APPENDIX B: *WATER RIGHTS AND WATER USE*

WATER RIGHTS ANALYSIS

The purpose of this analysis was to determine the amount of allocated water within each of the 30 subbasins. The primary effort was focused on summarizing the water rights on file with the Department of Ecology. The water rights represent the major proportion of the allocated water, however, exempt ground water withdrawals (or exempt wells) are also legal entitlements to the use of water. Accounting for these exempt wells is a more difficult process since no tabulation of these wells is available. Hence, an analysis of two approaches to determine the number of water users withdrawing water from exempt wells was also undertaken. (It is easier to determine the number of water users rather than the number of wells since population numbers are readily available but the number of wells is not and, in addition, there may be more than one household per well).

METHOD

The Washington State Department of Ecology (WDOE) maintains a database, the Water Rights Accounting and Tracking System (WRATS), for tracking and storing water rights information. The WRATS database and GEOWRATS, a format of WRATS designed to spatially display the data, were obtained from WDOE in September 1999. GEOWRATS was used to identify, to the extent possible, the subbasin in which the point of diversion (POD) for each water right was located. WDOE has assigned the location of the POD of each water right in the database by using the nearest quarter-quarter (Q/4-Q/4) section of the actual POD legal description; the legal description of the point of diversion is not in the database but is on the original application, permit, and/or certificate.

The certainty of assigning a subbasin number to each water right depended on whether the Q/4-Q/4 section lay entirely within a subbasin or whether the subbasin boundary bisected the Q/4-Q/4 section. The former provided the most certainty of identifying the subbasin in which the water right POD was located. In the latter case, the assumption was made that if more than 75% of a Q/4-Q/4 section was within a particular subbasin, the POD located at the centroid of that Q/4-Q/4 section was assigned to that subbasin. These two steps covered 92% of the water rights and claims in the database. The remainder of the rights and claims were assigned subbasins using the following assumptions:

- If the majority of a Q/4-Q/4 section (based on visual inspection) was in a particular subbasin, a water right with that location was assigned to that subbasin.
- If the Q/4-Q/4 was bisected by a subbasin boundary, then the water right with that Q/4-Q/4 section location was assigned to the next downstream subbasin.
- If the Q/4-Q/4 section was entirely outside of the WRIA or if the right was tributary to the Pacific Ocean, the right was not included in this analysis.

Once water rights were assigned to a subbasin, review and organization was undertaken. The WRATS database included numerous duplicate entries that identified multiple points of diversion and/or points of use for the same water right document number. In addition, there were many *change* documents. Changes to water rights could include a change in use, additional points of diversion/withdrawal, change in point of diversion, and/or a change in the place of use. Under state law, a water user is required to file a change application for any of these alterations to a water right. (For more information, go to the WDOE website: http://www.wa.gov/ecology/pubs/981802wr/index.html). The duplicates were not counted in the overall summary of water rights, however, the number of *changes* to rights were noted in the summary table, but not added to the total numbers, either in allocated amounts or number of rights.

The number of water right certificates, permits, and applications for both surface and ground water were summarized by subbasin in Table B-4. The number of rights and claims were also tabulated by primary purpose and the total allocated amount was computed for each subbasin (Table B-3). Claims were summarized similarly (Table B-5), however, allocated amounts were not summarized since those data were not always included in the WRATS database.

Many anomalies have been noted using WRATS and GEOWRATS databases. In other western Washington projects, some water rights found on paper were not found in this database or the amount for each use associated with a water right was not clearly identified in WRATS. A more detailed analysis of the WRIA 22 and 23 data would be required to determine the extent to which that is the case for Chehalis Basin. Further, certain fields in the WRATS and GEOWRATS tables were blank, including allocated amounts and locations. Some of the missing data were obtained by contacting WDOE and requesting the information. Because of the missing data and the inexact nature of identifying the location of water right diversions/withdrawals based on the Q/4-Q/4 section, the information provided in this section is preliminary in nature and intended to provide a general understanding of the water allocation within each subbasin.

RESULTS

Based on the WRATS database (September 1999), the Chehalis Basin had a total of 2,597 water rights and 7,452 claims, including rights tributary to Grays Harbor. The database contained eight water rights and 129 claims that were identified either outside of the two WRIAs or that drained to the Pacific Ocean; these were not included in this analysis. The total allocated amount for diversions/withdrawals was almost 3,718 cfs with an annual volume limit of nearly 238,000 acre-feet. The total volume of storage rights was about 107,000 acre-feet. The water rights cover roughly 45,500 acres of irrigated land.

WRIA 22 - Lower Basin

There were a total of 769 water rights in WRIA 22 including 9 storage rights for a total allocated diversion/withdrawal amount of 2,901 cfs and volume limits at nearly 120,000 acre-feet. The largest number of rights was attributed to irrigation (406) and secondly, domestic use (200). There were about 10,204 acres associated with water rights assigned irrigation as a primary beneficial use; another 1,355 irrigated acres were associated with water rights for which other beneficial uses were primary, such as domestic or stock watering (Table B-1). Surface water

rights accounted for 91% (2,497 cfs) of the instantaneous rate, and ground water accounted for 9% (260 cfs). The vast majority of the 769 water rights were certificates; there were 63 applications and 16 permits in WRIA 22.

In WRIA 22, 30 of the water rights represented 90% of the total allocated diversion/withdrawal rate (Figure B-1); 27 surface water rights and 3 ground water rights. The largest allocation was a water right certificate for hydropower generation on the Wynoochee River (Subbasin 20) at 1,400 cfs; a non-consumptive right except within the reach between the point of diversion and the point of return flow. This right represents nearly half of all the allocated water in WRIA 22. Also, in Subbasin 20 there were two water right certificates for 110 cfs and 45 cfs for municipal and commercial/industrial uses; these rights were for the City of Aberdeen. In the Satsop River Basin (Subbasin 18), there was a 570 cfs surface water certificate for multiple domestic purposes held by Lake Arrowhead Community Club. This water right was substantial considering the use to which it has been allocated; 570 cfs could easily supply the demand for a large city. This right should be investigated in Level 2 to determine whether or not this was a data entry error. These four rights were the largest in WRIA 22. The next largest water right allocation was 35 cfs on the Hoquiam River in Subbasin 22, designated for commercial and industrial uses.

The largest ground water right was a power right for 35,909 gpm (approximately 80 cfs); this right was associated with the now defunct thermonuclear power plant, at the mouth of the Satsop River, built by Washington Public Power Supply System. It is possible that this right has never been used. Of the remaining two ground water rights, one was designated multiple domestic use and the other was municipal use for 4.9 cfs and 4.5 cfs, respectively.

The largest irrigation right in WRIA 22 was for 5.5 cfs from North Bay, hence, there were no significant single irrigation rights in this WRIA.

As part of the Level 2 Assessment, the status of these 30 water rights should be investigated to determine which ones are actually being used and which ones are not, or never have been used.

Table B-1: WRIA 22 Summary of Water Rights By Primary Beneficial Use

Primary Purpose	Number of Rights	Total Instantaneous Withdrawal Rate (cfs)	Annual Volume Limit (acre feet)	Irrigated Acres
Commercial	20	86.66	1,348	3
General Domestic	1	2.24	1,625	0
Multiple Domestic	85	612.44	4,218	5
Single Domestic	114	1.92	77	3
Environmental Quality	1	0.05	0	4
Frost Protection	5	6.72	961	0
Fish Propagation	34	157.56	411	0
Heat Exchange	3	1.84	118	0
Irrigation	406	175.84	13,102	10,204
Municipal	28	206.2	112,837	0
Power	6	1,489.43	54,360	9
Recreation	3	0.36	55	12
Right of Way	2	0.56	102	0
Stock	55	12.80	1,765	1,256
Wildlife	6	1.84	157	63
TOTAL	769	2,756.46	191,135	11,559

WRIA 23 -Upper Basin

In all, WRIA 23 contained 1,828 water rights for a total allocated amount of 961 cfs for direct flow diversions and ground water withdrawals; the volume limit was 116,728 acre-feet plus an additional storage volume of 35,657 acre feet (14 storage rights). Similar to WRIA 22, the largest number of rights were associated with irrigation use (1,102) and secondly, domestic use (347). Irrigation rights were tied to 33,947 acres (Table B-2). Excluding storage rights, the rights were split evenly between surface and ground water rights in WRIA 23. Surface water rights accounted for 55% (533 cfs) of the instantaneous rate and ground water accounted for 45% (428 cfs). The vast majority of the 1,828 water rights were certificates; there were 45 applications and 34 permits in WRIA 23.

As displayed in Figure B-1, 40% of the rights (724 in number) covered 90% of the allocated water. Twenty-two rights (~1%) covered 40% of the allocation. There were a significant number of small water rights throughout WRIA 23 that spread the allocation to many as compared to the few found in WRIA 22.

The largest two water rights in WRIA 23 were power rights for 140 cfs and 80 cfs held by Pacific Power and Light; the latter includes commercial use as well. The source of supply for these two rights was the Skookumchuck River (Subbasin 9). The top three ground water rights were intended for fish propagation for a total of 18,000 gpm or 40 cfs.

Table B-2: WRIA 23 Summary of Water Rights By Primary Beneficial Use

Primary Purpose	Number of Rights	Total Instantaneous Withdrawal Rate (cfs)	Annual Volume Limit (acre feet)	Irrigated Acres
Commercial	27	9.18	1,518	0
Multiple Domestic	210	42.69	6,783	0
Single Domestic	137	3.19	207	21
Frost Protection	2	8.12	360	145
Fire Protection	10	2.38	625	0
Fish Propagation	44	128.94	37,426	0
Heat Exchange	3	0.59	109	0
Highway	1	0.25	0	0
Irrigation	1,102	411.60	48,202	29,277
Municipal	36	60.92	14,003	24
Power	10	232.32	35,001	73
Recreation	28	5.93	583	118
Right of Way	4	1.55	572	0
Stock	194	51.02	6,871	4,242
Wildlife	20	2.57	125	47
TOTAL	1,828	961.25	152,385	33,947

The number of irrigation water rights (1,102) was 60% of the total number of rights, representing nearly 43% of the total allocated water (412 cfs) in WRIA 23. Many of these rights included single or multiple domestic use as a secondary beneficial use. Sorting out an amount associated with each beneficial use was not possible at this level of analysis. The largest surface and ground water irrigation rights were 3.33 cfs and 4.45 cfs for 33 acres and 30 acres, respectively. Although irrigation rights represented the largest allocation by beneficial use, the amounts of the individual rights were relatively small compared to the largest rights in WRIA 23 (i.e. power and fish propagation).

