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Purpose

An assessment of flow meters in the McCrae area to analyse usage patterns over the previous 5 years, with a specific focus on calculating the volume of water lost due to a burst event, which was identified and repaired towards the end of 2024.

Network Details

The McCrae area is serviced by a single incoming main pipe from the Dromana Reservoir (owned by Melbourne Water) with 4 distinct water supply zones (see also Figure 1). Water enters the area via the Waller Place Tank and the Waller Place pump station pumps to the Parkes Street Tanks. The Parkes Street pump station pumps to the Cook Street Tank. From the Parkes Street Tanks, customers are supplied within the following sub-zones:

- Parkes Street Tank Zone
    - LaTrobe Parade Pressure Reducing Sub-Zone
    - Waller Place Pressure Reducing Sub Zone
    - Flinders Street/Cinerama Crescent Pressure Reducing Sub -Zone

Flinders St/Cinerama Cres sub-zone has two points of supply, being Flinders St Pressure Reducing Station and Cinerama Cres Pressure Reducing Station. Cinerama PRS is fed from the Parkes St Tank Zone and has a setting of 108m while Flinders St PRS, also fed from the Parkes St Tank Zone, has a setting of 106m. This results in most of the flow coming from Cinerama PRS, with Flinders PRS frequently recording zero flow.

The water supply zone boundaries do not match suburb boundaries. LaTrobe Parade is in the suburb of Dromana. A portion of the McCrae suburb is in a water supply zone called Dromana Pressure Reducing Zone, which is along Point Nepean Rd.

Each of these zones supplies local residents while there are also a number of properties which are supplied from the main pump lines (Waller Place to Parkes Street, and Parkes Street to Cook Street). At Parkes Street, there is a smaller tank, whose primary purpose is to supply the pump station that supplies Cook Street Tank. A second larger tank has the primary purpose of supplying customers in the Parkes Street Tank Zone.

Within this area of the network there are a number of monitoring devices, including 10 flow sensors. These cover the inflow into the McCrae area as well as flow into each of the 4 sub-zones, the storage tanks within those zones, and some further sub-metering within the areas.

With the full digital meter roll-out only recently begun, digital meter data is not currently recorded within the area and hence total consumption on a 3-monthly basis is all that is available. It has not been used in this analysis.

