Kimberley Water Study

October 2008

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for Wildsight Kimberley/Cranbrook's *Kimberley Water Project*

wildsight
kimberley
cranbrook

The Kimberley Water Project was formerly the Mark Creek Recovery Program, which has focused mainly on restoration work in Mark Creek in the past. Now that Wildsight is doing more work on other watersheds in the area (especially Matthew and Kimberley Creeks), we have changed the name to reflect the broader focus. This study has been undertaken as part of our mandate to maintain healthy ecosystems in Kimberley area watersheds.

This is a version of the presentation given to the public at the Kimberley campus of The College of the Rockies on October 22nd, 2008.

Thanks to the **Columbia Basin Trust** and the
Columbia Kootenay Fisheries Renewal Partnership
for their financial support

Upper Mark Creek falls (35m high).

The reason for this study: We were concerned that there may not be enough water in Mark Creek below the dam for aquatic life and we were concerned about water use in Kimberley, especially in the context of current and potential future development.

We've been working on this study for a year and a half. Most of this time has been spent gathering data from various different sources. We were still waiting for some small pieces of data to come in, but with the upcoming referendum on the proposed boundary expansion, we decided to present our study now so that the public has the opportunity to see all the information that we have available and to help bring this issue to the forefront in the public debate on the proposed boundary expansion. While Wildsight Kimberley/Cranbrook has concerns about many aspects of the proposed boundary expansion and developments, the focus of this study is on maintaining a healthy ecosystem in Mark Creek and how that issue relates to our water use.

Our study was presented to City of Kimberley council on Oct. 14th in much less detail. This presentation is intended to give interested members of the public a detailed look at our study and the opportunity to ask questions.

Mark Creek (between reservoir and TeckCominco flume)

Contents of our Study:

1 Our Sources of Water:

Mark and Matthew Creeks supply water to Kimberley and Marysville respectively.

Mark Creek: elevation at dam - 1340m, highest point in watershed - 2670m, area - 107km2

Matthew Creek: elevation at intake - 1030m, highest point in watershed - 2730m, area - 148km2

Mark Creek

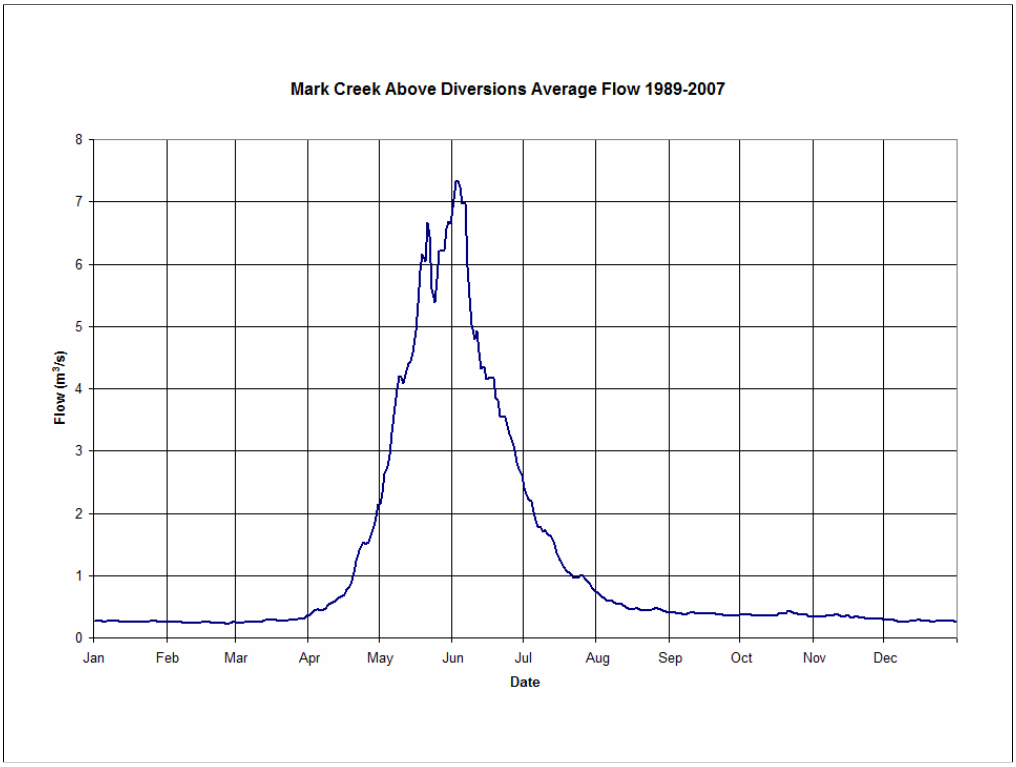
Continuous flow monitoring stations are marked in red and the municipal dam (water intake) and reservoir are marked in blue.

The upper flow monitoring station is called “Mark Creek above diversions” and is monitored for the City of Kimberley and the lower station is called “Mark Creek at Kimberley” and is monitored for TeckCominco.

View of Mark Creek watershed looking down towards the municipal reservoir (center) with the ski hill in the background

Matthew Creek

Municipal settling pond and water intake are marked in red. There is a continuous flow monitoring station named “Matthew Creek above diversions” just above the intake that is monitored for Tembec.



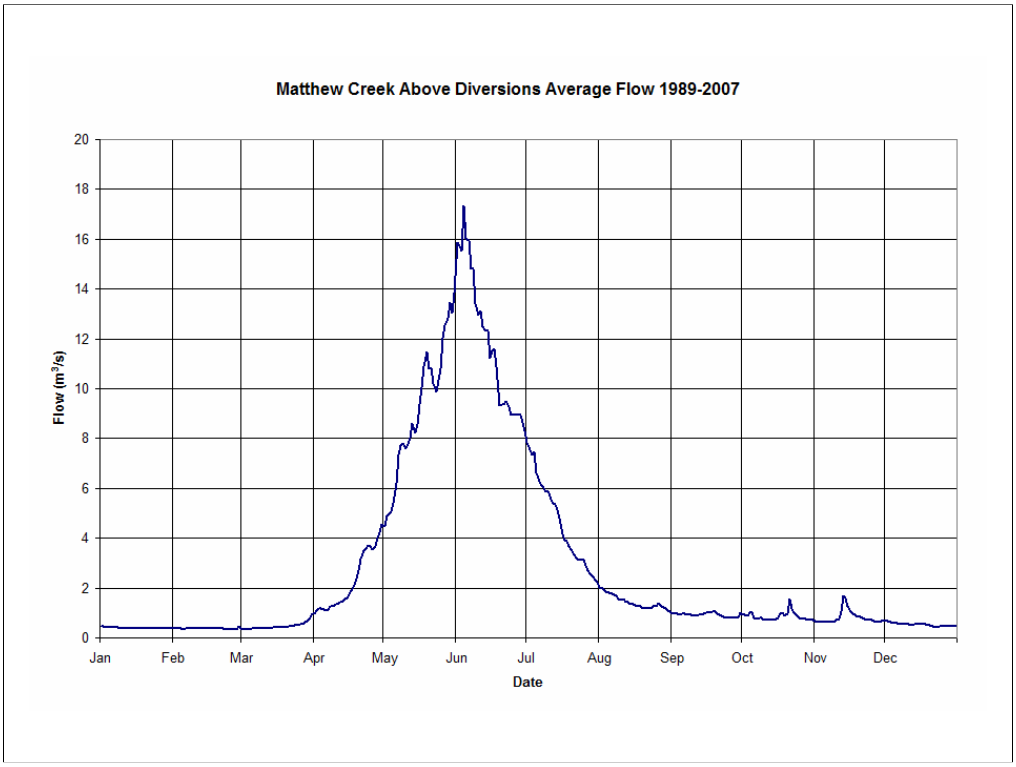
Mark Creek Hydrograph

Average flow (amount of water passing a point per unit of time) of 1.2 m^3/s

A cubic meter (m^3) is equal to 1000 liters or about 7 bathtubs full of water, so a cubic meter per second (m^3/s) is equal to about 7 bathtubs filled in one second. A cubic meter per second is also equal to the flow from about 6000 low-flow showerheads.

