Chandos Lake Water Level Investigation Report

Feb 12, 2021

Contents

Acknowledgements and thanks to….

Iain Gorman and I took on the water level investigation project for the CLPOA. Iain is a great supporter of all things Chandos. He regularly explores Flat Creek in his trusty kayak with camera and has many great shots of the flora and fauna along Flat Creek. It is truly a remarkable place, flowing through a highly diverse wetland.

The Crowe Valley Conservation Authority (Tim Pidduck and Neil McConkey) have generously supplied data and background.

1 Executive Summary

This study investigates the subject of water level variations on Chandos Lake. Chandos Lake is in the northern part of Peterborough County, east of Apsley, Ontario. The following concerns are explored:

- High spring waters flooding
- High summer waters affecting shorelines
- Flood control measures at Paudash dam affecting Chandos Lake
- Beaver activity on Flat Creek
- Condition of Flat Creek and the Culverts

1.1 Summary of Findings

a) A review of **Historical data** collected by the Crowe Valley Conservation Authority has shown a gradual increase in average water levels (May-Nov) over the last 20 years, of about 2 feet. See **Figure 5 Historical Chandos Lake Water levels**

b) **High spring waters** after Ice-Out are a natural phenomenon, and although we have had some very recent high waters, the historical reality is that this does occur from time to time.

c) Typically, there is a drop-off in **Summer Levels**, but in recent years this drop-off has been decreasing. See **Figure 7 Comparison of Lake levels**

d) Chandos Lake is essentially a reservoir for the Crowe River, and the primary purpose of the Paudash Dam, apart from regulating the levels of that lake, is to mitigate flood events along the Crowe River. This means that the operational control of the Paudash dam does not consider the impact on Chandos Lake. *(and it may have an insignificant effect - we won't know until we can obtain or estimate flows)* To see what the CVCA is up against flood-wise in the spring, see the 2016 youtube video https://www.youtube.com/watch?v=ROqs3hagT5M

e) Flat Creek essentially flows through a large wetland, which has the capacity to store large amounts of water. It is a natural home to beavers. The dams continually get washed away and the beavers continually come back. It is virtually impossible for them to seriously dam the creek as the land is so flat that the water can find a way around. The real problem with the beavers seems to be that the dams cause the buildup of silt, which along with abandoned dams, restricts the flow of water out of Chandos Lake, thereby helping keep low summer levels high. However, the beavers are here to stay.

f) There is a buildup of silt and debris in the Hwy 620 Flat Creek culverts that to an unknown, but probably to a significant extent, is restricting the flow out of Chandos Lake. (**Figure 3**)

1.2 Summary of Recommendations:

1. Verify the calibration of existing gauges.

2. Replace/upgrade/relocate the gauge at the culverts to a bi-directional flow and level gauge with remote real time monitoring and data collection.

3. If possible, install a level and flow gauge on the Crowe River somewhere near the confluence with Flat Creek. (the confluence is "swampy", and access is poor so this may well be impractical)

4. Remediate Flat Creek to the extent that it can be a navigable (for canoes) waterway, removing non-active obstructions (deadfall, silt, long-abandoned beaver dams). Leave the beavers and the active dams, lodges, etc, alone.

5. Establish desired maximum/minimum range for lake levels, and explore with the CVCA how the operational practice of the Paudash dam might help keep Chandos lake levels within these bounds, whilst still achieving the CVCA's downstream flood control goals. The proposed gauge near the confluence would be useful in determining the release of water from Paudash Lake. The proposed upgrade of the gauge at the culverts (to include bi-directional flow) would help us determine how much of the Chandos spring level rise was actually due to water coming from the Crowe.

6. A flood plain mapping exercise is **not recommended** at this time, as the shoreline is essentially fully built up, with the only outcomes perhaps being

negative ramifications on insurability and property values.

7. *The culverts have silted up by about 4' since their installation in early 1960's. At this time there is* ***no recommendation*** *to reduce the silt level because there is not enough certainty about the outcome, and there may well be unintended consequences. Indeed by many, the avoidance of low summer levels is seen as a positive outcome from this silt buildup.*

2 Background

Chandos Lake is in the Crowe Valley watershed, and as such is under the authority of the Crowe River Valley Conservation Authority (CVCA). The Chandos outlet, Flat Creek, connects the lake to the Crowe River.

The CVCA has various water control structures throughout the Crowe Valley, including the dam upstream of Flat Creek at Paudash Lake, where the Crowe originates. These are used to control flooding along the Crowe. Chandos Lake is an unregulated lake (ie no dams), and in fact is a flood reservoir for the Crowe River - a convenient place to store excess Crowe River water during the spring freshet.

