MAHANNAH & ASSOCIATES, LLC

EXPERT REPORT

DATE: 28 June 2010

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FROM: Chris C. Mahannah, P.E.

RE: Protestants Expert Report – Agricultural Consumptive Use

I. Introduction

As presented in the M&I Consumptive Use Expert Report, all the pending storage applications seek to store the consumptive use portion of base rights which have an existing manner of use as municipal. The applicants erroneously assume the storage applications are converting decreed irrigation rights and seek to store the decreed potential consumptive use component. All of the base rights sought to be stored were converted to municipal use, in many cases, decades ago which was summarized on Table 2 of the M&I CU report. Protestant presented evidence in that report suggesting a municipal consumptive use analysis is the proper basis for which to consider these pending primary storage applications. This report will present deficiencies in the Applicant's logic seeking storage of a theoretical potential agricultural consumptive use value.

Applicant Exhibit# 121 (exhibit numbers from Nevada State Engineer hearing 12/14-17/09) presents a net potential evapotranspiration (ET) consumptive use (CU) analysis for alfafa assuming a full water supply for the entire growing season. If downstream water rights and historical return flows are to be maintained, the actual historical CU of crops in the Truckee Meadows needs to be considered not some potential amount which could be consumed assuming ideal conditions to maximize the storage amount. Applicant's expert reports appear to be inconsistent on this issue where in Exhibit# 117, they suggest: "the historical consumptive use of a water right when used as decreed is the quantity of water that the State Engineer determines was consumed by the

EXHIBIT
tabbles
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historic crop. The Storage of the consumptive use portion of a water right does not result in a conflict or injury with existing rights." (page 2) Conversely, Applicant Exhibit# 121 seeks to store a maximum potential CU while Exhibit #117 suggests the actual historic CU is the appropriate amount to store to protect existing rights. If the State Water Resources Control Board (Board) should decide to consider the CU amount using an agricultural analysis versus the Protestant's argument that the M&I CU analysis is appropriate, then the analysis must be done based on actual historic agricultural CU as suggested in Applicant Exhibit# 117 to ensure existing rights are protected.

Actual historical crop CU will usually always be less than Potential alfalfa CU because of the following limiting factors:

1. Water Supply Limitations
2. Irrigation Season Length Variability
3. Irrigation Methods & Field Application Efficiency
4. Crop Type
5. Variable Sources of Supply

The remainder of this report will focus on issues the Board should consider if a historic agricultural CU is the basis from which storage of the CU will be allowed.

II. Historical Agricultural Consumptive Use Analysis

Table 1 is a summary of the TROA primary storage applications and associated base rights traced back to the original Orr Ditch Decree claim number. This table also shows the base acreage stripped under the first permit which abrogated the Decree claim from decreed to municipal use. The total acreage associated with the base acreage stripped for all applications approximates 3,146 acres. The approximate base acreage locations for the Truckee Meadows applications are shown on the map at Tab# 11. Table 2 summarizes the acreages for each ditch and Table 3 summarizes for the individual applications grouped by ditch.

Applicants are requesting a consumptive use component of at least 2.5 af/ac based upon attachments to their applications, however in Exhibit#121 they suggested 2.9 af/ac is the volume to store based on a net potential CU analysis. Historically the State Engineer has limited applications seeking changes of Truckee River rights which are not sewered back to TMWRF to 2.5 af/acre. See permit terms associated with permits 67182, 67183, 67525, 67526, 71113, and 71669 for examples where a 2.5 af/ac CU limit was imposed. Additionally, the TROA EIS only addressed impacts associated with the assumption that storage would be limited to 5/8 of the direct diversion right or 2.5 af/acre. See correspondence with the BOR modeler, Tom Scott on 3 March 2008 at Tab# 9, and provides references where storage of the consumptive use is addressed in the TROA FEIS. To approve anything beyond 2.5 af/acre would unravel any impact analysis addressed in the TROA FEIS. As the following analysis will show, 2.5 af/ac for an actual historic agricultural CU number will exceed historical CU in the Truckee Meadows, especially in drought years.

Water Supply Limitations & Irrigation Season Length

Potential CU use can be limited by supply, especially during drought conditions. Presenting a Potential CU number of 2.9 af/ac is meaningless if the crop does not have sufficient water supply to meet Potential CU. Applicants in Exhibit# 121 have assumed a growing season from 15 April – 31 October which is approximately 200 days long or 6.6 months. Talbot's Special Master Report in 1925 (Tab#2) makes several references to irrigation season length and variability:

> "The defendant's appropriations have been for, and are allowed for, an indefinite irrigation season approximating 5.5 months or 165 days." Page 33.

> "The defendants have testified that ordinarily the irrigation season in the Reno Valley begins about the middle of April, but varies considerably in different

years, and a lasts for about five or five and a half months (150-165 days)." Page 93.

Current practices by the U.S. Federal Watermaster's (Watermaster) office compute full season diversion rates assuming a 160 day irrigation season. Review of agricultural diversion records (Tab# 4) for the period 1989 – 2006 shows that on average the irrigation diversions run from May – September or 150 days which is in agreement with Talbot's Special Master Report. During drought years of 1990 – 1992 and 1994, the irrigation season was substantially shorter, ending in June, July or August depending upon the severity of the drought and storage available in upstream reservoirs.

In 1918, E.P. Osgood under the direction of S.T. Harding, irrigation expert, conducted field trials on alfalfa at several tracts of land on the University of Nevada (UNR) Agricultural Experiment Station Farm and the Nevada Asylum Farm. E.P. Osgood was an engineer who was also responsible for surveying nearly all the lands and ditches in the Truckee Meadows and preparation of the 1913 colored Plane Table maps which were eventually used to assist in the delineation of acreages for the Claims in the Orr Ditch Decree. Applied water, tail water runoff, crop yield, soil type and first and last irrigation dates were measured. This study entitled: "Data on Water Requirements of Certain Lands in Truckee Meadows, Nevada – Shown by Actual Use of Water on Five Separate Tracts" is included at Tab#3. In 1918 which was an average water year, the dates of first irrigation ranged from 1-15 May while the last irrigation date ranged from 5 August – 10 September. The average length of the irrigation season for the six tracts in this study was only 111 days.

Applicant's assumption of a full season of 6.6 months or 200 days every year to compute Potential CU will over estimate actual historical CU which is limited during drought periods. It is recognized that crop ET will continue for some time after the last irrigation depending on crop type, effective rooting depth, available water holding capacity (AWC) within the effective rooting depth, soil moisture, etc, however to assume a full supply every year for a season length of 6.6 months or 200 days is not realistic.

Watermaster diversion records/practices and Special Master Report support an average season length of 150-160 days.

Truckee River flows at the Farad USGS gage which is located in the Truckee Canyon near Floriston, CA and upstream of any Truckee Meadows agricultural diversions, were analyzed for the period from 1909 – 2006 to further assess shortage years when Floriston Rates were not being met. Floriston Rates are defined as 500 cfs from 1 March – 30 September and 400 cfs for 1 October – last day of February at the Farad gage. The Watermaster has found that a full irrigation supply can be delivered when these rates are met. When these rates are not met, the irrigation season will be shortened or a deficit irrigation supply will be delivered, thus limiting actual CU to some value less than potential CU.

At Tab#5 a table is included which shows the average monthly flows in cfs at Farad gage. For the years 1994 – 2006 when reliable monthly fish flow releases from Stampede, Boca and Prosser can be computed, they were subtracted from the Farad monthly flows to arrive at rate to compare with the Floriston rate requirements. According to the Watermaster, prior to 1994, the monthly fish flow releases were difficult to determine due to accounting procedures in place prior to that time. Fish flow releases started in 1976;so from 1976 to 1994, the following analysis will be conservative and potentially increase the time when Floriston Rates were being met.

For each year from 1909 – 2006, the last month Floriston Rates were met is noted in the tables at Tab# 5. Rates were assumed to be met if the flow was within 5% of the rate, therefore the March – September cutoff rate was 475 cfs and the October rate was 380 cfs. An irrigation season flow index was also computed for each year whereby the April – October total flow at Farad was divided by the long term season average which resulted in an index range of 0.22 in the most extreme drought year 1931 to 2.95 in flood year 1983. An index value of 1.0 would represent an average irrigation season flow volume. The data was then sorted to determine the number of years when Floriston rates were met the entire irrigation season and then for portions of the season which resulted in the following summary:

MONTHS FLORISTON RATES WERE MET	# YRS	%	AVG INDEX
Entire Season	65	66%	1.19
September	3	3%	0.89
August	8	8%	0.75
July	6	6%	0.71
June	8	8%	0.65
May	4	4%	0.38
April	2	2%	0.29
None	2	2%	0.31
TOTAL:	98		

In summary 34% of the time or 33 out of the 98 years flows were analyzed, Floriston Rates were not met which limited the irrigation season and actual CU of crops in the Truckee Meadows. The effects of adding Boca reservoir storage in 1939 and Prosser in 1962 were also analyzed to see how significant the added upstream storage would extend the Floriston Rates. For the time period 1940 – 2006, when Boca would have been in place for 66 years and Prosser for 44 years, the percentage of time rates were met the entire season was only increased by 7% compared to the period 1909 - 2006. Analyzing the time period 1962 – 2006 when both Boca and Prosser would have been in place over the same period only increased the percentage of time rates were met the entire season by a nominal 1% compared to the 1909 – 2006 period. This insignificant increase in time rates were met was due to back to back drought years in the early 1990's when reservoir levels were depleted. In summary, even with added upstream storage, 33-34% of the time, Floriston Rates were not being met resulting in a reduced irrigation season or delivery amount thus reducing actual CU.

If Applicant's Exhibit#121, Table 5 is adjusted to reflect their suggested net Potential CU value of 2.9 af/ac for the full April – October season, the cumulative net Potential CU values throughout the season are presented in the following table. Using the Applicant's own data, it is readily apparent the effects a shortened irrigation season have on actual CU. For example, assuming irrigation supplies were terminated in July, the crop was irrigated to its potential up until then, full AWC soil moisture conditions at the end of July, and useable soil moisture of 4 inches, the actual CU would be limited to approximately 2.0 af/ac under those conditions. Obviously, if irrigation were terminated earlier, the actual CU would be even less which happens during drought years. These calculations do not reflect additional limitations to actual historical CU which will be discussed in the following sections.

MONTH	APPLICANT Table 5. CUMULATIVE TOTAL OF CUAW-ADJ	APPLICANT Table 5. CUMULATIVE TOTAL OF CUAW-ADJ
	Inches	feet
APR	0.94	0.08
MAY	6.49	0.54
JUN	13.26	1.11
JUL	20.68	1.72
AUG	27.27	2.27
SEP	32.18	2.68
OCT	34.80	2.90

Irrigation Methods & Field Application Efficiency

The predominate method of irrigation in the Truckee Meadows was flood irrigation of which there are several types: flooding from field ditches (contour ditches), borders, flooding in checks or basins and furrow irrigation as described on pages 8 – 12 of Orr Ditch Defendants Exhibit 10-J (Tab#6) which is a Bulletin published by the Agricultural Experiment Station at the University of Nevada (UNR). Flooding from field ditches or contour ditch method is commonly used to irrigate sloping, rocky or undulating and shallow soils where leveling is not advisable and is the least efficient method of flood irrigation. This type of irrigation method is common in pasture settings while the furrows were the common method for irrigating alfalfa in the Truckee Meadows.

Field Application Efficiency is a measure of how much water applied to a field ends up in the effective root zone available to meet the CU of the crop. As a field is flood irrigated a portion of the water applied will run off as tail water and another portion infiltrates as deep percolation beyond the effective root zone of the crop. Field Application Efficiency is a function of slope, soil texture, and Distribution Uniformity (DU) which is a measure of how evenly water infiltrates across a field. See Figure 25 in the Food and Agricultural Organization (FAO) document provided at Tab# 7 for an illustration of these concepts. Steeply sloping fields will have more tail water runoff than flatter fields and lighter textured soils will have more loss to deep percolation past the effective root zone than heavier textured soils. This concept was partially demonstrated in the data collected by Osgood and Harding (Tab# 3) in 1918 where applied water, absorbed water and waste or tail water runoff was measured on different soil types. The 'Waste' percentage range in this study of 0-24% only accounted for tail water waste, not any waste due to deep percolation past the effective root zone. FAO 24, Table 37 (Tab# 7) published a range of Application Efficiencies from 50 – 70% for the contour ditch and furrow methods of irrigation. ASCE Journal of the Irrigation and Drainage Division (Tab# 8) noted furrow Application Efficiencies ranging from 60-70%. These concepts are also discussed in the Special Master Report (Tab#2) at pages 61-64. At page 71 of the Special Master Report, reference is made to an un-named UNR Experiment Station Bulletin published by one of the expert witnesses for the defendants which estimated the average head gate duty in the Truckee Meadows at 3.18 af/ac and a CU of 2.15 af/ac which results in an Application Efficiency of 67.6%.

Field Application Efficiencies become important factors in limiting actual CU particularly for those lands which do not receive tail water for their supply from up gradient irrigated lands or ditches. The Special Master Report addresses this issue and states: 'under the Steamboat Canal, the highest ditch and on the south side of the river, and which supplies to lands which do not receive waste water from above for the most of its length of about thirty miles...' (page 79). The same is noted for the Highland Ditch on the north side of the river which doesn't receive waste water from ditches or lands above. This concept would also apply to the Orr Ditch past the point of termination of the

Highland Ditch as there would be no up gradient ditches or lands to provide waste water return flows to augment direct diversions. Table 2 summarizes the acreages by ditch for all the subject base rights for the applications and 34% of the acreage involved in the original base rights are from the Highland, Steamboat or Orr ditches which would not benefit from waste water return flows to augment their supply. Therefore, assuming an average head gate delivery from these ditches of 4.0 af/ac and a range of 50-70% for Field Application Efficiency, the amount of available water to meet CU is reduced to 2.0 – 2.8 af/ac. If there happened to be supply limited year due to drought and only 2.0 af/acre of head gate duty were available, assuming it is applied in a manner to match CU of the crop demand and a range of 50-70% for Field Application Efficiency, the actual CU for that year would only be 1.0 – 1.4 af/acre, or less than half the amount the Applicants suggest of 2.9 af/ac.

Crop Type

Although Talbot's Special Master Report (Tab# 2) indicates alfalfa has become the principal crop in the Truckee Meadows, other crops were grown and both the Special Master Report and Orr Ditch Decree reduce head gate duties for those. For grain, the Decree calls for the head gate duties to be reduced by two-thirds or assuming an average head gate duty of 4.0 af/ac x 2/3 = 2.67 af/ac. For potatoes, corn or beets the Decree calls for head gate duty reduction of four-fifths or 4.0 af/ac x 4/5 = 3.2 af/ac (page 86).

The September, 1954 Feasibility Report for the Washoe Project (Tab#10) indicates: "Most of the irrigated lands with adequate drainage but late-season water shortages produce alfalfa, wheat, barley, oats, and rotation pasture. Some small irrigated tracts with adequate drainage are used for potatoes, onions, and truck crops. A few farms produce hardy fruits such as apples, plums, and pears. Lands with a drainage deficiency are generally limited to permanent native pastures, meadow hay, and other low-nutrient feed crops" (page 68). The Applicant's assumption of alfalfa as the only crop will result in an overestimate of historic CU when there was some percentage of other crops grown which use less water. Applicants make no attempt to quantify or acknowledge this fact.

Orr Ditch Defendants Exhibit 10-J (Tab#6) details water use on various crops grown at the UNR Ag Experiment Station within the Truckee Meadows between 1914 - 1917. They found the most economical use and highest yields for the following crops using these amounts of applied water:

Alfalfa:	3.5 af/ac
Wheat:	2.3 af/ac
Potatoes:	1.4 af/ac
Sugar Beets:	1.5 af/ac

It should be noted that these values are applied water or head gate duties and CU would be even less. Detailed historical records are not available for various crop types and acreages in the Truckee Meadows, however some acknowledgement and adjustment should be made for historic CU for crops which use less water. In the following GIS mapping analysis, an attempt has been made to show the various crops in production at the time the 1913 plane table maps were prepared by the BOR.

Variable Sources of Supply

In reviewing the decree for many of the base claims, there is allowance for irrigation of the land from waste and drain flows, tributary creek flows (not a part of claim being changed), and reference to swampy areas which imply high groundwater tables. Therefore the source of supply for some of these claims may be from other sources than direct Truckee River diversions, such as groundwater, tributary creeks, waste, and drain flow contributing to historical CU. The Special Master Report at page 83 notes 6,690 acres of lands served by creeks, reservoirs, springs and waste and an additional 4,324 acres of lands served from waste under river ditches. The tributary creeks draining the Carson Range on the south side of the river including: Hunter, Evans, Thomas and Whites (Howards) creeks all could provide either direct or waste water return flows to augment direct diversions from the river. Some of these are specifically noted in the Decree. For example, Application 73797 involving Claim 65 from the Steamboat Ditch also allowed water for these areas from Evans Creek and Wheeler Reservoir storage. Also Application 73869 involving Claims 485 and 489 from the Cochran Drain were allowed to be irrigated from spring and tributary waters of Thomas Creek.

For areas of the Truckee Meadows which experienced shallow groundwater tables, a portion of the CU could have been met by groundwater which originated from recharge within the Truckee Meadows basin and not direct diversion from the river. In reality, once irrigation practices were initiated in the Truckee Meadows and deep percolation and return flow patterns established, the shallow groundwater would have been a combination of recharge sources within the basin (precipitation & tributary infiltration) and secondary recharge from the irrigation practices. It would be difficult to quantify with any degree of certainty the percentage of CU met by shallow groundwater recharged within the basin, tributary creek or spring flows; however, it should be recognized as a component of the historical CU in the Truckee Meadows. The Applicants are seeking to store Truckee River waters in upstream reservoirs so it would not be appropriate or possible to store the component of any local (groundwater, tributary creek or spring flows) source of historical CU water in upstream reservoirs.

GIS Analysis of Base Rights

To provide a visual reference for some of the concepts discussed above, a GIS mapping effort was undertaken for a representative sample of the base rights for each ditch within the Truckee Meadows as summarized on the map at Tab#11. A total of eighteen (18) of the applications as summarized on Table 4 and the map at Tab#11 were mapped in detail (Map Keys: A-R) showing the Claim boundary and extent of the area stripped for the initial base right converting from decreed to municipal. These boundaries were then overlaid on the following images where coverage existed up until the point the lands were subdivided for M&I use:

1. Osgood (BOR) colored 1913 Truckee River Adjudication Survey Plane Table Maps
2. 6/29/1939 USDA black and white aerial photographs
3. 7/10/1946 USGS black and white aerial photographs
4. 3/5/1967 Farm Service Agency black and white aerial photographs
5. 4/11/1977 Great Basin Aerial Surveys black and white aerial photographs

In reviewing aerial photographs for the eighteen existing places of use under the base rights (A-R, Tab#'s 12- 29), nearly all of the existing places of use were in the process of being subdivided between 1967 – 1977, therefore in most cases the last photograph shown is the 3/5/1967 image. This supports the Protestants Exhibit# 801 which stated the water rights had been stripped for M&I purposes and lands dried up for decades in most cases.

The 1913 plane table maps were reviewed for each of eighteen base rights and crops in production at that time were noted.Table 5. In most cases there were other crops in production besides alfalfa including grain and potatoes which have reduced head gate duties per the Decree. There were also numerous notations for 'rocky pasture' and in the case of Application 73908 (Detail K), 'sage/brush and rocks' which would obviously have a much lower CU than alfalfa. It is recognized that crop type changes with time, however to assume the entire irrigated acreage in the Truckee Meadows was alfalfa is not realistic nor would it represent a historical CU.

Where the method of irrigation could be determined from the aerial photographs, it was noted on Table 5. Generally the higher ditches (Highland & Steamboat) serving more steeply sloping lands used the contour ditch method of irrigation which has lower Application Efficiencies. The lower ditches generally served flatter fields and used the furrow or border/check systems which have slightly higher Application Efficiencies. However, there were some lower ditches which served lands using the contour ditch method. Field Application Efficiencies become important factors in limiting actual CU particularly for those lands which do not receive tail water for their supply from up gradient irrigated lands or ditches such as Steamboat, Highland and the majority of the Orr ditch, as discussed above. These lands comprise 34% of the acreage involved in the original base rights.

Some of the existing places of use under the base rights included areas that were not historically irrigated or included riparian and water surface areas associated with the Truckee River or tributary streams. This is noted on Table 5. Consideration should be made for lands which were never historically irrigated and had no CU from Truckee River water or riparian lands (Truckee River & tributaries) which still continue to have CU. Allowing a storage CU component on these types of lands would not be appropriate and would harm existing rights.

III. Summary & Conclusions

Protestant's M&I CU report presented a municipal consumptive use analysis which is the proper basis for the Board to consider the storage applications. In that relatively straight forward analysis, an annual average of 50% of the base right duty was suggested to be stored. Converting that into a duty, assuming an average head gate duty of 4.0 af/acre would translate into 2.0 af/ac. Considering all of the limiting factors presented above which should be considered for an actual historical CU analysis, 2.0 af/ac is also a reasonable duty assuming an agricultural conversion. The Applicant's position of storing a Potential CU duty of 2.9 af/acre will exceed what was historically consumed in the Truckee Meadows and harm existing downstream rights. If the Board should consider the agricultural conversion as the proper basis rather than a municipal conversion, the storage timing of the agricultural consumptive use component should match the monthly agricultural consumptive use percentages. The Orr Ditch Decree allows up to 25% per month for <u>direct</u> diversion for irrigation, however this is considerably more than the April – October agricultural consumptive use percentages which range from a low in April of ~3% to a high in July of ~21%. Limiting the monthly storage of the agricultural consumptive use during the April – October growing season to their historical depletions will match return flow patterns in time, location and amount, thus protecting downstream rights. It would harm existing rights to allow 25% per month of the CU to be stored during November – March when historically the crops would be dormant and consuming very little water.

TABLE 1. SUMMARY OF TROA PRIMARY STORAGE APPLICATIONS - REVISED

APP #	CHANGE OF	CHANGE OF	CHANGE OF	CHANGE OF	DITCH	PRIORITY	DECREED ACRES STRIPPED	DUTY STRIPPED	DECREE DUTY	OWNER	FILE DATE	RATE	DUTY	PROTESTED BY:	COMMENTS OR NOTES IN ORR DITCH DECREE
							ACRES	AF/AC	AF/AC			CFS	AFA		
73783	42732	314DTR			ORR	4/1/1872	82.70	4.00	4.00	TMWA	2/1/06	1.200	330.80	Churchill, TCID, Fallon	
73791	42733	311DTR			ORR	4/1/1872	155.81	4.00	4.00	TMWA	2/3/06	3.229	623.24	Churchill, TCID, Fallon	
73792	42736	619DTR			GLENDALE	2/1864	90.76	3.55	3.5 & 4.0	TMWA	2/3/06	3.400	322.00	Churchill, TCID, Fallon	
73794	58383	337DTR 338DTR			ORR EXT.	4/1/1872	66.24	4.00	4.00	RENO-CITY	2/3/06	0.911	264.96	Churchill, TCID, Fallon	338DTR can also be seved from North Truckee Drain Ditch & from waste water
73795	62406	42713	31939	52DTR	STEAMBOAT	1/14/1878	32.03	4.00	4.00	RENO-CITY	2/3/06	0.487	128.13	Churchill, TCID, Fallon	
73796	62855	25444	67DTR		STEAMBOAT	1/14/1878	21.58	4.00	4.00	RENO-CITY	2/3/06	0.207	86.30	Churchill, TCID, Fallon	
73797	63601	29104	65DTR		STEAMBOAT	1/14/1878	40.30	4.00	4.00	TMWA	2/3/06	0.431	161.20	Churchill, TCID, Fallon	Additional water allowed for these areas from Evans Creek & Wheeler Reservoir storage
73798	63785	88DTR 88ADTR			STEAMBOAT	1/14/1878 4/1/1914	10.83	4.00	4.00	TMWA	2/3/06		43.31	Churchill, TCID, Fallon	Port. Withdrawn from original application
73799	63507	47636	35752	142DTR	HOGAN	5/1/1864	112.88	4.00	4.00	RENO-CITY	2/3/06	5.643	451.52	Churchill, TCID, Fallon	
73800	69871	343DTR 344DTR			SPANISH SPR. THRU ORR	4/1/1872	27.92	4.00	4.00	TMWA	2/3/06	1.180	111.68	Churchill, TCID, Fallon	Decree allows for claim to be served by drain & waste
73849	27756	534DTR 535DTR			N. TRUCKEE	1/29/1865 9/3/1887	33.65	4.28	4.0 & 4.5	TMWA	2/17/06	0.375	144.16	Churchill, TCID, Fallon	Decree allows lands to be served from waste water from lands above
73850	27757	570DTR			N. TRUCKEE	1/29/1865	157.00	4.00	4.00	TMWA	2/17/06	3.660	628.00	Churchill, TCID, Fallon	
73851	27758	578DTR			N. TRUCKEE	1/29/1865	99.00	4.00	4.00	TMWA	2/17/06	3.430	396.00	Churchill, TCID, Fallon	
73852	27759	579DTR 580DTR			N. TRUCKEE	1/29/1865	130.83	4.00	4.00	TMWA	2/17/06	2.812	523.32	Churchill, TCID, Fallon	Waste water from Peoples Drain & lands above are allowed for these areas
73853	42727	19938	611DTR		STEPHENS	11/1862	95.93	4.00	4.00	TMWA	2/17/06	3.680	383.72	Churchill, TCID, Fallon	Port. of area stripped were swamp for which no water was to be diverted until drained & dry
73854	42728	615DTR			GLENDALE	2/1864	57.89	3.68	3.5 & 4.0	TMWA	2/17/06	2.180	213.00	Churchill, TCID, Fallon	
73855	55383	356DTR 357DTR			INDIAN FLAT	12/20/1871	61.73	4.50	4.50	TMWA	2/17/06	2.330	277.78	Churchill, TCID, Fallon	
73863	46465	529DTR			N. TRUCKEE	1/29/1865	19.28	4.50	4.50	TMWA	2/23/06	0.175	86.76	Churchill, TCID, Fallon	
73865	50015	522DTR 524DTR			EASTMAN	12/8/1865	35.41	4.38	4.0 & 4.5	TMWA	2/23/06	0.885	154.98	Churchill, TCID, Fallon	Decree allows lands to be served from waste water from lands above
73868	56062	574DTR 575DTR			N. TRUCKEE	1/29/1865 4/11/1881	38.00	4.00	4.00	TMWA	2/23/06	0.955	152.00	Churchill, TCID, Fallon	Waste water from N. Truckee Drain & lands above are allowed for these areas
73869	57013	485DTR 489DTR			COCHRAN DRAIN	12/1/1862	86.11	4.00	4.00	RENO-CITY	2/23/06	2.897	344.45	Churchill, TCID, Fallon	Lands can also be irrig with spring & trib waters of Thomas Cr.
73870	57309	583DTR			SESSIONS	4/1863	100.97	4.50	4.50	RENO-CITY	2/23/06	3.780	454.37	Churchill, TCID, Fallon	
73871	62454	48903	405DTR 406DTR		SULLIVAN & KELLY	10/11/1871	41.75	4.00	4.00	RENO-CITY	2/23/06	1.377	167.00	Churchill, TCID, Fallon	
73872	65244	576DTR 577DTR			N. TRUCKEE	1/29/1865 4/11/1881	29.96	4.00	4.00	TMWA	2/23/06	0.720	119.84	Churchill, TCID, Fallon	Waste water from N. Truckee Drain & lands above are allowed for these areas
73908	66158	25118	514DTR		ABBEE	3/3/1879	141.91	4.50	4.50	TMWA	3/1/06	3.550	638.60	Churchill, TCID, Fallon	
73909	66575	24132	409DTR		SULLIVAN & KELLY	10/11/1871	59.25	4.00	4.00	TMWA	3/1/06	2.250	237.00	Churchill, TCID, Fallon	
73910	66577	23074	569DTR		N. TRUCKEE	1/29/1865	50.95	4.00	4.00	TMWA	3/1/06	1.410	203.80	Churchill, TCID, Fallon	
73911	66578	23075	325DTR		ORR EXT.	4/1/1872	46.40	4.00	4.00	TMWA	3/1/06	0.625	185.59	Churchill, TCID, Fallon	

APP #	CHANGE OF	CHANGE OF	CHANGE OF	CHANGE OF	DITCH	PRIORITY	DECREED ACRES STRIPPED	DUTY STRIPPED	DECREE DUTY	OWNER	FILE DATE	RATE	DUTY	PROTESTED BY:	COMMENTS OR NOTES IN ORR DITCH DECREE
							ACRES	AF/AC	AF/AC			CFS	AFA		
73912	66660	22640	517DTR		ABBEE	3/3/1879	18.19	4.40	4.0 & 4.5	TMWA	3/1/06	0.630	80.00	Churchill, TCID, Fallon	
73913	66676	23653	20425	503DTR	SCOTT RANCH	3/19/1873	9.56	4.50	4.50	TMWA	3/1/06	0.475	43.00	Churchill, TCID, Fallon	
73914	66695	25121	584DTR		SESSIONS	4/1863	13.31	4.50	4.50	TMWA	3/1/06	0.494	59.90	Churchill, TCID, Fallon	
73915	68649	387DTR			ENGLISH MILL	5/1/1863	16.92	4.00	4.00	TMWA	3/1/06	0.535	67.68	Churchill, TCID, Fallon	
73917	27755	532DTR 533DTR			N. TRUCKEE	1/29/1865 9/3/1887	114.06	4.09	4.0 & 4.5	TMWA	3/1/06	1.589	466.24	Churchill, TCID, Fallon	Waste water from Peoples Drain & lands above are allowed for these areas
73986	58559	346DTR 347DTR			SPANISH SPR. THRU ORR	4/1/1872	68.46	4.00		SPARKS / TMWA	3/13/06	0.926	273.83	Churchill, TCID	Drain & wastewater allowed
73987	58560	343DTR 344DTR			SPANISH SPR. THRU ORR	4/1/1872	34.30	4.00	4.00	SPARKS / TMWA	3/13/06	0.908	137.20	Churchill, TCID	Drain & wastewater allowed
74076	42735	329DTR			ORR EXT.	4/1/1872	25.15	4.00	4.00	TMWA	3/28/06	0.420	100.60	Churchill, TCID	
74077	65970	23118	600DTR		PIONEER	12/1861	137.00	4.00	4.00	TMWA	3/28/06	3.421	548.00	Churchill, TCID	
74078	65204	491DTR			SCOTT RANCH	3/19/1873	10.67	4.50	4.50	TMWA	3/28/06	0.537	48.01	Churchill, TCID	
74079	65583	405DTR 406DTR			SULLIVAN & KELLY	10/11/1871	15.25	4.00	4.00	TMWA	3/28/06	0.503	61.00	Churchill, TCID	Drain & wastewater allowed
74080	66463	568aDTR 568DTR			N. TRUCKEE	1/29/1865 9/3/1887	14.91	4.00	4.00	TMWA	3/28/06	0.274	59.64	Churchill, TCID	Waste water from Peoples Drain & lands above are allowed for these areas
74081	66750	23266	440DTR		COCHRAN	12/1/1862	7.00	4.00	4.00	TMWA	3/28/06	0.175	28.00	Churchill, TCID	
74082	68159	46361	80DTR		STEAMBOAT	1/14/1878	137.56	4.00	4.00	TMWA	3/28/06	2.373	550.23	Churchill, TCID	
74083	68160	46360	74DTR		STEAMBOAT	1/14/1878	28.20	4.00	4.00	TMWA	3/28/06	0.508	112.79	Churchill, TCID	
74084	69420	581DTR			N. TRUCKEE	1/29/1865	16.24	4.00	4.00	TMWA	3/28/06	0.355	64.92	Churchill, TCID	
74085	70494	581DTR			N. TRUCKEE	1/29/1865	10.01	4.00	4.00	TMWA	3/28/06	0.220	40.04	Churchill, TCID	
74193	16494	413DTR			COCHRAN	12/1/1862	24.82	4.50	4.50	TMWA	4/13/06	0.460	111.69	Churchill, TCID, Fallon	
74194	16758	434DTR			COCHRAN	12/1/1862	15.70	4.08	4.00	TMWA	4/13/06	0.240	64.03	Churchill, TCID, Fallon	Drain & wastewater allowed
74195	28972	19938	611DTR		STEPHENS	11/1862	16.24	4.00	4.00	TMWA	4/13/06	0.783	64.96	Churchill, TCID, Fallon	
74196	56734	24614	181DTR		LAST CHANCE	12/22/1874	35.70	4.50	4.50	TMWA	4/13/06	0.399	160.65	Churchill, TCID, Fallon	
74197	62534	576DTR			N. TRUCKEE	1/29/1865	46.79	4.00	4.00	RENO/SPARKS/ TMWA	4/13/06	1.170	187.15	Churchill, TCID, Fallon	Waste water from N. Truckee Drain & lands above are allowed for these areas
74198	66590	26351	407DTR		SULLIVAN & KELLY	10/11/1871	38.50	4.00	4.00	TMWA	4/13/06	1.243	154.00	Churchill, TCID, Fallon	
74199	68158	46359	86DTR		STEAMBOAT	1/14/1878	45.15	4.00	4.00	TMWA	4/13/06	0.900	180.60	Churchill, TCID, Fallon	
74200	38212	130DTR			HIGHLAND	4/1/1875	208.84	3.75	3.75	TMWA	4/13/06	3.420	783.15	Churchill, TCID, Fallon	
74201	61498	351DTR 352DTR			SPANISH SPR. VALLEY	4/1/1872	21.38	3.25	3.25	SPARKS-CITY	4/13/06	0.211	69.50	Churchill, TCID, Fallon	
74202	62405	124DTR			HIGHLAND	4/1/1875	89.10	3.75	3.75	TMWA	4/13/06	1.568	334.10	Churchill, TCID, Fallon	

TOTAL ACRES: 3146.08

AVERAGE DUTY (AF/AC): 4.03

TOTAL DUTY: 12,684.42

TABLE 2. SUMMARY OF TROA APPLICATIONS SORTED BY DITCH ON IRRIGATION CLAIMS - REVISED

DITCH	PRIORITY	ACRES	%
N. TRUCKEE	1/29/1865 - 9/3/1887	761	24%
ORR, ORR EXT., SPANISH SPRINGS, SPANISH SPRINGS VALLEY	4/1/1872	528	17%
STEAMBOAT	1/14/1878 & 4/1/1914	316	10%
HIGHLAND	4/1/1875	298	9%
GLENDALE	2/1864	149	5%
ABBEE	3/3/1879	160.1	5%
SULLIVAN & KELLY	10/11/1871	155	5%
PIONEER	12/1861	137	4%
COCHRAN	12/1/1862	134	4%
STEPHENS	11/1862	112	4%
SESSIONS	4/1863	114	4%
HOGAN	5/1/1864	113	4%
INDIAN FLAT	12/20/1871	62	2%
LAST CHANCE	12/22/1874	36	1%
EASTMAN	12/8/1865	35	1%
SCOTT RANCH	3/19/1873	20	1%
ENGLISH MILL	5/1/1863	17	1%
		3146	100%

TABLE 3. SUMMARY OF TROA PRIMARY STORAGE APPLICATIONS SORTED BY DITCH ON IRRIGATION CLAIMS - REVISED

APP #	CHANGE OF	CHANGE OF	CHANGE OF	CHANGE OF	DITCH	PRIORITY	DECREED ACRES STRIPPED (ACRES)	DUTY STRIPPED (AF/AC)	DECREE DUTY (AF/AC)	OWNER	FILE DATE	RATE (CFS)	DUTY (AFA)	PROTESTED BY:	COMMENTS OR NOTES IN ORR DITCH DECREE
73908	66158	25118	514DTR		ABBEE	3/3/1879	141.91	4.50	4.50	TMWA	3/1/06	3.550	638.60	Churchill, TCID, Fallon	
73912	66660	22640	517DTR		ABBEE	3/3/1879	18.19	4.40	4.0 & 4.5	TMWA	3/1/06	0.630	80.00	Churchill, TCID, Fallon	
							160.10								
74081	66750	23266	440DTR		COCHRAN	12/1/1862	7.00	4.00	4.00	TMWA	3/28/06	0.175	28.00	Churchill, TCID	
74193	16494	413DTR			COCHRAN	12/1/1862	24.82	4.50	4.50	TMWA	4/13/06	·0.460	111.69	Churchill, TCID, Fallon	
74194	16758	434DTR			COCHRAN	12/1/1862	15.70	4.08	4.00	TMWA	4/13/06	0.240	64.03	Churchill, TCID, Fallon	Drain & wastewater allowed
73869	57013	485DTR 489DTR			COCHRAN DRAIN	12/1/1862	86.11	4.00	4.00	RENO-CITY	2/23/06	2.897	344.45	Churchill, TCID, Fallon	Lands can also be irrig with spring & trib waters of Thomas Cr.
							133.63								
73865	50015	522DTR 524DTR			EASTMAN	12/8/1865	35.41	4.38	4.0 & 4.5	TMWA	2/23/06	0.885	154.98	Churchill, TCID, Fallon	Decree allows lands to be served from waste water from lands above
							35.41								
73915	68649	387DTR			ENGLISH MILL	5/1/1863	16.92	4.00	4.00	TMWA	3/1/06	0.535	67.68	Churchill, TCID, Fallon	
							16.92								
73792	42736	619DTR			GLENDALE	2/1864	90.76	3.55	3.5 & 4.0	TMWA	2/3/06	3.400	322.00	Churchill, TCID, Fallon	
73854	42728	615DTR			GLENDALE	2/1864	57.89	3.68	3.5 & 4.0	TMWA	2/17/06	2.180	213.00	Churchill, TCID, Fallon	
							148.65								
74200	38212	130DTR			HIGHLAND	4/1/1875	208.84	3.75	3.75	TMWA	4/13/06	3.420	783.15	Churchill, TCID, Fallon	
74202	62405	124DTR			HIGHLAND	4/1/1875	89.10	3.75	3.75	TMWA	4/13/06	1.568	334.10	Churchill, TCID, Fallon	
							297.94								
73799	63507	47636	35752	142DTR	HOGAN	5/1/1864	112.88	4.00	4.00	RENO-CITY	2/3/06	5.643	451.52	Churchill, TCID, Fallon	
							112.88								
73855	55383	356DTR 357DTR			INDIAN FLAT	12/20/1871	61.73	4.50	4.50	TMWA	2/17/06	2.330	277.78	Churchill, TCID, Fallon	
							61.73								
74196	56734	24614	181DTR		LAST CHANCE	12/22/1874	35.70	4.50	4.50	TMWA	4/13/06	0.399	160.65	Churchill, TCID, Fallon	
							35.70								
73849	27756	534DTR 535DTR			N. TRUCKEE	1/29/1865 9/3/1887	33.65	4.28	4.0 & 4.5	TMWA	2/17/06	0.375	144.16	Churchill, TCID, Fallon	Decree allows lands to be served from waste water from lands above
73850	27757	570DTR			N. TRUCKEE	1/29/1865	157.00	4.00	4.00	TMWA	2/17/06	3.660	628.00	Churchill, TCID, Fallon	
73851	27758	578DTR			N. TRUCKEE	1/29/1865	99.00	4.00	4.00	TMWA	2/17/06	3.430	396.00	Churchill, TCID, Fallon	
73852	27759	579DTR 580DTR			N. TRUCKEE	1/29/1865	130.83	4.00	4.00	TMWA	2/17/06	2.812	523.32	Churchill, TCID, Fallon	Waste water from Peoples Drain & lands above are allowed for these areas
73863	46465	529DTR			N. TRUCKEE	1/29/1865	19.28	4.50	4.50	TMWA	2/23/06	0.175	86.76	Churchill, TCID, Fallon	
73868	56062	574DTR 575DTR			N. TRUCKEE	1/29/1865 4/11/1881	38.00	4.00	4.00	TMWA	2/23/06	0.955	152.00	Churchill, TCID, Fallon	Waste water from N. Truckee Drain & lands above are allowed for these areas
73872	65244	576DTR 577DTR			N. TRUCKEE	1/29/1865 4/11/1881	29.96	4.00	4.00	TMWA	2/23/06	0.720	119.84	Churchill, TCID, Fallon	Waste water from N. Truckee Drain & lands above are allowed for these areas
73910	66577	23074	569DTR		N. TRUCKEE	1/29/1865	50.95	4.00	4.00	TMWA	3/1/06	1.410	203.80	Churchill, TCID, Fallon	
73917	27755	532DTR 533DTR			N. TRUCKEE	1/29/1865 9/3/1887	114.06	4.09	4.0 & 4.5	TMWA	3/1/06	1.589	466.24	Churchill, TCID, Fallon	Waste water from Peoples Drain & lands above are allowed for these areas

APP #	CHANGE OF	CHANGE OF	CHANGE OF	CHANGE OF	DITCH	PRIORITY	DECREED ACRES STRIPPED (ACRES)	DUTY STRIPPED (AF/AC)	DECREE DUTY (AF/AC)	OWNER	FILE DATE	RATE (CFS)	DUTY (AFA)	PROTESTED BY:	COMMENTS OR NOTES IN ORR DITCH DECREE
74080	66463	568aDTR 568DTR			N. TRUCKEE	1/29/1865 9/3/1887	14.91	4.00	4.00	TMWA	3/28/06	0.274	59.64	Churchill, TCID	Waste water from Peoples Drain & lands above are allowed for these areas
74084	69420	581DTR			N. TRUCKEE	1/29/1865	16.24	4.00	4.00	TMWA	3/28/06	0.355	64.92	Churchill, TCID	
74085	70494	581DTR			N. TRUCKEE	1/29/1865	10.01	4.00	4.00	TMWA	3/28/06	0.220	40.04	Churchill, TCID	
74197	62534	576DTR			N. TRUCKEE	1/29/1865	46.79	4.00	4.00	RENO/SPARKS/ TMWA	4/13/06	1.170	187.15	Churchill, TCID, Fallon	Waste water from N. Truckee Drain & lands above are allowed for these areas
							760.68								
73783	42732	314DTR			ORR	4/1/1872	82.70	4.00	4.00	TMWA	2/1/06	1.200	330.80	Churchill, TCID, Fallon	
73791	42733	311DTR			ORR	4/1/1872	155.81	4.00	4.00	TMWA	2/3/06	3.229	623.24	Churchill, TCID, Fallon	
73794	58383	337DTR 338DTR			ORR EXT.	4/1/1872	66.24	4.00	4.00	RENO-CITY	2/3/06	0.911	264.96	Churchill, TCID, Fallon	338DTR can also be seved from North Truckee Drain Ditch & from waste water
73911	66578	23075	325DTR		ORR EXT.	4/1/1872	46.40	4.00	4.00	TMWA	3/1/06	0.625	185.59	Churchill, TCID, Fallon	
74076	42735	329DTR			ORR EXT.	4/1/1872	25.15	4.00	4.00	TMWA	3/28/06	0.420	100.60	Churchill, TCID	
73800	69871	343DTR 344DTR			SPANISH SPR. THRU ORR	4/1/1872	27.92	4.00	4.00	TMWA	2/3/06	1.180	111.68	Churchill, TCID, Fallon	Decree allows for claim to be served by drain & waste
73986	58559	346DTR 347DTR			SPANISH SPR. THRU ORR	4/1/1872	68.46	4.00		SPARKS / TMWA	3/13/06	0.926	273.83	Churchill, TCID	Drain & wastewater allowed
73987	58560	343DTR 344DTR			SPANISH SPR. THRU ORR	4/1/1872	34.30	4.00	4.00	SPARKS / TMWA	3/13/06	0.908	137.20	Churchill, TCID	Drain & wastewater allowed
74201	61498	351DTR 352DTR			SPANISH SPR. VALLEY THRU ORR	4/1/1872	21.38	3.25	3.25	SPARKS-CITY	4/13/06	0.211	69.50	Churchill, TCID, Fallon	
							528.36								
74077	65970	23118	600DTR		PIONEER	12/1861	137.00	4.00	4.00	TMWA	3/28/06	3.421	548.00	Churchill, TCID	
							137.00								
73913	66676	23653	20425	503DTR	SCOTT RANCH	3/19/1873	9.56	4.50	4.50	TMWA	3/1/06	0.475	43.00	Churchill, TCID, Fallon	
74078	65204	491DTR			SCOTT RANCH	3/19/1873	10.67	4.50	4.50	TMWA	3/28/06	0.537	48.01	Churchill, TCID	
							20.23								
73870	57309	583DTR			SESSIONS	4/1863	100.97	4.50	4.50	RENO-CITY	2/23/06	3.780	454.37	Churchill, TCID, Fallon	
73914	66695	25121	584DTR		SESSIONS	4/1863	13.31	4.50	4.50	TMWA	3/1/06	0.494	59.90	Churchill, TCID, Fallon	
							114.28								
73795	62406	42713	31939	52DTR	STEAMBOAT	1/14/1878	32.03	4.00	4.00	RENO-CITY	2/3/06	0.487	128.13	Churchill, TCID, Fallon	
73796	62855	25444	67DTR		STEAMBOAT	1/14/1878	21.58	4.00	4.00	RENO-CITY	2/3/06	0.207	86.30	Churchill, TCID, Fallon	
73797	63601	29104	65DTR		STEAMBOAT	1/14/1878	40.30	4.00	4.00	TMWA	2/3/06	0.431	161.20	Churchill, TCID, Fallon	Additional water allowed for these areas from Evans Creek & Wheeler Reservoir storage
73798	63785	88DTR 88ADTR			STEAMBOAT	1/14/1878 4/1/1914	10.83	4.00	4.00	TMWA	2/3/06		43.31	Churchill, TCID, Fallon	Port. Withdrawn from original application
74082	68159	46361	80DTR		STEAMBOAT	1/14/1878	137.56	4.00	4.00	TMWA	3/28/06	2.373	550.23	Churchill, TCID	
74083	68160	46360	74DTR		STEAMBOAT	1/14/1878	28.20	4.00	4.00	TMWA	3/28/06	0.508	112.79	Churchill, TCID	
74199	68158	46359	86DTR		STEAMBOAT	1/14/1878	45.15	4.00	4.00	TMWA	4/13/06	0.900	180.60	Churchill, TCID, Fallon	
							315.65								
73853	42727	19938	611DTR		STEPHENS	11/1862	95.93	4.00	4.00	TMWA	2/17/06	3.680	383.72	Churchill, TCID, Fallon	Port. of area stripped were swamp for which no water was to be diverted until drained & dry
74195	28972	19938	611DTR		STEPHENS	11/1862	16.24	4.00	4.00	TMWA	4/13/06	0.783	64.96	Churchill, TCID, Fallon	

APP #	CHANGE OF	CHANGE OF	CHANGE OF	CHANGE OF	DITCH	PRIORITY	DECREED ACRES STRIPPED (ACRES)	DUTY STRIPPED (AF/AC)	DECREE DUTY (AF/AC)	OWNER	FILE DATE	RATE (CFS)	DUTY (AFA)	PROTESTED BY:	COMMENTS OR NOTES IN ORR DITCH DECREE
							112.17								
73871	62454	48903	405DTR 406DTR		SULLIVAN & KELLY	10/11/1871	41.75	4.00	4.00	RENO-CITY	2/23/06	1.377	167.00	Churchill, TCID, Fallon	
73909	66575	24132	409DTR		SULLIVAN & KELLY	10/11/1871	59.25	4.00	4.00	TMWA	3/1/06	2.250	237.00	Churchill, TCID, Fallon	
74079	65583	405DTR 406DTR			SULLIVAN & KELLY	10/11/1871	15.25	4.00	4.00	TMWA	3/28/06	0.503	61.00	Churchill, TCID	Drain & wastewater allowed
74198	66590	26351	407DTR		SULLIVAN & KELLY	10/11/1871	38.50	4.00	4.00	TMWA	4/13/06	1.243	154.00	Churchill, TCID, Fallon	
							154.75								
						TOTAL ACRES:	3146.07						12,684.42		

AVERAGE DUTY (AF/AC): 4.03

TABLE 4. SUMMARY OF TROA PRIMARY STORAGE APPLICATIONS FOR WHICH DETAIL MAPPING WAS PERFORMED - REVISED

MAP KEY	APP #	CHANGE OF	CHANGE OF	CHANGE OF	CHANGE OF	DITCH	PRIORITY	DECREED ACRES STRIPPED (ACRES)	DUTY STRIPPED (AF/AC)	DECREE DUTY (AF/AC)	RATE (CFS)	DUTY (AFA)	COMMENTS OR NOTES IN ORR DITCH DECREE
A	73791	42733	311DTR			ORR	4/1/1872	155.81	4.00	4.00	3.229	623.24	
B	73792	42736	619DTR			GLENDALE	2/1864	90.76	3.55	3.5 & 4.0	3.400	322.00	
C	73797	63601	29104	65DTR		STEAMBOAT	1/14/1878	40.30	4.00	4.00	0.431	161.20	Additional water allowed for these areas from Evans Creek & Wheeler Reservoir storage
D	73799	63507	47636	35752	142DTR	HOGAN	5/1/1864	112.88	4.00	4.00	5.643	451.52	
E	73852	27759	579DTR 580DTR			N. TRUCKEE	1/29/1865	130.83	4.00	4.00	2.812	523.32	Waste water from Peoples Drain & lands above are allowed for these areas
F	73853	42727	19938	611DTR		STEPHENS	11/1862	95.93	4.00	4.00	3.680	383.72	Port. of area stripped were swamp for which no water was to be diverted until drained & dry
G	73855	55383	356DTR 357DTR			INDIAN FLAT	12/20/1871	61.73	4.50	4.50	2.330	277.78	
H	73865	50015	522DTR 524DTR			EASTMAN	12/8/1865	35.41	4.38	4.0 & 4.5	0.885	154.98	Decree allows lands to be served from waste water from lands above
I	73869	57013	485DTR 489DTR			COCHRAN DRAIN	12/1/1862	86.11	4.00	4.00	2.897	344.45	Lands can also be irrig with spring & trib waters of Thomas Cr.
J	73870	57309	583DTR			SESSIONS	4/1863	100.97	4.50	4.50	3.780	454.37	
K	73908	66158	25118	514DTR		ABBEE	3/3/1879	141.91	4.50	4.50	3.550	638.60	
L	73909	66575	24132	409DTR		SULLIVAN & KELLY	10/11/1871	59.25	4.00	4.00	2.250	237.00	
M	73917	27755	532DTR 533DTR			N. TRUCKEE	1/29/1865 9/3/1887	114.06	4.09	4.0 & 4.5	1.589	466.24	Waste water from Peoples Drain & lands above are allowed for these areas
N	73986	58559	346DTR 347DTR			SPANISH SPR. THRU ORR	4/1/1872	68.46	4.00		0.926	273.83	Drain & wastewater allowed
O	74077	65970	23118	600DTR		PIONEER	12/1861	137.00	4.00	4.00	3.421	548.00	
P	74082	68159	46361	80DTR		STEAMBOAT	1/14/1878	137.56	4.00	4.00	2.373	550.23	
Q	74196	56734	24614	181DTR		LAST CHANCE	12/22/1874	35.70	4.50	4.50	0.399	160.65	
R	74200	38212	130DTR			HIGHLAND	4/1/1875	208.84	3.75	3.75	3.420	783.15	
						TOTAL ACRES:		1,813.51				7,354.28	
						AVERAGE DUTY (AF/AC):		4.06					

TABLE 5. DETAIL MAPPING REVIEW & SUMMARY - REVISED

MAP KEY	APP #	CHANGE OF	CHANGE OF	CHANGE OF	CHANGE OF	DITCH	DECREED ACRES STRIPPED (ACRES)	DUTY (AFA)	1913 PLANE TABLE CULTURES	IRRIGATION METHOD	EPOU FULLY IRRIGATED IN ANY AERIAL PHOTO	COMMENTS OR NOTES IN ORR DITCH DECREE
A	73791	42733	311DTR			ORR	155.81	623.24	Grain, Alfalfa, Pasture	F	Yes	
B	73792	42736	619DTR			GLENDALE	90.76	322.00	Clover, Potatoes, Alfalfa, Wheat, Garden	F	Yes	EPOU includes TR, Not irrigated to potential in 1967 & 1977
C	73797	63601	29104	65DTR		STEAMBOAT	40.30	161.20	Rocky Pasture, Alfalfa, Grain, Orchard	CD	No	Additional water allowed for these areas from Evans Creek & Wheeler Reservoir storage. Riparian Trib. area
D	73799	63507	47636	35752	142DTR	HOGAN	112.88	451.52	Rocky Pasture, Alfalfa, Orchard	B/C	Yes	Not irrigated to potential
E	73852	27759	579DTR 580DTR			N. TRUCKEE	130.83	523.32	Wild Hay, Alfalfa	FUR & B/C	Yes	Waste water from Peoples Drain & lands above are allowed for these areas. GW contribution?
F	73853	42727	19938	611DTR		STEPHENS	95.93	383.72	Tule Swamp, Wild Hay	CD	Yes	Port. of area stripped were swamp for which no water was to be diverted until drained & dry. GW contribution?
G	73855	55383	356DTR 357DTR			INDIAN FLAT	61.73	277.78	Alfalfa, Pasture	F	Yes	
H	73865	50015	522DTR 524DTR			EASTMAN	35.41	154.98	Alfalfa, Potatoes	F	Yes	Decree allows lands to be served from waste water from lands above. Port. of Claim boundary riparian
I	73869	57013	485DTR 489DTR			COCHRAN DRAIN	86.11	344.45	Wild Hay, Tule Swamp Flooded Pasture	CD & FUR	No	Lands can also be irrig with spring & trib waters of Thomas Cr. GW contribution?
J	73870	57309	583DTR			SESSIONS	100.97	454.37	Alfalfa, Marshy Meadow, Wild Hay	B/C	No	GW contribution? EPOU covers TR & riparian area

MAP KEY	APP #	CHANGE OF	CHANGE OF	CHANGE OF	CHANGE OF	DITCH	DECREED ACRES STRIPPED (ACRES)	DUTY (AFA)	1913 PLANE TABLE CULTURES	IRRIGATION METHOD	EPOU FULLY IRRIGATED IN ANY AERIAL PHOTO	COMMENTS OR NOTES IN ORR DITCH DECREE
K	73908	66158	25118	514DTR		ABBEE	141.91	638.60	Rocky Pasture, Rocks & Sage, Marshy Pasture, Swamp	CD	No	GW contribution? Alfalfa PET on 'Rocks & Sage' - not full PET
L	73909	66575	24132	409DTR		SULLIVAN & KELLY	59.25	237.00	Grain, Alfalfa, Pasture	B/C	Yes	
M	73917	27755	532DTR 533DTR			N. TRUCKEE	114.06	466.24	Grain, Wild Hay	F	Yes	Waste water from Peoples Drain & lands above are allowed for these areas. GW contribution?
N	73986	58559	346DTR 347DTR			SPANISH SPR. THRU ORR	68.46	273.83	Wild Hay & Swamp, Marshy w/ Alkali Spots	CD	No	Drain & wastewater allowed. GW contribution? Rocky hill not irrigated
O	74077	65970	23118	600DTR		PIONEER	137.00	548.00	Wild Hay Pasture, Swamp, Salt Grass	CD & B/C	Yes	GW contribution?
P	74082	68159	46361	80DTR		STEAMBOAT	137.56	550.23	Grain, Alfalfa, Pasture, Garden	CD	Yes	Not full PET
Q	74196	56734	24614	181DTR		LAST CHANCE	35.70	160.65	Pasture, Alfalfa, Garden, Rocky Pasture,	CD & B/C	No	Not full PET. Road/homestead in EPOU
R	74200	38212	130DTR			HIGHLAND	208.84	783.15	Rocky Pasture, Meadow, Alfalfa	C/D	Yes	Urbanization since 1939 or 70 years of M&I - supports M&I CU argument.
						TOTAL ACRES:	**1,813.51**	**7,354.28**				
						AVERAGE DUTY (AF/AC):	**4.06**					

IRRIGATION METHOD:

F FLOOD, UNDETERMINED TYPE
CD CONTOUR DITCH
B/C BORDERS AND/OR CHECK
FUR FURROW

AGRICULTURAL CONSUMPTIVE USE REPORT TAB INDEX

In the District Court of the United States

in and for

The District of Nevada

— IN EQUITY DOCKET No. A-3 —

The United States of America

Plaintiff

— VS —

Orr Water Ditch Company, et al.

Defendants

FINAL DECREE

EXHIBIT

Tab 1

FINAL DECREE

This cause having been heretofore heard by the Court and, following argument by counsel, the matter having been referred to George F. Talbot, as Special Master, and the said Special Master having thereafter rendered his report and made his findings, and the same having been approved and adopted by the Court (except as disallowed or modified by the Court) by a certain order termed "Temporary Restraining Order" made and entered in said cause under date of February 13, 1926:

NOW, THEREFORE, in accordance therewith, IT IS HEREBY ORDERED, ADJUDGED AND DECREED AS FOLLOWS:

That the parties, persons, corporations, intervenors, grantees, successors in interest and assigns and substituted parties above and hereinafter named and their successors in interest and assigns are, and each of them is, as against every other one, hereby adjudged to be the owners of the water rights hereinafter specified and set forth and entitled and allowed to divert and use, from the Truckee River and its tributaries and from the streams, springs, drain and waste waters hereinafter mentioned, and by and through their respective ditches, canals, flumes, dams and reservoirs, for the irrigation of their respective hereinafter described lands, for generating electricity and power, for municipal purposes, for supplying the people living in cities and towns, for reclamation of arid lands, for watering livestock, for domestic uses and other beneficial purposes, water in the respective amounts and subject and according to the respective dates of appropriation and priorities as hereinafter stated, found and allowed.

TRUCKEE RIVER DIVERSIONS

Government Rights

INDIAN DITCH

Claim No. 1. By order of the Commissioner of the General Land Office made on December 8, 1859, the lands comprising the Pyramid Lake Indian Reservation were withdrawn from the public domain for use and benefit of the Indians and this withdrawal was confirmed by order of the President on March 23, 1874. Thereby and by implication and by relation as of the date of December 8, 1859, a reasonable amount of the water of the Truckee River, which belonged to the United States under the cession of territory by Mexico in 1848 and which was the only water available for the irrigation of these lands, became reserved for the needs of the Indians on the reservation.

For the irrigation of 3130 acres of Pyramid Lake Indian Reservation bottom lands, plaintiff, the United States of America, is entitled and allowed to divert from the Truckee River through the Indian Ditch, the intake of which is on the left bank of the river in Section 18, T. 22 N., R. 24 E., Mount Diablo Base and Meridian, not exceeding 58.7 cubic feet of water per second to an amount not exceeding 14,742 acre feet of water in any calendar year with a priority of December 8, 1859; provided the amount of water so to be diverted shall not exceed a flow of one miner's inch, or one-fortieth of one cubic foot per second per acre for the aggregate number of acres of this land being irrigated during any calendar year and the amount of water applied to the land after an estimated transportation loss of 15 percent, shall not exceed 85-100 of an inch or 85-100 of one-fortieth of one cubic foot per second per acre for the total number of acres irrigated, and provided that the amount of water so diverted during any such year shall not exceed 4.71 acre feet per acre for the aggregate number of acres of this land being irrigated during that year, and further provided that the amount of water applied to the land shall not exceed four acre feet per acre for the aggregate number of acres of this land being irrigated during any calendar year.

This water is allowed for the United States and for the Indians belonging on said reservation and for their use and benefit and is not allowed for transfer by the United States to homesteaders, entrymen, settlers or others than the Indians in the event that said lands are released from the reservation or are thrown open to entry or other disposal than assignment or transfer to the Indians.

Claim No. 2. In addition to water for the above mentioned 3130 acres of Pyramid Lake Indian Reservation bottom lands, the Government is hereby and will be allowed to divert water from the Truckee River, with a priority of December 8, 1859, to the amount of one-fortieth of one cubic foot per second per acre for the irrigation of 2745 acres of Pyramid Lake Indian Reservation bench lands. The water so allowed for bench lands may be diverted from the Truckee River through the Truckee Canal or any other ditch now or hereafter constructed as the plaintiff may desire or authorize; provided that the amount of water for bench lands shall not exceed during any calendar year 5.59 acre feet per acre diverted from the river, nor exceed during any calendar year 4.1 acre feet per acre applied to the lands, for the aggregate number of acres of this land being irrigated during any year.

This water is allowed for the United States and for the Indians belonging on said reservation and for their use and benefit and is not allowed for transfer by the United States to homesteaders, entrymen, settlers or others than the Indians in the event that said lands are released from the reservation or are thrown open to entry or other disposal than assignment or transfer to the Indians.

DERBY DAM AND TRUCKEE CANAL

Claim No. 3. Under the Reclamation Act of June 17, 1902, the United States, acting by the Secretary of the Interior, on July 2, 1902, withdrew from public entry, excepting under the homestead laws in accordance with the provisions of the Act, the lands required for the Government's first reclamation project, now known as the Newlands Project. Thereupon and with due diligence the United States proceeded with the construction of the Derby Dam across the Truckee River in the SW¼ of Section 19, in T. 20, N., R. 23, E., Mount Diablo Base and Meridian, and with the construction of the Truckee Canal, with a carrying capacity of 1,500 cubic feet of water per second, running from this dam a distance of 31 miles to the Lahontan Reservoir on the Carson River, and with the construction of the Lahontan Reservoir, with a storage capacity of 290,000 acre feet, and with the construction of about 250 miles of lateral and sub-lateral irrigation canals sufficient for carrying water for the irrigation of 151,000 acres. On April 30, 1919, the Government had expended for this project $6,252,000.00. The lands so withdrawn for reclamation are naturally dry and arid and without the application of water are of little or no value, but with irrigation will produce valuable crops and furnish homes and support for a large population.

Subject to prior appropriations and vested rights permitted and confirmed by the Act of Congress of July 26, 1866, the plaintiff is entitled and allowed to divert, with a priority of July 2, 1902, through the Truckee Canal 1,500 cubic feet of water per second flowing in the Truckee River for the irrigation of 232,800 acres of lands on the Newlands Project, for storage in the Lahontan Reservoir, for generating power, for supplying the inhabitants of cities and towns on the project and for domestic and other purposes, and under such control, disposal and regulation as the plaintiff may make or desire, provided that the amount of this water allowed or used for irrigation shall not exceed, after transportation loss and when applied to the land, 3.5 acre feet per acre for the bottom lands, nor 4.5 acre feet per acre for the bench lands under the Newlands Project.

LAKE TAHOE STORAGE

Claim No. 4. Under the Reclamation Act and for irrigation and other beneficial uses on lands under said project and on lands within the basins of the Truckee, Carson and Humboldt rivers in Washoe, Storey, Lyon, Churchill and Humboldt counties, in the State of Nevada, and pursuant to notice posted, by direction and authority of the Secretary of the Interior and for and on behalf of the United States, on the right bank of the Truckee River at the site of the dam in said river near Tahoe City and in Placer County, California, and about 500 feet downstream from Lake Tahoe, on the 21st day of May, 1903, plaintiff is entitled to, and is allowed with a priority of that date and during all seasons of the year, to have flow into and to hold and store in Lake Tahoe and in a reservoir made of said lake by a dam at said site in said river constructed with the spillway crest thereof six feet above the floors of the flow-ways of said dam as then existing, all waters of or coming into said river or said lake, both surface and under flow, to the extent of 3,000 cubic feet per second and to the extent of the capacity of said lake as a reservoir made by said dam, to said height and subject to the continuous out-flow through said river from said lake or reservoir so made by said lake or dam, of such an amount of water as plaintiff may desire to release or may discharge from said lake or reservoir not exceeding at any time a flow of 3,000 cubic feet of water per second.

In addition to the above specified rights, the United States is entitled to store, discharge and control water in Lake Tahoe as provided in the judgment and decree filed and entered on June 4, 1915, in the case of the United States, plaintiff, versus The Truckee River General Electric Company, a corporation defendant, in the District Court of the United States in and for the Northern District of California, Second Division, and subject to said decree the United States shall be entitled to discharge from Lake Tahoe an amount of water sufficient to deliver to the head of the Truckee Canal at the Derby Dam, after transportation loss, 1,500 cubic feet per second. The plaintiff is entitled and allowed at will to release and discharge any of the water stored, or by this decree allowed to be stored, in Lake Tahoe and to flow the same and any other water to which it is entitled, acording to its priority, through the Truckee River to the Derby Dam and there divert the same through the Truckee Canal for irrigation, for storage in the Lahontan Reservoir, for generating power and for other purposes. The rights of said defendant Sierra Pacific Power Company (formerly The Truckee River General Electric Company) under said judgment and decree are hereby recognized and confirmed.

Power Ditches

FARAD PLANT

Claim No. 5. The Sierra Pacific Power Company, a corporation owner, is entitled an dallowed to divert at all times from the Truckee River through the Farad Power Flume, which has its intake on the north bank of the Truckee River in the S½ of Lot 6 in the NW¼ of Section 30, Township 18 North, Range Eighteen East, sufficient water, with a priority of the year 1899, to deliver, after transportation loss, to the wheel of the Farad Hydro-Electric power plant, 325 cubic feet of water per second and sufficient additional water with a priority of 1906 to deliver, after transportation loss, to the wheel of said plant, 75 cubic feet of water per second, said plant being situate in the SE¼ of Section 12, Township 18 N. R. 17 E., for the generation of electric power in said plant.

FLEISH PLANT

Claim No. 6. The Sierra Pacific Power Company, a corporation owner, is entitled and allowed to divert at all times from the Truckee River through the Fleish Power Ditch and Flume, which has its intake on the east bank of the Truckee River in the SE¼ of Section 6, Township 18, N. R. 18 E., sufficient water with a priority of February 16, 1904, to deliver, after transportation loss, to the wheel of the Fleish Hydro-Electric power plant, 327 cubic feet of water per second, said plant being situate in the NE¼ of the SE¼ of Section 30, Township 19 N. R. 18 E., for the generation of electric power in said plant.

VERDI PLANT

Claim No. 7. The Sierra Pacific Power Company, a corporation owner, is entitled and allowed to divert at all times from the Truckee River through the Verdi Power Ditch and Flume, which has its intake on the east bank of the Truckee River in the SE¼ of the SE¼ of Section 19, T. 19 N. R. 18 E. sufficient water, with a priority of October 21, 1909, to deliver, after transportation loss, to the wheel of the Verdi Power Plant 399 cubic feet of water per second, said plant being situate in the SE¼ of Section 8, T. 19 N. R. 18 E. for the generation of electric power in said plant.

In addition to such diversion for power purposes, Sierra Pacific Power Company, a corporation, is allowed to divert from said river through the Verdi Power Ditch 220 inches or 5.50 cubic feet of water per second for supplying the Katz Ditch for irrigation to the extent and with the priority hereinafter allowed to this company, for the Katz Ditch under irrigation rights.

In addition to such diversions for power purposes and for so supplying the Katz Ditch with water for irrigation, Sierra Pacific Power Company, a corporation, is entitled and allowed to divert and transport from the Truckee River, through the Verdi Power Ditch and Flume and to deliver to Verdi Lumber Company, a corporation, and Verdi Lumber Company is entitled to have diverted from said river through said ditch and flume by, and to receive from the Sierra Pacific Power Company, 100 inches of water with a priority of the year 1894 for supplying and maintaining the log pond of the Verdi Lumber Company in the Town of Verdi, and for logging and saw mill purposes.

WASHOE PLANT

Claim No. 8. The Sierra Pacific Power Company, a corporation owner, is entitled and allowed to divert at all times from the Truckee River through the Washoe Power Ditch and Flume, which has its intake on the south bank of the Truckee River, in the NW¼ of the NE¼ of Section 16, T. 19 N. R. 18 E. sufficient water, with a priority of October 27, 1902, to deliver, after transportation loss, to the wheel of the Washoe Hydro-Electric Power Plant, 396 cubic feet of water per second, said plant being situate in the SW¼ of the SW¼ of Section 14, in said township and range, for the generation of electric power in said plant.

Of the water so allowed to be diverted through the Washoe Power Ditch and Flume, Sierra Pacific Power Company is allowed to use during the irrigation season 12.4 inches or .31 cubic feet of water per second, not exceeding a seasonable amount of 50 acre feet for the irrigation of 12.4 acres of its land as hereinafter described and provided under Washoe Power Ditch under irrigation rights.

Also of the amount of water allowed to be diverted through the Washoe Power Ditch, Sierra Pacific Power Company is entitled and allowed to deliver to the defendant Leonidas Frederick Johnson and he is entitled and allowed to have and receive from Sierra Pacific Power Company, 50 inches or 1.25 cubic feet of water per second, to the seasonal amount of 257 acre feet, for the irrigation of his lands as described and as provided hereinafter under Washoe Power Ditch under irrigation rights.

RENO PLANT

Claim No. 9. The Sierra Pacific Power Company, a corporation owner, is entitled and allowed to divert at all times from the Truckee River through the Reno Power Ditch and Flume, which has its intake on the south bank of the Truckee River 1365 feet north, 35 degrees west from Quarter Section corner between Section 15 and 16, T. 19 N. R. 19 E. sufficient water with a priority of March 31, 1891, to deliver, after transportation loss, to the wheel of the Reno Hydro-Electric Power Plant, 250 cubic feet of water per second, and sufficient additional water with a priority of November 1, 1909 to deliver after transportation loss, to the wheel of said plant 46 cubic feet of water per second, said plant being situate in NE¼ of NE¼ Section 15, in said township and range, for the generation of electric power in said plant.

