GWMA Columbia Basin Ground Water Management Area

OF ADAMS, FRANKLIN, GRANT AND LINCOLN COUNTIES

Town of Wilbur, Washington

Groundwater Supply Review

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Prepared by the

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For

The Town of Wilbur

And the

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TOWN OF WILBUR, WASHINGTON
GROUNDWATER SUPPLY REVIEW

Introduction

Summary of Findings

The sources of water pumped from the Town of Wilbur's two primary wells are mixed. These sources include modern water mixed with young, but pre-modern water which dominates Well #3 and ancient, or fossil, sources which dominate Well #4. These wells appear to generally have stable water levels, and even experience artesian conditions. Given that though, reported seasonal declines in water level in one of the two wells, which is inferred to be the result of interference from irrigation wells in the area, should give pause for concern.

Comparing estimated water demand and growth predictions through the year 2060 to reported production capacity of the existing wells, assuming this capacity is constant into the future, it would appear that the Town's current primary well capacity will likely be sufficient to meet this projected future demand. However, if groundwater pumping increases in the Wilbur area this would further reduce the ability of the portion of the aquifer system being pumped to meet future demand.

When these data, observations, and predictions are taken together - water level declines suggested by the existing data, predictions from the GWMA groundwater model, groundwater geochemical data suggesting little modern recharge - GWMA anticipates there is the potential for groundwater supply shortfalls during maximum periods of dynamic drawdown (pumping) in the next several decades. Such trends are common in other areas of GWMA where long-term water level declines are occurring, and suggestive of pumping demands exceeding aquifer capacity. Based on that, GWMA recommends that the Town of Wilbur begin an active real-time groundwater level monitoring and pumping program so that it can better track these potential conditions, adjust water system operation to possibly mitigate some of these predicted impacts, and potentially begin to explore water supply and source alternatives.

Purpose

The purpose of this report is to summarize basic information and issues associated with current groundwater supply conditions, including demand, supply, water levels, and sources for the Town of Wilbur. This summary for the Town of Wilbur, lying in northern Lincoln County, Washington (Figure 1) is based on GWMA data and information developed during previous projects, information collected from the public works and/or other municipal personal, data available from the Washington Department of Health (WDOH), and data and information published or compiled by others, including the Washington Department of Ecology (ECOLOGY). This report also looks at predictions about future groundwater conditions developed using GWMA's groundwater flow model for the Columbia River basalt aquifer system. Based on these summaries this report also includes a general review of some basic potential future water supply alternatives.

This report is not meant to be a comprehensive look at current and future groundwater supply conditions. It is meant to provide a general review of current and potential future conditions. This report does not look at water rights, or other legal issues that would need to be resolved to gain access to potential future alternative water supplies.

GWMA prepared this report for the Town of Wilbur under a funding authorization from the Washington Legislature directed through the Office of the Columbia River. Topics covered in this review include summaries of:

1. Water demand.
2. Water supplies sources, including aquifer identification.
3. Water levels in municipal supply wells.
4. Groundwater geochemistry and age.
5. Potential future water supply options.

In addition to the summary report, supporting materials are included in attached appendices. These appendices include:

1. Appendix A – Wells logs, geologic interpretations, and related hydrogeologic information for the municipalities wells.
2. Appendix B – Water level data, including hydrographs.
3. Appendix C – A discussion of how the GWMA groundwater model was used to predict future water level trends.
4. Appendix D – A discussion of how groundwater geochemical data was used to identify potential groundwater sources, and data specific to the municipality.

Water Demand and Sources

Average daily water demand for the Town of Wilbur is approximately 1.0 acre-feet/day (337,518 gallons/day; 234 gpm) based on reported annual volume of water produced (based on WDOH records for 2010). Peak demand for the Town is estimated to be approximately 3.2 acre-feet (1,047,800 gallons/day; 728 gpm). Table 1 summarizes basic population and water demand data for Wilbur.

