APPENDIX **F**

MUNICIPAL WATER LEVEL HYDROGRAPHS

Municipal Water Level Hydrographs

The Safe Additional Available Drawdown value used in the Risk Assessment is the difference between the existing conditions (2008) water level elevation, and the safe water level elevation reported by the Region (which may be coincident with the top of screen, open hole, etc.). A series of observed water level hydrographs were created to examine the water level variability in the Region's municipal wells from 2000 to 2011 and are included in this Appendix.

The left hand side of each hydrograph contains the following well construction information:

- Ground surface elevation (m above sea level [asl])
- Interpreted observed 2008 average groundwater elevation (m asl)
- Pump intake elevation
- Elevation at the Top and Bottom of the Screen/Open Hole
- Safe Additional Available Drawdown (m)

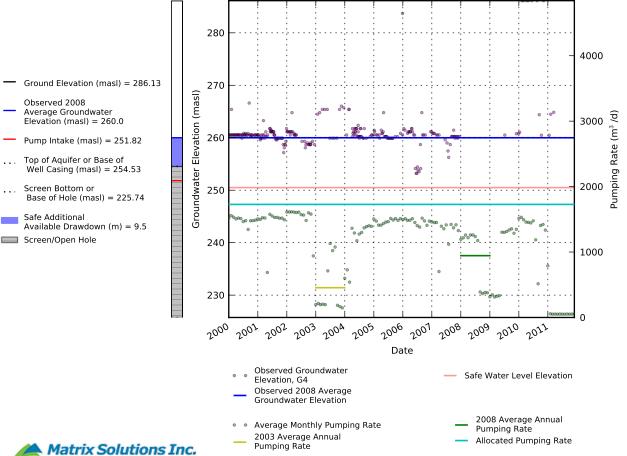
This information is illustrated schematically on the well diagram located to the left of the hydrograph.

The hydrograph located in the central portion of the page contains a legend beneath the graph, and highlights the following information:

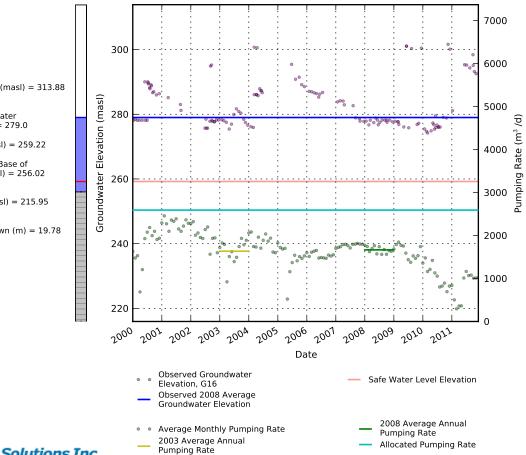
- Observed groundwater elevations (m asl)
- Interpreted observed 2008 Average groundwater elevation (m asl)
- Average monthly pumping rate (m³/d)
- 2008 average annual pumping rate (m^3/d)
- Allocated Rates (m³/d)
- Safe water level elevation (m asl)

In some instances, the observed groundwater elevations illustrated on the hydrographs are inaccurate and were not used in the development of the Safe Additional Available Drawdown values. Appendix H lists these wells and the methodology used to develop the alternative observed 2008 pumped water level elevations used in the calculation of the Safe Additional Available Drawdown values.

HYDROGRAPH City: Cambridge / Well Field: BLAIR ROAD Consult_ID: G4 / Obj_Num: 6500110





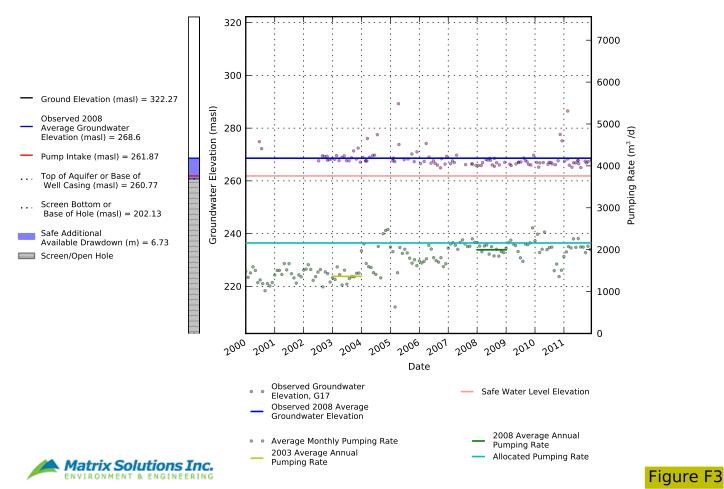


- Ground Elevation (masl) = 313.88
- Observed 2008 Average Groundwater Elevation (masl) = 279.0
- Pump Intake (masl) = 259.22
- ... Top of Aquifer or Base of Well Casing (masl) = 256.02
- ... Screen Bottom or Base of Hole (masl) = 215.95
- Safe Additional Available Drawdown (m) = 19.78 Screen/Open Hole

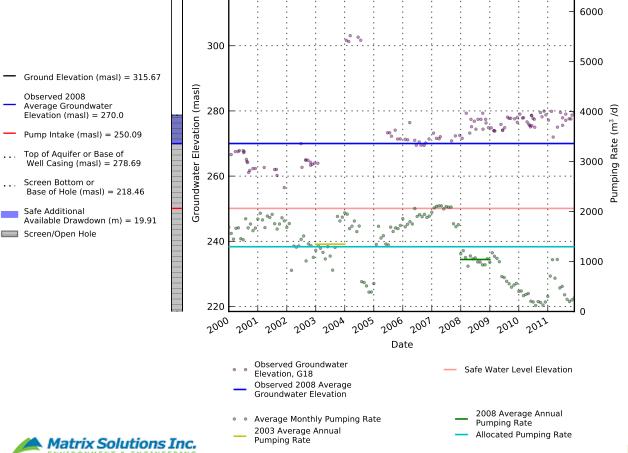


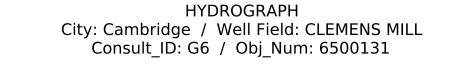


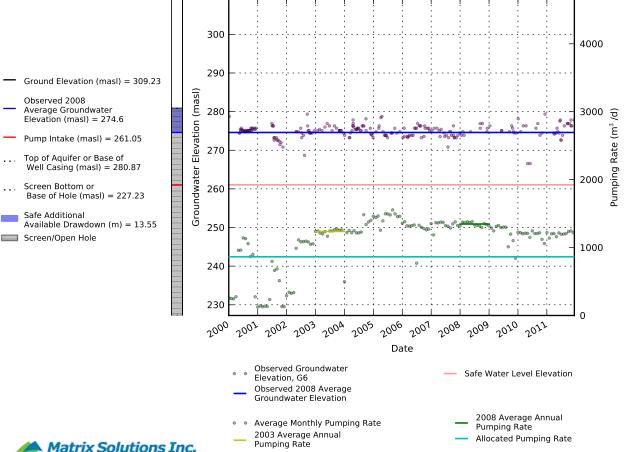
HYDROGRAPH City: Cambridge / Well Field: CLEMENS MILL Consult_ID: G17 / Obj_Num: 1000017

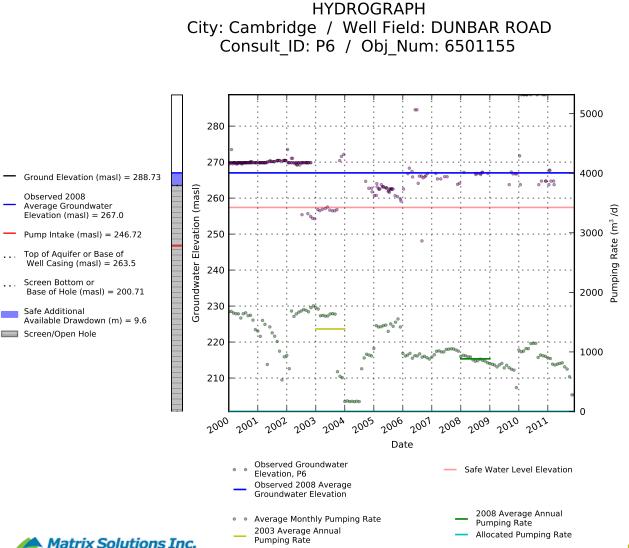


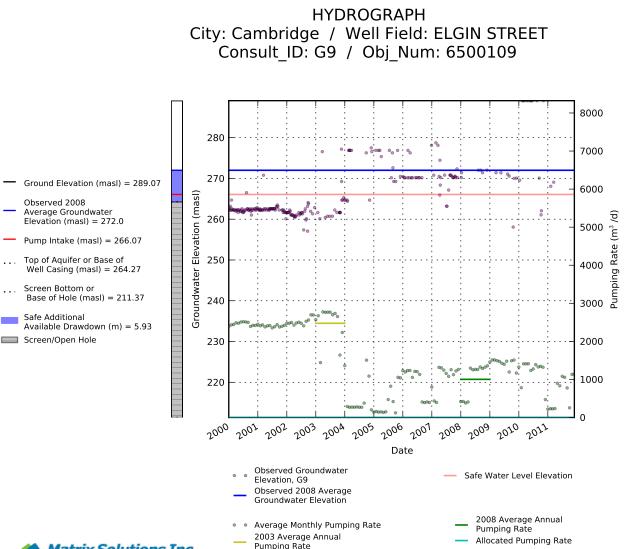
HYDROGRAPH City: Cambridge / Well Field: CLEMENS MILL Consult_ID: G18 / Obj_Num: 1000013







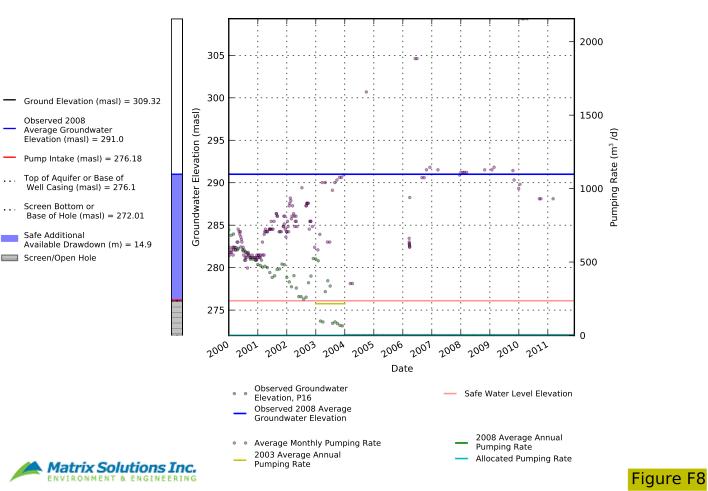




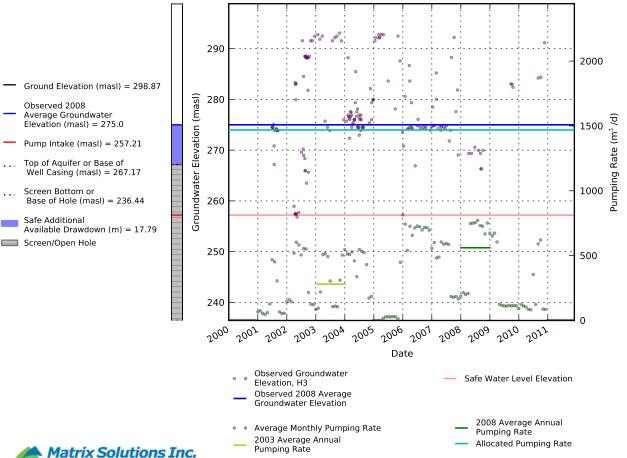




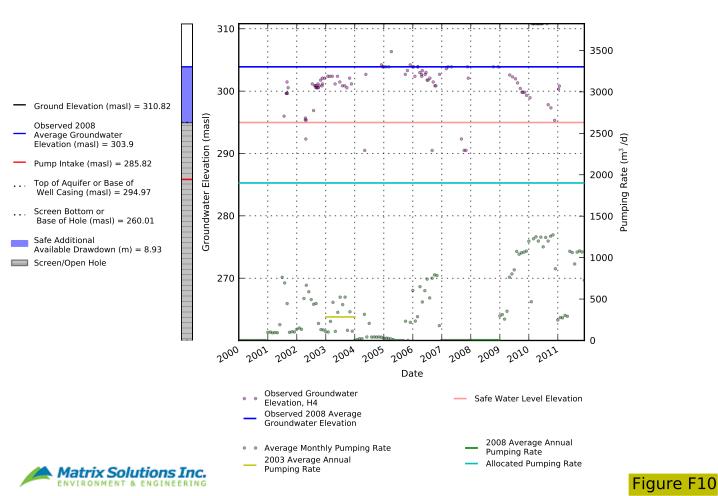
HYDROGRAPH City: Cambridge / Well Field: FOUNTAIN STREET Consult_ID: P16 / Obj_Num: 6505937