Minimum recorded daily average flow of 0.11 m^3/s and maximum recorded instantaneous flow of 24 m^3/s (note that the graph shows flow average flow over multiple years)

Note the very high flows in spring due to snowmelt



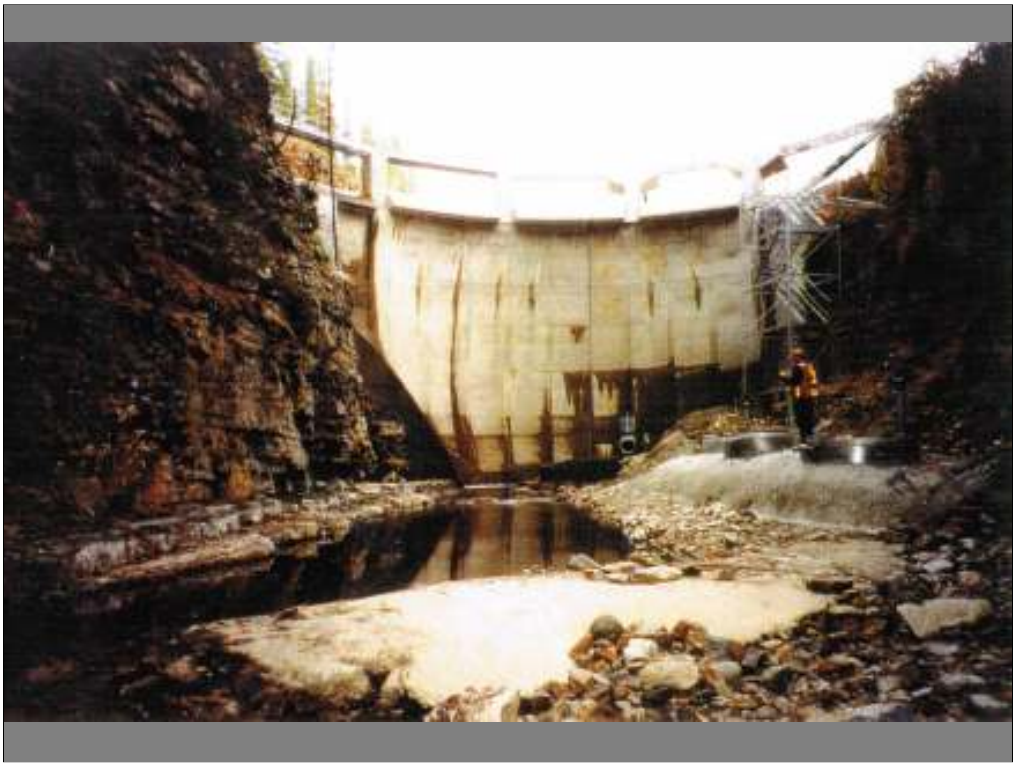
Matthew Creek Hydrograph

Average flow of 2.8 m^3/s, minimum recorded daily average flow of 0.13 m^3/s and maximum recorded instantaneous flow of 50 m^3/s (note that the graph shows flow average flow over multiple years)

Note that this graph uses a different scale than the Mark Creek one as there is quite a bit more water in Matthew Creek.

2 The City of Kimberley Water System :

Mark Creek reservoir



City of Kimberley dam and intake on Mark Creek

Mark Creek Water Supply System

Population of Kimberley: 5112 (estimated)

Three **industrial users** at $0.26 per m^3: Trickle Creek Golf Course
Kimberley Alpine Resort (Ski Hill)
TeckCominco (inactive)

Water licenses: 12 million m^3 per year or average 0.39m^3/s

Water distribution system: 45000 m^3 per day or 0.52m^3/s

Reservoir: 272 000 m^3

Riparian flow valve: 0.02 m^3/s

Load balancing reservoirs: 5, total of 4767m^3

Industrial water use is metered and users pay 26 cents per cubic meter. Residential water users pay a flat rate per quarter, but based on average consumption residential users pay a similar price.

The water distribution system has a capacity greater than the flow in the creek much of the year. In other words, for most of the year, our water distribution system can distribute a greater amount of water per day than the amount of water flowing into the reservoir. In terms of low-flow showers, the system can supply about 3000 at once.

The reservoir, if it is completely drained (leaving approximately 10% of its volume, which is inaccessible) contains enough water for 21 days of average August water use or 37 days of average December water use.

The operations manager aims to maintain flow over the top of the reservoir to maintain water quality. Briefly, if water doesn't flow over the top of the dam, debris and other material no longer flows out of the reservoir. Organic and inorganic material tends to increase levels of undesirable organisms in the water taken from the reservoir, i.e. water quality is lower.

The riparian flow valve provides a small amount of water for aquatic life downstream of the dam.

You may have seen some large concrete cylinders around town. These are load balancing reservoirs, which vary by about 1/8th of their total volume and are controlled by automatic float valves. Their total capacity is about a winter day's water use in Kimberley, but some areas of Kimberley do not receive their water from these reservoirs.

Note: Forest Crowne is currently connected to the Mark Creek water supply system.

Matthew Creek Water Supply System

Population of Marysville: 1350 (estimated)

One **industrial user** at $0.26 per m^3: TeckCominco

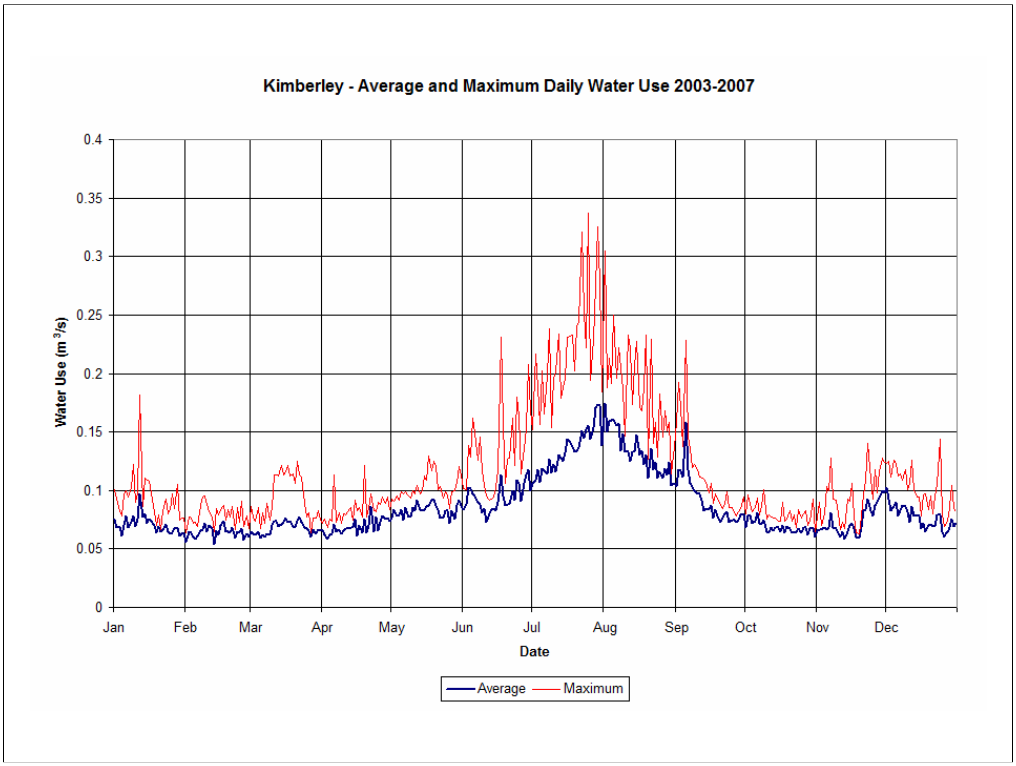
Water licenses: 2.3 million m^3 per year or average 0.07m^3/s

