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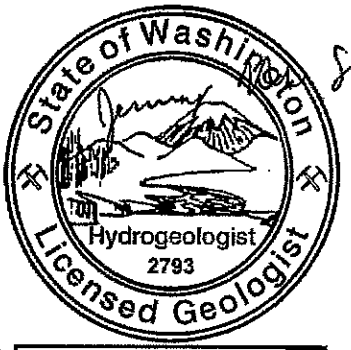
MEMORANDUM

Project No.: 070024-013

June 29, 2011

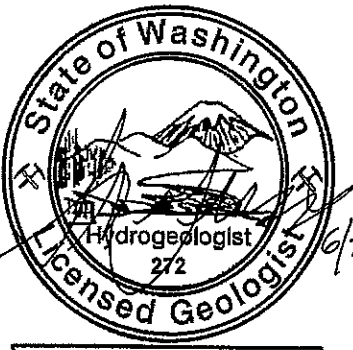
To: John Foltz and Dave McClure, Klickitat County Natural Resources Department

cc: WRIA 30 Water Resource Planning and Advisory Committee



Jeremy Michael Shaha

6/29/11



Steve J. Germiat

6/29/11

From: **Jeremy M. Shaha, LHG**
Project Hydrogeologist

Steve J. Germiat, LHG, CGWP
Senior Associate Hydrogeologist

Re: **2011 Little Klickitat Subbasin Water Level Monitoring Summary, WRIA 30**

Project Objectives

In 2007, the Water Resource Planning and Advisory Committee (PAC) for Water Resource Inventory Area (WRIA) 30 received funding from the Washington State Department of Ecology (Ecology) to conduct a more detailed assessment of hydrologic and water use conditions in both the Swale Creek and Little Klickitat subbasins of WRIA 30 (Figure 1). The assessment provided additional information to help address data gaps regarding water availability on a subbasin scale, and thus support Ecology's processing of pending applications for new water rights in the subbasin (Aspect, 2007).

As part of the 2007 water availability study, water level monitoring networks were established for the two subbasins. Since June 2007, water level measurements have continued to be collected on a semi-annual basis in the well networks to begin assessment of long-term trends in groundwater levels, which helps determine sustainability of existing groundwater withdrawals and thus water availability. The semi-annual measurements have generally been collected corresponding to pre-irrigation (spring) and post-irrigation (autumn) conditions.

Subsequently, Ecology provided additional funding (Grant No. G1000101) to expand the Little Klickitat subbasin monitoring network and provide annual water level monitoring data analysis and reporting. Field reconnaissance for the expansion of the Little Klickitat subbasin monitoring network was performed in May 2010. This memorandum provides a summary of the water level measurements from the entire monitoring network to date (since June 2007).

Well Monitoring Network

The water level monitoring network was established in order to: (1) provide spatial coverage of the basin, and (2) provide a representative number of wells completed in the various aquifers to allow for differentiation of water levels within the respective hydrostratigraphic units. Within Little Klickitat subbasin, the thin veneer of unconsolidated alluvium occurring locally is not considered to be an important water supply aquifer due to the limited number of wells completed within the respective unit. Therefore, for the purposes of this assessment, the alluvium aquifer has not currently been included in the water level monitoring network.

The expansion of the Little Klickitat subbasin monitoring network added 5 new wells, bringing the total number of wells to 11. Figure 2 depicts the locations of the wells included in the water level monitoring network. Table 1 summarizes the well information, and Table 2 presents the water level measurements to date.

Well Survey

Wells included in the original monitoring network were surveyed (x, y, z) by a licensed surveyor with Klickitat County Public Works, as described in Aspect Consulting (2007). Wells included in the expanded monitoring network were surveyed by Klickitat County Public Works in December 2010. Table 1 includes survey data for the wells included in the monitoring network.

Water Level Measurements

Depth-to-water measurements were conducted in all monitoring network wells using either an electric water level indicator (tape) or a sonic water level indicator (sounder)[1]. The former provides greater precision, but has the significant disadvantage of potentially becoming permanently caught on wiring or other appurtenances within the well casing. The latter has less precision but is much faster to use, and more importantly, does not have the risk of becoming caught in the well. The Quality Assurance Project Plan (QAPP) (Aspect, 2010) for this project provides a quality control (QC) evaluation between the tape and sonic sounder based on measurements collected since 2007. The evaluation documents reliability of the sonic sounder for measuring depths-to-water less than about 250 feet (Aspect, 2010).

All depth-to-water measurements were made in accordance with the project-specific QAPP (Aspect, 2010), and relative to the top of well casing or other defined measuring point at the wellhead. The selected measuring point for each well was marked in magic marker, if possible, and was documented in the field form so that it can be reproduced during subsequent measurement rounds. Other pertinent information regarding the well or the measuring of water levels in it were also recorded in the field notes.