In addition to such allowed diversions for power purposes through the Reno Power Ditch and Flume, Sierra Pacific Power Company is entitled and allowed to divert from the Truckee River and convey through said ditch and flume and deliver to defendants Sarah McClure, James Murray, William Murray and Sam Murray and their successors, and they are entitled and allowed to have and receive from said company, 50 inches of water for the irrigation of their lands as hereinafter described and provided under Indian Flat Ditch under irrigation rights.

RIVERSIDE MILL DITCH

Claim No. 10. The Riverside Mill Company, incorporated, owner, is entitled and allowed to divert at all times from the Truckee River, through the Riverside Mill Ditch and Flume, which has its intake on the north bank of the Truckee River at a point 84 feet westerly from the center of Chestnut Street in the City of Reno and in the NW¼ of the SE¼ of Section 11, T. 19, N., R. 19, E., 70 cubic feet of water per second with a priority of May, 1863, for operating the Riverside Flour Mill in the City of Reno and for generating power and for milling purposes.

WADSWORTH POWER PLANT
(Solicitor: James T. Boyd)

Claim No. 13. The Wadsworth Light and Power Company, incorporated, owner, is entitled and allowed to divert at all times from the Truckee River, through the Wadsworth Light and Power Company Ditch, which has its intake on the north bank of the Truckee river in the NW¼ of the SW¼ of Section 13, T. 20, N., R. 23, E., Mount Diablo Base and Meridian, 31.3 cubic feet of water per second with a priority of June 26, 1897, for delivering, after an allowed transportation loss of 20 per cent, 25 cubic feet of water per second to the wheel at the pumping and power plant of this company, situated in the SE¼ of the SE¼ of Section 33, in T. 21, N., R. 24, E., M.D.M., for the operation thereof and for pumping and for generating electrical and other power.

WADSWORTH WATER SUPPLY
(Solicitor: James T. Boyd)

Claim No. 14. In addition to the amount of water so allowed to be diverted for generating power, for pumping and the operation of its plant, the [illegible] Light and Power Company is entitled and allowed to divert at all times from the Truckee River through its said power ditch, for supplying the Town of Wadsworth and the people living in or near this town with water for fire protection, for the irrigation of their lawns, gardens and lands, and for household and other purposes, 3.13 cubic feet of water per second with a priority of June 26, 1897, for the delivery, after an allowed transportation loss of 20 per cent, of 2.5 cubic feet of water per second to the reservoir of said company in the SE¼ of the SE¼ of Section 33, in T. 21, N., R. 24, E., M.D.M., and to said people for said purposes. (See Irrigation Rights for irrigation water allowed under this ditch, No. 635.)

WINTER DITCH REGULATION

The owners and operators of ditches through which the diversion of water is allowed for generating electricity and power and for milling, mechanical and municipal purposes; and for supplying the inhabitants of any city or town, whenever ice shall collect in any of their ditches, shall be allowed to divert from the Truckee River and use such additional amount of water as may be required for flushing out such ice and so long only as may be required for such flushing, provided that the water diverted for such flushing shall not in any case be more than 20 per cent of the amount which is fixed and allowed by this decree to be diverted through the ditch in which said flushing is done.

All water diverted or used for generating electricity or power or for operating mills or power plants shall be returned directly to the Truckee River after being so used. Extra water for preventing congestion by ice and for flushing ice allowed to be used in ditches supplying water for municipal purposes when required must be returned directly to the river when used for these purposes.

IRRIGATION RIGHTS

The parties, persons and corporations hereinafter named and their grantors and predecessors in interest have acquired rights of appropriation in, and have diverted and appropriated from the Truckee River and its tributaries and used for the necessary irrigation of their respective hereinafter described lands, water in the respective amounts and under the respective priorities as stated in the following table. As shown by the following tabulations and columns, each of the parties, persons and corporations named in the columns headed, "Owner," directly or by his, her or its grantor or predecessor in interest, on and continuing after the date in the columns headed "Date of Priority" and opposite his, her or its name or described lands, from the stream last named above his, her or its name or in connection therewith, and through the ditch or ditches named in the columns headed "Ditch" and opposite his, her or its name or described lands, for the necessary irrigation of his, her or its lands as described opposite his, her or its name and in the columns under the words "Acres Irrigated" and following columns, diverted and appropriated water in the amount or amounts stated opposite his, her or its name or described lands and in the columns, headed "Approximate Diversion," and water sufficient to deliver to his, her or its said lands after transportation loss, the amounts in flow and acre feet per season stated opposite his, her or its name or described lands and in the columns under the words "Amount Allowed Delivered to Land":

Date of Priority	Owner	Ditch	Point of Diversion: Side of Stream	Point of Diversion: In ¼ of ¼	Section	T-N	R-E	Acres Irrigated Direct: Cult'd	Direct: Wild Hay	Drain: Cult'd	Drain: Wild Hay	In ¼ of ¼	Section	T-N	R-E	Approximate Diversion: Inches	Approximate Diversion: Sec. Feet	Estim'd Transit Loss Per Cent	Amount Allowed Delivered, Maximum Flow (In. equals 1/40 sec. ft.): Inches Per Acre	Total Inches	Sec. Feet	Per Season: Ac. Ft. Per Acre	Acre Feet
1920	C. S. Laughton	By Pumping from Well	On	W½ Lot 1 of NW¼	5	10	20	34.0				N½ Lot 1 of NW¼	5	10	20				1½	52	1.30	4.0	130
1910	C. S. Laughton		Waste Water from Peoples' Drain ditch by Laity ditch through Lot 2 of NW¼ Sec. 5, T. 10 N., R. 20, E., of a priority of 1870. Also allowed for the east 17.0 acres of this area provided water from all sources shall not exceed the single amount of 71 acre feet provided for said 17.0 acres.																				
1920	George Peno	By Pumping from Well	On	W½ Lot 1 of NW¼	5	10	20	18.5				W½ Lot 1 of NW¼	5	10	20				1½	10	0.48	4.0	60

GENERAL PROVISIONS

In the foregoing table and columns pertaining to irrigation water rights the word, "Direct," means that the acreages specified thereunder are irrigated by water hereby allowed to be diverted from the river, creek or stream last named above the acreage; the word, "Drain," means that the acreages thereunder are irrigated by drain or waste water hereby allowed and ordered for the irrigation thereof; the word, "Season," means the time in any calendar year when irrigation may be needed; the word, "Priority," means the time when the water right was initiated. "Inch" means one-fortieth (1/40th) of one cubic foot per second, which, in general is the amount of water which will flow through an orifice having an area of one square inch, under a pressure of six (6) inches at the center of the opening. "Acre Foot," means the amount of water which will cover an area of one acre to a depth of one foot.

All of the above described ditches, lands and sections are in townships north and ranges east, Mount Diablo Base and Meridian. All of the irrigated lands are in the State of Nevada, except a part of the tracts listed under Dog, O'Neil, and Sunrise creeks. All of the ditches, canals and flumes are in the State of Nevada excepting the Farad and the upper end of the Fleish. Lake Tahoe is partly in Nevada and partly in California and the outlet of the lake to the Truckee River and the dam controlling the storage in the lake are in the State of California.

Without the application of water thereto the above described lands are dry and arid and irrigation is necessary for the production of valuable crops thereon. The respective amounts of water hereinbefore stated to have been appropriated for or used on these lands, are in each instance as specified therefor necessary and sufficient for the reasonable and economical irrigation of crops thereon other than grain, potatoes, corn and beets. These do not need to be irrigated for so many months as alfalfa and pasture. Only two-thirds of the amount of water in acre feet hereinbefore specified or allowed for the irrigation of any of the above described tracts of land is necessary for, or should be or is allowed for the irrigation of grain grown thereon. Only four-fifths of the amount of water in acre feet designated above for the irrigation of said tracts of land is necessary for, or should be or is allowed for, the irrigation of potatoes, corn or beets grown thereon. Young alfalfa needs frequent irrigations for a long season. An additional amount of ten per cent of the quantity of water hereinbefore specified in acre feet for the irrigation of any of the above described lands is necessary for and should be and is allowed for the irrigation thereof during the first year that alfalfa is sown thereon, whether the alfalfa be sown with o. without grain.

The amounts of water which the parties to this action have appropriated and used for purposes other than the irrigation as stated above are necessary and sufficient for the uses for which they have been appropriated.

The above named parties who so appropriated water for irrigation have also used and in addition thereto are entitled and allowed to use water for livestock and domestic purposes, but only in such amounts as may be necessary for watering stock and for domestic purposes; provided that the priority in respect of the use of water for livestock and domestic purposes of any person shall be identical with the priority of such party for irrigation.

IT IS FURTHER ORDERED AND DECREED that that certain agreement known as the Truckee River Agreement, dated July 1, 1935, entered into by the United States of America, party of the first part, Truckee-Carson Irrigation District, party of the second part, Washoe County Water Conservation District, party of the third part, Sierra Pacific Power Company, party of the fourth part, and such other users of the waters of the Truckee River as may have or shall become parties to said agreement by signing their names thereto, parties of the fifth part, which agreement provides (among other things) for the upstream storage of the waters of the Truckee River and its tributaries, be and the same is hereby approved, adopted by the Court and made a part of the decree and shall be binding as between the signatory parties to said agreement.

Vater for irrigation is allowed to be used at any time, provided that the a1. applied to the land during any calendar year shall not exceed the quantity in acre feet allowed to the land.

No owner or person or party entitled to the use of water under this decree shall be allowed to use for irrigation during any calendar month more than twenty-five per cent of the quantity of direct water in acre feet hereby allowed for the land for the season.

If it shall appear at any time in regard to the actual use and need of water for irrigation that the amount hereinbefore estimated and allowed to be diverted from the river or stream into any ditch or canal is not sufficient after transportation loss to deliver to the land the flow allowed by this decree for application to the land, the allowance or flow as fixed by this decree for application to the land shall control, and there may, and hereby is allowed to be diverted from the stream a larger amount than the amount hereinbefore estimated for diversion from the stream, to the extent necessary to supply to the land; after actual transportation loss, the flow of water allowed by this decree for application to the land. Whether more or less than the amount hereinbefore estimated for diversion from the stream by any ditch, the quantity of water diverted for irrigation shall in every case be only such an amount as will supply to the land, after actual transportation loss, the amount of water allowed by this decree for application to the land and only the quantity needed for the irrigation thereof.

When any other user will thereby be deprived of any part of the water to which he is entitled, no ditch owner or user shall be allowed to divert away from the stream extra water for regulating the flow in any ditch.

The parties, persons, corporations, intervenors, grantees, successors in interest and substituted parties hereinbefore named, and their and each of their servants, agents, attorneys, assigns and all persons claiming by, through or under them and their successors, in or to the water rights or lands herein mentioned or described, are and each of them is hereby forever enjoined and restrained from asserting or claiming any rights in or to the waters of the Truckee River or its tributaries, or the waters of any of the creeks or streams or other waters hereinbefore mentioned except the rights, specified, determined and allowed by this decree, and each and all of said parties, persons, corporations, intervenors, agents, attorneys, servants, assigns and successors in interest; and all persons claiming by, through or under them, are hereby perpetually restrained and enjoined from diverting, taking or interfering in any way with the waters of the Truckee River or its tributaries or with waters of any of the creeks or streams, or with any of the other waters hereinbefore mentioned, so as to in any manner prevent or interfere with the diversion, use and enjoyment of the waters of any of the other persons or parties as allowed or adjudicated by this decree, having due regard to the relative priorities herein set forth; and each of the said parties and persons and each of their agents, servants, attorneys and employees is hereby enjoined and restrained from ever taking, diverting, using or claiming any of the water so decreed, in any manner or at any time so as to in any way interfere with the prior rights of any other persons or parties having prior rights under this decree, as herein set forth, until such persons or parties having prior rights have received for their several uses the waters hereby allowed and adjudged to them.

Except as herein specially provided no diversion of water into any ditch or canal, in this decree mentioned shall be permitted except in such amount as shall be actually, reasonably necessary for the economical and beneficial use for which the right of diversion is determined and established by this decree. The amounts of water hereinbefore allowed are declared to be sufficient for the uses herein mentioned, and any and all use of water in excess of such decreed amounts is declared to be wasteful, and all wasteful or excessive use of water is hereby prohibited.

In any case where water is obtained from two or more sources, the a[illegible] ite amount of the combined waters from such sources which may be used, [illegible]ot exceed the amount required for such use as herein determined.

Whenever in this decree words of ownership are used in connection with any irrigated lands, such words shall not adjudicate, determine or affect any property rights therein, and this decree does not and shall not in any way determine the title to or rights in any property whatsoever, other than the rights to the diversion and use of water as herein determined and established. In the cases where, by this decree, water is allowed to be diverted through any ditch by the owner thereof for another party the conditions of any contractual relations existing between them are not hereby determined.

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 the 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 his said action in such case and the circumstances connected therewith and leading thereto. Whenever the necessities of the situation appear to the Court to so require, the Court shall authorize the employment by the Water Master of such person or 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. The terms of employment, expenses and compensation of said Water Master and his assistants, the payment thereof and the means and methods for securing funds with which to pay the same, shall be fixed by orders which the Court may hereafter from time to time make. The compensation and expenses of the Water Master and his assistants shall be borne by the parties whose rights are adjudicated by this decree in the following manner, to-wit: One-third by the United States, one-third by the Sierra Pacific Power Company, and the remaining one-third by the remaining persons or corporations whose rights are adjudicated by this decree. Any person feeling aggrieved by any action or order of the Water Master may in writing and under oath complain to the Court, after service of a copy of such complaint on the Water Master, and the Court shall promptly review such action or order and make such order as may be proper in the premises.

The owner or owners of each ditch or canal herein authorized to divert water from the Truckee River or any of its tributaries, or from any ditch or canal or other waterway receiving water therefrom, shall, within sixty (60) days after the entry of this decree, or such lesser time as may be fixed by the Water Master, install and thereafter at all times properly maintain in such ditch, canal or other waterway, a reliable, sufficient and easily-operated regulating headgate and locking and measuring devices, to be approved by the Water Master, whereby the water diverted into such ditch, canal or other waterway at any and all times may be properly regulated and correctly measured.

The stored water of any reservoir, including Lake Tahoe, may be turned into and carried in the channel of any natural stream and mingled with the waters thereof and diverted therefrom for the proper uses of the persons or parties entitled thereto. The Water Master, upon timely notice, shall so regulate the headgates along the streams and do and direct to be done such other things as may be needful to transport such stored water and deliver the same to the person or persons entitled thereto. All persons are hereby prohibited from in any way interfering with any such stored water while the same is being legally carried to the persons or parties entitled thereto.

The quantities of water permissible to be diverted by the owners of the several ditches, through said ditches, on account of the several priorities herein decreed, are decreed subject to the obligations of said owners to divert and use water only at such times as needed and only in such amounts as may be required under a reasonable, economical and beneficial use. Rotation, or the combining and exchanging of the use of water between ditches and among users shall be permitted when necessary in order to obtain reasonable economy in the use of the water of the river or other streams, or in order to give to each ditch or user a more advantageous irrigation head, provided that such rotations shall not injuriously affect any of the rights determined and allowed by this decree. The Water Master may arrange for such rotations and consult with and endeavor to obtain the agreements of the various water users thereto, as the occasion may require and shall promptly report to this Court his action in the premises.

All users of water allowed by this decree a flow of less than one inch per acre for his, her or their respective lands may, with the consent of the Water Master or by his direction to the owners or person in charge of the ditch through which the water is conveyed, use when needed for the irrigation of his, her or their land, a larger flow than specifically allowed by this decree, up to and not exceeding one inch per acre, provided the amount of water used during any calendar year shall not exceed the seasonal acre feet allowance for the land, and that the flow allowed would not, if continuous, deliver in any one month in excess of twenty-five (25) per cent of the seasonal allowance in acre feet heretofore in this decree specifically allowed for said lands.

Whenever any person or party shall not be receiving the amount of water to which he is entitled under this Decree, the Water Master shall, upon request open, close, lock and regulate the necessary headgates, ditches and other works used for the diversion and application of such waters as to apportion the same as herein provided, and for that purpose may enter upon the lands of any and all persons having rights adjudicated by this Decree.

Persons whose rights are adjudicated hereby, their successors or assigns, shall be entitled to change, in the manner provided by law the point of diversion and the place, means, manner or purpose of use of the waters to which they are so entitled or of any part thereof, so far as they may do so without injury to the rights of other persons whose rights are fixed by this decree.

The State of Nevada is not a party to this suit but the rights of the State to water through different ditches which divert from the Truckee River for the State and numerous parties to this action have been estimated for convenience and purposes of administration.

The several parties to this suit shall pay and bear their own costs.

Said Sierra Pacific Power Company is the identical party and corporation referred to herein and in the "Temporary Restraining Order" made and entered in said cause on February 13, 1926, as the "Truckee River General Electric Company, a corporation", the name of said corporation having been heretofore changed, pursuant to law, from the Truckee River General Electric Company to Sierra Pacific Power Company.

The foregoing adjudications set forth in Claims Numbers 1 to 744, inclusive, of this Decree are based upon conditions existing at or prior to the entry of said Temporary Restraining Order herein on February 13, 1926; and such adjudication shall not be deemed to limit, reestablish, or otherwise affect any rights acquired, created or lost subsequently thereto by conveyance, transfer, abandonment, non-user, contract (including said Truckee River Agreement) or otherwise, but the rights of the United States shall be as herein adjudicated as of the date of this decree save only as the same may be affected by said Truckee River Agreement.

Done in open court this 8th day of September, 1944.

FRANK H. NORCROSS,
District Judge.

United States District Court
District of Nevada

The United States of America
against
Orr Water Ditch Company and Others

THE TRUCKEE RIVER CASE

SPECIAL MASTER'S
GENERAL EXPLANATORY REPORT

BY
GEORGE F. TALBOT
Special Master

EXHIBIT
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In and for the District of Nevada

UNITED STATES OF AMERICA, Plaintiff, vs. ORR WATER DITCH COMPANY et. al., Defendants.	IN EQUITY No. A-3

SPECIAL MASTER'S GENERAL EXPLANATORY REPORT

A report giving details regarding all of the 806 water rights which have been determined in this case would contain hundreds of pages which might never be needed by the court. Such a report is unnecessary because rehearings have been had regarding the most of the rights of the defendants which were not originally allowed to their satisfaction by the proposed findings, and revisions of these have been made since the rehearings, which in all respects except the general one relating to duty of water hereinafter considered, appear to be satisfactory to all the defendants except in three or four instances in which it is expected that further dispute or contest between defendants will be carried to the attention of the court. As to these, special reports may be supplied if needed. Consequently, this report is made for the purpose of reviewing the general propositions involved, and being helpful to the court and counsel by explaining the reasons for the conclusions reached by the Special Master regarding these propositions.

THE CASE

The original complaint in this action was filed on March 3, 1913, the day before the first inauguration of President Wilson. By leave of court an amended complaint was filed July 25, 1914, which brought in additional defendants and new allegations. Later other parties intervened. This court has jurisdiction of the case because the United States is a party. The suit was brought by the direction and authority of the Attorney-General for the purpose of obtaining an adjudication of the rights to the waters of the Truckee River and its tributaries, and fixing the priorities and amount of water needed by the defendants under their appropriations for power plants, irrigation, storage, municipal, and other purposes; to secure for the Indians at the Pyramid Lake Reservation a reasonable amount for their needs, and to allow the government to divert, store and deliver the residue to the extent needed by homesteaders and users on the Reclamation Project. The complaint required the defendants to set up and show their claims and asked for a decree quieting rights.

The State of Nevada was not made a party to this action because of the necessity of bringing the case in the Supreme Court of the United States if the State were made a defendant. The State is using water through ditches which supply some of the defendants. The amounts of water to which the State is entitled for the hospital for mental diseases, University stock farm, agricultural experiment station, and fish hatchery have been estimated for purposes of administration, and on the same basis as the rights allowed to the defendants.

As soon as the solicitors and engineers for the government became prepared for trial the taking of evidence began before the Judge of this court, Hon. E. S. Farrington, on the 4th day of August, 1919. Later it appeared that so many rights were involved and the introduction of testimony would be so extended that if heard personally by the Judge the trial of criminal and civil cases, conducting of other business, and the duties of this court would be long and unduly delayed. Thereupon the court found that an exceptional condition existed requiring reference to a master. Accordingly on October 14, 1919, the court appointed the undersigned, George F. Talbot, Special Master in this case, to continue the taking of testimony, give consideration to all the evidence, and report the same with recommendations "as to conclusions of fact and of law, and as to form and substance of the decree to be entered." Thereupon the taking of testimony proceeded before the Special Master. His Honor, Judge Farrington, sat with the Special Master and listened to the general arguments which consumed eleven days in September, 1922.

Thereafter the water rights involved were under consideration by the Special Master for the greater part of nearly two years. Upon the completion of his proposed findings, and on July 24, 1924, written notices were mailed to counsel stating that "all parties and solicitors desiring to examine the findings and form of decree tentatively proposed by George F. Talbot, Special Master, and to be informed regarding the time for offering objections and modifications thereto, are requested to appear at District Court Room No. 2 in the Court House in the City of Reno, Nevada, at 11 o'clock A. M. on Saturday, July 26, 1924."

At that time and place attorneys appeared for the defendants, and to them it was announced that the findings and form of decree tentatively proposed by the Special Master were ready for publication and examination, and that copies thereof would be placed immediately in the offices of designated attorneys. On the same day copies were delivered to the United States Attorney, and forwarded to the Special Assistant to the Attorney-General in charge of the case for the United States.

All parties were allowed until August 15, 1924, for offering amendments and taking exceptions to the findings and form of decree tentatively proposed. Upon request of numerous defendants and due showing of necessity upon their behalf this time was extended to September 1st, and again to and including September 15, 1924.

There were presented by that date one exception to the proposed decree by the United States, and thirty-six sets of exceptions were filed stating general objections on behalf of most of the defendants, and special objections relating to many of their rights, and requests for modifications of the proposed findings and form of decree. Pursuant to notice given in August the argument upon these exceptions and desired modifications began in Reno on September 22, 1924, and continued for eight days. Because of the objections of some of the attorneys Judge Farrington did not sit with the Special Master during this argument. The taking of evidence and hearing arguments have been in Reno for the purpose of saving the many hundreds of litigants and witnesses trips to Carson City.

The exceptions and objections so filed and argued on behalf of the combined water users assert that the Special Master has overlooked the principle of law of prior appropriation; that the priority given the United States for its Indian lands is erroneous; that by the doctrine of relation water is allowed for the lands under the Truckee-Carson or Newlands Project, and not allowed to the defendants for irrigable lands not heretofore reclaimed: that an excess amount of water is allowed for diversion through the Derby Dam by the government and for lands not yet reclaimed in the reclamation project; that the proposed findings failed to provide any time in which the United States Reclamation Service is required to make beneficial use of the water; that the amount of water in acre feet alloted to the defendants is insufficient for their needs, and should be increased to 6½ acre feet for the irrigating season; that the limitation of the use in any one month to 28% of the season's allowance of water for irrigation is a depredation of property rights, revolutionary and destructive; that the seasonal acre foot allowances are restrictive and amount to a confiscation of defendants vested rights to economic use within their respective appropriations and priorities, allow an insufficient amount of water when available to produce on their lands maximum crop production; that the right proposed to allow the Government under claim No. 4 attempts to apply the force of a decree heretofore rendered which grew out of litigation to which these defendants were not parties; that water was improperly allowed for the Pyramid Lake Indian Reservation upon a priority date December 8, 1859, the date of withdrawal of the lands for the reservation and that no priority should be granted to the Indians earlier than the date of the confirmation of the reservation of the lands by the order of the President, March 23, 1874; that 4½ acre feet is an insufficient amount of water for the proper irrigation of crops as shown by the application of that quantity of water under the Orr Ditch in the year 1924; that the proposed findings fail to allow the amount of water which has been diverted and used by the defendants upon their lands; that the approximate diversion and estimated transit losses as stated in the proposed findings are too low and should be increased at least 25%.

The extent of these objections and the exceptions relating especially to various rights are better shown by reference to the exceptions presented and on file.

By the last argument these general and many special questions regarding the rights of the parties in this action were presented and in some instances more carefully than they had been before. Rights under conflicting judgments and claims for more land, more water, and irrigation priorities were strongly urged. Later many hearings and conferences were given to contending defendants and by reason of these their rights became more clearly apparent. Efforts for conciliation were made and compromises obtained, so that rights could be more accurately and satisfactorily determined and trouble and expense for litigants and the time of the court saved in the future.

Some of the defendants regard this suit as an imposition. This is a mistake, for on the contrary it is one of the best things that ever happened to the water users. The cultivated lands are estimated to be worth from $200 to $300 per acre and some near the City of Reno $500 per acre, and nearly all of their value, aggregating millions of dollars, is in the water rights. They have obtained patents, deeds, and abstracts for the land, but the most of them, and especially those who have been free from litigation, have nothing of record showing the extent of their water rights which constitute the most of the value of their holdings, for land is abundant and dependent upon the right to the water which is worth several times more than the land without water. The most of these vested rights were initiated long before there were any state statutes or laws requiring application to a State Engineer, permits or recording, and were acquired merely by diverting and using the water, and in some cases aided by notices of intention, and have remained dependent largely upon the memory of witnesses, nearly all of whom have gone. Better evidence could have been obtained and more satisfactory determinations made many years ago. It is important to the parties and the public to have defendants rights so defined in judgments that they will be assured reasonable quantities of water for their uses, that waste may be prevented and the surplus water given to later appropriators, or allowed for reclamation projects to the end that agricultural production may be increased and that there may be fertility in places where there is now desert waste. A decree in this case should allow and fix as a valuable asset for all time every water right involved so definitely that uncertainty and future litigation will be avoided, that every owner will know what he has to use, to sell, or to leave to his heirs, and that every purchaser may feel safe in buying. This will be obtained at a comparatively small cost for water litigation and it is estimated that the expense of the most of the defendants including attorneys fees need not exceed more than about one third of the annual charge for the delivery per inch of water by the companies who are acting as conveyors. The government has borne the most of the expense for surveys, maps and preparation for trial, and in many instances has given assistance to the defendants in the presentation of their claims.

The government engineer has been of great aid in supplying descriptions of the lands and ditches. For most of the lands his surveys were made jointly with, or were approved by, engineers for the defendants. In all instances where there has been doubt regarding acreages or more irrigated land has been claimed he has stood ready to make corrections or survey any lands omitted. So far as known or claimed water has been allowed by the Special Master for every acre irrigated except for a few more acres for two ranches claimed recently and after the blue printing of his final findings. As to these it is recommended that the court allow in the decree water for any additional irrigated lands as may be shown by proper surveys.

The government, the court, and the Special Master have been anxious for a speedy determination of this case. It is regretted that the work could not have been completed at an earlier date. Persons not actually engaged in water litigation have no proper conception of the time required. Such litigation usually takes longer than anticipated by those who are occupied with the case. Regarding this suit as of first importance the Special Master has endeavored to reach conclusions, complete the determinations, and submit his report at the earliest date which would permit due consideration and careful and proper allowances of all water rights involved. The most of these were initiated fifty to sixty-five years ago, but few who have actual knowledge of the facts on which the earlier rights are based remain to testify. In some instances relevant records in suits in the state court and of instruments in the county recorder's office were not introduced in evidence. The extent of many of the rights was in doubt until given careful examination and study. Deficiency of the testimony submitted and conflicting state court judgments rendered at different times over a long period regarding the claims of defendants among themselves have enhanced the difficulty in reaching correct conclusions.

Time has been well spent with the rehearings and extra conferences with opposing claimants which have resulted in better understanding and more correct determinations. Except as to general objections which will be further urged, apparently nearly all defendants are satisfied or will abide by the amount of land, priorities, and flows of water alloted to them. It is expected that they will continue to object to their acre foot limitations and to the allowances to the government.

More than half of the twelve years, during which the case has been pending, was needed and consumed by the engineers and solicitors for the government in the very careful preparation of the case for trial. As soon as they were ready the court began taking testimony. After the supposed close of the evidence on the main trial the solicitors for the government were busy for a year with their final brief and proposed decree and in preparation for the general argument.

No suit should ever be determined until it can be decided properly. This is not the only water case in which long periods have been consumed and needed for preparation for trial, introduction of evidence and making determinations. The case of the Washoe Lake Reservoir and Galena Creek Ditch Company vs. Ira Winters and others regarding the right to pump water from Washoe Lake for the irrigation of a few ranches has been pending in the Washoe County District Court for over three years and is not yet finally submitted for decision. The Quinn River case involving about forty ranches was commenced seventeen years ago last October and after submission was under advisement for about four years in the state court. The appeal pertaining to the rights of three ranches in that case was argued and submitted for decision in the State Supreme Court over three years ago, and has not been decided. Proceedings were pending for about sixteen years before the State Engineer for making determinations of the rights of 458 claimants to the water of the Humboldt River and its tributaries. In order to expedite the proceedings the Legislature made increasd appropriations, and the State Engineer toward the last of the sixteen years had four deputies with assistants working in four districts at the same time gathering evidence and making determinations which were filed in the court at Winnemucca about two years ago. Under the statute the filing of these determinations had the effect of the filing of a complaint upon the institution of suit, Bergman v. Kearney in this court and Vineyard Land and Stock Company v. District Court in the State Supreme Court have so held.

After the proceedings for about sixteen years before the State Engineer and about two years more before the court at Winnemucca evidence is now being taken regarding the priorities and claims of the Humboldt River claimants prior to making adjudication of their rights. To have these and other rights in the state finally determined will save litigation and trouble in the future and be of great benefit to water users. This has been recognized by the state legislature, which for the last ten years that work of the State Engineer's office pertained to Humboldt River rights made appropriations for his office of $41,000 in 1915, $42,000 in 1917, $54,200 in 1919, $75,000 in 1921, $49,500 in 1923, aggregating $261,700. In addition to state appropriations moneys were paid to the state engineer by Humboldt River water users in proportion to their acreages to aid him in making determinations. Water rights in Carson Valley and those on the Walker River were adjudicated years ago by the federal court. The government was not a party then and consequently not bound and is now seeking to have the rights of those rivers ascertained and fixed by decrees in new suits.

Many objections were made to the introduction of evidence which generally were over-ruled. With no jury to be influenced it seemed best to allow considerable freedom in the introduction of evidence, so that the record would be full. The Special Master or the Court need not consider or be influenced by anything which is not material.

Numerous objections were made to statements which had been recorded in pursuance of the act of the legislature of 1889, providing for the making and recording of statements of ditches and claims to water. These statements are admissible at least for showing what was claimed by the owners in possession at the time they were made, and as admissions against interest in cases where more water is claimed now under an early priority than was claimed at the time the statements were made. Bulletins and pamphlets are admitted as far as they are illustrative of testimony of witnesses, and as shown to be correct by testimony or other evidence or by circumstances. Motions to dismiss stand overruled.

The claim of the Wadsworth Light and Power Company for $25,000 against the government has not been allowed. If such a claim could be maintained by a defendant in a suit of this character more evidence would have to be introduced before any fair estimate could be made regarding the damages caused. No doubt, the power company sustained heavy losses by the removal of the division point of the railroad company from Wadsworth to Sparks, which reduced the population of Wadsworth to a small fraction of what it was previously.

ORDERS FOR PLEADINGS, AMENDMENTS AND STIPULATIONS

In some instances, or regarding some rights, there has been a laxity in regard to pleadings and proofs. Some deficiencies have been supplied by stipulation, or by personal examination by the Master in the field. It is recommended that the court make an order allowing all parties in this case, at any time within 30 days after the entry of the order, to make and file any pleadings, as originals or as amendments, or any stipulation, to support the Special Master's Final Findings and the allowances of water and rights as therein made and determined, and that by such an order all parties to this action be allowed 30 days after the time has expired for preparing and filing such pleadings, amendments or stipulations in which to object thereto, and in which to prepare and file counter or answering pleadings or amendments; and that such order provide that in all these, and regarding all rights concerning which no further pleadings, amendments or objections were filed shall be deemed to be supported and sustained by proper pleadings, evidence, stipulation or proof. Also a general order should be made substituting and entering as defendants all persons designated in the final findings as grantees or successors in interest.

GOVERNMENT OWNERSHIP.
STATE CONTROL.

The territory now comprising the State of Nevada was ceded to the United States upon the close of the Mexican War by the treaty of Guadelupe-Hidalgo on Feb. 2, 1848, which dated the cession from July 2, 1847, the day Commodore Sloat raised the flag at Monterey.

The Truckee River, the rights to the water of which and its tributaries are at issue in this case, runs out of Lake Tahoe, and after receiving water from Donner Lake, the site of the tragedy of the Donner Party, in 1846, and from other lakes and streams, flows into and supplies Pyramid Lake.

Coming by way of Oregon General Fremont discovered Pyramid Lake, January 10 ,1844, and so named it because of the island that rises in the lake and resembles the great Cheops. On the night of January 15th he camped at the mouth of the Truckee River which he called Salmon Trout River.

On May 20th of that year an emigrant train left Council Bluffs and journeyed westward on the Oregon Trail which was then open. En route Martin Murphy and five sons and seventeen other men with this train formed a desire to go to California, and the others wished to continue to Oregon. For some days a new captain was selected nightly. Finally the Murphy party separated from the emigrant train this side of the Rocky Mountains and came by Thousand Springs Valley to the headwaters of the Humboldt River and traveled down that stream. Near Battle Mountain they found a friendly Indian who was willing to guide them. They took him with them until they reached the sink of the Humboldt River. There they were greatly disappointed because they had believed that the river would run to the Pacific Ocean and furnish water for their journey. After maps were drawn on the sand and explanations made the good Indian showed them to the Truckee River near Wadsworth. They had named him from a French Canadian guide with the emigrant train on the Oregon Trail, and when he brought them to the river they gave it the same name. With slight change from the name of the guide it has since been known as the Truckee River. General Fremont called Lake Tahoe, Lake Bonpland in honor of the great scientist friend of Humboldt. At one time it bore the name of Bigler, but it could not escape the Indian name which it bears. It is one of the great mountain lakes of the world. Its beauties have been described by George Wharton James in his book, "The Lake of the Sky," and by numerous other writers. It was mentioned by Mark Twain in two of his books.

The melting snows in the high Sierra-Nevada mountains and canyons feed this and other lakes and tributaries which supply the Truckee River with the water which is used for power, irrigation, municipal and domestic purposes, and is the great source of wealth in its locality.

After the discovery of gold by Marshall at Sutter Creek in 1848 the rush to California began in 1849. For ten years thousands of travelers on their way to the placer mines, after crossing wide deserts, passed along the Truckee River by the present site of the City of Reno and were gladdened by the pure water for themselves and animals, without one of them stopping to appropriate for homes, agricultural or other purposes, the water or land which were free for the taking and have since become worth millions of dollars. Under a generous government the great natural resources of a new country, the mines with precious metals, the timber of virgin forests, the land, the water, were free to the first occupants. With settlement and growth of population the irrigated lands and use of water have since increased until there is not enough to fully supply in dry years the needs of all users without storage. Now the necessity of determining rights and priorities, so that the earlier appropriators may be supplied first when there is not enough water for all, arises and we are confronted by a dispute as to whether the government or the state owns the water.

It must be conceded that the United States owned the water after the cession from Mexico, and while the land was a part of Utah territory and later Nevada territory after its organization in 1861. By what act of legislation, in what way, if any, has the government parted with its ownership of the water which it obtained with the land sixteen years prior to the time the state was organized? Every right, title, and condition once shown to exist is presumed to continue until there is some evidence of transfer or change. Ownership can be conveyed only by the owner, or by prescription which does not run against the government, or by conquest or force which is impossible against the United States. In Congress as the sole legislative agency of the sovereign people of the nation lies the only power for making disposal of the public domain, or government ownership in water or other property. The awarding of the water to the state by the court, if unauthorized by Congress would be unwarranted judicial legislation. Has Congress ever transferred the water to the state?

At the time the country was ceded by Mexico the water was obtained with it as part of the land. In the general objections filed on behalf of the defendants and over the citation of cases it is said "a water right is real property in the strictest sense of the word." The authorities from Blackstone to the latest decisions agree that water is real estate. Sixteen years after the United States acquired the land and water the constitution of the State of Nevada was adopted with the same provisions as the Enabling Act "That the people inhabiting said territory do agree and declare that they forever disclaim all right and title to the unappropriated public lands lying within said territory, and that the same shall be and remain at the sole and entire disposal of the United States."

This was an express reservation to the government of the land and with it the water which was as much a part of the land as the minerals and the timber. This reservation appears to have been more precautionary than necessary because Congress had not authorized any transfer or conveyance of the water to the state.

Solicitors for defendants have placed special reliance upon the following provisions in the act of Congress of July 26, 1866:

> "Whenever, by priority of possession, rights to the use of water for mining, agricultural, manufacturing or other purposes, have vested and accrued, and the same are recognized and acknowledged by the local customs, laws, and the decisions of the courts, the possessors and

owners of such vested rights shall be maintained and protected in the same; and the right of way for the construction of ditches and canals for the purpose herein specified is acknowledged and confirmed."

If the state owned the water from the time of its organization Congress could not legislate regarding its ownership or control by this act passed two years after statehood. If the government owned the water Congress had jurisdiction over and could have conveyed the water to the state. Instead of doing this it provided that whenever by prior possession rights to the use of water had accrued and become vested under local customs, laws and decisions owners of such vested rights should be maintained and protected in the same. This was in effect a grant to the appropriators and not to the state of the water which they had appropriated without permission of the owner, the United States. By the word "whenever" continuing appropriations were allowed to be made so long as the act remained in force or the water was not withdrawn or reserved by the government; but there was no grant to the state of the unappropriated nor of the appropriated water. The grant was only to the use of the water for prior possessors and appropriators, past and future, in accordance with local customs, laws, and decisions which meant state or local control. There was nothing in the act conveying or authorizing conveyance of the unappropriated waters to anyone or in any way except that whenever by prior possession rights to the use of water became vested and accrued the possessors or owners of such vested rights should be maintained and protected under the customs, laws and decisions of the courts. Federal statutes or general laws could not so well meet the varying conditions and necessities in different parts of the country, and Congress generously donated to the appropriators the water belonging to the United States for the appropriations made, and to be made, and wisely provided for local or state control.

The provisions of the later acts of Congress, including the one of July 9, 1870 making by section seventeen thereof patents for homesteads or preemptions subject to accrued water rights, which may have been acquired under the ninth section of the act of 1866; and the act of March 3, 1891, amending the Desert Land Act and providing that the privilege granted should not be construed to interfere with the control of water for irrigation or other purposes under the authority of the respective states, contain no language indicating conveyance or transfer of the water from the government to the state. In these and other acts Congress continued to assume control and government ownership and to pursue the policy initiated by the Act of 1866, and was careful to guard the appropriations or rights which had accrued under the local laws. This is especially apparent in the following language of the Desert Land Act of March 3, 1877:

"Provided, however, that the right to the use of water by the person so conducting the same, on or to any tract of desert land of six hundred and forty acres shall depend upon bona fide prior appropriation; and such right shall not exceed the amount of water actually appropriated, and necessarily used for the purpose of irrigation and reclamation; and all surplus water over and above such actual appropriation and use, together with the water of all lakes, rivers and other sources of water supply upon the public lands and not navigable, shall remain and be held free for the appropriation and use of the public for irrigation, mining and manufacturing purposes subject to existing rights."

This provision as well as other statutes was subject to repeal or amendment, or the reservation or withdrawal of the water from appropriation by act of Congress later.

Section 8 of the act of June 17, 1902 known as the Reclamation Act provides:

"That nothing in this act shall be construed as affecting or intended to affect or to in any way interfere with the laws of any State or Territory relating to the control, appropriation, use, or distribution of water used for irrigation, or any vested right acquired thereunder, and the Secretary of the Interior, in carrying out the provisions of this act, shall proceed in conformity with such laws, and nothing herein shall in any way affect any right of any State or of the Federal Government or of any landowner, appropriator, or user of water in, to or from any interstate stream or the waters thereof: Provided, That the right to the water acquired under the provisions of this act shall be appurtenant to the land irrigated, and beneficial use shall be the basis, the measure, and the limit of the right."

The legislature promptly adopted and enacted into the state statute the provisions of the last sentence of this section. By this act Congress again assumed that the government owned the unappropriate water and continued the policy of leaving the control of the appropriated waters to the state and carefully provided that nothing in the act should affect any right of any state or of the federal government or any appropriator or user of water in, to, or from any interstate stream.

All of the different acts of Congress recognize and confirm the right of appropriators of water for beneficial purposes and authorize the control of these rights in accordance with state and local laws and regulations. No doubt, the state could acquire rights by appropriation of unappropriated or unreserved water for power, irrigation, storage, or other beneficial purposes, as well as an individual or company.

The early decisions of the Nevada Supreme Court written by Justice Whitman and Chief Justice Lewis and the one in Union Mill and Mining Co. v. Ferris (2 Sawyer, 176) in so far as they hold that the water is part of the land, that Congress alone can dispose of the title to the water and that no state law can defeat it stand unreversed (Rio Grande Dam Case, 174 U. S.) On the basis that both belonged to the United States, Congress by the act of 1866 legislated as freely regarding the water as the mineral lands. The "Nevada Act of February 13, 1867 was a recognition by the legislature of the state of the validity of the claim made by the government of the United States to the mineral lands." (Heydenfeldt v. Daney Mining Co., 93 U. S., 10 Nevada, 314.)

As the defendants' water rights are a grant from the government with special provisions for their control by the state, the defendants own, and are protected in their rights or appropriations the same and as fully as if they had been acquired from the state.

The federal courts are supreme in the construction of the act of Congress and have assured state control. The construction of a state statute by the State Supreme Court is conclusive, and is followed by the federal courts including the Supreme Court of the United States. The idea that by this suit the defendants are deprived of anything which would be afforded them by the state law is a misconception.

The question as to whether the state owns the water is important to the government, but does not affect or vary the defendants' vested rights in the least. To the defendants the question whether the state or the government owns the water is as immaterial as one would be as to whether the state or government owns the unappropriated public domain from which the defendants in some instances obtained patents for their lands directly from the government, while in others they obtained patents from the state after the grant of the land by the government to the state. By the act of 1866 the government adopted the local laws and decisions in regard to the initiation and control of water rights and they are as complete as they would be if Congress had conveyed the water to the state previous to their inception or had directly enacted the state statute. As held by the Supreme Court of the United States and other courts these rights as conferred and vested by the state laws are allowed and confirmed and protected by the federal courts the same as by the state courts, and as freely as they could be if the state owned the unappropriated water.

The provision in the Reclamation Act directing the Secretary of the Interior to proceed in conformity with the state laws relating to control, use, and distribution of water used in irrigation, or any vested right acquired thereto, means that the Secretary shall observe the state laws in regard to accrued rights, but did not constitute a grant to the state, and did not mean that the Secretary should comply with any state law when reserving or withdrawing for reclamation projects unappropriated water owned by the government. In fact, there are no state laws attempting to regulate the withdrawal or control by the government of its unappropriated water. The statement in the act that nothing therein affected any right of the government, assumed government ownership of the unappropriated water and left that right as complete as it was before the passage of the act.

All of these federal acts are on the basis of government ownership. It could have been only with the understanding that the government owned the water that Congress legislated for the protection of the rights, which by the act of 1866 it had authorized to be acquired in accordance with local customs and state laws and for the regulation of the use of water under the Reclamation Act. There is nothing in these acts or in any act of Congress indicating an intention to convey to the state the water belonging to the United States. It is claimed that the act of 1866 had that effect. Scrutiny and analysis of the act fails to disclose such a purpose. It is as far from conveying the water to the state as it is from conveying to the state the mines and the public domain, on which the act allows rights of way and appropriations of mineral lands to be made. It confirms rights to water which "have vested and accrued, or have been acquired, under local customs, laws and decisions." It declares that the mineral lands of the public domain are free to exploration and occupation subject to regulations prescribed by law and local customs.

The government is as free to reserve or withdraw at any time the unappropriated water as it is the unappropriated part of the public domain, portions of which it has withdrawn at will for military and Indian reservations, forest reserves, petroleum and oil reserves, and other purposes. The allowance of free appropriations or gifts of water for power, irrigation, or other purposes, or of part of the public domain for grazing, homesteads and mining locations is not a conveyance to the state. The fact that the people have been allowed to benefit to the extent of billions of dollars by free use of ranges for livestock, mineral lands, timber, and water for irrigation, power, and other purposes does not prevent the government from reserving any of its unappropriated water, land, or resources. The government may, at its pleasure, discontinue the privileges enjoyed by citizens of making free appropriations of property belonging to the United States. The unappropriated water as well as any part of the unappropriated domain may be withdrawn at any time from further appropriation. The rights of defendants have accrued and become vested only to the appropriated part of the water leaving the remainder subject to reservation and disposal by the United States. After the defendants claimed and were allowed their water rights under the act of Congress of 1866 it would be inconsistent to hold that the state and not the government owns the water.

It is also contended that upon the organization of the state it became the owner of the water. But does mere assumption of statehood convey to the state water owned by the government, with, or regardless of, the provision in the state constitution that the public domain is expressly reserved to the United States except small portions granted the state for specific purposes? Without Congressional authorization it was as impossible for the state to become the owner of the water as of the land or other government property by the mere fact of assuming statehood. It has been argued that the admission of the state into the union on equal standing with the original states conveyed the right to the water. There is no more reason to infer that such admission conveyed the water than there is to conclude that it granted the lands, government reservations, and other properties to the state. If the state had owned the water previous to statehood as did the thirteen colonies and as Texas did it would continue to own the water after statehood, and the water would not belong to the governmen because it had never been conveyed to or belonged to the government. The admission was on equal terms politically and as far as state rights and privileges are conferred by the federal constitution, but without reference to the state acquiring water or an equal amount of property with other states. The parent government may give to or withhold from the child upon assuming statehood as much or as little of the water or public domain as it may desire. Lands were given to the state for the State Prison, irrigation and school purposes. The statement in the Declaration of Independence that all men are created equal, does not mean that they are equal mentally, physically, or have any right of conveyance to them of an equal amount or similar kind of property. It means that they have equal rights and privileges for participation in government, for using their own capabilities, for enjoying life and liberty, for acquiring and possessing property and pursuing and obtaining safety and happiness.

Senator Newlands, who had been instrumental in securing the passage by Congress of the Reclamation Act of June 17, 1902, drew, and hastened at the first opportunity to have the state legislature pass, the act of 1903 providing for a State Engineer, for the measurement of water rights and for cooperation of the state with the Secretary of the Interior in the work relating to the Truckee-Carson Project.

The act of 1903 provided: "All natural water courses and natural lakes, and the waters thereof which are not held in private ownership, belong to the public and are subject to appropriation for beneficial use."

Acts of the legislature of 1899 and 1907 declared that: "All natural water courses and natural lakes, and the waters thereof which are not held in private ownership belong to the state."

Section I of the act of March 22, 1913 states;

> "The water of all sources of water supply within the boundaries of the state whether above or beneath the surface of the ground belongs to the public."

Water not held in private ownership was declared by the act of 1899 to be subject to regulation and control by the state, and by the acts of 1903, 1907 and 1913 to appropriation for beneficial uses.

With local control always existing, first with acquiesence and later by confirmation under the act of Congress of 1866 the legislature of a later generation may have believed that the water belonged to the state. Instead of so stating it would have been more accurate to have declared that the water not held in private ownership was subject to appropriation and use by the public as allowed by the act of Congress. The earlier acts of the state legislature, including the one of 1866 providing rights of way for ditches, and the one passed in the very dry year of 1889 requiring appropriators to record their ditches and statements of their claims, and which was repealed by the succeeding legislature, made no assertion of state ownership. With full power of control of the waters appropriated and of the methods of appropriation the state could not acquire by legislative declaration the ownership of the unappropriated water which belonged to the United States. If there be any doubt as to whether the decision of the Supreme Court of the United States in the Rio Grande Dam and Irrigation case is conclusive, ordinary fundamental principles sustain the continued ownership of the Government to the water as acquired with the public domain by discovery, conquest, or treaty. Declarations by the state legislature that the water belongs to the state are as futile and ineffective in conveying title as would be a state statute declaring that the timber or grasses or mineral lands or reservations on the public domain or the post-office building belonged to the state.

In Wieland, State Engineer, v. Pioneer Irrigation Company the United States Supreme Court denied the claim to the water of an interstate stream based on the declaration in the Constitution and laws of the State of Colorado that the water was the property of the public. The Court held the state line made no difference and decreed the water to the prior appropriator and not to the State.

Decisions concerning tide water and inland navigable water bear on different questions than those which are pertinent to the water diverted by the defendants for irrigation and other purposes.

By authorization of Congress the rights of appropriators of water are initiated under and are controlled by local and state laws and regulations only, while the rights of appropriators of the public domain for lode and placer mining claims are initiated and governed by the federal statutes supplemented and aided by state laws and local regulations, which must not be in conflict with the federal statutes.

Conditioned that additional aid be provided by the state for settlers Congress at the close of its last session made an initial appropriation of a half million dollars for beginning construction of the Spanish Spring Valley reservoir near the City of Reno, the estimated cost of which is over four million dollars. For this and other purposes, such as the much larger one proposed for damming the Colorado River at Boulder or Black Canyon so as to impound for power and irrigation large amounts of the flood waters which now do damage, are based on the right of the government to divert, store and use the unappropriated or surplus water without injury to owners of vested rights or dimunition of the supply for their beneficial needs. The Government has expended seven millions of dollars for constructing works and supplying water for users under the Newlands Project.

In taking and using the unappropriated water for these great enterprises for the benefit of the nation and states no prior appropriator is deprived of the water necessary for his uses, and the government has a free hand and cannot be required to make applications and pay charges to, or obtain permits from, the State Engineer, or be hampered by state regulations which apply to the proper initiation and control of water rights by individuals.

"THE LAW OF APPROPRIATION"

Prior to the discovery of gold in California a large part of the territory west of the Missouri River had been shown in the geographies as the great American desert. There were vast areas of mountains and plains which were far distant from courts and police regulations. After the discovery there was a rapid increase in population. The enterprising people upon their arrival engaged in mining, cutting timber and incidentally in agricultural and other pursuits for the support of the new population. The use of water was necessary for mining, logging, operating saw mills, and for municipal and other purposes. The greater part of the territory such as that in Nevada was too dry and arid for the production of crops without irrigation. Legislatures had not provided laws to meet the exigencies. Possessed of sentiments of natural justice and equity and imbued with Anglo-Saxon ideas of self-government and protection the Argonauts early made rules for safe-guarding the people and property rights in the new communities they formed. Mining districts were organized and the miners made rules and regulations regarding the locating and working of mines, and the appropriation, measurement, sale and use of water, and the courts rendered decisions upholding and protecting possessory rights to the land, mines, water, and timber which were natural resources belonging to the government. The law is a progressive science and advances to meet the new conditions and necessities which arise in the affairs of men but it follows rather than leads the changed conditions demanding new legislative enactments and judicial constructions.

At the time the earliest rights involved in this suit were initiated beginning in 1858 and 1859 and before the organization of the Territory in 1861 and the State in 1864, and for a long time thereafter no statutes were in force, and there were no laws regarding the appropriation of water unless the Mexican Law inherent to the country or the Common Law could be said to apply.

Custom, common consent and the courts readily sustained the prior appropriations of water made for mining, fluming, and milling purposes, and in the arid regions for irrigation. Usage, and concerted action may supply the deficiency in the law, or may govern over an unsuitable law which is inapplicable to existing conditions or to the needs of the people. Sometimes public sentiment precedes or is above or controls the law. In regard to water and mines it approved the practices which complied with the needs of the new country and controlled Congress, which in compliance with public demand by the act of 1866 relinquished the rights of the government in so far as there were locations of mines and appropriations of water in accordance with local usages.

As we have seen this act approved and confirmed the appropriations of water which has been made or might thereafter be made under local customs, laws and decisions. Under this act of Congress nearly all of the water rights involved in this suit or existing in this state, available without storage, were acquired over a period of nearly half a century by usage and judicial decisions before there was any state statute regarding the appropriation of water.

Custom and the courts built and controlled the laws regarding water for 45 years before the Nevada legislature in 1905, three years after the government had reserved the water and began the construction for the Truckee-Carson project, provided that vested appropriations should be maintained and that new rights to water could be obtained only upon application to, and permit from, the State Engineer, which previously was not necessary. Prior to this legislation nearly all of the water, except the flood water obtainable by expenive storage works had been appropriated.

The requirement that a permit be obtained from the State Engineer makes the date of priority and the amount of apropriation definite by record so that uncertainty regarding these will not arise after long periods following the initiation of the right. The first appropriator is only entitled to as much water as is necessary to irrigate his land, and is bound under the law to make a reasonable use of it. What is a reasonable use depends upon the circumstances of each case. (Barnes v. Sabron 10 Nevada, 217, Union Mining & Milling Company v. Ferris 2 Saw. 176, Union Mining & Milling Company v. Dangberg 2 Saw. 450). Owing to delay in legislation and failure to early provide statutory regulation the permit rights allowed by, and under control of, the State Engineer, and which are not so uncertain as the older vested rights, are comparatively few.

In the decisions of the Supreme Court of the State of Nevada in Van Sickle v. Haines in 1872 the law of riparian rights, as existing under the Common Law, which requires the preservation of streams in the natural channel, was upheld on the theory that the owner of the land bordering on the banks of the stream under a patent obtained prior to the act of 1866, from the United States, which was the owner of the land and the water before the issuance of the patent, gave the right to the holder of the patent to have the water come down the channel and to prevent its material diminution and diversion for irrigation and other purposes because that right existed in the government before issuance of the patent and prior to the passage of the act of 1866, as was permissible under the concessions made by, and terms of this act. The Court soon reversed its decision in so far as it held that the water could not be taken away from the patentee owning the banks of the stream but not in regard to government ownership, and held that such a decision was unsuitable to the conditions existing in this state and that the prior appropriator of water for irrigation became the owner of the usufruct therein, and could divert the water to the extent necessary to supply his beneficial needs under the decisions in Barnes v. Sabron, Jones v. Adams, Stevenson v. Reno Smelting and Reduction Works and other cases. This is, and for more than forty years has been, the law in this commonwealth and other arid states. That the numerous defendants are entitled to water sufficient with economical use for irrigation and other beneficial purposes in the order of the dates of their priorities, and that the earlier appropriator is entitled to be supplied first when there is not enough water for all is the settled law as created by custom and the State Supreme Court and later approved by the Nevada statute confirming vested rights.

THE LAW OF RELATION

This enables an appropriator who completes his appropriation with reasonable diligence to maintain his full right as of the date of its inception. In making allowances or determining defendants' appropriations there has been a liberal application of the Doctrine of Relation. Their rights have been allowed from the date of their initiation in all cases where reasonable diligence was exercised in constructing a ditch or continuing or finishing the work or completing the irrigation or appropriation according to the original intention or plan, except variations by consent or compromise of owners in the allowance of rights on Galena and Upper Steamboat Creeks as later stated in this report.

It is claimed that under the Doctrine of Relation the defendants should be allowed water for the lands they own which have never been irrigated, and which they have never made any preparation to irrigate, but this doctrine allows water of the date of the initiation of their right only to the extent that reasonable diligence has been used in constructing the ditch and in making or completing the use of the water. The lapse of from several to fifty years without any effort to finish the ditch or works or complete the appropriation or extend the area cultivated or to irrigate the land for which water is now claimed is not proceeding with diligence and under the law is not the basis for the initiation of rights of the date the ditch was constructed and used for the irrigation of other lands.

On behalf of defendants it is stated that by relation they are entitled to water for their unirrigated lands on the same theory that the government has been allowed water for the unclaimed lands under the reclamation project. The conditions are not similar. The government had a right to withdraw its unappropriated water at will and hold it withdrawn as long as desired and it is not bound by any law of relation or rule of diligence; but if such law did apply to the government, or if the Newlands Reclamation Project had been undertaken by the defendants or a private company to which the law of relation would apply, the controlling facts would still be dissimilar.

The government gave notice of intention to withdraw 1500 cubic feet per second of water from the river and proceeded with due diligence to construct the Derby Dam and Truckee Canal for the diversion of this water, and the Lahontan Reserboir for storage and an extended system of canals and laterals for distributing the water for irrigation and has expended over seven millions of dollars for the project. It is true that the government is allowed a large amount of land for irrigation, and a quantity in excess of what there is water to supply. A part of the water for this land is furnished by the Carson River. The waters of the two rivers are commingled in the Lahontan Reservoir, and lands now under cultivation and others to be reclaimed will be supplied with a portion of the water from both rivers. Only such parts of the new land for which water is allowed as settlers may desire to occupy and reclaim will be provided with water in amounts necessary for their irrigation, and these amounts are not as large as allowed to many of the defendants who must be supplied first. The insufficient water available will control or limit the quantity of land to be irrigated. Nearly all of the defendants' rights are based and allowed on priorities initiated long prior to the time that the government reserved the water or began work on the project.

The defendants' appropriations have been for, and are allowed for, an indefinite irrigation season approximating 5½ months or 165 days. During the cold weather or the spring and fall they require a smaller flow of water than they have been allowed.

The greater part of the water diverted from the river by the government at the Derby Dam has supplied ranches at Fernley and Swingle Bench, and is conveyed through the Truckee Canal for storage in the Lahontan Reservoir, and the diversion for this storage can continue for more than half of the year by taking water in excess of the defendants needs and which would otherwise be wasted or flow down the river to Pyramid Lake.

The advantages of storing water without depriving early appropriators of any water they need for irrigation during the growing season are apparent, as by storage the water that flows for the greater part of the year can be saved and used for irrigation later in the season or in the following year. The benefits derived by storage and by the government project need not deprive the defendants of any water necessary for their crops under their prior rights.

The reclamation of lands under the project has not been as rapid as expected or desired, but within twenty years after beginning work on the project the government has supplied water for the irrigation of more lands than the defendants have reclaimed or irrigated in sixty years. Some of the settlers on the project have had a struggle under adverse conditions, but as a whole it has been a success in bringing the desert to fertility and productiveness, and adding population and wealth, a great asset to the state and nation.

The Nevada Supreme Court defined the law of relation in the leading case of Ophir Silver Mining Company against Carpenter (4 Nev. 534), which has been cited in Rogers v. Pitt (129 Fed.) and in other states:

"If any work is necessary to be done to complete the appropriation the law gives a reasonable time in which to do such work, and protects the rights during such time by relation to the time when the first step was taken.

But when the work necessary to complete an appropriation of running water is not completed with diligence the right to the use of the water does not relate back to the time when the first step was taken to secure it, but dates from the time the work is completed or the appropriation is fully perfected.

Rose in 1859 designed a large ditch to carry a certain quantity of water from the Carson River, a distance of over four miles, to Dayton, and constructed a sufficiently large head, but after proceeding less than half a mile reduced its size so that a small proportion only of the quantity of water originally intended passed through it, and it was not enlarged to its originally intended dimensions until after 1862, and in 1859 the Ophir Silver Mining Company constructed a ditch, tapping the river below the head of the Rose ditch and on the enlargement of the Rose ditch the Ophir ditch was deprived of its supply. It was held that Rose had not prosecuted the work on his ditch as originally intended with reasonable diligence, and that therefore, he was only entitled to the quantity of water which he ran through his ditch in 1859, when the Ophir ditch was constructed.

Diligence in the prosecution of the work does not require unusual or extraordinary efforts, but only such constancy of purpose or labor as is usual with men engaged in like enterprises who desire a speedy accomplishment of their designs, such assiduity in its prosecution as will manifest a bona fide intention to complete it within a reasonable time."

To allow the defendants by relation water for their lands which they have permitted to remain unirrigated for fifty or sixty years would work a great injustice among themselves. The early appropriator who during this long period has reclaimed and irrigated only a part of his lands would take the water away from his more progressive neighbor who initiated his right a little later, but long ago reclaimed and irrigated all of his land.

ROTATION

Solicitors for the plaintiff and for the defendants have differed widely regarding the right of the court to enforce rotation or the exchange or combined use of water by different owners, so that each may have a larger head for a shorter period and save time and water in covering the land. Upon the argument cases were cited favoring rotation but none in which it had actually been enforced by judicial decree without consent. As the courts are already at the threshold of enforcing rotation and have long upheld the requirements which demand its enforcement, such as economical use and prevention of waste, it is high time to step over and require that rotation be practiced and enforced by the court in all cases where it will save water and benefit and not injure any of the users. By decisions and statutes it has become well settled that appropriators are entitled to no more water than necessary to supply their needs when economically used, and that waste will be restrained and prevented, and it necessarily follows that waste which can be easily avoided by requiring rotation should be prevented and rotation enforced so that water may be saved. The testimony of experts for the government is in accord with that given on behalf of the defendants by many of the practical farmers with long experience in irrigation that large heads of water are desirable and that their use will save water as well as time in irrigation. The larger ranches are allowed ample heads of water for rotation on different parts of their own land, but many of the defendants with small acreages would be benefited if allowed a good irrigating head of water for a day or a part of a day sufficient to cover their small tracts of land, instead of having a few inches running all the time, and taking so long to reach across the land that the greater part of the water is lost in deep percolation and evaporation, and must have the attention of the irrigator daily all summer. Under the decisions and statutes every user of water is limited to his need with economical use. When he has received enough to supply this he is not entitled to more as a continuous flow to waste. As the demand for water has increased and there is not enough for all without preventing waste the courts must conserve the water in compliance with the statute and prevent waste by limiting the time of use to the needs of the user as well as by reducing the flow and by allowing the water when not needed to be taken for rotation or use by others who do need it.

Rotation should be encouraged, and whenever it will benefit and not injure the owners of water rights it should be considered compulsory and be required. With an acre foot limitation no one has a right to use water in greater quantity or for a longer period than will reasonably provide for his beneficial needs, and if he and other users can be supplied best by combining their flows, no one will be injured and all cornered will be benefited, and the court and water master should enforce rotation accordingly, regardless of objections by any of the users, and allow any objector the combined head for the proper irrigation of his lands, and depriving him of his own limited flow at other times, except as the same or some part thereof may be necessary for irrigation or domestic use.

When the need of the user is supplied, which is all the law gives him, he must not be allowed to prevent the conservation of water by rotation when that is a benefit instead of a detriment to him, and when the Legislature has provided that "When the necessity for the use of the water does not exist th right to divert it ceases, and no person shall be permitted to divert or use the waters of this State except at such times as the water is required for a beneficial purpose. (Statutes 1899, 1907, 1913.)

GOVERNMENT RIGHTS

Pyramid Lake Indians

The Indians were not so unfriendly or active in committing depredations upon the first coming of the white men, or until they were so numerous as to encroach materially upon the territory, and means of support which the Indians had long enjoyed without molestation. After the discovery of the Comstock Lode in 1859, which was after there had been a flow of emigration to California through Nevada for ten years, there was an influx of people to this part of the state then called Washoe. The game which had been plentiful for the Indians was being killed and driven away and the pine nut trees which had provided a part of their sustenance were being cut down. In May 1860 nine Indians killed the men at William's Station near Dayton. Major Ormsby and his companies went in pursuit, and seeking to capture or destroy the Indians, he and a large number of his followers were killed on May 12, 1860, in the fight near the lower end of the Truckee River on lands in the Pyramid Lake Indian Reservation, withdrawn by the order of the Commissioner of the General Land Office dated December 8, 1859, pursuant to the request of the Commissioner of Indian Affairs on November 29, 1859. The fight began about a half a mile from where the Indian Agency buildings are now situated. On the previous Sunday five white men had been hunting within the reservation.

On or about the second day in June, 1860, Col. Jack Hayes and his company avenged the death of Major Ormsby and companions, but remnants of the Indians remained upon the reservation lands. The withdrawal of these lands for the Indians was so ordered a year and a half before the fight, but the executive order by President Grant was not made until March 23, 1874. In the meantime the Civil War had occupied the attention of the government and it required months to communicate between here and Washington. The Commissioner of the General Land Office has frequently reserved land for different purposes. The executive order of the president withdrawing and setting part the lands for the Indians became effective as of the date the lands were withdrawn by the Commissionr of the General Land Office in 1859. Withdrawals of lands would not serve their purpose if executive orders did not relate back to the time the withdrawals were made. At that time the rights of the defendants or of the appropriators of water from the river had not been initiated, the state had not come into existence, no one owned any of the water but the government. If any law applied it was the riparian, which required the water to flow down the channel to the lands of the reservation, which are the lowest on the river. The act of 1866 permitting rights to be acquired by appropriation had not been passed. But if it be conceded that the riparian law did not apply or control, the withdrawal of the land for the reservation for the use and benefit of the Indians necessarily implied the withdrawal of a reasonable amount of water for the needs of the Indians.

Congress has passed an act providing for the allotment of a meagre five acres per Indian. Why should anyone begrudge or object to allowing enough water for irrigation by the Indians of these small tracts of land, and of the land they have under cultivation? Under similar conditions white men are not satisfied to try and make a living on such a small amount. Under the Homestead and Preemption Acts they have been permitted to obtain 160 acres, and under the Desert Act a section, or 640 acres, with water. And so long as its two million grant lasted this state sold 640 acres to each applicant, and every member of the family whether of age or not could buy that amount at $1.25 per acre.

In this arid climate where crops cannot be grown without irrigation some homesteaders have struggled with eighty or one hundred and sixty acres with water. A white man cannot make a living on a thousand acres without water. A meagre five acres per capita for the Indians without water would be fit only for a starvation camp and burying ground. It cannot be presumed by a court of justice that a great and humane Government contemplated such a fate for the helpless remnants of a race which is vanishing rapidly since deprived of a vast territory which before the coming of the white people supplied ample game, fish, pine nuts and easy means for their humble living. "To him who hath shall be given and to him who hath not shall be taken away even that which he hath." "When you take the props which support my house you take my house. You take my life when you do take the means whereby I live." Men residing here for 50 years say the last year, 1924, was the driest one they have known. Users above the reservation took all the water from the river last summer for irrigation on porous lands in the narrow valley, and the return flow was sufficient to enable the Indians to produce good crops without depriving the defendants from taking all the water above.

NEWLANDS RECLAMATION PROJECT

The Reclamation Act was approved June 17, 1902. Fifteen days later and on July 2 the United States, acting by the Secretary of the Interior, withdrew from public entry, except under the Homestead laws in accordance with the provisions of the act, the land required for the government's first reclamation project. Originally this was called the Truckee-Carson Project from the rivers supplying the water. The name has been changed to the Newlands Project in memory of Senator Newlands, who, after years of effort, was instrumental in having Congress pass the reclamation act.

After the withdrawal of the lands the government proceeded with the construction of the Derby Dam across the Truckee River and with the construction of the Truckee Canal, with a capacity for diverting 1,500 cubic feet of water per second, running from the dam, a distance of 31 miles, to the Lahontan Reservoir on the Carson River, and with the construction of the Lahontan Reservoir, with a storage capacity of 290,000 acre feet and with the construction of 250 miles of lateral and sub-lateral irrigation canals. By April 30th, 1919 the government had expended over six million dollars for the project. The lands so withdrawn for reclamation were dry and arid and without the application of water were of little or no value, but with irrigation produce valuable crops and furnish homes and support for a large population.

Subject to prior appropriation and vested rights permitted and confirmed by the act of Congress of July 26, 1866, the United States has been allowed with a priority of July 2, 1902, the date of the withdrawal of the lands for the project, the right to divert through the Truckee Canal 1,500 cubic feet of water per second flowing in the Truckee River for the irrigation of 232,000 acres of land on the project, for storage in the Lahontan Reservoir, for generating power, for supplying the inhabitants of the cities and towns on the project and for domestic and other purposes, and under such control, disposal and regulation as the United States may make or desire, provided, that the amount of this water allowed or used for irrigation shall not exceed per season, after transportation loss and when applied to the land, 3.5 acre feet per acre for the bottom lands, nor 4.5 feet per acre for the bench lands. The 1,500 cubic feet per second of water so allowed is the quantity which was claimed in the notices posted and recorded by the government about the time of beginning construction of the dam and canal. The Lahontan Dam and Reservoir are constructed across the Carson River and impound the flood and surplus waters of that stream which are supplemented by the Truckee River water conveyed through the Truckee Canal. Along this canal water is diverted for irrigation, principally at Fernley. Of the wtaer for the project it has been estimated that about 60 per cent is supplied by the Truckee River and about 40 per cent by the Carson River. These proportions may vary in different years according to the varying snowfall on the respective water sheds in the Sierra Nevada mountains which supply these rivers. As the government could reserve or take all or any part of the unappropriated water from either stream the proportion is not material to defendants having prior or vested rights. The defendants under the act of Congress of 1866 and in accordance with the state laws are fully protected and are allowed under their prior appropriations water to the extent of their needs, and as securely as if the state owned the water. As to these appropriations, they should have no concern regarding the amount of the excess or unappropriated water withdrawn by the government for conveyance through the Truckee Canal or concerning the quantity of land or number of acres to be reclaimed or irrigated, for which the government may desire to supply water on the project. There is not sufficient water for the irrigation of the 232,800 acres of land for which the water is allowed but the amount may be increased by additional storage and the water allowed for application to any part of the lands as may be desired for the benefit of the settlers.

The objections made to the allowances to the United States for the project have already been sufficiently considered in this report in so far as it is claimed that the state owned the water. The government as the owner could withdraw ad libitum any part of the public domain or unappropriated water. The withdrawal of the lands for reclamation as authorized by the provisions of the Act carried with it by implication the reservation of unappropriated water required for the irrigation of the lands, and to the extent claimed by the notices posted and recorded in different counties by the Government. The withdrawal of the lands and the expenditure of millions of dollars in the construction of dams, reservoirs and canals would be entirely futile without water for the irrigation of the arid soils.

