Washoe County Department of Water Resources

Steamboat and Tributary Municipal Water Supply Yield Analysis

June 2007

Prepared for
Washoe County Department of Water Resources

Prepared by
ECO:LOGIC Engineering

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Consulting Engineers

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This report was prepared by ECO:LOGIC Consulting Engineers under a contract with Carollo Engineers and approved by Washoe County on July 5, 2005 to provide additional yield analysis for water rights on Browns Creek, Galena Creek and Steamboat Creek. ECO:LOGIC has completed this work with the assistance of subconsultants MBK Engineers, Michael Buschelman Consulting, Walker & Associates and Susan Oldham, Attorney. Don Mahin, Washoe County Department of Water Resources, served in a technical review and advisory capacity.

Please note that TEC Civil Engineering Consultants provided comments to the original Steamboat and Tributary Municipal Water Supply Yield Analysis report, dated October 9, 2006. Those comments along with responses are included in Sections A through E.

Questions regarding information contained within this report should be directed to:

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EXECUTIVE SUMMARY

The Steamboat and Tributary Municipal Water Supply Yield Analysis is an update to the water resources component of Washoe County's 2002 South Truckee Meadows Facility Plan. The Facility Plan is an integrated water supply analysis, which makes the best use of the available water resources to meet a year round municipal demand. The available water resources considered in the 2002 Facility Plan consist of local groundwater, wholesale water from the Truckee Meadows Water Authority and water from several of the local creeks. The creeks evaluated in the original 2002 Facility Plan include Galena, Thomas and Whites Creek.

This analysis uses the same methodology conducted in the 2002 Facility Plan but revisits the use of water from Galena Creek, and incorporates additional water from Browns and Steamboat Creeks into the County's South Truckee Meadows water supply plan. The analysis does not determine the water right yields for these individual creeks. Rather, it evaluates the additional municipal demand that can be supplied from these creeks in a dry year in combination with the other available municipal water resources already included in the Facility Plan. The analysis conducted assumes all of the available water rights are in use in any given year. For that reason, the flows generated in the analysis will not match the historic flow in these streams.

The amount of water flowing in the creeks is highly variable. A municipal water supply must have water available to supply customers at all times during drought years, not just during average or normal conditions. For this reason, only the water rights that provide water in a dry year could be considered for municipal purposes. The dry year demand that can be served by the combined yield of the water resources from this evaluation is 17,758 acre feet. This is 15% higher than the 15,469 acre feet demand from the original 2002 Facility Plan.

Washoe County is beginning to construct the municipal water supply facilities recommended in the 2002 Facility Plan. These facilities include a new municipal water treatment plant, which will have an initial capacity of 6 million gallons per day. The treatment plant will purify creek water and poor quality groundwater so that it is suitable for drinking.

Unlike the Truckee River system (with Lake Tahoe, Boca Reservoir and other reservoirs), there is no reliable surface storage reservoir in the South Truckee Meadows that can store water during wet periods to be released when needed. Water is stored in Washoe Lake, but it does not provide a reliable water supply through multiple dry years such as the historic drought, which included 1992. During such dry periods, water is unable to be released from Washoe Lake into Steamboat Creek because water levels have dropped below the outlet of a small dam. For this reason storage underground was analyzed. Unfortunately excess water occurs so infrequently and often at times of the year when treatment is at full capacity; therefore, the treatment and facilities

required to treat, inject and store enough water in wet years to have a water supply in dry years was cost prohibitive.

All of these issues affect the amount of water that the creeks can provide in a dry year. For instance, 30,131 acre feet of creek water rights from Galena, Thomas, Whites, Browns and Steamboat Creeks were considered in the analysis. These creeks supply 20,000 acre feet of water in an average year, but only 7,600 acre feet of water in a dry year. After excluding those rights which were assumed to remain in irrigation, water rights committed to make up return flow, and all water rights which do not provide a supply in a dry year, the amount of creek water right available from the five creeks analyzed total 10,686 acre feet and provide a 6,729 acre foot supply in an average year and a 4,670 acre foot supply in a dry year.

In addition to the surface water, Washoe County manages 9,575 acre-feet of groundwater in the South Truckee Meadows. This groundwater is committed for future developments and much of it will be used for back-up of Galena, Thomas and Whites Creeks in the late summer and during drought periods. Because the County groundwater was already considered for drought back-up in the 2002 Facility Plan, these rights provide limited additional back-up for the Browns and Steamboat Creek water referenced in this analysis.

Up to 5,400 gallons per minute of wholesale supply capacity is also available to the South Truckee Meadows from TMWA. This updated water supply analysis considered increasing the capacity from TMWA to serve as drought back-up to the added creek rights. This analysis concluded that the yield of the Steamboat Creek, Browns Creek and Galena Creek water rights could not be improved by increasing the wholesale supply above 5,400 gallons per minute. Increasing the capacity of the new County municipal water treatment plant was also evaluated, with similar results.

The 2002 Facility Plan did not evaluate the Steamboat or Browns Creek rights. This present evaluation concludes that the Galena, Browns and Steamboat Creek water rights can be used for municipal purposes; however, the facilities needed to allow their use is different than the facilities recommended in the 2002 Facility Plan. Based on this updated evaluation, the need for an upper water treatment plant off of Galena Creek is eliminated. However, additional treatment capacity at the County's new South Truckee Meadows Municipal Water Treatment Plant (up to 12 million gallons per day) and 1,800 acre feet of additional Truckee River water rights (a total of 3,600 acre feet) supplied through the 5,400 gallon per minute wholesale agreement will be needed to provide a reliable water supply.

Those lower priority Steamboat Creek water rights that were found to provide no incremental municipal water supply benefit during dry years do provide water in normal to wet years, and have potential benefits for uses other than meeting a municipal water demand such as make up for return flows.

Unlike the Truckee Meadows Water Reclamation Facility, the South Truckee Meadows Water Reclamation Facility does not have a permit to discharge treated effluent to Steamboat Creek or the Truckee River. All treated effluent must be reused for irrigation, industrial or other non-potable purposes. This situation is different than in the Central Truckee Meadows, because water rights can be committed at the full duty of the right where wastewater is allowed to return to the Truckee River. In the past where commitments have been made to serve Truckee River water in an area where effluent is treated at the South Truckee Meadows facility, Truckee River surface water rights were committed at the full face value of the right but the developer was also required to bring additional water rights in order to make other water right holders whole when the effluent is reused.

Since Truckee River water rights are deficient at times when Floriston rates could not be met, make up water is not required during the driest months of the drought. The tributary water rights are different because some water rights do provide a supply even during dry years and it is much more difficult to find a water right that will make up for the return flow that occurred historically. Therefore making commitments utilizing the consumptive use factor is much more important with these tributary water rights.

The actual consumptive use fraction used in the analysis does not impact the resulting overall municipal supply yield of Whites, Thomas, Steamboat or Browns Creeks. In dry years, these rights are not able to divert their full reduced duty, and increasing the duty will not supply additional water to these rights.

For Galena Creek, the consumptive use fraction does impact the municipal water supply yield due to the high yield of the Galena Creek rights with an 1862 or earlier priority. The consumptive use of these rights will ultimately need to be determined or accepted by the State Engineer.

Use of the 62.5% consumptive use fraction in this analysis does not preclude individuals with water rights from applying to the State Engineer for a different consumptive use fraction and justifying the higher fraction based on the historic use of the particular right. A sensitivity analysis was conducted to investigate what a different decision would have on water supply. It was determined that although the higher priority water right would become more valuable for municipal supply, lower priority water rights would become less valuable or even unusable for municipal purposes and the water supply would stay essentially the same. To date, all Washoe County water rights dedication agreements that utilize the South Truckee Meadows creeks contain a “look back” provision to adjust the water right dedications and commitments based upon any rulings of the State Engineer regarding yield and consumptive use of these creeks. Ultimately, the 62.5% consumptive use fraction used in this evaluation may be adjusted and reflected in Washoe County’s dedication rules.

BACKGROUND AND DESCRIPTION OF PROJECT

On August 20, 2002, the Board of County Commissioners (Board) adopted the South Truckee Meadows Water and Wastewater Facility Plan (Facility Plan). The Facility Plan identifies water supply, drinking water treatment and distribution, wastewater collection and treatment, and reclaimed water improvements needed within the South Truckee Meadows to serve planned development.

To meet the long-term drinking water resource needs of the community, an integrated water resource plan is being used. Key elements of the Facility Plan include continued use of wholesale water from the Truckee Meadows Water Authority (TMWA), continued use of ground water, water conservation, expansion of reclaimed water use for irrigation, and utilization of local tributary water for the municipal drinking water supply.

A water rights yield analysis has been completed to confirm Facility Plan work regarding the yields of Galena, Whites and Thomas Creeks. The subject of this report is to provide additional yield analysis for water rights on Browns Creek, Galena Creek and Steamboat Creek. Intensifications of land use and expansions of areas that are seeking water service have also increased the buildout demand used for the yield analysis by approximately 15% over the Facility Plan estimate. The current estimate of buildout demand to be served is approximately 17,758 acre feet (AF).

The scope of work for this project includes the following major items:

- Determine how best to use Steamboat Creek water rights to maximize yield for M&I uses.
- Evaluate scenarios for maximizing yield of water rights based on agreed upon criteria.
- Determine feasibility of passive conjunctive use – surface water use in lieu of groundwater pumping - during high flow years.
- Develop a list of implementation issues associated with highest rated scenarios.

The report is organized into the following major sections:

- Water Rights Studied
- Browns Creek Water Rights
- Steamboat Creek Water Rights
- Washoe Lakes
- Description of Model
- Model Results
- Conclusions

WATER RIGHTS STUDIED

The project to study Browns Creek and Steamboat Creek water rights is much more complicated than the study of Thomas Creek, Whites Creek and Galena Creek compiled for the South Truckee Meadows Facility Plan. The previous data must be compiled in a model that attempts to meet South Truckee Meadows demand with 9,500 acre feet of groundwater, Thomas, Whites and Galena Creeks and wholesale surface water from the TMWA system. The model also had to be run with multiple scenarios to see what increased demand could be met with the Browns Creek and Steamboat Creek rights.

In order to add the Browns Creek water rights to the study it was necessary to estimate the hydrology of Browns Creek flow, taking into account new data and flow in similar watersheds. In order to add the Steamboat Creek water rights to that plan, it becomes necessary to simulate the operation of Washoe Lake including the use of Washoe Lake and Galena Ditch Company shares. In order to improve the yield of both types of water rights in a drought, groundwater recharge was evaluated for the potential to store excess water that could be used conjunctively with the creek water rights. The study also looked at taking the Galena Ditch water right directly from Galena Creek and expanding the list of Galena Creek water rights that may become available for M&I use.

BROWNS CREEK WATER RIGHTS

Background

Waters of Browns Creek and its tributaries are being placed to beneficial use for irrigation, domestic, stock watering and recreation purposes. On June 12, 1958, the Nevada Division of Water Resources entered an order for the determination of the relative rights of the water users in accordance with Nevada Revised Statutes 533.090. On October 22, 1971, the Division of Water Resources entered a notice for taking proofs to determine water rights. On August 16, 1976, the Second Judicial District Court of the State of Nevada in and for the County of Washoe, Judge John E. Gabrielli signed the final order of determination of the relative rights in and to the waters of Browns Creek and its tributaries.

The Browns Creek Decree provides that water for irrigation purposes can be diverted at any time during the year provided that the amount applied to the land during any calendar year shall not exceed the seasonal duty of 4.5 acre feet per acre for harvest crops, 4.0 acre feet per acre for meadow pasture or 3.5 acre feet per year for diversified pasture.

The headwaters of Browns Creek drain from the easterly facing slopes of Slide Mountain within the Carson Mountain Range located approximately 12 miles south of the Cities of Reno and Sparks, Nevada. The creek flows terminate in Steamboat Creek

in Pleasant Valley. Browns Creek is fed by springs and melting snow. There are three diversions from the main stem of Browns Creek.

Upper Browns Creek

The upper Browns Creek watershed is utilized for grazing. The upper most water use is primarily for stock water to serve 3,500 sheep and 50 cattle. These animals are allowed to drink water directly from Browns Creek and it's tributaries under decreed Proof Nos. 02748 and 02741 with respective priorities of 1878 and 1880.

First Diversion

The first diversion structure is located on the south side of Browns Creek in the NW1/4 SE1/4 of Section 15, T17N, R19E, MDM. This single diversion services multiple downstream water right owners with a priority 1858 under decreed Proof Nos. 02442, 02747, 02757, 02758, 02759, 02812 & 02850, a priority of 1865 under decreed Proof No. 02872 and a priority of 1877 under decreed Proof No. 02750.

The Browns Creek Decree allows for a maximum of 2,197.46 acre feet per year to be diverted at this location for irrigation purposes.

- Browns Creek water is commingled with water from Winters Creek, Davis Creek and Ophir Creek to supply 2,132.81 acre feet under Proof Nos. 02442, 02757 and 02812 for irrigation. Browns Creek and Winters Creek commingle water for the irrigation of the same harvest and pasture lands. Ophir Creek water is commingled with Browns and Winters Creeks for the irrigation of the southern portion of the harvest and pasture lands. All three water sources are used to provide the total volume of water required to irrigate the land identified under Proof Nos. 02442, 02757 and 02812.
- Browns Creek is the sole source of water to supply 64.65 acre feet under Proof Nos. 02747, 02758, 02759, 02850 and 02872.

An additional 14.00 acre feet is diverted at this location to replace evaporative and other losses from Joy Lake.

Second Diversion

Browns Creek receives water from Galena Creek. Galena Creek and Browns Creek waters are diverted to Washoe Valley a short distance downstream from the entry of this ditch into Browns Creek. This second diversion structure is located in the SE1/4 NE1/4 of Section 14 T17N, R19E, MDM. This diversion is utilized by the Washoe Lake Reservoir and Galena Ditch Company to transport Galena Creek and Browns Creek water to Lower Washoe Lake for storage and later release for downstream irrigation.

Refer to the section titled “Washoe Lake Water Rights” for additional discussion related to this diversion from Browns Creek.

Third Diversion

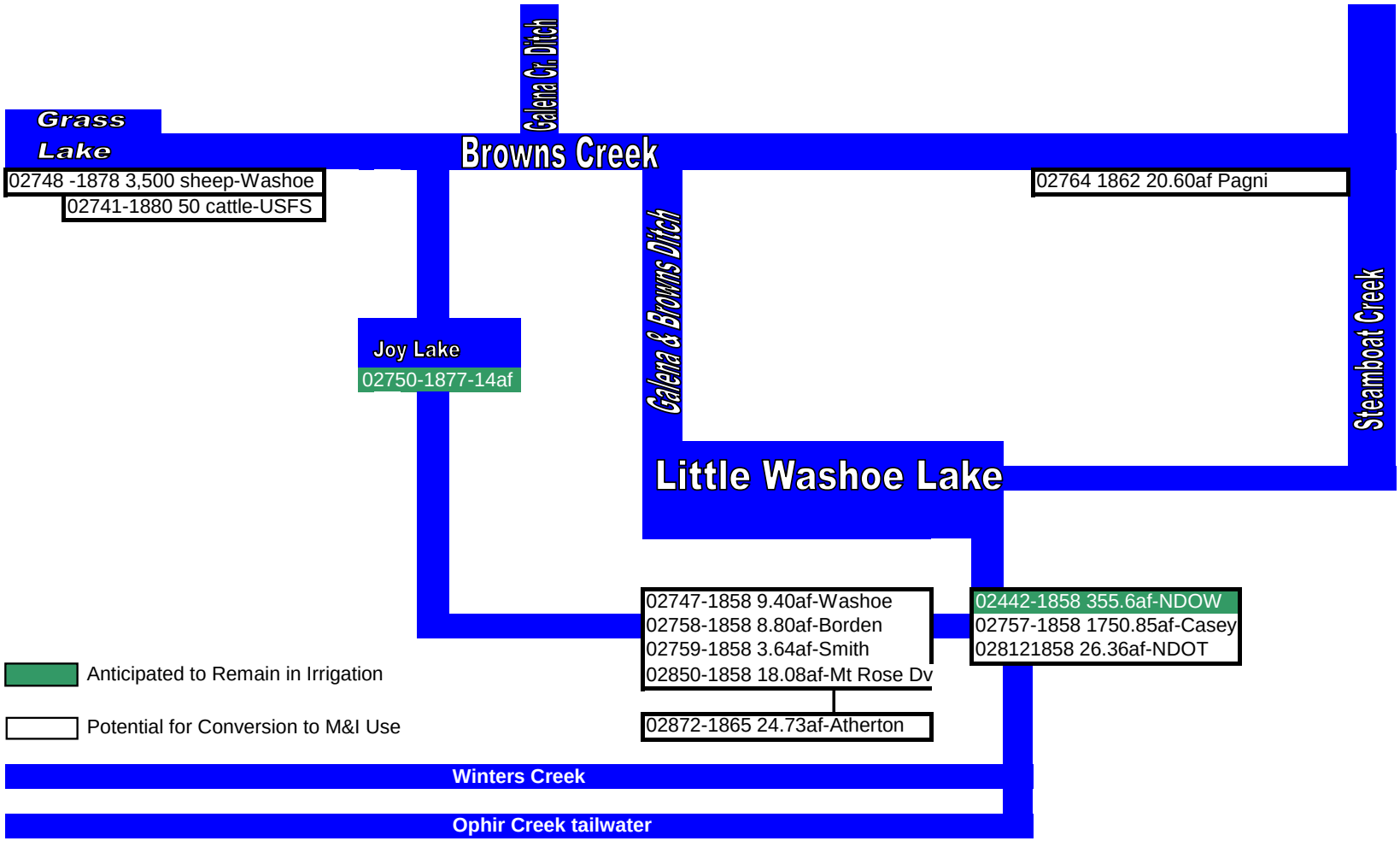
The third diversion is located just above the termination of Browns Creek into Steamboat Creek within the NE1/4 SE1/4 of Section 13, T17N, R19E, MDM. This diversion services a single downstream water right owner with a priority 1862 under decreed Proof No. 02764.

The Browns Creek Decree allows for a maximum of 20.60 acre feet per year to be diverted at this location for irrigation purposes.

Browns Creek Flow Analysis

Since 2002, the streamflow of Browns Creek has been periodically measured at several locations. These measurements have allowed correlation of the flow in Browns Creek with the flow of a similar watershed. The regression equation developed was used to estimate Browns Creek flow for the simulation period 1975 – 1995. Development of the new hydrology and comparison with past studies by TEC and Sierra Hydrotech are included as Appendix A.

Figure 1
Browns Creek Water Rights



STEAMBOAT CREEK WATER RIGHTS

Background

The following creeks have decreed water rights and flow into Steamboat Creek downstream of Little Washoe Lake:

- Browns Creek
- Evans Creek
- Galena Creek
- Thomas Creek
- Whites Creek (aka Browns Creek and Howard Creek)

Each of these creeks provides water to decreed water right owners prior to their confluence with Steamboat Creek. Thomas Creek and Evans Creek are also noted as supplemental sources of water for numerous direct decreed water rights from the Truckee River.

Table 1 contains a summary of decreed acres and acre footage for each creek. Not all of the decreed acres listed below are currently irrigated. Portions of these decreed water righted acres have been residentially, commercially and industrially developed.

Table 1 – Summary of Direct Water Resources

Water Resource	Irrigated Acreage	Duty
Browns Creek	562.87 acres	2,232 AF
Galena Creek	665.3 acres	3,018 AF
Whites Creek	1,035.10 acres	4,142 AF
Thomas Creek*	423.50 acres	2,573 AF
Evans Creek	334.80 acres	1,340 AF
Steamboat Creek	3,634.80 acres	15,300 AF

* Including those portions of Claims 222, 225, 486

The listed decreed tributary creek rights do not include the many supplemental water rights adjudicated in the Orr Ditch Decree. For instance several of the Truckee River decreed rights served by the Steamboat Canal, Last Chance Ditch, Lake Ditch and Cochran Ditch provide for the use of Thomas Creek water as a supplemental water supply at times when the primary water right would have been deficient. A report completed for the Washoe County Regional Water Planning Commission by Mr. Roderick L. Hall of Sierra Hydrotech, dated January 17, 1999, provides an overview of the decreed tributary water rights in the South Truckee Meadows.