3 Area Map

Figure 1 is a topo map of the area showing Chandos Lake, Flat Creek and the Crowe River:

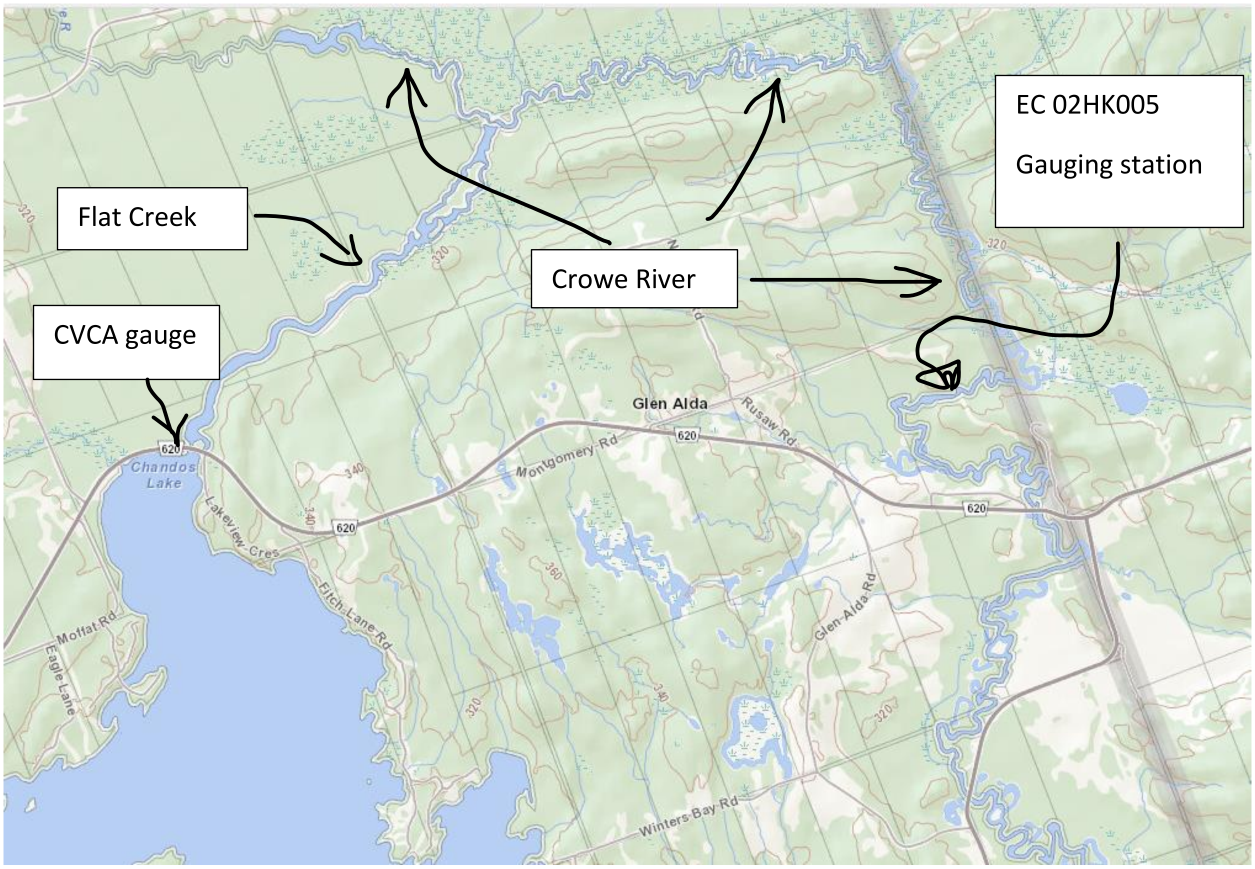

Figure 1 Flat Creek TOPO Map

4 Measuring Lake Levels

Some data is reported in SI units, and some in Imperial units. Both will be found in this report. Where possible, however, we have decided to go with Imperial units, and express lake levels in decimal feet. Somehow for this subject, “feet” seems to bring everything to a “human” scale.

Historical recorded lake extremes have been 1023 feet (311.81m) and 1029 feet (313.64m) above sea level (ASL). Typically, in any given year, the variation from the spring-high to the fall-low is in the order of 2-3 feet.

We have 3 sources of level measurement:

i) The CVCA gauge located at the culverts, calibrated to a known iron bar benchmark. This data has been collected since 1959, but has gaps, and at times is suspect, especially the extreme highs.
ii) the CLPOA stick gauge in South Bay calibrated to the culvert benchmark. This gauge was only established in 2018, and thus has limited data.
iii) The Environment Canada gauge on the Crowe River north of Glen Alda.

4.1 The CVCA Gauge

The Crowe Lake Conservation Authority maintain a gauge at the culverts from which they can upload data remotely. They have graciously made their data available to us. It is calibrated to an iron bar south of the culverts that has an elevation of 1026.25' (312.8m). At times we have found that our South Bay stick gauge measurements can be a foot lower than the CVCA gauge. However, on June 14, 2019 the CVCA reported 312.863m ASL, and the South Bay stick gauge measured 312.8, so they agreed within a couple of inches, which is pretty good. So, the accuracy of measurements is a concern, and one of the major recommendations of this report is that the CLPOA have the calibrations of the various gauge points re-verified by a professional surveyor. The CVCA gauge cannot measure flow in both directions, which is a limitation considering that in the spring water flows into Chandos when there is great concern about high waters.