Objections to the allowance for the project has been made under Section 8 of the Reclamation Act, which directs that the Secretray of the Interior, in carrying out its provisions, shall proceed in conformity with the state laws. Undoubtedly this meant protection to owners and required compliance with state laws in regard to vested water rights, with which the government has been careful to comply. There is nothing in the language of the Act indicating that the Government is required to comply with state regulations in order to withdraw, store or supply to settlers, its own water. There was no state law regarding the withdrawal or regulation of the water by the Government at the time the Reclamation Act was passed and the project was initiated by the government and there was no state statute requiring the posting or recording of notices, or providing for application to, or the obtaining of a permit from the State Engineer, in order to appropriate water. At that time the right to the use of water was obtainable by appropriation for a beneficial purpose.

The government did everything which would have been necessary to entitle it to the appropriation of the water if it had belonged to the state. Upon undertaking the Truckee-Carson project, notices were posted, which no state statute then required, the work was completed with diligence, and if the enterprise had been a private one the right to the water diverted for storage and irrigation would have been complete. The construction by the Government with diligence of the Derby Dam, the Truckee Canal, Lahontan Reservoir, and 250 miles of canals and laterals and the use of the water as made would have been sufficient to establish a government right if the state instead of the United States had been the owner of the water.

LAKE TAHOE STORAGE AND REGULATION

Exception was taken by the defendants to the allowance in the Proposed Findings, which gives the United States under the Reclamation Act the right to store in Lake Tahoe, and to discharge therefrom 3,000 cubic feet of water per second for irrigation and other beneficial uses on lands in the Newlands Project, or within the basins of the Truckee, Carson, and Humboldt Rivers in Washoe, Storey, Lyon Churchill and Humboldt Counties with a priority of May 21, 1903, pursuant to notice posted by direction of the Secretary of the Interior at the site of the dam at the head of the Truckee River near Tahoe City, California on that date, and subject to a flow from the lake of such an amount of water as the plaintiff desires released not exceeding 3,000 cubic feet per second.

In addition to the above right the United States was allowed the right to store, discharge and control water in Lake Tahoe as provided in the decree entered on June 4, 1915, in the case of the United States v. The Truckee River General Electric Company, which has been succeeded by Truckee River Power Company. Subject to this decree the findings allow the United States according to its priority to divert from the lake sufficient water to deliver to the Truckee Canal at the Derby Dam, after transportation loss, 1,500 cubic feet of water per second. These allowances have not been changed. They were made on the theory that they are subject to any prior appropriation rights of the defendants to the natural flow of the river. On their behalf it is said that they were not bound in that case because they were not parties. It is true that the decree could not be binding upon the defendants when they were not in that case. Apparently the water is regulated by the decree to supply the needs of the power companies similarly to the way it was previously regulated and used by them. It is not shown that the regulation of the water in accordance with the terms of the decree is in any way injurious to the defendants. The decree was upon stipulation signed by the Secretary of the Interior, and provided for the storage of water by regulation of the gates at Lake Tahoe, and the release of sufficient water at the head of the Truckee River to maintain a flow of 500 cubic feet per second from the first day of March to the 30th day of September, and of 400 cubic feet per second between the first of October and the last of February.

In the numerous provisions in that decree, including the one whereby the United States paid the power company $139,500 for the privilege of perpetually assuming, and relieving the power company from, the trouble and expense of regulating gates, and of holding and discharging the water according to the needs of the power company, it does not appear that any concession was made by the power company which was detrimental to the interests of the defendants or of the power company, although there may be a saving in cost for providing additional storage, and a resulting benefit to the United States, or water users who are expected to reimburse the government ultimately in having the control and operating of the gates, for providing additional storage of water which the government has reserved and has the right to store under the notice posted, if extra water for storage is, or becomes, available. The provisions of that decree may properly be carried into the decree in this case, being beneficial to the Power Company and not injurious to the other defendants.

Presumably the regulation under the decree by holding the spring flood and surplus water in the lake and releasing it in the summer and fall to operate power plants from which it has been returned to the stream and used by the defendants for late irrigation, of which otherwise they would have been deprived, has been of great benefit to them. But if this is not so and in support of their objections to having the provisions of that decree adopted in this case they can show that they might be injured thereby, then it should be considered that such provisions are not binding and should not be carried into the decree in this case further than they are equitable to all parties.

If in ordinary years there is no additional water to store in Lake Tahoe and the Government does not wish to provide for additional storage which would be available only in years having an unusually large amount of precipitation and desires to be clear of further regulating the water for the power company and to surrender its privilege of using the present gates for storing additional water which it could have stored by new works independent of the power company, the decree provides that upon the failure of the Government for thirty days to regulate the water this privilege or easement shall be forfeited. In the event of such forfeiture or discontinuance of regulation by the Government undoubtedly the power company will continue to release the water and return it to the river after it has been used for operation of the plants. But if instead the Government provides extra storage this will be subordinate to the defendants' irrigation rights having priorities earlier than 1903, and injury to the defendants in either case is not apparent.

Solicitors for the defendants have asked that a definition be made of stored water conditioned upon a specified level or elevation of the water in the lake at 6,227.4 feet above sea level. Evidence has not been introduced to show the elevation above which the water actually became stored water in the past ordinary years, and it would seem to be more difficult to do this for the future. It is impossible to determine what the varying snowfall will furnish hereafter unless some arbitrary mean be accepted by agreement. The amount of water which would be stored in excess of the natural flow during the irrigation season or the period at which the defendants are entitled to have their needs supplied first, will depend upon the varying amounts of precipitation in different years.

POWER PLANTS

Rights have been allowed for ten power plants on the Truckee River from Farad to Wadsworth for flows varying from 410 to 2.52 cubic second feet and aggregating 2,037.8 cubic second feet or 81.523 miners inches with different priorities from 1863 to 1909. After passing the wheels the water is returned to the river and used by power plants lower down.

The lowest power plant in operation which uses a large amount of water is the Reno Hydro Electric plant of the Truckee River Power Company which has a right of diversion of 256 cubic second feet with a priority of March 31, 1891, and 47 cubic second feet with a priority of November 1, 1909.

This and other power plants in operation do not interfere with the rights or diversions or needs of the Government or the defendants for water for irrigation down stream.

The diversions allowed for the irrigation of lands along the Truckee River below Reno aggregate more than the amount used by the Reno Power Plant so that the water used at the wheel and returned to the river is not in excess of the needs for irrigation lower down during the irrigating season.

Also the right of the Government to divert at all times 1,500 cubic second feet of water at the Derby Dam 23 miles below Reno through the Truckee Canal for storage and irrigation allows the Government, subject to the prior rights of the defendants, to divert and save the water after it has been used for generating power, and prevents any loss for irrigation purposes of water used by the Reno and other power plants.

WATER FOR CITIES OF RENO AND SPARKS

Under appropriations made by its predecessors in the year 1863 for irrigation, logging and milling, Truckee River Power Company, successor of The

Truckee River General Electric Company, has been allowed to divert from Hunter Creek 13.6 cubic feet of water per second for storage in the Hunter Creek Reservoir, situated southwesterly from the City of Reno, for sale and delivery to and for use of the people living in and near the cities of Reno and Sparks, for municipal, household, irrigation, fire protection and other purposes. Hunter Creek is one of the most continuous streams of good mountain water, and is free from contamination pertaining to the river. The Hunter Creek water was first reservoired and piped to the town of Reno in the year 1904.

The average monthly maximum amounts of water flowing in Hunter Creek and discharged into the Hunter Creek Reservoir from and including the year 1910 to and including the year 1919 were in cubic feet per second: January, 6.20; February, 5.97; March, 7.14; April, 8.26; May, 10.10; June, 10.17; July, 9.36; August, 8.02; September, 7.19; October, 6.78; November, 5.28; December, 5.95. General monthly average for these 10 years; 7.54 cubic feet per second.

The principal supply of water for the cities of Reno and Sparks is from the Highland Reservoirs at the northwesterly edge of Reno, which are supplied by the Highland Ditch. The location notice of this ditch was filed for record March 30, 1875. It did not specify that the water was to be appropriated for municipal or city purposes. Work on the ditch was commenced on or about July 6, 1875. For want of means the original owners were delayed for several years in the construction of the ditch and sold it to J. N. Evans, by whom it was promptly completed to the town of Reno.

In 1889 Evans and associates sold the Highland Ditch to the Reno Water Company with the condition that the right to the first 100 inches of water thereafter diverted or conveyed through it be allowed for serving the system of pipes and works in Reno and that the next 280 inches be reserved by the grantors for irrigation purposes in the proportion of 200 inches for Evans and 80 inches for B. G. Clow. Apparently this 100 inches was intended to be, and was ample, for supplying the small town of Reno at that time, and for many years thereafter. There is no evidence that as much as 100 inches was actually used or needed for the town until a much later period, or until after the reservation of the water for the reclamation project except as the court may take judicial knowledge of the census and requirement in cities generally. Very liberally under the principle of relation this 100 inches has been allowed the priority of March 30, 1875, the date the notice of location of the ditch for other purposes was filed. This allowed several years for completing the 12 mile ditch and small reservoir. It does not appear that thereafter work was continued on the ditch or that there was any enlargement, or intention to use more water, for many years. Assuming that the 100 inches was a reasonable supply, and not more than enough for the town, when it may have been more than enough, and in the absence of proof of the real use or increased needs of later dates, additional allowances were made in the Proposed Findings according to the increase in population shown by and with priorities well in advance of census reports, so as to allow fully as much water as may have been used or needed at any date.

The City of Sparks was not in existence until after the Government had undertaken the Truckee-Carson reclamation project. The railroad company bought a ranch which covered the present site of that city and moved the division point shops there from Wadsworth in December 1904, two years after the reservation of the water for the project. The first census covering Sparks was in 1910. It showed that the population at that time was 2,500 for Sparks and 10,867 for Reno, or a total for both cities of 13,367, as compared with 4,500 for Reno ten years earlier, or an increase of 300 per cent in the number of people to be supplied with water. The most of this increase was in, and after, 1904. The census for 1920 places the population of Reno at 12,016, and of Sparks at 3,238 or 15,254 for both places. There were in the town of Reno 1,320 people in 1880, and 3,503 people in 1890. From 1880 to 1920, with the addition of Sparks, the number of people had increased more than ten times.

The railroad company, instead of using water to which it is entitled through a ditch from the river, has been pumping from wells, and buying from the water company about 600,000 gallons a day for use in the shops and locomotives.

Shortly after the commencement of work on the Truckee Canal and Derby Dam, and beginning about 1903 and 1904, there was a great influx of people from other states to Tonopah and Goldfield, with the larger part of the travel to, and by, Reno. A number of Reno's important buildings were constructed with money from the new mining towns.

The statement and claim of the water company sworn to by its president, and filed in 1889, in accordance with the state statute passed that year claimed 32.29 second feet as the appropriation or capacity of the ditch, including water for irrigation and for the town of Reno. The original verified answer and counter-claim of the water company filed in this case in 1913, and its amended answer and counter-claim filed in 1919 claimed as the capacity and appropriation for the ditch 32.29 second feet from March 30, 1875, 35 second feet from 1901, and 47 second feet from 1908. The company has increased its claim to 74.02 second feet with a priority of March 30, 1875, which is over twice the amount of water which was claimed prior to 1908 by these pleadings. They alleged that it carried 32.29 second feet from 1875 until 1901, when it was increased 2.71 second feet and remained at that capacity until 1908, when its capacity was increased 12 feet making a total of 47. By brief the claim has been increased to 74.02 second feet with a priority of March 30, 1875. (Plaintiff's reply brief, 102).

The Final Findings allow water for all lands irrigated under the Highland Ditch and for 1194.7 acres with a priority of 1875, and 627.8 acres with priorities from 1914 to 1919.

Without inflow the capacity of the Highland Reservoirs is insufficient to furnish a supply for more than a few days. The engineer for the water company testified that the largest daily average of input and outflow in cubic second feet for the Highland Reservoirs were:

	Input	Outflow
January, 1919	10.85	10.65
July, 1919	12.95	13.25

This testimony, upon the cross examination, is the only evidence, if such it may be called, indicating or suggesting the amount of water used for supplying the cities of Reno and Sparks. That this amount of water was needed or actually used is not definitely shown, but upon the implication that this water was used for city purposes that much and more, to meet the increased needs have been allowed by the Final Findings. Whether there were large losses in leaky pipes or undue waste has not been shown. There is nothing in the record indicating why from 700 to 900 gallons or more than a dozen barrels per capita per day are being used, if they really are being used, by the people of these cities; or from three to five times as much as is being consumed in some unmetered cities, and seven to ten times as much as is being used in metered cities. Evidently some regulation which would prevent waste from leaky plumbing or pipes, and the running of hose continuously without sprinklers on small lawns, and yet allow every user a liberal amount of water for his needs, without extra charge, would result in an ample supply for the water company and all concerned.

At the time the Highland Ditch right was initiated it could not have contemplated, and was not known, that the City of Sparks would come into existence nor that large mines would be discovered at Tonopah and Goldfield and bring a greatly enlarged population to Reno nor that the railroad company would move its division point and shops to Sparks and create a new city requiring additional water. During a period of about 20 years from 1880 to the beginning of Sparks, and to the time the greatest increase in population of Reno occurred, there was no intention or effort to enlarge the ditch or appropriation towards supplying extra quantities of water to meet the increased demands caused later by the unexpected growth of Reno and Sparks or until these conditions actually arrived and there was opportunity to sell more water.

There is proof that since the increased demand for these cities and within twenty years when cleaning the Highland Ditch annually the banks would be trimmed wider, high places in the bottom lowered, and the carrying capacity of the ditch gradually increased from year to year. The water in the Highland Ditch was not originally appropriated with the intention of meeting these increased demands, nor was there any intention of enlarging the ditch therefor until the demand for an increased supply arrived. The greater part of the demand and use of water has arisen since the Government reserved the water for the Newlands Project.

It has been claimed that if the water company is not allowed a priority of 1875 for the water from the river, which of course would be without charge, the inhabitants of these cities may not be able to obtain a sufficient supply, in times of shortage, or if the water company must buy water to furnish these cities the cost of purchasing the water, and interest on this amount as increased investment must be paid by the consumers. If it be granted that this is true it is no reason for taking the water away from prior appropriators and destroying their vested rights without compensation. The Steamboat Canal, which supplies ranches with water for a distance of about thirty miles, was not started until 1878, three years after the Highland, and more than a score of other ditches and water rights were initiated later than the Highland Ditch, but many years before there was any indication or contemplation that the owners of the Highland Ditch would ever need or claim the large quantity of water which they are now demanding or using. To allow all the water claimed for the Highland Ditch and Reservoir as of 1875 when the notice was posted and work commenced would result in subordination of many vested prior rights under the Steamboat Canal and these other ditches.

The city consumers have been paying for the water they are using, while the water company has not been paying for the increasd quantities it has been supplying to them. A part of the water which the water company has been furnishing the inhabitants for about twenty years necessarily was under an appropriation and use initiated later than the priorities and rights of the defendants and later than the government reclamation project, and reservation of the water for settlers.

There is no reason to fear that the cities of Reno and Sparks cannot be supplied with any amount of water needed. If the water company does not wish to purchase water from appropriators or owners, or cannot obtain it at a reasonable cost it can be secured by condemnation proceedings or by pumping, or by purchase from the government under the act of Congress, or if the water company does not wish to supply ample water by these methods the cities can install their own water works and obtain the water by purchase from the defendants or government or by condemnation or by pumping, as many cities are doing satisfactorily. By condemnation proceedings the law allows preference for municipal purposes, but law and equity will not permit the taking of the water away from prior appropriators without payment to them for it in order to allow it to be supplied and sold by the water company to city inhabitants.

In the Proposed Findings, submitted in July, 1924, for delivery to the Highland Reservoirs after transit loss, the water company was allowed in accordance with the deeds and agreements of J. N. Evans and B. J. Clow to the Reno Water Company in 1889, 100 inches with the priority of 1875, and increases of 30 inches in 1890, 260 inches or 6.50 second feet as of date of January 1, 1905, at which time there was an increase of population in Sparks and Reno, and 180 inches or 4.50 second feet in 1919, making 14.25 second feet, or a second foot more than is shown ever to have been used or delivered at the reservoirs.

As it is evident that since a time after the Hunter Creek Water Company was organized in 1904 any shortage or deficiency in the flow of Hunter Creek, which was used toward furnishing the city of Reno, was supplied by water from the Truckee River diverted through the Highland Ditch to the Highland Reservoir, it is provided in the Findings that for keeping these reservoirs filled with water for use in the cities of Reno and Sparks, whenever the amount of water in Hunter Creek is not sufficient to allow the discharge from the Hunter Creek Reservoir of 9.9 cubic feet of water per second, the water company is allowed to divert from the river through the Highland Ditch, in addition to the quantities of water so allowed, an amount sufficient to deliver to the Highland Reservoir, after transportation loss of 15%, a flow the equivalent of any deficiency, with a priority of January, 1905, for the first 6.50 cubic feet per second and a priority of January, 1919, for the remainder thereof.

As a concession to the water company and to the people of the cities of Reno and Sparks and with the understanding that this will not affect the rights of other defendants to interpose objections, and that the expense of securing additional water would have to be borne eventually by the consumers, and that there is no objection by the government, the priority for the 30 inches has been advanced to 1890 and the priority for the 260 inches from 1905 to January 1, 1901. This may not be harmful or detrimental to the government so far as stored water is concerned. If any objection is made by the government or water users on the project or river before entry of the decree, the priority of 260 inches should be restored to 1905 and the one of 30 inches to 1900 as originally allowed in the Proposed Findings. This would be more in accordance with the evidence. The Government has been giving away its unappropriated water for more than a half a century, but this is no reason why it should give away other water after it has been reserved, if this would injure the settlers on the project or deprive them of having for irrigating their crops the water which they have been allowed or are entitled to use.

If necessary for the water company to purchase water from the government or from individuals it is entitled to make such reasonable charge against the consumers as will allow the company a reasonable income on the increased investment. With the growing population and demands and the delivery of larger quantities of water the cost of supplying the municipal needs should be relatively or proportionately less per gallon.

So far as the reservation or the appropriation by the government for the Truckee Canal and Lahontan Reservoir in 1902, prior to the increased appropriation by the water company after that time, the cost of the works, has been charged to the homesteaders and settlers on the theory that they are to pay for these as representing expense of delivery of the water to them and not as a charge for the water itself. If the canal and reservoir store and supply ample water for the project above the amount needed for the water company, there would not be much loss or detriment to the Government or to the settlers if water for city supply is allowed against the government priority. A very different situation would be presented if the water company were permitted to take the water away from prior appropriators whose land would be dried up and farms destroyed for want of irrigation.

A large part of the water used for municipal purposes returns to the river as sewerage above where it is diverted by the Government for irrigation. The percentage that returns from sewerage is not shown, and must be much less during the summer months while there is a heavy loss by evaporation and seepage in the irrigation of lawns.

The facts and the law are very far from supporting the claim of the water company that it should be allowed all the water it has used and nearly as much more with a priority of the date of the filing of the location notice of the ditch in 1875. There is no element of relation in the case and it is not similar to ones where there are permits issued in advance by state authorities for the appropriation of water or the construction of works. If the original locators of the Highland Ditch had intended to appropriate water for town or city purposes or to meet any increased demands of the people of Reno, and construction of the ditch and reservoirs for those purposes had been commenced and continued with reasonable diligence until they were of full capacity to deliver the amounts of water now needed, there would have been some notice or warning to appropriators who constructed other ditches and cleared, irrigated and improved their lands in the years following the location of the Highland Ditch.

Under the law of relation a notice of intention to appropriate and commencement of work must be followed up with reasonable diligence until the work is completed. The right of the prior appropriator takes effect by relation to the commencement of the work, if it is prosecuted to completion with reasonable diligence, and the rights of intervening appropriators are superseded. The principle of relation will not be applied when it will wrongfully defeat the rights of others. (2 Kinney p. 1285.)

In the Ophir Mining Company-Carpenter case (4 Nev.) the ditch was constructed for a short distance and then reduced in size, indicating an intention to construct a large ditch and to divert water according to its carrying capacity. The court held by failure to enlarge the ditch throughout its length within three years the right to the larger appropriation was lost to an intervening appropriator. Here for twenty years there was lack of intention, no commencement of work, nor completion with diligence of work for the appropriation of water in the large amount claimed by the water company, or for more than has been allowed. The United States Supreme Court in the Wyoming-Colorado case said: "It had not reached a point where there was a fixed and definite purpose to take it up and carry it through. An appropriation does not take priority by relation as of a time anterior to the existence of such a purpose."

The company acquired the right to only the amount of water appropriated by its predecessors prior to the time that the other appropriations from the river were made. Lobdell v. Simpson 2 Nev. 274, Barnes v. Sabron 10 Nev. 217, Proctor v. Jennings 6 Nev. 8. By relation under the Final Findings the water company is liberally allowed all the water appropriated by its predecessors with priorities enough earlier than the water was used to allow by the exercising of reasonable diligence any enlargement of the ditch or reservoir needed for supplying increased demands.

DEFENDANTS' IRRIGATION RIGHTS WATER DUTY SEASONAL ALLOWANCE ACRE FEET MONTHLY LIMITATION

Water has been allowed for every acre of land shown to have been irrigated ,except where the owner has segregated the water right from the land, and with as early a priority directly or by relation as the evidence would warrant. The duty or amount of water needed for the irrigation of the different lands for the production of crops is the one important feature remaining to be considered. The factors which have been considered in estimating the amounts of water needed are the kinds of soil, percolation, evaporation, transpiration, precipitation, character of the crops, surface waste, and climatic conditions affecting heat, cold, moisture and growth.

The testimony indicates as many as nine types of soil irrigated by river water, and two on Steamboat Creek, varying as to slope, and as to degrees of coarseness and compactness from gravelly lands, mostly near the river, to close adobe soils, which are more particularly characteristic along the Highland Ditch. The depth to hard pan varies greatly in different places, and this and coarseness or compactness cause variance in the amount of water lost by deep percolation. After studying the evidence the Special Master examined many of the lands. Without tests being made by actual irrigation it is impossible to determine the exact amount of water needed. When in doubt the intention has been to allow a liberal amount for the irrigation of the lands by the flooding and furrow methods, which have been in use from the beginning of irrigation in the valley of the Truckee. A part of the lands are too uneven or sloping for irrigation by the check or border system, unless levelled at large expense.

If the evidence introduced by the Government is discarded, the testimony of the defendants, inspection of the lands irrigated, and past and present conditions indicate that excessive quantities of water have been applied to some of the lands. Many of the defendants, but far from all, have been careful and economical in the use of water. Many have testified that they change it two or three times a day, while others have stated that they allowed it to run two and three days on the same land. On one large ranch it was usual to let the water run on one place for about six days.

Such useage is not only a waste of water needed for storage or later appropriators, and detrimental to them, but is an injury to the crops on which the water is allowed to run so long. Large heads or flows on short runs between frequent cross ditches and quick applications, with the water turned off as soon at it will reach over the ground, so as to allow the air and warmth to reach the plant roots will not only save time and water but will produce better yields. A few adobe or very compact soils may need longer applications to moisten the ground to the depth of vegetation, but they do not lose so much water by deep percolation as the coarse soils, on which it is mere waste to allow the water to run longer than necessary to cover the land. With the mistaken idea that the more water they apply the greater yield they will obtain some of the defendants have been killing alfalfa and stunting this and other crops. Such wasteful practice should be restrained for the benefit of all concerned, also allowing water to run and waste when not needed should be prohibited, especially in years of shortage.

The large heads or flows which have been allowed so water may be taken over the ground quickly and moved to other furrows or places for flooding, is a special reason why the water should be released or turned off as soon as it has reached over the ground to be irrigated. Many of the people buying, or paying for the delivery of water, irrigate with about 6/10 of an inch per acre or with only a little more than one-half of the heads or flows which have been allowed to the users who do not pay for the delivery of water, indicating much freer use of water by users who do not have to pay for what they waste.

The earliest appropriators settled near the river and creeks where water was convenient and there was less sagebrush to clear. Higher lands taken later, dryer and warmer, have proven to be quite as, or more, valuable, and especially for alfalfa, which has become the principal crop. Still higher lands were reclaimed and so much water used upon them that some lands below but distant from the river, which were originally dry and covered with sagebrush have become swampy, and too wet, and from them drain ditches have been constructed which carry water the entire year which seeps from lands irrigated above.

Some of the valuable ranches which early were irrigated with direct water, have for many years been more conveniently irrigated with an abundant supply of drain and waste water from lands above, and the direct water and ditches from the river are no longer used for them. As to these ranches provision has been made in the Findings and Recommended Decree for allowing return to the use of direct water if the waste becomes insufficient for their irrigation, by reason of less water being used above, as limited by the decree in this case.

The use of waste water should be encouraged and the users should not be penalized by loss of their rights to direct water, if its use becomes necessary for the proper irrigation of their lands. As evidence physical conditions control over the opinions and statements of witnesses.

In rendering decrees many years ago, and before the Legislature fixed any amount, it was rather usual for courts to allow an inch of water per acre to be diverted from the stream, regardless of the character of the soil. A number of the defendants who have been paying for the delivery of water have been producing excellent crops with less than one-half inch per acre. On one ranch the owners have been using two-thirds of an inch per acre on the higher part of the land for which they pay for the water, and are contending that the allowance by the Proposed Findings of one and a half inches per acre of water through a ditch from the river, for which they do not have to pay, is insufficient, and that unless they are allowed at least two and a half inches per acre their crops will be dried up and destroyed and their property confiscated. Most of the defendants who have ditches from the river with free early rights have not claimed more than an inch per acre diverted from the river, while others say they require several inches. These varying demands are due partly to a variance in soils and partly to the practice in irrigating.

Government ownership is no disadvantage to the defendants, and it would be of no benefit to them to have the state own the water, because the Government has no restrictions on appropriations and use of water, and the federal courts enforce none except as provided by the local customs, state legislatures and courts. No tribunal desires to deprive appropriators of a reasonable amount of water.

In different acts passed since 1905 the Legislature has been careful to declare that vested rights or appropriations of water made prior to that time should be respected and maintained, and that water should be used only when needed and in limited quantities. It is conceded that these rights could not be impaired by the Legislature or courts, or the amount of water allowed for them reduced below the quantity necessary for the owner's needs. By both legislative enactment and judicial decision the appropriator of water is limited to the amount required for beneficial purposes when economically used. The acts of the Legislature restricting the amount to be applied for irrigation are binding, unless they limit the quantity below the amount necessary for the land. For twenty years the Legislature has passed statutes and pursued a policy which indicated that in its judgment no greater flow than one one hundredth of a cubic foot per second or four-tenths of an inch, and not more than three acre feet per season per acre should be allowed for irrigation. Appropriations aggregating hundreds of thousands of dollars have been made for supporting the State Engineer's office and carrying out this policy.

Upon the Humboldt River, the one large stream system where the State Engineer made determinations preparatory to starting suit for the adjudication of the rights on that river, in his allowances he limited the flow to one one hundredth of a cubic foot per second or four-tenths of an inch per acre and three acre feet per acre for the oldest and all vested and other rights for harvest crops and limited the acre foot allowance for meadow pasture to one and one-half acre feet per acre per season and for diversified pastures it is three-quarters of an acre foot per acre per season.

Pasture. It is desirable and beneficial to keep pasture irrigated and growing during as long, if not a longer, season than other crops. Pasture is as much needed in the fall and summer after hay and grain have matured and been harvested as in the spring. This is especially true in regard to dairying, which during recent years has been more profitable than other kinds of ranching. While ample pasture is available the animals do their own harvesting and thrive better, and save the labor and large expense of cutting, stacking and feeding the hay, and consequently pasture is one of the most valuable crops. It should be allowed at least as much water as hay or any harvest crop and much more than grain. But this is not a reason for allowing water for all of the land in large pastures where only a part has been irrigated. As to these the maximum amount of water should be allowed for the part which has been irrigated and no water for the remainder.

At page 23 of the General Objections and Exceptions to the Proposed Findings the defendants state:

"The defendants further except and object to the twenty-eight per cent limitation as fixed by the proposed decree upon the ground that the same is violative of the doctrine and law established by the statute of this state based upon the long experience in the application of water to arid lands, and the wisdom and judgment of the legislative body, wherein a constant flow is recognized as the necessity and the basis of measurement and application."

Apparently this conclusion is a misconception, for the statutes do not recognize constant flow as the basis of measurement in application. They have provided that the flow shall not exceed one one hundredth of a cubic foot per second, and that the amount applied to the land during any season shall not exceed three acre feet per acre. These are only maximum limitations and the statute states that no more water shall be used than is necessary.

The act of 1899 provided:

"Section 3. There is no absolute property in the waters of a natural water course or a natural lake. When the necessity for the use of the water does not exist, the right to divert it ceases and no person shall be permitted to divert or use the waters of a natural water course or lake except at such times as the water is required for a beneficial purpose."

"Section 4. No person shall be permitted to divert or use any more of the water of a natural water course or natural lake than sufficient, when properly and economically used, to answer the purpose for which the diversion is made; nor shall any person be permitted to waste any such water, and all surplus water remaining after use, unavoidable wastage excepted, shall be returned to the channel by the persons diverting the same without unreasonable delay or detention."

The act of 1907 provided:

"Section 5. The maximum quantity of water which may hereafter be appropriated for irrigation purposes in the State of Nevada shall not exceed three acre feet per year for each acre of land supplied."

This concurred with the act of 1903.

The act of 1913 provided:

"Section 3. Beneficial use shall be the basis, the measurement, and the limit of the right to the use of water."

"Section 6. When the necessity for the use of water does not exist the right to divert it ceases and no person shall be permitted to use the water of this state except at such times as the water is required for beneficial purposes."

"Section 7. Rights to the use of water shall be limited to so much thereof as may be necessary, when reasonably, economically used for irrigation and other beneficial uses and the remainder of the water shall be allowed to flow in the natural stream."

"Section 11. The maximum quantity of water which may hereafter be appropriated in this state for irrigation purposes shall be as follows: Where the water is diverted for direct irrigation not to exceed one one hundredth of one cubic foot per second for each acre of land irrigated, where a main ditch enters or is adjacent to the land. Where water is stored not to exceed four acre feet per acre of land to be supplied, losses of evaporation, and transmission to be borne by the appropriator."

"Section 9 of this act provides: That a cubic second foot shall be the standard of measurement and that the unit of volume shall be an acre foot consisting of 43,560 cubic feet, and that one cubic foot per second equals 40 miner's inches." (This is true if the miner's inches are running under a six-inch pressure, but a cubic foot is the equivalent of 50 miner's inches under a four inch pressure.)

The Nevada Statute of 1919 provides:

"Rights to the use of water shall be limited and restricted to so much thereof as may be necessary, when reasonably and economically used for irrigation and other beneficial purposes, irrespective of the carrying capacity of the ditch, and all the balance of the water not so appropriated shall be allowed to flow in the natural stream from which such ditch draws its natural supply of water, and shall not be considered as having been appropriated thereby."

This follows or supports the early decisions in Barnes v. Sabron, and the Union Mill and Mining Company v. Ferris.

In accord with evidence on the part of the Government numerous defendants with long experience in irrigating testified without contradiction that large heads of water to flow quickly across the lands to be irrigated and then turned off were desirable.

The claim made by defendants that they should be allowed a continuous flow is not consistent with their own testimony, nor with the state statutes. The allowance to the defendants of excessive heads of water as large, and in some instances larger than they have been using, have been made for the very purpose of preventing continuous flow, except to the owners of large amounts of land, where it can be changed from one part to another, and for the purpose of saving time in irrigation and of saving water as seemed desirable under their own testimony. This is only one of a number of things provided by the Findings for the benefit of the defendants to which they are now objecting.

In the suit for adjudication of the Walker River Rights the Special Master allowed more than 100 of the users slightly less than one-half inch per acre, and a considerable number of the users about two-thirds of an inch per acre, others were allowed more by stipulation. Ordinarily the water in the Walker River fails in July, so that the diversions allowed would not deliver as much as three acre feet per acre from the natural flow of the river to the lands.

The Special Master has endeavored to allow a reasonable amount of water for the irrigation of all lands under the methods which have always been in vogue. The most of the defendants claim the right to divert one inch of water per acre for their lands, and except where they have been allowed the amount of water for which they have been paying for delivery, they have been given flows in all cases of not less than one inch per acre applied to the land in addition to estimated transportation losses, and in some instances a flow of one and one-half and two inches for small tracts on porous soils giving rapid return flow to the stream.

Now they have asked that these excessive flows which have been allowed for the very purpose of permitting of quick irrigation and release of the water be made continuous.

The defendants' rights have been fully allowed in accordance with the state laws except that the allowances by the Special Master gave them two and a half to five times the amount of flow provided by the state statute, and about one quarter to one half more in acre feet than allowed by the state statute or than would be supplied by a continuous flow of the statutory amount of one one hundredth of a cubic foot per acre for the irrigating season of five and a half months.

The testimony and actual demonstrations by the government witnesses showed that good crops were produced on coarse lands requiring large quantities of water at the Agricultural Experiment Station and University Stock Farm by the use of two and a half to three acre feet during the irrigating season, and the amount of two and a half to three acre feet has been found ample in adjacent arid states.

One of the principal expert witnesses for the defendants who had practical experience when young on a farm in the Reno Valley, and who has given extended study as director of the Agricultural Experiment Station at the University of Nevada, and has written a booklet or bulletin detailing the conditions and requirements in the Truckee Valley, estimated that the average duty or use of water in this valley is 3.184 vertical feet; that of such applied quantity 25.85 vertical inches or 67.6% is lost by evaporation and transpiration; 1.72 inches or 4.5% is lost by evaporation from slough and water surfaces; 7.49 vertical inches or 19.6% returns to the river as retarded seepage and 3.14 vertical inches or 8.2% is returned as waste water.

The defendants may use at any time as much or as little of the flow allowed providing they do not exceed the seasonal acre foot limitation. Heat increases evaporation and transpiration and the plants require more water in June and July than in April, May or September. The claim of defendants for a continuous flow of the full head allowed them is only an insistance upon having water to waste. The larger heads, the acre foot limitations, and the special provisions in the recommended decree for the use of even more water during periods of need than the allowed flows, have been for the two purposes of giving the defendants more water when it is needed and limited flows and saving waste at other times.

It is not understood why defendants are objecting to different things in this case which are for their benefit, or why they are complaining that they have not been allowed water in accordance with the state statutes when they have been allowed water for every acre shown to have been irrigated with priorities directly and liberally by relation fully as early as shown by the evidence and all in accordance with the state laws, except that they are allowed more water than these laws prescribe. In different statutes for twenty years the Legislature has provided that the amount of water applied to an acre should not exceed one one-hundredth of a cubic foot in flow nor three acre feet in depth per season. The omission of this acre foot provision in the late statute may have been with the understanding that it was surplusage or unneccessary, because nearly all the streams in the state are fed by melting snows and fail in the summer before there is time for the statutory allowance and flow to run or furnish three acre feet. Omitting the reclamation project which is supplied with stored water available for irrigation until fall the most of the crops in the state are raised with irrigation for only three or four months. The statutory limitation of four acre feet for stored water does not allow so much as three acre feet for application to the land after losses by evaporation and transportation.

The findings of the Special Master allow, where persons have been paying for the delivery of water the amounts in flow which have been used by them heretofore, and in all other cases not less than one inch per acre applied to the land, which is two and a half times the amount allowed by statute. Owners of very small tracts of porous land allowing rapid return flow to the stream have been allowed larger flows than an inch per acre so they could have a relatively larger head which would reach over the land quickly and be taken off and save time, trouble and water.

With the defendants allowed in flows more than they have been using and all the most of their ditches will carry, there is nothing regarding their allowance left to which they can object except the acre foot limitation, which really is the only restriction against waste by any who resort to excessive use.

The seasonal allowance under the findings to the defendants is generally about four acre feet, which is one-third more than the statutory maximum of three acre feet. The average allowed for all is 4.065 acre feet. On coarser lands the defendants have been given four and a half acre feet, which is one-half more than the three acre feet maximum provided by the statute.

These allowances so in excess of the statutory limitation are the only restrictions placed upon the defendants' amounts of water by the special master's Final Findings and Recommended Decree.

Exceptions by the defendants to these proposed allowances to them for irrigation of over one third more than the maximum provided by the state statute, or allowed by the State Engineer or in other arid states, and over one-half more than the amount in acre feet allowed by the United States Supreme Court in the Wyoming-Colorado case, were unexpected. It was believed more probable that objection to them would be made by the Government, on the ground that the amounts allowed were too large. The state statutes provide for the equivalent of four-tenths of an inch flow to the acre as a maximum and not as the continuous flow. The statutes declare that only so much water shall be used and at such times as may be necessary for economical irrigation, and at other times shall be allowed to flow in the stream. In the Wyoming-Colorado case the Supreme Court of the United States allowed and held that the amount of water "reasonably required for the irrigation of 181,500 acres of land in Wyoming" was 272,500 acre feet, an average of approximately one and a half acre feet per acre. Two acre feet was allowed for some of the land, and not over two and a half acre feet for any. The court found that the average annual evaporation in Wyoming and Colorado was between five and six feet. The mean evaporation at Reno for the years 1911 and 1912 was approximately five and a half feet (66.41 inches). The excess of one and a half acre feet allowed on the Truckee River system by the Special Master above the highest allowance for Wyoming lands made by the United States Supreme Court is far more than any difference in precipitation in the two localities during the irrigation season.

If the defendants are serious in their contention that the water should be allowed to them in compliance with the State statutes and that they must have a continuous flow, and they really so prefer, it is recommended that accordingly and in compliance with their wishes and instead of the acre feet and flow allowance made in the Special Master's Final Findings the Court allow them a continuous flow of four-tenths (.4) of an inch per acre, the maximum provided by statute, for a period of 165 days annually, with the privilege to each defendant to select his own irrigating season (or season to begin April 15), not exceeding this number of days which by the defendants' testimony appears to be the length of time during which irrigation is desirable.

Such continuous flow, or four-tenths of an inch, would provide in 165 days 3.3 acre feet. If that flow is enough during the warm period of maximum demand in June, July and August, it necessarily is more than needed in the cooler months of April, May and September, when plant growth and evaporation are less.

The mean evaporation from a free water surface at the Experiment Station at the University at Reno in the years 1911 and 1912 were in inches for April, 3.47 inches; May, 8.08; June, 10.42; July, 11.31; August, 11.41; and September, 8.51. Also the amount of water consumed by the plants is greater in the warm months. For plant consumption it takes from 300 to 500 pounds of water to produce one pound of dry matter, and on the basis of 300 pounds it requires to produce four tons of hay on an acre about 2,400,000 pounds of water or the equivalent of a continuous flow of about one-tenth (.1072) of a second foot for 165 days, or about nine-tenths of one acre foot (2,700,000 pounds) or less than one-fourth of the four acre feet of water allowed. The water cannot be applied without loss, but it must be conceded that unnecessary waste will result, such as allowing the water to run on the field for long periods after it has moistened the soil below the plant roots, which has been the practice of some of the defendants according to their testimony. The statute and the courts do not sancion such waste or the running of continuous flows when not needed, because it may be inconvenient for the user to give it proper attention. The law makes economical use a condition and limitation for every water right. With increase of population and demand for water for more intensive cultivation greater care must be exercised in conserving this essential element in a country where it is scarce and agriculture cannot exist without irrigation. Pleas for the continuance of the extravagant use of water because such has been the practice in the past with some irrigators cannot avail against the dire needs and public welfare.

Under the Special Master's Final Findings and Recommended Decree the defendants who are allowed four acre feet may according to their needs take an even continuous flow of 49/100 of an inch per acre for 165 days, or twice that amount for half that time to make their four acre feet, or a larger or smaller flow as needed at various times, instead of a continuous flow providing too little in the hot weather and too much in the spring and fall; and those who are allowed four and a half acre feet may take according to their needs a continuous flow of 54/100 of an inch for 165 days, or a varied flow to the limit of four and a half acre feet. Any ideal allowance and regulation, and especially in a locality so congested as the Reno, Steamboat and Pleasant Valleys, will give the user his proper quantity in acre feet with elasticity regarding the amount and time of flow and free of restriction as to beginning or length of irrigation season, so the greatest benefit may be obtained by having the water delivered as needed, and so that the user will have an incentive to save and be aware that if he takes the water when it is not needed or uses it longer than necessary he is wasting his own supply, and consequently may not have enough later in the season.

The full diversions in inches from the following named ditches in August and at the period of maximum demand were:

1900	Orr Ditch System	0.74
1904	All ditches from the River in Reno Valley	0.80
1908	Four big ditches: (Steamboat Canal, Last Chance, Lake, Orr)	0.76
1908	State Engineer's river flow records	0.74
	Average	0.75 inch flow

per acre or 1 and 1/8 acre feet for one month and 6.187 acre feet for 165 days. Under the Final Findings the transportation loss allowed for all ditches averages between 19 and 20%. The defendants claim this is too low. The average transportation loss allowed on the above named large ditches is over 20%, but if only 20% be deducted from the 6.187 acre feet 4.9496 acre feet remain as the amount delivered to the land in 165 days on the assumption that as much continuous flow was delivered in April, May and September as in August. While in fact for about half of the five and a half months so large a flow was not needed, and it is apparent that from the 4.9496 acre feet some considerable deduction should be made for the lesser requirement in the spring and fall than in the hot period of maximum demand. The acre feet allowances to the defendants average 4.065 acre feet or .884 less than the 4.9496 acre feet. The reduced needs in the cooler weather in the spring and fall, the usual spring storms, and a little more attention and care by users in handling the water and changing it as soon as it has covered and moistened the soil, should more than cover this difference without resulting in any depreciation in crops. Those who have been allowing the water to run two or three times as long without change as necessary do not need more than half the water they have been using. This wasteful practice is contrary to the letter and the spirit of the statutes. Under the conditions prevailing here this practice and the waste of water by continuous flow of as much in the cool weather in the spring and fall as in the warm period of maximum demand should be restrained by the courts. Enough for maximum demand must be too much for other periods and an even, continuous flow must result in waste at periods other than the time of maximum demand. Elasticity in flow to be regulated as desired by the user for his needs to the extent of a reasonable acre foot allowance is the best method and most beneficial for him as well as most economical. This will afford the best use of the water when it is needed and save it at other times.

With the allowances made, the defendants need not go without sleep or take a lantern to irrigate.

But the wasteful practices such as allowing the water to run in the same place for days should be stopped. In some localities users are glad to have the water for two hours at any time, day or night, once or twice a week.

Under the Steamboat Canal, the highest ditch and on the south side of the river, and which supplies water to the lands which do not receive waste water from above for the most of its length of about thirty miles, the average amount of water delivered during five and a half months in 1913, the year this suit was started, was 4.3 acre feet per acre. Under the Highland Ditch on the north side of the river and which does not receive waste water from ditches or lands above, the average amount of water delivered from April 15 to September 15, 1914, the period of five months provided for delivery of water by the contract, was 4.5 acre feet per acre. The water from these ditches was furnished by continuous flow and consequently an excess in the spring and fall compared with the need in summer. The Findings allow those users under these ditches the flows they have been receiving and under the provisions of the Recommended Decree if the water is available through the ditch the water master may allow increased flows when needed in hot weather subject to acre foot limitation so the user may have more of his water when needed and less at other times.

In behalf of the users under the Orr Ditch System, and as indicating the needs of lands under other ditches, it was urged that four acre feet of water was used in irrigating the lands under that system during the season of 1924, and that this amount was not sufficient for the proper irrigation of the lands as shown by the meager crops. By some of the ranchers who have lived in this vicinity the longest, last year was considered the driest known. Whether the proper amount of water was applied at the proper time, or whether too much was used to stunt the crops in May and June, or whether enough was applied in June and early July does not appear. Lands were exceptionally dry in March and proper irrigation was commenced and a considerable amount of water applied in that month so it would be obtainable before the shortage became acute. By late July it was impossible to obtain the amount of water needed for the irrigation of the crops. If the water used in March could have been held and applied in June or July the result would have been more beneficial. That four acre feet used at the proper time and in the proper way would not be sufficient for the irrigating of the lands under the Orr Ditch System was not shown. Whether the water was used in large heads to force it quickly across the lands and whether it was allowed to run in the same place two or three times as long as necessary to have it reach over the land and wet it does not apgated with four acre feet it is suggested that the lands under the Orr Ditch cannot be properly irrigated with four acre feet ,it is suggested that the court at the expense of the defendants appoint an efficient irrigator to irrigate as a test for one season any ranch or piece of land selected by the defendants as requiring the most water.

The Findings, allow enough to supply the flow defendants have been using in hot dry months of maximum demand, and a lesser amount when not so much is needed in early spring or late fall with shorter days, cooler weather, less plant growth, and less evapo-transpiration. The large heads allowed with acre foot limitation will give elasticity and best meet the conditions.

If the defendants use in months of maximum demand the full heads they have been using, apparently enough water is allowed by the Findings in acre feet to supply any reduced amounts of water they may need in the spring and fall, so the waste caused by continuous unnecessary use of full heads in spring and fall may be prevented.

As the plants grow faster and need more water in warm weather and the evaporation loss is greater, the granting of the demand of defendants for the continuous flow of the large heads allowed them for the purpose of making quick application of the water and taking it off would result in waste.

The allowances in the Findings have been made with the desire of giving ample amounts of water for the uses of the defendants if the water is properly handled, and beyond this of preventing waste. The evidence regarding the requirements of the lands is not clear in all instances. Inspection of the eleven types of soil regarding which evidence was introduced is not always conclusive as to their extent and water requirements. In case of doubt it has been deemed better to allow too much instead of too little water, but unintentionally too little may have been allowed in unknown instances.

Careful testing of the allowances by a few years trial under the supervision of a competent water master, assisted by good irrigators, may show that in some instances, and more especially on very coarse soils, the amounts of water allowed should be increased, but more generally that it should be reduced.

Monthly Limitation. The allowance of a continuous flow would not be consistent with the provision of the state statute that when the water is not needed, it shall be allowed to run in the stream.

The claim made for a continuous flow is not consistent with the statements of defendants in their testimony on the trial that it is better to have large heads of water to cover the ground quickly and be taken off. The allowance of large flows is in compliance with their evidence as well as with that of the Government, and with the understanding that when the water has covered and moistened the soil below the plant roots it will be taken off and not left to run to waste and injure the crops because this way may be more convenient.

The objection to the provision that not more than 28% of the acre feet allowance for the season shall be used in one month is not consistent with the demand for a continuous flow. With a continuous flow for five and a half months the use would be less than 20% in any month. The limitation of the use to not more than 28% of the acre foot allowance in any month permits a continuous flow during the month of .74 of an inch per acre under allowance of four acre feet and of .84 of an inch under allowances of four and a half acre feet, so that the flows allowed with this limitation to which the defendants are objecting are over one-half larger and are more favorable for them than the flow fixed as a maximum by the State statutes invoked by defendants. Under the basis of an average transportation loss of 20%, the 28% monthly limitation allows a continuous diversion from the stream during any month of over nine-tenths of an inch per acre to furnish the .74 inch flow applied to the four acre feet lands and a continuous diversion during any month of over one inch per acre for the four and a half acre feet lands. It is apparent that the monthly limitation of 28% of the acre foot allowance permits the diversion of about 20% more water by continuous flow in any month than the average diversion of .75 of an inch by the defendants in August, and consequently that is a restriction only upon a few who may be inclined to use more water than needed, to the injury of others.

The 28% monthly limitation is incidental to or a brake upon the allowance to the defendants of large or excessive heads for quick, easy, and beneficial irrigation, and is intended to prevent unnecessary waste and injury to their neighbors. With large heads allowed it is essential to have this limitation for the proper use and regulation of the water among the defendants, and especially in periods of scarcity and on the creeks that fail early, so that the prior appropriator may not use more water than he needs to deprivation of the later ones, and so that the upper users on the ditches may not consume all they will carry and more than their share before it reaches the lower users.

The defendants are allowed for irrigating:

By direct Truckee River water	29,055.1 acres
By waste under river ditches	4,324.4
	33,379.5

River water applied to these lands 27,979 inches or 699.33 second feet and 118,122 acre feet, and diverted 34,017 inches or 850.13 second feet, and 146,152 acre feet.

Other lands of defendants served by creeks, reservoirs, springs and waste are 6,690.5 acres allowed by 7,220 inches, 180.8 second feet, 27,929 acre feet. Total of defendants' lands irrigated 40,070.0 acres.

The United States is allowed 58.7 second feet and 12,152 acre feet annually for 3,130 acres at Pyramid Lake Indian Reservation, and if allotment be made under the act of Congress of five acres per Indian on bench lands for these approximately 2,635 acres, and for the irrigation thereof 4.1 second feet applied, and 5.59 second feet diversion. The United States is also allowed to store and discharge 3,000 cubic second feet of water at Lake Tahoe, if available, and to divert 1,500 cubic second feet of water through the Truckee Canal for storage in the Lahontan Reservoir and irrigation of 232,800 acres of land under the Newlands Reclamation Project, of which, 151,000 acres are partly supplied by Carson River water mingled with Truckee River water in Lahontan Reservoir.

The average annual discharge in acre feet of water in the Truckee at Calavada or state line from 1899 to 1912 was 800,988. The average discharges in acre feet during these years were 118,788 for April, 145,192 for May, 115,593 for June, 65,632 for July, 42,847 for August, and 36,102 for September.

In a country where irrigation is necessary for the production of crops and where water is so precious, limitation of the amount to be used to a reasonable quantity is essential in order to prevent waste, so as to allow any water above the quantities necessary for supplying the real needs of the land to go to other users. The irrigation of the largest amount of land possible by the application of reasonable quantities of water is very essential, and in order to secure the best results in this regard there must be limitation on the quantities of water allowed to be used, and on the heads or flows; but these should be liberal and it is more important to fix fair limitations in acre feet with permission to apply the flow as the user may desire. As by this limitation he is allowed an amount only sufficient to reasonably supply his needs, he will soon become aware that in wasting water he is wasting his own property, and self interest will check undue waste, and lead to production of better crops with a reasonable amount of water, leaving the excess over for other users so that more lands may be irrigated.

Since the Legislature declared many years ago that mining is the paramount industry in this state, agriculture has increased, and many of the mines which were then producing have been worked out or closed. Other mines have been discovered and are being worked, others will be discovered; but agriculture is most essential for the ultimate and permanent welfare. The conservation of water, without which crops cannot be produced, is of great importance. By irrigation the grains and grasses are waving in the fields and the vine and fig tree are producing and continuing to bring support and prosperity to the people of Damascus as they were at the time of the Saviour.

Less than two acres in a hundred of the seventy millions of acres in this state are cultivated because of the dry climate and deficiency of water. The percentage of public land (74.01) is the highest, and the per capita less than one person per square mile (.7) is the lowest of any in the Union.

To provide ample water for the needs of all defendants with economical use, prevent unnecessary waste and conserve the surplus for reclaiming more of the desert, increasing fertility and production, and providing support for a larger population, are of vital importance under the conditions prevailing in this commonwealth.

The Court should not hesitate to enforce economy in use, prohibit the waste of water, or to support the legislation and policy of the state, which since 1903, has limited in flow or acre feet, and to the needs of the user, the amount of water to be diverted.

GALENA AND STEAMBOAT CREEKS

In 1877 in a suit in the state court, in which the rights on Upper Galena Creek were not involved, a judgment defined the rights of water users in Steamboat and Pleasant Valleys by relation allowing full claims back to the times the ditches were first made. A decree rendered in 1882 in a case by these lower ranchers, brought in the name of George Smith, acting for himself and others, as plaintiff, against water users on Upper Galena Creek, carefully awarded the water according to small original appropriations and increases in the amounts of land irrigated for different years. Some of these defined priorities were for from two or a small number of acres up to larger amounts of land.

The Proposed Findings allowed all rights by relation which was more in accordance with the first mentioned judgment than other judgments for rights down stream. Owners in these valleys objected to the allowance of water rights so made on Upper Galena Creek, while claiming by relation for themselves down stream. Upon supplementary meetings before the Special Master they were informed that they could not have their water rights allowed by relation and the Upper Galena Creek water rights restricted to the actual amount of small original appropriations and later increases, and that the same rule for allowing rights should prevail up as well as down stream. After numerous hearings revised allowances were made by consent of the parties interested and which were a compromise between the two judgments, to neither one of which were all of the users parties.

By the Final Findings, and so made by consent, the claimants in Pleasant and Steamboat Valleys as well as the ones on Upper Galena Creek are allowed by relation water for considerable more land than was irrigated during the first years on their ranches, but are not allowed for all of their land from the time the ditches were started as in the earlier judgment. In the Final Findings the allowances have been made with a few priorities instead of many and appear to be fair and best for all concerned. It would be very difficult to administer the use of the water as allowed with priorities of different dates for only a few acres first for a lower ranch and then for an upper one, and the controlling priorities in the stream being entitled to part of the water for a day or less, when with a varying supply a secondary appropriator in a day or a few hours may be deprived of his right to use the water.

Also there are judgments in state courts relating to water rights on lower Steamboat Creek which are not in harmony. One of these in the case of Ramelli v. Sorgi was held by the State Supreme Court to be deficient in awarding a proportion of all the natural flow of the creek without specifying any limit to the amount of water which could be diverted or designating the amounts of the flow needed for the lands. This omission has been corrected and the proper amount needed for the lands allowed in the Proposed and Final Findings.

The Government and numerous new parties in this action are not bound by judgments in the state courts against a few of the defendants, but allowances have been made in accordance with state court judgments, except wherein they were in conflict with some basic principle of the law, such as the one in Ramelli v. Sorgi, which awarded one-third of the natural flow of Steamboat Creek without limit as to amount or need for beneficial use. The allowances made are in accordance with this judgment, except that they are limited to the specified amounts of water needed for the lands.

THOMAS CREEK

Apparently all users of water on this stream are satisfied with the allowances which have been made, except one. Near its lower end Thomas Creek has been dammed for many years so as to turn all of the water into the Jones Ditch, which is, and for a long time has been, the channel carrying all the waters of Thomas Creek.

A judgment in the State Court in the case of Marble v. Short awarded all the water flowing in the Jones Ditch without limit to the owner of that ditch, which was in effect an award of all the water in the creek whether in excess of the needs of the owner of the Jones ditch or not. The law generally and the statute of 1919 especially limits the use of water under this decree as well as under every other, to a reasonable amount economically used irrespective of the capacity of the ditch. Turning all the water into the Jones Ditch did not give a right to all the water in the creek any more than turning all the water in the river into a ditch would give a right to all the water in the river.

The Final Findings allow a reasonable amount of water for the lands irrigated by the owners of the Jones Ditch, and surplus water, when available, has been allowed to Short, a later appropriator from the ditch, which flows through his land, the same as if the water had been flowing in the natural channel. The later appropriator is entitled to and is allowed to take the surplus water for his necessary irrigation, the same as he would be if the water had been left to flow in the natural channel, through which either party would have an easement for conveying their needed water. (Ennor v. Raine, 27 Nev. 211.)

WASTE WATER RIGHTS

The well settled principle of the law that appropriation of waste water does not give any right to divert water directly from the river has necessarily been followed. Rights based on appropriations of waste water, as it comes, have been allowed according to their priority or first appropriation for irrigation. As we have seen, some ranches which were originally irrigated by direct water from the river, have for years past been supplied by ample waste water for their needs so that the use of direct water has been discontinued, and the expense of cleaning and maintaining long ditches from the river has been avoided. As stated, in these instances it is provided that the owners may return to the use of direct water as originally appropriated by them, in the event that the waste water becomes insufficient to supply their needs. In the very dry season of 1924 some ranchers depended upon waste water and had a better supply than some of the ranchers entitled to direct water, for which by reason of the drought sufficient could not be obtained. By more economical use the amount of waste water should be curtailed. It is very desirable to have whatever remains over applied again for irrigation of other lands.

STOCK WATER

Many of the ranches not bordering on the river and not having springs on the land have used through the ditches sufficient water in the winter for livestock and domestic purposes. The decree provides that water may be used as heretofore to the extent necessary for supplying livestock and for domestic use. In some other localities these needs in winter are supplied by pumping from wells and trouble with ice in ditches is avoided.

TRANSIT LOSS

Evidence regarding the percentage of loss of water by seepage and evaporation while being conveyed through ditches, is more or less certain or uncertain as to some of them, and as to others regarding which there is no definite proof, there is little to indicate the percentage of loss. Estimates of the transit losses have been made by comparing the soil, the size and grade of the ditches, and the volume of water conveyed. There is no satisfactory evidence regarding the accretions to ditch flows from seepage or waste water coming into the ditches. In the Findings the transit losses are stated as estimates as a guide and convenience in making the diversion, but as the specific allowances are for flows and acre feet amounts applied to the land, the amount allowed for loss in transit may be made more or less than these estimates so as to supply the amount allowed as applied to the land.

RIGHT OF CONVEYING WATER.

Among the first statutes passed regarding water were ones providing for rights of way for ditches across private lands. From an early date the courts have maintained the right of the appropriator entitled to the use of water to convey it through natural channels and ditches. (Ennor v. Raine, 27 Nev.) The act of 1899 provides:

"Section 1. Any stored water for irrigation or other beneficial purposes may be turned into the channel of any natural stream or water course and mingled with its waters, and then be reclaimed, but in reclaiming it, water already appropriated by others shall not be diminished in quantity."

DITCH COMPANY AS CONVEYOR. IRRIGATION RIGHT IN USER. RIGHTS OF CONVEYOR AND USER.

On behalf of the Steamboat Canal Company, the Orr Ditch and Water Company, and the company owning the Highland Ditch, and other companies charging for the delivery of water, it is claimed that the right to the water should be allowed to the companies and not to the users of the water. In fact on behalf of the Government the case was presented on this theory.

In this state, the basis for the right is the beneficial use which has been made by the appropriator or rancher. Statutes and decisions in other states holding that the right belongs, and should be allowed to the company conveying and distributing the water, are of no force here.

The opinions of the federal and state courts, including the Supreme Court of the United States, hold that if there is a conflict the construction of an act of Congress such as the one of 1866 by the federal courts is binding upon state tribunals the same as the construction of a state statute by the Supreme Court of the state is binding upon all federal courts. As Congress by this act has delegated the control of the use of water to the states, the decision of the State Supreme Court in the case of the Presole against the Steamboat Canal Company, to the effect that the one who applies to the irrigation of land, water delivered to him by a ditch company, is the owner of the appropriation right, and that the ditch company or owner of the ditch delivering the water is a conveyor entitled to reasonable payment for conveying and delivering the water, is conclusive in all courts, state and federal, not only against the Steamboat Canal Company, but in all such cases pertaining to water rights in this state. It is useless to go far afield, to pursue strange gods, or to consider the law, statutory or judicial, prevailing in this regard in other states. The local solicitor for the Government and counsel for ditch companies who have claimed that the appropriation rights do not belong to the persons who applied the water to the land may have been led astray by statutes or practices prevailing or decisions in other states.

Water from the Truckee River is delivered under a variety of conditions. Some companies have no appropriation right for the use of the water, and deliver for merely a fixed charge; other companies deliver to stockholders without any charge, excepting assessments sufficient to cover the maintenance and operation of the ditch; some receive water free in return for right of way, previously given, or under reservation made at the time they sold their interest in the ditch; some obtain it at lower rate by reason of a prior contract; some individuals owning ditches deliver water only to their own lands, while others charge for the delivery of part of it along the ditches. As provided by the recommended decree the conditions on which water is to be delivered by ditch companies or conveyors of water to the users, are not determined in this action.

The companies or individuals diverting and conveying the waters are entitled to divert enough to deliver to the users, after transportation loss, the amount allowed them for application to the land.

NO IRRIGATION SEASON

The defendants have testified that ordinarily the irrigating season in the Reno Valley begins about the middle of April, but varies considerably in different years, and lasts for about five or five and a half months.

As there is a great variance in seasons, and in some years which are extraordinary, water may be needed earlier than April or very late in the fall for plowing or for winter grains or other crops, it has been deemed best not to fix any period as an irrigating season, and to allow use of water at any time desired to the extent of the acre foot limit. Under this plan of regulation any of the owners who from force of habit may continue to waste water or to allow it to run longer than necessary on their lands will soon learn that the water they waste will reduce their own allowance and deprive themselves of water at the end of the season unless they are careful and prudent in its application. It is better to have the acre foot limit instead of a fixed or rigid irrigating season with necessarily smaller flows than have been allowed in many instances.

When the water user is given a good flow and a quantity of water measured in acre feet to supply his needs few other restrictions are necessary, and he should be allowed to divert and apply his water in such flows and at such time as will best serve his requirements. An irrigating season of fixed length and specified dates for beginning and ending to fit ordinary years could readily be provided, but apparently would be disadvantageous instead of beneficial, under the conditions prevailing in this, and many other, localities. In parts of this state where no one ever desires to irrigate earlier than April, and where there is an over-abundance of water as soon as the irrigating season begins, and in April, May and June, and there is no storage of the surplus, and little or no water remains for irrigation after the first of August, there is little need for specifying an irrigating season or an acre foot limitation, because irrigating would not be done anyway before a designated irrigating season, and if it were, there would be no loss of water which could be stored, and no water would remain to be used after such season, and the continuous flow would not be long enough to fill an acre foot allowance.

The situation here is different. Within the last three years plowing has been done in February and even in January in the Reno Valley, and in very exceptional years, far apart, it may be desirable to irrigate land for plowing and seeding as early as February, or for winter wheat or grains as late as November or December. The instances in which the use of water for irrigation so early or so late may be rare, but when they occur the owner should be free to use his water, and not be restricted by a defined irrigating season. Winter wheat, if started in the late fall or early winter, with sufficient moisture, matures early and produces a valuable crop without needing the water so late the following summer as other crops. In some of the creeks in this state the water does not run after June, and many of them do not supply water for irrigation after July, and consequently the irrigating season under them is automatically closed before August. To designate an irrigating season for these ending in September, or at any other date, would be unnecessary.

PROVISIONS OF DECREE

The recommended decree has been drawn for the purpose of fixing the priorities and water rights to the Truckee River and its tributaries, and quieting the title thereto, restraining waste, and protecting all parties concerned to the extent of their priorities and needs. The restrictive provisions of the recommended temporary restraining order are similar to those in the decree, except that in the temporary restraining order they are to be in force until the further order of the court and in the decree perpetually unless modification is possible after the term. It is desirable that the decree be put on trial by the temporary restraining order for three years or more, and until it has been tested during at least one dry year. This would be proceeding to a certain extent analogously to the provisions of the state statute of 1921, allowing three years for varying water duties after recommended determinations have been made by the State Engineer and put in force by the Court.

The amount of water allowed by the Final Findings and Recommended Decree is in most instances the same as the user has been obtaining by paying, in the cases where payments have been made, for the delivery of water, and in most other instances 4 to 4.50 acre feet for each acre of land irrigated and under a head or flow usually of 1 to 1.50 inches per acre. Also the Decree provides that only two-thirds of the amount of water in acre feet allowed by the Final Findings for irrigation should be allowed for the irrigation of potatoes, corn, and beets grown thereon. As young alfalfa needs frequent irrigation for a long season and additional amount of 10 per cent of the quantity of water designated in the findings for each user is allowed for the irrigation of his lands when necessary to irrigate and protect this growing crop thereon. Water for livestock and domestic purposes is allowed by the decree to be used as heretofore.

Necessarily if the users on the same ditch have different priorities and there is not sufficient water to meet the allowances for all those with the earliest priorities must be supplied first to the extent of their needs within their allowances.

The quantities of water allowed are stated in miner's inches because this method of measurement is more in use and better understood by the ranchers, and it is also stated in cubic second feet to comply with the state statute and because better understood by engineers. The recommended decree allows water to be used any time for irrigating as the owner may desire, provided the amount applied to the land during the calendar year shall not exceed the quantity in acre feet allowed for the land.

All allowances for irrigation are limited by the seasonal acre feet provisions which vary according to the types of soil and conditions from 3.25 to about 4.75 acre feet. There is a limitation in the recommended decree against the use for irrigation during any calendar month of more than 28 per cent. The quantity of direct water in acre feet allowed by this decree for the land for the season is designated for a nearer equalization in use and for protection among themselves of those who use direct water for irrigation. This limitation does not pertain to waste water which may come in short and varying periods and should be used in large heads when available.

Without this limitation and during years of water shortage some with early priorities or near the heads of the streams or ditches may use an undue quantity of the limited supply of water, and more than is really necessary for their needs to the deprivation and injury of other users.

The provision in the recommended decree is that if it shall appear that the amount of water estimated and allowed to be diverted from the river or stream into any ditch or canal is not sufficient after transportation loss to deliver to the land the flow allowed by the decree for application to the land, the allowance or flow as fixed by the decree for application to the land shall control and there may be diverted from the stream a larger amount than the one estimated for diversion from the stream to the extent necessary to supply the land after transportation loss. The flow of water allowed by the decree for application to the land is designed to assure the users the full amount of their allowance as applied to the land and to protect them against larger transportation loss than estimated by the allowances. In many instances the proof regarding transportation loss was meagre, and the estimates had been made for some of the ditches by comparison of the amount of transit loss shown by the evidence in regard to other ditches and sometimes on the mileage basis where the proofs did not indicate sufficient difference in the soil to make a variation in the transportation loss on the two ditches. The transportation loss varies so greatly according to types of soil, conditions of season and is so affected by waste and drainage and drought, that it is difficult to make accurate estimates even upon close examination of the ditches and soils. The intention has been to allow liberally for transit loss as well as for all other rights, but in actual administration limit the use of water to the terms of the decree. It may appear in some instances that a larger transportation loss should be allowed to the user, if by actual experience the water master may more accurately determine the amount of loss. After the decree has been on trial for a few years as a temporary restraining order the water master and court can more accurately determine the transportation loss.

In some of the ditches unnecessarily large heads of water have been diverted because this would make it more convenient to furnish ample or desired amounts through the ditches, but this practice should be discontinued when it will deprive others of the use of water, and is restrained by the terms of the recommended decree accordingly.

Some of the owners who have been paying for the delivery of water have been raising good crops with a head or flow which is economical or small for hot weather or at a period of maximum demand. They have been receiving the water through measuring boxes which delivered the same flow during the entire irrigating season and in some instances even later. Undoubtedly some of these owners have been producing their good crops with meagre amounts of water which were carefully handled in the hot weather while the head in early spring and late fall was larger than required. It is apparent that if they can have available and use in the period of maximum demand that part of the flow delivered to them in the early spring and late fall, which was in excess of their needs at those periods, to the extent of their allowed acre feet, they could irrigate their lands more easily than they have done in the past and a part of the excess water being delivered to them early and late could be saved. They should be encouraged in irrigating their lands with a flow of one-half inch per acre or less, while other owners have been using one inch per acre or more. There has been inserted in the recommended decree a provision that users allowed a flow of less than one inch per acre may with the consent of the water master, or by his direction, if the ditches will convey the water, use when needed a larger flow than specifically allowed by the decree, up to and not exceeding one inch per acre, provided the amount of water used during any calendar year shall not exceed the seasonal acre foot allowance for the land and shall not exceed the equivalent of the acre foot amount of water which the flow specifically allowed for the land would deliver in five and a half months.

When there is ample water for all users on the stream, the requirement that not more than 28 per cent of the allowance to any user shall be consumed in any month, may not be enforced; for by special provision in the recommended decree, if no objections be made to the water master by other users any of the owners of irrigation water rights may use more than 28 per cent of their allowances in any month, but not exceeding their seasonal acre foot allowances.

Whenever any water user feels that he is not receiving the amount of water to which he is entitled under the decree he should be entirely free to apply to the court or water master for relief.

If, as recommended, the allowance provisions of the recommended decree are put on trial and any of the defendants complain that they cannot properly irrigate their land with the amount of water allowed, it is suggested that the Court appoint an experienced and efficient irrigator to serve at the expense of the complaining defendant and irrigate the land for one or more seasons so that the amount really required for the proper economical irrigation of the land may be more accurately determined and so that more or less water may be allowed accordingly by final decree.

As provided in the recommended decree any of the owners should be allowed to change the form of diversion, and the place, means, manner, purpose, or use of water to which they are entitled, provided they do not injure other persons.

Locked boxes should be so fixed that any who are wasteful of water will receive only their allowance, and be limited to the amount needed and allowed for the land, so that if they use the water when it is not needed they will soon learn that they are wasting their own water and become more careful. No user, who is law abiding and does not desire to use more than his proper allowance of water fixed by the decree should object to receiving his allowance through a locked box, when other boxes are locked so that any who are so disposed cannot surreptitiously take more than their share. Among so many users there are some who may believe they need more water than is really necessary for their lands, and are willing to take more than their allowance if obtainable.

Careful provision should be made in the decree for enforcing its injunctive provisions after it has been put on trial as a temporary restraining order and modifications have been made regarding the allowances so they will assuredly be fair and just and allow the users ample water for their beneficial needs. In order to make proper distribution of the water, and especially in seasons of shortage, it is necessary to have measuring devices or boxes which may be properly set and safely locked under the control of the water master. He should be fully authorized to regulate the water in accordance with the allowances and rights of the owners and to enforce the decree to the extent of preventing any water user from taking water to which he is not entitled, and preventing others from being deprived of water to which they are entitled. He should be careful to require that where water is obtained from two or more sources the aggregate amount of combined water which is being used shall not exceed the amount required for such use as allowed by the decree.

