If the use of exempt wells has an “Eventual and Cumulative” negative impact on instream flows, can low impact development have an “Eventual and Cumulative” positive impact on instream flows?

Eventual and Cumulative

Domestic Use Water Model for Central Mason County

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Introduction

One of the obstacles to creating an agreed upon and workable watershed management plan for Water Resource Inventory Area 14 (WRIA 14) focuses on the debate around permit exempt wells. One hypothesis states that the eventual and cumulative residential use of water from permit exempt wells negatively impacts instream flows especially in the Johns Creek and Kennedy-Goldsborough watersheds.

This work looks at the potential for positive impacts to water resources through understanding and quantifying consumptive use and determining the cumulative and eventual effects of low impact development on residential water use and stormwater management. Capturing rain water from elevated impervious surfaces and returning household water use into the ground through onsite septic treatment systems can more than offset the consumptive use of residential well. Water returned into the soil will eventually and cumulatively reach the aquifer or reach a restrictive layer (aquitard) and move laterally until it intercepts a stream thus improving streamflow.

Background

WRIA 14[1] lies within Mason County and the western reaches of Thurston County. It stretches from Hood Canal in the north to the southwest portions of Puget Sound in the south. It encompasses Shelton, the only incorporated city in Mason County, as well as the Squaxin Island Tribal lands. According to Census estimates, the WRIA has approximately 40,000 residents with 13,810 residing in the city of Shelton and the Shelton UGA.

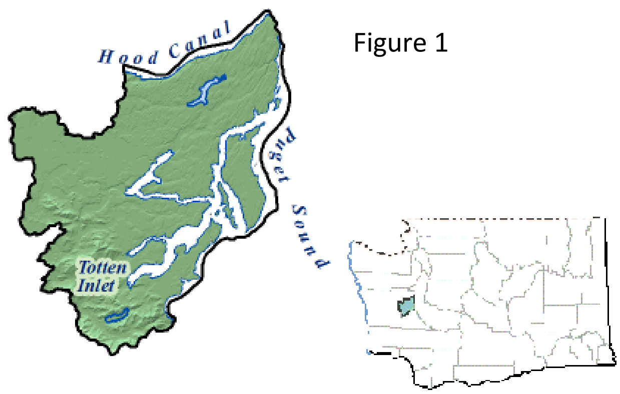

Figure 1

The basin is home to both forestry and commercial shell fishing as the top two major economic activities.

Since January 18th of 2018, domestic exempt wells in WRIA are limited to 950 gallons per day average use and must pay a $500 fee. This rule does not apply to exempt wells for agriculture, commercial, and stock watering. For the purpose of this paper, all references will apply to domestic exempt well use as outlined by SSB 6091.

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1 https://fortress.wa.gov/dfw/score/score/maps/map_details.jsp?geocode=wria&geoarea=WRIA14_Kennedy_Goldsborough

Water Balance

Figure 2 below depicts a typical moisture cycle. WRIA 14 differs from WRIA 16 to the north in that precipitation is not stored as snowpack which melts over the summer. Water arrives primarily in the winter months through rain as shown in Figure 3. Runoff and baseflow constitute major contributors to instream flows. Runoff contributes most during the months of high rainfall where base flows have a year-round contribution to instream flows.