In addition to the irrigation of decreed water righted lands, the creeks identified in Table 2 have allocations of water for storage purposes. Diversion rates from these creeks are

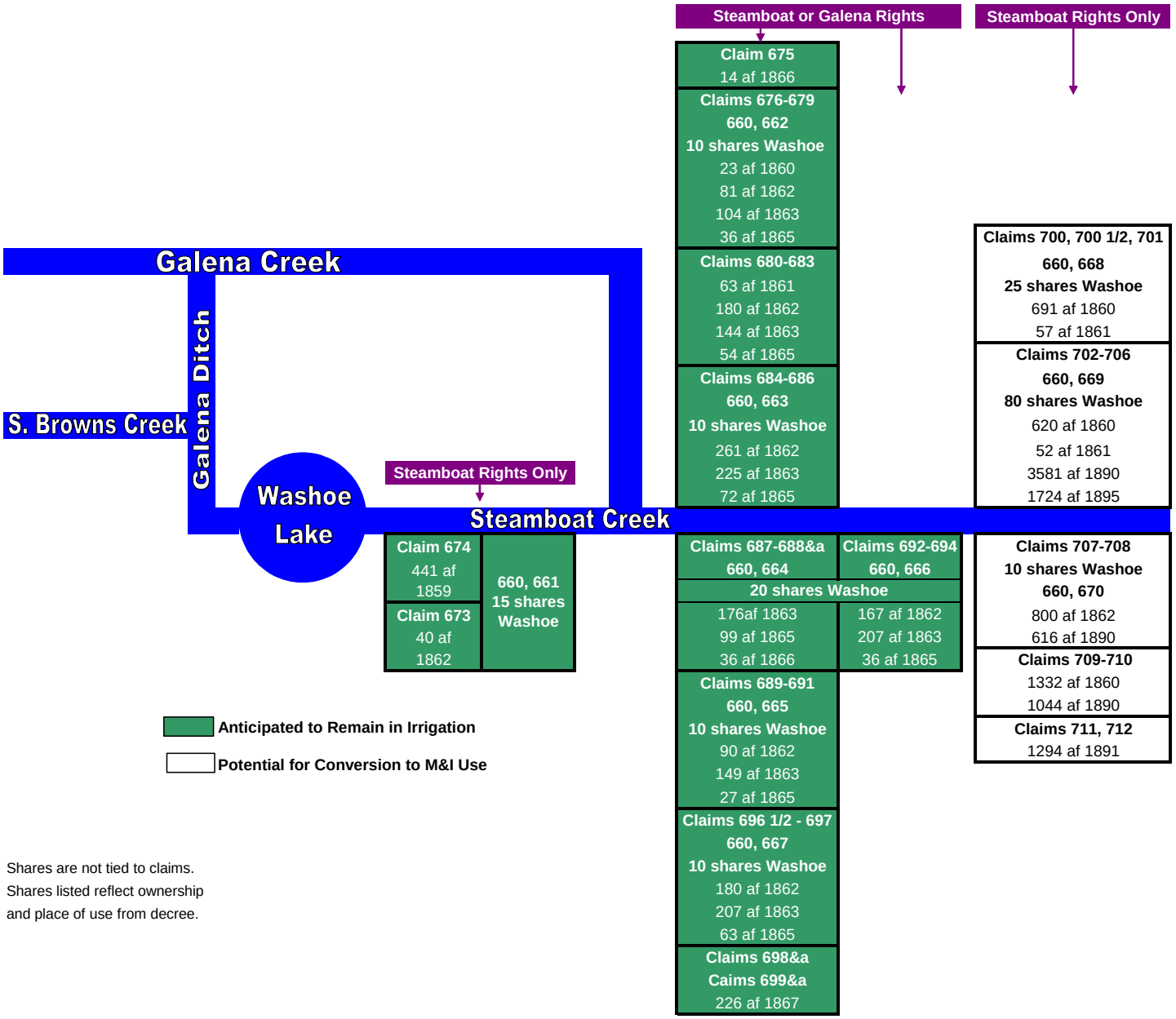
allowed during the irrigation season and/or non-irrigation season to fill and refill storage facilities. This stored water is allocated as a supplemental source of water for the irrigation of lands with direct water diversions from creeks and the Truckee River.

Table 2 – Allowable Diversions to Storage

Water Resource	Storage Location	Diversion Rate
Browns Creek	Washoe Lake	114 cfs (Claim 660a)
Galena Creek	Washoe Lake	114 cfs (Claim 660a)
Thomas Creek	Alexander Lake	25 cfs (Claim 713)
Evans Creek	Wheeler Reservoir	32 2/5 cfs (Claim 723

FIGURE 2

Steamboat, Steamboat/Galena, Washoe Lake Water Rights



WASHOE LAKES

Background

Washoe Lakes is a relatively shallow set of lakes located in Washoe Valley between the City of Reno and Carson City, Nevada. The surface area of Upper and Lower Washoe Lakes covers approximately 5,800 acres at the spillway stage of the Lower Lake storage dam. The storage dam and spillway are located at the northern end of Lower Washoe Lake immediately downstream of US Highway 395. This outlet controls the volume of water stored by both lakes.

The annual evaporative losses from Washoe Lakes are estimated to be 3.75 feet. An estimated 21 inches of this annual evaporation is found to occur from June 1st through August 31st.

There are numerous perennial and intermittent stream systems that contribute water to Washoe Lakes. Water from these creeks and springs not consumed by senior surface irrigation and other decreed rights contribute to Washoe Lakes storage.

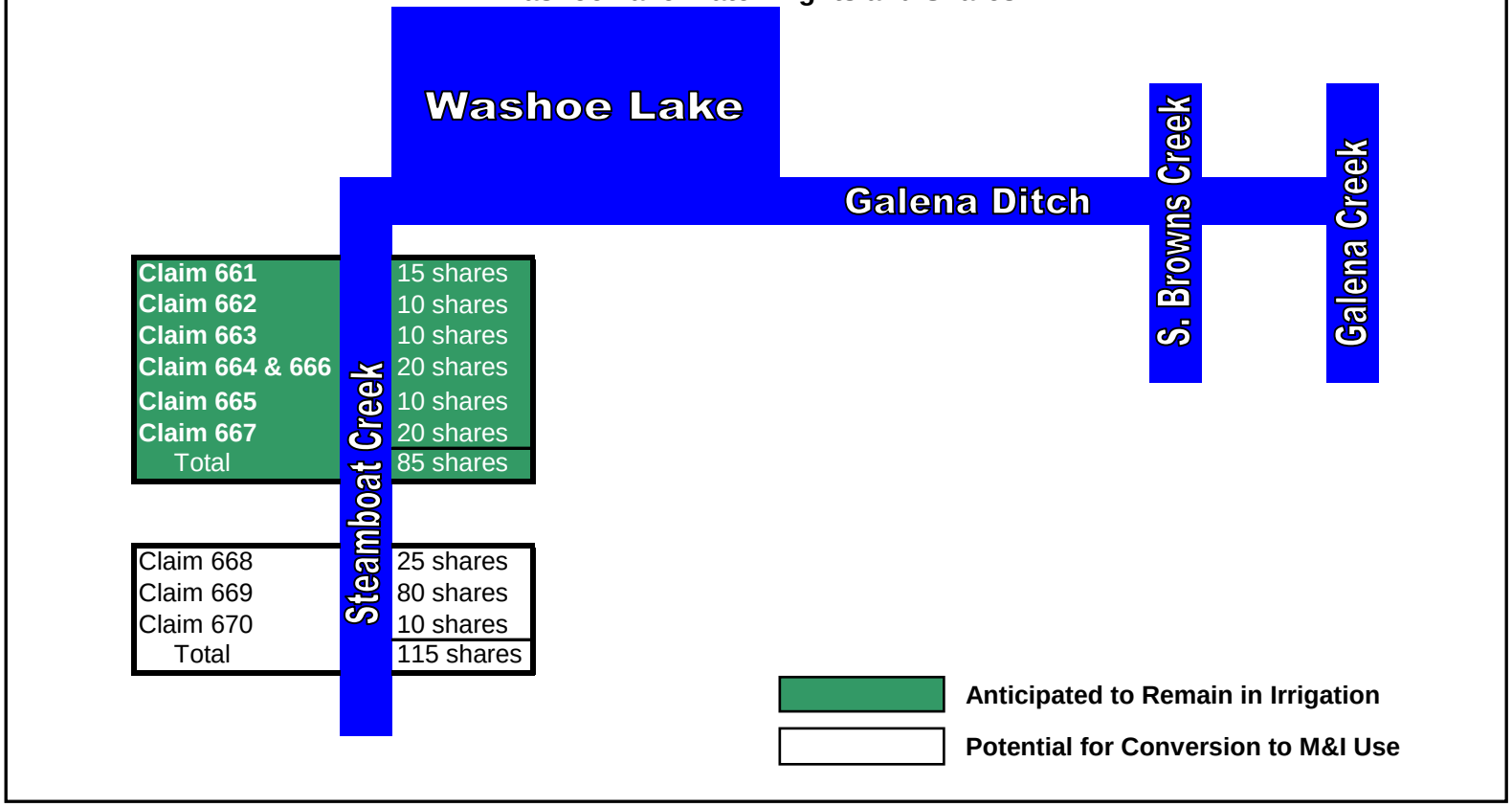
Starting from the south end of Upper Washoe Lake westerly to the outlet works at the northern end of Lower Washoe Lake are the following stream systems:

- McEwen Creek
- Bryan Creek
- Musgrove Creek
- Thompson & Lewers Creek
- Franktown Creek
- Ophir Creek
- Davis Creek
- Winters Creek
- Browns Creek by a diversion and ditch system
- Galena Creek by a diversion and ditch system

Starting from the south end of Upper Washoe Lake easterly to the outlet works at the northern end of Lower Washoe Lake are the following stream systems:

- Deadman Canyon Creek
- Jumbo Creek

Figure 3
Washoe Lake Water Rights and Shares



A great assortment of information on Washoe Lake is available but no one document or written account has attempted to compile that information. Therefore, the information collected has been compiled and summarized from numerous documents in this report.

Washoe Lakes cannot be fully understood from a water rights standpoint without reference to its three water storage rights. The Orr Ditch Decree stipulates under Claim Nos. 660 through 660d the priorities of storage and release of water from the Washoe Lake Reservoir as follows:

- First, an 1864 priority under Claim Nos. 660 and 660c for Washoe Lake Reservoir with capacity based on a wooden dam built by the Washoe Lake Reservoir and Galena Ditch Company to the high water mark of both Upper Washoe and Lower Washoe Lakes and filled with the surplus and unappropriated water from creeks and streams tributary to Upper Washoe and Lower Washoe Lake. Such stored water is used for the irrigation of lands of the stock holders of the Reservoir and Ditch Company as necessary to supplement any water supply available from Steamboat Creek and in the Pleasant Valley area, Steamboat and Galena Creek.
- Second, a May 25, 1889 priority under Claim Nos. 660, 660a and 660b for a second dam built at the outlet of Little Washoe Lake to the high water mark of Washoe Reservoir to be filled by a ditch, which is allowed to transport up to 114 cfs each of Galena and Browns Creek surplus waters. Because the Galena and Browns Creek ditch alignment crossed lands owned by Theodore Winters, an agreement dated May 18, 1889 between Mr. Winters and the Washoe Lake Reservoir and Galena Ditch Company stipulated that the water from Lower Washoe Lake could be released at any time but water above the Winter's wooden dam located between Washoe Lake and Lower Washoe Lake could only be released after July 1st. This wooden dam disintegrated decades ago and can no longer be located.
- A November 19, 1912 priority under Permit No. 2559 and described under Claim No. 660d allows for the operation and maintenance of a ditch to draw 5,000 acre feet of water from Upper Washoe Lake after it reaches it's low water mark. This water would pass through Lower Washoe Lake reservoir outlet works for the irrigation of 3,110 acres of irrigated lands owned by the Washoe Lake Reservoir and Galena Ditch Company stock holders. Additional water right holders have later priority rights to the dead storage of Upper Washoe Lake but those rights are not a part of the Orr Ditch Decree.

The Washoe Lake Reservoir and Galena Creek Ditch Company water rights are really supplemental in two respects.

First, the Orr Ditch Decree states that in Claims 660 through 672 "the stockholders in Washoe Lake Reservoir and Galena Creek Ditch Company are entitled to receive and use, through Steamboat Creek and their various ditches leading there from, for the

irrigation of their lands and for stock and domestic purposes, the water stored in or discharged from Washoe Lake Reservoir in proportion to the number …of shares." These water rights are therefore appurtenant to varying numbers of acres, some large and some small. The number of acres is not related to the share of water owned. If the irrigated acres can be served from Steamboat Creek, the right will not be allowed to take any of the Washoe Lake water. Since these rights are supplemental to the waters of Steamboat and/or Galena Creeks we recommend that the County and TMWA do not take any of the shares from Washoe Lake unless such entity also gets a sufficient portion of water rights associated with the shares. The opposite is also true. If the County or TMWA acquire Steamboat Creek water rights, it is very important that they acquire the associated shares at the same time.

The second manner in which the Galena Creek and Browns Creek water rights are supplemental is that the call of the ditch rights is limited to the amount of water necessary to fill Washoe Lake to its normal high water mark. Therefore, if Washoe Lake is spilling, there can be no diversions of excess water from Browns or Galena Creek.

Water Master's Authority for Washoe Lakes

The Orr Ditch Decree sets forth as Claim No. 660, the rights to divert water into and store and release water from Washoe Lake Reservoir through the Galena Ditch. These rights, set forth in more detail above, are the rights of the Washoe Lake Reservoir and Galena Creek Ditch Company, a Nevada Corporation with 200 shares of stock.

On page 87 of the Orr Ditch Decree, the Court stated: "A Water Master shall be appointed by this Court to carry out and enforce the provisions of this decree and the instructions and orders of Court, and if any proper orders, rules or directions of such Water Master made in accordance with and for the enforcement of this decree, are disobeyed or disregarded he is hereby empowered and authorized to cut off the water from the ditch or canal owners or water users so disobeying or disregarding such proper orders, rules or directions and the Water Master shall promptly report to the Court to so require, the persons to assist the Water Master as the Court may deem necessary to properly carry out the provisions of this decree and the orders of the Court."

Although the Water Master does not own these facilities, does not physically operate the facility and has no responsibility for the maintenance of the Washoe Lake Dam or Galena Ditch facility including the measuring devices to properly distribute water (although he could order installation of such a device), he is responsible for enforcing the terms of the agreement between I H Ball et al. and Winters dated May 18, 1889 and he is responsible for enforcing the provisions of the decree. Similarly, his authority is limited to water rights set forth in the Decree, which includes Lower Washoe Lake but does not include the water in Big Washoe Lake that is below the rim and is naturally held and ponded there for the benefit of water right holders other than the Reservoir and Ditch Company. The president of the Washoe Lake Reservoir and Galena Ditch

Company operates the diversion structure and outlet works but also has the responsibility to inform the Water Master of his actions and take instruction if the Water Master determines this operation is inconsistent with water rights.

The Winters Agreement

The provision for the existing dam construction and the rights to use the stored water in Lower Washoe Lake and above the dead storage in upper Washoe Lake was formalized in an agreement between Theodore Winters (hereinafter Winters) and the Washoe Lake Reservoir and Galena Ditch Company Shareholders, dated May 18, 1889, and recorded in the Office of the Washoe County Recorder. This storage agreement is recognized in the Orr Ditch Decree, the Final Decree for the Truckee River, adjudicated in the District Court of the United States in and for the District of Nevada in Equity, Docket No. A-3. Refer to Claim No. 660 on page 75 of the Orr Ditch Decree. To our knowledge he did not receive any storage rights in the reservoir, which is confirmed by the language of the Orr Ditch Decree; however, he did get a contractual right to control the floodgates. The successor to Winters therefore owns the right to control the floodgates to keep the reservoir from exceeding the natural high water mark and assuming the dam between the two lakes was restored, to prevent any water from Big Washoe Lake from being released prior to July 1st.

Historically the Water Master had only allowed releases from Washoe Lake Reservoir after July 1st of each year although more recently, the Water Master has allowed some earlier releases.

Based on meetings with the Water Master and further research of the documents provided by the Water Master and the State Engineer, the Water Master has now determined that it is possible to release water stored in Little Washoe Lake earlier than July 1st when called upon by the decreed share holders under Claim Nos. 661 through 672. However, because the old wooden dam has been removed, calling on water from Little Washoe Reservoir will lower the level in Big Washoe Lake. The authors of this study believe that this could cause some water right holders to replace the old Winters dam between these two lakes. Therefore it seems prudent, for the purpose of this study, to analyze the water supply from the shares either assuming a dam between the two lakes or with release from the lake only after July 1st.

So long as the water supply assumed to be available is not overestimated by reason of the dam's removal, the owners of Washoe Lake Reservoir and Galena Ditch shares should be able to operate to receive their storage without further commitments from Winters or their successor.

Storage Capacity of Washoe Lake

The United States Geological Survey in cooperation with the Nevada Division of Water Resources conducted a bathymetric reconnaissance survey of Big and Little Washoe Lakes and presented results in a 1972 report, Water Resources – Information Series Report No. 10. Using the USGS Rating No. 2. This report has been used for the combined Washoe Lakes since October 1, 1986. Table 3 depicts the amounts of operational storage based on storage versus elevation information prepared from the survey. The lakes have been empty during drought periods.

Table 3 – Big and Little Washoe Lake Operational Storage

	Elevation	Storage
Lake Spillway Elevation (combined storage)	5028.9 feet	36,900 af
Elevation at which Big Washoe is isolated from Little Washoe (combined storage)	5025.0 feet	17,300 af
Little Washoe Lake at isolation elevation (separate storage)	5025.0 feet	210 af
Elevation of Little Washoe Outlet	5022.8 feet	42 af
Operational storage is available for release and regulation as follows:		
Storage between spillway elevation and elevation when Lakes are separated		19,600 af
Little Washoe storage between elevation when lakes are separated and outlet elevation		168 af
TOTAL		19,768 af

Based upon the 1984 Open-File Report 84-465 prepared by the U.S. Geological Survey and entitled “Hydrology of Washoe Valley, Washoe County, Nevada”, the normal annual precipitation on the lakes is about 11 inches and the normal annual evaporation from the lakes is about 55 inches. This leaves net evaporation after accounting for precipitation of about 44 inches, or 3.7 feet.

Table 4 shows the hydrologic budget for the year 1980 based on the USGS Open-File Report 84-465.

Table 4 – 1980 Hydrologic Budget for Washoe Lake	
Stream Inflow	26,000 af
Valley and Lake Precipitation	22,900 af
Importation	4,000 af
TOTAL Inflow (rounded)	53,000 af
Lake Evaporation	23,000 af
Valley Evapotranspiration	27,300 af
Domestic Consumption	100 af
Export	700 af
Stream Outflow (to Steamboat Creek)	2,300 af
TOTAL Outflow (rounded)	53,000 af

Current Washoe Lake Storage Operation

Damonte Ranch has physically operated the dam and Browns and Galena ditch diversions since the 1950s with the oversight of the Federal Water Master.

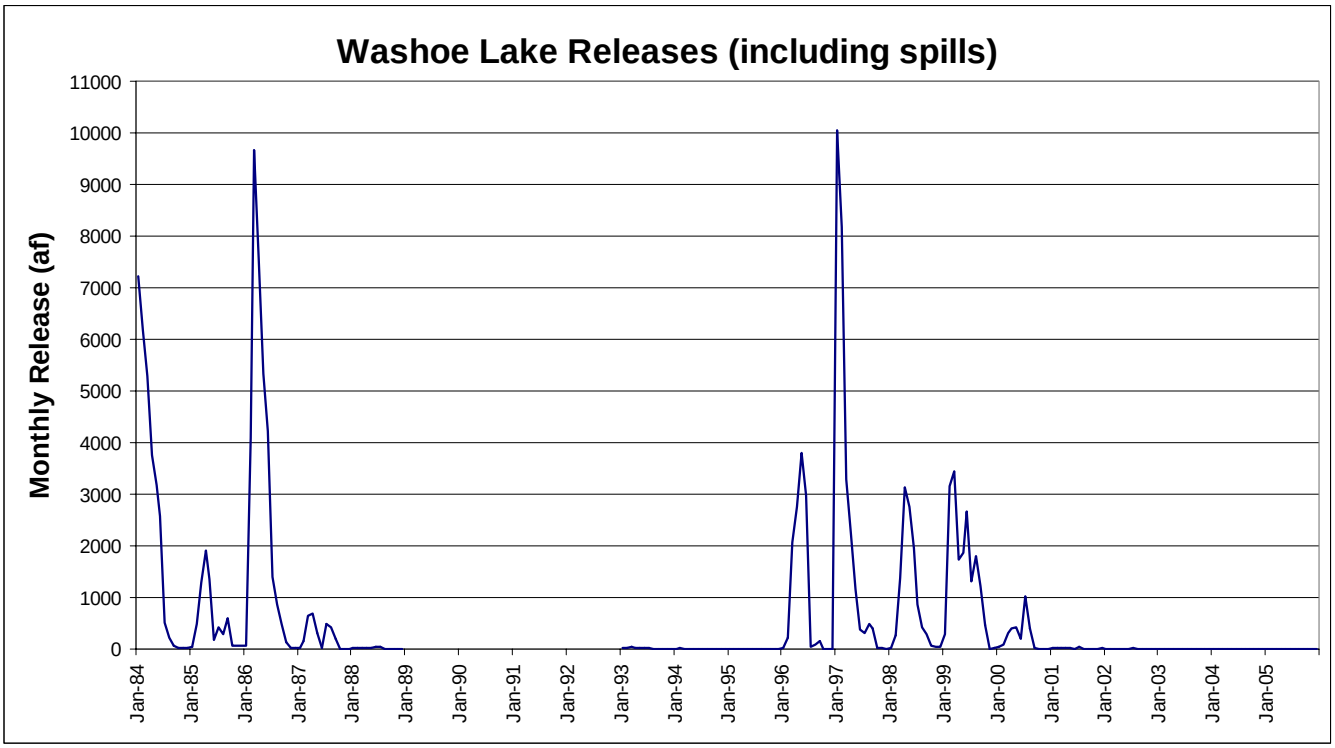
After approximately April 15th, the head gate at the outlet of Washoe Lake has been operated in accordance with Figure 4 on the next page. Stored water is provided to each shareholder based on the released water flow from storage and the percentage of this flow their shares represent. Each shareholder of record as of 1944 is listed along with their number of shares under Truckee River Decree Claim No. 660. The Water Master maintains a water flow recorder below the Washoe Lake Dam in order to record natural flows and storage releases from Washoe Lake into Steamboat Creek.