4.2 The CLPOA South Bay Gauge

This "stick" gauge was installed in 2018 on a rock face in South Bay, so data is only available from 2018 onwards.
When the twin culverts were installed around 1962, the horizontal centre-line was set at 1025' (312.42m) ASL. A benchmark was established on the top of the west culvert, south end, to be 1033.20' ASL.
This benchmark has been used to calibrate the South Bay gauge, and also to convert Iain Gorman's West Bay 2017 highwater mark to an ASL reading of 1027.7'.

4.3 The Environment Canada Gauge 02HK 005

This gauge is on the Crowe River just north of Glen Alda (44°50'42" N 77°55'46" W).

We can access this gauge in real time as well as look at historical data. This can be used to infer (poorly) the state of the Crowe River upstream at Flat Creek. What is really needed, however, is a gauge nearer the confluence of the Crowe and Flat Creek. The Glen Alda gauge is a level gauge that uses a stage-discharge model to calculate flow. As the waters here are about 8 feet lower than Chandos, and the intervening terrain is different, it is a very poor proxy for what is happening at the Crowe and Flat Creek confluence.

5 Factors affecting Lake Levels

A nominal level for Chandos Lake is 1025' (312.42m) above sea level. This is the elevation of the horizontal centre-line of the culverts at hwy 620. A desirable range for water levels for cottaging seems to be between 1024.5' and 1027 feet. (As of 1 Nov 2018, the level is about 1026')

By way of comparison, Paudash Lake, a regulated lake, is 100' higher in elevation, and has an annual water level fluctuation of about 20 inches.

The factors affecting the lake levels are:

i) The level of the Crowe at the Confluence
ii) The damming effects of the culvert silt and features along Flat Creek which come into prominence when the waters are low.
iii) The restrictive effects of the culverts and Flat Creek which slow the outflow. Under these conditions the lake level will rise until there is sufficient head to make the outflow equal to the inflow. (the "head" is the difference in height between the Crowe and the lake) In addition, as the levels rise, the resistance offered decreases, so it is a very dynamic situation.

5.1 Dynamic Equilibrium

As mentioned, the 3rd factor is a dynamic one. Water flows in from various sources and flows out at a rate based upon the resistance offered by the channel characteristics of Flat Creek (and the Culverts) and the height differential between the Lake and the Crowe. *The critical point is that the resistance offered by Flat Creek decreases as the waters rise. An equilibrium level is established once the outflow and inflow are equal. This equilibrium level will be higher the more the channel is constricted.*

Explanatory example of the Dynamic Equilibrium
(This is a much-simplified explanation, but should get the point across)

Assume the inflow water (cubic meters/sec) is constant all year around. Let us say it is 4 cubic metres/sec.

- *Assume at a level of 1024' Flat Creek can pass only 2 cubic metres/sec. Obviously, the lake level will rise, as not all the water entering Chandos can channel out.*
- *However, as waters do rise, the ability of Flat Creek to channel water increases because the cross-sectional area available to channel water increases.*
- *as the waters rise the head increases, and the resistance decreases. A point will then be reached where the input and output are equal, and this will be the level where the lake settles. Assume this is 1026'. (eg at 1026', Flat creek can channel 4 cubic metres/sec.)*
- *Note that similarly if in the spring the water starts at 1028 feet, and if at this level, the ability of Flat Creek to channel water was 6 cubic metres/sec, then the level would drop to 1026' where the equilibrium of 4 cubic metres is established.*

5.2 High Summer Levels

It is apparent from anecdotal evidence that the summer levels are higher than they used to be 20 years ago or so. Historically there would be a 20-24" drop over the summer, but in recent years the lake has been dropping less.

- If summer levels are remaining high, it is either because it is somewhat being dammed,
- And/or the impediments to outflow are such that a higher head of water in the lake is required to establish an equilibrium between inflow and outflow.
- The Crowe River at the confluence with Flat Creek is staying high.

5.3 Fall Draw Down

There is not the ability to actively draw-down Chandos in the fall. The best that can happen is that after the Paudash draw-down, that the Crowe drops to a level that will automatically lower Chandos. In order for this to occur, Flat Creek or the culverts must not offer obstruction to Chandos waters.

The fall draw-down is important as it provides more capacity to absorb the inflows of the next spring. And so high summer levels may begat high spring ones. However, recent modelling has indicated that a 1 foot of extra drawdown does not necessarily translate into an equivalent lower high spring water mark. This is a dynamic situation, and when the lake starts low, more water piles in from the Crowe. In addition, a lower starting level means it takes more time before Flat Creek can reverse, which means that more runoff will enter the lake before it can start to flow out. The following model derived graph shows this phenomenon.

