Wilmot Centre Well Field Pumping and Water Level Assessment

Wilmot Centre

Region of Waterloo

Water and Wastewater Services, 150 Frederick Street, Kitchener, ON N2G 4J3

Prepared by:

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Making Sustainability Happen

Revision Record

Revision	Date	Prepared By	Checked By	Authorized By
0	April 1, 2026	M. Digaletos	C. Johnston	C. Johnston
1	August 6, 2026	M. Digaletos	C. Johnston	C. Johnston

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Executive Summary

In support of the Water Supply Strategy Update (WSSU) project and to address current water constraints identified in the Mannheim Service Area, Region of Waterloo (Region) staff presented a report (EES-WIM-26-003) to Council on February 25, 2026. The report recommended the removal of the 1980 Policy on Water Taking – Wilmot Township (the Wilmot Agreement) which would allow up to 30 litres per second (L/s) additional water to be transferred to the Mannheim Service Area.

A delegation presentation from the Citizens for Safe Groundwater was received which presented concerns related to the increased pumping at the Wilmot Centre area. The report made special reference to the Schindelsteddle Wetland Complex, located approximately 1.8 kilometres (km) southeast of the well field, citing water level declines between 1.5 and 2.0 metres (m).

The Wilmot Centre Well Field is located within Wilmot Township, in the settlement of Shingletown, approximately 7 km west of the City of Kitchener. The well field consists of three production wells (K50, K51, and K52) and supplies water to both the Integrated Urban System (IUS) and the towns of Baden and New Hamburg. The water supplied to the IUS is pumped to the Mannheim Reservoir to supply the Mannheim Service Area. The production wells draw water from the AFB2 aquifer, the main water supply aquifer within the area. The Wilmot Centre Well Field has been operating since 1972 and is currently permitted under Permit to Take Water No. P-300-4271733410 for a maximum instantaneous flow from all three wells of 158 L/s.

The Region retained SLR Consulting (Canada) Ltd. (SLR) to complete an assessment of long-term pumping and water level responses in the Wilmot Centre Well Field area. Long-term datasets, including publicly available climate data, and pumping and water level data provided from the Region were compiled and evaluated to complete the assessment.

Annual precipitation totals were used to evaluate periods of lower precipitation which were used as a surrogate for potential variations in groundwater recharge given the time scale being considered. There were multiple periods of three or more years of below average precipitation during the pumping period in the 1970s, 1980s, 1990s, and recently from 2020 to 2022.

The Wilmot Centre Well Field has been demonstrated to be a reliable water supply source over a 53-year period. Since pumping began at the Wilmot Centre Well Field, the average annual pumping rate has been 92 L/s, with extended periods of below and above average pumping. Periods of above average pumping coincided with periods of three or more consecutive years of below average precipitation (drought periods). The most recent drought period was from 2020 to 2022.

The effects of increased pumping and reduced recharge on water levels in the source aquifer (AFB2) were evaluated in detail by reviewing water levels for monitoring wells installed near the production wells and background wells upgradient and downgradient of the well field.
The long-term water level trends at background wells upgradient and downgradient of the well field, with no observed response to pumping, exhibited annual seasonal variations of 0.5 to 1.0 m during periods of normal or above average precipitation. During drought periods, the water levels exhibited additional declines of approximately 0.5 to 1.0 m within the aquifer. The total decline in the AFB2 aquifer due to natural precipitation patterns was estimated between 1.0 and 2.0 m.

In areas away from the Wilmot Centre Well Field water level variations are controlled primarily by seasonal recharge and longer term precipitation trends. At the Esbaugh Sand & Gravel property groundwater levels across the subject property showed seasonal variations typically in the range of 0.5 to 1.0 m with water levels across the subject property declining by about 1.0 to 1.5 m in response to the drought period in 2020 to 2022, similar to other background monitoring wells in the Wilmot Centre Well Field area. The Schindelsteddle Wetland Complex shows similar responses with much more pronounced water level responses to precipitation and spring freshet conditions. The observed decline of 1.2 m to 1.3 m was similar to that observed in the Region's monitoring program locations and is interpreted to be due to below average recharge over this period and limited to no recharge in 2021 as evident by the lack of a seasonal spring rise in water levels. The Schindelsteddle Wetland Complex is beyond the zone of influence from pumping of the Wilmot Centre Well Field.

Table of Contents

Tables in Text

Figures in Text

Appendices

1.0 Introduction

The Region of Waterloo (Region) is responsible for supplying potable water throughout the Integrated Urban System (IUS). The IUS services the cities of Cambridge, Kitchener, Waterloo, as well as some rural communities in the Townships of North Dumfries (Lloyd Brown), Wilmot (Mannheim, Shingletown, St Agatha), and Woolwich (Breslau, Conestogo, Elmira, St Jacobs, West Montrose). Water supply sources for the IUS include multiple groundwater wells and a surface water supply from the Grand River. The Region is undertaking a Water Supply Strategy Update (WSSU) to ensure a safe and secure water supply into 2051 for the IUS. The study will review current water supply sources, assess future water demands, and investigate possible new water sources to meet the needs of the communities to 2051.

In support of the WSSU project and to address current water constraints identified in the Mannheim Service Area, Region of Waterloo (Region) staff presented a report (EES-WIM-26-003) to Council on February 25, 2026 with a recommendation to rescind the 1980 Policy on Water Taking – Wilmot Township (the Wilmot Agreement) (ROW 2026). The report indicates that there is sufficient water supply to meet both forecasted growth to 2051 in Baden and New Hamburg, and for surplus water to be transferred to the Mannheim Service Area from the Wilmot Centre Well Field. If pumping at the Wilmot Centre Well Field is allowed above the Wilmot Agreement, this would allow up to 30 litres per second (L/s) additional water to be transferred to the Mannheim Service Area.

In addition to the Region staff presentation at the Council meeting (February 25, 2026), a delegation presentation from the Citizens for Safe Groundwater was received which provided an overview of historical pumping and water level variations in the area of the Wilmot Centre Well Field and presented concerns related to the increased pumping from the Wilmot Centre Well Field. Additionally, there were concerns with the application from Esbaugh Sand & Gravel Ltd. for a Category 3 Permit To Take Water (PTTW) to draw water from a new wash pond to support the aggregate wash plant operations (Harden, 2026). The Esbaugh Sand & Gravel Ltd. aggregate pit is located at 1922 Witmer Rd, Petersburg, in the Township of Wilmot, and the proposed wash pond is located approximately 1.8 kilometres (km) southeast of the production wells. The Citizens for Safe Groundwater presented concerns for cumulative impacts of increased pumping from the Wilmot Centre Well Field and the PTTW application on water levels in the area. At the February 25, 2026 Regional Council meeting, the decision on the Wilmot Agreement was deferred to the next council meeting.

A special council meeting was held on April 8, 2026 as a follow-up to the February 25, 2026 meeting. A series of delegation presentations were heard from local citizens, water consultants, the Citizens for Safe Groundwater, and representatives from the Waterloo Region Home Builders Association and local developers. Reports from the Region were heard on the Mannheim Service Area Water Capacity Constraint Update on Work Underway (EES-WIM-26-006) and on the Wilmot Centre Aquifer Assessment (ESS-WIM-26-007), which included an early version of this report. A series of motions were made related to the 1980 Policy on Water Taking – Wilmot Township. The final motion that was passed was to rescind the policy to allow the transfer of surplus water to the Mannheim Service Area, while continuing to protect long-term water supply for growth in Wilmot Township, as outlined in report ESS-WIM-26-003, dated February 10, 20206.

The Region retained SLR Consulting (Canada) Ltd. (SLR) to complete an assessment of long-term pumping and water level responses in the Wilmot Centre Well Field area in support of the April 8, 2026 special council meeting. The original SLR report dated April 1, 2026 was included as part of the special council agenda.

This original report has been updated based on the council meeting and more recent work completed on climate impacts on groundwater recharge and water levels within the Waterloo Moraine.

This report summarizes the data analysis and interpretation completed to assess long-term trends (1960s to 2025) in groundwater levels related to pumping at the Wilmot Centre Well Field and variations in climatic conditions and groundwater recharge. The report is organized in nine (9) sections including this introduction. Section 2.0 provides background on Region pumping and the Wilmot Centre Well Field with Sections 3.0 to 5.0 presenting the historical climate, pumping and water level data and analysis. Section 6.0 presents a discussion of results. Section 7.0 presents the review conclusions, and references are included in Section 9.0. All figures and tables are included within the report text. Appendix A includes copies of water level hydrographs from Harden (2026) for the Esbaugh Sand & Gravel Ltd. PTTW application report.

2.0 Background

The following section presents an overall background summary of groundwater supply within the Mannheim Service area and specifically the Wilmot Centre Well Field as well as the presentation to Regional Council from the Citizens for Safe Ground Water and the report supporting the PTTW application for Esbaugh Sand & Gravel Ltd. from Harden (2026).

2.1 Regional Groundwater Supply – Mannheim Service Area

The Region is responsible for supplying water to communities throughout the Region. Within the major urban centres in the Region, the Integrated Urban System (IUS) services the Cities of Cambridge, Kitchener, Waterloo, and communities in surrounding Townships.

The Region has several well fields located within Wilmot Township, including the Erb Street, Mannheim West, and Wilmot Centre Well Fields that provide water to the IUS. The Wilmot Centre Well Field services Baden, New Hamburg, Shingletown, and the IUS.

In addition to these well fields, the Region operates well fields in New Hamburg, Foxboro Green, New Dundee and Petersburg that service the local communities or subdivisions. Water from these well fields is not transferred to the IUS. The remaining well fields in the Mannheim Service Area are located within the cities of Kitchener and Waterloo and include the Mannheim North, Mannheim East, Mannheim Aquifer Storage and Recovery system (ASR), Greenbrook, Strange Street, William Street, Parkway, Strasburg, and Laurel Well Fields as well as production well W10. Figure 2-1 presents the municipal production wells and well fields within the Region.

2.2 Hydrostratigraphy and Source Aquifers

2.2.1 Hydrostratigraphy

The Quaternary geology and stratigraphy of the of the Waterloo Moraine within the Mannheim Well Field area is well mapped and understood. The main hydrostratigraphic units are presented in Table 2-1.

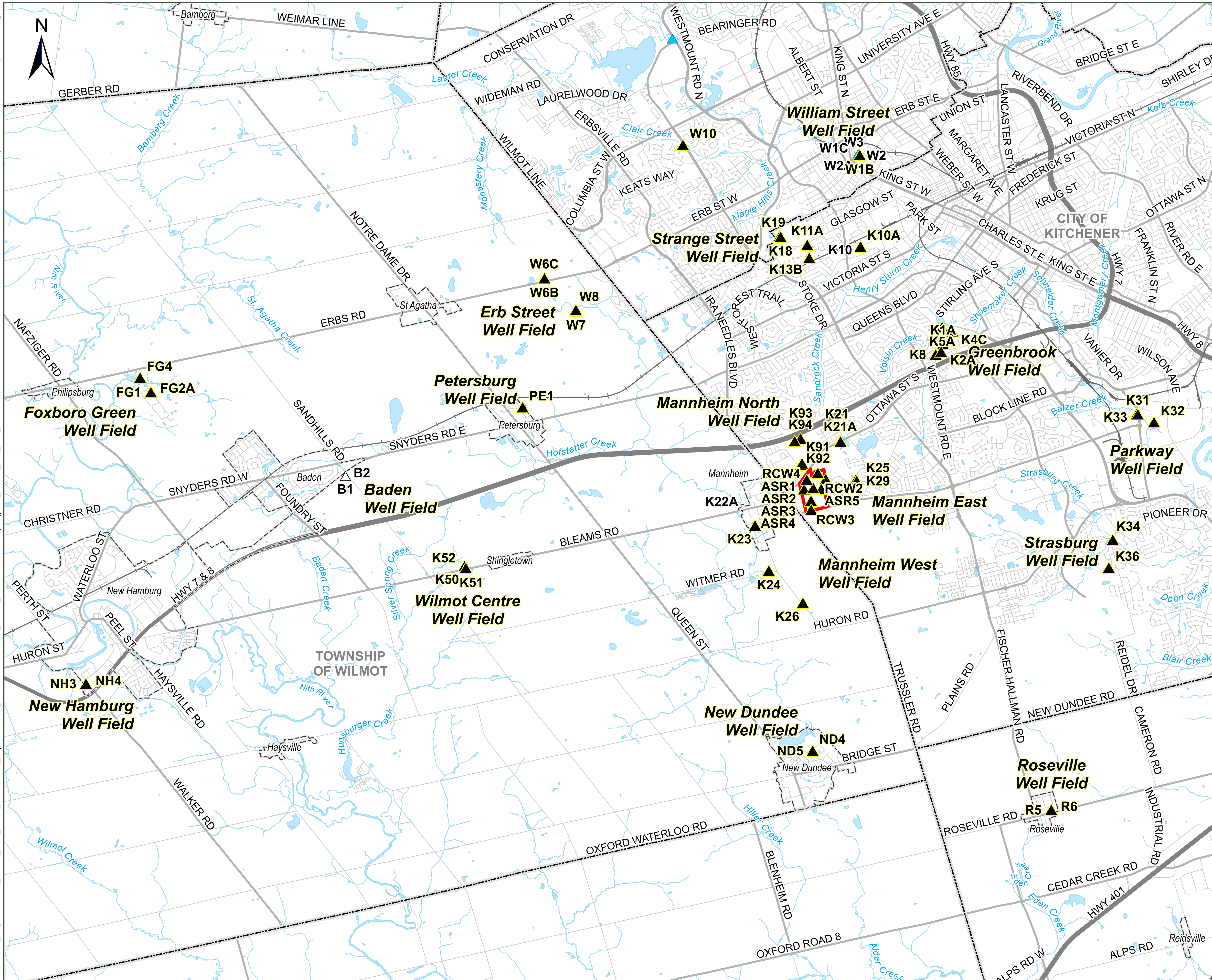
Table 2-1: Hydrostratigraphic Units

Unit	Type	Description
ATB1 Tavistock Till/Port Stanley Till	Aquitard	Discontinuous aquitard ranging from silt and clay till to sandy till, overlying the main regional aquifers of AFB1/AFB2.
AFB1/AFB2 Upper Waterloo Moraine Sediments	Aquifer	Silty sand to sand and gravel aquifers that represent a main supply aquifer. May be separated by ATB2.
ATB2 Middle Maryhill Till	Aquitard	Discontinuous silt and clay aquitard that where present separates the upper AFB1 unit from the AFB2 unit.
ATB3 Lower Maryhill Till	Aquitard	Clayey silt to silty clay till, laterally continuous and is a primary aquitard in the region.
ATC1/ATC2 Catfish Creek Till	Aquitard	A sandy to silty dense till, typically behaves as an aquitard, and is laterally continuous across much of southern Ontario. Thickest within the core of the Waterloo Moraine and thinning outwards towards the flanks.
AFD1 Pre-Catfish Creek Sand and Gravel	Aquifer	Glaciofluvial sand and gravel deposits that are discontinuous within the Moraine and an important supply aquifer for the cities of Kitchener and Waterloo and in North Dumfries.
ATE1 Canning Drift	Aquitard	Fine-textured till or glaciolacustrine deposits at the base of the Waterloo Moraine. Often acts as a confining unit above bedrock.
Bedrock	Aquifer	The underlying bedrock consists primarily of the Salina Formation with the overlying Bois Blanc Formation present in the New Hamburg area within the western portion of the Region.

2.2.2 Source Aquifers

The well fields within the central part of the Waterloo Moraine all pump from an upper aquifer unit referred to as AFB2. The main recharge to AFB2 occurs within the core areas of the Waterloo Moraine with groundwater flow moving west to southwest and east to southeast from the central axes of the moraine extending from St. Agatha through to New Dundee. Groundwater flow within AFB2 contributes to groundwater pumping, stream baseflow, and recharge to deeper aquifer units within the Waterloo Moraine (e.g., AFD1). This aquifer unit (AFB2) represents the main aquifer pumped within the Mannheim Service Area.

The second aquifer unit used for water supply purposes within the Mannheim Service Area is the deeper aquifers, referred to as AFD1/AFF1. This aquifer is primarily pumped within the eastern portion of the Mannheim Service Area at the Greenbrook and Parkway/Strasburg Well Fields within Kitchener and the Laurel Well Fields in Waterloo.



LEGEND:

- MANNHEIM RESERVOIR
- PRODUCTION WELL - IN SERVICE
- NEW PRODUCTION WELL - NOT COMMISSIONED
- PRODUCTION WELL - OUT OF SERVICE
- RAILWAY
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- WATERCOURSE
- MUNICIPAL BOUNDARY
- TOWN BOUNDARY
- WATERBODY

NOTES:
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REGION OF WATERLOO

WILMOT CENTRE WELL FIELD PUMPING AND WATER LEVEL ASSESSMENT

MUNICIPAL WELL FIELDS AND PRODUCTION WELLS

SLR

FIGURE NO: **2-1**

DATE: March 31, 2026

PROJECT NO: 241.032851.00001

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2.3 Wilmot Centre Well Field

The Wilmot Centre Well Field is located within Wilmot Township, in the settlement of Shingletown, approximately 7 km west of the City of Kitchener (Figure 2-1). The well field consists of three production wells: K50, K51, and K52. Production Well K52 has not been commissioned as a water supply well due to operational constraints in the pump house; however, it is currently pumping raw water to a local surface water pond (Eenkooren Pond). The Wilmot Centre Well Field draws water from AFB2 and supplies water to both the IUS and the towns of Baden and New Hamburg. The water supplied to the IUS is pumped to the Mannheim Reservoir to supply the Mannheim Service Area.

The Wilmot Centre Well Field production well details are presented in Table 2-2.

Table 2-2: Water Supply Details

Water Supply Well	Depth to Top of Screen (m)	Depth to Bottom of Screen (m)	Top of Screen Elevation (mASL)	Bottom of Screen Elevation (mASL)	Supply Aquifer
K50	30.8	39.3	328.5	320.0	AFB2
K51	30.5	39.6	328.8	319.7	AFB2
K52	30.5	38.1	328.7	321.1	AFB2
Notes: m = metre(s) mASL = metre(s) above sea level					

2.4 Wilmot Centre Agreement

In 1980 Regional Council endorsed the Wilmot Agreement, herein referred to as the 1980 Agreement. The 1980 Agreement sets out limits on the amount of water being diverted from Wilmot to the IUS. In addition to the pumping for the IUS, there is an agreement to supply water to the Eenkooren Pond adjacent to the supply wells.

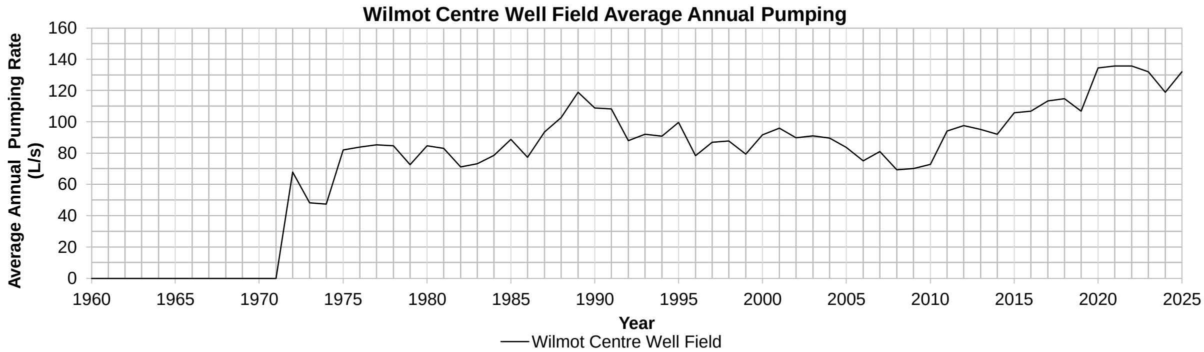
Based on the Wilmot Agreement, the amount of flow directed to the IUS from the three well fields within Wilmot Township are based on agreed pumping rates from the year 1978 are presented in Table 2-3:

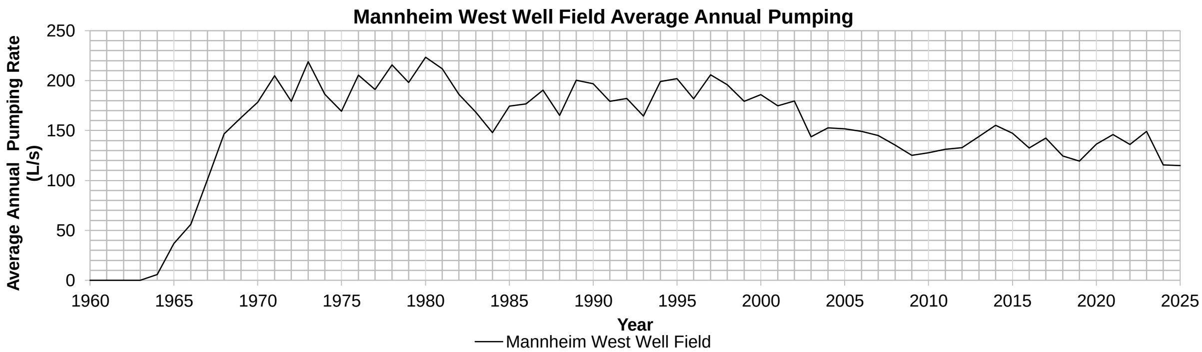
Table 2-3: 1980 Agreement Individual Well Field Pumping Rates to the IUS

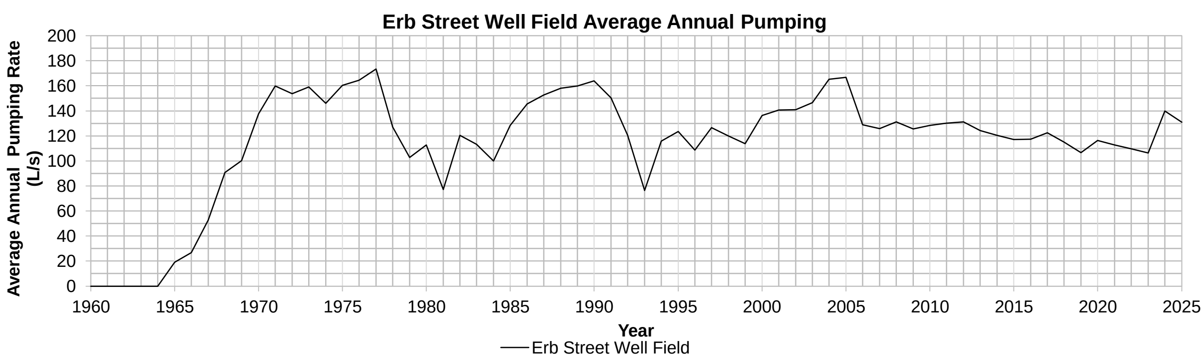
Well Field	1978 Annual Average Pumping (L/s)
Erb Street	128.0
Mannheim West	219.3
Wilmot Centre	87.3
Total	**434.2**
Notes: L/s = litre(s) per second	

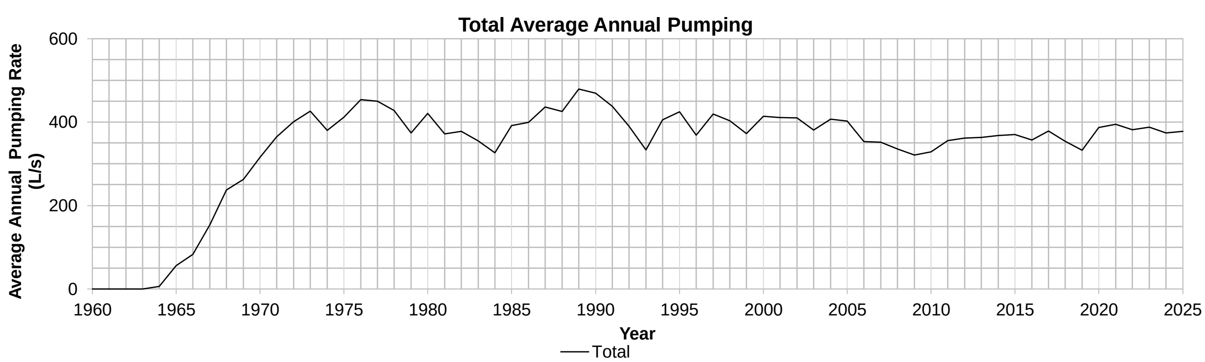
The historical annual average pumping rates for the Wilmot Centre, Mannheim West, and Erb Street well fields are plotted on Figure 2-2 relative to their respective 1978 rate agreed to in the 1980 agreement. The rates for the Wilmot Centre Well Field include both water that goes to the IUS as well as the water that is supplied to Baden and New Hamburger and to the Eenkooren Pond as agreed to by the Region. The Region operationally tried to balance the overall water taking from Wilmot to less than the total annual average pumping rate of 434 L/s to allow flexibility in operating the water supply and addressing well maintenance issues. The total pumping rates presented in Figure 2-2 are reflective of the total pumped from the well fields and include the water supplied to Baden and New Hamburg as well as the Eenkooren Pond. This water would need to be deducted to compare to the 434 L/s in the 1980 Agreement.

The supply to the Eenkooren Pond was put in place as a mitigation for two flowing artesian wells that were completed in the municipal aquifer and stopped flowing and discharging to Hunsberger Creek when pumping at the Wilmot Centre Well Field commenced in the 1970s. The wells originally discharged to the ditch along Sandhills Road that drained to the south, discharging to the church pond near the intersections of Sandhills Road and Bleams Road and ultimately to Hunsberger Creek. Historically, the requirement for the discharge to the pond was included in the PTTW; however, the clause was removed when the permit was renewed in 2006. In 2009, the Region provided a letter agreement to the landowner to confirm a minimum flow of 6 L/s of water will be provided to maintain water levels at the pond.









Notes:

The rates for the Wilmot Centre Well Field include both water that goes to the IUS as well as the water that is supplied to Baden, New Hamburg, and to the Eenkooren Pond as agreed to by the Region.

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Region of Waterloo
Wilmot Centre Well Field Pumping and Water Level Assessment

Figure Title: Average Annual Pumping Rates for Erb Street, Mannheim West, and Wilmot Centre

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Project Number: 241.032851.00001

Figure 2-2

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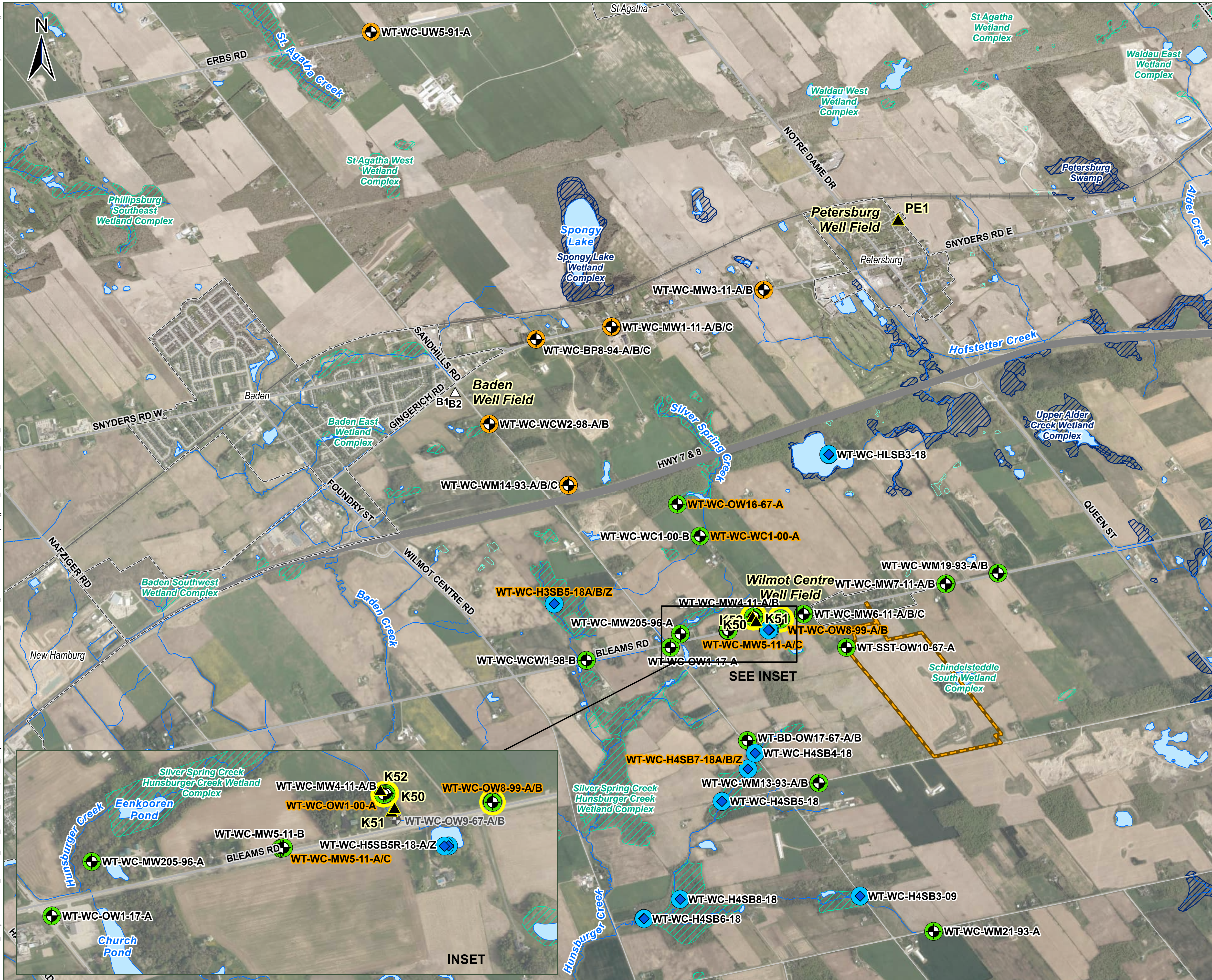
2.4.1 Permit to Take Water

The Wilmot Centre Well Field is permitted under PTTW No. P-300-4271733410, issued on July 13, 2024 by the Ministry of Environment, Conservation and Parks (MECP), and expires on May 31, 2034. The PTTW allows for a:

- Maximum instantaneous flow from all three wells of 158 L/s.
- Average annual daily flow of 158 L/s.

Condition 4.2 of the PTTW indicates that groundwater monitoring is required at five monitoring wells on a monthly basis (WT-WC-OW1-00-A, WT-WC-MW4-11-A/B, WT-WC-OW8-99-A/B). In addition, the Region manages a concurrent monitoring program for groundwater and surface water levels in the Wilmot Centre area (monitoring wells, drivepoint piezometers, and surface water stations). “Trigger levels” were first determined in 2001 (Stantec, 2001) and amended as required. The trigger levels and locations were re-assessed in 2018 (Stantec, 2020) and are amended each year based on monitoring data, as required. If water levels fall below respective trigger levels, an assessment is completed by a qualified professional to evaluate potential pumping and climate effects and to recommend potential modifications to the well field operations or monitoring program as required. An “exceedance” of a trigger level does not directly indicate an impact to water users or to the environment.. The 2025 monitoring program includes nine groundwater wells and six drivepoint piezometers / surface water stations with trigger levels (RJ Burnside, 2026).

The location of the selected monitors relative to the production wells is presented in Figure 2-3. The well details are presented in Table 2-4.