Water distribution system: 9000 m^3 per day or 0.10m^3/s

Load balancing reservoirs: 2, total of 2270m^3

The water licenses and water distribution system capacity are much lower than average flows in Matthew Creek. In other words, the amount of water that the city is allowed to take from the creek and the amount that the distribution system can distribute to water users is smaller than the amount of water in the creek.

The load balancing reservoirs' total capacity is about two days of winter water use.



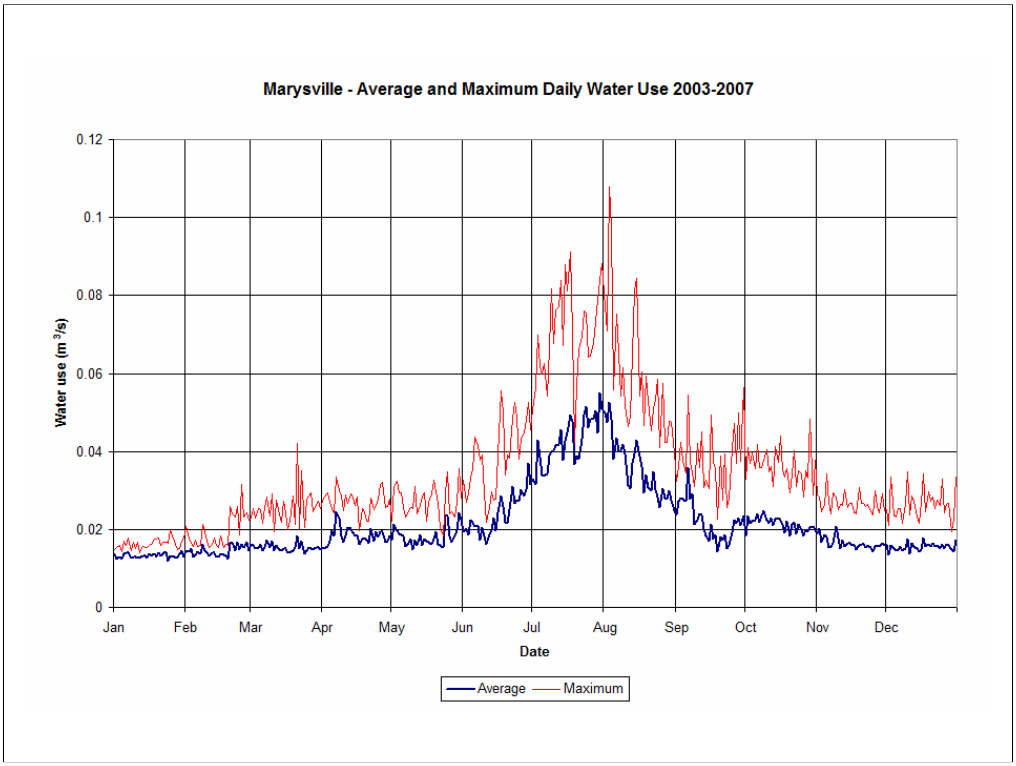
3 Our Water Use:

Our water use is monitored with daily totalizer readings for both systems and less accurate substation measurements for particular areas of the city.

The City of Kimberley has provided Wildsight with daily use records from 2003 to present, which are the only records they have available in electronic form.

Some of the daily measurements might represent more or less than 24 hours of water use, as the totalizer readings are taken manually and not always at the same time of day. This accounts for some of the up and down spikes in the maximum daily water use seen here.

In more concrete terms, 0.15 m^3/s represents one bathtub per second.



Note the different scale: Marysville water use is much lower than Kimberley use due to the lower population.

Kimberley Alpine Resort: Water Use

Ski Hill

Average 104 000 m^3/year

Maximum 170 000 m^3/year

Estimated maximum use of 0.07m^3/s / 5300m^3/day

Golf Course

Average 104 000 m^3/year

Maximum 107 000 m^3/year

Estimated maximum use of 0.025m^3/s / 2100m^3/day

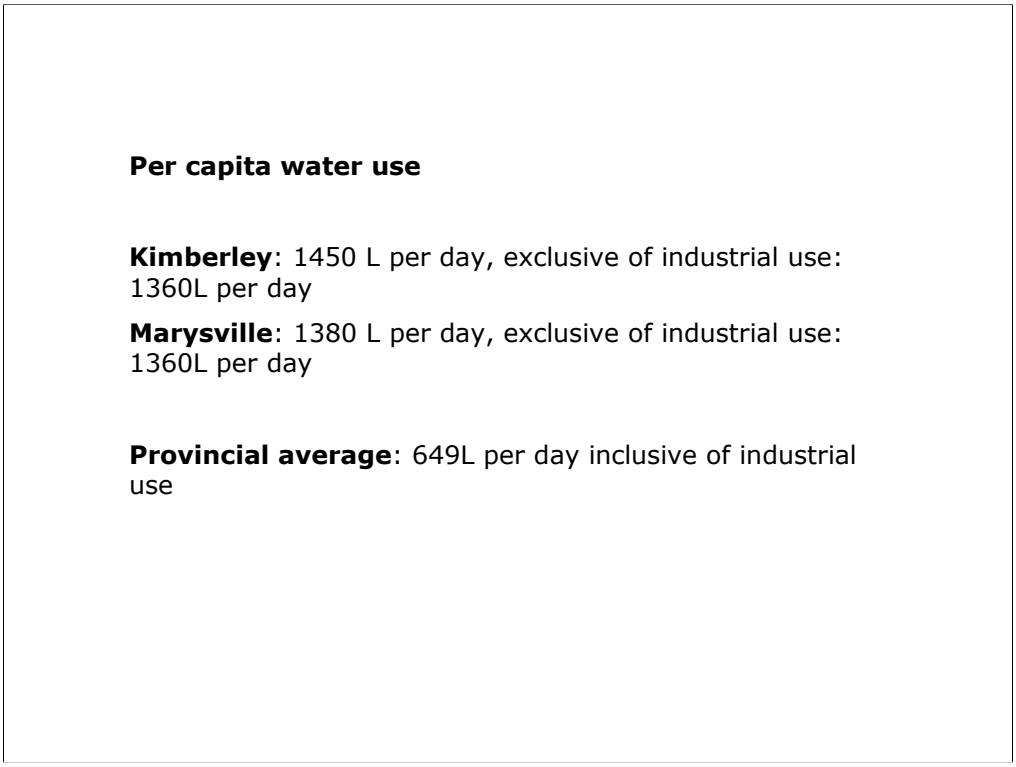
The Kimberley Alpine Resort uses water from the Mark Creek water distribution system.

