Water Pumps or Higher Walkways:

Comparing Their Financial Feasibility and Effectiveness in Managing Mission Creek's Water Level

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INTRODUCTION

Kelowna's Recent Climate History

Due to climate change, Kelowna's precipitation increasingly deviates from monthly averages, with some months receiving much less than average, and others much more. Moreover, summer months are seeing higher than average temperatures more frequently. June-August 2021, for example, saw record-breaking heat, and unexpected dryness, while contrastingly, this June's rainfall and melting snow pushed Mission Creek, approximately within a metre of overflowing. With unexpected, dangerously hot and dry temperatures, Mission Creek's potential overflowing creates two dangers respectively: drought, and damage to private properties.

Report Purpose

However, two potential solution exists for these problems: installing water pumps along Mission Creek and heightening its walkways. This report compares these solutions' feasibility in order to recommend which the city should implement in the near future. Installing water pumping stations along the creek that are connected to water storage tanks would allow using the creek as a water source, helping mitigate future droughts, while reducing the water level when the creek has a high water level. Meanwhile, heightening the walkways allows the creek to reach higher levels without causing flooding or endangering those who use the walkways

Scope

To compare theses solutions' feasibility, this report explores five topics:

- Is drought or flooding more likely?
- Which weather event concerns residents more?
- How expensive is each solution, including maintenance costs?
- Would the solutions bring the desired outcomes?

- Do citizens approve of either of these solutions?

Report Method

This report's data was collected in two ways: research and through an anonymous survey. The research component examined recent studies on Kelowna's climate history and projections to assess the likeliness of serious flood and drought in the coming years. The research also investigated the construction costs of installing water pumps along Mission Creek compared with heightening its walkways by examining estimates from landscaping company websites and reports prepared by other city governments. Meanwhile, the survey's purpose was to determine which weather event the public perceives as more likely and concerning, and their preference for the proposed solutions. 8 participants were asked to answer seven multiple-choice questions, with questions like:

- In your opinion, how likely is it that Kelowna experiences challenging levels of drought in the near future?
- How concerning that event would be for you?

Questions 1 through 6 let participants answer with five options ranging from "Highly Likely" or "Highly Concerning" to "Highly Unlikely" or "Not at all concerning", while in Question 7, participants chose which solution they preferred if only one could be implemented, with the option to propose alternative solutions if none appealed to them.

Summary of Findings

As a brief overview, climate studies showed Kelowna was becoming hotter and drier, and will likely continue to over the century. Regarding survey results, Kelowna residents felt drought was likelier and showed greater concern if it were to occur, compared with Mission Creek flooding. As for the cost-effectiveness of installing water pumps on Mission Creek compared

with higher walkways, installing water pumps was significantly more expensive, but yielded greater benefit, and this solution was favoured by residents.

DATA

Likeliness of Drought vs. Mission Creek Flooding

I. Climate history and projections

In a 2021 article from the journal *Climate Risk Management*, Hewer and Gough assessed climate change's impact on Kelowna's wine industry using the city's climate change history from 1970-2019, as well as projections. While the article examined multiple metrics relevant to winemaking, the most pertinent were changes in the number of extremely hot days (temperatures greater than 32 ˚C) and the average amount of precipitation received each year.

Concerning hot days, the average number of extremely hot days in a year has increased to roughly 20 days from 13, a 7 day increase (Hewer and Gough, 2021). Alarmingly, the article projected that years in the 2020s could have 13-15 more extremely hot days, and years by the end of the century could have 32-60 more, giving the example that all of July and August could soon be regularly 32 ˚C or hotter.

Average precipitation each year however, was a different story. Kelowna's annual average precipitation from 1970-2019 did not change in a significant way (Ibid, 2021). Nonetheless, with humidity, the article notes Kelowna has become less humid, and projects that April-October precipitation for the 2020s could have 0-11 mm less precipitation on average, while the 2050s through 2080s could have 10-27 mm less on average. Meanwhile, the article projected December-March could have 10-17 mm more precipitation, while the 2050s through 2080s could have 17-36 mm more precipitation.