LEGEND:

- PRODUCTION WELL - IN SERVICE
- PRODUCTION WELL - OUT OF SERVICE
- MONITORING WELL
- STREAMBED WELL / SURFACE WATER
- DECOMMISSIONED MONITORING WELL
- WILMOT CENTRE MONITORING WELLS
- BADEN MONITORING WELLS
- DRIVEPOINT PIEZOMETERS & SURFACE WATER LOCATIONS
- PERMIT TO TAKE WATER LOCATION
- MW1-18 STANTEC 2018 OTP PROPOSED TRIGGER MONITOR
- RAILWAY
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- WATERCOURSE
- ESBAUGH SAND & GRAVEL LTD. SITE
- MUNICIPAL BOUNDARY
- TOWN BOUNDARY
- PROVINCIALLY SIGNIFICANT WETLAND (MNR)
- EVALUATED WETLAND (MNR)
- UNEVALUATED WETLAND (MNR)
- WATERBODY

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REGION OF WATERLOO

WILMOT CENTRE WELL FIELD PUMPING AND WATER LEVEL ASSESSMENT

WILMOT CENTRE MONITORING LOCATIONS

SLR

FIGURE NO: **2-3**

DATE: March 31, 2026

PROJECT NO: 241.032851.00001

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Table 2-4: Current Wilmot Centre Monitoring Locations – WCLTMP and PTTW

Region Monitoring Well ID	Monitoring Program	Screen Interval (m)	Screen Interval (m)	Screen Interval (mASL)	Screen Interval (mASL)	Screened Unit / Watercourse	2024 Trigger Level (mASL)
		Top	Bottom	Top	Bottom		
WT-WC-MW4-11-A	PTTW	32.9	36.0	326.5	323.4	AFB2	-
WT-WC-MW4-11-B	PTTW	24.7	27.7	334.7	331.6	AFB1	-
WT-WC-MW5-11-A	WCLTMP	37.2	40.2	326.4	323.4	Reworked Material	351.86
WT-WC-MW5-11-C	WCLTMP	11.6	14.6	352.1	349.0	Reworked Material	351.86
WT-WC-OW1-00-A	PTTW and WCLTMP	4.4	5.4	354.9	353.9	ATB1	356.89
WT-WC-WC1-00-A	WCLTMP	29.6	32.6	331.9	328.8	AFB2	351.66
WT-WC-OW8-99-A	PTTW and WCLTMP	40.8	46.9	322.6	316.5	AFB2	351.71
WT-WC-OW8-99-B	PTTW and WCLTMP	25.3	31.4	338.2	332.1	AFB1	351.73
WT-WC-WCW1-98-A	WCLTMP	36.6	38.4	305.5	303.7	AFB2	345.51
WT-WC-WM21-93-A	WCLTMP	19.9	23.0	341.7	338.6	AFB2	345.20
WT-BD-OW17-67-A	WCLTMP	33.2	39.9	323.7	317.0	AFB2	351.40
WT-WC-H3SB5-18-B	WCLTMP	1.4	2.0	342.7	342.1	Shallow Overburden - Silver Spring Creek	344.30
WT-WC-H3SB5-18-A	WCLTMP	0.4	0.7	343.7	343.4	Shallow Overburden - Silver Spring Creek	344.32
WT-WC-H3SB5-18-Z	WCLTMP	-	-	-	-	Surface Water - Silver Spring Creek	344.08
WT-WC-H4SB7-18-B	WCLTMP	0.3	0.6	343.5	343.2	Shallow Groundwater - Kirby Farm N. Tributary	343.96
WT-WC-H4SB7-18-A	WCLTMP	2.0	2.6	341.9	341.3	Shallow Groundwater - Kirby Farm N. Tributary	344.66
WT-WC-H4SB7-18-Z	WCLTMP	-	-	-	-	Surface Water - Kirby Farm N. Tributary	343.94

Notes:
m = metre(s); mASL = metre(s) above sea level; PTTW = Permit to Take Water; WCLTMP = Wilmot Centre Long Term Monitoring Program; - = not applicable

2.4.2 Previous Aquifer Testing and Monitoring

Three main pumping tests were completed at the Wilmot Centre Well Field with the first test completed in 1970 during the development of the well field and the remaining two tests (1993-1994 and 2018) completed to assess the ultimate capacity and effects of pumping on groundwater levels and surface water features as part of subsequent studies.

2.4.2.1 1970 Pumping Test

An aquifer testing program was completed by International Water Supply Limited (IWS) at the Wilmot Centre Well Field as part of the original testing and development of the well field (IWS, 1970). As part of this program, a pumping test was conducted at K50 in a series of stages:

- Stage 1 (shutdown) began on April 14, 1970 following the completion of well development, where K50 was shut off for a period of 6 days.
- Stage 2 (pumping test) began on April 20, 1970, where K50 was pumping at a maximum rate of 158 L/s, for a period of 18 days.

Water levels were measured at monitoring wells WT-WC-OW5-67, WT-WC-OW6-67, WT-WC-OW8-67, WT-WC-OW9-67, WT-WC-OW10-67, WT-WC-OW16-67, WT-WC-OW17-67, and WT-WC-OW16-66 as well as Hofstetter Lake and a series of private wells. The maximum drawdown observed was 2.0 m at WT-WC-OW9-67 located 25 m south of Production Well K50. Drawdown was aligned in a north to south direction with 1.5 m observed at WT-WC-OW17-67 located 1.0 km to the south and 1.0 m at WT-WC-OW16-67 located 1.2 km to the north. Drawdown to the east was limited with 0.4 m at WT-WC-OW6-67, located 0.49 km to the east of K50, and 0.9 m at WT-WC-OW10-67 located 0.76 km to the southeast of K50.

No clear response was observed in Hoffstetter Lake or reduction in flow within Hunsberger Creek after considering the reduction in artificial discharge from the flowing well that was artesian prior to the testing and stopped flowing during the test as water levels dropped within the well. This flowing well previously discharged to Hunsberger Creek south of Bleams Road at approximately 15 L/s. Based on the results of the testing, IWS (1970) concluded the safe supply rate for the Wilmot Centre Well Field was 158 L/s.

2.4.2.2 1993-1994 Shutdown/Pumping Test

A hydrogeological study was completed by Terraqua (1995) to define the hydrogeological conditions of the Waterloo Moraine. This study included a shutdown and pumping test of select well fields to assess groundwater response to pumping. A shutdown/pumping test was completed at the Wilmot Centre Well Field from November 29, 1993 to February 9, 1994. The test was conducted in a series of stages:

- Stage 1 (pre-test) began on November 8, 1993, where the production wells (K50 and K51) were pumping at a combined 136 L/s, a harder rate than usual to achieve high drawdown prior to shut down (Stage 2).
- Stage 2 (shut down) began on November 29, 1993, where K50 was shut off and K51 was pumping at a reduced rate of 12.5 L/s for a period of 43 days.
- Stage 3 (start up, pumping test) began on January 11, 1994 where the production wells (K50 and K51) were pumping at a combined rate of 154 L/s for a period of 29 days.

A monitoring program was implemented and began on November 22, 1992 and continued until the end of the test on February 9, 1994.

A maximum drawdown within AFB2 near the production wells was 2.23 m at WT-WC-OW9-67-A. Responses to the shutdown and pumping test were evident in wells as far north as the Baden Well Field (0.31 m of drawdown) and as far south as WT-WC-WM13-93-A (0.79 m of drawdown). No responses were observed to the south at WT-WC-WM93-21. Responses to the east were limited to 0.66 m at WT-WC-OW10-67 and 0.16 m at WT-WC-16-66 with no response to pumping observed at WT-WC-WM93-19. The response to pumping was aligned in a generally northwest to southeast zone of influence and was similar to that observed during the original testing by IWS (1970).

2.4.2.3 2018 Operational Testing Program

A long-term monitoring program was established at the Wilmot Centre Well Field in early 2000 based on the results of the Baden-New Hamburg Water Supply Master Plan that was completed in 1994 (Stantec, 2001). The monitoring program was intended to document potential impacts to groundwater levels and surface water features as pumping was gradually increased at the well field. Due to demand requirements, the well field pumping was not increased as planned with the average annual daily flows between 2001 and 2014 averaging 85 L/s.

Stantec (2020) completed an operational testing program at the Wilmot Centre Well Field in 2018 to demonstrate the secure water supply rate from the well field. A pumping test was conducted over an approximate 5-month period and included pumping of the well field in four stages:

- Stage 1 began on May 24, 2018 at a combined pumping rate of 124 L/s, slightly over the previous rates of 108 L/s and continued for 34 days.
- Stage 2 began on June 27, 2018 at a combined pumping rate of 140 L/s and continued for 42 days.
- Stage 3 began on August 8, 2018 at a combined pumping rate of 155 L/s and continued for 23 days.
- Stage 4 began August 31, 2018 at a combined pumping rate of 104 L/s, similar to the pre-testing pumping rates, and continued for 61 days.

An extensive monitoring program was implemented for the testing program and was modified slightly from the previous monitoring program developed for the well field (Stantec, 2017). The monitoring program included:

- Groundwater levels at twenty-two (22) locations (42 monitors in total) within the main pumping aquifer (AFB2).
- Shallow groundwater levels at nine (9) locations (25 monitors in total) within AFB1/ATB1.
- Continuous stream flow monitoring at four (4) locations along Silver Springs Creek and Hunsburger Creek.
- Manual flow monitoring at six (6) additional locations.
- Fisheries habitat surveys at specific locations previously identified on Hunsburger Creek, Silver Springs Creek, and a tributary referred to as the Kirby Farm North Tributary.

Table 2-5 provides a summary of the monitoring locations with Figure 2-3 providing the overall locations monitored by the Region within the Wilmot Centre Well Field area as well as the specific monitoring locations for the 2018 aquifer testing program.

Monitoring trigger levels were originally developed for the Wilmot Centre Well Field and documented by Stantec (2001). The trigger levels were originally established as 0.1 m below the lowest observed water level within the groundwater monitoring wells and 0.05 m below the lowest observed water level within the drivepoint piezometers (shallow monitoring wells). These triggers were reflective of pumping and climatic conditions over the monitoring data range at the time, with average annual precipitation of 986 millimetres per year (mm/yr) in the three years prior to the testing period. The precipitation during this time was higher than the 1981 to 2010 climate normals of 912 mm/yr.

Table 2-5: 2018 Operational Testing Program Monitors and 2024 Trigger Levels

Region Monitoring Well ID	Screen Interval (m)	Screen Interval (m)	Screen Interval (mASL)	Screen Interval (mASL)	Screened Unit / Watercourse	2024 Trigger Level (mASL)
	Top	Bottom	Top	Bottom		
Wilmot Centre						
WT-WC-OW1-17-A	5.2	6.7	343.0	341.5	ATB1	-
WT-WC-MW4-11A	32.9	36.0	326.5	323.4	AFB2	-
WT-WC-MW4-11B	24.7	27.7	334.7	331.6	AFB1	-
WT-WC-MW5-11-A	37.2	40.2	326.4	323.4	Reworked Material	351.86
WT-WC-MW5-11-B	19.2	22.3	344.4	341.4	Reworked Material	-
WT-WC-MW5-11-C	11.6	14.6	352.1	349.0	Reworked Material	351.86
WT-WC-MW6-11-A	45.4	48.5	319.4	316.4	AFB2	-
WT-WC-MW6-11-B	15.2	16.8	349.8	348.3	AFB1	-
WT-WC-MW6-11-C	8.5	11.6	356.3	353.3	ATB1	-
WT-WC-MW7-11-A	31.7	34.8	338.2	335.2	ATB2	-
WT-WC-MW7-11-B	7.0	10.1	363.0	359.9	AFB1	-
WT-WC-OW1-00-A	4.4	5.4	354.9	353.9	ATB1	356.89
WT-WC-WC1-00-A	29.6	32.6	331.9	328.8	AFB2	351.66
WT-WC-WC1-00-B	7.6	9.1	353.8	352.3	ATB1	-
WT-WC-OW8-99-A	40.8	46.9	322.6	316.5	AFB2	351.71
WT-WC-OW8-99-B	25.3	31.4	338.2	332.1	AFB1	351.73
WT-WC-WCW1-98-B	7.6	10.7	334.5	331.4	AFB1	-
WT-WC-WCW1-98-A	36.6	38.4	305.5	303.7	AFB2	345.51
WT-WC-MW205-96-A	1.5	5.0	348.2	344.7	ATB1	-
WT-WC-WM13-93-B	28.3	31.4	332.2	329.1	AFB2	-

Region Monitoring Well ID	Screen Interval (m)	Screen Interval (m)	Screen Interval (mASL)	Screen Interval (mASL)	Screened Unit / Watercourse	2024 Trigger Level (mASL)
	Top	Bottom	Top	Bottom		
WT-WC-WM13-93-A	67.4	72.0	293.1	288.5	ATC1/AFC1/ATC2	-
WT-WC-WM19-93-A	44.7	47.7	332.8	329.8	AFB3	-
WT-WC-WM19-93-B	19.6	22.7	358.1	355.0	AFB1	-
WT-WC-WM21-93-A	19.9	23.0	341.7	338.6	AFB2	345.20
WT-SST-OW10-67-A	60.1	63.4	308.6	305.3	AFB2	-
WT-WC-OW16-67-A	43.9	47.2	324.1	320.7	AFB2	-
WT-BD-OW17-67-A	33.2	39.9	323.7	317.0	AFB2	351.40 [1]
WT-BD-OW17-67-B	35.9	39.3	321.0	317.6	AFB2	-
Baden						
WT-WC-MW1-11-A	44.8	46.9	346.9	344.7	AFB2	-
WT-WC-MW1-11-B	21.3	22.9	370.4	368.9	AFB1	-
WT-WC-MW1-11-C	6.4	7.9	385.3	383.7	ATB1	-
WT-WC-MW3-11-A	43.0	46.0	329.3	326.2	AFB2	-
WT-WC-MW3-11-B	30.2	33.2	342.2	339.1	AFB2	-
WT-WC-WCW2-98-B	29.0	30.6	342.9	341.2	AFB2	-
WT-WC-WCW2-98-A	48.0	49.5	323.8	322.3	AFB2	-
WT-WC-BP8-94-A	35.6	37.2	336.1	334.5	AFB2	-
WT-WC-BP8-94-B	29.9	32.0	341.8	339.7	AFB2	-
WT-WC-BP8-94-C	25.3	26.5	346.4	345.2	AFB2	-
WT-WC-WM14-93-C	18.3	21.3	352.8	349.8	AFB2	-
WT-WC-WM14-93-B	46.3	49.4	324.7	321.6	AFB2	-
WT-WC-WM14-93-A	92.6	95.6	278.4	275.4	Bedrock	-

Region Monitoring Well ID	Screen Interval (m)	Screen Interval (m)	Screen Interval (mASL)	Screen Interval (mASL)	Screened Unit / Watercourse	2024 Trigger Level (mASL)
	Top	Bottom	Top	Bottom		
WT-WC-UW5-91-A	30.2	33.2	348.6	345.5	AFB2	-
Drivepoint Piezometers & Surface Water Locations						
WT-WC-H3SB5-18-B	1.4	2.0	342.7	342.1	Shallow Overburden - Silver Spring Creek	344.30
WT-WC-H3SB5-18-A	0.4	0.7	343.7	343.4	Shallow Overburden - Silver Spring Creek	344.32
WT-WC-H3SB5-18-Z	-	-	-	-	Surface Water - Silver Spring Creek	344.08
WT-WC-H4SB3S-09-A	0.6	0.9	341.9	341.6	Shallow Groundwater - Kirby Farm S. Tributary	-
WT-WC-H4SB3D-09-A	1.9	2.5	340.6	340.0	Shallow Groundwater - Kirby Farm S. Tributary	-
WT-WC-H4SB3-18-Z	-	-	-	-	Surface Water - Kirby Farm S. Tributary	-
WT-WC-H4SB4S-09-A	0.5	0.8	346.0	345.7	Shallow Groundwater - Kirby Farm N. Tributary	-
WT-WC-H4SB4D-09-A	1.1	1.7	345.4	344.8	Shallow Groundwater - Kirby Farm N. Tributary	-
WT-WC-H4SB4-18-Z	-	-	-	-	Surface Water - Kirby Farm N. Tributary	-
WT-WC-H4SB5S-09-A	0.7	1.0	339.0	338.7	Shallow Groundwater - Kirby Farm N. Tributary	-
WT-WC-H4SB5D-09-A	2.2	2.8	337.6	337.0	Shallow Groundwater - Kirby Farm N. Tributary	-
WT-WC-H4SB5-18-Z	-	-	-	-	Surface Water - Kirby Farm N. Tributary	-
WT-WC-H4SB6S-09-A	0.7	1.0	327.0	326.7	Shallow Overburden - Hunsburger Creek	-
WT-WC-H4SB6D-09-A	1.6	2.2	326.0	325.4	Shallow Overburden - Hunsburger Creek	-
WT-WC-H4SB6-18-Z	-	-	-	-	Surface Water - Hunsburger Creek	-

Region Monitoring Well ID	Screen Interval (m)	Screen Interval (m)	Screen Interval (mASL)	Screen Interval (mASL)	Screened Unit / Watercourse	2024 Trigger Level (mASL)
	Top	Bottom	Top	Bottom		
WT-WC-H4SB7-18-B	0.3	0.6	343.5	343.2	Shallow Groundwater - Kirby Farm N. Tributary	343.96
WT-WC-H4SB7-18-A	2.0	2.6	341.9	341.3	Shallow Groundwater - Kirby Farm N. Tributary	344.66
WT-WC-H4SB7-18-Z	-	-	-	-	Surface Water - Kirby Farm N. Tributary	343.94
WT-WC-H4-SB8-18-B	0.3	0.6	329.1	328.8	Shallow Groundwater - Kirby Farm N. Tributary	-
WT-WC-H4-SB8-18-A	2.0	2.6	327.5	326.9	Shallow Groundwater - Kirby Farm N. Tributary	-
WT-WC-H4-SB8-18-Z	-	-	-	-	Surface Water - Kirby Farm N. Tributary	-
WT-WC-H5-SB5R-A	1.7	2.0	357.8	357.5	Shallow Groundwater - Battler/Tessmer Pond	-
WT-WC-H5-SB5R-18-Z	-	-	-	-	Surface Water - Battler/Tessmer Pond	-
WT-WC-HL-SB2-98-A	0.6	0.9	365.3	365.0	Shallow Overburden - Hofstetter Lake	-
WT-WC-HL-SB2-98-Z	-	-	-	-	Surface Water - Hofstetter Lake	-
WT-WC-HLSB3-18-A	0.7	1.0	365.0	364.7	Shallow Overburden - Hofstetter Lake	-
WT-WC-HL-SB3-18-Z	-	-	-	-	Surface Water - Hofstetter Lake	-

Notes:
m = metre(s)
mASL = metre(s) above sea level
- = not applicable
Trigger levels were documented in 2018 OTP and recent monitoring reports (Stantec, 2020; R.J. Burnside, 2025)
[1] Trigger level was reported in the 2024 monitoring report (RJ Burnside, 2025)

During the Stantec (2020) pumping test, the pumping rate was increased to 155 L/s, which was an increase of about 47 L/s from pre-testing rates. Drawdown due to increased pumping was monitored within aquifer unit AFB2. A drawdown of 0.7 m was observed at monitoring well WT-WC-MW4-11-A, which is immediately adjacent to the production wells. The zone of influence within AFB2 based on the interpreted 0.1 m drawdown was elongated in a northwesterly direction along Sandhills Road, extending about 4 km, from just north of Highway 7&8 to just south of Witmer Road and is reproduced in Figure 2-4. This drawdown extent is consistent with that observed by Terraqua (1995) and IWS (1970).

Drawdown within the shallow overburden aquifer (AFB1) was limited to the area immediately around the Wilmot Centre Well Field (Figure 2-5) where the intervening aquitard (ATB2) was found to be thin to absent. ATB2 is interpreted to be present beneath Silver Springs Creek as well as much of Hunsberger Creek and the upper reaches of the Kirby Farm North Tributary, limiting responses to pumping within these shallow aquifer systems.

Based on the detailed pumping test and monitoring program, Stantec (2020) concluded that the Wilmot Centre Well Field can be pumped at 158 L/s without impacting groundwater discharge to Silver Springs Creek or Hunsburger Creek and its tributaries. This is consistent with the testing program in 1994 that concluded the Wilmot Centre Well Field area can sustain an average daily pumping rate of up to 200 L/s (Terraqua, 1995) and the original testing by IWS (1970).

2.4.3 Water Level Monitoring Program

The Region operates a long-term monitoring program with the most recent annual report for the Wilmot Centre Well Field prepared for 2025 (RJ Burnside, 2026) and the annual trigger report for 2024 (RJ Burnside, 2025).

The monitoring period between 2020 and 2025 corresponded to a period of below average precipitation. During this time period, several monitoring locations exceeded the trigger levels more frequently.

WT-WC-MW5-11-A/C (located 235 m from the Wilmot Centre Well Field), WT-WC-OW8-99-A (located 200 m from the Wilmot Centre Well Field), and WT-BD-OW17-67-A (located 1 km from the Wilmot Centre Well Field) are completed within AFB2 and declined below the trigger levels shortly after pumping was increased in late 2019 to an average annual rates of 135 L/s between 2020 and 2022. Water levels during this period were approximately 1.0 to 1.5 m below typical ranges with slight recoveries in 2024 when average annual pumping decreased to 119 L/s. Water levels near the trigger levels were last observed in 2001 when the trigger levels were established. Precipitation in 2001 (900 mm) was just below the climate normal (919 mm), but was on the recovering end of the drought period from 1997-1999 which had similar (750 mm/yr) below average annual precipitation to the 2020 to 2022 drought period (769 mm/yr),

The period from 2020 to 2024 corresponded to a period of below average precipitation (848 mm/yr) with water levels in background wells (WT-WC-UW5-91-A and WT-WC-WM21-93-A), away from pumping influences, approximately 0.8 m below typical low water levels observed during the previous 20 years (July 2000 to 2020). The period between 2000 and 2020 corresponds to a period of above average annual precipitation (946 mm/yr) compared to the 2020 to 2024 period when average annual precipitation was 848 mm/yr. This indicates that lower precipitation and recharge can be attributed to at least 0.8 m of the 1.0 to 1.5 m declines in water levels observed at the monitoring wells noted above.

RJ Burnside (2025) recommended that the monitoring program from the 2018 operational performance test by Stantec (2020) should continue at the well field with the addition of WT-WC-UW5-91-A and WT-WC-WM31-93 to provide background data in areas away from pumping influences. They also recommended that the trigger water levels for wells in the program be reviewed.

2.5 Esbaugh Sand & Gravel Ltd. PTTW Application

Esbaugh Sand & Gravel Ltd. has applied for a Category 3 PTTW Application for a maximum water-taking of 225 L/s from an on-site wash pond to be constructed below the water table for the purposes of aggregate washing. The water from the washing operation will be recirculated through a series of sedimentation ponds to minimize groundwater taking. The total losses from the water taking (consumptive rate) were estimated to be less than 10 percent (22.5 L/s) with most of the water recirculated as part of the wash operations (Harden, 2026).

Harden (2026) completed a hydrogeological assessment to support the PTTW application which involved the drilling of eleven monitoring wells and installation of two staff gauges in the Schindelsteddle Wetland Complex, located in the centre of the property to monitor surface water levels (Figure 2-3). The monitoring wells and staff gauges were installed between April 2017 and April 2020. One monitoring well (MW1) is screened in the shallow system to a depth of 5 metres below ground surface (mBGS). The remaining wells are screened relatively shallow from depths ranging from 11.6 to 28.4 mBGS. Appendix A includes the monitoring locations and copies of the water level hydrographs from Harden (2026).

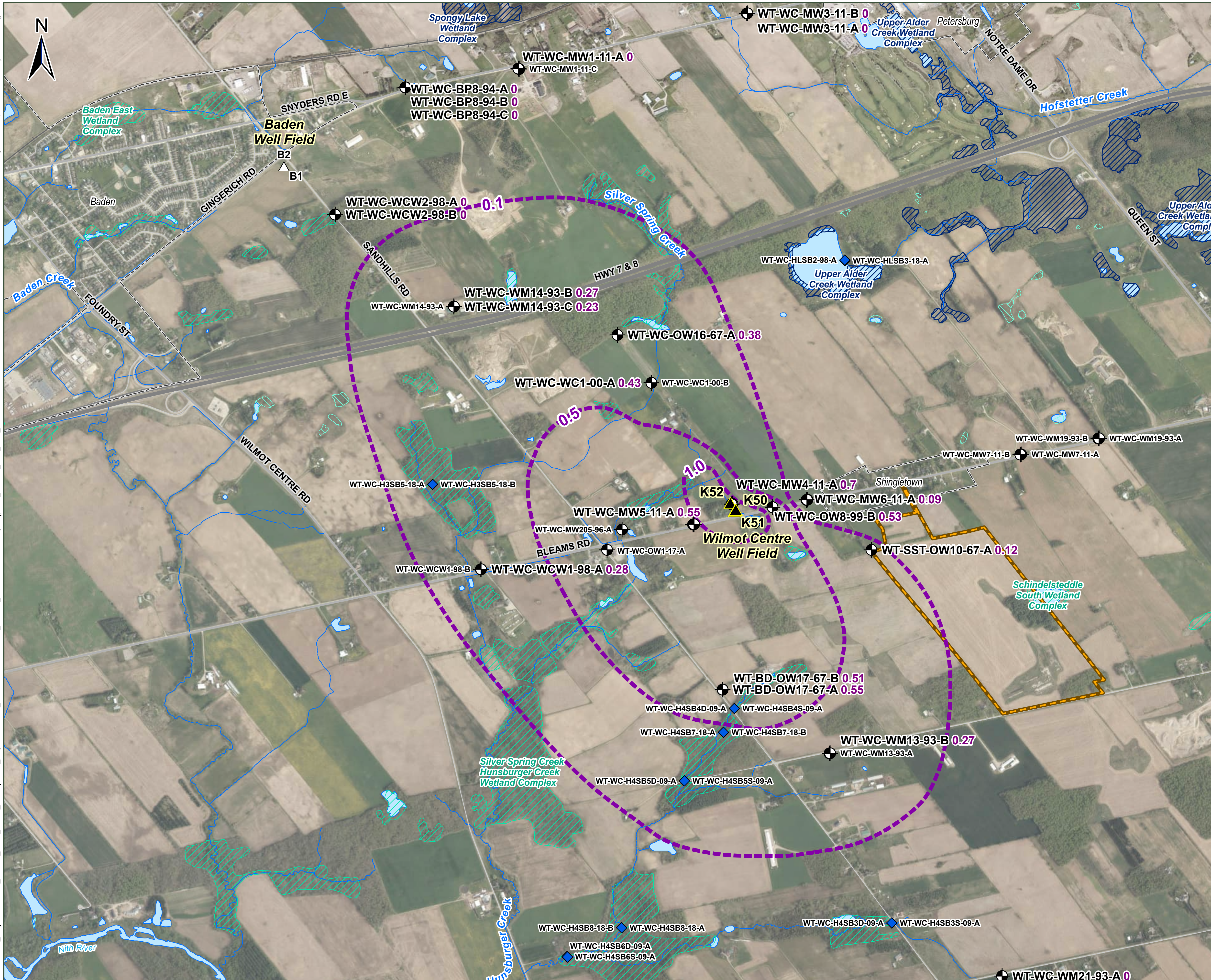
Water levels in groundwater monitoring wells across the subject property ranged from approximately 355.5 to 351.5 mASL with water levels showing seasonal variations typically in the range of 0.5 to 1.0 m (Appendix A). After 2020, water levels across the subject property declined by about 1.0 to 1.5 m. This is a similar decline as observed during the Region's water level monitoring program (RJ Burnside 2025)

The Schindelsteddle Wetland Complex shows similar responses with much more pronounced water level responses to precipitation and spring freshet conditions (Appendix A). Between 2017 and 2019, low water levels during the summer and fall were approximately 354 mASL. Between 2020 and 2022, the water levels decreased to lows between 352.7 and 352.8 mASL (Appendix A). This decline of 1.2 m to 1.3 m was similar to that observed in the Region's monitoring program locations and is interpreted to be due to below average recharge over this period and limited to no recharge in 2021 as evident by the lack of a seasonal spring rise in water levels. The lowest water levels were observed within the Schindelsteddle Wetland Complex were in the late-fall to early-winter 2025 at 352.5 mASL.

2.6 Delegation Report from Citizens for Safe Groundwater

A presentation was made at the February 25, 2026 council meeting from the Citizens for Safe Groundwater. The Citizens for Safe Groundwater presented concerns related to the cumulative impacts on water levels in the area due to increased pumping from the Wilmot Centre Well Field and the proposed water taking at the Esbaugh Sand & Gravel Ltd. for aggregate washing. Specifically, the delegation presentation raised concerns about declining water levels over the past 3 years (2021 to 2025) and the potential impacts on shallow groundwater levels and wetland features as well as the potential impact on private wells. The report made special reference to the wetland feature located adjacent to the Esbaugh Sand & Gravel Ltd. property, referred to as the Schindelsteddle Wetland Complex, citing water level declines reported between 1.5 and 2.0 m.

The delegation interpreted the decline to be due to no groundwater recharge in 2021, which is consistent with observations from the Region monitoring program but also is attributed to an extended period of below average precipitation (2020 to 2022) of 769 mm/yr, well below the climate normal of 919 mm/yr with 2022 being the lowest annual precipitation levels observed since 1971.



LEGEND:

- PRODUCTION WELL - IN SERVICE
- PRODUCTION WELL - OUT OF SERVICE
- MONITORING WELL
- STREAMBED WELL / SURFACE WATER
- 0.57 DRAWDOWN (M)
- DRAWDOWN CONTOUR (M)[3]
- RAILWAY
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- WATERCOURSE
- ESBAUGH SAND & GRAVEL LTD. SITE
- MUNICIPAL BOUNDARY
- TOWN BOUNDARY
- PROVINCIALLY SIGNIFICANT WETLAND (MNR)
- EVALUATED WETLAND (MNR)
- UNEVALUATED WETLAND (MNR)
- WATERBODY

NOTES:
1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE – ONTARIO.
2. CONTAINS INFORMATION MADE AVAILABLE UNDER GRAND RIVER CONSERVATION AUTHORITY'S OPEN DATA LICENCE V2.0.
3. STANTEC, 2020. 2018 OPERATIONAL TESTING PROGRAM, WILMOT CENTRE WELL FIELD, REGIONAL MUNICIPALITY OF WATERLOO.