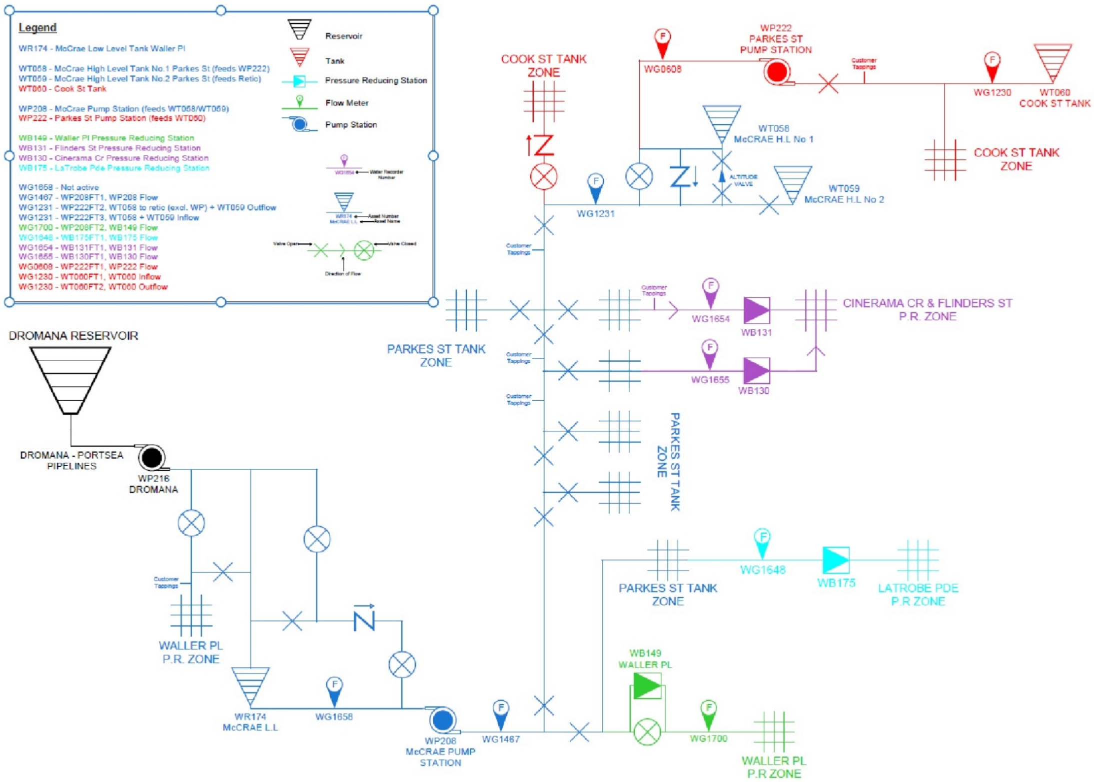

Figure 1: McCrae network zone and monitoring stations

The meters available and used for the work are given below:

Meter	Area
WP208FT1	McCrae Pump Station ID#1
WP208FT2	McCrae Pump Station ID#2
WB175FT1	LaTrobe Pde Pressure Reducting Sub-Zone
WB130FT1	Flinders St Pressure Reducing Sub-Zone
WB131FT1	Cinerama Cres Pressure Reducing Sub-Zone
WP222FT2	Parkes St Pump Station ID#2
WP222FT3	Parkes St Pump Station ID#3

Analysis

Data is gathered and managed by South East Water's SCADA network. Within the network there are 2 types of meter. For meters beginning WP, flow rate and time readings are taken at intervals when the rate change (which varies between meters) is sufficiently large to trigger a measurement or every 2 minutes, if there are a number of changes occurring at short intervals. The meters relevant to the water balance in this area which begin WB are Pulse counters and sum the pulses over a 5 minute period to give a flow rate. Given this flow rate can be assumed to be valid up until the next time stamp, it is possible to calculate volume through the meter in any time period by multiplying the time difference between the two time stamps by the flow rate, and then sum these for daily volumes. While, for edge cases, this may cause some minor discrepancies for time stamps around midnight, this would be resolved (balanced) the following day and hence does not impact the analysis below which focusses on periods of weeks or months.

While other analysis was performed on minimum nightly flows (which looks at water volumes over at overnight usage, e.g. 1-3am, when water usage is at a minimum) the focus of this work was on the total volume through each of the meters. Volume was therefore summed on a daily basis to minimise discrepancies (see note above) and balanced across the zone meters.

In order to perform the balance, volume into the network was compared with the volume into each of the sub-zones, combined with water in and out of the tank system in the Parkes Street tanks. As water can flow both in and out of these tanks, a separate balance was also made to ensure the water balance into, across and out of these tanks was acceptable. The remainder of this balance is then attributed either to usage by residents and businesses within this area which do not pass through one of the sub-meters, or through loss of water due to leaks or bursts in the network.

Three other steps were also important to confirm the balance and support the investigation into the volume lost by the burst event:

- Removal of invalid or missing data due to sensor downtime and maintenance
- An estimate of the uncertainty of the meters and balance
- A multi-year assessment of the impact of seasonal variation (particularly as the water usage on the Mornington Peninsula is highly impacted by summer visitors), while taking into account the potential anomalous impact of Covid on the water usage patterns

Results

Figure 2 shows the flow into the McCrae area over the last 5 years, prior to any data cleansing. Unsurprisingly there is a distinct seasonal profile with an increase in usage over the summer months, as well as higher usage in 2020 (potentially due to more people working remotely during Covid or a warmer year). Also apparent is the burst event which is under investigation here with an increase in volume above the typical summer peak towards the end of 2024.