While stock watering appeared to have a rather high allocation (51 cfs), a secondary use associated with this beneficial use was the irrigation of 4,242 acres. As stated above, at this Level 1 Assessment, the rates associated with primary, secondary, tertiary, etc., beneficial uses could not be separated out. The next highest number of rights is for domestic use, with 347 rights, for a total instantaneous withdrawal rate of 45.88 cfs.

Power and fish propagation, generally non-consumptive uses, represented 361 cfs or 38% of the total allocated rate. Included in this total was a surface water right for 80 cfs held in the name of Pacific Power & Light and intended for the Centralia Steam Plant, a thermoelectric power system high in its consumptive use of water. Therefore, all power rights cannot be assumed non-consumptive uses. Power, fish propagation, and irrigation accounted for 81% of the total allocation in WRIA 23. Power generation represents the highest water use per right (23.9 cfs/right), and frost protection the second highest (4.06 cfs/right). Fish propagation ranks third with 2.93 cfs/right, and municipal ranks fourth with 1.69 cfs/right. All other categories indicate less than 1 cfs per right. The ratio of cfs per right for irrigation uses was 0.37.

As part of a Level 2 Assessment, it would be worthwhile to investigate the 22 rights that cover 40% of the allocated water to determine whether or not these are currently being exercised under Washington State water law. Understanding the extent to which water rights are actually being used in WRIA 23 would be a more involved and costly endeavor than in WRIA 22, due to the significant number of small rights spread throughout the upper basin. In addition, Mahlum (WDOE, 1976) identified a number of rights within the Skookumchuck River basin that have not been developed; status of these should be determined in Level 2.

Figure B-1
Cumulative Allocated Water Assigned to Number of Rights
Chehalis River Basin (WRIAs 22 and 23)

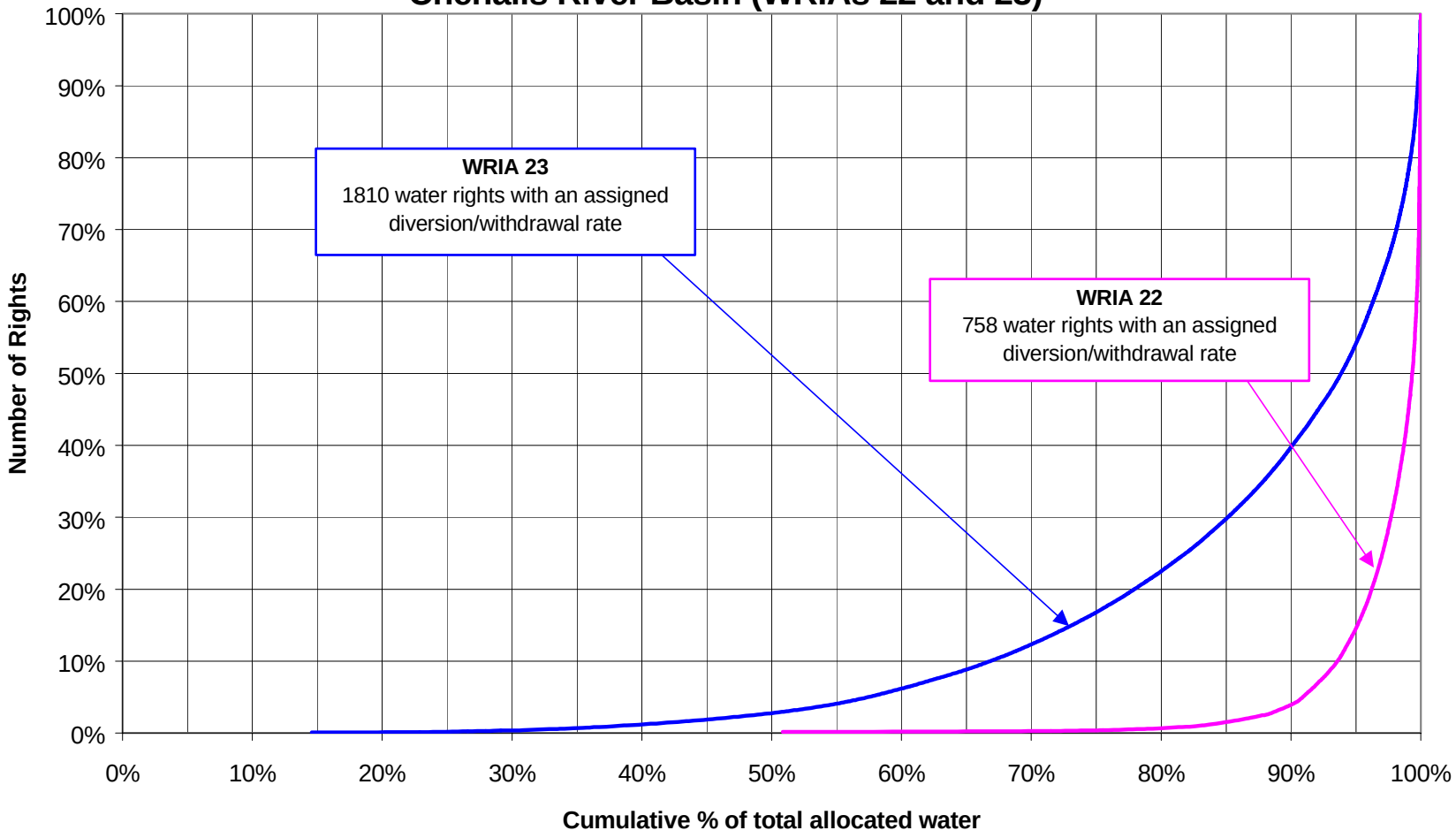


Table B-3. Summary of Water Rights' Allocated Amounts and Purposes. (Highlighted rows indicate subbasins which were selected for more detailed analysis in Section 3.)

	Allocated Amounts of Surface & Ground Water Right				Number of Water Rights by Primary Purpose									
Subbasin	cfs	acre feet	acres	Storage (acre feet)	Domestic	Irrigation	Recreation	Commercial	Power	Fish or Wildlife Propagation	Municipal	Stock Watering	Other	Total Uses
1	12.47	684	370	-	8	24		1	2	2	4	7	-	48
2	8.69	124	67	-	-	3	-	-	1	1	-	2	-	7
3	10.99	1,061	1,124	-	-	23	-	-	-	-	-	4	-	27
4	66.51	6,976	4,865	5	46	157	7	1	1	9	1	19	4	245
5	9.97	2,243	253	-	1	11	1	-	-	2	1	3	-	19
6	14.00	139	77	-	4	3	-	-	-	2	1	2	-	12
7	62.46	7,636	4,642	-	26	129	2	3	1	8	5	29	-	203
8	2.50	237	323	-	2	6	-	-	-	-	1	1	2	12
9	312.87	12,063	1,549	35,399	21	69	-	5	2	4	12	7	3	123
10	67.48	10,204	4,332	17	44	162	3	7	1	7	4	22	-	250
11	217.56	33,218	8,092	224	109	227	12	7	1	18	1	38	6	419
12	2.07	329	184	-	4	5	-	-	1	-	-	1	-	11
13	173.68	41,768	8,067	60	83	285	2	3	-	9	6	59	5	452
Subtotal (WRIA 23)	***961.25***	***116,680***	***33,946***	***35,705***	***348***	***1,104***	***27***	***27***	***10***	***62***	***36***	***194***	***20***	***1,828***
14	17.29	2,876	699	-	22	45	-	4	-	-	3	5	1	80
15	76.04	1,088	61	-	9	3	-	1	-	13	-	-	2	28
16	3.20	249	174	-	3	6	-	-	-	1	-	1	1	12
17	0.94	153	104	-	4	5	-	-	-	-	-	3	-	12
18	604.28	1,556	871	-	8	19	-	-	1	5	-	12	-	45
19	71.55	11,399	5,453	6	27	114	1	1	-	2	4	12	1	162
20	1,574.28	36,129	1,204	70,050	12	29	1	3	1	2	4	7	1	60
21	22.94	145	204	48	18	13	-	1	-	2	2	1	-	37
22	60.17	179	52	12	24	9	-	1	1	1	3	2	1	42
23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24	7.38	88	52	-	9	8	-	1	1	2	-	3	-	24
25	86.55	633	309	469	7	12	-	-	1	7	-	1	2	30
26	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27	1.59	231	-	-	2	-	-	2	-	-	-	-	-	4
28	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29	2.10	-	-	-	1	-	-	-	-	-	1	-	-	2
30	123.31	60,603	1,771	605	28	56	-	3	1	5	5	8	-	106
GH	104.84	4,617	607	-	26	87	1	3	-	-	6	-	2	125
Subtotal (WRIA 22)	***2,756.46***	***119,945***	***11,559***	***71,190***	***200***	***406***	***3***	***20***	***6***	***40***	***28***	***55***	***11***	***769***
TOTAL	***3,717.71***	***236,625***	***45,505***	***106,895***	***548***	***1,510***	***30***	***47***	***16***	***102***	***64***	***249***	***31***	***2,597***

Table B-4. Summary of Ground and Surface Water Rights and Storage Rights. (Highlighted rows indicate Subbasins which were selected for more detailed analysis in Section 3.

	Surface Water					Ground Water					Storage	
Subbasin	# applications	#permits	# certificates	#changes	Total # rights	# applications	#permits	# certificates	#changes	Total # rights	#storage right	Total # Rights
1	2	2	43	-	47	-	-	1	-	1	-	48
2	-	1	6	-	7	-	-	-	-	-	-	7
3	-	-	27	-	27	-	-	-	-	-	-	27
4	1	2	170	2	173	5	2	62	1	69	3	245
5	-	-	16	2	16	-	-	3	-	3	-	19
6	1	-	11	-	12	-	-	-	-	-	-	12
7	2	-	123	-	125	6	4	68	2	78	-	203
8	-	-	6	-	6	-	-	6	-	6	-	12
9	-	-	68	-	68	5	2	44	1	51	4	123
10	1	1	116	1	118	1	1	129	1	131	1	250
11	-	-	164	-	164	9	8	234	7	251	4	419
12	-	-	7	-	7	-	1	3	-	4	-	11
13	-	1	139	-	140	12	8	290	12	310	2	452
Subtotal (WRIA 23)	***7***	***7***	***896***	***5***	***910***	***38***	***26***	***840***	***24***	***904***	***14***	***1,828***
14	2	1	48	-	51	3	1	25	-	29	-	80
15	4	-	16	-	20	3	-	5	-	8	-	28
16	-	-	8	-	8	-	-	4	-	4	-	12
17	-	-	12	-	12	-	-	-	-	-	-	12
18	1	2	21	1	24	-	1	20	1	21	-	45
19	2	-	80	-	82	7	1	71	3	79	1	162
20	2	1	34	1	37	2	-	19	-	21	2	60
21	-	-	36	-	36	-	-	-	-	-	1	37
22	-	-	38	-	38	-	-	3	-	3	1	42
23	-	-	-	-	-	-	-	-	-	-	-	-
24	-	1	22	-	23	-	-	1	-	1	-	24
25	1	1	15	-	17	1	-	10	-	11	2	30
26	-	-	-	-	-	-	-	-	-	-	-	-
27	-	-	2	-	2	1	-	1	-	2	-	4
28	-	-	-	-	-	-	-	-	-	-	-	-
29	-	-	2	-	2	-	-	-	-	-	-	2
30	2	-	67	-	69	2	1	32	-	35	2	106
GH	10	1	32	1	43	20	5	57	2	82	-	125
Subtotal (WRIA 22)	***24***	***7***	***433***	***3***	***464***	***39***	***9***	***248***	***6***	***296***	***9***	***769***
TOTAL	***31***	***14***	***1,329***	***8***	***1,374***	***77***	***35***	***1,088***	***30***	***1,200***	***23***	***2,597***

Table B-5. Water Claims Summary. (Highlighted rows indicate subbasins which were selected for more detailed analysis in Section 3.)