0 125 250 500 750 m

SCALE: 1:20,000
PAGE SIZE 11 x 17
NAD 1983 UTM Zone 17N

THIS MAP IS FOR CONCEPTUAL PURPOSES ONLY AND SHOULD NOT BE USED FOR NAVIGATION

REGION OF WATERLOO

WILMOT CENTRE WELL FIELD PUMPING AND WATER LEVEL ASSESSMENT

2018 AQUIFER TESTING PROGRAM - DRAWDOWN IN AFB2

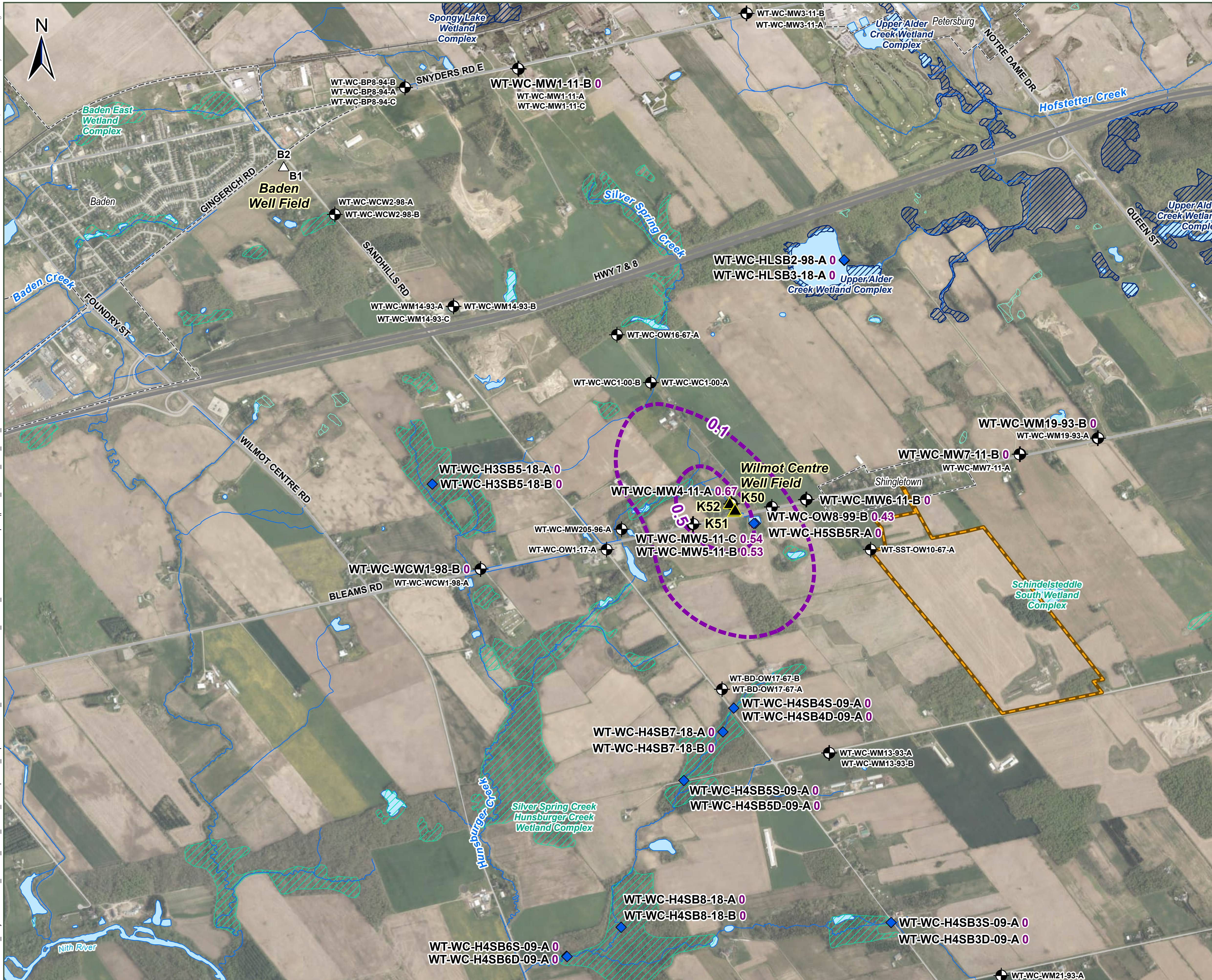
SLR

FIGURE NO: **2-4**

DATE: March 31, 2026 PROJECT NO: 241.032851.00001

GIS PATH: G:_Projects\241\241_032378_ROW_ASR\1_Workspace\1_Maps\WilmotWF_WaterLevelAssess\241_032378_WilmotWaterLevels.aprx || 241_032851_TM1_02-4_DrawdownAFB2

Last Saved: Tuesday, March 31, 2026 2:09 PM by christina.coghlan



LEGEND:

- PRODUCTION WELL - IN SERVICE
- PRODUCTION WELL - OUT OF SERVICE
- MONITORING WELL
- STREAMBED WELL / SURFACE WATER
- 0.57 DRAWDOWN (M)
- DRAWDOWN CONTOUR (M)[3]
- RAILWAY
- HIGHWAY
- MAJOR ROAD
- LOCAL ROAD
- WATERCOURSE
- ESBAUGH SAND & GRAVEL LTD. SITE
- MUNICIPAL BOUNDARY
- TOWN BOUNDARY
- PROVINCIALLY SIGNIFICANT WETLAND (MNR)
- EVALUATED WETLAND (MNR)
- UNEVALUATED WETLAND (MNR)
- WATERBODY

NOTES:
1. CONTAINS INFORMATION LICENSED UNDER THE OPEN GOVERNMENT LICENCE – ONTARIO.
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3. STANTEC, 2020. 2018 OPERATIONAL TESTING PROGRAM, WILMOT CENTRE WELL FIELD, REGIONAL MUNICIPALITY OF WATERLOO.

0 125 250 500 750 m

SCALE: 1:20,000
PAGE SIZE 11 x 17
NAD 1983 UTM Zone 17N

THIS MAP IS FOR CONCEPTUAL PURPOSES ONLY AND SHOULD NOT BE USED FOR NAVIGATION

REGION OF WATERLOO

WILMOT CENTRE WELL FIELD PUMPING AND WATER LEVEL ASSESSMENT

2018 AQUIFER TESTING PROGRAM - DRAWDOWN IN AFB1

SLR

FIGURE NO: **2-5**

DATE: March 31, 2026

PROJECT NO: 241.032851.00001

3.0 Climatic and Precipitation Trends

The following section presents the climatic data and methodology for processing to allow a review of annual precipitation and temperature trends. The review is presented to identify longer term variations in climatic conditions that may have impact on recharge and groundwater levels.

While recharge can be impacted by a wide variety of factors, including soil type and soil moisture content, timing and magnitude of precipitation events, land use cover and slopes, and temperature, the annual variations in precipitation data were used as a surrogate for potential variations in groundwater recharge given the time scale being considered (53 years).

3.1 Data Compilation Methodology

Historical climatic data were obtained from the Environment and Climate Change Canada (ECCC) historical weather database for nearby Roseville station (Climate ID No. 6147188). Dates with missing precipitation and temperature data were supplemented with ZUM 9 climate data recorded at the Waterloo Wellington A (Climate ID No. 614387), Kitchener/Waterloo (Climate ID No. 6144239), and Region of Waterloo Int'l Airport (Climate ID No. 6149388) stations using the ECCC Adjusted and Homogenized Canadian Climate Data (AHCCD) station-joining protocol (Mekis and Vincent, 2011; Wang et. al., 2017). The station-joining protocol produced a complete climate dataset to analyse climatic trends in the Mannheim Well Fields area.

The combined dataset ranges from 1973 to 2025. The daily precipitation from the combined dataset was summed to generate annual totals, with daily temperature averaged to provide annual average daily temperature. Climate normals for the period of 1981 to 2010 were obtained from the Roseville station and used for comparison to historical data.

3.2 Annual Climate Trend Assessment

The annual temperature (mean) from 1973 to 2025 is plotted with the 1981 to 2010 climate normals on Figure 3-1. The mean annual temperature fluctuates around the historical climate normal (7.3 °C) from 1973 to 1997 and is generally 1 to 3 degrees above the climate normal since 1997. Since 1973 annual average temperatures have shown a gradual increase over time.

Figure 3-1 presents the annual precipitation trends over the period 1973 to 2025 and the climate normal precipitation of 919 millimetres (mm) from Roseville for the period 1981 to 2010. The average annual precipitation from 1973 to 2025 is 920 mm/yr, which is within 1 percent of the 1981 to 2010 climate normal. Therefore, the 1981 to 2010 climate normal is considered appropriate for comparison to precipitation data over this period. A five-year moving average trend line is shown to allow identification of longer periods of above and below average precipitation relative to the climatic normal (919 mm/yr).

The annual total precipitation generally fluctuates above and below the climate normal (Figure 3-1) with cyclical patterns of extended above and below average precipitation evident over time. Extended years with precipitation levels below the climate normal occur approximately every 5 to 10 years and include:

- Period A – corresponding to three years in four of precipitation below the climate normal between 1978 to 1981 with an average annual precipitation of 840 mm/yr (Period A on Figure 3-1).

- Period B – corresponding to four years of precipitation below the climate normal between 1987 to 1989 with an annual precipitation of 810 mm/yr (Period B on Figure 3-1).
- Period C – corresponding to three years of precipitation below the climate normal between 1993 to 1995 with an average annual precipitation of 816 mm/yr (Period C on Figure 3-1).
- Period D – corresponding to three years of precipitation below the climate normal between 1997 to 1999 with an average annual precipitation of 750 mm/yr (Period D on Figure 3-1).
- Period E – corresponding to three years of precipitation below the climate normal between 2020 to 2022 with an average annual precipitation of 769 mm/yr (Period E on Figure 3-1).

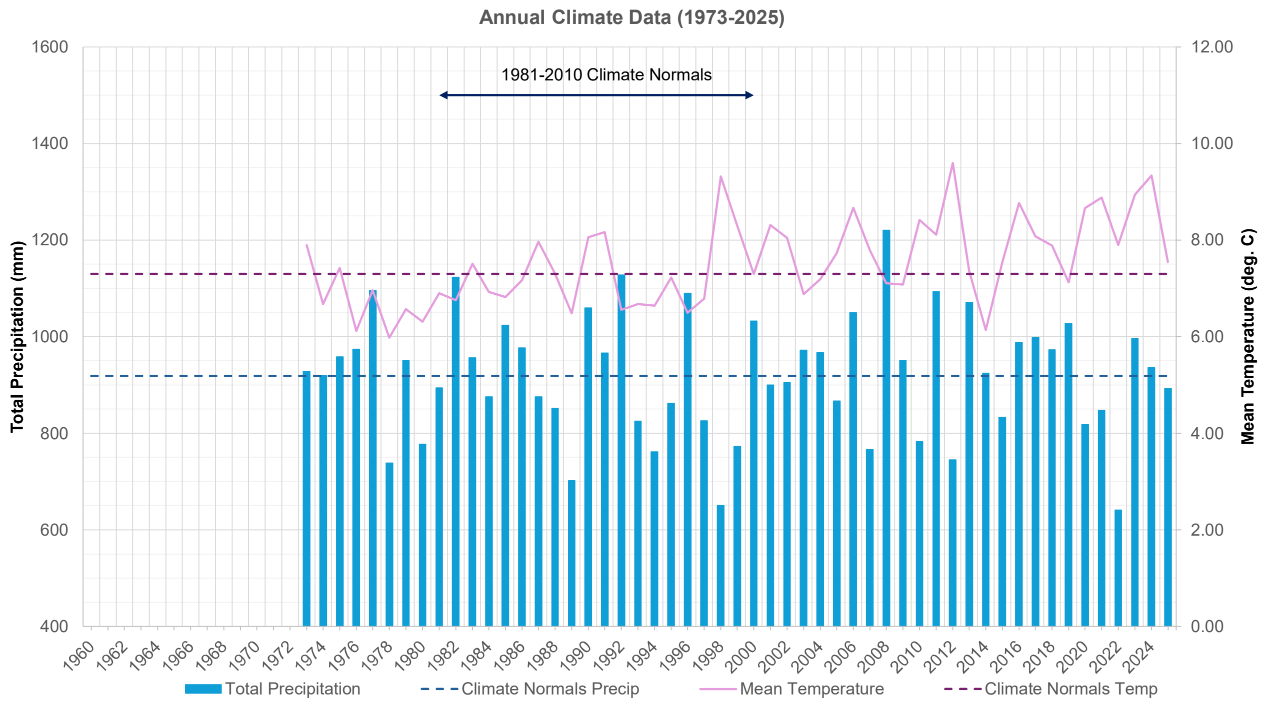
Four of these five periods, including the most recent period (2020 to 2022), also occurred during periods where the five-year moving average trend line declines below the climate normal. The most recent period of below average precipitation (2020 to 2022; Period E on Figure 3-1) is the second lowest precipitation average since 1973 and was similar to the average precipitation observed in the 1997 to 1999 period (Period D on Figure 3-1). During this 53-year period, annual precipitation levels below 750 mm/yr (82% of climate normal) were only recorded four times, in 1978, 1989, 1998, and 2022 with precipitation below 700 mm/yr (76% below climate normal) only recorded in 1998 and 2022.

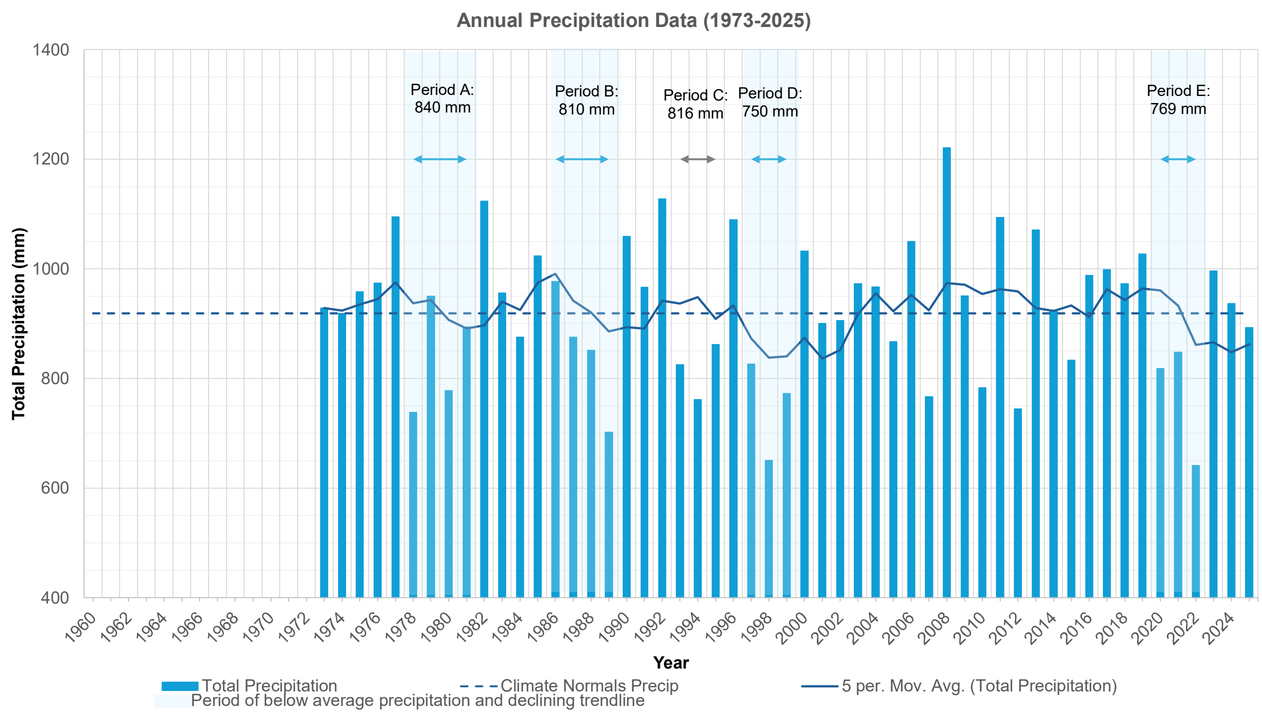
Precipitation was reviewed for the main recharge periods that typically occurs during the spring (March to May) and fall (September to November). While winter snowpack and melt conditions will impact on groundwater recharge, the precipitation from March to May and September to November were taken as representative of the period of higher recharge potential to simplify the evaluation.

Figure 3-2 presents the seasonal precipitation amounts for spring (March through May) along with the corresponding Climate Normals to provide an indication of precipitation during the main spring recharge periods. The Climate Normal dataset indicates that the average monthly precipitation recorded from March to May (i.e., a 3-month period covering spring freshet) is 220 mm. Four periods with more than three consecutive years of average monthly precipitation below the spring Climate Normal precipitation of 220 mm/yr (spring drought periods) were identified, including 1985-1990 (186 mm), 1997-1999 (174 mm), 2005-2008 (174 mm), and 2020-2022 (158 mm). The most recent spring drought period, from 2020 to 2022, contains the lowest total seasonal precipitation on record at 158 mm/yr. In each of the following years 2023, 2024, 2025 and 2026, precipitation levels increased to 264, 259, 212, and 281 mm, respectively, resulting in an average of 254 mm. Within this period (2023 to 2026), the average monthly precipitation for 3 of the 4 years exceeded the climate normal seasonal precipitation, signalling a recovery from the seasonal drought conditions of 2020-2022.

Figure 3-3 presents the seasonal precipitation amounts for fall (September through November) along with the corresponding climate normal to provide an indication of precipitation during the main fall recharge periods. The climate normal dataset indicates that the average monthly precipitation recorded from September through November is 250 mm. There are four periods with more than three consecutive years of average monthly precipitation less than the fall climate normal precipitation of 250 mm/yr (fall drought periods): 1974-1976 (220 mm/yr), 1997-2000 (181 mm/yr), 2015-2017 (178 mm/yr), and 2023-2025 (163 mm/yr).

The 2020 to 2025 period includes the lowest spring precipitation on record (158 mm/yr) with the fall low occurring from 2023 to 2025 (164 mm/yr), again representing the lowest fall precipitation on record. While precipitation levels during the spring increased through 2023 and 2024, the below-average fall precipitation may hinder recharge and delay recovery of groundwater and soil moisture levels. The timing of the precipitation events and impacts on groundwater recharge will be reviewed in Section 6.0.





Notes:

Client / Project:
Region of Waterloo
Wilmot Centre Well Field Pumping
and Water Level Assessment

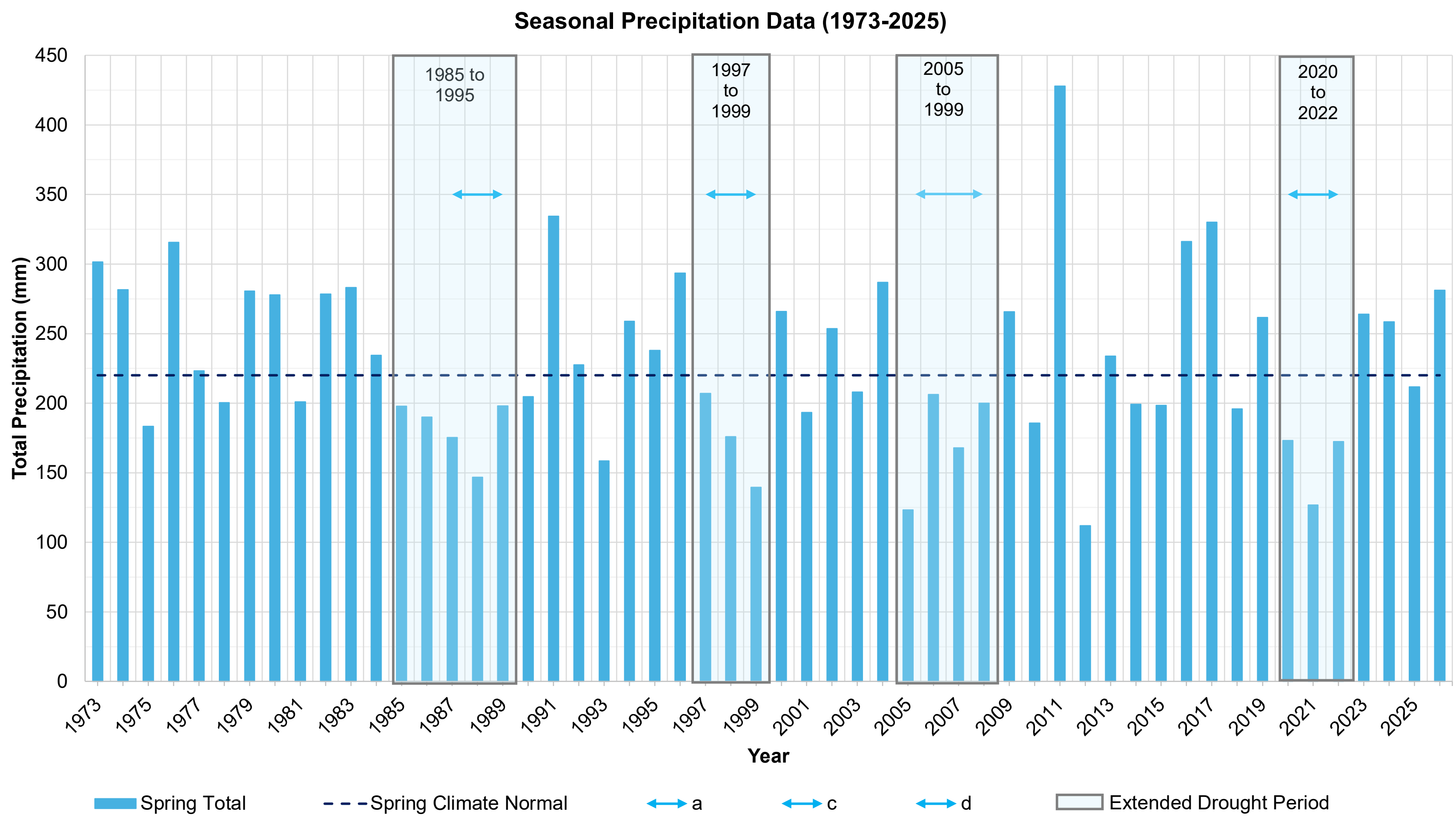
Title:
Total Annual Precipitation and Average Temperature
Compared to Climate Normals (1973-2025)

Date: April 1, 2026

Figure 3-1

Project Number: 241.032851.00001

SLR

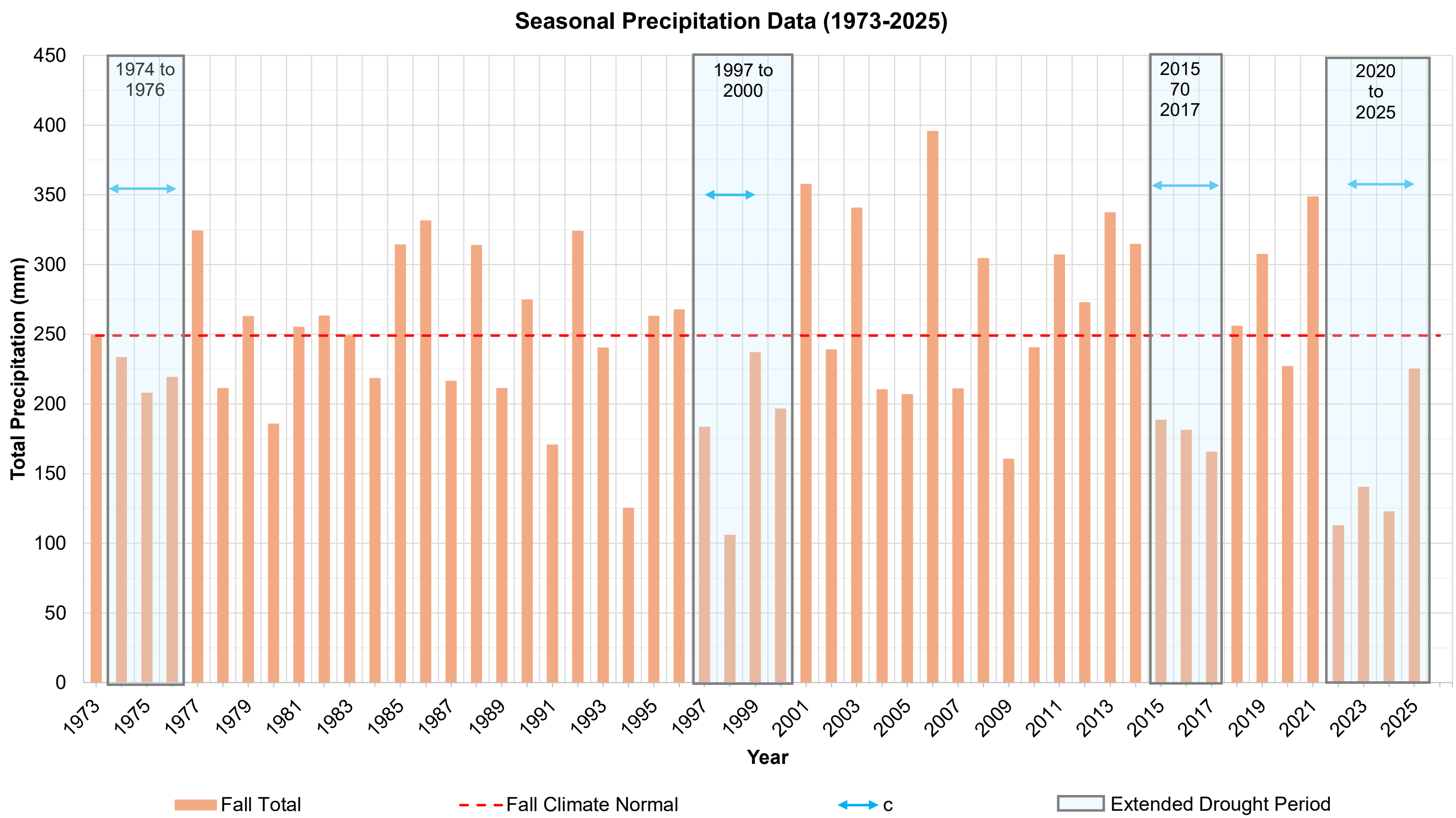


Notes:

Extended drought period refers to a period of three or more years with below average (below climate normal) total precipitation with declining trend (5 year moving trendline).

Client / Project:	Region of Waterloo Wilmot Centre Well Field Pumping and Water Level Assessment
Title:	Spring (March to May) Precipitation Trends (1973-2025)
Date:	July 10, 2026
Project Number:	241.032851.00001
Figure	3-2

SLR



Notes:

Extended drought period refers to a period of three or more years with below average (below climate normal) total precipitation with declining trend (5 year moving trendline).

Client / Project:

Region of Waterloo
Wilmot Centre Well Field Pumping and Water Level Assessment

Title:

Fall (Sept to Nov) Precipitation Trends (1973-2025)

Date: July 10, 2026

Project Number: 241.032851.00001

Figure 3-3

4.0 Historical Pumping Wilmot Centre Well Field

The pumping history for the Wilmot Centre Well Field was reviewed to confirm historical trends. Given that the Baden Well Field was historically used to meet the needs of the communities of Baden and New Hamburg, pumping from Production Wells B1 and B2 at the Baden Well Field have been included as they were pumped from the same aquifer as the Wilmot Centre Well Field. The Baden Well Field is located approximately 3 km to the north and upgradient from the Wilmot Centre Well Field (Figure 2-1).

4.1 Data Compilation Methodology

Pumping data were obtained from the Region and consisted of average pumping rates in cubic metres per day for each pumping well for varying time periods (e.g., average pumping rate for a single day or multi-day period). The data were processed to provide average daily and annual pumping rates for each production well.

The reliable operating flow determined from groundwater modelling completed in support of the WSSU for the Wilmot Centre Well Field is included for comparison. This flow rate was determined based on detailed groundwater modelling, which confirmed that pumping at 158 L/s is sustainable, with additional available drawdown remaining at the well field. Although the Wilmot Centre Well Field may be able to produce higher sustainable pumping rates, the pumping rate is limited by the current PTTW to a maximum rate of 158 L/s and not by the sustainable capacity of the well field.

4.2 Annual Pumping Trends

Figure 4-1 presents the average annual daily pumping rates from the Wilmot Centre and Baden Well Fields. Pumping data from the Wilmot Centre Well Field began in 1972 with pumping data at the Baden Well Field starting in 1977. Pumping from the Baden Well Field was discontinued as a water supply source due to elevated nitrate concentrations with pumping to waste terminated in 1999 based on detailed modelling which confirmed that groundwater with elevated nitrate concentrations would not result in nitrate concentrations above 6 milligrams per litre (mg/L) at the Wilmot Centre Well Field (Stantec and Waterloo Hydrogeologic, 1999). Since this time, the Region has been actively monitoring groundwater quality in the area to confirm nitrate concentrations. This monitoring supports the conclusions of previous work with nitrate concentrations noticeably declining over the past decade from an average of 4.1 mg/L in 2015 to 2.3 mg/L in 2025 at K50, and from an average of 1.2 mg/L in 2015 to 0.5 mg/L in 2025 at K51.

From the pumping data, five main pumping periods were identified:

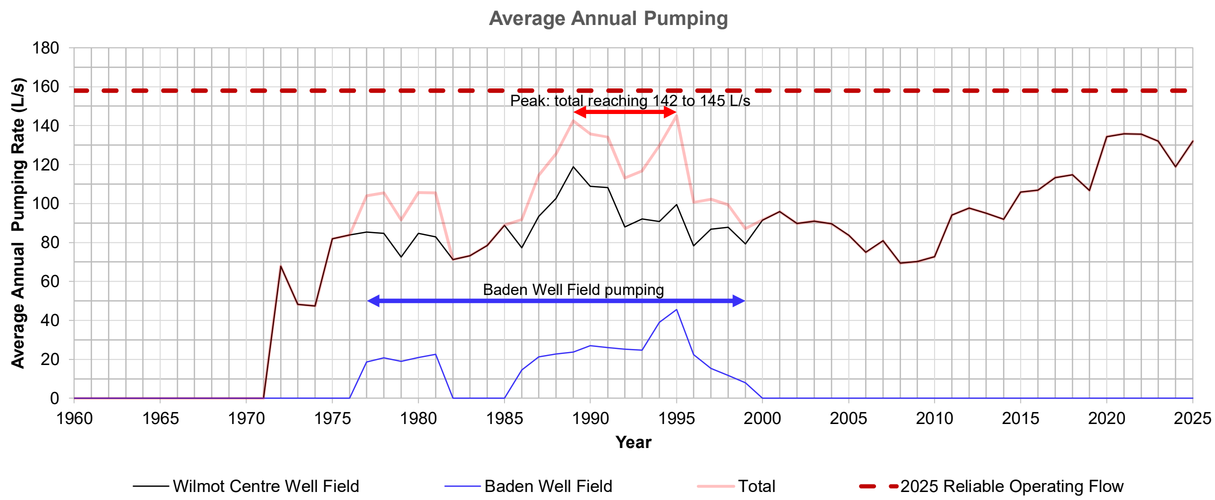
- Period 1 – total pumping from the Wilmot Centre Well Field averaging 74 L/s between 1972 and 1981 (Period 1 on Figure 4-1).
- Period 2 – beginning in 1982 pumping at the Wilmot Centre Well Field gradual increased reaching 119 L/s in 1989 (Period 2 on Figure 4-1).
- Period 3 – pumping gradually declined back to historical ranges (79 L/s) at the Wilmot Centre Well Field by 1999 (Period 3 on Figure 4-1). During this same period, the Baden Well Field was in operation with the total pumping from both well fields hitting 142 and 145 L/s in 1989 and 1995, respectively. The Baden wells were not pumped after 1999.

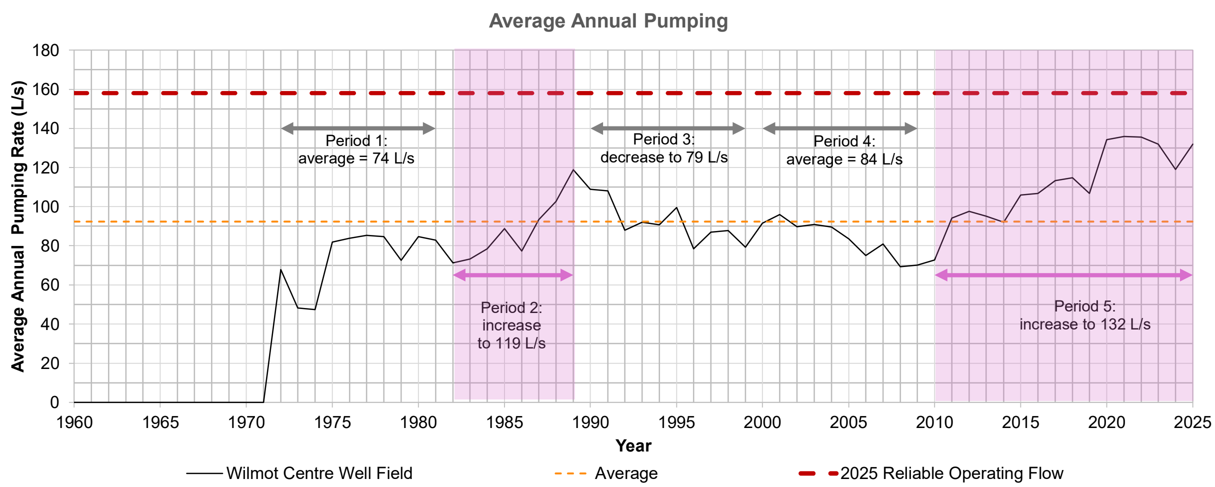
- Period 4 – from 2000 to 2009 (Period 4 on Figure 4-1) the average pumping rate (84 L/s) at the Wilmot Centre Well Field was similar to historical ranges during Period 1 and 3. The Baden Wells were not used during this time.
- Period 5 – since 2010 pumping at the Wilmot Centre Well Field has been gradually increasing from 73 L/s to 132 L/s in 2025 (Period 5 on Figure 4-1). The Baden Wells were not used during this time.