If a downhole water level indicator was used for the depth-to-water measurement, the lower couple of feet of tape was rinsed and wiped with a clean paper towel. Any rust or other visible material on the water level indicator after a measurement was also wiped off using a clean paper towel prior to the next measurement.

[1] Global Water WL600 or equivalent instrument.

A table of static water level measurements from either the respective well logs or previous monitoring event was carried in the field. Measurements that varied greatly from past measurements in a given well (accounting for differences between spring and fall) were repeated for confirmation.

Description of Well Monitoring Network Aquifers

A generalized geologic history of the Little Klickitat subbasin is provided in the WRIA 30 Level 1 watershed assessment (WPN and Aspect, 2004). Water-bearing hydrostratigraphic units within the study area include (from youngest to oldest):

- Simcoe Mountains volcanic deposits;
- Wanapum basalt (Priest Rapids, Roza, and Frenchman Springs members); and
- Grande Ronde basalt.

The Wanapum and Grande Ronde basalts are formations within the Columbia River Basalt Group (CRBG). Groundwater in the CRBG primarily occurs in the top of the individual flows (“flow top”), which became vesicular (porous) as gas bubbles escaped the flows during cooling, and/or at the flow bottoms (sometimes referred to as “pillows”). Flow tops and bottoms—collectively referred to as interflow zones—are usually porous and permeable, and therefore transmit water more readily than the intervening massive portions of the basalt flow interior, which generally constitute flow barriers, except where fractured. For wells completed in the interflow zones between the various basalt units, water levels are considered to be representative of the underlying basalt aquifer. A permeable flow top is normally present for each flow, while permeable flow bottoms range from relatively thick units to completely absent. The lateral continuity of water-bearing interflow zones is highly variable. Within the Goldendale area of Little Klickitat subbasin, a majority of the wells completed in the CRBG are completed in the interflow zones of the Wanapum basalt aquifer (Priest Rapids, Roza, and Frenchman Springs members). The water level monitoring network currently does not include any wells completed solely in the Grande Ronde basalt aquifer.

In addition, terrestrial sediments can be deposited between the underlying flow top and overlying flow bottom during time periods between basalt flows. These sediments are collectively considered part of the Ellensburg Formation and can be either relatively permeable or impermeable; depending on composition, thickness, and lateral extent. Both the lateral continuity and thickness of the water-bearing interflow zones are highly variable.

Simcoe Mountains Volcanic Aquifer

The Simcoe Mountains volcanic deposits are generally composed of basalt flows and volcanic cinder erupted from a series of low shield volcanoes and subsidiary cinder cones within the local area. Within Little Klickitat subbasin, particularly the Goldendale area, the Simcoe Mountains volcanic deposits are a prolific aquifer.

Of the 11 wells included in the Little Klickitat subbasin water level monitoring network, there are currently 2 wells completed in the Simcoe Mountains volcanic aquifer (T05/R14-R1 and T05/R15-19L1). Figure 2 provides the location of these wells. Additional wells completed in the Simcoe Mountains volcanic aquifer may need to be added in order to improve spatial coverage of groundwater level monitoring in this aquifer. One well which could be included in a further expansion of the Little Klickitat subbasin water level monitoring network is the City of Goldendale's Chlorination Station well, located in Section 21 of T05/R16.

Wanapum Basalt Aquifer

Of the 11 wells included in the Little Klickitat subbasin water level monitoring network, there are currently 9 wells completed in the Wanapum basalt aquifer. Figure 2 provides the location of these wells.

Summary of Groundwater Level Measurements

Table 1 provides a summary of the groundwater level measurements from the Little Klickitat subbasin water level monitoring network to date. Evaluation of long-term trends in groundwater levels provides insight regarding aquifer response to precipitation patterns and sustainability of the existing level of groundwater withdrawal.

Long-Term Groundwater Level Trends

Long-term groundwater level trends can be evaluated for the 4 wells included in the water level monitoring network as part of the Swale Creek and Little Klickitat subbasin water availability reports (Aspect, 2007). Groundwater level measurements for these wells have been made on a semi-annual basis (pre-irrigation and post-irrigation) since June 2007. In addition, semi-annual water level measurements for the City of Goldendale's Third Street (T04/R16-16Q1) and Dingmon (T04/R16-28A1) wells have been collected since November 2007. Figure 3 provides long-term groundwater level hydrographs for these wells. Solid lines indicate wells completed in the Wanapum basalt aquifer, while dashed lines indicate wells completed in the Simcoe Mountains volcanic aquifer. Since there are currently only three rounds of water level measurements (May 2010, November/December 2010, and May 2011) for the expanded monitoring network wells, long-term groundwater level trends will not be evaluated for these wells at this time. Trends for wells monitored since 2007 are outlined below.

