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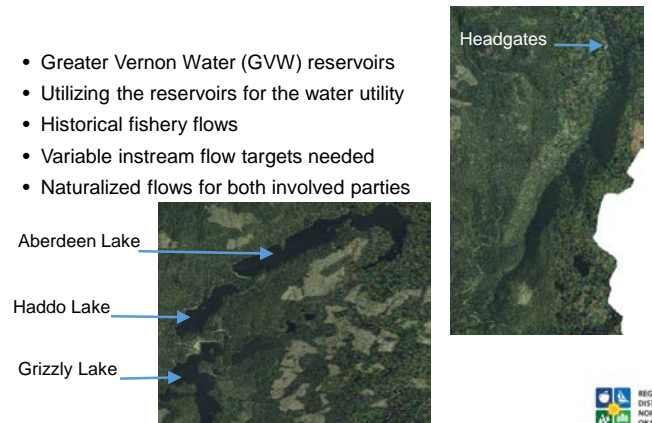
# A Practical Application of EFNs

The development and  
application of EFNs by  
Greater Vernon Water

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## Background

- Greater Vernon Water (GVW) reservoirs
- Utilizing the reservoirs for the water utility
- Historical fishery flows
- Variable instream flow targets needed
- Naturalized flows for both involved parties




Aberdeen Lake

Haddo Lake

Grizzly Lake

Headgates



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Greater Vernon Water (GVW) is a regional water utility that supplies drinking water to over 55,000 customers in addition to supplying water for agricultural purposes. GVW utilizes three reservoirs in the Duteau Creek watershed: Grizzly, Aberdeen, and Haddo Lakes. These reservoirs fill most years. Reservoir management focuses on utilizing each reservoir and matching released water to downstream requirements.



The outlet of Haddo reservoir marks the start of Duteau creek which feeds down to the Headgates pond. Headgates dam contains the intake to the GVW diversion that supplies water to GVW. The reservoir at Headgates is a small balancing reservoir with one to two hours of storage during peak demand.

Historic fisheries flow releases into Duteau Creek below Headgates Dam were prescribed by the Fisheries and Oceans Canada in 1978. Bessette Creek has been of high concern in regards to low flows and instream ramping rates for fisheries since at least 1995, with Duteau Creek being a significant tributary to Bessette. In 2010, Ministry of Forests, Lands, Natural Resource Operations & Rural Development (MFLNRORD) initiated a three year hydrologic assessment/study for the Bessette Creek and main tributaries. The study concluded that there was a need for variable flow targets that more closely represent naturalized flows that worked for the water supply utility and fishery flow targets.

There are several water users in the Bessette Creek water basin, not just the GVW utility. We understand there are larger water constraint issues occurring in this watershed than only our utility but this presentation will focus on it from a GVW prospective. The fishery department's overall goals are for the fish in Bessette Creek. GVW started working with MFLNRORD in 2011 make changes to improve fisheries flows but also have to ensure that our users have enough water for their needs.

## Fish Habitat

- Chinook and Coho salmon, rainbow trout and Kokanee
- Fish life stages
- Different water depth and velocity requirements
- Spring spawning
- Sudden flow decrease
- Historical fishery flows adjustments

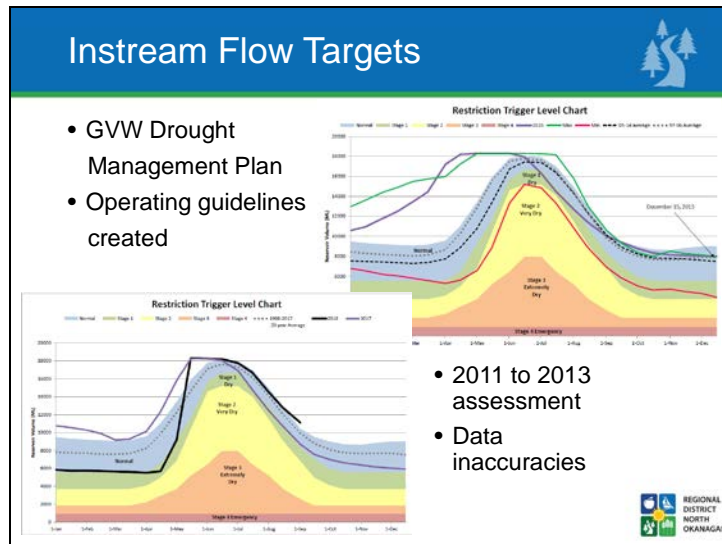


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Fish species that are the focus in this area are Chinook and Coho salmon, rainbow trout, and Kokanee. The Bessette Creek is a very important habitat for these fish stocks and is a high priority for fish flow restoration. There are three important life stages which are; adult migration and spawning and juvenile rearing. Each of these fish species and their life stages have different water depth and velocity requirements.