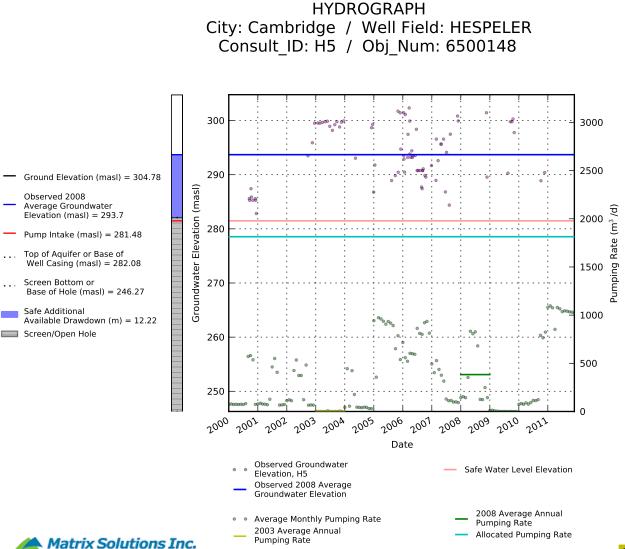


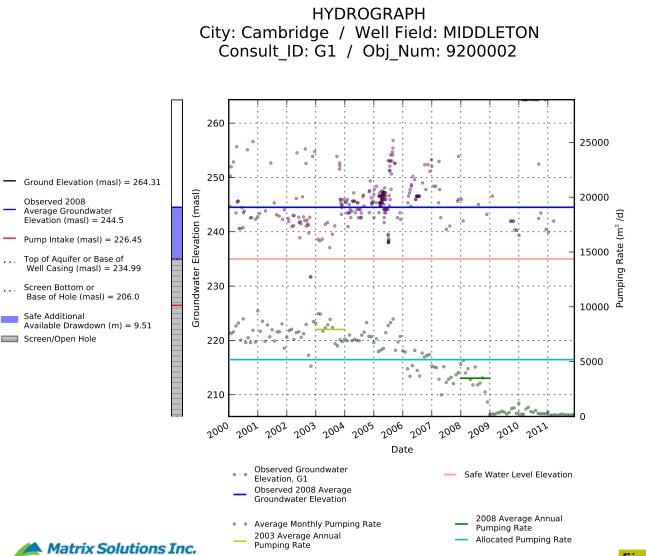
HYDROGRAPH City: Cambridge / Well Field: HESPELER Consult_ID: H3 / Obj_Num: 6500142



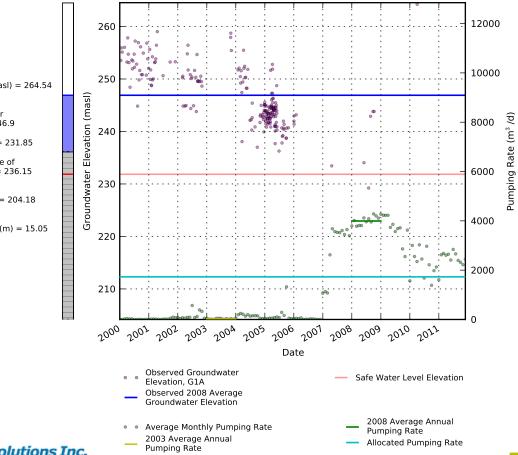
HYDROGRAPH City: Cambridge / Well Field: HESPELER Consult_ID: H4 / Obj_Num: 6500146







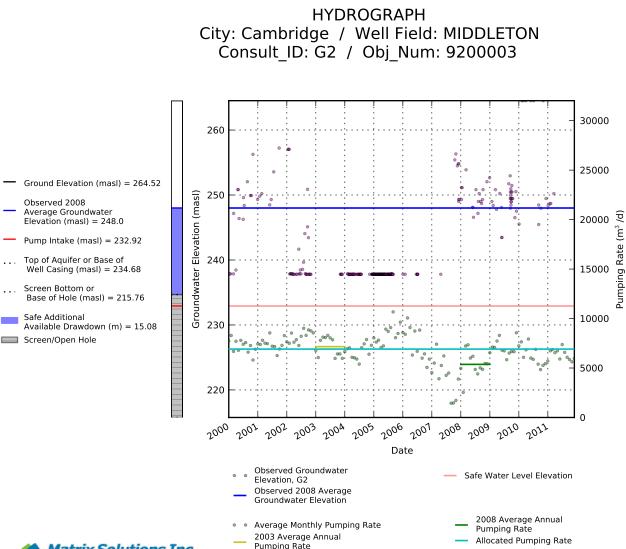
HYDROGRAPH City: Cambridge / Well Field: MIDDLETON Consult_ID: G1A / Obj_Num: 1000315



- Ground Elevation (masl) = 264.54
- Observed 2008 Average Groundwater Elevation (masl) = 246.9
- Pump Intake (masl) = 231.85
- ... Top of Aquifer or Base of Well Casing (masl) = 236.15
- ... Screen Bottom or Base of Hole (masl) = 204.18
- Safe Additional Available Drawdown (m) = 15.05 Screen/Open Hole

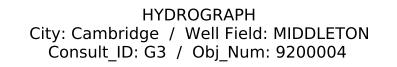


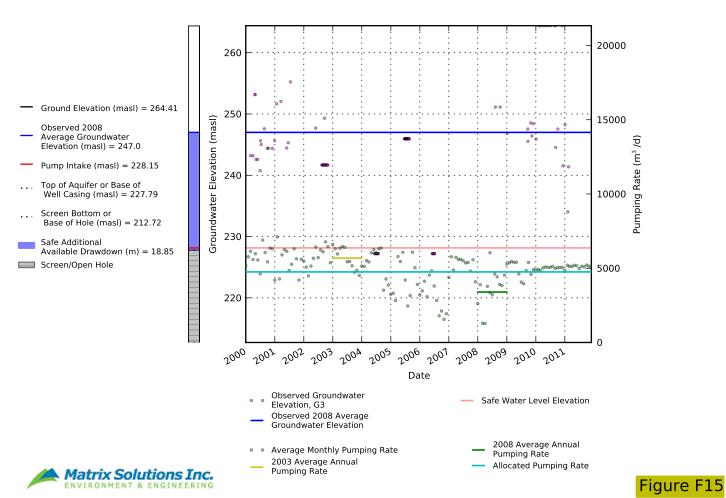




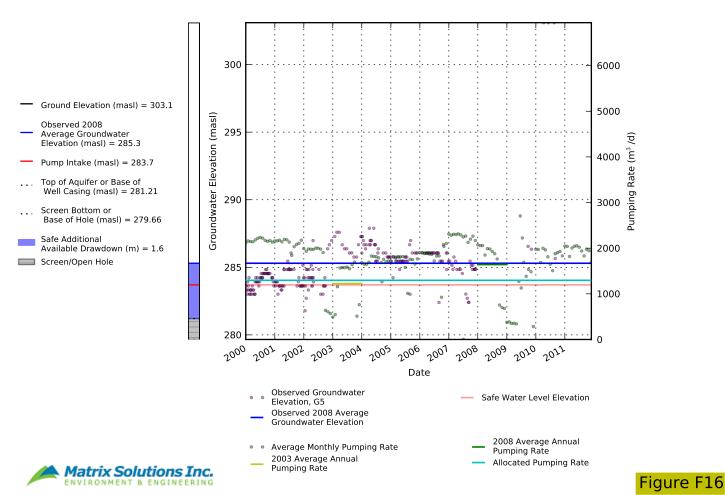




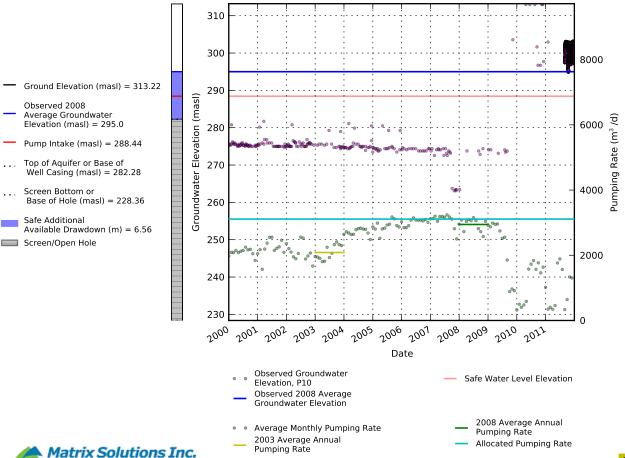


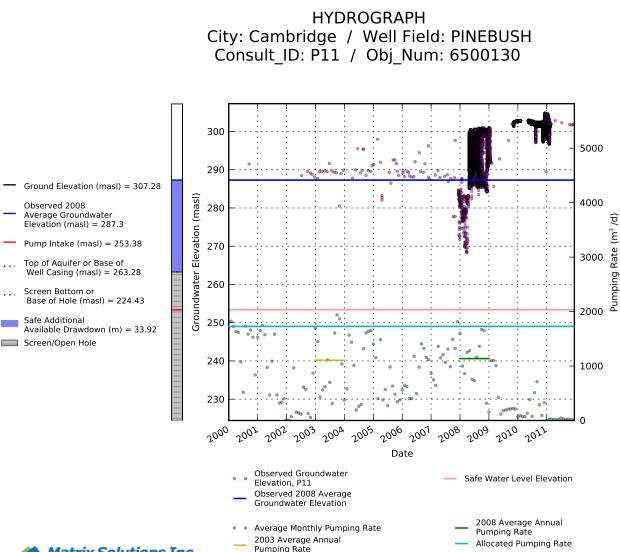


HYDROGRAPH City: Cambridge / Well Field: PINEBUSH Consult_ID: G5 / Obj_Num: 6500129



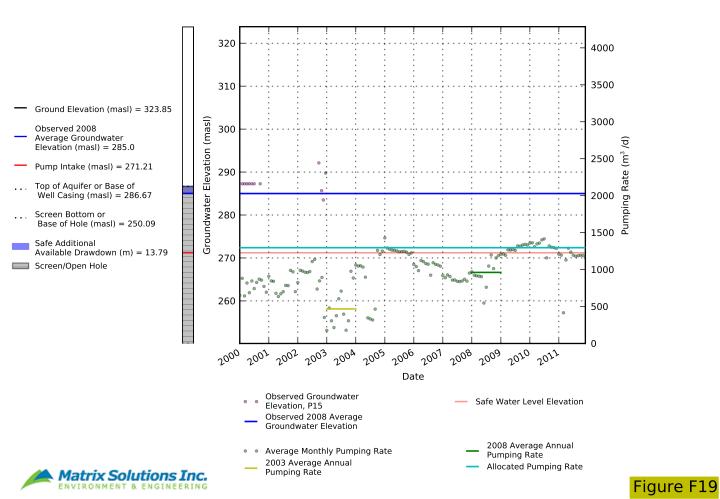
HYDROGRAPH City: Cambridge / Well Field: PINEBUSH Consult_ID: P10 / Obj_Num: 6500132