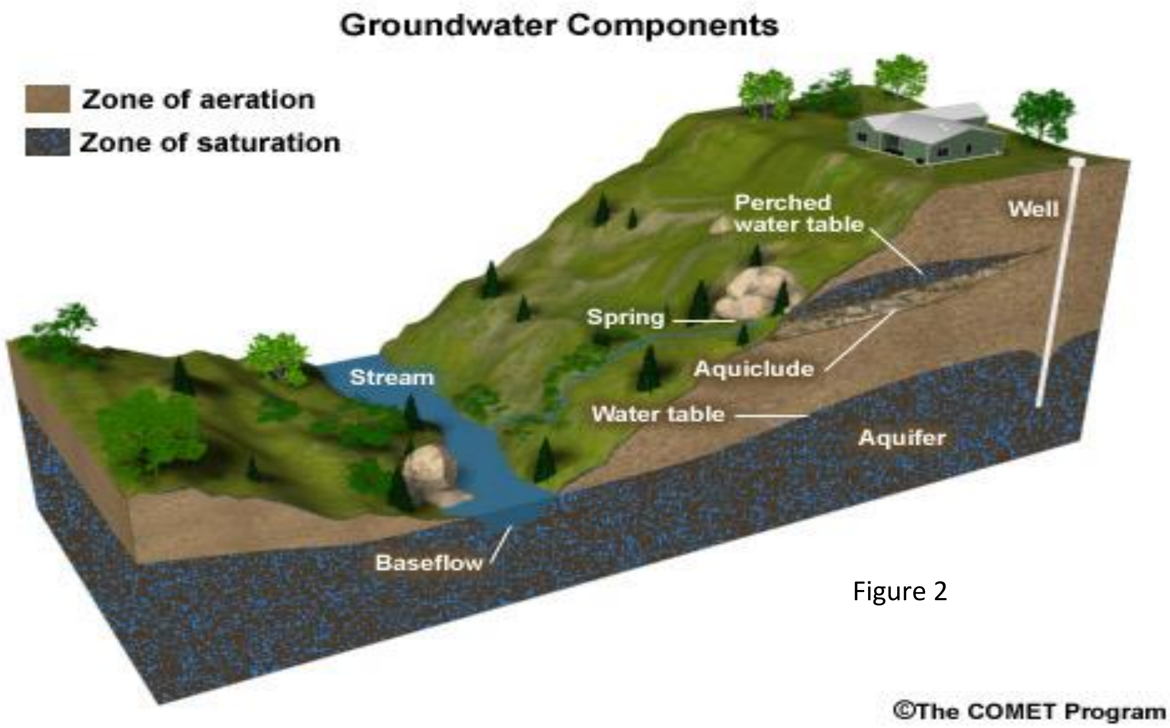


Figure 2

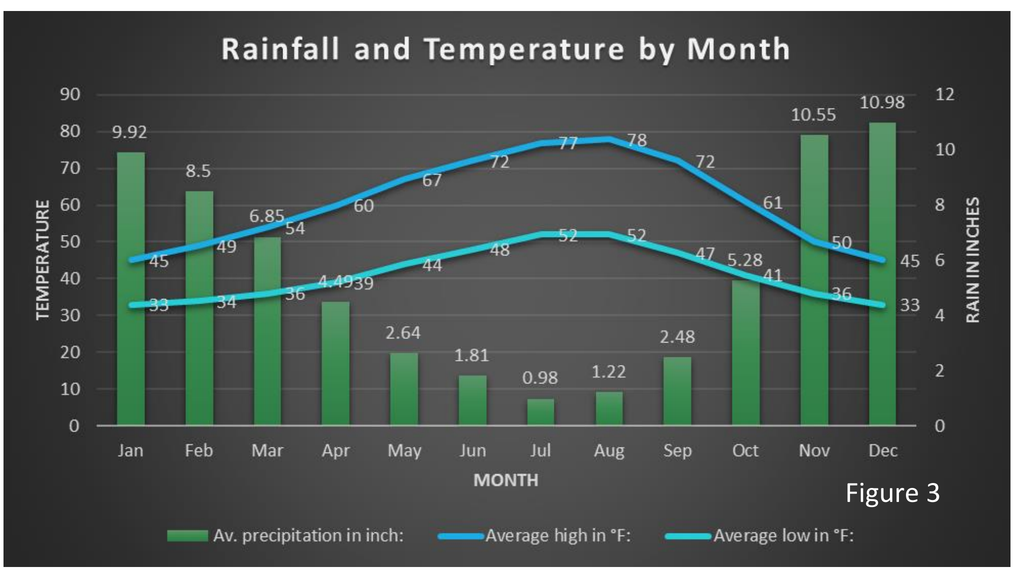


Figure 3

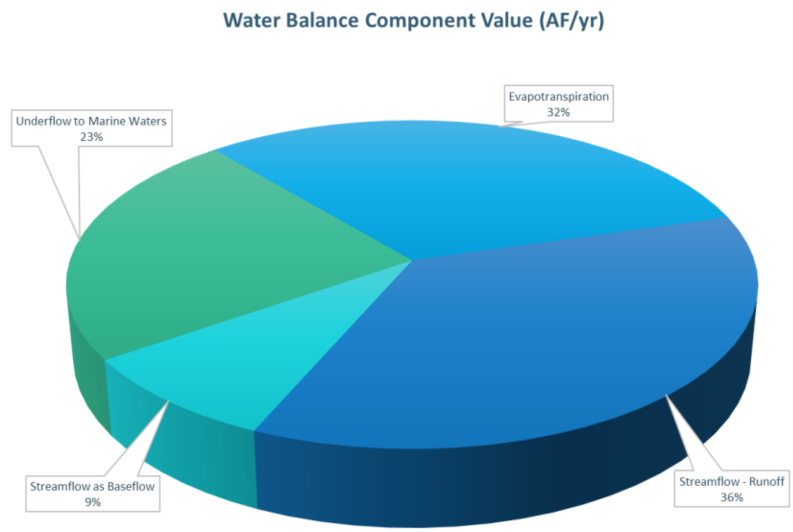
Water Balance Quantification

Rainfall is typically depicted at a value of acre feet per year when looking at the basin.