Abrupt changes to flow volumes can affect spawning and cause fish kills. Rainbow trout spawn in the spring so freshet is an important time for this species. The fish wait downstream until the water reaches the criteria they need and then they head upstream and spawn. During the spawning time if flows decrease suddenly and/or drastically, the fish can be trapped and die as they can't return downstream. Also if the stream level drops below where the spawning occurred it will cause death in the laid eggs.

With the historic fisheries flows, GVW only adjusted low level outlet at Headgates four times per year based on specific dates. A change was needed from the water utility and fisheries perspective to have a more fluid and reactive system in place to drive flow adjustments.

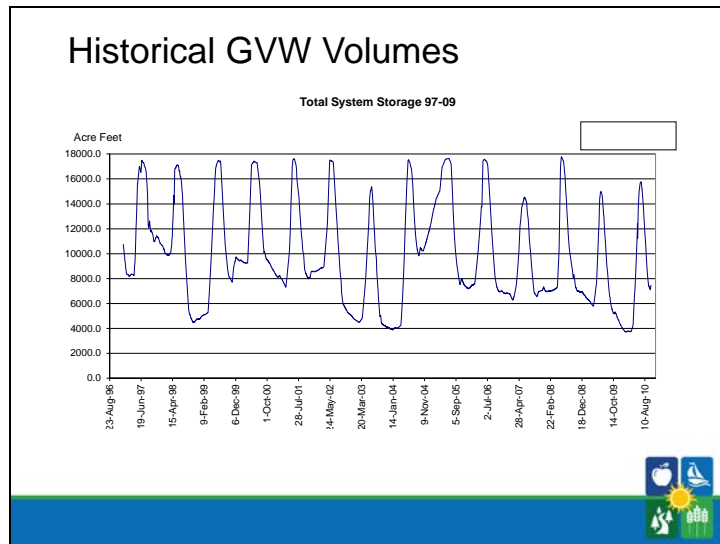


In-stream fishery flow targets were created that would vary based on water storage for Greater Vernon Water (GVW) and would work within GVW’s Drought Management Plan. The top right graph outlines 2015 (drought year) reservoir volumes. 2015 freshet occurred earlier than normal and also stopped spilling early which caused GVW to start using storage earlier than normal. This was a very dry year when the province was in Stage 4 but we were able to limit the impact to our customers due to our reservoir management. The lower left corner graph shows 2017 and 2018 water volumes. Compared to 2017, 2018 storage levels were very low at the start of the year and GVW relied on the storage being replenished by snow and rain. The rain luckily occurred in May 2018.

Operating guidelines were created to help water utility operations attempt to meet fishery targets without unduly risking the water supply available for consumption. These targets were created after an extensive environmental flows and hydrologic assessment was completed for the Bessette Creek watershed which Duteau Creek is a tributary of.

The data needed to create the instream flow targets was hard to acquire as much of it was unavailable, short term, or of questionable precision. One result of this process is that GVW is working on increasing and improving its data collection.

Data from studies performed on nearby watersheds for MFLNRORD were used to calculate the naturalized flows for Duteau Creek Watershed and consequently predict undammed lower Duteau Creek flows. Due to the relatively high RDNO water usage compared to upper lakes storage volume the proposed changes to flows released for fisheries purposes is a more complex issue than it is on nearby dammed watersheds.






The GVW water utility is relatively unique in that we utilize a large portion of our storage every year; whereas most other utilities that this study compared to had large volumes of storage. Most utilities divert water for use and the excess goes to fish. Our system has historically been viewed as diverting some water for fish, while the majority goes to GVW water use. Also separating us from other utilities is the fact that our reservoirs do not hold a large volume of water in comparison to the volumes that come from the entire watershed.

