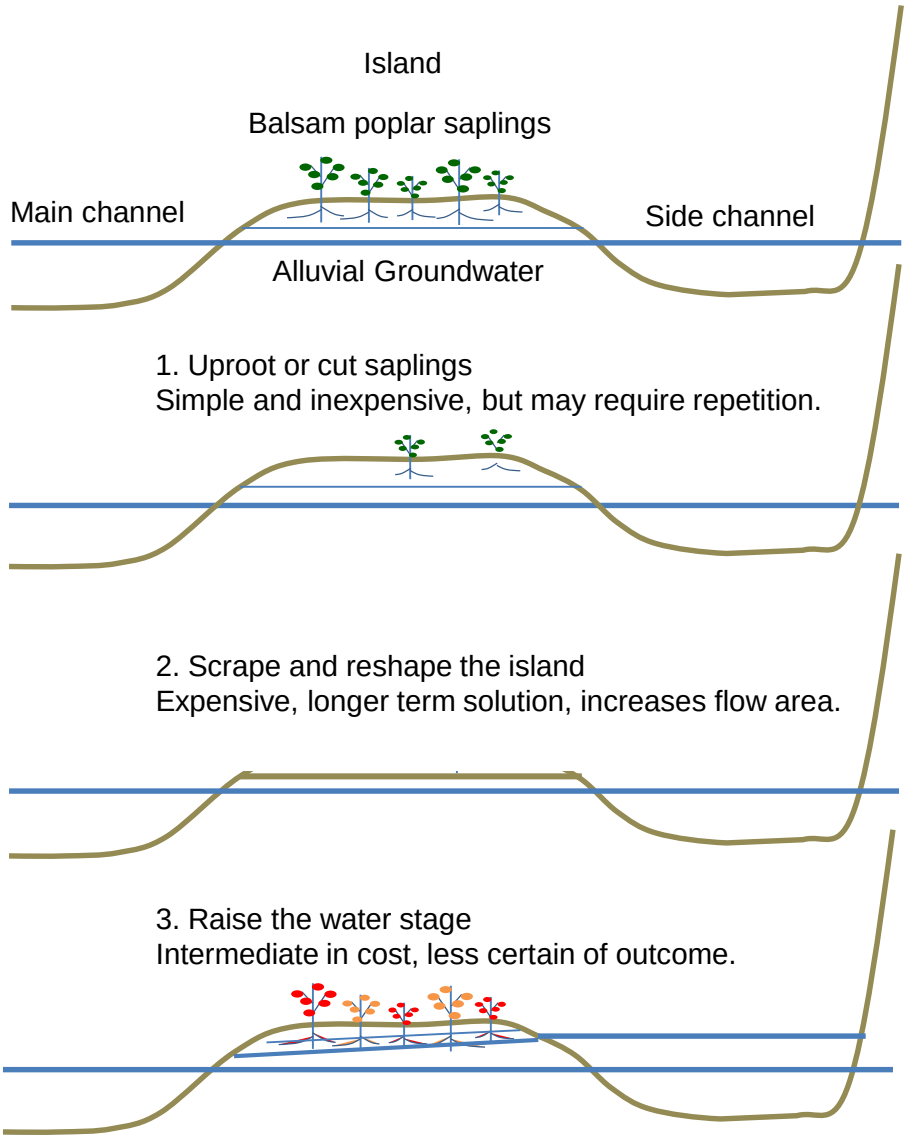


Figure 19. Three approaches to avoid woodland development on Louise Island: (1) control the plants, (2) lower the island, or (3) raise the water level.

10.1. Vegetation Control

The most direct and probably least expensive strategy to manage the growing poplars would involve direct vegetation control. The saplings could be cut by hand or Mowing with a walk-behind brush mower might be suitable. This could be lowered onto the island from the bridge with a small crane truck. Cutting or mowing would be more lethal during the in-leaf interval but this might still require repetition if the poplars resprouted.

Alternately, the saplings might be uprooted. This would have been easy in 2015 and might still be feasible manually and mechanical levelage systems are available. These have leveraged 'pullers', or devices to clamp onto the stem and then a winch is used to pull out the saplings. Small machinery might also be lowered from bridge offering another approach. Uprooting would prevent regrowth and might thus be preferable to cutting, but would require more work effort. Uprooting will become more difficult and less practical as the trees grow. Similarly, the other control measures will become more difficult over time, encouraging early response.

The use of most herbicides is strongly discouraged in riparian zones due to the prospective water contamination. Conversely, there are some herbicides with rapid degradation or limited toxicity that could be more suitable. Also, rather than spraying that allows contanimating drift and covers the gravel bar surface, direct foliar application of a systemic herbicide such as glyphosate might be safe and effective.

Herbivory might provide another option. Poplars are extremely palatable and deer and other native ungulates often severely reduce poplar seedling recruitment. Placing deer on the island would probably be disfavored but domesticated sheep or goats might be acceptable. The island would contain the animals that might be introduced for intervals within and across years. The City of Calgary is already using sheep and goats for vegetation mangement and thus has experience, and access to animals. A disadvantage of browsing would be limited control if the strategy included leaving some bands or patches, although there might temporary fencing.

While vegetation control might require repetition, the extensive poplar colonization after the 2013 was a rare event, reflecting the exceptional flood. With future high flows there could again be seedling colonization but these would be unusual. Thus, if the current cohort of saplings is controlled, the future work requirement should be limited. Additionally, even with repetition, the cost of vegetation control might be a small fraction of the multiple-million dollar cost of island scraping and shaping.

10.2. Island Scraping and Shaping

Following from the HGM analyses, lowering of the island surface would increase the substrate saturation and inundation. This would especially disfavor the inundation-intolerant poplars, along with other plants that are adapted to higher and drier positions. Surface scraping was proposed by Klohn Crippen and Berger (2017b) with the island surface lowered by 1 to 1.5 m. This approach could involve first scraping and stockpiling the coarser surface sediments that provide an erosion-resistant gravel armour layer. The underlying layer would be excavated and removed and the armour layer is repositioned to provide the desired surface elevation. Along with this process, there are also prospects to shape the surfaces to provide fish habitat features (Klohn Crippen Berger, 2017b).

An initial cost estimate for this management strategy was $6.5 million (Klohn Crippen Berger, 2017b). A somewhat similar approach is anticipated for the Centre St. Bar, which will probably be the first project of this type that will be undertaken in Calgary. As planning for the Centre St. project has advanced, the relocation of the excavated material was recognized as a substantial challenge and cost. One strategy would involve trucking the excavated material and depositing it back into the Bow River floodway. A prospective site was identified with a gravel bar a short distance downstream from Bearspaw Dam.

10.3. Water Management

The shaping approach would lower the island surface to reach a level that would often be saturated and thus lethal for balsam poplars. An alternate strategy would be to raise the water level. Just as the 1888 Water Power Co. dam provided a local rise in the water level, a smaller structure could elevate water, especially in the side channel adjacent to the Louise Island. Such a structure is currently proposed with the Calgary Urban Surf Wave Project. That project was not developed to address the hazard of growing poplars on Louise Island but this could provide another environmenta benefit.

III. Urban Surf Beach and River Waves

11. The Proposed Surf Waves Project

Stabilized with buried timbers from the Eau Claire MillStream, the 10th St. Wave is a standing wave at the Louise Bridge that has been popular for river surfers and kayakers. Following from the popularity of this 'accidental' wave, the river surfers have proposed a larger wave development in the side channel along Louise Island. The current wave provides 'proof of principle' and river surfing is a rapidly growing recreation in Calgary and elsewhere.

The design concept for the Calgary Urban Surf Beach and River Waves project ('Wave Project') displays the configuration (below). The primary component is a transverse feature across the channel. A weir-like gate raises the water level, backing up the side channel. A sloping drop passes the flow to the wave former, a spoiler or 'kicker' that shapes the standing wave. Pneumatic or hydraulic controls allow adjustment for different river flows or users. With the substantial channel width, there could be three independent waves side-by-side.

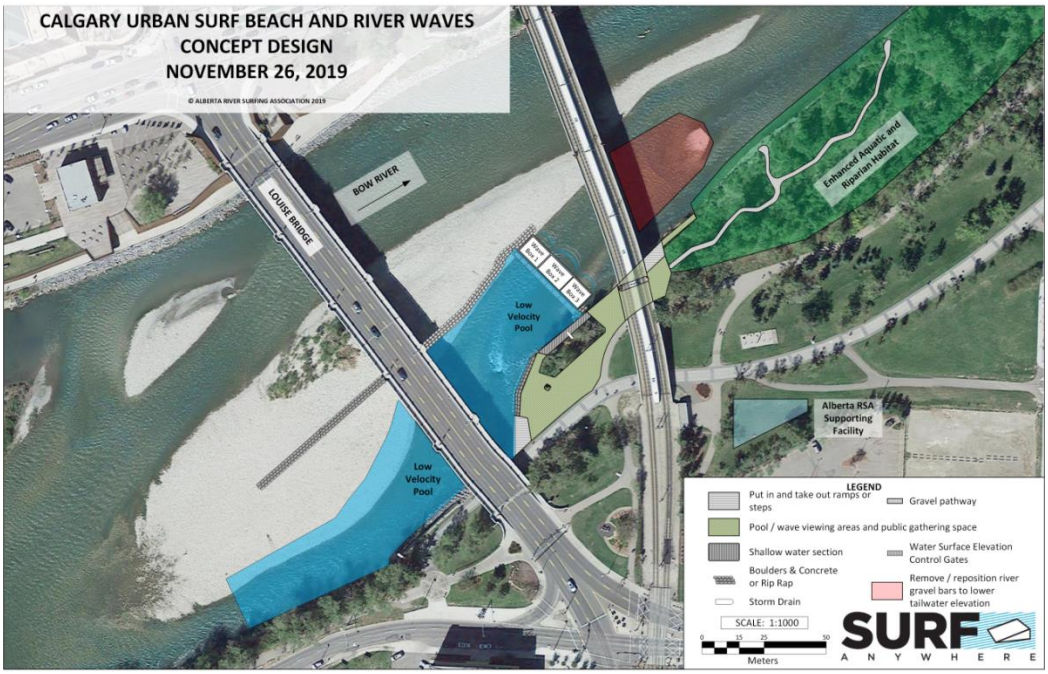


Figure 20. Design concept for the Urban Surf Waves project at Louise Island (SurfAnywhere).

An adjacent pedestrian plaza would encourage visitors and ease river access, while the pedestrian bridge below the C-Train Bridge would enable elevated viewing. The C-Train Bridge piers provide hard structures that stabilize the development. The stepped bands along the plaza would provide a gravel beach into the water and the bank downstream along the shoreline pier could be sloped to provide another beach area.

Figure 21. An artist conception of the Urban Beach and Surf Waves. However, as in the concept design, the band between the channels would be much wider with the downstream zone of Louise Island (provided by SurfAnywhere).

There is complementarity between the urban surf wave project and Louise Island woodland management since the elevated side channel would raise the alluvial groundwater and thus saturate higher elevations below Louise Island. This would inhibit the inundation-intolerant poplars and relative to the island hydrology, raising the adjacent channel would provide a similar outcome as scraping the island to lower the surface. With a raised side channel, the groundwater table would slope downwards across and downstream along the island. The shallow substrate saturation would be most complete near the side channel and limited along the main channel.

The concept design proposes a longitudinal berm on Louise Island that would extend upstream and downstream from a bridge pier (prior page). This would stablize the system, maintain separation between the side and main channels, and direct higher flows. Alternately, an elongated band of poplars could provide a similar function, and suitable bands of saplings are already established (Section 13.2, following). This would encourage a bioengineering approach that would stabilize the project development and avoid erosion of the urban wave feature while providing environmental enhancement.

12. Environmental Impacts from the Proposed Urban Surf Waves Project

The Urban Surf Waves Project ('Wave Project') would involve relatively minor alterations within the side channel and along the adjacent banks, including along Louise Island. The environmental impacts would be localized and generally slight. This proposed project would be a very minor development relative to the prior developments along the Bow River corridor, including those around Louise Bridge.

12.1 Hydrology

Aspects of the hydrology of the Bow River have been previously analyzed, including specific studies around the 10th St. Bridge (Klohn Crippen Berger, 2017b). That study applied the City of Calgary's one-dimensial (1-D) HEC-RAS model for the Bow River corridor after the 2013 flood.

Flows – minimal impact

The Wave Project would alter the flow characteristics along the side channel but not change the flow rate (discharge). The channel elevation would be raised and this would extend upstream through the Louise Bridge but not to the upstream end of Louise Island. Consequently, the flow split between the main and side channels should be unaffected.

Floods – minimal impact

As already reviewed, the dozen dams upstream provide some attenuation of minor to moderate floods along the Bow River through Calgary. With prolonged, intense rain through the watershed, major floods will persist, as occurred in 2013.

The Wave Project would slightly alter the side channel and the gate to raise the water level and the wave former could be lowered with a heavy rain event in the watershed, minimizing the impact on flood flow patterns. For flood resilence there should be coordination of the Wave Project with vegetation management and possible shaping of Louise Island.

Groundwater – minor localized impact

Raising the side channel surface would correspondingly elevate the alluvial groundwater table. This would provide a minor, local influence and the groundwater is naturally dynamic, reflecting the variations in the river level. There will be a rich invertebrate community in the hyporheic zone where there a mixing of shallow groundwater and surface water and this community should readily adjust to the elevated groundwater. The elevation of the groundwater table would influence water availability and root inundation for riparian plants.

River Ice – minimal impact

With cold winters, ice forms on and along the Bow River through Calgary. This was recognized as a consideration for the possible shaping of Louise Island (Klohn Crippen Berger, 2017b). Management of ice formation and movement was a primary objective for the Bearspaw Dam, which is ~19 km upstream from Louise Island. That dam followed a destuctive flood in December, 1950, caused by an ice jam at St. George's (Zoo) Island (Zoo Island), which flooded 23 city blocks (https://floodstory.com/floods/1950-flood).

Operation of Bearspaw Dam has reduced diurnal pulsing that influences river ice formation and movement. In the winter, the dam outflow is warmer than the upstream river water and this delays ice formation downstream. River ice is visible in some of the aerial photographs posted on Google Earth but these do not display major ice jamming at Louise Island.

River users have reported an 'ice trap' at Prince's Island and this is consistent with aerial photographs from Mar 22, 2017 (below), Jan 6, 2012 and Mar 19, 2007. As the floodplain widens downstream of the Peace Bridge there is a zone with sediment deposition (Figure 16), where ice forms more readily, blocking floating ice.

Figure 22. Ice along the Bow River, March 22, 2017. Ice has formed at the upstream end of Prince's Island (upper right), which blocked floating ice, causing jamming.

The proposed Wave Project would provide slight change in the side channel configuration and the elevation gate and wave ramp might be lowered during the cold interval. Consequently, river ice patterns would be unaffected. Beneficially, the reduced river ice formation and movement due to Bearspaw Dam should minimize ice damage to the project.

12.2 Geomorphology – minor alteration

River flows provide the driver for fluvial geomorphic processes. Since Bow River flows and floods will not be altered, there would be correspondingly minimal alteration to sediment erosion, transport and deposition, which influence the river bed, banks, bars and islands. The Wave Project would involve localized sediment excavation to deepen the tailwater pool downstream of the wave feature. Through control of the wave structure, jets of water can be directed to scour the pool and avoid sediment accumulation or the need for repetitive excavation.

12. 3 Aquatic Ecosystem – slight impact

Assessment of the prospective impacts on fish and the aquatic ecosystem considered published papers and discussion with Joseph Rasmussen (Univ. Lethbridge, Mar. 31, 2020). Dr. Rasmussen is an expert in aquatic ecology and trout biology, has fished the Bow River through Calgary over a half century, and has completed numerous studies of trout in southern Alberta.