Galena Ditch Operations

Under Truckee River Decree Claim No. 660a on page 75, the following language describes the limit of water decreed for storage in Little Washoe Lake.

"Thereupon, by and through this ditch, the Washoe Lake Reservoir and Galena Creek Ditch Company appropriated and conveyed to the reservoir 114 cubic feet per second of the surplus and unappropriated water of Galena Creek and a like amount of the unused and unappropriated water of Brown's Creek and is allowed and is entitled, and since and including the year 1889 ---By reason of prior appropriation and by said wooden dam the Washoe Lake Reservoir and Galena Creek Ditch Company and the parties to this action who are hereinafter named stockholders of the operation are allowed the storage and for the irrigation of their hereinafter described lands and capacity of said dam, the waters naturally flowing into Washoe Lake and Lower Washoe Lake."

Figure 4



The Browns Creek diversion and the water diverted from Galena Creek and Browns Creek to Washoe Lake has historically commenced about October 15th and has been cut off approximately April 15th of each year when Galena Creek and Browns Creek decreed irrigators begin diverting water for irrigation. The actual diversion into the Galena and Browns Ditch has been about 20 cfs.

Diversions to Washoe Lake Reservoir are terminated each year when water is called upon for irrigation, which is roughly in the middle of April. The Ditch Company also has the right to take additional water from Browns and Galena as a last priority right behind all irrigators at other times of the year to the extent that Washoe Lake Reservoir is not at the natural high water mark.

Shares in the Washoe Lake Reservoir and Galena Ditch Company

The ditch from Galena Creek and Browns Creek and the dam at the outlet of Washoe Lake are operated and maintained by a corporation incorporated after the original Washoe Lake Reservoir and Galena Ditch Company allowed their charter to lapse and be revoked. The second corporation carries the same name as the original corporation.

Shares in the original Washoe Lake Reservoir and Galena Creek Ditch Company were allocated to decreed irrigators. Some of the shares were transferred prior to the charter

being revoked and some after. Each share represents a percentage of the stored water. This stored water can be utilized to supplement decreed water rights from Steamboat Creek to the extent their right is not fully served from some other source.

Generally when a corporation is dissolved, the assets and liabilities of the corporation are generally liquidated or distributed to the stockholders. The first Washoe Lake Reservoir and Galena Creek Ditch Company, which existed in 1953, was never formally dissolved. The charter was revoked for non-payment of fees. Because there is no evidence that the water rights were ever deeded to the new company, additional steps may be necessary to clean up the title to these rights.

The new corporation has been acting as a company which collects assessments in order to provide the service of operating and maintaining the dam and the ditch facilities on behalf of those shareholders paying for water to be released on their behalf. Many of the original owners of shares are not paying for the operation of the dam but this probably will not affect their beneficial ownership in the assets.

DESCRIPTION OF MODEL

Overview of Modeled Operations

The primary purpose of the system operation is water supply. While there are a few lakes within the system that could provide some flood control, this purpose was not considered in this model.

The South Truckee Meadows water supply model was developed as an Excel spreadsheet. System conditions (e.g., beginning reservoir storage and water demand schedules for each claim) are initialized for a given date with operations determined by a series of rules and constraints. Each month's operation is dependent upon the state of the system at the end of the previous month. This model was used to simulate continuous operation of the system, month-to-month and year-to-year, over a time period of 21 years. This corresponds to the period of historical record. The effects of a set of demand schedules and operating rules can be evaluated by running a simulation over the hydrologic record that includes periods of flood and prolonged drought. A full description of the model is included in Appendix B.

Originally, water on the creeks and storage in the lakes were used for irrigation of appurtenant lands. Limited amounts of water were stored in the winter, and land was irrigated by either direct diversion from creeks or releases of storage from approximately April through October. As residential development occurs, water rights are being converted to municipal and industrial use (M&I). Some rights have also been converted to provide return flow credit to make up for Truckee River water delivered to the South Truckee Meadows. The model allocates available flow in the creeks to these three uses (irrigation, M&I water supply, and return flow credit) based on demand schedules and priority of the rights.

A “return flow water right” is required whenever effluent from the M&I use of an Orr Ditch Decree water right is not returned back to the source of supply. A “return flow water right” is not required if the M&I use is limited to the consumptive use portion of the Orr Ditch Decree water right. Rights dedicated to provide return flows for the use of Truckee River water rights do not need to be main stem Truckee River rights and may be tributary creek rights as long as the replacement water flows past the Vista Gage on the Truckee River during years when the Floriston Rates are met. Permits have been approved which allow some Steamboat Creek rights to be used for return flow purposes. When creek rights are converted from agricultural to use for return flow purposes, the Nevada State Engineer specifies the percent credit allowed for each claim. Junior claims may not receive 100% credit for return flow purposes. Table 5 shows the percentage allowed when Steamboat Creek claims were converted to use for return flow purposes in permits issued by the Nevada State Engineer.

Table 5 – Duty of Steamboat Creek Water Rights when used for Return Flow

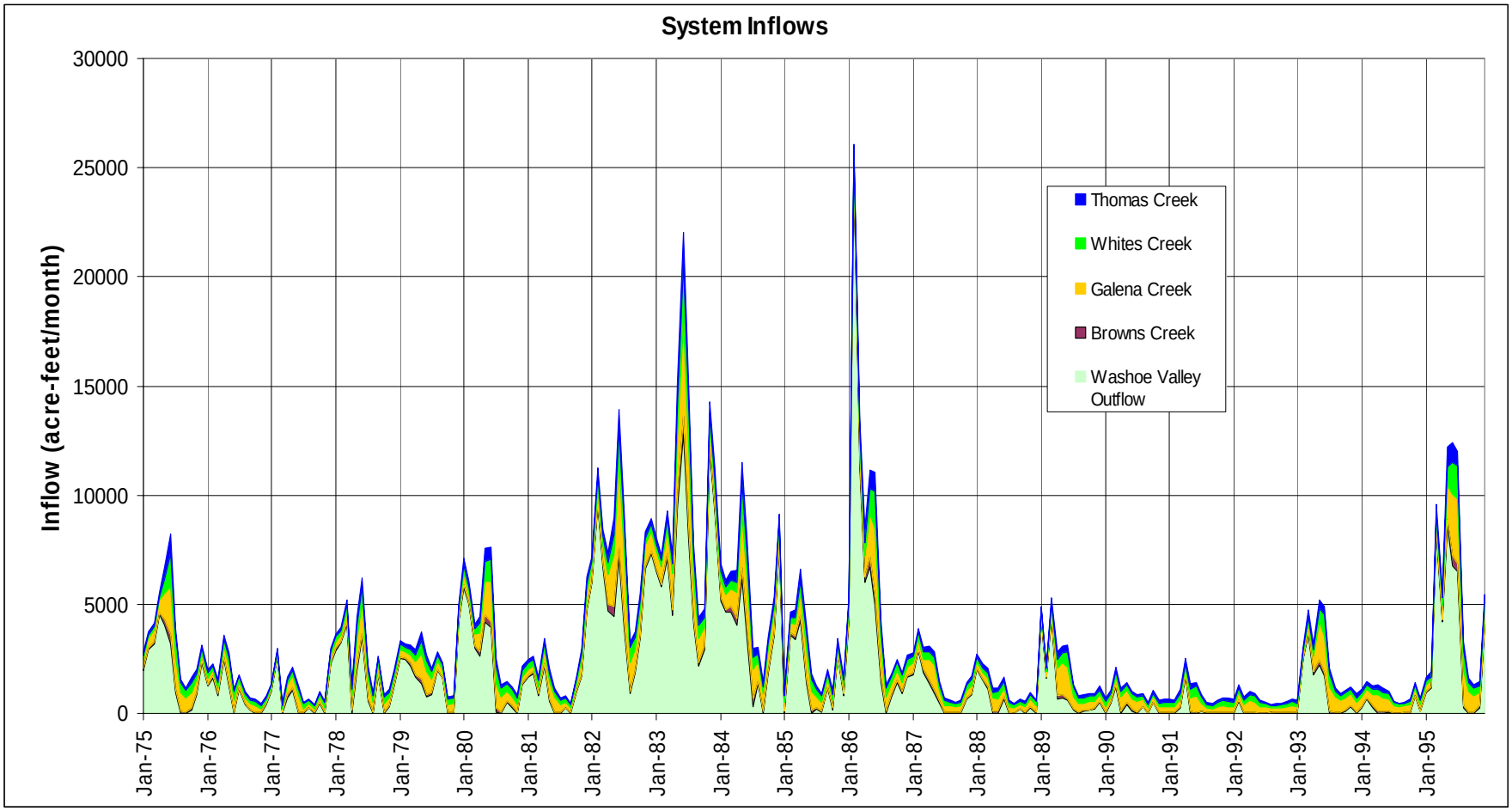
Claim	Priority	% Duty when converted to return flow use
700	1860	100%
700 ½	1860	100%
701	1860	100%
702	1860	100%
703	1860	100%
704	1861	100%
705	1890	40%
706	1895	0%
707	1862	85%
708	1890	65%

Source: permits issued by Nevada State Engineer

Hydrologic Data Development

Since there is little storage on the system, the water supply is dependent on the volume and timing of runoff. The hydrology for Browns Creek was developed as part of this project and is documented in Appendix A. Hydrology developed as part of the Facility Plan was used for Galena, Whites and Thomas Creeks and for the inflow from Washoe Valley. Figure 5 shows water that was available each month for the simulation.

Figure 5 – Monthly Water Availability



Beneficial Uses Considered

This study assumed water was used for three purposes:

- Some rights will remain in irrigation. Although historically these rights may not have been exercised each year, this study assumed full use of all rights.
- Some rights will be used to supply M&I demand.
- Some rights will be used for return flow purposes. This group of tributary water rights is used to provide return flows to the Truckee River during years when Floriston Rates are met to offset the export or land application of effluent resulting from the use of direct diversion Truckee River water rights.

M&I Demands

Previous work estimated that M&I demand in the South Truckee Meadows would reach 15,469 acre feet per year. For this study, buildout demand was increased 15% to 17,758 acre feet per year. Scenarios were also run with increased demands to determine whether there were unused water resources that could be used, thereby increasing the yield of the water rights.. No additional yield resulted therefore the 15% increase was used for additional studies.

Current facilities limit distribution of treated surface water to specified supply zones, specifically, the portions of the service area higher than Thomas Creek Road. Without additional facilities, only 71% of M&I demand in the South Truckee Meadows can be served by tributary water or wholesale water.

Table 6 – Projected Annual Water Demands (mgd)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Original Demand Estimate	7.3	7.4	7.9	12.3	16.9	20.2	23.7	23.2	16.3	12.5	7.8	7.4
Increased Demand for Current Evaluation	8.4	8.5	9.1	14.1	19.4	23.2	27.3	26.7	21.0	14.4	9.0	8.5
Demand Served by Tributary Water or Wholesale	5.9	6.0	6.4	10.0	13.8	16.4	19.3	18.9	14.9	10.2	6.4	6.0

Consumptive Use Assumptions

Water not consumptively used is available for use by other rights on the system. Each of the three beneficial uses considered in the study consume different portions of their rights.

- Rights used for irrigation may consume more than their allocated duty because of transit losses in the ditches, or they may consume less than their duty when there are significant return flows.
- Rights used for M&I supply do not have transit losses and do not provide any return flow. However, the Nevada State Engineer may reduce the duty allowed when rights are converted from irrigation to M&I use.
- The Nevada State Engineer has determined the duty allowed on rights that have been converted to use for return flow purposes. A one hundred percent conversion ratio has been allowed for several of the early priority rights, but the junior rights have a reduced duty when used for return flow purposes.
- Tributary water rights used for M&I supply are limited to a consumptive use component of 62.5%. Since these rights provide return flows to downstream water rights, no additional water rights need to be obtained when effluent from waste treatment facilities is used for land application.

Detailed consumptive use assumptions are included as Appendix C.

Operating Schedules for Exercising Individual Rights

- Rights that remain in irrigation receive water from April through October each year. Irrigation schedules for various creeks were developed in previous work. For irrigation rights, water not available in one month cannot be scheduled in addition to demand in subsequent months.
- Rights converted to M&I use received water on a 12-month schedule. For M&I, if water was not available to fill demand in one month, it could be called on in addition to demand in subsequent months as long as no more than 25% of the right was diverted in any single month. Different scenarios and hydrologic year types result in the application of water resources from the creeks in different patterns:
    - Browns and Steamboat Creek rights are typically used for winter M&I demand.
    - Thomas Creek rights are used during the irrigation season since they are delivered to the water treatment plant via the Steamboat Ditch.
    - Galena Creek rights are used during the summer when demand is highest.
    - Whites Creek rights are used year round and fill in demand depending on year type.

- Rights used to make up for effluent reuse based on surface water rights are available on a 12-month schedule and are called on whenever water is available.

MODEL RESULTS

Assumptions and Constraints

Initial plans are to construct a 6 mgd water treatment plant to treat tributary water and groundwater that doesn't meet water quality standards. This model assumes that the ultimate planned capacity of 12 mgd is available year round. Wholesale water is available from TMWA at a maximum capacity of 5,400 gallons per minute. Seventy-one percent of the buildout demand can be served by this treated water or by treated wholesale water. Twenty-nine percent of the demand can only be served by groundwater due to a lack of facilities to convey treated wholesale or tributary water higher in the service area than Thomas Creek Rd. The use of up to 9,575 acre feet of groundwater is available to serve dry year demands. This groundwater is already dedicated for development and represents a demand that is not yet fully realized.. Tributary water is managed to reduce the need for wholesale and groundwater.

Many model simulations were performed to arrive at a recommended scenario which included modifications such as altering the constraints listed above, altering the season of diversion, and altering the order of use of the water rights under consideration. Through this process it was found that the yield of the Steamboat Creek, Browns Creek and Galena Creek water rights were insensitive to increases in the wholesale supply above 5,400 gpm and treatment capacity above 12 mgd. The lower priority Steamboat Creek water rights were also found to provide no incremental M&I water supply benefit during dry years with hydrology similar to 1992. These lower priority Steamboat Creek water rights do provide some water in normal to wet years and may have other potential beneficial uses that do not require meeting a demand in the driest year.

The previous Facilities Plan work recommended the direct diversion of water that is currently diverted into Washoe Lakes for storage per Orr Ditch Claim No. 660a for M&I supply. This study determined that the use of the Claim No. 660a right without the associated Steamboat Creek water rights would not be feasible as this claim is a right which is supplemental to the Steamboat Creek supply. This study found that the combination of the earlier priority Steamboat Creek rights and the shares produce a winter and spring water supply that can be relied upon in conjunction with other water resources available to Washoe County to provide a reliable M&I water supply.

Treatable excess surface water (creek water in excess of the M&I demand schedule and greater than the available surface water treatment capacity) was also evaluated as a potential water supply that could increase the overall yield of the combined resources. Based on the historical flow record for the tributary creeks, this water is generally available in normal years as peak runoff during January through March. In dry years,

treatable excess surface water is only available for one month, typically in February or March. Additional water treatment plant capacity coupled with an aquifer storage and recovery (ASR) program using the County's wells on the Mt. Rose alluvial fan would be needed to implement this water supply option. It was assumed that additional groundwater production capacity could be developed to recover the stored water.

The quantity of excess surface water that could be diverted, treated, stored, and then recovered and supplied over a 12-month M&I delivery schedule was estimated. Results of this analysis indicate that the planned 12 MGD treatment plant could "theoretically" supply up to 50 acre feet of additional demand. With a 15 MGD treatment plant available to treat the peak runoff, up to 800 acre feet of additional demand could "theoretically" be supplied.

There are several factors that limit the potential of this water supply option, including facilities to convey the water to the recharge wells, actual groundwater recharge capacity, the ability of the aquifer of retain and recover the recharged water, and the need for additional groundwater production capacity to meet the added demand. More important however, is the need to bank excess water over multiple years for use during dry years. Based on the historical record, over 5,000 acre feet of water would need to be recharged and stored during wet years to ensure the 800 acre feet of additional water supply is available for later withdrawal in dry years.

In conclusion, this water supply option is based upon numerous uncertainties. Once the water treatment plant is constructed and operational, Washoe County should monitor the actual treatable excess surface water, and consider the potential feasibility of this option in the future when more information is known.

Recommended Buildout Scenario

In this scenario only tributary water rights that provide dry year yield are dedicated for M&I use or Return Flow Credit. Rights dedicated for M&I use include:

- 2,003 acre feet of Thomas Creek water rights were evaluated for this scenario. When used for M&I, only 62.5% of the right may be diverted, 37.5% must remain in the creek to make up for historic return flow. Water from Thomas Creek is diverted through an irrigation ditch to the treatment plant. To avoid significant losses, these rights were only exercised during the irrigation season when the ditch is being used for other deliveries.
- 4,142 acre feet of Whites Creek rights. The State Engineer has allowed a 100 percent consumptive use for Whites Creek water rights due to their historical irrigation practices and the re-diversion of the tail water runoff for the irrigation of adjacent lands. Water from Whites Creek can be used year round.
- 922 acre feet of Galena Creek water rights. When used for M&I, only 62.5% of the right may be diverted, 37.5% must remain in the creek to make up for

historic return flow. Water from Galena Creek flows to Steamboat Creek where it is piped to the treatment plant.

- 1,817 acre feet of Browns Creek water rights. When used for M&I, only 62.5% of the right may be diverted, 37.5% must remain in the creek to make up for historic return flow. Water from Browns Creek flows to Steamboat Creek where it is piped to the treatment plant.
- 1,801 acre feet of Steamboat Creek water rights were evaluated for M&I use. This number is the result of setting aside the rights that provide no incremental M&I water supply benefit in drought years and recognizing the dedications of Steamboat Creek water rights that have already been made for return flow purposes. When used for M&I, only 62.5% of the right may be diverted, 37.5% must remain in the creek to make up for historic return flow. Early priority Steamboat Creek rights receive their full duty without supplemental water from Washoe Lake shares when they are diverted in the winter and spring. Water from Steamboat Creek is piped to the treatment plant.
- 4,779 acre-feet of Steamboat Creek water rights were evaluated for return flow uses.

Use of M&I Resources

- In the winter and spring, use Steamboat and Browns Creek water first to either 1) satisfy demand or, 2) use up treatment plant capacity. If additional tributary water is needed, use Whites Creek water. Satisfy remaining demand with wholesale supply.
- If the year has an average forecast, use wholesale supply (up to 5,400 gpm) before pumping groundwater. If wholesale supply reaches 3,600 acre feet late in the year, satisfy additional demand with extra groundwater.
- If the year has a dry forecast, use additional groundwater up to 16.2 mgd capacity or 9,575 acre feet annually before calling for wholesale supply.

Summary of Model Results

Water supply from the creeks in the South Truckee Meadows is highly variable. The 10,686 acre feet of rights evaluated supply 7,629 acre feet of water in an average year, but only 4,679 acre feet of water in a dry year. By limiting the yield of the tributary water rights to the dry year supply, other water rights can be re-timed to provide a firm water supply. Water in the creeks is limited in the summer when M&I demand is largest but can be supplemented with 3,600 acre feet of wholesale water from TMWA and 9,575 acre feet of groundwater. Additionally, wholesale and groundwater will be required to fill daily fluctuations of tributary supplies and for peaking.

If 3,600 acre feet of Truckee River supply is acquired for wholesale delivery from TMWA, the use of groundwater can be minimized in average years. The use of the Truckee River water rights will require return flow water rights. Groundwater will still be required in the summer when tributary water is limited and wholesale deliveries are at the maximum 5,400 gpm.

Dry years will require 9,575 acre feet of groundwater. In the late summer during droughts, very little tributary water is available and most of the demand must be filled with wholesale and groundwater. If groundwater pumping is limited to an average of 16.2 mgd, there may be small shortages in supply. This simulation was 33 acre feet (0.35 mgd or 1.3%) short of meeting the August dry year demand.

Pump zone facility constraints limit the use of tributary water and wholesale supplies. 5,190 acre feet of the projected demand is located in the areas that can only receive groundwater. This “groundwater only” is the peach colored bar on the M&I Supply charts.

Table 8 lists the yields of individual rights that were evaluated for M&I supply. Early priority rights such as Claim 718 on Thomas Creek provide a full supply even in dry years whereas junior rights, such as Claim 222, do not provide any supply in a dry year. The yield of individual claims should be considered to determine the commitment that can be made.