Wanapum Basalt Aquifer

Based on the hydrographs on Figure 3, none of the Wanapum basalt aquifer wells monitored showed any significant long-term decrease in groundwater levels during the period of monitoring (June 2007 to May 2011). One well (T04/R15-26H1) had an overall increase in groundwater levels of about 10 feet since June 2007. Seasonal changes of up to 10 feet were observed in several of the Wanapum basalt aquifer wells (T04/R15-26H1, T04/R16-16Q1, and T04/R16-28A1). For these wells, the lowest groundwater levels were consistently observed during the post-irrigation measurements (November) and the highest groundwater levels were consistently observed during pre-irrigation measurements (April - June). The seasonal declines in the water levels are primarily in response to pumping; however, the water levels have consistently recovered on an annual basis over the period of record. Therefore, the available data indicate that the Wanapum basalt aquifer

storage is not being depleted and that current and recent historical pumpage in Little Klickitat subbasin is sustainable on a regional scale.

In addition, the lack of depletion observed in the Wanapum basalt aquifer storage has occurred during a generally below-average period of precipitation. Figure 4 presents both the annual precipitation and the mean annual precipitation (upper portion of figure) and the cumulative departure from the mean annual precipitation (lower portion of figure) in Goldendale (NOAA Station #453222) and at Satus Pass (NOAA Station #457342) for the period of record (1931 - 2010)[2]. Note that individual months with more than 5 days of missing data were not used for monthly or annual precipitation statistics (so those years are not displayed on Figure 4).

With the exception of 1995-1998 and 2010 (based on Goldendale data[3]) and 2006 (based on Satus Pass data), annual precipitation has been at or below the mean annual precipitation since 1984. However, the below-average precipitation has not appeared to affect groundwater levels in the Wanapum basalt aquifer, indicating that the aquifer is not overly sensitive to long-term precipitation trends and may be able to handle additional withdrawals.

Recommendations

It is recommended that the expanded water level monitoring network continue to be monitored on at least a semi-annual basis (pre-irrigation and post-irrigation measurements), subject to availability of funding. Although an effort was made to expand the Little Klickitat subbasin water level monitoring network in 2010, only 5 additional wells were added based on permissions received from well owners. Therefore, it is recommended that, when possible, the Little Klickitat subbasin water level monitoring network be expanded to include additional wells, especially wells completed in the Simcoe Mountains volcanics aquifer in the northern portion of the subbasin.

References

Aspect, 2007, Hydrologic Information Report Supporting Water Availability Assessment - Swale Creek and Little Klickitat Subbasins, WRIA 30, June 29, 2007.

Aspect, 2010, Quality Assurance Project Plan for Water Level Monitoring – WRIA 30, April 9, 2010.

Watershed Professionals Network (WPN) and Aspect, 2004, WRIA 30 Level 1 Watershed Assessment, March 15, 2004.

[2] The cumulative departure plot is an effective way to illustrate longer-term trends in precipitation which influence groundwater levels regionally (e.g., extended wet or drought periods). The absolute values on the plot's y axis have little meaning since they depend on the year started. However, the scale of the y axis and shape of the curve are not dependent on year started.

[3] The 1995 and 1998 data points for Goldendale are not plotted because of gaps in the daily record; however, even with the missing data, the annual precipitation is at or above average.

Limitations

Work for this project was performed and this memorandum prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Klickitat County for specific application to the referenced property. This memorandum does not represent a legal opinion. No other warranty, expressed or implied, is made.

Attachments

Table 1 – Little Klickitat Subbasin Water Level Monitoring Network
Table 2 – Monitoring Network Water Level Data
Figure 1 – Little Klickitat Subbasin
Figure 2 – Little Klickitat Subbasin Water Level Monitoring Network
Figure 3 – Groundwater Hydrographs
Figure 4 – Long-Term Precipitation Trends

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Table 1 - Little Klickitat Subbasin Water Level Monitoring Network