The daily figures are averages over an entire day. Instantaneous use is much higher because both the golf course and ski hill fill reservoirs to supply their water needs. Also, snow making and irrigation tends to take place at specific times of the day (primarily at night).

The golf course uses water, which they store, from Trickle Creek for their irrigation needs until they no longer have sufficient water, which is usually in July or August, and then they use water from the municipal system.

We have asked Resorts of the Canadian Rockies (operator of the golf course and ski hill) a set of questions about their water use, including question about the efficiency of their snow making equipment, their peak demand, how they manage their water storage and so on but we haven't received anything specific in reply from them.

TeckCominco doesn't use a significant amount of water in Kimberley.



Per capita water use numbers from other cities, for comparison: Nelson ~1100 L per capita per day, Cranbrook ~700L per capita per day, Kelowna ~400L per capita per day

We don't know why our water consumption is so high. Of course, it could be that we just use a lot of water. Leakage is one possibility that many people mention (we have a few kilometers of old galvanized pipe that may be leaking). However, we do have lower water consumption in the winter, so we can calculate very roughly based on per capita use data that leakage is probably not more than 35% of our total water use and is likely much less. Another issue is that there are an estimated 140 houses in Kimberley that require constant flow in their pipes to prevent freezing during the winter. There are flows out of the distribution system to maintain chlorine concentration requirements (in Forest Crowne and at the end of Rotary Drive), but those likely only account for a few percent of our total water use.

4 Flow Requirements for Aquatic Life:

We are concerned about the reach between the Mark Creek dam and intake and the TeckCominco flume approximately 2.5km downstream (and 1.5km upstream of Kimberley). The reach includes a canyon section, the 35m falls, and the former reservoir. The end points of the reach are indicated by the blue dots.

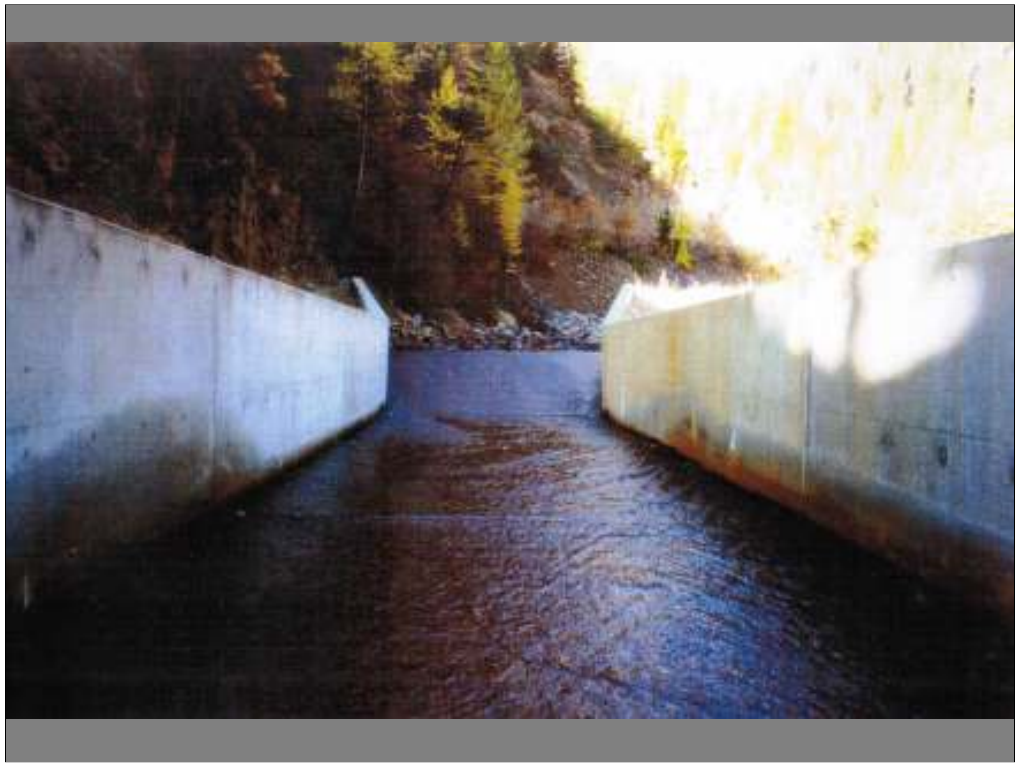
Because of the higher flows and lower water use in Matthew Creek we aren't concerned at this time about aquatic life in Matthew Creek.

Upper Mark Creek Falls

A glide in the reach

We are concerned about the whole aquatic ecosystem, but the limiting species in this case is the largest fish species present in the reach. For the purposes of this report, we will concentrate on the limiting species because the largest fish are the first population to suffer when water levels are very low. Specifically, when water levels are very low, pool habitat becomes too shallow which can negatively affect the fish directly or due to increased water temperatures.

Former reservoir, creek on the right



TeckCominco flume at end of the reach. This is not suitable habitat for fish.

In particular, the largest fish species in the reach in question of Mark Creek are Westslope cutthroat trout (WCT), which are a provincially listed species at risk.

When there are non-native, introduced rainbow trout present, WCT will interbreed with them, which creates a hybridized population. In the Kootenays, only about 20% of populations are non-hybridized.

The study author fishing (unsuccessfully) as part of Wildsight's genetic study

Last year, Wildsight completed a genetic sampling program in Mark Creek. We determined that the WCT populations in Mark Creek are not hybridized. This increased the ecological value of the populations relative to other populations in the area that are hybridized with non-native rainbow trout.

One of the WCT that was genetically tested for Wildsight's genetic testing program (the fish were not harmed for this testing)

The reach is also free of Eastern brook trout, which are found in Mark Creek, but are not found upstream of the flume in downtown Kimberley.

Brook trout are a non-native, introduced species that compete with the WCT, reducing the size of WCT populations. The absence of brook trout also increases the ecological value of the WCT populations in the reach.

More concretely, one pool below the dam was found to contain 110-120 WCT in a study conducted for Wildsight by Interior Reforestation.