Table 7 – Water Resources Studied to Satisfy Demand Curve (AF)

Available Tributary Water Resources	Rights Acquired for M&I	Average Year (non-drought) Supply	Yield	Dry Year Supply	Yield
Whites	4,142	3,732	81%	2,201	53%
Thomas	2,003	1,185	51%	539	27%
Galena	922	574	61%	576	62%
Browns	1,817	1,013	47%	388	21%
Steamboat	1,802	1,124	62%	975	54%
Total Tributary Water	**10,686**	**7,629**	**71%**	**4,679**	**44%**
Additional Resources					
Wholesale Water		3,460		3,472	
Groundwater		6,795		9,575	
Total Available Supply		**17,883**		**17,725**	
Excess Tributary Water Available for Recharge		-125		0	
Delivered Supply		**17,758**		**17,725**	
Note: Depending on the type of year, there may be from time to time excess wholesale water available for recharge.					

Figure 6

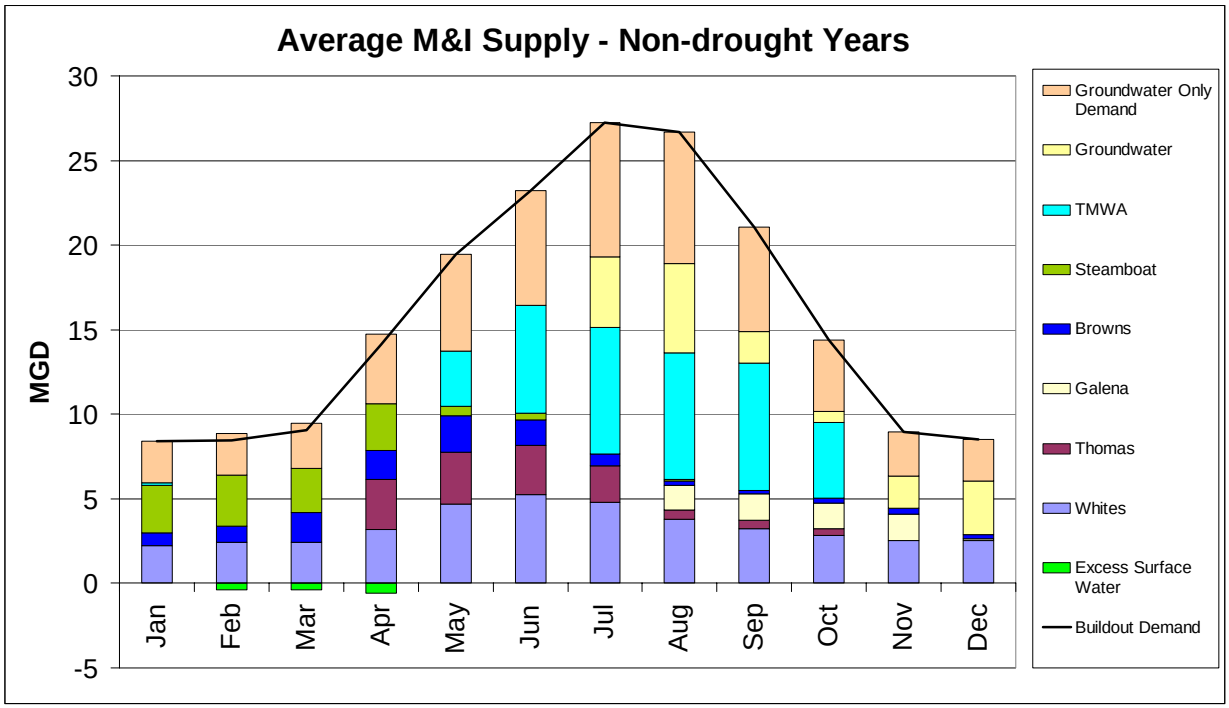


Figure 7

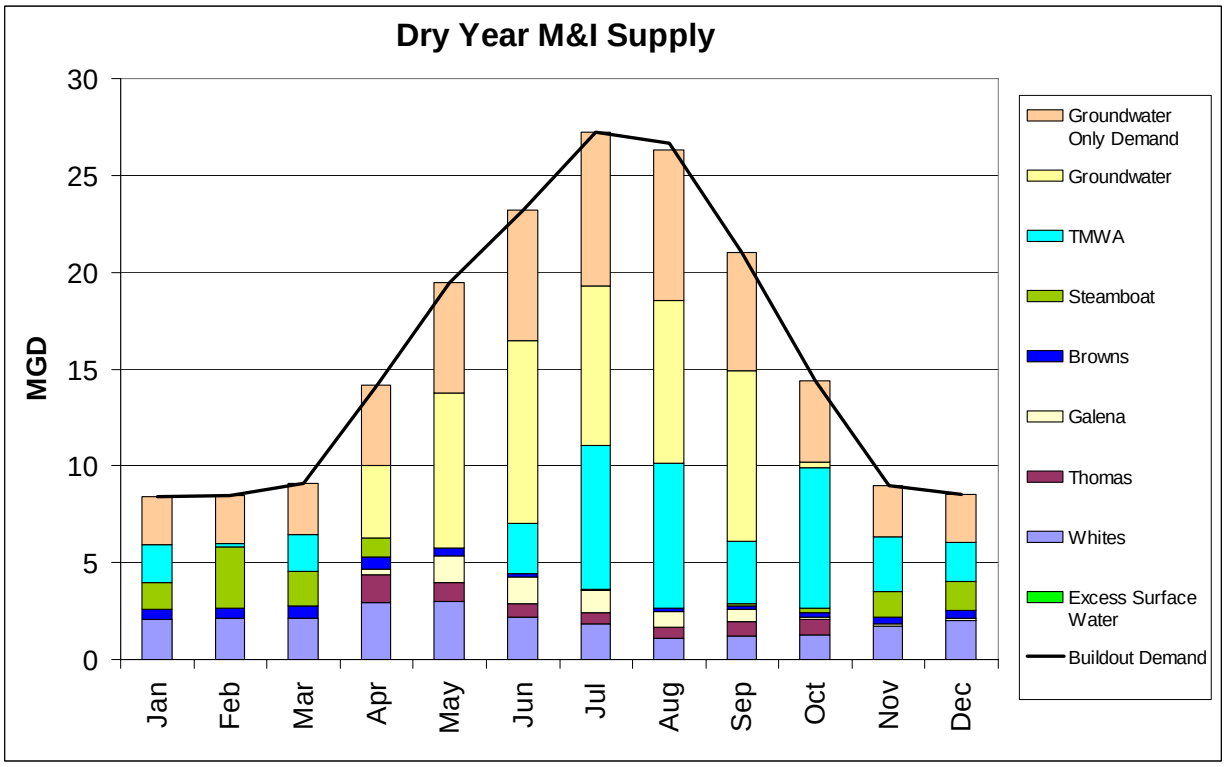


Table 8 - Recommended Scenario Yield Summary 12 mgd Capacity Treatment Plant, 17,759 acre feet Annual Demand									
Claim #	Annual Right	Minimum	Average	8-year Drought Average (1987-1994)	Average for non-drought years	Minimum Yield	Average Yield	8-year Drought Yield (1987-1994)	Non-drought yield
Total M&I	10686	4679	6909	6053	7631	44%	65%	57%	71%
Whites Creek									
715	1860	1103	1596	1421	1758	59%	86%	76%	95%
716	1922	929	1466	1225	1663	48%	76%	64%	87%
717	360	174	275	229	311	48%	76%	64%	87%
Total Whites M&I	4142	2206	3337	2875	3732	53%	81%	69%	90%
Thomas Creek									
Casazza Branch									
718	381	238	238	238	238	63%	63%	63%	63%
75a	401	21	191	144	238	5%	48%	36%	59%
222	112	0	40	18	59	0%	36%	16%	53%
225	25	0	9	4	13	0%	36%	16%	53%
Holcomb Branch									
719	530	137	266	217	311	26%	50%	41%	59%
720	554	143	278	227	325	26%	50%	41%	59%
Total Thomas M&I	2003	539	1022	849	1186	27%	51%	42%	59%
Galena Creek									
652	270	169	169	169	169	63%	63%	63%	63%
653	319	199	199	199	199	63%	63%	63%	63%
654	36	23	23	23	23	63%	63%	63%	63%
655	180	113	113	113	113	63%	63%	63%	63%
657	90	42	55	55	55	47%	61%	61%	61%
Total Galena M&I	895	545	558	558	558	62%	62%	62%	62%
Browns Creek									
2747	9.4	2	4	3	5	21%	47%	36%	56%
2757	1750.85	375	827	630	976	21%	47%	36%	56%
2758	8.8	2	4	3	5	21%	47%	36%	56%
2759	3.64	1	2	1	2	21%	47%	36%	56%
2812	26.36	6	12	9	15	21%	47%	36%	56%
2850	18.08	4	9	7	10	21%	47%	36%	56%
Total Browns M&I	1817	390	859	653	1013	21%	47%	36%	56%

Table 8 - Recommended Scenario Yield Summary 12 mgd Capacity Treatment Plant, 17,759 acre feet Annual Demand - Continued									
Claim #	Annual Right	Minimum	Average	8-year Drought Average (1987-1994)	Average for non-drought years	Minimum Yield	Average Yield	8-year Drought Yield (1987-1994)	Non-drought yield
Steamboat Creek									
700	33	20	21	20	21	60%	62%	62%	63%
700.5	33	20	21	20	21	60%	62%	62%	63%
701	33	5	20	18	21	16%	60%	55%	63%
702	59	36	37	37	37	60%	62%	62%	63%
703	124	74	78	77	78	60%	62%	62%	63%
704	10	2	6	6	6	16%	60%	55%	63%
707	177	28	104	94	111	16%	59%	53%	63%
709	1332	798	831	828	833	60%	62%	62%	63%
Total Steamboat M&I	1802	982	1116	1101	1126	54%	62%	61%	63%

CONCLUSIONS

The issues evaluated herein are complicated. The more evaluation is performed, the more is learned on constraints and best operating parameters.

A thorough spreadsheet model has been developed that will allow Washoe County to determine the yield of individual water rights offered for dedication. Priority is an important factor that affects the yield and suitability for dedication for M&I purposes.

Multiple scenarios were evaluated to optimize the use of the combined water resources. For example, one specific result is that Galena Creek rights are best used in the late summer or fall to take advantage of early year Steamboat and Browns Creek flows.

For scenarios that evaluated the use of high spring runoff flows to increase supply, eliminating the 12 mgd treatment capacity constraint and wholesale capacity constraint of 5,400 gpm resulted in the need for additional Truckee River water rights at approximately a 1:1 ratio to the new demand. In other words, removal of these specific facility constraints did not provide an increased municipal water supply yield for the tributary water rights because they do not have a dry year yield. An equivalent amount of Truckee River water rights would be needed to back up the tributary rights. Therefore, there would be little, if any, benefit to the total municipal water supply by increasing the treatment plant or wholesale water supply capacity.

Approximately 3,600 acre feet of Truckee River water rights will be needed to supplement the tributary and groundwater supplies to meet an increased demand level

of 17,758 acre feet. These Truckee River water rights can be used to directly support demand in the planning area. They also form a part of the resources that are used annually to manage the Steamboat Creek and Browns Creek rights to provide a supply in the late summer when these two tributaries do not provide sufficient water to meet the municipal demands. This represents an increase in the use of Truckee River water in the planning area over the quantity studied in the Facility Plan. The TMWA 5,400 gpm delivery constraint is consistent with the increased use of Truckee River water, the existing wholesale contract, and no additional transmission facilities will be needed to accommodate the delivery of this additional water to the study area. The use of the wholesale Truckee River water supply will require return flow water rights.

Using new Browns Creek flow monitoring data, this evaluation shows that there is less flow than previously thought. It will be important to enforce flows and diversions through Pleasant Valley to meet a 12-month water supply schedule. Pending applications to take the water under a winter diversion schedule are inconsistent with the optimal use of the Browns Creek water as a component of the municipal water supply in the study area. If the Browns Creek water rights are to be used for municipal supply, new or amended applications will be needed to facilitate the diversion schedule examined in this study.

In dry years, Washoe Lake stores water in the dead storage of the lake so that it cannot be discharged to Steamboat Creek. To avoid this artificial constraint upon the dry year use of the Galena Creek supplemental water, water rights associated with Galena Creek and Washoe Lake shares to be used for M&I purposes needs to remain in the creeks rather than be diverted to Washoe Lake. In order to ensure Pleasant Valley water rights holders remain whole, they should be allowed to utilize Washoe Lake storage for agricultural uses. By reducing the demands placed upon Washoe Lake storage, water will not need to be released as fast from the lake and the level can stay higher longer.

Water rights to be used for municipal supply will need appropriate change applications. Due to the relatively scarce water supply in dry years, it will be necessary to have more enforcement of water rights diversion priorities so that the yields achieved in this study can be realized.

If Washoe County accepts Steamboat Creek rights for municipal purposes with priority of 1865 or later, the associated shares need to be dedicated to the County so that the yields presented in this report can be attained. Steamboat Creek rights and the associated shares should not be severed from each other for any planned use for municipal supply or return flow purposes. When used in the winter and spring, early priority Steamboat Creek rights may call on water that was previously diverted to Washoe Lake.

It is concluded that it is acceptable to draw water from Washoe Lake storage prior to July 1st; however, this analysis did not rely upon this assumption.

Washoe Lake does not provide a water supply in dry years such as 1992; therefore, it is not advisable to divert the Galena Creek supplemental supply to Washoe Lake in years where it appears that the water will be trapped in Washoe Lake and unable to be discharged to Steamboat Creek from the Lake.

The sum of the water available from both the Steamboat Creek rights and shares during wet years can be no more than the duty of the Steamboat Creek rights, due to the supplemental status of the shares and the duty limits imposed by the Orr Ditch Decree. This is further limited by the consumptive use approach taken by the Facility Plan to avoid the need to acquire additional water rights to offset the land application of effluent.

Title research will be required on all Washoe Lake/Galena Creek shares offered for dedication.

The use of the Washoe Lake/Galena Creek shares as an independent water supply source (without the respective associated Steamboat Creek water rights) as originally envisioned in the 2002 Facility Plan is not a viable approach to providing municipal water supply due to the supplemental nature of the shares as a source to augment the associated Steamboat Creek water rights. The shares are supplemental and cannot be relied upon in the absence of the Steamboat Creek water rights. The yield of the Steamboat Creek water rights is improved if they are managed and used in conjunction with the respective Washoe Lake / Galena Creek shares. This current analysis finds that the early priority Steamboat Creek water rights with their associated Washoe Lake / Galena Creek shares can be used in conjunction with the other resources in the Facility Plan to produce a reliable municipal water supply.

The previously calculated yield of the Thomas, Whites and Galena Creek water rights were reaffirmed by this evaluation.

Steamboat Creek rights with priority later than 1862 and Browns Creek rights with priority later than 1858 provide no dry year yield (years similar to 1992). If the County does accept the dry year, zero yield rights for M&I purposes, the overall yield of the remaining rights is decreased from 61% to 14%, Browns Creek is decreased from 47% to 18%.

The 2002 Facility Plan did not evaluate the Steamboat Creek rights. This present evaluation concludes that the water resources previously evaluated as a Galena winter diversion in the 2002 Facility Plan will need to be replaced with Galena, Browns and Steamboat Creek water rights. This eliminates the need for the proposed upper water treatment plant, requires additional capacity at the STMWTP, and requires augmentation of water resources with Truckee River rights through the wholesale agreement.

This evaluation confirms the need for a creek diversion and pipeline between Steamboat Creek at Rhodes Road and the STMWTP. The recommended scenario would require a 2.5 to 3 mile long pipeline with 7.7 mgd capacity.

The demand that can be served by the combined yield of the resources from this evaluation is 17,758 AF. This is 15% higher than the 15,469 acre feet demand from the original 2002 Facility Plan. One of the differences in the total yield is due to the consumptive use factor being reduced from approximately 85% (Page 2-40, Ph II, TM 2) to 62.5%. Using the 62.5% consumptive use fraction of the water rights eliminates the need for effluent return flow water rights.

Appendix A

Appendix A - Hydrologic Analysis of Browns Creek

Description of Browns Creek Watershed

The Browns Creek headwaters are located near the summit of highway 431 between Mount Rose and Slide Mountain. The northern branch of Browns Creek flows out of Grass Lake where there are some senior water rights for in-channel watering of cattle and sheep. Water also drains into Browns Creek from the Hidden Lake area near Mount Rose Ski Area.

A few miles downstream, water is diverted from Browns Creek into Joy Lake. Water diverted to Joy Lake is released to supply water rights in the Washoe Valley area as described in the Browns Creek Decree. About a mile further downstream, water from Browns Creek is diverted to Washoe Lake for storage per the Orr Ditch Decree. The remaining water in Browns Creek flows into Steamboat Creek just north of Little Washoe Lake.

Available Browns Creek Flow Data

Since September of 2002, TEC has taken periodic streamflow measurements on Browns Creek at several locations: above the Joy Lake diversion; the diversion into Joy Lake; and below the Washoe Lake diversion. The measurements above the Joy Lake diversion were used for correlation with similar watersheds.

Table 1 – Browns Creek Flow Measured Above the Joy Lake Diversion

Date	Flow (cfs)
9/30/02	0.758
10/14/02	0.737
10/28/02	0.842
11/11/02	1.055
11/26/02	1.003
12/9/02	0.647
12/24/02	0.960
1/7/03	1.476
1/20/03	1.128
2/3/03	1.655
2/18/03	1.340
3/4/03	1.166
3/17/03	1.617
4/1/03	2.667
4/15/03	2.304
4/29/03	1.662
5/13/03	2.979
5/27/03	5.109
6/10/03	3.198
6/24/03	3.009
7/9/03	1.463
7/22/03	0.867
8/5/03	0.784
8/19/03	0.527
9/2/03	0.582
9/15/03	0.429
9/29/03	0.602
10/14/03	0.666
10/27/03	0.735
Date	**Flow (cfs)**
11/10/03	0.830
11/24/03	0.794
12/8/03	0.875
12/22/03	0.981
1/9/04	0.920
1/23/04	0.881
2/2/04	0.850
2/17/04	2.114
3/1/04	1.135
3/15/04	1.927
4/1/04	3.165
4/20/04	2.350
4/27/04	3.739
5/19/04	3.349
06/15/04	1.854
06/28/04	1.565
07/12/04	0.779
07/29/04	0.497
08/06/04	0.541
09/07/04	0.507
10/05/04	0.552
10/22/04	0.677
11/08/04	0.834
11/18/04	0.998
12/03/04	0.720
12/16/04	0.595
12/27/04	0.944
01/17/05	0.924
Date	**Flow (cfs)**
01/26/05	0.853
02/11/05	0.664
02/25/05	4.017
03/08/05	1.714
03/25/05	1.497
04/11/05	2.187
04/22/05	2.998
05/11/05	3.13
05/20/05	20.24
06/02/05	8.74
06/20/05	4.462
07/01/05	4.403
07/22/05	2.471
07/29/05	1.958
08/12/05	1.146
08/25/05	0.965
09/12/05	1.421

09/22/05	0.788
Mean Flow (2002)	0.857
Mean Flow (2003)	1.578

Mean Flow (2004)	1.369
Mean Flow (2005)	3.399
Mean Flow (Total)	1.887

Similar Basin Correlation

Selection of Possible Basins

The following is a list of USGS recording gages in Washoe and Carson City Counties that were considered for correlation with Browns Creek. Only streams that drain watersheds between one and twenty square miles and that have currently operating recording gages were considered.

