ATTACHMENT E

Evaluation of the Potential Conversion of Irrigation Water to Municipal Use in the Virgin River Basin, Washington County, Utah

Jerry D. Olds, P.E.

(December 2018)

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1.0 PURPOSE

As the service area of the Washington County Water Conservancy District (District) continues to experience one of the highest growth rates in the United States, there is a growing need to supply reliable water to meet these new demands. Many of the easier and less expensive water resource projects have been built, and other alternatives to supply the needed water are being critically examined. As agricultural lands are developed into commercial property or residential subdivisions, a potential source of water is to convert the historical irrigation water use to municipal needs. In addition, municipalities may acquire irrigation rights outside their service area and transfer them to supply their needs.

The District requested an evaluation of the potential quantity of water that might reasonably be converted from irrigation to municipal use. There are numerous factors that must be considered in evaluating this matter and this report will identify several limitations that will affect the quantity of water that is economically and physically available. It is not the intent of this report to identify and solve all problems regarding this matter, but rather, to provide information to allow water managers to make informed decisions.

The District and the State of Utah encourages and supports the conversion of agricultural water rights to municipal use. This is generally done through the market system, with a willing seller conveying ownership of the water right to the public entity who needs the water. Institutional and regulatory authorities are in place and well defined to deal with this change in water use.

2.0 QUANTIFICATION OF IRRIGATION WATER RIGHTS

2.1 WATER RIGHT PRIORITY LISTS

In 2015, the Division of Water Rights (DWRi) compiled a priority list of surface water rights in the Virgin River basin, identifying those water rights upstream from the Washington Fields Diversion.[1] This list is the basis for the water rights that were

[1] This diversion is located South 1150 feet and East 350 feet from the W¼ Corner, Section 21, T42S, R14W, SLB&M and supplies water to the St. George and Washington Canal Company.

examined and evaluated as part of this effort. The water rights were divided into various lists based on the source of supply, for example, Ash Creek and La Verkin Creek. Priority lists covering the various major tributaries were compiled and are shown in Appendix A. The DWRi priority list does not include the Santa Clara River, Upper Ash Creek above Ash Creek Reservoir, and East Fork Virgin River above the Barracks Ranch. The irrigation water rights on the East Fork Virgin River, above Barracks Ranch, were identified using the list of water rights regulated under the East Fork Virgin River Distribution System, as shown on the DWRi web page. These water rights were tabulated and are shown in Appendix A, Table A11. For the Santa Clara River and Upper Ash Creek drainages, detailed priority lists were not compiled. To evaluate the amount of irrigation water potentially available for conversion for these two areas, additional investigation was done and is discussed later in this report.

Each irrigation water right was evaluated to determine the sole supply acres for the individual water right. The allowable diversion (annual diversion) and allowable depletion (or consumptive use) were determined using the following approach. The duty in the basin ranges from 6.00 acre-feet per acre in St. George/Hurricane area to 3.00 acre-feet per acre in the upper reaches of the North Fork drainage. In the areas where the duty was in question, the water right was called up on the DWRi database and the View Map feature was used to display the point(s) of diversion and places of use. Then, in the Layers pull down menu the Irrigation Duty Values was selected. This allowed for a direct determination of the duty. The depletion was determined using various stations in the basin contained in the report entitled *Consumptive Use of Irrigated Crops in Utah*. A list of various stations for which consumptive use values are available is shown in Table 1.

The water rights were then sorted by priority date, from earliest to latest priority. The water rights on the priority lists are divided into five different groups based on priority: 1) 1889 or earlier; 2) 1890-1900; 3) 1901-1919; 4) 1920-1949; and 5) after 1950. In reviewing the individual rights, it was noted that several water rights have already been acquired by public water suppliers. This is denoted on the priority lists with the yellow highlight.

Table 1: National Weather Service sites in or near the Virgin River Basin with estimated consumptive use from calibrated SCS Blaney-Criddle equation taken from *Consumptive Use of Irrigated Crops in Utah, Research Report 145, Utah Agricultural Experiment Station, Utah State University, Project Director Robert W. Hill, October, 1994 (Research Report 145)*.

Units: Inches

Station	Elev.	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Alton	7040					4.26	7.95	4.97	5.68					22.86
Bryce Canyon	7920					2.34	7.20	5.39	4.69	0.60				20.21
Kanab	4950				3.29	6.45	6.93	6.20	5.45	3.90	1.54			33.77
La Verkin	3220			0.65	4.28	5.83	6.94	7.46	6.58	4.57	2.03			38.35
New Harmony	5290				1.66	6.33	6.43	6.26	7.09	2.98	0.20			30.95
Orderville	5460				0.05	5.82	5.66	7.87	4.16	3.19				26.76
St. George	2760			1.58	4.24	6.92	8.00	7.79	6.66	5.02	2.80			43.00
Veyo	4600				3.02	6.16	6.99	6.29	5.43	4.49	0.48			32.87
Zion NP	4050				3.63	5.46	8.74	6.56	4.72	4.46	1.65			35.23

2.2 EXISTING IRRIGATION WATER RIGHTS BY STREAM

Table 2 is a summary of the existing irrigation water rights by stream. From the priority list there is a total water right acreage of approximately 13,700 acres.[2] If a full water supply is available, the corresponding annual diversion would be about 74,700 acre-feet and the depletion 42,900 acre-feet. These figures represent the maximum amount of water that could be diverted or depleted under the water rights if a full water supply is available.

2.3 IRRIGATION WATER RIGHTS ALREADY CONVERTED

Table 3 shows a summary of the irrigation water rights which are already being used for municipal purposes, or rights that have been acquired by municipalities and are in the process of being converted from irrigation to municipal water use. The figures set forth in Table 3 are in addition to the amounts shown in Table 2. There are nearly 3,800 acres of such water right acreage with a corresponding diversion of 21,400 acre-feet and an associated depletion allowance of nearly 11,700 acre-feet. Thus, a significant portion of the irrigation water rights have been or are currently being converted over to municipal uses. There are a number of municipalities and districts that own these water

[2] This figure does not include acreage in the Santa Clara River drainage or in the Upper Ash Creek area.

rights, including Zion National Park. Several municipal water users have acquired shares of stock in some of the irrigation companies. This information is not part of the

Table 2: Summary of irrigation water rights in the Virgin River Basin. The water rights are listed on the stream which is the source of supply. The sole supply acres, allowable diversion and allowable depletion are tabulated into five priority date ranges.

	Priority Date														
Stream/ Reach	< /= 1889			1890-1900			1901-19			1920-49			After 1950		
	Acres	Div	CU	Acres	Div	CU	Acres	Div	CU	Acres	Div	CU	Acres	Div	CU
Virgin River															
Zone 1	599	3,592	2,143	5,101	30,604	18,260				548	3,288	1,962	237	1,422	839
Zone 2				1,746	10,473	5,586				699	4,197	2,238			
Zone 3	179	894	526							4	18	10	291	1,454	855
Quail & Leeds Ck	258	1,545	824				390	2,338	1,247				43	261	139
Ash Creek- Lower	121	620	433	6	33	17	42	252	134	15	91	49			
Ash Creek - Upper															
LaVerkin Creek	16	98	52	3	18	10	24	128	67						
North Creek	58	289	170										74	409	257
North Fork	300	1,438	834	441	1,322	661	64	193	97					5,400 *	
Kolob Creek	16	48	24												
Deep Creek	219	658	329	18	53	26	77	230	115						
Clear Creek	20	80	45							206	824	459			
East Fork (lower)	36	179	105				86	343	191				285	1,423	837
East Fork (upper)	1,281	5,122	2,856	161	644	359	6	23	13	34	136	76	34	136	76
Santa Clara River															
Subtotals	3,103	14,563	8,341	7,476	43,147	24,919	689	3,507	1,864	1,506	8,554	4,794	964	4,969	3,003

* The 5,400 acre-feet is storage in Navajo Lake under WR 61-64 and is used for supplemental irrigation at La Verkin Bench Canal, Hurricane Canal and St. George & Washington Field Canal. The water right does not define a sole supply acreage and thus is not included in the totals. Due to the application lapsing and being reinstated it has a priority date of 2/8/1966.

Acreage =	13,738	acres
Diversion =	74,740	acre-feet
Depletion =	42,921	acre-feet

water right records available from the DWRi and thus is not specifically addressed in Table 3. In support of the above statement, a copy of the ownership ledger for the St. George and Washington Canal Company was obtained and it shows just over 40% of the shares of stock being owned or controlled by municipalities.[3]

In analyzing Table 3 there are a couple of important findings that can be made. First, the water rights which have historically supplied the La Verkin Bench Canal are now in the name of La Verkin City. Second, a large portion of the water rights on Lower Ash Creek have already been converted to municipal use. It is believed this has occurred because of the good water quality and reliable flows in Lower Ash Creek.

[3] Official Ownership Ledger (Excel Spreadsheet) of the St. George and Washington Canal Company provided by the District.

Table 3: Summary of irrigation water rights in the Virgin River Basin that ownership is shown to be in the name of a public water supplier. Many of these water rights are already being used to supply public water systems. For the other water rights, most have change applications that have been approved to convert the water use from irrigation to municipal.

	Priority Date														
Stream/ Reach	**</= 1889**			**1890-1900**			**1901-19**			**1920-49**			**After 1950**		
	Acres	Div	CU	Acres	Div	CU	Acres	Div	CU	Acres	Div	CU	Acres	Div	CU
Virgin River															
Zone 1	28	165	88	52	312	176				163	978	583	266	1,595	952
Zone 2				603	3,626	1,931									
Zone 3				17	99	56									
Quail & Leeds Ck	*19*	114	*61*				*10*	57	*32*						
Ash Creek - Lower	*503*	3,018	*1,610*	*128*	769	*410*	*301*	1,807	*963*						
Ash Creek - Upper															
LaVerkin Creek	38	228	122				30	181	97	26	105	68	10	61	33
North Creek	19	93	54												
North Fork	560	2,630	1,486	29	116	58				20	61	29			
Kolob Creek				27	82	41				*667*	4,000	*2,270*	*242*	1,124	*481*
Deep Creek	1	4	2												
Clear Creek	7	29	16							27	106	59			
East Fork (lower)															
Santa Clara River															
Subtotals	1,175	6,281	3,439	856	5,004	2,672	341	2,045	1,092	903	5,250	3,009	518	2,780	1,466

Acreage =	3,793	acres
Diversion =	21,360	acre-feet
Depletion =	11,678	acre-feet

Estimated acreage based on the allowable diversion

Estimated consumptive use (depletion) based on allowable diversion

3.0 "PAPER WATER" VERSUS "WET WATER"

As stated earlier, the existing irrigation water rights in the basin represent a potential annual diversion of just over 74,700 acre-feet annually. This figure does not accurately reflect what might be allowed for conversion under the change application process and what may physically be available or economically feasible to convert to municipal use. The two primary reasons for the difference between the "paper water" and the actual "wet water" that can be relied upon to supply future municipal needs are: 1) the priority date of the water right; and 2) the reliability of the water source to supply adequate

water, particularly during drought conditions. These two very important issues are analyzed and discussed in the following sections.

In acquiring irrigation water rights, the priority date is very important because under Utah water law, the water right(s) with the earliest priority date receive their full supply before water rights with later priority dates are delivered water. The diversion and use of water on the Virgin River system is regulated by a water commissioner who works under the direction of the DWRi. Efforts over the past several years have resulted in increased monitoring and regulation to help ensure early priority rights are satisfied before the later priority rights are delivered water.

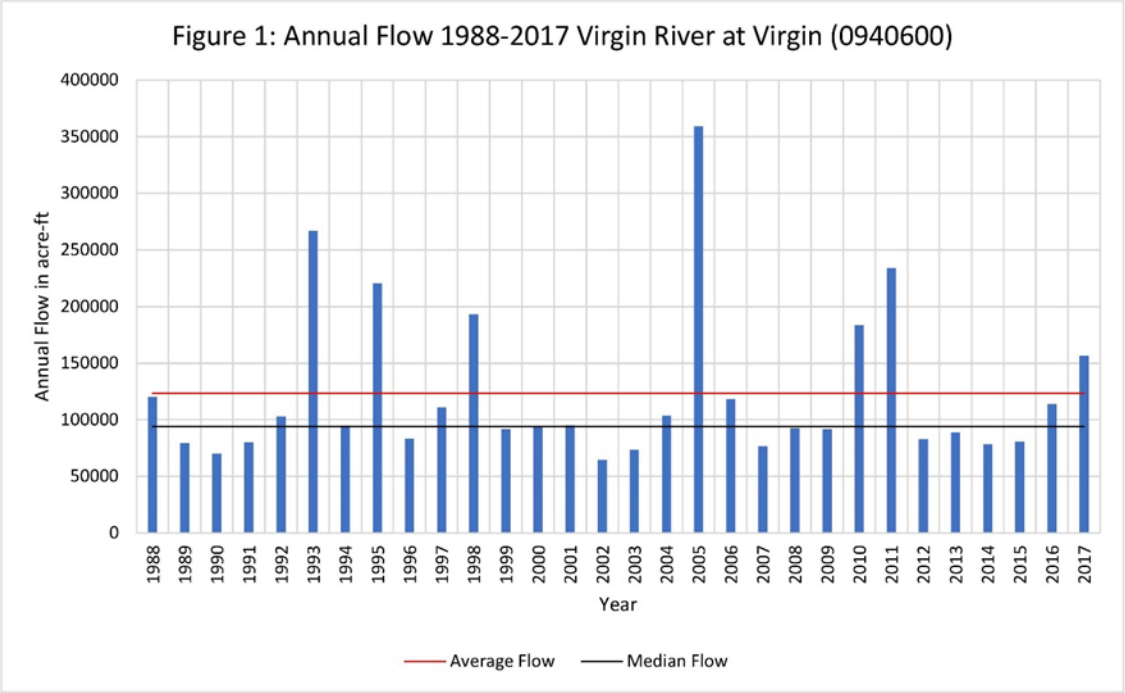
3.1 STREAMFLOW ANALYSES

The hydrology of the Virgin River Basin presents challenges to those who rely on it to provide their water supply. The flow of the surface streams in the basin varies a great deal because of the geology of the area and the climatic conditions. While there are some groundwater sources, they are not extensive and thus cannot be relied on to solve all water shortages.

For this report, the last 30 years of streamflow records, 1988-2017, were used for analyses. For this thirty-year period, the average flow for the Virgin River at Virgin USGS gauging station, number 09406000, is about 123,400 acre-feet and the median flow is about 94,000 acre-feet. This 30-year period is much drier than the long-term period of record.[4] Even though the average is 123,400 acre-feet, this same data tells us that in half the years the flow is 94,000 acre-feet or less. The large difference between the average and the median values is a result of extreme high-flow events that occur in some years during winter rain or summer monsoon thunderstorms. The lowest flow year was 2002, in which the annual flow was 64,500 acre-feet, or about half the annual average flow. See Figure 1, below. Thus, caution must be used in dealing with water supply analyses for the Virgin River and using averages which significantly overestimate the reliable water supply. There is not a complete data set of streamflow

[4] The average flow for this station over the entire period of record, 1911-2017, is 141,300 acre-feet

measurements throughout the basin to evaluate the availability of water on all the tributaries.

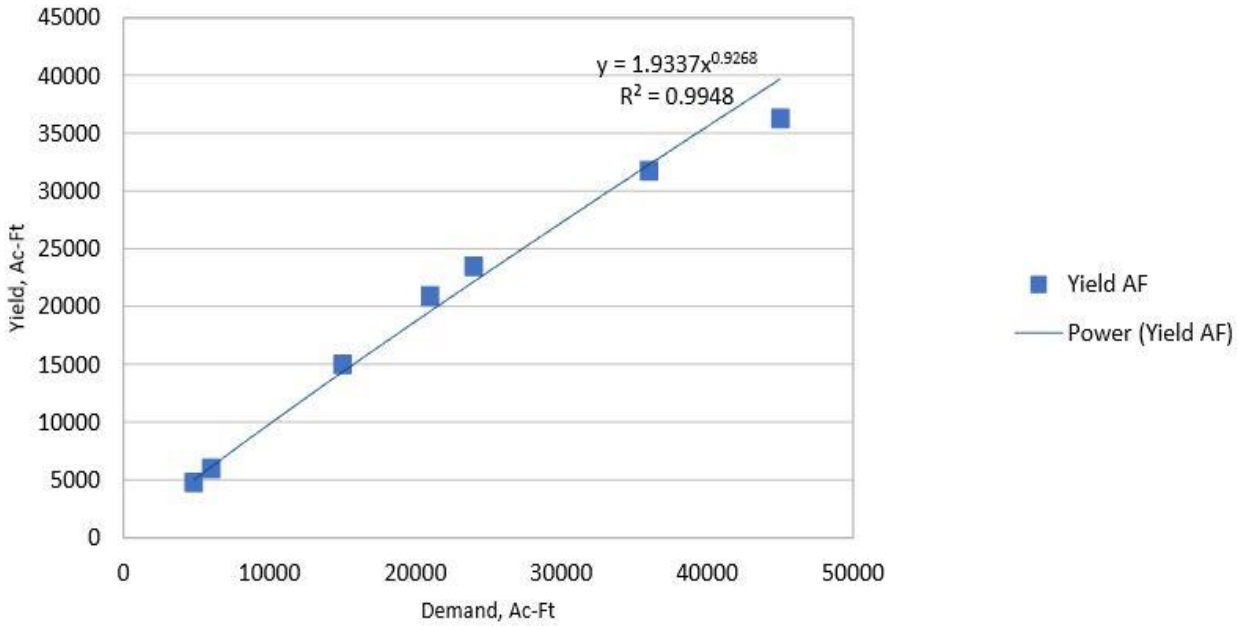


There are numerous irrigation water rights in the Virgin River Basin. To evaluate which water rights may be best, you need to closely examine the relative priority date of the water right to ensure it receives a reliable water supply. As stated above another major element of any such evaluation is to assess the amount of water and the reliability of the source to provide a firm supply of water, particularly during low flow water years.

3.2 DEMAND-YIELD ANALYSIS

Generally, the major demands and large blocks of early priority water rights on the Virgin River are located just downstream of the Virgin River at Virgin gauge. There are numerous other water rights throughout the basin that have early priority dates; it is assumed they are regulated appropriately and the flows at the Virgin River at Virgin gauge would reflect the use of the upstream water rights. Therefore, to get an estimate of what the yield is to various priority water rights, a demand-yield curve was constructed based on the streamflow data from the Virgin River at Virgin gauge and the downstream water rights. See Figure 2.

Figure 2: Virgin River at Virgin Demand - Yield Curve, 1988- 2017



The irrigation demand for various amounts of acreages was calculated using a spreadsheet to determine the monthly irrigation demand. Then a comparison of the monthly streamflow, as measured at the Virgin River at Virgin gauge, was made to see if there is adequate water to supply the irrigation demand.[5] See Appendix B for the data used in compiling the demand-yield curves. At an irrigation demand of about 20,000 acre-feet or about 3,300 acres (at 6.00 acre-feet per acre) there is a firm-water supply. However, as you increase the demand to 3,500 acres or 21,000 acre-feet, shortages begin to occur in 6 of the 30 years. At 4,000 acres (24,000 acre-feet demand) there were shortages in 19 of the 30 years.