Table 1. Wilbur Population and Water Demand Data.

POPULATION DATA			
	2010	2030	2060
Est. Population	884	987	1,146
Est. Population Growth, %	-0.33 (2000 – 2010)	0.55	0.5
SWSMP Population Projections: 0.57% between 2010 and 2015; 0.61% from 2015 to 2020; 0.55% from 2020 to 2025. Projected growth for the remainder of the planning period = 0.5%. Highest historical population in Town = 1,138 (1960).			
WATER DEMANDS			
	2010	2030	2060
Average Daily Demand (ADD), gpd	337,520	378,724	448,695
Max. Day Demand (MDD), gpd	1,047,800	1,175,715	1,372,303
Average Daily Demand, gpm	234	263	312
Max. Day Demand, gpm	728	816	953
Largest Water Users: School (irrigation), Town (parks and swimming pool).			

The Town of Wilbur public water supply system utilizes two primary wells (***Wells #3 and #4***) and one well (***Well #2***) for emergency back-up (Table 1). The Town does not use a surface water supply. ***Well #3*** has a reported pumping capacity of 840 gpm and ***Well #4*** has a reported pumping capacity of 650 gpm based on WDOH records. ***Well #2***, the emergency backup well, has a reported pumping capacity of 500 gpm. Table 2 summarizes well operation information while Table 3 lists basic well construction information. Well logs, geologic interpretations, and related information for Town wells are found in Appendix A.

Table 2. Well Source Operational Data.

Name	Usage	Flow, gpm	Comments
Well No. 2 (SO3)	Backup	500	Little analytical data; nitrate and fluoride present
Well No. 3 (SO2)	Primary	840	Nitrate present (usually 2-6 mg/l), trace fluoride
Well No. 4 (SO1)	Primary	650	Nitrate present (typically 1-2 mg/l)
Total Primary Capacity		1,490	Wells No. 3 and 4
Total Backup Capacity		500	Well No. 2
Observations on Source Water: Recovery time for Well No. 4 has dropped over the past 10 years due to more irrigation pumps operating to the south of Town.			

Reviewing reported water demand data and growth predictions through the year 2060 (Table 1) the Town of Wilbur has a predicted average daily demand and predicted peak daily demand of approximately 312 gpm and 953 gpm in 2060, respectively. When compared to Table 2, it would appear that the Town's current primary well capacity of approximately 1,490 gpm will likely be sufficient to meet this projected future demand. However, if groundwater pumping increases in the Wilbur area this would further reduce the ability of the portion of the aquifer system being pumped to meet future demand.

Table 3. Well Identification and Construction.

Town well ID	*GWMA ID*	*ERO #*	*Date drilled*	*Date use ended*	*Total depth (feet)*	*Casing depth (feet)*	*Seal depth (feet)*
#2			1967		502	17	
#3	L0547		1962		294	294	
#4	L2075		1976		375	70	70

Groundwater Conditions

Aquifers

Given the layered nature of the Columbia River basalt aquifer system, the majority of the water produced from any water well comes from the bottoms and tops ***(also referred to as interflow zones)*** of geologic unit(s) a well is open too. As a consequence, wells open to the same interflow zones generally will display a high degree of hydraulic continuity. Conversely, wells that are not open to the same interflow zone(s) will display limited, to even no, hydraulic continuity. Given these relationships knowing which unit interflow zone(s) a set of wells is open too provides information useful in optimizing well use, groundwater pumping, water delivery, and identifying the portion of the aquifer system being pumped.

Some basic hydrogeologic observations about Town wells are summarized below and in Table 4:

- ***Wells #3 and #4,*** the primary Town wells, are pumping groundwater from the Priest Rapids and Roza Members, Wanapum Basalt and the Sentinel Bluffs Member of the Grande Ronde Basalt. In Well #3 though production from the Wanapum Basalt may be relatively small because casing extends almost to the bottom of the well.
- ***Well #2,*** the emergency well, is also open to these same Wanapum basalt and Grande Ronde Basalt members.