Table 2 – USGS Gaged Similar Basins

Agency	Site Number	Site Name	From	To	Count
USGS	10311089	N FORK KINGS CANYON DIVERSION NR CARSON CITY, NV	1989-03-08	2004-09-30	5686
USGS	10311090	NORTH FORK KINGS CANYON CREEK NEAR CARSON CITY, NV	1989-03-10	2004-09-30	5684
USGS	10311100	KINGS CANYON CREEK NEAR CARSON CITY, NV	1976-06-01	2004-09-30	10349
USGS	10311200	ASH CANYON CK NR CARSON CITY, NV	1976-07-01	2004-09-30	10319
USGS	10336698	Third Ck nr Crystal Bay, NV	1969-10-01	2004-09-30	11565
USGS	103366993	Incline Ck abv Tyrol Village nr Incline Village NV	1990-05-01	2004-09-30	5267
USGS	103366995	Incline Ck at Hwy 28 at Incline Village, NV	1989-12-28	2004-09-30	5391
USGS	10336700	INCLINE CK NR CRYSTAL BAY, NV	1969-10-01	2004-09-30	7935
USGS	10336715	MARLETTE C NR CARSON CITY, NV	1973-10-01	2004-09-30	11323
USGS	10347600	HUNTER C NR RENO, NV	1961-10-01	2004-09-30	5864
USGS	10348460	FRANKTOWN C NR CARSON CITY, NV	1974-06-01	2004-09-30	11080
USGS	10348850	GALENA C AT GALENA C STATE PARK	1984-10-01	2004-09-30	7305

Runoff data from five of these watersheds were compared with Browns Creek flows. Below are geographic descriptions of each of these watersheds:

Browns Creek (above Joy Lake diversion):
USGS Gage Number: 10348860
Drainage Area Above Gage: 3.6 sq mi
Gage Elevation: 5520 feet
Latitude: 39°20'28" Longitude: 119°49'05"

Ash Canyon Creek near Carson City:
USGS Gage Number: 10311200
Drainage Area Above Gage: 5.2 sq mi
Gage Elevation: 5080 feet
Latitude: 39°10'35" Longitude: 119°48'17"

Galena Creek at the State Park:
Gage Number: 10348850
Drainage Area Above Gage: 7.69 sq mi
Gage Elevation: 6320 feet
Latitude: 39°21'16" Longitude: 119°51'27"

Kings Canyon Creek near Carson City:
Gage Number: 10311100
Drainage Area Above Gage: 4.06 sq mi
Gage Elevation: 5180 feet
Latitude: 39°09'14" Longitude: 119°48'25"

Daggett Creek near Genoa
Gage Number: 10310400
Drainage Area Above Gage: 7.69 sq mi
Gage Elevation: 6320 feet
Latitude: 39°21'16" Longitude: 119°51'27"

Franktown Creek:
USGS Gage Number: 10348460
Drainage Area Above Gage: 3.24 sq mi
Gage Elevation: 7380 feet
Latitude: 39°12'12" Longitude: 119°52'17"

Chart 1 shows runoff for each of these watersheds during the period from September 2002 through September 2005. The solid line is the actual Browns Creek flows that were measured above the diversion to Joy Lake. Because their flow patterns were similar to Browns Creek, regression analysis was performed on both Ash Canyon and Galena Creeks. Table 3 compares the Browns, Galena, and Ash Canyon Creek flows:

Chart 1 – Recent Flow for Similar Basins

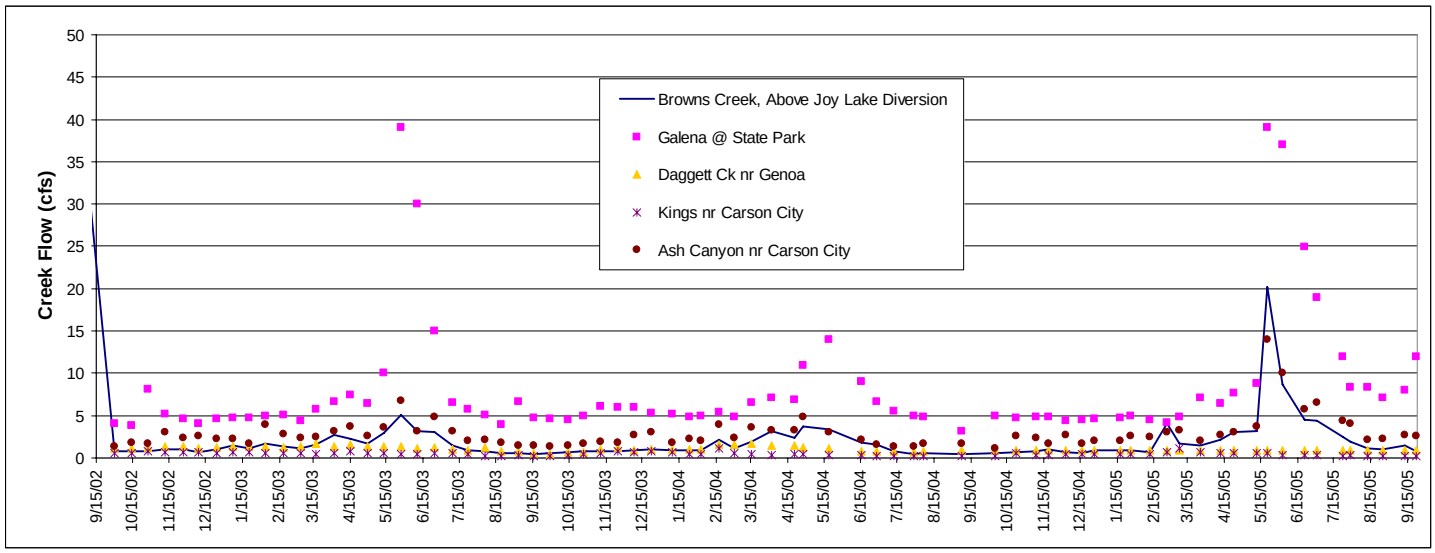


Table A3 – Browns, Galena and Ash Canyon Flows

	Browns Creek, Above Joy Lake Diversion	Galena @ State Park	Ash Canyon nr Carson City
Date	Flow (cfs)	Flow (cfs)	Flow (cfs)
9/30/02	0.76	4.1	1.4
10/14/02	0.74	3.8	1.8
10/28/02	0.84	8.1	1.7
11/11/02	1.06	5.2	3.1
11/26/02	1.00	4.6	2.4
12/9/02	0.65	4.1	2.6
12/24/02	0.96	4.6	2.3
1/7/03	1.48	4.7	2.3
1/20/03	1.13	4.7	1.7
2/3/03	1.66	5	3.9
2/18/03	1.34	5.1	2.8
3/4/03	1.17	4.4	2.4
3/17/03	1.62	5.8	2.5
4/1/03	2.67	6.7	3.2
4/15/03	2.30	7.4	3.7
4/29/03	1.66	6.4	2.6
5/13/03	2.98	10	3.6
5/27/03	5.11	39	6.8
6/10/03	3.20	30	3.2
6/24/03	3.01	15	4.8
7/9/03	1.46	6.6	3.2
7/22/03	0.87	5.7	2
8/5/03	0.78	5.1	2.1
8/19/03	0.53	4	1.8
9/2/03	0.58	6.7	1.5
9/15/03	0.43	4.7	1.5
9/29/03	0.60	4.6	1.4
10/14/03	0.67	4.5	1.5
10/27/03	0.74	5	1.7
11/10/03	0.83	6.1	1.9
11/24/03	0.79	6	1.8
12/8/03	0.88	6	2.7
12/22/03	0.98	5.3	3.1
1/9/04	0.92	5.2	1.8
1/23/04	0.88	4.8	2.3
2/2/04	0.85	5	2
2/17/04	2.11	5.4	4
3/1/04	1.14	4.8	2.4
3/15/04	1.93	6.5	3.6
4/1/04	3.17	7.1	3.3
4/20/04	2.35	6.9	3.3
4/27/04	3.74	11	4.9
5/19/04	3.35	14	3.1
06/15/04	1.85	9	2.1
06/28/04	1.57	6.7	1.6
07/12/04	0.78	5.5	1.3
07/29/04	0.50	5	1.3
08/06/04	0.54	4.8	1.7
09/07/04	0.51	3.2	1.7
10/05/04	0.55	5	1.1
10/22/04	0.68	4.7	2.6
11/08/04	0.83	4.8	2.4
11/18/04	1.00	4.9	1.7
12/03/04	0.72	4.4	2.7
12/16/04	0.59	4.5	1.7
12/27/04	0.94	4.6	2
01/17/05	0.92	4.7	2
01/26/05	0.85	5	2.6
02/11/05	0.66	4.5	2.5
02/25/05	4.02	4.2	3
03/08/05	1.71	4.9	3.3
03/25/05	1.50	7.1	2
04/11/05	2.19	6.4	2.7
04/22/05	3.00	7.7	3.1
05/11/05	3.13	8.8	3.7
05/20/05	20.24	39	14
06/02/05	8.74	37	10
06/20/05	4.46	25	5.7
07/01/05	4.40	19	6.5
07/22/05	2.47	12	4.4
07/29/05	1.96	8.3	4.1
08/12/05	1.15	8.3	2.1
08/25/05	0.97	7.1	2.3
09/12/05	1.42	8	2.7
09/22/05	0.79	12	2.6

Browns Creek measurements for 2/25/05 and 5/20/05 are inconsistent with the measurements for Galena or Ash Canyon Creeks. These data points were not used in the following regression analyses.

Regression Analysis with Ash Canyon Creek

The USGS has been continuously recording flow data on Ash Canyon Creek since July 1976. The data for gage #10311200 is available on their web site: http://nwis.waterdata.usgs.gov/nv/nwis/nwis

Since Browns Creek water rights are currently either for irrigation or storage of winter time flows, and the types of flow differ during these time periods, it is appropriate to evaluate the correlation of these two basins during these time periods separately. During the spring and early summer, snowmelt from the higher elevations swells the creeks increasing their flow. During the fall and winter, flow diminishes to a base flow with occasional runoff from larger storms. When the regression analysis is broken up into these two period, the Browns Creek snowmelt has a high correlation with Ash Canyon snowmelt (R2 = 0.87), while the winter flows are not nearly as correlated (R2 = 0.50). Splitting the regression creates a better estimate of water supply that would be available from Browns Creek.

Chart 3 – Snowmelt regression between Ash Canyon and Browns Creeks

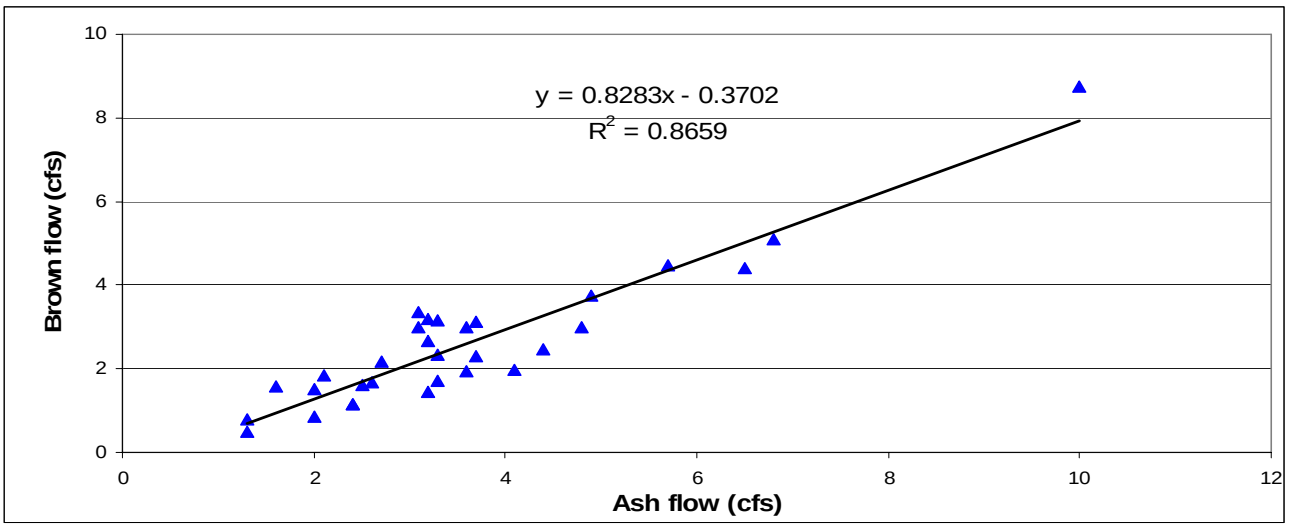
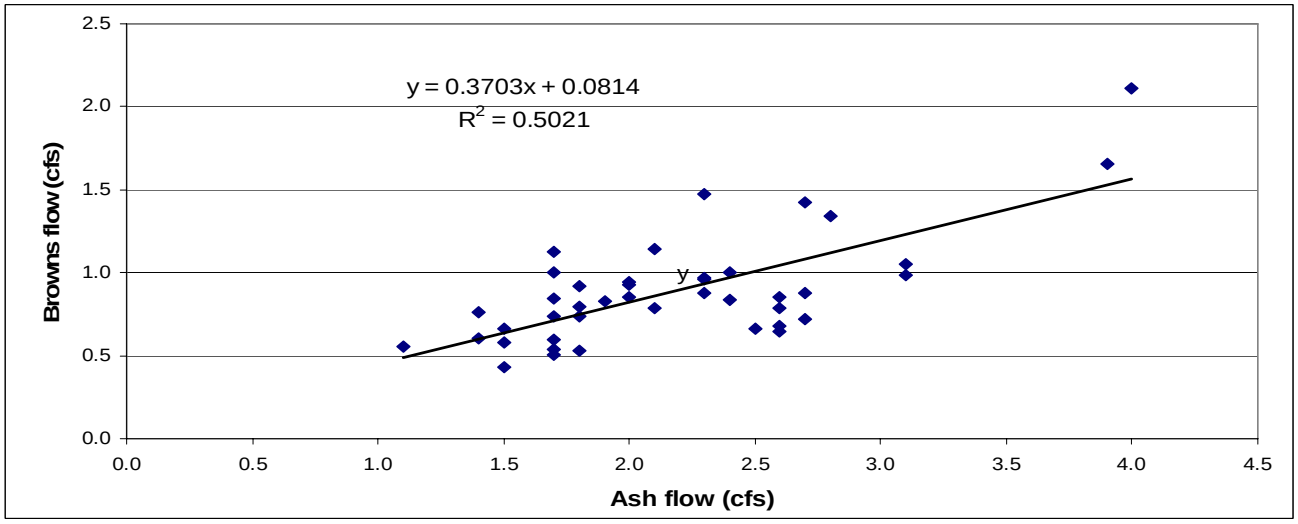
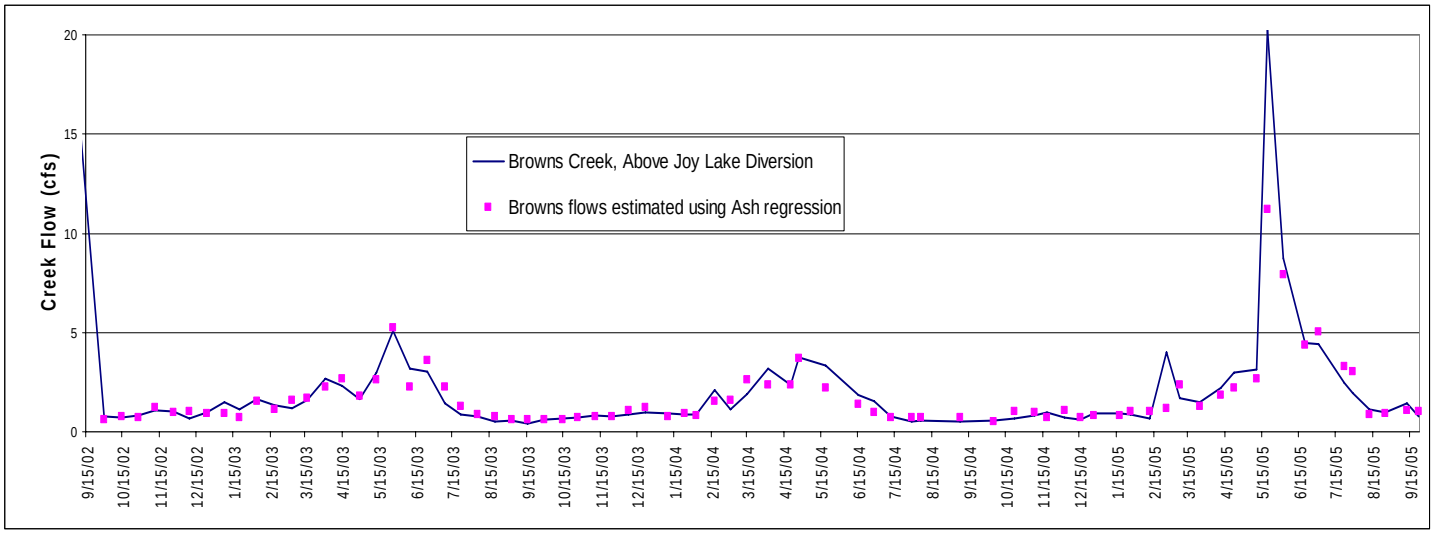


Chart 4 – Baseflow regression between Ash Canyon and Browns Creeks



The “Dual Regression” with Ash Canyon Creek closely predicts the observed flows on Browns Creek from 2002 through 2005.

Chart 5 – Fit of Dual Season Ash Canyon Regression with Measured Browns Creek Flows



Regression Analysis with Galena Creek

Performing similar analysis with Galena Creek, there is very little correlation during the fall and winter and only the snowmelt runoff has any correlation.

Chart 7 – Snowmelt regression between Galena and Browns Creeks

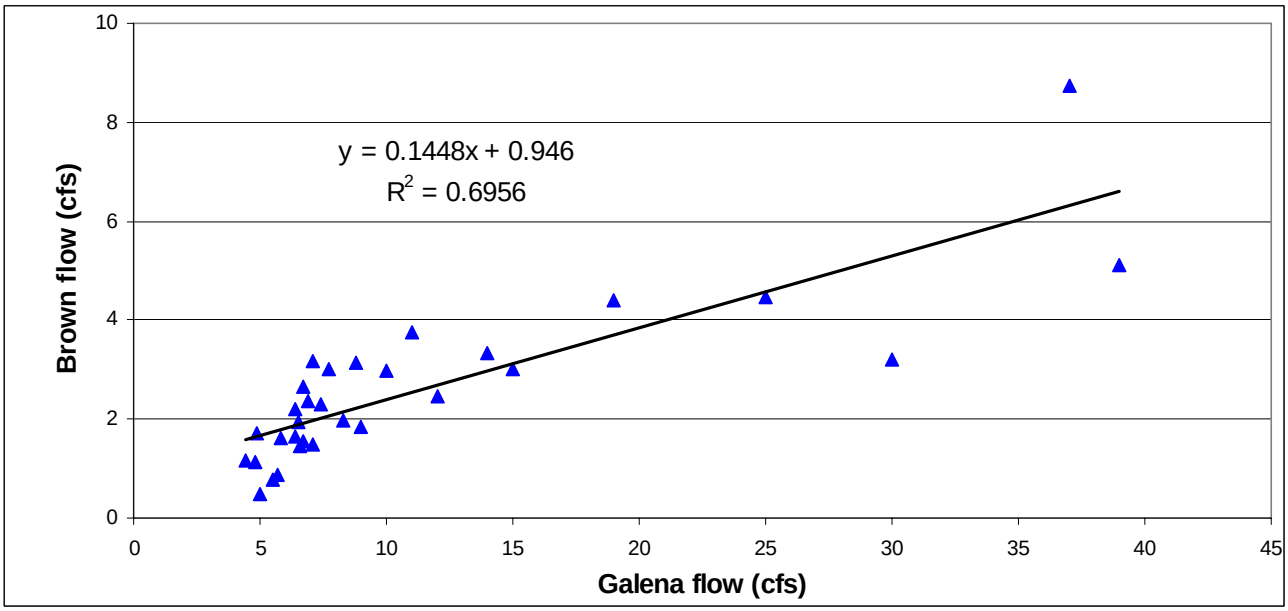
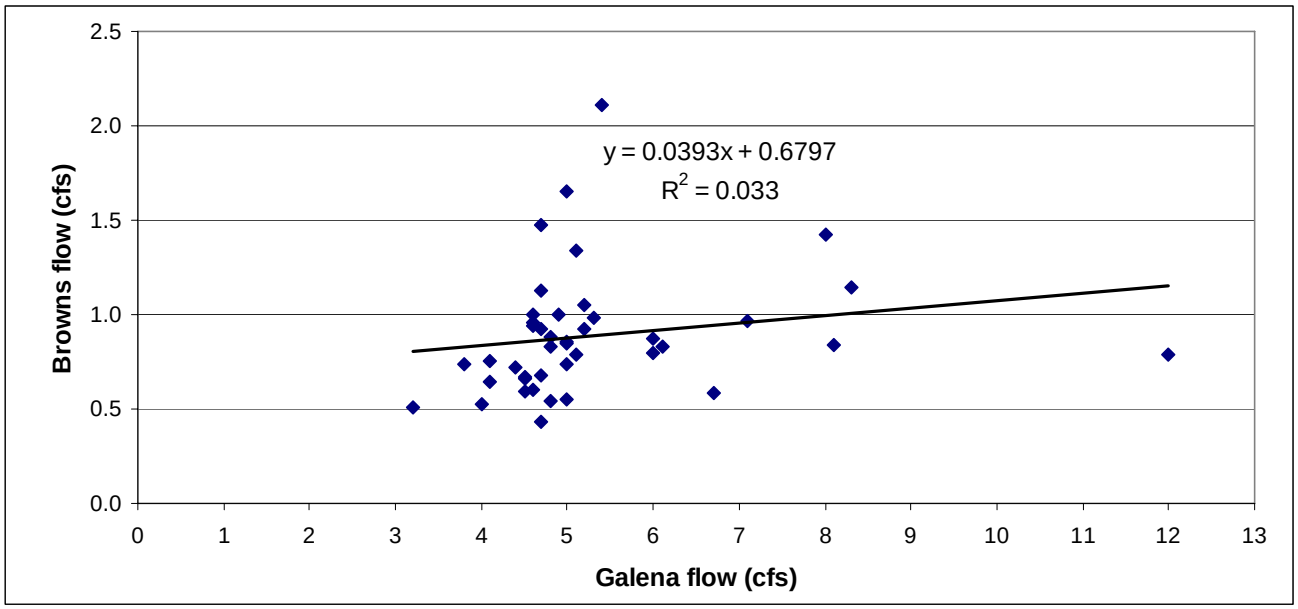
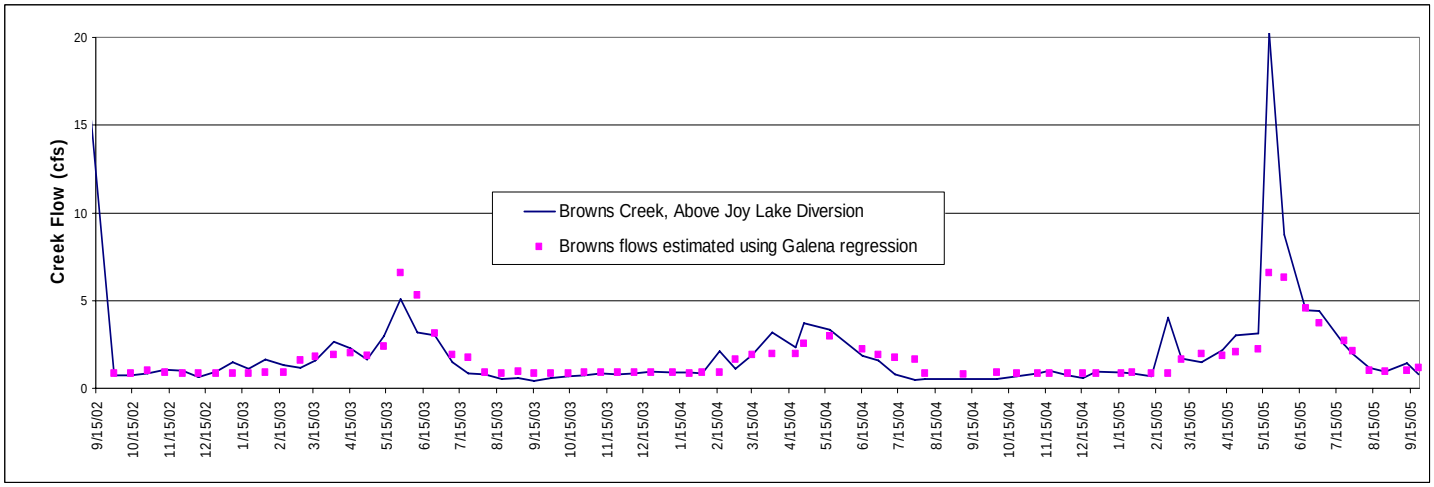


Chart 8 – Baseflow regression between Galena and Browns Creeks



The "Dual Regression" with Galena Creek predicts flows that are similar to observed flows on Browns Creek from 2002 through 2005, but not nearly as closely as the Ash Canyon Creek regression.