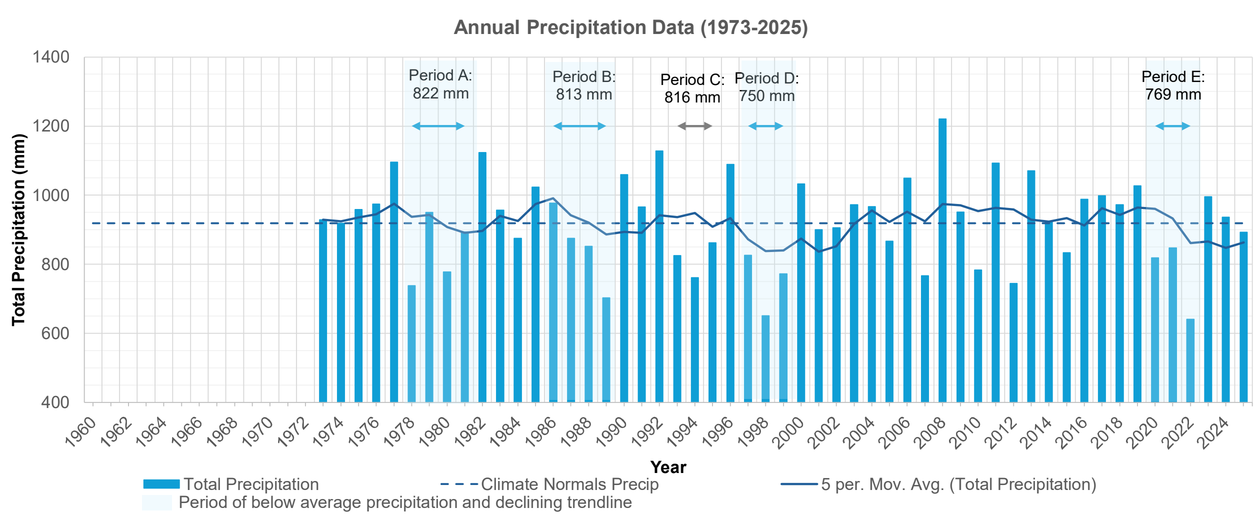
From an aquifer perspective, AFB2 (the aquifer unit water is extracted from both the Baden and Wilmot Centre Well Fields) has experienced annual pumping above 120 L/s for extended periods of time during 1988 to 1995 and recently between 2020 and 2025 at only the Wilmot Centre Well Field.

Over the 53-year period since pumping began at the Wilmot Centre Well Field, the average annual pumping rate was 92 L/s at the Wilmot Centre Well Field, with some below average pumping (Period 1, most of Period 3, and Period 4) and some periods with above average pumping (Period 2, start of Period 3, and Period 5) (Figure 4-1).

When comparing with periods of below average precipitation, some occurred during below average pumping (Periods A, C and D), while others occurring during periods of above average pumping (Periods B and E). The impacts of pumping and below average precipitation on groundwater levels is discussed in Section 5.3.







Notes:

Client / Project:
Region of Waterloo
Wilmot Centre Well Field Pumping
and Water Level Assessmen

Title:
Average Annual Pumping at the Wilmot Centre and Baden Well Fields (1972-2025)

Date: April 1, 2026
Figure 4-1
Project Number: 241.032851.00001

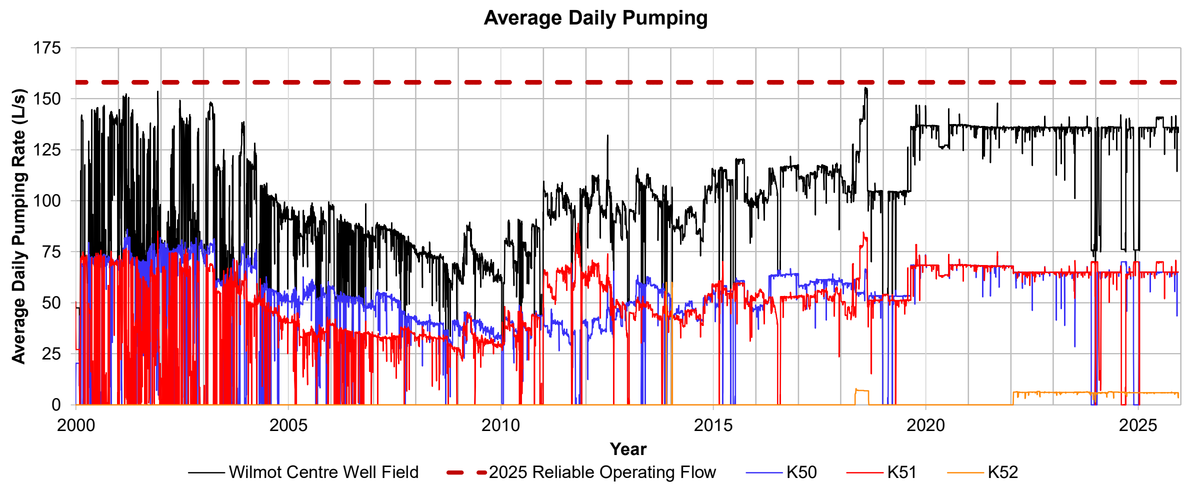
SLR

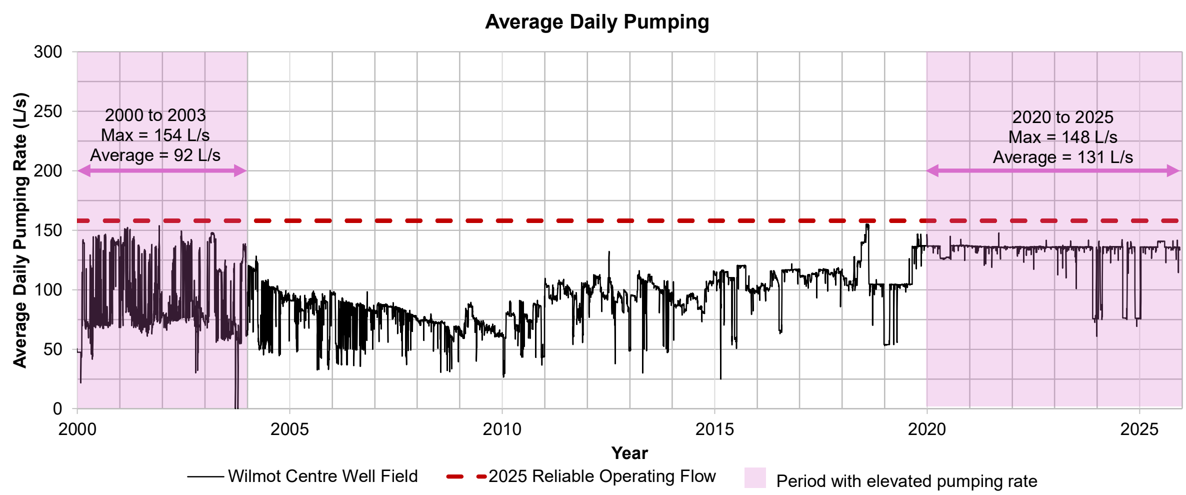
4.3 Daily Pumping 2000-2025

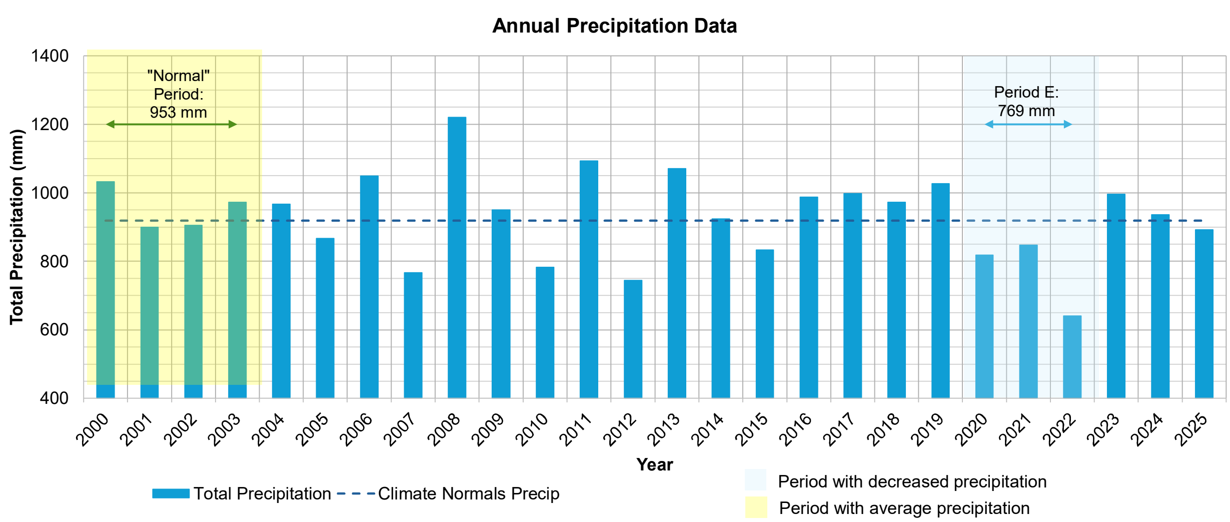
The average daily pumping rates were plotted from 2000 to 2025 for the Wilmot Centre Well Field to assess the recent increasing pumping trends during this period. The daily pumping and annual climate data are plotted on Figure 4-2. Two key pumping periods were identified:

- 2000 to 2003 – the pumping rate generally fluctuated between 70 and 138 L/s, with an average daily rate of 92 L/s. The daily pumping rate reached a maximum of 154 L/s on multiple occasions, close to the 2025 reliable operating flow of 158 L/s.
- 2020 to 2025 – the pumping rate was relatively consistent averaging 131 L/s with two main periods of pumping fluctuations in 2024 when pumping decreased from approximately 135 L/s to 75 L/s.

Due to the frequent fluctuations in pumping rate between 2000 to 2003, the average annual pumping data does not capture the frequent elevated pumping rates above 120 L/s. Pumping during this time corresponds to a period of "normal" precipitation (953 mm/yr) and is expected to indicate water levels typical of pumping at high rates. The 2020 to 2025 period overlaps with a period of reduced precipitation from 2020 to 2022 (769 mm/yr), followed by a period of average precipitation above the climate normal. These periods (2000 to 2003, and 2020 to 2022) can be used to interpret responses to pumping during periods of normal and below-average precipitation. This comparison will be discussed in Section 5.4.







Notes:

Client / Project:
Region of Waterloo
Wilmot Centre Well Field Pumping
and Water Level Assessment

Title:
Average Daily Pumping at the Wilmot Centre Well Field
Compared to Total Annual Precipitation (2000-2025)

Date: April 1, 2026

Figure 4-2

Project Number: 241.032851.00001

5.0 Historical Water Levels and Pumping Responses

Historical water level data were compiled and compared with pumping data from the Baden and Wilmot Centre Well Fields and the annual precipitation data to provide insights into the response of water levels to both longer term pumping and precipitation/recharge conditions. This section brings together the climatic data presented in Section 3 and the historical pumping presented in Section 4 to provide an interpretation of the effects on groundwater levels from pumping at the Wilmot Centre Well Field. These pumping effects are interpreted together with the impact of varying climate conditions, which can often be incorrectly interpreted as solely a pumping response.

5.1 Data Compilation and Methodology

A water level database was provided by the Region for monitoring wells in the Wilmot Centre and Baden Well Field areas. Discrete (e.g., manual water levels) and continuous (e.g., processed datalogger data at one-hour time intervals) datasets were provided. The average daily water level for each location was calculated for the duration of the dataset. The average daily water level was considered appropriate for the long-term trend analysis being completed.

5.2 Monitoring Well Selection

For this assessment, monitoring wells screened in the key municipal aquifer (AFB2) were selected from the list of locations in Table 2-5 that are spatially distributed around the Wilmot Centre Well Field. This was undertaken as pumping will have the greatest effect on water levels immediate adjacent to the production well and will become progressively less with radial distance from the well. The locations selected represent various areas of interest. These included:

- Monitoring wells in recharge areas north of the Wilmot Centre Well Field and Baden Well Fields where pumping influences were expected to be minimal,
- Monitoring wells screened near the Baden Well Field and Wilmot Centre Well Field to provide the direct water level response to pumping, and
- Monitoring locations downgradient of the Wilmot Centre Well Field.

Groundwater monitoring locations were selected with the longest data set to allow comparison to the early periods of pumping in the 1970s. Table 5-1 describes the selected monitoring locations and dataset range. The selected wells are screened at varying depths from 19.9 to 46.9 mBGS (348.6 to 315.4 mASL) within AFB2. The Wilmot Centre Well Field production wells are screened from 30.5 to 39.6 mBGS (328.8 to 319.7 mASL).

Table 5-1: Monitoring Well Details for Long-term Water Level Trend Assessment

Region Monitoring Well ID	Start Date	End Date	Screen Top (m)	Screen Bottom (m)	Screen Top (mASL)	Screen Bottom (mASL)	Screened Unit	Trigger Level (mASL) (Stantec, 2020; RJ Burnside, 2025)	Selection
WT-WC-BP8-94-A	7/9/1998	12/11/2023	35.6	37.2	336.1	334.5	AFB2	-	Upgradient Recharge Area
WT-WC-UW5-91-A	7/9/1998	11/26/2025	30.2	33.2	348.6	345.5	AFB2	-	Upgradient Recharge Area
WT-WC-MW4-11A	8/17/2011	11/28/2025	32.9	36.0	326.5	323.4	AFB2	-	Near Wilmot Centre Production Wells
WT-WC-OW8-99-A	2/15/2000	1/23/2026	40.8	46.9	322.6	316.5	AFB2	351.71	Near Wilmot Centre Production Wells
WT-WC-OW9-67-A [a]	9/1/1967	12/10/2013	40.5	43.8	318.5	315.1	AFB2	-	Near Wilmot Centre Production Wells
WT-BD-OW17-67-A	11/22/1967	1/23/2026	33.2	39.9	323.7	317.0	AFB2	351.40	Downgradient
WT-WC-WM21-93-A	7/8/1998	11/26/2025	19.9	23.0	341.7	338.6	AFB2	-	Downgradient
WT-WC-WM13-93-B	7/9/1998	12/11/2023	28.3	31.4	332.2	329.1	AFB2	-	Downgradient

Notes:
[a] this well is decommissioned and is not part of the 2018 monitoring program.
m = metre(s)
mASL = metre(s) above sea level
- = not applicable

5.3 Average Annual Pumping and Water Level Trends (1973 to 2025)

Figures 5-1 through 5-3 present hydrographs for select monitoring wells distributed around the Wilmot Centre Well Field. The periods of low precipitation and increased pumping discussed in Sections 3.0 and 4.0 are overlayed on the hydrographs for reference.

5.3.1 Water Levels in Vicinity of Wilmot Centre Production Wells

Long-term average daily water levels at monitoring wells in the vicinity of the Wilmot Centre production wells (K50, K51, and K52) are presented on Figure 5-1 (hydrograph). To provide a comparison, water levels were selected from:

- WT-WC-OW9-67-A which is located within 25 m of K51 and has data extending back to 1967, just prior to the start of pumping at the Wilmot Centre Well Field. Data from WT-WC-OW9-67-A ended in 2013. Due to the close proximity to WT-WC-MW4-11-A it is anticipated that water levels in the aquifer at WT-WC-OW9-67-A and WT-WC-MW4-11-A will be the most influenced by pumping and reflective of aquifer levels immediately adjacent to the production wells, providing a long term data set.
- WT-WC-MW4-11-A located 15 m from K52 with data starting in 2011.
- WT-WC-OW8-99-A located about 200 m east of K51 with data starting in 2000. This location recently had water levels below the trigger criteria (previously discussed in Section 2.4.2.3).

The time series for these locations can be combined to provide a continuous dataset over the entire pumping period.

The following provides a summary of the water level responses observed including during key pumping periods (Pumping Periods 1, 2 and 5) and periods when precipitation is below the climatic normals for extended periods (Precipitation Periods A, B, D, and E):

- 1972 to 1977 (start of Pumping Period 1 on Figure 5-1): this period corresponds to the start of pumping at the Wilmot Centre Well Field with an average annual precipitation total of 943 mm/yr, slightly above the climatic normal. Groundwater levels in AFB2 at WT-WC-OW9-67-A were approximately 353.5 mASL before the start of pumping at the Wilmot Centre Well Field. With the start of pumping water level decreased to approximately 351.0 mASL by 1975, corresponding to a water level decline of approximately 2.5 m. From 1975 to 1977 the water levels were relatively stable around 351.0 mASL for an average annual pumping rate of approximately 84 L/s.
- 1978 to 1981 (Precipitation Period A on Figure 5-1): this period corresponds to the first period of below average precipitation with an annual average over the four-year period of 840 mm/yr. The average annual pumping rate at the Wilmot Centre Well Field was 81 L/s during this period, slightly lower than the pumping rate from 1975 to 1977 (84 L/s). Despite the similar pumping rate water levels at WT-WC-OW9-67-A gradually decreasing from approximately 351.0 mASL to 350.5 mASL, representing an additional decline of 0.5 m. This 0.5 m decline can be attributed to the extended period of below average annual precipitation levels.
- 1982 to 1989 (Pumping Period 2 and Period 2B on Figure 5-1): this period corresponds to a period of increasing pumping rate up to 119 L/s and periods of above (Period 2) and below average precipitation (Period 2B).

  - 1982 to 1985 (Pumping Period 2): the average annual pumping rate is steadily increasing from 71 to 89 L/s with an average annual pumping rate of 78 L/s over this period, slightly lower than the average rate during the previous period from 1978 to 1981 (Period A; 81 L/s). The average annual precipitation during this period was 995 mm/yr, above the climate normal, and greater than the average annual precipitation recorded from 1978 to 1981 (Period A; 840 mm/yr). Groundwater levels at WT-WC-OW9-67-A increased from 350.5 mASL to 352.0 mASL, a recovery of approximately 1.5 m. This water level recovery is interpreted to be related increased precipitation and recharge, as opposed to the slight reduction in pumping rate as the annual average rate was increasing during this period from 71 to 89 L/s.
  - 1986 to 1989 (Period 2B): the average annual pumping rate steadily increased to 119 L/s. During this time, the average annual pumping rate was 98 L/s with an average annual precipitation of 852 mm/yr, below the climate normal, and much lower than the average annual precipitation observed from 1982 to 1985 (995 mm/yr). During this time of increased pumping and lower than average precipitation, groundwater levels at WT-WC-OW9-67-A decreased from 352.0 mASL to 350.0 mASL, a decline of 2.0 m, the lowest recorded.

    The decline resulted in a groundwater elevation (350 mASL) 1 m below the observed water level from 1975 to 1977 (351 mASL), which suggests that both the increase in pumping coupled with below average precipitation levels were the cause of this observed decline. From 1985 to 1990 spring precipitation averaged 186 mm/yr and was below the climate normal of 220 mm/yr and is the only period since 1973 with a five year period of precipitation below the climate normal, suggesting reduced recharge could be the main driver for the water level decline during this period.

- 2000 to 2009 (Pumping Period 4 on Figure 5-1): this corresponds to an extended period (10 years) of relatively normal precipitation and stable pumping rates. Annual precipitation was below the climate normal for four years and above the climate normal for six years. The annual precipitation ranged from 767 to 1221 mm/yr with an average annual precipitation of 963 mm/yr, slightly above the climate normal.

  The average annual pumping rate during this period ranged from 69 L/s in 2008 to 96 L/s in 2001, with an average annual rate of 84 L/s. The hydrograph shows that the water levels at WT-WC-OW9-67-A increased approximately 2 m during this 10-year period and at the end of this period were approximately 353.5 to 354.0 mASL, or 0.5 m above the water levels observed in the early 1970s prior to the start of pumping. This represents an important point; despite pumping at the well field for 37 years water levels were similar to pre-pumping levels.

- 2010 to 2025 (Pumping Periods 5-1, 5E, and 5-2 on Figure 5-1): this period corresponds to a steady increase in pumping from approximately 73 L/s to 135 L/s (Period 5). This period included a 3-year period of below average precipitation (2020 to 2022; Period 5E).
  - 2010 to 2019 (Period 5-1): this period corresponds to an extended period (10 years) of relatively normal precipitation, similar to 2000 to 2009 (Period 4). There were three years below, and seven years above the climate normal. The annual precipitation ranged from 745 to 1093 mm/yr, with an average total precipitation of 944 mm/yr, slightly above the climate normal. The average pumping rate increased from 73 L/s in 2010 to an average annual maximum of 115 L/s in 2018, with an average annual rate of 100 L/s from 2010 to 2019.

The hydrograph indicates that the water level at WT-WC-OW9-67-A was approximately 353.5 mASL at the start of the period, which was similar to the water level observed under pre-pumping levels in the early 1970s. Using the combined dataset from WT-WC-MW4-11-A and WT-WC-OW9-67-A (well was decommissioned during this period), the water level decreased to 352.0 mASL, a decline of 1.0 to 1.5 m over the ten-year period. As climate was considered near "normal", the water level decline is attributed to an increase in pumping with water levels showing a clear response to pumping during this time. The observed low groundwater elevation of 352.0 mASL during this time is above water levels observed during the previous period of increasing pumping under similar climate conditions (Period 2), and just 1.0 to 1.5 m below pre-pumping water levels observed in 1968 and 1969 despite pumping at an average annual rate of 100 L/s.

- 2020 to 2022 (Pumping Period 5E): this period corresponds to a three year period of below average annual precipitation. The average annual precipitation was 769 mm/yr, and the total precipitation observed in 2022 (641 mm) was the lowest annual precipitation measured in the entire study period. This also corresponds to a period of increasing pumping rates, with annual rates increasing from 107 L/s in the preceding year (2019) to 136 L/s in 2022. The average annual pumping rate over this period was 135 L/s.

  The hydrograph indicates that water levels at WT-WC-MW4-11-A decreased from approximately 352.0 mASL to 351.0 mASL, a water level decline of approximately 1 m over a three-year period, which is interpreted to be related to mainly the on-set of drought conditions with one of the lowest annual precipitation periods observed over the 53-year period. The water level within AFB2 at the end of 2022 was approximately 351.0 mASL in the vicinity of the production wells, which was consistent with historical water levels observed between 1975 and 1980 and 1987 and 1988 during similar prolonged drought conditions and lower pumping rates, 1975 to 1980 was 82 L/s and 1987 to 1988 was 98 L/s. Despite the higher pumping rates in 2020 to 2022 of 135 L/s, similar water levels are observed indicating drought conditions have a pronounced impact on water levels in the area of the Wilmot Centre Well Field.

- 2023 to 2025 (Pumping Period 5-2): this corresponds to a period of similar pumping with an average annual pumping rate of 128 L/s. Total annual precipitation ranging from 893 mm/yr to 996 mm/yr, an average of 942 mm/yr, slightly above the climate normal during this period.

  The hydrograph shows that the water levels observed at WT-WC-MW4-11-A fluctuated approximately 1 m above 351.0 mASL in response to brief periods of decreases in pumping (Period 5-2). A water level response to spring recharge is evident in 2022 (0.30 m) and 2023 (0.28 m) under stable pumping. This is higher than in 2021 when only a 0.1 m response can be interpreted. From the low water levels of 350.8 mASL at the end of 2023 water levels recovery approximately 0.4 m through to the summer of 2025 with fluctuations due to variable pumping in 2024 and 2025 making spring recharge harder to interpret. From the summer of 2025 water levels decline further from approximately 351 mASL to 350.8 mASL at the end of November to similar water levels to those observed in 2023. This slight decline may be attributed to the lower spring recharge in 2025 as a clear water level response to precipitation during this period is not evident.

The water levels observed at WT-WC-MW4-11-A at the end of the study period were approximately 350.8 mASL, which is only 0.2 m below the water levels observed from 1975 to 1978 (351 mASL) under above average climate conditions (956 mm/yr) and lower pumping rate (average of 84 L/s). In addition, the observed water level in 2025 is higher than the levels historically observed at the end of 1989 (Period 2B) after a period of below average climate (810 mm/yr) and lower average pumping rate (98 L/s).

5.3.1.1 Trend Summary Under Influence of Pumping

The following key observations were made through the long-term trend analysis in the vicinity of the Wilmot Centre production wells:

- The water level prior to pumping was approximately 353.5 mASL. The water levels observed near the production wells have fluctuated between approximately 350 mASL and 354 mASL during the 53-year pumping period.
- The observed water level during a three-year period (1975 to 1977) of “stable” pumping at an average annual rate of 84 L/s and above average annual precipitation (1,009 mm/yr) was approximately 351 mASL, a 2.5 m water level decline from pre-pumping conditions. During a longer period (2000 to 2009; 10 years) with average annual pumping of 84 L/s and above average climate conditions (963 mm/yr), the observed water levels increased from approximately 351.5 to 353.5 mASL, or a 2 m recovery in AFB2. The water level was near pre-pumping water levels observed at the well field. This suggests that prolonged periods of “normal” precipitation result in aquifer recovery at a sustained pumping rate.

  During a prolonged period (2010 to 2019) of above average precipitation 944 mm/yr and at an increasing annual pumping rate (annual average of 100 L/s) a long-term water level decline of approximately 1.5 m in AFB2 near the production wells to approximately 352 mASL was recorded. As climate was considered relatively “normal” (i.e., annual precipitation fluctuating above and below the climate normal) during this period, the water level decline from 2010 to 2019 may partially be attributed to an increase in pumping. However, the 1.5 m decline over a 10-year period is of similar magnitude to the effects from periods of reduced precipitation discussed below.
- Periods of three or more consecutive years of below average precipitation appear to be correlated with periods of rapid water level decline. Water level declines of 2 m and 1.5 m were observed from 1986 to 1990 (over a four-year period) and from 2020 to 2022 (over a three-year period), respectively. The average annual precipitation and average annual pumping rate during 2020 to 2022 (769 mm/yr; 98 L/s) were greater than 1986 to 1990 (810 mm/yr; 135 L/s).

  The lowest water levels observed during the recent period from 2022 to 2025 (351 mASL) were higher than those observed in the 1986-1990 period (350 mASL), despite the higher pumping rate and lower average precipitation in 2020 to 2022 (i.e., the total water level decline was less pronounced than the 1975 to 1977 period).

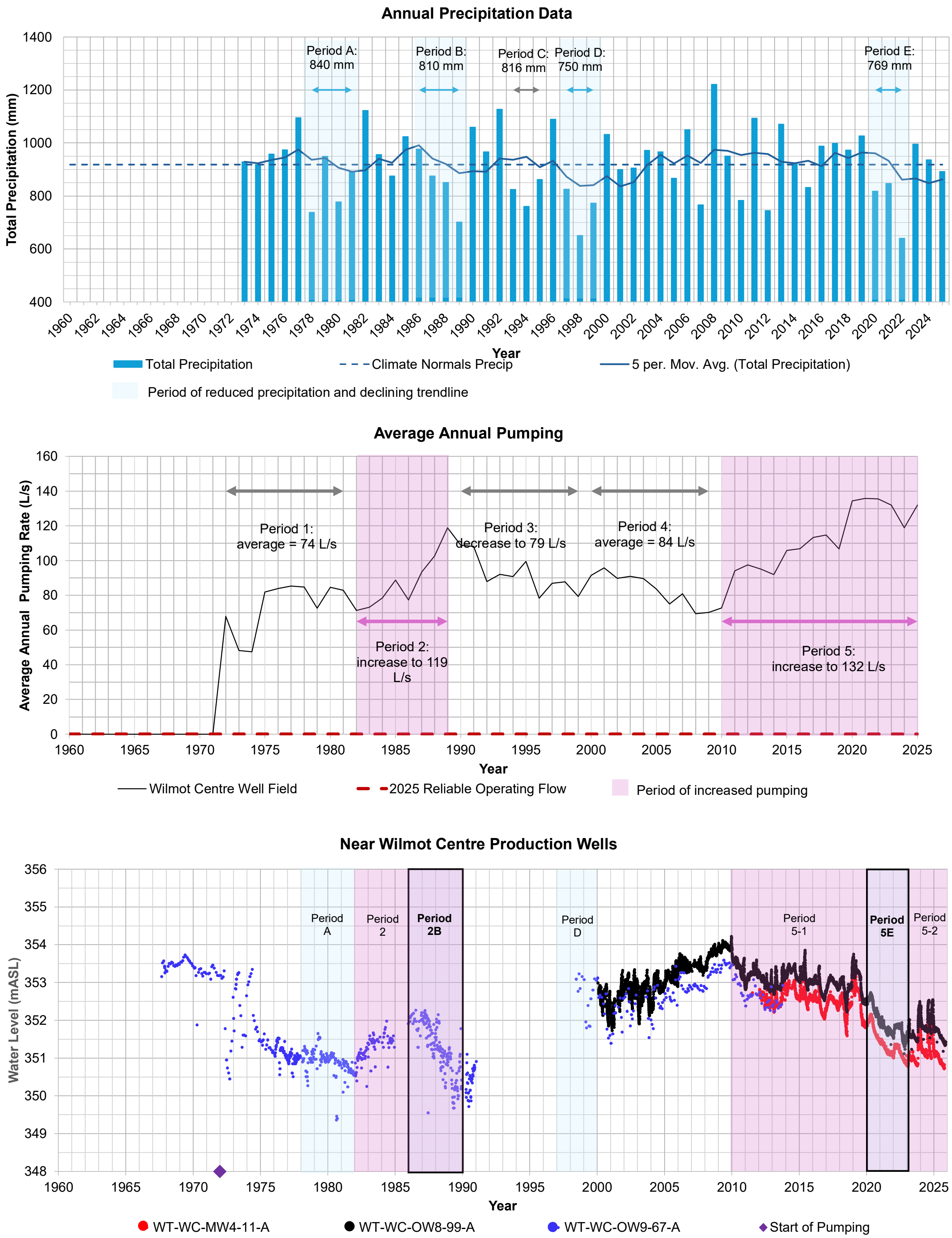
  In addition, the observed water level (351 mASL) at the end of 2022 was in line with the water levels observed during a period of lower average annual pumping rate (84 L/s) and above average precipitation (966 mm/yr) from 1975 to 1977, shortly after pumping began.

The low water level observed following the three-year low precipitation period (1986 to 1990; 350 mASL) was approximately 1 m below the 1975 to 1977 level (351 mASL) and corresponded to the lowest observed historical water level for the study period based on the provided dataset.

These observations support that longer periods of below average precipitation may have a more pronounced effect on water levels than shorter periods of reduced precipitation and that the climate effect is within the same magnitude of pumping responses immediately adjacent to the production wells. This effect will make interpretation of water level variations away from the well field harder as the effects of pumping become less and can be overshadowed by climatic responses and variations in recharge.

- The low water levels observed since 2020 are within the historical range at the Wilmot Centre Well Field, despite the extended period of elevated pumping rate.

The effect of climate on drawdown rates is explored in 5.3.2 by evaluating the long-term trends in the upgradient and downgradient wells (background conditions).



Notes:	**Client / Project:**	Region of Waterloo Wilmot Centre Well Field Pumping and Water Level Assessment	
	Title:	Hydrograph of Long-term Water Levels in Monitoring Wells Near Wilmot Centre Production Wells Compared to Annual Precipitation and Average Annual Pumping Rates	SLR
	Date:	April 1, 2026	**Figure 5-1**
	Project Number:	241.032851.00001	

5.3.2 Background Water Level Trends

Water levels observed at monitoring wells located upgradient and downgradient of the Wilmot Well Field (i.e., outside the anticipated areas of pumping influence) were reviewed to assess water level responses related to variations in climatic conditions.

5.3.2.1 Upgradient Water Level Trends

Long-term average daily water levels at monitoring wells upgradient of the Wilmot Centre production wells (K50, K51, and K52) are presented on Figure 5-2 (hydrograph). To provide a comparison, water levels were selected from the following upgradient monitoring wells screened in AFB2 (Figure 2-3):

- WT-WC-BP8-94-A which is located 2 km north of the Wilmot Centre Well Field, just east of the Baden Well Field, and has data available from 1998 to 2023. This location is situated halfway (800 m) between historical monitoring well WT-MW-WM15-93 and WT-OW2-69-A (Baden Well Field), which were monitored as part of the 1993-1994 pumping/shut down test. The drawdown recorded at WT-OW2-69-A was 0.3 m and no drawdown was observed at WT-MW-WM15-93 (Terraqua, 1995). In addition, Stantec (2020) reported no drawdown due to increased pumping during the 2018 pump test at WT-WC-BP8-94-A (Figure 2-4).
- WT-WC-UW5-91-A located 3.8 km north of the Wilmot Centre Well Field with data available from 1998. Well WT-WC-UW5-91-A is considered an appropriate background location per the most recent monitoring report (RJ Burnside, 2026).