It was determined by the parties involved that a guideline to vary the fishery flow requirements was needed. Typically a real-time flow monitoring station that closely mimics the stream in question can be used. There was only one such station available located in Nobel Canyon on Coldstream Creek which is in a different watershed but daily runoff patterns are not closely enough related to Duteau Creek to be able to use as a surrogate. It was decided an alternate method would be used which would utilize water availability stages to vary environmental flow targets. GVW already had Trigger Factors implemented to determine water supply status based on the Drought Management Plan mentioned previously. These are based on total storage volume in the three reservoirs and there are 5 stages that are based on criteria outlined in the GVW's Drought Management Plan: Normal, Stage 1, Stage 2, Stage 3, and Stage 4, with both Normal and Stage 1 occurring the most frequently. A Stage 1A was created as well which allowed GVW to reduce fishery flows before they would impact our utility flows. This was decided early on in the project as fisheries wanted to collaborate with us and work with our limited storage volumes.

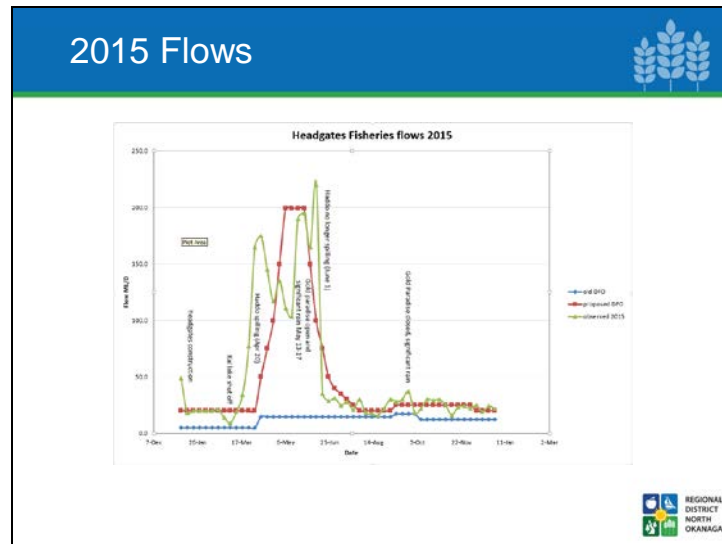
## Implementation

- New fishery target flows since 2015
- Working target
- Mimic naturalized flows
- Flow ramp up and down



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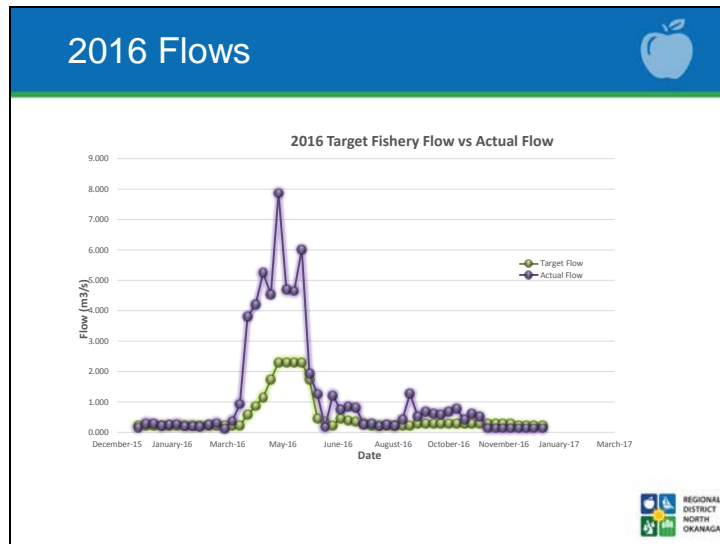
The GVW utility has been working with the new customized fishery target flows since 2015. It is very much a working target as some parts are not feasible at this time. The goal of the new fishery target flows was to more closely mimic what the creek would do without any manmade infrastructure in place to impact the timing and volume of flows. A high priority for fisheries was the gradual increasing and decreasing of flows around freshet events. Dammed systems can create a fill event followed by a sudden and dramatic spill event whereas a natural system would gradually scour the downstream channel. GVW started to make changes to water release rates prior to freshet a couple of years before the implementation of the new fisheries flow as it was found that this change also benefits the water utility as it decreases the high turbidity events observed at the intake downstream at Headgates.