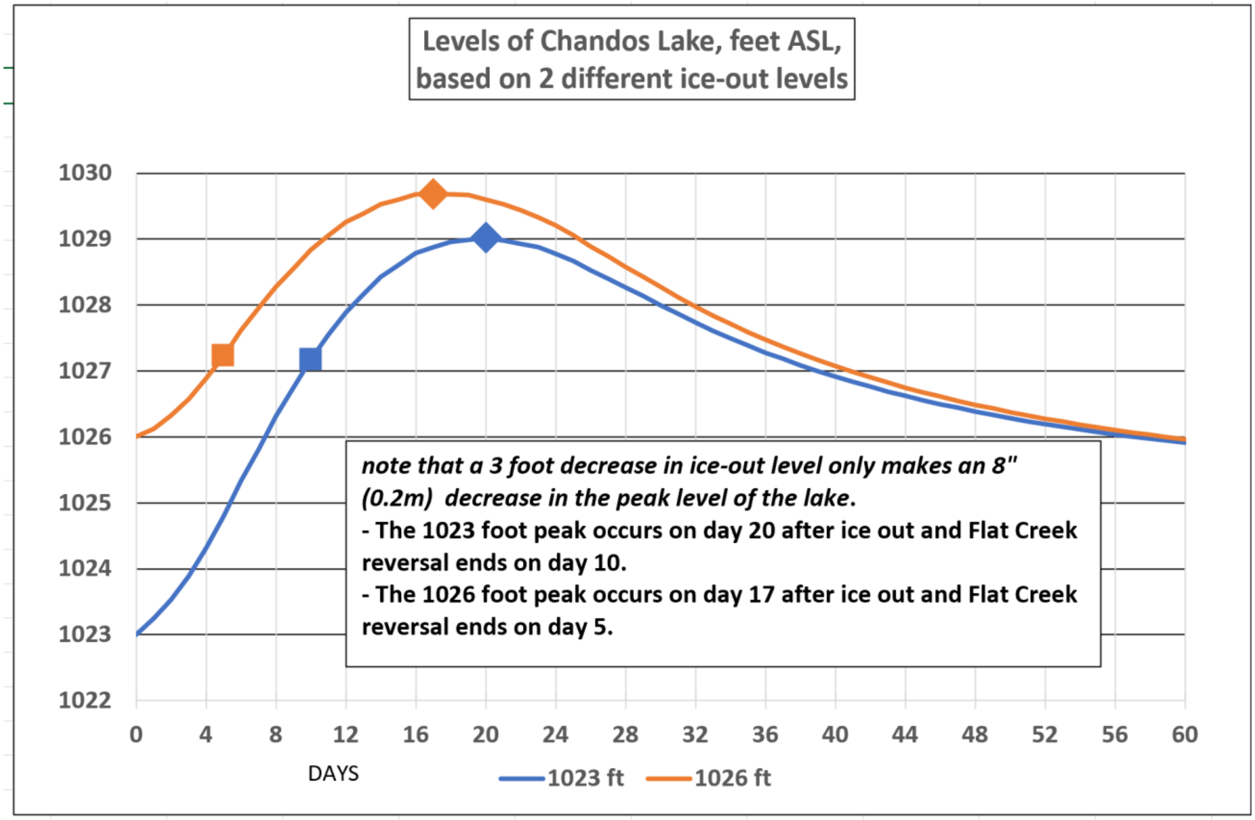

Figure 2 typical model output

It must be stated that a model is only as good as its assumptions and calibration, and that the modelling work is ongoing, so please take **Figure 2 typical model output** as preliminary.

5.4 High Spring Waters

The **high spring waters** are influenced by a number of factors, mainly runoff, rate of runoff, precipitation, and the reversal of Flat Creek.

Although high waters have been a recent concern, with 2019 being a recent high, the historical reality is that there have been many other springs with high waters after ice-out.

5.5 What is the condition at the culverts?

The twin culverts were installed around 1962. A recent investigation of the state of the culverts reveals that about 4' of silt and debris has accumulated. We do not know if the culverts were initially partially filled with rock or gravel, but if so, it would likely only have been to a foot or so. This silt build-up presents a serious restriction to the flow of water out of the lake.

However, it is important to state that we do not know the effect of remediating the culverts alone, as the condition of Flat Creek may be a more significant factor in constricting water flow and thus determining lake levels. (Or it could make a dramatic difference!).