In providing a firm water supply from the Virgin River the drought period of 1999-2004 presents significant challenges. For this period the average annual flow as measured at

[5] A monthly model was used to make these comparisons. The monthly models for the Virgin River tend to overestimate the water supply because of rain events that result in high flows for short durations. These high flow events increase the monthly flow value but only occur for a few hours or days and generally contain high sediment making the water unusable.

the Virgin River at Virgin gauge, is about 87,000 acre-feet or 70% of the 1988-2017 average and major shortages showed up in the demand-yield analysis for this period. Water managers need to assume similar conditions will exist in the future.

The 1900 priority or earlier water rights for Hurricane Canal, La Verkin Bench Canal and approximately one-third of the water supply for the St. George and Washington Canal[6] originates above the gauge. These water rights combined create a demand on the River of 3,720 acres or 22,320 acre-feet (3,720 acres x 6.00 acre-feet/acre). The demand-yield curve is showing that for this level of demand, the yield is good.

However, there are shortages and under the priority system the water rights with 1900 priority (and after) are the ones that experience shortages, particularly during drought years. See Figure 3. When examining this graph, keep in mind that up to a level of about 3,300 acres, the water supply is very good. However, added demand above this level creates shortages, and under the priority system it is the later priority water rights that experience the cuts, while the early priority water rights receive their entire supply.

Therefore, from the demand-yield analysis, it appears that water rights in the lower reaches of the Virgin River with priority dates of 1900 or earlier receive a reasonably firm water supply. The 1900 priority water rights will experience some shortages in drought years and those water rights with priority dates after 1900 will experience significant shortages, particularly during drought years such as 2002.

Generally, the tributary streams do not have long-term streamflow gauges and they are not located above the major irrigation diversions. For this reason, a demand-yield analysis cannot be done for the tributary streams, except for Leeds Creek (a tributary to Quail Creek). The USGS Leeds Creek near Leeds gauging station has flow measurements from October 1964 to present and the only significant diversion above the gauge is the spring diversion for the Leeds Domestic System.

[6] The amount of water supplied to the Washington Field Diversion from above the Quail Pipeline Diversion varies depending on the time of year and water supply conditions. It appears to range from a quarter to a third of the flow they divert. For the demand-yield analysis one-third was used.

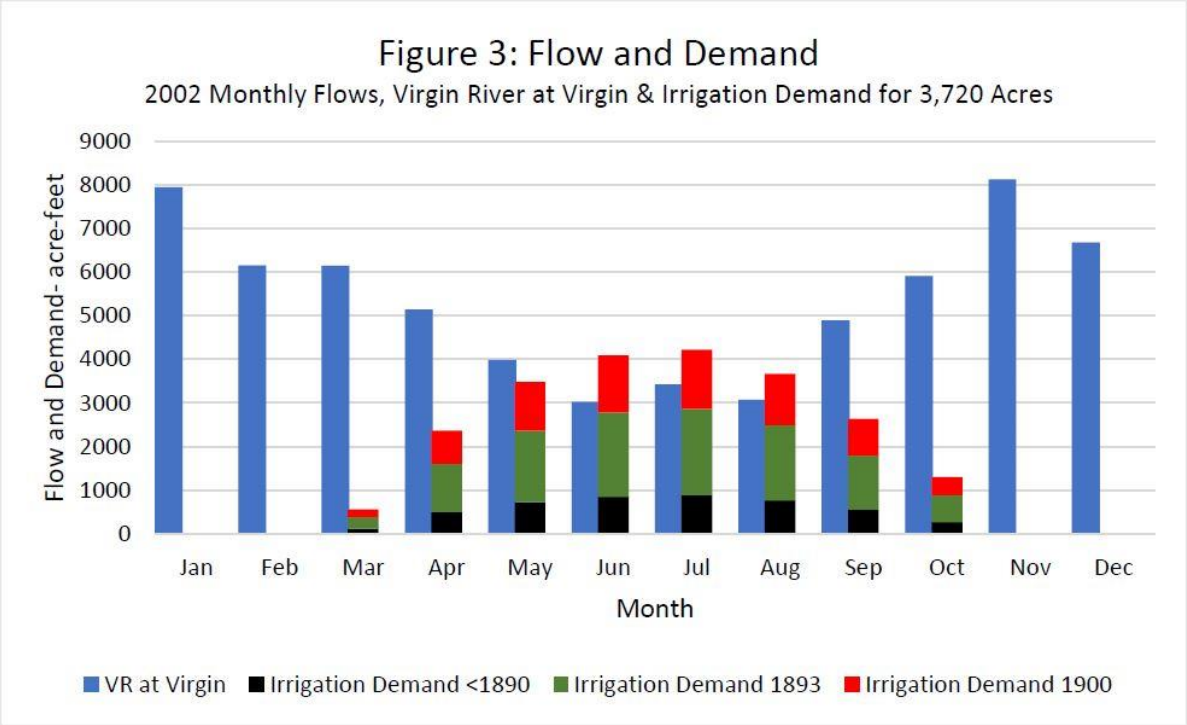


Figure 4 is the Demand-Yield Curve for Leeds Creek. There are about 248 acres of irrigation rights with an 1880 priority date that would be accounted for at the stream gauge. This represents an irrigation demand of about 1490 acre-feet. For the period, 1988-2017, Leeds Creek yields about 1340 acre-feet for this demand or an average water supply of 90%.

In 2002, the lowest flow year for this gauging station there was only about a 40% supply for the 1880 priority rights. Therefore, water rights on Leeds Creek with a priority date later than 1880 will experience even larger shortages.

The demand-yield results apply to the main stem of the Virgin River and Leeds Creek and would not necessarily be representative of the other tributary streams. It is believed the demand-yield relationship for most tributaries would have a less favorable result (less water than the main stem of the Virgin river) because of their limited watershed area. The demand-yield analysis for Leeds Creek supports this position.

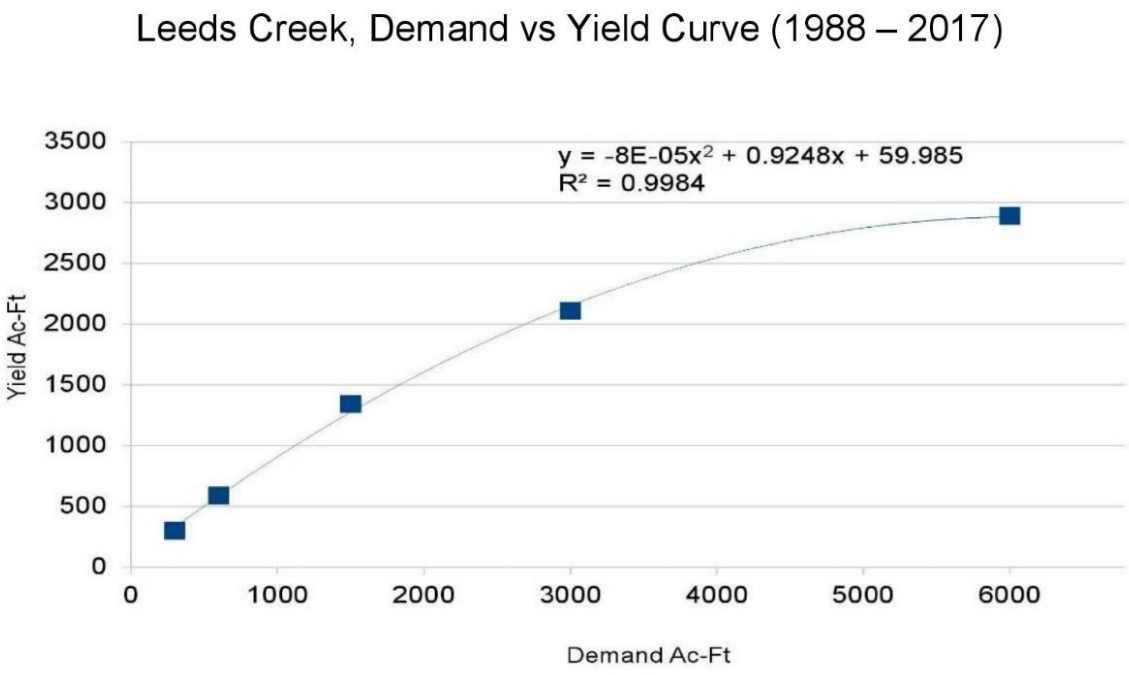


Figure 4: Demand-Yield Curve for Leeds Creek for the period 1988 to 2017

The water rights on the East Fork Virgin River largely have priority dates prior to 1900, with nearly 85% of the irrigated acreage covered by water rights having priority dates between 1865 to 1880. The return flows from these irrigated lands has historically went to satisfy downstream water rights. Thus, only the depletion would be allowed to be changed to municipal use outside the immediate drainage.

In discussions with the River Commissioner he indicated that the system generally has adequate water during April to mid-June, then in mid-June through mid to late August the flows drop to about 45 to 60% supply and after mid to late August the flows increase. In drought years he believes the water supply is more stable on the East Fork than other streams in the region. Using the River Commissioner's observations, it is calculated that about 70% of the irrigation demand, on average, are met. For the 1900 priority and earlier water rights this results in about 2,250 acre-feet (3,215 acre-feet x 0.70) being available for conversion to municipal uses.

3.3 THE 2015 DISTRIBUTION ORDER

Under a letter dated June 30, 2015, the DWRi issued a Cease Use Notice Regarding Water Rights on the Virgin River and its Tributaries with Priority Date of 1901 or Later. See Appendix C.

In the notice it states:

> The Virgin River and its tributaries are experiencing significantly diminished flows because of continued drought. Utah state law provides that appropriators shall have priority among themselves according to the dates of their respective appropriations, so that each appropriator is entitled to receive the appropriator's whole supply before any subsequent appropriator has any right (UCA 73-3-21.1(2)(a)). Water users at the Washington Fields Diversion have placed a call on upstream water rights later than their 1900 priority water rights.
>
> **With this notice the state engineer is ordering surface water users on the Virgin River and its tributaries above the Washington Fields Diversion to immediately cease diversion and use of water rights with a priority date of 1901 or later, until further notice.**

The notice was mailed to the owners of about 400 water rights in the drainage. Several water right owners have more than one water right. In 2015, the annual flow of the Virgin River at Virgin was 80,500 acre-feet; this year ranks as the eighth driest year during the 30-year period of 1988 to 2017.

The actions taken by the DWRi appear to be in agreement with the results of the demand-yield analysis set forth above.

3.4 UPPER ASH CREEK AND SANTA CLARA RIVER

Upper Ash Creek drainage is characterized by small perennial streams that experience large fluctuations in streamflow throughout the year and from year-to-year. The major streams are Kanarra Creek, Main Creek, Comanche Creek and Ash Creek. These streams have water rights to irrigate about 1,160 acres, with priority dates between 1864 to 1890. In 2011, DWRi staff evaluated the availability of water for irrigation rights

supplied from Kanarra Creek.[7] The Kanarra Field Reservoir and Irrigation Company Water Right Number 81-2501 has an 1864 priority date and is the earliest priority on Kanarra Creek. The evaluation found that this water right was fully satisfied 67.16% of the time, under average conditions. The later priority water rights were only satisfied 26.60% of the time. Conditions on the other streams mentioned above are likely similar.

Thus, water managers are cautioned, when acquiring water rights in this area to understand that even the earliest water rights are not fully satisfied. Water managers should consider entering into agreements that allow the municipality to have first call on the source to ensure they can provide the required water supply.

Currently, in Upper Ash Creek, the practice is to not use the surface water directly but rather obtain the water right (or shares) and then file a change application to move it to groundwater. This approach could be used to provide some municipal water. There are some irrigation groundwater rights in the area that supply reliable quantities of water.[8] The potential conversion of irrigation water rights to municipal use appears to be limited in this area. For this report, it is assumed that 2,000 acre-feet could be available for conversion to municipal use.

The hydrology of the Santa Clara River is very unique – at times there is too much water and other times the streamflow is very limited. The average flow of the Santa Clara River at the Gunlock USGS gauge, number 09409880, is 18,510 acre-feet annually. The median value is 10,470 acre-feet.[9] This big difference indicates that the flow fluctuates significantly from year-to-year. The highest yearly flow occurred in 1980 at 66,670 acre-feet and the lowest annual flow was 4,750 acre-feet in 1977. To develop an estimate of the amount of irrigation water that could be converted to municipal use,

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[7] See Memorandum to File, dated 1 March 2011, from Nathan Moses regarding Conversion of Surface Source to Groundwater Source, on the files for Water Right Numbers 81-2501, 2543, 2544, 231, 2652, 232, 2545 and 227.

[8] See Water Right Number 81-192, 245, 465, 1635 and 4019 near the center of the valley and near Kanarraville WRs 81-776, 791 and 5182.

[9] The Santa Clara at Gunlock gauging station operated from August 1969 to October 2013. The USGS now operates a streamflow gauge below Gunlock Reservoir named Santa Clara River below Windsor Dam near Santa Clara, Station Number 09410100.

the diversions for the major irrigation companies on the system were compiled from the Santa Clara River Commissioner's reports for the years 2010 to 2017. There is some storage on the system that can provide some water when dealing with drought, but generally the storage is not adequate for multiple years of drought. From 2010 to 2017, the two consecutive years where the diversions were the lowest were 2014 and 2015. These two years were used as a yardstick to determine how much water was reliably available to supply municipal needs.

The reported diversions for each company were divide by the irrigation duty where the lands are located to determine an "equivalent acreage". This acreage figure was multiplied by the consumptive water use value of alfalfa at the Veyo Station for those lands above Gunlock Reservoir and the consumptive water use by alfalfa at the St. George station for those lands below Gunlock Reservoir. See Appendix A, Table A12. It is assumed that depletion will be the limiting factor in converting irrigation water rights to municipal on the Santa Clara River. This assumption is made because the return flow from the upper water rights supply those that divert at Gunlock Reservoir under the Santa Clara Project and return flows from the Santa Clara Project help supply two diversions on the lower Santa Clara that rely nearly exclusively on irrigation return flows. Using this approach, it is estimated that about 4,500 acre-feet would be available as a reliable supply in most years. In arriving at this figure, the diversions to New Castle, for the Shivwits Band and the instream flows were not included.

The Shivwits Band have up to 1,900 acre-feet annually that they can lease, as provided for in the January 18, 2001 Settlement Agreement.[10] It is reported that about 14% of the shares in Ivins Irrigation Company, 6% of the shares in New Santa Clara Fields Irrigation Company and 61% of the shares in St. George Clara Fields Company are

[10] See Shivwits Band of the Paiute Indian Tribe of Utah Water Rights Settlement Agreement and the Santa Clara Project Agreement both entered into on January 18, 2001. The parties are: Bloomington Canal Company; Edward Bowler, a shareholder in the Gunlock Irrigation Company; Ivins Irrigation Company; the Lower Gunlock Reservoir Corporation; the New Santa Clara Field Canal Company; the Shivwits Band of the Paiute Indian Tribe of Utah; the Southgate Irrigation Company; the City of St. George, Utah; the St. George Clara Field Canal Company; the United States of America; the State of Utah; and the Washington County Water Conservancy District.

owned by municipalities.[11] Taking this into account, then the amount of water available for conversion to municipal use is about 3,800 acre-feet.

4.0 LIMITATIONS AND ITEMS TO CONSIDER

4.1 PRIORITY DATE

When acquiring irrigation water rights to supply future municipal needs it is very important that early priority water rights be obtained so that during drought years adequate water is available to supply the community's needs. As discussed in the demand-yield analysis, on the main stem of the Virgin River, it appears that water rights with 1900 and earlier priority dates can be expected to provide a reliable water supply. Water rights with priority dates after 1900 will most likely experience significant shortages during drought periods and the municipality would need to have other water sources that could be used to augment their water needs.

On tributary streams where the streamflow is not as reliable as the main stem of the Virgin River, even water rights with priority before 1900 may not have adequate water to supply their demands. See discussion regarding Leeds Creek in Section 3.2. Water managers are cautioned to critically review the nature of the tributary stream regarding the physical water supply and perhaps only consider obtaining the earliest priority rights on the stream.

4.2 WATER QUALITY

The quality of water is very important for most types of water use, but especially so for municipal use. For this report, only total dissolved solids (TDS) are examined. In the Water Needs Assessment Report[12] it makes the following statement regarding TDS:

> Water supplies that meet the EPA's secondary untreated Maximum Contaminant Level (MCL) for drinking water of Total Dissolved Solids (TDS) less than 500 mg/L are deemed usable for culinary purposes in this Assessment. The EPA's secondary untreated MCLs are guidelines which address aesthetic concerns in culinary water,

[11] Email or spreadsheets from each company indicating public ownership of shares.

[12] Lake Powell Pipeline Project, Final Water Needs Assessment, April 2016, prepared for the Utah Division of Water Resource, prepared by MWH.

such as taste, color and odor. The EPA does not establish MCLs for secondary untreated water; therefore, an upper limit of 1,000 mg/L TDS was assumed for M&I secondary untreated water use in this report, which is the maximum TDS level for the least salt tolerant residential ornamental landscape. (page 2-10)

The TDS of surface water sources in the Virgin River Basin varies throughout the year and is influenced by natural runoff, irrigation return flows, saline springs, land use practices and other activities. The TDS upper limit of 500 mg/L for culinary purposes and 1,000 mg/L for secondary untreated water use appear to be reasonable as set forth in the Water Needs Assessment Report and will be used for this report. The major source of concern regarding TDS is the discharge from the La Verkin Hot Springs[13] located on the boundary between La Verkin and Hurricane in the SW¼, Section 25, T41S R13W, SLB&M. The discharge from the spring is about 10.9 cubic feet per second (cfs),[14] with the average dissolved-solids concentration at 9250 mg/L, and a temperature of about 107° Fahrenheit.

La Verkin Hot Springs discharges into the Virgin River and greatly affects the downstream water quality. In the TMDL Water Quality Study of the Virgin River Watershed prepared for the Utah Division of Water Quality,[15] several statements are made that help bring the issue of water quality into focus; they are as follows:

1. The average TDS concentration in the Virgin River above the Quail Creek Diversion (497 mg/L) was multiplied by the estimated flow in the Virgin River below the Quail Creek Diversion (45 cfs). This resulted in an annual load of approximately 20 million kg/yr of TDS. The TDS concentration above the Quail Creek Diversion is considered representative of natural conditions because

[13] This spring area is referred to by several different names, including La Verkin Hot Springs, Dixie Hot Springs and Pah Tempe Springs. For this report we will refer to it as La Verkin Hot Springs.
[14] See page 11, Hydrosalinity Studies of the Virgin River, Dixie Hot Springs, and Littlefield Springs, Utah, Arizona, and Nevada; Scientific Investigations Report 2014-5093 (SIR 2014-5093).
[15] TMDL Water Quality Study of the Virgin River Water Shed, EPA Approval Date: September 20, 2004, submitted to Utah Department of Environmental Quality, Division of water Quality, Salt Lake City, Utah, 84116.

anthropogenic activities have limited impact on TDS in this segment of the Virgin River.

2. The average TDS concentration of the La Verkin Hot Springs (9,650 mg/L) was multiplied by the estimated flow (11.5 cfs; USDI, 1973). This resulted in an annual load of approximately 100,000,000 kg/yr of TDS.
3. The combined load of the Virgin River below the Quail Creek Diversion and La Verkin Hot Springs was divided by the combined flow to result in an average concentration of 2,360mg/L.