Subbasin	Surface Water # Claims	Ground Water # Claims	Combined Surface & Ground Water Claims	Total # Claims	Purposes General Domestic	Irrigation	#Acres	Stock	*Unknown*	Total
1	**35**	**67**	**1**	**103**	**90**	**8**	**158**	**-**	**5**	**103**
2	10	28	-	38	37	1	50	-	-	38
3	3	17	-	20	17	-	10	1	2	20
4	97	726	1	824	766	19	681	27	12	824
5	97	20	-	117	106	3	114	6	2	117
6	3	3	-	6	5	-	13	1	-	6
7	**53**	**618**	**-**	**671**	**638**	**7**	**1,200**	**23**	**3**	**671**
8	22	90	-	112	103	1	158	6	2	112
9	2	7	-	9	7	-	-	-	2	9
10	76	903	-	979	910	37	965	25	7	979
11	67	944	2	1,013	957	11	1,290	31	14	1,013
12	-	1	-	1	1	-	-	-	-	1
13	81	958	2	1,041	976	19	3,660	27	19	1,041
Subtotal (WRIA 23)	***546***	***4,382***	***6***	***4,934***	***4,613***	***106***	***8,299***	***147***	***68***	***4,934***
14	**52**	**230**	**-**	**282**	**263**	**7**	**363**	**7**	**5**	**282**
15	21	70	-	91	86	3	47	1	1	91
16	11	53	-	64	64	-	18	-	-	64
17	13	14	-	27	26	1	27	-	-	27
18	19	87	-	106	100	1	2,226	3	2	106
19	**65**	**351**	**-**	**416**	**368**	**16**	**542**	**17**	**15**	**416**
20	51	119	-	170	159	2	116	6	3	170
21	70	112	-	182	154	14	808	8	6	182
22	67	131	-	198	188	5	921	1	4	198
23	-	-	-	-	-	-	-	-	-	-
24	32	74	-	106	98	3	25	3	2	106
25	**31**	**211**	**-**	**242**	**224**	**8**	**2,012**	**6**	**4**	**242**
26	-	4	-	4	4	-	-	-	-	4
27	9	58	-	67	64	-	20	-	3	67
28	7	6	-	13	11	1	1	-	1	13
29	-	3	-	3	2	1	12	-	-	3
30	86	460	1	547	486	40	1,386	8	13	547
GH	21	-	1	22	21	-	-	-	1	22
Subtotal (WRIA 22)	***555***	***1,983***	***2***	***2,518***	***2,055***	***102***	***8,524***	***60***	***59***	***2,518***
TOTAL	***1,101***	***6,365***	***8***	***7,452***	***6,668***	***208***	***16,823***	***207***	***127***	***7,452***

WATER USE

Estimates of actual water use have not previously been determined for WRIAs 22 and 23. Outside of large diversion/withdrawals for municipal or industrial use, records of water use are generally not available. In the absence of these records, estimating actual water use was a difficult task. The estimates developed for this analysis were based on population data from the 1990 census. These estimates should be viewed as preliminary and should be refined using 2000 census data in the Level 2 Assessment in conjunction with a comprehensive review of all public water system plans.

ESTIMATION OF CURRENT AND FUTURE POPULATION

The estimate of current and future water use is, in part, based on population statistics. Population data were most often summarized by political boundaries rather than watershed boundaries, making it difficult to translate the data into water use for a particular basin or subbasin. The Chehalis Basin encompasses the majority of Grays Harbor County and a portion of both Lewis and Thurston Counties. Population statistics, such as number of people per household, and population projections into the 21st century for these three counties, were the primary sources (Census Bureau: (http://venus.census.gov/)) used to develop water use estimates.

Table B-6: County Population Data and Projections

	Grays Harbor County		Lewis County		Thurston County	
Year	Population	% increase	Population	% increase	Population	% increase
1990	64,175	-	59,358	-	161,238	-
1995	67,699	5	65,498	10	189,203	17
2000	71,848	6	70,286	7	214,767	14
2005	73,905	3	76,004	8	243,550	13
2010	76,821	4	80,843	6	267,988	10
2015	81,010	5	86,249	7	295,443	10
2020	86,309	7	92,395	7	324,911	10

The population in Grays Harbor County was projected to grow at a rate of 0.6% to 1.4% per year; Lewis County was expected to grow from between 1.2% to 2% per year and; projected growth for Thurston County, which includes Olympia, was anticipated at a rate of 2% to 3.4% per year, the fastest growing of the three counties.

Three sources were reviewed for population data within each WRIA: Chehalis Basin Action Plan (1992), U.S.G.S. Water Use Study for 1990 and 1995, and the actual 1990 census data in a GIS format for Lewis County. The latter was used in estimating populations for two of the five subbasins in Chapter IV. Without GIS census data from Thurston County, the GIS data format could not be used to estimate WRIA 23 population. A GIS layer for Grays Harbor County census data was not available for WRIA 22. The Action Plan numbers were also based on the 1990 census data.

Population data summarized from the two primary sources varied considerably (Table B-7). Since the Action Plan (1992) reported 1990 population data only, the 1995 numbers were estimated based on County growth projections. The USGS estimated the 1990 population at about 55% of the Action Plan number for WRIA 22. In WRIA 23, the USGS estimated the 1990 population at about 20,000 fewer than the Action Plan. The USGS estimates were lower overall than the Action Plan estimates.

Table B-7: Population Data for each WRIA

Source	WRIA 22		WRIA 23	
	1990	1995	1990	1995
Chehalis River Basin Action Plan (1992)	57,600	60,480[1]	77,000	84,700[2]
USGS	37,080	36,110	58,1200	83,330

[1]Projected population based on Grays Harbor County statistics.
[2]Projected population based on Lewis County statistics

The USGS numbers appeared to be low since the public water systems in WRIA 22 reported serving a population of 49,343 in 2000. Applying the increase in growth for Grays Harbor County to the 1995 USGS population figures, the 2000 population would be 37,915, nearly 12,000 people fewer than the number served by the public water systems in that WRIA. Therefore, the Action Plan (1992) numbers were used as a better representation of the actual population.

Current and future populations were estimated using the average rate of growth for the County populations, i.e. Grays Harbor County statistics were used to estimate future population for WRIA 22, and Lewis and Thurston County statistics were used to estimate future population for WRIA 23. About one-third of WRIA 23 is situated in Thurston County, therefore, a weighted growth rate for the two counties was developed using this ratio. Using these estimated WRIA populations, water use for the residential sector was estimated to the year 2020 (Table B-8).

Table B-8: Future Population Projections by WRIA

WRIA	2000	2005	2010	2020
22	64,109	66,032	68,673	76,914
23	94,000	103,400	110,640	122,810

[1]Projected population based on Grays Harbor County statistics.
[2]Projected population based on Lewis County statistics

CURRENT RESIDENTIAL WATER USE

Method

Without actual records, an estimate of residential water use can be determined by using design standards for the development of public water systems (WDOH,1999). The Water System Design Manual (WDOH, 1999) bases its determination of water demand on average annual rainfall by the following equation:

$$\mathbf{ADD = (8{,}000/AAR) + 200}$$

where ADD = average day demand per equivalent residential unit (ERU);
AAR = average annual rainfall.

An ERU was defined as a residential unit equivalent to a single-family residence. The average number of people per household must also be determined to convert the ADD to an average daily demand per person (gallons per capita per day = gcd).

The monthly distribution of water for residential water use is constant for in-house use, but increases primarily in the months of July, August, and September when precipitation is the lowest and crop water requirements for lawns and gardens are highest. Outside lawn and garden watering can increase summertime demand by more than 50% (WDOH, 1998). In the Water System Design Manual (1999), the recommended maximum day demand for designing water systems is:

MDD = 2 X ADD

where MDD = maximum day demand.

The majority of the population in the Chehalis Basin is concentrated in two areas (Aberdeen/Hoquiam and near Centralia/Chehalis) and along the low-lying river valleys of the basin. The location of Elma was used to represent the mid-basin area. While the average annual precipitation is significantly higher in the upper part of the watershed, relatively few people live in these areas. Therefore, the precipitation values used for determining residential water use were based on the three areas defined above. As shown in Table B-9, the average day demand for one single-family residence ranged from 296 in Aberdeen to 374 in Centralia.

Table B-9: Average Annual Precipitation near Population Centers

	Average Annual Precipitation (inches)	Average Day Demand gallons per day/ERU[1] (ADD)	Per Capita Daily Demand (gcd)
Aberdeen	83	296	118
Elma	67	319	128
Centralia	46	374	144

[1]ERU = equivalent residential unit ~ 1 single-family residence

From the 1990 census data, there were approximately 2.5 people/household in Grays Harbor County and 2.6 people per household in Lewis and Thurston Counties. Using these data, the average daily per capita water demand was computed and ranged from 118 gcd (gallons per capita per day) to 144 gcd. The maximum day demand (double the average day demand) ranged from 236 gcd to 288 gcd. The latter values represent water use during periods of extensive outside lawn and garden watering in the dry season.

A significant portion of irrigation water is lost to evapotranspiration while the remaining water either becomes subsurface flow or overland flow; the amount returned can be as much as 60% of the withdrawal. In-house residential water use consumes about 20% to 30% of the water delivered, the remainder (70% to 80%) returns to surface or ground water depending on treatment of discharge. Wastewater treatment at a centrally located plant will discharge water back to the river at a designated point. Septic systems will delay the return flow as the

wastewater is filtered through the leach field following subsurface pathways, a portion of which may return to a surface water body and a portion of which may return to ground water.