II. Interpretation of Climate Data

Turning to this report's first question: Is drought or Mission Creek flooding more likely? With the data presented, this question is hard to answer at first glance. This mainly comes from the fact the article made no correlation between high temperatures and lack of precipitation. So even if temperatures are getting hotter, it's not a given this alone will cause reduced water levels or drought conditions. Likewise, projections indicated winter months could become wetter, while the remaining months drier. Whether this winter precipitation makes up for the lost summer precipitation, or even causes above average levels for Mission Creek when the snow melts, is uncertain. What can be said is much of the year in Kelowna will have likely have less precipitation, causing the year as a whole to be generally drier. This makes Mission Creek flooding seem unlikely, and drought occurring instead much more likely.

Considering this climate data and projections, installing water pumps along Mission Creek seems like the more pressing solution, not because Mission Creek will be experiencing water levels close to flooding, but because excess water will likely become scarcer. Thus, unexpected extra water in Mission Creek should be taken advantage as soon as possible and put into reserve, to prepare for potential water scarcity. It should be noted too that with increasing temperatures, water demand will likely increase, as dehydration from the heat will occur faster. Consequently, heightening the Creek's walkways does not seem a logical solution with average precipitation decreasing, and thus the likeliness of the river overflowing. While the science indicates drought is likelier, the next question is which event concerns residents more? As the survey results will show, it seems to be drought.

Survey of Citizens' Climate Concerns

I. Survey Results

Concerning the possibility Mission Creek could flood in the near future, most (5 in 8) survey participants felt such an event was likely (See *Figure 1* below). 1 in 4 were unsure, and 1 in 8 felt the event was unlikely. Importantly, none considered it highly unlikely or highly likely, thus making the responses not very spread out over the five possible options.

This contrasts with the possibility of challenging drought in Kelowna. While survey participants were divided over how likely they felt a challenging drought was (*Figure 2*), combined, an overwhelming 75% thought it was likely or highly likely, compared to the 62.5% feeling flooding was likely (a 12.5% difference). Intriguingly, the remaining participants were either unsure about the likeliness of challenging drought, or felt it was highly unlikely, with none thinking it unlikely. This makes Figure 1's data much more spread out than Figure 2's.

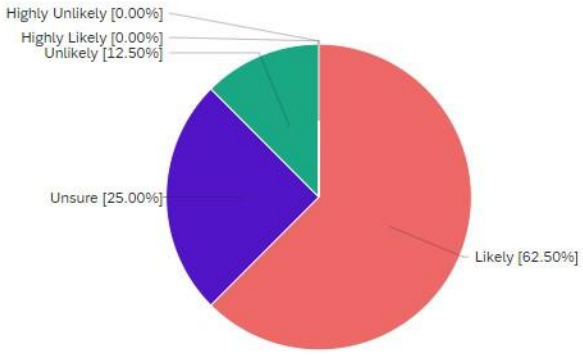

Figure 1: Perceived likeliness of Mission Creek flooding in near future

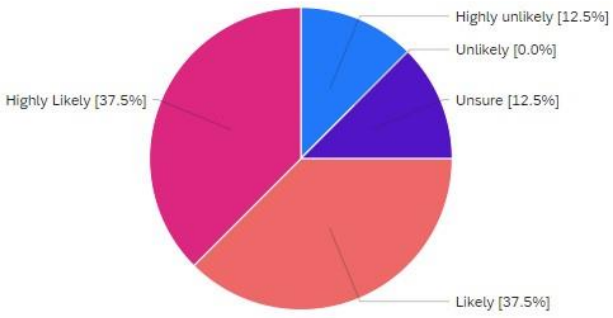

Figure 2: Perceived likeliness of drought in Kelowna in near future

A pattern emerges when the previous responses are compared with participants' level of concern if flooding or drought were to occur (see *Figure 3*). Like Figure 1, in Figure 3, 5 in 8 participants would be concerned by Mission Creek flooding. Slightly different from

Figure 1 however, none were unsure about their concern, with 1 in 4 instead feeling unconcerned if flooding occurred. Likewise, 1 in 8 were not at all concerned if flooding occurred. For concerns about drought (*Figure 4*), while divided in their level of concern, an overwhelming 7 in 8 participants (82.5%) were concerned or very concerned by the possibility of challenging drought. 1 in 8 were unconcerned, and none were unsure. Interesting too, data from these figures was limited to 3 of the possible options, like Figure 1, but unlike Figure 2.