The first year of collecting data and attempting to meet proposed fisheries flows was successful at times and unsuccessful quite often. Difficulties of measuring creek flow and storage (for most of the year) plus having a drought year with concerns of wasting too much water contributed to some of the flow control issues. As can be seen by the graph, huge fluctuations in flow can occur with little to no operational control, such as during spill events. In 2015 the initial flows as spill started to occur did not meet the new proposed flows and were earlier than most years. If an attempt was made to meet proposed flow during early freshet all water would have to be directed through the Haddo low level outlet and create a situation where there could possibly have been no spill until the last weeks of May when significant rain and melt occurred. It is entirely possible to open Haddo low level outlet more during spill to reduce the fluctuations on the low side especially if Grizzly and Aberdeen are currently spilling. This was decided to be an operational change in the coming years as the new SCADA lake levels would allow for this to be determined. Having Haddo opened more during freshet will also allow for a smoother transition to the lower June fisheries flows.

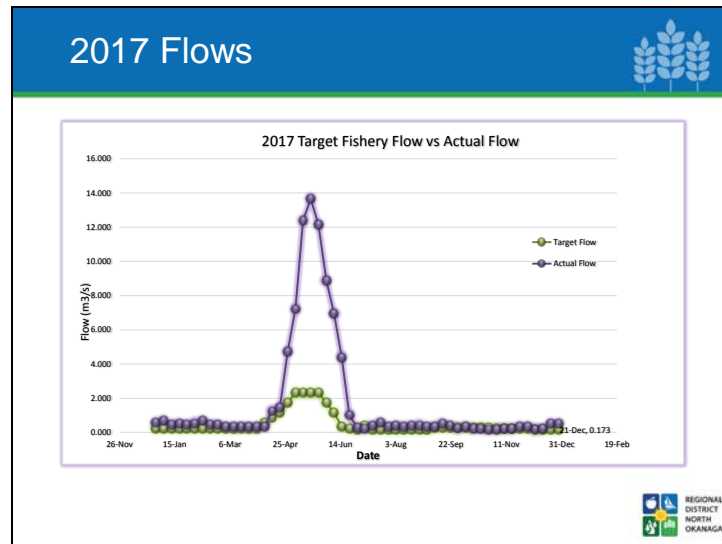
Rain events (not all shown in the graph) and operation issues caused a fair bit of fluctuations as well. Depending on the length of a rain event gate adjustments at Haddo were often minimized so as to avoid low flow conditions once the event ended. Operational issues such as having GVW's other major source being taken offline without notice created a period of low flows as Haddo gate adjustments have to be made after the fact. Having actual flows associated with the gate position should aid in reducing flow fluctuations due to operational issues.

For most of the 2015 year the scour flow was set to meet the old fisheries flows to maintain a minimum flow whenever Headgates was not spilling.

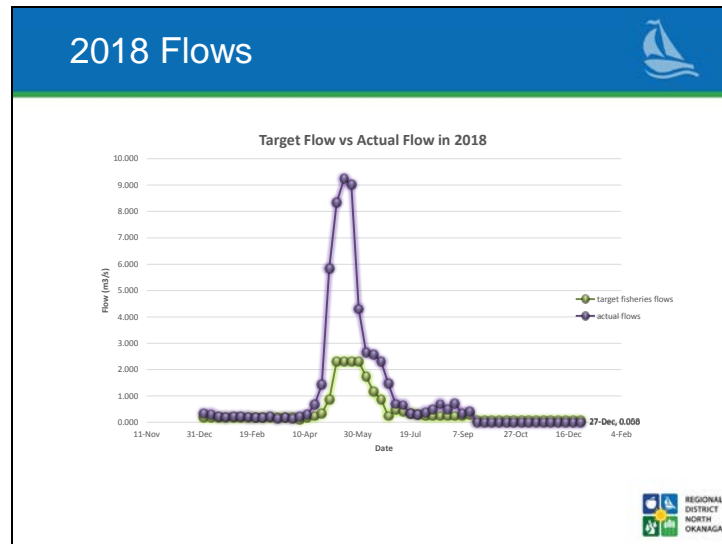


In 2016, you can see that the actual flow curve was smoother compared to 2015 with fewer sharp decreases or increases. The peak flow was in May at almost 8000 m<sup>3</sup>/s.