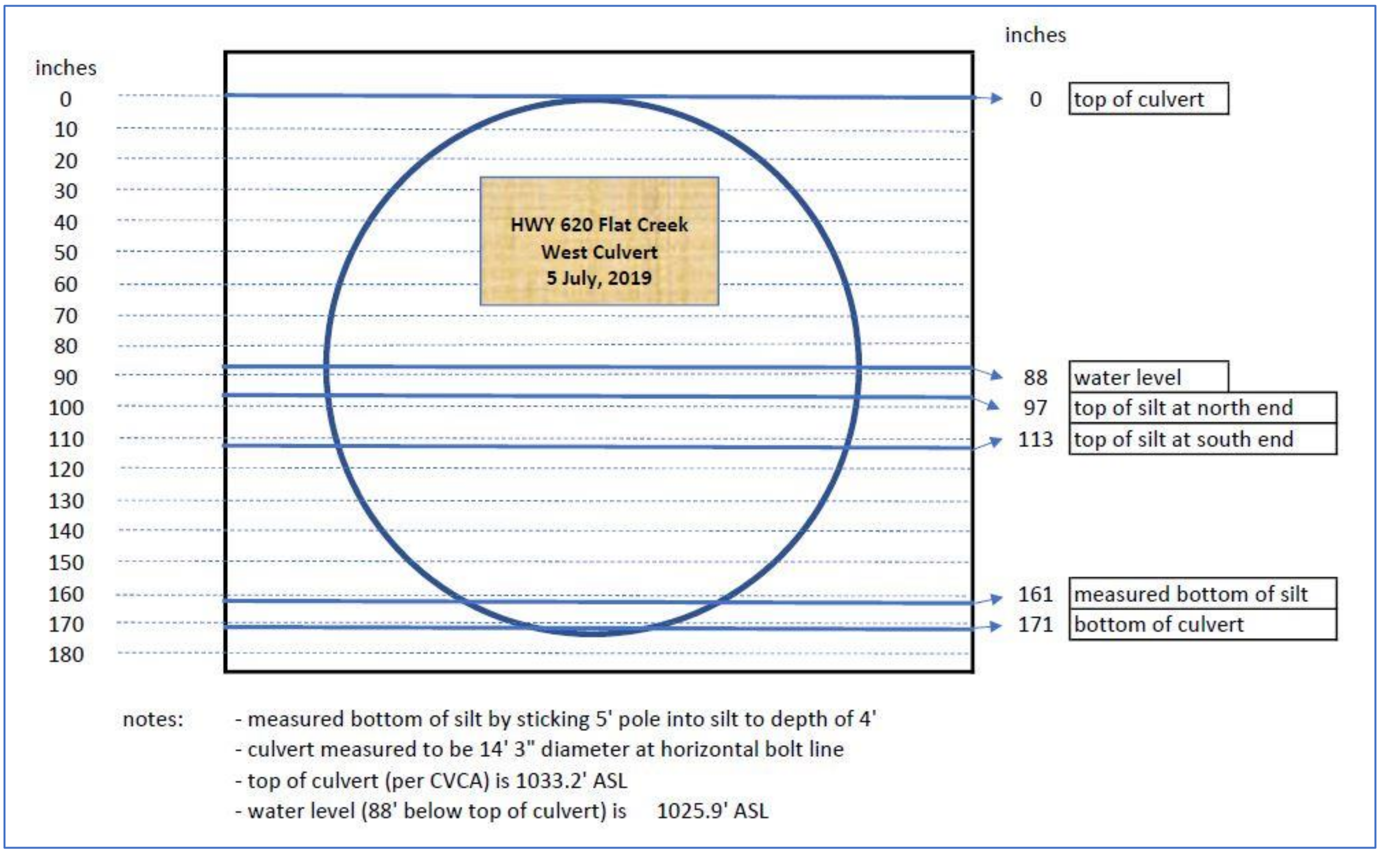

Figure 3 West Culvert Silt Condition

5.6 Low Summer Waters

We have not had this problem in recent years, but at one point there was consideration given to placing a dam at the culverts to keep the summer waters from falling too low. See the report excerpt below. (**Figure 4**)

A stop-log dam type of structure at the culverts was considered for Chandos lake in the Crowe Valley Conservation Report of 1963 issued by the Department of Lands and Forests. (**Figure 4**). Note that they were as much concerned 50-60 years ago with low lake levels as we are today with high summer waters.

(A dam at the culverts was never carried through with; It is believed that this was because it would have eliminated Chandos as a Crowe River reservoir, thereby compounding flooding problems downstream.)

(In the 1950's-60's the Ontario government was busy putting water control structures everywhere to avoid the terrible floods experiences with Hurricane Hazel, and other drastic flood events)

Please note that the reference in the excerpt to hwy 504 was from when 504 circumnavigated the lake. The northern portion from Apsley to Glen Alda was re-numbered to 620 soon after.

CHAPTER 6

REMEDIAL MEASURES

1. Proposed Dams

(a) Chandos Lake

A dam is recommended for this popular resort lake to reduce the fluctuations in lake levels and particularly for maintaining higher levels in the late summer and early fall. The three years of records compiled for this report indicated high water levels in the spring which drop steadily during the summer. Low water levels cause considerable difficulty, especially in regard to docking facilities and the increased danger of shoals to boats.

The Department of Highways plans to construct a new culvert on Highway No. 504 at the outlet of Chandos Lake in the summer of 1963. The possibility of incorporating a control section in the proposed structure was discussed with this Department and a preliminary plan and cost estimate for the additional work involved were prepared. The estimated cost for the dam section was $8,000. This information was submitted to the Authority for their consideration.

The structure would consist of a twin box culvert with a control section on the upstream end. Each opening would be 14 feet 7 inches wide by 12 feet high and provision would be made for stop logs to regulate the water levels. Manually-operated winches would be provided to raise and lower the logs.

Figure 4 Crowe Valley Conservation Report of 1963 excerpt

5.7 Regarding Beaver Activity…

Beaver activity can be classified as follows:

- *Active Dams*. -These essentially cross from one side of a watercourse to the other, usually at a narrow spot. One purpose of the dam is to raise the water so that the underwater entrance to the beaver lodge can remain ice free during the winter. Because Flat Creek is essentially in a wetland, it is pretty much impossible to construct a dam that would stop flow.