Three primary sportfish occur along the Bow River through Calgary. Whitefish (*Prosopium williamsoni*) are abundant but trout are sparse from Bearspaw Dam to the Calgary Weir (Askey et al., 2007); this segment includes the Wave Project location. Two introduced trout species progressively increase in abundance downstream of the Calgary Weir and the Bonnybrook Wastewater Treatment Plant, including the prevalent rainbow trout (*Oncorhynchus mykiss*) and less abundant brown trout (*Salmo trutta*) (Askey et al., 2007).

The renowned 'Blue Ribbon Bow' is often regarded as the segment from the Calgary Weir to the Carsleland Weir with the maximum trout productivity about in the middle of this segment (Askey et al., 2007). In this segment, the undammed Highwood River inflows and that river and its tributaries including the Sheep River and Ware Creek provide the primary streams for trout spawning. The high productivity of trout results from nutrient enrichment with effluent from Calgary's wastewater treatment plants, and water warming downstream from Bearspaw Dam contributes to the transition in fish distributions around the Calgary Weir (Askey et al., 2007; Sinnatamby et al., 2020).

The Calgary Weir previously blocked upstream fish passage and with the recent river reconnection with the Harvie Passage project, there should be some upstream expansion by the Bow River trout. There has been some electrofishing and tagging to track fish movements with the Harvie Passage. Reporting is limited but the initial expansion might be modest. The 2013 flood and Harvie Passage reconstruction will impact the patterns. Continued tracking should provide more information about the trout population in the Bow River upstream of the Harvie Passage, and possible presence near the Wave Project.

There is concern for the Bow River trout fishery since the rainbow trout population declined by about one-half from 2003 to 2013 (Cahill et al., 2018). This may reflect: (1) downstream flushing and reproductive failures with the 2005 and especially 2013 floods, (2) invasion with whirling disease and (3) catch-and-release mortality that may be compounded with warmer water (Cahill et al., 2018). While rainbow trout have particularly declined, brown trout might be more resiliant with characteristics such as nocturnal feeding.

Representing a minor and localized development, the Wave Project would probably have very slight influence on the overall aquatic ecosystem. The physical alterations would slightly alter habitat but the primary environmental concern would probably be for upstream fish passage.

Fish Movement – slight impediment to upstream passage

The project could be similar to prior developments at Bend, OR (below) and Boise, ID, with similar structures and hydrological outcomes.

Figure 23. The Green Wave (Wave #3) at the Bend Whitewater Park (Deschutes R).(1) Submerged control gate, (2) Overflow or nappe – laminar (sheet) flow, (3) Guides, (4) Slower and somewhat turbulent side flow, (5) Wave shaping steel flaps – hydraulically adjustable spoilers, (6) Recovery and recirculation eddies, (7) Turbulent tailwater (S.Rood, Aug 2019).

The common whitefish and sparse trout that reside in the Bow River around the Louise Bridge should readily pass downstream over the surf wave, unharmed. Some mature whitefish or trout could be capable of upstream passage since these fish occupy streams with natural rapids. The central flow would be swift while irregular flows along the sides could enable passage (prior photo). However, while flume studies can assess the swim capacities, field behavior is more complex (Williams et al., 2012). Some fish passage structures have succeeded, while others have failed and empirical study is required to confirm passage (Bunt et al., 2012).

While some adults might succeed, upsteam passage of juvenile fish would probably be hindered or blocked by the wave feature, when raised. No formal studies at river surf waves were found with a Google Scholar search but analyses or modeling that assessed artificial features in whitewater parks have concluded that these would impede upstream fish passage (Stephens et al., 2015, with papers cited). Fortunately, unlike features formed with boulders and concrete, the remotely controlled mechanical wave feature would be lowered nightly, allowing fish passage.

Recognizing the impact on fish passage, some whitewater parks include alternate channels. For the Bend project, the whitewater park replaced a weir that provided a hazard for river floaters and blocked upstream fish passage. Three channels were constructed, with the whitewater channel with the surf wave (prior photo) and other substantial drop features. The second 'fish ladder' channel provides numerous smaller drop features which were engineered to permit upstream fish passage. This channel is very popular for floating on tubes and suitable for novice and intermediate boaters. A third habitat channel has less flow and an inflow that would challenge fish passage but provides a range of aquatic and wetland habitats.

Along the Bow River through Calgary downstream from the proposed Wave Project, the Harvie Passage project involved major reconstruction downstream of the Calgary Weir. That weir had blocked upstream fish passage and created a lethal hydraulic recirculation with a dozen drownings (http://www.canadianriversafety.ca/w/core/index.php?title=Province:Alberta).

The Harvie Passage project also included the construction of alternate channels. In-channel structures were constructed to raise the water level toward the weir surface, eliminating the retentive recirculation. A Grade III advanced whitewater channel includes three major drop features which probably impede upstream fish passage. About eight smaller drop features on the Grade II 'low-water' channel should allow upstream fish passage, especially for mature trout.

Weirs on the Boise River, ID, have also been modified to provide whitewater paddling parks and surf waves similar to that proposed at Louise Bridge. There, fish ladders were constructed adjacent to the wave features. This is a common strategy across Europe, where hazardous and impassible weirs have been modified to provide a safe boat channel and an adjacent fish ladder.

Similar to those other applications, the proposed Wave Project at Louise Island would retain the alternate channel. Only the side channel would be developed while the main channel will continue to provide a larger, unimpeded connection along the river corridor. River fish are often exploratory and if they were unable to swim up the wave feature they would probably move to the main channel and proceed. The individuals and populations would probably readily adapt to the minor alteration, and the net impediment to upstream fish passage should be slight.

Aquatic Habitat – minor benefit
While assessments of whitewater parks have indicated that the drop structures impede upstream fish passage, the features enhance fish habitats. These provide deeper pools, increased variation in the depths and velocitys, and oxygenation

With the proposed Calgary surf wave project, the elevation gate will produce a slow-flowing upstream pool that would provide a different river environment than that along the artificially uniform channel through this Bow River segment. The turbulent plunge below the wave feature will introduce oxygenation, along with a range of depths and velocities that contribute variation in the aquatic habitat. The excavated tailwater pool could be beneficial and over-wintering pools are limited along some southern Alberta streams. Indeed, the proposed wave feature resembles the 'V-weir' structures that were implemented along the Crowsnest and Castle Rivers to enhance trout habitat as part of the mitigation program for the Oldman River Dam Project. There could thus be a minor benefit from project relative to aquatic habitat.

12.4 Riparian Ecosystem – the Eau Claire Woodland

The Wave Project proposes enhancement to the riparian woodland along the south bank below the C-Train Bridge. The history of this location is presented by Klohn Cripper Berger (2017b) with progressive aerial photographs from 1924 to 2014, and Google Earth provides images to July, 2019. Adjacent to Eau Claire Park, it will be referred to as the 'Eau Claire Woodland'.

In 1924, when the dam and log and power channel were still in position, wooded islands occurred at that location. The woodland expanded to 1948 but there was some clearing and the channel was infilled in the mid-1950s. There was some bank removal along upstream end of the woodland before 1997, possibly in association with the C-Train Bridge construction.

Following the connection of the prior island to the river bank with the channel infilling, the Bow River channel adjacent to the Eau Claire Woodland was relatively narrow (Figure following). The channel width was about one-half of the width at Louise Bridge, and this would have funneled and constricted the 2013 flood flow. Subsequently, there was substantial erosion along the south bank, while the opposite north bank had been heavily armoured, resisting erosion.

The flood scour removed a ~12 m strip of the Eau Claire Woodland, with the the bank erosion extending for almost 200 m and tapering at the ends (below). The channel width was expanded by about 20% (63 to 75 m) but there is a narrower channel near the boat ramp.

Figure 24. Pre-flood (top, Sept 22, 2012, 61 m^3/s) and post-flood (bottom, Aug. 22, 2015, 67 m^3/s) aerial photographs of the'Eau Claire Woodland', the riparian woodland along the Bow River downstream of the C-Train Bridge. The shorelines are traced in red and yellow, revealing the extent of bank erosion with the 2013 flood.

Following the channel widening, a steep cut-bank step often 2 m in height remains along the shoreline of the Eau Claire Woodland. With the wave project, this could be shaped in places to provide a gradual slope. The gravel bank should be suitable for willow plantings for bank bioengineering. The woodland should not be elevated, and would continue to allow flood overflow through the Eau Claire Woodland. This reduces the hazard to the opposite bank along Memorial Drive, as is the current case.

The C-Train Bridge pier provides a stable shoreline position. Flanking that structure, there might also be a gradually sloped gravel beach. Further downstream along the riparian woodland, two or more trails would slope down the bank. These would provide pedestrial access to the and allow egress by surfers and boaters, downstream from the surf wave. These would be linked to an improved trail system through the Eau Claire Woodland. Improved access and debris removal would reduce the irregular camping and illict actitivies in the woodland area, providing changes that would reportedly be favored by the Calgary Police Service.

Figure 25. View downstream over Louise Island, displaying the C-Train Bridge and the eroded

cut-bank along the 'Eau Claire Woodland' (S.Rood, Aug., 2019).

Relative to the riparian woodland resouce, the treatment of Louise Island will be most influential. If the balsam poplars were entirely removed and the island surface excavated, the barren island would provide limited habitat. Conversely, if longitudinal bands were permitted to development in poplar groves, there would be habitat for birds and other wildlife. Also, bands of riparian poplars, especially along the island margin, would benefit the aquatic ecosystem through the contribution of leaf and branch litter that contributes to the food web and also with favorable shading.

12.5 Navigation/Recreation – Deliberate Enhancement

The priority of the Urban Waves Project is to enhance recreation on and along the Bow River at Louise Island. Three adjacent surf waves would be developed, with hydraulically adjustable shapers, flaps or spoilers, which would allow for adjustments of the wave shapes for different users and to compensate for changes in river flows. The surf wave should be ideal and popular for river surfers and kayakers. Smooth 'green waves' are naturally very rare, and lacking at the Harvie Passage whitewater channels.

The wave feature would extend across the side channel south of Louise Island and create a moderate whitewater feature, probably with the navigation difficulty assessed as between Class II and Class III (Class II+, Class III is assessed as the limit for open canoes with skilled paddlers). The wave would probably be readily passable with rafts or closed kayaks, but could impose a slight challenge for open canoes, stand-up paddleboards or sit-on kayaks. With warm weather those users would be more likely to choose the channel, knowing that they could get wet. There should be signage upstream of Louise Island, informing river floaters of the wave channel and directing users to the unimpeded main channel on river left (facing downstream).

The wave feature would anchor an urban park development with the social plaza and the likely attraction of food vendors. There is accessible viewing, including relatively unique, elevated viewing from the pedestrian bridge below the C-Train Bridge. The location is near Downtown Calgary and would be ideal for a walking or biking loop along the Bow River Pathways and could include the distinctive Peace Bridge, Eau Claire Park and even Prince's Island.

The Wave Project could also be complementary to the required project to limit woodland development on Louise Island. These two projects both require work on Louise Island and combined planning and implementation could increase the efficiency and reduce the costs.

IV Louise Island Park

13. Design Concepts for Louise Island

13.1 – Flood Hazard

The priority with Louse Island management is to avoid an extensive riparian woodland that would impede the flow of flood waters especially through the centre-right span of Louise Bridge. Fortunately, the current configuration may be sufficient to convey hundred-year flood flows (Figure following). This could be similar to the 2013 flood situation, when the river rose up towards the top of the bridge spans but the bridge deck was well above the flood waters and there was minimal flow over the adjacent river banks onto roadways or the urban areas.

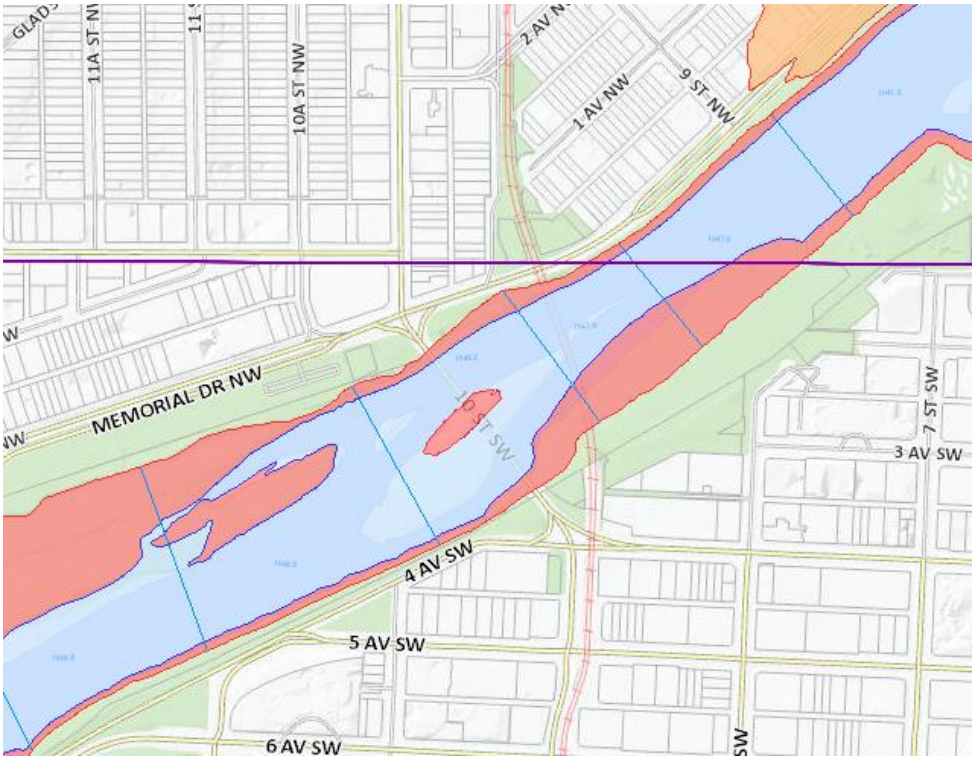


Figure 26. Floodway map of the Bow River at Louise Bridge. The Floodway is in pink, with the estimated 100-year flood inundation. Consistent with the mapping, there was no overland flooding into the adjacent urban zones in 2013 (City of Calgary Regulatory Flood Map, 2020).

The 2013 flood raised and expanded Louise Island through sediment deposition. Conversely, the flood scoured the the main channel and especially the side channel through Louise Bridge (Figure 16). With this combination of deposition versus scour, the total flow cross-section might have been slightly altered. The present channel and island configuration may be acceptable relative to the flood hazard, but flow impedance with woodland development should be avoided.

There are other considerations relative to the flood risk along the Bow River through Calgary. Climate change is a concern and the hydrological consequences vary regionally. Flood peaks in the free-flowing Bow River at Banff have gradually declined over the past century, partly due to changes in snow packs and especially earlier snow melt (Rood et al., 2016). Conversely, heavy rain events that contribute to major floods such as in 2013 might increase (Pomeroy et al., 2016).

The increased draw-down of Ghost Reservoir will provide some additional flood flow attenuation and there are opportunities for additional flood water storage with upstream reservoirs (Sheer et al., 2013). Louise Island provides a slight and local concern and there are many more flood mitigation and resiliance projects along the Bow and Elbow Rivers through Calgary. All of these would benefit from flood flow attenuation upstream.

13.2 Concept Plan – Louise Island Park

With the 2013 flood Louise Island was elevated and expanded and this created a large barren area that was suitable for seedling colonization. As described (Section 9), balsam poplar seedlings were abundant and these have now grown into saplings. Based on the 2015 seedling distributions and analyses of inundation patterns displayed in the numerous aerial photographs, we developed the 'camo-map' method to project areas of shrub and woodland development (Rood et al., 2016; 2019). Our projection for Louise Island appears to be generally correct but there was more extensive poplar survival than anticipated, probably due to low flow years after establishment. There was also a band of sapling that extends upstream from bridge pier 3 (from north). The influences of the piers on scour and deposition were not incorporated with the inundation method.