Keeping these concepts in mind, residential water withdrawals have associated return flows that must be accounted for in a water balance. The reach of the river that experiences the total impact of the withdrawal is between the point of diversion and the point of return. Therefore, downstream of the point of wastewater discharge, the impact is less than the total diversion.

Results

The ADD and MDD were applied to the current estimated populations in both WRIAs to understand the total current water use for the residential sector (Table B-10).

Table B-10: Estimated Current Residential Water Demand

WRIA	Average Per Capita Water Demand (gcd)	Year 2000 Average Day Water Demand (cfs)	Year 2000 Maximum Day Water Demand (cfs)
22	123	12	24
23	144	21	42
TOTAL		33	66

In WRIA 22, the total allocated water for domestic or municipal use was 820.56 cfs. The municipal portion of this amount (206.2 cfs) may include commercial and light industrial uses as well. In any event, the allocation amount was significantly larger than the total population demand of 12 cfs for the average day demand, and 24 cfs for the maximum day demand. The very large multiple domestic right (570 cfs), allocated to Lake Arrowhead Club, was an outlier for the typical allocation associated with this primary purpose.

In WRIA 23, 45.88 cfs has been allocated for single- and multiple- domestic use while the municipal water rights totaled 60.92 cfs; the total of these rights was 106.8 cfs. Again, this allocation was more than double the year 2000 residential water demand.

While municipal rights are often not used to their full entitlement reserving for future growth, investigation into the multiple domestic rights would be a worthwhile endeavor to understand what portion of the rights are actually being used. The single domestic rights were sufficiently small to place those at a lower priority for investigation. Multiple domestic rights are those associated with more than one dwelling, i.e. motels, trailer courts, campgrounds, parks, schools, port districts, public utility districts, diking and drainage districts, water districts, reclamation districts, and counties, none of which are under municipal control.

Public Water Systems

Another avenue for arriving at residential water use was to investigate public water system records. A list of public water systems was obtained in 1999 from the Washington State Department of Health for the entire Chehalis Basin. This database included the number of residential and non-residential connections, the population served, and the locations (to the

nearest quarter-quarter section) of the public water systems' sources of supply. Since service area boundaries were not available for the public water systems at this time, the point of withdrawal was used as the identifier for assigning the water system to the appropriate subbasin. The locations of the systems can be refined, if necessary, in a Level 2 assessment, by using service area boundaries rather than the source water location.

Information for all the water systems in WRIAs 22 and 23 is summarized by subbasin in Table B-11. There were 586 public water systems on the WDOH list (1999), 481 in WRIA 23, and 106 in WRIA 22. By point of diversion, 72 systems were located outside of the WRIA boundary; 55 from WRIA 23 and 17 from WRIA 22. Further review of service boundaries would have to be conducted to understand whether or not these water systems are actually outside of the basin and not just their point of diversion. If these water systems are within the boundary of either WRIA, their water use would be considered an importation and the associated return flow would be augmenting the Chehalis River system.

Of the total public water systems in WRIA 23, more than two-thirds were small systems; 335 (70%) were Group B systems and the remaining 146 were Group A systems. Group A systems represent the larger facilities that serve 15 or more connections or 25 or more people/day for 60 or more days/year. Group B systems serve 1) less than 15 connections and less than 25 people for 60 or more days/year or 2) any number of people for less than 60 days per year or 3) less than 15 connections in use less than 60 days per year. In WRIA 22, there were nearly an equal number of small and large water systems: 72 in Group A and 63 in Group B water systems. A summary of the WDOH data indicate the total resident population in 1999 served by a public water system was 39,390 in WRIA 23 and 49,343 in WRIA 22; total resident connections were 15,312 and 16,862, respectively. The resident population divided by the resident connections results in the number of people per household for each WRIA; 2.6 and 2.9 people per household in WRIA 23 and 22, respectively. The former agrees with the Lewis County average of 2.6 people/dwelling unit, as found in the U.S. Census Bureau database. The Grays Harbor County average is higher than the 2.5 people/dwelling unit estimated by the U.S. Census Bureau. The public water system data reflects a higher household density in the more urban centers, while the county data represents the rural areas as well.

Table B-11. Public Water System Summary for WRIA 22 and 23. *(Highlighted rows indicate subbasins which were selected for more detailed analysis in Section 3.)*

WRIA 22 Public Water System Summary

Subbasin #	# PWS	Group A	Group B	Resident Population	Resident Connections	Total Connections	Largest Supplier
14	20	12	8	2,083	923	972	City of McCleary
15	6	1	5	25	12	18	Bingham Creek Hatchery
16	4	2	2	11	5	8	Chappell Cole Water Supply
17	-	-	-	-	-	-	NA
18	7	3	4	18	10	52	Schafer State Park
19	15	7	8	3,314	1,322	1,335	City of Elma
20	7	4	3	4,426	1,495	1,911	City of Montesano
21	3	2	1	18,035	4,990	4,991	City of Aberdeen
22	4	1	3	9,042	3,522	3,522	City of Hoquiam
23	-	-	-	-	-	-	NA
24	1	-	1	2	1	2	R& L Grocery
25	10	4	6	80	34	55	Riverview Recreation Area
26	-	-	-	-	-	-	NA
27	4	3	1	49	20	24	Wildwood Mobile Home Park
28	-	-	-	-	-	-	NA
29	-	-	-	-	-	-	NA
30	10	6	4	4,578	1,308	1,331	Grays Harbor Co Water Dist 2
GH	15	8	7	7,680	3,220	5,824	City of Westport
Unknown	12	6	6				
Out of Basin	17	13	4				

TOTAL	**106**	**72**	**63**	**49,343**	**16,862**	**20,045**

WRIA 23 Public Water System Summary

Subbasin #	# PWS	Group A	Group B	Resident Population	Resident Connections	Total Connections	Largest Supplier
1	2	1	1	600	360	377	Town of Pe Ell
2	-	-	-	-	-	-	NA
3	1	1	-	4	2	3	Camp Grace
4	35	9	26	3,716	1,312	1,326	Boisfort Valley Water Corp.
5	2	-	2	15	8	9	2533 Water System
6	2	2	-	21,100	8,165	8,165	City of Centralia
7	43	14	29	1,144	467	558	Lewis Co Water Dist #2
8	5	2	3	328	104	106	K & L Water System
9	18	8	10	942	376	388	Bucoda Water Dept
10	49	18	31	557	240	331	View Ranch Estates Water Assoc.
11	106	36	70	5,106	1,980	2,199	Scott Lake
12	3	1	2	400	160	210	Cedar Creek Corrections Center
13	137	34	103	5,358	2,085	2,253	City of Tenino
UNKNOWN	23	1	22	120	53	70	Swope MH Park, Summerwood M Manor
Out of Basin	55	19	36				

TOTAL	481	146	335	39,390	15,312	15,995

Residential water use can be estimated for the public water system supplied customers using the same techniques applied for the entire population (Table B-12). Again, the average and maximum per capita demand of Aberdeen and Elma were averaged and used for WRIA 22 and the per capita demand for Centralia was used for WRIA 23. Interestingly enough, the total demand was about the same in both WRIAs as the decrease in per capita demand in WRIA 22, due to higher precipitation levels, offset its higher population.

Table B-12: Estimated Current Public Water System Supplied Residential Water Demand

WRIA	Average Per Capita Water Demand (gcd)	Year 2000 Average Day Water Demand (cfs)	Year 2000 Maximum Day Water Demand (cfs)
22	123	9	18
23	144	9	18
TOTAL		18	36

Service area boundaries for public water systems were identified as a data gap in this analysis. In addition, some of the actual withdrawals or diversions conveyed to public water systems may be on record with WDOH.

Self-Supplied Water Users

The number of self-supplied water users can be estimated as the difference between the total WRIA population and the population served by a public water system. For WRIA 22 there were an estimated 14,766 self-supplied water users, while WRIA 23 had roughly 54,610. Self-supplied water users either withdraw/divert water under a water right or use water from a well with exempt status under RCW 90.44.050.

According to the water rights tabulation, 616.60 cfs has been allocated in WRIA 22 to domestic use for either single or multiple housing; 1.92 cfs has been allocated to 114 single-family households (~285 people). In WRIA 23, 45.88 cfs has been allocated to domestic use; about 7% or 3.19 cfs was appropriated for 137 single-family homes (~356 people).

The primary beneficial use listed in the water rights database for many of the public water systems was multiple domestic. Therefore, identification of the water rights for each water system would have to be undertaken to understand the relationship between multiple domestic rights and the self-supplied population, which would also lead to understanding the number of the self-supplied water users withdrawing water from an exempt well. Two methods for estimating exempt well use are described and evaluated in the Exempt Well section of this Appendix.

Self-supplied water use can be estimated using the same techniques applied for the entire residential population (see above). Again, the average and maximum per capita demand of Aberdeen and Elma were averaged and used for WRIA 22 and the per capita demand for

Centralia was used for WRIA 23. The self-supplied average day demand in WRIA 23 was about four times that of the demand in WRIA 22 (Table B-13).

Table B-13: Estimated Current Self-Supplied Water Demand

WRIA	Average Per Capita Water Demand (gcd)	Year 2000 Average Day Water Demand (cfs)	Year 2000 Maximum Day Water Demand (cfs)
22	123	3	6
23	144	12	24
TOTAL		15	30

Future Residential Water Use

Future residential water use was estimated using the population projections that were based on average growth rates (see above) and the same per capita demand as that calculated for current water use. The demand was converted to cfs for easy comparison with streamflows. The increased demand in WRIA 22 was roughly 3 cfs (Table B-14) over the next 20 years, while WRIA 23 anticipated future demand was calculated to increase by over 6 cfs.

Table B-14: Estimated Future Residential Water Demand

WRIA	Average Per Capita Water Demand (gcd)	Average Day Water Demand (cfs)			
		2000	2005	2010	2020
22	123	12	12.5	13	15
23	144	21	23	25	27
TOTAL		33	33.5	38	42

COMMERCIAL AND INDUSTRIAL WATER USE

Commercial and industrial water use can be supplied to an entity through a public water system or self-supplied through an individual well. An estimate of the number of commercial and industrial connections (or non-residential) served through public water systems can be computed by subtracting the residential connections from the total connections. For WRIA 22, the non-residential connections totaled 3,183; for WRIA 23, the number of commercial and industrial connections was 683.

The water rights allocated for commercial/industrial use total 86.66 cfs in WRIA 22 and 9.18 cfs in WRIA 23, for a total of 95.84 cfs. The six largest of these rights account for 86% of the total commercial/industrial allocation. Grays Harbor Pulp & Paper has three water rights for 35 cfs, 15 cfs, and 5 cfs; the Weyerhauser Company has the right to the third largest for 12.2 cfs. The

Port of Grays Harbor has a right to 3.5 cfs, and an unknown industry (Quiggs Brothers McDonald) has the right to 4.4 cfs.