- *Beaver Lodges* – One might see a "hut" or lodge, usually by the river bank. These do not have a significant effect on levels, though they may contribute to restricted water flow.

- *Old Beaver dams* – as a dam deteriorates, various components (sticks, stones, mud) become floating debris, or stay on the bottom of the creek bed, contributing to "silt buildup". At low water levels, these build ups contribute to restricting water flow. The floating debris can combine with other material, logs, etc, to again restrict water flow.

6 Historical Chandos Lake Water levels

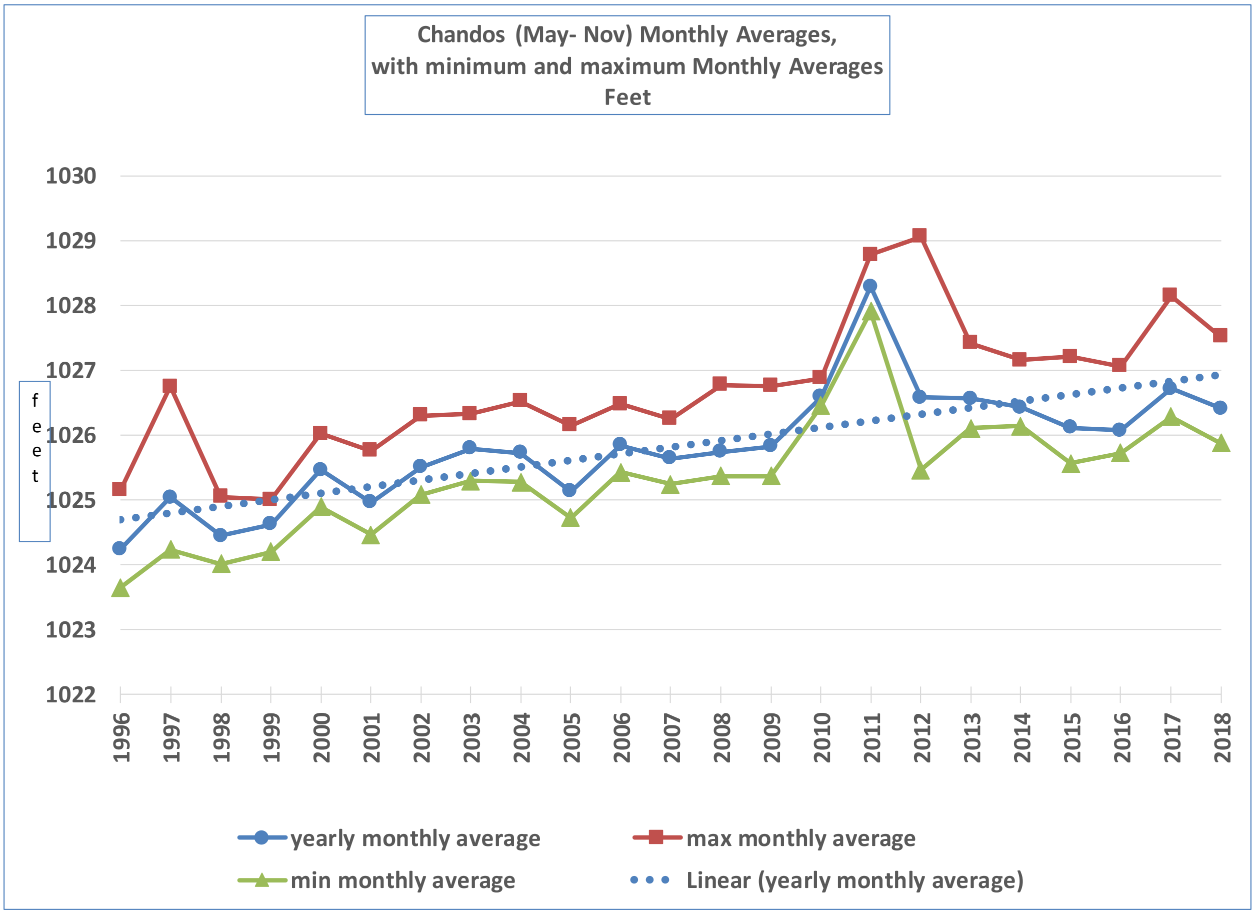

Figure 5 Historical Chandos Lake Water levels

The above graph shows CVCA historical lake levels using May to Nov (Ice-free) data over the last 20 years. The general trend of increasing lake levels is apparent, amounting to approximately 2 feet over the last 20 years. Also, the annual difference between the averages of the highest month and the lowest month is about 2 feet.

As the raw data have various anomalies, we are not reporting the recorded minimum and maximum daily data, but rather are averaging data over each month and then reporting the maximum and minimum months. No doubt the daily max and min over a given year would be more extreme than what is reported monthly, but some individual data points are suspect.

Figure 6 below appears in the Crowe Valley Conservation Report of 1963 issued by the Department of Lands and Forests. It is believed to be relatively "trustworthy",

given that it was relied upon to design the road crossing of Flat Creek by the present Peterborough County Road 620. (Prior to 1963, this piece of Hwy was actually Provincial Hwy 504, which then looped around Chandos Lake).
It is believed the measurements were taken with an altimeter calibrated to a Geological Survey of Canada (GSC) datum. It is not known for sure how the measurements were taken, nor with what accuracy.