Note, the water quality above the Quail Creek Diversion is 497 mg/L, which is acceptable for municipal uses. However, after the discharge from La Verkin Hot Springs enters the river, the TDS concentration ranges from about 800 mg/L during spring runoff to over 2,000 mg/L during the summer months and low-flow periods. Therefore, in acquiring water rights that divert downstream of La Verkin Hot Springs the TDS level will present challenges and will not be a viable direct water source for municipal purposes, unless it is blended with good quality water or treated.

Alternatives should be explored as to how the waters of the lower Virgin River can be utilized before it is degraded by discharge from La Verkin Hot Springs. There could be some potential to transfer irrigation water rights to groundwater sources that contribute to the flows of the river in this reach.

4.3 WATER RIGHTS CHANGE APPLICATION PROCESS

When transfers of water from irrigation to municipal use involves a change in the point of diversion, nature of use and/or place of use, a change application is required to be filed and approved by the DWRi. In the discussions in this report regarding converting irrigation water to municipal, it is assumed the source of supply will remain the same. In the change application process the State Engineer examines the rates and amounts of hydrologic depletion associated with the historical water use as compared to the proposed use to assure that there is not an enlargement of the underlying water right.

The purpose of this examination is to protect downstream water rights and ensure the depletions are not increased. Irrigation water rights also have a defined period of use, with common irrigation seasons in the basin being March 1 to November 30 and April 1

to October 31. In filing the required change application most municipalities change the period use from the irrigation season to year-round municipal use. Attempts are made to allow this to occur, but there are instances where this could impact other existing water rights. If the period of use is restricted to the historical irrigation period, then other sources such as reservoir storage or groundwater would be needed to provide water during the non-irrigation season.

If the waste water from the municipality is delivered to a treatment facility where the method of treatment is evaporative lagoons, then it will most likely reduce the amount of water that can be converted from irrigation to municipal purposes. The current approach by the DWRi regarding change applications is to require the applicant to maintain records demonstrating uses under the change application do not exceed the historical depletion limits.

In Appendix D there are two Orders of the State Engineer that show the conditions of approval for change applications transferring irrigation water rights to municipal use. The calculation sheet in Appendix D shows an example evaluating how the municipal water use is converted under a change application involving irrigation water rights. The water use practices and hydrologic conditions vary with each system and need to be evaluated on a case-by-case basis. For the assumed conditions presented in the calculation sheet about 72.5% of the historical irrigation diversion can be diverted for municipal purposes. Under conditions where the water use depletes nearly all the water diverted, such as where municipalities utilize reuse of their sewage affluent or through industrial processes, the depletion allowance for the water right may control the amount of water that is allowed to be changed.

Table D1 sets forth how the amount of water that can be potentially converted to municipal from the irrigation water rights on the main stem of the Virgin River and selected tributaries was calculated. The calculations are shown step-by-step. For this case it is made more complicated because of the water quality considerations on the lower Virgin River. The demand-yield analysis indicates what water rights are viable to convert to municipal use. The analysis found that water rights with 1900 priority dates and earlier, provide a reliable water supply. This priority of water rights covers 4,970

acres of irrigation. This acreage would provide for the diversion of up to 26,900 acre-feet, limited to the depletion of 15,100 acre-feet. The water use practices of the municipality would determine what percentage of the water is returned to the system and thus, what percentage of the historical irrigation diversion they would be allowed to divert.

For this report it is assumed the municipal conversion amount would be close to the historical depletion of 15,100 because of potential reuse. The municipality will be required to keep detailed records to show through actual water use data, that they are not exceeding the 15,100 acre-feet depletion limit.

5.0 FINDINGS AND SUMMARY

Developing estimates on how much irrigation water can be converted to municipal use in order to meet the future water demands of the District service area involves numerous factors.

- It is very important that irrigation water rights have early priority dates, so they can provide a reliable supply, particularly during drought periods.
- In acquiring 1900 or later priority rights there could be some reductions in the amount of water available for diversion under such water rights during periods of drought. There is a large block of water rights with 1900 priority dates. It is at this level of priority where shortages begin to appear on the main stem of the Virgin River. The shortages under this situation would be shared throughout the 1900 priority block of water rights, assuming all other parameters are equal.
- On the smaller streams it was found that even the earliest priority water rights experience shortages under average conditions. If such water rights are acquired, water managers should enter into an agreement giving the municipality first call on their portion of the water.
- If the water is moved a significant distance or to another source, then the impact on intervening water rights will have to be considered.
- Irrigation return flows are important components on many of the streams in the

basin and must be considered in this type of evaluation. As a result, the quantity of water that can be converted is not a simple calculation.

- Another critical factor is that the irrigation water rights are owned by mutual irrigation companies, private companies and individuals. Not every water right owner will want to sell their water rights or shares of stock.

The findings of this investigation are set forth in the following table (Table 4). The amounts shown for the Virgin River and selected tributaries are the amounts for 1900 and earlier priority water rights as shown on Table 2. The water rights in the lower Virgin River are subtracted because of poor water quality. An adjustment is made to add one-third of the 1900 and earlier priority water of St. George and Washington Canal Company, since it is supplied from water originating above La Verkin Hot Springs.

Table 4: Estimate of the amount of Irrigation Water that Potentially can be Converted to Municipal Use in the Virgin River Basin.

Stream	Potential Municipal Depletion
Virgin River & Selected Tributaries	15,100[16]
Santa Clara River	3,800
East Fork	2,250
Upper Ash Creek	2,000[17]
	23,200 (rounded)

The figures presented above represent a reliable water supply that should be expected even during times of drought with manageable shortages. If the municipality has other water sources to augment the water available from later priority water rights, then additional supplies could be made available.

[16] See Table D1 in Appendix D.
[17] The economic feasibility of developing this water is problematic.

Appendix A

Priority Lists:

Virgin River, Ash Creek, East Fork, La Verkin Creek, Quail Creek, North Creek,

North Fork, Kolob Creek, Deep Creek, Clear Creek, East Fork Virgin River above Barracks Ranch

Santa Clara River Calculations

TABLE A1: Priority list for the main stem of the **Virgin River** from Grafton area downstream to the Utah-Arizona stateline. This section of the river is divided into three Zones to account for differences in diversion and depletion allowances. Zone 1 is from the Stateline upstream to Quail Creek Pipeline Diversion; Zone 2 is the diversions at the Quail Diversion that serve the La Verkin & Hurricane areas; and Zone 3 is for those water rights upstream of the Quail Diversion to the Grafton area. The allowable diversion amounts are taken from the DWRi webpage and range from 5.00 to 6.00 acre-feet per acre. The allowable depletion are based on the following stations: Zone 1: St. George NWS Station, 3.58 acre-feet per acre; Zone 2: LaVerkin NWS Station, 3.20 acre-feet per acre; and Zone 3: Zion NP NWS Station, 2.94 acre-feet per acre.

Zone	WR#	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
				CFS	Acre-Feet		Sec	T S	R W			
3	81- 2738	Elisha Lee	1862	0.20	56	I	4	42	11	11.20	56	33
3	81- 2802	Joseph Barney	1862	0.13	35	I	4	42	11	7.00	35	21
1	81- 4069	Brigham Jarvis	1862	10.00		I	21	42	15	550.00	3,300	1,969
3	81- 2401	Virgin Irrigation Company	1865	2.92		I	30	41	11	160.60	803	472
1	81- 2233	Utah Division of Wildlife Resources	1880	0.50	165	Inst Flow	14	41	13	27.50	165	88
1	81- 4084	William Atkin	1880	0.89		I	14	43	16	48.60	292	174
					Subtotals for Priority Block				Zone 1	**598.60**	**3,592**	**2,143**
									Zone 3	**178.80**	**894**	**526**
									Zone 1	**27.50**	**165**	**88**
1	81- 1127	St. George and Washington Canal Co	1890	0.44	144	I	21	42	14	24.00	144	86
2	81- 2477	City of La Verkin	1890	4.97	1640.22	I	29	41	12	273.37	1,640	875
3	81- 2481	City of La Verkin	1890	0.03	20	Ind	28	41	12	3.33	20	11
1	81- 2636	Lylie Howells	1890	0.42		I	36	41	14	23.30	140	83
1	81- 3542	St. George and Washington Canal Co	1890	1.07	351.48	I	21	42	14	58.58	351	210
1	81- 3543	City of St. George	1890	0.95		I	21	42	14	52.02	312	176
1	81- 3544	St. George and Washington Canal Co	1890	29.85	8608.8	I	21	42	14	1,434.80	8,609	5,137
3	81- 3547	St. George and Washington Canal Co	1890	0.1487	49.071	Ind	28	41	12	8.18	49	29
2	81- 2475	Hurricane Canal Company	1893	31.24	10308.062	I	29	41	12	1,745.50	10,473	5,586
3	81- 2482	Hurricane Canal Company	1893	0.04	30	Ind	28	41	12	5.00	30	16
1	81- 707	Corp of the Presiding Bishop LDS Church	1900	6.50		I	34	42	15	480.00	2,880	1,718
2	81- 2476	Washington County Water Cons District	1900	1.00	330	Mu I	29	41	12	55.00	330	176
2	81- 3107	Washington County Water Cons District	1900	1.00	160	Mu I	29	41	12	26.67	160	85
1	81- 3548	St. George and Washington Canal Co	1900	56.00	18480	I	21	42	14	3,080.00	18,480	11,026
2	81- 3927	Washington County Water Cons District	1900	1.00	500	I	24	41	13	83.33	500	267
2	81- 4334	City of La Verkin	1900	3.00	990	I	29	41	12	165.00	990	528
					Subtotal for Priority Block				Zone 1	**5,100.68**	**30,604.08**	**18,260.43**
									Zone 2	**1,745.50**	**10,473.00**	**5,585.60**
									Zone 1	**52.02**	**312.12**	**175.83**
									Zone 2	**603.37**	**3,620.20**	**1,930.77**
									Zone 3	**16.51**	**99.07**	**56.00**
3	81- 3054	Michael S. and Linda H. Behling	9/2/1921	0.16	17.65	I D S	2	42	11	3.53	18	10

Zone	WR#	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
				CFS	Acre-Feet		Sec	T S	R W			
2	81- 1381	Washington County Water Cons District	8/8/1922	33.93	19000	Mu I P	29	41	12			
2	81- 4108	Washington County Water Cons District	8/8/1922	2.68	1500	Mu P FC R	29	41	12			
2	81- 4367	Washington County Water Cons District	8/8/1922	0.89	500	Mu P FC R	29	41	12			
2	81- 110	Washington County Water Cons District	7/5/1928	35.00		P	29	41	12			
2	81- 124	Washington County Water Cons District	11/6/1931	65.00		P	29	41	12			
2	81- 143	Washington County Water Cons District	12/6/1937		4000	Mu P FC R	29	41	12			
2	81- 157	Hurricane Canal Company	3/29/1940	63.00	4196.7	I	29	41	12	699.45	4,197	2,238
1	81- 174	St. George and Washington Canal Co	6/5/1943	9.00		I	21	42	14	450.00	2,700	1,611
1	81- 182	Lee C. and Cleo R. Atkin	5/5/1944	2.40		I	21	42	14	98.00	588	351
1	81- 183	City of St. George	5/18/1944	3.00		I	23	43	16	162.94	978	583
					Subtotal for Priority Block				Zone 1	**548.00**	**3,288.00**	**1,961.84**
									Zone 2	**699.45**	**4,196.70**	**2,238.24**
									Zone 3	**3.53**	**18**	**10**
									Zone 1	**162.94**	**978**	**583**
									Zone 2			
3	81- 260	Grafton Heritage Partnership Project	3/20/1950	2.00		I	3	42	11	56.00	280	165
3	81- 265	Lee Valley Ranch LLC et al	8/7/1950	5.00	838.5	I	4	42	11	167.70	839	493
1	81- 1612	Hinchcliff Family Trust	9/7/1951		2	I	27	41	12	0.30	2	1
1	81- 285	J and S Farms, et al.	3/21/1953	3.70		I	27	42	15	63.92	384	229
1	81- 328	5M Incorporated, et al.	8/27/1956	4.63	440.22	I	30	41	13	72.38	434	259
1	81- 4257	Winding River Associates LLC	8/27/1956	0.31	28.98	I	30	41	13	4.83	29	17
3	81- 344	Linda Collet and Jerry Glazier	12/27/1957	1.50		I	23	41	12	67.10	336	197
1	81- 391	Niota Investment LLC	5/26/1959	0.16	25.6875	I	10	42	14	4.28	26	15
1	81- 1468	K & E Properties LC et al	5/26/1959	0.17	50.97	I S	15	42	14	5.34	32	19
1	81- 4025	SITLA	5/26/1959		10.08	I	15	42	14	1.68	10	6
1	81- 4153	Niota Investment LLC	5/26/1959	0.49	77.0625	I	10	42	14	12.84	77	46
1	81- 4155	Niota Investment LLC	5/26/1959		8.71	I	10	42	14	1.45	9	5
1	81- 4596	Washington County Water Cons District	5/26/1959	1.72		I	10	42	14	80.87	485	290
1	81- 4974	Washington County Water Cons District	5/26/1959		25.6875	I	10	42	14	4.28	26	15
1	81- 4977	Washington County Water Cons District	5/26/1959		77.0625	I	10	42	14	12.84	77	46
1	81- 5006	Washington County Water Cons District	5/26/1959		18.79	I	10	42	14	3.13	19	11
1	81- 190	City of St. George	1/11/1960	10.00	714.06	I	12	43	16	119.10	715	426
2	81- 507	Washington County Water Cons District	1/15/1962		147600	Mu I P	29	41	12			
2	81- 1382	Washington County Water Cons District	1/15/1962		12820	Mu I P Misc	29	41	12			
2	81- 2273	Washington County Water Cons District	1/15/1962		28891.45	Mu P FC R	29	41	12			
2	81- 3996	Washington County Water Cons District	1/15/1962		5108.55	Mu I P Misc	29	41	12			
2	81- 4211	Washington County Water Cons District	1/15/1962		50000	Mu	29	41	12			
1	81- 3819	Washington County Water Cons District	10/1/1971		274.08	I	15	42	14	45.68	274	164
1	81- 400	Kenneth R. Anderson	12/1/1971	2.00		I	26	41	13	24.30	146	78
2	81- 2318	Washington County Water Cons District	6/23/1983	250.00		P	29	41	12			

Zone	WR#	Owner	Priority Date	Quantity		Uses	Location				Acres, Sole Supply	Allowable Diversion	Allowable Depletion
				CFS	Acre-Feet		Sec	T	S	R W			
					Subtotal for Priority Block					Zone 1	**237.01**	**1,422**	**839**
										Zone 3	**290.80**	**1,454**	**855**
										Zone 1	**265.91**	**1,595**	**952**
					Total Existing Irrigation					Zone 1	**6,484.29**	**38906**	**23205**
										Zone 2	**2,444.95**	**14670**	**7824**
										Zone 3	**473.13**	**2366**	**1391**
					Converted Irrigation					Zone 1	**508.37**	**3050**	**1799**
										Zone 2	**603.37**	**3620**	**1931**
										Zone 3	**16.51**	**99**	**56**

Existing irrigation water rights
Converted irrigation water rights

Uses: D=Domestic, FC=Fish Culture, Ind=Industrial, Inst Flow = Instream Flow, I=Irrigation, Mu=Municipal, P=Power, R=Recreation, S=stockwatering

TABLE A2: Water Right Priority List for Ash Creek and tributaries below Ash Creek Reservoir down to the confluence with the Virgin River. The allowable diversion taken from the DWRi web page. For those water rights with a 6.00 acre-feet per acre duty, the consumptive use of 3.20 acre-feet per acre from the La Verkin station is used. For those water rights with a 5.00 acre-feet per acre duty the consumptive use of 2.58 acre-feet per acre from the New Harmony station is used.

Zone	WR #	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion	Source
				cfs	Acre-Feet		Sec	T S	R W				
2	81- 2849	Sunroc Corporation	1860	0.12		I	36	39	13	6.50	33	17	Leap Creek
2	81- 3047	Pintura Irrigation Co.	1860	0.87	240	I	3	40	13	48.00	240	240	South Ash Creek
1	81- 3474	Toquerville City	1862	0.0376	12.384	Mu	35	40	13		12		Toquerville Sprs and Ash Ck
1	81- 3475	Toquerville City	1862	0.204	67.44	Mu	35	40	13		67		Toquerville Sprs and Ash Ck
1	81- 3476	Toquerville City	1862	0.2816	93.12	Mu	35	40	13		93		Toquerville Sprs and Ash Ck
1	81- 4863	Washington County WCD	1862	0.4324	142.416	Mu	35	40	13		142		Toquerville Sprs and Ash Ck
1	81- 4864	Washington County WCD	1862	2.346	775.56	Mu	35	40	13		776		Toquerville Sprs and Ash Ck
1	81- 4865	Washington County WCD	1862	3.2384	1070.88	Mu	35	40	13		1,071		Toquerville Sprs and Ash Ck
1	81- 1145	Hurricane City Corp.	1870	1.09	360	Mu	11	41	13		360		Upper Ash Creek Springs
2	81- 3048	Pintura Irrigation Co.	1870	0.13	35	I	3	40	13	7.00	35	18	Ash Creek
2	81- 3049	Pintura Irrigation Co.	1870	0.64	175.5	I	3	40	13	35.10	176	91	South Ash Creek
2	81- 3067	Sunroc Corporation	1870	0.22		I	36	39	13	12.00	60	31	Leap Creek
1	81- 1143	City of Hurricane	1880	0.3	97.8	Mu	11	41	13		98		Ash Creek Springs
1	81- 2743	Hurricane City Corp	1880	0.09	3	Mu	11	41	13		3		Upper Ash Creek Springs
1	81- 2744	Hurricane City Corp	1880	0.18	60	Mu	11	41	13		60		Ash Creek Springs
1	81- 2745	Hurricane City Corp	1880	0.1	36	Mu	11	41	13		36		Ash Creek Springs
1	81- 4126	Hurricane City Corp	1880	0.04266	13.8206	Mu	11	41	13		14		Ash Creek Springs
1	81- 1073	LaVerkin City	1880	0.3	72.00	Mu	11	41	13		72		Ash Creek Springs
1	81- 2739	Toquerville City	1880	0.05734	18.57939	I	23	41	13	3.10	19	10	Ash Creek
1	81- 3179	Anderson Jct. Irr Wtr Assc, et al.	1885	0.2578	77.0848	I	7	40	13	12.85	77	41	Sand Hollow Creek
1	81- 4402	Leeds Domestic WU Assoc	1885		24	I	7	40	13	4.00	24	13	Sand Hollow Creek
1	81- 4902	Washington County WCD	1885	0.5712	170.7912	I	7	40	13	28.47	171	91	Sand Hollow Creek
						Subtotal for Priority Block				**121.45**	**620**	**437**	
							Converted				**3,018**		
1	81- 687	LaVerkin City	1890	0.491	71.35	Mu	11	41	13		71		Ash Creek Springs
1	81- 1602	LaVerkin City	1890	1	330	Mu	11	41	13		330		Ash Creek Springs
1	81- 1144	Hurricane City	1893	1.114		Mu	11	41	13	61.27	368	196	Ash Creek Springs
2	81- 1975	Sunroc Corporation	1900	0.31		I	36	39	13	6.63	33	17	Leap Creek
						Subtotal for Priority Block				6.63	33	17	
							Converted				**769**		
2	81- 14	Pintura Irrigation Company	3/19/1910	1.86		I	3	40	13				South Ash Creek

Zone	WR #	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion	Source
				cfs	Acre-Feet		Sec	T S	R W				
1	81- 4829	Charlotte E. Potter et al	9/5/1912	0.11992	26.4072	I	14	41	13	4.40	26	14	Ash Creek
1	81- 4562	Kenneth R. Anderson	9/5/1912	0.10901	24	I	14	41	13	4.00	24	13	Ash Creek
1	81- 2487	Ray & Kathy Bence Trust	9/5/1912	0.25	22.08	I	14	41	13	3.68	22	12	Ash Creek
1	81- 38	Martha Simpson	9/5/1912	0.12705	1.5678	I	14	41	13	15.15	91	48	Ash Creek
1	81- 4609	R B Lichfield Family LP	9/5/1912	0.40574	89.3448	I S FC	14	41	13	10.78	65	34	Ash Creek
1	81- 4642	R B Lichfield Family LP	9/5/1912	0.1082	23.8302	I	14	41	13	3.97	24	13	Ash Creek
1	81- 4063	Toquerville City	9/5/1912	0.0128	3.84	Mu	35	40	13		4		Toquerville Sprs and Ash Ck
1	81- 37	Washington County WCD	9/5/1912	3	484.2	I	35	40	13	80.70	484	258	Toquerville Sprs and Ash Ck
1	81- 4866	Washington County WCD	9/5/1912	0.1472	44.16	Mu	35	40	13		44		Toquerville Sprs and Ash Ck
1	81- 51	Washington County WCD	4/7/1914	8		I	2	41	13	212.40	1,274	680	Ash Creek
						Subtotal for Priority Block				**41.98**	**252**	**134**	
							Converted				**1,807**		
2	81- 170	Robert M. Brown	8/24/1942	1.4		I	36	39	13				North Ash Creek
1	81- 2801	Gaius P. Crosby	11/22/1961	0.125	13.05	I	14	41	13	2.18	13	7	Ash Creek
1	81- 503	R B Lichfield Family LP	11/22/1961	0.5	39.24	I S FC	14	41	13	6.54	39	21	Ash Creek
1	81- 4610	R B Lichfield Family LP	11/22/1961	0.375	39.15	I S FC	14	41	13	6.53	39	21	Ash Creek
						Subtotal for Priority Block				**15.24**	**91**	**49**	
										185.30	**997**	**638**	

Existing irrigation water rights

Irrigation water rights held or converted to municipal use.