Mark Creek

Minimum flow requirements downstream of reservoir:
(Integrated Watershed Management Plan)

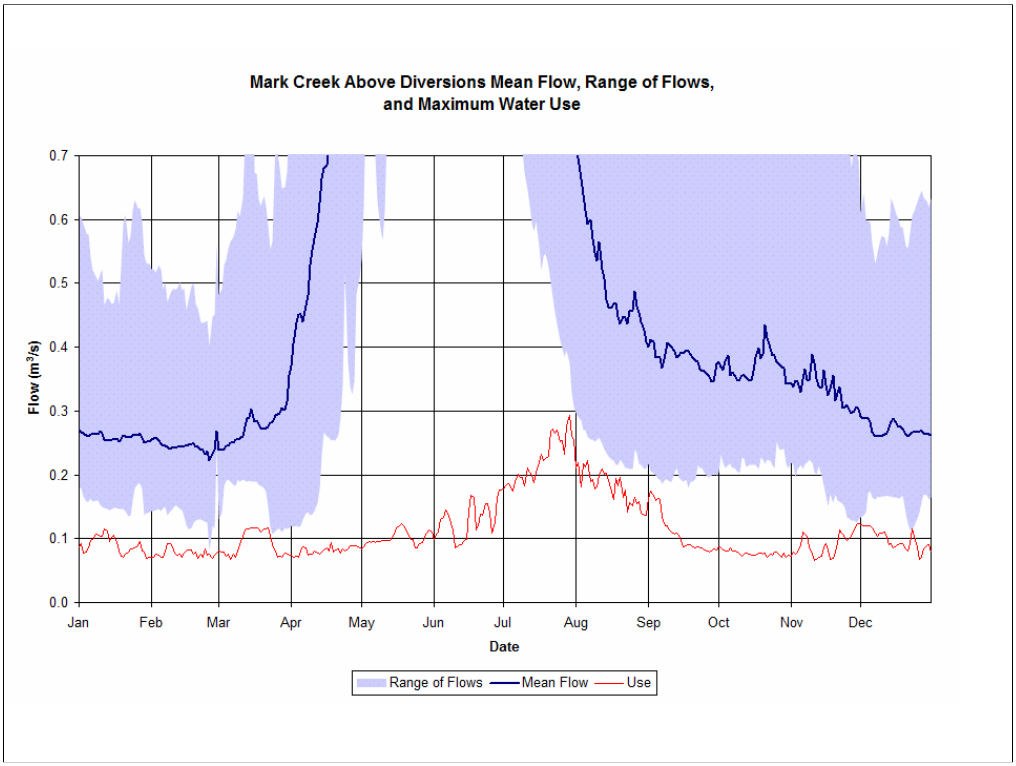
0.15 m^3/s optimum, 0.09 m^3/s minimum

Note that the minimum flow requirements are much higher than the flow through the riparian flow valve (which is approximately 0.02 m3/s). Unless there is significant flow over the top of the dam, these flow requirements are not currently being met.

These flow requirements are estimated values from the Ministry of Environment. In order to determine better estimates for the minimum flow required, a more detailed study can be done of the reach by a biologist.

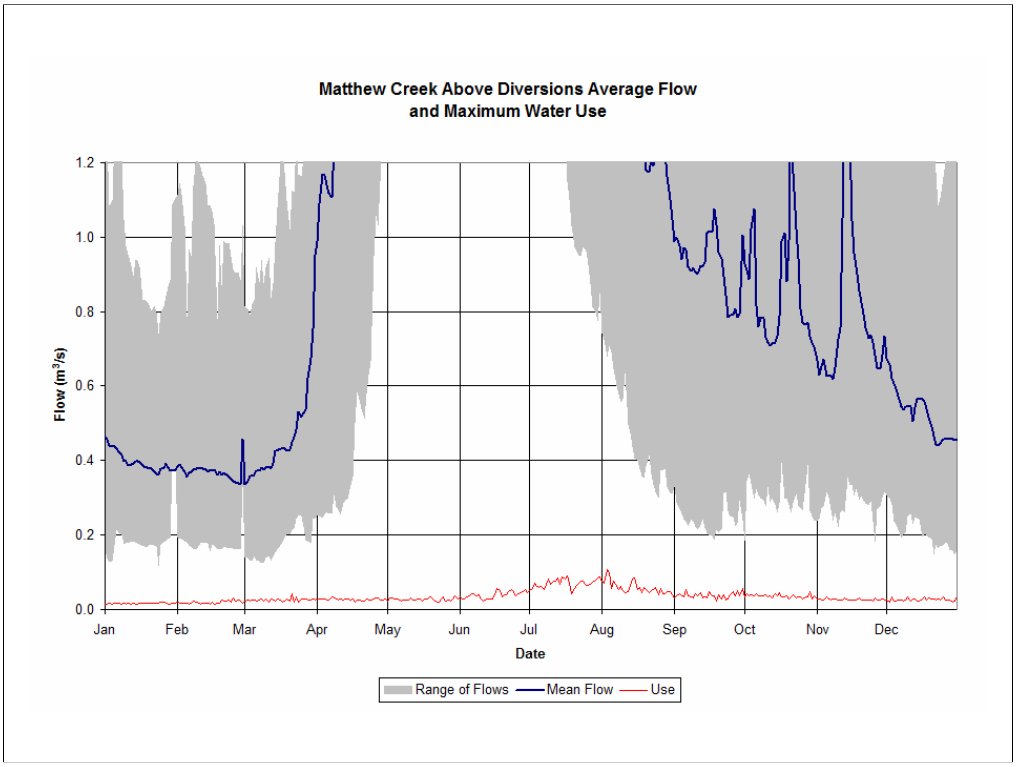
Wildsight commissioned a study of the fish population in Mark Creek from Interior Reforestation in 2001. They reported concerns about minimum water depths in the winter "bordering on resulting in fish mortality" in the reach. They recommend that a more detailed study be undertaken to determine the critical water depths for overwintering habitat.

There are flows into the reach, including one 400m below the dam, but they are relatively small. We don't have any actual data to say how much water they provide, nor does the City of Kimberley. We do know, from flow records provided by TeckCominco for Mark Creek at Kimberley (on Gerry Sorenson Way), that the flow when Mark Creek reaches Kimberley is 0.09 ± 0.03 m^3/s greater than the calculated flow below the dam in low flow periods. We do know that there is some water entering the Mark Creek below the dam, but we don't know where it enters the creek. Clearly, more information is needed on this issue.



5 Low Flow analysis:

The graph above shows the two periods for which we are concerned that we may not have enough water to meet the needs of aquatic life and of water users. One period of concern is in the late summer (August 1st to September 15th) when flows in the creek are low, but water consumption for irrigation of lawns, etc. is high and the other is in the early winter (November 15 – January 15) when flows in the creek are low and water consumption can be high due to snowmaking. Both periods are visible on the graph where the red line, representing maximum recorded water use, approaches the blue area that shows the range of flows in the creek. Note that the period of high consumption shown in mid-March is not typical for the period (it is only present in 2005) and therefore doesn't merit particular concern for a long-term analysis. There are also reasonable concerns about the later winter period, but we have chosen to focus on the early winter period because of the greater threat of high water consumption during that period.