Water Balance Component	Value (AF/yr)
Precipitation	1,360,000
Evapotranspiration	430,000
Streamflow - Runoff	490,000
Streamflow as Baseflow	120,000
Underflow to Marine Waters	320,000 [2]

Table 1

Acre feet/yr. is less valuable when looking at a per parcel or per acre measurement, but the ratios remain constant which does provide value in smaller scale water modeling. The following chart depicts water balance per acre based on undeveloped property with average forest cover.



Source: Kennedy-Goldsborough Watershed Phase II Level 1 Assessment 2002

Figure 4

WRIA 14 receives an average of 65 inches of rain per year or 1,755,468 gallons per year per acre. Using the percentages above distributes water as follows in Table 2.

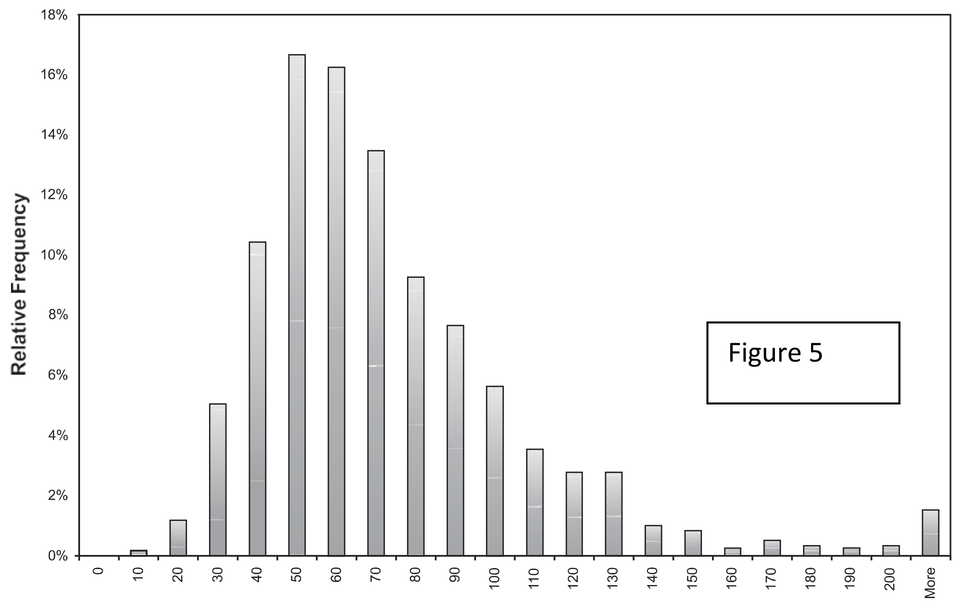
Water Balance per acre	gallons/acre
Precipitation	1,755,468
Evapotranspiration	561,750
Streamflow - Runoff	631,968
Streamflow as Baseflow	157,992
Underflow to Marine Waters	403,758

[2] Kennedy – Goldsborough Watershed Phase II Level 1 Assessment Chapter 6

Consumptive Use – Determining Per Person Usage

The average daily residential use was determined using the EPA Onsite Wastewater Treatment Systems Manual. Chapter 3, Estimating Flows, cites several studies[3] which estimates a per person residential use of between 50 and 70 gallons per person per day in residences built before the U.S. Energy Policy Act (EPACT) standards went into effect in 1994. Full implementation of new high-efficiency standards for washing machines and dishwashers further reduce per person per day water usage by another five gallons per day. This study uses 60 gallons per day per person which coincides with these studies as well as WAC 246-272A.

Distribution of mean household daily per capita indoor water use for 1,188 data-logged homes[4]



Source: Mayer et al., 1999

Consumptive Use – Determining Gross Household Usage

Using 60 gallons/person/day is multiplied by the mean household occupancy in Mason County of 2.57 persons per household. The resulting 154.20 gallons per day multiplied by 365 days yields a yearly residential household usage of 56,283 gallons per home per year. This provides the mean gross residential usage per home.