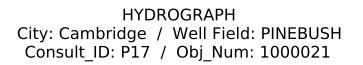


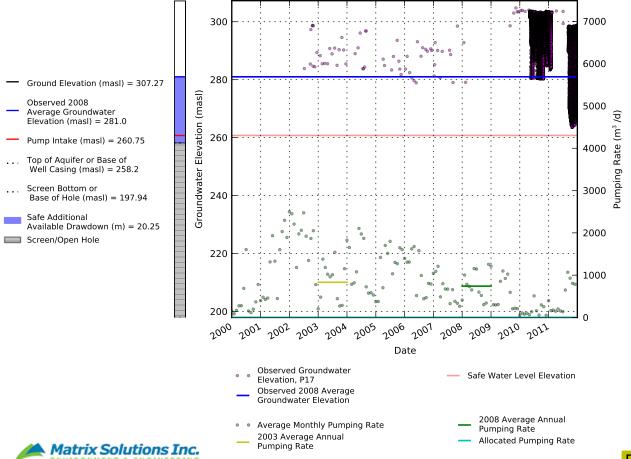




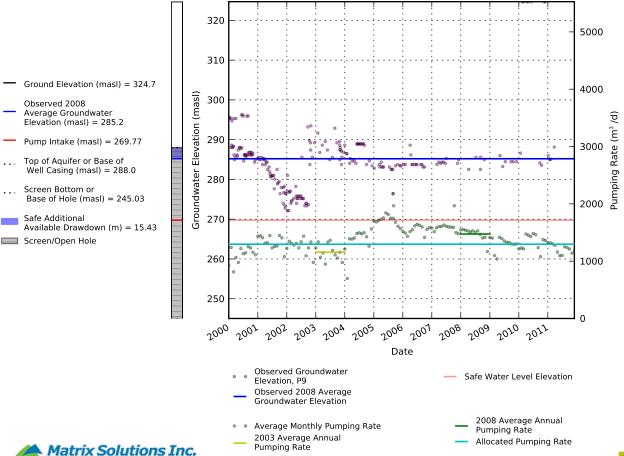
HYDROGRAPH City: Cambridge / Well Field: PINEBUSH Consult_ID: P15 / Obj_Num: 9200010





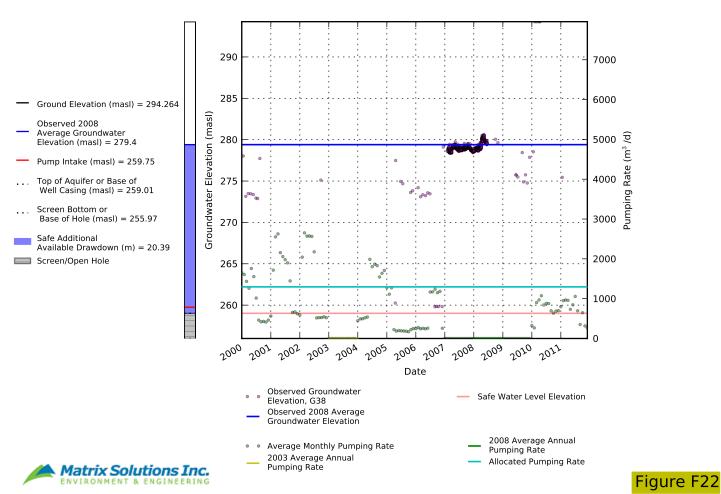


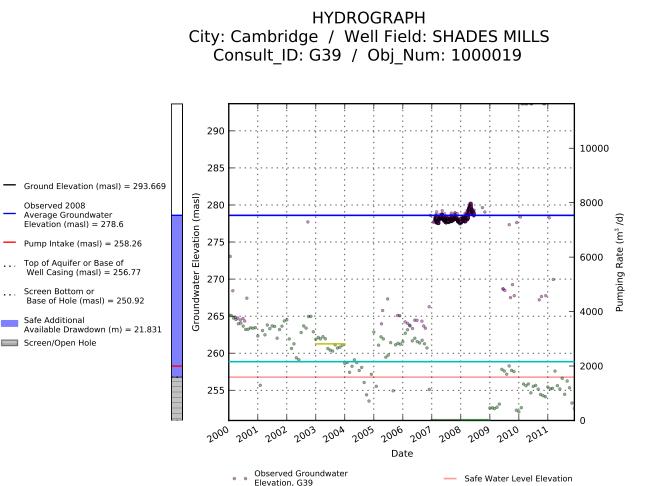
HYDROGRAPH City: Cambridge / Well Field: PINEBUSH Consult_ID: P9 / Obj_Num: 6500128





HYDROGRAPH City: Cambridge / Well Field: SHADES MILLS Consult_ID: G38 / Obj_Num: 1000018





Observed 2008 Average Groundwater Elevation

2003 Average Annual

Pumping Rate

Average Monthly Pumping Rate

Matrix Solutions Inc.

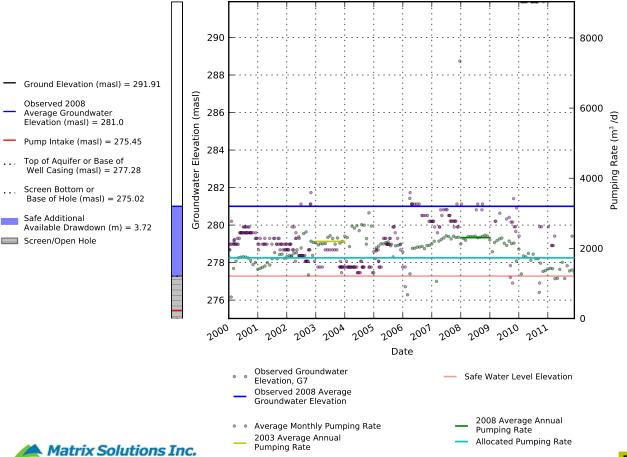
Figure F23

2008 Average Annual

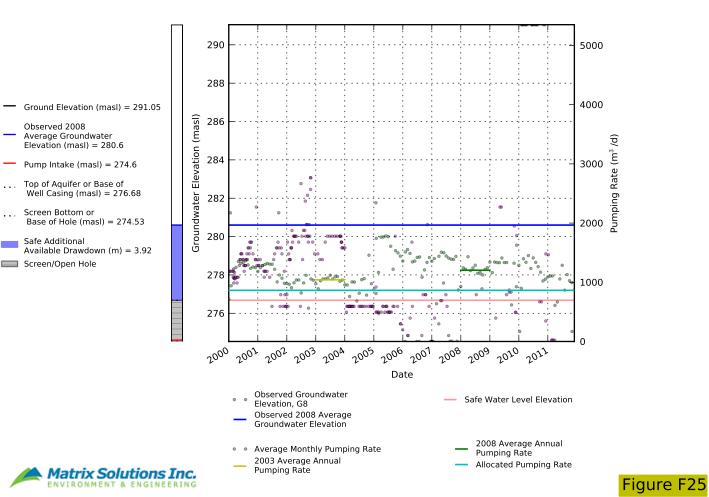
Allocated Pumping Rate

Pumping Rate

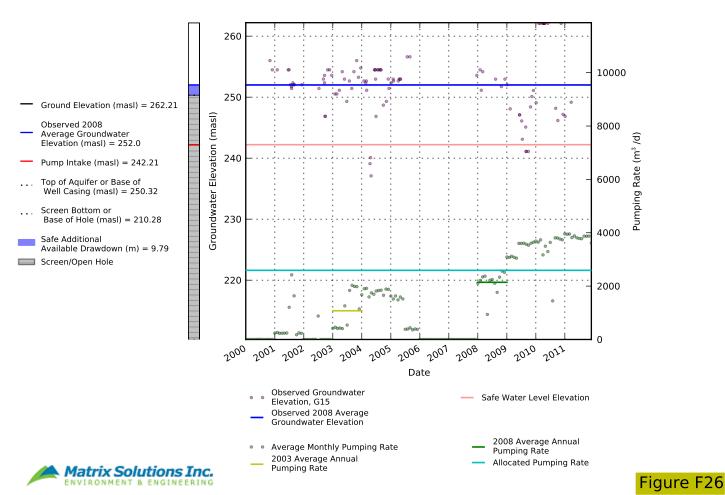
HYDROGRAPH City: Cambridge / Well Field: SHADES MILLS Consult_ID: G7 / Obj_Num: 9200006



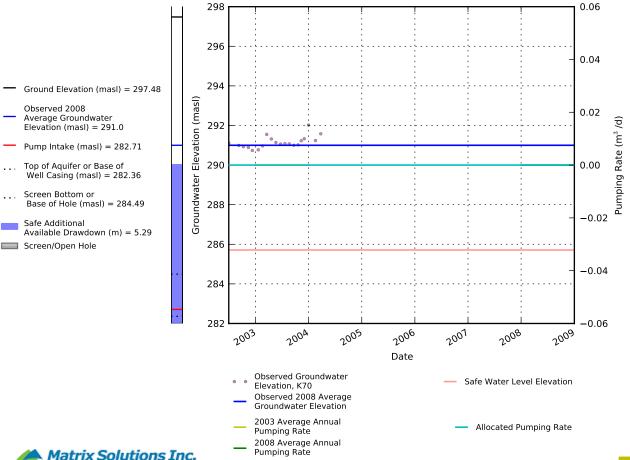
HYDROGRAPH City: Cambridge / Well Field: SHADES MILLS Consult_ID: G8 / Obj_Num: 9200007



HYDROGRAPH City: Cambridge / Well Field: WILLARD Consult_ID: G15 / Obj_Num: 9200001

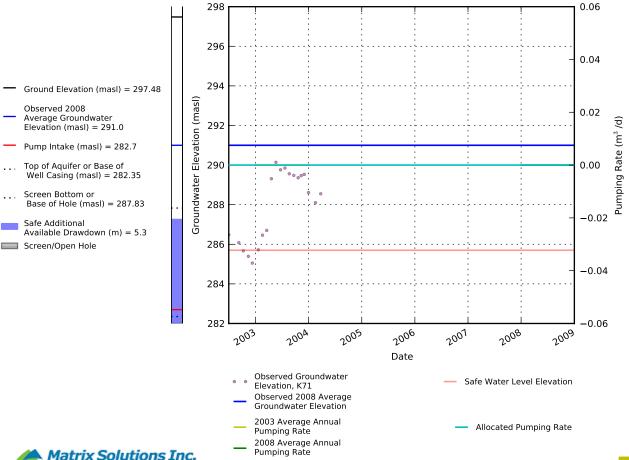


HYDROGRAPH City: Kitchener / Well Field: FORWELL/POMPEII Consult_ID: K70 / Obj_Num: 6504698

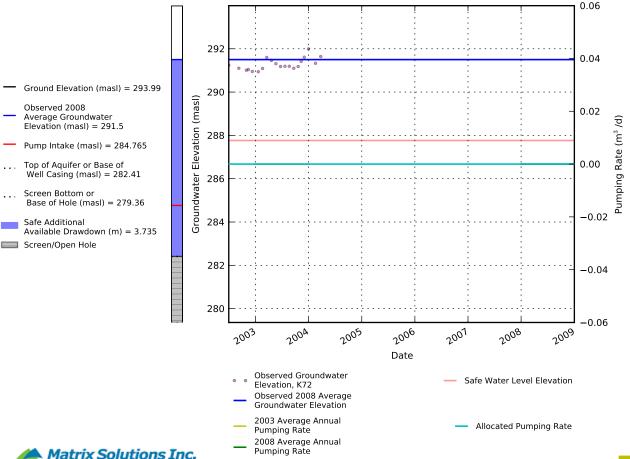




HYDROGRAPH City: Kitchener / Well Field: FORWELL/POMPEII Consult_ID: K71 / Obj_Num: 6504699

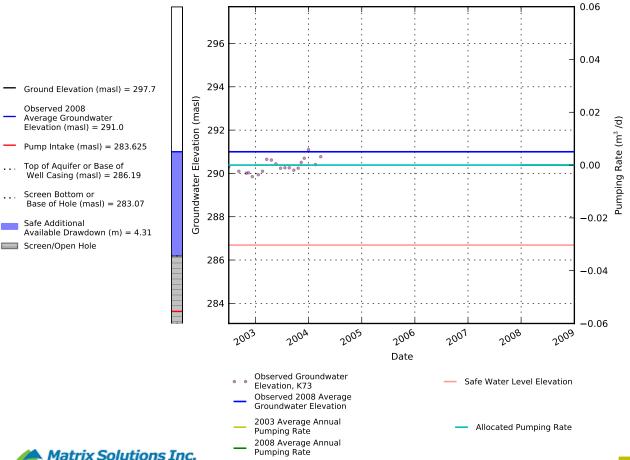


HYDROGRAPH City: Kitchener / Well Field: FORWELL/POMPEII Consult_ID: K72 / Obj_Num: 6505032