Table 4. Well Hydrogeology.

Town well ID	*GWMA ID*	*Sed*	*SMB*	*Tpr, Tr*	*Tf*	*Tgsb*	*Deeper GRB*	*pumping rate (gpm)*	*DD (ft)*	*SC (gpm/ft-DD)*
#2				x		x		500	295	1.7
#3	L0547			x		x		60	6	10.0
#4	L2075			x		x		1000	113	8.8

Explanation:
x – unit well is interpreted to be open too, as follows: ***Sed*** – suprabasalt sediment, ***SMB*** – Saddle Mountains Basalt, ***Tpr*** – Priest Rapids Member Wanapum Basalt, ***Tr*** – Roza Member Wanapum Basalt, ***Tf*** – Frenchman Springs Member Wanapum Basalt, ***Tgsb*** – Sentinel Bluffs Member Grande Ronde Basalt, ***Deeper GRB*** – Grande Ronde units deeper than the Tgsb.
Test pumping rate (gpm) – Reported pumping test pump rate in gallons per minute.
DD (ft) – Feet of water level drawdown in the well during the pumping test, equivalent to dynamic drawdown. Adding DD to the static depth to water gives the dynamic, or pumping, depth to water.
SC (gpm/ft-DD) – Specific capacity, which equals the gallons pumped during the test per foot of drawdown. The larger the number, the more productive a given well is.

Water Levels

Water level data, especially coupled with pumping data, provides information useful in determining well performance and aquifer conditions, including the presence or absence of hydrologic connection between different wells. When referring to water level data one should look at both ***static and dynamic (pumping)*** levels.

- Static water level refers to the water level in a well when it is not being pumped.
- Dynamic water level refers to the water level in a well when it is being pumped.

The difference between static and dynamic (pumping) water levels is referred to as ***drawdown***. Understanding drawdown is important in well use because when pumping (dynamic) results in drawdown that brings the dynamic water level to depths near the pump the well will lose the ability to produce water. This is commonly coupled with damage to the pump.

This section, including Table 5, summarizes what GWMA has learned about Town of Wilbur well water levels. This section also summarizes some basic predictions about future water levels in Town wells predicted by GWMA's groundwater model. Additional water level information is found in Appendix B, and a discussion of the GWMA groundwater model is found in Appendix C.

Although static and dynamic water levels in Town wells are not regularly measured or recorded by the Town some basic observations are available, as follows:

- When originally completed *Well #4* was an artesian well with 11 psi shut-in pressure. Public works personnel report that static water level in it drop during peak demand and irrigation season.
- Conversely, static water level in *Well #3* is not affected by area pumping, and it along with the water level in *Well #2* have been relatively stable since they were first drilled.

Table 5. Observed and Predicted Changes in Groundwater Level in Wilbur Wells.

Town well ID	*GWMA ID*	*Initial DTW (ft)*	*Date*	*Most recent DTW (ft)*	*Date*	*Obs av static rate of change (ft/yr)*	*Projected rate of change (ft/yr)*	*Predicted approx. static DTW in 2060*	*Predicted approx. static DTW in 2060*
#2		135	1967						
#3	L0547	175	1962				-0.7	244	250
#4	L2075	0					-1.44		

Explanation:
DTW – depth to water.
Date – year water level to left was measured.
Obs av static rate of change (ft/yr) – average water level decline rate, in feet per year, based on initial and most recent DTW.
Projected rate of change (ft/yr) – rate of water level decline, in feet per year, predicted by the GWMA groundwater model in the next 30 years.