Beyond this information, it is difficult to estimate current or future commercial/industrial water use without knowing the exact enterprises. Investigation of the six largest water rights to determine the associated actual use should be undertaken in a Level 2 Assessment, to understand the proportion between commercial allocations and actual use.

Irrigation

In the past, the Census of Agriculture summarizes agricultural data by county every five years including some statistics on irrigated land. The USGS reported water use information by WRIA and by county once every five years, as well. However, after 1995 these data will no longer be summarized by WRIA. Little or no information is available that details the spatial distribution of irrigated agriculture in either WRIA.

The Census of Agriculture reported that there were 5,765 irrigated acres of land in Lewis County in 1997 from which 4,842 acres were harvested for cash crops (USDA, 1999). Staff from the Natural Resource Conservation Service in Chehalis indicated that roughly half of Lewis County's irrigated lands are in the Chehalis Basin, an estimated 2,880 acres. The USGS reports irrigated land in WRIA 23 at 12,444 acres. Regardless of the data used, actual use appears to be much less than the allocation since the irrigation water rights covered 33,947 acres of land for an annual volume of irrigation water of 55,908 acre-feet (1.65 acre-feet/acre).

Grays Harbor County's data were relied on for understanding irrigated area in WRIA 22. The County reported 3,067 acres of irrigated land, 2,480 acres of irrigated croplands in the *1997 Census of Agriculture – Washington, State and County Data (USDA, 1999).* The USGS reported 2,140 acres irrigated. The total water righted acreage was 11,559 with an associated annual volume of 14,827 acre-feet (1.42 acre feet/acre). As in WRIA 23, the estimates of actual irrigated area were substantially lower than the water righted acreage.

Based on conversations with NRCS in both Grays Harbor and Lewis Counties and the data reported in the 1997 Agricultural Statistics, irrigated agriculture appeared to be on the decline. Irrigated land, which includes irrigated cropland and irrigated pasture (not a cash crop), declined by nearly 30% between 1992 and 1997 in Grays Harbor County, while irrigated cropland declined by over 40% during that same time period. Irrigated land in Lewis County decreased by about 25% and irrigated croplands declined by slightly more than 22% during that same period.

While the acres irrigated may be less than the water rights, it still represents a significant use of water. Irrigated agriculture is the highest consumptive use in the Chehalis Basin with perhaps one exception; the thermoelectric steam plant in Centralia. Because of the significance of this impact on the watershed, exploration of the relative volumes of monthly consumptive use was undertaken.

From discussions with NRCS and Conservation District staff in both Grays Harbor County and Lewis County, pasture grass has become the predominant crop currently irrigated. Pasture grass

is being used to supply feed to the beef and dairy industry in both counties. Field corn is also being grown and irrigated for the same use, but to a lesser extent than pasture grass. Cannery corn and peas were grown over large areas previously, but these two crops have declined significantly in recent years. In Lewis County, the local cannery will no longer be processing corn and peas after this year; farmers are expected to convert to some other cash crop. The Grays Harbor Conservation District reported about 2,500 acres of peas and corn being grown. About 50% to 60% of these acres were planted in cannery corn, an irrigated crop. Some silage corn was also irrigated although the size of area planted was unknown. Peas were typically not irrigated since they were planted early in the spring and harvested before the weather became too dry.

According to the 1997 Census of Agriculture, there were minor amounts of corn, wheat, and potatoes grown in Lewis and Grays Harbor Counties. About 60% to 70% of the irrigated croplands were planted in alfalfa hay, with some lesser acreages in vegetables and orchards.

Crop consumptive use, the amount of water a crop directly needs, can be calculated using several different empirical methods. Irrigation requirements for Washington (James et. al, 1989) advocate the use of a modified Blaney-Criddle method, a temperature-based method. Doorenbos and Pruitt's (James et. al., 1989) adaptation of the Blaney-Criddle method is based on data from a wide-range of climates and crop coefficients for a wide range of crops, both of which are useful in Washington. A detailed description of this method is beyond the scope of this document, however, for purposes of understanding irrigation water use, certain data that were developed from the Doorenbos and Pruitt Blaney-Criddle method were selected to demonstrate the monthly variability of crop water requirements.

Pasture and field corn were used to assess crop irrigation requirements since one is relatively high in consumptive use and the other relatively low, representing the major crops grown in the area. Some vegetables have lower consumptive use, however, since the extent of their production was unknown, they were not used in this analysis. Table B-16 summarizes the mean monthly temperature and precipitation, effective precipitation, crop consumptive use, and crop irrigation requirements for pasture/turf and field corn, and the crop irrigation requirements, assuming an efficiency of 50%. Figures B-3 and B-4 indicate the seasonal variation of precipitation, temperature, and crop consumptive use of both crops for Centralia and Aberdeen. Climate data for Centralia was used for WRIA 23, and Elma and Aberdeen climate data were used for subbasin analyses in WRIA 22.

Efficiency can be defined as that portion of the delivered water that is actually used by the crop. In other words, an efficiency of 50% means that twice the water must be withdrawn as that which is actually used by the crop. This takes into account on-farm losses, ditch conveyance losses, and deep percolation to ground water. Table B-15 displays some typical on-farm efficiencies. NRCS staff recommended using an efficiency of 40% to 50% since farms in the Chehalis Basin do not have the technology and sophistication of large farms in eastern Washington.

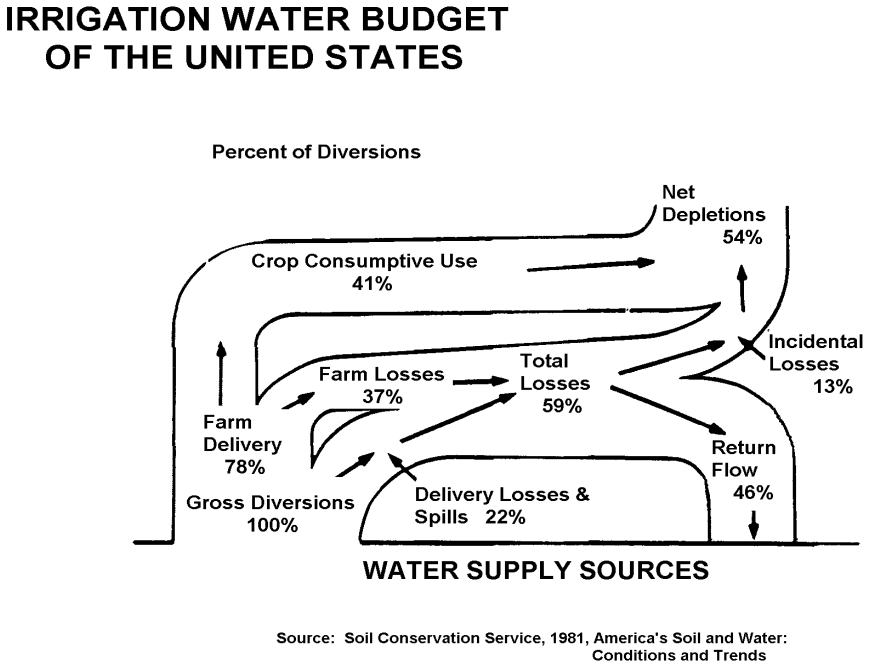
Table B-15: Typical on-farm efficiencies for various types of irrigation systems.

System	Efficiency
Surface:	
Average system, no treatment	50%
Partial treatment, i.e. land leveling or irrigation pipelines etc.	60%
Land leveling, delivery pipeline, and drainage system meeting design standards	70%
Tailwater recovery system with proper land leveling, delivery pipeline, and drainage system	85%
Sprinkler	60 – 75%
Trickle	85 – 90%

Source: From Irrigation Requirements for Washington – Estimates and Methodology, EB1513, Cooperative Extension, Washington State University, Pullman, Washington, 1989.

Figure B-2 illustrates the different pathways of water use after it has been withdrawn from a system. The percentages are based on irrigated agriculture nationwide. However, the diagram provides a good demonstration of the different physical mechanisms that take place from an agricultural diversion.

Figure B-2. U.S. Irrigation Water Budget



Source: Soil Conservation Service, 1981, America's Soil and Water: Conditions and Trends

As an example of irrigation demand, assuming the acres irrigated in WRIA 23 were in pasture grass, their number equaled that reported by the Census of Agriculture (5,765 acres), and the on-farm efficiency was 50%, the annual volume demand would be 16,960 acre feet. For WRIA 22, a similar number was calculated and equaled 4,150 acre-feet/year. Over a four-month irrigation season the former translated to roughly 70 cfs and the latter to about 17 cfs, not insubstantial amounts of water.

Given the order of magnitude difference in the allocated and potentially irrigated acreage in both WRIAs, investigation into the actual use of irrigation water may be a worthwhile effort. As irrigated lands decline and the fact that there appears to be substantially less irrigation than the acreage allocated under water rights suggests, it would be useful to know which water rights were actually being used and which ones were not. Because irrigation represents such a high consumptive use of water, this effort may be worth the time and cost to sort out in a Level 2 Assessment, however, without the cooperation of the farmers this endeavor may prove fruitless.