Given their proximity to the leak event, and their tendency to buffer flows throughout the area, a water balance was checked on the water storage tanks at the Parkes Street site (Figure 3). As expected, water in and out of the storage fluctuates around 0 with a peak day's change being less than 1ML (1 million litres), which aligns with the total storage capacity of those tanks being 2.44ML (compared to a 2023 flow of 187ML into the zone). Over the entire 5 years there is a net outflow of 6.2ML from the tank (difference between the total volume into and out of the tank). This is clearly higher than the volume in the tanks but is attributable to a combination of potential outages of one of the 3 meters in this area (WP222FT3) between March and May 2021 and minor, but within specification, inaccuracies in the meters.

Due to the high importance given to the most recent 2 years data, additional focus was given to ensuring any inaccurate data in that time from any of the meters in question was removed. This led to 3 days data requiring clear exclusion from the analysis. These typically followed times when a meter was offline, with the data issues an unavoidable outcome of how the volumetric calculation was made (specifically, where no data is available to know when the flow stopped). These days are given below. Where there was uncertainty in the correctness of the data, the data was left in the dataset so there was no preferential selection of results.

- 13/03/24

    - No data from meter WP208FT2 for following 4 days
- 03/08/23
    - No data from meter WP208FT2 for following 14 days
- 26/05/24
    - No data from meter WB131FT1 for following 5 days

The final water balance for the area can be seen in Figure 4. This balance is between the input flow from meter:

- WP208FT1 (McCrae Pump Station)

Against the output from the meters:

- WP208FT2 (Waller Place)
- WB175FT1 (Latrobe Parade)
- WB131FT1 (Flinders Street)
- WB130FT1 (Cinerama Court)

As well as the balance of the flow into and out of the Parkes Street tanks:

- WP222FT3 - WP222FT2

Also included in Figure 4 is the 7-day rolling average which highlights the increase in usage towards the summer months each year, as well as the burst event under investigation.

To check that the water balance was reflective of typical usage in a catchment, a check was performed confirming that the water assumed to be flowing into the zone for the balance was in the order expected for the number of connections in the area. With winter usage of 120-250kL per day (slightly higher during Covid), a typical rate of 2.6 people per household for Greater Melbourne (Household size | Australia | Community profile), and usage of 163 L/p/day (Water Outlook | Melbourne Water), this would imply around 280-590 occupied properties. Given there are 972 connections in there area, this would imply an occupancy rate of between 29 and 61% which, given the holiday nature of the Mornington Peninsula, seems reasonable. Typical summer usage is in the order of 420-450kL per day, or 990-1060 occupied properties, which clearly implies higher usage or higher people per property in summer. Summer weekly average peak daily usage has hit as high as 560kL, or 1,320 properties. This would imply a 30% increase combined across either additional per person usage and people per household, which also seems reasonable for peak summer holiday periods.

In order to calculate the water lost during the burst event, which coincides with the increase in summer usage, it is critical to balance the seasonal change in water use while also removing the typical household consumption which remains in the balance. This can be done by using the average of the previous 4 years as typical and applying this to the 5-year period. The remainder can then be attributed to atypical usage which may be due to:

- Higher or lower household consumption than typical
- Warmer or cooler weather leading to changes in consumption patterns
- Unmetered usage events
- Leak or burst events

In Figure 5, a ‘typical’ year calculated from the previous 5 years is shown. By removing this seasonal variation from each of the years the balance described above can be displayed (Figure 6). As expected, the results hovers around 0 which indicates ‘typical’ usage. While there are other short term variations from 0, there is a distinct and consistent increase above 0 towards the end of the year with the final peak on 30/12/24. The latter data coincides with the burst repair date in South East Water's asset maintenance system of the 31/12/24. Day 1 of the leak is harder to pinpoint, and this period is shown in Figure 7. The last date that the water balance drops below 0 is the 30/10/24 (60-day period) with a clear increase after that. However, minor drops below 0 may be due to the storage of water in the tanks which support supply in the area. Given this, it could also be argued that there is a more consistent increase above 0 implying the event started on 05/10/24 (85-day period). This much more gradual increase may also, however, be explained by an increased household usage in the summer (e.g. warmer weather and increased usage) of 24/25 (compared to previous years). The totals for these periods are 37 (60-day) and 38 ML (85-day) respectively.