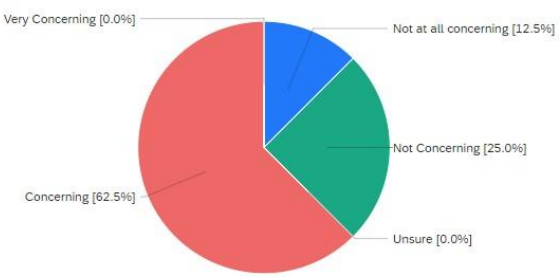

Figure 3: Resident's level of concern if Mission Creek flooded

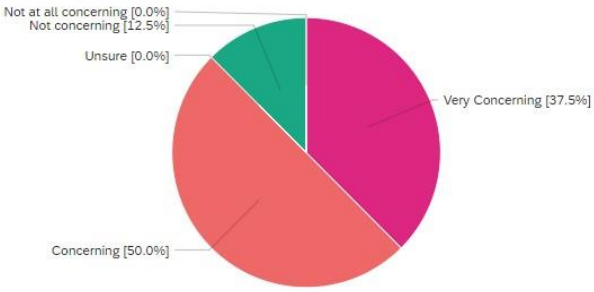

Figure 4: Resident's level of concern if drought occurred

As might be expected based on the previous figures, the solution which greater support from participants was installing water pumps along Mission Creek (compare *Figure 5 and 6*). In Figure 5, participants were divided in their level of support for heightening Mission Creek's walkways, with only 3 in 8 participants supporting or strongly supporting the proposal. 1 in 8 were unsure, with the remaining 1 in 2 (50%) somewhat opposing the proposal. This makes Figure 5 as spread out as Figure 2 in data, and different from Figures 1, 3, and 4.

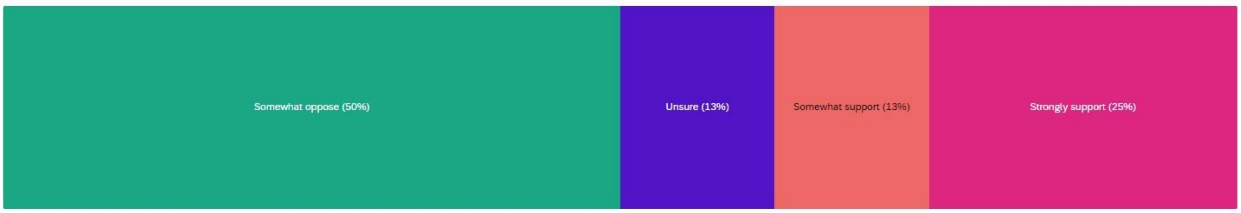

Figure 5: Level of support for heightening Mission Creek's walkways

This contrasts starkly with support for installing water pumps along Mission Creek. In Figure 6, 7 in 8 participants (82.5%) supported or strongly supported the proposal, with only 1 in 8 unsure, and none opposing. Like Figures 1, 3, and 4, responses in Figure 6 are limited to 3 of the possible options.

Figure 6: Level of support for installing water pumps along Mission Creek

Yet, Figure 7 complicates the data. When asked which solution participants preferred if only one could be implemented in the near future, there was no consensus, despite a majority of participants supporting installing water pumps in the previous question. For participants who chose "None of these", they could propose an alternative solution, and one participant did, suggesting to "regulate the flow rate and volume of water into the

creek from upstream."