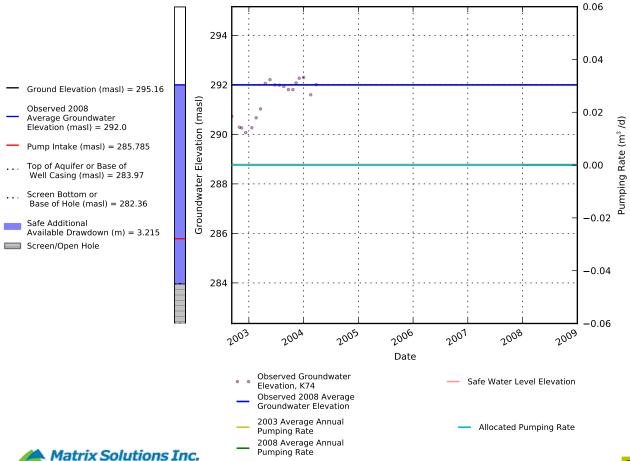




HYDROGRAPH City: Kitchener / Well Field: FORWELL/POMPEII Consult_ID: K73 / Obj_Num: 6505033



HYDROGRAPH City: Kitchener / Well Field: FORWELL/POMPEII Consult_ID: K74 / Obj_Num: 6505034



HYDROGRAPH City: Kitchener / Well Field: FORWELL/POMPEII Consult_ID: K75 / Obj_Num: 6505035

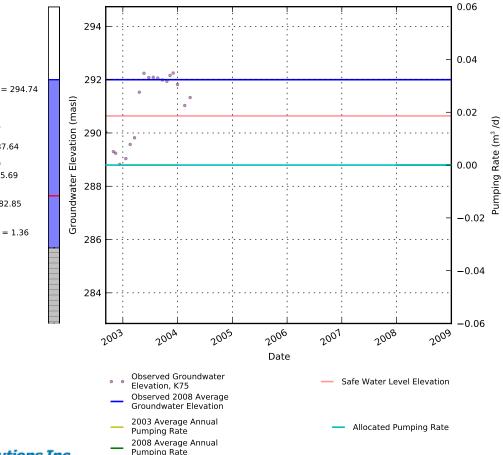


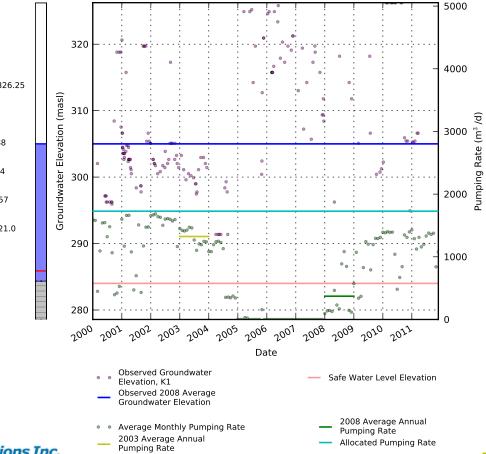
Figure F32

Ground Elevation (masl) = 294.74

- Observed 2008 Average Groundwater Elevation (masl) = 292.0
- Pump Intake (masl) = 287.64
- ... Top of Aquifer or Base of Well Casing (masl) = 285.69
- ... Screen Bottom or Base of Hole (masl) = 282.85
- Safe Additional Available Drawdown (m) = 1.36 Screen/Open Hole



HYDROGRAPH City: Kitchener / Well Field: GREENBROOK Consult_ID: K1 / Obj_Num: 1000034



- Ground Elevation (masl) = 326.25
- Observed 2008 Average Groundwater Elevation (masl) = 305.0
- Pump Intake (masl) = 285.88
- ... Top of Aquifer or Base of Well Casing (masl) = 284.34
- ... Screen Bottom or Base of Hole (masl) = 278.57
- Safe Additional Available Drawdown (m) = 21.0 Screen/Open Hole



HYDROGRAPH City: Kitchener / Well Field: GREENBROOK Consult ID: K2 / Obj Num: 1000003

- 8000 320 7000 Ground Elevation (masl) = 327.08 Groundwater Elevation (masl) 6000 310 (p . ш 5000 Pump Intake (masl) = 293.222000 Pumping Rate (Well Casing (masl) = 288.08 300 Base of Hole (masl) = 279.61 Available Drawdown (m) = 19.532000 290 1000 • 280 0 2000 2002 2003 2004 2005 2006 2007 2008 2009 2001 2010 2011 Date **Observed Groundwater** Safe Water Level Elevation 0 Elevation, K2 Observed 2008 Average Groundwater Elevation 2008 Average Annual Average Monthly Pumping Rate Pumping Rate 2003 Average Annual Allocated Pumping Rate Pumping Rate
- Matrix Solutions Inc.

Observed 2008 Average Groundwater

Elevation (masl) = 303.0

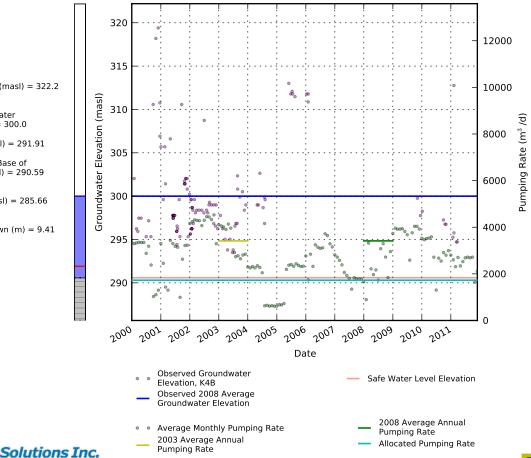
Top of Aquifer or Base of

Screen Bottom or

Safe Additional

Screen/Open Hole



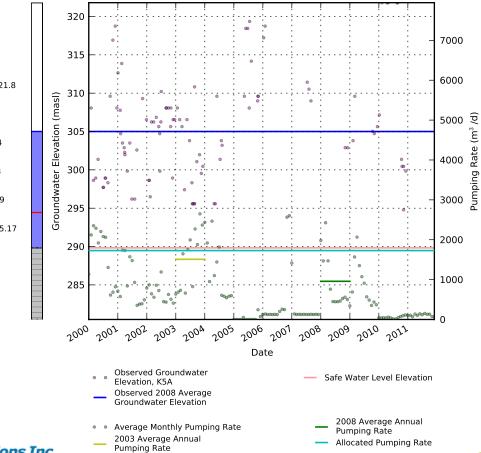


- Ground Elevation (masl) = 322.2
- Observed 2008 Average Groundwater Elevation (masl) = 300.0
- Pump Intake (masl) = 291.91
- ... Top of Aquifer or Base of Well Casing (masl) = 290.59
- ... Screen Bottom or Base of Hole (masl) = 285.66
- Safe Additional Available Drawdown (m) = 9.41 Screen/Open Hole





HYDROGRAPH City: Kitchener / Well Field: GREENBROOK Consult_ID: K5A / Obj_Num: 9200915

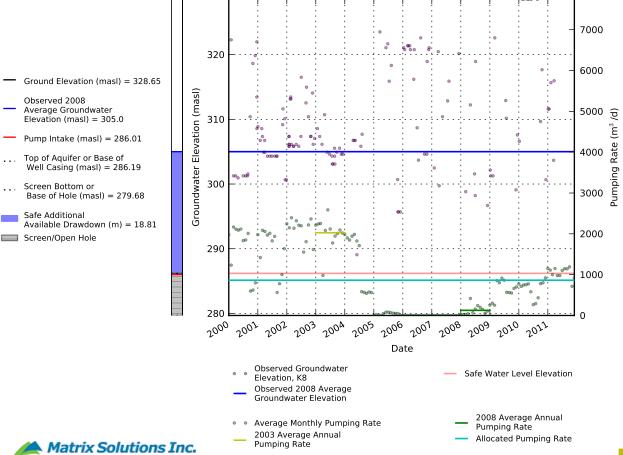


- Ground Elevation (masl) = 321.8
- Observed 2008 Average Groundwater Elevation (masl) = 305.0
- Pump Intake (masl) = 294.44
- ... Top of Aquifer or Base of Well Casing (masl) = 289.83
- Screen Bottom or Base of Hole (masl) = 280.49
- Safe Additional Available Drawdown (m) = 15.17 Screen/Open Hole

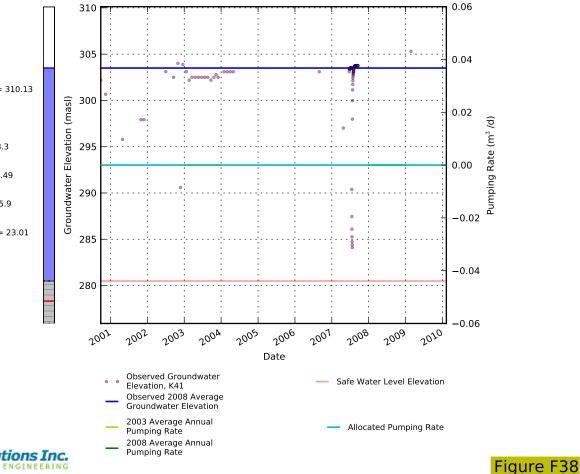




HYDROGRAPH City: Kitchener / Well Field: GREENBROOK Consult_ID: K8 / Obj_Num: 1000834



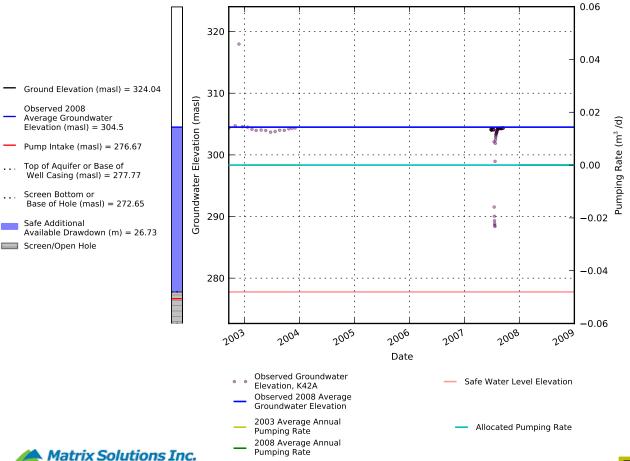
HYDROGRAPH City: Kitchener / Well Field: LANCASTER Consult_ID: K41 / Obj_Num: 6500219



- Ground Elevation (masl) = 310.13
- Observed 2008 Average Groundwater Elevation (masl) = 303.5
- Pump Intake (masl) = 278.3
- ... Top of Aquifer or Base of Well Casing (masl) = 280.49
- ... Screen Bottom or Base of Hole (masl) = 275.9
- Safe Additional Available Drawdown (m) = 23.01 Screen/Open Hole

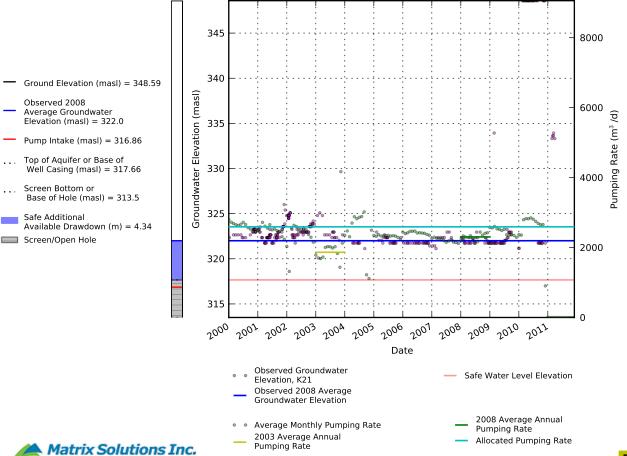


HYDROGRAPH City: Kitchener / Well Field: LANCASTER Consult_ID: K42A / Obj_Num: 6500353