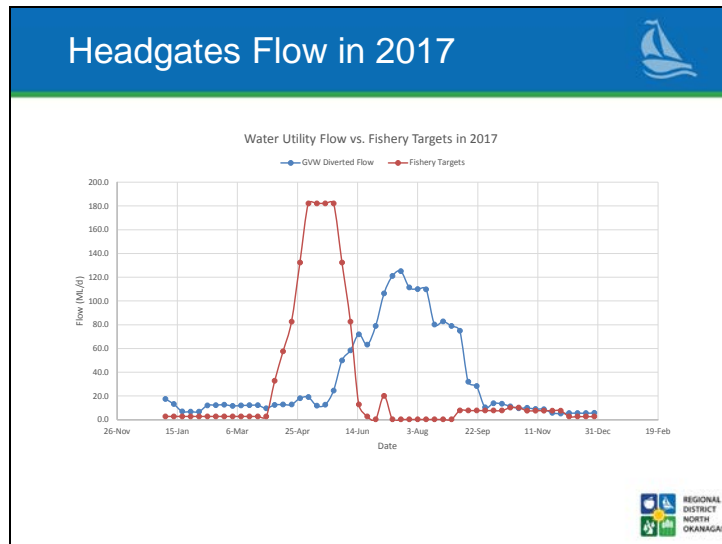




In 2017, the actual flow was better than 2016 without any sudden sharp decreases or increases. This was a very wet spring though, with a very dry summer. The peak flow was also in May but reached almost 14, 000 m<sup>3</sup>/s, one of the highest flows at Headgates we have on record. There is also a slight ramping up and down for freshet.



In 2018, you can see when we start to gradually ramp up before spill and then try to gradually ramp back down as freshet spill ends. The peak flow was again in May at just over 9000 m<sup>3</sup>/s.





This graph outlines the fishery targets compared to the GVW diverted flows in 2017. It gives a good visual of the peak target flow required for fisheries during freshet and the remainder of the year the utility uses the bulk of the water.

GVW used to only manage for peak water use for the irrigation season but now manages for two peak flow needs at different times of the year, spring high flow targets for fisheries and peak flows for GVW during the irrigation season (usually May/June until September). Changes to flow are made for most of the year based on supplying the water utility needs. Providing fisheries flows is a requirement and a priority, however there are other constraints GVW has to work within as well.

## Challenges

- Lack of real time data
- Old infrastructure
- Historic flow curves inaccurate
- GVW flow demand fluctuations
- Distance from Haddo outflow to Headgates inflow



Some of the difficulties in achieving the new fisheries flow targets were related to the lack of real time data currently collected within the Duteau Creek watershed at the start of this program. Old infrastructure also contributed to the unreliability of data collection. For example, spillway construction at Headgates and the Haddo weir is not correct to provide reliable data (see pictures of Haddo Weir overflowing). Historic flow curves are inaccurate as well so there is not 100% confidence in the data collected. Some upgrades were completed to help operations manage the flows and there are other improvements proposed for the future that should make the new targets more attainable (at least on wet years).



The spill level at Headgates pond as it compares to flow is not very accurate. The observed flow over the spillway sill is not uniform and the historic flow curve appears to be off by 35%. The spill level is currently measured inside the intake screen building which is influenced by GVW flow demand creating lower lake readings during periods of high demand. There is currently no real time measurement of the flow through the scour pipe; therefore it is only adjusted 4 times a year to ensure a minimum fisheries flow requirement.

Scour flow remains an estimate without a proper weir to measure flow. GVW is working towards installing a proper measurement for both the spill and scour at Headgates.

We have no control between Haddo outflow and Headgates inflow, so water released from Haddo can be quite variable dependent on weather events.

## Solutions

- Aberdeen and Grizzly lake levels in real time
- Updated Haddo weir
- Flow reading added to SCADA in future





In 2015, Grizzly and Aberdeen lake level measuring was added to our SCADA system, which gave us real time information on all the upper lakes, making it possible to predict the overall storage level, as well as, fill rates or drawdown rates. The real time storage from the lakes makes it easier to achieve the new proposed fishery flows as we can now compare actual storage and filling to historical trends.

A more accurate Haddo weir plate was installed and the construction of higher wing walls has helped in making the water level reading from this station usable when ice is not present. GVW is moving towards data we are more confident in from this site but further work is still needed. We don't capture the highest flow events and don't have a confident flow curve for these high events.