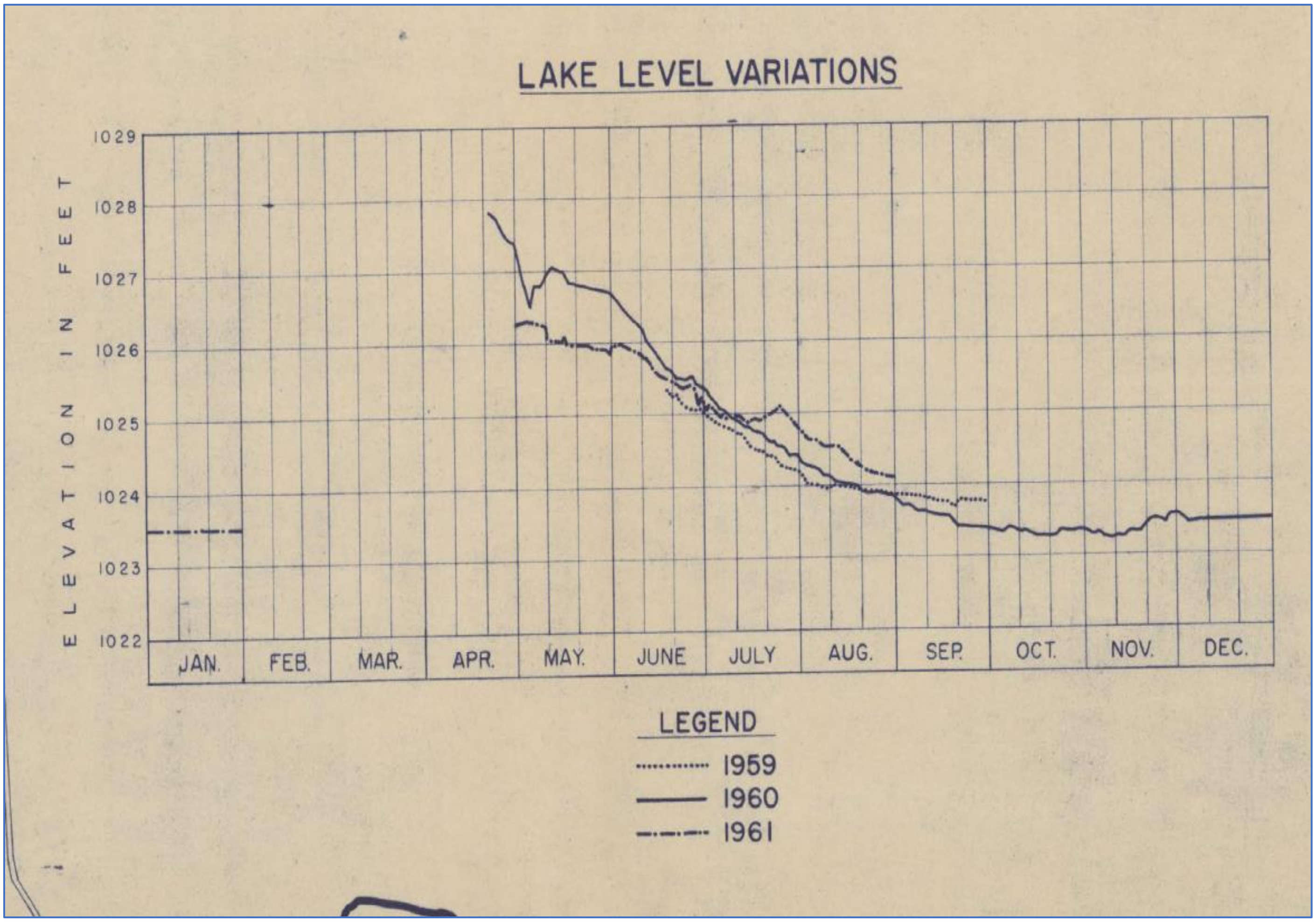

Figure 6 Crowe Valley Conservation Report of 1963 -Chandos Levels 1959-61

Figure 6 shows a July 1 lake level between 1025' and 1025.5'. It also shows that 1960 had very high waters, having a within-year variation of over 4 feet.

The 1966 report of Crysler, Davis and Jorgensen says that in April 1960 a High Water Mark of 1028.3 feet was recorded, and that in most years the level varies between 1024 and 1026.2'. It also says that a minimum cottage floor level of 1029 feet was recommended.

For a modern-day reference, Iain Gorman's High Water Mark from 2017 is calculated to be at 1027.7 feet, and his peak reading in April 2019 was 1028.28'.

A significant finding is that **Figure 6** shows a drop of a good foot from 1025' to1024' from July 1 to August 31 in the years 1959-61.
<u>In 2018, however, there essentially was no summertime drop</u>: From July 1, 2018 to Nov 1, 2018, the level as measured at the South Bay Gauge actually rose slightly, from 1025.8' to 1026.0'. This means that although present day start of summer levels are only about 0.5' higher than 1960, late summer levels are now about 2 feet higher than in 1960.
(The July 1, 2019 lake level reading is 1025.9')

The following graph shows some recent lake levels in comparison to the 1960 data in **Figure 6 Crowe Valley Conservation Report of 1963 -Chandos Levels 1959-61**.