Uncertainty estimates have also been made for the calculation using 2 methods. The first considers the variation from 0 of the seasonally adjusted water balance. This variation could come from 3 significant sources:

- Behaviour patterns (public holidays, weekends, weather)
- Storage (filling of or usage from water tanks)
- Uncertainty in measurements

The second method is to consider the uncertainty of the meters themselves. Given the **NMI R 49-1 Water meters for cold potable water and hot water** requirements for meter accuracy, class 1 water meters are required to have an accuracy of 1% at the upper flow rate zone while class 2 water meters have a 2% requirement (increasing for temperature ranges above 30 °C. Using these 2 methods result in uncertainties for each of the 60- and 85-day periods.

For the first method (95% confidence interval) this is 9 and 13ML respectively. It is emphasised that this includes uncertainty derived from real-life usage by customers and the network operation and hence and is not reflective of the measurements alone. For the second method (class 1 meter, 1% uncertainty, calculated on typical usage per meter) it is 2 and 3ML respectively. As the second method would be a component of the first method, this aligns. It is also noted that the size of this error does depend on the error being consistent (i.e. a bias) for all meters. To clarify this, all meters would need to have a (co-incidental) bias in a positive or negative direction depending on whether they were inflows or outflows to the area to achieve the largest uncertainty.

Combining these leads to two possible ranges:

- 60-day period: 34-39ML
- 85-day period 34-41ML

(Please note results may be impacted by rounding at the decimal place level)

Conclusion

Given the information above, calculating the additional volume in the 2 time periods and attributing all of this water to a burst event (as opposed to any increase in household consumption due to a warmer summer) indicates the volume of water lost in this time period is, including uncertainties, 34-41ML if both 60- and 85-day estimates are taken into account.

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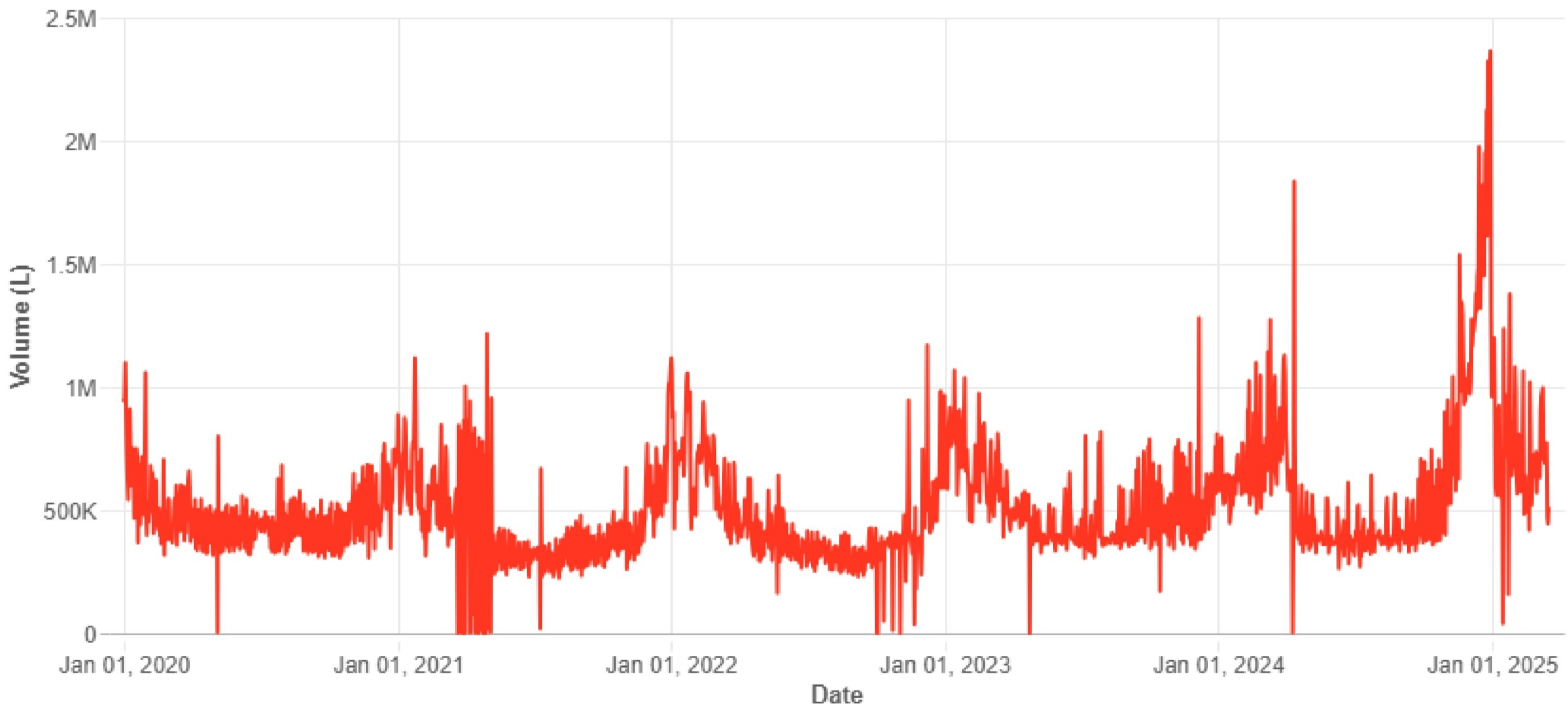