Chart 9 – Fit of Dual Season Galena Regression with Measured Browns Creek Flows



Estimate of Browns Creek Hydrology for Period of Interest

The daily Ash Canyon Creek flow measurements and the following regression equations were used to estimate Browns Creek flows:

Snowmelt runoff (Mar – Jul): Browns flow = 0.8283 * Ash Canyon Flow – 0.3702

Fall and Winter baseflow (Aug – Feb): Browns flow = 0.3703 * Ash Canyon Flow + 0.0814

If Ash Canyon Flow > 10 cfs, Browns flow = Ash Canyon flow * 3.6 / 5.2

Table 4 – Ash Canyon Creek Monthly Flows (in Acre-Feet)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1976							92	102	92	113	104	106
1977	109	95	118	150	138	95	62	53	63	82	90	114
1978	127	105	164	184	242	209	147	124	109	110	118	125
1979	160	123	179	184	268	168	141	128	96	106	109	120
1980	237	159	152	243	387	366	245	160	143	138	151	156
1981	141	164	156	163	159	108	73	65	73	97	165	177
1982	146	255	254	380	610	598	431	293	274	299	274	259
1983	238	231	366	351	713	1168	773	569	386	371	450	418
1984	354	285	343	371	736	595	407	272	222	258	253	242
1985	232	200	250	341	274	182	132	124	153	177	175	204
1986	216	490	460	355	575	623	364	236	205	241	204	204
1987	190	177	193	211	181	118	93	80	87	118	143	145
1988	139	134	163	163	143	100	65	54	58	85	108	105
1989	114	121	191	206	198	142	93	86	85	115	118	122
1990	123	114	144	147	128	91	60	48	55	73	81	96
1991	102	92	139	141	154	112	63	57	56	61	88	93
1992	108	118	101	107	90	51	42	33	40	59	63	95
1993	113	89	207	199	274	223	135	81	75	120	142	150
1994	128	115	149	136	124	82	44	44	48	72	79	89
1995	119	115	226	202	417	613	447	265	179	173	156	186
1996	187	313	340	453	663	626	379	259	238	206	332	573
1997	709	382	380	452	620	502	383	295	236	266	246	187
1998	277	221	423	270	355	828	344	256	240	252	304	324
1999	303	301	308	377	508	579	305	256	189	256	248	196
2000	216	247	261	292	320	200	178	142	162	233	263	204
2001	142	137	206	178	208	121	98	94	120	89	170	168
2002	171	137	129	254	217	110	83	81	75	104	163	151
2003	187	173	175	178	262	195	160	116	93	101	112	159
2004	129	144	205	233	231	145	84	95	95	113	114	135
2005	134	150	188	179	508	454	304	165	151			
Ave	192	186	227	245	335	324	208	154	137	155	173	183
Min	102	89	101	107	90	51	42	33	40	59	63	89
Max	709	490	460	453	736	1168	773	569	386	371	450	573

Table 5 – Estimate of Browns Creek Monthly Flows (in Acre-Feet)

	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
1976							53	43	39	47	43	44
1977	45	40	75	102	92	57	28	25	28	35	38	47
1978	52	43	114	131	178	151	100	51	45	46	48	51
1979	72	50	126	130	200	118	95	52	40	44	45	49
1980	115	64	102	179	297	281	180	64	58	56	61	63
1981	57	65	107	113	109	67	37	29	32	41	66	70
1982	59	116	188	286	453	458	335	113	106	116	106	101
1983	93	90	278	269	520	809	539	236	148	142	188	160
1984	136	110	258	285	525	452	314	105	87	100	99	94
1985	91	79	184	261	204	129	87	51	61	71	70	80
1986	85	263	348	273	432	463	279	92	81	94	80	80
1987	75	70	138	153	128	76	54	34	37	49	58	58
1988	56	54	111	112	96	60	30	25	26	37	45	44
1989	47	49	136	149	141	96	55	37	36	47	48	50
1990	50	47	97	100	84	53	27	23	25	32	35	40
1991	43	38	93	95	105	71	30	26	25	27	37	39
1992	45	48	60	66	51	20	11	17	19	27	28	40
1993	47	37	149	144	204	163	89	35	33	49	57	60
1994	52	47	101	91	80	46	14	21	23	31	34	38
1995	49	47	165	146	319	460	348	103	71	69	62	74
1996	74	134	257	354	479	466	291	101	93	81	134	279
1997	383	154	292	353	467	394	295	114	92	103	96	74
1998	108	86	313	202	272	589	263	100	94	98	117	125
1999	117	125	233	285	377	435	230	100	75	100	97	77
2000	85	96	191	220	242	144	125	58	65	91	102	80
2001	58	55	148	126	150	78	58	40	49	38	68	67
2002	68	55	84	189	157	69	46	35	32	43	65	61
2003	74	68	122	126	195	140	110	48	39	42	46	64
2004	53	58	145	171	168	98	46	40	40	47	47	55
2005	55	60	133	126	364	352	230	66	61			
Ave	81	78	164	181	245	234	147	63	55	62	70	75
Min	43	37	60	66	51	20	11	17	19	27	28	38
Max	383	263	348	354	525	809	539	236	148	142	188	279

The driest year estimated was 1992 where the total volume of flow out of Browns Creek was just over 400 acre-feet. In 1992, this water was split fairly evenly between water available for irrigation during the summer and water available for storage during the winter. In wetter years, the water available for irrigation is quite a bit larger than water available for storage. Table 3 below summarizes estimated Browns Creek flows sorted into various seasons from 1977 through 2005.

Table 6 – Summaries of Estimated Browns Creek Flows (in Acre-Feet)

	Calendar Year Total (Jan – Dec)	Water Year Total (Oct – Sep)		Mar-July Total	Aug-Feb Total		Summer Irrigation water (Apr – Oct)	Winter Storage water (Nov – Mar)
1977	613	637		355	300		368	247
1978	1010	969		674	269		702	294
1979	1022	1033		668	363		679	347
1980	1518	1461		1038	410		1115	375
1981	794	822		434	423		428	352
1982	2438	2217		1720	413		1868	499
1983	3471	3262		2414	725		2663	667
1984	2567	2824		1835	1120		1870	852
1985	1368	1467		866	655		864	547
1986	2571	2517		1795	681		1714	846
1987	930	1064		549	573		531	443
1988	696	746		409	346		386	337
1989	892	861		577	273		562	321
1990	613	663		361	316		344	292
1991	630	633		394	236		379	249
1992	433	448		208	248		212	230
1993	1068	983		749	216		717	301
1994	578	651		331	334		306	318
1995	1913	1763		1438	243		1516	332
1996	2743	2432		1847	587		1865	601
1997	2818	3040		1801	1225		1819	1243
1998	2367	2299		1640	673		1618	677
1999	2250	2335		1560	775		1601	716
2000	1497	1508		921	628		944	545
2001	935	1051		561	508		539	443
2002	907	927		547	385		573	343
2003	1076	1086		694	379		701	391
2004	967	970		628	350		609	366
2005		1575		1206	343		1199	349
Max	3471	3262		2414	1225		2663	1243
Min	433	448		208	216		212	230
Ave	1453	1457		973	483		989	466

Comparison with Previously Developed Hydrology

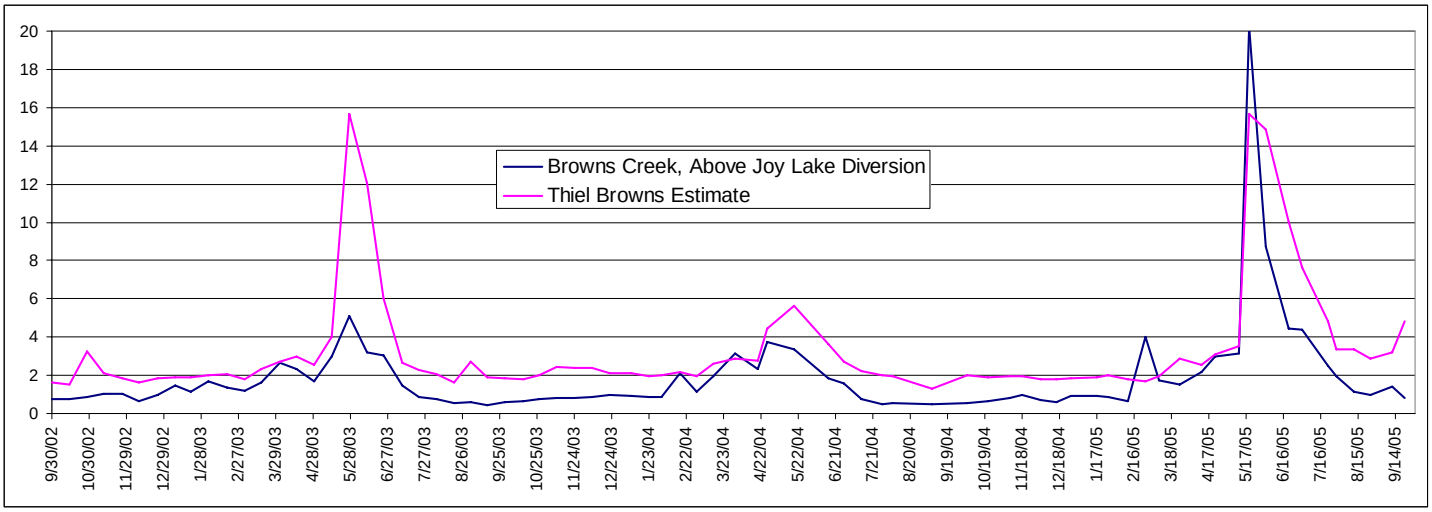
Both TEC and Sierra Hydrotech previously estimated Browns Creek flows. Because of a lack of actual measurements, both estimates were based on mean annual rainfall data and estimated mean annual runoff of the Galena Creek watershed.

Evaluation of TEC Estimate of Browns Creek Flows

The TEC report multiplied Galena Creek flows by two coefficients: an adjustment for basin size (0.528), and a correction factor that was an average of the Ophir and Winters Creek adjustments (0.7607).

We used the TEC coefficients to estimate Browns Creek flows from September 2002 to September 2005 and compare them with measured flow. The flow estimates using the TEC procedure are typically higher than the actual measured flow. Over an entire year, the TEC procedure could significantly overestimate the water available from Browns Creek water rights. Chart 10 below compares these flows:

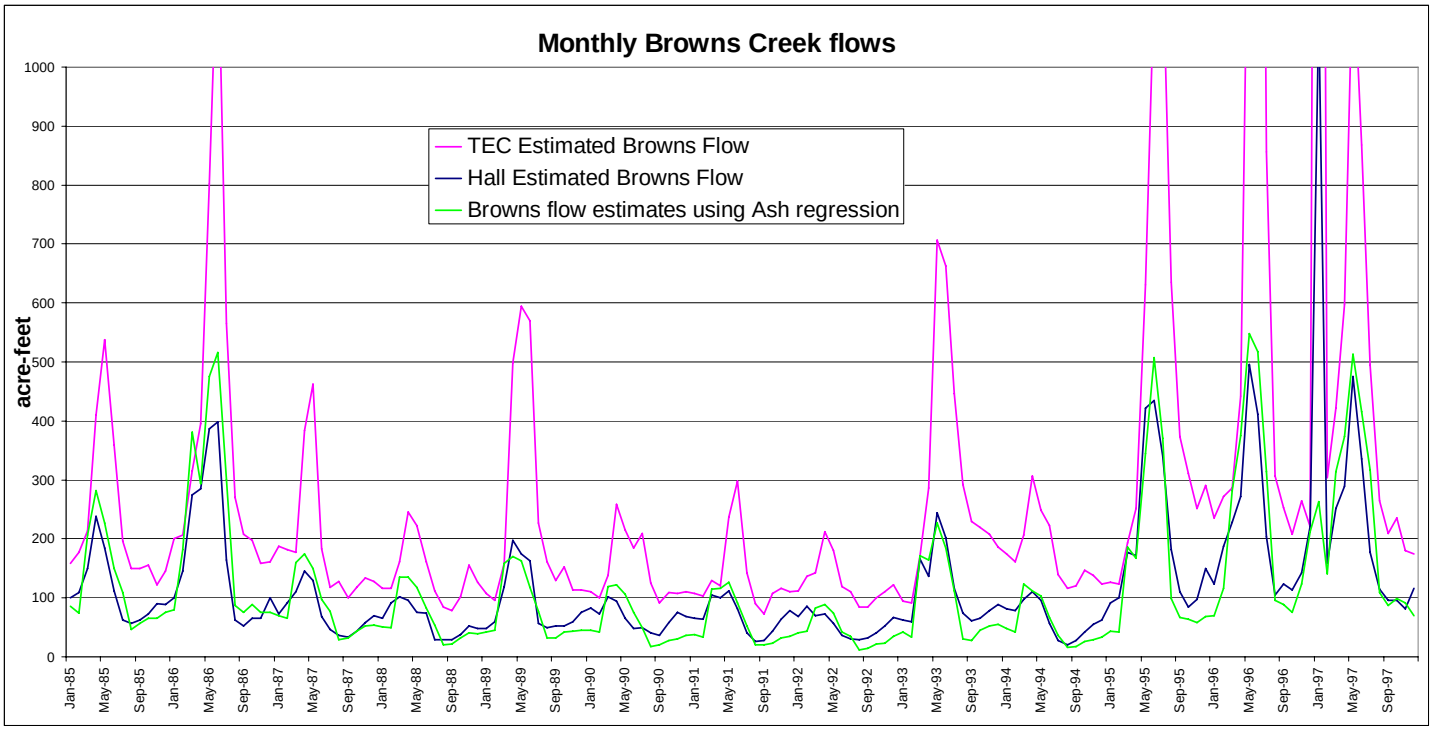
Chart 10 – Comparison of Estimates Using TEC Method and Measured Browns Creek Flows



Sierra Hydrotech Analysis

Sierra Hydrotech estimated Browns Creek flows using a rainfall runoff model. Rather than try to reproduce Hall's model, the regression equations presented in this report were used to estimate Browns Creek flows for the period 1985 through 1997, and these flows were compared with the documented Sierra Hydrotech and TEC estimates. While the TEC estimates are much higher than the newer Ash Canyon regression estimates, the Sierra Hydrotech estimates are fairly close. Further analysis indicates that the Sierra Hydrotech estimates are typically lower than the Ash Canyon regression estimates during high flows and higher during low flows.

Chart 11 – Comparison of Sierra Hydrotech, TEC and Ash Canyon Regression Estimates of Browns Creek Flows



Appendix B

APPENDIX B – South Truckee Meadows Detailed Model Description

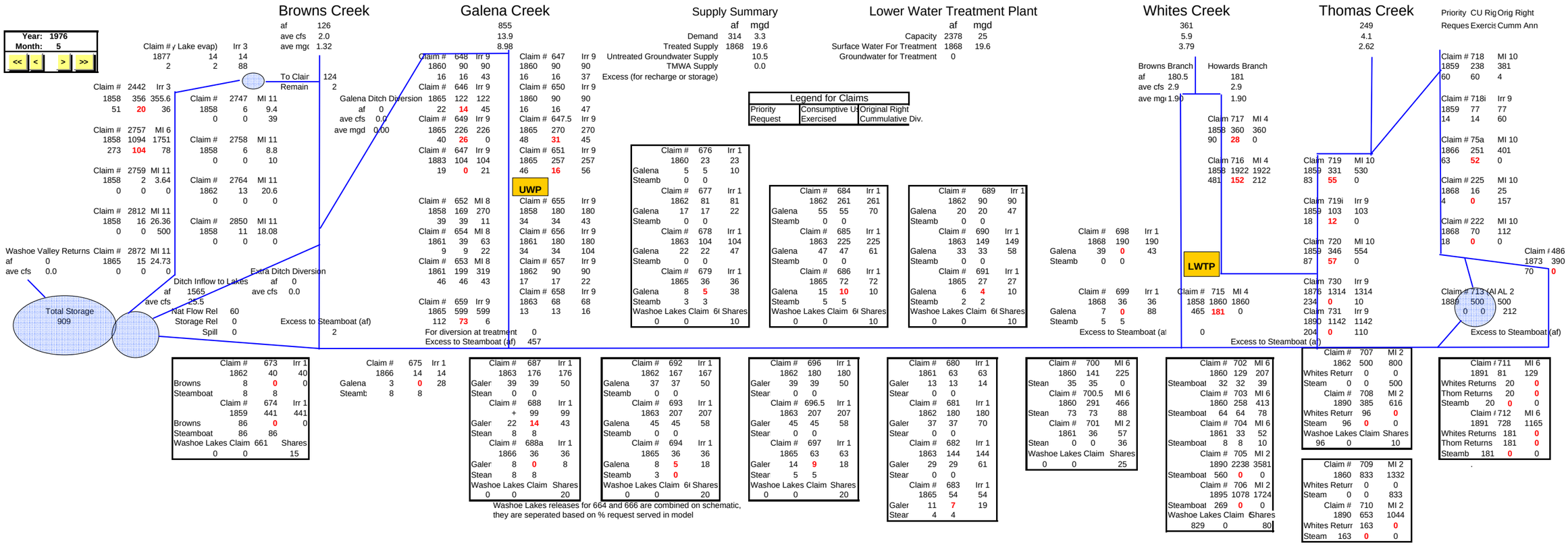
GENERAL MODEL DESCRIPTION

The South Truckee Meadows water supply model was developed as a spreadsheet. System conditions (e.g., beginning reservoir storage and water demand schedules for each claim) are initialized for a given date, with operations determined by a series of rules and constraints. Each month's operation is dependent upon the state of the system at the end of the previous month. The model is used to simulate continuous operation of the system, month-to-month and year-to-year, over a time period of 20 years. The effects of a set of demand schedules and operating rules can be evaluated by running a simulation over the hydrologic record that includes periods of flood and prolonged drought.

This type of model can be used to evaluate a given set of demands or operational rules over a sequence of months and years. Starting with the historical hydrology (watershed inflows), the model stores or moves water based on a given set of rules and constraints such as demands, bypass requirements, flood control or spillway requirements. The results indicate what water is expected to be available for various purposes under the specified operational rules.

SYSTEM DEPICTION

Figure 1 is the model representation of the Steamboat Creek and tributary system. Monthly inflows are input, along with evaporation rates, operating parameters, flow requirements, and water demands. Operations of the Washoe Lakes system were designed, based on discussions with the Federal Water Masters Office, to mimic actual operations.