The water levels observed at both locations exhibit similar fluctuating patterns (Figure 5-2). The water levels recorded during the low-precipitation events (Period D and Pumping Period 5E) were reviewed relative to periods of "normal" precipitation (Pumping Periods 4, 5-1 and 5-2):

- 1997 to 1999 (Period D on Figure 5-2): this corresponds to a three-year period of below average precipitation (average of 750 mm/yr). Water levels were recorded at both wells starting in 1998, capturing water level trends in the two final years of this period. The hydrograph indicates that the water level at WT-WC-UW5-91-A exhibited a decline of approximately 0.75 m from approximately 358.5 mASL in 1998 to 357.75 in 1999. Similarly, the water levels recorded at WT-WC-BP8-94-A decreased by approximately 1 m (355 to 354 mASL) from 1998 to 1999. Note that the total decline cannot be quantified without water level data pre-1998, and the magnitude of the decline over this three-year period is anticipated to be greater than observed. There are no evident seasonal responses in the hydrograph for this period (i.e., fluctuations in water level associated with wetter and drier seasons).
- 2000 to 2009 (Pumping Period 4 on Figure 5-2): this corresponds to an extended period (10 years) of relatively normal precipitation (962 mm/yr) and stable pumping rates at the Wilmot Centre Well Field. Well WT-WC-UW5-91-A shows clear seasonal fluctuations of approximately 0.5 to 1 m a year with peaks occurring in the first half of each year associated with spring recharge. The magnitude of the seasonal fluctuations is more difficult to discern at WT-WC-BP8-94-A, however, the general trend in fluctuations appears similar to those observed further upgradient at WT-WC-UW5-91-A. The clear seasonal fluctuations observed at WT-WC-UW5-91-A support that this location is not directly impacted by pumping influences from the Wilmot Centre Well Field and is a good background well for comparison.

The increase in water level in 2008 to 2009 maybe attributed to the elongated period of above average precipitation supporting recharge to the aquifer system. The total annual precipitation observed in 2008 was the highest recorded annual precipitation during this study period (1,221 mm).

- 2010 to 2025 (Pumping Periods 5-1, 5E, and 5-2 on Figure 5-2):
    - 2010 to 2019 (Pumping Period 5-1): this corresponds to another extended period (10 years) of relatively normal precipitation (944 mm/yr), similar to 2000 to 2009 (Period 4) discussed above. The hydrograph shows fluctuations at both monitoring wells with relatively stable water levels despite this being a period of increased pumping at the Wilmot Centre Well Field. This supports that these wells are not significantly influenced by pumping. The seasonal fluctuations are approximately 0.5 to 1 m at both wells.
    - 2020 to 2022 (Period 5E): this corresponds to a three-year period of below average annual precipitation (769 mm/yr). The total precipitation observed in 2022 (641 mm) was the lowest annual precipitation measured in the entire study period. The hydrograph shows that the water level at both WT-WC-BP8-94-A and WT-WC-UW-91-A decreased by approximately 1 m during this period, similar to the decline observed at the locations near the production wells during this timeframe, and similar to the decline observed during Period D discussed above (1997 to 1999).

      The average precipitation during Period 5E was 769 mm/yr, similar to the precipitation amount recorded from 1997 to 1999 (750 mm/yr; Period D). The seasonal fluctuations in 2020 was 0.2 m with no seasonal response clear in 2021 compared to the water levels measured from 2000 to 2019 (0.5 to 1.0 m) and are similar to Period D (1997 to 1999). As WT-WC-UW-91-A is outside the zone of influence and WT-WC-BP8-94-A is expected to be under minimal influence, if any from pumping, the 1 m decline is attributed to the three-year period of below average precipitation. Accounting for seasonal fluctuations, the total decline is approximately 1.5 m.
    - 2023 to 2025 (Period 5-2): this corresponds to a period of elevated pumping (average annual pumping rate of 128 L/s) with slightly above average annual precipitation (942 mm/yr). The hydrograph indicates that the water levels recorded at WT-WC-UW-91-A were relatively stable between 357.5 mASL and 357.8 mASL, despite continued pumping at elevated rates. This further supports that WT-WC-UW-91-A is not under direct influence of pumping, and that the decline observed from 1998 to 1999 and from 2020 to 2022 were a direct result of reduced precipitation rather than increased pumping at the Wilmot Centre Well Field. The dataset for WT-WC-BP8-94-A only includes water levels recorded up to 2023 and as a result a full review could not be completed.

5.3.2.2 Downgradient Water Level Trends

Long-term average daily water levels at monitoring wells located downgradient of the Wilmot Centre production wells (K50, K51, and K52) are presented on Figure 5-3 (hydrograph). To provide a comparison, water levels were selected from the following upgradient monitoring wells screened in AFB2 (Figure 2-3):

- WT-BD-OW17-67-A is located 1 km south of the Wilmot Centre Well Field, with data starting in 1967, and is reported to be influenced by pumping at the Wilmot Centre Well.

WT-BD-OW17-67-A appears to exhibit a similar pattern to monitoring wells near the production wells (Figure 5-1). This location was monitored as part of the 1993-1994 shutoff/pump test (Terraqua, 1995) with a reported water level decline of 0.66 m in response to pumping at 155 L/s.

- WT-WC-WM13-93-B is located 1.4 km south of the Wilmot Centre Well Field, with data starting from 1998. This location was monitored as part of the 1993-1994 shutdown/pump test, and the recorded drawdown at this well was 0.79 m (Terraqua, 1995). This location was monitored as part of the 2018 pump test (Stantec, 2020) and exhibited a 0.27 m drawdown due to the increase in pumping of 47 L/s (Figure 2-4).
- WT-WC-WM21-93-A is located 2.4 km downgradient from the well field, with data from 1998 to 2025 and is interpreted to be outside of the influences of pumping. This well was also monitored as part of the 1993-1994 shutdown/pump test (Terraqua, 1995) and did not exhibit a response to either the shutdown or pumping test. Therefore, this location is considered representative of background and natural climate variation in the area to the south of the Wilmot Centre Well Field and is a background location for the current monitoring program (RJ Burnside, 2026).

The hydrograph shows the clear responses to pumping at WT-BD-OW17-67-A compared to the further downgradient wells. The water level trends were assessed for key periods of below average precipitation (Period D and Period 5E) compared to periods of normal or above average precipitation (Periods 4, 5-1, and 5-2):

- 1997 to 1999 (Period D on Figure 5-3): this corresponds to a three-year period of below average precipitation (average of 750 mm/yr). The hydrograph shows that water levels recorded at WT-BD-OW17-67-A decreased from a maximum of 353.5 mASL to a minimum of 351.5 mASL, a water level decline of approximately 2 m over the duration of the three-year period. This occurred during a period of relatively stable pumping (average annual rate of 85 L/s). There appears to be localized influence of pumping on the water levels during this period.

  In comparison, the water levels observed at downgradient well WT-WC-WM21-93-A exhibited a decline of 1 m, from approximately 346.25 to 345.25 mASL, based on the available data recorded in 1998 to 1999 (no available data in 1997). Note that the total decline cannot be quantified without water level data pre-1998, and the magnitude of the decline over this three-year period is anticipated to be greater than 1 m.. These observations are consistent with those made at upgradient background well WT-WC-UW5-91-A, which exhibited a decline of 0.75 m over during this period (Figure 5-2).

  The water levels recorded at WT-WC-WM13-93-B from 1998 to 1999 (no available data in 1997) decreased from a maximum of 348.5 mASL to a minimum of 347.5 mASL, a decline of 1 m. This location has some influence from pumping with a similar increase in water level observed in 1999 as observed at WT-BD-OW17-67-A.

- 2000 to 2009 (Pumping Period 4 on Figure 5-3): this period corresponds to an extended period (10 years) of relatively normal precipitation (963 mm/yr) and stable pumping rates at the Wilmot Centre Well Field. Well WT-WC-WM21-93-A shows clear seasonal fluctuations of approximately 0.5 to 1 m a year with peaks generally occurring in the first half of each year corresponding to the seasonal recharge. These fluctuations are similar to those observed at upgradient background well WT-WC-UW5-91-A during this period.

The lack of response to pumping from the Wilmot Centre Well Field supports this well as an appropriate background well for comparison and provides a good indication of seasonal variations in water levels in response to recharge conditions.

The increase in water level in 2008 to 2009 may be attributed to the long period of above average precipitation supporting recharge to the aquifer system as there is no influence from pumping. The total annual precipitation observed in 2008 was the highest recorded annual precipitation during this study period (1221 mm).

- 2010 to 2025 (Pumping Periods 5-1, 5E, and 5-2 on Figure 5-3):
    - 2010 to 2019 (Period 5-1): this corresponds to another extended period (10 years) of relatively normal precipitation (944 mm/yr), similar to 2000 to 2009 (Period 4) discussed above. The hydrograph shows seasonal fluctuations at WT-WC-WM21-93-A with relatively stable water level trends. In comparison, there are pronounced aquifer responses observed at upgradient monitoring well WT-BD-OW17-67-A, and, to a lesser extent, at WT-WC-MW13-93-B.

      The water level responses observed at WT-WC-WM21-93-A are representative of natural variations in water level (i.e., not under direct influence of pumping). The seasonal fluctuations observed at WT-WC-WM21-93-A were approximately 0.5 m, or between 346.0 and 346.5 mASL, during this period.
    - 2020 to 2022 (Period 5E): this period corresponds to a three-year period of below average annual precipitation (769 mm/yr). The hydrograph shows that the water level at background well WT-WC-WM21-93-A decreased by approximately 1 m during this period, from approximately 346.5 mASL to 345.5 mASL. This decline of 1 m is similar to that observed at upgradient wells WT-WC-BP8-94-A and WT-WC-UW-91-A (Figure 5-2).

      In addition, the decline can be compared to the water level trend observed from 1997 to 1999 (Period D), with similar below average precipitation (750 mm/yr). The seasonal fluctuations in 2020 and 2021 are muted compared to the water levels measured from 2000 to 2019, similar to Period D (1997 to 1999). As WT-WC-WM21-93-A is located outside the zone of influence, the 1 m decline is attributed to the three-year period of below average precipitation. Considering seasonal fluctuations, this amounts to a 1 to 1.5 m decline in water levels from reduced recharge to the aquifer.

      In comparison, WT-BD-OW17-67-A is under the direct influence from pumping and exhibited a 1.5 m decline in water level suggesting up to 0.5 m of the observed decline is related to pumping. Well WT-WC-WM13-93-B, which does show lower influences from pumping, exhibited a water level decline of approximately 1 m, similar to WT-WC-WM21-93-A suggesting limited response to the changes in pumping during this time period at this location.
    - 2023 to 2025 (Period 5-2): this corresponds to a period of elevated pumping (average annual pumping rate of 128 L/s) with slightly above average precipitation (942 mm/yr). The hydrograph indicates that the water levels recorded at WT-WC-WM21-93-A were relatively stable between 345.5 mASL and 346.0 mASL, despite continued pumping at elevated rates.

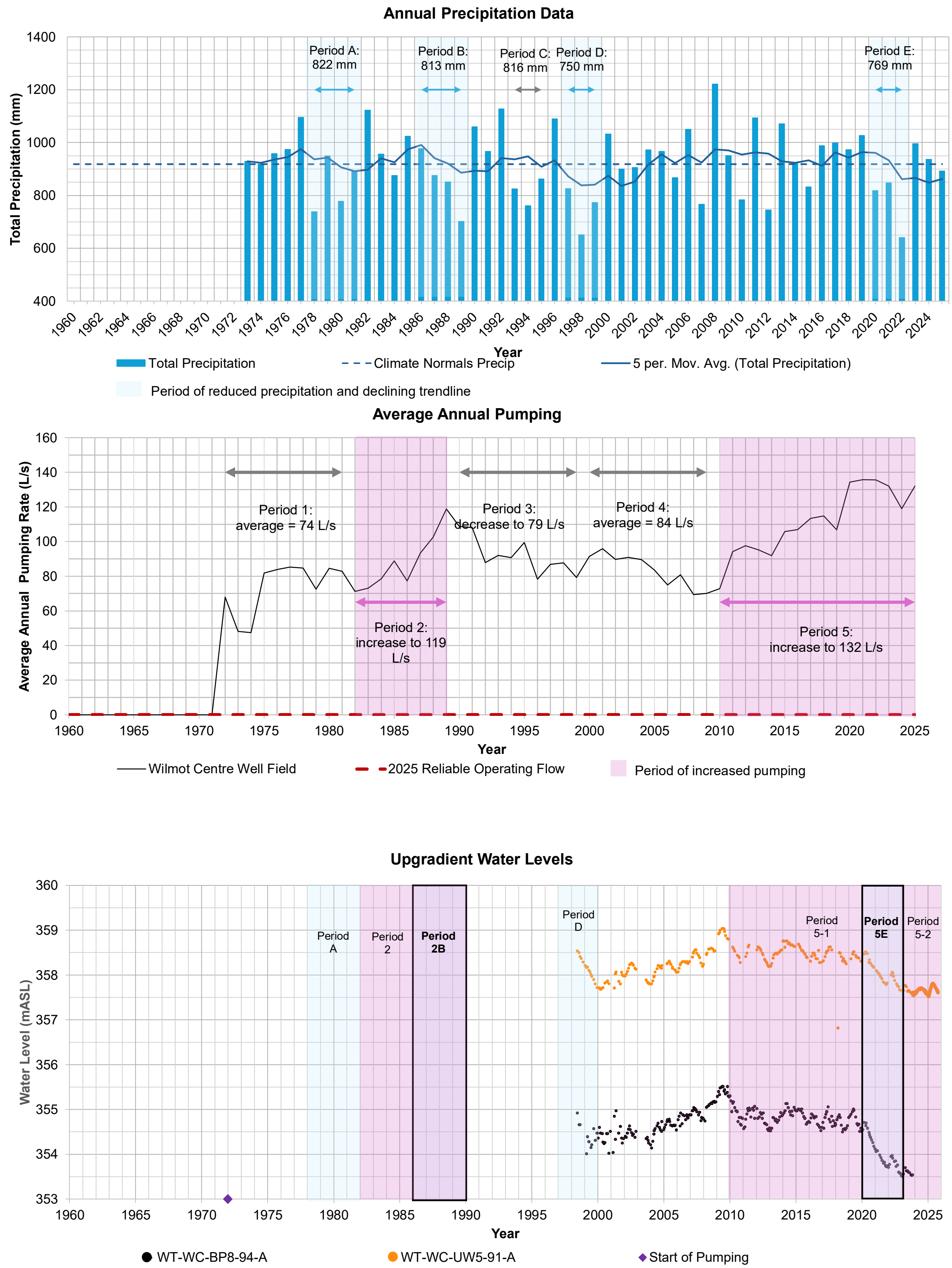
This further supports that WT-WC-WM21-93-A is not under direct influence of pumping, and that the decline observed from 2020 to 2022 was la direct result of reduced precipitation and recharge rather than increased pumping at the Wilmot Centre Well Field.

The water levels observed at WT-BD-OW17-67-A, which is under influence from pumping, did not appear to be increasing or decreasing, with fluctuations up to 0.5 m above and below 351.5 mASL. The low water levels observed at the end of the study period (351 mASL) are greater than the historical minimum water level recorded in 1989 of approximately 350.25 mASL. Trends could not be assessed at WT-WC-WM13-93-B due to limited data (dataset ends in 2023).

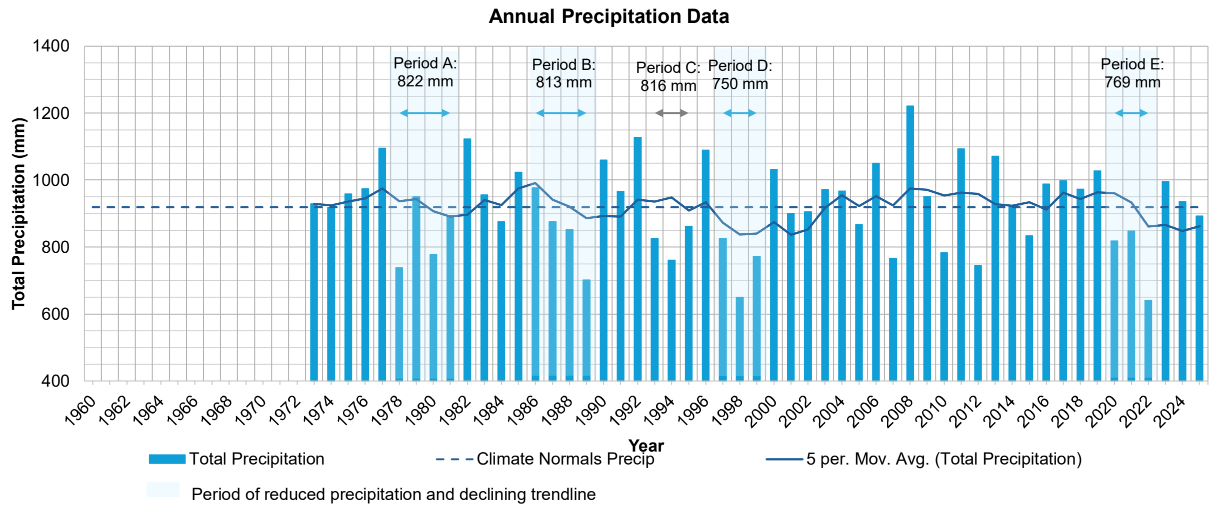
5.3.2.3 Trend Summary at Background Monitoring Wells

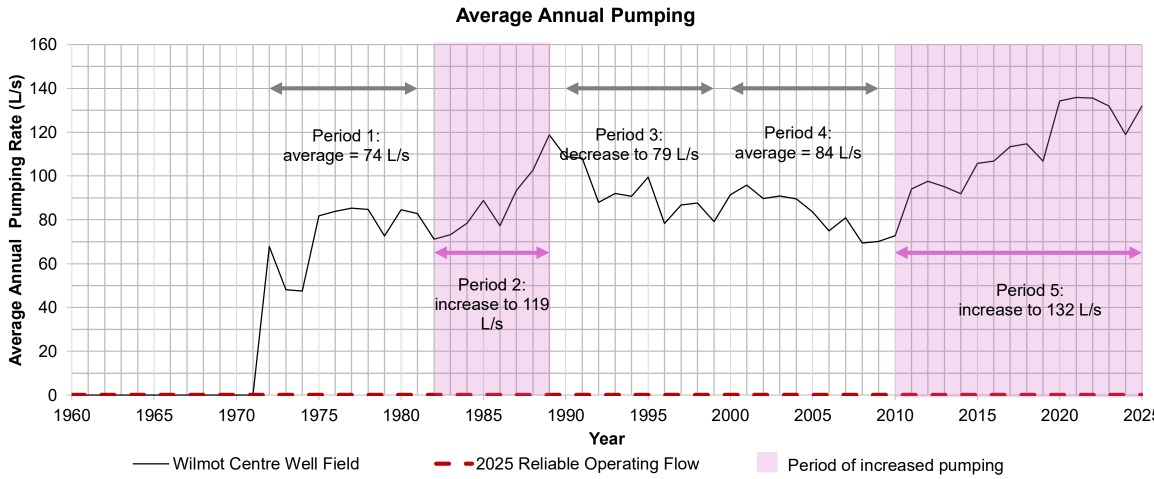
The following key observations were made based on review of the hydrographs at upgradient and downgradient background monitoring wells screened in AFB2:

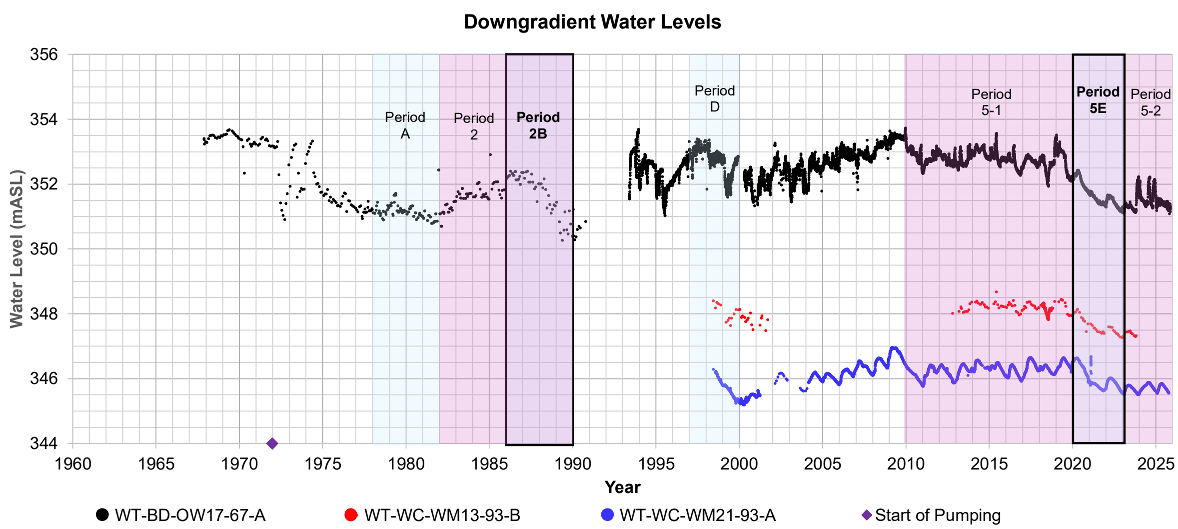
- Monitoring wells WT-WC-UW5-91-A, located 3.8 km north of the Wilmot Centre Well Field, and monitoring well WT-WC-WM21-93-A, , located 2.4 km south of the Wilmot Center Well Field, are not under direct influence of pumping from the Wilmot Centre Well Field and represents background groundwater levels downgradient of the well field.
- The water levels observed at these background wells during the three periods of normal/above average precipitation from 2000 to 2009, 2010 to 2019, and from 2023 to 2025 exhibited clear seasonal fluctuations rather than direct response to pumping rates. The magnitude of the seasonal variations was 0.5 to 1 m each year, with peaks generally occurring in the first half of each year coinciding with the spring recharge. The water levels were generally relatively stable despite periods of increased pumping at the Wilmot Centre Well Field, which further supports that they are appropriate background monitoring wells for comparison to water level trends observed near the production wells.
- During three-year periods of below average precipitation from 1997 to 1999 and from 2020 to 2022, the water levels declined up to 1 m and seasonal fluctuations appeared muted compared to periods of extended normal or above average precipitation. Considering seasonal fluctuations, these data suggest that the effect of three to four year periods of below average precipitation (drought conditions) may be resulting in up to 1 to 1.5 m of water level decline upgradient and downgradient of the Wilmot Centre Well Field.
- The water levels measured in recent years (e.g., 2023) are the lowest or near the minimum water levels observed at each monitoring well based on the available data. Note that there were no representative background upgradient or downgradient monitoring locations with a dataset prior to 1998. Therefore, an assessment could not be completed to compare the recent “low” water levels to historical pre-pumping water levels or previous periods of below average precipitation and increased pumping (e.g., from 1989 to 1989).



Notes:	**Client / Project:** Region of Waterloo Wilmot Centre Well Field Pumping and Water Level Assessment	
	Title: Hydrograph of Long-term Water Levels in Monitoring Wells Upgradient of Wilmot Centre Production Wells Compared to Annual Precipitation and Average Annual Pumping Rates	SLR
	Date: April 1, 2026	**Figure 5-2**
	Project Number: 241.032851.00001	







Notes:

Client / Project:
Region of Waterloo
Wilmot Centre Well Field Pumping
and Water Level Assessment

Title: Hydrograph of Long-term Water Levels in Monitoring Wells Downgradient of Wilmot Centre Production Wells Compared to Annual Precipitation and Average Annual Pumping Rates

Date: April 1, 2026

Figure 5-3

Project Number: 241.032851.00001

SLR

5.3.3 Water Levels in AFB1 Aquifer

The water levels in the upper overburden aquifer AFB1, which is generally separated from the underlying main supply aquifer AFB2, were evaluated to assess if there were responses from pumping. AFB1 is separated from AFB2 by an intervening aquitard unit, ATB2 which is variable in thickness (3 to 20 m) in the area 2 km around the Wilmot Centre Well Field. The only areas where ATB2 was thin to absent include the area immediately around the production wells and to the south of Witmer Road where ground surface elevations decrease and AFB2 is exposed at surface.

Based on the review of the 2018 pump test data (Stantec 2020), responses to pumping in AFB1 at the Wilmot Centre Well Field were limited to the immediate area around the production wells (WT-WC-MW6-11-B, WT-WC-OW8-99-B, WT-WC-MW4-11-B, WT-WC-MW5-11-B,C) where water level responses of 0.4 to 0.7 m (Figure 2-5) were observed for an increase in pumping of 47 L/s. These responses were slightly less than the response observed in AFB2 in the area (Figure 2-4). In areas away from the well field no responses to pumping were reported in AFB1 indicating that where ATB2 is present it provides an effective aquitard unit and limits the response to pumping within the overlying aquifer and surface water features.

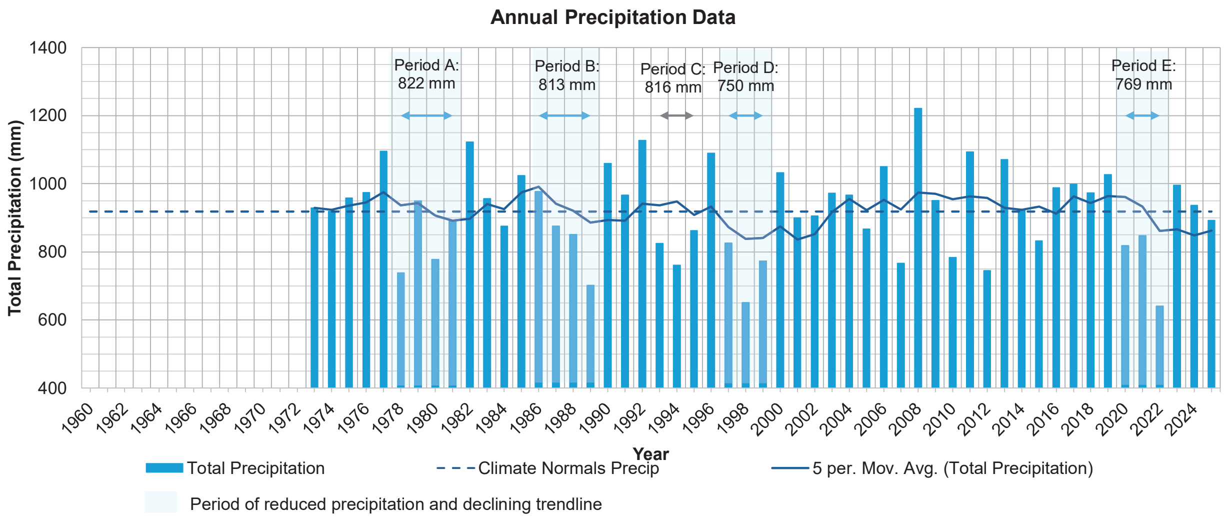
Long-term average daily water levels at monitoring wells adjacent to, east, and west of the Wilmot Centre Well Field are presented on Figure 5-4 (hydrograph). To provide a comparison, water levels were selected from:

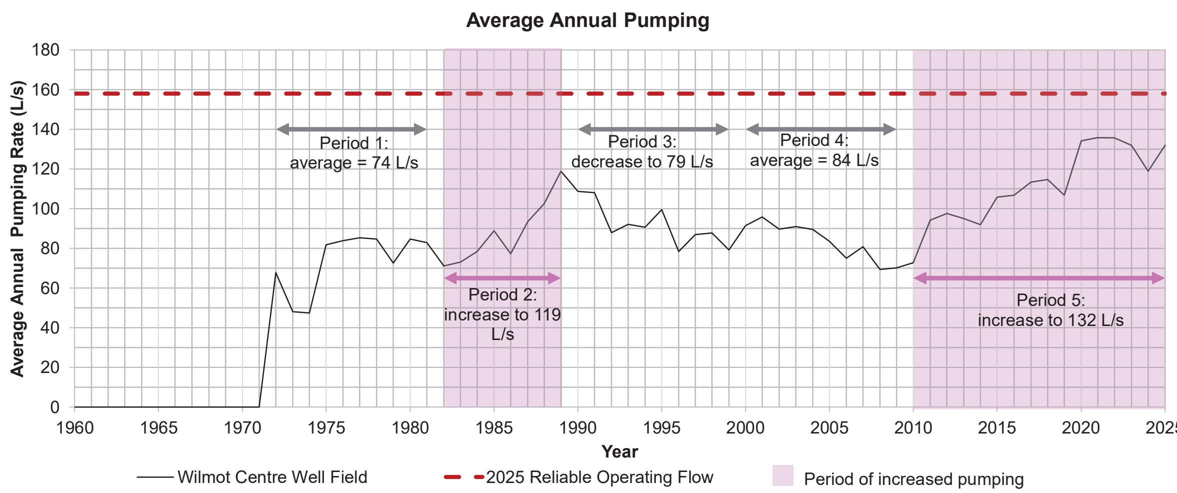
- WT-WC-MW4-11-B which is located 15 m from K52 with data starting in 2011. The drawdown observed in 2018 due to increased pumping was 0.67 m (Stantec, 2020).
- WT-WC-OW8-99-B which is located 0.2 km east of the production wells with data starting in 2000. The drawdown observed in 2018 due to increased pumping was 0.43 m (Stantec, 2020).
- WT-WC-MW6-11-B which his located 0.4 km east of the production wells with data starting in 2013. This location was outside the area of influence from increased pumping (Stantec, 2020).
- WT-WC-WM19-93-B which is located 2 km east of the production wells with data starting in 1998. This location was outside the area of influence from increased pumping (Stantec, 2020).
- WT-WCW1-98-B which is located 1.4 km west of the production wells with data starting in 1998. This location is adjacent to Silver Springs Creek, a tributary of Hunsburger Creek, and was outside the area of influenced from increased pumping (Stantec, 2020).
- WT-HBC-H4SB4D-09-A which is located 1.0 km south of the production wells on the tributary of Hunsburger Creek.

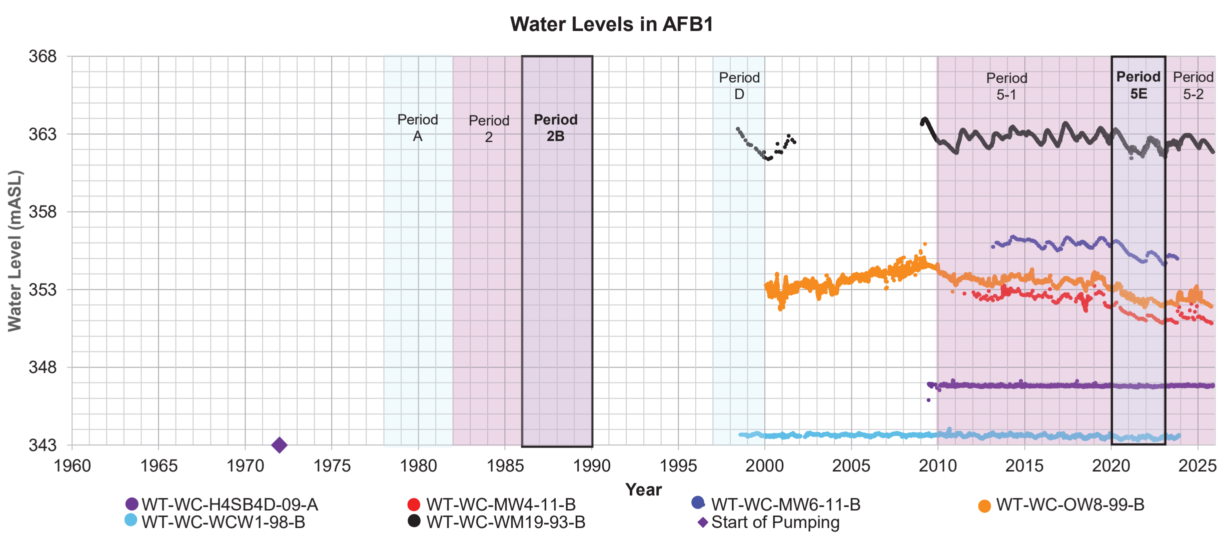
The following key observations were made based on review of the hydrograph:

- The long-term water levels recorded in the vicinity of the production wells showed a response to pumping. The hydrograph shows responses at WT-WC-MW4-11-B and WT-WC-OW8-99-B, consistent with observations made at wells screened in AFB2 (Figure 5-1). This suggests that the AFB1 aquifer in the immediate vicinity of the production wells and up to 0.2 km east of the production wells is under some influence from pumping.