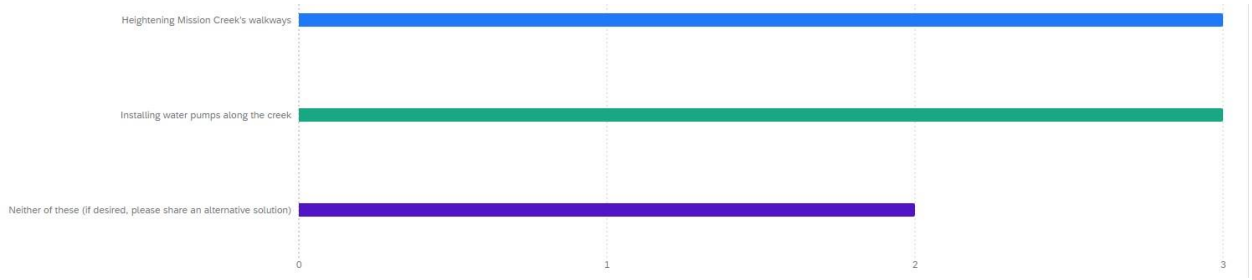

Figure 7: Preferred solution if only one could be implemented

II. Interpreting Survey Results

Comparing the survey's results with the previously discussed climate study, the most significant detail is how residents' perception that drought is more likely aligns with the findings of the climate study. This means any effort to address potential drought in Kelowna based on the climate study will likely be popular, and require less resources to convince residents of their urgency and need. This contrasts with if the climate study found Kelowna was becoming wetter, but the survey participants felt Kelowna was becoming drier, or vice versa. In that case, additional work educating residents would need to be done, lest such projects seem pointless, and thus unpopular.

However, even though residents' perception align with climate studies, the fact Figure 2's data is more spread out than other figures should be taken into account. The data is somewhat spread to the extremes, with few participants unsure, and half of participants feeling drought is either highly likely or highly unlikely. This means perceptions about drought likeliness could be a polarizing issue, so while a majority might not need convincing of the drought's likeliness, there is potential for a vocal minority to question the urgency of drought-relief measures. This is somewhat further demonstrated by Figure 5, where while 50% somewhat oppose heightening the creek's walkways, a majority of those who support the proposal, strongly support it. This potential polarization can also be seen

in Figure 7, with its lack of consensus on which solution participants preferred if only one solution could be implemented, and one participant offering an alternative solution.

Very briefly considering the alterative solution that one participant proposed, it can be agreed it would be effective at controlling the creek's water levels, but it seems inefficient in face of the possibility of drought. Properly examining this participant's proposal exceeds this report's scope, but it nonetheless should be kept in mind, as it could prove an intriguing topic of further research if installing water pumps proves to costly.

Concluding this section, to answer this report's questions, "which weather event concerns residents more?" and "which solution do they prefer?", the survey shows more consider drought likely, have far greater concern if it occurred, and support installing water pumps as a way to prevent it. So, while there is potential for polarization, and some effort would be required to convince the most skeptical, the survey results concur with the climate study, and support installing water pumps on Mission Creek over heightening its walkways.

Controlling Mission Creek's water levels

I. Heightening Mission Creek's Walkways

The last remaining questions for this report are whether the proposed solutions are cost-effective: how expensive are the solutions, and do they achieve their intended goal? Unsurprisingly with any city project, costs are not cheap, but there are methods to reduce project costs.

Examining the costs of heightening Mission Creek's walkways first, this solution seems cheaper than installing water pumps. One cost estimate from the website of a residential landscaping company placed the cost of using fill dirt at $5-25 USD per yard, and sand at

$15-50 USD per yard (2022 Topsoil, Sand & Fill Dirt Delivery Costs). With this estimate, the cost of the sand and fill dirt required for Mission Creek's walkways can be calculated. Mission Creek's walkways within Kelowna are about 7km long. To determine the cost, the 7km can be converted to yards (7655 yrds), and then the lowest and highest prices can be multiplied by the distance in yards. However, since walkways on both sides of the creek would need to be heightened, the final value would then be doubled. Together, this makes the material cost for the creek's walkways potentially $76k-766k USD ($98k-983k CAD), depending on whether sand, fill dirt, or some combination was used. Yet, this estimate does not include potential cost for hiring contractors or paying city construction crews that would spread and pack the sand or dirt. While cost of city construction crews is uncertain and could be determined later, some suggest avoiding external contractors can reduce project costs. The city of Pembroke Pines in Florida for example saved $150k-200k USD ($193k-256k CAD) by using city construction crews instead of outside contractors (Johnson, 2019).

Analyzing the effectiveness of heightening the creek's walkways, a certain disadvantage appears. Besides the fact climate history and projections do not indicate much need for mitigating higher creek water levels, the main issues are how higher walkways would look. Mission Creek's walkways are already decently high. If they were raised higher, they may look odd in the surrounding landscape. While this is no indication of their effectiveness, a city project which is not aesthetically pleasing, may require more work than normal to convince residents, and may even draw some criticism as "poor planning." Nonetheless, if the walkways were heightened, it would be straightforward to measure its effectiveness. All that would need to be asked is whether the walkways have been raised high enough

relative to creek water levels. A cost advantage of a higher walkways is that they are easy to reverse. If the walkways were heightened but later found to be unnecessary the excess dirt and could be easily removed and distributed elsewhere. As will be seen, this reversibility is not an option in the case of water pumps.