Year: 1976
Month: 5
<< < > >>
Browns Creek
af 126
ave cfs 2.0
ave mgd 1.32
Galena Creek
855
13.9
8.98
Supply Summary
af mgd
Demand 314 3.3
Treated Supply 1868 19.6
Untreated Groundwater Supply 10.5
TMWA Supply 0.0
Excess (for recharge or storage)
Lower Water Treatment Plant
af mgd
Capacity 2378 25
Surface Water For Treatment 1868 19.6
Groundwater for Treatment 0
Legend for Claims
Priority Request
Consumptive Use Exercised
Original Right Cummulative Div.
Whites Creek
361
5.9
3.79
Thomas Creek
249
4.1
2.62
Priority CU Rig Orig Right
Reques Exercis Cumm Ann
Claim # 1877 14 14
2 2 88
Claim # 2442 Irr 3
1858 356 355.6
51 20 36
Claim # 2757 MI 6
1858 1094 1751
273 104 78
Claim # 2759 MI 11
1858 2 3.64
0 0 0
Claim # 2812 MI 11
1858 16 26.36
0 0 500
Washoe Valley Returns
af 0
ave cfs 0.0
Claim # 2872 MI 11
1865 15 24.73
0 0 0
Total Storage 909
To Clair 124
Remain 2
Galena Ditch Diversion
af 0
ave cfs 0.0
ave mgd 0.00
Claim # 2747 MI 11
1858 6 9.4
0 0 39
Claim # 2758 MI 11
1858 6 8.8
0 0 10
Claim # 2764 MI 11
1862 13 20.6
0 0 0
Claim # 2850 MI 11
1858 11 18.08
0 0 0
Ditch Inflow to Lakes
af 1565
ave cfs 25.5
Nat Flow Rel 60
Storage Rel 0
Spill 0
Extra Ditch Diversion
af 0
ave cfs 0.0
Excess to Steamboat (af) 2
Claim # 648 Irr 9
1860 90 90
16 16 43
Claim # 646 Irr 9
1865 122 122
22 14 45
Claim # 649 Irr 9
1865 226 226
40 26 0
Claim # 647 Irr 9
1883 104 104
19 0 21
Claim # 652 MI 8
1858 169 270
39 39 11
Claim # 654 MI 8
1861 39 63
9 9 22
Claim # 653 MI 8
1861 199 319
46 46 43
Claim # 659 Irr 9
1865 599 599
112 73 6
For diversion at treatment 0
Excess to Steamboat (af) 457
Claim # 647 Irr 9
1860 90 90
16 16 37
Claim # 650 Irr 9
1860 90 90
16 16 47
Claim # 647.5 Irr 9
1865 270 270
48 31 45
Claim # 651 Irr 9
1865 257 257
46 16 56
UWP
Claim # 655 Irr 9
1858 180 180
34 34 43
Claim # 656 Irr 9
1861 180 180
34 34 104
Claim # 657 Irr 9
1862 90 90
17 17 22
Claim # 658 Irr 9
1863 68 68
13 13 16
Claim # 676 Irr 1
1860 23 23
Galena 5 5 10
Steamb 0 0
Claim # 677 Irr 1
1862 81 81
Galena 17 17 22
Steamb 0 0
Claim # 678 Irr 1
1863 104 104
Galena 22 22 47
Steamb 0 0
Claim # 679 Irr 1
1865 36 36
Galena 8 5 38
Steamb 3 3
Washoe Lakes Claim 6(Shares
0 0 10
Claim # 684 Irr 1
1862 261 261
Galena 55 55 70
Steamb 0 0
Claim # 685 Irr 1
1863 225 225
Galena 47 47 61
Steamb 0 0
Claim # 686 Irr 1
1865 72 72
Galena 15 10 10
Steamb 5 5
Washoe Lakes Claim 6(Shares
0 0 10
Claim # 689 Irr 1
1862 90 90
Galena 20 20 47
Steamb 0 0
Claim # 690 Irr 1
1863 149 149
Galena 33 33 58
Steamb 0 0
Claim # 691 Irr 1
1865 27 27
Galena 6 4 10
Steamb 2 2
Washoe Lakes Claim 6(Shares
0 0 10
Browns Branch
af 180.5
ave cfs 2.9
ave mgd 1.90
Howards Branch
181
2.9
1.90
Claim # 717 MI 4
1858 360 360
90 28 0
Claim # 716 MI 4
1858 1922 1922
481 152 212
LWTP
Claim # 698 Irr 1
1868 190 190
Galena 39 0 43
Steamb 0 0
Claim # 699 Irr 1
1868 36 36
Galena 7 0 88
Steamb 5 5
Excess to Steamboat (af
Claim # 715 MI 4
1858 1860 1860
465 181 0
0
Excess to Steamboat (af)
Claim # 719 MI 10
1859 331 530
83 55 0
Claim # 719i Irr 9
1859 103 103
18 12 0
Claim # 720 MI 10
1859 346 554
87 57 0
Claim # 730 Irr 9
1876 1314 1314
234 0 10
Claim # 731 Irr 9
1890 1142 1142
204 0 110
Excess to Steamboat (af)
Claim # 718 MI 10
1859 238 381
60 60 4
Claim # 718i Irr 9
1859 77 77
14 14 60
Claim # 75a MI 10
1866 251 401
63 52 0
Claim # 225 MI 10
1868 16 25
4 0 157
Claim # 222 MI 10
1868 70 112
18 0 0
Claim # 486
1873 390
70 0
Claim # 713 (Al AL 2
1889 500 500
0 0 212
Excess to Steamboat (af)
Claim # 673 Irr 1
1862 40 40
Browns 8 0 0
Steamboat 8 8
Claim # 674 Irr 1
1859 441 441
Browns 86 0 0
Steamboat 86 86
Washoe Lakes Claim 661 Shares
0 0 15
Claim # 675 Irr 1
1866 14 14
Galena 3 0 28
Steamb 8 8
Claim # 687 Irr 1
1863 176 176
Galer 39 39 50
Stean 0 0
Claim # 688 Irr 1
+ 99 99
Galer 22 14 43
Stean 8 8
Claim # 688a Irr 1
1866 36 36
Galer 8 0 8
Stean 8 8
Washoe Lakes Claim Shares
0 0 20
Claim # 692 Irr 1
1862 167 167
Galena 37 37 50
Steamb 0 0
Claim # 693 Irr 1
1863 207 207
Galena 45 45 58
Steamb 0 0
Claim # 694 Irr 1
1865 36 36
Galena 8 5 18
Steamb 3 0
Washoe Lakes Claim 6(Shares
0 0 20
Claim # 696 Irr 1
1862 180 180
Galer 39 39 50
Stear 0 0
Claim # 696.5 Irr 1
1863 207 207
Galer 45 45 58
Stear 0 0
Claim # 697 Irr 1
1865 63 63
Galer 14 9 18
Stear 5 5
Washoe Lakes Claim Shares
0 0 20
Claim # 680 Irr 1
1861 63 63
Galer 13 13 14
Stear 0 0
Claim # 681 Irr 1
1862 180 180
Galer 37 37 70
Stear 0 0
Claim # 682 Irr 1
1863 144 144
Galer 29 29 61
Stear 0 0
Claim # 683 Irr 1
1865 54 54
Galer 11 7 19
Stear 4 4
Claim # 700 MI 6
1860 141 225
Stean 35 35 0
Claim # 700.5 MI 6
1860 291 466
Stean 73 73 88
Claim # 701 MI 2
1861 36 57
Stean 0 0 36
Washoe Lakes Claim Shares
0 0 25
Claim # 702 MI 6
1860 129 207
Steamboat 32 32 39
Claim # 703 MI 6
1860 258 413
Steamboat 64 64 78
Claim # 704 MI 6
1861 33 52
Steamboat 8 8 10
Claim # 705 MI 2
1890 2238 3581
Steamboat 560 0 0
Claim # 706 MI 2
1895 1078 1724
Steamboat 269 0 0
Washoe Lakes Claim Shares
829 0 80
Claim # 707 MI 2
1862 500 800
Whites Returr 0 0
Steam 0 0 500
Claim # 708 MI 2
1890 385 616
Whites Returr 96 0
Steam 96 0 0
Washoe Lakes Claim Shares
96 0 10
Claim # 709 MI 2
1860 833 1332
Whites Returr 0 0
Steam 0 0 833
Claim # 710 MI 2
1890 653 1044
Whites Returr 163 0
Steam 163 0 0
Claim # 711 MI 6
1891 81 129
Whites Returns 20 0
Thom Returns 20 0
Steamb 20 0 0
Claim # 712 MI 6
1891 728 1165
Whites Returns 181 0
Thom Returns 181 0
Steamb 181 0 0
Washoe Lakes releases for 664 and 666 are combined on schematic,
they are seperated based on % request served in model

BASIC MODEL ASSUMPTIONS

Operations

The primary purpose of the system operation is water supply. There are a few lakes within the system that could provide some flood control; however, that purpose was not considered in this model.

Originally water on the creeks and storage in the lakes were used for irrigation of appurtenant lands. Limited amounts of water were stored in the winter, and land was irrigated by either direct diversion from creeks or releases of storage from approximately April through October. As residential development has occurred, water rights are being converted to municipal and industrial use. While peak demand still occurs in the summer, use of water has increased in the winter.

Water rights on Steamboat Creek and its tributaries have been adjudicated and operations and priorities are specified in the Federal Orr Ditch Decree and the State of Nevada's Browns Creek Decree.

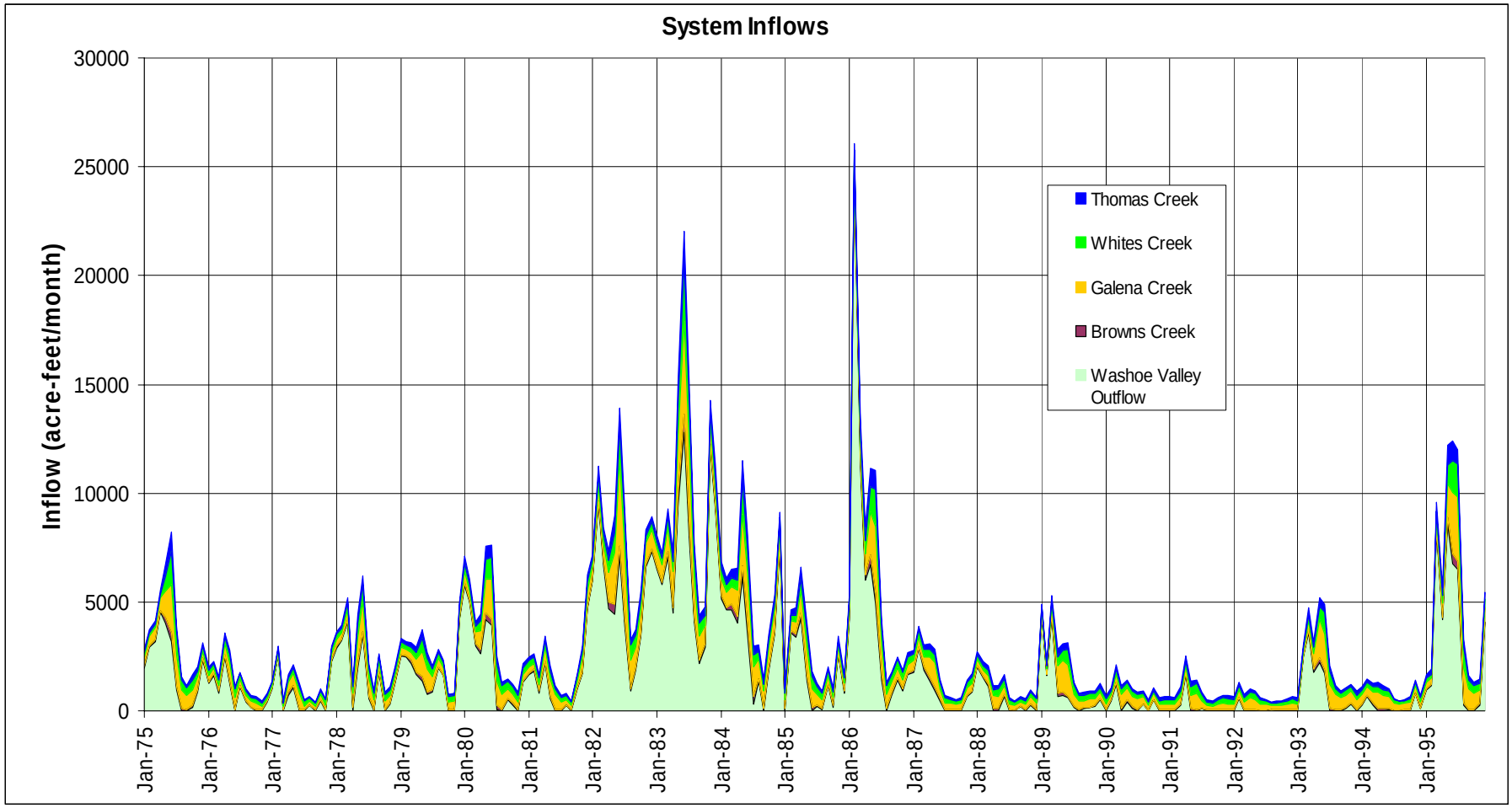
Historic irrigation practices included flooding of lands. Excess water would runoff and return flows were utilized to irrigate other lands. For irrigation diversions, this model utilizes the consumptive use data previously developed and documented in Phase II of the South Truckee Meadows Facilities plan. Water not consumptively used is returned to the system for use by other claims.

Previously when claims have been converted from irrigation to M&I use, the Nevada State Engineer has authorized a consumptive use portion of the water rights that is available for diversion. Historically rights on Whites Creek were completely used. The consumptive use portion for these rights was authorized at 100%. For this analysis, the consumptive use portion of rights on all other creeks was set to 62.5%. If a larger percentage is authorized, yield of rights for M&I would be increased.

Hydrologic Data Development

Since there is little storage on the system, the water supply is dependent on the volume and timing of runoff. The hydrology for Browns Creek was developed as part of this project and is documented in a separate memo. Hydrology developed as part of the South Truckee Meadows Facilities Plan was used for Galena, Whites and Thomas Creeks and for the inflow from Washoe Valley.

Other than claims described in the decrees, no depletions or accretions were considered as a part of this study.


System Inflows
Inflow (acre-feet/month)
30000
25000
20000
15000
10000
5000
0
Jan-75
Jan-76
Jan-77
Jan-78
Jan-79
Jan-80
Jan-81
Jan-82
Jan-83
Jan-84
Jan-85
Jan-86
Jan-87
Jan-88
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Thomas Creek
Whites Creek
Galena Creek
Browns Creek
Washoe Valley Outflow

User Interfaces

The “Annual Summary” worksheet is used to change the schedule that water is requested for each claim. It also summarizes the annual total amount of water that was diverted to each claim in the simulation shown on the “annual summary” worksheet.

Monthly amounts of water diverted to each claim are depicted on the “schematic” worksheet. This worksheet can be used to evaluate the use of water for a month for the entire system. The controls on the upper left can be used to step through the simulation month by month.

Several sheets within the model provide additional graphic and tabled information regarding the results of each simulation. These sheets are described later in this report.

Model Layout

The model is coded by several worksheets within a single Excel workbook. The individual worksheets group common functions or purposes. Several of the worksheets are further organized into sections to provide the user with logically grouped information.

The Excel workbook contains the following worksheets:

- Annual Summaries – used to set schedules and view summary results
- System schematic - used to view month-to-month simulation results
- All Year Analysis – provides average annual results summary and graphics
- Dry Year Analysis – provides dry year results summary and graphics
- 1993 Analysis – provides results summary and graphics for 1993 (for comparison with previous analysis)
- Cumm Diversions – tracks annual cumulative diversion to each claim
- The following worksheets allocate waters of individual creeks to irrigation, diversion to storage, and M&I uses
    - Browns Creek
    - Galena Creek
    - Whites Creek
    - Thomas Creek
    - Steamboat Served by Excess – serves excess from Whites and Thomas Creeks to claims downstream of their confluences on Steamboat Creek
    - Washoe-Steamboat Model – serves claims with Steamboat “Natural Inflow” according to priority and as defined in Orr Ditch Decree. Also determines releases of storage from Washoe Lakes and allocates waters to claims with shares.
- Washoe Lakes evap – contains Elevation-Volume-Area data for Washoe Lakes as well as monthly evaporation data
- Precipitation – contains monthly precipitation and evapotranspiration data (developed as part of the South Truckee Meadows Facilities Plan)
- Schedules – contains a selection of schedules for water use
- Inflow Chart – graphical depiction of water available in the simulation
- % Served – tracks percent of requests served by priority for each creek (used to check model consistency

These worksheets are described in more detail on the next pages.

Annual Summaries Worksheet

This worksheet contains parameters typically used to control the simulation of the system. Data is presented individually for each claim.

The *Annual Summaries worksheet* is divided into the following sections:

- Decree Data
  This section describes priority, annual right, original irrigated acreage, transmission loss and associated Washoe Lakes shares for each claim.

- Operations
  Selecting a schedule associated with each claim describes how water will be exercised within the system.

- Yield Summary
  This section summarizes the yield of each claim when exercised on the defined schedule. Summary includes minimum year yield, average year yield, average yield for the 8-year drought (1987-1994), and average yield for non-drought years. It should be noted that for a claim converted to M&I use and assigned a 62.5% consumptive use portion, 62% yield indicates that all water allowed the claim was exercised.

- Annual Yields
  This sections describes the amount of water for each claim that was diverted in each year.

Schematic Worksheet

This worksheet contains a schematic representation of the major components and claims in the water system that are simulated by the model. The user can specify the month to display by typing the year and month in the control box located in the worksheet. The user may also step through the simulation one month at a time or one year at a time by clicking on the forward and backward arrows in the control boxes.

All Year Analysis and Dry Year Analysis Worksheets

These worksheets summarize the simulation and create the tables and charts used in the report. The All Year Analysis averages the data for each month separately to estimate “average year” results. The Dry Year Analysis is a summary of the simulation for 1992.

1993 Analysis Worksheet

This worksheet is similar to the Dry Year Analysis, except summaries are for 1993. These results were used for comparison with past analysis, but were not included in the report.

Cumm Diversions Worksheet

This worksheet totals and tracks diversions made to each claim for a calendar year from all sources. In addition to being used for summaries, this information is used to restrict diversions to the annual amount allowed each claim.

Simulation Worksheets

The monthly allocation of water to claims is performed on these worksheets. Details of the model logic for Browns Creek including the equations embedded in the model are contained in the following section. Other simulation worksheets are similar.

The Simulation Worksheets for each creek are visually grouped into five sections:

- Inputs for the simulation including evapotranspiration and Inflow data.
- Summary data of the simulation for the creek.
- Actual monthly diversion data for each claim.
- Desired or scheduled diversion data for each claim.
- Allocation of available waters based on priority. This section also includes return flows calculated for irrigated acreage.

Claims that receive water from multiple sources are represented on multiple simulation worksheets. For example claim 707 receives excess water from Whites Creek that flows into Steamboat Creek (*Steamboat Served by Excess* worksheet) as well as water from Steamboat natural flow and releases of stored water from Washoe Lakes (both contained on *Washoe-Steamboat Model* worksheet). The *Schematic* worksheet separates the water diverted by source for these claims.

Washoe Lakes Evap Worksheet

Elevation-Volume-Area relationships were previously developed by the US Geological Survey. The following charts were provided by Kerry Garcia. Tables are included in separate section.

Updated from USGS Water Resources Data, Nevada, Water Year 2004 page 307 and personal correspondence with Kerry Garcia									
	Combined Lakes			Washoe Lake Gage #10348700			Little Washoe Lake Gage #10348700		
Elevation	Volume	Area		Volume	Area		Volume	Area	
(feet)	(acre-feet)	(acres)		(acre-feet)	(acres)		(acre-feet)	(acres)	
5017.5	0	0		0	0				
5018	100	320		100	320				
5019	900	800		900	800				
5020	2200	1650		2200	1650				
5021	4302.3	2360		4300	2360		2.3	0	
5022	7210	2858		7200	2840		10	18	Elevation at which can't release water (5021.1 feet)
5023	10050	3111		10000	3060		50	51	
5024	13525	3355		13400	3280		125	75	
5025	17500	4190		17300	4100		200	90	elevation at which lakes become one lake
5026	22000	4900		21700	4800		300	100	
5027	27000	5465		26600	5360		400	105	
5028	32500	5658		32000	5550		500	108	Assume wooden dam 6 feet high
5029	38050	5910		37400	5800		650	110	Spillway at 5028.9 feet
5030	44050	6011		43300	5900		750	111	
5031	50050	6062		49200	5950		850	112	
5032	56660	6080		55700			960		

5032.7	60600	6100		59600			1000		
5033	62700			61700			1000		

Precipitation Worksheet

This worksheet uses the average Reno and Carson City monthly precipitation data and a monthly evapotranspiration (ET) value developed as part of the South Truckee Meadows Facilities Plan and calculates a net ET for each month of the simulation. These net ET values are used to determine consumptive use and return flows for irrigated lands.

Monthly Evapotranspiration in inches:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.25	0.38	0.55	2.94	6.24	9.74	9.8	8.39	5.55	2.65	0.46	0.27

Schedules Worksheet

This worksheet lists schedules that can be selected from for each claim. Ten irrigation schedules, eleven M&I schedules, two Alexander Lake, one recharge and three return flow schedules are available for selection.