To assure every water user that he will receive the water to which he is entitled, a competent water master should be appointed by the court to enforce the provisions of the decree and the instructions and orders of the court. If any proper orders or directions of the water master made in accordance with the provisions of the decree are disobeyed or disregarded he should be given full power to cut off the water from the owner disobeying or disregarding such proper orders or directions until he complies, to the end that the decree may be promptly enforced. In such instances prompt report of the circumstances thereof should be made to the court.

All owners, at their own expense, should be required to install and maintain proper regulating head gates and locked measuring boxes, or other devices as directed and approved by the water master, whereby the water diverted and to which they are entitled may be regulated and correctly measured and delivered to them.

In the Master's allowances and recommended decree the lands to which the water is applied are described as belonging to the owner of the water right, and it has been the purpose to allow a reasonable amount of water for every acre of land which has been irrigated. The amount of water needed for each particular tract of land has been fixed but it is not intended that the recommended decree or findings shall determine the property rights in the land, other than the rights to the diversion and use of specified amounts of water thereon. Many transfers by deeds, conveyances, and deaths of owners, have occurred while this suit has been pending, and all of these transfers are covered by the recommended decree or findings, and under the law, and by special provisions in the decree, the successors of the prior owners, whoever they may be, although not named, have acquired the rights of their predecessors.

It is provided in the recommended decree that the rights of all parties to this action and of their grantees, assigns, or successors under any transfer or legal succession in interest after the commencing of this action shall not be prejudiced by anything in the decree, and that except as otherwise stated therein the provisions of the decree shall bind and inure to the benefits of the grantees, assigns, and successors in interest of the owners and parties, whether substituted as parties or appearing in this case or named herein or not.

As drawn the recommended decree provides that the stored waters of Lake Tahoe, and of any reservoir, may be turned into and carried in the channel of the natural stream and mingled with the waters thereof and be diverted therefrom for proper uses by the persons entitled thereto.

After the provisions of the recommended decree are put on trial for three years or more, and are tested by a dry year and are finally modified, they may be more safely carried into the final decree of the court. Provisions should be made therein, if possible, for such further changes in the final decree, and especially in regard to water duty and ditch transportation losses, as further time and experience may show to be needful and just. If there is any rule or requirement prohibiting the modification of the final decree after the court term in which it is rendered, some exception to such rule or requirement should be made or provided for decrees pertaining to water rights, because these are based in these arid regions on needs for beneficial use, which differ from other property, in that they vary as time advances and conditions change. Accordingly provisions for the modification of the final decree have been inserted, so that if possible it may be modified in the future in any manner desired.

MOTION TO DISMISS

During the taking of testimony a motion was made to dismiss the case on the ground that the state owned the water, and that the court had no jurisdiction to entertain this action because the state as such owner had not been made a party. Such motion should not prevail, because the state does not own the water and if the state did own the water the United States, as well as any other claimant or water user, could maintain an action to have rights determined. The defendants' rights may be determined as readily in this action as if the state owned the water, and the same as if this suit had been commenced by an individual claimant.

SPECIAL MASTER'S COMPENSATION

It is recommended that the compensation of the Special Master be determined by the Court and ordered paid by the United States, because the suit was instituted at the instance of, and for the benefit of, the United States, and the United States has the greatest interest in the determination of the water rights, but more especially because the work of the Master is in the nature of judicial services such as performed by federal judges, whose salaries are paid by the United States and not charged to litigants. In the event that the Court orders that part of the compensation be paid by the defendants it is recommended that the compensation be first paid by the United States, and that upon entry of decree or final adjustment the payment of the compensation be prorated so that the plaintiff and the defendants, including the power companies, will pay in proportion to the acre feet of water which they are allowed per annum and that the acre feet for the power companies be estimated upon the basis of continuous flow.

FINIS

Upon closing it is a pleasure to acknowledge the appreciation felt for the great assistance rendered, and many courtesies extended by the numerous solicitors who have represented the large number of clients in this action. Regret is expressed for the passing of such eminent lawyers as Judges Downer and Cheney and Jerome L. Vanderwerker, who have fallen in service since the taking of testimony began, and also for the loss of Mr. Robert G. Withers, who ably represented the Government during the years he was in charge of the case, and who has been succeeded by that kindly and proficient Special Assistant to the Attorney General, Hon. Ethelbert Ward.

Appreciation is expressed for the aid given by such distinguished irrigation experts as Harding, Henny and Norcross and by such eminent engineers as L. H. Taylor, who from the time of its initiation for several years was in charge of the Truckee-Carson Project or the construction of the dam and canal; Seymour Case, former State Engineer; E. C. McClellan, Fred Gould, King and Malone, and T. K. Stewart, who has passed on, and who as representative of the defendants in surveying many of the fields, joined with E. P. Osgood, the experienced and efficient engineer for the Government, who has surveyed nearly all the lands and ditches on the Truckee and its tributaries, and who has stood ready to assist the defendants in having all of their irrigated lands surveyed and included.

The highest appreciation is felt for the aid given by practical irrigators and many witnesses who were pioneers in the country, and who had knowledge of the construction of ditches and early appropriations of water, and without whose testimony priorities could not be properly determined. These are men who have been prominent in the community for more than half a century, such as George Peckham, Lorenzo D. Smith, who came with his father to Pleasant Valley in 1858 and is entitled to the earliest of all the water rights, and Orville R. Sessions, who since giving his testimony has passed to the Great Beyond.

GEORGE F. TALBOT,
Special Master.

Carson City, Nevada,

June 12, 1925.

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D

(D continued)

(S continued)

Summary of Irrigation, Truckee Meadows - 1918

Farm	Field Plot	Area ac	Applied Water af/ac	Absorbed Water af/ac	Waste af/ac	Waste %	1st Irrigation	Last Irrigation	Irr Season days	Soils	Crop	;rop Yield Tons/ac
University Stock Farm	1	0.95	2.85	2.57	0.28	10%	5/1/1918	9/2/1918	124	Shallow grit loam in hardpan	New Alfalfa	
	2	0.71	2.85	2.35	0.5	18%	5/2/1918	9/2/1918	123			
	3	0.79	2.89	2.46	0.43	15%	5/2/1918	9/2/1918	123			
	4	0.56	2.87	2.41	0.46	16%	5/2/1918	9/2/1918	123			
	5	0.38	3.13	2.38	0.75	24%	5/3/1918	9/2/1918	122			
	6	0.30	3.02	2.55	0.47	16%	5/3/1918	9/2/1918	122			
Average:			2.94	2.45	0.48	16%			123		2 Cuttings	4.17
Experiment Station Farm	1	0.06	2.98	2.62	0.36	12%	5/9/1918	8/24/1918	107	Shallow clay loam on clay	Old Alfalfa	
North Tract#1	2	0.07	2.63	2.27	0.36	14%	5/9/1918	8/24/1918	107			
	3	0.06	2.79	2.45	0.34	12%	5/9/1918	8/24/1918	107			
	4	0.14	2.44	2.08	0.36	15%	5/9/1918	8/24/1918	107			
	5	0.14	2.29	2.03	0.26	11%	5/9/1918	8/24/1918	107			
	6	0.15	2.30	2.04	0.26	11%	5/9/1918	8/24/1918	107			
	7	0.15	2.14	1.87	0.27	13%	5/1/1918	8/24/1918	115			
Average:			2.51	2.19	0.32	13%			108		2 Cuttings	3.16
Experiment Station Farm	1	0.39	2.45	2.35	0.10	4%	5/9/1918	8/21/1918	104	Deep gravel & loam, mixed	2nd Yr. Alfalfa	
South Tract#1	2	0.48	2.56	2.43	0.13	5%	5/10/1918	9/4/1918	117			
	3B	0.11	2.32	2.29	0.03	1%	5/10/1918	8/15/1918	97			
	3F	0.22	2.83	2.78	0.05	2%	5/10/1918	9/4/1918	117			
	4	0.33	2.34	2.23	0.11	5%	5/10/1918	9/4/1918	117			
	5	0.46	2.07	1.99	0.08	4%	5/10/1918	9/4/1918	117			
Average:			2.43	2.35	0.08	3%			112		3 Cuttings	5.57
Nevada Asylum Farm	1	0.53	3.11	2.97	0.14	5%	5/13/1918	9/10/1918	120	Shallow grit loam on cemented	3rd Yr. Alfalfa	
West Tract	2	0.60	2.94	2.83	0.11	4%	5/13/1918	9/10/1918	120	cobble wash subsoil		
	3	0.39	3.24	3.02	0.22	7%	5/13/1918	9/10/1918	120			
Average:			3.10	2.94	0.16	5%			120			
Nevada Asylum Farm	1	0.49	1.91	1.82	0.09	5%	5/14/1918	8/31/1918	109	Barren cemented cobbles	3rd Yr. Alfalfa	
East Tract	2&3	0.69	1.97	1.88	0.09	5%	5/14/1918	8/23/1918	101	subsoil at top, loamy sand		
	4	0.35	2.39	2.18	0.21	9%	5/15/1918	8/31/1918	108	further out, both underlaid by		
	5	0.27	2.39	2.24	0.15	6%	5/15/1918	8/31/1918	108	nearly clear sand		
Average:			2.17	2.03	0.14	6%			107			
Experiment Station Farm	1	0.14	3.66	3.66	0	0%	5/11/1918	8/27/1918	108	Porous gravel clay loam	Alfalfa	
Official Alfalfa Plats	7	0.14	3.04	3.04	0	0%	5/11/1918	8/5/1918	86	largely on clay		
	12	0.14	3.16	3.16	0	0%	5/13/1918	8/17/1918	96			
Average:			3.29	3.29	0.00	0%			97			

Ref: Data on Water Requirements of Certain Lands in the Truckee Meadows, Nevada Shown by Actual Use of Water on Five Separate Tracts
Demonstrations by: E.P. Osgood, Engineer under direction of S.T. Harding, Consulting Engineer

tabbies EXHIBIT Tab 3

DATA ON
WATER REQUIREMENTS OF CERTAIN LANDS IN
TRUCKEE MEADOWS, NEVADA

Shown by Actual Use of Water on

Five Separate Tracts

Demonstrations by E. P. Osgood, Engineer

Under direction of S. T. Harding, Consulting Engr.

Summary of Irrigation

Truckee-Meadows, Reno, Nevada- 1916.

Tracts & Checks		Irrigation Water Applied (Ac. In.)		Wasted		Soils
University Stock Farm	#1	2.05	2.07	.36	10.0	Shallow silt loam in hardpan
	2	3.05	2.55	.50	17.0	
	3	2.89	2.20	.48	15.0	
	4	2.87	2.41	.45	15.0	
	5	3.15	2.80	.76	23.0	
	6	2.02	2.15	.47	16.0	
Average		2.94	2.46	.49	17.0	
Experiment Station Farm N. Tr. #1	1	2.98	2.53	.35	12.0	Shallow clay loam on clay
	2	2.60	2.27	.36	14.0	
	3	2.79	2.45	.34	12.0	
	4	2.44	2.08	.36	16.0	
	5	2.39	2.03	.36	11.0	
	6	2.30	2.04	.26	11.0	
	7	2.14	1.87	.27	13.0	
Average		2.51	2.19	.33	13.0	
Experiment Station Farm S. Tr. #1	1	2.46	2.36	.10	4.0	Deep gravel & loams, mixed
	2	2.56	2.43	.13	5.0	
	3B	2.62	2.29	.03	1.0	
	3F	2.88	2.70	.06	2.0	
	4	2.24	2.25	.11	5.0	
	5	2.07	1.99	.08	4.0	
Average		2.43	2.35	.08	3.0	
Asylum Farm-West Tr.	#1	2.11	2.07	.14	4.5	Shallow silt loam on cemented pebble wash subsoil
	2	2.94	2.03	.11	4.0	
	3	2.34	2.03	.21	7.0	
Average		2.10	1.94	.15	5.0	
Asylum Farm-East Tr.	#1	1.91	1.82	.09	5.0	Barren cemented cobble subsoil at top, loamy sand
	2 & 3	1.97	1.88	.09	5.0	further out, both underlaid by nearly clean sand.
	4	2.39	2.18	.21	9.0	
	5	2.39	2.24	.11	5.0	
Average		2.16	2.03	.12	6.0	

Summary of Infection (con)

[illegible] - 1919.

Plots & Changes		Infection				
[illegible]	(1)	5.52	1.00	0	0	[illegible]
[illegible]	(2)	2.09	1.04	0	0	
	(3)	2.10	2.15	0	0	
Total & Average		[illegible]	[illegible]	0	0	[illegible]
" 2nd [illegible]		1.06	1.04	0	0	

University Stock Farm — New Alfalfa

1st Change from South

Approximate Size 64 ft. frontage x 660 ft. depth 19½ furrows 650 ft. long.
Area by Planetable 0.946 acs. Grade Av. 2.5 ft. per 100 ft.
Soil: Shallow silt loam 12" [illegible] on a shallow layer of clay resting on hardpan.

1918 Date	Number of Irrigation	Interval Days	Irrigation Water Ac. ft.	Per furrow	Runoff	Head per furrow	Head at front	Total Time	Remarks
									Good alfalfa, no growth. Ground furrowed but dry
May 1	2		.37	.35	.02	5.0	.040	88	5h 30m Ground dry & hard but alfalfa good stand
		23							furrows too small
May 22	3		.30	.27	.03	17.0	.060	114	5h 40m
		13							
June 7	4		.29	.27	.02	7.0	.10	71	5h 50m Washed out in part by intermediate [illegible]
		12							
June 19	5	Av.	.29	.22	.02	8.0	—	—	7h 20m [illegible] on 4 [illegible]
(21)									(1 19 on lower)
		16							
July 5	5	Av.	.24	.22	.04	11.0	.094	144	3h 25m
							.035	108	2h 15m Lower half [illegible]
		10							1st cutting July 4th.
July 12	6	Av.	.14	.13	.01	15.0	.028	130	3h 5m Evenly furrowed, [illegible]
		13							
July 23	7	Av.	.30	.25	.05	10.0	.031	110	5h 15m
		16							
Aug. 8	8	Av.	.35	.32	.03	4.0	.054	103	5h 30m Bottom flooded, runoff [illegible]
		13							
Aug. 21	9	Av.	.35	.32	.04	8.0	.046	75	4h 20m
		17							
Sept 5	10	Av.	.22	.18	.04	20.0	.020	135	6h 30m Head cut down after establishing water in furrows
	Totals		2.86	2.57	.28	10.0			
Sept 19	Rain		.11						Soil samples indicated better irrigation than any applied irrigation [illegible]
Sept 20									2nd cutting — Sept. 20th.

University Check Farm — Hay Alfalfa

2nd Change from South

Approximate Size 51 ft. frontage x 550 ft. depth 12 furrows 550 ft. long.
Area by Planimeter 0.795 acs. Grade Av. 2.3 ft. per 100 ft.
Soil: Shallow grit loam 12" ± thick on a shallow layer of clay resting on hardpan.

1910 Date	Number of Irrigation No.	Interval Days	Irrigation Water Appl'd Av. ft.	Absorb'd	Wasted	Wasted %	Head Per Furrow Sec. ft.	Length of Front in feet	Total Time Irrigat. Hours	Remarks
May 3	1		.63	.55	.07	12.0	.026	132	6h 30m	Av. of changes 4, 5 & 4. [illegible] soil [illegible]
		20								
May 23	2		.28	.20	.15	47.0	.114	52	2h	Flooding. Furrow too small [illegible] direction; ground surface warped, much of water onto next (change).
		16								
June 7	3		Av. .29	.27	.02	7.0	.060	71	3h 30m	Change cut in [illegible] by intermediate feed ditch.
		12								
June 19	4		Av. .40	.40					—	Saturated. Main canal repaired, [illegible] broke in during night. Allow .40 [illegible]
		13								
July 2	5		Av. .25	.24	.01	4.0	.046	76	5h 35m	
										1st Cutting - July 4
		10								
July 12	6		.16	.14	.02	14.0	.081	116	5h 15m	Newly furrowed, middle ditch cut off.
		13								
July 25	7		.27	.22	.05	16.0	.045	75	5h 15m	
		15								
Aug. 9	8		.27	.27	—	1.0	.071	81	3h 20m	Strong head to ends & then flooded.
		12								
Aug. 21	9		.21	.13	.08	40.0	.039	Av. 95	5h 30m	Heavy head, then light head [illegible] measured. Considerable waste [illegible]
		12								
Sept 2	10		.27	.21	.06	20.0	.024	Av. 150	6h 45m	Light head after furrows established.
	Total		2.83	2.38	.50	[illegible]				
Sept 15 Rain			.17							Soil samples indicated better irrigation than any applied irrigation from ditch.
Sept 20										2nd Cutting.

University Stock Farm. New Alfalfa.

3d Charge from South

Approximate Size 68 ft. frontage x 508 ft. depth 16 Furrows 492' to 508 ft. long.

Area by Planimeter 0.750 Acs. Grade Av. 2.8 Ft. per 100 ft.

Soil: Shallow silt loam 10" ± thick on a shallow layer of clay, resting on hardpan.

1926 Date	Number of Irrigation	Interval No. Days	Irrigation Water Appl'd Ac. Ft. per Acre	Abs'b'd	Wasted	%	Head Per Furrow Sec Feet	Feet of Front @ 1 Sec. Ft. Feet	Actual Time Irrig-ing. Hours	Remarks.
May 8	1		.33	.26	.07	22.0	.039	129	6h 30m	Av. of charges 2, 3 & 4. Sec. ?? soil etc.
		20								
May 28	2		.25	.27	.08	17.0	.032	114	5h 20m	
		16								
June 7	3		.33	.26	.07	22.0	.027	84	5h 40m	
		12								
June 19	4		.40	.40	—	—	—	—	—	Saturated. Head broke during night when main canal repaired & back on. Willow 20 [illegible]
		13								
[illegible] 2	5		.30	.24	.04	14.0	.026	140	5h 50m	1st cutting July 2nd.
		10								
July 12	6		.24	.20	.04	14.0	.037	107	4h	Not refurrowed.
		13								
July 25	7		.24	.22	.02	10.0	.034	115	4h	On the furrowed, otherwise could not make furrows wrong direction & water off course.
		15								
Aug. 9	8		.27	.25	.02	6.0	.028	140	6h 5m	
		12								
Aug. 21	9		.29	.22	.07	22.0	.041	97	4h 25m	
		11								
Sep. 2	10		.19	.15	.04	20.0	.016	Av. 200	6h 25m	
	Totals		2.89	2.48	.45	16.0				
Sep. 13	Rain		.13							Soil samples indicated better irrigation than any applied irrigation from ditch.
Sep. 20										3rd cutting.

University Stock Farm   New Alfalfa.

4th Change from South.

Approximate Size 60 ft. frontage x 420 ft. depth 15 furrows 378 to 462 ft. long.

Area by Planetable 0.564 acs.   Grade Av. 2.6 ft. per 100 ft.

Soil: Grit loam, shallow, 12 in. thick on a shallow layer of clay resting on hardpan.

1916 Date	Number of Irrigation No.	Interval Days	Irrigation Water Appl'd Ac. Ft. per acre	Ab'b'd	Wasted	%	Head per Furrow Sec. ft. Each	Feet of Front per Sec.ft. Feet	Actual Time Irrigating Hours	Remarks
May 2	1		.32	.25	.07	22.0	.028	139	4h 00m	Est. of [illegible]
		20								
May 22	2		.33	.27	.06	17.0	.032	114	5h 30m	
		16								
June 7	3		.35	.28	.07	22.0	.047	84	3h 20m	
		12								
June 2?	4		.21	.19	.02	6.0	.023	176	6h 25m	
		13								
July 2	5		.36	.32	.04	11.0	.045	86	3h 55m	
										1st cutting July 4.
		10								
July 12	6		.18	.15	.03	18.0	.057	109	1h 45m	Freshly re-furrowed. Large furrow, fine [illegible]
		18								
July 28	7		.30	.27	.03	10.0	.037	107	6h 40m	
		16								
Aug 9	8		.34	.32	.02	7.0	.019	40	12h 50m	Heavy head, flooding out of furrows.
		12								
Aug 21	9		.24	.15	.09	37.0	.05?	[illegible]	3h 30m	Heavy head to establish, then light head rest of time.
		13								
Sep 2	10		.19	.15	.04	27.0	.018	200	5h 55m	
	Totals		2.87	2.41	.46	16.0				
Sep 15	Rain		.11							Soil samples indicated a better irrigation than any applied irrigation from ditch.
		7								
Sep 20										2nd cutting.

University Stock Farm — New Alfalfa

5th Change from South.

Approximate size 25 ft. frontage x 645 ft. depth 11 furrows 612 to 675 ft. long.

Area by planimeter 0.364 Acs. Grade 2.0 ft. per 100 ft.

Soil: Shallow grit loam, 12" [illegible] on a shallow layer of clay resting on hardpan.

1926 Date	Number of Irrigation	Interval Days	Irrigation Water Acs.	Ac. Ft. per A	Ac. Ft. Wasted	%	Head per Furrow Sec. Ft.	Reach of Stream Feet	Time Hours	Remarks
May 8	1		.40	1.10	.43	43.0	.103 / .078	38 / 135	50m / 8h [illegible]	Heavy head at start; light head to help absorption
		13								
May 21	2		.30	.81	.14	50.0	.073	43	1h 25m	135 x 6. Excessive; 5 furrows on south delayed.
		17								
June 6	3		.25	.22	.03	12.0	.036	125	5h	
		11								
June 19 / 22	4		.28	.25	.03	10.0	--	--	7h 30m	average
		17								
July 2	5		.30	.24	.04	13.0	.023	135	3h 50m	
										1st Cutting July 4.
July 12	6		.20	.15	.05	25.0	.032	140	2h 50m	Freshly re-furrowed
July 25	7		.24	.25	.05	16.0	.037	150	3h 30m	
Aug. 9	8		.22	.13	.03	13.0	.014	200	5h 45m	
Aug. 21	9		.40	.50	.10	25.0	.024	100	4h 30m	
Sept. 2	10		.32	.28	.07	21.0	.010	195	6h 40m	Head too light at start; had to increase it.
	Totals		3.12	2.80	.75	24.0				
Sept 15	Rain		.11							Soil samples indicated a [illegible] than [illegible] applied irrigation from ditch.
Nov. 20										2nd Cutting.

University Stock Farm — New Alfalfa.

[illegible] Change from South.

Approximate Size 42 ft. frontage x 476 ft. depth 12 furrows 440 to 511 ft. long.

Area by Planetable 0.503 Acs. Grade Av. 2.3 ft. ± per 100 ft.

Soil: Shallow grit loam, 10" thick, on a shallow layer of clay resting on [illegible]

1916 Date	Number of Irrigation No.	Interval Days	Irrigation Water App'd	Abs'b'd	Wasted Ac. Ft. p Acre	Wasted %	Head			Remarks
							.056	65	10m	
May 5	1		.55	.30	.25	45.0	.026	135	6h 5m	Heavy head at start, [illegible] lost on [illegible] how much could be absorbed.
		18								
May 21	2		.35	.21	.14	39.0	.072	48	2h 30m	B & 16 excessive account of [illegible] of 3 furrows on south.
		18								
June 8	3		.25	.22	.03	12.0	.025	120	3h	
		11								
June 19	4		.38	.35	.03	8.0	-	-	7h 30m	[illegible]
		13								
July 2	5		.26	.22	.04	15.0	.038	124	2h 50m	
										1st cutting July 4.
		10								
July 12	6		.19	0	.19	0	.106	56	5h	Lowered, run as border check. Considerable [illegible] to surface but proper allowance made. Crop [illegible] out. Flow not checked back.
		13								
July 25	7		.50	0	.50	0	.107	35	15	Border check. Flow checked back to prevent excessive
		15								
Aug 9	8		.51	0	.51	0	.104	34	22m	" "
		12								
Aug 21	9		.28	0	.28	100	.162	19	27m	
		12								
Sept 2	10		.27	0	.27	0	.111	32	2h	Irregular head. Rain [illegible]
	Totals		3.02	2.55	.47	15.0				
	Rain		.11							Soil samples indicated a better irrigation than any applied irrigation from ditch.
Sept 20										

University Stock Farm

Crop Yields

A comparison of crop yields [illegible] by the demonstration [illegible] is afforded by the following figures very kindly furnished by [illegible] (1917) [illegible]

Crop Yields [illegible]

[illegible]

Farms	[illegible]		[illegible]		[illegible] Crop	
	Yield per acre	[illegible]	Yield per [illegible]	[illegible]	Yield per acre	[illegible]
[illegible] our farms	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible] Farm	[illegible]	100	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Experiment Station Farm North Tract (?) Old Alfalfa.

1st. [illegible] from West.

Approximate [illegible] 90 ft. [illegible] furrows 80 to 90 ft. long.

Area by Planimeter 0.050 (?) acs. Grade 5.0 ft. per 100 ft. at top; 0.5 ft per 100' at bottom

Soil: Mostly [illegible] silty loam [illegible]

1916 Date	Number of Irrigation	Interval No. Days	Ac. ft. per acre	[illegible]	[illegible]	[illegible]	[illegible]	Feet	Time of Irrigation hours	Remarks
May 9	1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	127	[illegible]	[illegible]
		14								
May 23	2		.15	.20	[illegible]	[illegible]	[illegible]	1.3	[illegible]	
		13								
June 5	3		[illegible]	[illegible]	[illegible]	[illegible]	.010	200	[illegible]	[illegible]
		12								
June 17	4		[illegible]	.10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		9								
June 26	5		.27	[illegible]	[illegible]	[illegible]	.010	300	[illegible]	[illegible]
		14								
July 10	6		[illegible]	[illegible]	.04	[illegible]	[illegible]	131	[illegible]	[illegible]
		11								
July 21	7		.25	[illegible]	–	1.4	[illegible]	114	39m	[illegible]
		18								
Aug [illegible]	8		.26	.38	–	0.5	[illegible]	[illegible]	40m	[illegible]
		6								
Aug 6	9		.20	[illegible]	–	1.4	[illegible]	79	[illegible]	[illegible]
		16								
Aug 22	10		.23	.38	–	0	.216	65	[illegible]	[illegible]
[illegible]										[illegible]
	Totals		2.98	[illegible]	0.45	1.0				
[illegible] 13	Rain		.11							[illegible]

Experiment Station Farm   North Tract   Old Alfalfa.

[illegible] Change from West.

Approximate Size 27 ft. frontage x 87 ft. depth 9 furrows 90 to 105 ft. long.
Area By Planimeter .0068 acres.   Grade (0.5 ft. per 100 ft. Bot
(5.0 [illegible] Top

Soil: Mostly 6" [illegible] of yellow silt loam on deep yellow clayish subsoil.

1918 Date	Number of Irrigation & Interval No	Days	Irrigation Water App'd Ac. ft. per acre	Abs'd	Wasted	%	Head per furrow sec. ft.	Feet of front per 100 ft.	Actual time irrigating hours	Remarks:-
										Subsoil came close to surface over large part
										of area & badly sod-bound.
May 9	1		.34	.32	.15	14.0	.016	137	1h 50m	
		14								
May 23	2		.25	.20	.05	[illegible]	.014	125	1h	
		13								
June 5	3		.44	.32	.12	7.6	.010	200	3h 45m	
		12								
June 17	4		[illegible]	.16	.04	25.0	.008	3.74	2h 50m	Whole [illegible] to [illegible]. See chart 1.
		9								
June 26	5		.27	.21	.06	[illegible]	.010	300	2h 15m	
		15								1st Cutting.
July 10	6		.24	.20	.04	17.0	.017	191	3h 10m	[illegible] to whole tract. [illegible]
		11								
July 21	7		.22	[illegible]	0	1.0	.052	109	37m	4 applications 15, 15, 14 & [illegible] min. during 1h [illegible]
		12								
Aug. 2	8		.23	.23	0	.5	.036	84	43m	5 " " during 1h 55m
		6								
Aug. 8	9		.12	.12	0	0	.027	34	14m	2 applications 9 & 5 min. during 20 m.
		16								
Aug 24	10		.25	.24	0	0	.034	55	25m	3 " , 10, 10 & 3 min. during 1h 18m
Sep. 2										2nd Cutting.
	Totals		2.65	2.47	.36	16.0				
										Water broken silt loam into clay [illegible]
Jan 11	Rain		.11							[illegible] more,
										[illegible]

[illegible] Old alfalfa.

3rd [illegible] from West.

[illegible] 1.0 ft. depth 3 furrows 100 to 150 [illegible]
(0.5 ft. per 100 ft. Bot.
[illegible] 0.0[illegible] [illegible] (0.0 [illegible] Top

[illegible] of [illegible] loam on [illegible], clayish subsoil.

1916	Number of Irrigation & [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Head of [illegible]	Total Time Irrigat-ing	Remarks :-
May 7	1	[illegible]	[illegible]	[illegible]	[illegible]	.016	[illegible]	1h [illegible]	
	14								
May 22	2	[illegible]	[illegible]	[illegible]	[illegible]	.0[illegible]	[illegible]	[illegible]	
	15								
June 6	3	.31	.20	.10	[illegible]	[illegible]	[illegible]	[illegible] 40m	
	12								
June 17	4	[illegible]	.18	.0[illegible]	[illegible]	.02[illegible]	[illegible]	[illegible] 50m	[illegible]
	9								
June 26	5	.7	.1	[illegible]	[illegible]	.02[illegible]	30[illegible]	[illegible] 15m	
									1st cutting June 29.
	16								
July 10	6	[illegible]	[illegible]	.04	1.0[illegible]	.030	121	[illegible] 10m	[illegible]
	11								
July 21	7	[illegible]	[illegible]	0	0	.036	83	40m	[illegible] lications: 17,15, [illegible]
	18								
Aug. 8	8	.41	.45	0	1.0	.035	54	46m	[illegible] 27m & 10m, 6h 29m [illegible]
	16								
Aug. 24	9	.73	.20	0	0	.031	40	55m	[illegible] 21m & 14m, 20m [illegible]
	*								
Sep 8									2nd cutting.
	Totals	[illegible].79	[illegible].16	.3[illegible]	12.0				
Sep 12	Rain	.11							[illegible]
									[illegible]
									[illegible]

Experiment Station Farm. North Tract. Old Alfalfa.

4th Change from West.

Approximate size [illegible] ft. frontage x 1[illegible] ft. depth 15 furrows 155 to 160 ft. long.

Area [illegible] 0.14 [illegible] [illegible] 1.[illegible] ft. per 100 ft.

Soil [illegible] yellow [illegible] deep, yellow, clayish [illegible] soil.

1.18 : Date	Number of Irrigation	Interval Days	Irrigation water Applied	Absorbed	Wasted	%	Per furrow sec. ft.	Feet of run	Time Irrigating Hours	Remarks
			Ac. Ft. per Acre							
May 9	1		.31	.26	.05	1[illegible]	.052	93	1h 16m	
		14								
May 23	2		.25	.20	.05	20.0	.1[illegible]	13[illegible]	1h	
		13								
June 6	3		.[illegible]	.23	.10	2[illegible]	.0[illegible]	[illegible]	2h 40m	
		13								
June 17	4		.22	.16	.06	[illegible]	.0094	327-	2h 50m	Whole tract at once. [illegible]
										[illegible]
		11								
June 28	5		.21	.18	.03	27.0	.011	376	2h	[illegible] 5
June 29										1st Cutting.
		12								
July 10	6		.24	.20	.04	17.0	.01[illegible]	131-	2h 10m	Whole tract at once. [illegible]
		14								[illegible] 5 & 7.
July 24	7		.22	.22	0	1.0	.027	111	1h 40m	5 Applications 25 & 25 [illegible]
		15								
Aug 8	8		.21	.21	0	1.0	.0[illegible]	39	1h 10m	2 applications 50 & 20 min, [illegible]
		16								
Aug 24	9		.19	.19	0	0	.016	70	54m	2 [illegible] 42 & 12 [illegible]
Sep 22										2nd Cutting.
	Totals		2.44	2.05	.35	15.0				
Sep 13	Rain		.17							[illegible] into [illegible]
										crop vigorously. [illegible]
										took it in [illegible]

[illegible] Alfalfa.

[illegible] from West
Approximate [illegible] 76 [illegible] 135 [illegible] depth [illegible] 150 to 159 ft. long.
[illegible] 0,[illegible] [illegible] 1.0 [illegible] per 100 ft.
[illegible] soil [illegible] subsoil.

1913 Date	Number of Irrig. No.	Interval Days	Water applied (Acre ft. per acre) Gross	Absorb'd	Wasted	[illegible]	Head per furrow Each	Feet of front reached	Time	Remarks
May 9	1		.5	.44	.01	6.6	.035	86	1h	
		15								
May 24	2		.18	.1[illegible]	.0[illegible]	12.0	.037	112	55m	
		13								
June 6	3		.[illegible]	.17	.0[illegible]	[illegible]	[illegible]	95	1h	
		11								
June 17	4		.[illegible]	.16	[illegible]	[illegible]	.09[illegible]	[illegible]	[illegible]	[illegible] whole tract at once. [illegible]
		11								
June 28	5		.24	.18	.[illegible]	7.0	.0[illegible]	76	[illegible]	
June 29										[illegible] cutting.
		13								
July 10	6		.[illegible]4	.[illegible]0	.04	15.[illegible]	.[illegible]	191	[illegible]h 10m	[illegible] tract at once [illegible]
		14								
July 24	7		.31	.31	0	1.0	.0[illegible]	135	1h [illegible]	[illegible] applications: 10, 20 [illegible]
		15								
Aug 8	8		.30	.30	0	1.0	.0[illegible]	84	1h [illegible]m	[illegible] 45 & [illegible]
		16								
Aug 24	9		.[illegible]	.32	0	0	.05[illegible]	54	46m	[illegible]
Sep. 2										[illegible] cutting.
	Totals		[illegible].29	[illegible].03	.[illegible]	11.0				
Sep. 13	Rain		.11							[illegible] loam [illegible] clay [illegible]
										[illegible]
										rain, [illegible]

[illegible] Station Farm [illegible] Test [illegible] Alfalfa.

[illegible] Irr. Test.

Approximate size 39 ft. frontage x [illegible] ft. depth [illegible] furrows 105 ft. long.

Area [illegible] Grade [illegible] per 100 ft.

Soil: [illegible]

1918 Date	Number of irrigation & interval: No.	Days	Irrigation water: Ac. ft. applied	Ac. ft. absorbed	Wasted	Head per second ft.	Head per second ft. per furrow	Feet of furrows & [illegible]	Time: Hours	Remarks
May 9	1		.30	.27	.03	10.0	.016	130	[illegible]	
		16								
May 24	2		.18	.15	.03	10.0	.017	115	50m	
		13								
June 6	3		.23	.17	.06	10.0	.032	38	1h	
		11								
June 17	4		.22	.16	.06	10.0	.025	247	2h 10m	Whole tract at once. [illegible]
		11								
June 28	5		.23	.19	.04	15.0	.011	60	3h	
June 29										1st cutting.
July 10	6		.24	.20	.04	15.0	.016	151	2h 10m	Whole tract at once. See [illegible]
		14								
July 24	7		.32	.32	0	1.0	.033	107	1h 30m	3 applications, 65, 20 & 10 m [illegible]
		15								
Aug. 8	8		.29	.29	0	1.0	.033	91	1h 10m	2 " 50 & 20m. [illegible]
		16								
Aug. 24	9		.29	.29	0	1.0	.035	66	45m	2 " 35 & 11m [illegible]
Aug. 28										2nd cutting.
	Totals		2.50	[illegible]	[illegible]	11.0				
										[illegible]
	Rain		.11							[illegible]
										[illegible]

[illegible] Station Farm [illegible] Tract Old Alfalfa
7th Change from West.

156

Approximate size 37 ft. frontage x ~~165~~ 156 ft. depth 12 Furrows 153 to 159 ft. long.
Area by Planimeter 0.145 Acs. Grade 0.7 ft. per 100 ft.
Soil: About 12" of yellow grit loam on deep, yellow, clayish subsoil.

1916 Date	Number of Irrigation	Interval Days	Irrigation [illegible]	[illegible]	[illegible]	%	Head Per Furrow Sec. ft.	Feet of Front [illegible]	Actual Time Irrigating	Remarks
May 1	1		.30	.27	.03	10.0	.016	190	2h 45m	
		16								
May 24	2		.18	.16	.02	11.0	.027	112	55m	
		13								
June 6	3		.23	.17	.06	26.0	.034	93	1h	
		11								
June17	4		.22	.16	.06	27.0	.009+	337–	3h 30m	Av. [illegible]
		11								
June28	5		.23	.19	.04	17.0	.011	230	4h	
June29										1st cutting
		12								
July10	6		.24	.20	.04	17.0	.016+	192–	5h 10m	Av. Whole tract at once. See Change 4.
		14								
July24	7		.21	.21	0	1.0	.041	100	1h 0m	3 Applic: 40, 10, & 10 min. [illegible]
		15								
Aug 8	8		.25	.25	0	1.0	.036	86	1h	3 Applic: 40 & 20 min., [illegible]
		16								
Aug 24	9		.28	.27	.01	3.0	.053	85	49m	2 Applic 32 & 16 min., 1hr. [illegible]
Sep 21										2nd Cutting
Total			2.14	1.87	.27	13.0				
Sep 13	Rain		.11							Got thru grit loam into clay & started pasture grow vigorously. About .14" more of rain, later, took it into winter in fine shape.

Experiment Station Farm

Crop Yields

North Tract - Old Alfalfa

Acres	Duty of Water Acre Ft. per A.	1st Cutting Yield per Acre Tons	2nd Cutting Yield per Acre	Total - Yield per Acre
0.77	[illegible]	1.05	1.21	[illegible]

South Tract - New Alfalfa

Check	Duty Acre Ft. per A.	Area Acres	Yields Lbs.	Tons per A.	Crop
1	[illegible]	[illegible]	[illegible]	1.09	1st Crop
2	2.66	[illegible]	[illegible]	[illegible]	"
3	2.37	[illegible]	[illegible]	[illegible]	"
4	[illegible]	[illegible]	1405	[illegible]	"
5	2.07	[illegible]	[illegible]	[illegible]	"
[illegible]		[illegible]	[illegible]	[illegible]	1st Crop
"		"	[illegible]	[illegible]	2nd "
"		"	[illegible]	[illegible]	3rd "
Total	[illegible]	[illegible]	[illegible]	[illegible]	Three Crops

[illegible]

[illegible]

[illegible]

1916 Date	Number of irrigation	Interval in days								Remarks
May [illegible]	1		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
		[illegible]								
June 1	2		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
June 17	3		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]										[illegible]
July [illegible]	4		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		17								
July [illegible]	5		.44	.46	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		20								
Aug 15	6		.26	.33	0	0	.04	[illegible]	[illegible]	[illegible]
Aug. 21		30								[illegible]
Totals	7		[illegible]	[illegible]	[illegible]	[illegible]				
Sept 15	Rain		.11							[illegible]
Oct. 8			[illegible]							[illegible]

Experiment Station Farm. South Tract (Con). New Alfalfa
(2nd year)

[illegible] from north.
[illegible] 70 ft. frontage x 280 ft. depth [illegible] furrows 280 ft. long.
[illegible] 0.37 [illegible] 1.0 ft. per 100 ft.
[illegible]

1918 Date	Number of Irrigation	Interval days	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Actual Time	Remarks
										[illegible]
May 10	1		.12	.10	.01	[illegible]	[illegible]	[illegible]	1h [illegible]	[illegible] crop.
		21								
May 31	2		[illegible]	.26	.04	[illegible]	[illegible]	[illegible]	1h 0m	
		15								
June 15	3		.45	[illegible]	[illegible]	[illegible]	[illegible]	91	3h 0m	
June 28 & 29										1st cutting.
		24								
July 9	4		.42	.39	.03	[illegible]	.037	45	1h 20m	
		17								
July 26	5	26	.35	.34	.02	5.0	.037	45	1h 10m	
Aug 15	6		.27	.26	.01	2.0	.049	51	1h 11m	Was flooded; very little waste allowed.
Aug 21										2nd cutting.
		20								
Sep 4	7		.30	.30	0	0	.024	55	1h 10m	Waiting on choked furrows. Was flooded quite heavy.
Totals	7		[illegible]	[illegible]	.13	[illegible]				
										Soil sample showed moisture [illegible]
Sep. 15	Rain	.11								[illegible]
										[illegible]
Oct. 8										[illegible]

[illegible] Station [illegible] – [illegible] on Alfalfa.
(2nd year)

[illegible]

Approximate [illegible] ft. [illegible] 2 .50 [illegible] 7 furrows 350 ft. long
[illegible] 1.3 ft. per 100 ft. long.
[illegible] irregular.

1918 Date	Number of Irrigation	Interval	Irrigation [illegible]				Feet of furrow	Time of irrigat-ing	Remarks
May 16	1		1.38	[illegible]	[illegible]	[illegible]	[illegible]	30m	Flooding 9 furrows. No level yet.
		22							
June 7	2		[illegible]	[illegible]	[illegible]	[illegible]	14	17m	Border check from now on.
		14							
June 21	3		[illegible]	[illegible]	[illegible]	[illegible]	16	19m	
[illegible]									1st cutting.
		24							
July 9	6		.34	[illegible]	[illegible]	.27	14	13m	
		17							
July 26	5		[illegible]	[illegible]	[illegible]	[illegible]	13	20m	
		20							
Aug 15	6		[illegible]	[illegible]	[illegible]	.185	16	[illegible]	
Aug 21									[illegible] cutting.
		20							
Sep 4	7		.36	.43	0	0	[illegible]	18	[illegible]
Totals	7		2.32	[illegible]	.63	1.0			
									[illegible]
Sep 15	Rain		.11						[illegible]
									[illegible]
									[illegible]
Oct 8									3rd cutting.

Experiment Station Farm [illegible] Tract [illegible] Alfalfa
(2nd year)

[illegible]

1916 Date	[illegible]
May 19	[illegible]
June 1	[illegible]
14	[illegible]
June 1[illegible]	[illegible]
June 2[illegible]	[illegible]
24	[illegible]
July [illegible]	[illegible]
17	[illegible]
July [illegible]	[illegible]
20	[illegible]
Aug. [illegible]	[illegible]
Aug. [illegible]	[illegible]
29	[illegible]
Sep. 4	.44 [illegible]
Totals	[illegible]
[illegible]	[illegible]
Oct. 6	[illegible]

80

Experiment Station Farm South Tract, New Alfalfa. (2nd Year)

[illegible] ft. Strip from North.

Approximate size 64 ft. frontage x 250 ft. depth 16 furrows 250 ft. long.

Area by planetable 0.327 Ac. Grade 1.6 ft. per 100 ft.

Soil: Gravelly silt, [illegible] sand loam. Irregular.

1916 Date	Number of Irrigation No.	Interval Days	Irrigation water App'd	Abs'd	Wasted	Ac. Ft. per Acre	Head per furrow Sec. ft.	Head ft.	Actual Time Irrigating Hours	Remarks:-
										Side hill and very gravelly at head.
May 10	1		.55	.54	.01	5.6	.071	42	1h 5m	Considerable care required to distribute.
		21								
May 31	2		.31	.29	.02	8.0	.102	40	40m	
		15								
June 15	3		.35	.33	.02	8.0	.077	39	1h	1st cutting June 26 - 29.
		24								
July 9	4		.31	.29	.02	6.0	.060	37	51m	
		17								
July 26	5	20	.44	.42	.02	4.0	.082	48	1h 3m	
Aug 15	6		.27	.26	.01	4.0	.071	42	50m	
		20								2nd cutting Aug. 21
Sep 4	7		.31	.31	0	0	.063	48	1h 4m	Good flooding of bottom half here.
Totals	7		2.54	2.43	.11	5.0				
Sep 15	Rain		.11							Soil sample shows moisture [illegible]
										[illegible] fine [illegible] about [illegible] of
										[illegible] [illegible] took
										moisture into [illegible].
Oct. 6										3rd cutting, Oct. 6.

5046

Experiment Station Farm. South Tract. New Alfalfa. (2nd year).

[illegible] from north.

Application [illegible] 250 ft. long.

[illegible] Grade 1.4 ft. per 100 ft.

[illegible]

1918 Date	Number of application	Rain fall	Irrigation water				[illegible]	Cost of [illegible]	Time of irrigation	Remarks:—
May 16	1		.40	.35	[illegible]	[illegible]	[illegible]	52	1h 46m	
		21								
May 31	2		[illegible]	[illegible]	.02			41	[illegible]	
		[illegible]								
June [illegible]	3		[illegible]	.27	.02			51	1h [illegible]	
										[illegible]
		[illegible]								
July 9	4		[illegible]	[illegible]	[illegible]		[illegible]	51	1h 10m	
		17								
July [illegible]	[illegible]	20	[illegible]	.24	.01	[illegible]	[illegible]	60	[illegible]	
Aug. [illegible]	[illegible]		.47	.26	.01	1.50	.031	69	1h 10m	
		20								[illegible]
Sept. 4	7		.26	[illegible]	0	0	.04[illegible]	66	1h 17m	Good [illegible]
Totals	7		[illegible]	[illegible]	.08	[illegible]				
Oct. 19	Rain		.13							[illegible] moisture [illegible]
										[illegible] more of rain
										[illegible]
										[illegible] winter
Oct. 8										[illegible]

Nevada Hayles Farm [illegible] Old Alfalfa (3rd Yr.?)

[illegible] from West

Approximate size 75 ft frontage, width 60 for [illegible] 324 to 330 ft long

Area by Planimeter .520 acs. Grade 1.6 ft per 100ft., [illegible] (Level for 60 ft at head)

Soil: Fair grit loam 14" thick [illegible] brown cemented boulder & gravel subsoil [illegible]

1916 Date	Number of Irrigation No.	Interval Days	Irrigation Water Applied	Ac. ft per Acre Abs'd	Wasted	%	Head Per Furrow sec ft	Amount of Head per 100 ft	Actual Time of Irrigating Hours	Remarks
May 13	1		.40	.40	0	1.0	.033	105	6h 15m	1, 2 & 3 together. No levee control. [illegible]
		15								head flooded. Hard irrigating.
May 29	2		.28	.24	.04	[illegible]	.032	45	1h 5m	Levee control for flat from now on
		14								
June 12	3		.51	.50	.01	2.5	.077	47	1h 40m	
		19								1st cutting, June 18th.
July 1	4		.01	.21	.05	16.0	.049	40	1h 5m	
		8								
July 9	5		.24	.24	.0	1.0	.050	40	50m	
		12								
July 21	6		.34	.33	.01	4.0	.07	47	1h 25m	
		10								
July 31	7		.27	.26	.01	[illegible]	.066	55	1h 40m	
		10								
Aug 10	8		.28	.27	.01	5.0	.062	34	1h 5m	2 applications, 40m apart (45 & 20m)
		12								2nd cutting Aug. 13 or 14th.
Aug 22	9		.39	.38	.01	2.5	.037	34	1h 25m	2 applications, 40m apart. (1h & 25m)
		9								
Aug 31	10		.23	.23	0	0.0	.074	49	1h	2 applications, 45m & 15m, 30m apart
		10								
Sep 10	11		.13	.13	0	0	[illegible]	33	14m	2 applications, 12m & 52m, 8m apart
Totals	11		3.11	2.97	.14	[illegible]				
Sep 13	Rain		.11							In this soil rain would have been ample for [illegible]
										irrigation of Sept. 10th [illegible]
Oct. 5										3rd cutting, Oct. 5th.

[illegible] West Tract Old Alfalfa (3rd Yr.?)

[illegible]

[illegible] 80 ft. frontage [illegible] ft. depth 25 furrows 512 to 534 ft long.

Area by [illegible] 0.401 acs., grade 1.8 ft. per 100 ft., but (Level for 75 ft. at head)

Soil; [illegible]

1918 Date	Number of Irrigation / Interval days	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Hours	Remarks
									[illegible]
									[illegible]
May 17	1	.40	.40	0	[illegible]	.024	150	1h [illegible]	No level control [illegible]
	16								
May [illegible]	2	.22	.27	.01	[illegible]	.035	30	1h	[illegible]
	24								
June [illegible]	3	.21	.21	0	11.0	.035	53	1h 5m	[illegible]
	19								1st cutting, June 18th
July [illegible]	4	.31	[illegible]	.03	[illegible]	.033	56	1h 20m	
	8								
July 9	5	.24	.23	.01	[illegible]	.070	62	1h	
	12								
July 21	6	.24	[illegible]	.01	[illegible]	.016	55	1h 6m	
	10								
July 31	7	[illegible]	.26	.01	15.0	.074	67	1h 20m	
	10								
Aug 10	8	.28	.27	.01	16.0	.057	60	1h 15m	2 Applns [illegible]
	12								2nd cutting, Aug. 13 or 14th
Aug 22	9	.31	.29	.02	17.5	.054	67	1h 37m	2 Applns [illegible]
	9								
Aug 31	10	.22	[illegible]	0	3.0	.057	62	1h 10m	2 Applns [illegible]
	10								
Sep 10	11	.16	.16	0	0	.056	64	50m	2 Applns [illegible]
Totals	11	2.94	2.82	.11	[illegible]				
Sep 13	Rain	.11							[illegible]
									[illegible]
Oct. 5									3rd cutting, Oct. 5th

[illegible] Test Tract 01 Alfalfa (3rd Yr.?)

[illegible] Change [illegible]

Approximate [illegible] average x 25% ft. depth 21 furrows 156 to 512 ft. long.

Area [illegible] 0.[illegible] acre. Grade 2.0 ft. per 100 ft., [illegible] (level for 70 ft. at [illegible])

Soil: Shallow [illegible] loam 11" [illegible] thick on a [illegible] compacted boulder & gravel subsoil [illegible]

1918 Date	Number of Irrigation	Interval Days	Irrigation Water Applied Ac. Ft.	[illegible]	[illegible]	[illegible]	Head Per Furrow sec. ft.	Water front [illegible]	Actual Time Irrig. Hours	Remarks
										Surface [illegible] ditch
May 16	1		.40	.40	0	1.0	.026	156	4h 15m	No levee control. [illegible] change
		16								
May 29	2		.27	[illegible]	.06	16.0	.051	72	1h 15m	
		14								
June 1[illegible]	3		.26	[illegible]	[illegible]	12.0	.042	90	1h 10m	Cotton flooded [illegible] other [illegible]
										[illegible]
		19								1st Cutting, June 18th
July 1	4		[illegible]	[illegible]	.04	1[illegible]	.031	60	1h 20m	
		8								
July 9	5		.26	.22	.0[illegible]	1[illegible]	.070	47	45m	
		12								
July 21	6		[illegible]	.21	[illegible]	[illegible]	.06[illegible]	44	25m	
		10								
July 31	7		[illegible]	[illegible]	.0	[illegible]	.07[illegible]	40	3h	
		10								
Aug 10	8		.32	.30	.0	[illegible]	.074	50	55m	
		12								[illegible]
Aug 2[illegible]	9		.27	[illegible]	.01	[illegible]	.036	68	55 m	[illegible]
		8								
Aug 31	10		.24	[illegible]	0	[illegible]	.0[illegible]	65	[illegible]	[illegible]
		10								
Sep 1[illegible]	11		.2[illegible]	.19	.0[illegible]	[illegible]	.038	[illegible]	50m	[illegible]
Totals	11		[illegible]	[illegible]	[illegible]					
										[illegible]
										[illegible]
Oct 5										2nd Cutting, Oct. 5th

[illegible] [illegible] Farm [illegible] Tract Old Alfalfa (3rd year?)

1st [illegible] from [illegible].

Approximate size 47 ft. frontage x 480 ft. depth 15 furrows 411 to 480 ft. lo[illegible]

Area by [illegible] [illegible] [illegible] [illegible] ft. per 100 ft. [illegible] ft. per 100 ft.

Soil: [illegible] to rock [illegible] loamy [illegible]

1916 [illegible] of: Irrigation [illegible]

Date [illegible]

		0								
[illegible] 1	1		[illegible]	[illegible]	[illegible]		[illegible]		[illegible]	
		1								
[illegible] 2	2		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
June 11	5		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	
		3								
June [illegible]	6		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
July 1	[illegible]		[illegible]	.48	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		4								
[illegible]	[illegible]		.7	.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		4								
July 1st	7		.10	.39	.01	[illegible]	[illegible]	[illegible]	[illegible]	
		5								
July [illegible]	8		.14	.13	.01	[illegible]	.007	[illegible]	[illegible]	
		6								
Aug. 8	9		.10	.09	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
		7								
Aug 16	10		.12	.11	.01	[illegible]	[illegible]	.07	[illegible]	
		10								
[illegible] 22	11		.07	.07	0	0	.080	.60	[illegible]	
		8								
[illegible] 31	12		.17	.17	0	2.0	.090	[illegible]	[illegible]	
Totals	12		[illegible]	1.32	.09	[illegible]			[illegible]	
Avg.										
[illegible] 12	[illegible]	.11							[illegible]	

[illegible] (2nd year?)

[illegible] depth 24 furrows 380 to 411 ft. long.

[illegible] per 100 [illegible] 400 ft.

[illegible] 100 [illegible]

1923 Date	Number of irrigation	Interval [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	per [illegible] of [illegible]	[illegible]	Total time irrigating hours	Remarks
June 14	1		.83	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	
[illegible]	2		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
June 13	3		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
June 26	4		[illegible]	.47	0	[illegible]	[illegible]	[illegible]	[illegible]	
		11								[illegible]
July 1	5		.35	.14	.01	4.0	.100	85	[illegible]	
		4								
July 6	6		.25	.20	.05	20.0	—	—	—	Allow [illegible]
		15								
July 10	7		.36	.34	0	[illegible]	.011	97	[illegible]	[illegible]
		8								
July 22	8		.22	.42	0	[illegible]	[illegible]	[illegible]	[illegible]	
		8								
Aug. 5	9		.10	.40	0	[illegible]	.011	82	[illegible]	
		7								[illegible]
Aug. 19	10		.20	.100	0	1.0	.050	50	[illegible]	
										[illegible]
Aug. 26	11									[illegible]
										[illegible]
[illegible]	11		1.71	.230	.09	[illegible]				[illegible]
										[illegible]
										[illegible]
										[illegible]

Nevada Asylum Farm   East Tract.   Old Alfalfa (2nd yr?)

4th Change from East.

Approximate size 45 ft. frontage x 968 ft. depth 10 furrows 968 ft. long.

(2.7 ft. per 100 ft.

Area by planimeter [illegible] Acs.   Grade([illegible] ft. " " "

Soil: A little subsoil [illegible]

1916 Date	Number of Irrigation & Interval (Days)	Irrigation Water: Applied	Used	Wasted	Head: Per furrow: Sec ft.	Actual Rate of Advance: Feet per Hr.	Time to irrigate 968 ft.	Remarks
May 15	1 / 15	.08	.08	0	1.0	.088	50	72 [illegible]
May 30	2 / 28	.19	.19	0	4.0	.047	88	31 [illegible]
June 11	3 / 9	.28	.25	.03	8.0	.025	180	[illegible]
June 20	4 / 11					.004 / .021	325 / 325	[illegible]
July 1	5 / 6	.15	.13	.02	15.0	.080	52	20 [illegible]; 1st cutting June 27th
July 5	6 / 12	.27	.25	.05	30.0	-	-	Allow for waste turned on by someone [illegible] to dry furrows [illegible]
July 19	7 / 5	.40	.40	0	4.0	.085	48	[illegible]
July 26	8 / 8	.24	.23	.01	3.0	.080	80	[illegible]
Aug 5	9 / 7	.07	.05	.02	11.0	.104	80	[illegible]
Aug 10	10 / 12	.09 / .20	.09 / .16	0 / .04	4.0 / 24.0	.095	92	[illegible]
Aug 23	11	.07	.07	0	0	.072	40	[illegible]
(Aug 29)	[illegible] 4							[illegible]
Aug 31	12	.25	.20	.05	20.0			[illegible]
Totals	12	[illegible]	[illegible]	[illegible]	9.0			[illegible]
Sep 15	[illegible]	.17						[illegible]

[illegible] Test Tract. Old Alfalfa (3rd year)

5th Flume from East.

Approximate size 20 ft. frontage x 800 ft. depth: 1 furrows [illegible] ft. long.

(2.1 ft. per 100 ft.

Area by [illegible] 0.367 acs. Grade (5.2 " " "

Soil: A little [illegible] at top but mostly good loam sand on clear sand.

1918 Date	Number of Irrigation No.	Interval Days	Irrigation water Applied In.	Absorbed In.	Wasted In.	Wasted %	Head per furrow sec. ft.	Cost of water front per 100 ft. Cent	Time of irrigating Hours	Remarks
May 15	1		.34	.34	0	1.9	.063	85	1h 40m	
		15								
May 30	2		.19	.19	0	[illegible]	.017	62	1h 05m	
		12								
June 11	3		.18	.13	.05	(.0	.023	128	5h 30m	Head of .050 s.f. [illegible] furrow [illegible]
		9								(1st [illegible])
June 20	4		.14	.14	.0	.0	(.004	(806	(7h 40m	
							(.001	(270	(21	
		11								1st cutting June 24th.
July 1	5		.18	.15	.03	15.0	.020	63	50m	
		4								
July 5	6		.28	.20	.08	30.0	–	–	–	All [illegible]
		13								[illegible]
July 18	7		.13	.13		.0	.079	40	25m	
		8								
July 26	8		.12	.12	0	4.0	.100	23	22m	
Aug 3	9		.13	.12	.01	10.0	.106	22	15m	
Aug 10	10		.13	.13	0	1.0	.115	33	18m	2 [illegible]
										2nd cutting August 10th [illegible]
Aug 22	11		.09	.09	0	.0	.097	30	25m	([illegible])
			.20	.16	.04	20.0	–	–	–	([illegible])
Aug 31	12		.15	.15	0	4.0	.097	33	55m	2 [illegible]
										1st to 15th of Sep. [illegible]
Totals	12		2.39	2.24	.15	6.0				
Sep 15	Rain		.11							Soil sample showed good [illegible] of this [illegible]
										not wet since last irrigation [illegible]

Experiment Station Farm — Official Alfalfa Plats - Series of 12

[illegible] Plat [illegible] South
Approximate size 17 ft. [illegible] x 250 ft. [illegible] 7 furrows 2.0 ft. [illegible]
Nominal area 1/7 acre. Grade 1.2 ft. per 100 ft.
Soil: Gravel & [illegible] loam, [illegible] at [illegible] 4 ft.

1918 Date	Number of Irrigation	Irrigation Water					Head per furrow		[illegible]		Pipes	
		Observed	Applied	Absorbed	Wasted						Actual time [illegible]	
1st Crop Irrigation under direction of Univ. of Nevada										5 pipes	3 pipes	1 pipe
May 31	1		.75	.75	0	0	.037	102	[illegible]	[illegible] to 1.21	1.21 to [illegible]	[illegible]
	26											
June 6	2		.75	.75	0	0	.038	102	[illegible]	[illegible]	2.00 to 5.20	[illegible] noon
	12									[illegible] to 11.45		
June 13	3		.75	.75	0	0	.031	102	[illegible]	1.00 to [illegible]		
										[illegible]		
Totals	3	2.25	2.25	2.25	0	0						[illegible]
	22								[illegible]			
July 12	4		.48	.48	0	0	.078	47	[illegible]	3.20 to 4.[illegible]		[illegible]
	20									[illegible] to [illegible]		
Aug 6	5		.[illegible]	.[illegible]	0	0	.[illegible]	51	[illegible]	[illegible]		
Totals	2		.77	.77	0	0						[illegible]
Totals	5		3.04	3.04	0	0						[illegible]
Sep 13	Rain		.11									[illegible]
Sep 30	Add. Rain		.14									[illegible]
2nd Crop Irrigation under direction of S. [illegible]												

1916	[illegible]	[illegible]
Date	[illegible]	[illegible]
June 8	[illegible]	17
[illegible]	5	[illegible]
Totals	[illegible]	[illegible]
[illegible]	[illegible]	23
July 18	[illegible]	20
Totals	[illegible]	[illegible]
Totals	[illegible]	[illegible]
Sep 15	[illegible]	11

Soil and Moisture Samples

Soil: Dark, porous, grit, loam abt. 8 to 14 ins. [illegible] clay about 18 ins. thick on cemented [illegible] hardpan [illegible]

No.	Depth Inches	Moisture %	Date 1918	Time as to Irrigation	Description, Soil.
1	0-6	[illegible]	May 5	Before	6 th. way down, loam dry
2	6-12	7.9	"	"	" [illegible]
3	12-14	12	"	"	" [illegible]
4	0-14	12.1	May 5	[illegible] after	[illegible] loam
5	14	[illegible].4	"	"	" [illegible]
6	0-15	13.4	May 5	24 hr. after	[illegible]
7	15	13.1	"	"	" [illegible]
1181	0-9	8.4	May 24	Before	[illegible]
2	15	17.[illegible]	"	"	" Clay [illegible]
1191	0-10	12.7	May 25	72 hr. after	[illegible]
					[illegible]
2	15	19.9	"	"	" [illegible] clay [illegible] of hardpan
3	30	13.7	"	"	" Hardpan [illegible] yellow [illegible] gravel & little clay
4	42	16.4	"	"	" [illegible] gravel [illegible]
A1	0-12	10.3	May 22	Before	[illegible] loam
2	15	13.4	"	"	" Clay on hardpan
2201	0-12	10.1	June 7	Before	3rd [illegible] way down, alfalfa good [illegible]
2	21	21.0	"	"	" Yellow clay, quite moist, no hardpan
1221	0-10	7.7	June 7	Before	3rd [illegible] no clay [illegible]
					Hardpan at 11"
1201	0-10	12.8	June 8	24 hr. after	2nd [illegible] down alfalfa good & thrifty [illegible]
					[illegible] loam
2	21	25.7	"	"	" [illegible] yellow clay [illegible] hardpan
4401	0-12	10.5	June 21	Before	4 th [illegible] alfalfa [illegible]
					[illegible] too dry
2	24	15.9	"	"	" Stiff clay, good moisture
3	48	23.1	"	"	" (Clay & sandy clay [illegible] good moisture. At [illegible] clay
					soil with dark streaks
4	60	[illegible]	"	"	" Sandy clay again & very moist [illegible]
					[illegible]
41-1	0-13	8.2	June 21	Before	4th [illegible] 50' east & below [illegible]
					[illegible] clay on hardpan
44-1	0-18	9.2	June 25	72 hr. after	4th [illegible] At lower end in middle of [illegible]
					little alfalfa [illegible]

Soil and Moisture Samples

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
46-1	0-11	11.5	July 11	Before 2nd	70' [illegible]
44-1	0-22	20.8	July 11	Before 2nd	100' above botto[illegible]
					[illegible] silt [illegible] considerable [illegible]
81-1	0-18	21.0	July 18	72 hrs after 2nd	60' out below [illegible]
					[illegible] 16"
82-1	0-21	20.1	July 16	72 hrs [illegible] 2nd	[illegible]
85-1	0-15	11.9	July 16	72 hrs [illegible] 2nd	30' [illegible]
					[illegible]
84-1	0-30	19.0	July 16	72 hrs after 2nd	[illegible]
2	29		"	"	[illegible]
					[illegible]
186-1	0-12	11.4	July 16	[illegible]	[illegible]
2	-10	17.7	"		[illegible]
					[illegible]
87-1	0-12	8.2	May 24	Before [illegible]	[illegible]
					[illegible]
92-1	0-12	21.8	July 26	Before 2nd	100' above bottom, [illegible]
2	12	18.5	"	"	[illegible]
94-1	0-12	22.1	Aug 1	11 hrs after 3rd	[illegible]
				24 hrs after	[illegible]
				[illegible]	[illegible]
					[illegible]
86	0-12	*20.7	Aug 14	As above	[illegible]
8A	12	20.4	"	"	[illegible]

* Question mark by Soil [illegible] as #85 [illegible] should have [illegible]

Experiment title: Farm [illegible] Tract Old Alfalfa

Soil and Moisture Samples

Soil: 8" to 1[illegible]" of yellow grit clay loam on deep dense yellow clayish subsoil. Subsoil in some spots seems to become sandier below 3 ft and to take water better.

No.	Depth Inches	Moisture %	Date 1918	Time as to Irrigation	Irrigation	Location, Soil
10-1	0-12	7.1	May 7	Before	5th	Taken by Harding before any irrigation
2	24	11.9	"	"	"	
3	36	13.2	"	"	"	
4	48	23.0?	"	"	"	Possibley thru to a sandy clay subsoil
11-1	0-12	10.5	May 11	48 hrs After	2nd	6th furrow, 35' out, [illegible] way down. Subsoil clay near surface
2	24	15.5	"	"	"	Poorest soil & alfalfa of tract. Heavily sod-
3	36	14.0	"	"	"	bound with blue grass
4	48	9.7	"	"	"	This foot dryer but drove easier
20-1	0-12	1[illegible].7	May 25	28hrs after	4th	[illegible] Dark gritty silt, wet
2	24	16.3	"	"	"	Wet. "Pigtail" clay bored up at bottom
3	36	14.9	"	"	"	Clay chips, firm
4	40	13.4	"	"	"	Dense clay grinding to powder stopped auger
27-1	0-12	10.0	June 6	Before	2nd	20' out, west side. Dark alfalfa. "Pigtail" clay, too stiff
2	24	16.5	"	"	"	Same
3	30	13.6	"	"	"	Dense clay grinding to powder stopped auger.
47-1	1-12	-----	July 18	Before	6th	[illegible] Grit loam, good moisture see No. 50
	24	11.8	"	"	"	Clay & grit [illegible] moisture
	2[illegible]	-----	"	"	"	At 28" compacter & dryer like subsoil. Hard to bore at 32"
50-1	0-12	18.5	July 1[illegible]	[illegible] hrs after	6th	[illegible] out. 4' from [illegible]. Grit loam getting clayery at 12"
2	24	12.9	"	"	"	Clay, firmer & dryer at 1[illegible]" but bored good to 24"
3	30	12.9	"	"	"	At 2[illegible]" some [illegible] grit. Clayey [illegible] dry, hard to bore. (Tight at
4	32	13.4	"	"	"	cemented clayey material. Dry subsoil. Probably below alfalfa roots/
62-1	0-12	8.2	July 26	Before	2nd	[illegible] out. Alfalfa good color, [illegible] 15" high. Grit clayloam [illegible]
2	24	14.6	"	"	"	More clayey but considerable moisture still
3	30	14.5	"	"	"	Dense clayey, but considerable moisture [illegible] about stopped at 30"
64-1	0-12	11.5	Aug 2	Before	2nd	20' out in middle of pole. [illegible] alfalfa going to bloom at
						10" high. Poor ground, [illegible] gritty clay
2	24	10.3	"	"	"	More clay
3	36	14.8	"	"	"	Clay
65-1	0-12	10.1	Aug 2	Before	1st	20' above bottom in well stabled quite light green alfalfa about 20" high
						Grit loam

Experiment Station Farm. North Tract (Con.)

Soil and Alfalfa Samples.

No.	Depth Inches	Moisture %	1910 Date	Time as to Irrigation	Cut	Location, Soil.
66-2	12-24	1.8	Aug. 1	Before	1st	More clayey.
3	36	[illegible]	"	"	"	Clay
4	48	11.0	"	"	"	Clay
67-1	0-12	11.4	Aug. 3	24 hrs. After	2nd	30' out. Clay at 9 or 10" & much dryer. 5' from 64
						Poor alfalfa. Soil wet between furrows.
2	24	16.3	"	"	"	Clay. Cut out a [illegible] root.
3	36		"	"	"	Clay. Apparently some moisture got in
68-1	0-12	7.9	Aug. 8	Before	3d	70' out. Alfalfa fairly green only a little budding or bloom.
						A little moisture at 12", none above.
2	24	13.7	"	"	"	Quite clayey. A little moisture
3	36	12.7	"	"	"	" " Some moisture still.
4	48	11.8	"	"	"	Dense clayey sand. Some moisture.
69-1	0-12	7.5	"	"	3rd	70' out. Alfalfa considerable in bloom. Yellow silt loam. Pretty dry
2	24	8.82	"	"	"	(Sample accident [illegible] seen) Clay. Pretty dry. [illegible]
3	36	12.1	"	"	"	Pretty dry. Clay.
4	48	11.4	"	"	"	Clay. Pretty dry. [illegible] said tract as whole not so [illegible] yet
						[illegible] this sample [illegible]
75-1	0-12	8.3	Aug 24	"	2nd	20' out in short alfalfa [illegible]. Poor soil, sod bound.
						[illegible] Compare 76 & 79.
2	24	17.2	"	"	"	Clay. [illegible] to bottom still.
3	36	11.8	"	"	"	Clay. [illegible]
73-1	0-12	15.7	Aug. 27	75 hrs. After	"	Silt. Wet.
2	24	17.4	"	"	"	Clay. Plastic. Took water to bottom.
3	36	17.6	"	"	"	Clay. Stiff. Moisture [illegible] gradually.
76-1	0-12	8.6	Aug 24	Before	4th	[illegible] out. [illegible] alfalfa, [illegible] in [illegible] only.
						[illegible] dry & stiff. Compare 77 & 79.
2	24	11.9	"	"	"	Clayey. "
3	36	11.8	"	"	"	" A little more crumbly [illegible]
4	48	12.1	"	"	"	Some, rather sandy.
79-1	0-12	15.6	Aug 27	75 hrs after	"	[illegible] from 77 Silt loam. [illegible]
2	24	15.7	"	"	"	Clay. Pretty stiff.
3	36	10.9	"	"	"	A little more moisture [illegible] probably but not below.
4	48	12.3	"	"	"	Sandier clay. Seems to have [illegible] little [illegible].