Groundwater Geochemistry

Groundwater geochemical data can be useful in determining the recharge source, age of recharge, and mixing of different sources of water. Examples of how GWMA's groundwater geochemical data are used include the following:

- C-14 age and percent modern carbon (PMC) provides a measure of the average age of when groundwater samples entered the groundwater system as recharge, and an indication of the preponderance of older or younger waters in the sample.
- Stable isotopes of oxygen ($^{18}O/^{16}O$) and hydrogen (D/H) can be used to identify the presence of specific end members that may comprise mixed groundwater samples. End member isotopic signatures are consistent and therefore, if a mixed groundwater is known to contain certain end members, the contributory percentages of each end member can be back calculated for a given mixed groundwater sample. Basic isotopic signatures are:

- For modern water delta D is generally between greater than -140/ml and -80/ml, and delta ^{18}O is between -17/ml and -9/ml.
- For ancient, or fossil, groundwater, delta D is between -130/ml and -160/ml, and delta ^{18}O is between -16/ml and -19/ml.

- TU is a measure of tritium, with those samples having TU over 0.5 generally having some modern component. Generally, the higher the TU the more abundant modern water is in the sample. TU less than 0.1 indicates essentially no modern water is present.
- Molar equivalent values (meq/l) provide additional information about the presence of modern water versus older water.
  - High meq/l values for sodium and potassium (Na+K) and silica dioxide (SiO_2), coupled with low values for sulfate (SO_4), calcium (Ca), and Magnesium (Mg) generally suggest very old groundwater.
  - Opposite trends generally indicate younger to modern groundwater.

Using these different geochemical data sets GWMA evaluates the potential age of the source(s) of groundwater being pumped from sampled wells. Recharge ages of these groundwater sources, from oldest to youngest, include ancient (or fossil), geologically young but pre-modern, or modern. In addition, the evaluation looks at potential mixing of different aged groundwater sources, including which of the sources may dominate the sampled water. Generally, the ranges of ages identified in this evaluation include:

- Modern, which is groundwater recharged in approximately the last 60 to 65 years.
- Geologically young, or pre-modern, which is groundwater recharged prior to the 1940's, but which could be hundreds to several thousand years old.
- Ancient (or fossil), which is groundwater that was recharged during the Pleistocene, or early Holocene, essentially prior to approximately 10,000 years ago.
- Mixed, which includes mixes of different aged sources. Where GWMA interprets groundwater sources to be mixed, we attempt to identify which aged source predominates, if possible.

Groundwater geochemical data collected from the Town of Wilbur's ***Wells #3 and #4*** is listed on Table 6. Additional information about the use of groundwater geochemistry in evaluating groundwater age and recharge source is provided in Appendix D.

Table 6. Basic Geochemical Data.

Town well ID	*GWMA ID*	*C-14 age (yrs)*	*PMC*	*TU*	*Delta D*	*Delta O18*	*Na+K (meq/l)*	*HCO3+CO3 (meq/l)*	*Ca (meq/l)*	*Mg (meq/l)*	*SO4 (meq/l)*	*SiO2 (meq/l)*
#2												
#3	L0547	1880	79.15	1.6	-132.2	-16.67	1.09	8.15	2.12	1.55	0.81	1.11
#4	L2075	5100	52.99	0.3	-137.8	-18.34	0.74	5.49	1.29	0.91	0.31	1.21

Explanation:
C-14 age (years) – average age of groundwater bearing the carbon 14 isotope.
PMC – percent modern carbon.
TU – tritium units calculated to be present in water.

Observations about groundwater geochemical sampling results include the following:

- ***Well #3*** displays mixed chemistry, with geologically young, to modern water dominating. There also is fossil groundwater present in this well.
- In ***Well #4*** the sources of water are mixed, but dominated by older sources than those seen in ***Well #3***. This shift to older sources may be reflective of the presence of a seal in ***Well #4***, and not in ***Well #3***.

Water quality data reported to the WADOH for ***Well #3*** (e.g., fluoride < 0.5 mg/l; nitrate-N 3.0 to 5.8 mg/l) and ***Well #4*** (e.g., fluoride < 0.3 mg/l; nitrate-N 0.6 to 2.0 mg/l) supports this general trend. ***Well #3*** with higher nitrate-N concentrations is interpreted to pick up more modern recharge than ***Well #4***.