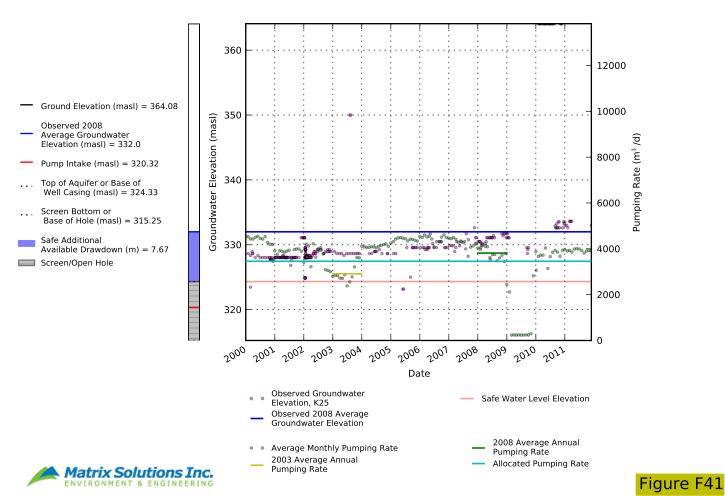




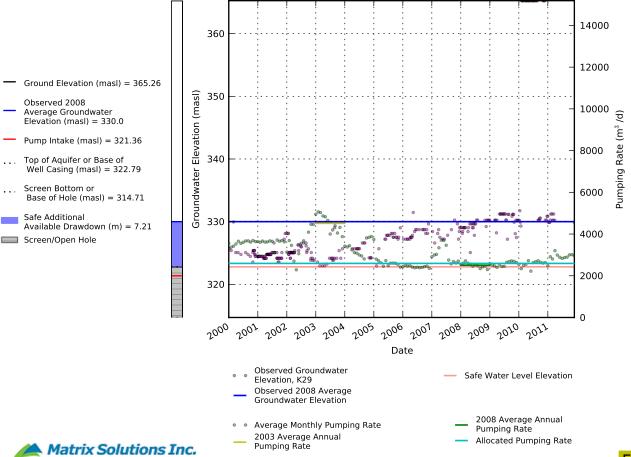
HYDROGRAPH City: Kitchener / Well Field: MANNHEIM EAST Consult_ID: K21 / Obj_Num: 6501407



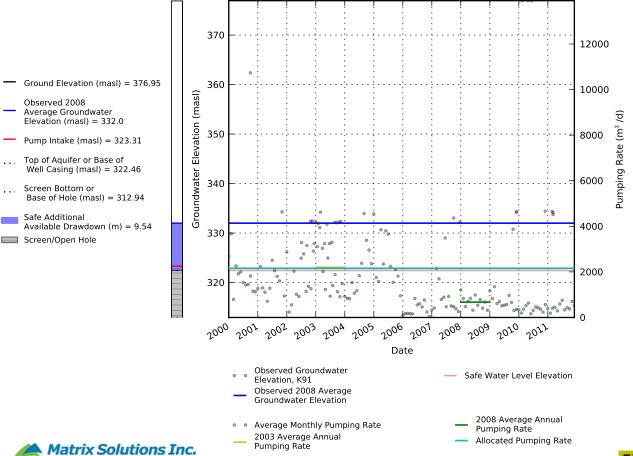
HYDROGRAPH City: Kitchener / Well Field: MANNHEIM EAST Consult_ID: K25 / Obj_Num: 6501807



HYDROGRAPH City: Kitchener / Well Field: MANNHEIM EAST Consult_ID: K29 / Obj_Num: 6506310

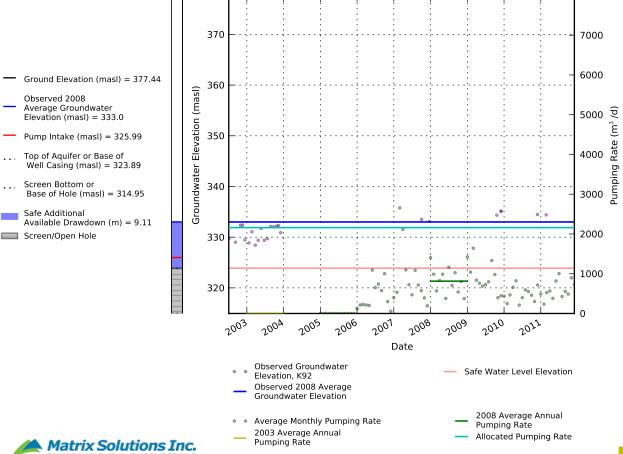


HYDROGRAPH City: Kitchener / Well Field: MANNHEIM EAST PEAKING Consult_ID: K91 / Obj_Num: 6506790

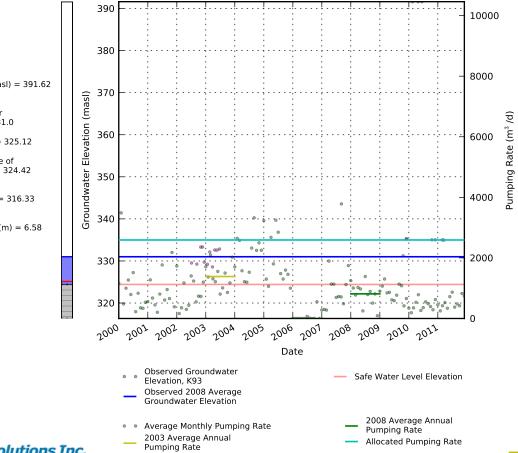




HYDROGRAPH City: Kitchener / Well Field: MANNHEIM EAST PEAKING Consult_ID: K92 / Obj_Num: 6506791



HYDROGRAPH City: Kitchener / Well Field: MANNHEIM EAST PEAKING Consult_ID: K93 / Obj_Num: 6506792

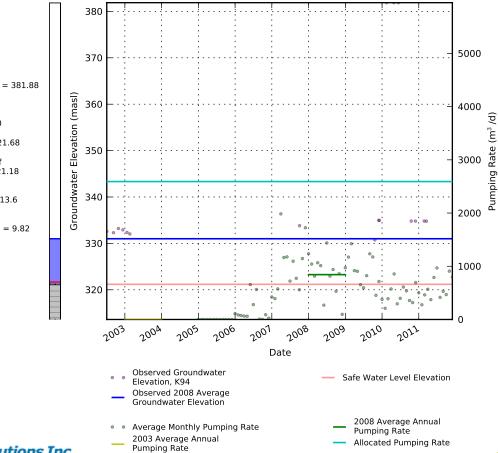


- Ground Elevation (masl) = 391.62
- Observed 2008 Average Groundwater Elevation (masl) = 331.0
- Pump Intake (masl) = 325.12
- ... Top of Aquifer or Base of Well Casing (masl) = 324.42
- ... Screen Bottom or Base of Hole (masl) = 316.33
- Safe Additional Available Drawdown (m) = 6.58 Screen/Open Hole





HYDROGRAPH City: Kitchener / Well Field: MANNHEIM EAST PEAKING Consult_ID: K94 / Obj_Num: 6506789

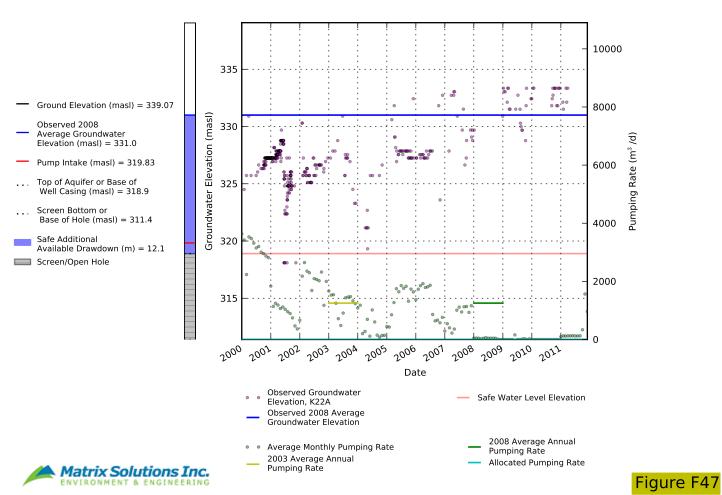


- Ground Elevation (masl) = 381.88
- Observed 2008 Average Groundwater Elevation (masl) = 331.0
- Pump Intake (masl) = 321.68
- ... Top of Aquifer or Base of Well Casing (masl) = 321.18
- ... Screen Bottom or Base of Hole (masl) = 313.6
- Safe Additional Available Drawdown (m) = 9.82 Screen/Open Hole

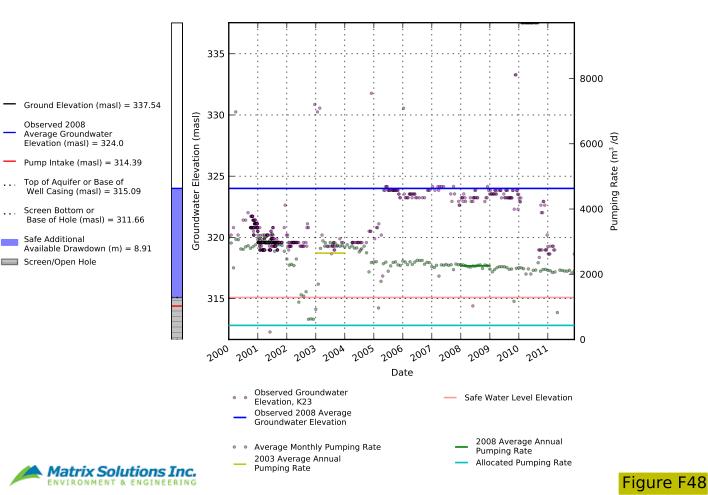




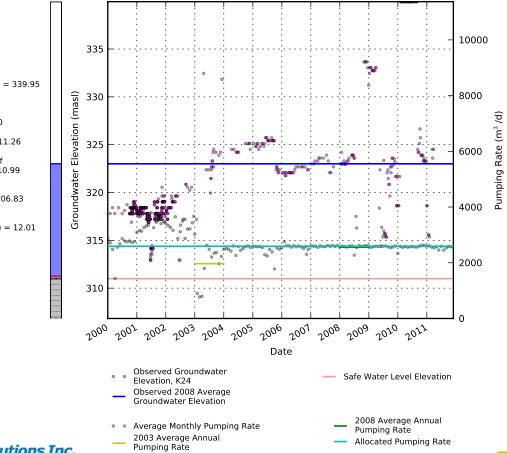
HYDROGRAPH City: Kitchener / Well Field: MANNHEIM WEST Consult_ID: K22A / Obj_Num: 6502169



HYDROGRAPH City: Kitchener / Well Field: MANNHEIM WEST Consult_ID: K23 / Obj_Num: 6502162



HYDROGRAPH City: Kitchener / Well Field: MANNHEIM WEST Consult_ID: K24 / Obj_Num: 6502171

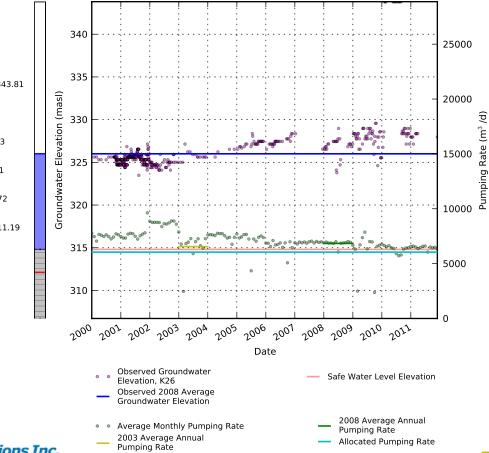


- Ground Elevation (masl) = 339.95
- Observed 2008 Average Groundwater Elevation (masl) = 323.0
- Pump Intake (masl) = 311.26
- ... Top of Aquifer or Base of Well Casing (masl) = 310.99
- ... Screen Bottom or Base of Hole (masl) = 306.83
- Safe Additional Available Drawdown (m) = 12.01 Screen/Open Hole





HYDROGRAPH City: Kitchener / Well Field: MANNHEIM WEST Consult_ID: K26 / Obj_Num: 6503145

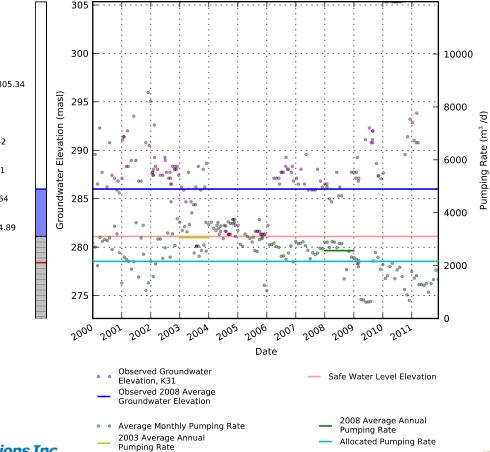


- Ground Elevation (masl) = 343.81
- Observed 2008 Average Groundwater Elevation (masl) = 326.0
- Pump Intake (masl) = 312.13
- ... Top of Aquifer or Base of Well Casing (masl) = 314.81
- Screen Bottom or Base of Hole (masl) = 306.72
- Safe Additional Available Drawdown (m) = 11.19 Screen/Open Hole