For Louise Island, the management priority is to avoid woodland development that would block flood flow through the bridge spans. Poplars should be cleared from the flow path especially through the centre-right span. Conversely, narrow bands of poplars that are aligned with the bridge piers should have minor influence. Supporting this intepretation, the aerial photograph during the 2013 flood displays regularly spaced, river-wide waves that are perpendicular to the river banks. This indicates aligned flow that passes downstream (Figure 14). The regular waves are also displayed downstream from the two left bridge spans but there is more turbulent irregularity downstream of the right bridge spans, reflecting some flow blockage.

Since the longitudinal bands of poplars extending from the bridge piers would be less detrimental, these could be retained and these would provide environmental benefits. The poplars in the flow path through the spans should be cleared to provide an unimpeded flow path. With this principle, a preliminary design was provided to City of Calgary river engineers in April 2019. Following these further analyses the plan has been refined. The major strategy persists, and the revised Louise Island Park plan also considers woodland management along the downstream portion of Louise Island (Figure 28, following).

Figure 27 (= Figure 2). The Louise Island Park concept plan.

(1) Clear poplar saplings to avoid woodland development that could impede flood flows,

(2) Leave shoreline poplar bands for habitat, island stabilization and the aquatic food-web,

(3) Allow a mid-island poplar band to provide wildlife habitat, and

(4) The Urban Surf Beach and River Waves project.

(aerial orthophoto Aug 2019, S.Rood)

The refined plan would include the clearing of saplings of poplars and other shrubs or trees from the flow paths through the centre and centre-right bridge spans (‘1’). Uprooting could provide the initial management method, first manually and if some larger saplings were too resistent, a machine could be lowered from the bridge. There could also be some thinning or clearing of established shrubs in the remant woodland grove that extends upstream from bridge pier 2.

Poplar saplings could be allowed to remain in narrow bands along the Louise Island margin in positions that are aligned with the bridge piers (‘2’). These would stabilize the island and resist erosion. The shoreline bands would also provide habitat and benefit the aquatic ecosystem and fish. The leaf and branch litter contribute substantially to the invertebrate community and the aquatic food web, and the trees also provide shade.

There might also be a mid-island band of poplars that extends upstream from bridge pier 3 (‘3’). This shouldn’t substantially impede flood flows through the centre or centre-right spans and would provide another woodland grove. This band would also be aligned with the island margin band downstream of bridge pier 3.

Following the clearing of the poplars and other woody plants, the flow path should remain relatively unimpeded. The woodland bands would provide woodland groves within the urban landscape and contribute rich habitat for birds and other wildlife. As the woodland bands grow and mature, these would increasingly contribute to ecosystem services. Urban trees provide a range of environmental benefits, including the trapping of air pollutants and carbon capture.

The Louise Island Park concept would also be complementary to the Urban Beach and Surf Waves project (‘4’). That project proposes a longitudinal berm extending upstream and downstream from bridge pier 3 (Figure 23), which would stabilize the island system and direct flows along the side channel. The woodland band could provide similar functions, along with ecological benefits. There might still be a hardened berm adjacent to the wave feature, and this would provide a more defined influence. The boulder berm might even extend upstream to the bridge and there might be some blending of the boulder berm and woodland band. There might be less need for the berm upstream of Louise Bridge if the woodland band extended upstream from bridge pier 3.

If the Louise Island Plan seems promising, there is some urgency to the clearing of the poplar saplings. Uprooting or cutting will become progressively more difficult as the poplars grow in size and root system. With or without other components, the prompt removal of the poplar saplings along the flow paths through the bridge spans would be strategic.

Triple Bottom Line – Economic, Environmental and Social Benefits

This report provides a concept design and there should be broader assessment. While the details will be refined, the concept is consistent with the City of Calgary 'triple bottom line' objectives.

Relative to the project economic cost and benefit, there is the need to undertake some action to avoid the development of a dense woodland on Louise Island. A woodland that extends across the island would impede future flood flows, increasing the flood damage and cost. For vegetation control, clearing might be less expensive than scraping and excavation of the island surface.

Riparian woodlands provide rich environmental resources and the Louise Island Park would enable bands of poplars along the island margin and with a mid-island band. Riparian woodlands provide the richest wildlife habitats through Calgary and support a range of birds and other animals. The river-side bands would also benefit the aquatic ecosystem and fish. The riparian trees and shrubs provide leaf and branch litter that contribute to the aquatic food-web and offer shade as well as supporting invertebrate communities that are linked to the aquatic ecosystem.

As a valued social resource, the Bow River provides a focus for recreation and environmental appreciation through Calgary. The Bow River Pathways are popular for hiking, biking and relaxation, with the Bow River and adjacent riparian zones providing interest and connection with nature. Extending the triple bottom line consideration, Slaney et al. (2019) introduce 10 economic factors, 4 environmental factors and 6 social factors that should be considered and could favor the Louise Island Park concept.

Additionally, the Urban Beach and Surf Waves project would provide substantial economic and social benefits related to recreation and tourism. Thus, the combined development for Louise Island Park and the Wave Project would provide substantial promise. The 2013 flood through Calgary was devasting but also provides some opportunities, including these paired projects.

Acknowledgements

Analyses were supported with funding from the City of Calgary, Alberta Environment and Parks (Watershed Resiliancy and Restoration Program), Alberta Innovates (Water Innovation Program), the Natural Sciences and Engineering Research Council and SurfAnywhere (Calgary).

The consideration of aquatic ecosystem impacts from the Urban Waves Project followed discussion with Joseph Rasmussen (University of Lethbridge). Prior discussions with Wes Dyck (Klohn Crippen Berger, Calgary) and Jon Slaney (City of Calgary) and their colleagues, and with Neil Egsgard (SurfAnywhere, Calgary) are gratefully acknowledged. Thanks are extended for field assistance from Sobadini Kaluthota (Lethbridge College) and Dianne Fitzgerald (Chinook Environmental Resources, Lethbridge), who also assisted with the report text.

References

Armstrong, C., H. V. Nelles, M.D. Evenden (2009) The River Returns: An Environmental History of the Bow. McGill-Queens University Press, Montreal.

Askey, P. J., Hogberg, L. K., Post, J. R., Jackson, L. J., Rhodes, T., & Thompson, M. S. (2007). Spatial patterns in fish biomass and relative trophic level abundance in a wastewater enriched river. Ecology of Freshwater Fish, 16(3), 343-353. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1600-0633.2007.00221.x

Bunt, C. M., Castro-Santos, T., & Haro, A. (2012) Performance of fish passage structures at upstream barriers to migration. River Research and Applications, 28(4), 457-478. https://onlinelibrary.wiley.com/doi/abs/10.1002/rra.1565

Cahill, C.L., Mogensen, S., Wilson, K.L., Cantin, A., Sinnatamby, R.N., Paul, A.J., Christensen, P., Reilly, J.R., Winkel, L., Farineau, A., & Post, J.R. (2018) Multiple challenges confront a high-effort inland recreational fishery in decline. Canadian Journal of Fisheries and Aquatic Sciences, 75(9), pp.1357-1368. https://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2018-0086#.XoyBwkBKiUk

Haro, A., Castro-Santos, T., Noreika, J., & Odeh, M. (2004) Swimming performance of upstream migrant fishes in open-channel flow: a new approach to predicting passage through velocity barriers. Canadian Journal of Fisheries and Aquatic Sciences, 61(9), 1590-1601. https://www.nrcresearchpress.com/doi/abs/10.1139/f04-093#.XoyGgkBKiUk

Kibel, P. S. (Ed.). (2007). Rivertown: rethinking urban rivers. MIT Press.

Klohn Crippen Berger (2017a) Calgary Rivers Morphology and Fish Habitat Study. Submission to City of Calgary with Summary and 3 Volumes.

Klohn Crippen Berger (2017b) Appendix VIII. 1. Tenth Street Gravel Bar Lowering and Fish Habitat Enhancement Project. Submission to City of Calgary, 52 pages.

Kolden, E., Fox, B. D., Bledsoe, B. P., & Kondratieff, M. C. (2016) Modelling whitewater park hydraulics and fish habitat in Colorado. River Research and Applications, 32(5), 1116-1127. https://pdfs.semanticscholar.org/9534/848a91dfbe221c9e93cd2d26875492ed517b.pdf

MacLennan, J. (1987) Blue Ribbon Bow. Lone Pine Publishing, Edmonton. Alberta.

Pinkster, J. (2015) Brown Trout Spawning Activity in the Lower Elbow River. Bow River Chapter – Trout Unlimited Canada. https://bowriver.org/2015/09/01/brown-trout-spawning-activity-in-the-lower-elbow-river/

Pomeroy, J.W., Stewart, R.E., & Whitfield, P.H. (2016) The 2013 flood event in the South Saskatchewan and Elk River basins: Causes, assessment and damages. Canadian Water Resources Journal, 41, 105-117. https://doi.org/10.1080/07011784.2015.1089190

Rood, S.B., Kaluthota, S., Philipsen, L.J., & Zanewich, K.P. (2016) Analyzing and projecting post-flood vegetation colonization along the Bow River through Calgary, Alberta. University of Lethbridge, 129 pp. http://scholar.ulethbridge.ca/rood/publications/analyzing-and-projecting-post-flood-vegetation-colonization-along-bow-river

Rood, S.B., Taboulchanas, K., Bradley, C.E., & Kalischuk, A.R. (1999) Influence of flow regulation on channel dynamics and riparian cottonwoods along the Bow River, Alberta. Rivers, 7(1), 33-48. http://people.uleth.ca/~rood/RoodRivers(Bow).pdf.pdf

Rood, S. B., Kaluthota, S., Philipsen, L. J., Slaney, J., Jones, E., Chasmer, L., & Hopkinson, C. (2019) Camo-maps: An efficient method to assess and project riparian vegetation colonization after a major river flood. Ecological Engineering, 141, 105610. https://www.sciencedirect.com/science/article/abs/pii/S0925857419303349

Rood, S. B., Foster, S. G., Hillman, E. J., Luek, A., & Zanewich, K. P. (2016). Flood moderation: Declining peak flows along some Rocky Mountain rivers and the underlying mechanism. Journal of Hydrology, 536, 174-182. https://www.sciencedirect.com/science/article/pii/S0022169416300774

Sheer, A.M.S., Nemeth, M.W., Sheer, D.P., Ham, M., Kelly, M., Hill, D., & Lebherz, S.D. (2013) Developing a new operations plan for the Bow River basin using collaborative modeling for decision support. Journal of the American Water Resources Association, 49(3), 654-668. https://doi.org/10.1111/jawr.12068

Slaney, J., Rood, S., Dick, W., & Rennie, C. (2019) The City of Calgary's River Morphology Risk Mitigation Program. E-proceedings of the 38th IAHR World Congress, September 1-6, 2019, Panama City, Panama. 9 pages.

Stephens, T. A., Bledsoe, B. P., Fox, B. D., Kolden, E., & Kondratieff, M. C. (2015) Effects of whitewater parks on fish passage: a spatially explicit hydraulic analysis. Ecological Engineering, 83, 305-318. https://doi.org/10.1016/j.ecoleng.2015.06.032

Sinnatamby, R. Niloshini, Mayer, Bernhard; Kruk, Mary; Rood, Stewart; Farineau, Anne; Post, John; (2020) Considering multiple anthropogenic threats in the context of natural variability: Ecological processes in a regulated riverine ecosystem. Ecohydrology (in press)

Williams, J. G., Armstrong, G., Katopodis, C., Larinier, M., & Travade, F. (2012) Thinking like a fish: a key ingredient for development of effective fish passage facilities at river obstructions. River Research and Applications, 28(4), 407-417. https://onlinelibrary.wiley.com/doi/abs/10.1002/rra.1551

B. Boise and Bend River Wave Review by Ryan Richard

Boise and Bend River Wave Review by Ryan Richard

Ryan W.M. Richard is the premier adjustable river wave shaper in the world. Ryan was the first wave shaper at the Boise River Park. Boise River Park was the first modern adjustable river wave. Ryan was hired by Bend, Oregon, to shape the Bend River wave. Ryan Richard has unmatched experience and knowledge about shaping waves and has extensive information about the operations and designs for the best adjustable river waves in the world at Bend and Boise.

Supplemental information, diagrams, and explanations will be provided. Specific additional information can be requested as necessary to fulfill contractual agreements

Table of Contents

1.1 Preliminary Information 2
1.2 Key Operational Failures/Successes/Improvements 7
1.3 Wave control successes/failures/improvements 9
1.4 Usability Failures/Successes/Improvements 11
1.5 Key Community Management Features 12
1.6 Initial Safety/risk Issues and Mitigation attempts/successes 14
1.7 Life Cycle Failures/Successes/Improvements 16
1.8 Operations/maintenance Costs and Requirements 18
1.9 Ideal Wave Design/Model 19

1.1 Preliminary Information

Key wave performance design failures, successes, and possible improvements.

1.1.1 Bend Whitewater Park

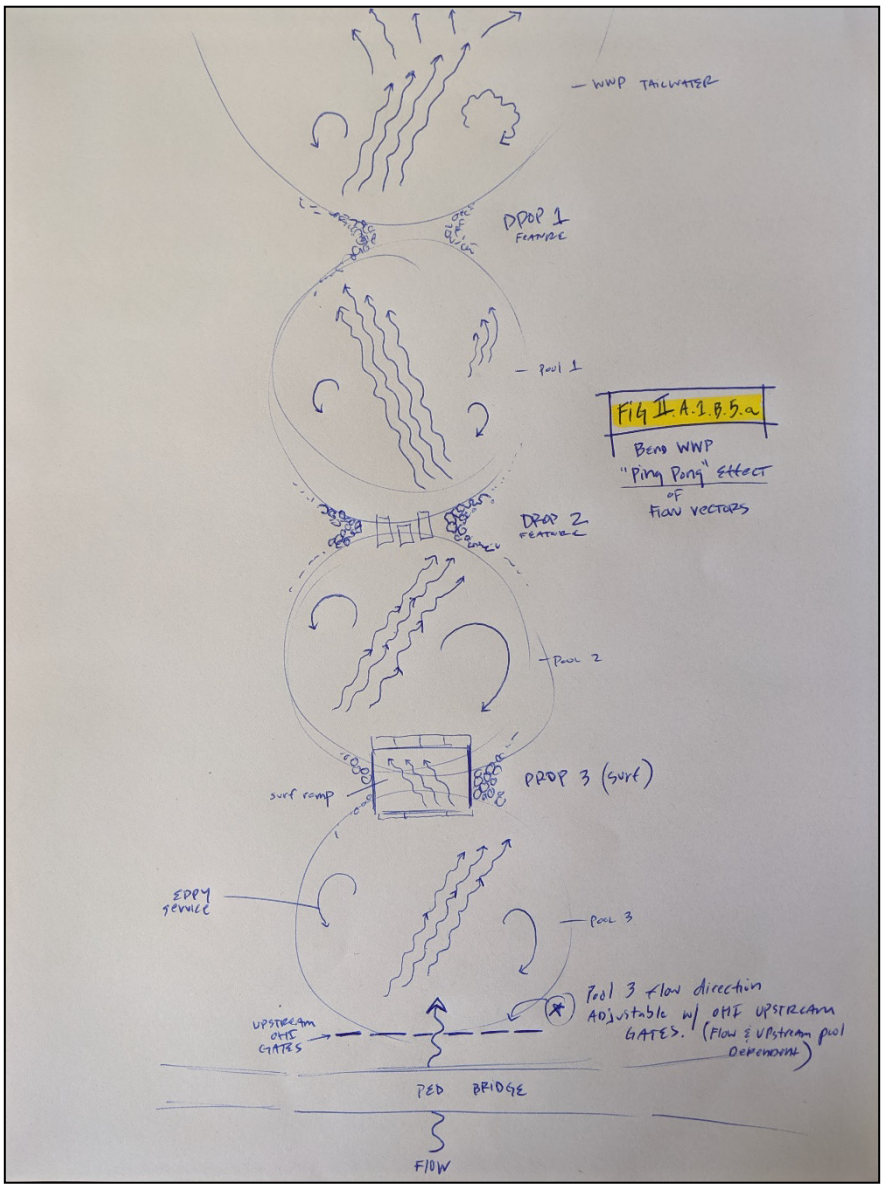
1.1.1.1 Successes

1. The structure produces a feature that performs as intended at the designed flow rate.
2. Wave performance is consistent through a small window of flow rates. The dam controlled river caters to this window regularly, and consistency is expected to improve as more regulations are implemented on flow regimes within the Deschutes River.
3. Adjustable kickers to modify sheet flow contours allow for variability as well as increased consistency.
4. Additional pneumatic gates allow for small adjustments to increase consistency of wave, despite being used not as designed
    a. Tailwater control gates being used abstractly
5. Tailwater monitoring via pressure transducers is a precise and reliable tool for measuring wave characteristics and function
6. Multiple options for flow bypass works well for wave performance
    a. Habitat Channel Bypass
        i. Manual gate controls
        ii. 50-150 cfs of bypass
        iii. Limited somewhat by environmental factors (depth of habitat pond)
    b. Fish Ladder/Tuber Channel Bypass
        i. Pneumatic gate controls
        ii. 50-450 cfs of bypass
        iii. Limited by blowout of alluvial material at extreme flows during floater offseason; limited dramatically during floater season (max of 125 cfs during summer months)
7. Ability to make pure sheet flow, pure hydraulic jump, and hybrid waves gives more versatility and workability (not intended by design)
8. Sequential wave layout can allow for jet vectoring that can impact downstream features