Figure 2: Daily volumes into the McCrae area

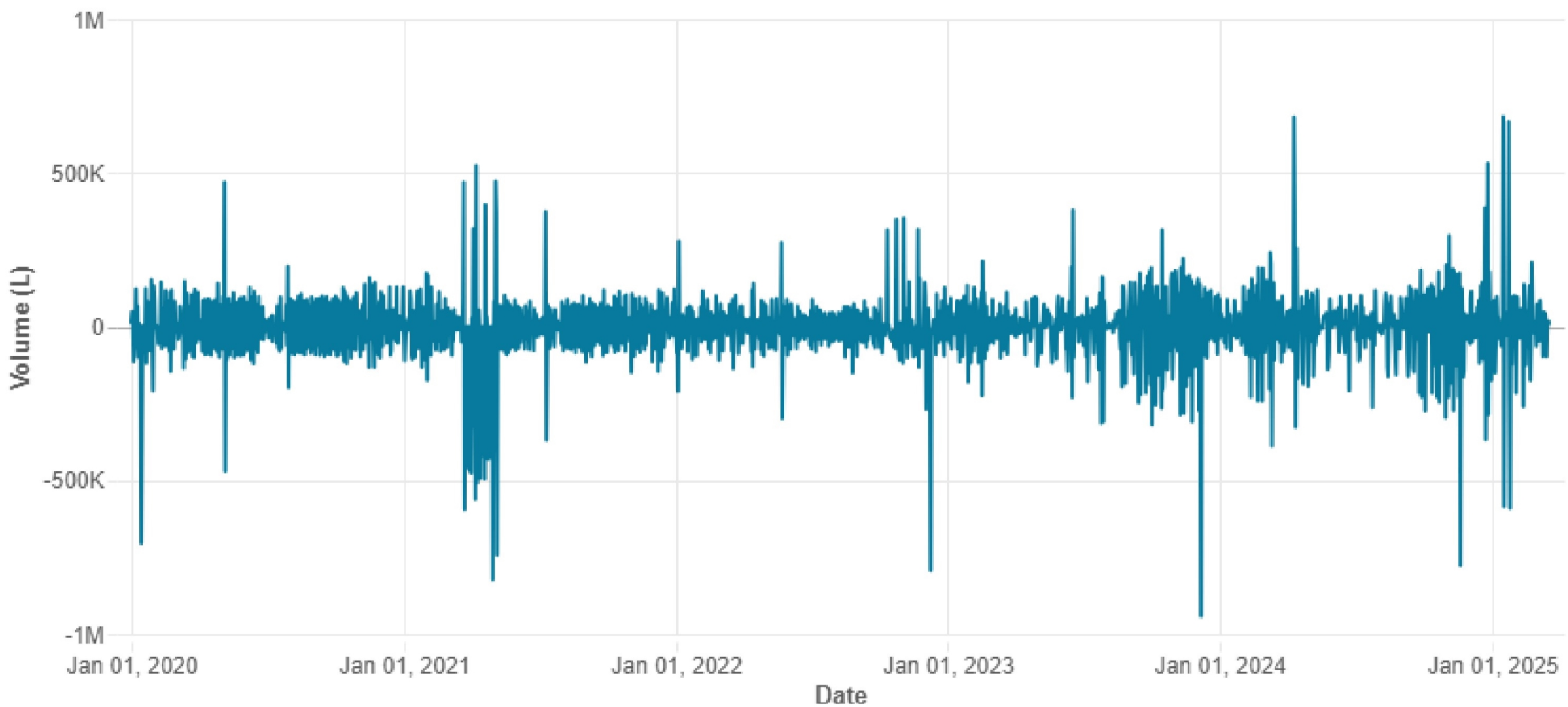

Figure 3: Water balance for the tanks within the Parkes Street sub-area