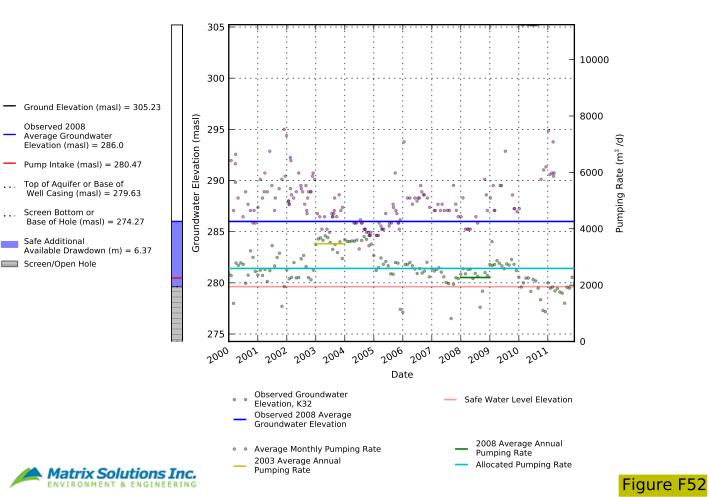
HYDROGRAPH City: Kitchener / Well Field: PARKWAY Consult_ID: K31 / Obj_Num: 6500292



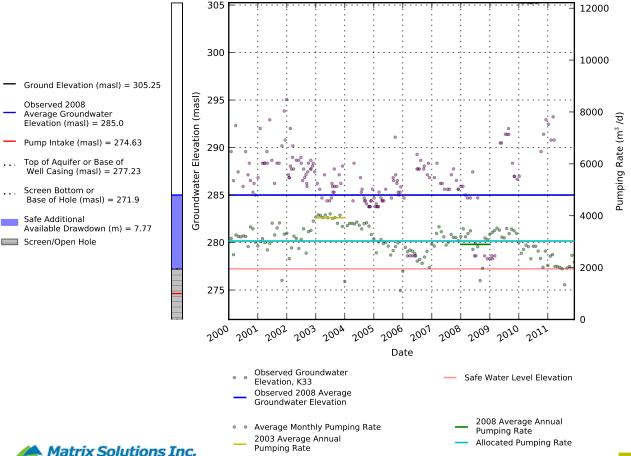
- Ground Elevation (masl) = 305.34
- Observed 2008 Average Groundwater Elevation (masl) = 286.0
- Pump Intake (masl) = 278.42
- ... Top of Aquifer or Base of Well Casing (masl) = 281.11
- ... Screen Bottom or Base of Hole (masl) = 272.64
- Safe Additional Available Drawdown (m) = 4.89 Screen/Open Hole



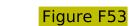
HYDROGRAPH City: Kitchener / Well Field: PARKWAY Consult_ID: K32 / Obj_Num: 9200016



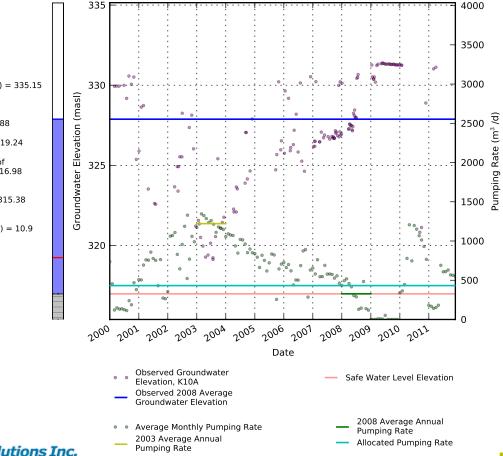
HYDROGRAPH City: Kitchener / Well Field: PARKWAY Consult ID: K33 / Obj Num: 6500352







HYDROGRAPH City: Kitchener / Well Field: STRANGE STREET Consult_ID: K10A / Obj_Num: 6505373

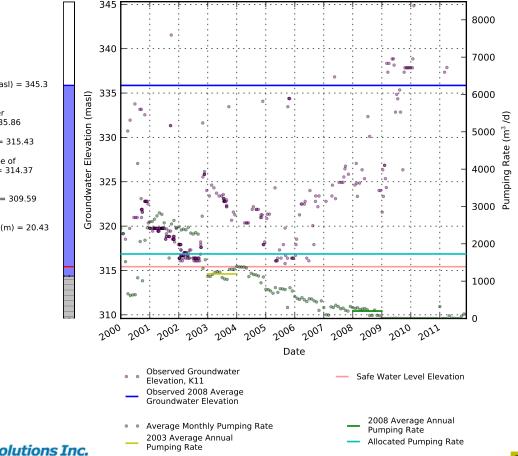


- Ground Elevation (masl) = 335.15
- Observed 2008 Average Groundwater Elevation (masl) = 327.88
- Pump Intake (masl) = 319.24
- ... Top of Aquifer or Base of Well Casing (masl) = 316.98
- Screen Bottom or Base of Hole (masl) = 315.38
- Safe Additional Available Drawdown (m) = 10.9 Screen/Open Hole





HYDROGRAPH City: Kitchener / Well Field: STRANGE STREET Consult_ID: K11 / Obj_Num: 1000037

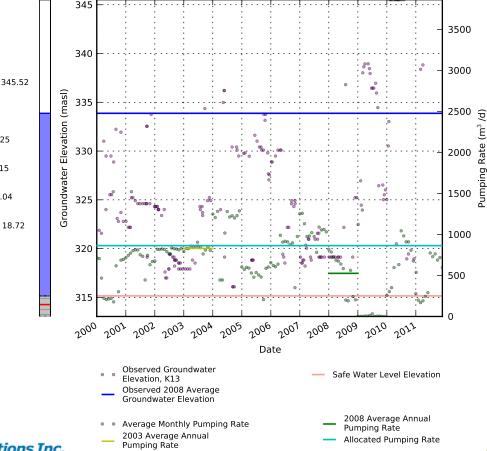


- Ground Elevation (masl) = 345.3
- Observed 2008 Average Groundwater Elevation (masl) = 335.86
- Pump Intake (masl) = 315.43
- ... Top of Aquifer or Base of Well Casing (masl) = 314.37
- ... Screen Bottom or Base of Hole (masl) = 309.59
- Safe Additional Available Drawdown (m) = 20.43 Screen/Open Hole





HYDROGRAPH City: Kitchener / Well Field: STRANGE STREET Consult_ID: K13 / Obj_Num: 6500193

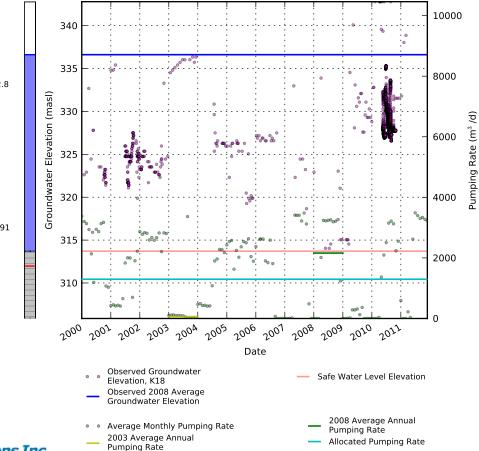


- Ground Elevation (masl) = 345.52
- Observed 2008 Average Groundwater Elevation (masl) = 333.87
- Pump Intake (masl) = 314.25
- ... Top of Aquifer or Base of Well Casing (masl) = 315.15
- Screen Bottom or Base of Hole (masl) = 313.04
- Safe Additional Available Drawdown (m) = 18.72 Screen/Open Hole



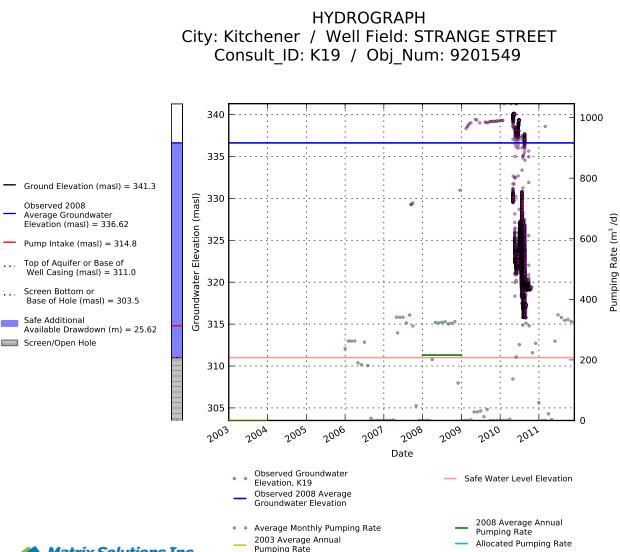


HYDROGRAPH City: Kitchener / Well Field: STRANGE STREET Consult_ID: K18 / Obj_Num: 6504268



- Ground Elevation (masl) = 342.8
- Observed 2008 Average Groundwater Elevation (masl) = 336.62
- Pump Intake (masl) = 311.97
- ... Top of Aquifer or Base of Well Casing (masl) = 313.71
- ... Screen Bottom or Base of Hole (masl) = 305.86
- Safe Additional Available Drawdown (m) = 22.91 Screen/Open Hole





Matrix Solutions Inc.

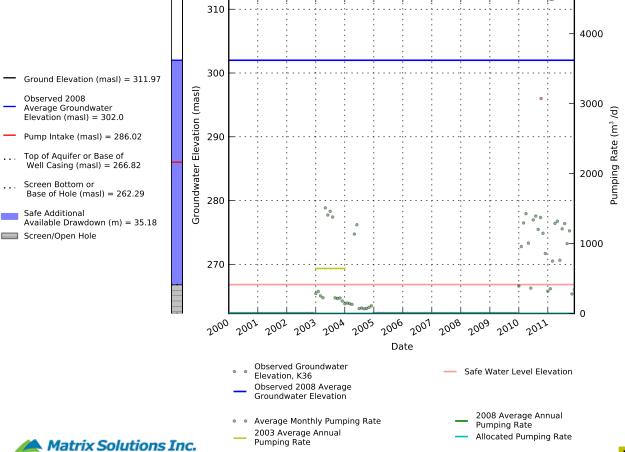
Observed 2008

Safe Additional

HYDROGRAPH City: Kitchener / Well Field: STRASBURG Consult_ID: K34 / Obj_Num: 6500921

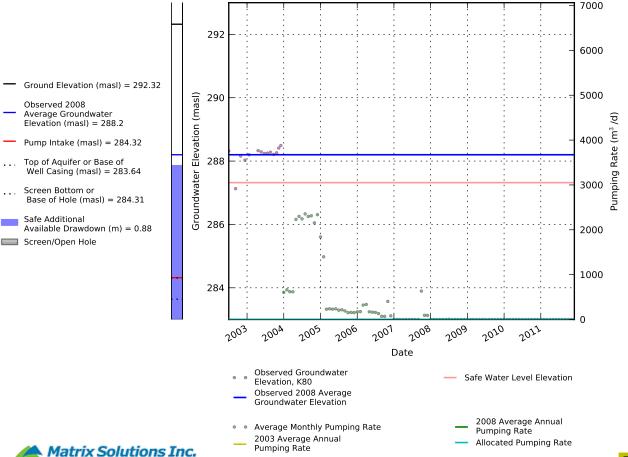
12000 300 10000 295 Ground Elevation (masl) = 303.64 Groundwater Elevation (masl) Observed 2008 Average Groundwater 8000 Pumping Rate (m³ /d) Elevation (masl) = 279.4 290 Pump Intake (masl) = 275.9 : Top of Aquifer or Base of 6000 ٥. Well Casing (masl) = 274.99 285 Screen Bottom or Base of Hole (masl) = 269.65 4000 Safe Additional 280 Available Drawdown (m) = 4.41Screen/Open Hole 2000 275 270 0 2002 2001 2003 2004 2005 2007 2008 2009 2000 2006 2010 2011 Date **Observed Groundwater** Safe Water Level Elevation 0 Elevation, K34 Observed 2008 Average Groundwater Elevation 2008 Average Annual Average Monthly Pumping Rate Pumping Rate 2003 Average Annual Allocated Pumping Rate Pumping Rate Matrix Solutions Inc. Figure F59