1.1.1.2 Failures

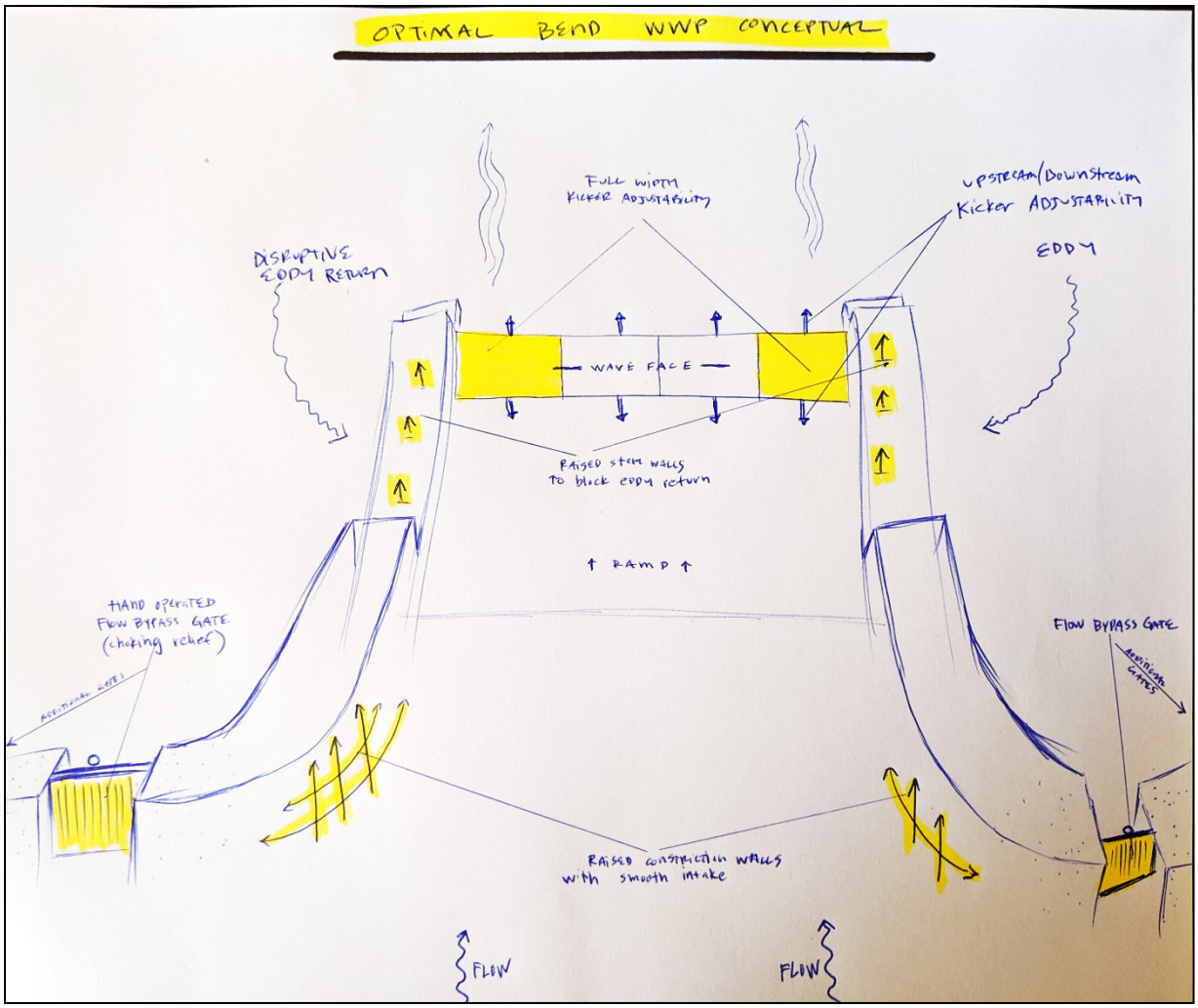
1. Only 20 ft out of 37 ft of kicker portion (sheet flow face) of wave adjustable via pneumatic gates
2. Extreme low flows in river make for a strong yet shallow wave face that increases impact risk
3. Normal peak flows in river can make wave fragile and crumble, giving a less desirable experience

4. Active and adjustable tailwater offset is improperly designed (too high), essentially taking adjustable tailwater out of the equation (always at lowest setting)
5. Overall layout of whitewater channel's sequential waves gives 'ping pong' effect.
    a. 4 features are staggered at small opposing angles to each other, often resulting in overly disturbed flow or crossflow through features (Figure II.A.1.B.5.a)



6. Constraining stem walls next to wave are too low
    a. Too low near trough/wave allowing eddy return to pour over creating wave face disturbances

b. Too low at top of ramp creating non-delineated flow and inconsistency (blossoming effect)
c. Top of ramp walls were not designed to properly vector current into/next to ramp at higher flows
d. See optimal Bend Whitewater park diagram

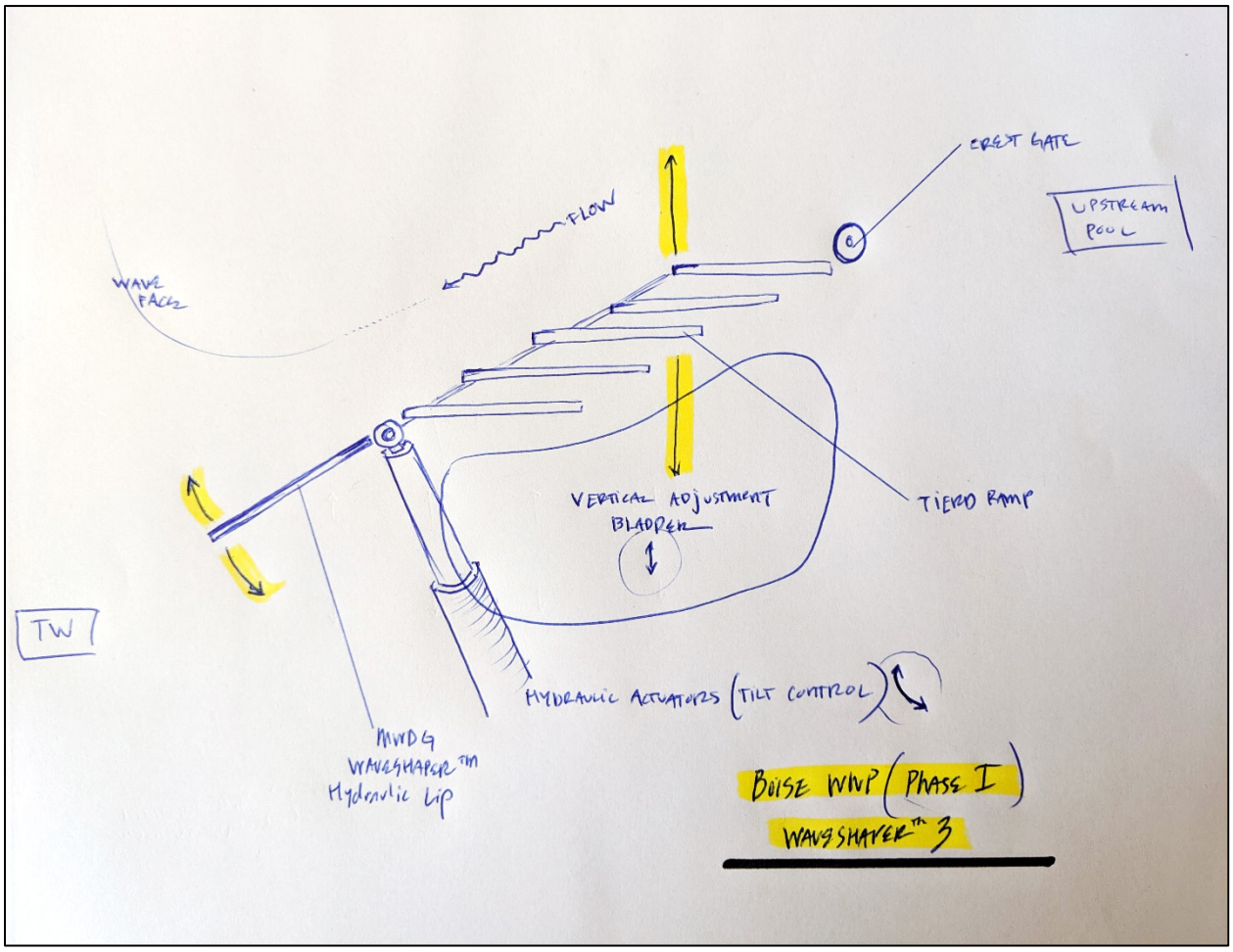


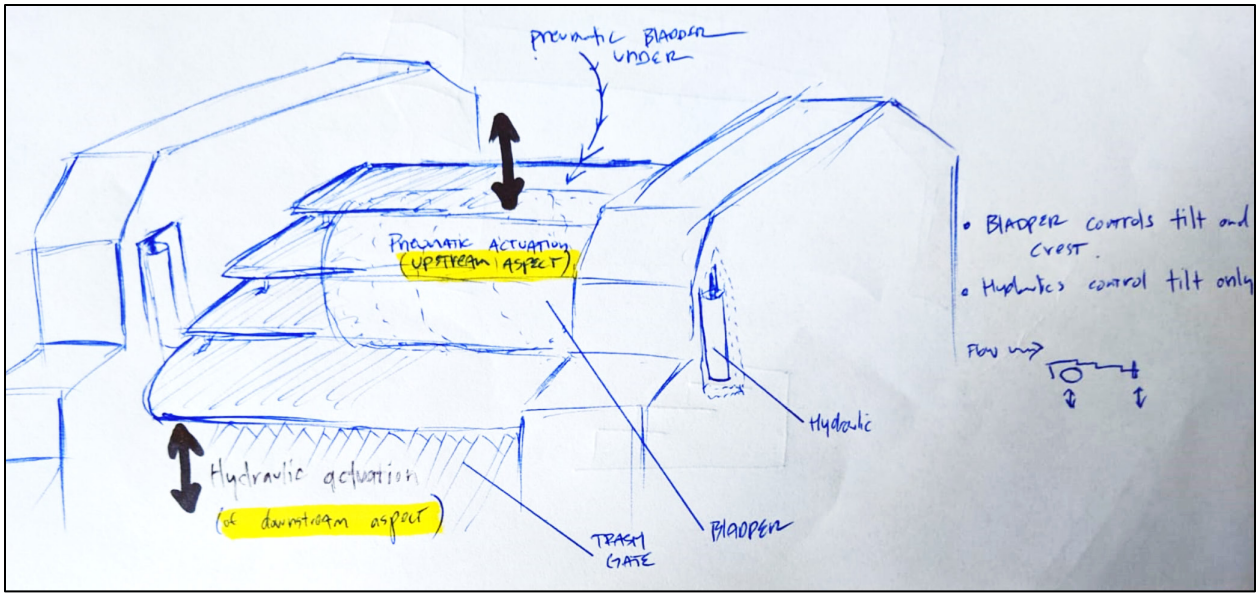
1.1.2 Boise Whitewater Park

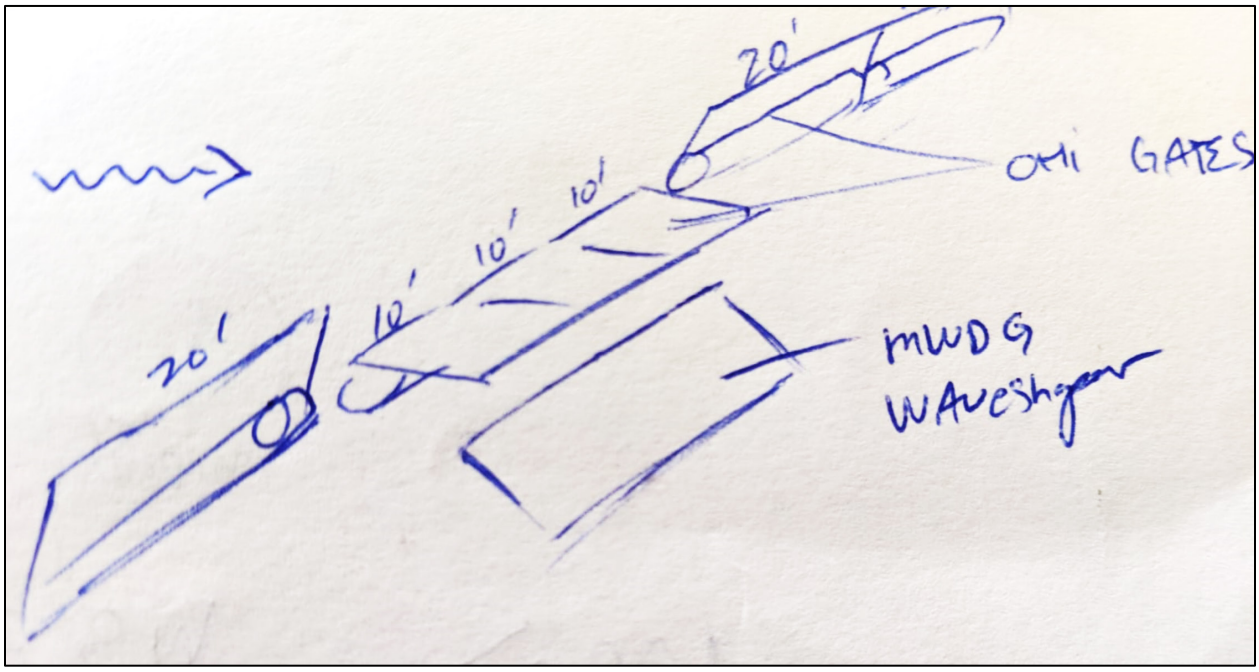
1.1.2.1 Successes

1. Versatile, free form style of adjustability
2. Simple but effective layout gives shaper options to 'find' new features through wide window of flows (200 cfs – 3300 cfs)
3. Potentiating technologies
    a. Obermeyer Hydro gates/flashboards positioned to work in conjunction with McLaughlin Waveshaper technology, creating increased effects to flow and wave performance (Fig. II.2.a.2.a)
    b. Bypass control can make secondary feature

c. Waveshaper 3, or the intended high flow bypass channel, contains hydraulic Mclaughlin Waveshaper mounted on adjustable pneumatic bladder to control crest gate level/upstream pool level (Fig. II.2.a.3.a)
d. Large Obermeyer gates give powerful flushing capability to remove deposits/alter bathymetry for increased wave performance/maintenance