## Lessons Learned


- Gradual increase and decrease of flows



When the upper lakes are close to filling (usually Grizzly first, followed by Aberdeen and then Haddo) extra water should be released in steps to allow for the stream between Haddo and Headgates pond to slowly be widened to minimize water quality concerns. In the years following 2015, prior to spill, operations opened Haddo gate more in order to reduce possible lower flow periods throughout freshet. A flow reading on SCADA is planned to be added in the coming years.

## Collaboration

- GVW strives to be a team player
- Thompson Okanagan Regional Drought and Response Team
- Fundamental part of local community




We realize that there are larger water constraints occurring in the watershed besides our needs. As a result of this project a collaboration has been formed between several government agencies during and since the implementation of this program. The RDNO team joined the Thompson Okanagan Regional Drought Response Team in 2018. This was an important collaboration to help us be aware of other needs in the Duteau watershed and surrounding areas. Participation with this group also makes GVW's information available to necessary players for drought management.

As GVW provides water to many different facets of the community including fruit growers, different crop growers, livestock, as well as households, it is an integral part of the culture in the Vernon area.

## Looking Forward

- Feedback after implementation of new flows
- Hydrometric station below Headgates
- Data sharing of real time information
- Increased confidence in Headgates data





GVW would like feedback from the government whether there has been any improvement downstream since the water utility implemented the new fishery flows. We have been told that the fishery department is complaint driven and there haven't been any complaints since we implemented the new flows but there is no data to determine if there has been a change. A hydrometric station downstream of Headgates would need to be upgraded to real time for fisheries to determine if flows have improved due to our operations. However, this station records other inflows besides just Headgates, so is not entirely reliable as an indicator of our changes.

It has been discussed that GVW could share data with fisheries from a different water quality station on Coldstream Creek. This project is a collaboration with GVW and MoE and is available in real time when the instruments are working. However, this station was buried in a sandbank during the 2017 freshet and was offline for most of the year. Fisheries would also like access to Headgates live data once we are confident in it. By 2020, we are hoping to have Headgates data that we are more confident in that we could discuss sharing with fisheries.



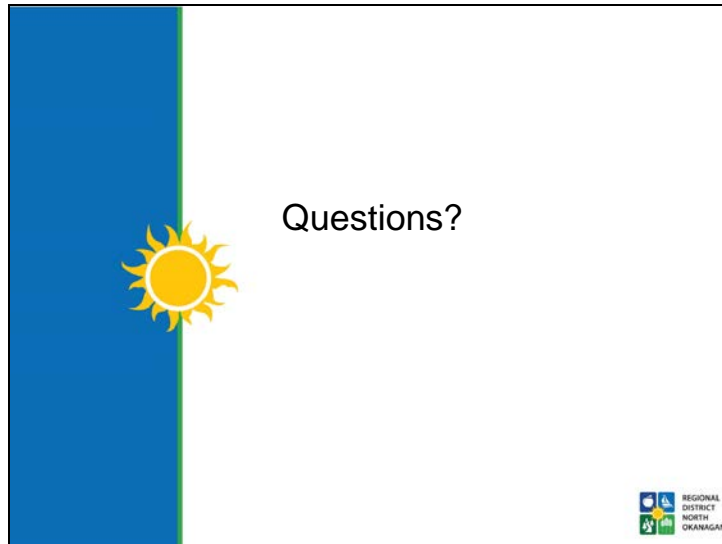
**Conclusion**

- More naturalized flows
- Challenges to meet targets
- Many components out of GVW control
- Collaboration is key!



To summarize; the goal for the new fishery targets was to have more natural flows with gradual ramping up and down for freshet.

GVW had several challenges with these new targets, some were resolved, some we are hoping will be resolved with current and future work plans, and a few challenges we don't have a solution for at this time. Many components in the watershed are outside of GVW's control. Collaboration has played a very important role in this project and will continue to have a high priority in the future. Some changes have been neutral to GVW and some changes have benefitted GVW. No changes have been negative other than having to invest in improved data collection and training operations staff. In the end, GVW will have a much better understanding of our resource while assisting in the better management of other resources. GVW believes that partnerships are key to the continual improvement of our utility and makes all involve more resilience to climate change.



Questions?

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