HYDROGRAPH City: Kitchener / Well Field: STRASBURG Consult_ID: K36 / Obj_Num: 6506160

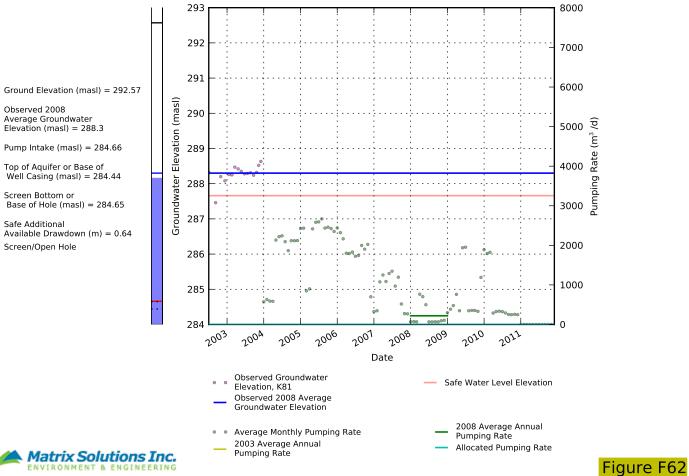




HYDROGRAPH City: Kitchener / Well Field: WOOLNER Consult_ID: K80 / Obj_Num: 6504313



HYDROGRAPH City: Kitchener / Well Field: WOOLNER Consult ID: K81 / Obj_Num: 6504994



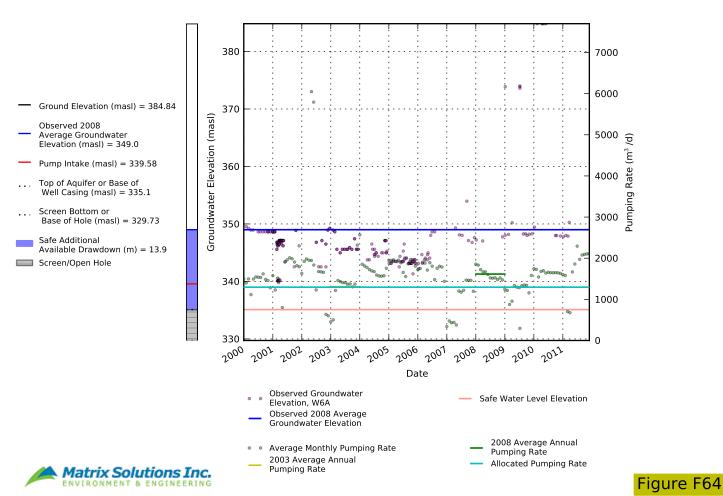


- Screen Bottom or Base of Hole (masl) = 284.65
- Safe Additional Available Drawdown (m) = 0.64Screen/Open Hole

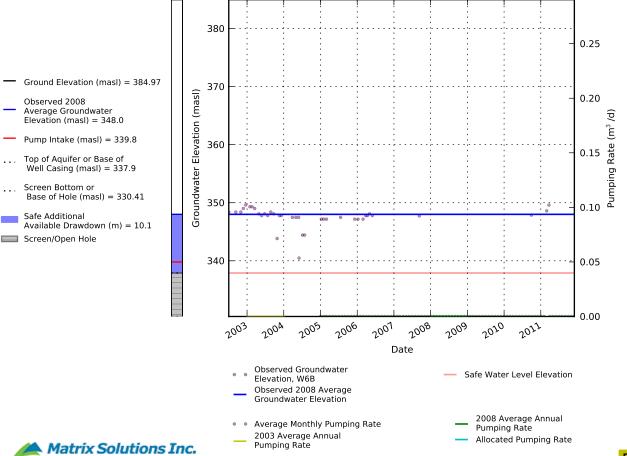
HYDROGRAPH City: Kitchener / Well Field: WOOLNER Consult_ID: K82 / Obj_Num: 6504993

294 12000 292 10000 Ground Elevation (masl) = 293.49 290 Groundwater Elevation (masl) Observed 2008 8000 Average Groundwater Pumping Rate (m³ /d) Elevation (masl) = 286.0288 Pump Intake (masl) = 280.87 6000 Top of Aquifer or Base of Well Casing (masl) = 280.67286 Screen Bottom or Base of Hole (masl) = 282.38 4000 Safe Additional • 284 Available Drawdown (m) = 2.13Screen/Open Hole 2000 282 280 0 2004 2003 2005 2006 2007 2008 2009 2010 2011 Date **Observed Groundwater** Safe Water Level Elevation 0 Elevation, K82 Observed 2008 Average Groundwater Elevation 2008 Average Annual Average Monthly Pumping Rate • Pumping Rate 2003 Average Annual Allocated Pumping Rate Pumping Rate Matrix Solutions Inc. Figure F63

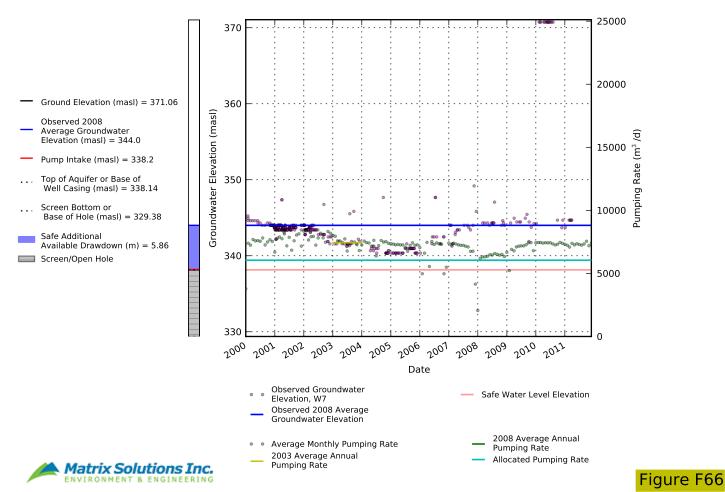
HYDROGRAPH City: Waterloo / Well Field: ERB STREET Consult_ID: W6A / Obj_Num: 6503210



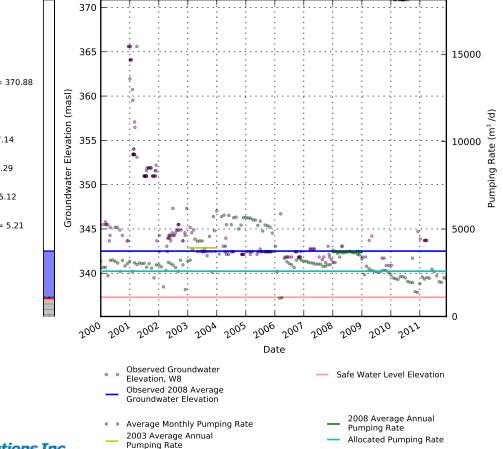
HYDROGRAPH City: Waterloo / Well Field: ERB STREET Consult_ID: W6B / Obj_Num: 6505741



HYDROGRAPH City: Waterloo / Well Field: ERB STREET Consult_ID: W7 / Obj_Num: 6502377



HYDROGRAPH City: Waterloo / Well Field: ERB STREET Consult_ID: W8 / Obj_Num: 6503180

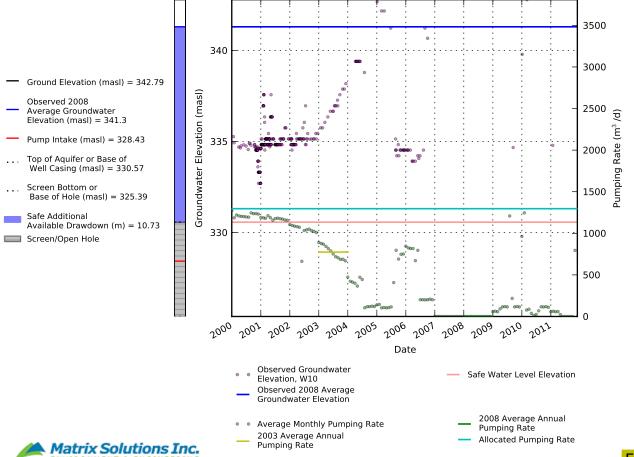


- Ground Elevation (masl) = 370.88
- Observed 2008 Average Groundwater Elevation (masl) = 342.5
- Pump Intake (masl) = 337.14
- ... Top of Aquifer or Base of Well Casing (masl) = 337.29
- ... Screen Bottom or Base of Hole (masl) = 335.12
- Safe Additional Available Drawdown (m) = 5.21 Screen/Open Hole





HYDROGRAPH City: Waterloo / Well Field: WATERLOO NORTH Consult_ID: W10 / Obj_Num: 6503645

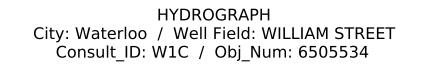


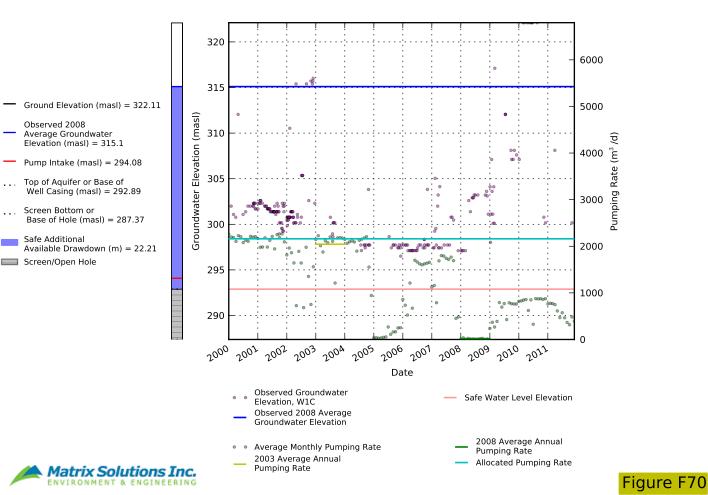
HYDROGRAPH City: Waterloo / Well Field: WILLIAM STREET Consult_ID: W1B / Obj_Num: 6504731

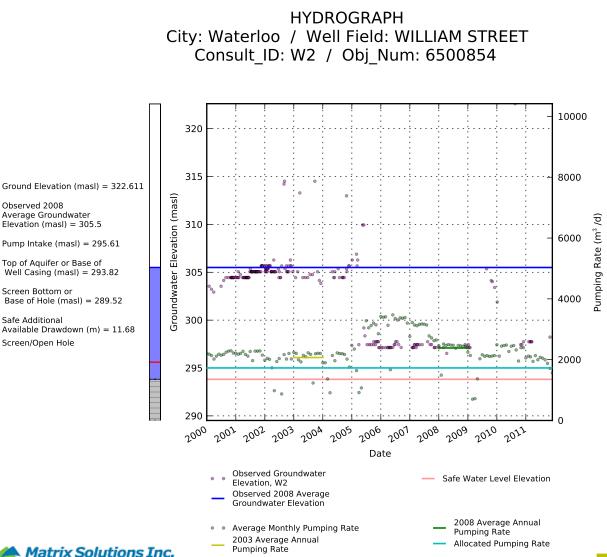
- 7000 320 6000 315 Groundwater Elevation (masl) 5000 Pumping Rate (m³ /d) 310 4000 3000 305 œ • 2000 300 1000 295 0 2009 2000 2001 2002 2004 2005 2006 2007 2008 2003 2010 2011 Date **Observed Groundwater** Safe Water Level Elevation 0 Elevation, W1B Observed 2008 Average Groundwater Elevation 2008 Average Annual Average Monthly Pumping Rate Pumping Rate 2003 Average Annual Allocated Pumping Rate Pumping Rate
- Ground Elevation (masl) = 322.45
- Observed 2008 Average Groundwater Elevation (masl) = 309.9
- Pump Intake (masl) = 302.26
- ... Top of Aquifer or Base of Well Casing (masl) = 302.36
- ... Screen Bottom or Base of Hole (masl) = 293.21
- Safe Additional Available Drawdown (m) = 7.54
 Screen/Open Hole