1.1.2.2 Failures

1. Wide range of flows and open style adjustability REQUIRES expert level knowledge to shape quality and SAFE features. High hydrodynamic knowledge also required to create new features that fulfil aforementioned requirements
2. Flood stage occurrences
    a. The Boise R. often reaches flood stage (every 1-5 years) of 4,000-10,000 cfs
3. Large cobble river substrate (4-6” diameter river rock) can be difficult to flush with OHI gates

4. Trash gates meant to protect area beneath McLaughlin Waveshaper have too wide of slats, allowing debris to deposit under the Waveshaper and limit range, sometimes restricting movement to a single degree of declination
5. Requires costly, time consuming, and dangerous debris removal with diver and suction devices
6. Stem walls on Waveshaper 3 are excessively high.
    a. Minimal to no negative impact on wave performance, however, gives a less desirable experience for the user "walled in" and may increase impact risk

1.2 Key Operational Failures/Successes/Improvements

1.2.1 Bend WWP

1.2.1.1 Successes

1. Schneider Electric PLC interface (HMI) has simple and functional layout with available adjustability of pressure transducer offsets, duty cycle, deadband, etc.
2. Overly complex system functions well considering opportunity for failure/issue

1.2.1.2 Failures

1. Due to high volume of conduit/junctions/valves etc., air leaks are frequent
    a. Excessive compressor use (15,200 hours in 4 years, average 48 hr period shows 20-30 hrs of operation) to maintain gates on pressure holds
    b. Leaking gates can cause inconsistencies with wave performance, require more diligent monitoring by wave shaper, and cause regulated upstream pool elevations to drop unexpectedly. At worse, gate leaks can cause safety hazards, such as excessive flow volume in fish ladder/floater channel causing class 1-II rapids to rise to Class III/IV
2. Automated level control to maintain upstream pool levels non-functioning
    a. Causes excessive gate movement
    b. No safety mitigation/wave performance
3. Water in bladder leaks
    a. Venturi style vacuum used to 'suck' gates flat to river bottom
    b. If water leaks into the bladder of an OHI gate or airline conduit, vacuum can pull water backwards into valve manifolds, causing rust and additional pneumatic leakage, eventually causing valve failure
4. Floater Bypass/fish ladder volume requires minimal volume during summer months
    a. During seasonally high flow volumes, the bypass cannot be ramped up for wave performance because of safety concerns for floaters. This is unfortunate because this is the exact time that the bypass needs to have increased volume for maintained wave performance
5. Flow measurement of Bypass channel

a. A single pressure transducer gives an elevation in feet above sea-level, however there is no flow meter to be able to calculate CFS.

1.2.2 Boise Whitewater Park

1.2.2.1 Successes

1. With an experienced and innovative shaper, the Boise WWP offers almost limitless combinations of gate configurations, many of which contain world-class features for surf and kayaking at varied flows

1.2.2.2 Failures

1. Automated pool level control
    a. Similar to the Bend Whitewater Park, the Boise Whitewater Park's automated upstream pool maintaining program does not take into account user safety, wave quality, and causes excessive compressor use
    b. City of Boise did not have adequate funding to support a full time waveshaper. Before Phase II was built, the city could only afford 20 hrs a week at $9.00/hr
    c. This led to several shapers getting burned out and not having the time or resources to utilize the potential of the park
    d. Hybrid waves became the standard choice for waveshapers prior. Instead of switching between high performance surf and high performance kayak waves regularly, the shaper would leave 'hybrid' waves in for long periods of time that were usable by both surfers and kayakers but was mediocre at best for both user groups. Hybrid waves are a lazy and very poor approach to waveshaping
2. Schedule Disproportionality
    a. Once hybrid waves were discontinued, a schedule was created to give 50/50 balance to high performance surf waves and high performance kayak features
    b. The Boise Whitewater Park does have the ability to have 2 adjacent features, but the majority of the year must rely on a schedule
    c. With the increase in popularity of river surfing, a disproportionality of park usage occurred
    d. With a day on/day off format, the park was essentially packed on surf days and essentially empty on kayak days
    e. This caused community strife that will be covered in later sections
3. Improvements
    a. This section emphasizes the need for a dedicated, visionary waveshaper who is given the resources necessary to do the job adequately

1.3 Wave control successes/failures/improvements

1.3.1 Bend Whitewater Park

1.3.1.1 Successes

1. Pulse controls
    a. Schneider Electric HMI interface added a 'pulse' option to the manual inflate/deflate controls that added a level of precision to gate fine-tuning

1.3.1.2 Failures

1. Overall system does not have enough sensitivity to be consistent
    a. Inclinometers only measure to nearest 1/10th degree
    b. Using pulse controls, it is obvious that there are several (3-5) gate positions within 1/10th of a degree
    c. With certain gates (such as sheet flow kickers of surf wave) this insensitivity can cause inconsistencies within wave controls
    d. Improvements- Inclinometers to measure to nearest 1/100th of a degree or in M.O.A.
    e. Pressure readings on bladder PSI only measures to nearest 1/10th PSI
    f. Similar to inclinometers, gate control would be more consistent if PSI readings were accurate out to 1/100th of PSI
    g. Pneumatic inconsistencies
2. Flow dynamics variable
    a. River flow/pressure/water weight can cause different PSI readings at the same gate position and vice versa
    b. Gates can also have identical PSI readings in two different positions, e.g. when water is pouring over the crest of the gate versus the crest of the gate being above the upstream water line
3. Speed
    a. Pneumatic pressure for gate controls are adequate, however move slowly compared to hydraulic gates and require a significant amount of time to equalize after movement.
4. Non-utilized gates
    a. As mentioned before, the gates used to adjust tailwater have two problems
    b. The tailwater range was not properly correlated to wave performance OR the size of the OHI gates are not adequate to attain desired elevations
    c. Most use of tailwater control gates sacrifices the feature directly downstream of the gates. At worst, they can create more hazardous conditions for the downstream feature
5. Auto-inflate

a. Both the Bend and Boise WWP have gate auto-inflation issues. The cause is unknown, but likely has to do with sticking solenoid valves and small leaks from the air supply source
b. Unexpectedly high positioned gates can happen in a relatively short time (>1hr in some circumstances) and can result in problems with upstream pool levels, bypass channels, or can create dangerous hydraulics/pour-overs

1.3.2 Boise Whitewater Park

1.3.2.1.1 Successes

1. Hydraulic components/controls are fast, efficient, and consistent
2. Larger size OHI gates can move riverbed substrate when necessary; have a wide effective range

1.3.2.1.2 Failures

1. Trash gate slats too wide for substrate and debris size
    a. The hydraulic Waveshaper must be dropped to its lowest degree of declination during all times of flood stage (<4000 CFS) to minimize backflow and debris deposit under the shaper. If this is not done, the Waveshaper may lose effective range or even become completely locked (>1 degree of mobility)
2. Boise WWP also has an auto-inflate issue in the bladder that controls the height/crest gate of Waveshaper 3
    a. While the air bladder inflates, the hydraulic portion of the waveshaper remains constant relative to the bladder, NOT to horizontal/level. This can result in a very retentive, aerated hydraulic that is perpendicular to the flow of the river, walled in by large stem walls. This problem can manifest in under an hour if no mitigation is implemented. The resultant 'hole' has a high likelihood of retaining a swimmer with obvious consequences.
    b. Improvements: This issue could be remedied in a variety of ways. Ideally, the leak would be fixed and new hardware that is more resistant to rust/corrosion/leaks would be used. This could be a costly and large project to undertake, very possibly needing "in-water" work and corresponding permitting. Alarms should also be used to alert the shaper when a crest gate reaches a certain height deemed to be dangerous. A more automated approach or added failsafe mechanism could be to have an automatic blow-off system that would bleed air from the bladder if a certain PSI was reached.
3. OHI Gate footings impact issue
    a. While the large OHI gates at Boise are powerful and effective, they can be somewhat self-destructive. There are certain configurations at certain

flows that can cause highly erosive effects to the grout footings that the gates themselves sit on. This is because when the gates lay flat, the footings protrude about 2 feet past the top of the gate. This means that constant cobble and alluvium are tearing away at the concrete as the water moves substrate downstream (direct positive correlation between flow and damage)

4. Improvements: A simple improvement would be adding a thin sheet of steel over the footings to protect from erosive effects. A thin layer of textured rubber or other polymer could be added on top of that for foot traffic traction and safety

1.4 Usability Failures/Successes/Improvements

1.4.1 Bend Whitewater Park

1.4.1.1 Successes

1. The surf wave at the Bend WWP has one of the most user friendly entrances in existence
    a. Stem walls have steps adjacent to the sweet spot of the wave on either side allowing for "step-on" ability, nullifying the need for a traditional paddle in and pop-up
    b. The surf wave face is very uniform and consistent
    c. The perpendicular shape of the wave, along with a uniform sheet flow provides a consistent wave that has available power at any section across the 37 ft. face.
    d. While more advanced surfers may prefer dynamic shapes, the uniformity of Bend's wave is extremely conducive to beginners. Most people figure it out on their first or second try, and can be making turns after an hour or two of practice
2. No Schedules
    a. Having multiple sequential waves designed specifically for certain craft allows for features optimized for the sport they are designed for. This keeps the park more stable, the waves more consistent, reduces workload on the compressor and entire system. This can also help with strife within the different communities, as no one user group feels marginalized for the benefit of another

1.4.1.2 Failures

1. Sequential Waves
    a. While sequential waves have many benefits (as mentioned previously) they can have downfalls as well. Bend WWP has approximately 9 ft. of total headloss over 450 linear feet. Having 4 waves within this area means that eddy service is good, but somewhat small, especially for beginners.

Missing an eddy results in swimmers going through downstream features that may be occupied by another user, increasing impact potential

b. A possible improvement to this situation would be to adjust the runout or eddy service based on the size of the headloss of the feature. For example, if one feature has a headloss of 4 feet, it should have a larger runout than that of a 2 ft. headloss feature. Unfortunately, with Bend's design, the waves are spaced evenly through the park despite having greatly varied size and energy

2. Access to whitewater features
    a. Designers intentionally limited access to the whitewater features. The only way to get to the features is to cross the Fish Ladder/floater channel which is 1-4 ft deep water with class I and II rapids, sharp, slick rock, and other hazards. This may seem like a nice thing to experienced river users, as it prevents excessive crowd formation near the wave. It could also be considered somewhat of a safety tool, as non-experienced river people have a 'buffer' to keep them away from the most powerful sections of the park. However, spectating of surfers on the wave is fairly limited if you do not cross the fish ladder/floater channel. The only other option is to view from a bridge that spans over the top of the park. This provides a clear view of the surfers however it is quite far away from the action and does not allow for any interaction between users/spectators
3. Underground "Sidewalk"
    a. A non-whitewater landscape architect designed and implemented an underwater pathway in the river left eddy service behind the surf wave. This was made of 2-3 ton toe boulders stacked in a line to make a relatively flat path that can sit anywhere from 6" to 3' under the surface of the water. This is obviously a bad idea. These submerged boulders only make for impact hazards, both on user's legs and surfboard fins, as well as potential foot entrapment hazards
4. Improvements- keep the eddy service deep water and make a return path on a nearby bank instead

1.5 Key Community Management Features

1.5.1 Overall Problems with both parks

1. Both the Bend WWP and the Boise WWP have a similar issue that has caused some friction within the community, especially between user groups
    a. Both parks were designed by engineers who have kayak backgrounds. Both parks were also backed and even somewhat funded by community non-profit kayak groups. With the current extreme popularity of river surfing compared to kayaking, there seems to be some light and occasionally significant contention between the groups, mostly in the direction of kayakers towards surfers. Kayakers feel like they put in the

majority of the work to make these parks happen and surfers came in after the fact and took over. The fallacy of mindset on overly protective/defensive kayakers is the fact that they are singling out a user group for being popular. That is an unfair discrimination towards surfers. Today, surfers outnumber kayakers in both parks by a large margin, probably close to 20:1.

b. There is no known 'solution' for this issue. There are basic facts that seemingly dictate these behaviors
    i. River surfing is accessible. A cheap board and maybe a wetsuit are the only 'required' gear pieces to begin the sport. A full kayak setup, even on a conservative budget, is going to cost at least $1,000 USD to begin (kayak, helmet, paddle, spray skirt, etc.)
    ii. Whitewater kayaking has a steeper learning curve. River surfing definitely isn't easy to begin, but for most situations it requires jumping on the wave and attempting over and over again until the basics are learned. Kayaking requires significant prerequisite work, i.e. roll techniques, paddle strokes, etc. before even attempting in an actual whitewater environment. These factors also contribute to the accessibility of surfing and lack thereof in kayaking
    iii. River surfing appeals to bystanders. Most non-whitewater folk are aware that people use small, specialized boats and heavy duty safety equipment to paddle in and through extreme whitewater conditions. Unfortunately, the average bystander has no idea of the time, work, and talent that goes into this sport and therefore doesn't seem to have a huge interest in learning about it. Conversely, everyone knows what surfing is. And most everyone thinks they know that surfing only occurs in tropical ocean settings like Hawaii. So, when said bystander sees a surfer standing in the middle of the river, facing upstream, well, it's a spectacle to say the least. I think this factor can play a role in the separation between user groups. Again, the boaters feel like they put in all the work, the surfers reap the attention and glory.

2. Obviously being an ambassador of inclusiveness is important to overcoming this situation. All user groups need to recognize that they all share the love of whitewater recreation. For now, this philosophy is all that can be applied to the current 'issue' between user groups, but something else must be done to relieve the tension. Being biased, I think everyone should just evolve to standing on their feet if they are unhappy with sitting in a boat. But that's just one surfer's opinion.

1.6 Initial Safety/risk Issues and Mitigation attempts/successes

1.6.1 Bend Whitewater Park

1.6.1.1 Whitewater Channel (Center Channel)

1. Obermeyer Gate Layout/Design
    a. In my personal opinion, the pneumatic gate layout of the park was not designed with safety as a priority. Ideally, these gates would be configured to achieve a desired recreational feature while maintaining safety as a priority. This is easier said than done but attempting to reach a 'fool-proof' setup would be ideal. Instead, gates were configured to achieve a single goal, i.e. tailwater control or upstream pool maintenance with seemingly no consideration for potential risk factors.
    b. For example, Drop 2 of the Bend WWP, aka Kricket's wave, is a kayak wave/hole feature using the same technology implemented at Glenwood Springs, CO WWP (same engineer). This technology is 30,000 lb concrete cubes known as Wave Bloks. They have a tapered edge on their downstream side and produce a narrow- troughed hydraulic jump. These blocks work great at the correct flows. But the designer decided to add 3 OHI pneumatic gates on the upstream side of these Wave Bloks to control tailwater elevation for the upstream feature (Drop 3). While the gates work great to control tailwater for Drop 3, they drastically increase the impact hazard at Drop 2. When the gates are elevated, the pour over dropped directly on top of the upstream side of the Wave Bloks, and even plunged behind them creating not only an impact hazard but also a significant entrapment hazard. (Fig. II.F.1.a.1.a.i.)
    c. This was remedied with added concrete to fill voids behind (upstream) of the Wave Bloks and smooth out the impact area of the top of the Wave Bloks. As they sit today, they still can pose a significant impact hazard if inflated too high. Therefore, they are rarely inflated and are only used with extreme discretion by the operator.
2. Boulder Stacking at Groins of Drops
    a. Each drop has a protruding groin on either side to contain and maintain pool elevations, support eddy service, etc. Local rock was chosen for this process (Basalt rock) and stacked rather haphazardly to build each groin. Basalt rock does not stack neatly like other rocks such as granite. This meant that each groin was a sharp, sieving wall of rock that contained impact and entrapment hazards. The choice to simply stack indigenous rock was based purely on aesthetics. I cannot stress how important it is to prioritize functionality (and safety) over appearance.
    b. The solution was to inject 8,000 psi grout into these groins during low water season. This completely mitigated the sieve hazard, and, to a degree, lessened some of the inherent 'sharpness' of basalt rock by

covering areas with smooth grout. This also helped keep pool elevations consistent and notably improved eddy service.