Use: I = Irrigation, Mu = Municipal, S = Stockwatering, FC = Fish Culture

Converted or owned by municipality **5593**

TABLE A3: Priority list for **East Fork Virgin River** and tributaries from below the diversion at Barracks Ranch area down to the confluence with North Fork Virgin River. The duty is 4.00 acre-feet per acre in the Meadow Creek area and 5.00 acre-feet per acre in the Springdale area. The consumptive use is from the Orderville and Zion National Park station, respectively.

WR #	Owner	Priority Date	Quantity			Location			Acres, Sole Supply	Irr. Duty AF/A	CU AF/A	Allowable Diversion	Allowable Depletion
			cfs	Acre-Feet	Uses	Sec	T S	R W					
81- 1784	Sanctuary Ranch, LLC	1865	0..49	135.00	I	9	42	10	27.00	5.00	2.94	135	79
81- 2247	Sanctuary Ranch, LLC	1865	0.16	43.5	I	16	42	10	8.70	5.00		44	26
							Subtotal		**35.70**			**179**	**105**
81- 65	Juniece S. & Marvin P. Hoyt, et al	2/17/1919	0.667	151.88	I	28	40	8	37.97	4.00	2.23	152	85
81- 3021	Howard Family Trust etal	2/17/1919	1.33	191.04	I	28	40	8	47.7604	4.00		191	107
81- 4179	Alma K. Kirkpatrick	2/17/1919		0.50	I	28	40	8	0.125	4.00		1	0
							Subtotal		**85.86**			**343**	**191**
81- 2414	Sanctuary Ranch, LLC	1/15/1962		859.85	FC	16	42	10					
81- 4420	Sanctuary Ranch, LLC	1/15/1962		237.75	I	9	42	10	47.55	5.00		238	140
81- 4527	Sanctuary Ranch, LLC	1/15/1962		210.20	I	9	42	10	42.04	5.00		210	124
81- 4597	Sanctuary Ranch, LLC	1/15/1962		252.80	I	9	42	10	50.56	5.00		253	149
81- 4660	Sanctuary Ranch, LLC	1/15/1962		234.00	I	9	42	10	46.80	5.00		234	138
81- 4698	Sanctuary Ranch, LLC	1/15/1962		30.50	I	9	42	10	6.10	5.00		31	18
81- 4700	Sanctuary Ranch, LLC	1/15/1962		329.75	I	9	42	10	65.95	5.00		330	194
81- 4766	Sanctuary Ranch, LLC	1/15/1962		78.40	I	9	42	10	15.68	5.00		78	46
81- 4797	Sanctuary Ranch, LLC	1/15/1962		11.60	I	9	42	10	2.32	5.00		12	7
81- 4798	Sanctuary Ranch, LLC	1/15/1962		37.90	I	9	42	10	7.58	5.00		38	22
							Subtotal		**284.58**			**1423**	**837**

TABLE A4: Priority list for **La Verkin Creek**. The subtotals and total figures do not include water rights held by public water suppliers. WRs 81-3580 and 81-3581 are denoted as disallowed on the DWRi database. WR 81-4065 has comments on file that raise the issue of nonuse. These three water rights are not included in total acreage and water quantity figures.

Zone	WR #	Owner	Priority Date	Quantity			Location			Acres, Sole Supply	Irr. Duty AF/A	CU AF/A	Allowable Diversion	Allowable Depletion
				cfs	Acre-Feet	Uses	Sec	T S	R W					
1	81- 4038	Ash Creek SSD	1880	0.255	61.2	I	14	41	13	10.2	6.00	3.20	61	33
1	81- 3434	Brett B. & Helana Cahoon	1880	0.155	37.2	I	12	41	13	6.2	6.00	3.20	37	20
1	81- 3580	Robert H. & Kay Bruggeman	1880	0.0975										
1	81- 3561	Washington County WCD	1880	0.3675	88.2	I	14	41	13	14.7	6.00	3.20	88	47
1	81- 3576	Washington County WCD	1880	0.1265	63	I	12	41	13	10.5	6.00	3.20	63	34
1	81- 3578	Washington County WCD	1880	0.0775	18.6	I	12	41	13	3.1	6.00	3.20	19	10
1	81- 3589	Washington County WCD	1880	0.2175	52.2	I	12	41	13	8.7	6.00	3.20	52	28
1	81- 3931	Washington County WCD	1880	0.025	6	I	12	41	13	1	6.00	3.20	6	3
								Subtotal		**16.4**			**98**	**52**
										38.00			**228**	**122**
1	81- 4065	E.J. Graff	1890	0.075	18	I	23	41	13	3	6.00	3.20	18	10
1	81- 4039	Ash Creek SSD	1902	0.12	28.8	I	14	41	13	4.8	6.00	3.20	29	15
1	81- 3545	David W. Hunter, et al.	1902	0.025	6	I	12	41	13	1.48	6.00	3.20	9	5
1	81- 3581	Robert H. & Kay Bruggeman	1902	0.015		I	12	41	13					
1	81- 3562	Washington County WCD	1902	0.2325	55.8	I	14	41	13	9.3	6.00	3.20	56	30
1	81- 3577	Washington County WCD	1902	0.1125	27	I	12	41	13	4.5	6.00	3.20	27	14
1	81- 3579	Washington County WCD	1902	0.035	8.4	I	12	41	13	1.4	6.00	3.20	8	4
1	81- 3590	Washington County WCD	1902	0.1575	37.8	I	12	41	13	6.3	6.00	3.20	38	20
1	81- 3932	Washington County WCD	1902	0.225	52.266	I	12	41	13	8.711	6.00	3.20	52	28
2	81- 68	Lloyd & Wayne Jones	12/6/1916	2.00		I	18	40	12	18.05	5.00	2.58	90	47
								Subtotal		**24.33**			**128**	**67**
										30.211			**181**	**97**
	81- 180	Washington County WCD	1/6/1947	5.00	104.68	I	10	38	11	26.17	4.00	2.58	**105**	**68**
1	81- 615	Washington County WCD	3/31/1964	1.00	61.2	I	14	41	13	10.2	6.00	3.20	**61**	**33**
								Totals		**40.73**			**226**	**119**
								Converted		**104.58**			**575**	**318**

Notes:

WR 81-180 historically POU near Kanarraville. Change Application No. a21554 adds PODs on lower La Verkin Creek and the Virgin River and converts use to Mu.

DWR instream flow Water Right Number 81-2233 is shown on the Virgin River priority list.

TABLE A5 : Priority list for **Quail Creek**, Leeds Creek and tributaries. The irrigation duty is 6.00 acre-feet per acre and the consumptive use (depletion) was calculated using the La Verkin station.

WR #	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
			cfs	Acre-Feet		Sec	T S	R W			
81- 3759	Amy Lu S. Jones, et al.	1880	0.07296	24	I	36	40	14	4.00	24	13
81- 3760	Bonnie Lloyd, et al	1880	0.00912	3	I	36	40	14	0.50	3	2
81- 4034	Crocker Enterprises	1880	0.009	3	I Mi	36	40	14	0.50	3	2
81- 4625	Crocker Enterprises	1880	0.0319	10.5	I	1	41	14	1.75	11	6
81- 4846	Crocker Enterprises	1880	0.01842	6.06	I	1	41	14	1.01	6	3
81- 1157	Crocker Properties LLC	1880	0.13272	43.62	I Mi	36	40	14	7.27	44	23
81- 3758	CII Enterprises LLC, et al	1880	0.19588	57	I	36	40	14	9.50	57	30
81- 1121	Leeds Domestic Water Users Assoc.	1880	0.05	4.5	D	16	40	14		5	
81- 2220	Leeds Domestic Water Users Assoc.	1880	0.05	14.4	D	16	40	14		14	
81- 3299	Leeds Water Company	1880	4.1	1353.53	I	36	40	14	223.02	1,338	714
81- 2478	Washington County Water CD	1880	0.275	95.85	Mu	36	41	14		96	
81- 3756	William Emett	1880	0.18		I	23	41	14	10.00	60	32
							Subtotal		**257.55**	**1,545**	**824**
										114	
81- 1123	Leeds Domestic Water Users Assoc.	1900	0.1727	57	I	36	40	14	9.50	57	30
							Subtotal		**9.50**	**57**	**30**
81- 12	Hunger Hole LTD Partnership, et al.	11/22/1909	4.5	1440	I	35	40	14	240.00	1,440	768
81- 3764	Leeds Water Company	1910	0.69	227.77	I	36	40	14	37.53	225	120
81- 25	Purgatory Irrigation Company	12/29/1910	5		I D S	23	41	14	112.10	673	359
							Subtotal		**389.63**	**2,338**	**1,247**
81- 299	W.G. and Lois C. Bain	11/2/1953		74.985	I	23	41	14	**43.45**	**261**	**139**
							Total		**690.63**	**4,144**	**2,210**
		Duty AF/A:	**6.00**				**Converted**			**171**	
		CU AF/A:	**3.20**								

TABLE A6: Priority list for **North Creek**. The duty for this area is 5.00 acre-feet per acre. The consumptive use for the Zion National Park station was used, which is 2.94 acre-feet per acre.

WR #	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
			cfs	Acre-Feet		Sec	T S	R W			
81- 4053	Virgin Irrigation Company	1865			I	12	41	12			
81- 2402	Hank Moyle Family Trust	1870	0.53	142.362	I S Oth	5	41	11	26.86	134	79
81- 3619	Hank Moyle Family Trust	1870	0.48		I	6	41	11	26.2	131	77
81- 3727	Hank Moyle Family Trust	1870	0.09		I	12	41	12	4.8	24	14
81- 1122	Virgin Canal Company	1870	0.34	92.5	I	12	41	12	18.5	93	54
							Subtotal		**57.86**	**289**	**170**
									18.5	**93**	**54**
81- 4531	K&K Family LC, Virgin Canal Co.	8/6/1951	0.26591	40.49	FC R Oth	12	41	12		40	40
81- 47	Virgin Canal Company	8/6/1951	2.46032	374.6429	I	12	41	12	70.9286	355	209
81- 4326	Virgin Canal Company	8/6/1951	0.0236	3.6	I	12	41	12	0.72	4	2
81- 4886	Virgin Canal Company	8/6/1951	0.4371	6.66	I	12	41	12	1.332	7	4
81- 4982	Virgin Canal Company	8/6/1951	0.0233	3.5571	I	12	41	12	0.7114	4	2
							Subtotal		**73.69**	**409**	**257**
							Total Existing		**131.55**	**698**	**427**
			Duty AF/A	5.00			**Total Converted**		**18.5**	**93**	**54**
			CU AF/A	2.94							

TABLE A7: Priority list for NORTH FORK VIRGIN RIVER and tributaries. The stream was divided into three reaches: 1. Below the confluence of the East Fork and North Fork; 2. North Fork from confluence with East Fork upstream to upstream boundary of Zion National Park; and 3. Area above Zion National Park. The duty ranges from 3.00 to 5.00 acre-feet per acre. A number of the water rights above the Park are located in Kane County.

Reach	WR #	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
				cfs	Acre-Feet		Sec	T S	R W			
2	81- 4739	Rockville Town Ditch Co	1862	0.75	206.4321	I	32	41	10	82.5728	413	243
2	81- 1120	Town of Rockville/Rockville Town Ditch Co.	1862	3.09	850.568	I	32	41	10	170.1136	851	500
2	81- 1146	Hall and Grafton Irrigation Company	1863	1.3	358.5	I	32	41	10	71.7	359	211
2	81- 4051	F.D. Gifford	1865	0.27		I	21	41	10	15	75	44
2	81- 1147	Hall and Grafton Irrigation Company	1865	1.42	391	I	32	41	10	78.2	391	230
2	81- 1142	Springdale Town & Springdale Irr Co	1870	2.64		I FC	22	41	10	145.11	726	427
2	81- 3392	Springdale Town	1870	1.33	365.95	Mu	22	41	10	73.19	366	215
2	81- 1128	Zion National Park	1877	1.21	266.8	Mu Oth	34	40	10	66.7	267	133
1	81- 1135	Hall & Grafton Irr Co	1880	0.27	73.5	I	32	41	10	14.8	74	44
2	81- 3608	Zion National Park	1880	1.38	303.6	Oth	22	41	10	75.9	304	152
3	81- 773	Zion Mountain Land Holdings, LLC	1880		22.78	I S	26	39	9	3.4503	10	5
3	81- 4699	Zion Mountain Land Holdings LLC	1880		50	I	26	39	9	16.6667	50	25
3	81- 4713	Zion Mountain Land Holdings LLC	1880		9.12	I	26	39	9	3.04	9	5
2	81- 1126	John R. Crawford	1881	0.28		I	15	41	10	14.26	57	29
2	81- 1124	Zion National Park	1881	0.53	117.6	Mu Oth	15	41	10	29.4	118	59
							Subtotal			**299.69**	**1438**	**834**
										560.41	2630	1486
3	81- 3317	Charles H. Esplin & Sons Land & Livestock	1890	1.9644	354.5	I	19	38	8	118.5	356	178
3	81- 3318	Charles H. Esplin & Sons Land & Livestock	1890	1.053			31	38	8	63.1	189	95
3	81- 3319	Charles H. Esplin & Sons Land & Livestock	1890	0.427		I	6	39	8	25.6	77	38
3	81- 2963	East Zion Special Service District	1890	0.1832	30.121	I	26	39	9	10.04	30	15
3	81- 4340	Honey Badger Adventure Club	1890	0.0027	0.5	I	19	38	8	0.1666	0	0
3	81- 4521	Honey Badger Adventure Club	1890		0.5	I	19	38	8	0.1666	0	0
3	81- 733	Marie M. Wood, et al	1890	1	159.86	I S	25	38	9	23.3	70	35
3	81- 2647	Marie M. Wood	1890	0.5		I S	25	38	9	30	90	45
3	81- 4618	North Fork Water Company	1890	0.08251	13.75	I	26	39	9	4.5833	14	7

Reach	WR #	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
				cfs	Acre-Feet		Sec	T S	R W			
3	81- 4965	North Fork Water Company	1890	0.00749	1.25	I	26	39	9	0.4167	1	1
3	81- 4612	Zion Mountain Land Holdings LLC	1890	0.03	5	I	26	39	9	1.667	5	3
3	81- 4656	Zion Mountain Land Holdings LLC	1890	0.09	15	I	26	39	9	5	15	8
3	81- 4714	Zion Mountain Land Holdings LLC	1890	0.1868	30.879	I	26	39	9	10.293	31	15
2	81- 1129	Zion National Park	1894	0.53	116	Mu Oth	34	40	10	29	116	58
3	81- 4141	Valerie Joy Hurst	1900	0.0428	7.725	I	29	38	8	2.575	8	4
3	81- 4142	Valerie Joy Hurst	1900	0.0034	2.1375	I	30	38	8	0.7125	2	1
3	81- 4564	Valerie Joy Hurst	1900	0.0073	1.3046	I	19	38	8	0.4349	1	1
3	81- 1541	Gloria Bulloch et al	1900	0.226		I	24	39	9	9.6	29	14
3	81 1542	Gloria Bulloch et al	1900	0.022		I D S	24	39	9		0	0
3	81- 3030	Donette and Dennis Carr	1900	0.0208	2.97	I	19	38	8	0.99	3	1
3	81- 4481	Donette and Dennis Carr	1900		0.75		19	38	8	0.25	1	0
3	81- 3026	Gary E. Fike, et al.	1900	0.1518	30.0625	I	30	38	8	10.0209	30	15
3	81- 4174	The Corp. of the Presiding Bishopric	1900		1	I	32	38	8	0.3333	1	0
3	81- 3045	James B. & Patricia M. Kearns, et al.	1900	0.6408	115.625	I	29	38	8	38.0434	114	57
3	81- 3027	James M. and Tori L. Park	1900	0.01623	2.9301		19	38	8	0.9767	3	1
3	81- 3038	James M. and Tori L. Park	1900	0.01388		I	19	38	8	0.82	2	1
3	81- 3046	James M. and Tori L. Park	1900	0.07875		I	19	38	8	4.74	14	7
3	81- 3850	James M. and Tori L. Park	1900	0.00138	0.25	I	19	38	8	0.0833	0	0
3	81- 4414	James M. and Tori L. Park	1900	0.00138	0.25	I	19	38	8	0.0833	0	0
3	81- 4503	James M. and Tori L. Park	1900	0.00276	0.5	I	19	38	8	0.1667	1	0
3	81- 4119	Susan E. Moffett	1900	0.0056	1		19	38	8	0.3333	1	0
3	81- 4937	Lockey Family Trust	1900		0.25	I	32	38	8	0.0833	0	0
3	81- 3020	North Fork Ranch, LLC	1900	0.0145		I	20	38	8	0.87	3	1
3	81- 3022	North Fork Ranch, LLC	1900	0.13925		I	20	38	8	7.9	24	12
3	81- 3025	North Fork Ranch, LLC	1900	0.00725		I	20	38	8	0.437	1	1
3	81- 3028	North Fork Ranch, LLC	1900	0.00926		I	20	38	8	0.55	2	1
3	81- 3034	North Fork Ranch, LLC	1900	0.00462		I	20	38	8	0.27	1	0
3	81- 3036	North Fork Ranch, LLC	1900	0.08762		I	20	38	8	4.96	15	7
3	81- 3039	North Fork Ranch, LLC	1900	0.0525		I	20	38	8	3.15	9	5
3	81- 3041	North Fork Ranch, LLC	1900	0.50125		I	20	38	8	30.15	90	45
3	81- 3044	North Fork Ranch, LLC	1900	0.02625		I	20	38	8	1.58	5	2