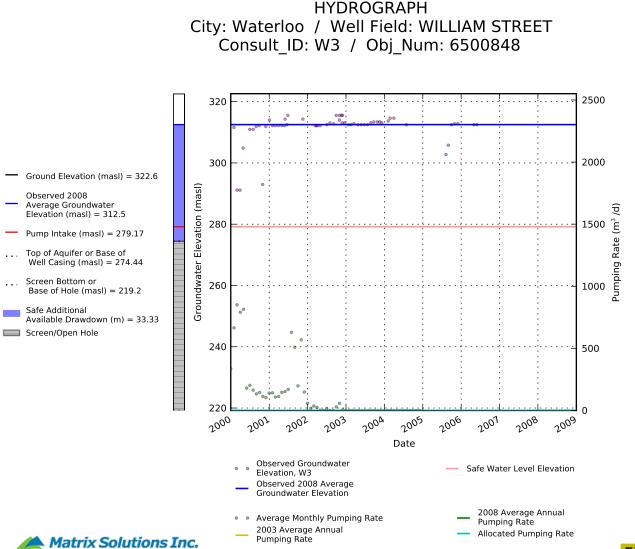




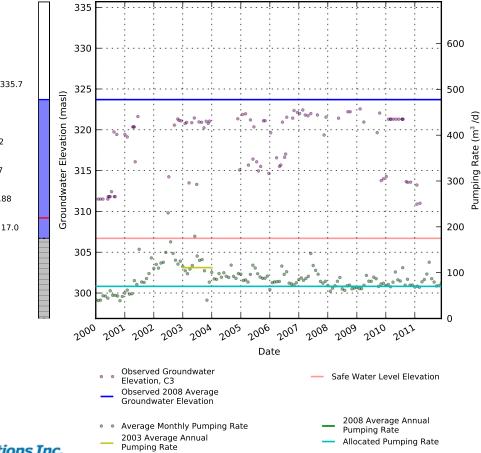


- Observed 2008 Average Groundwater Elevation (masl) = 305.5
- Pump Intake (masl) = 295.61
- Top of Aquifer or Base of Well Casing (masl) = 293.82
- Screen Bottom or Base of Hole (masl) = 289.52
- Safe Additional Available Drawdown (m) = 11.68Screen/Open Hole





HYDROGRAPH City: Rural / Well Field: CONESTOGO (PLAINS) Consult_ID: C3 / Obj_Num: 1000298

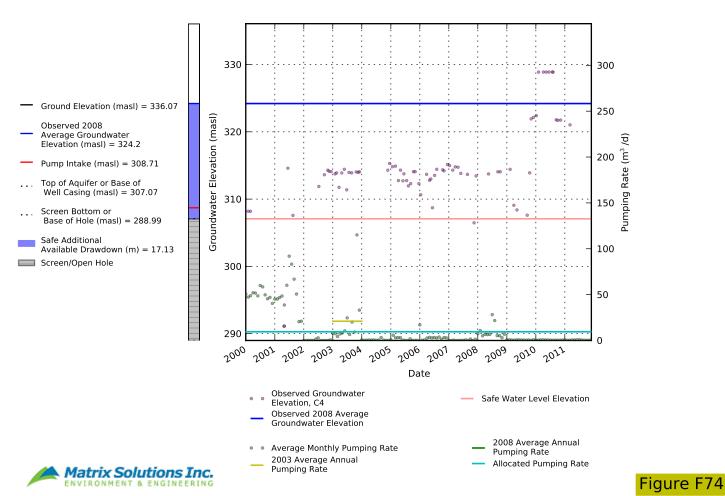


- Ground Elevation (masl) = 335.7
- Observed 2008 Average Groundwater Elevation (masl) = 323.7
- Pump Intake (masl) = 309.2
- ... Top of Aquifer or Base of Well Casing (masl) = 306.7
- ... Screen Bottom or Base of Hole (masl) = 296.88
- Safe Additional Available Drawdown (m) = 17.0 Screen/Open Hole

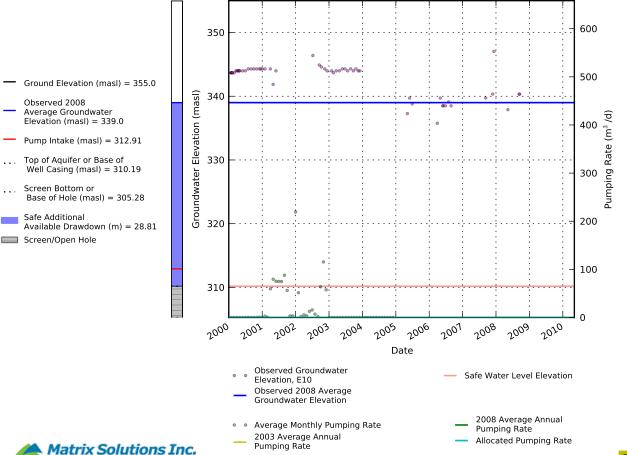




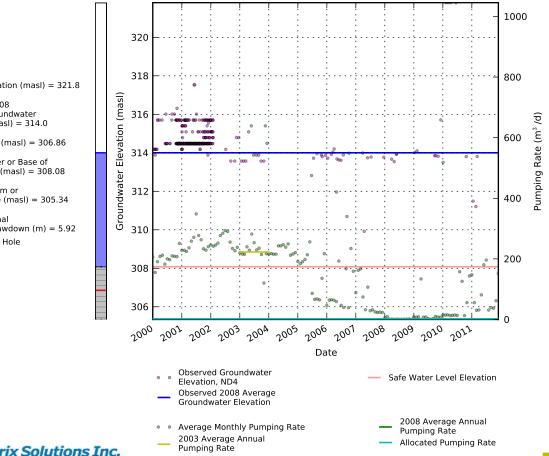
HYDROGRAPH City: Rural / Well Field: CONESTOGO (PLAINS) Consult_ID: C4 / Obj_Num: 6506670



HYDROGRAPH City: Rural / Well Field: ELMIRA Consult_ID: E10 / Obj_Num: 1000297



HYDROGRAPH City: Rural / Well Field: NEW DUNDEE Consult ID: ND4 / Obj_Num: 6506733

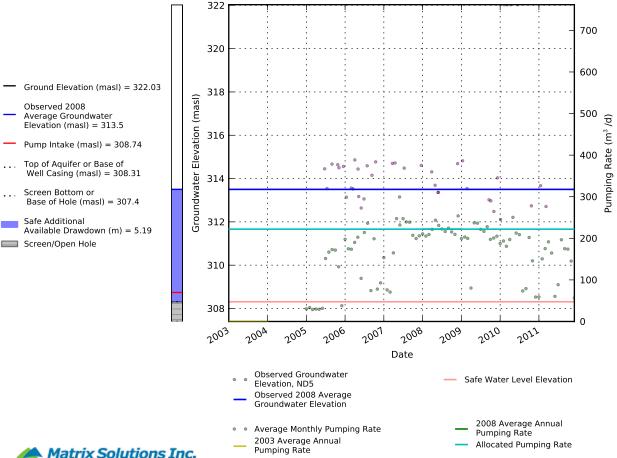


- Ground Elevation (masl) = 321.8
- Observed 2008 Average Groundwater Elevation (masl) = 314.0
- Pump Intake (masl) = 306.86
- Top of Aquifer or Base of Well Casing (masl) = 308.08
- Screen Bottom or Base of Hole (masl) = 305.34
- Safe Additional Available Drawdown (m) = 5.92Screen/Open Hole

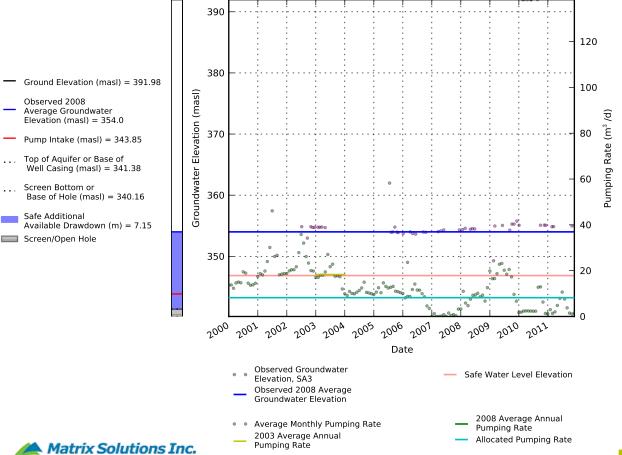




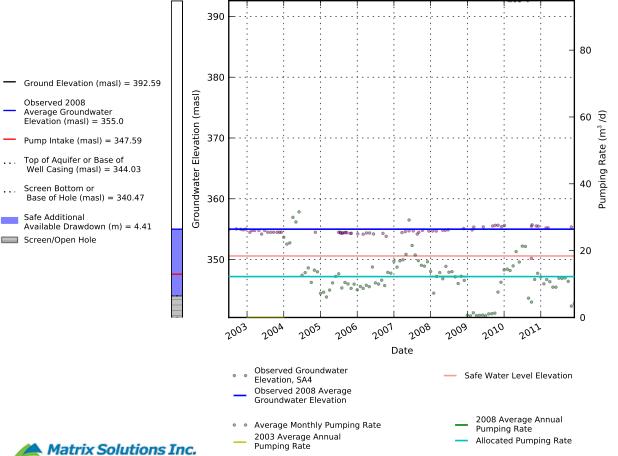
HYDROGRAPH City: Rural / Well Field: NEW DUNDEE Consult_ID: ND5 / Obj_Num: 9201303



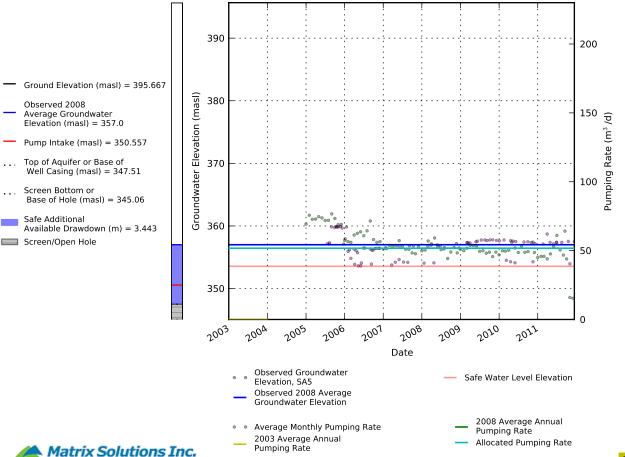
HYDROGRAPH City: Rural / Well Field: ST. AGATHA Consult_ID: SA3 / Obj_Num: 6505872



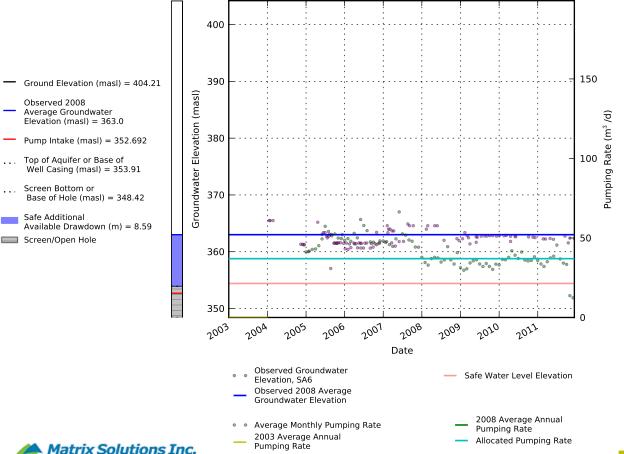
HYDROGRAPH City: Rural / Well Field: ST. AGATHA Consult_ID: SA4 / Obj_Num: 6506274



HYDROGRAPH City: Rural / Well Field: ST. AGATHA Consult_ID: SA5 / Obj_Num: 6502359



HYDROGRAPH City: Rural / Well Field: ST. AGATHA Consult_ID: SA6 / Obj_Num: 6505740



HYDROGRAPH City: Rural / Well Field: WEST MONTROSE Consult_ID: WM1 / Obj_Num: 9200037