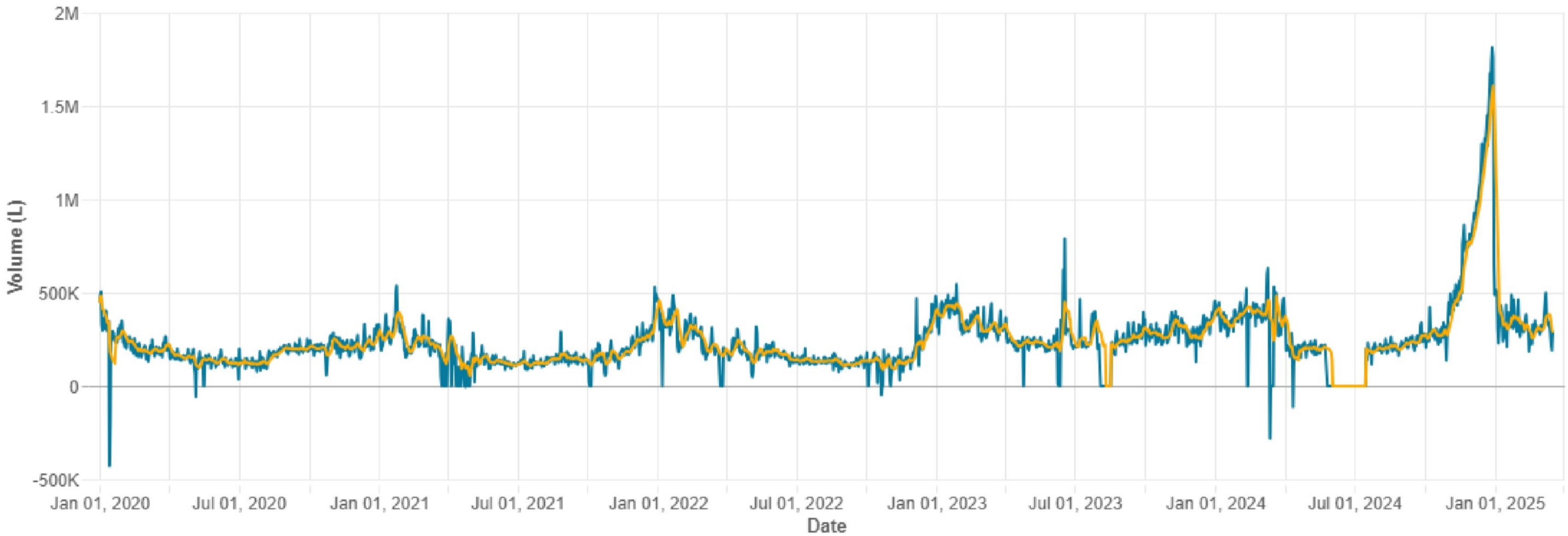

Figure 4: Water balance for the McCrae area (blue) and 7-day rolling average (yellow)