Reach	WR #	Owner	Priority Date	Quantity cfs	Quantity Acre-Feet	Uses	Location Sec	Location T S	Location R W	Acres, Sole Supply	Allowable Diversion	Allowable Depletion
3	81- 3029	North Fork Ranch, LLC et al	1900	0.0417		I	20	38	8	2.49	7	4
3	81- 4099	Gary S. Menaker et al	1900	0.0582	1.25	I	19	38	8	0.4167	1	1
3	81- 3037	Phyllis C. Bingham, et al	1900	0.0805	14.3954	I	19	38	8	4.8018	14	7
3	81- 3031	Four Way Associates, LLC	1900	0.1875		I	19	38	8	11.17	34	17
3	81- 727	GBAC Trust	1900	0.0883	15.45	I S	31	38	8	5.0667	15	8
3	81- 4479	Scott and Cindee Petrocco	1900	0.0116	0.25	I	19	38	8	0.833	2	1
3	81- 4680	Stewart M. Freshwater	1900	0.0056	1	I	30	38	8	0.333	1	0
3	81- 4615	Susan and Scott Richey	1900	0.0233	0.5	I	19	38	8	0.1667	1	0
3	81- 3024	Kirby Lambet Living Trust et al	1900	0.00725		I	20	38	8	0.437	1	1
3	81- 3035	Kirby Lambet Living Trust et al	1900	0.00462		I	20	38	8	0.27	1	0
3	81- 3043	Kirby Lambet Living Trust et al	1900	0.02625		I	20	38	8	1.58	5	2
3	81- 4100	Theodore & Deborah Chun Moon	1900	0.0292	1	I D	32	38	8	0.25	1	0
							Subtotal			**440.76**	**1322**	**661**
										29.00	**116**	**58**
3	81- 4973	Michael J. Hess	1903		0.75	I	32	38	8	0.25	1	0
3	81- 62	Henry & Jo C Bulloch	8/13/1915	1.08	192.6	I	33	38	8	64.2	193	96
							Subtotal			**64.45**	**193**	**97**
2	81- 117	Zion National Park	5/31/1929	0.01		Mu Oth	34	40	10			
3	81- 2952	USA Bureau of Land Mgt	1/7/1946	1.5		I	33	39	9	18.58	56	28
3	61- 64	St. George & Washington Canal Co.	2/8/1966	10	5400	I	17	38	8			
							Subtotal			**18.58**	**56**	**28**
								Total		**804.90**	**2954**	**1592**
								Converted		**607.99**	**2802**	**1572**

TABLE A8: Priority list for **Kolob Creek** and tributaries. The irrigation duty or allowable diversion is 3.00 acre-feet per acre and it is assumed that the consumptive use is half the diversion amount. A number of segregations, changes and exchange applications have been filed on WR 81-42 which is supplied from Kolob Reservoir. For purposes of this evaluation they are assumed to be exchange applications and are tallyed under WR 81-42.

WR #	Owner	Priority Date	Quantity			Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
			cfs	Acre-Feet	Uses	Sec	T S	R W			
81- 3204	Dale Ray & Marilyn Wilcox, et al.	1880	0.165	29.85	I	36	38	11	9.95	30	15
81- 1504	OBW Kolob, LC	1880	0.102	18.48	I	36	38	11	6.15	18	9
							Subtotal		16.10	48	24
81- 1137	Washington County Water CD	1900	0.4558	82.35	I	36	38	11	27.45	82	41
							Subtotal		27.45		
81- 142	Washington County Water CD	12/3/1937		4000.00	I	36	38	11	*667*	4000	*2270*
							Subtotal				
81- 42 *	Washington County Water CD	9/7/1951		58.80	I	36	38	11	19.6005	59	29
	Exchange Appl	9/7/1951							179.9	540	270
81- 307	Washington County Water CD	5/10/1955		250.00	I	39	38	11	*42*	250	*140*
81- 335	Kolob Recreational Association Inc	10/10/1957		275.44	FC	13	39	11		275	42
							Subtotal		241.50	1124	481

* A total of 73 exchanges have been filed totaling 539.7 acre-feet, representing 179.90 acres of historical irrigation. These exchanges are primarily used in the Kolob area.

Duty AF/A = 3.00

Converted = 5206

CU AF/A = 1.50

Estimated acreage based on the allowable diversion

Estmated depletion/consumptive use based on allowable diversion

TABLE A9: Priority list for **Deep Creek** and tributaries. Allowable diversion taken from DWRi web page and allowable depletion assumed to be half the allowable diversion. Water rights 81-743 & 3352 are located in Kane County.

WR #	Owner	Priority Date	Quantity		Uses	Location			Sole Supply	Allowable Diversion	Allowable Depletion
			cfs	Acre-Feet		Sec	T S	R W			
81- 3507	C. Brent & Kathryn T. Bulloch, et al.	1880	0.582	72.5	I	12	38	10	19.04	57.13	28.56
81- 1753	Gayle H. & Leah C. Adams, et al	1880	0.23	65.442	I D S	32	38	10	19.50	58.50	29.25
81- 3506	Trossach Loch Estates Owners Assoc.	1880	0.12	11.55	I D S R FC	1	38	10	1.27	3.80	1.90
81- 5045	Kevin & NaNon Bulloch Family Trust	1880	0.1235	15.375	I	12	38	10	5.13	15.38	7.69
81- 3438	Scott & Henry Matheson Bulloch	1884	1.77			33	38	10	27.00	81.00	40.50
81- 3439	Scott & Henry Matheson Bulloch	1884	1.7234	123.7319	I	4	39	10	41.24	123.73	61.87
81- 3440	Scott & Henry Matheson Bulloch	1884	1.77		I	5	39	10	38.24	114.73	57.37
81- 3441	Scott & Henry Matheson Bulloch	1884	0.111		I S	4	39	10	11.60	34.80	17.40
81- 3442	Scott & Henry Matheson Bulloch	1884	0.056		I S	4	39	10	5.80	17.40	8.70
81- 3443	Scott & Henry Matheson Bulloch	1884	0.045		I S	9	39	10	41.24	123.73	61.87
81- 3446	Scott & Henry Matheson Bulloch	1884	0.223		I S	33	38	10	10.50	31.50	15.75
								Subtotal	**219.30**	**658**	**329**
81- 743	Jane A. Bradshaw Trust et al	1890	0.042		I S	7	38	9	2.50	7.50	3.75
81- 3352	Jane A. Bradshaw Trust et al	1890	0.25		I	7	38	9	15.00	45.00	22.50
								Subtotal	**17.50**	**52.50**	**26.25**
81- 83	Thorley Ranch Company Inc	11/24/1919	1.08		I	5	39	10	68.70	206.10	103.05
81- 3362	Thorley Ranch Company Inc	11/24/1919	0.12		I	5	39	10	7.90	23.70	11.85
81- 355	Washington County Water CD	8/26/1957	50	6000	Mu	7	38	10			
								Subtotal	**76.60**	**229.80**	**114.90**

Duty AF/A = 3.00

Converted 1.27 3.80 1.90

CU AF/A = 1.50

TABLE A10: Priority list for **Clear Creek** and tributaries. All of the water rights on this list are located in Kane County. The allowable diversion taken from DWRi web page and the allowable depletion assumed to be equal to value of Orderville station. Water rights already converted to municipal use shown in yellow and are not included in totals of the amount of water that can be converted.

WR #	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
			cfs	Acre-Feet		Sec	T S	R W			
81- 2534	Chat Ranch, LLC	1885	0.3264		I S	26	40	9	20.00	80	45
81- 2964	Chat Ranch, LLC & East Zion SSD	1885	0.13648	33.072	I S	26	40	9	7.268	29	16
81- 4657	Southwest Airways Holding Co.	1885		0.428	I S	26	40	9	0.107	0	0
							Subtotal		20.11	80	45
81- 101	Clear Creek Water, LLC, et al.	3/3/1924	2.2742	529.6759	I	34	40	9	132.419	530	295
81- 4329	Clear Creek Water, LLC, et al.	3/3/1924	0.8587	200	I	34	40	9	50.00	200	112
81- 4308	East Zion Special Service District	3/3/1924	0.00437	1	I	34	40	9	0.25	1	1
81- 4182	East Zion Partners, LLC et al	3/3/1924	0.147	87.341	I	34	40	9	21.5653	86	48
81- 4260	East Zion Special Service District	3/3/1924	0.0225	5.24	I	34	40	9	1.31	5	3
81- 4273	East Zion Special Service District	3/3/1924	0.044	10.25	I	34	40	9	2.5625	10	6
81- 4348	East Zion Special Service District	3/3/1924	0.0642	15	I	34	40	9	3.75	15	8
81- 4393	East Zion Special Service District	3/3/1924		10	I	34	40	9	2.5	10	6
81- 4661	East Zion Special Service District	3/3/1924		3	I	34	40	9	0.75	3	2
81- 4662	East Zion Special Service District	3/3/1924		53	I	34	40	9	13.25	53	30
81- 4330	Robert and Sandra Horton	3/3/1924		4.7999	I	34	40	9	1.1992	5	3
81- 5047	East Zion Special Service District	3/3/1924	0.03933	9	I	34	40	9	2.25	9	5
81- 5087	Zion Mountain Land Holdings LLC	3/3/1924	0.0041	3.333	I	34	40	9	0.834	3	2
							Subtotal		206.02	824	459
					Duty AF/A =		4.00				
									Converted		
					CU AF/A =		2.23		7	29	16
									27	106	59

Table A11: Priority list for the East Fork Virgin River above Barracks Ranch. Water rights taken from East Fork Distribution System. Diversion allowance is 4.00 acre-feet per acre and depletion is 2.23 acre-feet per acre based on the Orderville station.

WR Num	Owner	Priority Date	Quantity		Uses	Location			Acres, Sole Supply	Allowable Diversion	Allowable Depletion
			CFS	Acre-Feet		Sec	T S	R W			
81-1139	Orderville Irrigation Co.	1865	4.42	1,062.00	I	27	40	7	265.50	1,062	592
81-1141	Mt. Carmel Irrigation Co.	1865	6.58		I	9	41	7	404.00	1,616	901
81-1673	Glendale Irrigation Co.	1865	7.23		I	11	40	7	434.00	1,736	968
81-2960	Barry & Judy Ford Trust	1865	0.50		I	11	40	7	28.20	113	63
81-2953	Muddy Creek Irrigation Co.	1880	2.47		I	1	41	8	148.80	595	332
									1,280.50	**5,122**	**2,856**
81-1138	Thunderbird Acquistions LLC	1890	0.23		I	19	41	7	13.50	54	30
81-1140	Orderville Irrigation Co.	1900	0.27	82.20	I	27	40	7	20.55	82	46
81-1155	Barracks Ranch	1890	0.06	12.59	I	36	41	8	3.15	13	7
81-2704	Grassy Canyon Hideaway	1890	0.25	58.80	I S Oth	35	39	7	12.17	49	27
81-2705	Grassy Canyon Hideaway	1890	0.16		I S	1	40	7	10.00	40	22
81-2778	Clair & Betty Hall	1890	0.25	59.28	I	17	39	6	14.82	59	33
81-2990	Dennis MacDonald et al	1890	0.18		I	9	39	6	11.00	44	25
81-2992	Little Bit of Heaven Inc et al	1890	0.15		I	16	39	6	9.00	36	20
81-4666	Long Valley Land Co.	1890	0.05	11.00	I	17	39	6	2.75	11	6
81-4703	Foote Family Trust	1890		13.40	I D S	36	41	8	2.99	12	7
81-2779	Lauren M. Varney	1900	0.30		I S	17	39	6	18.20	73	41
81-2780	Graham/Mary Duncan et al	1900	0.20		I S	17	39	6	12.10	48	27
81-2781	Karl J. MacDonald	1900	0.24		I S	17	39	6	14.10	56	31
81-2993	Little Bit of Heaven Inc et al	1900	0.28		I	16	39	6	16.80	67	37
									161.12	**644**	**359**
81-2706	Carroll Revocable Trust	1902	0.09		I S	1	40	7	**5.80**	**23**	**13**
81-91	Barracks Ranch	6/22/1922	1.88	170.56	I	36	41	8	**33.95**	**136**	**76**
81-342	Barracks Ranch et al	2/15/1963	1.52	138.56	I	36	41	8	**33.95**	**136**	**76**
								Total	**1,515.32**	**6061**	**3379**

Table A12: Estimate of the amount of irrigation water that reasonably can be converted to municipal use from the Santa Clara River.

Water User	Duty	2010	2011	2012	2013	2014	2015	2016	2017
Pine Valley Irigation Co.	4.00	1,414	1,721	1,575	1,419	1,112	1,370	1,408	2,019
Central Canal	5.00	2,199	3,595	978	1,487	577	756	941	1,742
Veyo Irrigation	5.00	1,183	1,593	965	1,045	341	567	809	1,117
Gunlock Irrigation	5.00		742	611	590		548	478	
Gunlock Field	5.00	806	808	608	601	366	656	449	856
Gunlock Town	5.00	540				329	547	424	537
New Santa Clara Fields Canal Co.	6.00	2,186	1,457	1,494	915	1,011	1,259	1,059	1,293
St. George Clara Field Canal Co.	6.00	2,233	3,081	2,963	3,192	2,702	858	2,881	3,154
Ivins Irrigation Co.	6.00	1,529	1,394	1,301	1,353	1,157	1,150	1,027	1,245
Shivwits Band of the Paiute Tribe		827	894	1,043	900	800	657	453	1,095
Instream Flow (3 cfs)		2,036	612	1,721	2,061	2,167	1,416	2,179	2,315
Irrigation diversions, not including Shivwits or Instream Flow		12,090	14,391	10,495	10,602	7,595	7,711	9,476	11,963

Two consecutive years with lowest diversions: 2014 and 2015

Calculate equivalent acreage:	Diversions		Equivalent Acres			Irr to
	2014	2015	2014	2015	CU AF/A	Mun
4.00 AF/A Duty	1,112	1,370	278	343	2.74	850
5.00 AF/A Duty	1,613	3,074	323	615	2.74	1,284
6.00 AF/A Duty	4,870	3,267	812	545	3.58	2,428
	7,595	7,711				4,562

Consumptive Use for acreage above Gunlock Reservoir based on Veyo station, 32.87 inches or 2.74 ft. and acreage below Gunlock Reservoir based on St. George station, 43.00 inches or 3.58 ft.

Use 4,500 Acre-Feet

Appendix B

Monthly Demand-Yield Analysis

Monthly_Demand_&_Yield

Modeling data used to construct the demand-yield curve and the evaluate water availability at the Virgin River at Virgin gauge

Monthly Flow in Acre-Feet for Virgin River nr Virgin USGS 0940600

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Check
1987	7841	7638	9852	16566	12924	5518	4540	6716	4627	7730	12660	8128	104741	104740
1988	8118	8309	10147	24188	21656	8727	5572	8436	5603	5359	6559	7269	119944	119943
1989	7160	7910	14085	9711	6079	3907	4286	4941	3548	4621	6290	6649	79188	79187
1990	6781	6339	7240	7924	6113	3947	4143	4600	4625	5661	6048	6631	70052	70052
1991	7091	6240	10385	9562	10693	5411	4140	4096	3996	4742	6591	6938	79885	79885
1992	7079	8392	13743	19353	12272	5516	4334	5714	4409	7345	7164	7690	103012	103011
1993	19008	25323	33878	58364	69747	15205	7184	6698	4873	8684	8898	8860	266721	266722
1994	8701	9683	11540	13853	12111	5393	4054	4296	5129	6018	6502	7609	94889	94889
1995	11550	12916	37543	28697	54817	28536	9055	6950	6807	6480	8567	8485	220403	220403
1996	8265	12089	9713	7801	5706	4026	4294	4237	3937	4990	8900	9382	83341	83340
1997	15610	8858	11111	12268	8904	4935	3731	7281	13367	9495	7626	7787	110973	110973
1998	7928	9342	16302	29266	52356	17917	9824	5859	15638	9808	9832	9124	193196	193196
1999	8674	8148	8225	9590	11653	7724	6643	7250	4992	5062	6526	7164	91650	91651
2000	7361	8961	11599	16727	10181	4701	4003	4370	3880	7498	7031	7380	93691	93692
2001	7254	7200	11476	17109	16169	5189	4328	5459	3535	4580	5861	7016	95175	95176
2002	7940	6147	6143	5135	3987	3025	3421	3074	4895	5907	8122	6670	64467	64466
2003	7113	7781	9836	8102	8342	3773	3495	4360	3620	4199	6028	6843	73492	73492
2004	6633	7509	9552	13267	7821	3753	3925	3993	2331	20376	14414	10147	103722	103721
2005	53728	25740	30982	57241	1E+05	35879	8866	9796	5901	8832	7938	8053	359270	359270
2006	7995	7974	12783	24339	18591	5788	7577	5274	5193	8799	6787	7295	118395	118395
2007	7186	6807	7712	6651	5357	3638	4657	7607	6309	4967	6042	9800	76733	76733
2008	11673	9007	10685	12526	12236	5794	4897	4623	3812	5076	6660	5591	92580	92580
2009	8519	7841	8763	14993	15673	6258	4447	3812	3822	4739	6079	6869	91815	91815
2010	7815	8668	12028	22461	33951	11151	5268	6490	4570	9291	7753	54040	183485	183486
2011	11863	9497	19521	53292	65371	24409	8214	6383	6688	9473	9927	9427	234065	234065
2012	8180	7950	9745	11778	6192	3913	4552	6224	5226	5570	6551	6976	82858	82857
2013	6147	7367	8757	9483	7557	3739	5371	7000	8577	7099	9705	8093	88893	88895
2014	8319	6934	7345	5722	5078	3414	3911	5738	13523	5488	6087	6817	78377	78376
2015	7103	6107	8186	5905	6458	4372	4810	4998	8642	9453	6849	7654	80537	80537
2016	8582	9737	11718	17829	14283	5749	4195	8275	8440	5703	7939	11554	114006	114004
2017	14658	20668	24510	35669	17542	5685	5964	5577	5069	5740	7555	8150	156787	156787