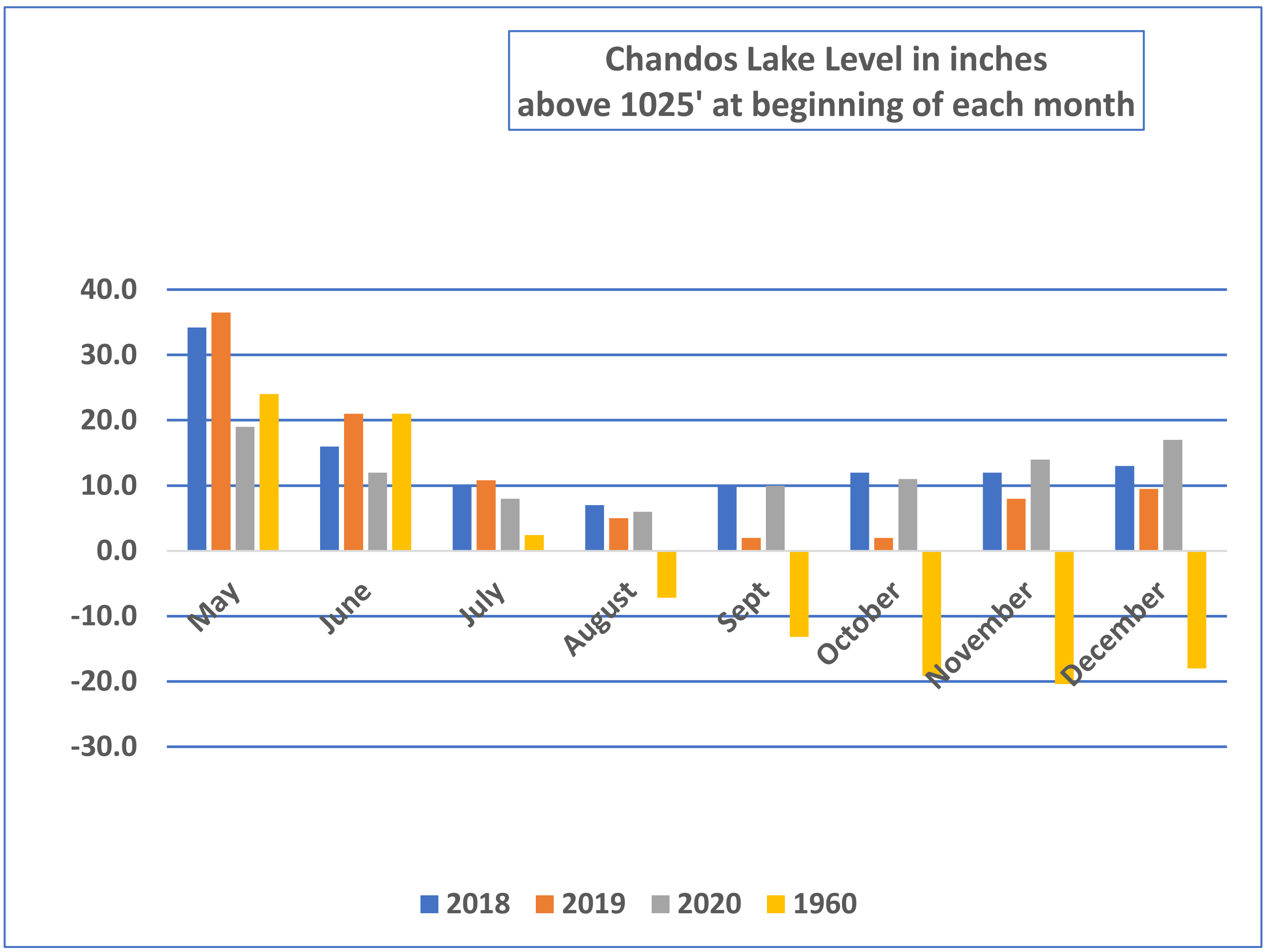

Figure 7 Comparison of Lake levels

7 Managing Flat Creek Remarks

Placing Flat Creek (including the culverts!) under some kind of active maintenance/management seems a desirable course of action, but the path to do this is not straightforward and requires more investigation and work. The focus should be on conservation, navigation, and protection of this valuable ecosystem and wetlands.

Caution would have to be taken against any actions that could materially affect the level of the lake as there are consequences from having water levels too low. (As noted previously, the 1960's dam-related feasibility study was undertaken partly because summer lake levels were deemed to be too low, causing dockage and shoal issues.)

Potential consequences of changing the water level:

-changes to the littoral zone and its biota and macrophytes (ie the plants that can grow in the region where sunlight can reach the lake bottom)

-changes to the nesting habitat for loons.

-Interference with fish spawning grounds

-shoreline changes with respect to docks and beaches.

8 List of Figures