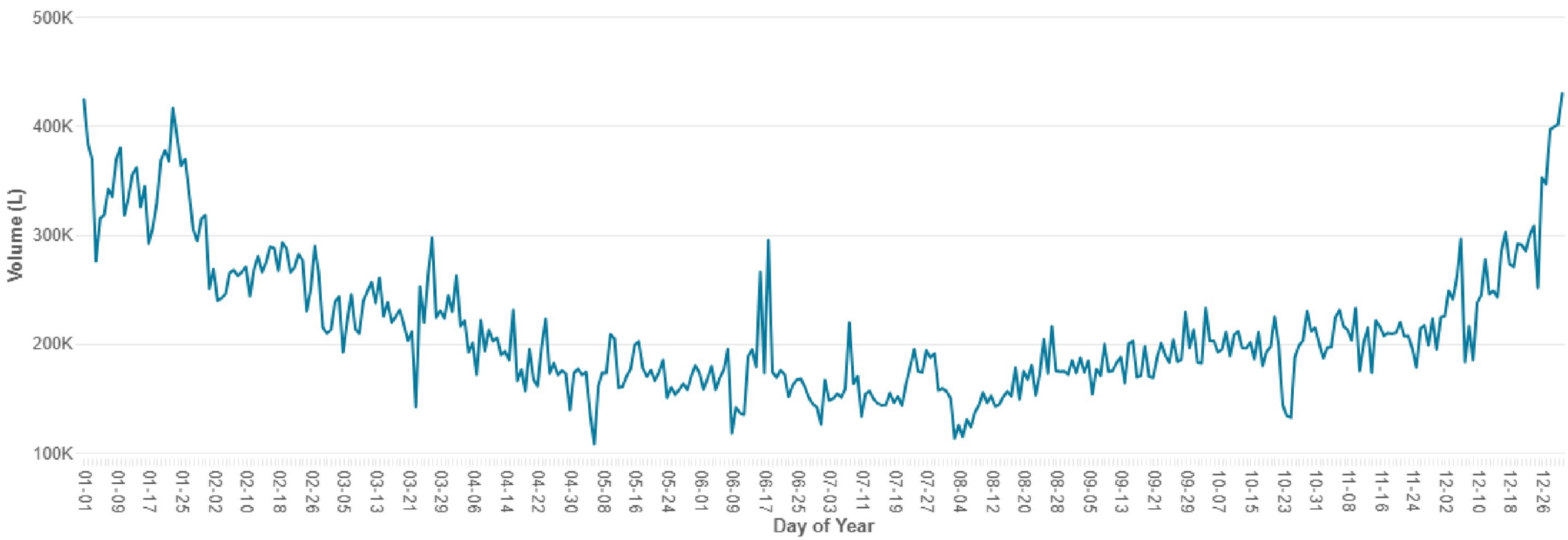

Figure 5: Profile of a typical year for the balance of water usage in the McCrae metered area