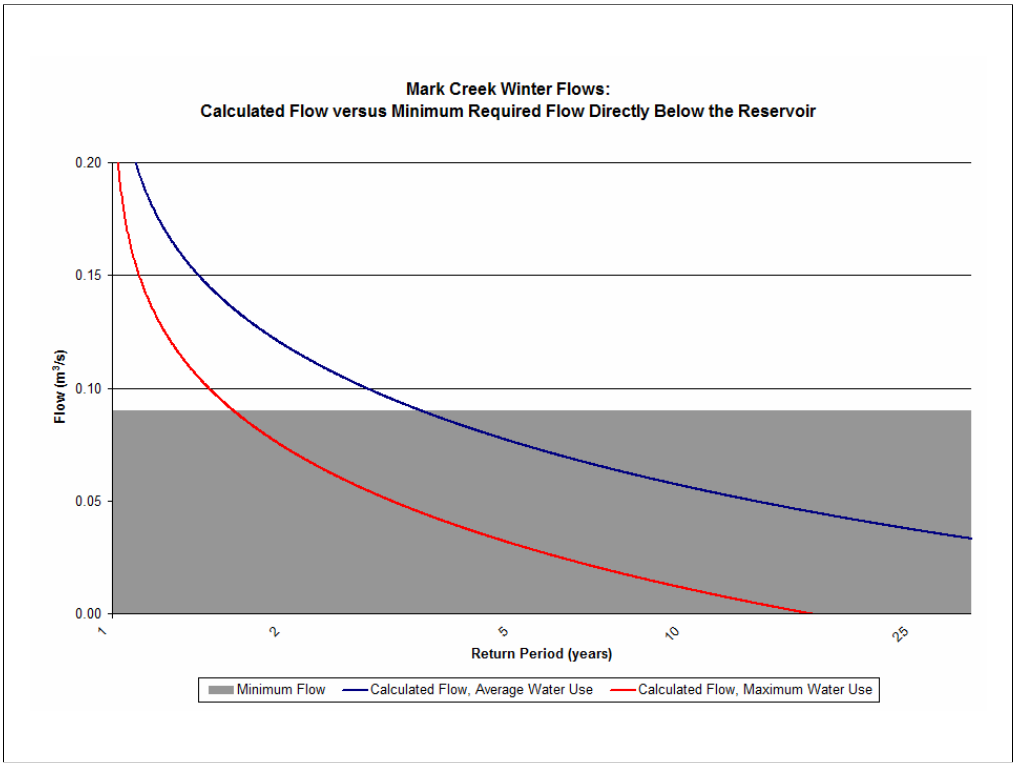


For Matthew Creek, water consumption is much lower than the flows in the creek, so there is no reason for concern.

Low flow frequency analysis

	Low Flow Return Period (years)	Daily Average Flow (m^3/s)	Monthly Average Flow (m^3/s)
Mark Creek (Winter)			
	2	0.20	0.24
	10	0.13	0.17
	25	0.11	0.15
Mark Creek (Summer)			
	2	0.28	0.38
	10	0.21	0.25
	25	0.19	0.22
Matthew Creek (Winter)			
	2	0.29	
	10	0.16	
	25	0.13	
Matthew Creek (Summer)			
	2	0.6	
	10	0.31	
	25	0.23	

The figures above are the results of a Log-Pearson III calculation of the predicted low flows for three different return periods. The return period indicates the average length of time between low flow events. For example, from the able above our prediction is that for Mark Creek, in the winter period, on average every 10 years, the flow will drop to 0.13m^3/s.

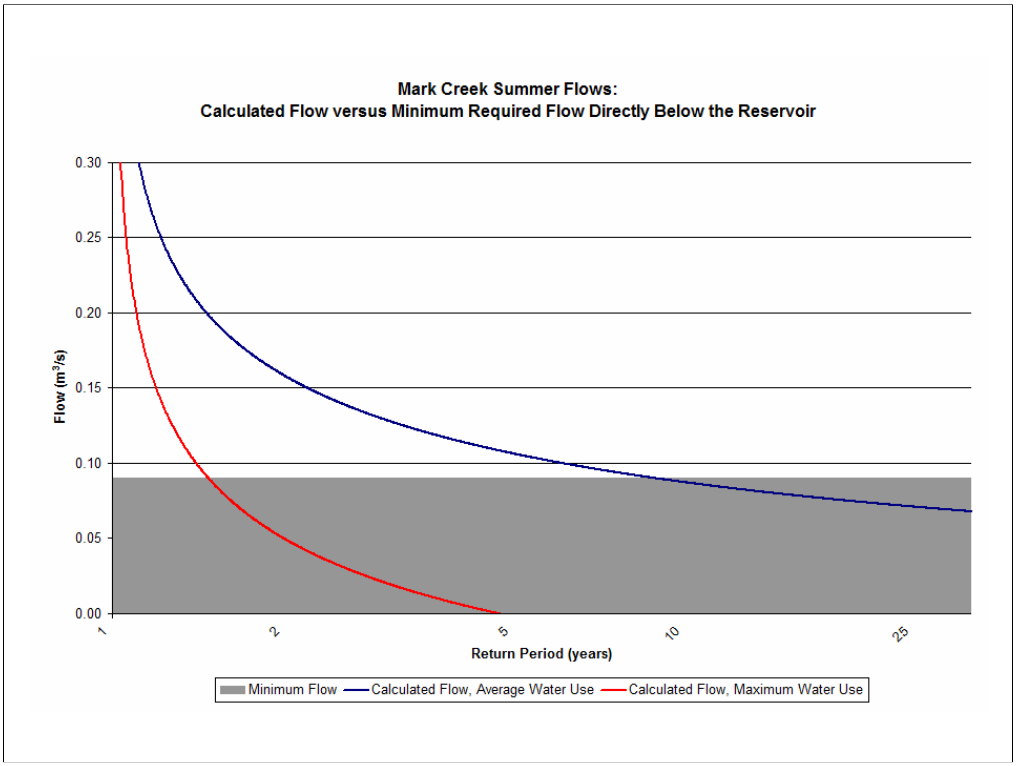


Limiting cases:

The graph above shows the case where the reservoir is not used at all, i.e. all water flowing out of the reservoir must be replaced by water flowing into the reservoir. This is the situation if flow is maintained over the top of the reservoir at all times (as is the aim of the City of Kimberley, to maintain water quality).

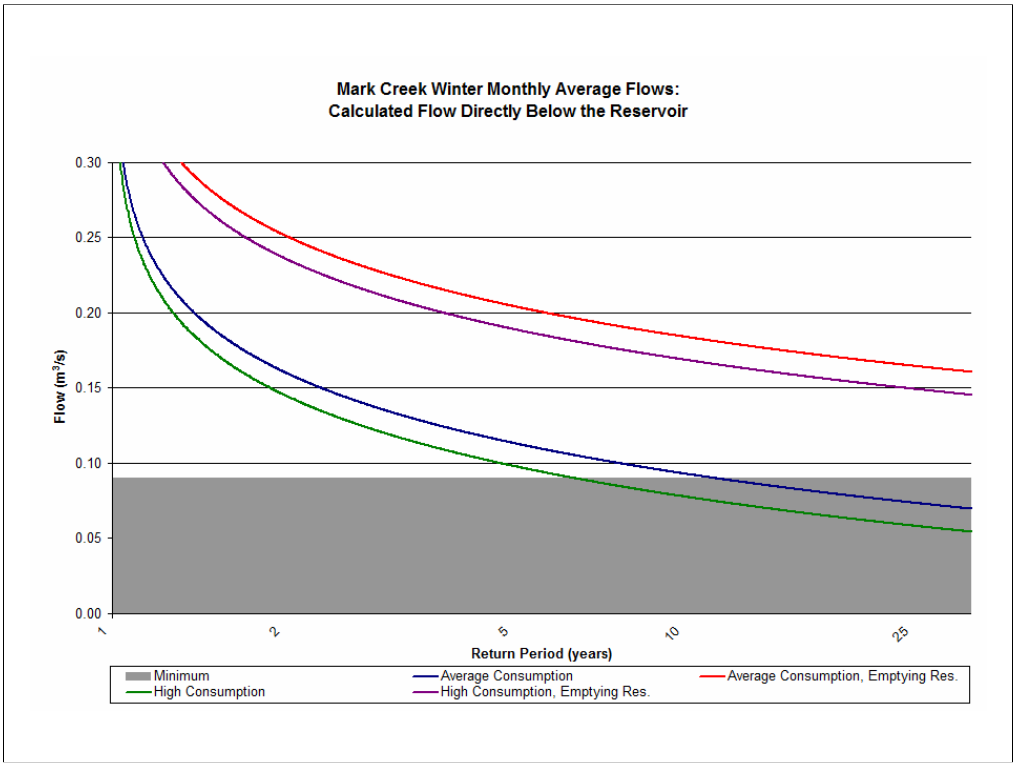
The grey area represents the minimum flow required for aquatic life downstream of the reservoir (0.09 m^3/s). The blue line represents the calculated flow downstream of the reservoir with average water consumption (the flow into the reservoir minus the average water use for the period). The x-axis is the return period. The red line is the same as the blue, but using maximum recorded water consumption.