- The water levels recorded at WT-WC-MW6-11-B and WT-WC-WM19-93-B did not exhibit a response to pumping over the duration of the monitoring period. Seasonal fluctuations were observed in the hydrograph, consistent with observations made at background wells screened in AFB2 (WT-WC-BP8-94-A, Figure 5-1; and WT-WC-UW5-91-A, Figure 5-2). Based on these data, the eastern extent of the pumping influence is interpreted to be within 0.4 km of the production wells.
- The water levels recorded at WT-WCW1-98-B are stable and generally within 1 m over the course of the entire monitoring period from 1998 to 2025 and are not under direct influence from pumping. This is consistent with observations made during the 2018 pump test (Stantec, 2020). Therefore, the zone of influence from pumping is restricted to less than 1 km west of the production wells.
- There were no shallow wells with available water level data in AFB1 immediately south of the well field. The 2018 OTP (Stantec, 2020) monitored shallow groundwater (WT-WC-H4SB4D-09-A) at the tributary feeding into Hunsburger Creek, approximately 1 km south of the production wells and within 0.1 km of monitoring well WT-BD-OW17-67-A (screened in AFB2). WT-BD-OW17-67-A shows a direct response to pumping (Figure 5-3) with an observed drawdown of 0.55 m in response to increased pumping of 47 L/s (Stantec, 2020). No observed response was noted at WT-WC-H4SB4D-09-A or the other surface water monitoring locations in this area during the pump test (Stantec, 2020), which supports the conclusion that pumping at current rates does not impact the shallow overburden aquifer in the area of Witmer Road and the tributary of Hunsburger Creek. In addition, upward gradients between AFB1 and the surface water feature were maintained during the testing period, which continued groundwater discharge and no impact from pumping (Stantec, 2020).







Notes:

Client / Project:
Region of Waterloo
Wilmot Centre Well Field Pumping
and Water Level Assessment

Title: Hydrograph of Long-term Water Levels in Monitoring Wells in AFB1 Compared to Annual Precipitation and Average Annual Pumping Rates

Date: April 1, 2026

Figure 5-4

Project Number: 241.032851.00001

5.4 Daily Pumping Rates and Water Level Trends (2000 to 2025)

Figure 5-5 presents the daily pumping data for the Wilmot Centre Well Field with a hydrograph showing key monitoring wells situated near the production wells (combined WT-WC-MW4-11-A and WT-WC-OW9-67-A), and upgradient (WT-WC-UW5-91-A; representative of background conditions) and downgradient (WT-WC-WM21-93-A; representative of background conditions) of the Wilmot Centre Well Field. In addition, wells that may have some influence from pumping were included for comparison: WT-WC-BP8-94-A (upgradient) and WT-WC-WM13-93-B (downgradient).

The water level trends were assessed in conjunction with the identified periods of elevated pumping and decreased precipitation. The following observations were made:

- 2000 to 2003: during this period of elevated but variable pumping, there is a direct response to pumping conditions observed in near-production well monitor WT-WC-OW9-67-A with water levels fluctuating between approximately 351.5 and 353.0 mASL (1.5 m variation). No clear seasonal trend is evident over this period at WT-WC-OW9-67-A.

  Upgradient background well WT-WC-UW5-91-A exhibited minor seasonal fluctuations of 0.5 m, between 356.75 and 358.25 mASL. Downgradient background well WT-WC-WM21-93-A exhibits similar natural seasonal fluctuations with water levels during this time varying from 345.2 and 346.2 mASL, an increase of approximately 1.0 m. Both monitoring wells show a steady increase in water levels over this time period.

- 2020 to 2022: the water levels upgradient, downgradient and in the vicinity of the production wells declined during this period despite relatively consistent pumping. At WT-WC-MW4-11-A, near the production wells, the water level declined approximately 1 m from the seasonal low, and up to 2 m from the seasonal high observed in 2019.

  The water levels upgradient and downgradient of the production wells declined approximately 1 m. The seasonal variations observed at background wells WT-WC-UW5-91-A and WT-WC-WM21-93-A were muted in 2021 compared to historical fluctuations.

- 2023 to 2025: the water levels observed at near-production well monitor WT-WC-MW4-11-A appear to respond to decreasing pumping events (75 L/s on four occasions) with corresponding recoveries of approximately 1.0 m. Water levels at upgradient background well WT-WC-UW5-91-A and WT-WM-WM21-93-A appear stable with variation of 0.5 m observed in 2025.

  There was limited data available for upgradient and downgradient wells WT-WC-BP8-94-A and WT-WC-WM13-93-B, respectively. The available data for 2023 show that the water levels appear stable with minor seasonal response of approximately 0.25 m. The response to pumping could not be evaluated during this period.

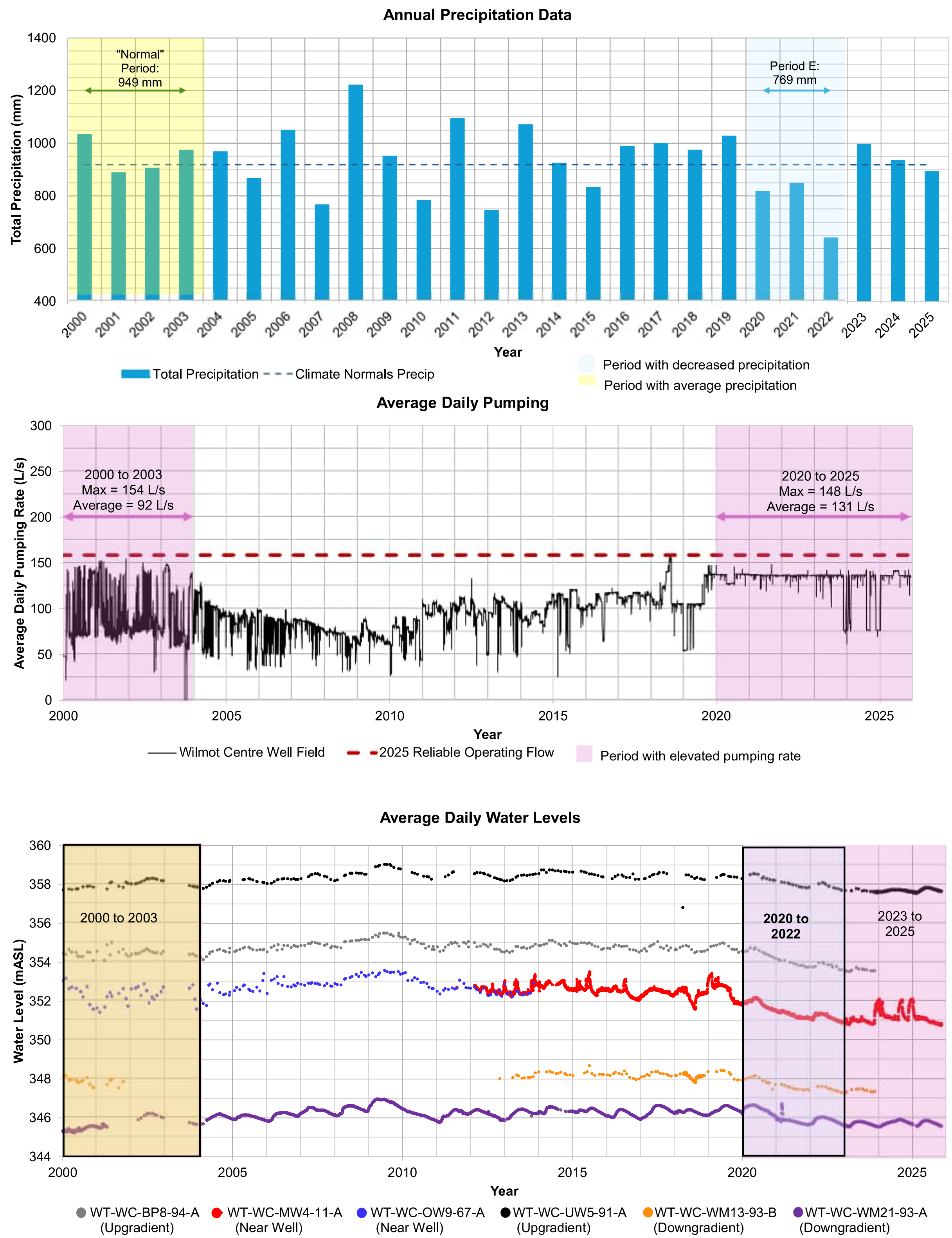
5.4.1 Trend Summary 2020-2025

This review of daily water level and pumping data supports the long-term trend assessment presented in Section 5.3:

- There is no influence from pumping observed at the selected background wells. These wells exhibit seasonal fluctuations between 0.5 and 1 m. Seasonal climatic impacts on water levels (decline) were observed at background wells during prolonged periods of lower than average precipitation reflective of drought conditions. During these drought period water level declines of 1.0 to 1.5 m are observed.
- The same water level decline was observed near the production wells from 2020 to 2022 during periods of reduced precipitation and increased pumping. This can be attributed to compounding effects of increased pumping with prolonged periods of below average precipitation.

  This can be seen best at WT-WC-MW4-11-A, located immediately adjacent to the production wells. Over the period 2020 to 2022, water levels at this location declined approximately 1.0 m due to reduced precipitation despite relatively consistent pumping at average annual rates of 135 L/s. In contrast, when pumping rates decrease from approximately 136 L/s to 75 L/s water level recoveries of approximately 0.5 m were observed over a 1 to 1.5 month period.

These observations suggest that in close proximity to the wells, the effects of increased pumping can have a similar or slightly greater effect on the water levels than extended periods (three or more years) of below average precipitation.



Notes:

Client / Project:
Region of Waterloo
Wilmot Centre Well Field Pumping
and Water Level Assessment

Title: Hydrograph for Monitoring Wells Upgradient, Downgradient, and Near the Wilmot Centre Well Field Compared to Daily Pumping and Total Annual Precipitation (2000-2025)

Date: April 1, 2026

Figure 5-5

Project Number: 241.032851.00001

6.0 Discussion

6.1 Pumping Rates and Zone of Influence

The Wilmot Centre Well Field has been drawing water from aquifer AFB2 for 53 years. Multiple aquifer testing programs have been completed at this well field (discussed in Section 2.4.2), including the original testing program that supported the well field development in 1970. The aquifer testing programs were completed at pumping rate of up to 158 L/s (IWS, 1970; Stantec, 2020; Terraqua, 1995). The current maximum allowable pumping rate in the PTTW is 158 L/s and was supported by these aquifer testing programs.

The current pumping rates are limited by the PTTW and not by the sustainable capacity of the aquifer system. The Wilmot Centre Well Field may be able to produce higher sustainable pumping rates with Terraqua (1995) recommending a sustainable average annual daily pumping rate of up to 200 L/s. This would need to be confirmed with groundwater modelling and a detailed testing and monitoring program.

The drawdown observed during historical aquifer test programs indicate that the zone of influence is preferentially elongated in a northwesterly direction and is limited in extent to the east of the well field (IWS, 1970; Terraqua, 1995). The extent of the influence to the west could not be defined due to limited data, but was up to 0.28 m at WT-WC-WCW1-98-A located 1.5 km to the west. The maximum drawdown within AFB2 adjacent to the production wells for pumping rates up to 158 L/s was approximately 2 m compared to static pre-pumping test conditions (IWS, 1970; Terraqua, 1995).

The drawdown 3 km north of the well field was 0.3 m at WT-OW2-69-A at the Baden Well Field with no drawdown observed at WT-MW-WM93-15 which is located a similar distance to WT-OW2-69-A but further east (Terraqua, 1995). The drawdown 1.4 km south of the well field was 0.8 m at WT-WC-WM93-13-A with no response to pumping observed at WT-WC-WM93-21 which is located 3 km to the south of the well field (Terraqua, 1995). Drawdown to the east was best defined during the original aquifer testing program with 0.9 m observed at WT-WC-OW10-67, located 0.76 km to the southeast, and 0.4 m at WT-WC-OW6-67, located 0.49 km to the east (IWS, 1970).

The Schindelsteddle South Wetland Complex is situated approximately 1.8 km southeast of the well field, and 1 km southeast of WT-SST-OW10-67 in the northern portion of the Esbaugh Sand & Gravel property. WT-SST-OW10-67 had an observed drawdown of 0.66 m during the 1994-1995 pumping test (Terraqua, 1995), consistent with the drawdown of 0.9 m observed in the 1970 pumping test (IWS, 1970). A review of the water level data for the Schindelsteddle South Wetland Complex presented in Harden (2026) indicates that the monitoring wells and wetland staff gauge did not show a response to periods of reduced pumping in 2024 indicating the wetland complex is located beyond the zone of influence of the Wilmot Centre Well Field.

The historical aquifer tests support that surface water features within the Wilmot Centre Well Field are hydraulically isolated by an aquitard (ATB1) and are not impacted by pumping. The 2018 test (Stantec, 2020) indicated that drawdown within the shallow overburden aquifer (AFB1) was limited to the area immediately around the Wilmot Centre Well Field (Figure 2-5). Beyond this area Stantec (2020) concluded that changes in surface water levels were attributed to changes in precipitation and not due to increased pumping at Wilmot Centre, and that the vertical gradients were consistent with historical observations during the test.

Monitoring well WT-BD-OW17-67-A (located 1 km south of the well field) exhibited clear responses to pumping in historical aquifer tests and as evidenced in the long-term hydrographs (Figure 5-2). This monitoring location is located adjacent to a tributary of Hunsburger Creek which was monitored (WT-WC-H4SB4S-09 and WT-WC-H4SB4D-09) as part of the 2018 OTP (Stantec, 2020). The monitoring results indicated that there was no response from pumping in the surface water monitoring locations and that upward vertical gradients were maintained with only direct responses to precipitation events recorded during the testing period (0.25 m). These observations support that the presence of the ATB2 aquitard provides sufficient hydraulic separation between the shallow overburden aquifer and the water supply aquifer AFB2.

6.2 Climate Effects and Long Term Water Trends

A review of long term water level data was completed to consider effects of seasonal recharge and longer term periods of below average precipitation to better understand the effects of climate in comparison to water level responses from pumping.

Natural annual fluctuations in water levels associated with spring freshet and recharge were observed in the long-term hydrographs for monitoring wells screened within AFB2 and are most clear in wells that were not affected from pumping (Figure 5-2 and Figure 5-3). The seasonal variations ranged over time but were generally within 0.5 to 1 m per year with peaks occurring generally in the first half of each year coinciding with the spring freshet and seasonal recharge.

In addition to the annual seasonal water level variations attributed to spring recharge, there are longer periods with three or more consecutive years of below average precipitation (referred to as drought periods herein) that were observed on a 5 to 10 year frequency since the 1970s. These occurred in 1978-1981 (840 mm/yr), 1986-1989 (810 mm/yr), 1993-1995 (816 mm/yr), 1997-1999 (750 mm/yr) and 2020-2022 (769 mm/yr) with annual total precipitation at or less than 80% of climate normal (919 mm/yr) recorded four times, in 1978, 1989, 1998, and 2022. The lowest periods with precipitation below 700 mm/yr (24% below the climate normal) were recorded in 1998 and 2022. Water levels at background monitoring wells during the period 1997-1999 and 2020-2023 declined up to 1 m with seasonal fluctuations muted compared to periods of normal or above average precipitation suggesting reduced recharge during these periods. These data suggest that water level variations of between 0.5 to 1.0 m are attributed to seasonal variations in precipitation and recharge. During periods of prolonged below average precipitation (i.e., drought periods) additional water level declines of between 0.5 to 1.0 m are observed.

Over the 53-year pumping period the maximum effects on water levels are evident immediately adjacent to the production wells at WT-WC-OW9-67-A and WT-WC-MW4-11-A. WT-WC-OW9-67-A provides the longest water level record with water levels ranging from a high of approximately 353.5 mASL prior to pumping in 1967 to lows of 349.7 mASL in 1989 to 1990. This represents approximately 3.8 m of water level variation over the 53-years of pumping. Despite the well field being pumped at an average annual rate of 92 L/s during the 53-years period, water levels returned to pre-pumping levels of 353.0 to 353.5 mASL several times in the late-1990s and through 2006 to 2019. The long-term water level variation of 3.8 m with AFB2 adjacent to the production wells is due to a combination of pumping and varying climate conditions, which are often incorrectly interpreted as solely pumping responses. Considering the natural water level declines of up to 1.0 to 2.0 m due to combined precipitation variations and drought conditions, the maximum decline in water level due to pumping the vicinity of the production wells is estimated at 2.0 to 2.5 m for pumping rates up to 158 L/s. This drawdown range is consistent with historical aquifer testing at the Wilmot Centre Well Field.

The top of the well screen interval for the Wilmot Centre Well Field production wells ranges from 328.5 to 328.8 mASL. The lowest water levels observed over the 53-year period was approximately 350 mASL adjacent to the production wells resulting in approximately 20 m of available drawdown in aquifer AFB2 relative to the top of the well screens.

The most recent drought conditions in 2020-2022 resulted in the lowest observed annual precipitation on record and an average annual precipitation of 769 mm/yr, 84% of the climatic normal of 919 mm/yr. Long-term hydrographs indicated that the observed water levels over the last six years are consistent with historical low water levels during drought periods. For example, the minimum water level observed at WT-WC-OW9-67-A (near production wells) from 2020 to 2025 was approximately 350.7 mASL, which is about 1.0 m above the historical minimum water level observed of 349.7 mASL in 1990, a period of 4 years with below average precipitation (Figure 5-1).

The adaptive monitoring program for the Wilmot Centre Well Field has a trigger level based program that were established in 2001 at 0.1 m below the lowest observed water level within the groundwater monitoring wells. During the most recent drought period water levels approached or exceeded the trigger levels at select locations. The trigger water levels were assigned based on monitoring conducted from 1998 to present and have been adjusted over time (Stantec 2001, 2020; RJ Burnside, 2024, 2025). These trigger levels may not be representative of historical climatic conditions or drought periods. The most recent monitoring reports (RJ Burnside, 2025) recommended that the trigger water levels for wells in the program be reviewed as there are multiple instances of water levels previously observed close to or below the 2024 trigger levels during periods of pumping at less than 150 L/s (from 2000 to 2005). The review of trigger levels should consider the longer term water level trends and the effects on water levels during drought conditions.

In areas away from the Wilmot Centre Well Field, water level variations are controlled primarily by seasonal recharge and longer-term precipitation trends. At the Esbaugh Sand & Gravel property, groundwater levels across the subject property ranged from approximately 355.5 to 351.5 mASL between 2017 and 2025 with seasonal variations typically in the range of 0.5 to 1.0 m. From 2020 to 2022 water levels across the subject property declined by about 1.0 to 1.5 m in response to the period of below average precipitation, similar to other background monitoring wells in the Wilmot Centre Well Field area. The Schindelsteddle Wetland Complex shows similar responses with much more pronounced water level responses to precipitation and spring freshet conditions. Between 2017 and 2019, low water levels during the summer and fall were approximately 354.0 mASL whereas between 2020 and 2022 the water levels decreased to lows between 352.7 and 352.8 mASL. This decline of 1.2 m to 1.3 m was similar to that observed in the Region's monitoring program locations and is interpreted to be due to below average recharge over this period and limited to no recharge in 2021 as evident by the lack of a seasonal spring rise in water levels. The water levels from monitoring wells and the Schindelsteddle Wetland Complex do not show any responses to variation in pumping at the Wilmot Centre Well Field indicating these areas are outside of the zone of influence from pumping.

7.0 Summary of Pumping and Climate Effects on Water Levels

Based on the evaluation completed on climate, pumping, and water level data provided, the following conclusions are provided:

- The long-term water level data since 1967 indicates overall changes in water levels of up to 3.8 m compared to pre-pumping conditions at Wilmot Centre Well Field. Of this change pumping at rates up to 158 L/s at the Wilmot Centre Well Field result in water level decreases of 2.0 to 2.5 m with natural variability in precipitation and drought periods affecting water levels by up to 1.0 to 2.0 m. The effects on water levels from reduced precipitation and drought conditions are within the same magnitude of pumping responses immediately adjacent to the production wells. This effect will make interpretation of water level variations away from the well field hard as the effects of pumping become less and can be overshadowed by climatic responses and variations in recharge.
- Longer periods (e.g., three to four years) of below average precipitation, and associated reduction in recharge to AFB2 result in an additional natural water level decline of between 0.5 and 1.0 m.
- In the immediate vicinity of the production wells, low water levels of approximately 351 mASL observed in 2023 to 2025 are consistent with low water levels observed in 1978 to 1981 when similar periods of below average precipitation were recorded. The water levels between the two periods are similar despite pumping rates during 2023 to 2025 being approximately 47 L/s greater, at an average annual pumping rate of 128 L/s.
- Water level responses in the area of the Wilmot Centre Well Field were similar to those observed in pumping tests completed in 1970, 1993-1994 and 2018 at pumping rates up to 158 L/s. Given the 53-years of pumping at the Wilmot Centre Well Field and relatively consistent range of water levels, long-term monitoring data supports the conclusion of a long-term sustainable pumping rate for the well field of at least 158 L/s. Over this period water levels returned to pre-pumping levels of 353 to 353.5 mASL several times in the late-1990s and through 2006 to 2019.
- The drawdown from pumping observed during historical aquifer tests indicate that the zone of influence is preferentially elongated in a northwesterly direction and is limited in extent to the east of the well field. The Schindelsteddle South Wetland Complex appears to be located beyond the zone of influence of the Wilmot Centre Well Field with no responses to pumping evident in the water level data from Harden (2026).
- Water level responses within the shallow aquifer (AFB1) and surface water features, including the Schindelsteddle Wetland Complex, are interpreted to be affected by longer term periods of below average precipitation and recharge. Responses to pumping within the shallow aquifer (AFB1) are limited to the area immediately around the Wilmot Centre Well Field where the intervening aquitard (ATB1) is thin to absent.

8.0 Closure

This report has been prepared by SLR Consulting (Canada) Ltd. for the Region of Waterloo.

Regards,

SLR Consulting (Canada) Ltd.

Digitally signed by Craig Johnston
DN: cn=Craig Johnston, o=SLR Consulting (Canada) Ltd., email=cjohnston@slrconsulting.com
Date: 2026.08.06 17:40:53 -04'00'

Maria Digaletos, M.Sc., P.Geo.
Senior Hydrogeologist

Craig Johnston, M.Sc., P.Geo.
Principal Hydrogeologist

9.0 References

Harden. 2026. Hydrogeological Evaluation for PTTW Application, Hallman Pit. Prepared for Esbaugh Sand & Gravel Ltd. Harden Environmental Services Limited. January 2026.

IWS. 1970. Kitchener Water Commission Wilmot Aquifer – Well No. 50 Report. International Water Supply Limited.

Mekis, É. and Vincent, L.A., 2011. An overview of the second generation adjusted daily precipitation dataset for trend analysis in Canada. Atmospheric-Ocean, v 49(2), 163-177.

ROW. 2026. Sustainable Use of Water Resources for Municipal Supply (1980 Policy on Water Taking – Wilmot Township). Region of Waterloo Engineering and Environmental Services, EES-WIM-26-003, Region of Waterloo. February 10, 2026.

RJ Burnside, 2026. 2025 Biennial Groundwater Monitoring Report – Wilmot Centre Well Field (K50, K51, K52). Prepared for Region of Waterloo, June 2026.

RJ Burnside, 2025. 2024 Annual Trigger Level Memorandum for Wilmot Centre. Prepared for Region of Waterloo. June 2025.

Stantec. 2001. Baseline Monitoring Report, Wilmot Centre Well Field. Prepared for the Region of Waterloo, Stantec Consulting Ltd., November 2001.

Stantec. 2017. Revisions to the Operational Testing Program, Wilmot Centre Well Field. Prepared for the Region of Waterloo, Stantec Consulting Ltd., March 2017.

Stantec. 2020. 2018 Operational Testing Program, Wilmot Centre Well Field. Prepared for the Region of Waterloo, Stantec Consulting Ltd., January 2020.

Stantec and Waterloo Hydrogeologic. 1999. Nitrate Migration Control Feasibility Study. Prepared for the Region of Waterloo, April 1999.

Terraqua. 1995. Baden-New Hamburg Water Supply Master Plan and Project, Wilmot Centre Well Field Assessment. Prepared for the Region of Waterloo, Terraqua Investigations Ltd., November 1995.

Wang, X.L., Xu, H., Qian, B., Feng, Y. and Mekis, É., 2017. Adjusted Daily Rainfall and Snowfall Data for Canada. Atmospheric-Ocean, v 55(3), 155-168

Appendix A Harden (2026) Report Hydrographs

Wilmot Centre Well Field Pumping and Water Level Assessment

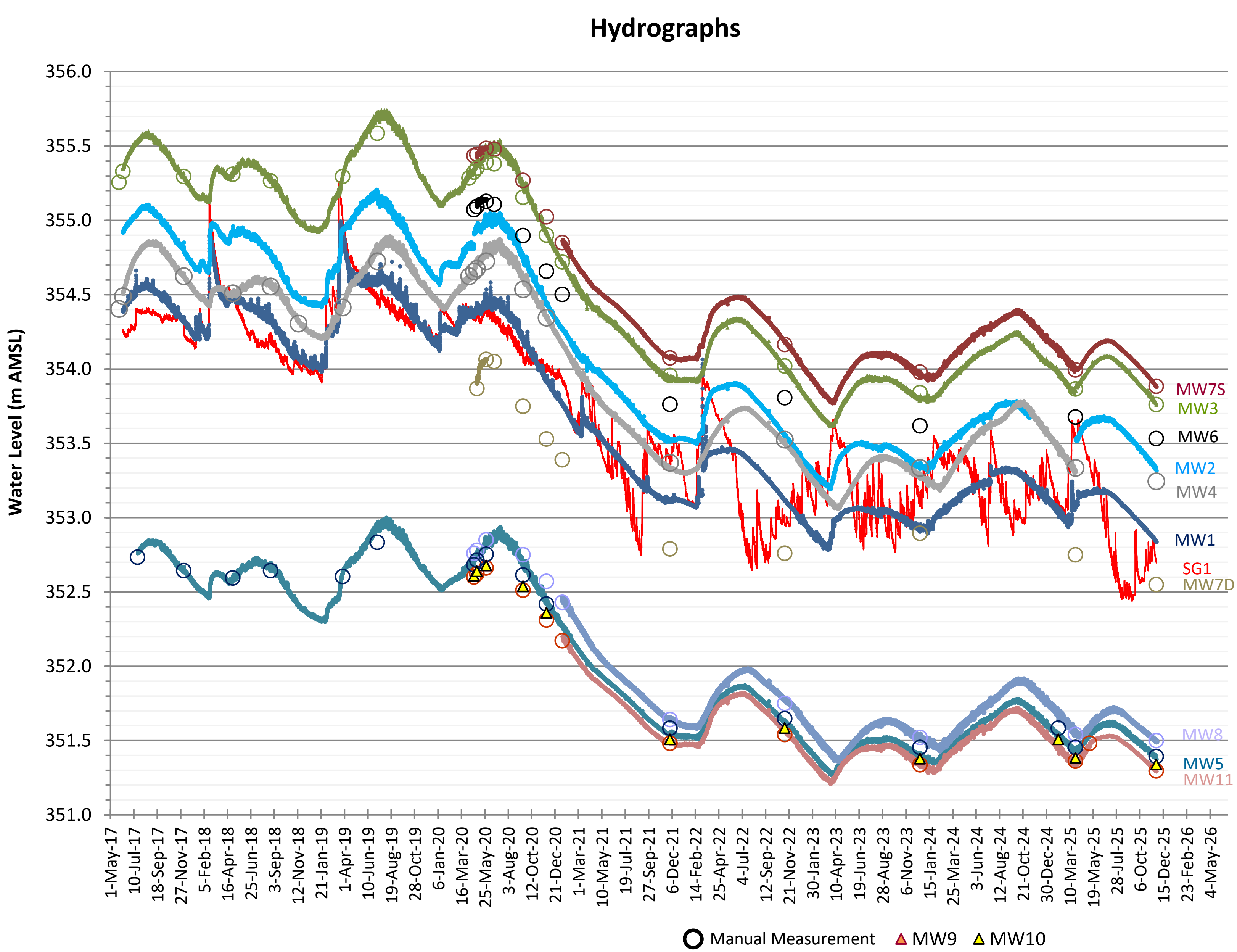
Wilmot Centre

Region of Waterloo

SLR Project No.: 241.032851.00001

August 6, 2026

Harden Environmental Services Ltd.	**Project No:** 1728	Hydrogeological Evaluation for PTTW Application Hallman Pit	**Figure 12: Monitoring Locations - Aerial Imagery**
	Date: Jan 2026	1922 Witmer Road, CON South of Bleams Rd, PT LOT 10 Township of Wilmot, Regional Municipality of Waterloo	
	Drawn By: AR		