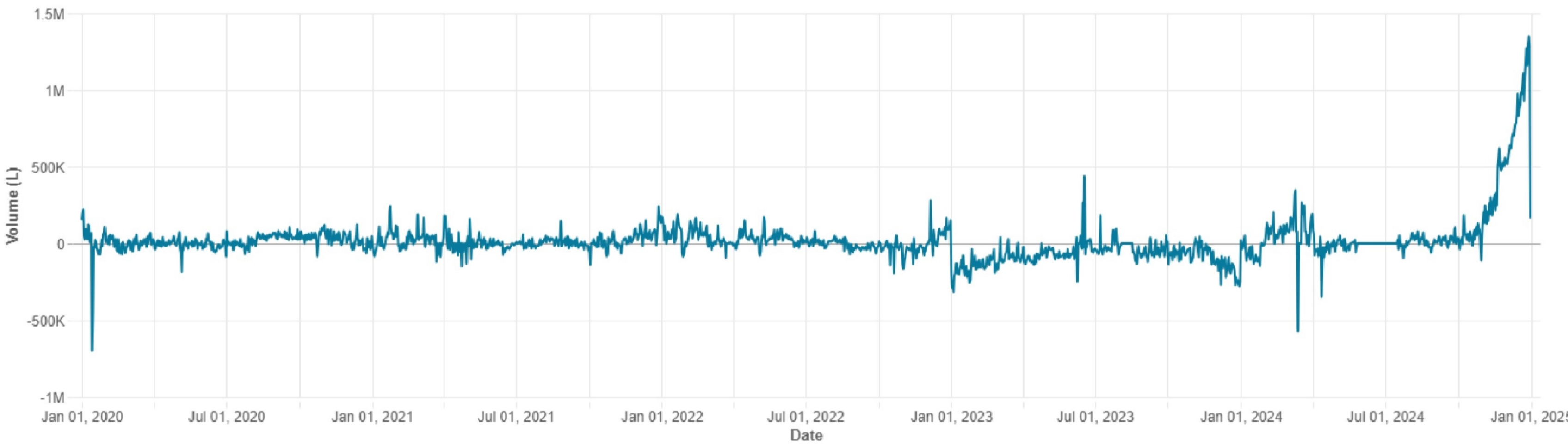

Figure 6: Water balance in the McCrae area when adjusted for typical household usage and seasonal effects

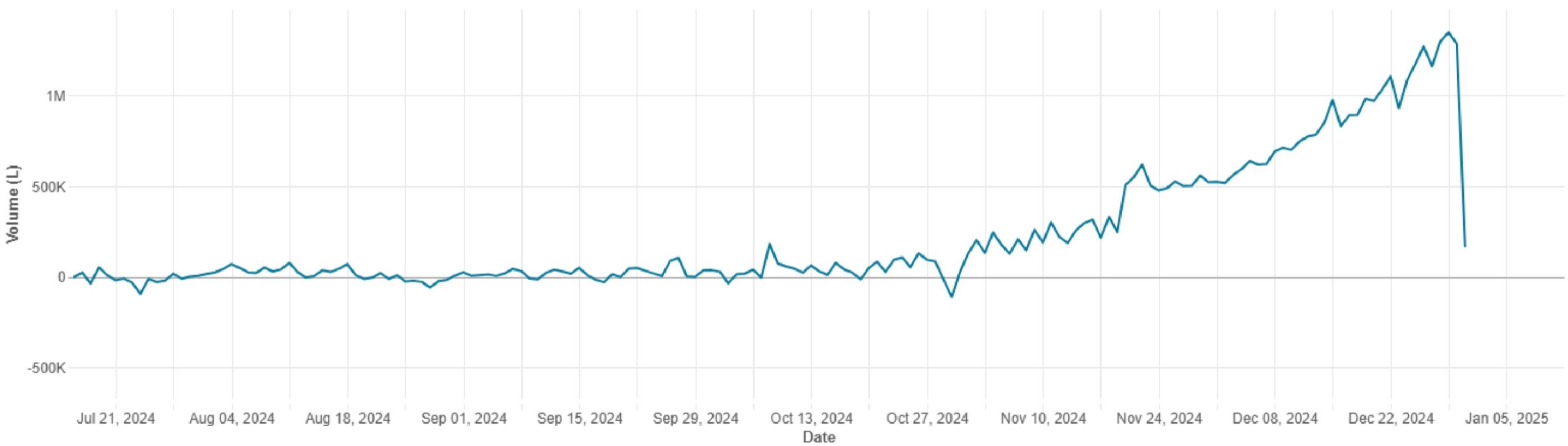

Figure 7: Water balance in the McCrae area when adjusted for typical household usage and seasonal effects, zoomed for the July – December 2024 period