Consumptive Use- Determining Net Household Usage

Septic recharge rates from domestic use returning to soils through rural individual onsite septic systems are estimated at 80%. This accounts for evapotranspiration occurring at the soil interface. 80% of 56,283

[3] USEPA Onsite Wastewater Treatment Systems Manual 3.3.1 Residential wastewater flows page 3-1

[4] USEPA Onsite Wastewater Treatment Systems Manual page 3-5

gallons returning to soils yields 45,026.4 gallons returned to soils leaving a net usage of 11,256.60 gallons per home per year.

Put in perspective, 11,256 gallons per home per year equates to 30.84 gallons per home per day or 12 gallons per person per day.

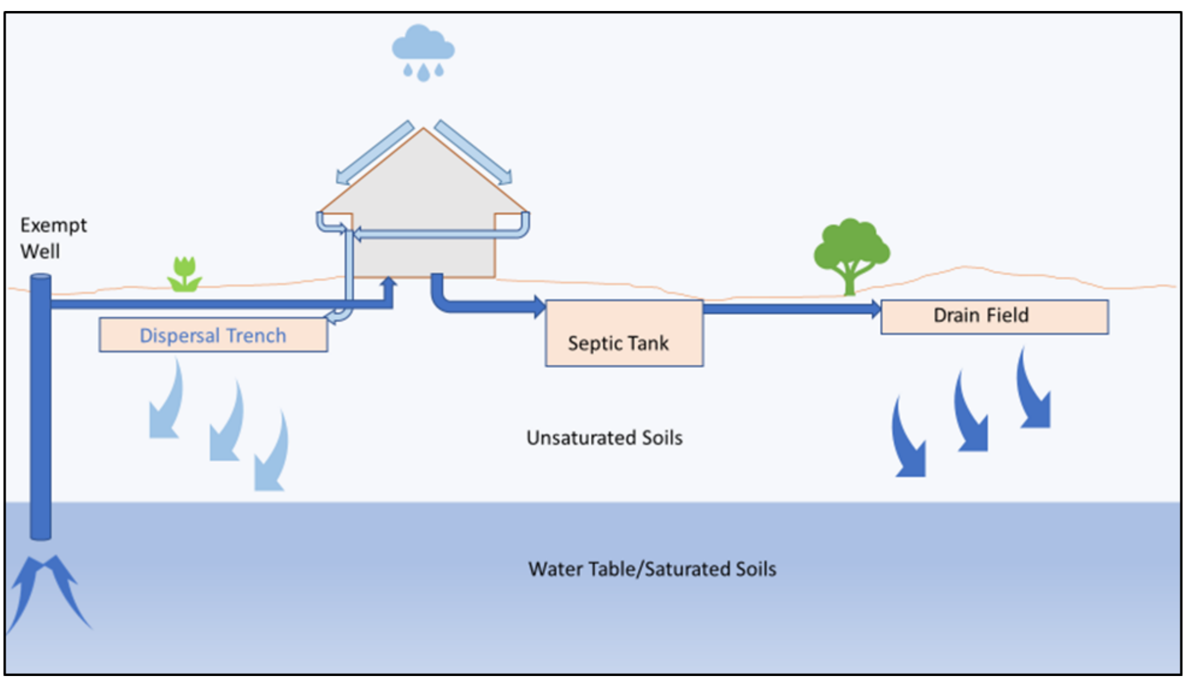
Recharge from Septic Systems

Water discharged from septic systems eventually and cumulatively make their way downward to the uppermost aquifer which are typically those aquifers that intersect and support in-stream flows. Discharges that intercept an impermeable layer before reaching the aquifer move transversely through the soils on downward gradients until intersecting with streams or more permeable layers. This is somewhat of a simplification, underground topography is complex, yet these observations are typical.

Mitigation

Development

Changes in land use through development changes the nature of the water balance. Impervious surfaces add to run off. Underflow to marine waters may be increased as runoff on slopes leading to marine waters increases. Cleared land reduces evapotranspiration from water held in overhead canopies of mature forests thereby increasing the amount of water that reaches the ground. The following calculations are based on capturing rainwater from roofs and returning these waters to the soils through low impact development techniques. The calculations assume minimal land clearing on typical five acre rural parcels and do not take into account stormwater runoff from driveways or roads. Stormwater is mitigated through standard stormwater practices for less than 2000 square feet of impermeable surfaces and by stormwater plans for development covering more than 200 square feet. Stormwater on developed areas is to be held on that parcel and not to be a contributor to runoff.