1.6.1.2 Tuber Channel (River Left Channel)

1. A Promise to Tubers
    a. One of the big sells of the bond measure for the Bend WWP was the tuber channel, originally coined "Safe Passage"
    b. Prior to the whitewater park's construction, a dilapidated dam stood in its place. Floating the river had been steadily increasing in popularity, but all floaters had to portage around this dam midway through their float. The promise to the community was that, along with having world class whitewater features for expert recreationalists, the park would include a "Safe Passageway" channel for tubers and portaging would no longer be a necessity.
2. The Problem:
    a. While making one promise to the community, the "safe passage" was designed to function solely and completely as a juvenile fish ladder. This means that the 450 ft. span and 9 ft. elevation drop of this channel is divided into 12 different 8-14 inch drops. These drops create Class II whitewater and some mildly retentive holes. This doesn't sound too extreme to those used to rivers/whitewater, but to the completely uneducated and less-abled layperson, they can create some havoc. Most commonly, tubers get stuck in a retentive hole, then get pulled up against the tongue of the drop and are swiftly flipped out of their tube, often impacting rocks under the hydraulic. The volume of tubers through this channel regularly exceeds 250,000 in a single summer period, so the opportunity for multiple incidents is high. Since the float leading up to the WWP is flatwater, tubers often have unsecured items and garbage in the bottom of their tubes that gets dumped into the river during a 'flip'. Obviously, the loss of valuables, risk of minor injury, and most importantly, pollution to the river is a significant factor.
3. Solution:
    a. Branding
        i. Using the word "safe" to label anything pertaining to a WWP is a bad idea. Currently, the river left channel of the Bend WWP has been rebranded twice, now known simply as the 'Fish Ladder'
    b. Separation of amenities within a park
        i. I admire the decision to consolidate functionality within a park to save money, resources, etc. But tubers pose a significant challenge. Essentially, we are trying to pass layperson tubers safely through an advanced whitewater area. If a tubing population is to navigate through a WWP, it must have a dedicated channel or passage that is curtailed to the lowest-common-denominator

individual. It needs to be as foolproof as possible and ZERO common sense should be expected from this population.

1.6.2 Boise Whitewater Park

1. Similar to the Bend WWP, OHI gates at Boise appear to be arranged first and foremost for wave functionality
    a. Although the layout of the Boise WWP is much simpler and, in a sense, safer than the Bend WWP, it still has ample ability to create deadly hydraulics and other hazards
    b. In a sense, both parks and all adjustable parks require a huge investment and careful selection of an operator. There is a huge amount of power/control and these operators must be extremely knowledgeable, disciplined, and consistent in their pursuit to make good wave features while simultaneously maintaining SAFETY. This task requires a massive degree of diplomacy as well.
2. Unforeseen downstream hazards
    a. Large Boulders in washout of certain features
    b. There is one particular boulder outcropping that is directly behind a feature made on the river left side of the river. This boulder is not an issue for the main features of the park, as it sits in fairly calm water or a mild eddy, with the majority of jet velocity and energy safely passing next to the hazard. But one popular playboat feature, colloquially known as the “Garden City Hole” sends a fast and energetic jet directly into this rock/boulder hazard. Engineers probably didn’t recognize this during design and construction because they did not or could not have foreseen the operator using the park in this way. In a nutshell, the bulk of the research and thought needs to go into design prior to construction to ensure that any usable gate configuration does not pose significant hazards

1.7 Life Cycle Failures/Successes/Improvements

1.7.1 Bend Whitewater Park

1. Pneumatic Leaks
    a. With a high number of pneumatic gates (26) and miles of underground and under river conduit, the Bend WWP is prone to air and water leaks. This results in very high compressor use and a shortened lifespan.
    b. The takeaway from this fact is simple:
        i. Minimize number of gates, thereby decreasing statistical probability for leaks
        ii. ENSURE that all fittings and connections are triple-checked and done by those who are knowledgeable of the equipment.

iii. Spend the extra time/money/energy upfront to get construction done right the first time. The amount of permitting, money, and time it would take to get down to any one of the conduits within the Bend WWP post construction is MASSIVE, bordering impossible.

2. Island Construction
    a. The 3 channels of the Bend WWP are divided by two peninsulas or 'islands that run parallel to the flow of the river and span the full length of the park.
    b. Stacked basalt boulders were again implemented to construct these islands. This style of construction may suffice in a lower impacted, natural setting of a river, but an adjustable WWP makes for a highly dynamic and variable (and therefore highly erosive) environment.
    c. Solution:
        i. Grout injections
            1. Grout would be a good binder to increase structure and fight erosion. However, it is prone to undercutting and subsequent erosion so it is not a good standalone fix for this problem.
        ii. Sheet Pile
            1. Deeply driven and corrugated sheet pile is the best reinforcement to jetties/islands within a WWP. The steel and structure of sheet pile is very resistant to erosive effects of moving water and is by far the best bolster of man-made dividing structures within rivers. It can also be driven flush to the surface of the structure, making it virtually invisible.
3. Pneumatic gate Backup Systems
    a. Ideally, all pneumatic gates, especially the ones used for upstream pool elevation maintenance, should have at least one backup system if a bladder were to burst or lose pressure.
    b. This backup feature could be a hand operated winch or pulley system that could manually raise or lower gates as needed.
    c. A backup compressor with bypass capabilities should be implemented for any issues that may arise with the main compressor.
4. Plans for Bathymetric changes
    a. All parks, adjustable and static, should plan on riverbed substrate mobilization and have adequate plans for mitigating.
    b. Riverbed dynamics play a huge role in wave performance. If a park is not designed with this notion in mind or doesn't have an effective way of mitigating riverbed substrate mobilization, well designed parks can suffer immensely in regard to wave performance after just a couple of cycles of low and high flow seasons.

c. Substrate size, volume, and current location should all be considered when deciding on likelihood of mobilization and useful mitigation techniques.

1.7.2 Boise Whitewater Park

1. Similarities to Bend WWP
    a. As mentioned before, the Boise WWP utilizes similar technologies to the Bend WWP, specifically OHI pneumatics. It is susceptible to similar leak issues, but has some advantages over Bend WWP
    b. The Boise WWP has a smaller number of bladders (8) and there is a little more accessibility to conduit, however, the same precautions and adherence to detail should be implemented during initial construction.
    c. Hydraulic components (Waveshaper) were purposefully overbuilt and show no signs of deterioration or malfunction other than those related to substrate impaction covered earlier.
2. Substrate Mobilization
    a. The Boise R. near the WWP has large cobble (3-7 inches) that mobilizes, especially during frequent flood stages. This will continue to be a problem through the life cycle of this park.

1.8 Operations/maintenance Costs and Requirements

1.8.1 Overall Philosophy on cost disbursement

1. It is important to build lasting parks
    a. We know the erosive power of moving water. In general, WWP construction should always greatly err on the side of over-building/designing for ample lifespan and reduced need for maintenance/upkeep. Parks that are 'under' built are very susceptible to death. If maintenance and upkeep is required too often, a typical city based entity will drown in permitting regulations and run out of money to maintain the park. Once a wave is not performing to the community's perceived expectations, loss of interest will occur and subsequent lack of funding will ensue.
2. Operational costs vary greatly
    a. The cost to upkeep and maintain a park greatly depends on the type of park. A well-built static park will obviously require the least amount of operation costs and maintenance. Having plans and funding in order BEFORE problems arise is key, even in a low cost/static park.
    b. As parks increase in complexity and adjustability, more costs are involved in upkeep. Again, the key is considering every possible issue that could arise PRIOR to going into the build. The issues you think of WILL arise, along with other unanticipated problems. Construction and upkeep of moving parts under a river always brings access and permitting

challenges; the more preliminary planning and proactivity that goes into a park's build, the less of a headache that park will experience during times of needed upkeep and maintenance.

3. Wave operator
    a. If you have an adjustable park, your wave operator/ wave shaper is KEY. Similar to building a bolstered park ready to handle potential issues as they arise, investing in a well-qualified wave shaper is absolutely necessary. It is also important to bring this individual on to the project as early as possible. Your operator should have an intimate knowledge of how the park is built and may offer additional insight during construction. Often, when an engineer cannot be on site throughout the entirety of a build, an experienced operator can offer lots of pertinent information and direction to construction crews.
    b. An uninterested, unexperienced operator can run a park into the ground just as fast (if not faster) than an unfixable problem in the park itself.

1.9 Ideal Wave Design/Model

1.9.1 Adjustability

1. When it comes to producing a consistent, high performing wave at a variety of flows, adjustability is key
    a. Ideally, a combination of features would be real-time adjustable, preferably by hydraulic or similar fast/powerful actuation
    b. HEADLOSS of feature
        i. Controllable in-flow volume, with ability to completely close off or bypass flow for access for modular piece adjustments or maintenance
        ii. Controllable tailwater elevation through controllable groin with constriction movement (could be another recreational feature) or pneumatic gates on riverbed (again, potential secondary feature, but design should focus on water elevation controllability first and foremost.
    c. Ramp angle adjustability
        i. Angle of declination of ramp into wave
    d. Hydraulic Jump adjustability
        i. Controlled angle of declination under trough of wave, i.e. MWDG Waveshaper
    e. Sheet Flow adjustability
        i. Controlled angle of inclination of kicker platforms for sheet flow adjustability
    f. Kicker position adjustability up/down on ramp/waveshaper
2. These adjustable factors are the primary and priority adjustable features of a good wave. The overall Headloss of a feature has very dramatic effects on wave

formation with very little adjustment. The Ramp Angle/Hydraulic Jump/Sheet flow adjustability are the next most important factors in wave formation, and all have the ability to work independently of each other as well as have potentiating effects on each other, offering a wide variety of usable combinations

3. Optional additional adjustability
    a. Other adjustable factors could be implemented to add performance or variety to a wave feature. These options are more experimental and should not interfere with the functionality of the main adjustable points
4. Angle/direction of flow over ramp
    a. Ramp inflow could be vectored to make asymmetrical or directional wave faces
5. Bolt-on/modular convex texture pieces
    a. A variety of shapes could be implemented to the floor of wave ramp/wave face to add textures such as 'bumps', 'ribs', or 'shoulders. This will add variety and will allow for more advanced maneuvers. Controllable in-flow allows easy movement of modular pieces
6. Modularity
    a. Modular blocks are another massively useful tool in quick adjustability and experimentation
    b. Blocks can be adjusted while water is constricted or diverted away from the wave area
    c. Attachment points for blocks should be as bountiful and as versatile as possible. Basically, the entire proximal area upstream, downstream, and adjacent to the wave should contain evenly spaced attachment points. The drop structure and vertical stem walls can also have attachment points for even more versatility.
    d. Size of modular sections could be scaled up or down depending on application, as well as varied shapes for different desired outcomes.

1.9.2 Idea site selection layout of river/land

1. Ideal river flows
    a. Great waves can be built in a variety of flows. MWDG successfully constructed several waves on the S. Platte R. in Colorado, USA that function well at around 200 cfs. They also designed a successful static drop in Columbus, GA that functions well at over 10,000 cfs. Obvious size and power and difficulty/danger differences are present between these examples, but both are successful
    b. Ideally, river choice would provide a wide range of flows, such as Boise R.
    c. Dam controlled, 250 cfs in winter up to 10,000 cfs at flood stage.
    d. Often this river fluctuates in a stair-step/staggered manner where it will jump to a flow and hold it for a period of time before it jumps to another.

This gives a nice variety of tools to the operator and is ideal if the park is built correctly.

2. Dam controlled v. Natural
    a. Dam controlled is preferential over free flowing rivers
    b. Dam controlled rivers often jump to varied levels which makes for a more exciting wave season.
    c. Dam controlled rivers often allow more time for in-river work, either during initial construction or repairs/modifications.
    d. Even though dam controlled rivers are greatly influenced by weather, they tend to be more predictable and can give earlier notice about potential flow changes.
3. Riverbed substrate
    a. Bedrock
    b. The most immobile substrate is preferential, with something like 5 ton + boulders or bedrock is ideal.
    c. Mobile substrate such as cobble or sand can create ongoing and expensive problems with park performance
    d. Higher flows in rivers can cause more mobilization. Historical flows and *extensive* upstream assessment should be analyzed prior to site selection
4. Environmental Enrichment
    a. An ideal site is one that is ecologically struggling and could benefit from the construction of a whitewater park. This helps drastically with public support, grant funding, permit attainment, municipality involvement, and of course, the actual environment.
    b. Incorporating fish ladders that can also be used as bypass channels
    c. Adding upstream water elevation control can protect threatened wetlands or supply proper amounts of agricultural irrigation demands
5. Environmental enrichment restrictions
    a. While these actions can greatly expedite the construction and enhance the public's perception of whitewater parks, one must consider that in almost every application, these enrichment factors take utter priority over recreation. So, while they may help the park in many ways, they may also restrict the ability to create a great feature. This is again why initial design is so important. Often environmental factors are controlled to very tight tolerances, i.e. 1/100th of a foot or hundredths of degrees. A small miscalculation during design could ruin an entire park before it has even opened.

1.9.3 Scale Testing of Ideal Wave Structure

1. Size/Scale
    a. Larger size models will almost always give a better representation of a drop structure

   b. Increased size of model drastically increases costs of construction and operation
2. Accuracy
   a. Ideally, every testable component will be replicated precisely and to perfect scale, including things like modular pieces that attach as similarly as possible to full size.

C. Stakeholder Consultation for Calgary River Waves and Urban Beach

1.1 Stakeholder consultation

1.1.1 Organizations Contacted

The following organizations and representatives have been contacted about this project. All organizations and representatives have been supportive but want more information about the project as it develops. If specific additional information was requested, the request is listed in the Summary of Feedback section.

Organization	Department	Contact	Position	Email	Phone
City of Calgary	Calgary Fire Department – Fire & Rescue Services Support	Peter Steenaerts	Assistant Deputy Chief	Peter.Steenaerts@calgary.ca	403.988.8093
City of Calgary	Calgary Police Services – 1 District	Cst. Jessica Wood	Community Resource Officer	CRO11@calgarypolice.ca	403.567.6141
City of Calgary	Law and Legislative Services Department	James Floyd	Barrister & Solicitor	James.Floyd@calgary.ca	403.268.8375
City of Calgary	Parks	Laura Smith	Business and Policy Planner	Laura.Smith@calgary.ca	403.268.3739
City of Calgary	Planning – Urban Strategy	Joyce Tang	Program Manager Centre City	Joyce.Tang@calgary.ca	403.268.8382
City of Calgary	Recreation – Sport & Partnership Development	Dawn Burke	Sport Development Advisor	Dawn.Burke@calgary.ca	403.863.5385
City of Calgary	River Engineering – Watershed Planning, Water Resources	Sandra Davis	Planning Engineer	sandra.davis@calgary.ca	403.703.2284
City of Calgary	Roads – Structures & Bridges (Louise Bridge)	Charmaine Buhler	Senior Engineering	Charmaine.Buhler@calgary.ca	403.268.1771
City of Calgary	Transit – Infrastructure (LRT Bridge)	Lara Malmqvist	Senior Infrastructure Engineer	Lara.Malmqvist@calgary.ca	403.268.8393
Calgary City Council	Councillor Ward 7 Druh Farrell	Dale Calkins	Senior Policy & Planning Advisor	Dale.Calkins@calgary.ca	403.268.8393
Calgary City Council	Councillor Ward 8 Evan Woolley	Zev Klymochko	Communications & Development Advisor	caward8@calgary.ca	403.268.2504

Organization	Department	Contact	Position	Email	Phone
Calgary Residents	Downtown West Community Association	Gary Young	President	President@dwca.ca	403.275.5853
Calgary Residents	Eau Claire Community Association	James Hughes	President	info@eauclaireca.com	
Calgary Residents	Hillhurst Sunnyside Community Association	Kate Stenson	Director of Programs	Kate.s@hsca.ca	
Calgary River Users	Calgary River Users Alliance	Patrick Mahaffey	Lead Organizer	pmahaf@telus.net	
Provincial Legislature	Calgary Mountain View Dr. David Swann	Janice Fraser	Constituency Manager	Calgary.Mountainview@assembly.ab.ca	403.216.5445
Provincial Legislature	Calgary Buffalo Hon. Kathleen Ganley	Karen Mills		Calgary.Buffalo@assembly.ab.ca	403.244.7737
Federal Parliament	Calgary Centre Kent Hehr	Jamie Zuffa		Kent.Hehr@parl.gc.ca	403.244.1880

1.1.2 Summary of Feedback

This is a summary of all feedback that requested specific additional information. The Initial Design Report will include additional information.