Experiment Station Farm North Tract (con)

Soil and Moisture Samples

No.	Depth inches	Moisture 1919 %	Date	Time as to Irrigation	[illegible]	Location, Soil
177-1	0-12	11.4	Aug 24	Before	6th	[illegible] alfalfa in bloom, 18"high
2				"	"	[illegible] no bloom & #80 yellow grit loam
3	24	17.8	"	"	"	Clay
4	32	18.1	"	"	"	"
5	48	10.8	"	"	"	" probably sandier & and poor ground expose.
					"	Dodder or lovevine bad here & [illegible]
[illegible]-1	0-12	16.5	Aug 27	72 hrs after	6th	[illegible] #77 gritty loam gritty clay from 8" in whole
2				"	"	North tract good shape
3	24	15.8	"	"	"	gritty clay Stiff at bottom but took some moisture
4	36	15.6	"	"	"	" " Seems to have moregrit & moremoisture
5	48	12.4	"	"	"	[illegible] sandy clay. Drying good. More moisture, probably
692-1	0-12	15.2	Sep 14	21 da after (24hrs af 1 1/3" rain)	6th	[illegible] Near previous holes. 8" of grit well wet. Then clay & stiff, but moisture
2	24	14.6	Sep 14	"		diffusing in clay
6083	48	12.7	"	"		Clay pretty dry
						Clay pretty dry (Hay not hauled off yet.)

Experiment Station Farm South Crest New Alfalfa (2nd Yr)

Soil and Moisture Samples

Soil. [illegible] [illegible] to get across [illegible]. [illegible] silt, clay & sand loams [illegible] interspersed. Probably part of old [illegible] of [illegible].

No.	Depth Inches	Moist. %	1919 Date	Time as to Irrigation	Crop	Location, Soil
#31-1	0-12	6.7	Aug 5	[illegible]		[illegible] very gravelly, [illegible]
2	24	5.8	"	"		Same
3	36	5.2	"	"		Same
31-1	0-12	[illegible]	Aug 21	[illegible] After	[illegible]	Middle 30', silt, gravel loam
2	24	10.1	"	"	"	Same
3	36	10.2	"	"	"	Very sandy [illegible] of silt. [illegible]
4	48	12.0	"	"	"	Same
[illegible]-1	0-12	10.[illegible]	Aug 27	[illegible] Hrs. After	1st	30' above bottom. Between furrows. [illegible]
2	24	13.0	"	"	"	[illegible]
3	36	[illegible]	"	"	"	Some very silty sand, yellow. [illegible]
4	48	20.1	"	"	"	[illegible]
#36-1	0-12	14.4	June 8	[illegible] After	3rd	[illegible]
					Border	
2	24	9.72	"	"	"	Same
3	36	18.7	"	"	"	At 24" [illegible]
4	48	[illegible]	"	"	"	[illegible]
5	60	8.7	"	"	"	At 48" [illegible]
[illegible]-1	0-12	11.0	June 14	Before	2nd	60' above bottom. [illegible]
				"	"	[illegible] about [illegible] furrows.
2	24	12.[illegible]	"	"	"	[illegible]
3	36	17.6	"	"	"	[illegible]
4	48	14.4	"	"	"	[illegible]
#35-1	0-12	8.3	June 14	Before	3rd	60' above bottom, gravelly [illegible] light [illegible]
					Border	[illegible] between old furrows.
2	24	7.6	"	"	"	Still gravelly, slightly better moisture
3	36	6.2	"	"	"	Gravelly stopped by rock. [illegible]
#38-1	0-12	15.7	June 18	72 hrs After	3rd	60' above bottom. [illegible] coarse gravel [illegible]
					Border	[illegible] obtained.
2	24	11.0	"	"	"	[illegible] except streak of clay sand [illegible] white streaked
3	36	11.1	"	"	"	Coarser gravel, [illegible]
4	48	10.2	"	"	"	Mostly cemented gravel. [illegible]
5	60	7.97	"	"	"	Good silt & sand. Excellent moisture
6	72	15.5	"	"	"	Same excellent moisture

Experiment Station Farm South Tract (con)

Soil and Moisture Samples

No.	Depth Inches	Moisture %	1918 Date	Time after Irrigation	Where	Location, Soil
91-1	0-12	15.3	Sep 14	10da after	End	3/5 way down. Alfalfa very thrifty & succulent, [illegible]
				24 hrs after		Yellow grit loam Rain clear to bottom
				1 1/3" rain.		
2	24	10.8	"	"	"	Very gravelly. Rain seems to have worked into it
3	36	10.6	"	"		Gravel & sand. Moister at top than bottom
4	48	9.5	"	"	"	Clay & silt. Pretty dry. Small sections in drive[illegible]
				Experiment	Station Farm	Official Alfalfa Plats
	Soil: gravel & clay loam, quite porous					[illegible] but generally on quite tight subsoil clay at
			2 to 4 ft.	Some		what like South Tract above.
					Plat	end
93-1	0-12	10.8	Sep 14	29 da aft Ir.	Y	About middle. Only lower end needing irrigation, upper good. [illegible]
				Rains after		Well wet by rain, then clayey loam partly wet.
				1 1/2" rain		
2	24	10.0	"	"	"	Clay & much silt pretty dry.
3	36	11.5	"	"	"	Clayey. Quite dry. Whole tract, bottom as well as top, started up vigorously (after rain)
94-1	0-12	12.1	Sep 20	25 da aft irr.	Y	Moisture now well diffused into whole foot. Middle of plat
				14 da after		
				1 1/3" rain.		
2	24	10.6	"	"	"	Clay & sand Rain apparently worked clear to bottom
3	36	11.2	"	"	"	Apparently affected some by rain
95-1	0-12	11.2	Sep 20	44 das aft ir.	11	Middle of plat. Needing irrigation of whole plat before rain
				14 da. after		Whole foot moist
				1 1/3"rain		
2	24	9.2	"	"	"	Apparently all penetrated by rain but harder to drive sampler
3	36	10.1	"	"	"	Crumbles a little. [illegible] affected by rain

[illegible] Test Areas (Cont).

[illegible] Moisture Samples.

	Depth					
	Inches			60		
No.				[illegible]		[illegible]
71-1	[illegible]	[illegible]		[illegible]		30' [illegible] Flooded [illegible]
						[illegible]
						[illegible] silt loam [illegible]
72-1	[illegible]	[illegible]				20' [illegible] Flooded [illegible]
						[illegible]
						silt loam on rocky subsoil.
73-1	[illegible]	[illegible]				1st: 150' out [illegible]
						[illegible]
74-1	0-12	[illegible]				2nd: [illegible]
						[illegible]
						[illegible]
						[illegible]
						[illegible]
82-1	0-12	[illegible]				[illegible]
						[illegible]
83-1	[illegible]	[illegible]				1st: [illegible]
87	[illegible]	[illegible]		[illegible]		2nd: 100' out [illegible] Good moisture
				[illegible]		[illegible]
				[illegible]		[illegible]
				[illegible]		[illegible]
[illegible]	[illegible]	[illegible]				1st: 100' out [illegible]
						[illegible]
						[illegible]

Hovnan Asylum Farm [illegible] Tract

Soil and Moisture Samples

Soil: [illegible]

No.	Depth Inches	Moist. %	1918 Date	Time as to Irrigation	Crop	Location, Soil.
11-1	0-12	5.2	May 15	Before	Alf.	50' out [illegible] to 12" silty [illegible] sand
2	24	9.0	"	"	"	[illegible]
3	36	7.8	"	"	"	Sand, more [illegible]
4	46	7.5	"	"	"	Same
15-1	0-6	10.3	May 18	24 hrs After	"	125' [illegible]
2	6-12	8.4	"	"	"	[illegible]
						[illegible]
3	12-20	10.1	"	"	"	[illegible]
4	20-42	10.7	"	"	"	[illegible]
21-1	0-12	10.5	May 29	Before	[illegible]	125' [illegible]
2	24	10.2	"	"	"	Same
3	36	7.8	"	"	"	[illegible] sand
4	48	7.8	"	"	"	[illegible] sand
25-1	0-12	5.0	June 5	5 days After	[illegible]	120' out, [illegible] Silty sand
2	24	12.5	"	"	"	Same
3	36	11.9	"	"	"	[illegible]
4	48	15.5	"	"	"	Same
5	60	9.2	"	"	"	Same
6	72	9.2	"	"	"	Same
32-1	0-12	10.0	June 13	48 hrs After	[illegible]	100' [illegible] yellow silty [illegible]
2	24	11.0	"	"	"	[illegible]
3	36	6.6	"	"	"	[illegible]
42-1	0-12	9.7	June 24	96 hrs After	[illegible]	100' [illegible]
						[illegible]
2	24	8.2				Dirty [illegible] sand
3	36	[illegible]				[illegible]
4	48	9.[illegible]				Dirty [illegible] sand
5	72	7.4				Same
44-1	0-12	13.2	June 24	96 hrs After	[illegible]	125' out, [illegible]
2	24	14.4	"	"	"	Same
3	36	[illegible]		"	"	[illegible]
4	48	10.7	"	"	"	Dirty [illegible] sand [illegible]
5	72	10.9	"	"	"	Same

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
181-1	[illegible]	7.4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
							[illegible]
							[illegible]
181-1	[illegible]	7.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	24	7.0	"	[illegible]	"		[illegible]
5	[illegible]	7.2	"	"	"		[illegible]
185-1	0-6	1.2	[illegible]	[illegible]	[illegible]		[illegible]
							[illegible]
							[illegible]
181-1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
							[illegible]
							[illegible]
188-1	0-12	1.7	[illegible]	[illegible]	[illegible]		[illegible]
				[illegible]			
				[illegible]			
2	21	10.5	"		"		[illegible]
3	24	11.0	"	"	"		[illegible]
							[illegible]
30	0-9	13.2	"	[illegible]			[illegible]
							[illegible]
							[illegible]

[illegible] Irrigations — [illegible]
Some [illegible] Practice [illegible] Applications

From Eng File 5149-123

Test No	Head Feet of Frontage per Sec. Ft Feet	Av Length Irrigated Feet	Time Irrigating Minutes: Total	Time Irrigating Minutes: To time first appld runoff	Velocity of Irrig. Ft per Min: Basis of Tot Time	Velocity of Irrig. Ft per Min: To 1st Runoff	Use of Water: Applied Ac Ft P. Ac	Use of Water: Wasted %	
		Wm Lyell	Place	& Practice					
1	82	227	75	45	2.8	4.6	0.267	23	Potatoes
	82	213	95	65	2.2	3.2	.270	16	"
	82	219	65	40	3.2	5.2	.220	26	"
	82	225	80	50	2.6	4.1	.264	21	"
2	214	372	300	200	1.2	1.9	.338	28	Alfalfa
	123	358	300	220	1.2	1.6	.280	23	"
6	132	160	250	100	0.6	1.6	.497	28	Alfalfa
7	147	437	560	400	.8	1.1	.578	7	"
8	147	462	505	316	.9	1.4	.455	23	"
9	250	358	240	150	1.5	2.4	.153	27	"
10	365	347	290	135	1.2	2.6	.159	33	"
11	150	360	250	160	1.4	2.2	.301	27	"
12	177	341	322	180	1.0	1.9	.278	31	"
13	125	316	190	135	1.7	2.3	.303	18	"
14	99	291	175	80	1.7	3.6	.246	33	"
15	166	295	330	180	.9	1.6	.406	24	"
16	84	188	80	45	2.3	4.2	.324	23	Grain Stubble
16	135	200	155	65	1.2	2.9	.465	18	Young Alfalfa
17	190	328	270	195	1.2	1.7	.254	18	Alfalfa
18	300	158	280	65	.6	2.4	.351	37	"
19		415		100		4.2	.490	17	"
20	187	154	205	135	.7	1.1	.427	19	"
21	195	168	200	110			.378	35	"
22	143 Wrights	284	180	105	1.6	2.7	.574	40	"
23	113 Wrights	277	140	45	2.0	6.1	.259	60	"
23	130 Wrights	268	185	110	1.5	2.4	.310	35	"
24	44 Carter	318	385	300	.8	1.1	1.68	5	" Porous gravelly
25	40 Carter	304	250	155	1.2	2.0	1.23	6	" " "

Results of Reno Demonstrations – 1918, Harding & Osgood
Head, Time, Duty, etc.
Average Results for Season

Tract No.	Head Feet of Frontage per Sec. Ft. Feet	Av. Length Irrigated Feet	Time Irrigating Hours	Velocity of Irrigation Ft. per Min.	Method & Number of Irrigations	Water Applied Ac. Ft. per Acre: Total Duty	Water Applied Ac. Ft. per Acre: Average per Appl.n
	University Stock Farm – Shallow grit loam on hardpan at 18"±						
1	121	550	5h 0m	1.3			
2	89	550	3h 51m	2.4	Furrow 10	2.85	0.285
3	132	503	5h 12m	1.6	" 10	2.55	0.255
4	124	420	4h 18m	1.6	" 10	2.89	.289
5	148	345	4h 16m	1.4	" 10	2.87	.287
6	30	276	Ave. 4h 41m	0.7	" 10	3.13	.313
					Border 1st 10	2.70	.270
	North side – Exp. Sta. Farm – Shallow 12"± grit loam on dense silt or clay						
1	179	78	1h 41m	0.8	Furrow & 10	2.98	0.298
2	174	96	1h 38m	1.0	Flooding 10	2.63	.263
3	181	120	1h 58m	1.0	" 9	2.79	.310
4	178	142	2h 8m	1.1	" 9	2.44	.260
5	148	154	1h 53m	1.4	" 9	2.29	.254
6	161	159	1h 54m	1.4	" 9	2.30	.256
7	159	156	1h 50m	1.4	" 9	2.14	.238
	South side – Exp. Sta. Farm – Deep porous gravel loam & silt						
1	39	250	57m	4.4	Fur. & Flood 7	2.45	0.350
2	57	"	1h 36m	2.6	" 7	2.56	.365
3	16	"	21m	11.9	Border 7	2.32	.331
3	28	"	49m	5.1	Fur. & Flood 7	2.83	.405
4	39	"	56m	4.5	" 7	2.34	.335
5	54	"	1h 11m	3.5	" 7	2.07	.296
	West tract – Asylum Farm – Shallow loam on river boulder wash (Best surface soil scraped off)						
1	57	327	1h 27m	3.8	Flooding 11	3.11	0.283
2	71	318	1h 33m	3.4	" 11	2.94	.267
3	68	234	1h 15m	3.1	" 11	3.24	.295
	East tract – Asylum Farm – For sandy soil type						
1	113	430	1h 46m	4.1	Flooding 12	1.91	0.160
2 & 3	152	395	1h 51m	–			
4	134	325	1h 46m	3.1	" 12	2.39	.199
5	123	300	1h 33m	3.1	" 12	1.94	.162
	Exp. Sta. Alf. Plats – Mixed porous gravel loams & silts						
1	102 1st Crop *	290	5h 38m	0.9	Furrow 1st 6	4.50	0.750
1	52 2nd " *	"	2h 0m	2.4	Flood " "	2.82	.470
7	102 1st Crop	290	5h 38m	0.9	Furrow 1st 6	4.50	.750
7	47 2nd "	"	1h 27m	3.3	Flood " 6	2.37	.395
12	102 1st Crop	290	5h 38m	0.9	Furrow 1st 6	4.50	.750
12	85 2nd "	"	1h 32m	3.2	Flood " 6	2.73	.455

* 1st Crop irrigated by Exp. Sta. Force
* 2nd " " " Osgood under direction of S. T. Harding

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS, 1989

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat	0	0	0	0	2542	2118	3793	3442	2654	283	0	0	14832	
Coldron	0	0	0	264	575	468	624	680	617				3228	
Katz					(not in use this year)								0	
Highland	0	0	0	160	369	363	481	443	249	45	15	4	2129	
Last Chance	0	0	0	0	1520	1000	1540	1670	785	0	0	0	6465	
Lake	0	0	0	0	908	805	1180	1120	957	56	0	0	5026	
Orr	0	0	0	1090	3010	2260	2780	3180	1750	149	0	0	14219	
Cochran	0	0	0	62	296	173	263	192	254	0	0	0	1240	
North Truckee	0	0	0	136	415	258	141	141	137	0	0	0	1228	
Sessions	0	0	0	0	0	0	0	0	0	0	0	0	0	
Pioneer	0	0	0	393	1110	793	881	976	822	35	0	0	5010	
Glendale Ditch	0	0	0	7	15	14	15	15	12				78	
TOTAL DIVERSIONS													53455	(sum down)
STEAMBOAT-VISTA	0	0	0	2112	10760	8252	11698	11809	8237	568	15	4	53455	(sum across)
Murphy	0	0	0	100	358	114	675	447	185	0	0	0	1879	
Noce	0	0	0	85	35	10	83	31	0				244	
McCarran	0	0	0	136	243	111	338	358	177	25	0	0	1368	
Hill					(not in use this year)				-				0	
TOTAL DIVERSIONS													56966	(sum down)
STEAMBOAT-DERBY	0	0	0	2433	11396	8487	12794	12645	8599	593	15	4	56966	(sum across)
Washburn	0	0	0	0	27	56	108	62	59	0	0	0	312	
Gregory	0	0	0	12	109	125	189	208	142	0	0	0	785	
Herman	0	0	0	432	430	309	533	775	98	8	0	0	2585	
Pierson	0	0	0	38	3	28	104	81	0	0	0	0	254	
Olinghouse 1	0	0	0	5	46	39	38	58	0	5	0	0	191	
Proctor	0	0	0	112	396	248	185	683	324	0	0	0	1948	
Fellnagle	0	0	0	16	216	68	258	168	10	8	0	0	744	
Olinghouse 2					(not in use this year)									
Gardella	0	0	0	51	53	54	96	111	89	0	0	0	454	
Olinghouse 3	0	0	94	11	64	100	144	172	0	0	0	0	585	
Indian	0	0	0	373	858	525	1040	987	902	0	0	0	4685	
TOTAL DIVERSIONS													69509	(sum down)
STEAMBOAT-PYRAMID	0	0	94	3483	13598	10039	15489	15950	10223	614	15	4	69509	(sum across)

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS, 1989

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat	0	0	0	554	909	933	1371	1382	1257	1111	1085	269	8871	
Hunter Cr.	192	224	396	461	613	606	412	290	262	271	238	291	4256	
Highland	0	0	540	2900	3441	3297	3429	3277	3151	2935	1715	672	25357	
Idlewild Pumps	1014	595	300	424	514	707	1686	1557	817	3	0	28	7645	
Glendale T.P.	790	809	709	806	561	892	1331	851	514	0	0	1162	8425	
TOTAL M & I													54554	(sum down)
DIVERSIONS	1996	1628	1945	5145	6038	6435	8229	7357	6001	4320	3038	2422	54554	(sum across)

Original computer file lost. Rebuilt from hard copy, monthly formulas not saved.

EXHIBIT
tabbies
tab4

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS, 1990

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat			0	1166	3457	3339	3584	2824	0	0	0	0	14370	
Coldron				318	350	355	390	421	296				2130	
Katz						(not in use this year)							0	
Highland			7	432	665	720	368	313	0	0	0	0	2505	
Last Chance				399	1690	1430	1180	1000	0	0	0	0	5699	
Lake				206	1180	1070	984	738	0	0	0	0	4178	
Orr				1300	3440	2760	3180	2650	0	0	0	0	13330	
Cochran				23	136	221	259	334	312	0			1285	
North Truckee				97	260	222	168	201	0	0	0	0	948	
Sessions						(not in use this year)							0	
Pioneer				591	1140	950	970	1190	215	0			5056	
Glendale Ditch	est.			10	15	15	15	15	0				70	
TOTAL DIVERSIONS													49571	(sum down)
STEAMBOAT-VISTA	0	0	7	4542	12333	11082	11098	9686	823	0	0	0	49571	(sum across)
Murphy				106	230	319	407	586	286	0			1954	
Noce						(Stockwater only observed in 1990)							0	
McCarran				31	151	38	323	457	174	0	0		1174	
Hill						(not in use this year)							0	
TOTAL DIVERSIONS													52699	(sum down)
STEAMBOAT-DERBY	0	0	7	4679	12734	11439	11828	10729	1283	0	0	0	52699	(sum across)
Washburn				0	44	164	124	72	35				439	
Gregory				41	67	167	151	157	108	0			721	
Herman				193	547	431	402	719	136	85			2513	
Pierson				25	18	35	19	54	18	2			171	
Olinghouse 1	est. as 89		0	5	46	39	38	58	0	5	0		191	
Proctor				279	314	310	355	653	231	0			2142	
Fellnagle				86	356	247	374	0	0	0			1063	
Olinghouse 2						(not in use this year)								
Gardella				31	119	96	79	73	47				445	
Olinghouse 3	est. as 89		94	11	64	100	144	172	0	0	0		585	
Indian				487	1200	758	1390	1600	863	57			6355	
TOTAL DIVERSIONS													67324	(sum down)
STEAMBOAT-PYRAMID	0	0	101	5837	15509	13786	14904	14317	2721	149	0	0	67324	(sum across)

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS, 1990

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat	0	0	0	434	1277	1351	1429	1506	1877	1227	983	0	10084	
Highland	0	0	92	1923	2676	2831	2951	3166	2542	1755	1294	0	19228	
Idlewild Pumps	557	626	627	581	681	801	682	926	365	146	62	338	6392	
Glendale T.P.	1085	1013	1272	780	1098	1325	1414	1473	1028	697	58	744	11987	
TOTAL M & I													47691	(sum down)
DIVERSIONS	1642	1639	1991	3718	5732	6308	6476	7071	5812	3825	2397	1082	47691	(sum across)

Original computer file lost. Rebuilt from hard copy, monthly formulas not saved.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS, 1991

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat			0	698	3497	3797	3746	0	0	0	0	0	11738	
Coldron				565	535	546	289	154					2089	
Katz						(not in use this year)							0	
Highland				262	412	399	339	0	0	0	0	0	1412	
Last Chance				405	1500	1430	1270	0	0	0	0	0	4605	
Lake				262	1090	1020	873	0	0	0	0	0	3245	
Orr				1750	3100	3140	2960	0	0	0	0	0	10950	
Cochran				77	182	232	245	0					736	
North Truckee				51	250	225	192	0	0	0	0	0	718	
Sessions						(not in use this year)							0	
Pioneer				169	1090	1110	804	776	252	0	0	0	4201	
Glendale Ditch	est.			10	15	16	13	0					54	
TOTAL DIVERSIONS													39749	(sum down)
STEAMBOAT-VISTA	0	0	0	4249	11671	11915	10731	930	252	0	0	0	39749	(sum across)
Murphy (net)				118	278	346	456	333	218	145			1894	
Noce						(No diversion in 1991)							0	
McCarran (1991 net)				18	208	232	361	430	189	0	0		1438	
Hill						(not in use this year)							0	
TOTAL DIVERSIONS													43081	(sum down)
STEAMBOAT-DERBY	0	0	0	4385	12157	12493	11548	1693	659	145	0	0	43081	(sum across)
Washburn				16	46	17	27	0	0	0			106	
Gregory (net)				7	190	218	216	179	6				816	
Herman (net)				26	539	484	1007	549	152	0			2757	
Pierson				5	36	21	49	12	39	2			164	
Olinghouse 1			0	0	54	104	63	22	46				289	
Proctor				0	251	390	500	240	205	420			2006	
Fellnagle (est)				28	58	56	58	58	56				314	
Olinghouse 2						(not in use this year)								
Gardella				36	61	132	123	95	86				533	
Olinghouse 3			0	0	110	165	187	2	189				653	
Indian				421	848	1030	1270	1300	1070				5939	
TOTAL DIVERSIONS													56658	(sum down)
STEAMBOAT-PYRAMID	0	0	0	4924	14350	15110	15048	4150	2508	567	0	0	56658	(sum across)

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS, 1990

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat	0	0	0	352	1573	1913	2074	2950	1920	1390	1570	0	13742	
Highland	0	0	55	1525	2141	2570	2750	2200	1918	1568	1791	0	16520	
Idlewild - Highland Pumps	276	373	316	141	72	147	367	317	117	6	13	7	2152	
Idlewild - Hunter Pumps	167	182	158	617	385	338	390	326	244	634	153	533	4128	
Glendale T.P.	1326.24	1266.07	876.792	623.21	1060.07	1371.68	1461.01	1115.95	762.895	0	0	1529	11393	
TOTAL M & I													47934	(sum down)
DIVERSIONS	1768.63	1821	1405	3259	5231	6340	7042	6910	4963	3599	3527	2069	47934	(sum across)

Notes: Reminders for calcs; Stmbt M&I from Stmbt P.2.
Highland M&I from Summaries as Total - Irrigation
Report NET div from P.2 where is a monitored return to River.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS, 1992

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat			0	2278	4232	672	0	0	0	0	0	0	7182	
Coldron				0	315	298	123	92					828	
Katz					(not in use this year)								0	
Highland				562	676	87	0	0	0	0	0	0	1325	
Last Chance				1130	2010	309	0	0	0	0	0	0	3449	
Lake				680	1290	225	0	0	0	0	0	0	2195	
Orr			341	3140	3470	623	0	0	0	0	0	0	7574	
Cochran				220	269	123	17	0					629	
Eastman					(not monitored this year)									
North Truckee				91	105	22	0	0	0	0	0	0	218	
Sessions					(not in use this year)								0	
Pioneer				1096	1493	812	642	106	91	148	0	0	4388	
Glendale Ditch	est.			15	19	5	0	0					39	
TOTAL DIVERSIONS													27827	(sum down)
STEAMBOAT-VISTA	0	0	341	9212	13879	3176	782	198	91	148	0	0	27827	(sum across)
Murphy (net)				210	438	279	354	108	0	0			1389	
Noce					(not in use this year)								0	
McCarran (1991 net)				198	361	412	541	45	0	0			1557	
Hill					(not in use this year)								0	
TOTAL DIVERSIONS													30773	(sum down)
STEAMBOAT-DERBY	0	0	341	9620	14678	3867	1677	351	91	148	0	0	30773	(sum across)
Washburn				33	0	10	36	0	0	0			79	
Gregory (net)				155	119	212	158	202	39	0			885	
Herman (net)				400	493	411	573	568	279	0			2724	
Pierson				45	39	35	20	38	30	0			207	
Olinghouse 1			0	-14	27	47	86	75	43				292	
Proctor				167	361	158	250	498	158	0			1592	
Fellnagle (est)				28	58	56	58	58	56				314	
Gardella				32	104	80	98	110	56				480	
Olinghouse 3 (est)			0	0	185	120	110	85					500	
Indian				475	890	734	587	1000	791	500			4977	
TOTAL DIVERSIONS													42823	(sum down)
STEAMBOAT-PYRAMID	0	0	341	10969	16954	5730	3653	2985	1543	648	0	0	42823	(sum across)

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS, 1992

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat	0	0	0	692	1898	2268	2080	2280	2380	1370	756	35	13759	
Highland	0	0	1704	1818	2263	2136	2006	2434	1867	1595	183	0	16005	
Idlewild Pumps	327	297	523	448	487	292	193	159	0	0	198	202	3125	
Glendale T.P.	1593	1341	411	1262	1578	894	851	953	845	897	1235	912	12773	
TOTAL M & I													45662	(sum down)
DIVERSIONS	1920	1638	2638	4220	6226	5590	5130	5826	5092	3863	2372	1149	45662	(sum across)

Notes: Reminders for calcs; Stmbt M&I from Stmbt P.2.
Highland M&I from Summaries as Total - Irrigation
Report NET div from P.2 where is a monitored return to River.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS, 1993

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat			0	1321	2984	2739	2707	3477	2578	0	0	0	15806	
Coldron						(not in use this year)							0	
Katz						(not in use this year)							0	
Highland				201	392	392	406	406	223	0	0	0	2020	
Last Chance				301	1430	1530	1430	1290	515	0	0	0	6496	
Lake				138	948	1150	1060	1040	915	0	0	0	5251	
Orr			0	1840	2740	2900	2870	3110	1410	0	0	0	14870	
Cochran				134	306	298	309	266	160				1473	
Eastman						(not monitored this year)								
North Truckee				65	179	137	126	111	132	0	0	0	750	
Sessions						(not in use this year)							0	
Pioneer				732	1416	1111	1235	1035	1000	27	0	0	6556	
Glendale Ditch	est.			7	15	15	15	15	13				80	
TOTAL DIVERSIONS													53302	(sum down)
STEAMBOAT-VISTA	0	0	0	4739	10410	10272	10158	10750	6946	27	0	0	53302	(sum across)
Murphy (net)				100	423	103	287	267	259	0			1439	
Noce						(not in use this year)							0	
McCarran (net)				0	235	310	63	0	0	0			608	
Hill						(not in use this year)							0	
TOTAL DIVERSIONS													55349	(sum down)
STEAMBOAT-DERBY	0	0	0	4839	11068	10685	10508	11017	7205	27	0	0	55349	(sum across)
Washburn				27	0	64	27	14	0	0			132	
Gregory (net)				61	161	91	168	165	118	10			774	
Herman (net)				173	668	259	633	498	323	109			2663	
Pierson				15	62	27	24	12	11	0			151	
Olinghouse 1			0	37	36	67	58	59	65				322	
Proctor				0	474	420	557	575	373	0			2399	
Fellnagle (est)				25	52	51	52	52	51				283	
Gardella				60	139	77	104	48	16				444	
Olinghouse 3 (est)			0	18	86	31	303	67	205				710	
Indian				174	1100	534	1260	1450	1170	98			5786	
TOTAL DIVERSIONS													69013	(sum down)
STEAMBOAT-PYRAMID	0	0	0	5429	13846	12306	13694	13957	9537	244	0	0	69013	(sum across)

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS, 1993

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat	0	0	0	399	1356	1821	2353	2643	2592	2028	1398	0	14590	
Highland	7	6	738	1264	1908	2191	2607	2770	2328	2153	1040	0	17011	
Idlewild Pumps	167	221	29	310	249	325	687	646	544	7	115	419	3719	
Glendale T.P.	827	1072	674	1352	1284	1297	1798	1691	1429	191	413	1456	13484	
TOTAL M & I													48804	(sum down)
DIVERSIONS	1001	1299	1441	3325	4797	5634	7445	7750	6893	4379	2966	1875	48804	(sum across)

Notes: Reminders for calcs; Stmbt M&I from Stmbt P.2.
Highland M&I from Summaries as Total - Irrigation
Report NET div from P.2 where is a monitored return to River.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS, 1994

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat			0	3280	3640	2841	2130	2430	1400	0	0	0	15721	
CoMron				149	113	274	0	0	0	0	0	0	536	
Katz						(not in use this year)							0	
Highland			4	1100	1185	743	622	601	562	497	0	0	5314	
Last Chance				939	1510	633	0	0	0	0	0	0	3082	
Lake				729	1000	462	0	0	0	0	0	0	2191	
Orr			0	2510	3100	1370	0	0	0	0	0	0	6980	
Cochran				118	143	248	39	0	0	0	0	0	548	
Eastman						(not monitored this year)								
North Truckee				0	351	116	0	0	0	0	0	0	467	
Sessions						(not in use this year)							0	
Pioneer		12	28	679	1254	880	610	423	101	0	0	0	3987	
Glendale Ditch	est.			7	15	7	0						29	
TOTAL DIVERSIONS													38855	(sum down)
STEAMBOAT-VISTA	0	12	32	9511	12311	7574	3401	3454	2063	497	0	0	38855	(sum across)
Murphy (net)				94	206	213	291	276	114	0			1194	
Noce						(not in use this year)							0	
McCarran (net)				104	254	241	478	222	0	0			1299	
Hill						(not in use this year)							0	
TOTAL DIVERSIONS													41348	(sum down)
STEAMBOAT-DERBY	0	12	32	9709	12771	8028	4170	3952	2177	497	0	0	41348	(sum across)
Washburn				10	26	30	0	15	8	0			89	
Gregory (net)				18	66	164	128	193	195	0			764	
Herman (net)				380	401	445	652	561	246	0			2685	
Pierson				28	12	65	19	0	0	0			124	
Olinghouse 1				33	42	54	64	58	0	0			251	
Proctor				267	170	300	600	603	0	0			1940	
Fellnagle (est)				25	52	51	52	52	51	0			283	
Gardella				24	47	57	61	123	52	0			364	
Olinghouse 3 (est)				24	171	155	102	200	180	0			832	
Indian				760	1070	551	1030	1160	791	536			5898	
TOTAL DIVERSIONS													54578	(sum down)
STEAMBOAT-PYRAMID	0	12	32	11278	14828	9900	6878	6917	3700	1033	0	0	54578	(sum across)

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS, 1994

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat	0	0	0	477	973	1393	1275	1423	1052	0	0	0	6593	
Highland	0	0	961	1485	1510	1968	1941	1859	1685	836	253	0	12498	
Idlewild Pumps	497	405	180	61	0	0	0	0	0	0	0	0	1143	
Glendale T.P.	1378	1159	1360	1637	1530	1612	1308	1046	526	927	517	665	13665	
Chalk Bluff	0	0	123	996	1017	1423	1768	1660	1573	1412	1168	998	12138	
TOTAL M & I													46039	(sum down)
DIVERSIONS	1876	1564	2624	4656	5031	6396	6292	5988	4836	3175	1937	1663	46039	(sum across)

Notes: Reminders for calcs; Stmbt M&I from Stmbt P.2
Highland M&I from Summaries as Total - Irrigation
Report NET div from P.2 where is a monitored return to River.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS, 1995

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat[1]				0	2910	2950	3260	3225	4484	2070	0	0	18899	
Coldron					(not in use this year)								0	
Katz					(not in use this year)								0	
Highland[2]				124	332	382	405	406	394	407	0	0	2450	
Last Chance				0	577	1200	1490	1330	1100	309	0	0	6006	
Lake				0	633	1020	1070	1120	980	119	0	0	4942	
Orr				0	1770	2630	2510	2830	2800	593	0	0	13133	
Cochran				0	167	436	416	325	344	22	0	0	1710	
Eastman					(not monitored this year)									
North Truckee				0	25	275	280	174	76	0	0	0	830	
Sessions					(not in use this year)								0	
Pioneer				0	573	1005	1375	1042	349	51	0	0	4395	
Glendale Ditch	est.			0	15	15	15	15	15	0	0	0	75	
TOTAL DIVERSIONS													52440	(sum down)
STEAMBOAT-VISTA	0	0	0	124	7002	9913	10821	10462	10542	3571	0	0	52440	(sum across)
Murphy (net)				0	120	183	285	360	84	0			1032	
Noce					(not in use this year)								0	
McCurran (net)				0	56	331	293	120	100	0			900	
Hill					(not in use this year)								0	
TOTAL DIVERSIONS													54372	(sum down)
STEAMBOAT-DERBY	0	0	0	124	7178	10427	11399	10947	10726	3571	0	0	54372	(sum across)
Washburn				0	28	38	48	42	69	10	0		235	
Gregory (net)				0	30	128	120	206	106	52	0		642	
Herman (net)				73	900	0	957	671	840	0	0		3441	
Pierson				0	28	24	12	31	28	0	0		123	
Olinghouse 1				0	43	48	96	52	54	0	0		293	
Proctor				0	810	231	394	654	540	0	0		2629	
Fellnagle (est)				25	52	51	52	52	51	0	0		283	
Gardella				0	24	83	123	121	81	15	0		447	
Olinghouse 3 (est)				83	11	19	198	122	28	0	0		461	
Indian				0	670	912	1740	1600	1350	54	0		6326	
TOTAL DIVERSIONS													69252	(sum down)
STEAMBOAT-PYRAMID	0	0	0	305	9774	11961	15139	14498	13873	3702	0	0	69252	(sum across)

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS, 1995

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF	
Steamboat	0	0	0	0	100	100	180	565	506	0	0	0	1451	
Highland	0	0	32	451	1268	1746	2115	1982	1829	1805	675	0	11903	
Idlewild Pumps	Off line in 1995.												0	
Chalk Bluff	1108	1285	1132	1417.42	1615	2061	2185	2454	1949	1181	945	336	17668	
Glendale T.P.	539	816	595	842	854	828	1165	1609	1525	1276	1013	1036	12099	
TOTAL M & I													43121	(sum down)
DIVERSIONS	1646	2101	1759	2711	3837	4735	5645	6610	5809	4262	2633	1372	43121	(sum across)

Notes: Reminders for calcs; Stmbt M&I from Stmbt P.2.
Highland M&I from Summaries as Total - Irrigation
Report NET div from P.2 where is a monitored return to River.

1. Steamboat Ag. Diversion totals calculated from total at the head minus Hunter Creek diversion not including any spills.

2. Highland agriculture diversion are estimated values provided by SPPCo.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	115	2159	3529	4667	5470	270	-	-	-	16210
Coldron	-	-	-	-	(not in use this year)			-	-	-	-	-	0
Highland[1]	-	-	845	2987	2991	2900	3630	570	343		-	-	14266
Last Chance	-	-	-	50	1320	1290	1380	1130	482	-	-	-	5652
Lake	-	-	-	0	748	849	1030	1140	986	208	-	-	4961
Orr	-	-	-	369	2190	2790	2660	2840	2980	952	-	-	14981
Cochran	-	-	-	0	261	357	274	255	282	115	-	-	1544
Eastman	-	-	-	-	(not in use this year)			-	-	-	-	-	0
North Truckee	-	-	-	35	87	133	158	147	149	100	-	-	809
Sessions	-	-	-	-	(not in use this year)			-	-	-	-	-	-
Pioneer	-	-	-	48	1440	1710	1220	1160	534	-	-	-	6112
Glendale Ditch	est.	-	-	0	6	6	6	6	2	-	-	-	26
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	845	3604	11202	13564	15225	12718	6028	1375	0	0	64561
Murphy (net)	-	-	-	-	45	465	509	722	46	-	-	-	1767
Noce	-	-	-	-	(not in use this year)			-	-	-	-	-	0
McCarran (net)	-	-	-	-	193	319	335	375	10	-	-	-	1232
TOTAL DIVERSIONS VISTA-DERBY	0	0	0	0	238	764	844	1097	56	0	0	0	2999
Washburn	-	-	-	7	79	61	78	65	0	-	-	-	290
Gregory (net)	-	-	-	3	57	109	116	86	51	-	-	-	422
Herman (net)	-	-	-	0	571	359	932	1180	893	4	-	-	3939
Piesson	-	-	-	0	27	0	129	52	16	-	-	-	224
Proctor	-	-	-	0	572	232	350	421	57	-	-	-	1632
Fellnagle (est)	-	-	-	14	38	37	38	38	31	-	-	-	196
Gardella	-	-	-	58	90	74	100	122	37	-	-	-	481
Indian	-	-	-	149	1480	889	1390	2060	2840	-	-	-	8808
Olinghouse 1	-	-	-	0	43	41	0	164	0	-	-	-	248
Olinghouse 3 (est)	-	-	-	19	5	24	12	105	34	-	-	-	199
TOTAL DIVERSIONS DERBY-PYRAMID	0	0	0	249	2962	1826	3145	4293	3959	4	0	0	16438
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	845	3853	14402	16154	19214	18108	10043	1379	0	0	83998

notes 1. The Highland Ditch agricultural diversion is computed by subtracting the SPPCo reported Chalk Bluff outlfow volumes from the total diversion recorded at the head. An unrecorded volume of water is spilled back the river via the Washington spill and the drain below San Rafael Park.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Highland T.P.	-	-	425	1293	1329	-	-	-	-	-	-	-	3048
Idlewild Pumps	-	-	-	-	-	-	-	-	-	-	-	-	0
Glendale T.P.	757	668	329	815	1255	1998	2189	2359	1894	1733	0	0	13997
Chalk Bluff T.P.	910	677	1241	1681	2938	4763	5311	5796	5157	4038	3050	2895	38457
TOTAL M & I DIVERSIONS	1667	1345	1995	3789	5523	6761	7500	8155	7051	5771	3050	2895	55502

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	1,277	3,255	2,403	3,018	3,690	3,400	855	-	-	17,898
Coldron						no diversions in 1997							0
Highland[1]	-	-	-	-	450	176	668	930	1,002	-	-	-	3,226
Last Chance	-	-	-	-	783	797	893	894	1,140	602	-	-	5,109
Lake	-	-	-	-	859	791	772	756	774	443	-	-	4,395
Orr	-	-	-	670	2,210	2,270	2,850	3,140	1,440	-	-	-	12,580
Cochran	-	-	-	47	164	74	103	186	216	220	-	-	1,010
North Truckee (est.)	-	-	-	-	56	121	138	103	29	-	-	-	447
Pioneer	-	-	-	-	689	499	676	638	578	19	-	-	3,099
Pioneer Effluent (UNR)		-	-	-	75	113	152	171	144	68	-	-	723
Glendale Ditch						Abandoned in 1997							
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	1,994	8,541	7,244	9,270	10,503	8,723	2,207	0	0	48,487
Murphy (net)	-	-	-	-	111	257	317	340	227	3	-	-	1,255
McCarran (net)	-	-	-	-	309	113	293	230	262	-	-	-	1,207
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	1,994	8,961	7,614	9,880	11,078	9,212	2,210	0	0	50,949
Washburn	-	-	-	-	22	73	33	64	42	-	-	-	234
Gregory (net)	-	-	-	36	138	86	62	33	22	26	-	-	404
Herman (net)	-	-	-	-	289	284	493	403	-	-	-	-	1,469
Pierson	-	-	-	-	37	52	69	63	0	-	-	-	221
Proctor	-	-	-	-	548	191	892	357	403	-	-	-	2,391
Fellnagle (est)	-	-	-	(non-regulated diversion, no measurement station)							-	-	0
Gardella	-	-	-	-	51	7	37	130	148	-	-	-	373
Indian	-	-	-	-	1,110	607	1,540	1,800	1,150	246	-	-	6,453
Olinghouse 1 (pump)	(provisional)		-	-	-	1	130	70	77	-	-	-	278
Olinghouse 3 (pump)	(provisional)		-	1	13	17	39	25	43	-	-	-	138
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	2,031	11,169	8,932	13,175	14,023	11,098	2,482	0	0	62,909

notes 1. The Highland Ditch agricultural diversion is computed by subtracting the SPPCo reported Chalk Bluff outflow volumes from the total diversion recorded at the head. An unrecorded volume of water is spilled back the river via the Washington spill and the drain below San Rafael Park.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Highland T.P.	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps	-	-	-	-	-	-	-	-	-	-	-	-	0
Glendale T.P.	-	-	-	547	2,109	1,740	2,327	2,424	1,808	775	-	-	11,730
Chalk Bluff T.P.	2,581	1,852	3,542	4,551	5,322	5,186	5,901	6,147	5,431	4,715	3,469	3,148	51,846
TOTAL M & I DIVERSIONS	2,581	1,852	3,542	5,098	7,431	6,926	8,228	8,571	7,239	5,490	3,469	3,148	63,576

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	-	1,528	2,120	3,291	4,670	3,440	649	-	-	15,698
Coldron						no diversions in 1998							0
Highland[1]	-	-	-	91	496	463	520	1,047	1,347	-	-	-	3,964
Last Chance	-	-	-	-	488	532	757	626	714	591	-	-	3,708
Lake	-	-	-	-	601	491	756	752	455	83	-	-	3,138
Orr	-	-	-	-	831	2,360	2,810	3,220	2,520	294	-	-	12,035
Cochran (est.)	-	-	-	-	131	86	227	152	147	-	-	-	743
North Truckee (est.)	-	-	-	-	86	61	90	101	87	-	-	-	425
Pioneer (net)	-	-	-	-	356	519	656	620	465	28	-	-	2,643
Pioneer Effluent (UNR)		-	-	-	97	173	256	262	78	0	-	-	866
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	91	4,614	6,805	9,363	11,450	9,253	1,645	0	0	43,220
Murphy (net)	-	-	-	-	100	165	322	346	155	0	-	-	1,088
McCarran (net)	-	-	-	-	117	338	359	188	98	-	-	-	1,099
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	91	4,830	7,308	10,043	11,984	9,506	1,645	0	0	45,408
Washburn (net)	-	-	-	-	69	33	47	37	31	-	-	-	217
Gregory (net)	-	-	-	-	78	21	51	106	119	0	-	-	375
Herman (net)	-	-	-	-	0	338	408	476	230	16	-	-	1,468
Pierson	-	-	-	-	30	0	77	88	52	-	-	-	247
Proctor (net)	-	-	-	-	0	0	357	165	175	-	-	-	697
Fellnagle (est)	-	-	-	(non-regulated diversion, no measurement station)							-	-	0
Gardella	-	-	-	-	47	105	103	38	15	-	-	-	308
Indian (net)	-	-	-	-	759	554	1,269	1,251	323	0	-	-	4,155
Olinghouse 1 (pump)	(provisional)		-	-	1	0	0	0	17	0	-	-	18
Olinghouse 3 (pump)	(provisional)		-	-	0	15	35	25	2	80	-	-	157
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	91	5,853	8,374	12,390	14,170	10,470	1,741	0	0	53,049

notes 1. The Highland Ditch agricultural diversion is computed by subtracting the SPPCo reported Chalk Bluff outflow volumes from the total diversion recorded at the head. An unrecorded volume of water is spilled back the river via the Washington spill and the drain below San Rafael Park.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Highland T.P.	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps	-	-	-	-	-	-	-	-	-	-	-	-	0
Glendale T.P.	-	-	-	42	931	1,656	2,477	2,498	1,653	806	-	-	10,062
Chalk Bluff Highland	-	-	-	2,519	3,415	3,462	3,582	3,053	2,667	1,888	2,563	1,188	24,338
Chalk Bluff Pump	3,153	2,763	3,227	1,511	1,415	1,315	2,437	3,244	1,719	2,111	621	1,995	25,512
TOTAL M & I DIVERSIONS	3,153	2,763	3,227	4,072	5,762	6,433	8,496	8,795	6,039	4,805	3,184	3,184	59,912

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	-	2,003	2,928	2,982	3,389	3,228	1,433	-	-	15,963
Coldron						no diversions in 1999							0
Highland[1]	-	-	-	537	933	953	1,028	494	1,091	1,175	-	-	6,211
Last Chance	-	-	-	-	519	636	692	918	910	458	-	-	4,133
Lake	-	-	-	-	572	648	613	636	288	0	-	-	2,757
Orr	-	-	-	-	1,980	2,470	2,540	3,130	2,520	0	-	-	12,640
Cochran (net)	-	-	-	-	320	172	185	322	160	102	-	-	1,261
North Truckee (est.)	-	-	-	-	65	103	69	101	99	-	-	-	437
Pioneer (net)	-	-	-	-	661	998	825	795	562	0	-	-	3,840
Pioneer Effluent (UNR)	-	-	-	49	191	235	302	186	268	149	-	-	1,380
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	586	7,244	9,143	9,236	9,971	9,126	3,317	0	0	48,622
Murphy (net)	-	-	-	-	301	221	372	251	43	0	-	-	1,188
McCarran (net)	-	-	-	-	236	183	323	251	204	0	-	-	1,197
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	586	7,781	9,547	9,931	10,473	9,373	3,317	0	0	51,007
Washburn (net)	-	-	-	-	61	25	22	30	34	42	-	-	214
Gregory (net)	-	-	-	-	64	69	89	41	49	0	-	-	312
Herman (net)	-	-	-	-	522	383	616	370	599	153	-	-	2,643
Pierson	-	-	-	-	15	83	0	0	0	0	-	-	98
Proctor (net)	-	-	-	-	257	0	167	740	0	290	-	-	1,454
Fellnagle (est)	-	-	-	(non-regulated diversion, no measurement station)							-	-	0
Gardella (net)	-	-	-	-	85	85	57	62	51	0	-	-	310
Indian (net)	-	-	-	-	999	848	771	1,485	665	266	-	-	5,034
Olinghouse 1 (pump)	(provisional)		-	0	29	2	2	32	26	25	-	-	114
Olinghouse 3 (pump)	(provisional)		-	0	128	66	117	30	94	0	-	-	435
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	586	9,941	11,107	11,772	13,263	10,891	4,092	0	0	61,651

notes 1. The Highland Ditch agricultural diversion is computed by subtracting the SPPCo reported Chalk Bluff outflow volumes from the total diversion recorded at the head. An unrecorded volume of water is spilled back the river via the Washington spill and the drain below San Rafael Park.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Highland T.P.	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps	-	-	-	-	-	-	-	-	-	-	-	-	0
Glendale T.P.	0	0	0	130	2,230	2,210	2,500	2,250	1,320	2,050	1,020	0	13,710
Chalk Bluff Highland	160	60	1410	2,960	3,070	3,020	2,910	2,010	2,600	3,040	2,360	3,240	26,840
Chalk Bluff Pump	3,060	2,990	2,040	920	2,340	2,870	3,430	3,380	2,890	1,180	0	90	25,190
TOTAL M & I DIVERSIONS	3,220	3,050	3,450	3,010	7,640	8,100	8,840	7,640	6,810	6,270	3,380	3,330	65,740

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	532	3,250	2,960	3,260	3,030	2,970	401	-	-	16,403
Coldron						no diversions in 2000							0
Highland[1]	-	-	-	344	791	580	568	754	874	287	-	-	4,198
Last Chance	-	-	-	-	750	764	779	766	712	280	-	-	4,051
Lake	-	-	-	-	664	647	626	429	274	0	-	-	2,640
Orr	-	-	-	778	2,570	2,490	3,160	2,510	734	0	-	-	12,242
Cochran (net)	-	-	-		98	144	271	213	173	0	-	-	899
North Truckee (est)	-	-	-	10	37	53	150	135	140	-	-	-	525
Pioneer (net)	-	-	-	245	925	681	954	990	1,130	36	-	-	4,961
Pioneer Effluent (UNR)	-	-	-				no record				-	-	0
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	1,909	9,085	8,310	9,768	8,827	7,007	1,004	0	0	45,919
Murphy (net)	-	-	-	86	112	231	447	118	137	0	-	-	1,131
McCarran (net)	-	-	-	-	331	254	289	186	272	0	-	-	1,332
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	1,995	9,528	8,804	10,504	9,131	7,416	1,004	0	0	48,382
Washburn (net)	-	-	-	5	86	51	12	14	13	0	-	-	181
Gregory (net)	-	-	-	25	39	79	38	165	101	0	-	-	447
Herman (net)	-	-	-	0	679	374	687	627	703	265	-	-	3,335
Pierson	-	-	-	0	0	45	228	232	0	0	-	-	505
Proctor (net)	-	-	-	0	532	391	206	423	331	0	-	-	1,883
Fellnagle (est)	-	-	-			(non-regulated diversion, no measurement station)					-	-	0
Gardella (net)	-	-	-	26	39	75	82	97	67	0	-	-	386
Indian (net)	-	-	-	290	524	861	1,053	1,089	927	311	-	-	5,055
Olinghouse 1 (pump)	(provisional)		-	48	37	63	66	41	0	27	-	-	282
Olinghouse 3 (pump)	(provisional)		-	0	47	16	14	28	46	0	-	-	151
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	2,389	11,517	10,759	12,890	11,847	9,604	1,607	0	0	60,607

notes 1. The Highland Ditch agricultural diversion is computed by subtracting the SPPCo reported Chalk Bluff outflow volumes from the total diversion recorded at the head. An unrecorded volume of water is spilled back the river via the Washington spill and the drain below San Rafael Park.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Highland T.P.	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps	-	-	-	-	-	-	-	-	-	-	-	-	0
Glendale T.P.	0	0	0	161	2,317	2,377	2,480	2,435	2,013	1,451	0	0	13,234
Chalk Bluff Highland	241	0	1149	3,388	3,318	4,051	4,294	4,117	3,830	4,122	3,438	460	32,408
Chalk Bluff Pump	2,884	2,966	2,564	2,405	1,998	2,080	2,066	2,794	1,824	956	52	689	23,278
TOTAL M & I DIVERSIONS	3,125	2,966	3,713	5,954	7,633	8,508	8,840	9,346	7,667	6,529	3,490	1,149	68,920

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	-	2,273	2,900	2,990	3,000	2,970	785	-	-	14,918
Coldron							no diversion in 2001						0
Highland[1]	-	-	-	335	786	818	1,238	1,231	687	0	-	-	5,095
Last Chance	-	-	-	-	587	768	692	696	825	332	-	-	3,900
Lake	-	-	-	-	684	601	742	666	647	84	-	-	3,424
Orr	-	-	-	403	2,500	2,370	2,700	2,660	1,270	0	-	-	11,903
Cochran (net)	-	-	-				no record this year				-	-	0
North Truckee (est.)	-	-	-	33	133	124	93	53	106	-	-	-	542
Pioneer (net)	-	-	-	263	592	708	608	554	744	0	-	-	3,469
Pioneer Effluent (UNR)	-	-	-	0	296	229	197	263	196	0	-	-	1,181
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	1,034	7,851	8,518	9,260	9,123	7,445	1,201	0	0	44,432
Murphy (net)	-	-	-	0	323	245	374	360	101	0	-	-	1,401
McCarran (net)	-	-	-	-	0	180	98	257	197	2	5	2	741
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	1,034	8,174	8,941	9,732	9,740	7,743	1,203	5	2	46,574
Washburn (net)	-	-	-	28	4	33	71	24	27	0	-	-	187
Gregory (net)	-	-	-	15	37	79	114	131	34	0	-	-	410
Herman (net)	-	-	-	-	407	164	493	761	58	0	-	-	1,883
Pierson							PLPT fisheries - non consumptive					-	0
Proctor (net)	-	-	-	32	280	385	377	473	422	0	-	-	1,969
Fellnagle (est)	-	-	-				(non-regulated diversion, no measurement station)				-	-	0
Gardella (net)	-	-	-	52	86	93	86	158	80	0	-	-	555
Indian (net)	-	-	-	265	1,008	1,260	1,620	1,404	475	0	-	-	6,032
Olinghouse 1 (pump)	(provisional)		-	0	46	43	55	103	8	0	-	-	255
Olinghouse 3 (pump)	(provisional)		-	15	30	13	192	188	24	0	-	-	462
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	1,441	10,072	11,011	12,740	12,981	8,871	1,203	5	2	58,327

notes 1. The Highland Ditch agricultural diversion is computed by subtracting the SPPCo reported Chalk Bluff outflow volumes from the total diversion recorded at the head. An unrecorded volume of water is spilled back the river via the Washington spill and the drain below San Rafael Park.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Highland T.P.	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps	-	-	-	-	-	-	-	-	-	-	-	-	0
Glendale T.P.	0	0	0	112	2,191	2,188	1,761	1,814	1,722	1,138	0	0	10,925
Chalk Bluff Highland	0	2615.2	1832.8	3,057	4,453	4,238	4,117	4,169	3,677	1,742	0	0	29,901
Chalk Bluff Pump	3,572	640	2,258	1,582	1,717	1,858	2,111	2,341	2,139	3,885	4,092	3,682	29,877
TOTAL M & I DIVERSIONS	3,572	3,255	4,091	4,751	8,361	8,284	7,989	8,323	7,538	6,765	4,092	3,682	70,702

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	-	764	3,390	3,590	3,560	3,300	847	-	-	15,451
Coldron	-	-	-	-		-					-	-	[illegible]
Highland[1]	-	-	-	216	447	433	447	447	332	0	-	-	2,322
Last Chance	-	-	-	-	399	756	832	893	712	203	-	-	3,795
Lake	-	-	-	-	609	574	635	510	464	0	-	-	2,792
Orr	-	-	-	-	1,900	2,586	2,693	3,050	1,937	0	-	-	12,166
Cochran (net)	-	-	-	-	not monitored this year						-	-	0
North Truckee (est.)	-	-	-	14	81	86	62	0	0	-	-	-	243
Pioneer (net)	-	-	-		312	286	560	241	611	0	-	-	2,010
Pioneer Effluent (UNR)	-	-	-	0	364	364	371	345	350	0	-	-	1,794
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	230	4,876	8,476	9,190	9,036	7,706	1,050	0	0	40,617
Murphy (net)	-	-	-	214	240	200	326	255	98	0	-	-	1,333
McCarran	0.0	0.4	0.0	19.0	15.0	30.0	30.0	16.0	30.0	0.9	0.0	0.0	141
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	463	5,131	8,705	9,546	9,317	7,834	1,051	0	0	42,091
Washburn (net)	-	-	-	21	30	5	0	0	89	0	-	-	145
Gregory (net)	-	-	-	17	54	78	47	75	145	0	-	-	416
Herman (net)	-	-	-	360	336	386	422	499	510	36	-	-	2,549
Pierson	-	-	-		PLPT fisheries - non-consumptive						-	-	0
Proctor (net)	-	-	-	191	339	0	429	545	228	0	-	-	1,732
Fellnagle (est)	-	-	-	(non-regulated diversion, no measurement station)							-	-	350
Gardella (net)	-	-	-	34	66	93	69	35	52	0	-	-	348
Indian (net)	-	-	-	431	1,032	829	1,381	1,731	724		-	-	6,128
Olinghouse 1 (pump)	(provisional)		-	0	1	1	2	2	2	0	-	-	8
Olinghouse 3 (pump)	no record this year due to lowering of dam and lack of rating on pump										-	-	0
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	1,517	6,989	10,097	11,396	12,204	9,583	1,087	0	0	53,768

notes 1. The Highland Ditch agricultural diversion is computed by subtracting the SPPCo reported Chalk Bluff outlfow volumes from the total diversion recorded at the head. An unrecorded volume of water is spilled back to the river via the Washington spill and the drain below San Rafael Park.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Highland T.P.	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps	-	-	-	-	-	-	-	-	-	-	-	-	0
Glendale T.P.	0	0	0	221	2,017	2,148	2,351	2,412	2,364	1,574	0	0	13,087
Chalk Bluff Highland	0	966	3778	4,494	4,451	4,261	4,163	4,489	4,492	4,606	1,419	0	37,119
Chalk Bluff Pump	3,373	2,154	-132	525	1,186	1,766	1,999	1,953	1,490	128	1,291	2,380	18,113
TOTAL M & I DIVERSIONS	3,373	3,120	3,646	5,240	7,654	8,176	8,513	8,854	8,346	6,308	2,710	2,380	68,319

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	0	1,790	2,690	3,220	3,520	2,950	0	-	-	14,170
Coldron						not monitored							44
Highland[1]	-	-	-	216	447	433	447	447	332	0	-	-	2,322
Washoe Power Ditch						not monitored							98
Last Chance	-	-	-	0	579	859	852	792	852	11	-	-	3,945
Lake	-	-	-	-	547	558	581	565	475	77	-	-	2,803
Orr	-	-	-	-	1,613	1,683	1,880	1,693	1,450	0	-	-	8,319
Cochran (net)						not monitored this year							184
North Truckee (est.)						no diversions in 2003							0
Pioneer (net)	-	-	-	0	503	487	441	595	502	0	-	-	2,528
Pioneer Effluent (UNR)	-	-	-	236	241	53	0	277	185	50	-	-	1,042
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	452	5,720	6,763	7,421	7,889	6,746	138	0	0	35,455
Murphy (net)	-	-	-	0	84	165	262	175	34	77	-	-	796
McCarran	0.9	0.0	0.0	0.0	0.0	0.0	4.4	9.6	13.0	33.0	29.0	19.0	109
TOTAL DIVERSIONS STEAMBOAT-DERBY	1	0	0	452	5,804	6,928	7,687	8,074	6,793	248	29	19	36,360
Washburn (net)	-	-	-	0	22	95	3	2	8	SW	-	-	130
Gregory (net)	-	-	-	0	52	64	116	122	92	0	-	-	446
Herman (net)	-	-	-	141	429	345	637	443	754	SW	-	-	2,749
Pierson	-	-	-			PLPT fisheries - non-consumptive					-	-	0
Proctor (net)	-	-	-	145	199	244	344	379	446	0	-	-	1,757
Fellnagle (est)	-	-	-			(non-regulated diversion, no measurement station)					-	-	350
Gardella (net)	-	-	-	44	55	71	39	78	130	SW	-	-	417
Indian (net)	-	-	-	358	800	1,197	1,377	889	610	0	-	-	5,231
Olinghouse 1 (pump)						No record for 2003							0
Olinghouse 3 (pump)						No record for 2003							0
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	1	0	0	1,140	7,361	8,944	10,203	9,987	8,833	248	29	19	47,440

notes 1. The Highland Ditch agricultural diversion is reported by TMWA and is computed as the balance of water remaining from the measured flow at the head of the ditch minus the water diverted to the Chalk Bluff Water Treatment Plant.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps	-	-	-	-	-	-	-	-	-	-	-	-	0
Glendale T.P.	0	0	0	12	1,790	2,207	2,198	2,032	2,159	2,037	3	1	12,439
Chalk Bluff Highland	0	374	3591	4,507	4,799	4,524	4,367	4,491	4,436	4,886	2,998	2,944	41,917
Chalk Bluff Pump	2,704	2,200	66	324	1,186	1,756	2,102	1,973	1,783	397	0	0	14,491
TOTAL M & I DIVERSIONS	2,704	2,574	3,657	4,843	7,775	8,487	8,667	8,496	8,378	7,320	3,001	2,945	68,847

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	0	2,730	2,680	2,830	2,980	1,940	0	-	-	13,160
Coldron						not monitored							44
Verdi Power - Katz Ditch	0	0	0	11	23	23	23	23	11	0	0	0	114
Highland[1]	0	0	0	216	447	433	447	447	332	0	0	0	2,322
Washoe Power Ditch	0	0	0	9	18	18	18	18	9	0	0	0	90
Last Chance	-	-	-	0	637	801	896	1,000	554	0	-	-	3,888
Lake	-	-	-	0	339	446	495	482	470	0	-	-	2,232
Orr	-	-	-	0	1180	1933	2003	2068	1410	0	-	-	8,594
Cochran (net)						not monitored this year							184
North Truckee (est.)						no diversions in 2004							0
Pioneer (net)	-	-	-	0	471	552	200	276	189	0	-	-	1,688
Pioneer Effluent (UNR)	-	-	-	46	209	193	274	231	202	124	-	-	1,280
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	282	6,054	7,079	7,186	7,525	5,117	124	0	0	33,596
Murphy (net)	-	-	6	76	44	17	154	57	80	0	-	-	434
McCarran	0.0	0.0	1.7	40.0	20.7	43.7	32.3	21.2	18.6	0.0	0.0	0.0	178
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	8	398	6,118	7,140	7,372	7,603	5,216	124	0	0	34,208
Washburn (net)	-	-	-	6	6	30	42	128	38	0	-	-	251
Gregory (net)	-	-	-	39	70	94	129	104	3	0	-	-	439
Herman (net)	-	-	-	0	445	186	753	282	223	sw	-	-	1,889
Pierson	-	-	-			PLPT fisheries - non-consumptive					-	-	0
Proctor (net)	-	-	-	0	251	749	468	374	15	0	-	-	1,857
Fellnagle (est)	-	-	-			(non-regulated diversion, no measurement station)					-	-	350
Gardella (net)						no diversions in 2004							0
Indian (net)	-	-	-	234	963	707	1,152	1,116	688	0	-	-	4,860
Olinghouse 1 (pump)						No record for 2004							0
Olinghouse 3 (pump)						No record for 2004							0
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	8	677	7,854	8,906	9,916	9,607	6,183	124	0	0	43,854

notes 1. The Highland Ditch agricultural diversion is reported by TMWA and is computed as the balance of water remaining from the measured flow at the head of the ditch minus the water diverted to the Chalk Bluff Water Treatment Plant.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps - Reno High	0	0	0	0	16	12	12	15	14	14	0	0	83
Glendale T.P.	0	0	0	1,570	2,287	2,448	2,676	2,515	865	0	0	0	12,361
Chalk Bluff Highland	810	0	0	2,448	4,557	4,609	4,540	4,353	3,753	4,147	2,535	0	31,752
Chalk Bluff Pump	2,290	2,571	3,347	2,253	1,065	2,265	3,218	3,177	1,755	620	325	3,022	25,908
TOTAL M & I DIVERSIONS	3,100	2,571	3,347	6,271	7,925	9,334	10,446	10,060	6,387	4,781	2,860	3,022	70,104

NOTE The Verdi Power - Katz Ditch used in 2004 for the first time in many years.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	0	1,830	2,520	2,790	2,610	2,530	685	-	-	12,965
Coldron					no consumptive use in 2005								0
Verdi Power - Katz Ditch	0	0	0	11	23	23	23	23	11	0	0	0	114
Highland[1]	0	0	0	216	447	433	447	447	332	0	0	0	2,322
Washoe Power Ditch	0	0	0	9	18	18	18	18	9	0	0	0	90
Somersett Pumps				0	11	39	83	72	40	19			263
Last Chance	-	-	-	0	230	843	714	863	984	327	-	-	3,961
Lake	-	-	-	0	158	519	449	535	488	sw	-	-	2,149
Orr	-	-	-	0	488	1900	1922	1830	1741	0	-	-	7,881
Cochran (net)													184
North Truckee (est.)					no diversions in 2005								0
Pioneer (net)	-	-	-	0	346	414	528	312	166	0	-	-	1,766
Pioneer Effluent (UNR)	-	-	-	70	75	465	648	582	399		-	-	2,239
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	386	3,626	7,174	7,622	7,292	6,700	1,031	0	0	33,934
Murphy (net)	-	-	0	17	121	42	69	39	51	84	-	-	423
McCarran	0.0	0.0	0.0	13.9	16.7	16.7	16.2	10.3	24.4	0.0	0.0	0.0	98
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	337	3,763	7,233	7,708	7,341	6,775	1,115	0	0	34,455
Washburn (net)	-	-	-	0	35	23	14	35	44	37	-	-	188
Gregory (net)	-	-	-	5	94	65	103	93	38	0	-	-	397
Herman (net)	-	-	-	0	201	155	387	62	545	sw	-	-	1,350
Pierson	-	-	-		PLPT fisheries - non-consumptive						-	-	0
Proctor (net)	-	-	-	52	337	248	314	564	173	0	-	-	1,688
Fellnagle (est)	-	-	-	(non-regulated diversion, no measurement station)							-	-	350
Gardella (net)					no diversions in 2005								0
Indian (net)	-	-	-	209	662	645	1,197	1,188	727	0	-	-	4,628
Olinghouse 1 (pump)					No record for 2005								0
Olinghouse 3 (pump)					No record for 2005								0
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	602	5,092	8,369	9,723	9,283	8,302	1,152	0	0	43,056

notes 1. The Highland Ditch agricultural diversion is reported by TMWA and is computed as the balance of water remaining from the measured flow at the head of the ditch minus the water diverted to the Chalk Bluff Water Treatment Plant.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER M & I DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL. AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps - Reno High	0	0	0	4	5	8	10	7	2	0	0	0	36
Glendale T.P.	0	0	0	729	1,189	2,017	2,200	2,197	1,762	0	0	0	10,094
Chalk Bluff Highland	0	0	0	623	4,337	4,374	4,278	4,111	3,830	4,073	3,545	2,773	31,944
Chalk Bluff Pump	2,974	2,627	2,996	3,333	962	1,869	3,059	3,079	2,507	1,363	18	450	25,237
TOTAL M & I DIVERSIONS	2,974	2,627	2,996	4,689	6,493	8,268	9,547	9,394	8,101	5,436	3,563	3,223	67,311

NOTE The Verdi Power - Katz Ditch used in 2004 for the first time in many years.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	0	902	2,320	2,490	2,390	2,270	706	-	-	11,078
Coldron							no consumptive use in 2006						0
Verdi Power - Katz Ditch							no diversions in 2006						0
Highland[1]				216	447	433	447	447	332	0			2,322
Washoe Power Ditch				9	18	18	18	18	9	0			90
Somersett Pumps				0	0	15	40	30	47	4			137
Last Chance	-	-	-	0	171	918	875	837	757	241	-	-	3,799
Lake	-	-	-	0	319	502	415	668	636	148	-	-	2,688
Orr	-	-	-	0	746	1550	1339	1610	918	0	-	-	6,163
Cochran (net)													184
North Truckee (est.)							no diversions in 2006						0
Pioneer (net)	-	-	-	0	110	413	246	103	220	0	-	-	1,092
Pioneer Effluent (UNR)	-	-	-								-	-	0
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	225	2,713	6,169	5,870	6,103	5,190	1,099	0	0	27,553
Murphy (net)	-	-		0	65	70	112	118	93	0	-	-	458
McCarran	0.0	0.0	0.0	0.0	11.0	16.7	7.8	30.8	7.6	0.0	0.0	0.0	74
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	225	2,789	6,256	5,990	6,252	5,290	1,099	0	0	28,085
Washburn (net)	-	-	-	0	6	0	4	21	42	22	-	-	95
Gregory (net)	-	-	-	0	46	135	61	34	78	0	-	-	354
Herman (net)	-	-	-	0	331	413	104	204	440	0	-	-	1,492
Pierson	-	-	-				PLPT fisheries - non-consumptive				-	-	0
Proctor (net)	-	-	-	0	87	247	362	378	157	0	-	-	1,231
Fellnagle (est)	-	-	-				(non-regulated diversion, no measurement station)				-	-	350
Gardella (net)							no diversions in 2006						0
Indian (net)	-	-	-	0	662	686	1,044	1,098	1,026	148	-	-	4,664
Olinghouse 1 (pump)							No record for 2006						0
Olinghouse 3 (pump)							No record for 2006						0
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	225	3,921	7,737	7,565	7,987	7,033	1,269	0	0	36,271

notes 1. The Highland Ditch agricultural diversion is reported by TMWA and is computed as the balance of water remaining from the measured flow at the head of the ditch minus the water diverted to the Chalk Bluff Water Treatment Plant.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER MUNICIPAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat Ditch	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps - Reno High	0	7	8	19	20	25	38	24	29	14	6	0	190
Glendale T.P.	0	0	0	0	1,320	2,011	1,848	1,840	1,790	1,202	0	0	10,011
Chalk Bluff Highland	0	0	0	3,176	4,175	4,290	4,426	4,431	4,260	2,072	0	0	26,830
Chalk Bluff Pump	3,352	2,985	3,387	641	1,887	2,357	2,970	2,768	2,097	1,968	3,252	3,461	31,125
TOTAL M & I DIVERSIONS	3,352	2,992	3,395	3,836	7,402	8,683	9,282	9,063	8,176	5,256	3,258	3,461	68,156

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER AGRICULTURAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat (net)	-	-	-	0	1,799	2,150	2,280	2,270	2,110	167	-	-	10,776
Coldron						no consumptive use in 2007							0
Verdi Power - Katz Ditch						no diversions in 2007							0
Highland[1]				216	447	433	447	447	332	0			2,322
Washoe Power Ditch				9	18	18	18	18	9	0			89
Somersett Pumps				3	8	28	23	20	1	0			83
Last Chance	-	-	-	0	567	833	859	946	787	0	-	-	3,992
Lake	-	-	-	0	513	529	508	471	427	35	-	-	2,483
Orr	-	-	-	0	639	895	972	910	411	0	-	-	3,827
Cochran (net)													184
North Truckee (est.)													30
Pioneer (net)	-	-	-	0	446	334	575	458	96	0	-	-	1,909
Pioneer Effluent (UNR)	-	-	-								-	-	0
TOTAL DIVERSIONS STEAMBOAT-VISTA	0	0	0	228	4,437	5,220	5,682	5,540	4,173	202	0	0	25,696
Murphy (net)	-	-		40	53	72	64	159	91	0	-	-	479
McCarran	0.0	0.0	0.0	2.1	8.0	5.4	8.5	5.0	0.0	0.0	0.0	0.0	29
TOTAL DIVERSIONS STEAMBOAT-DERBY	0	0	0	271	4,498	5,298	5,754	5,704	4,264	202	0	0	26,204
Washburn (net)	-	-	-	32	9	7	8	31	42		-	-	130
Gregory (net)	-	-	-	14	93	92	68	152	67	0	-	-	486
Herman (net)	-	-	-	0	385	167	468	302	162	0	-	-	1,484
Pierson	-	-	-			PLPT fisheries - non-consumptive					-	-	0
Proctor (net)	-	-	-	188	258	334	184	550	178	0	-	-	1,692
Fellnagle (est)	-	-	-			(non-regulated diversion, no measurement station)					-	-	350
Gardella (net)						no diversions in 2007							0
Indian (net)	-	-	-	171	1,089	945	1,341	1,044	0	0	-	-	4,590
Olinghouse 1 (pump)						No record for 2007							0
Olinghouse 3 (pump)						No record for 2007							0
TOTAL DIVERSIONS STEAMBOAT-PYRAMID	0	0	0	676	6,332	6,843	7,824	7,783	4,713	202	0	0	34,935

notes 1. The Highland Ditch agricultural diversion is reported by TMWA and is computed as the balance of water remaining from the measured flow at the head of the ditch minus the water diverted to the Chalk Bluff Water Treatment Plant.