Little Klickitat Subbasin Annual Monitoring Report
WRIA 30, Washington

Ecology Well Log Data						Well Survey Data				
Ecology Well Log ID	TRS Label	Completion Date	Dia (in)	Depth (ft)	Aquifer	Northing[1] (SPS 83; ft)	Easting[1] (SPS 83; ft)	Wellhead Elevation[2] (ft MSL)	Casing Stick-up (ft)	**Monitoring Network**
191874	T04/R15-26H1	5/25/99	6	395	Wanapum	172446.7	1541300.9	1567.9	1.5	Original Network
417943	T04/R15-29M1	7/25/05	6	500	Wanapum	171181.3	1521711.9	1689.3	2.29	Original Network
302767	T04/R15-29Q1	12/11/00	6	240	Wanapum	169640.1	1524932.9	1720.3	1.5	Original Network
521074	T04/R15-32F1	2/3/07	6	416	Wanapum	167372.0	1522129.5	1801.8	3.27	Original Network
324536	T04/R16-16Q1	7/18/00	20	488	Wanapum	179395.7	1560946.8	1652.7	-	Original Network
139743	T04/R16-17P1	7/19/78	8	600	Wanapum	181894.2	1555224.9	1681.2	1.8	Expanded Network
205211	T04/R16-28A1	1/3/72	10	534	Wanapum	173748.0	1563236.4	1751.0	-	Original Network
132923	T05/R14-14R1 T05/R15-27A1	5/22/79	6	300	Simcoe Mountains	205007.4	1536002.3	2157.8	2.6	Expanded Network
191916/ 380146	T05/R15-19L1	5/14/04	6	320	Simcoe Mountains	208760.2	1517619.0	2041.7	1.3	Expanded Network
465677	T05/R16-27M1	10/13/06	6	675	Wanapum	203029.9	1563790.6	2267.3	0.7	Expanded Network
588746	T05/R16-35H1	4/30/09	6	462	Wanapum	197298.9	1573569.8	2055.5	1.8	Expanded Network

Notes:

[1] Northing and Easting coordinates are in Washington South State Plane coordinate system (NAD 1983 datum).

[2] All elevations are in NAVD 1988 datum.

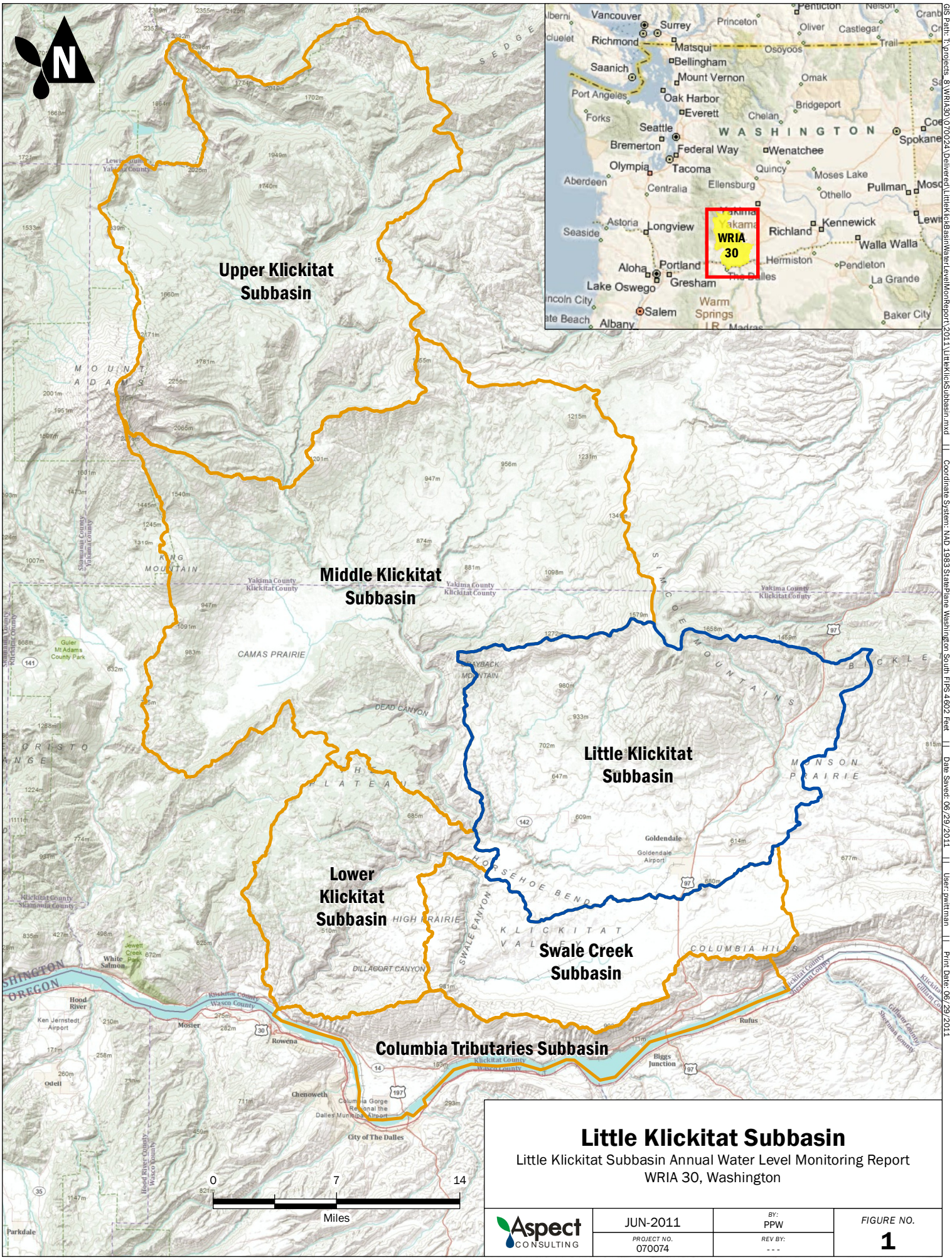
[3] Indicates wells included in the City of Goldendale's groundwater level monitoring program.