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
St George	Alfalfa CU inches	1.58	4.24	6.92	8.00	7.79	6.66	5.02	2.80	43.00
La Verkin	Alfalfa CU inches	0.65	4.28	5.83	6.94	7.46	6.58	4.57	2.03	38.34
	Duty 6 AF/A	0.15	0.64	0.94	1.10	1.13	0.99	0.71	0.35	6.00

Assume 40% of acreage is represented by St. George station and 60% by the La Verkin station

# Acres	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Annual
1000	153	637	935	1099	1133	987	709	349	6003
2500	381	1591	2339	2748	2834	2468	1773	873	15007
3500	534	2228	3274	3848	3967	3455	2482	1222	21009
3300	503	2101	3087	3628	3740	3257	2340	1152	19809
3720	568	2368	3480	4090	4216	3672	2638	1298	22330
4000	610	2546	3742	4398	4534	3948	2837	1396	24011
6000	915	3819	5613	6596	6800	5923	4255	2094	36016
7500	1144	4774	7016	8245	8501	7403	5318	2618	45020

The following calculations show the amount of water available for 1000 acres, 2500 acres, 3500 acres, 4000 acres, 6500 acres and 7500 acres using an ideal irrigation demand pattern. Months in which shortage occur are highlighted in pink

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	
1000 Acres	1988	153	637	935	1099	1133	987	709	349	
	1989	153	637	935	1099	1133	987	709	349	
	1990	153	637	935	1099	1133	987	709	349	
	1991	153	637	935	1099	1133	987	709	349	
	1992	153	637	935	1099	1133	987	709	349	
	1993	153	637	935	1099	1133	987	709	349	
	1994	153	637	935	1099	1133	987	709	349	
	1995	153	637	935	1099	1133	987	709	349	
	1996	153	637	935	1099	1133	987	709	349	
	1997	153	637	935	1099	1133	987	709	349	
	1998									
	1999									
	2000	153	637	935	1099	1133	987	709	349	6003
	2001	153	637	935	1099	1133	987	709	349	
	2002	153	637	935	1099	1133	987	709	349	
	2003									
	2004									
	2005									
	2006									
	2007									
	2008	No shortage at 1000 acres level								
	2009									
	2010									
	2011									

	2012										
	2013										
	2014										
	2015										
	2016	153	637	935	1099	1133	987	709	349		
	2017	153	637	935	1099	1133	987	709	349		
										Average	6000
		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
2,500 Acres	1987	381	1591	2339	2748	2834	2468	1773	873		15007
	1988	381	1591	2339	2748	2834	2468	1773	873		15007
	1989	381	1591	2339	2748	2834	2468	1773	873		15007
	1990	381	1591	2339	2748	2834	2468	1773	873		15007
	1991	381	1591	2339	2748	2834	2468	1773	873		15007
	1992	381	1591	2339	2748	2834	2468	1773	873		15007
	1993	381	1591	2339	2748	2834	2468	1773	873		15007
	1994	381	1591	2339	2748	2834	2468	1773	873		15007
	1995	381	1591	2339	2748	2834	2468	1773	873		15007
	1996	381	1591	2339	2748	2834	2468	1773	873		15007
	1997	381	1591	2339	2748	2834	2468	1773	873		15007
	1998	381	1591	2339	2748	2834	2468	1773	873		15007
	1999	381	1591	2339	2748	2834	2468	1773	873		15007
	2000	381	1591	2339	2748	2834	2468	1773	873		15007
	2001	381	1591	2339	2748	2834	2468	1773	873		15007
	2002	381	1591	2339	2748	2834	2468	1773	873		15007
	2003	381	1591	2339	2748	2834	2468	1773	873		15007
	2004	381	1591	2339	2748	2834	2468	1773	873		15007
	2005	381	1591	2339	2748	2834	2468	1773	873		15007
	2006	381	1591	2339	2748	2834	2468	1773	873		15007
	2007	381	1591	2339	2748	2834	2468	1773	873		15007
	2008	381	1591	2339	2748	2834	2468	1773	873		15007
	2009	381	1591	2339	2748	2834	2468	1773	873		15007
	2010	381	1591	2339	2748	2834	2468	1773	873		15007
	2011	381	1591	2339	2748	2834	2468	1773	873		15007
	2012	381	1591	2339	2748	2834	2468	1773	873		15007
	2013	381	1591	2339	2748	2834	2468	1773	873		15007
	2014	381	1591	2339	2748	2834	2468	1773	873		15007
	2015	381	1591	2339	2748	2834	2468	1773	873		15007
	2016	381	1591	2339	2748	2834	2468	1773	873		15007
	2017	381	1591	2339	2748	2834	2468	1773	873		15007
	No shortages for 2,500 acres									Average	

Monthly_Demand_&_Yield

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
3500 acres	1988	534	2228	3274	3848	3967	3455	2482	1222		21009
	1989	534	2228	3274	3848	3967	3455	2482	1222		21009
	1990	534	2228	3274	3848	3967	3455	2482	1222		21009
	1991	534	2228	3274	3848	3967	3455	2482	1222		21009
	1992	534	2228	3274	3848	3967	3455	2482	1222		21009
	1993	534	2228	3274	3848	3967	3455	2482	1222		21009
	1994	534	2228	3274	3848	3967	3455	2482	1222		21009
	1995	534	2228	3274	3848	3967	3455	2482	1222		21009
	1996	534	2228	3274	3848	3967	3455	2482	1222		21009
	1997	534	2228	3274	3848	3731	3455	2482	1222		20773
	1998	534	2228	3274	3848	3967	3455	2482	1222		21009
	1999	534	2228	3274	3848	3967	3455	2482	1222		21009
	2000	534	2228	3274	3848	3967	3455	2482	1222		21009
	2001	534	2228	3274	3848	3967	3455	2482	1222		21009
	2002	534	2228	3274	3025	3421	3074	2482	1222		19260
	2003	534	2228	3274	3773	3495	3455	2482	1222		20463
	2004	534	2228	3274	3753	3925	3455	2331	1222		20722
	2005	534	2228	3274	3848	3967	3455	2482	1222		21009
	2006	534	2228	3274	3848	3967	3455	2482	1222		21009
	2007	534	2228	3274	3638	3967	3455	2482	1222		20800
	2008	534	2228	3274	3848	3967	3455	2482	1222		21009
	2009	534	2228	3274	3848	3967	3455	2482	1222		21009
	2010	534	2228	3274	3848	3967	3455	2482	1222		21009
	2011	534	2228	3274	3848	3967	3455	2482	1222		21009
	2012	534	2228	3274	3848	3967	3455	2482	1222		21009
	2013	534	2228	3274	3739	3967	3455	2482	1222		20901
	2014	534	2228	3274	3414	3911	3455	2482	1222		20520
	2015	534	2228	3274	3848	3967	3455	2482	1222		21009
	2016	534	2228	3274	3848	3967	3455	2482	1222		21009
	2017	534	2228	3274	3848	3967	3455	2482	1222		21009
At 3,500 acres 6 of 30 years experience shortages										Average	20888

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct		
	1988	610	2546	3742	4398	4534	3948	2837	1396		24011
4,000 Acres	1989	610	2546	3742	3907	4286	3948	2837	1396		23273
	1990	610	2546	3742	3947	4143	3948	2837	1396		23170
	1991	610	2546	3742	4398	4140	3948	2837	1396		23617
	1992	610	2546	3742	4398	4334	3948	2837	1396		23811

Monthly_Demand_&_Yield

	1993	610	2546	3742	4398	4534	3948	2837	1396	24011
	1994	610	2546	3742	4398	4054	3948	2837	1396	23531
	1995	610	2546	3742	4398	4534	3948	2837	1396	24011
	1996	610	2546	3742	4026	4294	3948	2837	1396	23400
	1997	610	2546	3742	4398	3731	3948	2837	1396	23208
	1998	610	2546	3742	4398	4534	3948	2837	1396	24011
	1999	610	2546	3742	4398	4534	3948	2837	1396	24011
	2000	610	2546	3742	4398	4003	3948	2837	1396	23480
	2001	610	2546	3742	4398	4328	3948	2837	1396	23805
	2002	610	2546	3742	3025	3421	3074	2837	1396	20651
	2003	610	2546	3742	3773	3495	3948	2837	1396	22348
	2004	610	2546	3742	3753	3925	3948	2331	1396	22252
	2005	610	2546	3742	4398	4534	3948	2837	1396	24011
	2006	610	2546	3742	4398	4534	3948	2837	1396	24011
	2007	610	2546	3742	3638	4534	3948	2837	1396	23251
	2008	610	2546	3742	4398	4534	3948	2837	1396	24011
	2009	610	2546	3742	4398	4447	3812	2837	1396	23788
	2010	610	2546	3742	4398	4534	3948	2837	1396	24011
	2011	610	2546	3742	4398	4534	3948	2837	1396	24011
	2012	610	2546	3742	3913	4534	3948	2837	1396	23526
	2013	610	2546	3742	3739	4534	3948	2837	1396	23352
	2014	610	2546	3742	3414	3911	3948	2837	1396	22405
	2015	610	2546	3742	4372	4534	3948	2837	1396	23985
	2016	610	2546	3742	4398	4195	3948	2837	1396	23672
	2017	610	2546	3742	4398	4534	3948	2837	1396	24011
At 4,000 acres for the 30 yr period 1988-2017, 19 years experience shortages										Average 23488

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	
6000 acres	1988	915	3819	5613	6596	5572	5923	4255	2094	34788
	1989	915	3819	5613	3907	4286	4941	3548	2094	29124
	1990	915	3819	5613	3947	4143	4600	4255	2094	29387
	1991	915	3819	5613	5411	4140	4096	3996	2094	30085
	1992	915	3819	5613	5516	4334	5714	4255	2094	32261
	1993	915	3819	5613	6596	6800	5923	4255	2094	36016
	1994	915	3819	5613	5393	4054	4296	4255	2094	30440
	1995	915	3819	5613	6596	6800	5923	4255	2094	36016
	1996	915	3819	5613	4026	4294	4237	3937	2094	28936
	1997	915	3819	5613	4935	3731	5923	4255	2094	31285
	1998	915	3819	5613	6596	6800	5859	4255	2094	35952

1999	915	3819	5613	6596	6643	5923	4255	2094		35859
2000	915	3819	5613	4701	4003	4370	3880	2094		29396
2001	915	3819	5613	5189	4328	5459	3535	2094		30953
2002	915	3819	3987	3025	3421	3074	4255	2094		24591
2003	915	3819	5613	3773	3495	4360	3620	2094		27690
2004	915	3819	5613	3753	3925	3993	2331	2094		26444
2005	915	3819	5613	6596	6800	5923	4255	2094		36016
2006	915	3819	5613	5788	6800	5274	4255	2094		34559
2007	915	3819	5357	3638	4657	5923	4255	2094		30659
2008	915	3819	5613	5794	4897	4623	3812	2094		31568
2009	915	3819	5613	6258	4447	3812	3822	2094		30781
2010	915	3819	5613	6596	5268	5923	4255	2094		34484
2011	915	3819	5613	6596	6800	5923	4255	2094		36016
2012	915	3819	5613	3913	4552	5923	4255	2094		31084
2013	915	3819	5613	3739	5371	5923	4255	2094		31729
2014	915	3819	5078	3414	3911	5738	4255	2094		29225
2015	915	3819	5613	4372	4810	4998	4255	2094		30877
2016	915	3819	5613	5749	4195	5923	4255	2094		32563
2017	915	3819	5613	5685	5964	5577	4255	2094		33923
At 6,500 acres 26 of 30 years experience shortages									Average	31757

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	
	1988	1144	4774	7016	8245	5572	7403	5318	2618	42092
7,500 Acres	1989	1144	4774	6079	3907	4286	4941	3548	2618	31297
	1990	1144	4774	6113	3947	4143	4600	4625	2618	31964
	1991	1144	4774	7016	5411	4140	4096	3996	2618	33195
	1992	1144	4774	7016	5516	4334	5714	4409	2618	35525
	1993	1144	4774	7016	8245	7184	6698	4873	2618	42553
	1994	1144	4774	7016	5393	4054	4296	5129	2618	34424
	1995	1144	4774	7016	8245	8501	6950	5318	2618	44567
	1996	1144	4774	5706	4026	4294	4237	3937	2618	30736
	1997	1144	4774	7016	4935	3731	7281	5318	2618	36818
	1998	1144	4774	7016	8245	8501	5859	5318	2618	43476
	1999	1144	4774	7016	7724	6643	7250	4992	2618	42161
	2000	1144	4774	7016	4701	4003	4370	3880	2618	32506
	2001	1144	4774	7016	5189	4328	5459	3535	2618	34063
	2002	1144	4774	3987	3025	3421	3074	4895	2618	26938
	2003	1144	4774	7016	3773	3495	4360	3620	2618	30800
	2004	1144	4774	7016	3753	3925	3993	2331	2618	29554
	2005	1144	4774	7016	8245	8501	7403	5318	2618	45020

Monthly_Demand_&_Yield

2006	1144	4774	7016	5788	7577	5274	5193	2618		39384
2007	1144	4774	5357	3638	4657	7403	5318	2618		34910
2008	1144	4774	7016	5794	4897	4623	3812	2618		34678
2009	1144	4774	7016	6258	4447	3812	3822	2618		33891
2010	1144	4774	7016	8245	5268	6490	4570	2618		40126
2011	1144	4774	7016	8245	8214	6383	5318	2618		43713
2012	1144	4774	6192	3913	4552	6224	5226	2618		34643
2013	1144	4774	7016	3739	5371	7000	5318	2618		36981
2014	1144	4774	5078	3414	3911	5738	5318	2618		31996
2015	1144	4774	6458	4372	4810	4998	5318	2618		34493
2016	1144	4774	7016	5749	4195	7403	5318	2618		38218
2017	1144	4774	7016	5685	5964	5577	5069	2618		37847
									Average	36286

Demand-Yield Curve Analysis for Leeds Creek, USGS gauge #09408000,

Average monthly flow for Leeds Creek in CFS

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1988	4.92	6.75	7.43	10.7	16.8	19.8	8.99	21.6	6.01	4.8	4.78	4.73
1989	4.75	4.13	4.91	4.4	4.44	3.76	2.74	2.52	1.92	2.3	2.24	2.39
1990	2.35	2.4	2.71	2.78	2.31	2.9	2.35	2.55	2.26	2.31	2.66	2.01
1991	2.18	2.32	4.21	7.83	5.84	8.93	8.02	4.73	3.93	3.06	3.01	2.62
1992	3.04	5.25	12.1	13.2	14.7	15.9	8.9	5.81	4.76	4.24	3.99	3.76
1993	12.2	18.3	28.5	32.1	28.6	31.6	23.4	13.1	7.81	7.38	6.35	5.59
1994	4.9	5.22	6.52	7.47	8.48	8.63	5.01	4.3	3.52	3.55	3.56	3.72
1995	5.82	10.9	25.9	17.5	17.5	24.1	30.3	15.1	8.67	6.32	5.76	4.91
1996	4.27	4.58	5.09	5.03	3.7	2.56	2.93	2.26	2.25	2.38	3.39	3.51
1997	6.7	5.7	5.65	6.02	6.39	7.81	4.93	3.56	4.18	3.47	3.73	3.8
1998	4.08	5.99	13.1	19.2	22.2	22.2	27.5	13.8	9.41	7.59	7.24	6.05
1999	5.29	4.86	4.24	4.23	3.99	5.45	5.93	4.14	3.2	2.81	2.84	3.31
2000	2.83	3.2	5.75	6.38	7.68	7.68	4.73	3.24	2.97	3.22	4.02	3.85
2001	3.85	4.71	7.42	9.34	11.2	13.1	8.06	4.53	3.25	2.83	2.95	2.99
2002	2.87	2.46	2.38	2.28	1.96	1.37	0.98	0.84	0.985	1.17	1.56	1.59
2003	1.59	1.99	3.83	3.69	3.16	2.28	2.55	2.89	2.36	1.93	2.32	2.59
2004	2.74	3.29	7.38	7.48	8.19	10.3	7.52	4.91	3.52	9.95	10.3	10.4
2005	60.7	34.7	25.8	23.9	32	45.8	33.1	20.6	10.4	7.46	6.32	5.6
2006	4.91	4.22	5.76	7.2	8.08	8.92	5.65	3.37	2.86	3.55	3.94	2.64
2007	2.54	3.01	2.62	2.39	1.69	1.1	0.91	1.07	1.83	1.36	1.7	2.36
2008	2.55	3.61	5.22	5.13	6.65	7.79	5.94	4.8	3.33	3.16	3.43	2.8
2009	3.94	6.3	5.75	6.57	8.35	10.6	6.06	4.07	3.34	3.04	3.46	3.22
2010	3.34	5.06	13.1	13.7	13.7	18.3	12.6	6.45	4.36	4.66	5.1	46.8
2011	11.5	11.2	14.6	14.9	15.8	21.7	19.3	10.5	7.27	5.27	4.86	4.65
2012	4.38	4.22	4.22	4.23	4.7	3.79	3.02	3.37	3.34	2.89	2.87	2.89
2013	2.71	2.85	3.33	3.89	3.93	3.63	3.39	3.01	10.7	5.71	4.54	4.06
2014	3.77	3.31	3.18	3	2.58	2.1	1.99	2.3	2.4	2.19	2.38	2.51
2015	2.5	2.6	3.26	3.05	3.37	4.69	3.37	2.82	2.51	2.63	2.76	2.63
2016	2.87	3.43	3.74	5.66	9.94	10	5.55	3.38	2.84	2.94	2.96	3.38
2017	4.78	14.5	13.7	13.8	15.4	17.3	10.6	6.91	4.64	3.79	3.61	3.67

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Average monthly flow for Leeds Creek in acre-feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
# Days	31	28	31	30	31	30	31	31	30	31	30	31	
1988	303	375	457	637	1,033	1,178	553	1,328	358	295	284	291	7,091
1989	292	229	302	262	273	224	168	155	114	141	133	147	2,441
1990	144	133	167	165	142	173	144	157	134	142	158	124	1,784
1991	134	129	259	466	359	531	493	291	234	188	179	161	3,424
1992	187	292	744	785	904	946	547	357	283	261	237	231	5,775
1993	750	1,016	1,752	1,910	1,759	1,880	1,439	805	465	454	378	344	12,952
1994	301	290	401	445	521	514	308	264	209	218	212	229	3,912
1995	358	605	1,593	1,041	1,076	1,434	1,863	928	516	389	343	302	10,448
1996	263	254	313	299	228	152	180	139	134	146	202	216	2,526
1997	412	317	347	358	393	465	303	219	249	213	222	234	3,732
1998	251	333	805	1,142	1,365	1,321	1,691	849	560	467	431	372	9,587
1999	325	270	261	252	245	324	365	255	190	173	169	204	3,032
2000	174	178	354	380	472	457	291	199	177	198	239	237	3,355
2001	237	261	456	556	686	781	496	278	193	174	176	184	4,478
2002	177	136	146	136	120	79	60	52	59	72	94	98	1,229
2003	99	111	235	219	195	136	157	177	78	119	87	143	1,756
2004	90	189	453	445	504	619	463	302	210	612	616	643	5,146
2005	3734	1930	1587	1420	1964	2723	2041	1263	620	463	377	347	18,469
2006	308	231	353	428	496	530	348	207	171	219	221	162	3,674
2007	156	167	160	142	104	65	56	66	108	84	101	146	1,355
2008	33	131	323	306	409	463	365	295	198	193	233	151	3,100
2009	220	348	354	391	512	624	372	250	199	187	206	198	3,861
2010	205	281	805	817	835	1083	773	397	259	286	223	2725	8,689
2011	685	629	891	885	970	1297	1184	644	433	324	288	286	8,516
2012	267	242	259	252	288	225	186	207	199	178	172	174	2,649
2013	77	161	205	232	242	216	208	186	636	351	270	190	2,974
2014	231	184	195	178	159	124	122	142	143	135	142	137	1,892
2015	128	144	201	182	208	279	207	173	149	161	164	161	2,157
2016	175	199	232	336	611	595	341	208	169	181	176	208	3,431
2017	294	807	843	821	947	1032	653	425	276	233	215	226	6,772
Alfalfa CU			0.65	4.28	5.83	6.94	7.46	6.58	4.57	2.03			38.34