U.S. DISTRICT COURT WATER MASTER
TRUCKEE RIVER MUNICIPAL DIVERSIONS

MONTH Ditch Name	JAN AF	FEB AF	MAR AF	APR AF	MAY AF	JUN AF	JUL AF	AUG AF	SEP AF	OCT AF	NOV AF	DEC AF	TOTAL AF
Steamboat Ditch	-	-	-	-	-	-	-	-	-	-	-	-	0
Idlewild Pumps - Reno High	0	0	1	9	18	19.92	25	25	20	10	8	1	135
Glendale T.P.	0	0	0	0	951	1,697	1,962	1,751	1,539	0	0	0	7,899
Chalk Bluff Highland	0	0	3,188	4,730	4,776	4,121	4,544	4,461	4,056	4,644	3,290	3,014	40,822
Chalk Bluff Pump	3,474	3,136	874	1,115	2,118	2,727	2,849	2,947	1,792	735	0	14	21,880
Tracy Power Plant	218	146	136	136	130	172	245	471	372	29	123	123	2,301
TOTAL M & I DIVERSIONS	3,693	3,283	4,298	5,990	7,992	8,736	9,625	9,654	7,780	5,418	3,418	3,151	73,038

FARAD IRRIGATION SEASON FLOWS & INDEX GROUPINGS				
1	2	3	4	5
YEAR	FARAD - FISH RELEASE (APR-OCT) (AF)	INDEX[1]	LAST MONTH @ FULL FLORISTAN RATES	AVG SEASON PER USFWM RECORD
1992	89,458	0.24	APR	APR-JUN
1934	129,515	0.35	APR	
APRIL AVERAGE		0.29		
1988	167,667	0.45	AUG	
2004	209,616	0.56	AUG	MAY-SEP
1920	269,425	0.72	AUG	
1979	273,894	0.74	AUG	
1912	284,578	0.76	AUG	
1928	296,382	0.80	AUG	
1985	322,462	0.87	AUG	
1936	408,309	1.10	AUG	
AUGUST AVERAGE		0.75		
1939	216,446	0.58	FULL	
1959	220,660	0.59	FULL	
1947	228,288	0.61	FULL	
1955	237,839	0.64	FULL	
1944	245,762	0.66	FULL	
1968	247,524	0.66	FULL	
2003	249,596	0.67	FULL	MAY-SEP
1966	253,980	0.68	FULL	
1964	266,256	0.71	FULL	
1954	267,402	0.72	FULL	
2000	267,481	0.72	FULL	APR-SEP
1989	277,172	0.74	FULL	APR-SEP
1948	278,844	0.75	FULL	
1987	279,085	0.75	FULL	
1972	288,024	0.77	FULL	
1913	297,187	0.80	FULL	
1951	301,001	0.81	FULL	
2005	312,961	0.84	FULL	MAY-SEP
1945	315,141	0.85	FULL	
1976	316,566	0.85	FULL	
1941	324,218	0.87	FULL	
1957	330,165	0.89	FULL	
1970	335,860	0.90	FULL	
1962	338,566	0.91	FULL	
1978	350,713	0.94	FULL	
1918	351,849	0.94	FULL	
1921	358,109	0.96	FULL	
1963	358,818	0.96	FULL	
1946	359,511	0.97	FULL	
1973	362,215	0.97	FULL	
1984	377,260	1.01	FULL	
1923	377,906	1.01	FULL	
1980	383,915	1.03	FULL	
1965	389,794	1.05	FULL	
1950	390,441	1.05	FULL	
1910	405,229	1.09	FULL	
1940	416,065	1.12	FULL	

Farad Flows_CCM_11-13-09.xls

EXHIBIT
tabbles
tab 5

FARAD IRRIGATION SEASON FLOWS & INDEX GROUPINGS				
1	2	3	4	5
YEAR	FARAD - FISH RELEASE (APR-OCT) (AF)	INDEX[1]	LAST MONTH @ FULL FLORISTAN RATES	AVG SEASON PER USFWM RECORD
1915	427,954	1.15	FULL	
1953	432,523	1.16	FULL	
1919	439,275	1.18	FULL	
1995	443,098	1.19	FULL	MAY-OCT
1943	477,226	1.28	FULL	
1927	491,621	1.32	FULL	
1986	493,100	1.32	FULL	
1999	507,478	1.36	FULL	MAY-SEP
1956	515,914	1.39	FULL	
1922	519,049	1.39	FULL	
2006	525,164	1.41	FULL	MAY-SEP
1971	529,703	1.42	FULL	
1942	540,266	1.45	FULL	
1974	548,097	1.47	FULL	
1917	549,115	1.47	FULL	
1975	567,731	1.52	FULL	
1916	569,134	1.53	FULL	
1998	606,558	1.63	FULL	MAY-SEP
1914	635,534	1.71	FULL	
1938	681,894	1.83	FULL	
1909	721,029	1.94	FULL	
1982	723,006	1.94	FULL	
1967	730,791	1.96	FULL	
1958	748,534	2.01	FULL	
1969	795,131	2.13	FULL	
1911	893,084	2.40	FULL	
1952	946,238	2.54	FULL	
1983	1,098,401	2.95	FULL	
FULL AVERAGE		1.19		
1961	158,333	0.43	JUL	
1949	240,234	0.64	JUL	
2002	240,310	0.65	JUL	MAY-SEP
1997	299,529	0.80	JUL	MAY-OCT
1937	315,900	0.85	JUL	
1993	326,166	0.88	JUL	APR-SEP
JULY AVERAGE		0.71		
1991	142,169	0.38	JUN	APR-JUL
1933	174,955	0.47	JUN	
1929	181,096	0.49	JUN	
1930	247,929	0.67	JUN	
1925	270,435	0.73	JUN	
1981	278,439	0.75	JUN	
1932	324,220	0.87	JUN	
1935	329,035	0.88	JUN	
JUNE AVERAGE		0.65		
1931	83,295	0.22	MAY	
1924	128,388	0.34	MAY	
1990	171,863	0.46	MAY	APR-AUG
1926	180,638	0.48	MAY	

FARAD IRRIGATION SEASON FLOWS & INDEX GROUPINGS

1	2	3	4	5
YEAR	FARAD - FISH RELEASE (APR-OCT) (AF)	INDEX[1]	LAST MONTH @ FULL FLORISTAN RATES	AVG SEASON PER USFWM RECORD
MAY AVERAGE		**0.38**		
1994	91,000	0.24	NONE	APR-JUN
1977	137,479	0.37	NONE	
NONE AVERAGE		**0.31**		
2001	200,946	0.54	SEP	APR-SEP
1960	254,767	0.68	SEP	
1996	541,821	1.45	SEP	APR-OCT
SEPTEMBER AVERAGE		**0.89**		
Maximum	1,098,401			
3rd quartile	468,694			
Median	324,219			
1st quartile	250,692			
Minimum	83,295			
Average	372,497			

[1] Index = Column 2 / Average Apr-Oct Flow

MONTHS FLORISTAN RATES WERE MET	# YRS	%	AVG INDEX
Entire Season	65	66%	1.19
September	3	3%	0.89
August	8	8%	0.75
July	6	6%	0.71
June	8	8%	0.65
May	4	4%	0.38
April	2	2%	0.29
None	2	2%	0.31
TOTAL:	98		

RANKED FARAD FLOWS - ESTIMATED FISH RELEASES						
FROM STAMPEED/BOCA & PROSSER RESERVOIRS DURING 1994-2006 PERIOD						
YEAR	TOTAL FLOW (APR-OCT)	IRR SEASON INDEX	LAST MONTH @ FULL FLORISTAN RATES	AVG SEASON PER USFWM RECORD		
	AF					
1931	83,295	0.22	MAY			
1992	89,458	0.24	APR	APR-JUN		
1994	91,000	0.24	NONE	APR-JUN		
1924	128,388	0.34	MAY			
1934	129,515	0.35	APR			
1977	137,479	0.37	NONE			
1991	142,169	0.38	JUN	APR-JUL		
1961	158,333	0.43	JUL			
1988	167,667	0.45	AUG			
1990	171,863	0.46	MAY	APR-AUG		
1933	174,955	0.47	JUN			
1926	180,638	0.48	MAY			
1929	181,096	0.49	JUN			
2001	200,946	0.54	SEP	APR-SEP		
2004	209,616	0.56	AUG	MAY-SEP		
1939	216,446	0.58	FULL			
1959	220,660	0.59	FULL			
1947	228,288	0.61	FULL			
1955	237,839	0.64	FULL			
1949	240,234	0.64	JUL			
2002	240,310	0.65	JUL	MAY-SEP		
1944	245,762	0.66	FULL			
1968	247,524	0.66	FULL			
1930	247,929	0.67	JUN			
2003	249,596	0.67	FULL	MAY-SEP		
1966	253,980	0.68	FULL			
1960	254,767	0.68	SEP			
1964	266,256	0.71	FULL			
1954	267,402	0.72	FULL			
2000	267,481	0.72	FULL	APR-SEP		
1920	269,425	0.72	AUG			
1925	270,435	0.73	JUN			
1979	273,894	0.74	AUG			
1989	277,172	0.74	FULL	APR-SEP		
1981	278,439	0.75	JUN			
1948	278,844	0.75	FULL			
1987	279,085	0.75	FULL			
1912	284,578	0.76	AUG			
1972	288,024	0.77	FULL			
1928	296,382	0.80	AUG			
1913	297,187	0.80	FULL			
1997	299,529	0.80	JUL	MAY-OCT		
1951	301,001	0.81	FULL			
2005	312,961	0.84	FULL	MAY-SEP		
1945	315,141	0.85	FULL			
1937	315,900	0.85	JUL			
1976	316,566	0.85	FULL			
1985	322,462	0.87	AUG			
1941	324,218	0.87	FULL			
1932	324,220	0.87	JUN			
1993	326,166	0.88	JUL	APR-SEP		

YEAR	TOTAL FLOW (APR-OCT)	IRR SEASON INDEX	LAST MONTH @ FULL FLORISTAN RATES	AVG SEASON PER USFWM RECORD		
	AF					
1935	329,035	0.88	JUN			
1957	330,165	0.89	FULL			
1970	335,860	0.90	FULL			
1962	338,566	0.91	FULL			
1978	350,713	0.94	FULL			
1918	351,849	0.94	FULL			
1921	358,109	0.96	FULL			
1963	358,818	0.96	FULL			
1946	359,511	0.97	FULL			
1973	362,215	0.97	FULL			
1984	377,260	1.01	FULL			
1923	377,906	1.01	FULL			
1980	383,915	1.03	FULL			
1965	389,794	1.05	FULL			
1950	390,441	1.05	FULL			
1910	405,229	1.09	FULL			
1936	408,309	1.10	AUG			
1940	416,065	1.12	FULL			
1915	427,954	1.15	FULL			
1953	432,523	1.16	FULL			
1919	439,275	1.18	FULL			
1995	443,098	1.19	FULL	MAY-OCT		
1943	477,226	1.28	FULL			
1927	491,621	1.32	FULL			
1986	493,100	1.32	FULL			
1999	507,478	1.36	FULL	MAY-SEP		
1956	515,914	1.39	FULL			
1922	519,049	1.39	FULL			
2006	525,164	1.41	FULL	MAY-SEP		
1971	529,703	1.42	FULL			
1942	540,266	1.45	FULL			
1996	541,821	1.45	SEP	APR-OCT		
1974	548,097	1.47	FULL			
1917	549,115	1.47	FULL			
1975	567,731	1.52	FULL			
1916	569,134	1.53	FULL			
1998	606,558	1.63	FULL	MAY-SEP		
1914	635,534	1.71	FULL			
1938	681,894	1.83	FULL			
1909	721,029	1.94	FULL			
1982	723,006	1.94	FULL			
1967	730,791	1.96	FULL			
1958	748,534	2.01	FULL			
1969	795,131	2.13	FULL			
1911	893,084	2.40	FULL			
1952	946,238	2.54	FULL			
1983	1,098,401	2.95	FULL			

FARAD FLOWS - ESTIMATED FISH RELEASES

FROM STAMPEED/BOCA & PROSSER RESERVOIRS DURING 1994-2005 PERIOD

ALL VALUES IN CFS

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	LAST MONTH @ FULL FLORISTAN RATES	AVG SEASON PER USFWM RECORD
1909	1926	1147	1171	2811	2965	2849	1282	762	642	610	1015	1110	FULL	
1910	1250	1178	1685	1983	1426	943	755	668	498	427	418	473	FULL	
1911	664	968	1198	3246	3584	4168	2079	673	545	486	521	541	FULL	
1912	509	381	405	474	1314	1117	391	535	459	405	438	403	AUG	
1913	464	403	467	887	1340	686	494	513	484	400	409	390	FULL	
1914	867	531	1403	2841	3100	2144	856	543	529	503	570	581	FULL	
1915	490	416	600	1617	1914	1465	814	574	481	402	391	433	FULL	
1916	580	679	1932	3056	2253	1748	742	631	506	491	524	516	FULL	
1917	574	486	533	1674	2063	2560	1122	697	530	438	409	447	FULL	
1918	441	493	577	1412	1254	779	668	692	532	473	428	446	FULL	
1919	442	453	567	2143	2298	691	800	600	512	408	415	434	FULL	
1920	411	386	492	791	1427	673	495	502	330	222	340	350	AUG	
1921	454	427	1000	1188	1523	1261	540	515	509	384	308	282	FULL	
1922	395	424	489	915	3314	2238	648	521	504	419	417	456	FULL	
1923	426	456	631	1301	1901	979	588	530	517	422	405	407	FULL	
1924	439	434	409	488	499	284	181	220	279	171	144	89	MAY	
1925	95	604	567	1117	1326	632	471	419	258	240	185	210	JUN	
1926	202	288	523	1103	772	411	322	212	102	70	221	200	MAY	
1927	320	661	962	1722	2314	2024	635	510	491	437	444	392	FULL	
1928	452	383	1681	1216	1370	626	517	514	454	205	237	226	AUG	
1929	195	190	335	506	1022	497	319	252	251	139	153	359	JUN	
1930	200	328	671	1310	1024	726	321	278	317	132	157	84	JUN	
1931	111	121	304	456	521	142	54	54	75	75	78	115	MAY	
1932	210	208	497	1355	1823	1314	426	227	121	98	95	91	JUN	
1933	95	85	142	573	811	1067	240	84	47	78	106	139	JUN	
1934	159	220	695	632	349	174	300	353	221	110	141	85	APR	
1935	143	155	176	1589	2029	1229	312	137	73	76	83	95	JUN	
1936	222	302	609	2062	1994	1078	520	484	368	249	162	138	AUG	
1937	325	430	521	1250	1684	791	535	462	287	205	223	1368	JUL	
1938	394	430	512	2333	4140	2587	744	509	498	455	419	436	FULL	
1939	431	414	488	592	569	506	500	503	499	403	323	303	FULL	
1940	425	474	1078	1898	2117	905	525	508	499	424	458	485	FULL	
1941	429	648	839	741	1688	923	552	517	506	418	435	617	FULL	
1942	583	1187	631	2003	2131	2698	894	509	504	415	470	567	FULL	
1943	1060	2325	1938	2903	1821	1052	579	540	524	487	459	434	FULL	
1944	423	430	469	511	915	661	592	515	503	415	427	398	FULL	
1945	387	577	530	835	1596	798	526	501	502	437	441	502	FULL	
1946	498	460	551	1657	1545	745	538	513	502	440	468	423	FULL	
1947	448	463	498	562	754	512	509	503	498	425	371	377	FULL	
1948	437	337	310	672	889	1164	542	524	504	413	317	358	FULL	
1949	388	351	314	780	1010	565	512	465	371	261	193	229	JUL	
1950	344	406	464	1355	1838	1283	544	504	498	430	2064	2742	FULL	
1951	1481	1065	664	790	1182	1000	533	532	513	420	454	542	FULL	
1952	1132	1757	1629	3887	5674	3395	1160	541	541	443	458	616	FULL	
1953	918	1130	493	839	1519	2082	1060	578	565	505	472	446	FULL	
1954	428	434	609	880	1061	528	527	518	508	411	413	416	FULL	
1955	427	399	425	510	721	765	521	524	491	393	316	1863	FULL	
1956	1124	1077	1434	1712	2459	2134	667	523	521	516	557	536	FULL	
1957	457	506	1048	788	1163	1394	587	546	530	449	452	480	FULL	
1958	405	517	543	2914	5125	1996	657	559	589	532	473	476	FULL	
1959	469	438	515	541	539	528	540	544	536	413	362	365	FULL	
1960	311	426	550	744	761	675	605	560	496	385	248	298	SEP	
1961	167	256	256	505	549	514	461	327	171	87	83	105	JUL	
1962	87	193	273	1262	1259	878	514	500	485	894	478	452	FULL	
1963	419	1732	351	873	1920	1192	516	546	489	383	469	400	FULL	

FARAD FLOWS - ESTIMATED FISH RELEASES

FROM STAMPEED/BOCA & PROSSER RESERVOIRS DURING 1994-2006 PERIOD

ALL VALUES IN CFS

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	LAST MONTH @ FULL FLORISTAN RATES	AVG SEASON PER USFWM RECORD
1964	380	361	309	656	1087	732	530	532	488	387	300	1994	FULL	
1965	1341	1052	642	1222	1698	1256	622	558	522	559	707	1053	FULL	
1966	901	382	606	691	939	525	568	574	497	392	343	523	FULL	
1967	438	519	1116	544	3693	4233	1695	584	681	652	488	524	FULL	
1968	441	793	753	623	849	596	569	535	513	397	439	421	FULL	
1969	869	1526	2155	3428	3735	3848	851	536	548	434	403	601	FULL	
1970	1659	2003	1292	615	1148	1155	913	616	566	524	431	446	FULL	
1971	780	758	690	1029	1864	2305	988	882	922	982	450	461	FULL	
1972	466	488	786	852	1181	762	510	564	500	384	432	529	FULL	
1973	490	422	515	893	1294	923	770	775	752	588	684	438	FULL	
1974	1022	692	1351	2054	2203	1559	1216	822	635	562	547	525	FULL	
1975	523	527	554	827	2803	2027	1187	1084	705	715	447	417	FULL	
1976	411	415	553	820	958	709	748	731	646	511	353	345	FULL	
1977	359	351	334	389	423	407	406	401	211	51	63	113	NONE	
1978	229	339	673	845	1898	936	555	509	522	513	286	280	FULL	
1979	334	230	382	609	1377	812	534	476	431	469	323	316	AUG	
1980	1110	628	498	958	2035	1284	603	538	517	401	400	411	FULL	
1981	350	358	271	583	1538	528	459	484	444	561	975	1294	JUN	
1982	543	1419	894	2372	4301	2482	765	512	883	823	1807	2304	FULL	
1983	1251	2239	3101	3124	3951	5214	2921	1048	1482	441	2469	3586	FULL	
1984	3053	1741	1318	1055	1668	1426	864	508	505	406	448	447	FULL	
1985	416	423	557	1215	1894	567	506	480	468	368	383	391	AUG	
1986	476	2394	4073	2554	2404	1301	519	486	476	410	388	397	FULL	
1987	397	442	672	869	1283	610	496	490	475	379	300	326	FULL	
1988	310	305	297	469	498	472	483	506	254	84	126	100	AUG	
1989	215	199	728	1062	801	722	484	501	497	408	317	308	FULL	APR-SEP
1990	209	201	385	792	610	444	398	351	150	96	58	80	MAY	APR-AUG
1991	78	93	327	475	578	540	432	158	91	73	135	116	JUN	APR-JUL
1992	104	194	325	490	454	156	116	106	97	61	86	140	APR	APR-JUN
1993	235	264	804	977	1606	1276	567	450	370	144	85	124	JUL	APR-SEP
1994	110	128	288	423	436	228	153	112	81	61	101	115	NONE	APR-JUN
1995	420	404	1098	958	2256	1702	879	536	510	368	248	375	FULL	MAY-OCT
1996	329	1291	1481	1986	3381	1729	539	497	498	320	520	2042	SEP	APR-OCT
1997	8116	3264	2219	1155	1043	891	515	470	468	314	391	399	JUL	MAY-OCT
1998	445	449	1394	1751	2504	3022	1222	454	555	527	468	754	FULL	MAY-SEP
1999	672	1871	1839	1741	2985	1710	586	482	482	415	401	385	FULL	MAY-SEP
2000	412	481	686	1001	888	601	557	500	501	370	350	399	FULL	APR-SEP
2001	401	405	508	507	531	489	493	483	484	328	301	279	SEP	APR-SEP
2002	300	320	377	868	677	637	492	400	488	410	346	233	JUL	MAY-SEP
2003	368	335	485	660	815	734	500	509	505	399	338	221	FULL	MAY-SEP
2004	230	265	618	670	705	542	498	497	437	115	98	153	AUG	MAY-SEP
2005	182	227	402	679	1821	973	492	481	499	416	353	991	FULL	MAY-SEP
2006	1451	852	1353	2024	2850	1523	587	520	508				FULL	MAY-SEP

Estimated Average Fish Releases to Truckee River From Stampede/Boca and Prosser Reservoirs
Based on Available Monthly Reservoir Sheets Maintained by Federal Water Master
(values in cfs)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1994	0	0	0	394	932	317	0	0	0	0	0	0
1995	0	0	0	0	0	389	549	299	15	36	0	0
1996	0	0	0	0	0	173	365	56	105	91	1	13
1997	0	0	0	442	573	254	95	106	73	82	6	3
1998	0	0	8	265	136	0	184	282	132	61	0	0
1999	0	0	0	0	0	428	312	148	135	65	0	0
2000	0	0	0	42	335	51	49	109	101	115	50	118
2001	102	78	67	12	35	93	100	100	74	62	40	40
2002	0	30	40	228	391	152	66	11	0	48	7	0
2003	0	0	0	82	153	10	134	0	28	21	41	50
2004	50	50	43	87	178	80	60	22	6	36	31	25
2005	12	0	0	0	0	45	219	2	0	0	0	0
2006	0	0	0	0	0	0	381	123	132	na	na	na

Estimated Fish Releases to Truckee River From Stampede/Boca and Prosser Reservoirs
Based on Available Monthly Reservoir Sheets Maintained by Federal Water Master
(values in acre-feet)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1994	0	0	0	23,427	57,301	18,850	0	0	0	0	0	0	99,578
1995	0	0	0	0	0	23,130	33,778	18,361	908	2,183	24	0	78,384
1996	0	0	0	0	0	10,312	22,442	3,470	6,235	5,624	56	822	48,961
1997	0	0	0	26,271	35,228	15,100	5,832	6,498	4,369	5,025	355	192	98,870
1998	0	0	476	15,748	8,336	0	11,313	17,354	7,833	3,720	0	0	64,780
1999	0	0	0	0	0	25,438	19,181	9,112	8,055	4,005	0	0	65,791
2000	0	0	0	2,528	20,579	3,044	3,021	6,704	6,010	7,061	2,991	7,272	59,210
2001	6,268	4,319	4,119	703	2,129	5,524	6,147	6,147	4,408	3,821	2,380	2,459	48,424
2002	0	1,659	2,459	13,537	24,053	9,021	4,028	698	0	2,971	416	0	58,842
2003	0	0	0	4,896	9,379	583	8,269	0	1,648	1,262	2,443	3,074	31,554
2004	3,074	2,875	2,648	5,201	10,874	4,756	3,688	1,359	378	2,221	1,844	1,537	40,555
2005	717	0	0	0	0	2,697	13,449	121	0	0	0	0	16,984
2006	0	0	0	0	0	0	23,429	7,540	7,841	na	na	na	38,810

No. A-3-

U. S. District Court, Nevada.

U.S

Plaintiff.

vs.

Orr Ditch Co et al

Defendants

Dis Exhibit No. 10-J

FILED July 1 1925

E.O. Patterson

Clerk.

By J Donovan

UNION LABEL TYPOGRAPHICAL WASHOE

CARSON CITY, NEVADA

STATE PRINTING OFFICE, : JOE FARNSWORTH, SUPERINTENDENT

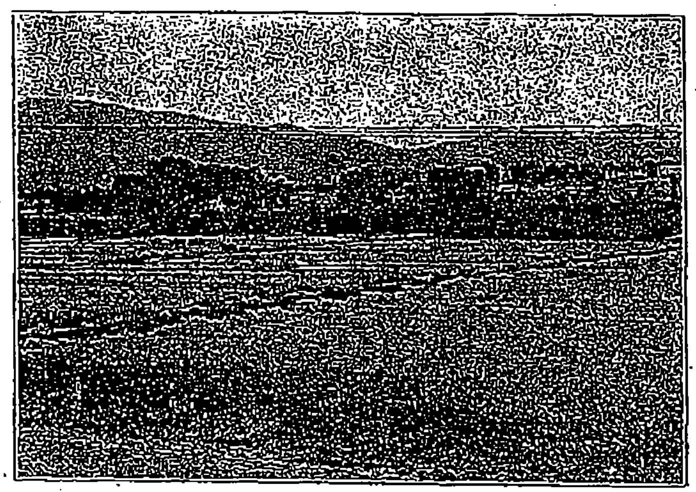
1919

EXHIBIT

Tab 6

IRRIGATION OF FIELD CROPS IN NEVADA

By
C. S. KNIGHT
and
GEORGE HARDMAN



BULLETIN No. 96

AGRICULTURAL EXPERIMENT STATION
THE UNIVERSITY OF NEVADA

CARSON CITY, NEVADA
STATE PRINTING OFFICE : : : JOE FARNSWORTH, SUPERINTENDENT
1919

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CONTENTS

IRRIGATION OF FIELD CROPS IN NEVADA

By C. S. Knight and George Hardman

INTRODUCTION

The approximate area of land in the State of Nevada is 70,285,440 acres. Of this amount about 900,000 acres, or 1.3 per cent, were irrigated in 1918. The State abounds in rich agricultural land, but the lack of additional water for irrigation prevents the cultivation of regions which are now lying idle as waste desert areas. To increase the area of irrigated land it becomes necessary either to furnish additional water by means of artesian wells or pumping, or to make a more conservative use of the present water supply. The irrigation experiments at the Nevada Station deal chiefly with the latter of these two methods.

Alfalfa, wheat, and potatoes are three of the most important cultivated crops grown in Nevada. Practically all of the alfalfa, most of the wheat, and all of the potatoes are grown under irrigation. In the course of the last nine years the acreage of alfalfa in this State increased from 89,000 to about 145,000 acres, or over 60 per cent; and the yield from 235,000 to about 500,000 tons, or an increase in production of 112 per cent. In 1918 about 80,000 acres of wheat were raised in Nevada, with a production of about 2,000,000 bushels. Approximately one-third of the crop was grown in Humboldt County, and over 80 per cent in Humboldt, Washoe, Churchill, Lyon, and Douglas Counties. The potato crop for the same year amounted to about 15,000 acres, with a production of approximately 75,000 tons. Over 60 per cent of this crop was produced in Lyon, Churchill, Washoe, and Douglas Counties.

A large part of the acreage of these crops in Nevada receives too much water to obtain the best yield and quality of crops, and for maintaining high-producing soils. The common practice in Nevada is to irrigate alfalfa at regular intervals with little regard to the actual needs of the crop for water, or to the possible injury to the soil by excessive irrigation. It is important, therefore, that the proper method of irrigation and the best time and depth of application be known. Furthermore, in years of water shortage irrigations should be omitted at those stages of growth when the crop is least affected. Pumped water is expensive as compared with surface water; hence, it is of value to the grower to know the least amount of water necessary to obtain the best results with the various crops. Since the supply of water is strictly limited and the supply of irrigable land is practically unlimited, it becomes of vital importance to the State to have authentic information on the most economical amounts of water to apply, consistent with profitable returns.

In view of the above facts, a series of experiments has been conducted during the last five years by the Nevada Agricultural Experiment Station comparing the different methods of application to determine the amount of water required and the best time to apply water to the

Note.—The authors are indebted to J. B. Menardi who assisted in the field work during the three-year period, 1914–1917; also to F. L. Bixby, Senior Irrigation Engineer, U. S. Department of Agriculture, for valuable suggestions, assistance, and diagrams.

crop to obtain the most favorable results; at which stage or stages of growth an application may be eliminated without seriously affecting the yield of grain; and also the most practical depths of applications when only two irrigations are possible. The average results of experiments on the irrigation of wheat, alfalfa, potatoes, red clover, and sugar-beets, together with results of earlier work on alfalfa, wheat, and barley, are given in this bulletin.

NEVADA WATER SUPPLY AND DRAINAGE AREAS

Nevada lies almost wholly within the Great Basin. In fact, with the exception of small streams tributary to the Snake River in the northeastern section of Nevada and some branches of the Colorado River in the southeastern section, the rivers drain into the interior of the State. These rivers are fed from the snowfall on the mountains of Nevada and the eastern slope of the Sierra in California. The Humboldt, Truckee, Carson, Walker, and Muddy are the principal rivers supplying water for irrigation.

Humboldt River.

This river has a length of 350 miles of air line, but measured in its irregular course it traverses a distance of about 1,000 miles. The melting snows of the Ruby, East Humboldt, Independence, and Diamond ranges are the sources of this river; it drains into the Humboldt Sink at the lower end of the Lovelock Valley. This stream has a drainage basin of 13,800 square miles, all within Nevada. More than 50 per cent of the irrigated area in this State receives its water from the Humboldt River.

Truckee River.

This is the most northerly river on the eastern slope of the Sierra emptying into the Great Basin. It receives its water supply chiefly from mountain lakes, which are fed by the melting snow of the Sierra in California. It is the outlet of Lake Tahoe, which has an elevation of 6,225 feet and covers an area of 193 square miles. The course of the Truckee is about 110 miles long, in which distance it has a total fall of 2,350 feet. It has a drainage basin of 2,310 square miles.

Carson River.

This river is formed by the East and West Forks, which receive their water supply from the melting snow on the eastern slopes of the Sierra Nevada in California. The river is about 120 miles long and has a total fall of 1,900 feet. It has a drainage basin in Nevada of 988 square miles.

Walker River.

This is the most southerly river draining from the Sierra Nevada into the Great Basin. It is formed by the East and West Forks, whose basins are separated by the Sweetwater range of mountains. The East Fork is fed by the melting snows from the eastern slope of the Sweetwater range and the western slope of the Walker River range, while the West Fork drains part of the eastern slope of the Sierra. This river is about 120 miles long, has a total fall of 1,600 feet, and a drainage basin of 2,420 square miles.

Muddy River.

The Muddy River is located in the southeastern part of Nevada. It receives its supply of water from constantly flowing springs in Arrow Canyon, and drains into the Virgin River, a tributary of the Colorado River. It has been estimated that the average annual flow of the river is about 28,000 acre-feet of water.

Small Streams in Northern Nevada.

The small streams in northern Nevada furnish water for about 14 per cent of the total irrigated area. The principal streams are the White River, Duck Creek, Steptoe Creek, Salmon River, Bruneau River, and Owyhee River. The White River is 75 miles long, and has an average annual run-off of about 28,000 acre-feet. Duck Creek and Steptoe Creek supply Steptoe Valley, and the Salmon, Bruneau, and Owyhee irrigate a considerable area in Nevada before emptying into the Snake River basin.

Artesian Wells in Southern Nevada.

In southern Nevada about 100 artesian wells, which develop flows at from 200- to 400-feet depths, furnish the water supply for the irrigation of a considerable area, the greater portion of which is located in the Las Vegas and Pahrump Valleys.

Washoe Lake.

By means of large pumping plants several thousand acres of land have been placed under intensive cultivation with the water from Washoe Lake. The water is elevated from 40 to 125 feet by the different plants.

IRRIGATED AREA IN NEVADA

The following table taken from the twelfth and thirteenth census of the United States, shows the total irrigated area in Nevada for 1900 and 1910, with the increase in per cent for the ten-year period:

IRRIGATED AREA BY COUNTIES IN NEVADA—ACREAGE

County	1900	1910	Increase per cent
The State	504,168	701,833	39.2
Churchill	29,533	35,114	18.9
Clark	(a)	8,110	......
Douglas	25,861	32,181	24.4
Elko	156,440	183,552	17.3
Esmeralda[b]	6,181	14,011	126.7
Eureka	21,831	18,715	14.3
Humboldt	124,950	207,708	66.3
Lander	18,803	23,312	24.1
Lincoln[a]	9,902	9,007	(a)
Lyon	32,422	62,143	91.7
Nye	12,866	19,078	57.7
Ormsby	1,563	2,426	55.2
Storey	690	891	29.1
Washoe	43,855	50,904	16.0
White Pine	19,360	32,795	69.3

It is noted from this table that about 30 per cent of the total irrigated area is located in Humboldt County and 56 per cent in Humboldt and Elko Counties, this area being irrigated from the Humboldt River and its tributaries.

[a] Change in boundary. Lincoln County divided into Lincoln and Clark Counties.
[b] Change in boundary. Esmeralda County divided into Esmeralda and Mineral Counties.

Methods of Irrigation.

The greater portion of the alfalfa acreage in Nevada is irrigated by some form of flooding. In the Lovelock Valley the border method of flooding is generally used; on the Truckee-Carson Project, the check system of flooding; in Washoe Valley, flooding from field laterals and by the furrow method; and in the Carson Valley the furrow or corrugation method is most common.

On light sandy soils it is very important to have available a sufficient head of water to flood the field in a short time so that very little water will be wasted by percolation through the soil beyond the depth of the plant roots. With the heavy clay loam or clay soils a relatively small head of water is required for a longer period of time, since the water percolates less rapidly through these soils. The heavy soils, however, have greater power for retaining water, and are better suited to fewer and heavier irrigations. Frequent light applications of water generally result in the best crops on the sandy and sandy-loam soils. Each

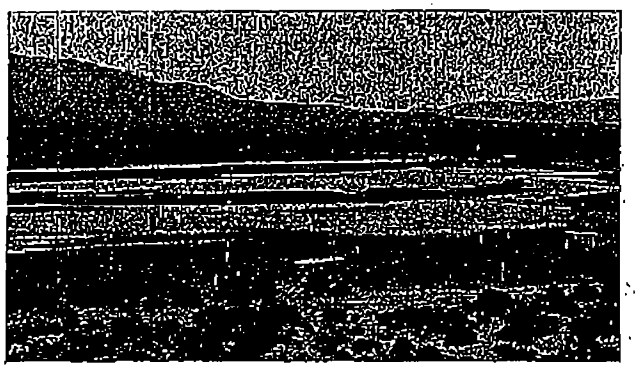

Plate 2—An excess of water is used in this method of flooding.

method of irrigation is peculiarly adapted to the soil conditions and slope of the land in the district where it is practiced.

Flooding from Field Ditches.

This is the cheapest method to install and the most wasteful of water, also a great deal of labor is required in distributing the water over the field. It is sometimes called the contour method, since the field ditches carry the water along the ridges and distribute it down the slopes over the field. This method is applicable to new lands for the first crop; to heavy, rocky, or very shallow soils where leveling is not advisable; and to small heads of water. One man can handle from two to four second-feet of water under this system.

Flooding in Borders.

Flooding in borders or border checks, where the land is comparatively level and does not bake excessively, is one of the most satisfactory methods of irrigation for either grain or alfalfa. This system is

practiced in Nevada on comparatively level land where a large head of water is obtainable. In preparing the land for this system, great care must be exercised in leveling the land between the border levees. For the rough leveling a Fresno scraper is commonly used, being followed by a tailboard scraper to make the levees. Another commonly used implement in Nevada is a large scraper mounted on four wheels with a heavy iron blade which works something on the order of a road grader. Where the levees are constructed with the tailboard scraper the operator drives across the field in the opposite direction to the levees, gathering the dirt for the levees from the surface of the borders, and at the same time leveling the borders.

The borders vary in length from 300 to 1,800 feet, with an average of 500 feet depending upon the slope of the land and the texture of the soil. The width may vary from 30 to 100 feet, with an average of about 60 feet. In irrigating, the water is turned into the border and carried down its entire length, the waste water either being picked up by the head ditch of the next series of border checks, or flowing into a drainage ditch. One man can handle about six second-feet of water under this method.

The system of border irrigation, practiced to a large extent in the Lovelock Valley, differs from the method explained above as follows:

When the field is properly leveled with a grader, the borders are marked off on the head line from sixty to ninety feet wide. A large V marker or ditcher is then used to make the levees, separating the borders at regular intervals. This is a heavy implement, mounted on four wheels, controlled by a system of levers, and requiring about sixteen horses for its operation. After these borders are seeded, a head ditch is then made with the same ditcher to carry the water to the borders. If one man is applying the water, he turns in as large a head as can be properly handled. Considerable experience is needed in this system of applying water, because, as soon as the soil at the upper ends of the borders is sufficiently wet, the water must be taken down the ditches between the borders to irrigate the lower portions of the land. These borders vary from 1,000 to 5,000 feet in length, depending upon the slope of the land. With a properly installed system the water can be brought down one side of the field for a considerable distance in a diagonal direction, instead of bringing the water down the ditch and turning it into the borders at frequent intervals. In this way a large tract can be irrigated in a day by one man. The ground is flooded for the first irrigation only, subsequent applications being made by allowing the water to seep from the ditches between the borders. In sections of Nevada where this system is practiced, wonderful crops of wheat and alfalfa are produced, but in such regions the soil is of a loose nature, contains a large amount of humus and does not bake after wetting. In this system one experienced irrigator can handle about six second-feet of water.

Flooding in Checks or Basins.

In this system of irrigation the levees are run across the field in both directions, dividing it into a series of checks or basins. In Nevada this method is largely practiced on new lands that require a great deal of leveling. The level tracts can be checked ready for the water with less expense than for any other system of flooding. This method is also desirable on lands that will not soak up readily when the water is run in furrows. On the Newlands Irrigation Project, where this system is commonly used in the production of hay and grain, the levees dividing the checks or basins are wide and low, and are generally covered with a crop. They are so constructed to prevent any waste of land and to make possible the harvesting of the crop with a mower or binder. In such a system some checks are higher than others. Water is turned into the higher checks, and, when the ground is sufficiently wet, it is taken off and run into the lower checks, and so on, until all the ground is irrigated. Although considerable water is lost by evaporation, very little goes into the drainage ditches. If the land has a gentle slope, the installation of this system is expensive as compared with the border method and flooding from field laterals. A large head of water can be

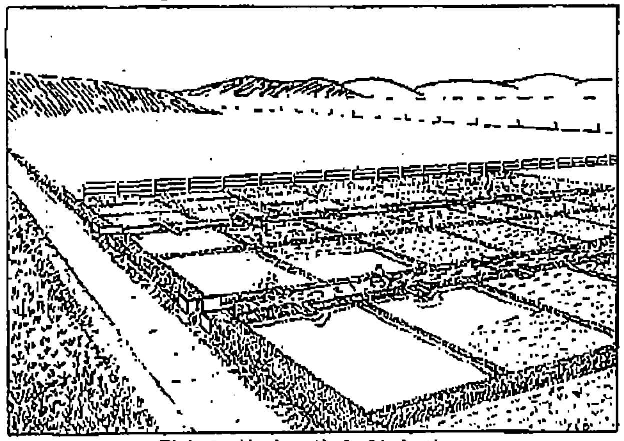

Plate 3—Check method of irrigation.

used with this system and one man can handle from seven to eight second-feet. On the Newlands Project the check system is being rapidly replaced by the border method.

Furrow-Irrigation.

Where the conditions are suitable and the land is sufficiently friable and mellow, the furrow method of irrigation is best adapted to the highest returns of hay and grain in Nevada. In this system the water is run through the field in small furrows and diffused laterally through the soil, but should not run over the surface. This system is adapted to small irrigating streams, considerable slopes, and heavy soils. The water may run in few or many furrows, or it may be run across the slope at any angle for the desired flow of water giving the heavy soils time to soak up. The feed ditches are nearly level and are generally

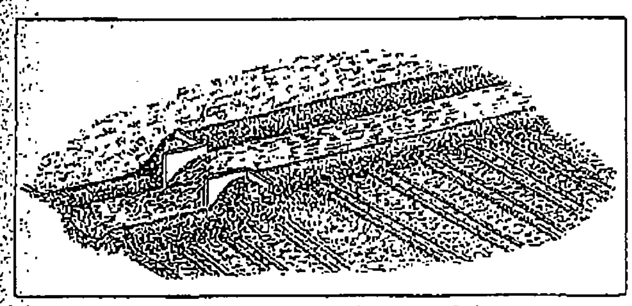

Plate 4—Furrow irrigation by means of pipes.

run across the slope of the field. In Nevada a great deal of trouble has been encountered on light soils in the washing away of the banks where the water is taken from the distributing ditch to the furrows. This condition has been met by the use of galvanized iron pipes from one and one-half to two inches in diameter and two feet long, or by the use of wooden spile made from lath or material sawed for the purpose. These pipes are placed in the bank of the distributing ditch and each pipe furnishes water for two to six furrows, depending upon the head

Plate 5—A minimum amount of water is used in the furrow method of irrigation.

of water in the feed ditch. By such a system a large field can be irrigated by one man, since his chief duty is to see that the proper head of water is maintained in the distributing ditches; also, the water is more evenly distributed in the furrows, so that it reaches the lower part of the field in the different furrows, at about the same time.

On the heavy soils of the Truckee Meadows practically every alfalfa field is furrowed, but the land is usually flooded from field ditches, the furrows providing easy channels for the water to the lower end of the field and drainage for the surplus water after each irrigation, which might otherwise stand in the low places and retard the growth of the crop. In irrigating grain more care must be taken to prevent the water from flooding the surface of the ground between the furrows.

The furrows vary in length with the slope of the land and the nature of the soil from 200 to 800 feet, the longer furrows being possible on the heavier lands with gentle slopes. Feed ditches run across the fields at intervals of from 200 to 800 feet, and in turn furnish water for the irrigation of the furrows below. Although the initial expense of installing this system is high, the water is easily handled and the expense of irrigating is small. A smaller head of water is used with this system than with the others.

IMPORTANT FACTORS AFFECTING DUTY OF WATER IN NEVADA

Type of Soil.

The type of soil probably causes greater variation in the amount of water required than any other one factor. In 1906, 12½ acres of alfalfa, at the Experiment Station, grown on gravelly soil with a very open gravelly subsoil, received a total depth of 8.5 feet of water and produced only two tons of hay per acre. The yield per acre-foot of water was only 0.24 tons. During the same year two acres of alfalfa grown on a sandy clay soil with a clay subsoil received a total depth of only 3 feet of water and produced 7.36 tons per acre or a yield of 2.45 tons per acre-foot of water.

Topography.

On lands that are rolling or that have steep slopes the amount of run-off is large, thus increasing the total irrigation required to produce the best crops. On the more uniformly level lands with light slopes practically all of the water applied may be retained by the land. On certain alfalfa fields in the Truckee Meadows, where the land is rolling, the total annual depth of irrigation varies from 5 to 10 feet, but more than one-half of this amount may be run-off that is used again on lower lands or drains back into the Truckee River.

Hardpan Near the Surface.

The following table shows the results obtained in 1910 on an acre of alfalfa, which received twelve irrigations with a total of about six acre-feet of water:

EFFECT OF HARDPAN ON THE AMOUNT OF WATER REQUIRED FOR ALFALFA*

Date of irrigation—		Depth of irrigation, feet	Yield per acre: First cutting, tons	Second cutting, tons	Third cutting, tons
April 10	0.120				
April 20	0.239				
May 5	0.409				
May 23	0.010				
June 8	0.662				
Total		2.081	1.65		
June 16	0.759				
June 27	0.537				
July 7	0.225				
July 8	0.430				
Total		1.957	......	1.65	
July 29	0.523				
August 6	0.678				
August 12	0.661				
Total		1,800	......	......	1.77
September 14	0.300	Irrigation for pasture			
Total irrigation	6.288		Total yield		4.07

*A heavy clay soil with a hardpan layer very close to the surface. The depth of irrigation includes run-off which was not measured.

It is noted from these results that soils with hardpan near the surface have very little capacity for retaining water, and in this instance about twice as much water is used to produce a crop as compared with similar soils without a hardpan layer near the surface.

Influence of Annual Rainfall.

In many States where irrigation is practiced the annual precipitation is an important factor to be considered in the results of investigations of irrigation methods, and particularly in the duty of water in field practice. The following table gives the total precipitation and monthly distribution for the past five years and for a period of eighteen years at the Experiment Station:

MONTHLY PRECIPITATION IN INCHES AT THE AGRICULTURAL EXPERIMENT STATION, FIVE-YEAR PERIOD, 1914–1918*

Month	1914	1915	1916	1917	1918	Average five years	Average 1900–1913
January	5.40	0.55	0.76	0.05	0.13	2.59	1.99
February	0.80	2.50	0.59	2.01	1.73	1.56	1.20
March	T	0.16	0.33	0.74	2.51	0.75	0.07
April	0.70	0.38	0.11	0.28	0.16	0.32	0.69
May	0.11	0.52	T	1.18	0.25	0.41	0.48
June	0.20	0.00	0.11	0.06	0.14	0.12	0.23
July	T	0.04	T	0.04	T	0.02	0.44
August	0.36	T	0.04	0.12	T	0.11	0.32
September	0.05	0.06	0.35	T	8.41	0.57	0.33
October	0.10	T	1.13	T	0.75	0.41	0.41
November	T	0.28	0.05	0.68	0.37	0.28	0.51
December	0.70	1.00	0.07	0.27	0.40	0.60	0.50
Total	8.71	5.82	10.44	5.43	8.95	7.83	8.31

*Information secured from the U. S. Weather Bureau, Reno, Nevada.

It will be seen from the above table that the average annual precipitation for the five-year period of irrigation investigations amounted to 7.83 inches. In May, 1917, the rainfall was 1.18 inches. With this exception, during no one month of the growing season throughout the five-year period was sufficient rainfall received to affect the moisture content of the soil; that is, the small amount of precipitation at any one time was subject to evaporation within a few hours. The entire rainfall in September, 1918, occurred after the crops were harvested. The results of these experiments are therefore based entirely on the water supplied by irrigation.

The average precipitation over the entire State, according to the reports of the United States Weather Bureau, is about 8.5 inches per year. The only source of Nevada's water supply is the snowfall upon her own mountain ranges and the precipitation upon the eastern slope of the Sierra in California. Throughout the agricultural districts of Nevada the rainfall is, in general, so slight and so poorly distributed during the growing season that it cannot be depended upon to supplement irrigation in supplying the moisture needs of crops.

Effect of Evaporation on the Amount of Water Required.

The following table gives the average evaporation by months at the Experiment Station from still water surfaces for the year 1912:

EVAPORATION FROM WATER SURFACES AT THE EXPERIMENT STATION IN 1912

Month	*Evaporation, feet*
January	0.101
February	0.148
March	0.110
April	0.280
May	0.569
June	0.667
July	0.650
August	0.651
September	0.608
October	0.452
November	0.182
December	0.134
Total	5.356

The annual evaporation from free water surfaces at the Experiment Station is shown to exceed five feet, the greatest losses occurring during the months of June, July, and August. At the Experiment Station on cultivated land the average loss of water annually by evaporation amounts to about fifteen inches. It is quite evident from these results that where the annual evaporation is high, more water is required to produce a crop than in districts where the normal conditions of evaporation prevail.

During the years 1908 and 1909 the Nevada Agricultural Experiment Station, in cooperation with the Office of Irrigation Investigations of the U. S. Department of Agriculture, conducted a series of experiments on the losses of water by evaporation from irrigated soils. These investigations were made at the Experiment Station Farm near Reno at an altitude of 4,490 feet on a sandy alluvial loam soil, which is typical of a large portion of the irrigated area in Nevada. The detailed results of these experiments are found in Bulletin 248, Office of Experiment Stations, U. S. Department of Agriculture. A summary of the results of this work follows.

Effect of Soil Mulches of Different Depths.

The following table gives the average evaporation from soils protected by different depths of soil mulches at the Nevada Agricultural Experiment Station for a period of three weeks (June 9–30, and September 1–22, 1908), with six inches of water applied:

Depth of mulch	*Loss in inches*	*Loss of total application, per cent*
Water surface	4.08	76.0
No mulch	1.41	23.6
3-inch mulch	0.88	14.6
6-inch mulch	0.36	6.0
9-inch mulch	0.17	2.0

The unmulched surface shows a loss, during the three weeks, of 23.6 per cent of the six inches of water applied. The use of the 3-inch mulch shows a loss of 62.5 per cent, the 6-inch mulch a loss of 25.5 per cent, and the 9-inch mulch a loss of 12 per cent, respectively, of the loss from the unmulched surface. These results indicate the value of a soil mulch when land is prepared for cropping and when possible during the growing season, especially with cultivated crops.

Effect of Cultivation at Different Depths.

The following table gives the average evaporation losses from cultivated and uncultivated surfaces at the Nevada Agricultural Experiment Station for a period of twenty-eight days (May 7–June 4, and June 8–July 6, 1909), with six inches of water applied:

Cultivation	*Loss in inches*	*Loss of total application, per cent*
Water surface	8.40	......
Cultivated six inches	1.09	18.2
Uncultivated	1.51	25.2

Duplicate tests were made in this experiment, and where cultivation was given, the soil was stirred to a depth of six inches in a manner similar to natural field methods. The cultivated surface showed a loss of 72.2 per cent, or a saving of 27.8 per cent of that receiving no cultivation, thus verifying the results previously mentioned in the value of cultivation to form a soil mulch in preventing the loss of water from the soil by evaporation.

Effect of Shallow- and Deep-Furrow Irrigation.

The following table gives the average evaporation losses from surfaces irrigated by flooding, and with furrows of different depths at the Nevada Agricultural Experiment Station for a period of twenty-eight days (July 8–August 5, and August 10–September 7, 1909), with six inches of water applied:

Depth of furrow	*Loss in inches*	*Loss of total application, per cent*
Water surface	11.13	......
Flooded	1.05	17.5
3-inch furrow	0.91	15.2
6-inch furrow	0.73	12.2
9-inch furrow	0.55	9.2

The results of this experiment show that water run in furrows, 3, 6, and 9 inches deep, caused a saving of 13.3 per cent, 30.5 per cent and 47.6 per cent, respectively, of the total loss from the flooded surface during this period of 28 days. Where the supply of water for irrigation is limited and the corrugation method of applying water is practical the use of furrows from 6 to 9 inches deep will undoubtedly result in greatly decreasing the loss of water from the soil by evaporation.

Overirrigation.

The use of excessive amounts of water tends to cause considerable losses from surface run-off and deep percolation. At the same time the quality and very often the quantity of the crop are reduced. Excessive irrigation of a wheat crop tends to produce a soft, mealy kernel that is not good for milling purposes. The experience of the Experiment Station with Marquis wheat under irrigation indicates that it is possible to produce a good grade of hard wheat with proper irrigation. After six years under irrigation this wheat ranks equal to the best wheat from the hard wheat sections of the Middle West. Overirrigation of alfalfa produces coarse stems and a smaller proportion of leaves. Potatoes become knotty and produce a second growth when given too much water.

EARLY INVESTIGATIONS

Duty of Water on Alfalfa.

The following table shows the average results in total irrigation, yield per acre and yield per acre-foot of water:

DUTY OF WATER ON ALFALFA AT THE EXPERIMENT STATION, 1906–1911

Year	No. of plat	Size of plat, acres	Total irrigation, feet	Yield per acre, tons	Yield per acre-foot of water, tons
1906		2	3.00	7.36	2.45
Average			3.00	7.36	2.45
1907	20	1	3.47	5.03	1.62
	22	1	2.80	5.11	1.82
	24–25	2	2.93	7.04	2.40
Average			3.07	5.93	1.93
1908	20	1	4.82	7.32	1.64
	21	1	3.30	6.02	1.60
	22	1	2.47	6.04	2.20
	23	1	2.02	5.00	1.46
	24–25	2	4.76	5.19	1.02
Average			3.55	5.90	1.63
1909	15		2.22	4.85	1.05
	16		3.48	4.23	1.21
	24		5.28	6.57	1.22
	25		2.93	6.31	2.00
	26, 27, 28		3.57	4.16	1.16
	20		2.54	6.94	2.73
	21		2.83	6.60	2.78
	22		3.70	4.60	1.22
	23		2.21	6.22	2.81
Average			3.16	5.53	1.91
1910	20		5.09	7.52	1.48
	21		3.05	6.01	2.16
	22		2.76	5.92	2.14
	23		2.61	6.35	2.43
	24		5.78	6.60	1.14
	25		3.58	6.02	1.68
Average			3.81	6.50	1.84
1911	20		3.64	5.15	1.41
	21		2.96	5.91	1.99
	22		2.26	4.56	2.02
	23		2.17	4.27	1.96
	24		3.87	3.34	0.86
	25		3.87	3.15	0.81
Average			3.03	4.30	1.51
Average for 6-year period, 1906–1911			3.27	5.93	1.87

NOTE—Sandy clay soil. Water measured from weir-box at an average distance of one-fourth mile from plats, applied under field conditions. Waste water from plats not measured.

It is noted that the greatest average annual total irrigation of 3.81 feet was given in 1910 with the second highest yield of 6.50 tons per acre or slightly above the average for the six-year period. During every other year the average total irrigation was less than 3.6 feet, or averaging 3.17 feet. The highest yield of 7.36 tons per acre was obtained in 1906 with a total irrigation of three feet of water. The average results for the six-year period show a yield of 5.93 tons per acre with a total irrigation of 3.27 feet, or at the rate of 1.87 tons per acre-foot of water.

Duty of Water on Crops Under Field Conditions in the Carson Valley, 1907.

In 1907 the Experiment Station in cooperation with Irrigation Investigations, United States Department of Agriculture, made a number of water duty determinations on the ranch of the Dangberg Land & Cattle Company in the Carson Valley. The following table gives the results of these determinations, including number of irrigations, depth of irrigation, yield per acre, and yield per acre-foot of water:

DUTY OF WATER ON FIELD CROPS AT THE DANGBERG RANCH, CARSON VALLEY, 1907*

ALFALFA

Crop	No. of irrigations	Total irrigation, feet	Date of cutting	Yield per acre, tons	Yield per acre-foot of water, tons
Field No. 1—61.32 Acres					
Alfalfa and Timothy, first crop	3	3.16	July 22–26	3.87	1.23
Alfalfa, second crop	3	2.71	Oct. 4–8	2.46	0.90
Total		5.87		6.33	†1.06
Field No. 2—80.50 Acres					
Alfalfa, first crop	2	3.08	July 1–4	1.68	0.55
Alfalfa, second crop	2	2.24	Sept. 5–8	1.49	0.66
Total		5.32		3.17	†0.60
Field No. 3—102.66 Acres					
Alfalfa, first crop	3	3.40	Aug. 16–20	2.02	0.85
Alfalfa, second crop. (Used for pasture balance of the season.)					
Total		3.40		2.02	
Field No. 8—50 Acres					
Alfalfa, first crop	3	2.94	July 22–23	3.40	1.16
Alfalfa, second crop	2	2.02	Sept. 18–20	2.40	1.18
Total		4.96		5.80	†1.17
Average for fields 1, 2, and 8		5.88		5.10	0.95
BARLEY AND WHEAT					
Field No. 1				bushels	bushels
Barley	3	2.88		91.10	21.48
Field No. 2					
Barley	3	2.08		54.50	31.50
Field No. 3					
Barley	3	2.48		78.60	31.70
Average—Barley	3	2.68		74.70	28.20
Wheat	2	2.33		44.00	19.00

*The yields shown in these tables are the results of common practice on the Dangberg ranch, one of the largest cultivated ranches in the State. The land represented by these fields was in a high state of cultivation, contained an excellent stand of alfalfa, and was irrigated by the furrow method. The depth of irrigation includes run-off, which was not measured.

†Average.

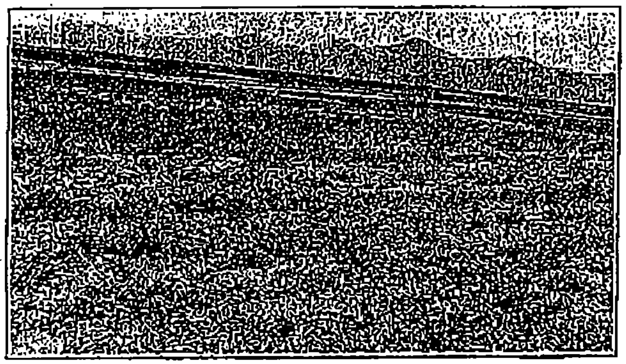

Plate 6—Overirrigation brings an excess of alkali to the surface. Note the thin stand of wheat on this land.

The average results for fields 1, 2 and 8 shows a yield of 5.1 tons of alfalfa per acre with a total irrigation of 5.38 feet, which gives a yield of 0.95 tons per acre-foot of water. The three fields of barley show an average total irrigation of 2.68 feet with a yield of 74.7 bushels, and a yield per acre-foot of water of 28.29 bushels. One field of wheat gave a production of 44 bushels per acre and 19 bushels per acre-foot of water with 2.83 feet applied.

RECENT INVESTIGATIONS

General Plan

Location and Soil Conditions.

This investigation of the irrigation of field crops was conducted at the Agricultural Experiment Station Farm at Reno during the five-year period, 1914–1918. The soil on these fields varies from a sandy loam to a clay loam, has an average depth of four feet, and is underlaid with course sand and gravel.

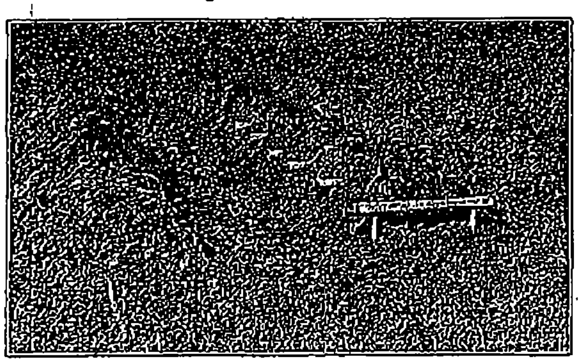

Plate 7—Method used in setting calibrated pipes.

The land was maintained in a relatively high state of fertility during the period of the experiment.

Measurement of Water.

The water applied to each plat was carefully measured by running it through calibrated iron pipes two inches in diameter by twenty-four inches long, set level in the bank of the distributing ditch and in the same horizontal plane. This provided for the measurement of water as it entered the plat, eliminating any possible error due to evaporation or seepage in the distributing laterals which often occurs when the measuring device is located at a distance from the plat. The head of water was constantly maintained at four inches by providing an overflow into a drainage ditch. The applications were so regulated that all of the water applied was used by the plats, thus preventing any run-off.

System of Checking.

To prevent any appreciable error due to variation in soil, a very careful system of checks was used, their frequency varying with the size of the experimental plats. With wheat, potatoes and sugar-beets every third plat was a check. Thus, by revising the actual yields of the plats in accordance with the checks, the variation in yields due to the difference in soil was largely removed.

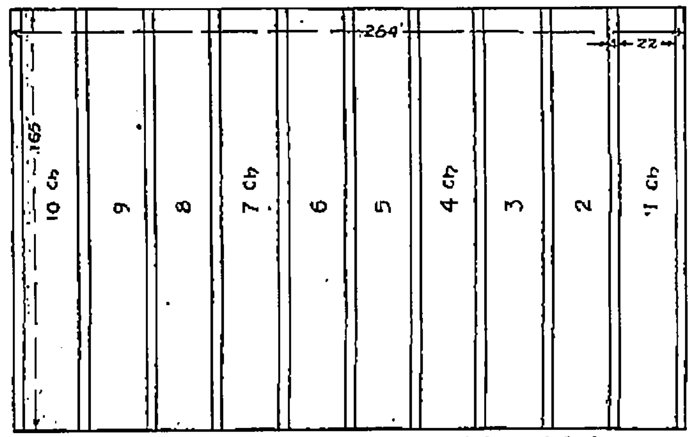

Plate 8—Irrigation of Wheat. Arrangement of plats and checks.

Harvesting.

In harvesting the crops in this experiment the outside portion of each plat was eliminated to prevent as far as possible any error due to seepage from adjacent plats. With wheat, alfalfa, and clover a four-foot cut was made around each plat, and the remaining areas were carefully measured before harvest. The two outside rows were eliminated from the potato and sugar-beet plats.

Soil Moisture.

Soil moisture determinations were made each year before the first irrigation and at various intervals during the period of growth of the crops. Soil samples were taken from three locations in each plat for each foot to a depth of four feet. The object of these investigations was to determine the effect of different methods of irrigation on the soil moisture content at various periods of growth.

IRRIGATION OF ALFALFA

The irrigation experiment with alfalfa was conducted during the four-year period, 1915–1918, and included twelve plats, each 23 feet wide by 290 feet long. The plats were separated by levees four feet wide and high enough to prevent any overflow from one plat to another.

The alfalfa was irrigated by the furrow method, small furrows being

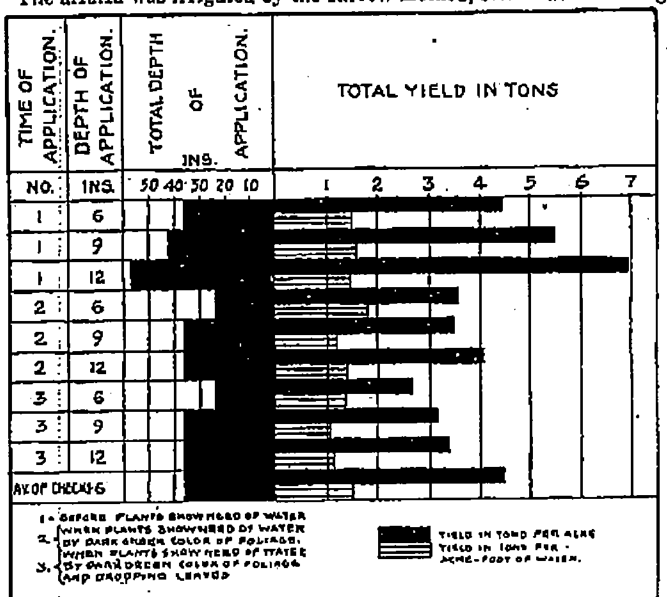

Plate 9—Irrigation of Alfalfa. Average results for the four-year period, 1915–1918, showing effect of irrigation on yield per acre and yield per acre-foot of water.

used at intervals of three feet to provide a ready channel for water to the lower ends of the plats. Water was measured into each plat through three pipes, the length of time required for an application varying from three hours forty-five minutes with the six-inch irrigation, to seven hours thirty minutes with the twelve-inch irrigation. Three check plats were used to prevent as far as possible any error due to variation in the soil. Six-, nine-, and twelve-inch applications were given at the following stages of wilting:

1. Before plants showed need of water.
2. When plants showed need of water by dark-green color of foliage.
3. When plants showed need of water by dark-green color of foliage and drooping leaves.

The checks were irrigated with nine-inch applications at the first stage of wilting. The alfalfa was harvested at the beginning of growth of the basal shoots from the crowns of the plants, or in the early bloom. Two cuttings were made each year of the experiment, the first cutting early in July and the second early in September. Samples representing the two cuttings from each plat were selected for determination of moisture and nitrogen content.

In this experiment a study was made of the depth of application, total irrigation, water and nitrogen content of plant, proportion of leaves to stems, yield per acre, and yield per acre-foot of water, in relation to the different stages of wilting, the results of which are included in the following table:

IRRIGATION OF ALFALFA

Average Results for the Four-Year Period, 1915–1918

Depth of application, inches	Total irrigation, inches	Total water content, per cent	Nitrogen, per cent	Proportion of leaves, per cent	Yield per acre, tons	Yield per acre-foot of water, tons
Irrigated Before Plants Showed Need of Water						
6	60	84.2	3.04	36.45	6.00	1.21
9	65	86.0	3.30	35.01	6.81	1.18
12	81	81.4	3.32	37.33	6.18	1.03
Irrigated When Plants Showed Need of Water by Dark-Green Color of Foliage						
6	42	78.6	3.38	40.20	5.50	1.07
9	45	81.2	3.55	40.64	5.45	1.61
12	54	77.8	3.00	38.40	5.48	1.57
Irrigated When Plants Showed Need of Water by Dark-Green Color of Foliage and Drooping Leaves						
6	22	76.8	3.46	44.27	4.08	2.23
9	32	77.5	3.70	41.46	4.42	1.73
12	29	72.8	3.10	38.55	4.86	1.03

In the average results of the first three plats which were irrigated before plants showed need of water, a total irrigation of 70 inches produced 5.99 tons of alfalfa per acre; and of the second stage of wilting, a total irrigation of 47 inches produced 5.49 tons per acre. The average increase in yield of 0.5 tons per acre was secured by an additional use of 23 inches, which was at the rate of 0.25 tons per acre-foot of water. In the last stage of wilting an average total irrigation of 29 inches produced a yield of 4.45 tons per acre. The above results indicate that alfalfa cannot be allowed to reach the wilting point without seriously lowering its production, but that good returns may be secured when water is withheld until the plants turn dark-green in color.

Most Economical Depth of Irrigation.

The most economical use of water with alfalfa was accomplished with a total irrigation of 3.5 feet applied when plants showed need of water by dark-green color of foliage, producing 5.59 tons per acre, or at the rate of 1.67 tons per acre-foot of water. The use on this plat was equivalent during the period of irrigation to a delivery of water at the rate of one second-foot for 85 acres, or 0.47 miner's inch per acre.