Table 2 - Monitoring Network Water Level Data
Little Klickitat Subbasin Annual Monitoring Report
WRIA 30, Washington

Ecology Well Log Data		June 2007 Measurements			November 2007 Measurements			April 2008 Measurements			December 2008 Measurements			April 2009 Measurements		
Ecology Well Log ID	TRS Label	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments
191874	T04/R15-26H1	34.4	1533.6	Rising water level	30.9	1537.0		22.5	1545.4	Rising water level	28.8	1539.1		20.7	1547.2	
417943	T04/R15-29M1	294.9	1394.4		294.2	1395.1		294.6	1394.7		294.1	1395.2		292.8	1396.5	
302767	T04/R15-29Q1	138.9	1581.4		138.4	1581.9		138.4	1581.9		138.3	1581.9		137.0	1583.3	
521074	T04/R15-32F1	177.9	1624.0		177.4	1624.4		178.8	1623.1		-	-	No permission	-	-	No permission
324536	T04/R16-16Q1	-	-		15.6	1637.1		11.9	1640.8		15.8	1636.9		12.2	1640.5	
139743	T04/R16-17P1	-	-		-	-		-	-		-	-		-	-	
205211	T04/R16-28A1	-	-		89.6	1661.4		83.6	1667.5		89.5	1661.6		84.2	1666.8	
132923	T05/R14-14R1 T05/R15-27A1	-	-		-	-		-	-		-	-		-	-	
191916/ 380146	T05/R15-19L1	-	-		-	-		-	-		-	-		-	-	
465677	T05/R16-27M1	-	-		-	-		-	-		-	-		-	-	
588746	T05/R16-35H1	-	-		-	-		-	-		-	-		-	-	

Table 2 - Monitoring Network Water Level Data
Little Klickitat Subbasin Annual Monitoring Report
WRIA 30, Washington

Ecology Well Log Data		December 2009 Measurements			May 2010 Measurements			November/December 2010 Measurements			May 2011 Measurements		
Ecology Well Log ID	TRS Label	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments	Depth to Water (ft bTOC)	GW Elevation (ft)	Comments
191874	T04/R15-26H1	26.8	1541.1		21.2	1546.7		24.03	1543.9		19.3	1548.6	
417943	T04/R15-29M1	292.6	1396.7		295.5	1393.8		295.26	1394.1		296.37	1392.9	
302767	T04/R15-29Q1	138.0	1582.3		137.6	1582.7		-	-	Obstruction at 136 ft	-	-	Obstruction at 136 ft
521074	T04/R15-32F1	-	-	No permission	-	-	No permission	-	-	No permission	-	-	No permission
324536	T04/R16-16Q1	14.9	1637.8		13.1	1639.6		13.2	1639.5		11.80	1640.9	
139743	T04/R16-17P1	-	-		39.2	1642.0		40.0	1641.2		39.5	1641.7	
205211	T04/R16-28A1	90.5	1660.5		85.5	1665.5		89.20	1661.8		83.5	1667.5	
132923	T05/R14-14R1 T05/R15-27A1	-	-		310.2	1847.6		312.20	1845.6		308.99	1848.8	
191916/ 380146	T05/R15-19L1	-	-		246.4	1795.3		249.35	1792.3		248.68	1793.0	
465677	T05/R16-27M1	-	-		416.7	1850.6		416.96	1850.3	Pump may be running	393.69	1873.6	Falling water level
588746	T05/R16-35H1	-	-		209.5	1846.0		215.16	1840.3	Rising water level	214.85	1840.6	Rising water level



Little Klickitat Subbasin

Little Klickitat Subbasin Annual Water Level Monitoring Report
WRIA 30, Washington