Table B-16. Climate data, Crop Consumptive Use, and Irrigation Requirements

CLIMATE DATA, CROP CONSUMPTIVE USE, AND IRRIGATION REQUIREMENTS

Centralia		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Mean Temp	°F	52.7	44.9	40.9	39.3	42.4	45.5	50.3	56	60.7	64.9	64.8	60.5	
Total Precip	in	4.23	6.8	7.51	6.6	5.26	4.76	2.92	2.06	1.88	0.8	1.16	2.07	46.05
Effective Precip	in	1.58	0.35	0	0.11	0.61	1.32	1.9	1.47	1.36	0.64	0.85	1.45	11.64
Pasture/Turf														
Crop Irrigation Requirement	in	0	0	0	0	0	0	0.86	2.51	3.31	5.17	3.65	2.15	17.65
Consumptive Use	in	1.53	0.33	0	0	0.35	1.27	2.76	3.98	4.66	5.8	4.49	3.6	28.77
Irrigation Efficiency = 50%		0.00	0.00	0.00	0.00	0.00	0.00	1.72	5.02	6.62	10.34	7.30	4.30	35.30
Field Corn														
Crop Irrigation Requirement	in	0.00	0	0	0	0	0	0	0	1.07	4.44	4.36	2.49	12.36
Consumptive Use	in	1.13	0	0	0	0	0	0	0.13	2.46	5.07	5.2	3.94	17.93
Irrigation Efficiency = 50%		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.14	8.88	8.72	4.98	24.72

Aberdeen		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Mean Temp	°F	52.7	45.4	41.5	40	42.5	44.5	48.4	53	57.2	60.2	60.8	58.9	
Total Precip	in	7.57	11.37	13.75	12.38	9.96	9.17	5.68	3.57	2.6	1.45	1.78	3.73	83.01
Effective Precip	in	1.43	0.36	0.04	0.11	0.56	1.35	2.16	2.31	1.8	1.04	1.22	2.15	14.53
Pasture/Turf														
Crop Irrigation Requirement	in	0	0	0	0	0	0	0	0.75	1.54	2.67	1.72	0.19	6.87
Consumptive Use	in	1.39	0.34	0.04	0.1	0.53	1.3	2.08	3.06	3.33	3.71	2.95	2.35	21.18
Irrigation Efficiency = 50%	in	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50	3.08	5.34	3.44	0.38	13.74
Field Corn														
Crop Irrigation Requirement	in	0	0	0	0	0	0	0	0	0	1.52	2.02	0.56	4.1
Consumptive Use	in	1.2	0	0	0	0	0	0	0	1.11	2.54	3.26	2.72	10.83
Irrigation Efficiency = 50%	in	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.04	4.04	1.12	8.20

Elma		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Mean Temp	°F	52.5	44.7	40.6	39	42.5	44.6	49	54.8	59.6	63.2	63.8	59.9	
Total Precip	in	6.18	9.79	10.62	10.18	8.15	7.37	4.63	2.67	2.04	1.12	1.48	2.99	67.22
Effective Precip	in	1.42	0.33	0.01	0.07	0.55	1.36	2.18	1.82	1.43	0.8	1.03	1.89	11.13
Pasture/Turf														
Crop Irrigation Requirement	in	0	0	0	0	0	0	0	1.41	2.12	3.18	2.14	0.52	9.37
Consumptive Use	in	1.37	0.31	0.01	0.00	0.32	1.31	2.13	3.23	3.54	3.99	3.17	2.41	21.79
Irrigation Efficiency = 50%	in	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.82	4.24	6.36	4.28	1.04	18.74
Field Corn														
Crop Irrigation Requirement	in	0	0	0	0	0	0	0	0	0	1.92	2.46	0.9	5.28
Consumptive Use	in	1.18	0	0	0	0	0	0	0	1.18	2.73	3.51	2.79	11.39
Irrigation Efficiency = 50%	in	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.84	4.92	1.80	10.56

Figure B-3. Comparison of Precipitation and Crop Consumptive Use
Aberdeen, Washington (Latitude 46.97°)
Source: WSU Cooperative Extension. Education Bulletin #1513.

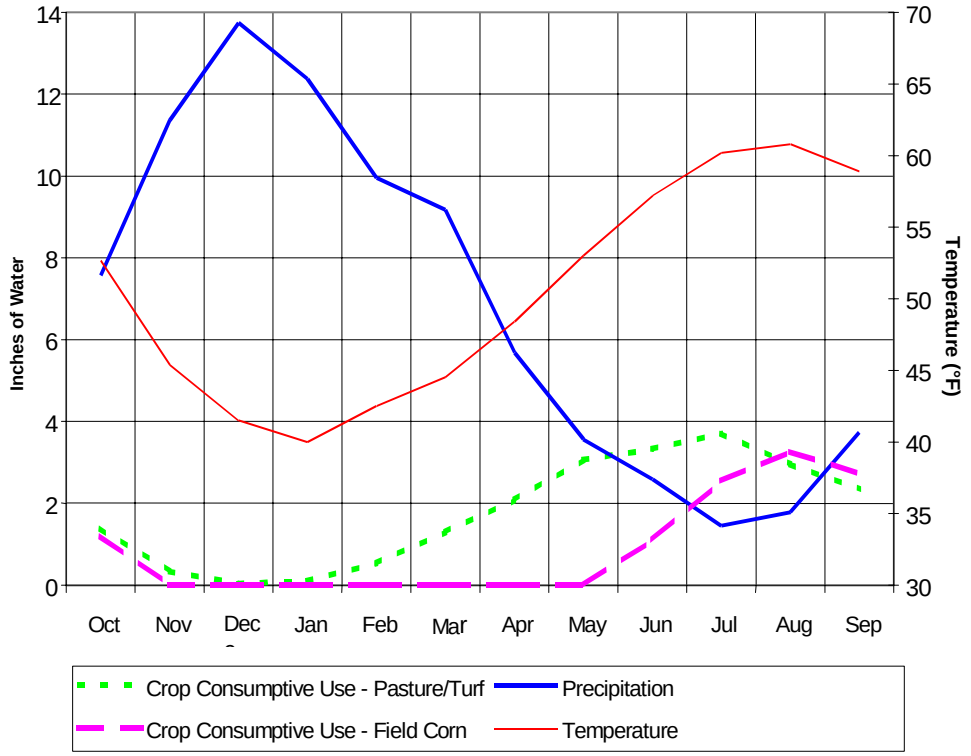
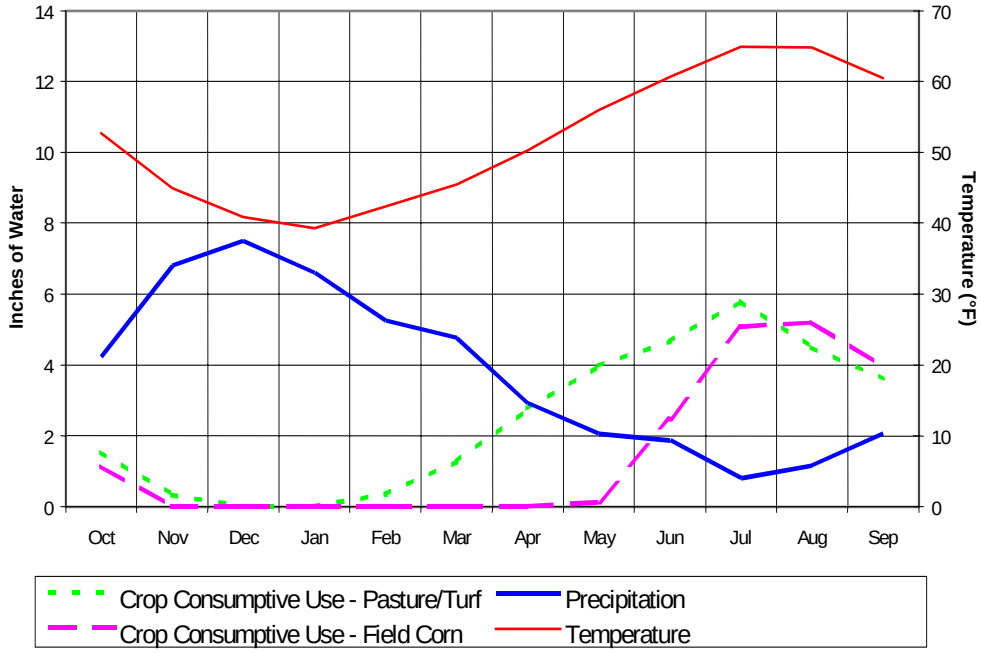


Figure B-4. Comparison of Precipitation and Crop Consumptive Use.
Centralia, Washington (Latitude 46.72°)
Source: WSU Cooperative Extension. Education Bulletin #1513.



Stock Watering and Washdown

The water used by livestock is relatively small compared to other uses, although, given large numbers of animals, the cumulative use may have an impact. An inventory of farm animals was not available except at the county level. The Census of Agriculture (1997) was used to understand the relative magnitude of water use by livestock and farm operations. The county data were summarized (Tables B-17 and B-18) and the relative magnitude of the water use within each WRIA can be understood from reviewing these data. Horses were not included in these figures since they are not considered a farm commodity and estimates of the numbers in each WRIA were not available from another source.

Table B-17: Stock Water Use

	Water Use[1] (gpd/animal unit)	Grays Harbor County		Lewis County	
		# animals	cfs	# animals	cfs
Cattle	12	9,882	0.18	25,904	0.48
Dairy Cows	20	3,889	0.12	8,360	0.26
Hogs/Pigs	4	186	<0.01	518	<0.01
Sheep/Lambs	2	387	<0.01	1,106	<0.01
Chickens	5-10/100	1,146	<0.01	11,358,040	1.32

[1]Source: WDOH, 1999.

Table B-18: Livestock Facilities' Water Use

	Water Use[1] (gpd)	Grays Harbor County		Lewis County	
		# farms	cfs	# farms	cfs
Dairy Sanitation	500	24	0.02	75	0.06
Sanitary Hog Wollow	20	12	<0.01	57	<0.01

[1]Source: WDOH, 1999.

Based on the county data and the computations in Table B-17 and B-18, in WRIA 22, probably less than 0.5 cfs is used for livestock operations, while in WRIA 23 the use may be as much as 1 cfs. Water rights associated with stock watering totaled 12.80 cfs in WRIA 22 and 51.02 cfs in WRIA 23. In addition to stock watering, these rights were also associated with 1,256 and 4,242 irrigation acres, respectively. In any event, the water rights were significantly higher than the calculated estimates of stock water demand herein. Relative to other water uses, this sector does not warrant further investigation.

EXEMPT WELL ASSESSMENT APPROACHES

The Chehalis Basin Partnership has expressed interest in understanding the number of exempt ground water withdrawals (i.e. exempt wells) that may be present throughout both WRIAs 22 and 23. According to the law (RCW 90.44.050), certain small-scale water uses are provided an exemption from the requirement to obtain a permit/water right as follows:

"…any withdrawal of public ground waters for stock-watering purposes, or for the watering of a lawn or of a noncommercial garden not exceeding one-half acre in area, or for single or group domestic uses in an amount not exceeding five thousand gallons a day, or for an industrial purpose in an amount not exceeding five thousand gallons a day, is and shall be exempt from the provisions of this section…"

Exempt wells are most often constructed for single or multiple domestic purposes. While exempt ground water withdrawals have been assigned a rate of withdrawal, they have not been assigned an annual volume limit. Water rights issued for domestic purposes since the 1960's have been assigned a rate of diversion/withdrawal and an annual volume limit. The lack of an annual volume limit associated with exempt wells has resulted in significant residential development statewide for which reliance on the full rate of 5,000 gallons per day has occurred. For example, certain development interests have constructed exempt wells and then proceeded to build six houses, commonly known as "six packs." These six packs likely will use the full rate of 5,000 gallons per day, yet a single-family home is less likely to use that full rate. The implementation of six packs, as well as the cumulative effect of numerous exempt wells pose the potential for greater use of ground water and, therefore, greater impact on the system.