The greatest total irrigation of 81 inches of water was accompanied

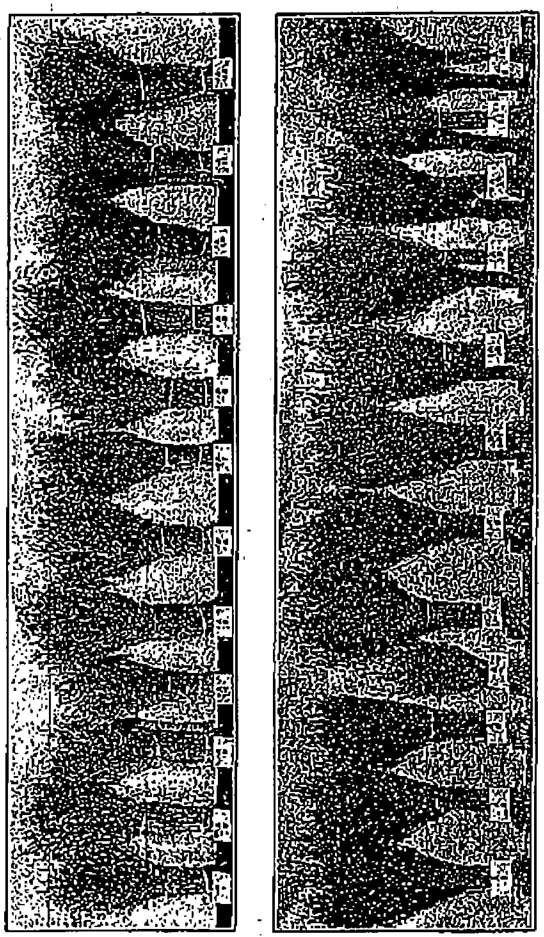

Plate 10—Variation in height of alfalfa with different methods of irrigation. Above, first crop; below, second crop. Plats 2, 5, and 9, irrigated before plants were allowed to show need for water, with 6-, 9-, and 12-inch applications, respectively. Plats 3, 8, and 10, irrigated when plants showed need of water by dark-green color of foliage, with 6-, 9-, and 12-inch applications, respectively. Plats 4, 8, and 11, irrigated when plants showed need of water by dark-green color of foliage and drooping leaves, with 6-, 9-, and 12-inch applications, respectively.

by the highest yield of 6.18 tons of alfalfa per acre and the lowest yield of 1.03 tons per acre-foot of water. Compared with the yield of 5.59 tons per acre the increase of 0.6 ton was obtained at the expense of an additional use of 39 inches of water which was at the rate of 0.18 ton per acre-foot. The lowest total irrigation of 22 inches gave the highest yield of 2.23 tons per acre-foot of water, but the lowest yield of 4.08 tons per acre.

Relation of Soil Moisture Content to Time and Amount of Irrigation.

Soil moisture samples were taken before the first irrigation and at harvest of the second crop. The samples were taken to a depth of four

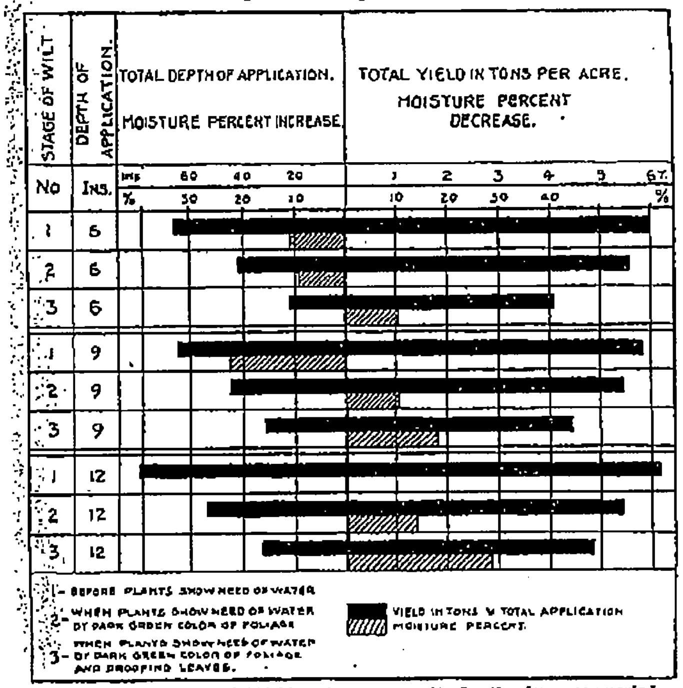

Plate 11—Irrigation of Alfalfa. Average results for the four-year period, 1915–1918, showing effect of irrigation on soil moisture.

feet and the borings from three different places on each plat were consolidated to insure a representative sample. During the year 1918 samples were taken before and after each irrigation in the manner above indicated. Experiments were also conducted to determine the weight per cubic foot and water-holding capacity of the surface foot in each plat. The following table compares the soil moisture contents before the first irrigation and before the second cutting of alfalfa at different stages of wilting, with six-, nine-, and twelve-inch applications.

IRRIGATION OF ALFALFA

Comparing the Per Cent of Decrease in Soil Moisture Content Before Harvest and Before the First Irrigation for the Four-Year Period, 1915–1918

	Before plants showed need of water, per cent	When plants showed need of water by dark-green color of foliage, per cent	When plants showed need of water by dark-green color of foliage and drooping leaves, per cent
Six-inch Applications—			
Total Irrigation, inches	60.00	42.00	22.00
Yield per acre, tons	6.00	5.59	4.09
Yield per acre-foot of water, tons	1.21	1.07	2.23
Average per cent of decrease in soil moisture at harvest	10.70*	0.10*	10.60*
Nine-inch Applications—			
Total irrigation, inches	65.00	45.00	32.00
Yield per acre, tons	6.31	5.46	4.42
Yield per acre-foot of water, tons	1.18	1.01	1.78
Average per cent of decrease in soil moisture at harvest	22.10*	10.40	18.30
Twelve-inch Applications—			
Total irrigation, inches	81.00	54.00	33.00
Yield per acre, tons	6.18	5.48	4.80
Yield per acre-foot of water, tons	1.03	1.57	1.93
Average per cent of decrease in soil moisture at harvest	0.00	14.00	28.20

*Average per cent of increase in soil moisture content at harvest.

An increase in soil moisture content at harvest is noted with six-inch applications in the first two stages of wilting and with nine-inch applications in the first stage, due in part to the frequency of irrigation. The greatest increase of 22.1 per cent is noted in the first stage of wilting with nine-inch applications and a total irrigation of sixty-five inches.

The most uniform decrease in moisture content at harvest is noted in the third or last stage of wilting. Here the total irrigation and yield per acre increase as the decrease in moisture content at harvest and the depth of application become greater. Generally the decrease in soil moisture content at harvest was greatest with the nine- and twelve-inch applications.

During the season of 1918 soil moisture determinations were made just before and within forty-eight hours after each irrigation, to determine the amount of water actually retained in the first four feet of soil, the results of which are given in the following table:

IRRIGATION OF ALFALFA

Average Soil Moisture Content Before and After Irrigation in 1918

Depth of irrigation, inches	Soil moisture content: Before irrigation, per cent	After irrigation, per cent	Increase, per cent	Amount of irrigation retained in upper 4 feet: Inches	Per cent
Irrigated Before Plants Showed Need of Water					
6	12.0	16.8	4.2	3.00	50.0
9	15.6	19.3	3.7	2.52	28.0
12	14.2	18.4	4.2	3.00	25.0
Irrigated When Plants Showed Need of Water by Dark-Green Color of Foliage					
6	11.1	17.0	5.9	4.20	70.0
9	11.7	18.2	6.5	4.60	51.0
12	12.7	18.4	5.7	4.05	33.7
Irrigated When Plants Showed Need of Water by Dark-Green Color of Foliage and Drooping Leaves					
6	10.3	16.1	5.8	4.55	75.8
9	9.7	16.8	7.1	5.00	56.0
12	9.4	17.0	7.6	5.40	45.0

This table gives the results of work for one year only, which cannot be considered as conclusive; however, they bear out the statements previously made. When alfalfa was irrigated before the plants showed need of water, about three inches of water of each application were held in the first four feet of soil. This amounts to one-half of a six-inch, one-third of a nine-inch, and one-fourth of a twelve-inch irrigation, the remainder of the water being lost by evaporation or percolation beyond the root zone.

The total amounts of water held in the soil were greatest with the last two stages of wilting. In each case a larger part of the six-inch application was retained than of the nine- or twelve-inch applications.

The high percentage of the six-inch irrigation retained in the second stage of wilting, or when plants showed need of water by dark-green color of foliage, accompanied by the high yield per acre and yield per acre-foot of water, indicates that this was the most economical use of water with alfalfa.

IRRIGATION OF WHEAT

The irrigation experiment with wheat was conducted during the five-year period, 1914–1918, and included sixty plats, each 22 feet wide by

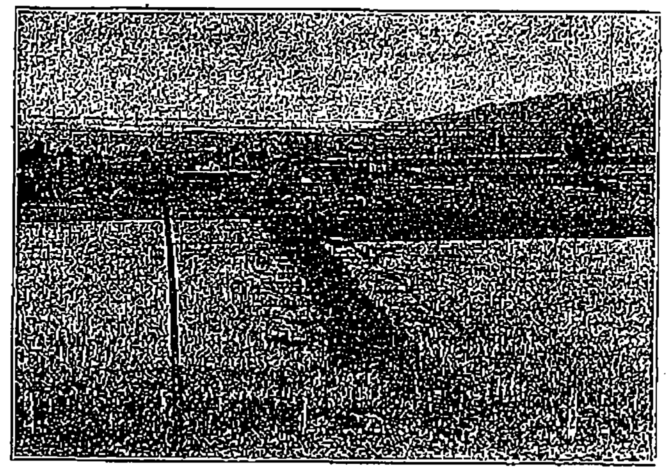

Plate 12—Irrigation of Wheat. Trimming the plats before harvest.

165 feet long. The plats were separated by levees four feet wide and high enough to prevent any overflow from one plat to another. Marquis wheat, used in this experiment, was treated each year for smut, and sown during the early part of April about two inches deep with a double-disk drill, using approximately seventy-five pounds of seed per acre. The wheat was irrigated by means of furrows placed at intervals of three feet. The water was measured into each plat through three pipes, one hour and seven minutes being required for a three-inch application, and a proportionate increase in time for the larger applications. Every third plat was a check.

Three-, five-, and seven-inch applications were given at the following stages of growth:

1. Five-leaf.
2. Boot.
3. Bloom.
4. Milk.
5. Dough.

Also six-, nine- and twelve-inch applications were given before and after heading.

In this test a comparison was made of the plats receiving an irrigation at each of the five stages of growth; with plats in which an irrigation was omitted at each of the five stages; with plats in which irrigations

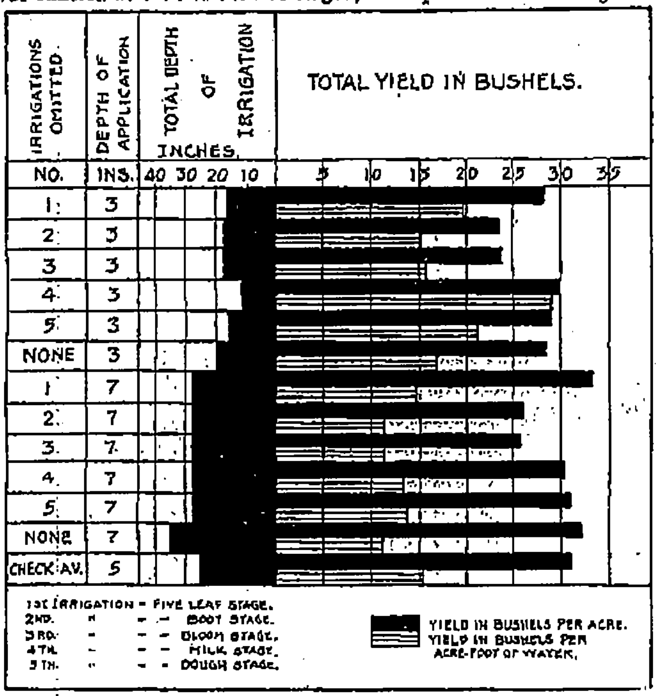

Plate 13—Irrigation of Wheat. Average results with four applications, for the five-year period, 1914–1918, showing effect of irrigation on yield per acre and yield per acre-foot of water.

were omitted at any two stages of growth; and with plats that received the same amounts of water in two applications only, one before and one after heading. The principal objects of the experiment were to determine the best depths of irrigation and the critical stages in the growth of the wheat crop.

The wheat plats were harvested in early August with a grain binder. The plats that received only three applications with a small total irrigation were the first to reach maturity. The wheat was threshed with

a small thresher operated by a six-horsepower gasoline engine. This machine made possible the thorough cleaning of the wheat with practically no loss in threshing.

Results with Four Applications.

The following table gives the results with three- and seven-inch applications when one irrigation was omitted at each of the different stages of growth, and the increase of seven-inch over the three-inch applications:

Irrigation of Wheat

Average Yields for the Five-Year Period, 1914–1918

One irrigation omitted at—	*Three-inch applications, bushels*	*Seven-inch applications, bushels*	*Average increase, per cent*
Five-leaf stage	28.1	33.2	18.5
Boot stage	23.4	26.2	11.9
Bloom stage	23.7	25.0	0.3
Milk stage	29.8	30.4	2.1
Dough stage	29.1	31.0	0.5
No irrigation omitted	28.4	32.2	13.4

These results are in favor of the seven-inch applications, the highest yield being obtained when an irrigation was omitted at the five-leaf stage. This yield of 33.3 bushels, is 18.5 per cent higher than the corresponding yield with three-inch applications, and four per cent greater than the yield of 32.2 bushels when no irrigations were omitted and a total of thirty-five inches of water was applied. With both three- and seven-inch applications the lowest yields are recorded when an irrigation was omitted at the boot or bloom stage. The results indicate that an irrigation may be omitted at the five-leaf, milk or dough stage without materially decreasing the yield of grain, but that an application omitted at the boot or bloom stage seriously interferes with the proper growth of the crop. The high yield of 33.3 bushels may be attributed to the greater development of root system with the first irrigation omitted and at the same time the plants did not suffer for lack of sufficient moisture before the irrigation at the boot stage.

Results with Three Applications.

The following table gives the average results with three- and seven-inch applications and with two irrigations omitted at the different stages of growth:

Irrigation of Wheat

Average Yields for the Five-Year Period, 1914–1918

Two irrigations omitted at—	*Three-inch applications, bushels*	*Seven-inch applications, bushels*	*Average increase, per cent*
Five-leaf and boot	16.0	20.4	28.8
Five-leaf and bloom	21.2	23.9	12.7
Five-leaf and milk	27.1	28.2	4.1
Five-leaf and dough	27.0	31.0	12.3
Boot and bloom	13.8	19.5	41.3
Boot and milk	21.2	23.5	10.8
Bloom and milk	23.2	23.8	2.0
Bloom and dough	24.8	29.6	16.1
Milk and dough	29.0	30.5	5.2
No irrigations omitted	28.4	32.2	13.4

The results here are also in favor of the seven-inch applications, although the variation in yield was more pronounced, especially between the three-inch and seven-inch applications. The highest yield was obtained with seven-inch applications when irrigations were omitted at the five-leaf and dough stages. However, this yield of 31.0 bushels was but slightly greater than the yield of 30.5 bushels obtained when applications were omitted at the milk and dough stages. The highest yield was four per cent lower than when no applications were omitted. The

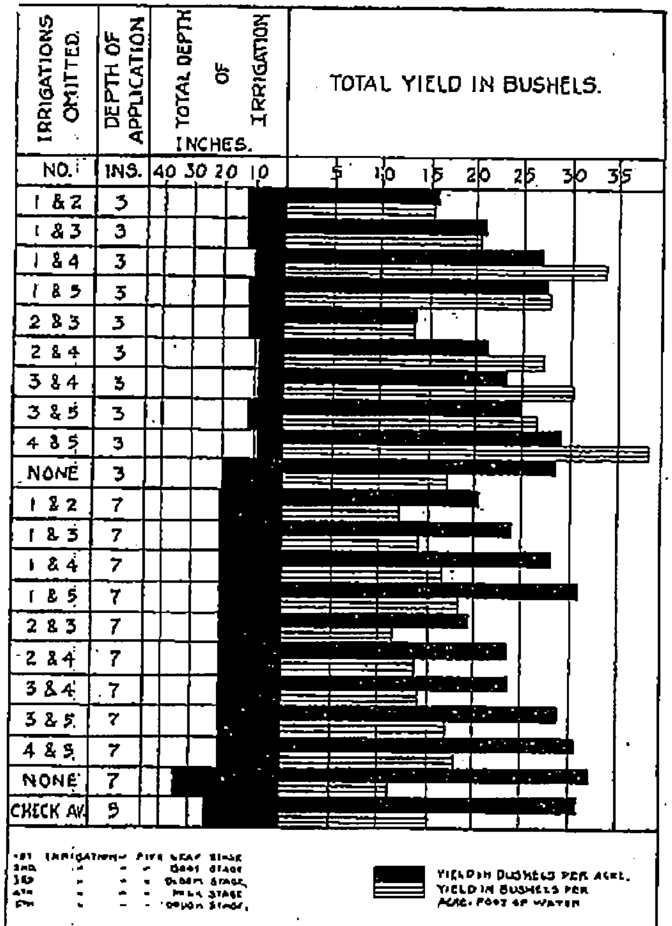

Plate 14—Irrigation of Wheat. Average results with three applications, for the five-year period, 1914–1918, showing effect of irrigation on yield per acre and yield per acre-foot of water.

lowest yield of 19.5 bushels with seven-inch applications was obtained with irrigations omitted at the boot and bloom stages.

With three-inch applications the highest yield was obtained when irrigations were omitted at the milk and dough periods. High yields were also obtained when irrigations were omitted at the five-leaf and milk and five-leaf and dough stages. The lowest yield was obtained when applications were omitted at the boot and bloom periods, the yield in this case being 53 per cent lower than the highest yield with three-inch applications. The other low yields correspond generally to the low yields with seven-inch applications.

The high yields obtained with seven-inch applications when irrigations were omitted at the five-leaf and milk, five-leaf and dough, and milk and dough stages indicate that irrigations omitted at any two of these stages have the least effect in lowering the yield of wheat.

The low yields with both three-inch and seven-inch applications when irrigations were omitted at the boot and bloom stages indicate that a very critical period in the irrigation of wheat is between the boot and the milk stages.

Yield Per Acre-Foot of Water with Three and Four Irrigations and Three- and Seven-Inch Applications.

The following table gives a comparison of the yields per acre and yield per acre-foot of water with three and four irrigations and three- and seven-inch applications:

Irrigation of Wheat

Average Results for the Five-Year Period, 1914–1918

	Three-inch applications: Total irrigation, inches	Yield per acre, bushels	Yield per acre-foot of water, bushels	Seven-inch applications: Total irrigation, inches	Yield per acre, bushels	Yield per acre-foot of water, bushels
One irrigation omitted at—						
Five-leaf stage	17	28.1	19.8	28	33.3	14.8
Boot stage	18	23.4	15.6	25	26.2	11.7
Bloom stage	18	23.7	15.8	28	25.0	11.4
Milk stage	12	20.9	20.9	28	30.4	13.4
Dough stage	10	20.1	21.3	28	31.0	13.3
No irrigations omitted	21	28.1	16.0	35	33.2	11.2
Two irrigations omitted at—						
Five-leaf and boot	13	16.6	15.3	21	20.4	12.1
Five-leaf and bloom	13	21.2	20.5	21	23.9	14.1
Five-leaf and milk	10	27.1	33.7	21	29.2	16.6
Five-leaf and dough	12	27.0	27.0	21	31.0	18.3
Boot and bloom	12	13.8	13.8	21	10.5	11.6
Boot and milk	9	21.2	27.9	21	23.6	13.6
Bloom and milk	9	23.2	30.9	21	23.3	14.0
Bloom and dough	12	24.8	20.4	21	28.8	16.0
Milk and dough	9	29.0	38.8	21	30.5	17.0
Average of checks				25	31.0	15.3

Note—Where a three-inch application failed to irrigate the entire plat, sufficient additional water was applied, accounting for the slight irregularity shown in the average total irrigation.

With a total irrigation of 28 inches of water given in four applications and an irrigation omitted at the five-leaf stage, the highest yield of 33.3 bushels per acre was accompanied by the highest yield of 14.8 bushels per acre-foot of water.

With seven-inch applications the highest yield of 18.3 bushels per acre-foot of water with a total irrigation of 21 inches was produced where irrigations were omitted at the five-leaf and dough stages and the lowest yield of 11.1 bushels per acre-foot of water with a total irrigation of 35 inches. With three-inch applications the greatest yield of 38.3 bushels per acre-foot of water was obtained with irrigations omitted at the milk and dough stages, and the lowest yield of 13.5 bushels per acre-foot of water with irrigations omitted at the boot and bloom stages.

Results with Two Irrigations.

The following table compares the yields of wheat per acre and yields per acre-foot of water where only two irrigations were given and different depths of applications used before and after heading:

IRRIGATION OF WHEAT

Average Results for the Five-Year Period, 1914–1918

Depth of irrigation: Before heading, inches	After heading, inches	Yield per acre, bushels	Yield per acre-foot of water, bushels
6	6	26.5	26.5
6	9	25.7	20.6
6	12	25.9	17.1
9	6	23.5	18.8
9	9	29.1	19.3
9	12	26.0	14.9
12	6	25.1	16.7
12	9	25.8	14.6
12	12	26.4	13.2

Where only two irrigations were given, the two nine-inch applications, one before and one after heading, produced the greatest yield of 29.1 bushels per acre, or 14.4 per cent less than the highest yield with 28 inches of water in four seven-inch applications. The twelve-inch irrigation before heading apparently provided more water than the crop utilized to best advantage. The maximum yield with two irrigations was obtained with a total of 18 inches of water applied when the crop turned dark green in color. With a total irrigation of less than 18 inches the yield was considerably decreased; whereas, a total irrigation of twenty-four inches in two twelve-inch applications produced an average of 26.4 bushels per acre or about ten per cent less than where the two nine-inch applications were used.

Yield Per Acre-Foot of Water with Two Irrigations.

The highest yield of 26.5 bushels per acre-foot of water was obtained with the smallest total irrigation of twelve inches, and the lowest yield of 13.2 bushels per acre-foot of water with the largest total irrigation of 24 inches. The third highest yield of 19.3 bushels per acre-foot of water was produced with the two nine-inch applications, indicating that this was the most economical use of water with wheat when only two applications were given.

With only two irrigations the yields were generally lower throughout than with a greater number of applications using the same total amount of water. It is therefore recommended that only in cases of water shortage is it advisable to use only two irrigations in preference to three or four applications, as shown in the results of these experiments where the yields of grain are generally much higher. It should be noted, however, that with only two irrigations possible, a profitable crop of wheat may be grown.

Relation of Soil Moisture Content to Time and Amount of Irrigation.

Soil moisture samples were taken at regular intervals each year during the period of irrigation to determine the variation in moisture content in relation to the time of irrigation and the depth of application.

Soil Moisture Contents with One Irrigation Omitted.

The following table gives a comparison of the soil moisture contents before the first irrigation and at harvest with three-inch and seven-inch applications and one irrigation omitted.

IRRIGATION OF WHEAT

Average Per Cent of Decrease in Soil Moisture Content at Harvest for the Five-Year Period, 1914–1918

	Three-inch applications		Seven-inch applications	
Irrigation omitted at—	Decrease, per cent	Yield per acre, bushels	Decrease, per cent	Yield per acre, bushels
None	11.0	28.4	0.8	32.2
Five-leaf stage	10.0	28.1	0.5*	33.3
Boot stage	17.2	23.4	2.4*	29.2
Bloom stage	0.6	29.7	9.9*	25.0
Milk stage	8.3	29.8	2.7*	30.4
Dough stage	26.0	28.1	14.4	31.0

*Average per cent of increase of soil moisture content at harvest.

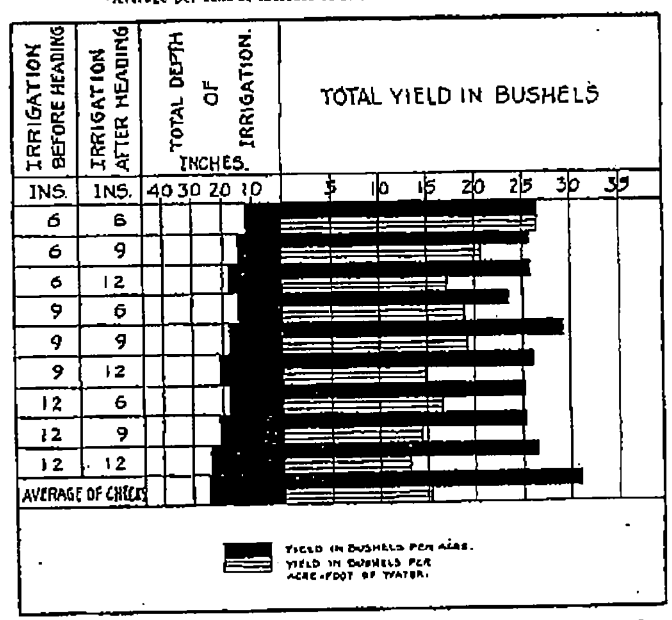

Plate 16—Irrigation of Wheat. Average results with two applications for five-year period, 1914–1918, showing effect of irrigation on yield per acre and yield per acre-foot of water.

These results show that the high yields per acre are generally accompanied by the greatest decrease in soil moisture at harvest as compared with the soil moisture content before the first irrigation. With three-inch applications the smallest decrease in soil moisture content at harvest, with an irrigation omitted at the bloom stage, was accompanied by the low yield of 23.7 bushels per acre, or 23 per cent less than the yield with one irrigation omitted at the dough stage.

With seven-inch applications the greatest increase in soil moisture content at harvest was obtained when an irrigation was omitted at the bloom stage, the yield being 25.9 bushels per acre, or 20 per cent less than the highest yield.

The omission of an irrigation at the bloom stage seriously checked the development of the wheat crop and prevented the plants from utilizing the moisture in the soil to the best advantage during the later periods of growth.

Soil Moisture Contents with Two Irrigations Omitted.

The following table gives a comparison of soil moisture contents before the first irrigation and at harvest with three-inch and seven-inch applications, and with two irrigations omitted:

IRRIGATION OF WHEAT

Average Per Cent of Decrease in Soil Moisture Content at Harvest for the Five-Year Period, 1914–1918

	Three-inch applications		Seven-inch applications	
Two irrigations omitted—	*Decrease, per cent*	*Yield per acre, bushels*	*Decrease, per cent*	*Yield per acre, bushels*
Five-leaf and boot	19.2	15.0	2.5	20.4
Five-leaf and bloom	2.1	21.2	10.1*	24.0
Five-leaf and milk	17.4	27.1	4.8	28.2
Five-leaf and dough	0.5	27.0	4.7	31.0
Boot and bloom	1.5	18.8	0.0	19.5
Boot and milk	0.5	21.2	7.3	23.5
Bloom and milk	16.2	23.2	0.4*	20.8
Bloom and dough	10.6	24.8	0.0	23.8
Milk and dough	24.0	20.0	11.7	30.5

*Average per cent of increase in soil moisture content at harvest.

It is noted in these results that with the three-inch applications the smallest decrease in soil moisture content at harvest was obtained with irrigations omitted at the boot and bloom stages, and accompanied by the lowest yield of 18.8 bushels per acre. The next lowest decrease in soil moisture content at harvest occurred with irrigations omitted at the five-leaf and bloom stages, accompanied by a comparatively low yield of 21.2 bushels per acre.

With the seven-inch applications it is interesting to note that where no decrease or where an increase is shown in the soil moisture content at harvest, one of the irrigations omitted in each instance was at the bloom stage. The average yield of these four plats was 24.0 bushels per acre, or 29.2 per cent less than the highest yield with one irrigation omitted at the five-leaf stage. This confirms the previous statement that an irrigation omitted between the boot and milk stages may seriously check the proper development of the crop.

IRRIGATION OF POTATOES

The irrigation experiment with potatoes included nineteen plats of four rows each. The potatoes were planted the last of May each year in rows three feet apart and about fourteen inches apart in the row. The potatoes were irrigated by means of comparatively deep furrows

three feet apart. Three-, six-, and nine-inch applications of water were at the following stages of growth:

1. Before plants showed a tendency to wilt.
2. When plants showed a tendency to wilt.
3. When leaves wilted down once.
4. When plants failed to revive at night.

The crop was harvested each year about the first of October. Of the four rows in each plat the two outside rows were eliminated to prevent as far as possible any variation due to seepage from adjoining plats. Three hills in different parts of each plat were selected for a determination of the starch content.[1]

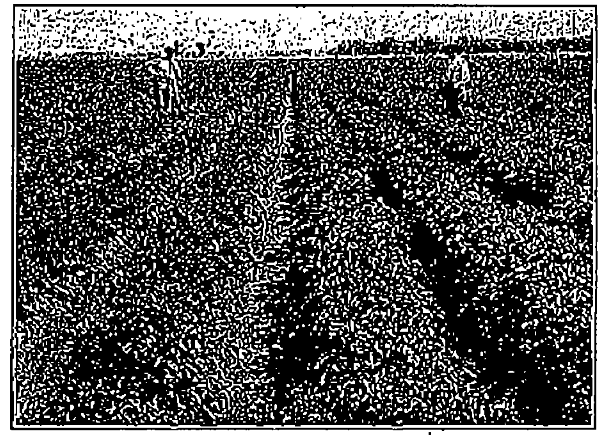

Plate 16—Irrigating a field of Nevada potatoes.

The following table gives the average results on total irrigation, water content, starch content, yield per acre and yield per acre-foot of water:

IRRIGATION OF POTATOES

Average Results for the Four-Year Period, 1914–1917

Depth of irrigation, inches	*Total irrigation, inches*	*Water content, per cent*	*Starch content, per cent*	*Yield per acre, pounds*	*Yield per acre-foot of water, pounds*
	Irrigated before plants were allowed to wilt				
3	22.5	70.7	69.3	15,383	8,022
6	28.5	70.4	65.4	10,577	4,630
9	36.2	77.3	68.3	13,402	4,239
	Irrigated when plants showed a tendency to wilt				
3	10.5	78.4	64.4	15,077	12,025
6	19.5	77.3	63.2	9,607	5,730
9	27.0	77.2	65.2	9,175	6,503
	Irrigated when plants wilted down once				
3	10.5	75.4	50.2	9,605	14,036
6	13.5	78.6	62.4	9,840	9,172
9	16.0	70.1	64.8	7,736	6,810

[1]The starch content was determined by means of direct acid hydrolysis. See page 53, Bulletin 107, Bureau of Chemistry, U. S. Department of Agriculture.

Irrigated when plants failed to revive at night					
3	0.0	78.7	69.8	5,825	11,058
6	7.5	78.4	58.6	5,525	10,571
9	0.0	78.0	59.8	8,593	4,404
Average of checks—					
0	24.0	70.8	60.0	9,753	4,858

The yield of potatoes in 1915 was materially decreased by dry rot, and in 1916 by an unfavorable season. However, all plats appeared to be equally affected; thus the comparative results are about as valuable as with greater production. The results showed that with the three-, six-, and nine-inch applications, the average total irrigation, the starch

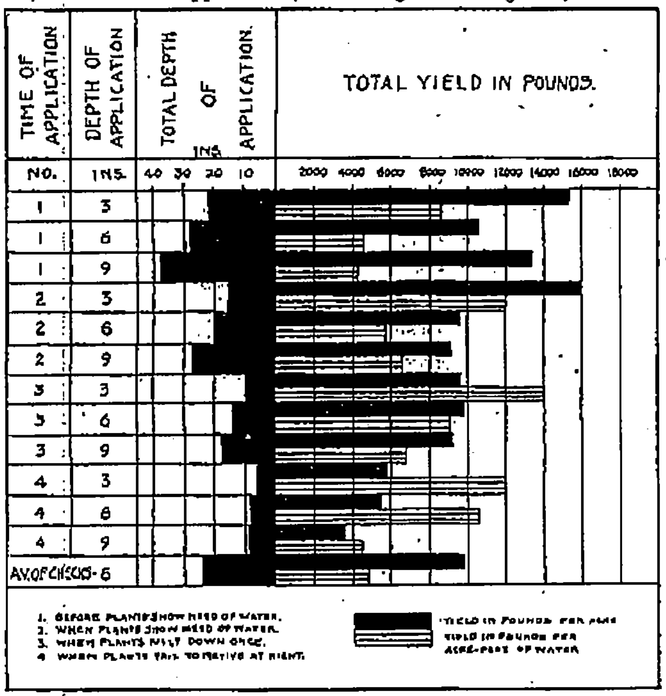

Plate 17—Irrigation of Potatoes. Average results for the four-year period, 1914–1917, showing the effect of irrigation on yield and yield per acre-foot of water.

content, and the yield per acre decreased with the advance in the wilting stage, while the yield per acre-foot of water increased, except in the last wilting stage, where a considerable decrease is noted with nine-inch applications.

The best average results were generally obtained with the three-inch applications at the different stages of wilting. For the four-year period,

the highest yield of 15,977 pounds per acre was obtained with an average total irrigation of 16.5 inches with three-inch applications given when the plants showed a tendency to wilt, and the yield per acre-foot of water was 12,025 pounds. The next best yield of 15,338 pounds per acre was secured with eight three-inch applications given before plants showed a tendency to wilt, although the yield per acre-foot of water was only 8,622 pounds per acre. Where the plants wilted down before irrigation, the potatoes made a second growth which resulted in lowering the yield per acre and starch content of the potatoes. The proportion of scabby potatoes was greatly increased in those plats which received a total irrigation of twenty-four inches or more of water.

General Statement.

The potato rows should be hilled up with good deep furrows between them, so that, when irrigated, the water will supply the deep-feeding roots, but will not come in contact with the tubers.

A too common error with the potato grower is the use of shallow furrows for carrying the water. The chief danger is in saturating the ground around the tubers, causing the soil to become hard and compact, a very undesirable condition for the development of a good hill of uniform potatoes. It is thus very important to use light irrigations in good deep furrows.

The potato crop should never be irrigated by means of flooding,

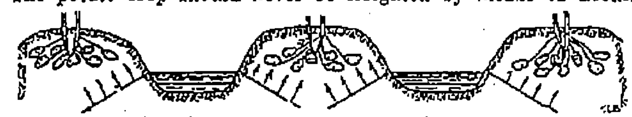

Plate 18—The proper method of irrigation for potatoes.

since this method causes the soil to pack around the tubers and prevents the ground from receiving sufficient water for the need of the plants.

The potato crop is very sensitive to an excess of moisture in the soil. Most of the failures in potato growing in this State have occurred on the heavy lands and have been due chiefly to this one cause. Soils which contain an excess of water are too cold for the proper development of the potato and offer conditions favorable to the formation of scab and rot. Most of the soils on the Experiment Station Farm are too heavy and too level for good results with potatoes. It is noted above that the most practical method of irrigation was by the use of light applications when the plants had turned dark-green in color. At the time of harvest this ground turns up in large clods unless irrigated immediately before digging. This condition indicates that the ground has packed too firmly for the proper development of uniform marketable potatoes. Such lands are made more porous by a heavy application of lime of gypsum, but the potatoes are liable to be badly affected with scab, as is the case when fresh manure is used in large quantities. Many growers overcome this objection on heavy soils by planting the potatoes on land with a considerable slope. Here the drainage is good and there is less danger that the soil will remain too wet.

For the best results with potato growing, well-drained land is essential, and only moderate applications of water should be given the crop when needed.

The following table gives a comparison of soil moisture content with potatoes before the first irrigation and before harvest, at different stages of wilting, with three-, six-, and nine-inch applications:

IRRIGATION OF POTATOES

Average Per Cent of Decrease in Soil Moisture Content Before Harvest for the Four-Year Period, 1914–1917.

Soil samples taken	Three-inch applications	Six-inch applications	Nine-inch applications
Irrigated before plants showed tendency to wilt			
Before first irrigation	20.8	19.8	19.0
Before harvest	19.6	18.9	19.8
Per cent decrease	5.8	4.5	4.2*
Irrigated when plants showed tendency to wilt			
Before first irrigation	18.7	20.5	18.6
Before harvest	18.0	18.1	17.8
Per cent decrease	3.7	11.7	4.3
Irrigated when leaves wilted down once			
Before first irrigation	18.9	16.9	19.8
Before harvest	17.6	17.2	16.6
Per cent decrease	6.5	1.8*	16.1
Irrigated when plants failed to revive at night			
Before first irrigation	19.3	18.9	18.4
Before harvest	16.5	15.1	16.9
Per cent decrease	14.5	20.1	8.2

*Average per cent of increase in soil moisture content at harvest.

With the three-inch irrigations at the different stages of wilting the soil moisture contents before harvest were slightly less than before the first irrigation. This decrease is most evident in the last stage of wilting with 14.5 per cent.

With the six-inch applications an increase is shown in the third stage of wilting, while in the other three stages the soil moisture content at harvest was less than before the first irrigation, amounting to a decrease of 20.1 per cent in the last stage of wilting.

With the nine-inch irrigations a decrease was shown in the last three stages of wilting, amounting to 16.1 per cent where irrigated when leaves wilted down once; while a slight increase occurred when irrigations were given before plants showed a tendency to wilt.

Where the heaviest yield of 15,977 pounds per acre was produced with a total irrigation of 17 inches of water in three-inch applications, given when the plants first showed a tendency to wilt, the soil moisture content before harvest was only 3.7 per cent less than before the first irrigation. This heavy yield was accompanied by the second highest yield of 12,025 pounds per acre-foot of water.

Where the lowest yield of 3,593 pounds per acre was produced with one nine-inch application at the last wilting stage, the soil moisture content at harvest was 8.2 per cent less than before the first irrigation. Moreover, the yield per acre-foot of water was only 4,464 pounds as compared with 12,025 pounds for the highest yield and 17 inches total irrigation.

No uniform variations occurred in soil moisture content with potatoes as were found with alfalfa in the various stages of wilting and with different depths of application.

IRRIGATION OF CLOVER

The irrigation experiment with clover (Common Red) in 1914 was conducted on a sandy clay soil with a gravelly subsoil, and included

twelve plats, each 10 feet wide and 264 feet long. The clover was planted in the spring of 1913 with a nurse crop of wheat, and produced one crop of hay that season after the wheat had been harvested. The plats were separated by levees four feet wide and high enough to prevent any overflow of water from one plat to another.

In the irrigation of clover, six-, nine-, and twelve-inch applications were given at the following stages of wilting:

1. Before plants showed need of water.
2. When plants showed need of water by dark-green color of foliage.
3. When plants showed need of water by dark-green color of foliage and drooping leaves.

During the season of 1914 two crops of hay were harvested on June 16, and August 5, respectively. Samples of hay were selected from each plat with the two cuttings for a determination of nitrogen content.[1]

The following table gives the depth of application, total irrigation, nitrogen content and yield per acre-foot of water:

IRRIGATION OF CLOVER—1914

Depth of application, inches	Total irrigation, inches	Nitrogen content, per cent	Yield per acre, tons	Yield per acre-foot of water, tons
Irrigated before plants showed need of water				
6	36	2.32	4.45	1.48
9	42	2.10	5.52	1.58
12	57	1.81	6.97	1.47
Irrigated when plants showed need of water by dark-green color of foliage				
6	24	2.29	3.58	1.79
9	36	2.32	3.51	1.17
12	36	2.13	4.08	1.36
Irrigated when plants showed need of water by dark-green color of foliage and drooping leaves				
6	24	2.50	2.71	1.35
9	36	2.28	3.10	1.03
12	36	2.11	3.38	1.13
Average of checks—				
6	36	2.32	4.49	1.50

Results.

The results show that clover cannot be allowed to reach the wilting stage without materially decreasing the yield of hay; also, that in these experiments applications of from nine to twelve inches given before the plants showed need of water gave the heaviest production of hay. However, where the total yield was greatest, the yield per acre-foot of water was low and the quality of hay inferior to that of other plats, due to the large proportion of coarse stems to leaves. The importance of the time of application of water is well illustrated in the results, since a gradual decrease in yield occurred in the different plats with the same applications of water, as the wilting stage advanced, before water was applied. Clover responded more readily to the heavy applications of water than any other crop.

The lowest nitrogen content is noted with the greatest total irrigation and the highest yield per acre. With this exception no uniform variation occurred in the nitrogen content.

[1] The nitrogen content was determined by the official method used by the Bureau of Chemistry, U. S. Department of Agriculture.

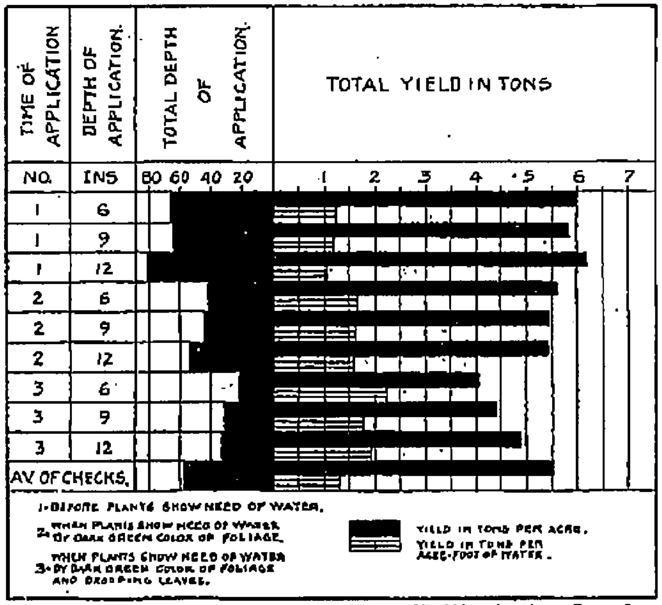

Plate 19—Irrigation of Clover. Average results 1914, showing effect of irrigation on yield per acre and piled per acre-foot of water.

SUGAR-BEETS

The irrigation experiment with sugar-beets during the two-year period, 1914–1915, included nineteen plats. Each plat consisted of four rows 165 feet long and two feet apart. The seed was planted with a hand drill, about one and one-half inches deep, at the rate of twenty pounds per acre.

In the irrigation of sugar-beets, two-, four-, and six-inch applications of water were given at the following stages of wilting:

1. Before plants showed a tendency to wilt.
2. When plants showed a tendency to wilt.
3. When leaves wilted down once.
4. When plants failed to revive at night.

When four leaves appeared on the plants, the beets were thinned to about ten inches apart in the rows. The crop received two hoeings when needed and was cultivated after each irrigation. The beets were harvested in late September with an ordinary walking beet-plow. Of the four rows in each plat, the two outside rows were eliminated as with potatoes. After plowing out the beets they were topped and weighed. Five average-sized beets from different parts of each plat were selected, weighed, and reserved for chemical analysis for sugar content and purity.[1] The following table compares the total irrigation,

[1] Sugar content and purity determined by means of indirect method. See Bulletin 148, page 14, Bureau of Chemistry, United States Department of Agriculture.

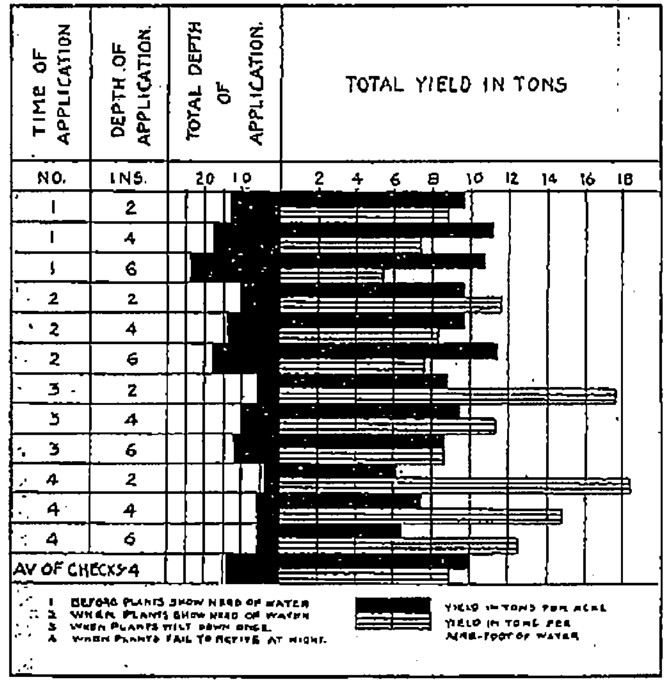

Plate 20—Irrigation of Sugar-Beets. Average results for the two-year period, 1914–1915, showing effect of irrigation on yield per acre and yield per acre-foot of water.

proportion of roots to tops, sugar content, purity, yield per acre, and yield per acre-foot of water at the different stages of wilting:

IRRIGATION OF SUGAR-BEETS

Average Results for the Two-Year Period, 1914–1915

Depth of application, inches	Total irrigation, inches	Proportion of roots to tops, per cent	Sugar content, per cent	Purity of beet, per cent	Yield per acre, tons	Yield per acre-foot of water, tons
		Irrigated before plants showed tendency to wilt				
2	13	70.1	21.05	86.20	9.68	8.84
4	18	72.0	20.02	81.57	11.31	7.37
6	24	74.0	21.18	82.52	10.70	5.35
		Irrigated when plants showed tendency to wilt				
2	10	74.1	22.01	87.34	9.64	11.58
4	14	74.0	21.48	87.12	9.67	8.30
6	18	69.5	20.60	82.20	11.43	7.02
		Irrigated when plants wilted down once				
2	6	72.0	23.30	76.01	8.80	17.60
4	10	71.2	21.01	84.48	9.40	11.28
6	12	67.8	22.01	83.02	8.57	8.57

Irrigated when plants failed to revive at night						
2	4	71.8	22.44	78.78	0.12	18.30
4	0	74.2	18.69	78.53	7.38	14.70
6	0	67.0	22.67	82.67	0.27	12.64

The average results for the two years show that the sugar-beets which were irrigated after they wilted down and failed to revive at night, did not produce a profitable crop. The greatest yield of 11.43 tons was obtained with three 6-inch applications given when the plants showed a tendency to wilt, and was accompanied by a relatively low yield of 7.62 tons per acre-foot of water. The lowest yield of 6.12 tons per acre was obtained in the last stage of wilting with two-inch applications, and was accompanied by the highest yield of 18.36 tons per acre-foot of water.

Only slight variations in yield are shown with the two-inch, four-inch, and six-inch applications, and also with the total irrigations of twelve, eighteen, and twenty-four inches. This is attributed partly to the lateral diffusion of moisture from one plat to another, since the plats were such a short distance apart. The sugar content of the beet was not materially affected by the stages of wilting or by the depth of application. The purity of juice in beets varied with the different stages of wilting, being greatest in the beets which received two- and four-inch applications where the plants showed a tendency to wilt. These plats produced an average of 9.65 tons of beets per acre. The error caused by this diffusion of water from one plat to another was so great that it was deemed advisable to discontinue this investigation after the two-year period.

SUMMARY

1. The approximate area of land in the State of Nevada is 70,285,440 acres, of which 900,000 acres, or 1.3 per cent, were irrigated in 1918.

2. In 1918, Nevada produced, approximately, 145,000 acres of alfalfa, 80,000 acres of wheat, and 15,000 acres of potatoes. These are the most important cultivated crops grown under irrigation.

3. Nevada lies almost wholly within the Great Basin. The Humboldt, Truckee, Carson, Walker and Muddy are the principal rivers supplying water for irrigation. More than 50 per cent of the irrigated area in the State received its water from the Humboldt River.

4. The greater portion of the acreage of alfalfa and grain in Nevada is irrigated by the border method of flooding. The furrow method is used in the irrigation of potatoes and other similarly cultivated crops.

5. The important factors affecting duty of water in Nevada are: Type of soil, topography, hardpan near the surface, annual rainfall and evaporation. The type of soil causes greater variation in the amount of water required under general field conditions than any other one factor.

6. The average results of early investigations on the irrigation of alfalfa at the Experiment Station, 1906–1911, show a total irrigation of 3.27 acre-feet of water, producing a yield of 5.93 tons per acre, or 1.87 tons per acre-foot of water.

7. During the five-year period of Irrigation Investigations, 1914–1918, practically no precipitation was received during the growing season that was sufficient to affect the moisture content of the soil. This is a unique condition which probably has not obtained in any other irrigated section of the West.

8. In the later investigations the water was measured into each plat through calibrated galvanized iron pipes two inches in diameter. Check plats were used to prevent, as far as possible, any errors due to variation in soil.

9. Alfalfa that was allowed to reach the wilting point before irrigation produced a relatively low yield per acre, but excellent returns were realized when irrigation was withheld until the plants turned dark green in color.

10. The most economical use of water with alfalfa was accomplished with a total irrigation of 3.5 feet applied when plants showed need of water by dark-green color of foliage, producing 5.59 tons per acre, or at the rate of 1.67 tons per acre-foot of water. Soil moisture determinations showed that 70 per cent of the six-inch applications was retained in the first four feet in depth of soil. The use on this plat was equivalent during the period of irrigation to a delivery of water at the rate of one second-foot for 85 acres, or 0.47 miner's inch per acre.

11. The highest yield of 6.18 tons per acre of alfalfa was obtained with 81 inches total depth when the crop was irrigated before plants showed need of water, but this was accompanied by the lowest yield of 1.03 tons per acre-foot. Compared with the yield of 5.59 tons per acre the increase of 0.6 ton was obtained at the expense of an additional use of 39 inches of water, which was at the rate of 0.18 ton per acre-foot. Soil moisture determinations showed that only 25 per cent of the twelve-inch applications was retained in the first four feet in depth of soil.

12. In the irrigation of alfalfa the decrease in soil moisture content at harvest was generally greatest with the nine- and twelve-inch applications. The total amounts of water held in the soil were greatest with the last two stages of wilting.

13. In the irrigation of wheat during the five-year period, 1914–1918, three- and seven-inch applications were given at two or more of the five stages of growth, including, five-leaf, boot, bloom, milk and dough stages.

14. The highest yield of wheat was obtained with 28 inches of water in four applications, when an irrigation was omitted at the five-leaf stage.

15. The highest yield of wheat with three irrigations occurred with 21 inches of water when applications were omitted at the five-leaf and dough stages.

16. The average yields of wheat were considerably higher with the seven-inch than with the three-inch applications.

17. The yields of wheat were relatively low when irrigations were omitted at the boot and bloom stages, thus indicating that a very critical period in the irrigation of wheat was between the boot and milk stages.

18. The highest yield of wheat with two irrigations was secured with nine-inch applications, one before and one after heading.

19. In the irrigation of wheat the high yields per acre were generally accompanied by the greatest decrease in soil moisture content at harvest as compared with the soil moisture content before the first irrigation.

20. In the irrigation of potatoes during the four-year period, 1914–1917, the highest yield was obtained with a total irrigation of 16.5 inches in three-inch applications, given when the plants showed a tendency to wilt.

21. In the irrigation of clover in 1914, a gradual decrease in yield occurred in the different plats with the same applications of water as the wilting stage advanced, before water was applied.

22. In the irrigation of sugar-beets during the two-year period, 1914–1915, the greatest yield was obtained with 18 inches of water in three-inch applications.

23. The results of these investigations on the irrigation of field crops, show that the most economical use of water was obtained with a total irrigation of 3.5 feet in six-inch applications for alfalfa and clover; 2.3 feet in seven-inch applications for wheat; and 1.5 feet in three-inch applications for potatoes and sugar-beets. When alfalfa fields are used for fall pasture, usually an additional irrigation is required after the last crop of hay is harvested.

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revised 1977

crop water requirements

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS ROME

When the leaching efficiency (Le) is 100 percent the wa   rop and LR is equal to (ETcrop - Pe)/(1 - LR). The leaching efficiency (Le) has been shown to vary with the soil type, and particularly with the internal drainage properties of the soil and the field. Since Le can be as low as 30 percent for cracking and swelling heavy clays and go to 100 percent for sandy soils, it must be measured at a most early date for the area under investigation.

EXAMPLE:

Given:

Cotton; ETcrop = 1065 mm/season; effective rainfall during growing season = 160 mm. From water analyses ECw = 7 mmhos/cm. Irrigation by a surface method. Soil is slightly layered, medium textured with measured Le = 0.7.

Calculation:

$$LR = \frac{7}{5 \times 7.7 - 7} \times \frac{1}{0.7} = 0.32 \qquad 100\% \text{ yield}$$

$$LR = \frac{7}{5 \times 9.6 - 7} \times \frac{1}{0.7} = 0.24 \qquad 90\% \text{ yield}$$

$$LR = \frac{7}{5 \times 13 - 7} \times \frac{1}{0.7} = 0.17 \qquad 75\% \text{ yield}$$

To meet seasonal ETcrop and LR depth of water required is respectively (1065 - 160)/(1 - LR) = 1330, 1190 and 1090 mm/season. Level of leaching requirement to be adopted must be based on available water at headworks, yields required and economic criteria. Timing of leachings must also be determined by available water supply at peak water demand periods.

The prediction of annual leaching requirements does not fully account for effect of type of salts, restrictive drainage conditions and excess rainfall. It does not cover waste water, trace metals and pesticides. Also, field water management practices when using saline water will affect yields. For detailed evaluation, references given should be consulted.1/

(ii) Irrigation efficiency (E)

To account for losses of water incurred during conveyance and application to the field, an efficiency factor should be included when calculating the project irrigation requirements. Project efficiency is normally subdivided into three stages, each of which is affected by a different set of conditions:

Conveyance efficiency (Ec): ratio between water received at inlet to a block of fields and that released at the project headworks.

Field canal efficiency (Eb): ratio between water received at the field inlet and that received at the inlet of the block of fields.

Field application efficiency (Ea): ratio between water directly available to the crop and that received at the field inlet.

Project efficiency (Ep): ratio between water made directly available to the crop and that released at headworks, or Ep = Ea.Eb.Ec.

1/ Ayers, R.S. and Westcot, D.W. Water quality for agriculture. Irrigation and Drainage Paper Paper No. 29. FAO Rome, Italy, 1976.
FAO/Unesco. Irrigation, Drainage and Salinity. An Intern. Source Book. Unesco, Paris. 1973.
Salinity Lab. Handbook No. 60. Diagnosis and Improvement of Saline and Alkali Soils. USDA, 1954.
FAO, Irrigation and Drainage Paper No. 7. Salinity seminar Baghdad. FAO Rome, Italy. 1972.
Unesco. Final report on the Gruesi Project, Tunisia. 1971.

Conveyance and field canal efficiency are sometimes combined as distribution efficiency (Ed), where Ed = Ec.Eb; field canal and application efficiency are sometimes combined as farm efficiency where Ef = Eb.Ea.

Factors affecting conveyance efficiency (Ec) are, amongst others, size of the irrigated acreage, size of rotational unit, number and types of crops requiring adjustments in the supply, canal lining and the technical and managerial facilities of water control. The field canal efficiency (Eb) is affected primarily by the method and control of operation, the type of soils in respect of seepage losses, length of field canals, size of the irrigation block and the fields. As can be expected, the distribution efficiency (Ed) has been shown to be particularly sensitive to quality of technical as well as organizational operation procedures (Ed = Ec.Eb). Farm efficiency (Ef) is much dictated by the operation of the main supply system in meeting the actual field supply requirements as well as by the irrigation skill of the farmers.

Table 37 Conveyance (Ec), Field Canal (Eb), Distribution (Ed) and Field Application Efficiency (Ea).

				ICID/ILRI
Conveyance Efficiency (Ec)				
Continuous supply with no substantial change in flow				0.9
Rotational supply in projects of 3 000 - 7 000 ha and rotation areas of 70 - 300 ha, with effective management				0.8
Rotational supply in large schemes (> 10 000 ha) and small schemes (< 1 000 ha) with respective problematic communication and less effective management:				
	based on predetermined schedule			0.7
	based on advance request			0.65
Field Canal Efficiency (Eb)				
Blocks larger than 20 ha:	unlined			0.8
	lined or piped			0.9
Blocks up to 20 ha:	unlined			0.7
	lined or piped			0.8
Distribution Efficiency (Ed = Ec.Eb)				
Average for rotational supply with management and communication	adequate			0.65
	sufficient			0.55
	insufficient			0.40
	poor			0.30
Field Application Efficiency (Ea)		USDA	US(SCS)	
Surface methods				
light soils		0.55		
medium soils		0.70		
heavy soils		0.60		
graded border			0.60 - 0.75	0.53
basin and level border			0.60 - 0.80	0.58
contour ditch			0.50 - 0.55	
furrow			0.55 - 0.70	0.57
corrugation			0.50 - 0.70	
Subsurface			up to 0.80	
Sprinkler, hot dry climate			0.60	
moderate climate			0.70	0.67
humid and cool			0.80	
Rice				0.32

Water losses can be high during field application. Low application efficiency (Ea) will occur when rate of water applied exceeds the infiltration rate and excess is lost by runoff; when depth of water applied exceeds the storage capacity of the root zone excess is lost by deep drainage. With surface irrigation, field layout and land grading is most essential; uneven distribution of water will cause drainage losses in one part and possibly under-irrigation in the other part of the field resulting in very low efficiency. Ea may vary during the growing season with highest efficiencies during peak water use periods.

In the planning stage, efficiency values for the various stages of water distribution and application are estimated on the basis of experience. When estimated too high water deficiencies will occur and either selective irrigation and/or improvement in operational and technical control (lining, additional structures, etc.) will be required. When estimated too low the irrigation area is reduced, and the system is therefore over-designed and probably wasteful irrigation is practised. However, the former is commonly the case. Some indicative data are given in Table 37 which are applicable to well designed schemes in operation for some years and based mainly on a recent comprehensive ICID/ILRI survey and USDA and US(SCS) sources.[1/]

EXAMPLE:
<u>Given</u>:
150 ha scheme, irrigation blocks of 10 ha with unlined canals, furrow irrigation, adequate management.
<u>Calculation</u>:
$Ep = Ed \times Ea = 0.65 \times 0.65 = 0.4$

1.2.4 <u>Summary of Calculation of Seasonal and Peak Project Supply Requirements (V)</u>

Once cropping pattern and intensity have been selected, irrigation requirements and water needs for leaching have been calculated and efficiency of the system estimated, the monthly, seasonal and yearly supply requirements for a given project acreage can be determined by:

$$V_i = \frac{10}{Ep} \sum_i \left[\frac{A(ETcrop - Pe - Ge - Wb)}{1 - LR}\right]_i \quad m^3/\text{period}$$

EXAMPLE:
<u>Given</u>: From previous examples:

crop	acreage A ha	ETcrop mm/year	Pe mm	Ge mm	Wb mm	LR fraction	Ep fraction
maize	90	840	20	-	-	0.44	0.4
berseem	90	400	150	90	-	0.22	0.4
cotton	60	1065	160	-	-	0.24	0.4
wheat	60	375	240	90	-	0.25	0.4

Project acreage 150 ha; cropping intensity 200%.
<u>Calculation</u>:

$$V = \frac{10}{0.4}\left[\left[\frac{840 - 20}{1 - 0.44} \times 90\right] + \left[\frac{400 - 150 - 90}{1 - 0.22} \times 90\right] + \left[\frac{1065 - 160}{1 - 0.24} \times 60\right] + \left[\frac{375 - 240 - 90}{1 - 0.25} \times 60\right]\right] = \underline{5.4\ 10^6}\ m^3/\text{year}$$

Similarly the monthly supply requirements can be determined.

1/ Bos M.G. and Nugteren J. On Irrigation Efficiencies. Publication 19. International Institute for Land Reclamation and Improvement, 89p. 1974.

Annex I: Irrigation efficiencies

Not all water taken from a source (river, well) reaches the root zone of the plants. Part of the water is lost during transport through the canals and in the fields. The remaining part is stored in the root zone and eventually used by the plants. In other words, only part of the water is used efficiently, the rest of the water is lost for the crops on the fields that were to be irrigated.

Figure 24 shows the irrigation water losses in canals; these are due to:

1. Evaporation from the water surface
2. Deep percolation to soil layers underneath the canals
3. Seepage through the bunds of the canals
4. Overtopping the bunds
5. Bund breaks
6. Runoff in the drain
7. Rat holes in the canal bunds

Figure 24. Irrigation water losses in canals

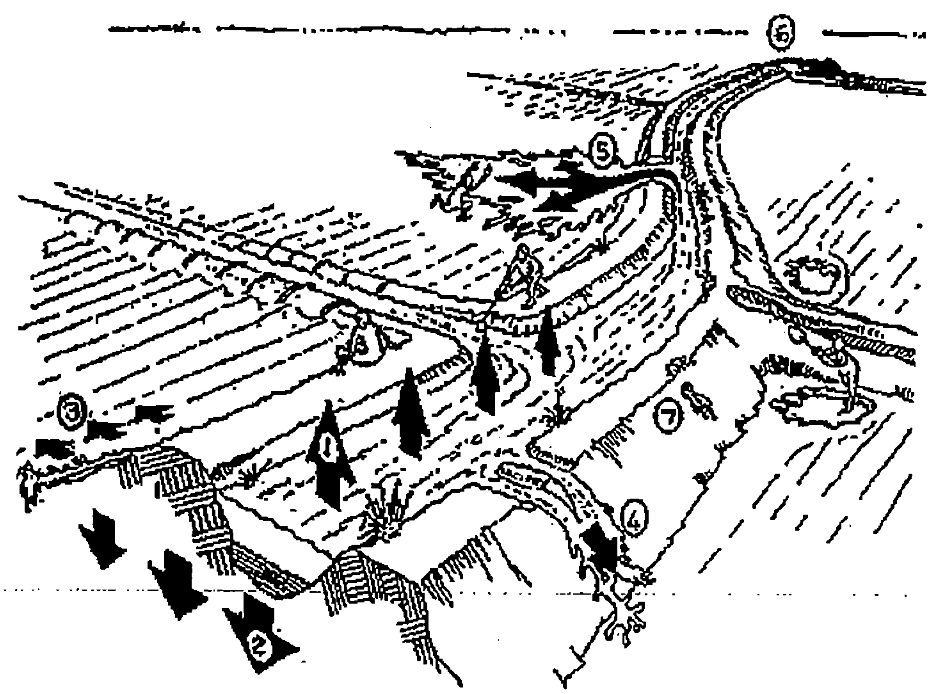
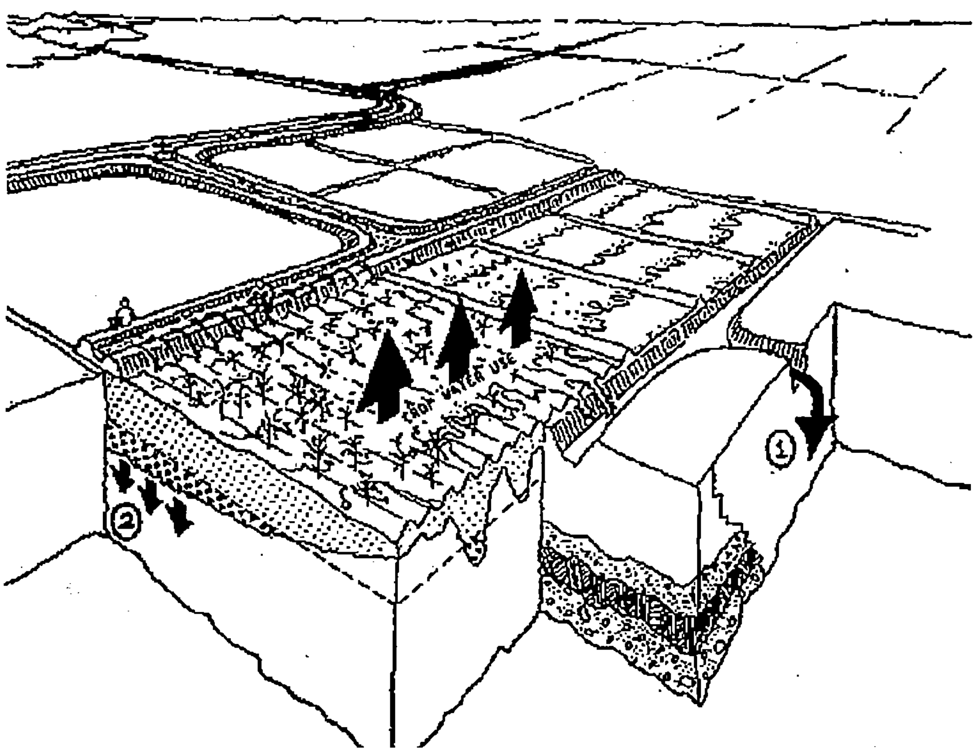


Figure 25 shows the irrigation water losses in the field; these are due to:

1. Surface runoff, whereby water ends up in the drain
2. Deep percolation to soil layers below the root zone

Figure 25. Irrigation water losses in the field



To express which percentage of irrigation water is used efficiently and which percentage is lost, the term **irrigation efficiency** is used.

The **scheme irrigation efficiency** (e in %) is that part of the water pumped or diverted through the scheme inlet which is used effectively by the plants. The scheme irrigation efficiency can be sub-divided into:

- the **conveyance efficiency (ec)** which represents the efficiency of water transport in canals, and

- the **field application efficiency (ea)** which represents the efficiency of water application in the field.

The conveyance efficiency (ec) mainly depends on the length of the canals, the soil type or permeability of the canal banks and the condition of the canals.

In large irrigation schemes more water is lost than in small schemes, due to a longer canal system. From canals in sandy soils more water is lost than from canals in heavy clay soils. When canals are lined with bricks, plastic or concrete, only very little water is lost. If canals are badly maintained, bund breaks are not repaired properly and rats dig holes, a lot of water is lost.

Table 7 provides some indicative values of the conveyance efficiency (ec), considering the length of the canals and the soil type in which the canals are dug. The level of maintenance is not taken into consideration: bad maintenance may lower the values of Table 7 by as much as 50%.

Table 7. INDICATIVE VALUES OF THE CONVEYANCE EFFICIENCY (ec) FOR ADEQUATELY MAINTAINED CANALS

	Earthen canals			Lined canals
Soil type	Sand	Loam	Clay	
Canal length				
Long (> 2000m)	60%	70%	80%	95%
Medium (200-2000m)	70%	75%	85%	95%
Short (< 200m)	80%	85%	90%	95%

The **field application efficiency** (ea) mainly depends on the irrigation method and the level of farmer discipline. Some indicative values of the average field application efficiency (ea) are given in Table 8. Lack of discipline may lower the values found in Table 8.

Table 8. INDICATIVE VALUES OF THE FIELD APPLICATION EFFICIENCY (ea)

Irrigation methods	Field application efficiency
Surface irrigation (border, furrow, basin)	60%
Sprinkler irrigation	75%
Drip irrigation	90%

Once the conveyance and field application efficiency have been determined, the **scheme irrigation efficiency (e)** can be calculated, using the following formula:

$$e = \frac{ec \times ea}{100}$$

with

- e = scheme irrigation efficiency (%)
- ec = conveyance efficiency (%)
- ea = field application efficiency (%)

A scheme irrigation efficiency of 50-60% is good; 40% is reasonable, while a scheme irrigation efficiency of 20-30% is poor.

It should be kept in mind that the values mentioned above are only indicative values.

EXAMPLE

QUESTION:

Determine the project irrigation efficiency for a scheme with a long canal system. The canals are constructed in heavy clay and the irrigation method is furrow irrigation. Maintenance of the canals is adequate.

ANSWER:

Estimate the conveyance efficiency, using Table 7: ec = 80%.

Determine the field application efficiency, using Table 8: ea = 60%.

Calculate the scheme irrigation efficiency, using the formula: $e = \frac{ec \times ea}{100}$

Thus, the scheme irrigation efficiency e = 80 x 60/100 = 48% or approximately 50%. This is considered a fairly good scheme Irrigation efficiency, for a surface Irrigation system.

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IRRIGATION AND DRAINAGE DIVISION

Proceedings of the American Society of Civil Engineers

ATTAINABLE IRRIGATION EFFICIENCIES[a]

By Lyman S. Willardson,[1] M. ASCE

INTRODUCTION

The earliest expression of the need for irrigation efficiency was reflected in the development of the term duty of water. Shortly after modern irrigation began in the west, it was apparent that the water supply would not be adequate. It was also obvious that some irrigators were using more water than others. Scientists (9,10) tried to determine the amount of water required to produce various crops and used the term duty of water to define this amount. The term was also used to evaluate the quantity of water required to produce a given weight of crop. This dual definition of the term led to some confusion.

A more precise definition of irrigation efficiency was required for water management purposes and in 1932, Israelsen (7) developed a definition for water application efficiency. He was concerned with water application on a single field and with determining the proportion of water applied to the field that was actually retained in the root zone. Since these early beginnings, other workers in irrigation have developed, refined, and redefined irrigation efficiency terms.

The general objective of irrigation is to provide a suitable moisture environment in the soil for plant growth. The water applied must be uniformly distributed over the soil surface. The amount applied should not exceed the available water storage capacity of the soil profile in the root zone, plus any leaching requirement. Overirrigation and leaching of nutrients should be avoided. Underirrigation that allows salts to accumulate in the soil and may cause plant water stress is undesirable. Water should be applied with the greatest uniformity possible with minimum water management losses. Erosion

Note.—Discussion open until November 1, 1972. Separate discussions should be submitted for the individual papers in this symposium. To extend the closing date one month, a written request must be filed with the Executive Director, ASCE. This paper is part of the copyrighted Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, Vol. 98, No. IR2, June, 1972. Manuscript was submitted for review for possible publication on January 18, 1972.

[a] Presented at the January 11-15, 1971, ASCE National Water Resources Engineering Meeting, held at Phoenix, Ariz.

[1] Agricultural Engr., Imperial Valley Conservation Research Center, Brawley, Calif.

EXHIBIT

tabbies

Tab 8

and deterioration of soil structure should be minimized. All of these requirements could be included and evaluated as irrigation efficiency.

IRRIGATION EFFICIENCY DEFINITIONS

There are at least 20 currently used definitions of irrigation efficiency. Israelsen (7) published some of the earliest definitions and later researchers (4,8,11) have used other definitions. When a definition of irrigation efficiency is used, the terms in the equation should be specified to avoid misunderstandings.

Concern for a particularly defined irrigation efficiency is determined in some degree by the individual's interest or need. The efficient application of water to a small plot of a specialty crop may be of vital concern to a farmer but will be of lesser interest to a river basin planner who is looking at an overall water supply. Diversions to other basins or preservation of a limited water supply may require interest in irrigation efficiency at all planning levels. Understanding the concept of consumptive use and plant water requirements should make it possible to decide which irrigation efficiency is important.