INITIAL DESIGN REPORT CONTENT & REQUESTED ADDITIONAL INFORMATION				These columns indicate additional information requested by each department								
The Initial Design Report will include other sections not listed here. Planning will be providing feedback soon. Organizations not listed did not request specific additional information.												
				CFD	CPS	Legal	Parks	Planning	Recreation	River Engineering	Roads	Transit
Benefits												
	Economic											
	Cultural											
	Environmental											
Operations												
	Facility Operating Organization(s)			Y		Y	Y					
		Explanation of organizations and roles		Y		Y	Y					
			Alberta River Surfing Association	Y		Y	Y					
			Surf Anywhere	Y		Y	Y					
			Calgary Parks	Y		Y	Y					
	Facility Ownership					Y	Y					
	Wave Structure Control and Operation			Y			Y			Y	Y	Y
	Flow Level Operations Plan					Y	Y			Y	Y	Y
	Daily Operations Plan			Y		Y	Y			Y	Y	Y
	Seasonal Operations Plan					Y	Y			Y	Y	Y
	Operation during major river events						Y			Y	Y	Y
		High Flow					Y			Y	Y	Y
		Ice coverage					Y			Y	Y	Y

INITIAL DESIGN REPORT CONTENT & REQUESTED ADDITIONAL INFORMATION				These columns indicate additional information requested by each department								
The Initial Design Report will include other sections not listed here. Planning will be providing feedback soon. Organizations not listed did not request specific additional information.												
				CFD	CPS	Legal	Parks	Planning	Recreation	River Engineering	Roads	Transit
		River Use Emergency		Y	Y		Y			Y		
		CFD / CPS Emergency		Y	Y		Y			Y		
		Slam Festival					Y			Y		
	Safety plan			Y	Y	Y	Y					
	River lifesavers program			Y	Y	Y	Y					
	Emergency response plan			Y	Y	Y	Y					
	Wave structure inspection					Y	Y				Y	Y
	Wave structure maintenance					Y	Y				Y	Y
	River hall operations						Y					
	River hall maintenance						Y					
	Signage					Y	Y				Y	Y
	Park land maintenance						Y					
Design												
	Design overview						Y		Y	Y	Y	Y
	Flood impacts									Y		
	Effect on bridges										Y	Y
		C-Train Bridge								Y		Y
		Louise Bridge								Y	Y	
	User safety			Y	Y							
	Boat passage			Y	Y					Y		
	Fish passage									Y		
	River Access / Egress									Y		
	Detailed area usage											

INITIAL DESIGN REPORT CONTENT & REQUESTED ADDITIONAL INFORMATION				These columns indicate additional information requested by each department								
The Initial Design Report will include other sections not listed here. Planning will be providing feedback soon. Organizations not listed did not request specific additional information.												
				CFD	CPS	Legal	Parks	Planning	Recreation	River Engineering	Roads	Transit
		Spectators										
		River users										
		Wave users										
	Detailed area design								Y			
		Riverbanks & park land			Y				Y			
			Area access & egress		Y				Y			
			Urban beach components						Y			
			Pathway integration		Y				Y			
			River hall		Y				Y			
			Signage						Y			
			Amenities						Y			
			Community gateways & tie-ins						Y			
		In-river								Y		
			Access & egress							Y		
			Riverbanks							Y		
			Boulder / concrete berms							Y		
			Construction near bridge piers							Y	Y	Y
			Wave structures							Y		
			Signage							Y	Y	Y
			Amenities							Y		
		Habitat enhancement								Y		

INITIAL DESIGN REPORT CONTENT & REQUESTED ADDITIONAL INFORMATION				These columns indicate additional information requested by each department								
The Initial Design Report will include other sections not listed here. Planning will be providing feedback soon. Organizations not listed did not request specific additional information.												
				CFD	CPS	Legal	Parks	Planning	Recreation	River Engineering	Roads	Transit
			Aquatic							Y		
			Riparian							Y		
	Life span					Y	Y			Y		
	Planned major interventions									Y		
Wave Technology												
	Key technology features									Y	Y	Y
	Wave technology									Y	Y	Y
	Installation									Y	Y	Y
	Maintenance & Inspection					Y	Y			Y	Y	Y
	Life span					Y	Y			Y	Y	Y
Hydraulic Modelling												
	Area effects through Bow River flow range									Y	Y	Y
	Wave structure hydraulic modelling									Y	Y	Y
	Sediment transport									Y	Y	Y
	Effect on bridges									Y	Y	Y
Approvals												
	Federal											
		Department of Fisheries & Oceans										
		Transport Canada - National Protection Program										

INITIAL DESIGN REPORT CONTENT & REQUESTED ADDITIONAL INFORMATION				These columns indicate additional information requested by each department								
The Initial Design Report will include other sections not listed here. Planning will be providing feedback soon. Organizations not listed did not request specific additional information.												
				CFD	CPS	Legal	Parks	Planning	Recreation	River Engineering	Roads	Transit
	Provincial											
		Alberta Environment & Parks - Water Act										
		Alberta Environment & Park - Public Lands										
		Historical Resources Management Branch - Historic Resources Impact Assessment										
	Municipal											
		City of Calgary										
Liability												
	Insurance coverage					Y						
		Industry standard insurance				Y						
		Participants				Y						
		City of Calgary				Y						
		Operating organizations				Y						
		Limits endorsements & exclusions				Y						
		Meeting obligations in the event of a claim				Y						
	Previous incidents, accidents & lawsuits					Y						

INITIAL DESIGN REPORT CONTENT & REQUESTED ADDITIONAL INFORMATION				These columns indicate additional information requested by each department								
The Initial Design Report will include other sections not listed here. Planning will be providing feedback soon. Organizations not listed did not request specific additional information.												
				CFD	CPS	Legal	Parks	Planning	Recreation	River Engineering	Roads	Transit
	Incident prevention plan			Y	Y	Y						
	Emergency response plan					Y						
	Waivers					Y						
Budget												
	Capital					Y	Y		Y			
	Operating					Y	Y		Y			
	Wave structure inspections & maintenance					Y	Y		Y			
Funding												
	Capital					Y	Y		Y			
		Federal				Y	Y		Y			
		Provincial				Y	Y		Y			
		Municipal				Y	Y		Y			
		Alberta River Surfing Association				Y	Y		Y			
		In-kind donations of materials and services				Y	Y		Y			
		Corporate				Y	Y		Y			
	Operating					Y						
		Alberta River Surfing Association				Y	Y		Y			
	Wave structure inspections & maintenance					Y						

INITIAL DESIGN REPORT CONTENT & REQUESTED ADDITIONAL INFORMATION				These columns indicate additional information requested by each department								
The Initial Design Report will include other sections not listed here. Planning will be providing feedback soon. Organizations not listed did not request specific additional information.												
				CFD	CPS	Legal	Parks	Planning	Recreation	River Engineering	Roads	Transit
		Alberta River Surfing Association				Y	Y		Y			
	River hall maintenance					Y						
		Alberta River Surfing Association				Y	Y		Y			

1.1.3 Calgary Fire Department – Feedback

From: Neil Egsgard, Surf Anywhere
Meeting Date: October 18, 2018

Hello Robin and Peter,

Thanks again for the meeting this morning. It was great to chat about the 10th Street Waves and Urban Beach project and get a CFD perspective. Below is a summary of our discussion and I have attached our current letters of support. Let me know if you have more to add or would like anything change. Could the CFD issue a Letter of Support for the concept but require more information for full support? Letters of Support are very helpful for progressing the project.

Participants

- Robin Loewen, CFD
  - Technical Teams Lead
- Peter Steenaerts, CFD
  - Has Technical Teams in his portfolio
- Neil Egsgard, Alberta River Surfing Association & Surf Anywhere

Primary Concerns

- Moving through the area in boat
  - CFD uses north channel due to visibility and calmer water
  - Ability for CFD to control the wave features and lower them if needed
- Any issues that could result in the need for rescue
  - No major issues in the current design
- Calls from motorists requiring response
  - Should be a minimal issue because wave is on far side of river from Memorial and Louise Bridge traffic cannot see the wave
- Alcohol use and river recreation if any area is licensed close to the river

Opportunities

- Having formal structures and an established organization that is responsible for the area results in more responsible stewards and community self-management
- Water rescue training at the wave

More Info

- How quickly can the wave raise and lower?
- How will the waves be adjusted if no one is on site?
- What happens at the end of the day? Will the wave be active at night?

Have a good day,

1.1.4 Calgary Legal Department – Feedback

From Neil Egsgard
Meeting Date: Sept 6, 2018 (conference call)

Attendees

- James Floyd, Legal & Liability, James.Floyd@calgary.ca
- Fazal Ashraf, Legal & Liability, Fazal.Ashraf@calgary.ca
- Neil Egsgard, Surf Anywhere

Notes

- Not legal advice but the kinds of things they we should address in the proposal
- Items to address
    - Signage
        - Appropriate signage
        - Signage around warnings
        - Potential links to websites
        - Age levels
        - Use at own risk
        - No life guards
        - Location
        - Maximum exposure
    - Expectations of government
        - Municipal
        - Provincial
        - Funding
        - Operations
        - Maintenance
        - How does this all function
    - Explain who we are
        - Are we a legal entity?
        - Are we an association?
        - Who makes up our group both Surf Anywhere and Alberta RSA?
    - Insurance
        - General liability
        - Does commercial liability cover injuries?
        - Are there waivers?
        - Can participants sign up?
        - Who would be involved in the waiver?
        - Are there appropriate funds in place to meet the obligation to deal with liability or negligence
        - Think about the lowest denominator

        - Drunk floater
        - People who have the highest risk
        - Middle of the night and drunk
    - How we would intend to have an insurance structure
    - Limits, endorsements and any exclusions
    - How will Surf Anywhere meet any obligations in the event of a claim
        - No surprises
    - The stronger the City's involvement the stronger the insurance and indemnity that will be required
    - How participants and City of Calgary are covered
    - City has their own insurance for their skatepark
    - Protect the public from themselves
- How will infrastructure be managed
    - Hours of usage
    - How do we address community issues?
        - Shoreline infrastructure
        - Maintenance
        - Repairs
        - Costs for all of this
- List of previous incidents and accidents and lawsuits
- What are the industry standards for insurance and operations?
- Emergency response plan
    - How are we preventing incidents?
    - How with CPS and fire respond
    - How are we making incidents less serious or stop it from getting worse?

1.1.5 Calgary Parks – Feedback

From Laura Smith, Business and Policy Planner, Calgary Parks
Meeting Date: First week of June 2018

Hey Neil,

I just realized I haven't emailed you yet after our meeting last week with any potential concerns about the long-term wave project.

From a Calgary Parks stance, overall we like the idea of activating our parks spaces, including those by the river, and promoting active living (and I think Recreation would be the same). I think a permanent Wave would help meet those objectives. My concerns revolve around funding, especially ongoing operating funding. As I mentioned, time and again we get money to build something, but don't get money to operate it. I would need to see an operating model that includes who would operate the gates, and what would the costs be around that. I can see it going a few different ways.

Operating Duties/Costs

I feel any official proposal to The City must not only include potential capital costs, but also long term operating costs. As far as I can figure, the following would probably be the ongoing operating duties:

- Operating the switch to put the gates up/down
- Clean up of site (eg additional garbage cans etc)
- Event support
- Coordinating maintenance and inspections
- Work with Fire to address safety issues
- Update website, Recreation guide, and any signage

What would this cost be? I'm guessing it may be the equivalent of one of our splash parks eg Riley Park. Those are operated by Recreation, so maybe Dawn could give you an idea. In addition, it is likely that to do the annual inspection/maintenance of the gates, we would need to apply for AEP approvals. We have found with River Access, no matter how much investigation has been done in the area before, or how small and minor the site is, the assessments required by consultants never comes in less than $100,000 – and often it's closer to $150,000. It would be interesting to know if AEP would allow us to do these environmental assessments once every five years, or would it need to be done every year.

Operating Responsibility

There's a couple of different ways we manage other recreation facilities we can look at:

- City operated facilities such as pools are supported by revenue (admission fees) and by tax dollars
- Community operated facilities such as the new Recreation Centres by YMCA, sport groups, or community associations, are supported by volunteer hours, grants, and rental fees. In this model, The City would still "own" the facility and would have the right to take it back at any time.

I think you heard in the meeting that because this is something very different, and poses different risks, The City would probably prefer to operate it. However, if you developed a model where you can demonstrate it could be community operated, maybe it could be considered.

Ownership/Liability

Who would own the facility? I think The City would insist on the ability to 'shut down the wave' at any time, and I'm not sure we could do that because the facility is on/in the property of the Province/Feds. Maybe this isn't complicated and is just a LOC to The City from the Province, but I would suggest it needs some thought. Maybe a conversation with the Province is needed at this stage?

Let me know if you want any more information or want to meet.

1.1.6 Calgary Planning – Feedback

From Neil Egsgard, Surf Anywhere
Meeting Date: November 23, 2018

Hello Everyone,

It was to meet last week to talk about the 10th Street Wave and Urban Beach project. I have attached the overview of the 10th Street Wave and Urban Beach project and the current letters of support. The letters of support cover local groups, municipal government, provincial government and federal government. The purpose of the meeting was to explain the plans for the area.

Attendees

- Jennifer Symcox, Plng & Partnership Mgmt Lead, Calgary Recreation
- Dawn Burke, Sports Coordinator, Calgary Recreation
- Tom Schlodder, Planner, Community Planning
- Julie McGuire, Planner, Community Planning
- Neil Egsgard, President, Alberta River Surfing Association & Surf Anywhere

Notes & Questions

- There is a City of Calgary plan to continue developing the riverbank and pathway area by the surf wave.
    - Q: Can you provide a good contact regarding that project?
- It was suggested that the Alberta RSA reach out to The City of Calgary - Environmental & Safety Management to get their feedback on any potential issues
- There may be a recreational facility developed at the CPA Lot 6 site but that is still in the very early planning stages
- It was suggested that the Alberta RSA contacts Calgary Economic Development
    - Tom Schlodder provided an introduction to David Ducasses at CED

Thank you all for your time and you help.

Regards,

Neil

1.1.7 Calgary Police Service – Feedback

Hello Cst. Jessica Wood, Cst. Robertson-More and Ms. Zalasky,

It was great to meet you all last week and thank you for you time. Here is a summary of what we discussed during our meeting about the 10th Street Waves and Urban Beach Project.