Aspect CONSULTING	JUN-2011	BY: PPW	FIGURE NO. 1
	PROJECT NO. 070074	REV BY: ---	

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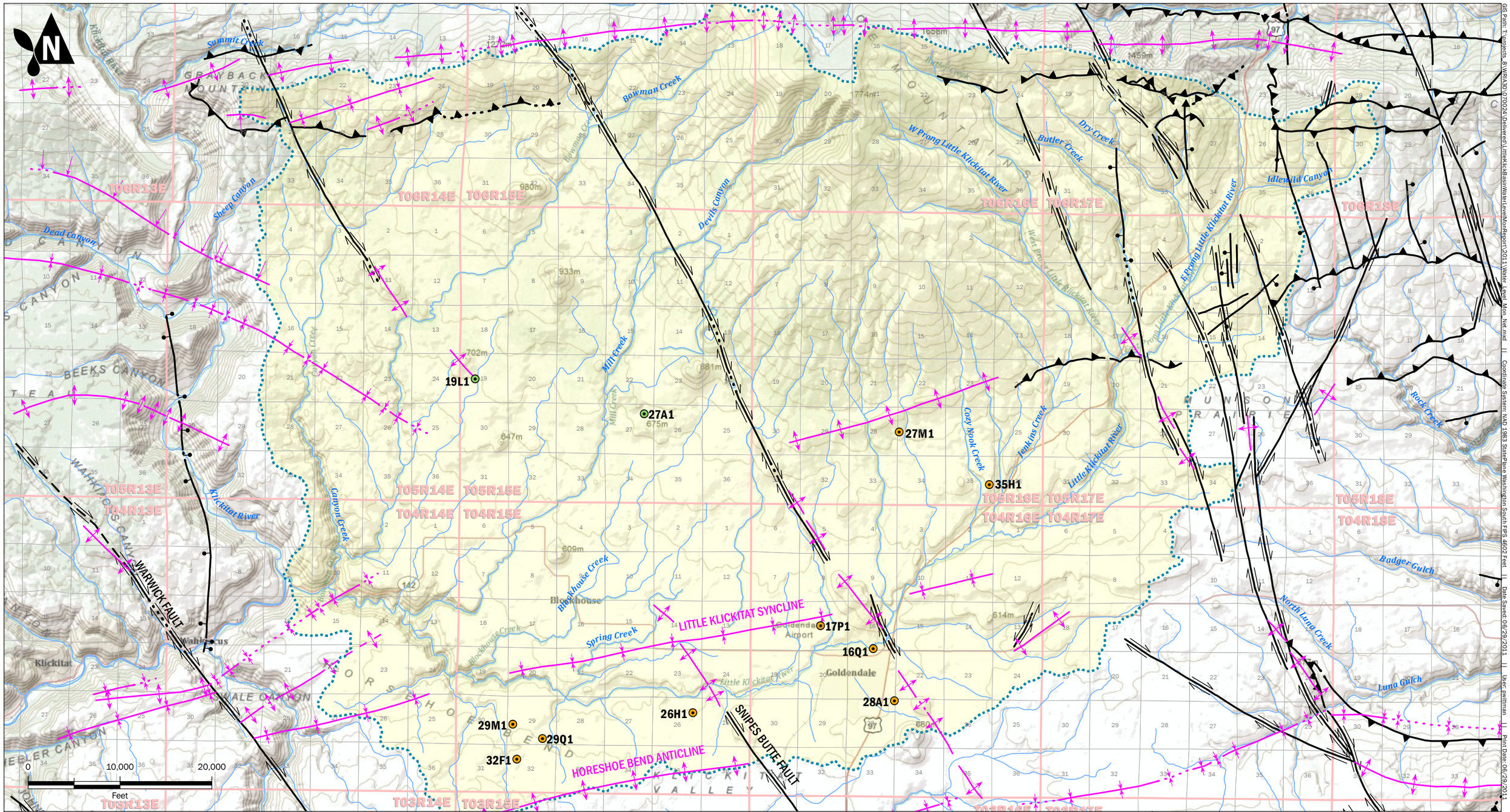

Surveyed Well Locations in the Groundwater Level Monitoring Network (by completion aquifer):

- Simcoe Mountains
- Wanapum

- Little Klickitat Subbasin
- Township/Range
- Watercourse
- Sections

Faults (WA DNR 1:100K)

- Normal fault, location accurate. Bar and ball on downthrown block
- Normal fault, location concealed. Bar and ball on downthrown block
- Thrust fault, location accurate. Sawteeth on upper plate
- Thrust fault, location inferred. Sawteeth on upper plate
- Thrust fault, location concealed. Sawteeth on upper plate
- Right-lateral strike-slip fault, location accurate.Arrows show relative motion
- Right-lateral strike-slip fault, location approximate. Arrows show relative motion
- Right-lateral strike-slip fault, location concealed. Arrows show relative motion
- Left-lateral strike-slip fault, location accurate. Arrows show relative motion
- Fault, unknown offset, location accurate
- Fault, unknown offset, location concealed