We can see that on average every 3-4 years, there will not be enough water in the creek to meet the minimum flow requirements and the average water consumption in the city, while maintaining flow over the top of the dam.



This graph is the same as the previous one, except that it covers the summer period.

We can see that on average every 9 years, there will not be enough water in the creek to meet the minimum flow requirements and the average water consumption in the city, while maintaining flow over the top of the dam.

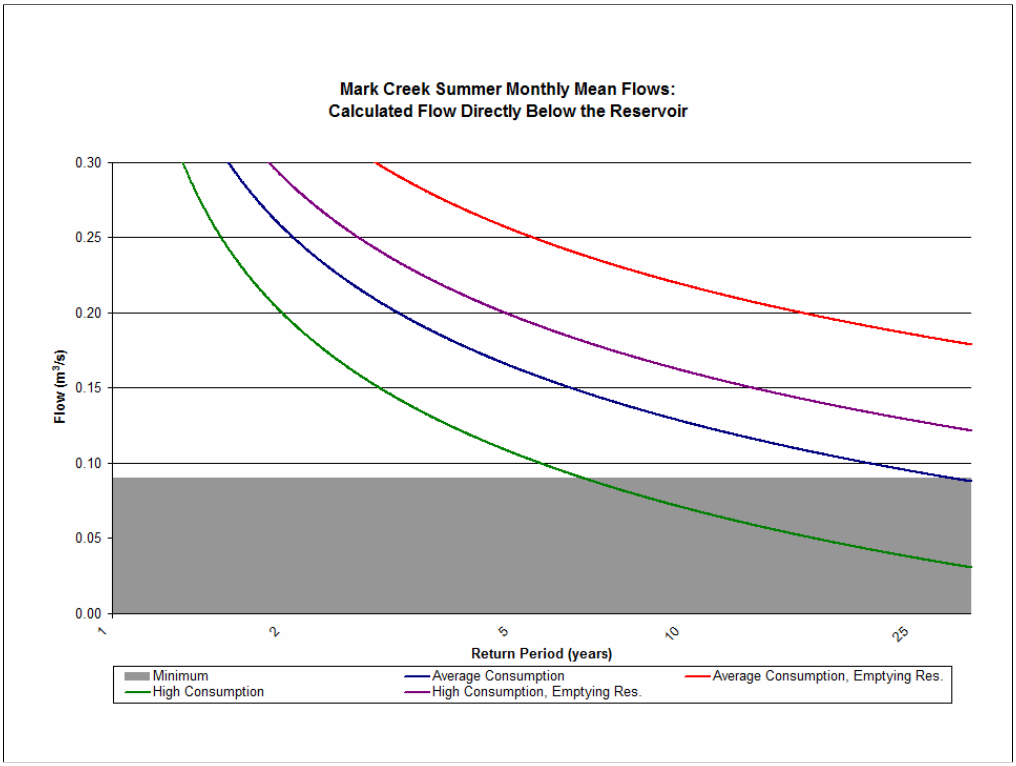


The graph above shows two cases: case 1, where the reservoir level is allowed to fluctuate over a month, but there is no net removal of water from the reservoir over the month, and case 2, where the reservoir is drawn down as much as is possible over one month. It is assumed in all cases that the reservoir will be managed so that flow downstream of the reservoir will be constant over the month.

Again, the grey area represents the minimum flow required for aquatic life downstream of the reservoir (0.09 m^3/s) and the x-axis is the return period. The blue line represents the calculated flow downstream of the reservoir with average water consumption in case 1 (fluctuating reservoir levels). The green line is the same as the blue, but using maximum recorded water consumption.

The red line represents the calculated flow downstream of the reservoir with average water consumption in case 2 (complete reservoir drawdown). The violet line is the same as the red, but using maximum recorded water consumption.

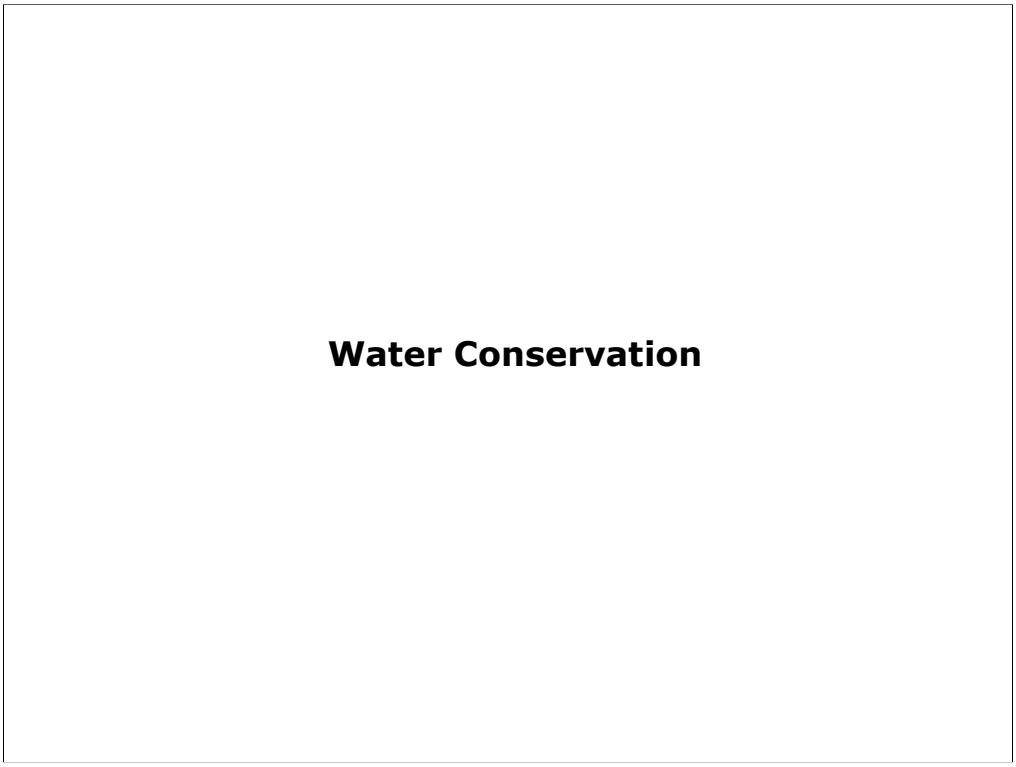
We can see that on average every 11 years, there will not be sufficient water in case 1 (fluctuating reservoir levels) to maintain the minimum flows downstream of the reservoir and supply water to meet average water consumption. On the other hand, in case 2 (complete reservoir drawdown), no shortfall is anticipated.



This graph is the same as the previous one, except that it covers the summer period. For the summer, potential shortfalls are less likely than the same cases in the winter.