Rainwater Capture

Capturing rainwater during the wet seasons and placing these waters directly into soils provides benefits to in-stream flows as they eventually and cumulatively add to flows as base flow. Base flows support the stream throughout the year mitigating impacts of hot, dry summers and exempt well usage. Capturing rainwater from elevated impervious surfaces is preferable to capturing stormwater runoff from driveways in that it needs no treatment before being placed directly into soils through low impact development.

Rainwater Calculation

A typical home in Mason County without a garage has an average of 2000 square feet of roof area. An average yearly rainfall of 65.7 inches at .62 gallons per square foot of roof area for 2000 square feet yields 81,468 gallons of water. Subtracting 11,256 gallons of net water usage per residence leaves a remainder of 70,211.4 gallons positive net impact. Residential usage is completely mitigated.

Irrigation

To this point, irrigation has not been addressed. Irrigation is the largest variable in the water calculation. Some residents tend to favor green summertime lawns while others choose to irrigate little if at all. For the purpose of this calculation the assumption will be made of a ¼ acre of either lawn or garden. Figure 3 indicates the driest and hottest months as June, July and August. Most irrigation, however, occurs in July, August and September.

Irrigation Calculation

From the previous calculation there is a remainder of 70,211 gallons available from mitigation for irrigation. To determine how much irrigation that would support the following calculation is made. Rules currently allow for not more than ¼ acre irrigation for an exempt well. The recommended water dosage for lawns and gardens is one inch of water per week. Irrigating one inch of water on ¼ acre equals 10,890 square feet at .62 gallons per square feet per week or 6,751.8 gallons per week. This yields 10.39 weeks of irrigation or the ability to irrigate from July 1st to September 13th.

Example:

Most of the rural developable land in WRIA 14 is zoned at RR-5 which means that each five-acre parcel has one development right. A typical homeowner goes to Mason County Community Development with plans to build on a forested five-acre parcel. Ground clearing is limited to what’s necessary for the home, driveways, utilities and generally a small yard. Out of five acres one to two acres may be cleared in development. This leaves the water balance as described in Figure 4 for the three undeveloped acres. The owners build a 2200 square foot home with a two-car garage which adds another 576 square feet. This combined roof area captures 113,078 gallons of water per year while the domestic water use of a typical home is 11,256 gallons. Rainfall captured provides nine times the water needed for domestic consumption. The remaining water balance of 101,821 provides the capability to irrigate a ¼ garden or lawn for 15 weeks.

Other Factors

Time

Water captured and returned through either on-site septic or from roofs takes time to reach either the water table or to travel horizontally to effect baseflow. The subsurface flows will intercept the shallowest saturated soils first which are the primary supports for base flow. In some areas of WRIA 14 with shallow soils and higher water tables, this impact may be almost immediate. Septic systems may be designed for shallow emplacement and may require higher levels of treatment before going to the dispersal component through systems such as a pressurized drain field or mound system. In areas with tighter and deeper soils, this process takes longer. Treated effluent travels farther and receives a higher level of treatment within the soils. This process also affects the way in which water withdrawal from a well influences base flows. The further the well is located from the intersection of base flow and in-stream flow, the less impact that well has on in-stream flow.

Disposal Component

Water returned from downspouts can be returned to soils through subsurface disposal components such as percolation trenches or through water gardens. Water gardens have a higher evaporation component and as a mitigation measure are less efficient. The deeper the point at which the rainwater is essentially injected into the soils, the greater the efficiency and reduction of evaporation which shortens the time needed to impact subsurface water.

Evapotranspiration and runoff

More than 30% of rainfall never makes it to the ground to be available to baseflow. The forest canopy keeps rainfall aloft and is lost to evapotranspiration. Clearing reduces the overhead canopy and allows more rainfall to reach the ground which adds to surface infiltration and baseflow support as well as contributing to greater runoff. This must be addressed in building plans and construction techniques in order to keep runoff from leaving the property

Conclusion

Instream flows are reduced in summer months. Each acre in WRIA 14 and 15 receives over 1.7 million gallons of rainfall per year most of which comes in the winter months. Much of that water is lost to runoff and evapotranspiration and is unavailable to support summertime base flows. The courts have determined that exempt domestic well use may have an adverse effect on instream flows. Using low impact development techniques of capturing rainwater and returning it to the soils in subsurface dispersal components easily offsets the consumptive domestic use by a factor of greater than 8 to 1. The most difficult component to quantify is irrigation use but calculations show that rainwater capture can support if not negate effects of ¼ acre individual home irrigation uses.

For purposes of community planning, a consumptive domestic use of 11,256 gallons per residence per year can be used as a good planning number.