Folds (WA DNR 1:100K)

- Anticline, location accurate
- Anticline, location approximate
- Anticline, location inferred
- Anticline, location concealed
- Syncline, location accurate
- Syncline, location concealed
- Monocline, anticlinal bend, location accurate
- Monocline, synclinal bend, location accurate

Little Klickitat Subbasin Water Level Monitoring Network

Little Klickitat Subbasin Annual Water Level Monitoring Report
WRIA 30, Washington

Aspect Consulting	JUN-2011	BY: JMS / PPW	FIGURE NO. 2
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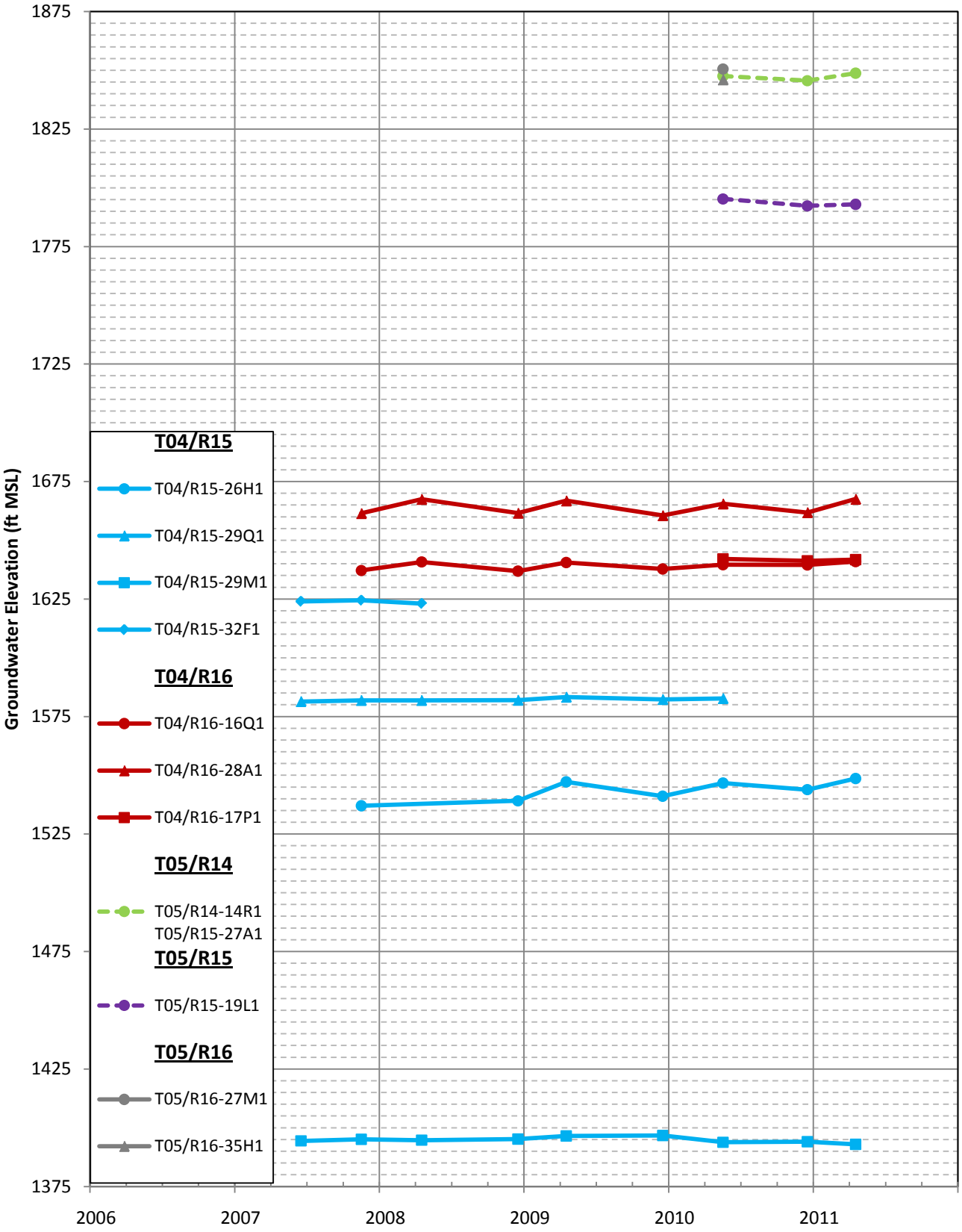
Notes:
Non-static groundwater level measurements from Table 2 were not included in the hydrographs.