However, the city has no policy on reservoir drawdown, so we don't know which of the scenarios we have analyzed represents the potential situation in drought conditions. We do know that the reservoir has been partially drawn down in the past (while the mine was still operating) and that some damage to the valve controls resulted due to ice movement resulting from falling water levels.

We currently enjoy high water quality in Kimberley, but we have been told by the City of Kimberley's operations manager that water quality decreases whenever the reservoir is not full, i.e. whenever there is no flow over the top of the dam. However, we don't know how much water quality is affected if the reservoir is not full, nor what the effect of lengthy periods without overflow or low reservoir levels would be.



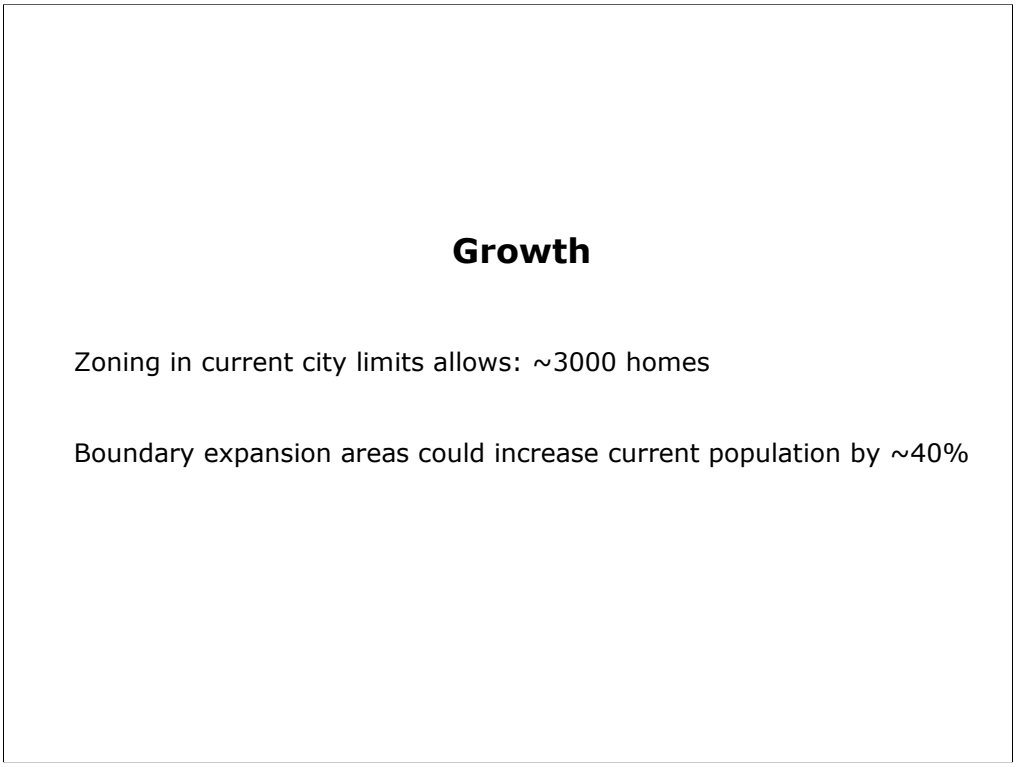
6 Water Conservation Measures

There are many possibilities for water conservation in Kimberley and Wildsight would like to see more water conservation measures in place.

We currently have voluntary outdoor sprinkling restrictions that recommend against watering during the heat of the day. Stricter watering restrictions and other water conservation measures could do a lot to reduce water demand during the summer.

However, as we have seen, the winter period is of greater concern than the summer period. Restrictions on watering don't have any effect on water demand in the winter, so other water conservation measures would be required to reduce demand in the winter.

We should note, however, that on a day when there is a lot of snow making, half the water used in Kimberley is used by the ski hill (over the winter period of concern, 17% of total water consumption is due to the ski hill). If snow-making demand could be reduced or eliminated, there would be more water left for aquatic life and for other water users during winter low-flow periods. We don't need to use drinking water to make snow on the ski hill. Resorts of the Canadian Rockies could use stored water (either from run-off in the spring and summer or from higher flow periods on Mark Creek) or they could use water from Matthew Creek to make snow.



7 Growth, Future Concerns, and Plans

Note that while many of 3000 homes currently allowed inside city limits would be in the Forest Crowne area, which will eventually use water from Matthew Creek, but there is also the possibility of further development at the ski hill, in the Lois Creek area, and in the downtown area, as well as the possibility of higher density in current residential areas. The proposed boundary expansion areas could increase the current population by about 40% (assuming all planned homes are built and occupied by an average of 2.4 people per home). We currently have the potential to significantly increase the population of Kimberley and the proposed boundary expansion would allow an even greater potential increase in population.

Obviously, a greater population means higher water consumption. However, our analysis is currently complex enough and adding a few different potential growth cases would make it too complex and too hypothetical to be useful. If we are able to find out what the City of Kimberley's reservoir management plan is, then we can make some predictions based on that plan. At the moment, all that we can say is that future growth has the potential to make the scenarios that we saw above significantly worse.

Finally, we know that there is a lot of available surface water in the area that we could use if we exceed the capacity of Mark Creek. Matthew Creek would be one of the obvious possibilities, but there would be significant infrastructure and ongoing costs to bring Matthew Creek water to Kimberley, which would require pumping as the Matthew Creek water intake is lower than water users in Kimberley.

Future Flow Trends

There are two potential environmental effects on future flows in Mark Creek. One is due to tree pine beetle tree mortality and related salvage logging in the Mark Creek watershed. In short, when there are fewer trees in the watershed, the moisture holding capacity of the land in the watershed decreases. When rain falls in the watershed, it will run off the slopes and into the Mark Creek faster than it has previously, which will mean that less water will be stored and slowly released. This means that summer lows will likely be lower.

Wildsight is currently working with a group from the UBC Institute for Resources, Environment and Sustainability on a study of the effect of the pine beetle on stream flows in the area, but we don't have any results from that study yet.

In the longer term, climate change could also effect Mark Creek flows. Two changes may be significant: hotter, drier, summers may results in lower late summer flows, and warmer, wetter, and possibly rainier winters may result in higher early winter flows. There is also the possibility that demand for water for irrigation of lawns could increase in hotter, drier summers as well.

However, these effects on future flows are less immediate and likely less significant than the more immediate effects on water demand due to population growth.

Recommendations

Wildsight Kimberley/Cranbrook recommends that the City of Kimberley:

(1) Monitor and manage flows downstream of the Mark Creek reservoir to meet the minimum flow requirements in the *Integrated Watershed Management Plan*.
(2) Conduct an assessment of fish habitat downstream of the reservoir to develop more detailed minimum flow requirements for the protection of aquatic life.
(3) Develop a written policy to manage reservoir levels in low flow conditions while maintaining acceptable water quality.
(4) Implement more aggressive water conservation measures in order to be able to meet the minimum flow requirements with minimal drawdown of the reservoir.
(5) Develop and publish a long-term plan for water supply in Kimberley that lays out the advantages and disadvantages (including estimated costs) of future changes in water supply that may be brought about by growth, to help inform the public debate about future population growth and boundary expansions.
(6) Begin discussions with Resorts of the Canadian Rockies to reduce the high water demand placed on the Mark Creek system by the Kimberley Alpine Resort during low flow periods.

8 Recommendations for the City of Kimberley

More detail, as well as references, is available in our report with the same title. You can find it on the Wildsight website:
http://www.wildsight.ca/news/kimberleywaterstudy