II. Installing Water Pumps on Mission Creek

Heightening the creek's walkways is the cheaper solution but seems pointless in face of climate data. The alternative is to install water pumps to draw on the creek's water, but this solution is significantly more expensive. In a report for its own water facility projects, the City of Modesto estimated the base construction cost for installing the relevant pipelines, water storage tanks, pumps, and backup electrical generators to be $1 million USD, or $1.3 million CAD (City of Modesto, 2017). However, Modesto's circumstances are different than Kelowna's. For installing water pumps on Mission Creek, only pipelines, and pumps may be required. Pipelines would be needed to transport the water pumped from Mission Creek, and the pump is the core component of the proposal. Backup generators may be excessive as water pumps could only be activated when the creek has an excess water level, but they may be necessary in future years if water demand significantly increases, and the pumps being unopertional would cause problems. Likewise, storage tanks are not necessarily needed for the project, unless city water storage would near full capacity with extra water from Mission Creek.

While Kelowna's case is different, Modesto's report luckily contains tables estimating the construction cost of water pipelines of diametres ranging from 6-36 inches. The table estimates water pipelines to cost $91-422 USD per foot, depending on pipe diametre (Ibid, 2017). If water pumps on Mission Creek were placed as close as possible to existing water

pipelines, where the distance was only 30 feet at most, the pipeline costs could be $3,466-16,251 CAD. The actual water pumps are the bulk of the cost for the solution. Depending on the desired horsepower of the pumping (50-450), a pump station could cost $1.2 million-3 million CAD. If water storage tanks were included in the project, it would cost an additional $2.1 million-12.7 million CAD, depending on the size of the tanks (1 million-6 million gallons). Without water tanks, the project could cost $1,203,466-$3,016,251 CAD, and $3.3 million-15.7 million CAD with new water tanks.

Reflecting on how effective the water pumps would be concerning the previously examined climate data, multiple benefits and disadvantages come to mind. The theoretical advantage of the water pumps is they increase the amount of water the city can collect. However, since Mission Creek flows into Okanagan Lake, which is the main source of Kelowna's water, there may not be any advantage to having the pumps on the creek, as changes in Okanagan's lake water level could affect Mission Creek's water level. Furthermore, existing water pumps stations could be expanded. The large cost is an immediate disadvantage, especially because it cannot be easily reversed after implemented like the walkways. While the water pipelines could be recycled, other components might be able to, or even sold.

III. Summarizing Pumps vs. Walkways

Thus, while installing water pumps could be hundreds of thousands, if not millions of dollars more expensive, and is less reversible, it would allow the city to draw on more water, something heightening the walkways cannot do. Regardless of which is chosen, the costs of both water pumps and higher walkways are well within the city's usual project spending, which has spent $2-13 million on recent projects (City of Kelowna, 2021).

CONCLUSION

Summary and Interpretation

In conclusion, this report investigated multiple questions, and found mostly unequivocal answers. A climate study showed Kelowna was becoming hotter and drier and will likely continue to do so in the following century. These conditions would likely increase water usage, while reducing water availability, making drought more likely. Likewise, survey participants' concerns matched climate history and projections, with drought thought of as more likely and concerning. Stemming from this, participants supported installing water pumps more than heightening Mission Creek's walkways, with some offering intriguing alternatives that could be further explored. Despite this, the issues seemed somewhat polarized, meaning installing water pumps could require some public education efforts. Lastly, it was found that while water pumps would be a more expensive project, they would be worth the investment.

Recommendations

Considering the presented data, this report recommends the Kelowna City Council pursue the following actions as soon as possible:

- Prepare a detailed plan and timeline for constructing the water pumps on Mission Creek, and connecting them to water reservoirs
- Prepare educational material concerning the need for, and benefits of installing water pumps on Mission Creek
- Integrate data and arguments from the climate study cited in this report (Hewer and Gough, 2021) into such educational material
- As needed, research the feasibility of regulating Mission Creek's flow and volume from upstream

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