Hydrographs
Water Level (m AMSL)
356.0
355.5
355.0
354.5
354.0
353.5
353.0
352.5
352.0
351.5
351.0
1-May-17
10-Jul-17
18-Sep-17
27-Nov-17
5-Feb-18
16-Apr-18
25-Jun-18
3-Sep-18
12-Nov-18
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27-Sep-21
6-Dec-21
14-Feb-22
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4-Jul-22
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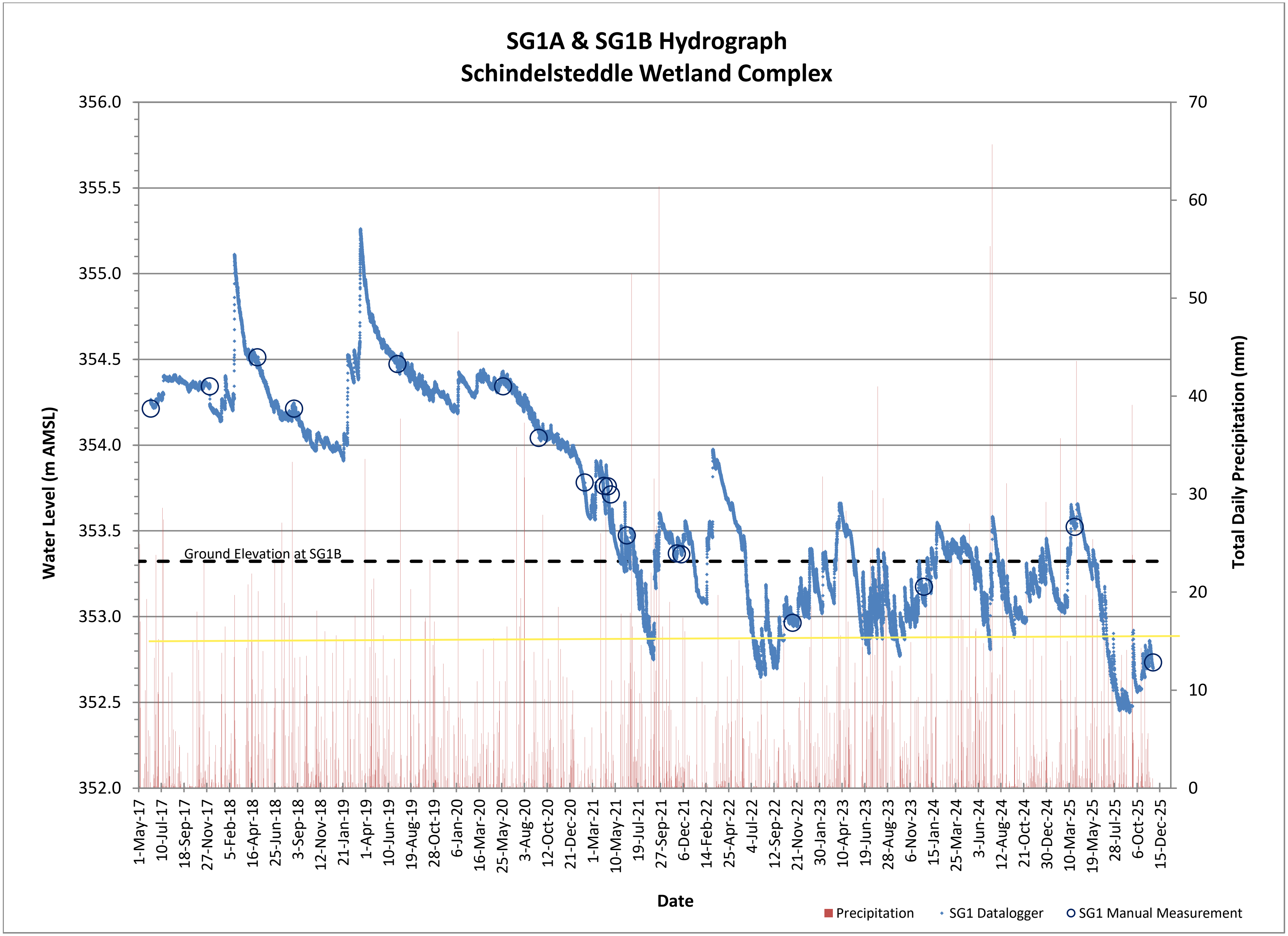
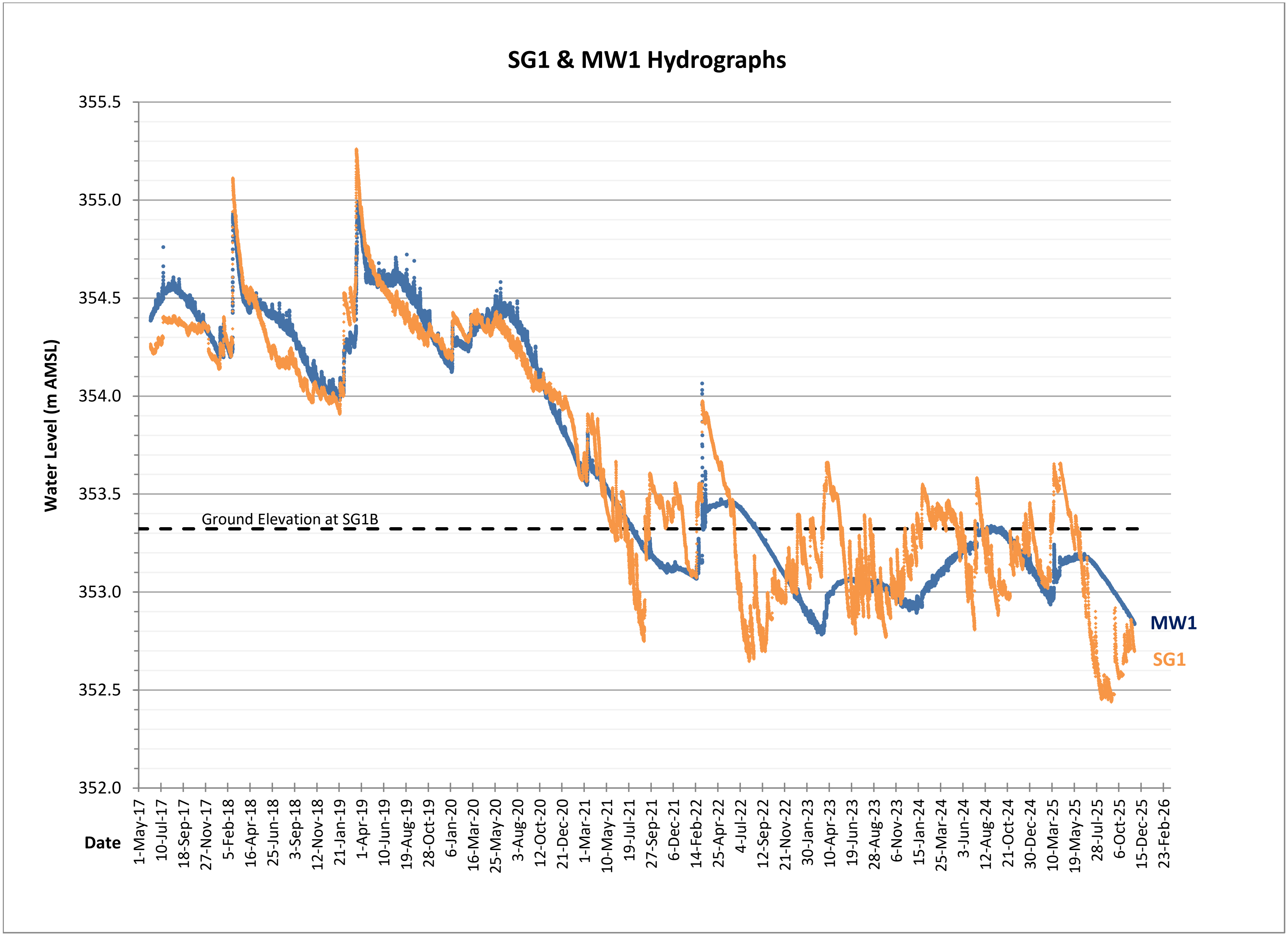
21-Nov-22
30-Jan-23
10-Apr-23
19-Jun-23
28-Aug-23
6-Nov-23
15-Jan-24
25-Mar-24
3-Jun-24
12-Aug-24
21-Oct-24
30-Dec-24
10-Mar-25
19-May-25
28-Jul-25
6-Oct-25
15-Dec-25
23-Feb-26
4-May-26
MW7S
MW3
MW6
MW2
MW4
MW1
SG1
MW7D
MW8
MW5
MW11
Manual Measurement
MW9
MW10


SG1A & SG1B Hydrograph
Schindelsteddle Wetland Complex
Water Level (m AMSL)
Total Daily Precipitation (mm)
Date
Ground Elevation at SG1B
356.0
355.5
355.0
354.5
354.0
353.5
353.0
352.5
352.0
70
60
50
40
30
20
10
0
1-May-17
10-Jul-17
18-Sep-17
27-Nov-17
5-Feb-18
16-Apr-18
25-Jun-18
3-Sep-18
12-Nov-18
21-Jan-19
1-Apr-19
10-Jun-19
19-Aug-19
28-Oct-19
6-Jan-20
16-Mar-20
25-May-20
3-Aug-20
12-Oct-20
21-Dec-20
1-Mar-21
10-May-21
19-Jul-21
27-Sep-21
6-Dec-21
14-Feb-22
25-Apr-22
4-Jul-22
12-Sep-22
21-Nov-22
30-Jan-23
10-Apr-23
19-Jun-23
28-Aug-23
6-Nov-23
15-Jan-24
25-Mar-24
3-Jun-24
12-Aug-24
21-Oct-24
30-Dec-24
10-Mar-25
19-May-25
28-Jul-25
6-Oct-25
15-Dec-25
Precipitation
SG1 Datalogger
SG1 Manual Measurement



SG1 & MW1 Hydrographs
Water Level (m AMSL)
355.5
355.0
354.5
354.0
353.5
353.0
352.5
352.0
Ground Elevation at SG1B
MW1
SG1
Date
1-May-17
10-Jul-17
18-Sep-17
27-Nov-17
5-Feb-18
16-Apr-18
25-Jun-18
3-Sep-18
12-Nov-18
21-Jan-19
1-Apr-19
10-Jun-19
19-Aug-19
28-Oct-19
6-Jan-20
16-Mar-20
25-May-20
3-Aug-20
12-Oct-20
21-Dec-20
1-Mar-21
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19-Jul-21
27-Sep-21
6-Dec-21
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25-Apr-22
4-Jul-22
12-Sep-22
21-Nov-22
30-Jan-23
10-Apr-23
19-Jun-23
28-Aug-23
6-Nov-23
15-Jan-24
25-Mar-24
3-Jun-24
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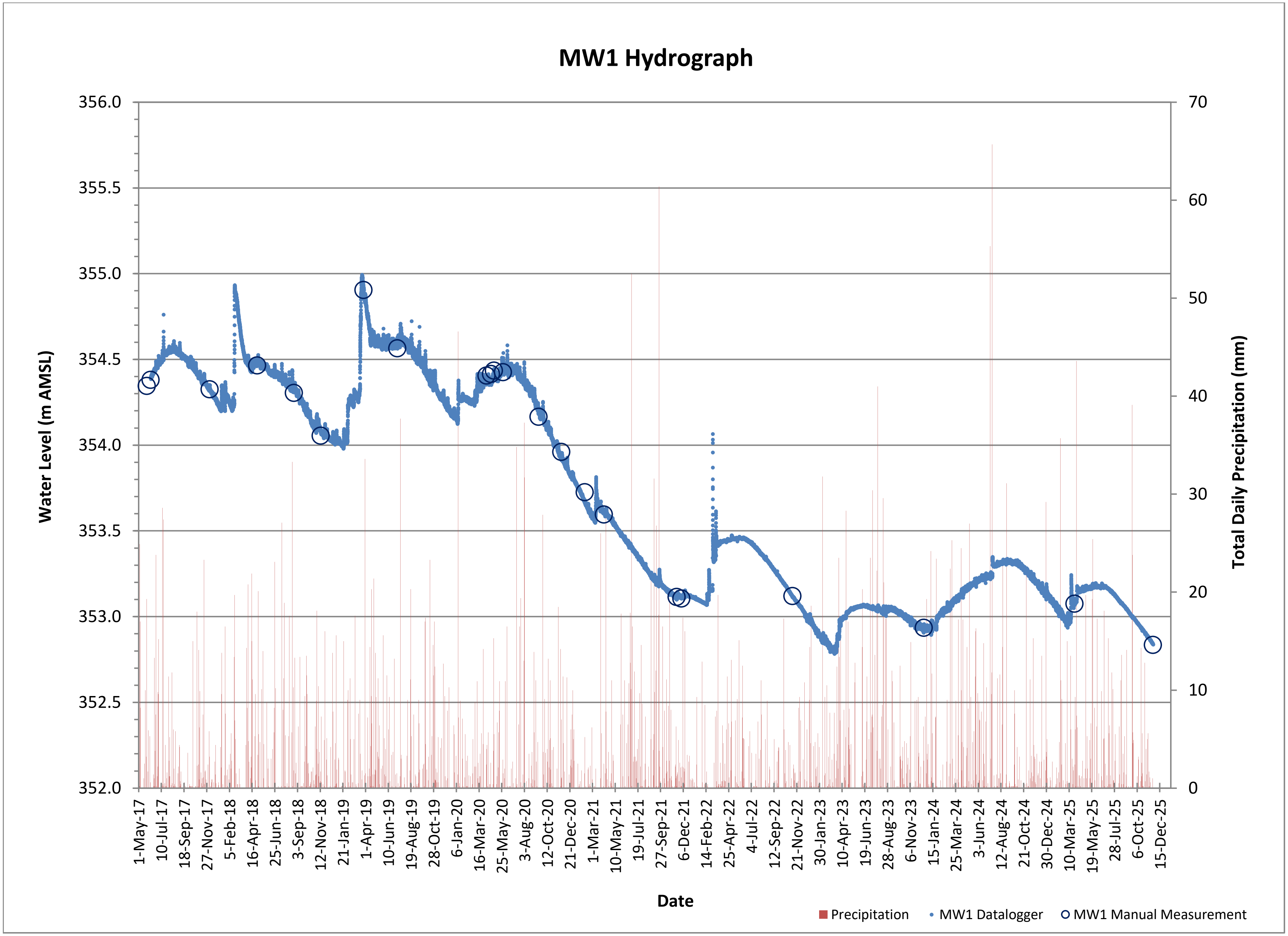
15-Dec-25
23-Feb-26


MW1 Hydrograph
Water Level (m AMSL)
356.0
355.5
355.0
354.5
354.0
353.5
353.0
352.5
352.0
Total Daily Precipitation (mm)
70
60
50
40
30
20
10
0
1-May-17
10-Jul-17
18-Sep-17
27-Nov-17
5-Feb-18
16-Apr-18
25-Jun-18
3-Sep-18
12-Nov-18
21-Jan-19
1-Apr-19
10-Jun-19
19-Aug-19
28-Oct-19
6-Jan-20
16-Mar-20
25-May-20
3-Aug-20
12-Oct-20
21-Dec-20
1-Mar-21
10-May-21
19-Jul-21
27-Sep-21
6-Dec-21
14-Feb-22
25-Apr-22
4-Jul-22
12-Sep-22
21-Nov-22
30-Jan-23
10-Apr-23
19-Jun-23
28-Aug-23
6-Nov-23
15-Jan-24
25-Mar-24
3-Jun-24
12-Aug-24
21-Oct-24
30-Dec-24
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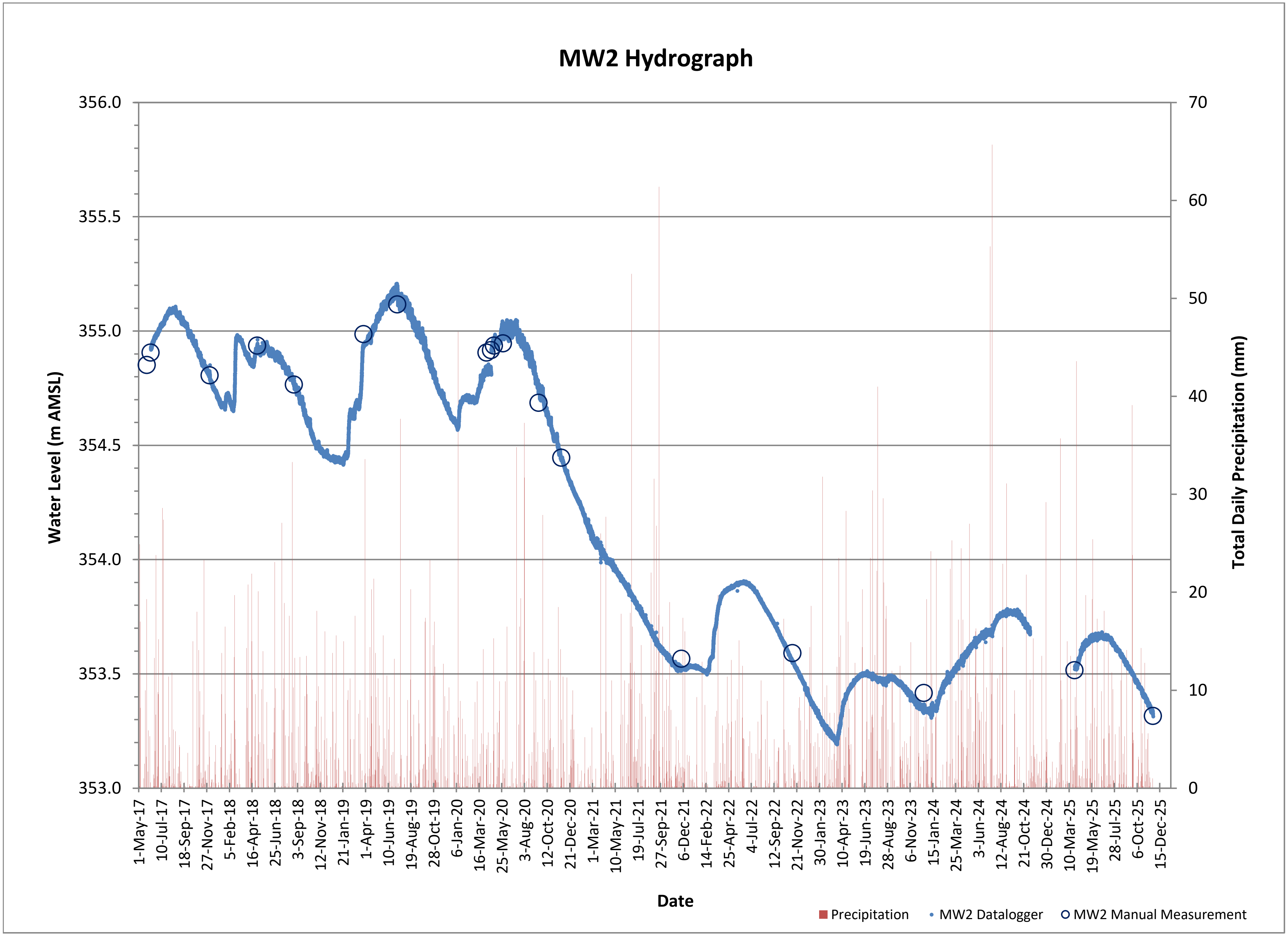
6-Oct-25
15-Dec-25
Date
Precipitation
MW1 Datalogger
MW1 Manual Measurement



MW2 Hydrograph
Water Level (m AMSL)
Total Daily Precipitation (mm)
356.0
355.5
355.0
354.5
354.0
353.5
353.0
70
60
50
40
30
20
10
0
1-May-17
10-Jul-17
18-Sep-17
27-Nov-17
5-Feb-18
16-Apr-18
25-Jun-18
3-Sep-18
12-Nov-18
21-Jan-19
1-Apr-19
10-Jun-19
19-Aug-19
28-Oct-19
6-Jan-20
16-Mar-20
25-May-20
3-Aug-20
12-Oct-20
21-Dec-20
1-Mar-21
10-May-21
19-Jul-21
27-Sep-21
6-Dec-21
14-Feb-22
25-Apr-22
4-Jul-22
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21-Nov-22
30-Jan-23
10-Apr-23
19-Jun-23
28-Aug-23
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3-Jun-24
12-Aug-24
21-Oct-24
30-Dec-24
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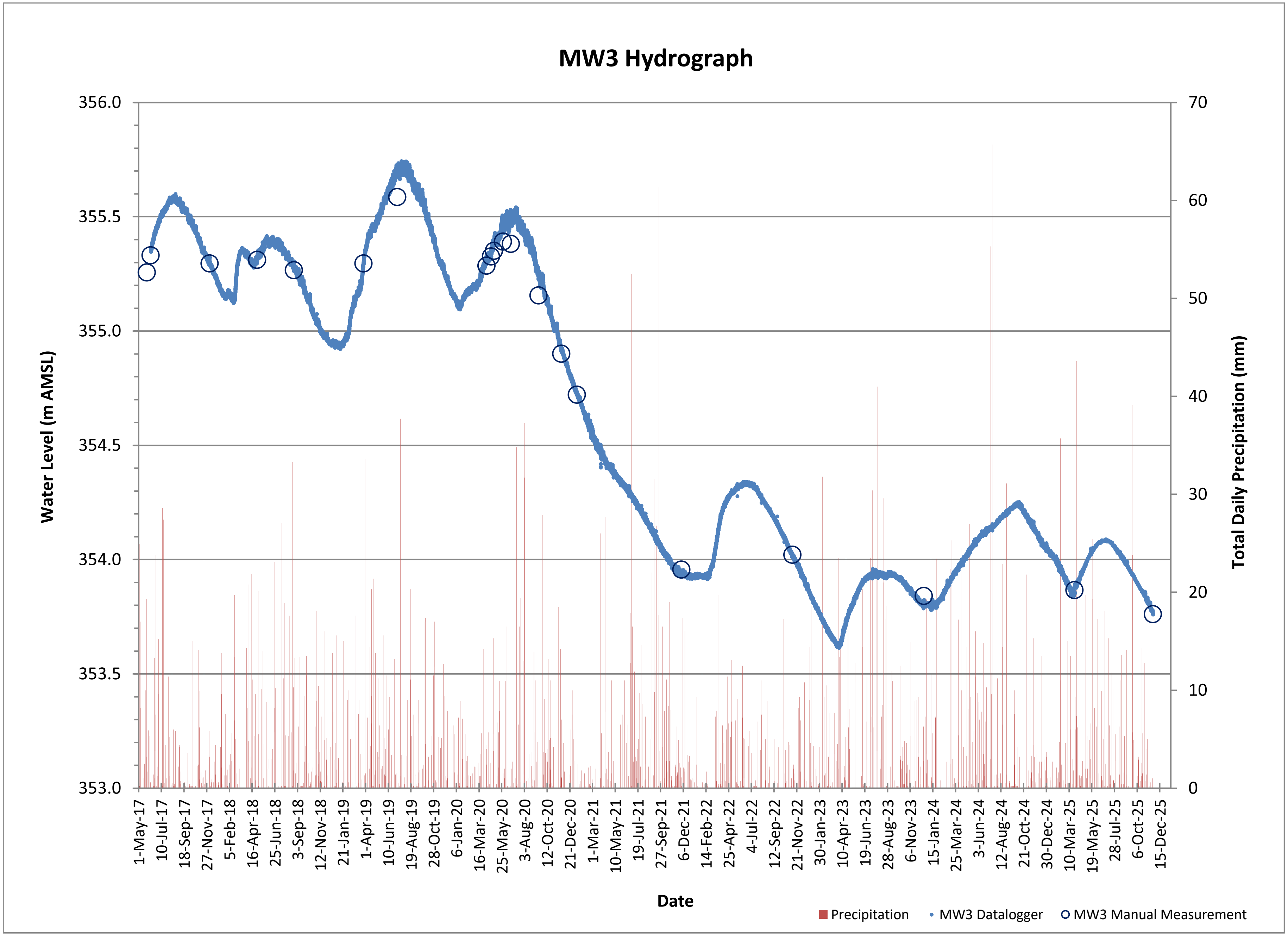
Date
Precipitation
MW2 Datalogger
MW2 Manual Measurement



MW3 Hydrograph
Water Level (m AMSL)
Total Daily Precipitation (mm)
356.0
355.5
355.0
354.5
354.0
353.5
353.0
70
60
50
40
30
20
10
0
1-May-17
10-Jul-17
18-Sep-17
27-Nov-17
5-Feb-18
16-Apr-18
25-Jun-18
3-Sep-18
12-Nov-18
21-Jan-19
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19-Aug-19
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6-Jan-20
16-Mar-20
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3-Aug-20
12-Oct-20
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30-Jan-23
10-Apr-23
19-Jun-23
28-Aug-23
6-Nov-23
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25-Mar-24
3-Jun-24
12-Aug-24
21-Oct-24
30-Dec-24
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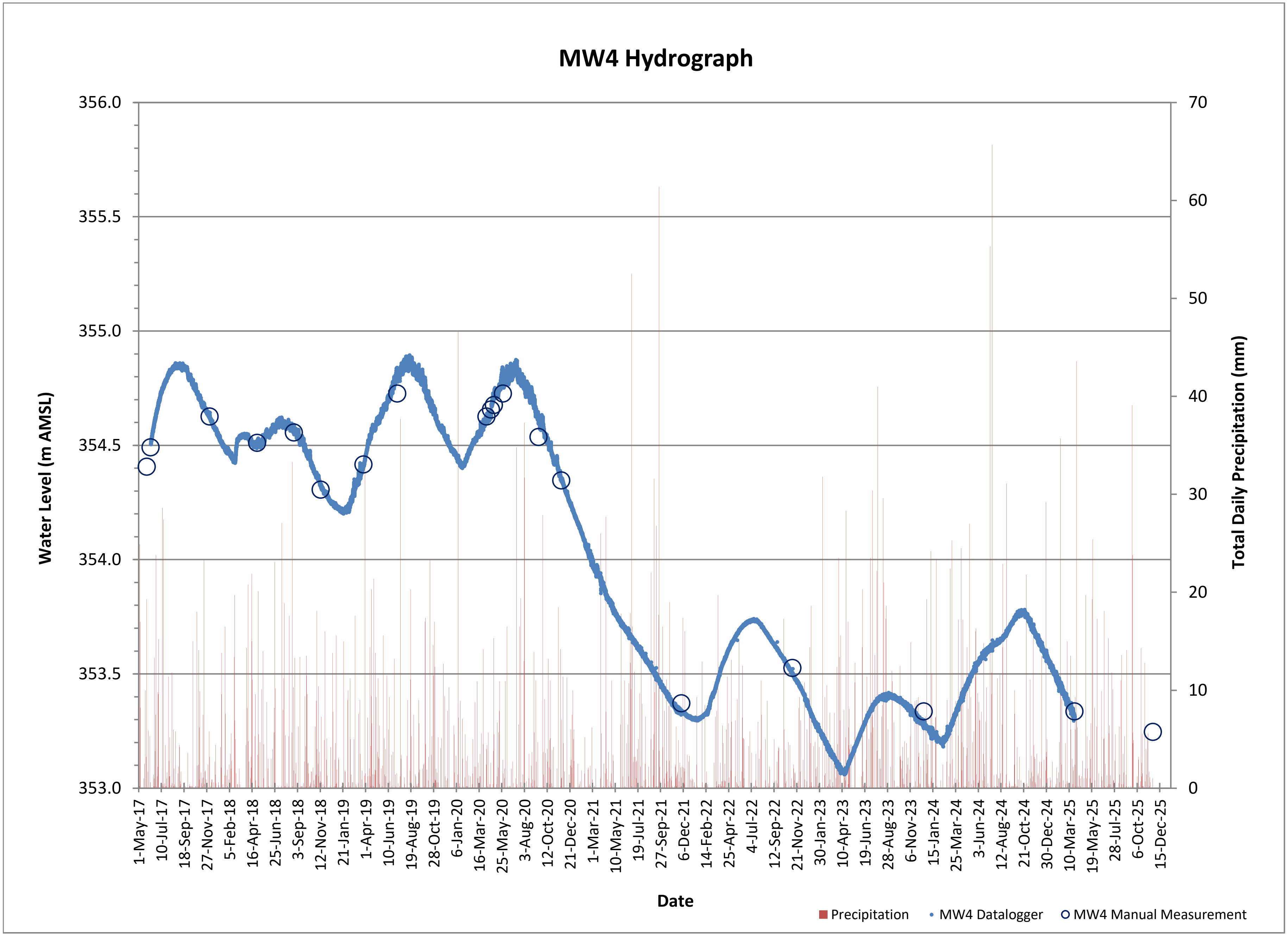
Date
Precipitation
MW3 Datalogger
MW3 Manual Measurement



MW4 Hydrograph
Water Level (m AMSL)
356.0
355.5
355.0
354.5
354.0
353.5
353.0
Total Daily Precipitation (mm)
70
60
50
40
30
20
10
0
1-May-17
10-Jul-17
18-Sep-17
27-Nov-17
5-Feb-18
16-Apr-18
25-Jun-18
3-Sep-18
12-Nov-18
21-Jan-19
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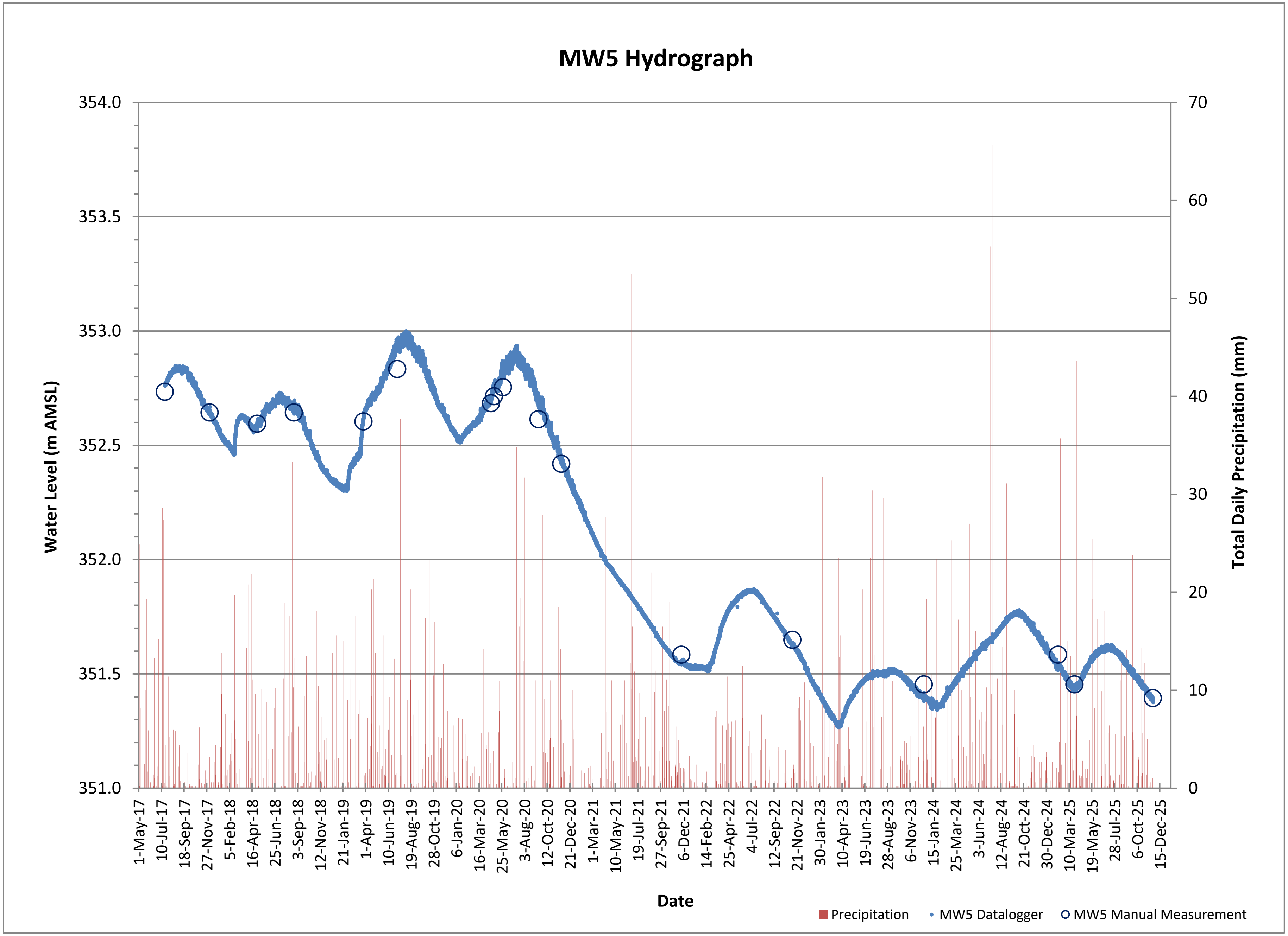
Date
Precipitation
MW4 Datalogger
MW4 Manual Measurement