While it is difficult to arrive at an accurate number of wells, two approaches were used, one based on population data and one based on land parcel data, to provide an estimate of water use by exempt wells. The first method was used as part of the five subbasin analyses in Section 3, and the second method was applied to two sections as examples for the Chehalis Basin Partnership to review. The latter being more detailed and, therefore, more costly was beyond the scope of the Level 1 Assessment. The purpose of this section is to compare the methods for future analyses; the results from these two methods cannot be compared since the methods were not used on the same land area. The two approaches are described below.

POPULATION-BASED ESTIMATE

This method utilizes population data, public water system information, and the WRATS water rights database to determine the number of exempt wells. The current subbasin population of self-supplied water users was estimated by subtracting the population served by a public water system from the estimated subbasin population. The next step was to identify, if possible, the multiple domestic water rights associated with small public water systems; the remaining rights would cover a portion of the self-supplied water users. That portion not covered by water rights was assumed to be using water from exempt ground water withdrawals.

The water demand by exempt wells was calculated from the population estimate described above and a per capita per day design water demand calculated from the equation developed by the Department of Health (1999). Detailed steps are included in Appendix B-1: Detailed steps for assessing exempt well status and associated water use.

In three of the five subbasins in which this approach was used, the number of water rights and the number of public water systems were too numerous or too difficult to match the two at this level of analysis. Examples describing results of the method as it was applied are provided below for comparison. The information was extracted from Section 3: Selected Subbasin Assessment. The application of the method varied slightly depending on the information available.

Subbasin #1 Example

In the Chehalis River Headwaters, the year 2000 population was estimated at 1,540. The Town of Pe Ell was the only public water system that served residential connections; population served was 600. The difference between the subbasin population and the Town of Pe Ell resulted in a total of 940 self-supplied water users. According to WDOE's WRATS database, there were 20 rights designated for domestic use (three of which were multiple domestic water rights as a beneficial use although not necessarily listed as the primary use). On the average, WDOE assigns a diversion rate of 0.01 cfs and a volume limit of 1 acre foot to a single domestic right. The multiple domestic rights had a rate of 0.29 cfs. To estimate the number of households potentially served by these three multiple rights, the rate of 0.01 cfs per household was used. Roughly 29 homes were supplied under these multiple rights. For the remaining 17 single domestic rights, one water right was assumed to provide a supply to one household. Adding these to the 29 homes under the multiple domestic right resulted in 46 households, or 120 people (Lewis County estimate = 2.6 people/household), withdrawing water under a legal entitlement. The remaining 820 people were either covered under a claim or exempt well. Using the average of 79 gallons per capita per day (gcd) (same as computed for the Town of Pe Ell), an estimate of 0.1 cfs of domestic water use can be made for the combined claim and exempt well population. For comparison, using the WDOH (1999) method the per capita per day demand was estimated at 111 gallons; using this number 820 people would use an estimated 0.14 cfs for domestic supply. Applying an efficiency of 75%, the withdrawal from exempt wells required to satisfy the demand ranged from 0.13 to 0.19 cfs. An adequate efficiency ranges from 70% to 80% (Summers, 1997); 75% was used for the purposes of this study. The actual value was unknown, except for the Town of Pe Ell.

Subbasin #14 Example

In the Cloquallum River (Subbasin # 14), Chehalis River Mainstem Lower Reach 1 (Subbasin #19) and the Neuwaukum River Subbasin #7, this method could only be partially completed. The result was estimated water use for the self-supplied water users under multiple domestic water rights, claims, and exempt wells. Multiple domestic rights would need to be further researched to determine which ones were associated with public water systems. The population served by multiple domestic rights not associated with a public water system must be determined and subtracted from the total population of self supplied water users to reach an estimate of exempt wells.

Subbasin #14 is discussed here as an example of the method's shortcomings. In Subbasin #14, the estimated year 2000 population was 3,330. The public water systems in the subbasin supplied a population of 2,083; the difference of 1,247 was assumed to be self-supplied water users. There were six single domestic rights providing water for about 15 people. The difference of 1,232 self-supplied water users (total self-supplied users less those covered under single domestic rights) were estimated to use about 0.24 cfs (127 gcd calculated using WDOH(1999)). Assuming an efficiency of 75%, the estimated rate of withdrawal was approximately 0.32 cfs. A portion of this amount may be from exempt ground water withdrawals, however, at this level of analysis it was difficult to discern that portion from the self-supplied users under multiple domestic water rights and those using water under the ground water withdrawal exemption.

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There were 20 public water systems and 16 multiple domestic rights, not all of which could be matched against each other. Ten of the 16 rights were tentatively matched with a public water system. One of the remaining six rights was an application and may not be used yet. The remaining 5 domestic multiple rights could not be associated with a public water system. A Level 2 analysis, if warranted, would involve researching the water rights associated with the different public water systems if the population method were to be employed.

An estimate of actual water use for the total population (applying 127 gcd) was approximately 0.66 cfs. Assuming water losses accounted for 25% of the withdrawal, a total demand of 0.87 cfs was estimated. The combined municipal and domestic water rights total 3.52 cfs, which means the estimated actual water use was about 25% of the total allocated water for this sector.

Subbasin #25 Example

In the Humptulips River, it was possible to associate most of the small public water systems with water rights and then assume a population under the remaining domestic rights. The residential population served by the public water systems was 80, with 34 residential connections. Fifty-eight of the 80 people lived within mobile home parks, and the remaining 22 people were associated with commercial enterprises.

There was one single domestic water right for 0.02 cfs and 6 multiple domestic water rights for 20.62 cfs. The largest residential right of 20 cfs was allocated to the City of Ocean Shores and constituted an out-of-basin diversion. One multiple domestic right was held by the Olympic National Forest for 0.1 cfs and was most likely associated with the Campbell Tree Grove Campground, federally owned and listed in the WDOH public water system database with one non-residential service connection.

Of the remaining four multiple domestic rights, with a total withdrawal rate of 0.52 cfs, three were tied reasonably well to the following public water systems: Timberview Mobile Home Park (population 25, residential connections 12); Warren Dahl (population 33, residential connections 11); and Riverview Recreation Area with 15 non-residential connections. At this level of analysis, the latter is an assumption since the only information available was the location of the system withdrawal in Township 20 North Range 10 West Section 7, which coincided with an irrigation/general domestic water right in the same section. The fourth multiple domestic right,

Copalis Water Fund Inc., could not be specifically identified with a public water system since there were none that identified a point of withdrawal in the same section.

According to the Grays Harbor County Assessor's database, there were 308 single-family parcels, 1 unit of 2 to 4 households, and 3 mobile home parks. At least two of the mobile home parks appeared to be covered by water rights. The third mobile home park was not identified as a public water system, however, the water right in the name of the Copalis Water Fund Inc. may cover this use. Assuming this was the third mobile home park, the parcels that appeared to have no water rights total 310 (307 of the single-family households and one 2- to 4-unit dwelling (assumed 3 units). These 310 households appeared to be covered by claims or exempt wells. Applying the Grays Harbor average people per household of 2.5, there were 775 people using water under exempt wells or claims. Assuming 119 gcd (WDOH, 1999) for self-supplied water users and an efficiency of 75%, the total water use from exempt wells was estimated at roughly 0.19 cfs.

PARCEL-BASED METHOD

The parcel-based method involved a detailed mapping of water rights on assessors' parcel maps, using water right documents from Ecology, public water system information (WDOH), and the county assessors' databases. This method offers an additional benefit of incorporating a water rights analysis that can lead to discovering water rights tied to parcels now served by public water systems, parcels to which more than one water right is associated but not used/needed, parcels to which water right(s) and claim(s) overlay one another, etc. This more detailed approach offers not only an understanding of exempt ground water withdrawals but also an opportunity to improve the water rights database so that the allocation of rights better represents the actual water use.

This method involves plotting the points of diversion and the places of use for each certificate, permit, application, and claim on a parcel map from the county assessor's office. The public water system boundaries must also be clearly defined. The data can be input into a GIS file and easily displayed. The final map can display the parcels served by a public water system, those that have water rights attached to them, and those that have no water right. Exempt wells are most frequently located on residential parcels; i.e. the parcels that do not fall within a service area or under the place of use for a water right. Although the exact number of wells will not necessarily be available, the number of households not served by a public water system or a water right can be determined. An average number of people per household for the county can be used to translate this into population. A per capita usage estimate can then be used to approximate water use.

This method was tested on two sample sections, one in Lewis County (Township 13N Range 2W Section 14) and one in Grays Harbor County (Township 17N Range 6W Section 10). The intent was to select a section in each of the two major counties in the Chehalis Basin; sections were selected based on the diversity of potential water uses. One is a section in the Neuwaukum River subbasin near the Town of Chehalis; the second is a section south of the Chehalis River near the Town of Elma. The outcome can be reviewed in Figures IV-1 and Figures IV-2 and has been summarized as follows.

Section 14:

Known Data (assessor's data, water rights, and public water system data).

- 11 water rights (see cross-hatched areas on figure)
- 15 claims
- 1 public water system (City of Chehalis) covers ~75% of the section (proposed urban growth area, water service boundary) including 97 parcels

Data Interpretation (overlay of rights with parcels)

- 1 agricultural parcel without a water right; unknown whether it is irrigated
- No residential/industrial parcels without water rights outside of public water system boundary
- 10 claims on parcels now within public water system boundary
- 6 water rights on parcels now within public water system boundary
- No exempt wells identified
- Total domestic water use can be estimated by the following equation, assuming there is one house per parcel of residential land:

97 parcels * 354 gallons/day per residential unit (WDOH, 1999) = 0.05 cfs.

Based on using the water service boundary for the proposed urban growth area, none of the 97 parcels were supplied water from an exempt well.

Section 10:

Known Data (assessor's data, water rights, and public water system data).