Duty 6 AF/A	0.10	0.67	0.91	1.09	1.17	1.03	0.72	0.32	6.00
50	5	33	46	54	58	51	36	16	300
100	10	67	91	109	117	103	72	32	600
250	25	168	228	273	293	258	180	80	1503
500	50	335	456	543	584	515	358	159	2999
750	75	502	684	815	876	772	536	238	4499
1000	100	670	912	1086	1167	1030	715	318	5998
50 Acres									
1988	5	33	46	54	58	51	36	16	300
1989	5	33	46	54	58	51	36	16	300
1990	5	33	46	54	58	51	36	16	300
1991	5	33	46	54	58	51	36	16	300
1992	5	33	46	54	58	51	36	16	300
1993	5	33	46	54	58	51	36	16	300
1994	5	33	46	54	58	51	36	16	300
1995	5	33	46	54	58	51	36	16	300
1996	5	33	46	54	58	51	36	16	300
1997	5	33	46	54	58	51	36	16	300
1998	5	33	46	54	58	51	36	16	300
1999	5	33	46	54	58	51	36	16	300
2000	5	33	46	54	58	51	36	16	300
2001	5	33	46	54	58	51	36	16	300
2002	5	33	46	54	58	51	36	16	300
2003	5	33	46	54	58	51	36	16	300
2004	5	33	46	54	58	51	36	16	300
2005	5	33	46	54	58	51	36	16	300
2006	5	33	46	54	58	51	36	16	300
2007	5	33	46	54	56	51	36	16	298
2008	5	33	46	54	58	51	36	16	300
2009	5	33	46	54	58	51	36	16	300
2010	5	33	46	54	58	51	36	16	300
2011	5	33	46	54	58	51	36	16	300
2012	5	33	46	54	58	51	36	16	300
2013	5	33	46	54	58	51	36	16	300

2014	5	33	46	54	58	51	36	16	300	
2015	5	33	46	54	58	51	36	16	300	
2016	5	33	46	54	58	51	36	16	300	
2017	5	33	46	54	58	51	36	16	300	
									8995	300
100 Acres										
1988	10	67	91	109	117	103	72	32	600	
1989	10	67	91	109	117	103	72	32	600	
1990	10	67	91	109	117	103	72	32	600	
1991	10	67	91	109	117	103	72	32	600	
1992	10	67	91	109	117	103	72	32	600	
1993	10	67	91	109	117	103	72	32	600	
1994	10	67	91	109	117	103	72	32	600	
1995	10	67	91	109	117	103	72	32	600	
1996	10	67	91	109	117	103	72	32	600	
1997	10	67	91	109	117	103	72	32	600	
1998	10	67	91	109	117	103	72	32	600	
1999	10	67	91	109	117	103	72	32	600	
2000	10	67	91	109	117	103	72	32	600	
2001	10	67	91	109	117	103	72	32	600	
2002	10	67	91	79	60	52	59	32	450	
2003	10	67	91	109	117	103	72	32	600	
2004	10	67	91	109	117	103	72	32	600	
2005	10	67	91	109	117	103	72	32	600	
2006	10	67	91	109	117	103	72	32	600	
2007	10	67	91	65	56	66	72	32	459	
2008	10	67	91	109	117	103	72	32	600	
2009	10	67	91	109	117	103	72	32	600	
2010	10	67	91	109	117	103	72	32	600	
2011	10	67	91	109	117	103	72	32	600	
2012	10	67	91	109	117	103	72	32	600	
2013	10	67	91	109	117	103	72	32	600	
2014	10	67	91	109	117	103	72	32	600	
2015	10	67	91	109	117	103	72	32	600	
2016	10	67	91	109	117	103	72	32	600	

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2017	10	67	91	109	117	103	72	32	600	
									17704	590
250 Acres										
1988	25	168	228	273	293	258	180	80	1,503	
1989	25	168	228	224	168	155	114	80	1,162	
1990	25	165	142	173	144	157	134	80	1,021	
1991	25	168	228	273	293	258	180	80	1,503	
1992	25	168	228	273	293	258	180	80	1,503	
1993	25	168	228	273	293	258	180	80	1,503	
1994	25	168	228	273	293	258	180	80	1,503	
1995	25	168	228	273	293	258	180	80	1,503	
1996	25	168	228	152	180	139	134	80	1,105	
1997	25	168	228	273	293	219	180	80	1,464	
1998	25	168	228	273	293	258	180	80	1,503	
1999	25	168	228	273	293	255	180	80	1,500	
2000	25	168	228	273	291	199	177	80	1440	
2001	25	168	228	273	293	258	180	80	1503	
2002	25	136	120	79	60	52	59	72	603	Shortages: 16 of 30 yrs
2003	25	168	195	136	157	177	78	80	1016	
2004	25	168	228	273	293	258	180	80	1503	
2005	25	168	228	273	293	258	180	80	1503	
2006	25	168	228	273	293	207	171	80	1444	
2007	25	142	104	65	56	66	108	80	646	
2008	25	168	228	273	293	258	180	80	1503	
2009	25	168	228	273	293	250	180	80	1496	
2010	25	168	228	273	293	258	180	80	1503	
2011	25	168	228	273	293	258	180	80	1503	
2012	25	168	228	225	186	207	180	80	1299	
2013	25	168	228	216	208	186	180	80	1291	
2014	25	168	159	124	122	142	143	80	963	
2015	25	168	242	273	208	186	149	80	1330	
2016	25	168	228	273	293	208	169	80	1443	
2017	25	168	228	273	293	258	180	80	1503	
									40264	1342 Yield AF
500 Acres										89.29 Yield %

1988	50	335	456	543	553	515	358	159	2,968	
1989	50	262	273	224	168	155	114	141	1,388	
1990	50	165	142	173	144	157	134	142	1,108	
1991	50	335	359	531	493	291	234	159	2,452	
1992	50	335	456	543	547	357	283	159	2,731	
1993	50	335	456	543	584	515	358	159	2,999	
1994	50	335	456	514	308	264	209	159	2,295	
1995	50	335	456	543	584	515	358	159	2,999	
1996	50	299	228	152	180	139	134	146	1,329	
1997	50	335	393	465	303	219	249	159	2,172	
1998	50	335	456	543	584	515	358	159	2,999	
1999	50	252	245	324	365	255	190	159	1,840	
2000	50	335	456	457	291	199	177	159	2124	
2001	50	335	456	543	496	278	193	159	2510	Shortages: 25 of 30 yrs
2002	50	136	120	79	60	52	59	72	628	
2003	50	219	195	136	157	177	78	119	1131	
2004	50	335	456	543	463	302	210	159	2518	
2005	50	335	456	543	584	515	358	159	2999	
2006	50	335	456	530	348	207	171	159	2256	
2007	50	142	104	65	56	66	108	84	675	
2008	50	306	409	463	365	295	198	159	2245	
2009	50	335	456	543	372	250	199	159	2364	
2010	50	335	456	543	584	397	259	159	2783	
2011	50	335	456	543	584	515	358	159	2999	
2012	50	252	288	225	186	207	199	159	1566	
2013	50	232	242	216	208	186	358	159	1650	
2014	50	178	159	124	122	142	143	135	1053	
2015	50	182	208	279	207	173	149	159	1407	
2016	50	335	456	543	341	208	169	159	2261	
2017	50	335	456	543	584	425	276	159	2828	
									63276	2109 Yield AF
										70 Yield %
1000 Acres										
1988	100	637	912	1,086	553	1,030	358	295	4,970	
1989	100	262	273	224	168	155	114	141	1,438	

1990	100	165	142	173	144	157	134	142	1,158	
1991	100	466	359	531	493	291	234	188	2,662	
1992	100	670	904	946	547	357	283	261	4,068	
1993	100	670	912	1,086	1,167	805	465	318	5,524	
1994	100	445	521	514	308	264	209	218	2,580	
1995	100	670	912	1,086	1,167	928	516	318	5,698	
1996	100	299	228	152	180	139	134	146	1,379	
1997	100	358	393	465	303	219	249	213	2,300	
1998	100	670	912	1086	1167	849	560	318	5,662	
1999	100	252	245	324	365	255	190	173	1,904	
2000	100	380	472	457	291	199	177	198	2274	
2001	100	556	686	781	496	278	193	174	3264	
2002	100	136	120	79	60	52	59	72	678	
2003	100	219	195	136	157	177	78	119	1181	
2004	100	445	504	619	463	302	210	318	2961	
2005	100	670	912	1086	1167	1030	620	318	5903	
2006	100	428	496	530	348	207	171	219	2499	
2007	100	142	104	65	56	66	108	84	725	
2008	100	306	409	463	365	295	198	193	2329	
2009	100	391	512	624	372	250	199	187	2635	
2010	100	670	835	1083	773	397	259	286	4403	
2011	100	670	912	1086	1167	644	433	318	5330	
2012	100	252	288	225	186	207	199	178	1635	
2013	100	232	242	216	208	186	636	318	2138	
2014	100	178	159	124	122	142	143	135	1103	
2015	100	182	208	279	207	173	149	161	1459	
2016	100	336	611	595	341	208	169	181	2541	
2017	100	670	912	1032	653	425	276	233	4301	
									86700	2890

Appendix C

Cease Use Notice, Dated June 30, 2015

GARY R. HERBERT
Governor

SPENCER J. COX
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES

MICHAEL R. STYLER
Executive Director

Division of Water Rights

KENT L. JONES
State Engineer/Division Director

June 30, 2015

Cease Use Notice Regarding Water Rights on the Virgin River and its Tributaries with Priority Date of 1901 or Later

The Virgin River and its tributaries are experiencing significantly diminished flows because of continued drought. Utah state law provides that appropriators shall have priority among themselves according to the dates of their respective appropriations, so that each appropriator is entitled to receive the appropriator's whole supply before any subsequent appropriator has any right (UCA §73-3-21.1(2)(a)). Water users at the Washington Fields Diversion have placed a call on upstream water rights later than their 1900 priority water rights.

With this notice, the state engineer is ordering surface water users on the Virgin River and its tributaries above the Washington Fields Diversion to immediately cease diversion and use of water rights with a priority date of 1901 or later, until further notice. The state engineer's authority to secure the equitable apportionment and distribution of water according to the respective rights of appropriators is outlined in UCA §73-2-1(3). Water users who fail to comply with this notice may be subject to civil and criminal penalties as outlined in statute. In future years water users may be provided verbal notice of priority distribution or water user head gates may be shut or locked with no more notice than a distribution tag secured to the controlling works.

Please be advised that Utah state law (UCA §73-5-4) requires all water users install and maintain controlling works and a measuring device that meet state engineer approval, and to make them accessible to the state engineer or water commissioner. Attached is a priority schedule showing water rights on the Virgin River and its tributaries above the Washington Fields Diversion. For additional information please contact one of the following: Water Commissioner David Jessop at (435) 673-3617, Regional Engineer Kurt Vest at (435) 586-4231, or Distribution Engineer Mike Silva at (801) 538-7430.

Sincerely,

Kent Jones, P.E.
Utah State Engineer

cc: David Jessop, Virgin River Water Commissioner
Kurt Vest, Southwestern Regional Engineer
Ron Thompson, General Manger, WCWCD
John Wadsworth, President, Hurricane Canal Co.
Matt Staheli, President, St. George and Washington Canal

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telephone (801) 538-7240 • facsimile (801) 538-7467 • TTY (801) 538-7458 • *www.waterrights.utah.gov*

Appendix D

Change Application Decisions &

Calculation Sheets for Converting Irrigation Water to Municipal Use

Potential Municipal Conversion Calculations

GARY R. HERBERT
Governor
SPENCER J. COX
Lieutenant Governor

State of Utah

DEPARTMENT OF NATURAL RESOURCES
Division of Water Rights

MICHAEL R. STYLER
Executive Director

KENT L. JONES
State Engineer/Division Director

ORDER OF THE STATE ENGINEER

For Permanent Change Application Number 71-497 (a42873)

JAN 0 3 2018

Permanent Change Application Number 71-497 (a42873) in the name of City of Milford, was filed on August 21, 2017, to change the points of diversion, places of use, and uses of 4.645 cubic feet per second (cfs) or 3184.0528 acre-feet (af) of water as evidenced by Water Right Numbers 71-1226, 71-1227, 71-1270, 71-1936, 71-4699, 71-497, 71-498, 71-499, and 71-500.[1] Heretofore, the water has been diverted from the following points located: (1) Well - South 930 feet and West 275 feet from the NE Corner of Section 7, T28S, R10W, SLB&M (existing 12-inch well, 110 feet deep); (2) Well - North 1250 feet and West 1035 feet from the E¼ Corner of Section 7, T28S, R10W, SLB&M (existing 14-inch well, 533 feet deep); (3) Well - South 1285 feet and West 1160 feet from the E¼ Corner of Section 6, T28S, R10W, SLB&M (existing 12-inch well, 439 feet deep); (4) Well - South 830 feet and West 780 feet from the NE Corner of Section 7, T28S, R10W, SLB&M (existing 7-inch well, 102 feet deep); (5) Well - South 690 feet and West 590 feet from the NE Corner of Section 7, T28S, R10W, SLB&M (existing 16-inch well, 467 feet deep); (6) Well - South 821 feet and West 830 feet from the NE Corner of Section 7, T28S, R10W, SLB&M (existing 16-inch well, 589 feet deep); (7) Well - North 10 feet and West 240 feet from the E¼ Corner of Section 31, T27S, R10W, SLB&M; (8) Well - South 160 feet and East 1250 feet from the NW Corner of Section 18, T28S, R10W, SLB&M; (9) Well - North 90 feet and East 80 feet from the S¼ Corner of Section 13, T29S, R11W, SLB&M (existing 14-inch well, 300 feet deep); (10) Well - North 50 feet and West 50 feet from the S¼ Corner of Section 13, T29S, R11W, SLB&M (existing 16-inch well, 298 feet deep); (11) Well - North 1310 feet and East 20 feet from the S¼ Corner of Section 13, T29S, R11W, SLB&M (existing 16-inch well, 445 feet deep); (12) Well - North 2640 feet and East 20 feet from the S¼ Corner of Section 13, T29S, R11W, SLB&M (existing 16-inch well, 683 feet deep); (13) Well - North 60 feet and West 3390 feet from the SE Corner of Section 7, T28S, R10W, SLB&M (existing 16-inch well, 605 feet deep). The water has been used for the irrigation of 49.85 acres

[1]Right No.	CFS	Acres	EDUs	Other	Municipal	Diversion (acre-feet)
71-497	0.5815				40.0	40.0*
71-498†	1.114				806.8599	806.8599
71-499†	**1.003				**726.4636	**726.4636
71-500†	**1.003				**726.4636	**726.4636
71-1226	0.243				175.97	175.97
71-1227†	1.7035				1,233.8293	1,233.8293
71-1270	0	0.1	1.0			0.85
71-1936	0	46.25		1.08		186.08
71-4699	0	3.5				14.0
Totals	4.645	49.85	1.0	1.08	2,983.1228	3,184.0528

*Historically Water Right 71-497 was used for the irrigation of 10.0 acres of land.
**Water Rights 71-499 and 71-500 are supplemental for a combined total CFS of 1.003 and 726.4636 acre-feet.
†The diversion limit for Water Rights 71-498, 71-499, 71-500, and 71-1227 was evaluated by projecting each flow limit in cubic feet per second, continuously diverted over 365.25 days per year, to account for leap year.

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from March 15 to November 1; year-round, indoor, domestic requirements of 1.00 equivalent domestic unit (EDUs); year-round municipal purposes within the service area of Milford; and year-round recreational purposes (golf course - culinary & sanitation uses limited to 1.08 acre feet). The water has been used in all or portion(s) of Section 31, T27S, R10W, SLB&M; Section 7, T28S, R10W, SLB&M; and Section 13, T29S, R11W, SLB&M.

Hereafter, it is proposed to divert 4.645 cfs or 3184.0528 acre-feet of water from points of diversion changed to: (1) Well - South 2600 feet and West 1330 feet from the NE Corner of Section 12, T28S, R11W, SLB&M (existing 16-inch well, 660 feet deep); (2) Well - South 400 feet and West 1429 feet from the NE Corner of Section 17, T28S, R10W, SLB&M (existing 12-inch well, 650 feet deep); (3) Well - South 690 feet and West 590 feet from the NE Corner of Section 7, T28S, R10W, SLB&M (existing 16-inch well, 589 feet deep); (4) Well - North 1250 feet and West 1035 feet from the E¼ Corner of Section 7, T28S, R10W, SLB&M (existing 14-inch well, 533 feet deep); (5) Well - South 79 feet and East 423 feet from the N¼ Corner of Section 13, T28S, R11W, SLB&M (existing 16-inch well, 351 feet deep); (6) Well - South 1285 feet and West 1160 feet from the E¼ Corner of Section 6, T28S, R10W, SLB&M (existing 12-inch well, 439 feet deep); (7) Well - South 821 feet and West 830 feet from the NE Corner of Section 7, T28S, R10W, SLB&M (existing 16-inch well, 589 feet deep); (8) Well - North 60 feet and West 3390 feet from the SE Corner of Section 7, T28S, R10W, SLB&M (existing 16-inch well, 605 feet deep); (9) Well - South 50 feet and East 70 feet from the N¼ Corner of Section 12, T28S, R11W, SLB&M (existing 16-inch well, 420 feet deep); (10) Well - South 40 feet and East 1320 feet from the N¼ Corner of Section 12, T28S, R11W, SLB&M (existing 16-inch well, 640 feet deep). The water is to be used for year-round municipal purposes within the service area of Milford.

Notice of the application was published in the Beaver County Journal on September 6 and 13, 2017. The application was protested by Green Diamond Ranch, a hearing was requested but subsequently the request was withdrawn.

The protestant's concerns are summarized as follows:

1. Several of the wells proposed under the application appear to be irrigation wells located south of the City's boundaries and adjacent to the Green Diamond property and its numerous irrigation wells. The project appears to be for commercial irrigation purposes rather than a recognized municipal use.

2. Whereas the valley is currently being mined insomuch that more water is being depleted from the valley than is being recharged, the protestant is concerned that putting this water to use will further exacerbate the situation and cause quantity impairment to protestant's existing rights.

The applicant responded as follows:

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1. Milford City has entered into a contract to sell surplus water. The city has the right to sell surplus water as confirmed in case law: *County Water System, Inc. V. Salt Lake City, 3 Utah 2d 46, 278 P.2d 285 (1954).* Additionally the applicant quotes from UCA §10-8-14 (2)(a) and (d). The subject wells are located on property owned by the City and there is no attempt to sell water rights, only "water that is surplus to the present needs of the residents of Milford City".