Supply Summary

The sources of water pumped from the Town of Wilbur's two primary wells are mixed. These sources include modern water (dominates in Well #3), young, but pre-modern waters which are common in both wells, and ancient, or fossil, sources, which dominate in Well #4. These wells appear to generally have stable water levels, and even experience artesian conditions. Based on that, the groundwater systems that supply Wilbur's wells appear to be able to meet the Town's demands. Given that though, reported seasonal declines in water level in one of the two wells, which is inferred to be the result of interference from irrigation wells in the area, should give pause for concern. Such trends are common in other areas of GWMA where long-term water level declines are occurring, and suggestive of pumping demands exceeding aquifer capacity.

When these data, observations, and predictions are taken together - water level declines suggested by the existing data, predictions form the GWMA groundwater model, groundwater geochemical data suggesting little modern recharge - GWMA anticipates the very real potential for groundwater supply shortfalls during maximum periods of dynamic drawdown (pumping) in the next several decades. Based on that, GWMA recommends that the Town begin an active real-time groundwater level monitoring and pumping program so that it can better track these potential conditions, adjust water system operation to possibly mitigate some of these predicted impacts, and potentially begin to explore water supply and source alternatives.

Potential Future Water Sources and Issues

The purpose of this section is to outline some potential future scenarios for: (1) continued development of deep, primarily Grande Ronde Basalt hosted portions of the aquifer system, (2) development of a suprabasalt aquifer and/or shallow basalt groundwater source, (3) use of surface water, and (4) water reuse. In each case we assume that the Town totally converts to a water system supplied by each of these sources.

Deep Grande Ronde Basalt Groundwater Source

Should the Town of Wilbur decide to construct a new deep Grande Ronde Basalt well, the top of the Grande Ronde Basalt is approximately 150 to 250 feet below ground surface in the Wilbur area. A water supply well targeted to supply 1000 to 1,500 gpm likely would have a nominal diameter of 12-inches to 16-inches for the producing interval, and this interval likely will extend at least 400, if not 600 feet into the Grande Ronde Basalt. As such, a new Grande Ronde well drilled and constructed in the Town area likely would be 550 to 850 feet deep. To minimize interference with existing Town wells, the casing would extend downwards to at least the depth of the existing wells, approximately 500 feet deep.

As noted above, water quality data reported to WADOH shows fluoride concentrations are very low in Town wells. However as noted above, as one goes deeper into the Grande Ronde Basalt aquifer system elevated fluoride, iron, manganese, and hydrogen sulfide concentrations should be expected. As the concentrations of these constituents reach certain thresholds, that will necessitate installation of treatment systems to meet regulatory requirements and aesthetic guidance

Shallow Basalt Groundwater Source

Based on the construction of the Town of Wilbur's current wells, the Town is currently exploiting the shallow groundwater system. As noted earlier, this portion of the aquifer system appears to generally be capable of meeting current Town water supply needs, but there is some evidence that it might not always be able to do so. Assuming there is not a significant increase in the demand on this portion of the aquifer system; the Town should be concerned about water quality in it. The evidence of elevated nitrate-N in WADOH samples suggests there is the potential for surface activities to impair the water quality of the shallow aquifer system.

Surface Water Source

The perennial surface water source nearest to Town Wilbur is the Columbia River behind Grand Coulee Dam, in Lake Franklin D. Roosevelt. This body of water is over a dozen miles away from town, and to access it a pipeline with significant lift would need to be constructed.

Water Reuse

Water reuse, e.g., utilization of treated waste water for irrigation or similar needs, to reduce demand on potable aquifer sources is a possibility. However, given the small size of the Town of Wilbur and lack of large industrial waste water sources, the resulting waste water stream would be small. Given this it is unlikely that developing a waste water reuse system would be economically viable.