Meeting Date & Location
January 16, 2019
1 District Building

Participants

- Cst. Jessica Wood, 1 District Community Resource Office, CPS
- Cst. Alasdair Robertson-More (also Marine Unit, Acting Sgt.), CPS
- Megen Zalasky, CPS
- Neil Egsgard, President, Alberta River Surfing Association

Notes

- Opportunities
    - Improved area usage
    - Downtown West Community Association is looking for more positive area uses
    - There are people rough camping in the bushes of the proposed environmental habitat improvement area
    - Properly and positively activating the area will reduce the amount of rough camping and undesired usage
    - Consider doing the riparian enhancement first to change the usage of that area before creating the facility. This provides a more comfortable change of area usage.
    - Talk to corporate security about a camera
    - Tie off points for boats on south bank and gravel island. Tie off points should be hidden from public
- Concerns
    - How to manage issues such as:
        - area access and egress
        - parking
        - user conflict
        - raft deflating
        - bike traffic
        - families going though feature in rafts
        - CPS boat access
    - Grass gets destroyed in river side areas with heavy usage

- Public perception of safety is important. The public needs to be able to see what is happening by the river well before getting to the river.
- River Hall should avoid having dark areas
- For river rescuers there are drop-in people using the river and they may be challenging and dangerous to rescue

Feel free to contact me at anytime if you have any additional comments or questions. Thanks again for you time and have a good day.

Neil

1.1.8 Calgary Recreation – Feedback

From: Dawn Burke
Email Date: June 19, 20818

Participants

- Dawn Burke, Calgary Recreation, Dawn.Burke@calgary.ca
- Claire McLean, Calgary Recreation, Claire.McLean@calgary.ca
- Laura Smith, Calgary Parks, Laura.Smith@calgary.ca
- Jonathan Slaney, River Engineering, Jonathan.Slaney@calgary.ca
- Neil Egsgard, Surf Anywhere

First, I would like to reiterate that this concept is very exciting and we are glad that you have brought to our attention.

I have collaborated with Claire McLean on my team to formulate the following response. We concur with Laura's comments and are concerned about the ongoing operations (both for human resourcing and financially) for this type of infrastructure.

Capital and Operating Budget

As this is a unique facility, any operating budgets that we have access to would not be a good benchmark for you to use in the development of an Operating Budget for this project. I would recommend looking to the other in-river wave projects to identify the financials needs for operating.

As you prepare both the Capital and Operating Budgets, we would ask you to make the assumption that The City of Calgary would not be a financial contributor. Please also ensure healthy contingency dollars are in place both. I would recommend that a multi-year operating budget be provided that shows the anticipated occasional costs to include bladder replacement, etc. Should any revenues or value in kind be available to the project, it would be beneficial to list them. Please reference our Sponsorship and Naming Rights Policy (CP2016-01) should you be exploring these fundraising options.

Support Amenities

To iterate of our comments from the meeting, an important aspect of this plan will be to identify how support amenities will be provided to citizens; including, but not limited to: washrooms, parking, garbage bins and maintenance, access and egress by foot to the site.

Please also follow-up with Coby Duerr or his alternate to get Calgary Fire Department's feedback on the plan.

Regards,

Dawn Burke

1.1.9 Calgary River Engineering – Feedback

Notes

Date of conversation: January 2, 2018
Participants

- Jonathan Slaney, River Engineering
- Neil Egsgard, Surf Anywhere

10th Street Bridge Comments

- Obeymeter gate hard to fix when it is in the middle of the river
- $100 / m^3 for contaminated mud removal

Princes Island Lagoon Comments

- Excavating the lagoon could provide the following
    - 12,000 cms excavation
        - 50 cms full river flow becomes 5 cms flow over waves
        - 200 cms full river flow becomes 30 cms of flow

1.1.10 Calgary Roads & Calgary Transit – Feedback

From: Neil Egsgard
Meeting Date: Week of October 22, 2018

Hello Lara and Charmaine,

Thank you for the meeting earlier this week. The information you provided was great. I have attached the drawings that we reviewed and a summary of what we discussed.

Purpose of Meeting

- To discuss the 10th Street Wave & Urban Beach project and any concerns from Roads and/or Transit regarding the project.
    - Additional information is available at: https://albertariversurfing.com/surfyyc
- To understand how the project can receive a letter of support from Roads and/or Transit
- To understand the information Roads and/or Transit needs to see about the project going forwards
- Discuss installing a camera on the Louise Bridge that films the wave area

Participants

- Charmaine Buhler, Calgary Roads (Louise Bridge)
- Lara Malmqvist, Calgary Transit (CTrain Bridge)
- Neil Egsgard, Alberta River Surfing Association & Surf Anywhere

Additional Information Requested

- From Roads
    - Any geo-technical information regarding the riverbed in the area of Louise Bridge
    - Any structural drawings of the Louise Bridge piers to allow more precise planning & design of wave infrastructure
    - List of pre-approved engineering consultants for study on effects of Wave/Beach project on bridge
    - Contact from Roads Lighting departments regarding installing a camera on the Louise Bridge light posts. The camera requires mounting and power
    - Conditional Letter of Support from Roads saying the project could be supported by Roads but additional information is needed
- From Transit
    - Any geo-technical information regarding the riverbed in the area of Louise Bridge

    - Any structural drawings of the Louise Bridge piers to allow more precise planning & design of wave infrastructure
    - List of pre-approved engineering consultants for study on effects of Wave/Beach project on bridge
    - Conditional Letter of Support from Transit saying the project could be supported by Transit but additional information is needed
- From the Alberta River Surfing Association
    - Digital versions of the Concept Drawing and Concept Design
        - These are attached
    - Example letters of support
        - These are attached
    - Life span of Obermeyer gates
        - Based on information from Obermeyer
        - 15+ years with no maintenance
            - Could be longer, this is the oldest installation that is operating without maintenance
        - 28+ years with maintenance
            - Could be longer, this is the oldest installation that is operating with maintenance
        - Gates are installed onto a concrete foundation and lifespan of concrete foundation will be determined by the design and construction
    - Maintenance of Obermeyer gates
        - Based on information from Obermeyer
        - Annual maintenance consists of
            - Checking bolt tightness once a year
            - Maintaining compressors and air dryers

Concerns from Transit and/or Roads

- Project must leave Louise Bridge and CTrain Bridge in same or better condition at the end of the construction and for the life span of the structure
- Life span of wave structures
- Who will be responsible for maintaining and repairing wave structures?
- Safety / warning signage on bridges
- Clear space around piers for inspections

Requirements for receiving Full Letters of Support from Transit and/or Roads

- Engineering report on the effect of the project on the bridges by specialized and pre-approved engineering firm. The report must include:
    - Effects
    - Mitigation
    - Life span of wave structure

    - How maintenance will by provided, by whom and how it will be funded
    - Pricing of major interventions to at least 30 years but preferably 100 years
    - How operation of waves will affect bridge piers
        - Model different scenarios
- Transit and/or Roads would review the engineering report and could issue full letters of support but that is not guaranteed

Thank you again for your assistance and your time.

Have a great day,
Neil

1.1.11 Downtown West CA Article about the 10th Street Waves and Urban Beach

DWCA President's Message

2018 COMMUNITY CLEANUP/RECYCLE DAY: I'd like to thank all the **volunteers,** the **Kerby Centre, London Drugs,** and the **City of Calgary** for such a successful event even though the weather was against us. Vehicles came from all over the city loaded to the brim with unwanted items. This is the first year we accepted important document shredding; unfortunately, we underestimated the amount we'd get and all five bins were completely filled by around 11am!

Our metal recycler's truck/trailer were filled by 1:30pm and one of our garbage trucks was also filled to capacity. There was plenty of yard waste for the organics truck. The city workers had fun with a pink shag rug they put on the ground at the rear of their garbage truck, providing quite a picture in the rain of pure luxury while feeding in the debris. Watching those garbage trucks devour couches and large furniture pieces in no time flat was somehow satisfying. :)

The Kerby Centre staff cooked up burgers and hot dogs, and provided everyone with coffee, muffins, chips, water, and pop. **KidseatRecycling** took away 8 kid carseats for proper recycling. The **Calgary Immigrant Support Society** collected a number of good bikes for their cause. **WINS (Women In Need Society)** collected a truckload of household items for their not-for-profit stores. See page ___ for more info, photos, and comments from the event.

TRAFFIC FLOW & SAFETY: The City transportation manager says: "Our reviews to date have shown that the 5 Ave two-way trial/lane reversal is working quite well. We've made a Capital Budget request to cover the costs of a permanent system. Funding availability will determine the future status of the project. Once we have a sense as to the future status of this, we will engage with stakeholders." This is really positive news, as this lane reversal has been ongoing for over 18 months and the signage gets spread across the sidewalks, becoming hazardous for pedestrians, especially those with small children.

TAKE ADVANTAGE OF THE 311 SERVICE: During the summer months, please be extra vigilant and report crime or bad behaviour appropriately. If you see graffiti, report it to 311 with a picture using the 311 app. Rapid reporting helps stop the broken-window effect.

311 CALGARY

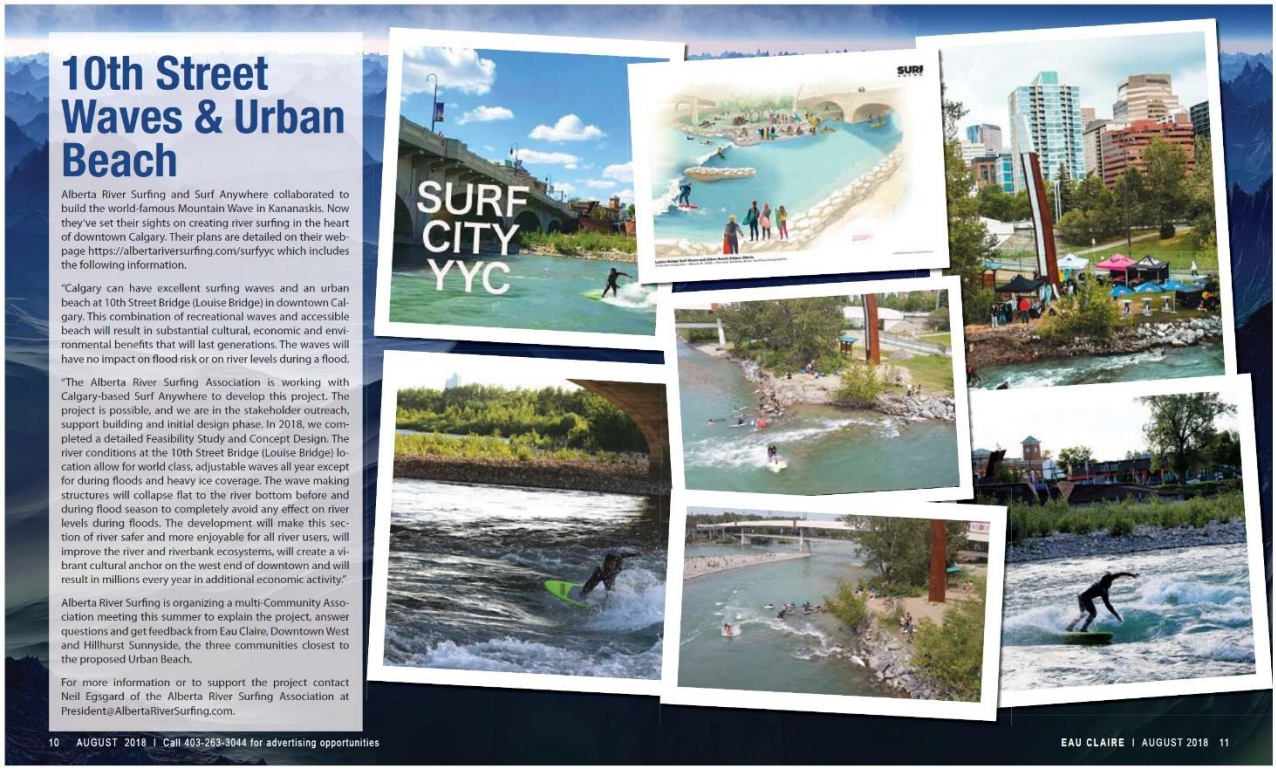
RIVER FLOW & SURFING: Once the high-stream flow advisory is lifted for the Bow River (see page 6) we will again see river surfing under the 10 St (Louise) Bridge. This is being done safely by the **Alberta River Surfing Association** which we hope to see more of in the next few years, as they are working on a project to develop the **10 Street Wave and Urban Beach** at the south bank of the Louise Bridge. Downtown West Community is the only place in the City where you can skateboard in the morning and river surf in the afternoon! Enjoy your summer!

PHOTO BY XPATMATT.COM

Gary Young - President, DWCA

Please visit www.dwca.ca for updates and to contact us.

1.1.12 Eau Claire CA Article about the 10th Street Waves and Urban Beach Project



10th Street Waves & Urban Beach

Alberta River Surfing and Surf Anywhere collaborated to build the world-famous Mountain Wave in Kananaskis. Now they've set their sights on creating river surfing in the heart of downtown Calgary. Their plans are detailed on their web-page https://albertariversurfing.com/surfyyc which includes the following information.

"Calgary can have excellent surfing waves and an urban beach at 10th Street Bridge (Louise Bridge) in downtown Calgary. This combination of recreational waves and accessible beach will result in substantial cultural, economic and environmental benefits that will last generations. The waves will have no impact on flood risk or on river levels during a flood.

"The Alberta River Surfing Association is working with Calgary-based Surf Anywhere to develop this project. The project is possible, and we are in the stakeholder outreach, support building and initial design phase. In 2018, we completed a detailed Feasibility Study and Concept Design. The river conditions at the 10th Street Bridge (Louise Bridge) location allow for world class, adjustable waves all year except for during floods and heavy ice coverage. The wave making structures will collapse flat to the river bottom before and during flood season to completely avoid any effect on river levels during floods. The development will make this section of river safer and more enjoyable for all river users, will improve the river and riverbank ecosystems, will create a vibrant cultural anchor on the west end of downtown and will result in millions every year in additional economic activity."

Alberta River Surfing is organizing a multi-Community Association meeting this summer to explain the project, answer questions and get feedback from Eau Claire, Downtown West and Hillhurst Sunnyside, the three communities closest to the proposed Urban Beach.

For more information or to support the project contact Neil Egsgard of the Alberta River Surfing Association at President@AlbertaRiverSurfing.com.

10 AUGUST 2018 | Call 403-263-3044 for advertising opportunities

EAU CLAIRE | AUGUST 2018 11

Appendix B

City of Calgary Letter of Support for the Wave at Tenth Street

September 14, 2020

Neil Egsgard
President, Alberta River Surfing Association
1059 5 Ave NW, Unit 205
Calgary, AB T2N 4S8
President@albertariversurfing.com

Dear Mr. Egsgard

Re: Support in Principle – Calgary River Waves Park Phase 1 – Preliminary Engineering

Calgary Parks has reviewed your request for Support in Principle for your funding application to Parks Foundation Calgary (PFC). This project is to complete the conceptual and preliminary engineering studies for the Calgary River Waves Park. We are pleased to provide this letter of Support in Principle.

We have no objection to the project, provided the following conditions are understood by all stakeholders:

1. The Alberta River Surfing Association (ARSA) is going to partner with PFC for the conceptual, preliminary engineering and initial permitting portion of the Calgary River Wave Park. The proposed Calgary River Wave Park will be located on the Parks land on the south bank of the Bow, the river bed and the Louise Bridge gravel island. The cost of this stage of the project is expected to be around $700,000. Your group is fully aware that Phase 2 is not part of this letter of support. All funds for this project will be the sole responsibility of the ARSA. In the case that preliminary studies or future West Eau Claire Design/Development engagement does not support future development, the City of Calgary will not be held liable for any monies spent to date.

2. ARSA acknowledges that any permanent design for the specified area will be determined after the City of Calgary undertakes a full design and engagement process of the future West Eau Claire Design and Development Engagement to determine the highest and best use for the park space. This letter of support does not indicate a preference of use at this time.

3. ARSA will continue to update the City of Calgary on project status and work with the City on future communications to ensure clarity of information.

4. ARSA will ensure that all applicable permits and formal approvals are obtained;

If you have any further questions regarding Calgary Parks' support of your project, please contact Ron Buchan, Parks Community Strategist at (403) 537-7571

Regards,

Keath Parker

Manager

Calgary Parks, Centre City

cc: Joyce Tang, Calgary Growth Strategies
Jennifer Duggan, Recreation

Jennifer Thopson, Arts & Culture

Nico Bernard, Parks Capital