2. While it is concerning that the aquifer continues to be in a state of decline, the City has at no time exceeded their water rights and has documentation supporting the stance. The application does not propose to pump additional water, only those water rights currently owned by the City.

While the State Engineer recognizes the concerns of the protestant it appears that this application meets the statutory requirements for approval and that it can be approved without adversely affecting existing rights. The applicant is put on notice that diligence must be shown in pursuing the development of this application which can be demonstrated by the completion of the project as proposed in the change application.

In evaluating applications which propose to change the nature of use of a water right, the State Engineer believes it is appropriate to examine the rates and amounts of hydrologic depletion associated with the historical water use as compared to the proposed use to assure that there is no enlargement of the underlying water right. In this case, it is believed that the historical water uses would have incurred the following rates and amounts of hydrologic depletion:

Prior Beneficial Use	Allowed Diversion	Rate of Depletion	Amount of Depletion
Irrigation 49.85 acres	199.40 acre-feet	62.81%[2]	125.2431 acre-feet
Domestic one family	0.4500 acre-foot[3]	20.00%[4]	0.0900 acre-foot
Recreational Use	1.0800 acre-feet	20.00%[5]	0.2160 acre-foot
Municipal	40.000 acre-feet	62.81%[6]	25.124 acre-feet
Municipal	2,943.1228 acre-feet	100.00%[7]	2,943.1228 acre-feet
Totals:	3,184.0528 acre-feet		3,093.7959 acre-feet

[2]*Consumptive Use of Irrigated Crops in Utah*, Research Report 145, Utah Agricultural Experiment Station, Utah State University, Logan, Utah, October, 1994, Table 25, "Milford Station".
[3]Based on the standard of an average yearly requirement of 400 gallons per day established by Administrative Rule R309-510-7(2).
[4]Based on the assumption that wastewater disposal was via a septic tank and buried drain field or similar on-site soil absorption system.
[5]Ibid.
[6]This 40.0 acre-feet of diversion for municipal use was historically used to irrigate 10.0 acres of land as perfected under Water Right 71-497 Certificate Number 4342, therefore the historical depletion is evaluated at 62.81% equal to other irrigation use in the area.
[7]Unless conditioned otherwise in the record, established rights which have been historically used for municipal use are considered to be 100.00% depletive by the Division.

SCANNED

It will be the responsibility of the City of Milford to assure that the hydrologic depletion limitations associated with its various rights are not exceeded.

It is, therefore, **ORDERED** and Permanent Change Application Number 71-497 (a42873) is hereby **APPROVED** subject to prior rights and the following conditions:

1. This approval is limited to the rights to divert and beneficially use water and does not grant any rights of access to nor use of land or facilities not owned by the applicant.

2. As noted, this approval is granted subject to prior rights. The applicant shall be liable to mitigate or provide compensation for any impairment of or interference with prior rights as such may be stipulated among the parties or decreed by a court of competent jurisdiction.

3. Water use under this approval shall be limited to municipal use within the service area of the City of Milford with a maximum diversion of 3,184.0528 acre-feet and hydrologic depletion of 3,093.7959 acre-feet as described herein. The applicant is required to maintain records of use sufficient to demonstrate the depletion of water associated with its use does not exceed 3,093.7959 acre-feet.

4. To accommodate the approval of this permanent change application, the use of 4.645 cfs or 3184.0528 acre-feet of water to be used for irrigation of 49.85 acres from March 15 to November 1; year-round, indoor, domestic requirements of 1.00 equivalent domestic unit (EDU); year-round municipal purposes within the service area of Milford; and year-round recreational purposes (Golf Course - Culinary & sanitation uses limited to 1.08 acre feet.) at the historical points of diversion and place of use must cease.

5. Whereas this Change Application has been filed to entirely replace and supersede prior approved Change Application Number 71-497 (a42046), with this approval that prior application is considered to have been **WITHDRAWN**.

6. The applicant and successor(s) shall maintain a permanent record of all water diverted under this application, said record to be made available for inspection by personnel of the Division of Water Rights upon reasonable request. **An annual report of all water diversions under this approval shall be submitted to the Division of Water Rights.**

7. The documents submitted as proof of beneficial use for this application, as required by statute at §73-3-16, Utah Code Annotated, shall include a full and correct copy of the metering record maintained as required herein.

8. Inasmuch as this application seeks to divert water from numerous points of diversion, it is necessary that detailed information be provided to the State

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Engineer to show which sources of supply are actually developed and used and the extent of their usage under this application. Upon the submission of proof as required by Section 73-3-16, Utah Code, for this application, the applicant must identify every source of water used under this application and the amount of water used from that source. The proof must also show the capacity of the sources of supply and demonstrate that each source can provide the water claimed to be diverted under this right as well as all other water rights which may be approved to be diverted from those sources.

Approval of this Permanent Change Application does not supersede the constitutional restrictions of Municipalities as they are forbidden to sell waterworks or rights under Article XI, Section 6 of the Utah Constitution.

The State Engineer has statutory responsibility to create and maintain water right records based on an administrative process outlined in statute. The State Engineer is not authorized by statute to adjudicate water right title or the validity of established water rights. It is noted that failure to exercise a water right within the statutory period could render all or a portion of a water right invalid through forfeiture. Parties who wish to challenge the validity of a water right are advised that a declaration of forfeiture is a judicial action and the courts are available to pursue such suits (UCA 73-1-4).

The applicant is strongly cautioned that other permits may be required before any development of this application can begin and it is the responsibility of the applicant to determine the applicability of and acquisition of such permits. Once all other permits have been acquired, this is your authority to develop the water under the above referenced application which under Sections 73-3-10 and 73-3-12, Utah Code Annotated, 1953, as amended, must be diligently prosecuted to completion. The water must be put to beneficial use and proof must be filed on or before **January 31, 2023**, or a request for extension of time must be acceptably filed and subsequently approved; otherwise the application will be lapsed.

Proof of beneficial use is evidence to the State Engineer that the water has been fully placed to its intended beneficial use. By law, it must be prepared by a registered engineer or land surveyor, who will certify to the location, uses, and extent of your water right. Upon the submission of proof as required by Section 73-3-16, Utah Code, for this application, the applicant must identify every source of water used under this application and the amount of water used from that source. The proof must also show the capacity of the sources of supply and demonstrate that each source can provide the water claimed to be diverted under this right as well as all other water rights which may be approved to be diverted from those sources.

Failure on your part to comply with the requirements of the applicable statutes may result in the lapsing of this permanent change application.

It is the applicant's responsibility to maintain a current address with this office and to update ownership of their water right. Please notify this office immediately of any change

SCANNED

of address or for assistance in updating ownership. Additionally, if ownership of this water right or the property with which it is associated changes, the records of the Division of Water Rights should be updated. For assistance in updating title to the water right please contact the Division at the phone number below.

Your contact with this office, should you need it, is with the Southwestern Regional Office. The telephone number is 435-586-4231.

This Order is subject to the provisions of Administrative Rule R655-6-17 of the Division of Water Rights and to Sections 63G-4-302, 63G-4-402, and 73-3-14 of the Utah Code which provide for filing either a Request for Reconsideration with the State Engineer or an appeal with the appropriate District Court. A Request for Reconsideration must be filed with the State Engineer within 20 days of the date of this Order. However, a Request for Reconsideration is not a prerequisite to filing a court appeal. A court appeal must be filed within 30 days after the date of this Order, or if a Request for Reconsideration has been filed, within 30 days after the date the Request for Reconsideration is denied. A Request for Reconsideration is considered denied when no action is taken 20 days after the Request is filed.

Dated this 3rd day of January, 2018.

Kent L. Jones, P.E., State Engineer

Mailed a copy of the foregoing Order this 3rd day of January, 2018 to:

City of Milford
PO Box 69
Milford UT 84751-0069

Green Diamond Ranch
c/o Steve Clyde, Attorney
201 South Main Street, Suite 1300
Salt Lake City, UT 84111-2216

Division of Water Rights
Water Use Program

BY: Doralee Cannon
Doralee Cannon, Applications/Records Secretary

SCANNED

GARY R. HERBERT
Governor
GREG BELL
Lieutenant Governor

State of Utah
DEPARTMENT OF NATURAL RESOURCES
Division of Water Rights

MICHAEL R. STYLER
Executive Director

KENT L. JONES
State Engineer/Division Director

FEB 21 2012

ORDER OF THE STATE ENGINEER
For Permanent Change Application Number 81-4902 (a37588)

Permanent Change Application Number 81-4902 (a37588) in the name of Washington County Water Conservancy District (the District), was filed on August 2, 2011, to change the places of use and nature of use of 170.7912 acre-feet (af) of water as evidenced by Water Right Number 81-4902. Heretofore, the water has been diverted from a surface source located North 2464 feet and West 2937 feet from the SE Corner of Section 7, T40S, R13W, SLB&M. The water was stored in a reservoir from January 1 to December 31, having a capacity of 5.00 acre-feet, and a dam height of 15 feet located in all or portion(s) of Section 27, T40S, R13W, SLB&M. The water has been used for the irrigation of 28.4652 acres from January 1 to December 31. The water was used in all or portion(s) of Section 22, T40S, R13W, SLB&M; and Section 27, T40S, R13W, SLB&M.

Hereafter, it is proposed to divert 170.7912 acre-feet of water from the same point as heretofore. The water is to be used for municipal purposes within the service area of Washington County Water Conservancy District.

Notice of the application was published in The Spectrum on September 1 and 8, 2011. No protests were received.

In evaluating applications which propose to change the nature of use of a water right, the State Engineer believes it is appropriate to examine the rates and amounts of hydrologic depletion associated with the historic water use as compared to the proposed use to assure that there is no enlargement of the underlying water right. In this case, it is believed that the historic water use would have incurred a rate of hydrologic depletion of approximately 53.26% of the duty of 6.00 acre-feet per acre.[1] The calculated total amount of hydrologic depletion would thus be approximately 90.96 acre-feet per year for the 170.7912 acre-feet of diversion allowance.

It will be the responsibility of the District to assure that the hydrologic depletion limitations associated with its various rights are not exceeded.

In addition to the depletion and diversion limits described herein, this water right is also limited to an instantaneous flow of 0.5712 cfs, proportional to the total flow assigned to parent Water Right 81-3179.

[1] *Consumptive Use of Irrigated Crops in Utah*, Research Report 145, Utah Agricultural Experiment Station, Utah State University, Logan, Utah, October 1994, Table 25, "La Verkin Station."

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It is the opinion of the State Engineer that this change application can be approved without adversely affecting existing rights. The applicant is put on notice that diligence must be shown in pursuing the development of this application which can be demonstrated by the completion of the project as proposed in the change application.

It is, therefore, **ORDERED** and Permanent Change Application Number 81-4902 (a37588) is hereby **APPROVED** subject to prior rights and the following conditions:

1. This approval is limited to the rights to divert and beneficially use water and does not grant any rights of access to nor use of land or facilities not owned by the applicant.

2. As noted, this approval is granted subject to prior rights. The applicant shall be liable to mitigate or provide compensation for any impairment of or interference with prior rights as such may be stipulated among the parties or decreed by a court of competent jurisdiction.

3. Water use under this approval shall be limited to a flow of 0.5712 cfs, a diversion of 170.7912, and a hydrologic depletion of 90.96 acre-feet of water associated with the historical irrigation of 28.4652 acres as described herein.

4. To accommodate the approval of this permanent change application, the use of 170.7912 acre-feet water for the irrigation of 28.4652 acres at the historic place of use must cease.

5. The applicant and successor(s) shall maintain a permanent record of all water diverted under this application, said record to be made available for inspection by personnel of the Division of Water Rights upon reasonable request. **An annual report of all water diversions under this approval shall be submitted to the Division of Water Rights.**

6. The documents submitted as proof of beneficial use for this application, as required by statute at §73-3-16, Utah Code Annotated, shall include a full and correct copy of the metering record maintained as required herein.

If historical resources such as human remains (skeletons), prehistoric arrowheads/spear points, waste flakes from stone tool production, pottery, ancient fire pits, historical building foundations/remains, artifacts (glass, ceramic, metal, etc.) are found during construction, call the Utah Division of State History at 801-533-3555.

The State Engineer has statutory responsibility to create and maintain water right records based on an administrative process outlined in statute. The State Engineer is not authorized by statute to adjudicate water right title or the validity of established water rights. It is noted that failure to exercise a water right within the statutory period could render all or a portion of a water right

invalid through forfeiture. Parties who wish to challenge the validity of a water right are advised that a declaration of forfeiture is a judicial action and the courts are available to pursue such suits. (UCA 73-1-4).

The applicant is strongly cautioned that other permits may be required before any development of this application can begin and it is the responsibility of the applicant to determine the applicability of and acquisition of such permits. Once all other permits have been acquired, this is your authority to develop the water under the above referenced application which under Sections 73-3-10 and 73-3-12, Utah Code Annotated, 1953, as amended, must be diligently prosecuted to completion. The water must be put to beneficial use and proof must be filed on or before **February 28, 2017**, or a request for extension of time must be acceptably filed; otherwise the application will be lapsed.

Proof of beneficial use is evidence to the State Engineer that the water has been fully placed to its intended beneficial use. By law, it must be prepared by a registered engineer or land surveyor, who will certify to the location, uses, and extent of your water right. Upon the submission of proof as required by Section 73-3-16, Utah Code, for this application, the applicant must identify every source of water used under this application and the amount of water used from that source. The proof must also show the capacity of the sources of supply and demonstrate that each source can provide the water claimed to be diverted under this right as well as all other water rights which may be approved to be diverted from those sources.

Failure on your part to comply with the requirements of the applicable statutes may result in the lapsing of this permanent change application.

It is the applicant's responsibility to maintain a current address with this office and to update ownership of their water right. Please notify this office immediately of any change of address or for assistance in updating ownership.

Your contact with this office, should you need it, is with the Southwestern Regional Office. The telephone number is 435-586-4231.

This Order is subject to the provisions of Administrative Rule R655-6-17 of the Division of Water Rights and to Sections 63G-4-302, 63G-4-402, and 73-3-14 of the Utah Code which provide for filing either a Request for Reconsideration with the State Engineer or an appeal with the appropriate District Court. A Request for Reconsideration must be filed with the State Engineer within 20 days of the date of this Order. However, a Request for Reconsideration is not a prerequisite to filing a court appeal. A court appeal must be filed within 30 days after the date of this Order, or if a Request for Reconsideration has been filed, within 30 days after the date the Request for Reconsideration is denied. A Request for Reconsideration is considered denied when no action is taken 20 days after the Request is filed.

Dated this 21st day of February, 2012.

Kent L. Jones, P.E., State Engineer

Mailed a copy of the foregoing Order this 21st day of February, 2012 to:

Washington County Water Conservancy District
533 East Waterworks Drive
St. George, UT 84770

Water Use Program
Division of Water Rights

BY:
Sonia R. Nava, Applications/Records Secretary

Calculation sheet for converting irrigation water to municipal use

The following is an example of converting irrigation water to municipal use. It is primarily for illustrative purposes, but we have used representative figures which would be expected for the area. The change application process evaluates the historical water use for the irrigation uses and then compares the proposed diversion and depletion figures for municipal water use as set forth in the application. The assumptions regarding the municipal water use reflect a water conservation approach.

Heretofore, Irrigation Water Use:

Irrigation of 100.00 acres

Diversion allowance: 100 acres x 6.00 acre-feet/acre = **600.00 acre-feet**

Depletion Allowance: 100 acres x 3.28 acre-feet/acre[1] = **328.00 acre-feet**

The difference between the diversion of 600 acre-feet and the depletion of 328 acre-feet is potential return flow to the hydrologic system and goes to supply downstream water rights. Under a change application this return flow and downstream water rights are the primary focus of the evaluation. The DWRi requires the applicant to maintain records to demonstrate uses under the change application do not exceed the depletion limitation.

Hereafter, Municipal Water Use:

It is assumed the municipality has lagoon wastewater treatment that evaporates the water. Other assumptions are: 1) Each family will divert 0.45 acre-feet per year for in-house uses and deplete about 80% of that water, or 0.36 acre-feet; 2) For each domestic connection there will be 1,500 square feet of lawn, shrubs and/or trees at a diversion allowance of 6.00 acre-feet per acre and a depletion of 3.28 acre-feet per acre (consumptive use at La Verkin station); and 3) Commercial, industrial and institutional uses to support each family of 0.34 acre-feet of diversion, with a corresponding depletion 0.255 acre-feet (75%).

	Diversion	Depletion
In-house Domestic Use	0.45 ac-ft	0.36 ac-ft
Irrigation of 1,500 sq feet	0.21 ac-ft	0.11 ac-ft
Commercial, Industrial & Institutional	0.34 ac-ft	0.255 ac-ft
Totals	**1.00 ac-ft**	**0.725 ac-ft**

Under this example, the heretofore uses for irrigation use depletions is 54.67% of the water diverted. Under the proposed municipal use 72.5% of the water diverted is depleted. Since the amount of water depleted cannot be increased, the municipal diversion needs to be reduced to 452 acre-feet. This is determined using the following equation: Diversion x .7255 = 328, solving for diversion, 328/.7255 results in 452 acre-feet.

[1] The irrigation consumptive use (depletion) is from the La Verkin station taken from Consumptive Use of Irrigated Crops in Utah, Research Report 145.

Table D1: Calculations of the quantity of irrigation water on the Virgin River and selected tributaries that can be converted to municipal use.

			Acres	Diversion	Depletion	
1	Virgin River Water	</= 1889	1822	9441	5485	
2	Rights 1900 & Earlier	1890-1900	7315	42503	24560	See Table 2
3	Priority	Sub-Total	9137	51944	30045	
4	Water Quality Adj.	</= 1889	599	3592	2143	See Table 2
5	Zone 1 (-)	1890-1900	5101	30604	18260	
6	St. George & Washington Field (+)	Total	4597	27584	16459	See Table A1
7		One third	1531	9185	5481	
8	Potential Municipal Conversion		**4968**	**26,900**	**15,100**	**

** Potential Municipal Conversion values are calculated = Row 3-(Row 4+5)+Row 7
Calculated by taking the sub-total for the 1900 and earlier priority values in row 3.
Subtract out the acreage in Zone 1 because of water quality, minus rows 4+5
Add the 1/3 of St. George & Washington Canal water that originates above La Verkin Hot Springs, see page 9.
The result in row 8 is the potential diversion and depletion that can be converted to municipal use

For this situation the irrigation water rights have an allowable diversion of 26,900 acre-feet and depletion allowance of 15,100 acre-feet. Under the change application process the municipality would be allowed to divert up to 26,900 acre-feet, but could not exceed the 15,100 acre-feet of depletion. The water use practices of the municipality determine what percentage of the water is returned to the system and thus what percent of the historical irrigation diversion they can divert. If the sewage effluent is treated by evaporative lagoons or is reused, this will significantly influence how much water is allowed to be diverted, since that water is depleted from the system. For this report it is assumed that reuse will become a major focus of future water-use practices in this area. Because of this, the quanity of water available for municipal conversion is 15,100 acre-feet.