- No water rights
- 11 claims
- No public water system

Data Interpretation (overlay of rights with parcels)

- 1 agricultural parcel without a water right; unknown whether it is irrigated
- 37 residential parcels with structures
- 11 claims cover 14 residential parcels, 2 utilities parcels, 3 undeveloped residential parcels
- 23 parcels must be using individual domestic wells (exempt status)
- Total domestic water use can be estimated by the following equation, assuming there is one house per parcel of residential land:

37 residences * 319 gallons per day (DOH, 1999) = 0.018 cfs

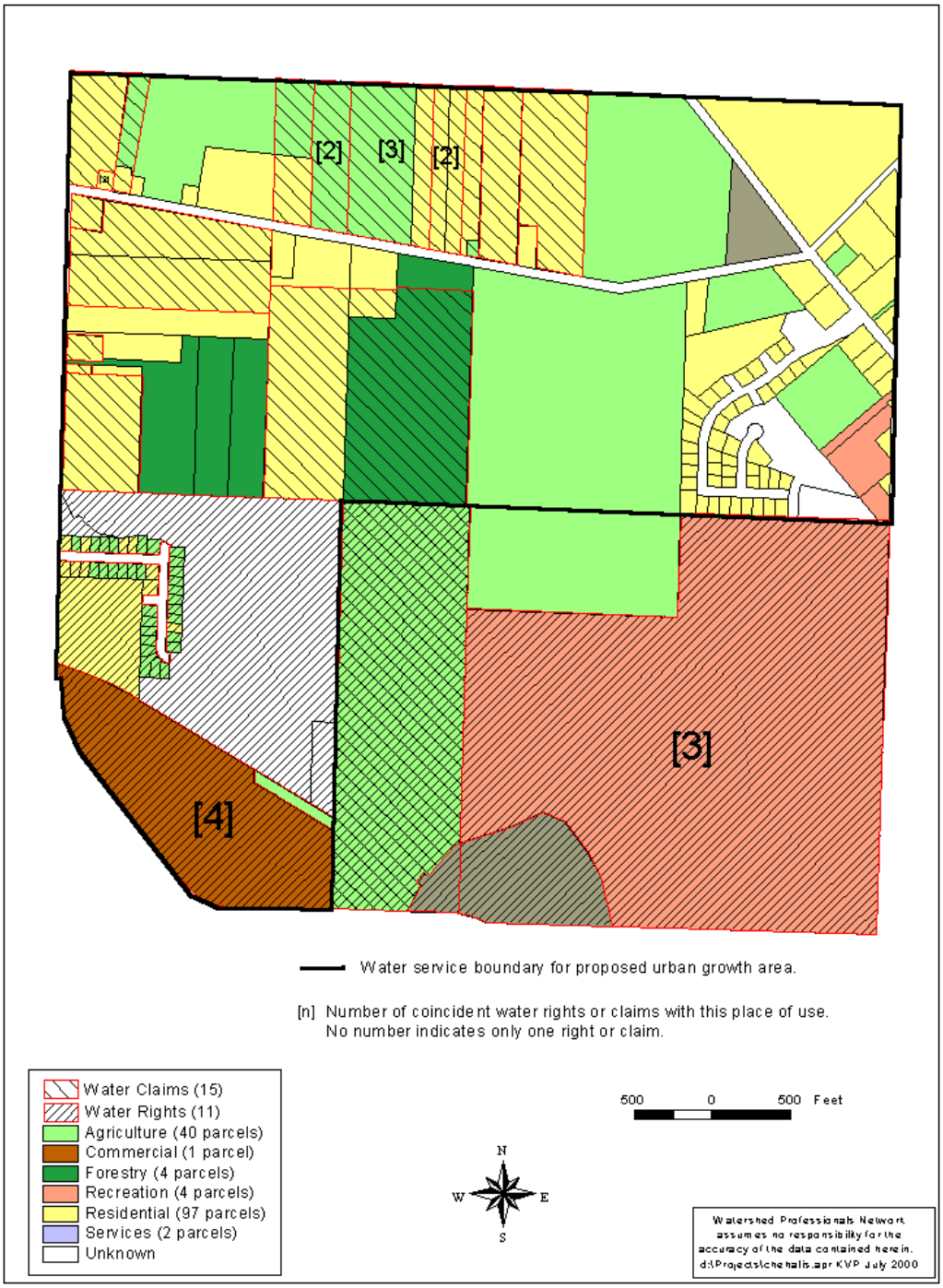

Figure IV-1. Parcel based approach for water rights and water use - Lewis County (T13N R02W S14) sample area.

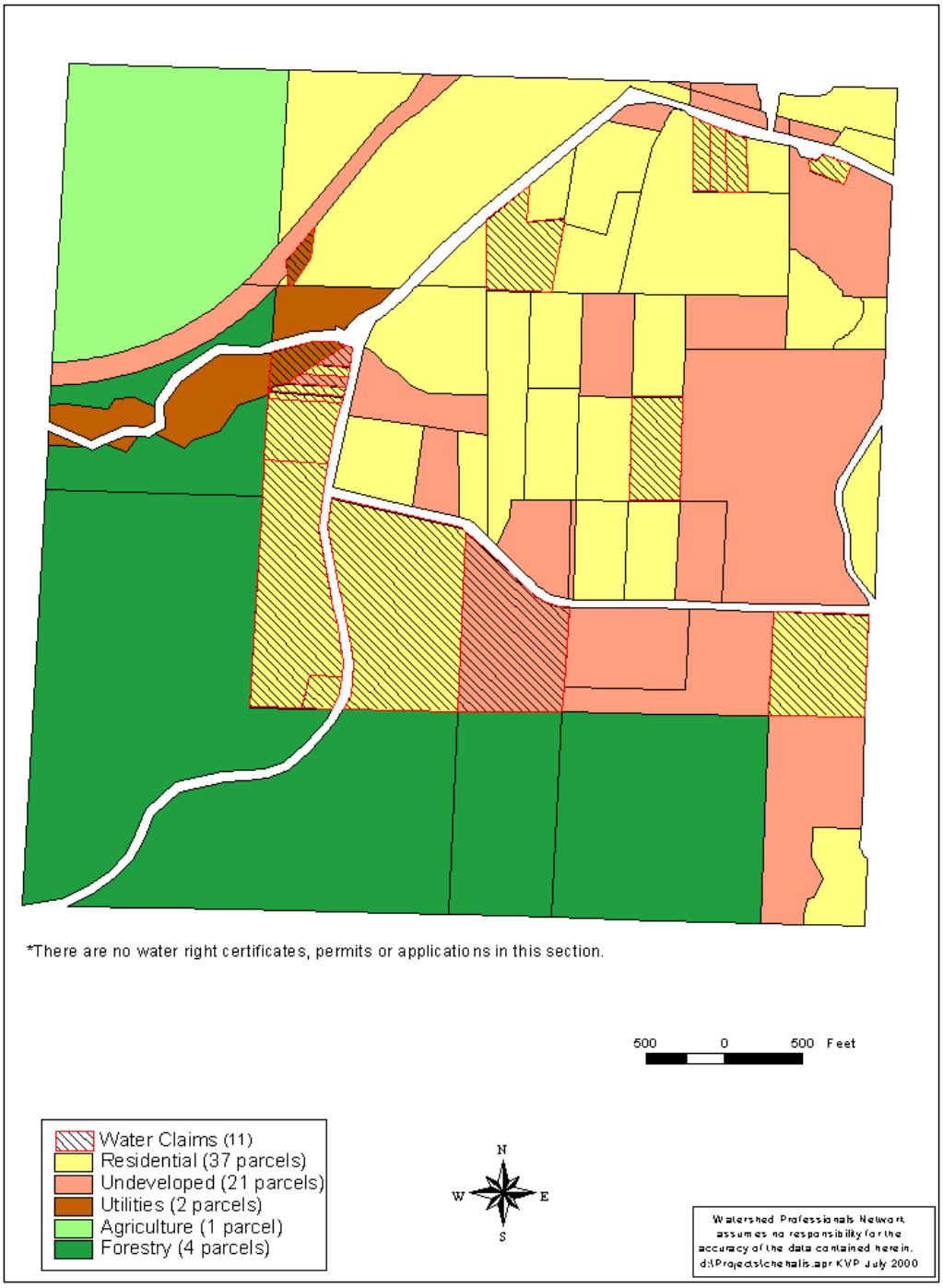

Figure IV-2: Parcel based approach for water rights and water use - Grays Harbor County (T17N R 06W S10) sample area.

CONCLUSIONS OF EXEMPT WELL ASSESSMENT APPROACHES

Population-Based Method

This method provided a rough estimate of the number of exempt wells in two of the five subbasins discussed above. In the case of Subbasins #7, #14, and #19, the number could not be derived without further inquiry into the original documents and applying the parcel-based method at least for the multiple domestic rights and public water systems. Also, the difficulty in Subbasin #14 was the lack of adequate population data. The number of self-supplied water users was the best that could be attained which included those covered by single and multiple domestic water rights. Therefore, using the number of self supplied water users would tend to overestimate the water use from exempt wells. This was the best that could be achieved in the Level 1 Assessment.

Parcel-Based Method

In Section 14, all of the residential parcels were within the public water system boundary urban growth area, leading to the understanding that there were currently no exempt wells in operation in this section. The 10 claims and 6 water rights on parcels within the service area could be retired based on the fact that these parcels now have an alternative source of supply.

Since there were no water rights in Section 10, all 37 of the residential parcels were assumed to be using exempt wells. The water use for these parcels was estimated to be 0.018 cfs (~13 acre-feet/year).

Section 14 was sufficiently close to a more urban environment, where rights that were identified may not be in actual use due to public water system expansion. In comparison, in Section 10, most of the water users were self-supplied, either under claims or exempt wells.

In addition to the identification of residential parcels, there were several agricultural parcels with claims to the use of water and several with water rights. To understand the actual use for irrigated agriculture, this parcel-based information would be useful as a starting point to determine whether these parcels were actually being irrigated. Also, the parcels that had overlapping rights, or claims, or both would need to be investigated to understand if multiple rights were necessary for the current uses of water.

The parcel-based method encompasses greater detail and would be more costly to perform, however, the water rights analysis portion of this exercise would enable Ecology to have a more accurate picture of actual versus allocated water use. The parcel-based method better defines the exempt well population by identifying the specific parcels not served by a public water system and not covered by a water right. The population-based method is useful in basins with few public water systems and few domestic rights, while the parcel-based method better defines exempt wells in more complicated basins.

RECOMMENDATIONS

- In WRIA 22, investigate the 30 largest water rights representing 90% of the allocated water to determine actual use.
- In WRIA 23, investigate the 22 rights to determine actual use. In addition, determine the status of the rights in the Skookumchuck River basin (those that potentially have not been developed) (Mahlum, 1976).
- Investigate the multiple domestic rights to understand actual use; especially the 570 cfs multiple domestic right for Lake Arrowhead Community Club.
- Obtain service area boundaries for public water systems and plot to determine subbasin location for place of use. Obtain actual use records, if available.
- Identify the water rights for each public water system to determine the multiple domestic rights that may be self-supplied.
- Investigate the six largest commercial/industrial water rights to determine the relationship between allocated and actual use for this particular sector.
- Determine the actual irrigated area in each WRIA and in each subbasin by engaging the Chehalis Basin Partnership to assist in developing communication with the farm community.
- Investigate the status of the 35,909 gpm (~80 cfs) power right for the now defunct thermonuclear plant (WPPS).
- Investigate the status of the 80 cfs right for thermoelectric power for the Centralia Steam Plant (WRIA 23) to understand the actual and consumptive use of the water withdrawn.

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