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V:\070024 WRIA 30 Phase 4\Deliverables\012 Water Availability\Little Klickitat Subbasin Monitoring\2011\Table 1 Fig 3 - Groundwater Level Monitoring Data.xls

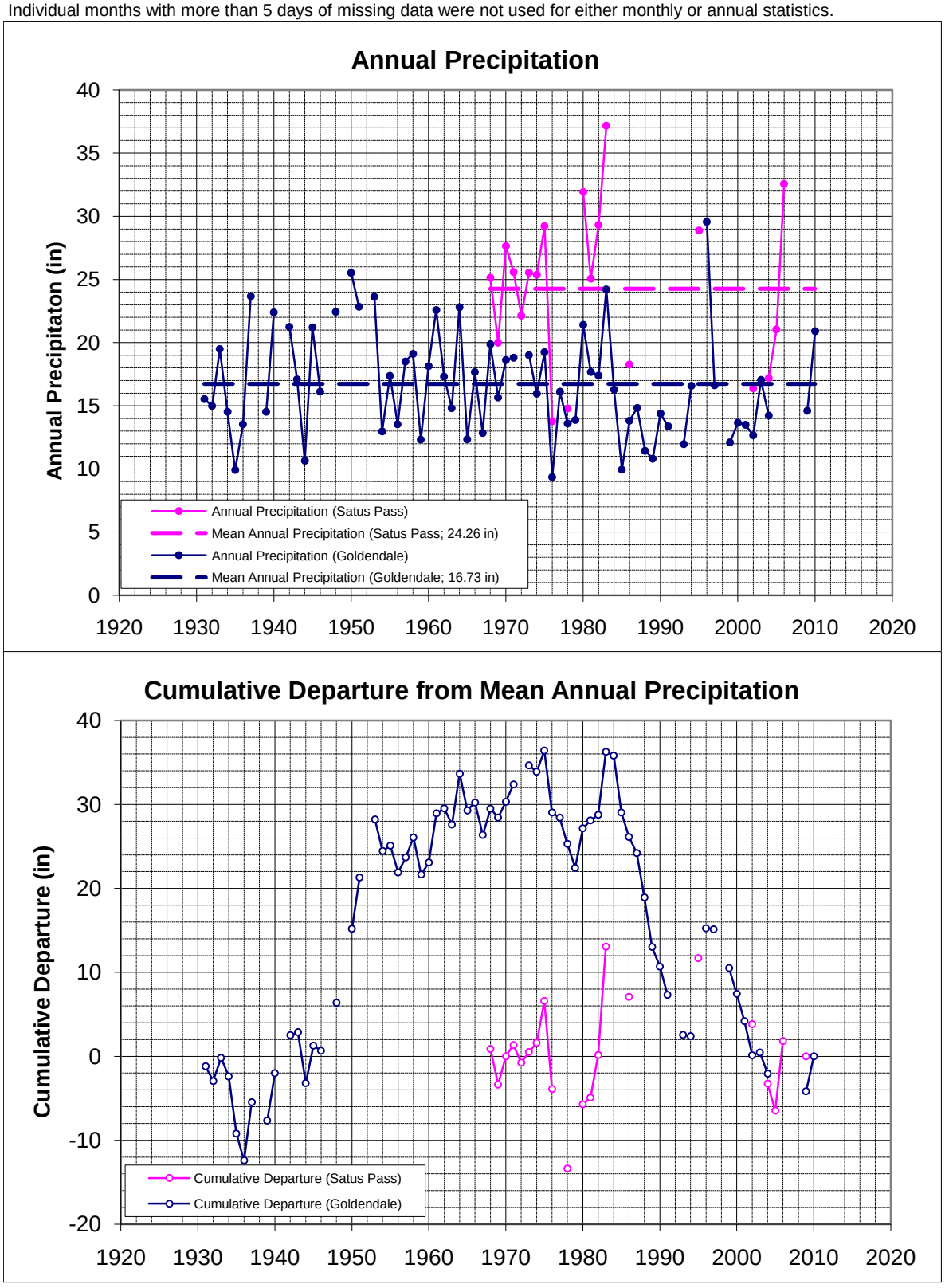
Figure 3 - Groundwater Hydrographs
Little Klickitat Subbasin Annual Monitoring Report
WRIA 30, Washington

Notes:

Goldendale annual precipitation data from Goldendale (NOAA #453222) and Goldendale 2E (NOAA #453226).

Satus Pass annual precipitation data from Satus Pass 2 SSW (NOAA #457342)

Individual months with more than 5 days of missing data were not used for either monthly or annual statistics.



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V:\070024 WRIA 30 Phase 4\Deliverables\012 Water Availability\Little Klickitat Subbasin Monitoring\2011\Fig 4 Precipitation Analysis.xls

Figure 4 - Long-Term Precipitation Trends

Little Klickitat Subbasin Annual Monitoring Report

WRIA 30, Washington