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Alexander Lake	AL 1	25.0%	25.0%	25.0%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cumm AL	AL 2	25.0%	50.0%	75.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Irr Normal	Irr 1	0.0%	0.0%	0.0%	5.5%	19.5%	18.9%	22.1%	19.7%	11.0%	3.5%	0.0%	0.0%
Cumm Norm	Irr 2	0.0%	0.0%	0.0%	5.5%	24.9%	43.8%	65.8%	85.6%	96.5%	100.0%	0.0%	0.0%
Irr Browns	Irr 3	0.0%	0.0%	0.0%	13.1%	14.3%	14.9%	15.3%	14.9%	13.9%	13.5%	0.0%	0.0%
Cumm Browns	Irr 4	0.0%	0.0%	0.0%	13.1%	27.4%	42.3%	57.7%	72.6%	86.5%	100.0%	0.0%	0.0%
Irr nrundata	Irr 5	0.0%	0.0%	0.0%	7.4%	18.0%	18.9%	21.4%	17.8%	14.1%	2.4%	0.0%	0.0%
Cumm nrundata	Irr 6	0.0%	0.0%	0.0%	7.4%	25.4%	44.3%	65.7%	83.5%	97.6%	100.0%	0.0%	0.0%
Irr with Winter	Irr 7	3.0%	3.0%	4.0%	7.0%	16.0%	17.0%	20.0%	16.0%	13.0%	1.0%	0.0%	0.0%
Cumm Winter	Irr 8	3.0%	6.0%	10.0%	17.0%	33.0%	50.0%	70.0%	86.0%	99.0%	100.0%	100.0%	100.0%
Hall Sched	Irr 9	0.0%	0.0%	0.0%	5.0%	17.8%	19.9%	22.7%	20.1%	11.0%	3.5%	0.0%	0.0%
Cumm Hall	Irr 10	0.0%	0.0%	0.0%	5.0%	22.9%	42.8%	65.5%	85.6%	96.5%	100.0%	100.0%	100.0%
M&I Max	MI 1	25.0%	25.0%	25.0%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cumm Max	MI 2	25.0%	50.0%	75.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
M&I nrundata	MI 3	5.4%	5.2%	5.6%	7.5%	10.3%	11.7%	13.0%	12.9%	10.1%	7.4%	5.5%	5.4%
Cumm nrundata	MI 4	5.4%	10.6%	16.2%	23.7%	34.0%	45.7%	58.7%	71.6%	81.7%	89.1%	94.6%	100.0%
M&I on irr sch	MI 5	0.0%	0.0%	0.0%	5.5%	19.5%	18.9%	22.1%	19.7%	11.0%	3.5%	0.0%	0.0%
Cumm irr sch	MI 6	0.0%	0.0%	0.0%	5.5%	24.9%	43.8%	65.8%	85.6%	96.5%	100.0%	100.0%	100.0%
M&I on summer	MI 7	0.0%	0.0%	0.0%	5.0%	17.8%	19.9%	22.7%	20.1%	11.0%	3.5%	0.0%	0.0%
Cumm summer	MI 8	0.0%	0.0%	0.0%	5.0%	22.9%	42.8%	65.5%	85.6%	96.5%	100.0%	100.0%	100.0%
Water Quality	MI 9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%	25.0%	25.0%	25.0%	0.0%	0.0%
Thomas Summer	MI 10	0.0%	0.0%	0.0%	25.0%	50.0%	75.0%	100.0%	100.0%	100.0%	100.0%	0.0%	0.0%
Late sch	MI 11	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%	50.0%	75.0%	100.0%	100.0%	100.0%
Recharge Schedule	MI 12	25.0%	18.0%	15.0%	18.0%	10.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
No Returns Schedules	R 1	0.0%	0.0%	0.0%	5.0%	17.8%	19.9%	22.7%	20.1%	11.0%	3.5%	0.0%	0.0%
	R 2	25.0%	50.0%	75.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
	R 3	0.0%	0.0%	25.0%	50.0%	75.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Inflow Chart Worksheet
This worksheet contains a chart of the total inflow to the system for the twenty year period of the simulation. The total inflow is split into inflow for each creek.

% Served Worksheet
This worksheet was used to verify that available water was being allocated by priority.

Browns Creek Worksheet (other creek worksheets are similar)

Rows on top of simulation describe inputs for each claim (copied from Annual Summaries page):

Title	Units	Row	Description
Claim		4	Claim number
Schedule		5	Selected schedule for desired diversion
Priority		6	Claim priority as defined in the appropriate decree
Annual Right	Acre-feet	8	Amount of water decreed, if right was considered for M&I use this is the consumptive use amount
Acres	Acres	9	Number of acres that water was appurtenant to as defined in the appropriate decree
Transmission Loss	Fraction	10	The Orr Ditch Decree allowed excess water to be diverted from the creek to make up for transmission losses in ditches.

The columns of the spreadsheet operate the creek allocating waters to each claim. All units in the model pages are in acre-feet per month:

Model Inputs Section			
Title	**Column**	**Equation**	**Description**
Month - Year	A		Used for creating monthly totals and graphics
Net ET	B		Monthly required evapotranspiration less historic average precipitation
Natural Flow	C		Natural flow in the creek when no diversion are made
Model Summary Section			
Call on water from Browns rights (pre 1889)	D	=V12-W12	Total diversions less total return flows. Sums water consumptively used on creek before diversion to Washoe Lakes
Exercised M&I Rights	E	=SUM(IF(LEFT($K$5:$U$5,1)="M",K12:U12,0))	Sum of diversions for M&I use from creek
Available Excess Natural Flow	F	=C12-D12	Water available for Steamboat Natural flow or diversions to Washoe Lakes
Diversion to Washoe limited by Exercised	G	='Washoe-Steamboat Model'!L12	Diversion to Washoe Lakes (Steamboat natural flow diversion calculations are performed on Washoe-Steamboat Model worksheet)
Excess Water to Steamboat Creek	H	='Washoe-Steamboat Model'!H12-'Washoe-Steamboat Model'!L12	Excess water that flows to Steamboat Creek (calculations performed on Washoe-Steamboat Model worksheet)

Actual Diversions Section

Title	Column	Equation	Description
2750 (Joy Lake evap)	J	=Y12*AN12	Desired diversion times percent served for priority
2442	K	=Z12*AR12	Desired diversion times percent served for priority
2747	L	=AA12*AR12	Desired diversion times percent served for priority
2757	M	=AB12*AR12	Desired diversion times percent served for priority
2758	N	=AC12*AR12	Desired diversion times percent served for priority
2759	O	=AD12*AR12	Desired diversion times percent served for priority
2764	P	=AE12*AZ12	Desired diversion times percent served for priority
2812	Q	=AF12*AR12	Desired diversion times percent served for priority
2850	R	=AG12*AR12	Desired diversion times percent served for priority
2872	S	=AH12*BD12	Desired diversion times percent served for priority
673	T	=AI12*AZ12	Desired diversion times percent served for priority
674	U	=AJ12*AV12	Desired diversion times percent served for priority
Total Diversions	V	=SUM(J12:U12)	Sum of diversion from Browns Creek
Total Return Flow	W	=AO12+BE12+BA12+AW12+AS12	Sum of return flows from irrigated acreage

Desired Diversions Section

Title	Column	Equation	Description
2750 (Joy Lake evap)	Y	=MAX(0,MIN(Y$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CE11),Y$8*0.25,VLOOKUP(Y$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*Y$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2442	Z	=MAX(0,MIN(Z$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CF11),Z$8*0.25,VLOOKUP(Z$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*Z$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2747	AA	=MAX(0,MIN(AA$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CG11),AA$8*0.25,VLOOKUP(AA$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AA$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2757	AB	=MAX(0,MIN(AB$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CH11),AB$8*0.25,VLOOKUP(AB$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AB$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2758	AC	=MAX(0,MIN(AC$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CI11),AC$8*0.25,VLOOKUP(AC$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AC$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2759	AD	=MAX(0,MIN(AD$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CJ11),AD$8*0.25,VLOOKUP(AD$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AD$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2764	AE	=MAX(0,MIN(AE$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CK11),AE$8*0.25,VLOOKUP(AE$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AE$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2812	AF	=MAX(0,MIN(AF$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CL11),AF$8*0.25,VLOOKUP(AF$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AF$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2850	AG	=MAX(0,MIN(AG$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CM11),AG$8*0.25,VLOOKUP(AG$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AG$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
2872	AH	=MAX(0,MIN(AH$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CN11),AH$8*0.25,VLOOKUP(AH$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AH$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
673	AI	=MAX(0,MIN(AI$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CO11),AI$8*0.25,VLOOKUP(AI$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AI$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month
674	AJ	=MAX(0,MIN(AJ$8-IF(MONTH($A12)=1,0,'Cumm Diversions'!CP11),AJ$8*0.25,VLOOKUP(AJ$5,Schedules!$B$4:$N$36,MONTH($A12)+1,0)*AJ$8))	Minimum of annual right remaining, 25% of annual right, and scheduled diversion for month

Allocation by Priority Section

Title	Column	Equation	Description
1877 Demand	AL	=Y12	Joy Lake evaporation is served before demands of senior priority since diversion to other claims must pass through lake.
Available	AM	=MIN(C12-$H$10,AL12)	Minimum of natural flow less required bypass and demand
% Served	AN	=IF(AM12>0,AM12/AL12,0)	If there is water available, amount available divided by the demand
Return Flow	AO	0	There is no return flow from Joy Lake evaporation.
1858 Demand	AP	=Z12+AA12+AB12+AC12+AD12+AF12+AG12	Sum of diversions with 1858 priority
Available	AQ	=MIN(C12-$H$10-AM12+AO12,AP12)	Minimum of natural flow less required bypass less water diverted for Joy Lake evaporation, and demand
% Served	AR	=IF(AQ12>0,AQ12/AP12,0)	If there is water available, amount available divided by the demand
Return Flow	AS	{=MAX(0,SUM(IF($Y$7:$AJ$7=CONCATENATE("I",AP$6),(IF($Y12:$AJ12=0,0,($Y12:$AJ12*Schedules!$G$48*AR12-$Y$9:$AJ$9*$B12))),0))))}	Sum for irrigation diversions, desired diversion times fraction usefully applied (from previous Facilities Plan) times % served, less acres irrigated times ET (array equation)
1859 Demand	AT	=AJ12	Diversion with 1859 priority
Available	AU	=MIN(C12-$I$10-AM12+AO12-AQ12+AS12,AT12)	Minimum of natural flow less required bypass less water diverted for Joy Lake and 1858 priority claims plus return flows from 1858 priority claims, and demand
% Served	AV	=IF(AU12>0,AU12/AT12,0)	If there is water available, amount available divided by the demand
Return Flow	AW	{=MAX(0,SUM(IF($Y$7:$AJ$7=CONCATENATE("I",AT$6),(IF($Y12:$AJ12=0,0,($Y12:$AJ12*Schedules!$G$48*AV12-$Y$9:$AJ$9*$B12))),0))))}	Sum for irrigation diversions, desired diversion times fraction usefully applied (from previous Facilities Plan) times % served, less acres irrigated times ET (array equation)
1862 Demand	AX	=AE12+AI12	Sum of diversions with 1862 priority
Available	AY	=MIN(C12-$I$10-AM12+AO12-AQ12+AS12-AU12+AW12,AX12)	Minimum of natural flow less required bypass less water diverted for Joy Lake and junior priority claims plus return flows from junior priority claims, and demand
% Served	AZ	=IF(AY12>0,AY12/AX12,0)	If there is water available, amount available divided by the demand
Return Flow	BA	{=MAX(0,SUM(IF($Y$7:$AJ$7=CONCATENATE("I",AX$6),(IF($Y12:$AJ12=0,0,($Y12:$AJ12*Schedules!$G$48*AZ12-	Sum for irrigation diversions, desired diversion times fraction usefully applied (from previous Facilities Plan) times % served, less acres

		$Y$9:$AJ$9*$B12))),0))))}	irrigated times ET (array equation)
Title	**Column**	**Equation**	**Description**
1865 Demand	BB	=AH12	Diversion with 1865 priority
Available	BC	=MIN(C12-$I$10-AM12+AO12-AQ12+AS12-AU12+AW12-AY12+BA12,BB12)	Minimum of natural flow less required bypass less water diverted for Joy Lake and junior priority claims plus return flows from junior priority claims, and demand
% Served	BD	=IF(AQ12>0,AQ12/AP12,0)	If there is water available, amount available divided by the demand
Return Flow	BE	{=MAX(0,SUM(IF($Y$7:$AJ$7=CONCATENATE("I",BB$6),(IF($Y12:$AJ12=0,0,($Y12:$AJ12*Schedules!$G$48*BD12-$Y$9:$AJ$9*$B12))),0))))}	Sum for irrigation diversions, desired diversion times fraction usefully applied (from previous Facilities Plan) times % served, less acres irrigated times ET (array equation)
Total Return Flow	BF	=AO12+AS12+AW12+BA12+BE12	Sum of all return flows

Washoe-Steamboat Model Worksheet

Rows on top of simulation describe inputs for each claim (copied from Annual Summaries page):

Title	Units	Row	Description
Claim		4	Claim number
Schedule		5	Selected schedule for desired diversion
Priority		6	Claim priority as defined in the appropriate decree
Annual Right	Acre-feet	8	Amount of water decreed, if right was considered for M&I use this is the consumptive use amount
Acres	Acres	9	Number of acres that water was appurtenant to as defined in the appropriate decree
Transmission Loss	Fraction	10	The Orr Ditch Decree allowed excess water to be diverted from the creek to make up for transmission losses in ditches.

The columns of the spreadsheet operate the Lakes allocating waters by shares to each claim. All units in the model pages are in acre-feet per month:

Model Inputs Section

Title	Column	Equation	Description
Month - Year	A		Used for creating monthly totals and graphics
Net ET	B	=VLOOKUP(YEAR($A12),Precipitation!$A$57:$AB$80,16+MONTH($A12))/12	Monthly net evapotranspiration
Previous Analysis Future Diversion to Washoe	C	437	Diversion to Washoe Lakes from previous Facilities Plan
Natural Inflow from Washoe Valley	D	1979	Historic inflow to Washoe Lakes from previous Facilities Plan
Total Steamboat Natural Flow	E	='Galena Creek'!F12+'Browns Creek'!F12+D12	Galena Creek excess + Browns Creek excess + inflow from Washoe Valley
Total Diversions from Natural Flow	F	=SUM(CX12:EO12)-IH12	Sum of diversions from natural flow less total return flow
Used from Browns natural flow	G	=MIN(F12,'Browns Creek'!F12)	Natural flow diversions are allocated first from Browns Creek excess flow
Remaining Browns Nat Flow	H	='Browns Creek'!F12-G12	Browns Creek excess less diversions from natural flow
Used from Galena Natural Flow	I	=MIN('Galena Creek'!F12,F12-G12)	After using Browns Creek flow, diversions are allocated from Galena Creek
Remaining Galena Nat Flow	J	='Galena Creek'!F12-I12	Galena Creek excess less diversions from natural flow

Title	Column	Equation	Description
Remaining Galena available for diversion to Ditch	K	='Galena Creek'!F12-MAX(I12,'Galena Creek'!$M$10)	Galena Creek excess less max of Used from Galena and Galena Creek bypass flow
Remaining Browns available for diversion to Ditch	L	='Browns Creek'!F12-MAX(G12,'Browns Creek'!$H$10)	Browns Creek excess less max of Used from Galena and Galena Creek bypass flow
Remaining Galena and Browns Excess to Steamboat	M	='Galena Creek'!M12+H12-L12	Natural flow in the creek when no diversion are made
Remaining Natural Flow to Big Lake Storage	O	=MIN(D12,E12-F12)	Minimum of natural inflow and natural flow less diversions
Remaining Ditch Flow to Little Lake Storage	P	='Galena Creek'!L12*(1-$P$1)+L12*(1-$P$2)	Galena diversion times 1 minus ditch losses plus Browns diversion times 1 minus ditch losses
Diversion to Storage	Q	=O12+P12	Remaining inflow to Big Lake plus ditch diversion
Evaporation	R	=MIN(MAX(0,V11-S12),VLOOKUP(V11,'Washoe Lakes evap'!$B$15:$C$31,2)*INDEX('Washoe Lakes evap'!$A$4:$L$4,1,MONTH(A12)))	Minumum of previous months storage less releases and Lake surface area times evaporation coefficient
Release for Demand	S	=SUM(AB12:AJ12)	Sum of releases for claims
Historic Release for Demand	T	0	Historic release (values from previous Facilities Plan) – used for comparison only
Spill to Steamboat	U	=MAX(0,V11+Q12-R12-S12-$V$2)	Previous storage plus diversion to storage less evaporation less release less maximum storage
End of Month Storage	V	=MAX(0,V11+Q12-R12-S12-U12)	Previous storage plus diversion to storage less evaporation less release less spill
Cummulative Releases	X	=IF(MONTH($A12)=1,S12,S12+X11)	If month is January, current release else current release plus previous cumulative release
Estimate available release	Y	=MAX(0,IF(MONTH($A12)<'Annual Summaries'!$C$130,0,IF(OR(MONTH($A12)=7,MONTH($A12)=8,MONTH($A12)=9),V11-'Annual Summaries'!$C$133-INDEX('Washoe Lakes evap'!$G$8:$I$8,1,MONTH($A12)-6),V11-'Annual Summaries'!$C$133)))	If month is less than first month of releases, 0, else if month is July through September total storage less minimum pool less evaporation. else storage less minimum pool
Release (one column for	AB through AK	=MAX(0,MIN(AM12,BR12+BS12))	Minimum of estimated remaining release for claim and desired release from shares for all

each claim 661-670			associated base claims
Title	**Column**	**Equation**	**Description**
Total M&I Release	Y	{=SUM(IF(LEFT($AB$5:$AJ$5)="M",AB12:AJ12,0))}	Sum of all releases for M&I (array formula)
Estimated remaining release (one column for each claim 661-670	AM through AU	=IF(MONTH($A12)=1,$Y12/'Annual Summaries'!C144*AM$10,$Y12/'Annual Summaries'!C144*AM$10-AW11)	Estimated available release divided by total # shares times # shares associated with claim less cumulative release for year
Unexercised Claims with shares	BG through BO	=SUM($BR$8:$BS$8)-IF(MONTH(A12)=1,0,SUM('Cumm Diversions'!CO12:CP12))	Sum of base claim rights less sum of cumulative diversions to base claims for year
Total unexercised rights with M&I shares	BP	{=SUM(IF(LEFT($BG$5:$BO$5)="M",BG12:BO12,0))}	Sum of all M&I unexercised claims
Desired release from shares	BR through CV	=ES12-CX12	Desired from Steamboat natural flow less actual diversion from natural flow

Diversions from Steamboat natural flow are calculated similar to diversion from creeks in columns CX to IH of this worksheet.

Appendix C

MBK ENGINEERS

Water Resources • Flood Control • Water Rights

M E M O R A N D U M

DATE: September 6, 2006

TO: John Enloe, Don Mahin, Sue Oldham, Steve Walker, Mike Bushelman

FROM: Tami Thompson

SUBJECT: Consumptive Use Assumptions in South Truckee Meadows Model

The South Truckee Meadows Model evaluates the yield of claims when water rights are used for agricultural, municipal and industrial (M&I), or to provide return flow credits for Truckee River rights. Each of these uses consumes a different portion of the right. Any return flows are available for other users.

The following specific operations were used for agricultural diversions:

- In addition to the scheduled diversion, some claims allow diversion water for transit losses in ditches. The transit losses specific to the STM range from 0 to 15% of the water being diverted depending on claim. This analysis assumed the total creek diversion was the scheduled demand plus any transit loss allowed. Water diverted to cover transit losses was not available to be consumptively used on lands.

- Previous work assumed that only 80% of water applied to agricultural lands was effectively available to crops. We have continued to use this assumption; only 80% of scheduled diversion was available for consumptive uses.

- No soil moisture accounting or groundwater interaction was considered for this analysis.

- Even in drought years, all lands were assumed to be irrigated. Water was diverted for claims each month it was available.

- Additional water for irrigation was not diverted in later months to make up for shortages in earlier months.

- Evapotranspiration (ET) was used to estimate consumptive use on agricultural lands.

- Previous work developed a relationship between the average monthly temperature and potential ET. The following table is the average monthly ET (in inches) previously developed:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann
0.25	0.38	0.55	2.94	6.24	9.74	9.8	8.39	5.55	2.65	0.46	0.27	47.22

Precipitation decreases the amount of applied water required to meet potential ET. Net ET was calculated as potential ET minus the average monthly Reno-Carson City precipitation from historic record. The average annual Net ET used was 38.22 inches or 3.19 feet.

- Water applied in excess of monthly net ET was assumed to runoff irrigated lands and become available for downstream rights.

When rights are converted from agricultural to M&I use, the Nevada State Engineer may reduce the original duty to reflect the amount of water consumptively used. The following table shows the expected duty when claims are converted to M&I use:

Creek	% of Duty when converted to M&I	
Thomas	62.5%	
Whites	100%	Historically irrigation returns were re-used within claims
Galena	62.5%	
Browns	62.5%	
Steamboat	62.5%	