MW5 Hydrograph
Water Level (m AMSL)
Total Daily Precipitation (mm)
354.0
353.5
353.0
352.5
352.0
351.5
351.0
70
60
50
40
30
20
10
0
1-May-17
10-Jul-17
18-Sep-17
27-Nov-17
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16-Apr-18
25-Jun-18
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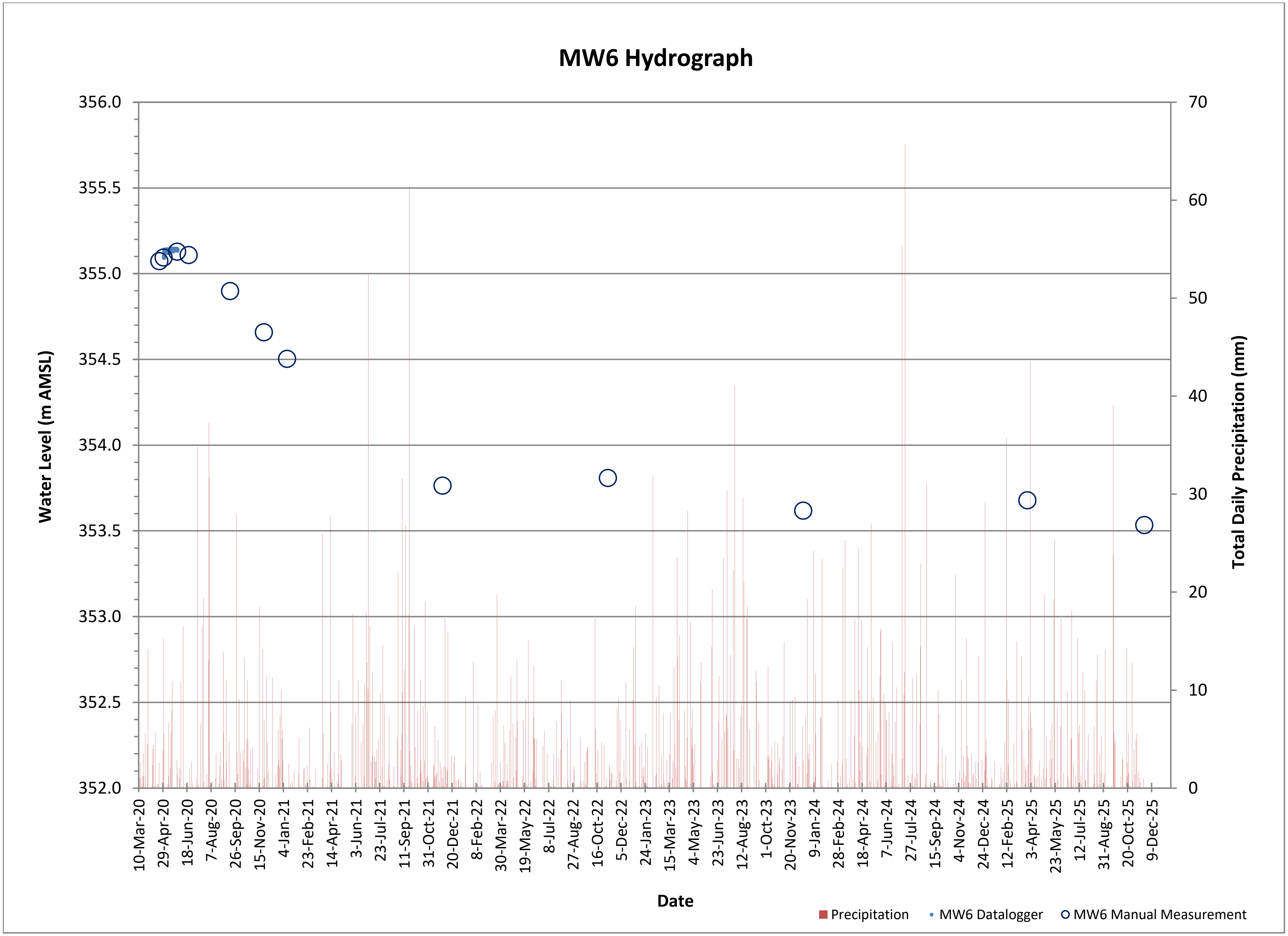
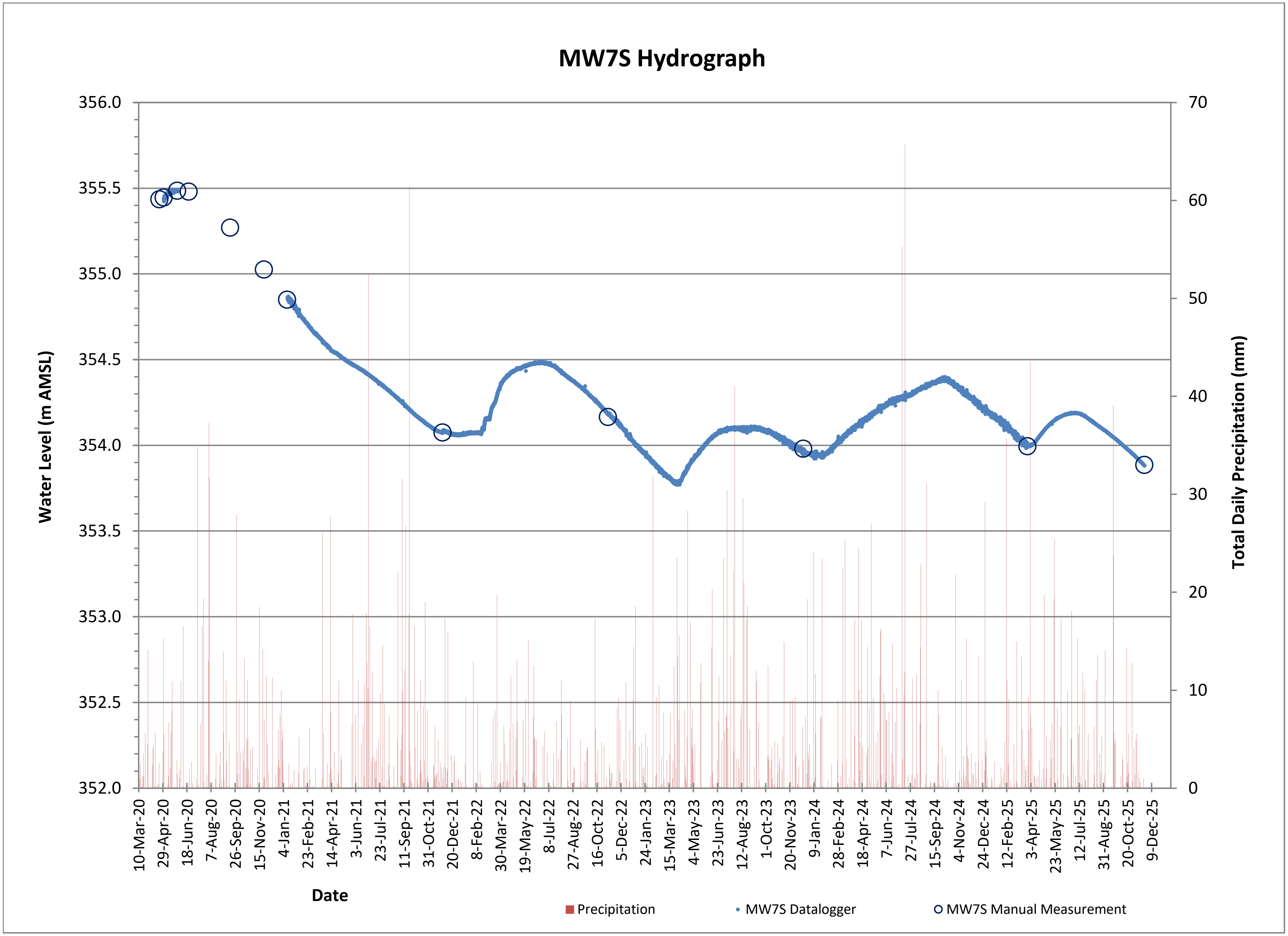
21-Oct-24
30-Dec-24
10-Mar-25
19-May-25
28-Jul-25
6-Oct-25
15-Dec-25
Date
Precipitation
MW5 Datalogger
MW5 Manual Measurement


MW6 Hydrograph
Water Level (m AMSL)
Total Daily Precipitation (mm)
Date
356.0
355.5
355.0
354.5
354.0
353.5
353.0
352.5
352.0
70
60
50
40
30
20
10
0
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
23-Feb-21
14-Apr-21
3-Jun-21
23-Jul-21
11-Sep-21
31-Oct-21
20-Dec-21
8-Feb-22
30-Mar-22
19-May-22
8-Jul-22
27-Aug-22
16-Oct-22
5-Dec-22
24-Jan-23
15-Mar-23
4-May-23
23-Jun-23
12-Aug-23
1-Oct-23
20-Nov-23
9-Jan-24
28-Feb-24
18-Apr-24
7-Jun-24
27-Jul-24
15-Sep-24
4-Nov-24
24-Dec-24
12-Feb-25
3-Apr-25
23-May-25
12-Jul-25
31-Aug-25
20-Oct-25
9-Dec-25
Precipitation
MW6 Datalogger
MW6 Manual Measurement



MW7S Hydrograph
Water Level (m AMSL)
Total Daily Precipitation (mm)
Date
356.0
355.5
355.0
354.5
354.0
353.5
353.0
352.5
352.0
70
60
50
40
30
20
10
0
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
23-Feb-21
14-Apr-21
3-Jun-21
23-Jul-21
11-Sep-21
31-Oct-21
20-Dec-21
8-Feb-22
30-Mar-22
19-May-22
8-Jul-22
27-Aug-22
16-Oct-22
5-Dec-22
24-Jan-23
15-Mar-23
4-May-23
23-Jun-23
12-Aug-23
1-Oct-23
20-Nov-23
9-Jan-24
28-Feb-24
18-Apr-24
7-Jun-24
27-Jul-24
15-Sep-24
4-Nov-24
24-Dec-24
12-Feb-25
3-Apr-25
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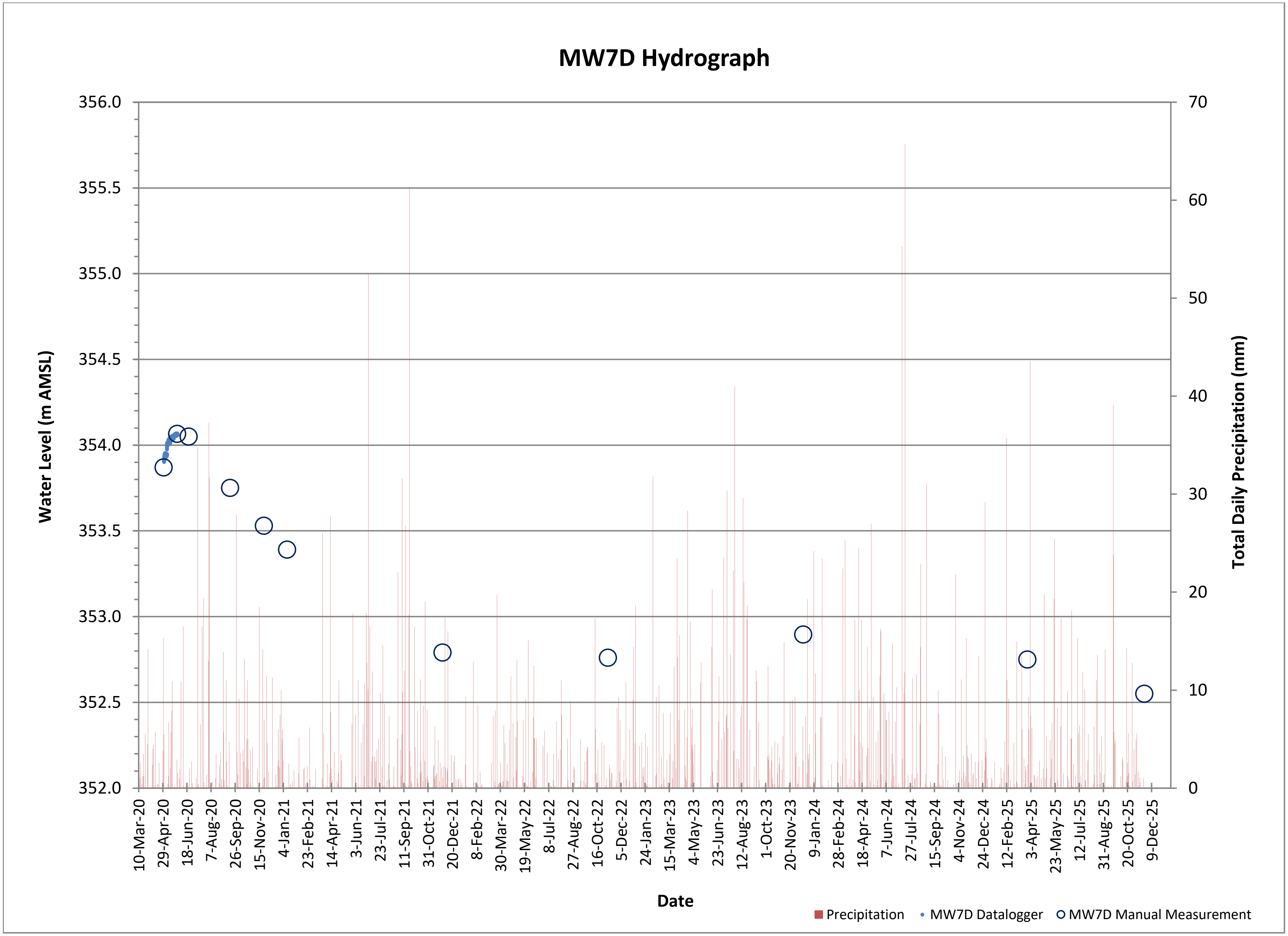
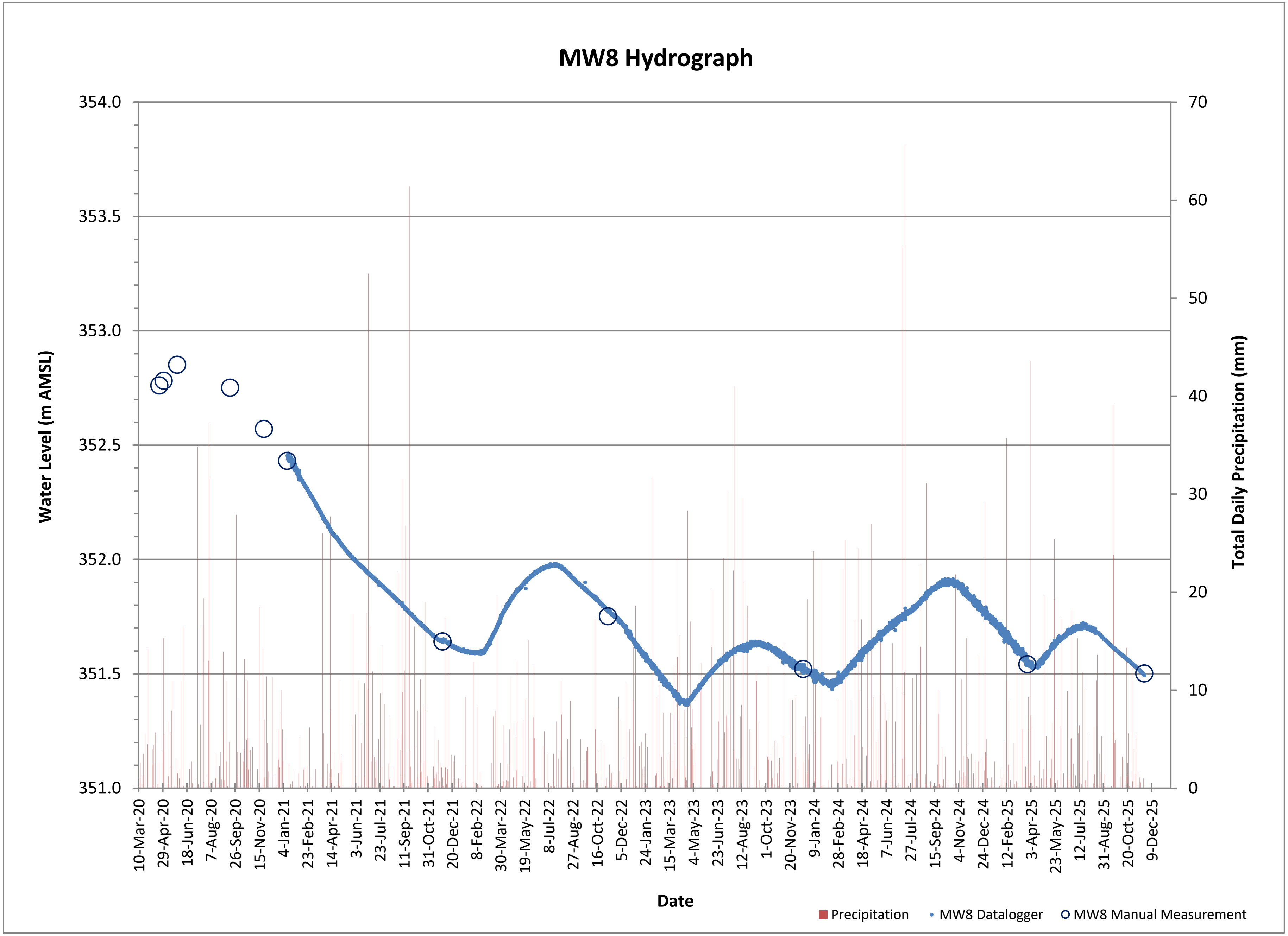
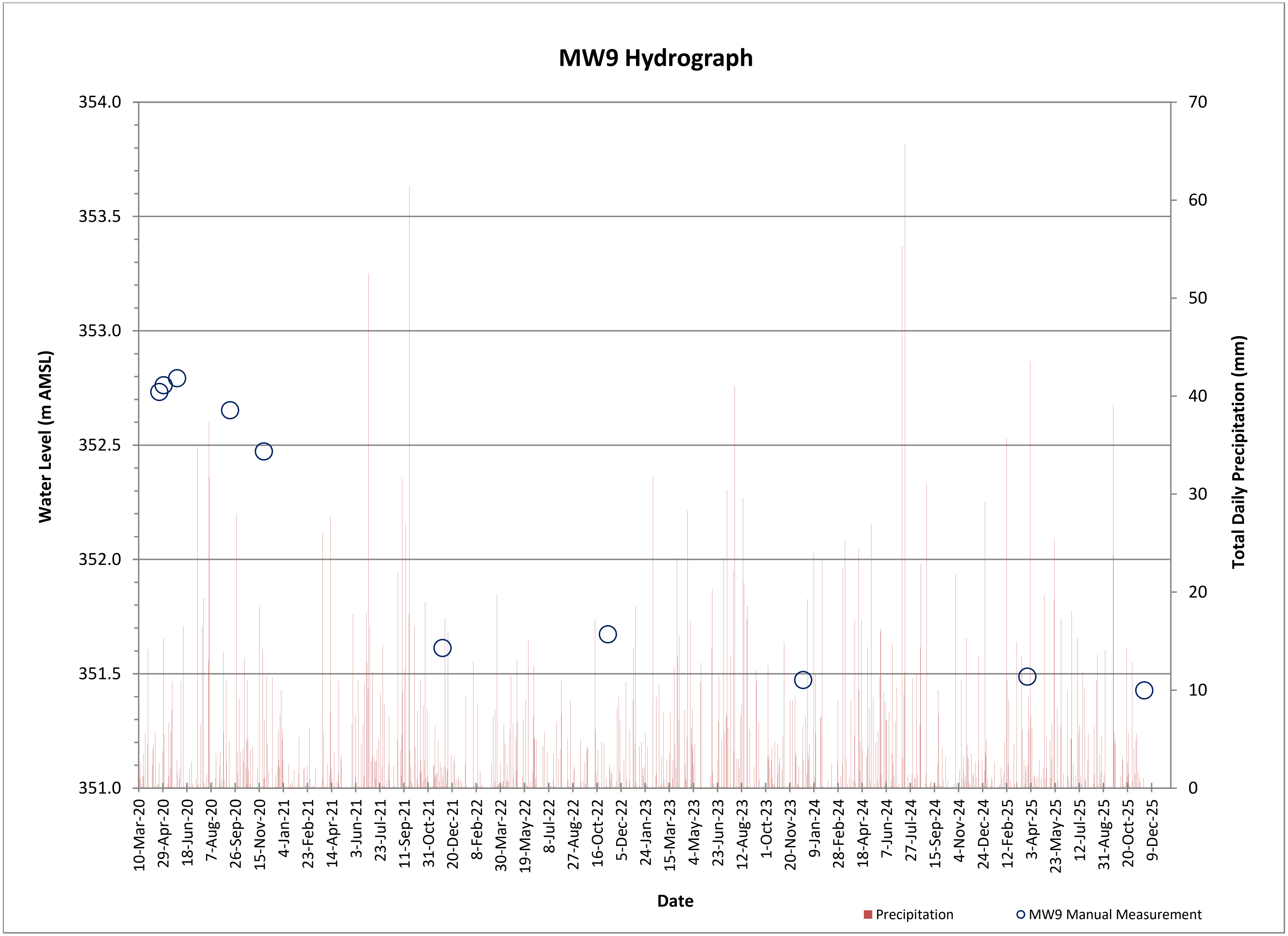
20-Oct-25
9-Dec-25
Precipitation
MW7S Datalogger
MW7S Manual Measurement



MW7D Hydrograph
Water Level (m AMSL)
Total Daily Precipitation (mm)
Date
356.0
355.5
355.0
354.5
354.0
353.5
353.0
352.5
352.0
70
60
50
40
30
20
10
0
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
23-Feb-21
14-Apr-21
3-Jun-21
23-Jul-21
11-Sep-21
31-Oct-21
20-Dec-21
8-Feb-22
30-Mar-22
19-May-22
8-Jul-22
27-Aug-22
16-Oct-22
5-Dec-22
24-Jan-23
15-Mar-23
4-May-23
23-Jun-23
12-Aug-23
1-Oct-23
20-Nov-23
9-Jan-24
28-Feb-24
18-Apr-24
7-Jun-24
27-Jul-24
15-Sep-24
4-Nov-24
24-Dec-24
12-Feb-25
3-Apr-25
23-May-25
12-Jul-25
31-Aug-25
20-Oct-25
9-Dec-25
Precipitation
MW7D Datalogger
MW7D Manual Measurement



MW8 Hydrograph
Water Level (m AMSL)
Total Daily Precipitation (mm)
Date
354.0
353.5
353.0
352.5
352.0
351.5
351.0
70
60
50
40
30
20
10
0
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
23-Feb-21
14-Apr-21
3-Jun-21
23-Jul-21
11-Sep-21
31-Oct-21
20-Dec-21
8-Feb-22
30-Mar-22
19-May-22
8-Jul-22
27-Aug-22
16-Oct-22
5-Dec-22
24-Jan-23
15-Mar-23
4-May-23
23-Jun-23
12-Aug-23
1-Oct-23
20-Nov-23
9-Jan-24
28-Feb-24
18-Apr-24
7-Jun-24
27-Jul-24
15-Sep-24
4-Nov-24
24-Dec-24
12-Feb-25
3-Apr-25
23-May-25
12-Jul-25
31-Aug-25
20-Oct-25
9-Dec-25
Precipitation
MW8 Datalogger
MW8 Manual Measurement



MW9 Hydrograph
Water Level (m AMSL)
354.0
353.5
353.0
352.5
352.0
351.5
351.0
Total Daily Precipitation (mm)
70
60
50
40
30
20
10
0
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
23-Feb-21
14-Apr-21
3-Jun-21
23-Jul-21
11-Sep-21
31-Oct-21
20-Dec-21
8-Feb-22
30-Mar-22
19-May-22
8-Jul-22
27-Aug-22
16-Oct-22
5-Dec-22
24-Jan-23
15-Mar-23
4-May-23
23-Jun-23
12-Aug-23
1-Oct-23
20-Nov-23
9-Jan-24
28-Feb-24
18-Apr-24
7-Jun-24
27-Jul-24
15-Sep-24
4-Nov-24
24-Dec-24
12-Feb-25
3-Apr-25
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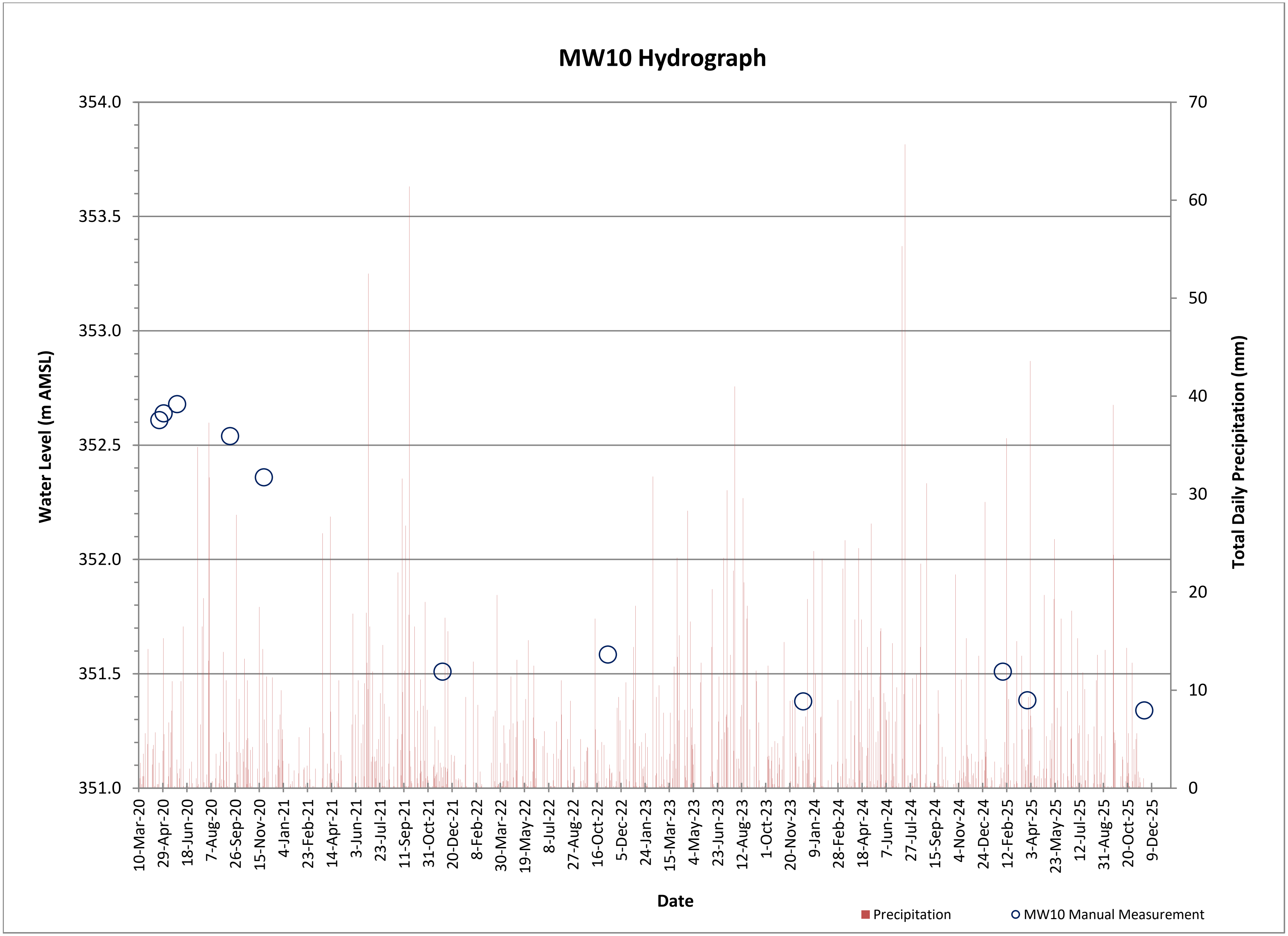
12-Jul-25
31-Aug-25
20-Oct-25
9-Dec-25
Date
Precipitation
MW9 Manual Measurement


MW10 Hydrograph
Water Level (m AMSL)
354.0
353.5
353.0
352.5
352.0
351.5
351.0
Total Daily Precipitation (mm)
70
60
50
40
30
20
10
0
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
23-Feb-21
14-Apr-21
3-Jun-21
23-Jul-21
11-Sep-21
31-Oct-21
20-Dec-21
8-Feb-22
30-Mar-22
19-May-22
8-Jul-22
27-Aug-22
16-Oct-22
5-Dec-22
24-Jan-23
15-Mar-23
4-May-23
23-Jun-23
12-Aug-23
1-Oct-23
20-Nov-23
9-Jan-24
28-Feb-24
18-Apr-24
7-Jun-24
27-Jul-24
15-Sep-24
4-Nov-24
24-Dec-24
12-Feb-25
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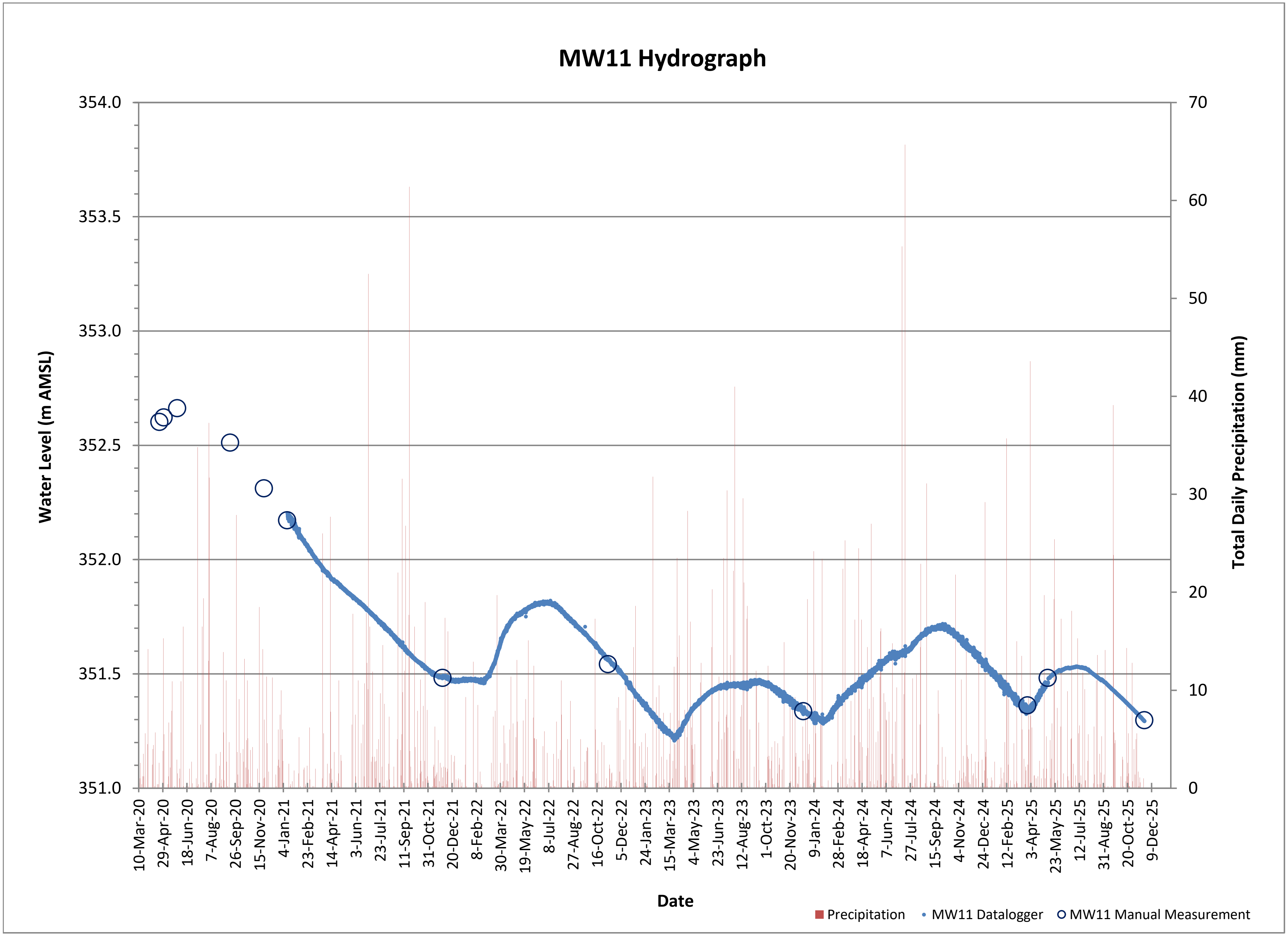
31-Aug-25
20-Oct-25
9-Dec-25
Date
Precipitation
MW10 Manual Measurement



MW11 Hydrograph
Water Level (m AMSL)
354.0
353.5
353.0
352.5
352.0
351.5
351.0
Total Daily Precipitation (mm)
70
60
50
40
30
20
10
0
10-Mar-20
29-Apr-20
18-Jun-20
7-Aug-20
26-Sep-20
15-Nov-20
4-Jan-21
23-Feb-21
14-Apr-21
3-Jun-21
23-Jul-21
11-Sep-21
31-Oct-21
20-Dec-21
8-Feb-22
30-Mar-22
19-May-22
8-Jul-22
27-Aug-22
16-Oct-22
5-Dec-22
24-Jan-23
15-Mar-23
4-May-23
23-Jun-23
12-Aug-23
1-Oct-23
20-Nov-23
9-Jan-24
28-Feb-24
18-Apr-24
7-Jun-24
27-Jul-24
15-Sep-24
4-Nov-24
24-Dec-24
12-Feb-25
3-Apr-25
23-May-25
12-Jul-25
31-Aug-25
20-Oct-25
9-Dec-25
Date
Precipitation
MW11 Datalogger
MW11 Manual Measurement

Making Sustainability Happen