Efficiency is computed to determine how well a particular goal is being reached. Since the goals of all determinations of irrigation efficiencies are not defined herein, no attempt will be made to define all possible irrigation efficiencies.

WATER FOR CULTURAL PRACTICES

The description of irrigation efficiency which follows will not include the efficiency of use of water for cultural practices. Erie (3) has listed a number of reasons for applying water other than to replenish water in the root zone: to aid germination; to protect from frost; to control corn borers and caterpillars; to aid growth of potato tubers; to rewet the surface soil after crop thinning; to maintain crispness in lettuce and other vegetables during harvest; to leach salts; to dissolve fertilizers; and to control temperature. Efficiencies of water applied for these purposes will not be treated herein.

FACTORS CONTROLLING IRRIGATION EFFICIENCIES

This paper will be concerned with irrigation efficiencies on a single field. The important efficiency factors will depend on the type of irrigation system used, and the physical, economic, and political constraints. There are also many judgment factors involved, and irrigation efficiency is now mainly controlled by the skill of the irrigator.

The irrigation efficiency to be considered herein is primarily that termed water application efficiency by Israelsen. This is the percentage of the water applied that is actually stored in the root zone for use by the crops. The uniformity of water absorption over the field directly affects water application efficiency.

The physical factors that affect water application efficiency are those related to the infiltration and storage of water in the soil. In surface irrigation, the slope and roughness of the soil surface, the soil infiltration characteristics, the stream size, and the volume of soil available for water storage are among the important considerations because they also affect the uniformity of distribution. For sprinkler irrigation, sprinkler spacing, nozzle size, and pressure are important for the same reason. The wind conditions may be very important at certain times.

TABLE 1.—WATER APPLICATION EFFICIENCIES, MILFORD, UTAH, 1959, POTATO FIELD, FARM NO. 35

Date of irrigation (1)	Water applied, in inches (2)	Water stored, in inches (3)	Application efficiency, as a percentage (4)
June 10-15	8.4	3.1	37
July 9-12	4.9	3.7	77
July 19-20	3.6	.9	26
July 26-27	3.1	.9	29
August 2-3	3.7	.9	24
August 9-10	3.4	1.3	38
August 16-17	3.9	1.7	44
August 23-24	3.7	1.8	49
August 30-31	3.1	2.7	87
September 6-7	3.7	2.2	69
September 13-15	3.7	1.5	41
Totals	45.1	20.7	Average 40

1 in. = 25.4 mm.

TABLE 2.—WATER DISTRIBUTION EFFICIENCIES, MILFORD, UTAH, 1958-1959, POTATO FIELD, FARM NO. 35, FURROW IRRIGATION SYSTEM

Date of irrigation (1)	Distribution efficiency, as a percentage (2)
June 10-15	79
July 9-12	88
July 19-20	87
July 26-27	69
August 2-3	69
August 9-10	86
August 16-17	96
August 23-24	90
August 30-31	92
September 6-7	86
September 13-15	81
	Average 84

Economic factors that may directly or indirectly affect water application efficiency are water costs and their relation to land preparation costs and labor costs, equipment costs, and the value of the crop being irrigated.

Political factors that may affect irrigation efficiencies are water laws and geographical location. Most appropriation water law is set up on the basis of the use of water being beneficial. What is beneficial use in terms of irrigation efficiency has never been adequately defined. Until precise definitions are written into law, political influence on irrigation efficiency will probably be toward lower rather than higher efficiencies.

WATER DISTRIBUTION

One major controlling factor in attainable irrigation efficiency is the water storage capacity in the soil at the time of irrigation relative to the amount applied and the uniformity of application. If, for example, it were physically and practically possible to distribute a 4-in. depth of irrigation water with absolute uniformity over a field which could only store 1-in. in the root zone, regardless of the precision and uniformity of the irrigation, the water application efficiency would be 25 %. This fact is relatively unrecognized by many irrigators. Table 1 shows data from a sequence of furrow irrigations on a potato field (12). The amount of water applied was nearly uniform during every irrigation; however, the amount of water stored in the soil varied greatly. Efficiency of water application varied between 24 % and 87 % during the season, depending on the available soil moisture storage capacity. The available moisture storage capacity at the time of irrigation can override all other factors in determining irrigation efficiency.

Uniformity of water application over a field is important also. An average application amount will be meaningful only if distribution is relatively uniform. Table 2 shows distribution efficiencies (1) for the same irrigations given in Table 1. Applying water nonuniformly will result in overirrigation with associated deep percolation losses in some areas and underirrigation with associated plant water stress in other areas.

It is possible to irrigate with a water application efficiency of 100 % every time by applying less water than the soil will hold at any location. For example, if the soil has a water deficiency of 12 in. and 1 in. is applied with reasonable uniformity, water application efficiency will be 100 % in every location on the field. However, the crop will not grow well. Underirrigation is obviously not the solution to the irrigation efficiency problem.

SURFACE IRRIGATION EFFICIENCY

Surface irrigation has one overriding disadvantage related to water distribution because the same surface used to absorb the water is also used as the transporting medium. The time differences developed in moving water over the surface result in nonuniform distribution.

The water intake characteristics of the soil largely determine the ease with which water can be relatively uniformly distributed over the surface. In general, the lower the infiltration rate, the simpler it is to obtain a uniform irrigation. Willardson and Bishop (11) have shown that it is relatively easy to obtain water application efficiencies above 60 % over a wide range of furrow stream or border stream advance conditions. Efficiencies range above 70 % on low intake rate soils. These water application efficiency values are predicated on a full irrigation over the entire field with no recovery of runoff water or adjustments to reduce runoff. If runoff water can be recovered, water

application efficiencies can be boosted above 80 %.

The change in infiltration characteristics of the soil with time very much complicates the problem of obtaining efficient surface application of water. Areal variations of intake rates within fields also cause problems. Light irrigations tend to be less efficient than heavier irrigations because of low uniformity of distribution. Another factor affecting water application efficiency is the areal variation of available soil water storage capacity that is a result of previous nonuniform water applications.

Various irrigation methods have been tried to eliminate time differentials in surface irrigation. Level basin irrigation in which large volumes of water were applied over a very short period to an enclosed area is one example. Runoff losses are eliminated and all the water applied is absorbed. It is presumed that water distribution over the field is uniform since the differences in intake opportunity time over the field are very small. However, water will percolate more rapidly into the more porous areas of any surface irrigated field, causing nonuniform distribution. High and low spots in the field also affect distribution uniformity significantly.

The problem of advance time is very apparent for furrow and border irrigation systems where lengths of run are very long. As indicated earlier, soils with low intake rates will allow the use of long lengths of run with reasonably efficient results. High infiltration rates soils are difficult to irrigate by any surface method. Obtainable efficiencies in surface irrigation depend entirely on the possibility of uniform distribution of water over the soil surface and uniform infiltration. With coefficients of uniformity above 80 %, water application efficiencies of surface irrigation can be as high as 80 %, if the water storage capacity of the root zone is not exceeded.

TRICKLE IRRIGATION EFFICIENCY

Trickle irrigation is coming into vogue in many parts of the world. Many countries are expressing interest in response to claims of very efficient use of water. Manufacturers of commercial trickle irrigation equipment are claiming anywhere from 50 % to 90 % reduction in irrigation water needs through the use of trickle irrigation. This is equivalent to irrigation water use efficiencies of 200 % and 1,000 % computed on a gross area basis. Research data (2) show water savings of 15 % to 50 % of the amounts usually applied by surface irrigation.

Research work in Israel indicates that when using equivalent amounts of water, yields are approximately doubled by trickle irrigation. No water is saved because leaching is needed periodically for salinity control, but the duty of water is increased. No claims related to water application efficiency were made. Estimates of a 50 % reduction in water requirements for trickle irrigation are based on the fact that only a small portion of the soil surface is wetted by irrigation and, therefore, surface evaporation of water is reduced. With trickle irrigation, as with surface irrigation, it is possible to irrigate with a true water application efficiency of 100 % by underirrigating so that no water is lost to runoff or deep percolation.

There have been no evaluations published of deep percolation losses under trickle irrigation. The efficiency obtained will depend on the spacing of the emitters and the rate of water application relative to the evapotranspiration

Subject: Re: EIS CU Questions
From: "Tom Scott" <tscott@mp.usbr.gov>
Date: Mon, 03 Mar 2008 14:22:20 -0800
To: "Chris Mahannah" <chris@gbis.com>
CC: "Kenneth Parr" <KPARR@mp.usbr.gov>

Chris,

Attached is a word document showing where the consumptive use is discussed in the Final EIS/EIR. In the model, we used 5/8 as the factor for storing consumptive use except for rights purchased from the Truckee Division. The assumption in the EIS for the Truckee Division was 10,300 acre-feet purchased for Water Quality and 6,800 acre-feet by Fernley M&I. It was assumed that Water Quality credit water would store 133% of the right (the right plus transportation losses). The reason for including the transportation losses was because this water is being transported out of the Truckee River Basin. When we were modeling this, we assumed either the State Engineer would grant the full water right and the transportation losses, or if the State Engineer did not grant this, then the Tribe has agreed that the excess water attributed to the transportation losses that went to Pyramid Lake would be accounted for as water quality credit water (this would involve an exchange with Fish or Fish Credit Water). For Fernley M&I, we did not store this in the main analysis. We only stored Fernley M&I in a sensitivity run, where Fernley was able to store 100% of the water right (no transportation losses included with Fernley M&I).

Sorry, I took so long to get back with to you.

Tom

>>> Chris Mahannah <chris@gbis.com> 2/1/2008 10:57 AM >>>

Hello Tom, Good to meet you yesterday & chat briefly about CU. Had a few follow up questions:

1. You mentioned CU being calculated at 5/8 x TMWA's converted Decreed rights available for storage. Where in the EIS or appendices is this stated & explained? I assume this is what was used for all the hydraulic modeling as well?
2. You also mentioned full duty storage of Truckee Division rights.

   Which rights were you referring to: Fernley's acquired M&I, WQSA acquistions, others or all of the above?

Thanks, Chris

Kenneth Parr wrote:

Chris, to expedite your request please contact Tom Scott at 884.8357.

Or by this email Tom Scott will get ahold of you. Kenneth.

>>> Chris Mahannah <chris@gbis.com> 01/30/08 11:06 AM >>>

Ken, Could you direct me to where specifically the consumptive use amount, determination, calculations, etc. can be found in the EIS? Thanks, Chris

EXHIBIT
tabbies
tab 9

--
Chris Mahannah, P.E. - Mahannah & Associates, LLC
Innovative Water Resource Solutions
voice: (775)323-1804 / fax: (775)323-1025

consumptive use.doc	**Content-Type:**	application/msword
	Content-Encoding:	base64

Page 3-38 - TROA FEIS/EIR

In order to implement TROA, the following actions would require approval under applicable State law:

• Retention in storage of the consumptive use portion of all or a portion of the water that TROA signatories were entitled to divert from the Truckee River out of Floriston Rate releases, consistent with water rights and storage contracts.

Pages 7-5,6 - Truckee River Agreement

Section 7.A.3(e) Portion to be Established. Except as provided in Sections 7.C.1 and 7.C.2, **Credit Water Establishment** by using **Changed Diversion Rights** that had been Exercised for consumptive purposes shall be limited to the portion of the water which would not otherwise have returned to the Truckee River. That portion shall be as follows:

(1) For **Changed Diversion Rights** having an original place of use in Nevada, such portion shall be determined by Nevada State Engineer pursuant to an application or applications filed to change the point of diversion and the place, means, manner or purpose of use of such rights. The procedures for relating the consumptive use component to an equivalent diversion amount shall be subject to approval of the **Orr Ditch Court** in the proceeding required by Section 12.A.4(b).

(2) For **Changed Diversion Rights** having an original place of use in California, such portion shall be determined pursuant to California law.

(3) For water under water rights which historically has been exported out of the **Truckee River Basin**, the consumptive use portion shall be 100 percent of the **Changed Diversion Rights**.

Page 12-3 - Truckee River Agreement

Section 12.A.4(b) Modifications to Orr Ditch Decree. This **Agreement** shall have been submitted to the **Orr Ditch Court** for approval of any necessary modifications in the provisions of the **Orr Ditch Decree**, including a satisfactory confirmation of the consumptive use portion of **Changed Diversion Rights**, and the **Orr Ditch Court's** approval thereof shall have been obtained.

Page 12-3 - Truckee River Agreement

Section 12.A.4(d) Water Right Changes Have Been Approved. The following changes to water rights, which the **Signatory Parties** deem are necessary to accomplish the purposes of this **Agreement**, either have been approved, or are approved conditioned on this **Agreement** entering into effect:

(5) a minimum of 12,000 acre-feet of changes to **Changed Diversion Rights** identified in Section 7.A.4(b)(1), with a consumptive use fraction of not less than 2.5 acre-feet per acre and a flexible 12-month diversion schedule; unless each of Water Authority, Pyramid Tribe and United States agree that such contingency has been otherwise satisfied or is not required for this **Agreement** to take effect, and provided that each of Water Authority, Pyramid Tribe, and United States have not identified any condition of such approval that would make the approval required under this Section 12.A.4(d)(5) inoperative;

Exhibit 15 – 7.8 - Water Resource Appendix

Water Quality Water Supply, Utilization and TMWRF Groundwater Component

There are no water quality considerations applied to the Current Conditions operation analysis. Future conditions (with and without TROA) operation includes operation in accordance with the water quality agreement among Reno, Sparks, Washoe County, Pyramid Lake Paiute Tribe and federal government. This agreement provides for acquisition of water rights and utilization of that supply to improve Truckee River water quality by increasing Truckee River flow and the river's consequent capacity to assimilate nutrients. The water rights acquired are as follows:

Truckee River between Farad and Vista: Under TROA, 7,600 acre-feet of water rights and, without TROA, 900 acre-feet of water rights are acquired: Acquisition of these rights is assumed to increase Truckee River flow by 62.5% of the acquired rights or diversion, whichever is less. The 62.5% portion can be stored in Truckee River reservoirs. (62.5% is considered to represent the consumptive use portion of these water rights.) Of the 7,600 acre-feet under TROA, 6,700 acre-feet are the "groundwater component" which is acquired in accordance with Section 1.E.4 of TROA.

Truckee River between Vista and Derby Dam: 1,500 acre-feet of water rights are acquired: The acquisition of these rights is assumed to increase Truckee River flow by 970 acre-feet or a proportionate share of diversion, whichever is less. The increased Truckee River flow is not stored in Truckee River reservoirs. It remains in the Truckee and flows to Pyramid Lake. (970 acre-feet are considered to represent the consumptive use portion of these water rights.)

Truckee Division of the Newlands Project: 10,300 acre-feet of water rights are acquired: When other Newlands Project rights are fully supplied (in accordance with OCAP), acquisition of these rights is assumed to increase Truckee River flow (available based upon water that would be left in Truckee at Derby) by 133% of the acquired rights or supply, whichever is less. The 133% portion can be stored in Truckee River reservoirs. (133% is considered to represent the head gate right plus Newlands Project system loss which, when taken together, represent the impact upon Truckee River flow associated with these rights.)

Exhibit 15 – 9, Water Resource Appendix

Fernley M&I Demand and Storage

For all alternatives except Current Conditions, Fernley M&I demand is set as 6,800 acre-feet per year. This demand is supplied using 6,800 acre-feet of water rights assumed to have been acquired and transferred from the Truckee Division. During normal water supply years, acquisition and transfer of these water rights results in a reduction in Truckee Division demand and consequent diversion from the Truckee River to serve the Newlands Project of 9,070 acrefeet. Under TROA, it is assumed to be possible for Fernley to establish and use Credit Water storage. However, since the annual demand is equal to the water right acquisition, there is no water available for establishment of Credit Water storage and, consequently, there is no Fernley M&I Credit Water storage operation in any of the alternatives.

Exhibit 16 gives operation examples, including storing the consumptive use portion of water rights.

WASHOE PROJECT

NEVADA-CALIFORNIA

FEASIBILITY REPORT

SEPTEMBER 1954

United States
Department of the Interior
Douglas McKay, Secretary

U.S. Bureau of Reclamation
W. A. Dexheimer, Commissioner
Region 4, Salt Lake City, Utah
E. O. Larson, Regional Director

SUMMARY--WASHOE PROJECT, NEVADA AND CALIFORNIA

Purpose

The Washoe project would provide irrigation water to supplement present supplies to provide a full supply to lands in Carson Valley and the Empire, Dayton, and Fort Churchill areas. In addition during dry cycles it would firm existing supplies of the Truckee River Storage and Newlands reclamation projects. Drains would be provided for lands in Carson Valley and under the Truckee River Storage project in Truckee Meadows. Hydroelectric energy would be generated to meet urgent local needs and to provide a portion of the repayment revenues. Project reservoirs would provide river regulation that would materially lessen flood damage. Benefits to recreation and public health would be created. The project would variously affect fish and wildlife with the net effect to be determined by final structural designs and operating criteria.

Plan

The Washoe project would be integrated with the existing Truckee River Storage and Newlands projects. It would also be coordinated with and dependent on the Truckee River channel improvement that was proposed by the Corps of Engineers and authorized in the Flood Control Act of 1954 with the provision that the authorization would not become effective unless and until the Washoe reclamation project had been authorized.

In the Truckee River Basin the Stampede Reservoir would be built to a capacity of [illegible] acre-feet on Little Truckee River. Reservoir water would be discharged through the Stampede tunnel and Calvada penstock to the 20,000-kilowatt Calvada powerplant on the Truckee River. Below the powerplant the water would be regulated at the [illegible] Calvada Reservoir. It would then flow in the Truckee River channel and through existing facilities to meet and supplement established rights and to replace part of the Carson River water now used on the Newlands project for use higher upstream. On lands of the Truckee River Storage project in Truckee Meadows deep drains would be installed and wells would be constructed to relieve artesian pressure.

In the Carson River Basin the Watasheamu Reservoir on the East Fork of the Carson River would be constructed to a capacity of 115,000 acre-feet. The reservoir would regulate flood flows now running to waste and some water now used by the Newlands project which would be replaced by Washoe project water from the Truckee River. Releases from Watasheamu Reservoir would pass through the 8,000-kilowatt Watasheamu powerplant at the base of the dam. The water would then be regulated at the Dressler Diversion Dam and Afterbay that would impound 1,040 acre-feet. At the dam some water would be diverted into the potential Carson Canal that would serve new lands along the [illegible] in Carson Valley and that would also deliver water to the West Fork of Carson River for distribution by existing canals diverting from that stream. Some water bypassing Dressler Diversion Dam, together with return flows reaching the stream, would be diverted to lands in Carson Valley and in the Empire, Dayton, and Fort Churchill areas. The remaining flows passing Dressler Dam would continue on to the Lahontan Reservoir of the Newlands project. The existing Allerman Canal in the Carson Valley would be enlarged and extended. Some new laterals would be constructed and existing laterals would be improved and extended as necessary. Systems of main drains would be installed in Carson Valley.

Principal agricultural production

Alfalfa, grain, pasture--dairy cows and beef.

SUMMARY--WASHOE PROJECT, NEVADA AND CALIFORNIA (continued)

Estimated annual increase in irrigation supply (acre-feet)

Carson Valley, Empire, Dayton, and Forth Churchill areas	68,300
Existing Truckee River Storage project	1/ 2,600
Existing Newlands project	1/ 1,700
Total	72,600

1/ Supply to be reserved for use in dry cycles.

Land area served (acres)

Project subarea	Full irrigation service land	Supplemental irrigation service land	Supplemental irrigation and drainage service land	Total
Carson Valley	5,100	19,990	18,170	43,260
Empire, Dayton, and Fort Churchill areas	--	6,300	--	6,300
Newlands project	--	70,000	--	70,000
Truckee River Storage project (Truckee Meadows)	--	14,070	12,730	26,800
Total	5,100	110,360	30,900	146,360

Power

Installed capacity (kilowatts)	28,000
Average annual project generation (kilowatt-hours)	95,871,000
Average annual reduction in existing generation (kilowatt-hours)	4,500,000
Average selling rate per kilowatt-hour	9 mills

Flood control

Annual reduction in flood damages	$288,900

Costs

Construction costs	$41,458,000
Annual operation, maintenance, and replacement costs	$210,540

Benefit-cost ratio

Average annual benefits would compare with average annual equivalent costs in ratio of 1.8 to 1.0

Repayment

Irrigation and drainage payments up to the ability of the water users would be made for 50 years after suitable development periods for various project lands. The power investment would be amortized in 50 years at 2.5 percent interest. Interest paid to the Federal Treasury would amount to $14,734,000. Net power revenues accruing for 14 years after repayment of the power investment would fully repay the part of the irrigation and drainage allocation beyond the repayment ability of the water users.

Allocations and repayment of project costs

Purpose served	Cost allocation: Construction cost	Interest during construction	Total reimbursable cost	Source of payment revenue: Irrigation and drainage payments	Power revenues
Irrigation and drainage	$17,391,000	--	$17,391,000	$8,180,000	$9,211,000
Power	18,247,000	$720,000	18,967,000	--	18,967,000
Flood control (nonreimbursable)	5,820,000	--	--	--	--
Total	41,458,000	--	36,358,000	8,180,000	28,178,000

Annual costs for operation, maintenance, and replacement paid by each purpose would be: irrigation and drainage, $51,130; and power, $152,850. Annual costs for flood control in the amount of $6,560 would be nonreimbursable.

C O N T E N T S

Report of the Regional Director

Substantiating Materials

Report of the Bureau of Reclamation

CONTENTS (Continued)

Report of the Bureau of Reclamation (continued)

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Report of the Bureau of Reclamation (continued)

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Report of the Bureau of Reclamation (continued)

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[illegible] of the Fish and Wildlife Service

Report of the National Park Service

CONTENTS (Continued)

Report of the National Park Service (continued)

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[illegible]S AND DRAWINGS

Page

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
REGION 4
Post Office Box 360
Salt Lake City 10, Utah

September 17, 1954

To: Commissioner

From: Regional Director

Subject: Report on Washoe Project, Nevada-California

1. This letter and the attached substantiating materials are submitted as a basis for securing Congressional authorization of the potential Washoe project, an economically justified and urgently needed reclamation development in west-central Nevada and east-central California. The project would provide storage regulation to control surface runoff for irrigation, power production, and flood protection. Also, through drainage and proper distribution of irrigation water, it would lower damaging ground water tables, increase usable water supplies, and improve public health. Opportunities for recreational development would be provided in an area of National recreational significance, and fish and wildlife benefits might be provided.

2. The Washoe project plan is the result of extensive investigations made under the sponsorship of the Bureau of Reclamation with the cooperation of the Fish and Wildlife Service, National Park Service, Corps of Engineers, Public Health Service, Geological Survey, Forest Service, Soil Conservation Service, and Federal Power Commission. Some of the cooperating agencies have prepared statements, which are appended to this report, on the project's probable effects on the interests with which they are concerned. Numerous State and local organizations have also cooperated in project investigations.

3. Authority to make this report and supporting investigations is provided in the Federal reclamation laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto).

Introduction

Project area

4. The Washoe project area includes the drainage basins of the Truckee and Carson Rivers which lie adjacent to each other on the eastern slope of the Sierra Nevada. Each basin consists of several separate areas formed by natural physiographic features. Of particular importance to the project in the Truckee River Basin is Truckee Meadows, near the center of

the basin. Particularly important to the Carson River Basin are Carson Valley and, in succession down the Carson River, the Empire, Dayton, Fort Churchill, and Lower Carson areas. Locations of the various areas are shown on the frontispiece map.

5. Chief cities of the project area are Reno and Sparks, located in Truckee Meadows on the Nevada side of the project area. Also important communities in the Nevada portion of the area are Carson City, the State's capital; and the agricultural communities of Fallon, Gardnerville, and Minden. Only small communities, including Truckee, Markleeville, Woodfords, and Tahoe City, are on the California side of the area. Lake Tahoe, lying astride the Nevada-California State line high in the Sierra Nevada, is a resort center of National prominence. Although Tahoe City is the only incorporated town on the lake shores, the lake is rimmed with homes, cabins, and resorts on both its Nevada and California sides and attracts thousands of tourists each year.

Needs of the area

6. Better regulation of the available water supply is urgently needed in the Washoe project area. Runoff of the Truckee and Carson Rivers, formed largely from melting snows in the high Sierra Nevada, comes as torrential floods in the spring but drops sharply after midsummer. The high spring flows run unused, destroying property along the Lake Tahoe shoreline, damaging Reno and Sparks, and inundating farm lands in both the Truckee and Carson River Basins. Also surplus ground water exists in both the Truckee and Carson River Basins. It menaces health and property in the vicinity of Reno and Sparks and seriously hinders crop production in Truckee Meadows and Carson Valley. Although damages are being caused by the excessive surface and ground water, thousands of acres of farm land produce only part of their potential because of late season water shortages. Other lands, capable of sustained crop production, are still in sagebrush for lack of water. Despite opportunities on the Truckee and Carson Rivers for new power production, demands for electic energy are outgrowing the supplies and large amounts of power must be imported across the high Sierra Nevada from California. In most cities existing domestic water supplies are adequate for the foreseeable future. Needs for domestic water, however, are outgrowing the available supplies in resort areas around Lake Tahoe and in the vicinity of Markleeville and Woodfords.

7. Improved irrigation practices in the Carson River Basin are essential to effective distribution of the available water resources. Because of the inadequate late-season supplies, farmers irrigate excessively in the spring in an attempt to keep the ground wet throughout the summer. Also, because of the lack of adequate storage regulation, they install checks to hold back water in numerous small impoundments on streams and sloughs. Such practices, although established in an attempt to use the limited water supplies to best advantage, result in waste of the available supply. They cause excessive evaporation and transpiration losses and contribute to the damaging high water table.

REPORT OF THE REGIONAL DIRECTOR

Existing developments

8. Some regulation of the Truckee and Carson River flows already has been accomplished but the control provided to date is only a part of that required for optimum utilization of the water resources. The largest reclamation developments on the rivers are two projects previously undertaken by the Bureau of Reclamation--the Truckee River Storage project constructed in 1937-39 and the older Newlands project constructed in 1903-15. These projects are briefly discussed below.

9. The Truckee River Storage project regulates flows of the Little Truckee River, chief tributary of the Truckee River, for irrigation of about 26,800 acres in Truckee Meadows in the Truckee River Basin. Regulation is provided at Boca Reservoir with a capacity of 40,900 acre-feet. The Washoe County Water Conservation District operates the project and is repaying the project construction costs under a contract with the Federal Government.

10. The Newlands project utilizes water of both the Truckee and Carson River systems for irrigation, principally in the Lower Carson area, and for the generation of hydroelectric energy. Contracts have been made to provide irrigation water to 70,000 acres. Water of the Truckee River is conveyed to the project area by the Truckee Canal. Truckee River water is regulated at Lake Tahoe, which provides 732,000 acre-feet of storage capacity for the project. Since construction of the Truckee River Storage project, some regulation has also been provided at Boca Reservoir for Little Truckee River water utilized under the Newlands project. In the Lower Carson area, the 290,900-acre-foot Lahontan Reservoir provides storage for Carson River water and for water of the Truckee River imported by the Truckee Canal. Power is generated at the Lahontan powerplant at the base of the Lahontan Dam. The Truckee-Carson Irrigation District has contracted with the United States for operation of the Newlands project and for payment of construction costs.

Plan of Development

11. The Washoe project would be integrated with the existing Truckee River Storage and Newlands projects. Also it would be closely coordinated with the development proposed by the Corps of Engineers and conditionally authorized by Congress for enlarging and deepening the Truckee River channel. The authorization for the channel improvement included in the Flood Control Act of 1954 will not become effective unless and until the Washoe reclamation project shall have been authorized pursuant to law.

12. The Washoe project would increase irrigation supplies at canal heads by an average of 72,600 acre-feet annually. This increase would provide for the full irrigation of 5,100 acres of land in Carson Valley, the supplemental irrigation each year of 38,160 acres in Carson Valley, and

the supplemental irrigation each year of 6,300 acres in the Empire, Dayton, and Fort Churchill areas. In addition, during dry cycles it would firm the existing supplies for the 26,800 acres of land in the Truckee River Storage project and the 70,000 acres under water right contract in the Newlands project. Local electric power supplies would be increased by a net annual amount of 91,371,000 kilowatt-hours. Control of the water provided by the project would reduce flood damages by an average annual amount of $288,900 and would alleviate seepage on 18,170 acres in Carson Valley and 12,730 acres in Truckee Meadows. The project is expected to incidentally improve public health and increase recreational values. It would variously affect fish and wildlife resources but its net effect on these resources will be dependent on structural and operational refinements not yet fully evaluated. The project does not provide for increasing domestic water supplies but, if warranted by the demand, it could be readily adjusted to meet the growing needs for domestic water around Lake Tahoe and in the vicinity of Markleeville and Woodfords. The project would not increase the supplies of Indian lands in the area as these lands are now using only a small portion of the water available to them. It would, however, in no way infringe on the Indians' existing rights.

Project works

13. Except for new distribution facilities that would be required for expanded irrigation in the Carson River Basin, practically parallel project works would be constructed in the Truckee and Carson River Basins. In each basin the project would involve Federal construction of a storage reservoir to control fluctuating streamflows, a plant and appurtenant works to utilize reservoir releases for hydroelectric power production, a small reservoir to reregulate the powerplant tailwater, facilities to transmit the power generated to the nearest load center, and drainage works to relieve waterlogging and salvage water for beneficial uses. In the Carson River Basin the project also would include Federal construction of new and enlarged canal and lateral systems. In both the Truckee and Carson River Basins small farm drains would be constructed by private interests. Brief descriptions of the project works are given in the following paragraphs.

Truckee River Basin

14. In the Truckee River Basin, storage would be provided at Stampede Reservoir to be built to a capacity of 126,000 acre-feet on the Little Truckee River. Water from the reservoir would be discharged through the potential Stampede tunnel and Calvada penstock to the Calvada powerplant that would be constructed on the main stem of the Truckee River. The plant would have a capacity of 20,000 kilowatts and an average annual generation of 61,939,000 kilowatt-hours. Its power output would pass through a substation near the plant and would then be transmitted about 7 miles to the Reno market area for delivery into existing systems. Water releases from the Calvada plant would be regulated at the 226-acre-foot Calvada Regulatory Reservoir on the Truckee River just below the plant. The water

[illegible]

[illegible] flow in the Truckee River [illegible] existing [illegible] established rights, to [illegible] supplies [illegible] ing Truckee River Storage [illegible] and to replace some of [illegible] [illegible] need on the [illegible] Valley and the Empire, Dayton, and Fort Churchill [illegible].

15. As a part of the project in Truckee Meadows, deep drains would be installed and some wells would be constructed to relieve artesian pressure. Small lateral drains also would be constructed by private interests to supplement the project drainage system.

Carson River Basin

16. In the Carson River Basin storage would be provided at the Watasheamu Reservoir to be constructed to a capacity of 115,000 acre-feet on the East Fork of the Carson River. This reservoir would regulate flood flows now running to waste and water that would be usable upstream in the Carson River Basin in exchange for Truckee River water provided the Newlands project. Releases from the reservoir would be dropped through a penstock to the 8,000-kilowatt Watasheamu powerplant to be located at the base of the dam. Power from this plant--an average annual amount of 33,932,000 kilowatt-hours--would pass through a substation near the plant and would then be transmitted about 25 miles to the Carson City market area for delivery into existing systems.

17. Below the Watasheamu powerplant, water would be regulated at the potential Dressler Diversion Dam and Afterbay that would impound 1,040 acre-feet of water. At the dam some water would be diverted into the potential Carson Canal and the remaining flow would continue down the East Fork and the main stem of the Carson River. Water diverted by the Carson Canal would be supplied to lands in southern Carson Valley--part being distributed to full service lands along the canal course and part being conveyed to the West Fork of Carson River and then distributed by existing facilities to supplemental service lands. Some water bypassing Dressler Diversion Dam on the East Fork, together with return flows reaching the stream, would be diverted to full and supplemental service lands in eastern Carson Valley and to supplemental service lands in the Empire, Dayton, and Fort Churchill areas. The remaining flow would continue to Lahontan Reservoir for use on the existing Newlands project. Diversions in Carson Valley would be made through the existing Allerman Canal that would be enlarged and extended, through new laterals that would be provided, and through existing laterals, some of which would be improved. In the Empire, Dayton, and Fort Churchill areas, diversions would be made through existing laterals that would be rehabilitated as necessary. In the Newlands project area, the existing distribution systems would continue to be utilized without modification.

18. Systems of main drains would be installed in Carson Valley as part of the project, and supplementary farm lateral drains would be constructed by private interests. Artesian relief wells for Carson Valley are not included in the project but may be found desirable at some future date.

Project operation

Irrigation

19. The increased irrigation supply provided by the project (72,600 acre-feet annually) would include 62,400 acre-feet for Carson Valley, 5,900 acre-feet for the Empire, Dayton, and Fort Churchill areas, and 4,300 acre-feet for the existing Truckee River Storage and Newlands projects. Approximately 2,600 acre-feet would be provided to the storage project and 1,700 acre-feet to the Newlands project.

20. In Carson Valley the 5,100 acres of full service land would experience an average annual shortage of only about 3 percent. The 30,160 acres of supplemental service land in the valley also would realize an average annual shortage of only about 3 percent compared with an existing shortage of about 30 percent. On the 6,300 acres of supplemental service land in the Empire, Dayton, and Fort Churchill areas, existing shortages, averaging about 23 percent, would be eliminated.

21. The project water provided to the Newlands and Truckee River Storage projects would be held over until dry cycles and then used to offset shortages. On the Truckee River Storage project the water would be used in a dry cycle such as the 1931-35 period and then would reduce shortages from 16 to 5.8 percent. On the Newlands project the water would be used over a period similar to the 1929-35 dry cycle and then would reduce shortages from 17.4 to 15.6 percent.

Drainage

22. The drainage program would be provided for supplemental irrigation service land, including 12,730 acres of land in Truckee Meadows under the Truckee River Storage project and 18,170 acres of land in Carson Valley. The ground water table would be lowered by the drains and artesian relief wells to be provided as part of the project, the supplementary farm lateral drains to be constructed by private interests, and the improved distribution of irrigation water which would be effected with project development. Successful operation of the drainage system in Truckee Meadows also would require improvement of the Truckee River channel proposed by the Corps of Engineers and recently authorized conditionally by Congress. Also in Carson Valley it would be necessary for farmers to remove many of the checks installed to hold back water in streams and sloughs. Only a few such checks would be required after late season irrigation was assured with project development.

23. It was not found practicable to provide drains to alleviate existing problems in the Empire, Dayton, and Fort Churchill areas. Damaging high ground water tables adjacent to the Carson River in these areas would be lowered, however, as a result of flow regulation provided by the project. The existing drainage system of the Newlands project is being extended and improved by the Truckee-Carson Irrigation District and would not be affected by the Washoe project development.

Power

24. The Calvada and Watasheamu powerplants to be constructed as a part of the Washoe project would produce an average of 95,871,000 kilowatt-hours of energy annually. Approximately 91,866,000 kilowatt-hours of the energy would be available for marketing and 4,005,000 kilowatt-hours would be lost in transformation and transmission. The marketable energy would be sold at an average rate of 9 mills a kilowatt-hour.

25. The project would decrease the output at existing plants of the Sierra Pacific Power Company by about 4,500,000 kilowatt-hours annually. The company would be compensated for its losses in production, probably by a lump sum payment. Such a payment has been included in the estimated cost of power features. The project is expected to increase production at the existing Lahontan powerplant by about 1,243,000 kilowatt-hours annually but this increase has not been taken into account in the project analyses.

Flood Control

26. The Washoe project would reduce floods along the Little Truckee and Truckee Rivers below Stampede Reservoir, including the Reno-Sparks area; along the Carson River; and along the East Fork of the Carson River below Watasheamu Reservoir. Further reductions of floods along these reaches of the rivers and reductions of floods at Lake Tahoe could be accomplished with the conditionally authorized Truckee River channel improvement planned by the Corps of Engineers and with developments outlined in paragraph 47.

27. The Washoe project's reduction of flood flows would be accomplished through coordinated operation of new and existing reservoirs. Inviolate storage space would be reserved for rain floods during the rainy season, from November through March. Storage space would be evacuated for snowmelt floods when heavy spring discharges were threatened. Water released to provide the regulatory capacity needed would be conserved in another reservoir lower on the river system for subsequent use in irrigation and power production.

Other Project Purposes

28. The National Park Service and the Forest Service recognize an important recreational potential at the Stampede Reservoir. The minor seasonal fluctuations of water surface elevation, suitable sites for recreational facilities, pleasant views, nearness to population centers, and access by good roads all foretell intensive recreational use.

29. The project effect on fish and wildlife resources can be definitely appraised only when final structural designs and operating criteria are determined. It is planned that a fish ladder be constructed at the

...Dam. Whenever justified protective devices for wildlife such as ... crossings on canals and appropriate fences would be provided at proj... facilities and water releases from reservoirs would be made to pro... fish. Through continued cooperation of the Fish and Wildlife Service with the Fish and Game Commissions of California and Nevada and with the Bureau of Reclamation, such adaptations as are justified will be made in project plans to best protect and enhance fish and wildlife values.

...40. Various aspects of the Washoe project would contribute to pub... health. The lowering of ground water tables by project drains and by ... regulation would eliminate areas of pollution and mosquito breed... and would facilitate sewage disposal. The increase in minimum stream ... in sections of the Truckee and Carson Rivers would also benefit ... disposal.

Water Rights

...41. Rights to store or divert any water for the Washoe project would ... established through appropriate applications to the California and ...vada State Engineers. In order that the most economical use of the water ... the entire project area may be effected, agreements would be required ... users of both Truckee and Carson River waters for modification of cer... established water rights and for exchanges of water among the various ... Among agreements that would be required are those mentioned below.

1. An agreement for modification of the Truckee River Agreement of 1935 and the Truckee River Final Decree of 1944 to permit exchanges of storage water among and releases from Lake Tahoe, Boca, and Stampede Reservoirs without materially reducing flows of the Truckee River at Iceland below the Floriston Rates.

2. A stipulation for the entry of a decree on the Carson River to provide a water right for the Newlands project of not to exceed 424,100 acre-feet of gross irrigation diversions annually from all sources of supply.

3. An agreement with the Truckee-Carson Irrigation District to permit temporary storage in Stampede and Watasheamu Reservoirs of water which otherwise would be stored in Lahontan Reservoir. (Water thus stored would ordinarily be released during the nonirrigation season but would also be subject to call to supply irrigation needs within established rights for Newlands project lands.)

4. An agreement by water users in the Carson Valley to limit their diversions of water to ideal irrigation requirements.

Cost Estimates

32. Federal construction costs of the Washoe project are estimated at $41,458,000 and annual operation, maintenance, and replacement costs of features to be Federally constructed are expected to amount to $210,540. The construction costs are based on July 1954 prices. Annual costs of power features are based on July 1954 prices while costs of other features were estimated on the projected price level of 180 (1939=100). Replacement costs were computed for a 50-year period on a sinking fund basis at 2.5 percent interest.

33. Construction costs and annual operation, maintenance, and replacement costs for individual project features to be Federally constructed are itemized below.

Estimated cost of Washoe project features

Feature	Construction cost 1/	Annual operation, maintenance, and replacement costs
Stampede Reservoir and Dam	$7,920,000	$8,900
Watasheamu Reservoir and Dam	10,050,000	10,800
Calvada Regulatory Reservoir and Dam	993,000	2,230
Dressler Diversion Dam and Afterbay	1,081,000	2,600
Stampede tunnel	8,867,000	5,690
Calvada penstock and surge tank	2,133,000	15,900
Carson Canal	1,193,000	7,400
Allerman Canal enlargement and extension	855,000	6,300
Laterals	912,000	10,300
Drains		
Truckee Meadows	1,385,000	7,000
Carson Valley	1,494,000	7,700
Calvada powerplant 2/	2,101,000	55,050
Watasheamu powerplant	1,662,000	43,900
Calvada substation and transmission system	378,000	15,170
Watasheamu substation and transmission system	434,000	11,600
Total	41,458,000	210,540

1/ Costs shown do not include interest during construction.

2/ Cost of Calvada powerplant includes lump sum payment to Sierra Pacific Power Company for decrease the project would cause in generation at the company's plants.

Economic Analyses

Cost allocations

34. Federal costs of the project have been allocated to irrigation and drainage, to power, and to flood control by the separable cost-remaining benefits method. Costs of interest during construction have been included in the reimbursable power allocation but excluded from the irrigation and drainage and flood control allocations. The allocations made are shown in the tabulation below.

Cost allocations

Purpose	Construction cost	Reimbursable interest during construction	Reimbursable investment	Average annual operation, maintenance, and replacement costs
Irrigation and drainage	$17,391,000	--	$17,391,000	$51,130
Power	18,247,000	$720,000	18,967,000	152,850
Flood control	1/ 5,820,000	--	--	1/ 6,560
Total	41,458,000	--	36,358,000	210,540

1/ Nonreimbursable.

Project repayment

35. [illegible] allocated [illegible] irrigation and drainage allocation [illegible] while the power allocation would be [illegible] power revenues in excess [illegible] costs would be used [illegible] of the irrigation [illegible] allocation after payment [illegible]

Irrigation and Drainage Repayment

36. Irrigation and drainage interests would pay their annual operation, maintenance, and replacement costs and would pay toward construction costs for a period of 50 years. Payments toward construction costs would be started after suitable development periods, ranging up to 8 years, on various land areas. The payments would vary for the different types of service land. Water users on full irrigation service land would pay at the rate of about $3.75 an acre and water users on supplemental irrigation service land would pay about $1.65 an acre-foot. Farmers would pay approximately $1.65 an acre for drainage in Carson Valley and about $2.20 an acre for drainage in Truckee Meadows. At the estimated rates of payment the irrigation and drainage interests would pay a total of about $163,600 a year. Thus in 50 years they would contribute $8,180,000 toward the irrigation and drainage allocation. The remaining portion of the allocation, amounting to $9,211,000, would be paid from net power revenues accruing in the 14-year period after payment of the power allocation was completed.

the irrigation and drainage repayment would be completed in 52 years after the close of the last development period.

Power Repayment

37. With marketable energy sold at an average rate of about 9 mills a kilowatt-hour, power revenues would amount to $826,795 annually. These revenues would pay power's full operation, maintenance, and replacement costs and within 50 years would pay off power's total allocation of construction costs with an interest rate of 2.5 percent on the unamortized balance. The interest, amounting to a total of $14,734,000, would be returned to the Federal Treasury. Net power revenues that would accrue for 14 years after repayment of the power allocation, amounting to $9,211,000, would be used to pay the portion of the irrigation and drainage allocation that could not be paid by the irrigation and drainage interests. In the last year of project repayment, surplus revenues of about $428,000 would be accrued.

Summary of Repayment

38. Anticipated returns on Federal construction costs are shown in the summary below.

Nonreimbursable cost		
Flood control allocation		$5,820,000
Repayment of reimbursable cost		
Irrigation and drainage allocation		17,391,000
From irrigation and drainage interests	$8,180,000	
From net power revenues (accruing after payment of power allocation)	9,211,000	
Power allocation (repaid from power revenues)		1/18,967,000
Total repayment		36,358,000
Interest on power allocation returned to Treasury		14,734,000
Earned surplus in last year of project repayment		428,000

1/ Costs include interest during construction

39. Water conservancy districts similar to those authorized by the laws of Colorado and Utah would be the most desirable entities to contract with the United States for repayment of reimbursable costs. Such districts would have the broad powers necessary to coordinate the various purposes and divergent interests of the project. Neither Nevada nor California yet has laws authorizing the formation of conservancy districts. The early enactment of such laws, particularly in Nevada, would be an aid to water resources development.

Benefit-cost analysis

40. Evaluated benefits from the overall Washoe project would compare with the attendant Federal costs in a ratio of 1.8 to 1 over a 100-year period of analysis beginning with the first year of full project operation. Benefits from each purpose of the project would exceed the attendant costs. The comparison of benefits and costs was made by computing both benefits and costs for each purpose of the project as average annual equivalents at 2.5 percent interest over a 100-year period.

41. Analyses made to date indicate that a total average annual benefit value of $2,900,000 would be realized over a 100-year period. This value includes $1,530,000 from irrigation and drainage, $1,081,100 from power production, and $288,900 from the project's control of flood flows. Incidental benefits are expected to result from recreation, mosquito abatement, and improvement of sanitary conditions. Fish and wildlife benefits may also be realized.

42. Annual equivalent costs of the Washoe project are expected to average $1,619,010 over a 100-year period. Approximately $535,830 of the annual equivalent costs would be attributable to irrigation and drainage, $913,920 to power, and $169,260 to flood control. The annual equivalent costs include an allowance for amortizing over the period of analysis the allocation of Federal construction costs made to each project purpose and include each purpose's share of the annual operation, maintenance, and replacement costs of Federally constructed facilities.

Alternative Plans and Ultimate Development

43. After construction of the Washoe project as outlined in this report, potentialities still would exist for substantial further development of Truckee and Carson River waters for irrigation, power generation, flood control, and other purposes. In the project area 115,300 acres of arable land would still need water, including 98,400 acres without any irrigation supply. Various possibilities for developing new water supplies for some of these lands or of transferring developed supplies from places of less efficient use are worthy of further study and could lead to a favorable plan for modifying and expanding the Washoe project. Any plan for expansion, however, would require full cooperation of river and reservoir operations and would depend on whether an agreement permitting such operation could be reached by the various water users and landowners affected. The magnitude of the plan would depend on the results of further investigations concerning water requirements for the Newlands project.

44. Since existing water shortages on the Truckee River Storage and Newlands projects are within permissible limits, the water that would be provided in the Washoe project to firm the supplies of the existing projects could be used to irrigate a substantial amount of nonirrigated land located elsewhere.

45. Water supply studies made for the Washoe project allowed prior water rights for the Newlands project on the basis of existing irrigation efficiencies for 70,000 acres of land. Rough studies show, however, that the irrigation efficiencies could be increased to make the same water supply serve a larger acreage. Any irrigation water made available through increased irrigation efficiencies could be utilized on additional arable lands in the Newlands project area or on other arable lands.

46. Long-time holdover storage could be provided by construction of the potential Washoe Reservoir at the site of the existing Washoe Lake and the potential Hope Valley Reservoir on the West Fork of the Carson River. These reservoirs would conserve for use in irrigation and hydroelectric power production the Truckee and Carson River flows remaining unused after full economical development of the Newlands and Washoe projects. Some Lake Tahoe storage would be transferred to Washoe Reservoir to reduce flood damages at the lake. Facilities would be constructed for generation of hydroelectric energy and appropriate water distribution works would be provided.

47. In order to reduce flood damage the maximum water surface elevation at Lake Tahoe could be reduced by a transfer of some of the lake's top storage capacity to Washoe Reservoir, as mentioned in the preceding paragraph. A reduction in the active storage requirement at Lake Tahoe might also be realized through reduced irrigation demands on the Newlands project provided the water saved were not transferred to other lands. A reduction in the required storage capacity at the lake might also result if the supplemental water intended to be furnished by the Washoe project to Truckee River Storage and Newlands project lands were eliminated from the plan. To the extent that such elimination would reduce storage requirements at the Stampede and Watasheamu Reservoirs, capacity would be provided to replace present storage space at Lake Tahoe. Some flood damage at Lake Tahoe might be prevented without reducing the present active storage capacity by lowering both the maximum and minimum permissible water surface elevations to the position where the least shoreline damage would result from lake level fluctuations between the two limits.

Conclusions

48. The Washoe project plan is a practicable means of obtaining beneficial utilization of surplus surface and ground water in the Truckee and Carson River Basins. It is coordinated with existing projects and additional potentialities for future development. Successful operation of the project is dependent on improvement of the Truckee River channel as planned by the Corps of Engineers and as authorized by Congress in 1954.

49. The Washoe project would have a benefit-cost ratio of 1.8 to 1, with consideration given only to benefits from irrigation and drainage, power production, and flood control. A higher ratio of benefits to costs

would be realized with consideration given to the benefits to recreation, mosquito abatement, and sanitation that are anticipated from the project and to possible benefits to fish and wildlife.

50. Reimbursable Federal costs of the project would be returned to the Treasury in a period of 50 years following appropriate development periods for project lands. Water conservancy districts similar to those authorized by the laws of Colorado and Utah would be the most desirable entities to contract with the United States for repayment of reimbursable costs. The early enactment of laws authorizing the formation of such districts in Nevada and California would be an aid to project development.

Recommendations

51. It is recommended:

1. That the plan of development of water resources described in the report be approved;

2. That authority be sought for the Secretary of the Interior, acting pursuant to the Federal reclamation laws (Act of June 17, 1902, 32 Stat. 388, and acts amendatory thereof or supplementary thereto), to construct, operate, and maintain the works required for the Washoe project as described in this report, with such modifications of, omissions from, and additions to the works as the Commissioner of Reclamation, with the approval of the Secretary, may find proper; provided that no construction shall be commenced until:

(a) A contracting entity satisfactory to the Secretary has been organized;

(b) An agreement with the project power customer or customers has been made which will assure payment for power and energy sold at rates approved by the Secretary; and

(c) Necessary agreements are made for river and reservoir operation including, but not necessarily limited to, those mentioned in paragraph 31 of this letter;

3. That land drainage be considered a component of the irrigation plan and that costs allocated jointly to irrigation and drainage be reimbursable without interest;

4. That the Secretary, upon consideration of all appropriate factors, shall determine what part of the estimated construction costs allocated to irrigation and drainage shall be paid by the owners of the lands benefited in annual installments over a period of 50 years and that costs so allocated in excess of such amount shall be paid from net revenues from the sale of project power after the costs allocated to power have been repaid with interest.

E. O. Larson

Local economy

Agriculture is the major industry of the project area with cattle ranching and the production of livestock feed providing most of the farm income. Agriculture, however, is dependent on irrigation and thus is limited by the available water supplies.

Because of its position on the Nation's transcontinental routes, the area receives considerable revenue from the maintenance of transportation facilities and from servicing operations. Lumbering and associated activities also are important sources of income. Pine and fir are harvested on the Sierra Nevada slopes and the timber is processed at Reno and Truckee.

Tourists contribute substantially to the economy of the area. Thousands of visitors are drawn to the area each year by scenic attractions and legalized gambling. Lake Tahoe, rimmed by cabins and resorts, is one of the most popular vacation spots in the West. Hunting and fishing opportunities in the project area are claimed to be among the best in the Nation and stimulate local sports-equipment and related businesses.

Mining and processing of mineral resources, once the chief enterprise in the project area, are now of relatively minor economic importance. The area still has known reserves of silver, gold, copper, lead, and tungsten. The deposits, however, are difficult to mine and the present mining enterprises are small. The rich veins of silver and gold, which started the boom of the late 1800's, are exhausted.

Water Development

Municipal systems

With the exception of a few small towns, the communities and rural districts in the project area receive domestic water of adequate quantity and quality from streams, springs, and wells. Most of the agricultural communities and the recreational areas are served through small private developments. Fallon has a local municipal development. Reno and Sparks are served by the Sierra Pacific Power Company which has direct flow rights to Truckee River water as well as storage rights for municipal purposes at Independence Lake. Reno also obtains water from nearby wells and from Hunter Creek, a small tributary of the Truckee River.

Existing reclamation projects

The area's agricultural enterprises have been made possible by numerous small reclamation developments constructed by private interests and by the large Newlands and Truckee River Storage projects constructed by the Bureau of Reclamation. The Bureau projects are briefly discussed in the following paragraphs.

The Truckee River Storage project, constructed in 1937-39, consists of the 40,900-acre-foot Boca Reservoir on the Little Truckee River. This reservoir regulates water of the river for supplemental irrigation of about 26,800 acres of land in Truckee Meadows near Reno. Water is distributed from the reservoir through canals and laterals constructed by various irrigation organizations and individuals prior to the project development. The Washoe County Water Conservation District operates Boca Reservoir and is repaying the project construction costs under a contract with the United States made in 1936.

The Newlands project, constructed in 1903-15, utilizes water of both the Truckee and Carson River systems for irrigation, principally in the lower Carson area, and for hydroelectric power production. Truckee River water is regulated in 732,000 acre-feet of capacity provided at Lake Tahoe by a small dam at the lake outlet. Since construction of the Truckee River Storage project, some Little Truckee River water utilized under the Newlands project has been regulated in Boca Reservoir. Water of the Truckee River for the Newlands project is diverted into the Truckee Canal by the Derby Dam on the main stem of the river. Part of the water is used on lands adjacent to the canal and part is conveyed 31 miles to the Carson River where it is regulated along with flows of the Carson River in the 290,900 acre-foot[1] Lahontan Storage Reservoir. Releases from the reservoir, as well as some direct releases from the Truckee Canal, pass through the Lahontan powerplant at the base of the dam and then are distributed for irrigation use. Distribution of irrigation water is made through a series of canals constructed as a part of the project.

From 1905 when water was first delivered until 1927, the Newlands project was operated by the Bureau of Reclamation. On December 8, 1926, the Truckee-Carson Irrigation District entered into a contract with the United States for operation of the project and for payment of construction costs. At present the district is obligated to provide water to about 70,000 acres either through rights antedating the project or accepted applications for project water. All of the 70,000 acres are commonly referred to as being under water right contract.

[1] Capacity of the reservoir has been increased from 273,600 acre-feet to 290,900 acre-feet through the use of 20-inch flashboards placed on top of the existing concrete spillway crests.

CHAPTER VII

AGRICULTURAL ECONOMY

As a basis for estimating the farmers' ability to repay project [illegible] studies were made of anticipated conditions without and with project development. The studies were based on actual records of farming [illegible] in the project area.

Without Project Development

Crops and livestock

Agricultural development in the project area consists primarily of [illegible] and cattle ranching. About 40 percent of the farms are dairy [illegible] and 15 percent are beef ranches. The remaining 45 percent are [illegible] farms, small subsistence farms, sheep farms, or combination [illegible] beef, and sheep enterprises. Although beef ranches comprise only [illegible] of the area's farms, they account for a significant part of [illegible] area's total farm income.

Nearly all lands in the project area are utilized for the production [illegible] to support the livestock industry. Most of the irrigated lands [illegible] adequate drainage but late-season water shortages produce alfalfa, [illegible] barley, oats, and rotation pasture. Some small irrigated tracts [illegible] adequate drainage are used for potatoes, onions, and truck crops. A [illegible] areas produce hardy fruits such as apples, plums, and pears. Lands [illegible] drainage deficiency are generally limited to permanent native pasture, meadow hay, and other low-nutrient feed crops. The nonirrigated [illegible] provide only limited grazing.

The feed crops produced in the area are nearly all consumed locally. [illegible] the dairy and truck crops are marketed at Lake Tahoe and Reno. [illegible] all beef cattle leaving the area are sold in California.

Farms and farmers

About 290 farms are located in the project area, exclusive of farms [illegible] Truckee River Storage and Newlands projects that would receive only [illegible] amount of supplemental water from the Washoe project in occasional [illegible] cycles. The farms vary greatly in size. Some subsistence or part-[illegible] farms, particularly in the area to be drained in Truckee Meadows, are [illegible] of only a few acres. A few beef ranches in Carson Valley contain [illegible] a thousand acres of irrigated crop land and irrigated pastures. In [illegible] these ranches utilize extensive mountain and desert range lands. [illegible] in various farm holdings in the project area are itemized on the following page.

Range in size	Number of farms
Less than 50 acres	90
51 to 100 acres	60
101 to 160 acres	50
161 to 320 acres	60
320 acres and over	30
Total	290

A considerable portion of both the irrigated land that would receive [illegible]mental water from the project and the new land that would be served [illegible] held in large ownership patterns that present a problem in view of [illegible] acreage limitation established by reclamation law. The project could [illegible] operate as planned if owners of the large holdings were prohibited [illegible] purchasing water for their land or if they refused to dispose of [illegible] in excess of acreages serviceable under the law. Some of the large [illegible]owners have indicated a willingness to make such adjustments as are [illegible]ary for them to participate in the project. The attitude of all of [illegible] landowners cannot be determined at this time but must be ascertained [illegible] in definite plan studies before construction is undertaken.

Nearly all the arable lands of the project are in private ownership. [illegible] only 8 percent of the farm operators were tenants. Few farmers [illegible] their farms.

Fiscal aspects

[illegible]essed valuations of cultivated lands in the project area range [illegible] about \$40 to \$80 an acre, and the valuations of nonirrigated grazing [illegible] vary from \$2 to \$6 an acre. Actual farm values are about \$125 to [illegible] an acre for cultivated land and about \$5 to \$20 an acre for nonirri[illegible] grazing land. The average tax rate levy for 1950 was about 45 mills.

Approximately 45 percent of the farms in the project area are mort[illegible] with the farm debt amounting to about \$2,000 for each farm mortgaged. [illegible]rrigation companies in the area are essentially free of indebtedness [illegible] for money owed to the Government for construction of the Newlands [illegible] [illegible]ckee River Storage projects. Payments for these projects are on [illegible].

With Project Development

Crops and livestock

[illegible]cause of climatic conditions, no change in the area's basic economy [illegible] result from project development. With the project, cattle ranching [illegible]rying would continue to be the main farm enterprises and most of [illegible] lands still would produce feed crops to support the livestock [illegible]y. With project development, however, crop yields would be realized

VII

first time on full service lands, and yields would be substan- increased on supplemental service lands. On drainage service alfalfa, wheat, barley, oats, and rotation pastures would be sub- for low-value wild meadow hay and permanent pastures. The feed as a result of the project would permit an expansion of the industry. Numbers of cattle maintained on existing farms would be increased, but beef operations are not expected to expand with project development as their growth is restricted by limita- available range lands.

Settlement

...proximately 40 to 50 new farms would be established on the 5,100 ... land to be brought under irrigation. Most of these farms would ... units. To provide an adequate standard of living and meet repay- ...ges, each unit would require approximately 80 acres of class 1 ... acres of class 2 land, or 110 acres of class 3 land.

Farm improvements

...provements required with project development would differ in vari- ... of the project area. Little more than cleaning or rehabilitat- ...isting farm laterals and control structures would be required on ...ntal service lands. For efficient use of the project water, the ... service lands would require construction of farm lateral drains ...ying amounts of leveling and ditch construction. The full irriga- ...ice lands would have to be cleared of sagebrush and would require ... and canal and lateral construction. Also on the full service ... farm buildings would have to be constructed, equipment obtained, and ... made for a domestic water system.

Development period

...velopment periods of varying lengths would be required after the ...livery of project water and before the irrigators were assessed ...ation costs. On supplemental service lands, a 2-year development ... would be required. A 5-year period would be needed on drainage ser- ..., and an 8-year period would be desirable for full irrigation ...lands. These development periods would be necessary to give farm- ... to establish new farmsteads, make necessary improvements in irri- ...stribution systems, and attain full crop production before paying ...tion charges. No development period would be necessary for lands ...ing projects which would receive project water only during dry

Local support

The Washoe project has the support of the local population. It has ... endorsed by the cities of Reno and Sparks and by prominent groups of

RECOMMENDATIONS

169. It is recommended that:

(1) In accordance with operation and flow data provided by the Bureau on which this report is based the scheduled minimum mean monthly streamflows be provided at the four project-controlled structures listed below, and further that instantaneous minimum releases from these structures be as follows:

(a) Calvada Regulatory Dam, 100 second-feet.

(b) Derby Dam, 35 second-feet (if possible, into Pyramid Lake).

(c) Watasheamu Dam, 35 second-feet.

(d) Dressler Diversion Dam, 80 second-feet.

(2) Studies and negotiations be conducted cooperatively by the Bureau of Reclamation, the Service, the California Department of Fish and Game, and the Nevada Fish and Game Commission to:

(a) Devise criteria for annual scheduling of releases from Lake Tahoe in relation to predictions of yield which will provide as large a continuous streamflow as possible consistent with the best water-conservation practice, and

(b) Secure an operating agreement among all interested agencies providing for the release of water from the lake on the schedules resulting from the application of the devised criteria.

(3) Changes in rates of release from the project control structures be gradual and minimal consistent with operational demands of tho project.

(4) A fish ladder or other facilities providing for upstream passage of trout be installed at Calvada Regulatory Dam.

(5) Releases of water to streamflow in the Little Truckee River be made from Stampede Dam at rates proportional to the predicted annual runoff of the contributing watershed so as to provide in years of predicted normal runoff a minimum instantaneous flow of 12 second-feet at a point one-fourth of a mile downstream from Stampede Dam. Scheduling of releases should be correlated with those from Lake Tahoe.

(6) Releases to streamflow below Derby Dam include all water decreed to lands located downstream from this point.

(7) Preliminary study be given by the planning agency to the feasibility and design of fish screens for the several project dam outlets and diversions.

(8) The Bureau of Reclamation continue to cooperate with the Nevada Fish and Game Commission in the establishment of a fish-cultural station in connection with either the Calvada Powerplant or Watasheamu Dam as desired by the Commission.

(9) The flume and the lined portion of the Carson Canal be fenced to prevent losses resulting from attempted crossings of these canal sections by deer.

(10) Earth-covered bridges be constructed at points throughout the length of the Carson Canal, the locations for which should be determined as the result of detailed study upon completion of the project.

(11) A study be made by the California Department of Fish and Game, the Nevada Fish and Game Commission, and the Service to determine wildlife habitat improvement measures that might be applied in cooperation with the Bureau of Reclamation to the peripheral reservoir lands.

(12) Any future negotiations involving the allocations of waters for irrigation purposes within the project area give full consideration to the water needs of the Stillwater and Fernley Wildlife Management Areas.

(13) Federal lands and project waters in the project area be open to free use for hunting and fishing except for sections of Federal and State wildlife management areas which are closed to hunting and areas reserved for safety, efficient operation, or protection of public property.

(14) The report of the Bureau of Reclamation include the preservation and propagation of fish and wildlife resources among the purposes for which the project is authorized.

CONCLUSIONS

170. It is concluded that the plan for the improvement of the Little Truckee and Carson Rivers as outlined in this report will be beneficial to fishery resources in the amount of $11,000 annually, and detrimental to wildlife resources in the amount of $8,000 per year. This conclusion is based upon the assumption that Recommendations (1), (3), (4), (7), (8), (9), (10), and (13) will be followed, and that the human populations in the project area will approximately double in the next 50 years.

171. If Recommendation (2) is followed, it is anticipated that it will be found possible to improve the flow regimen of the upper Truckee River over that considered with the Washoe Project as presently proposed. However, prior to completion of the recommended study no analysis can be made of the benefits which may result.

172. If Recommendation (5) is followed, the affected fishery resources of Little Truckee River will be preserved to the extent of about half of their existing value, or about $1,800 annually; however, as indicated in the Discussion, other intangible values of much greater importance will result from following this recommendation.

173. If Recommendation (6) is followed, the fishery resources of the lower Truckee River would be enhanced more or less in proportion to the increase in minimum flow regimen, and the fishery resources of Pyramid Lake (unevaluated) would be benefited to the

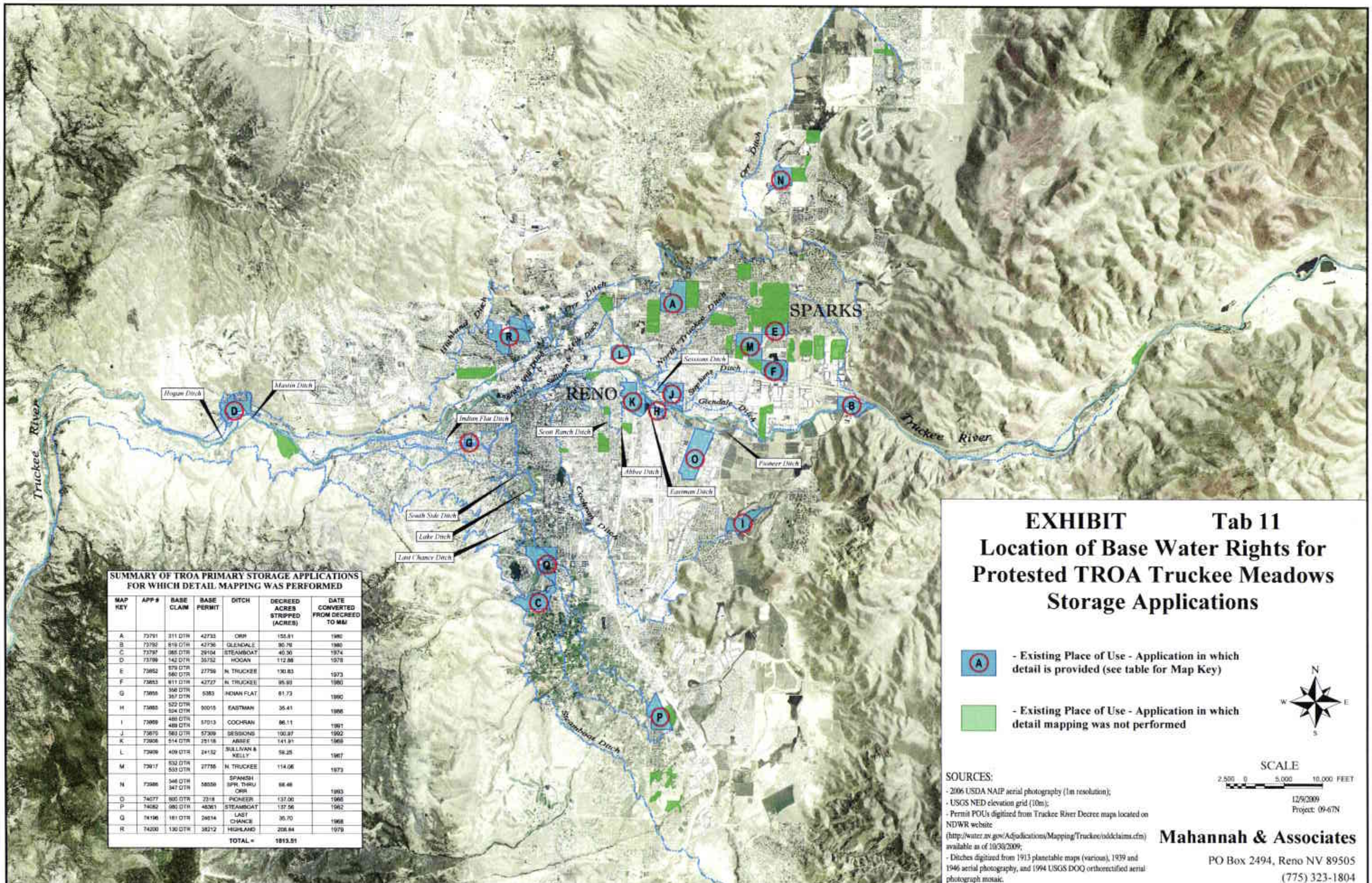
...ent that flows over their spawning areas in the river are ...mented and the life of the lake is prolonged by improvement of ...posed inflow.

174. Recommendation (11) may have the effect of reducing ... losses to wildlife resulting from inundation of habitat. The ...tent of such reduction of loss will depend largely upon the ...sibility, extent, and type of improvements made.

175. Recommendation (12) is necessary to protect the future ...velopment and operation of the Stillwater and Fernley Wildlife ...nagement Areas.

176. Recommendation (14) is designed to insure continued ...nsideration of fish and wildlife resources in the planning, ...velopment, and operation of the project.

Leo L. Laythe
Regional Director
May 12, 1954



SUMMARY OF TROA PRIMARY STORAGE APPLICATIONS FOR WHICH DETAIL MAPPING WAS PERFORMED

MAP KEY	APP #	BASE CLAIM	BASE PERMIT	DITCH	DECREED ACRES STRIPPED (ACRES)	DATE CONVERTED FROM DECREED TO M&I
A	73791	311 DTR	42733	ORR	155.61	1980
B	73792	619 DTR	42736	GLENDALE	90.76	1980
C	73797	085 DTR	29104	STEAMBOAT	40.30	1974
D	73799	142 DTR	35752	HOGAN	112.88	1978
E	73852	579 DTR 580 DTR	27759	N. TRUCKEE	130.83	1973
F	73853	611 DTR	42727	N. TRUCKEE	95.93	1980
G	73856	356 DTR 357 DTR	5383	INDIAN FLAT	61.73	1990
H	73865	522 DTR 524 DTR	50015	EASTMAN	35.41	1986
I	73869	488 DTR 489 DTR	57013	COCHRAN	86.11	1991
J	73870	563 DTR	57309	SESSIONS	100.97	1992
K	73906	514 DTR	25118	ABREE	141.91	1969
L	73909	409 DTR	24132	SULLIVAN & KELLY	59.25	1967
M	73917	532 DTR 533 DTR	27756	N. TRUCKEE	114.06	1973
N	73986	346 DTR 347 DTR	58559	SPANISH SPR. THRU ORR	66.46	1993
O	74077	600 DTR	2318	PIONEER	137.00	1966
P	74082	060 DTR	48361	STEAMBOAT	137.56	1962
Q	74196	161 DTR	24614	LAST CHANCE	35.70	1968
R	74200	130 DTR	38212	HIGHLAND	206.84	1979
				TOTAL =	1813.51	

EXHIBIT Tab 11
Location of Base Water Rights for Protested TROA Truckee Meadows Storage Applications

(A) - Existing Place of Use - Application in which detail is provided (see table for Map Key)

- Existing Place of Use - Application in which detail mapping was not performed

N
W
E
S

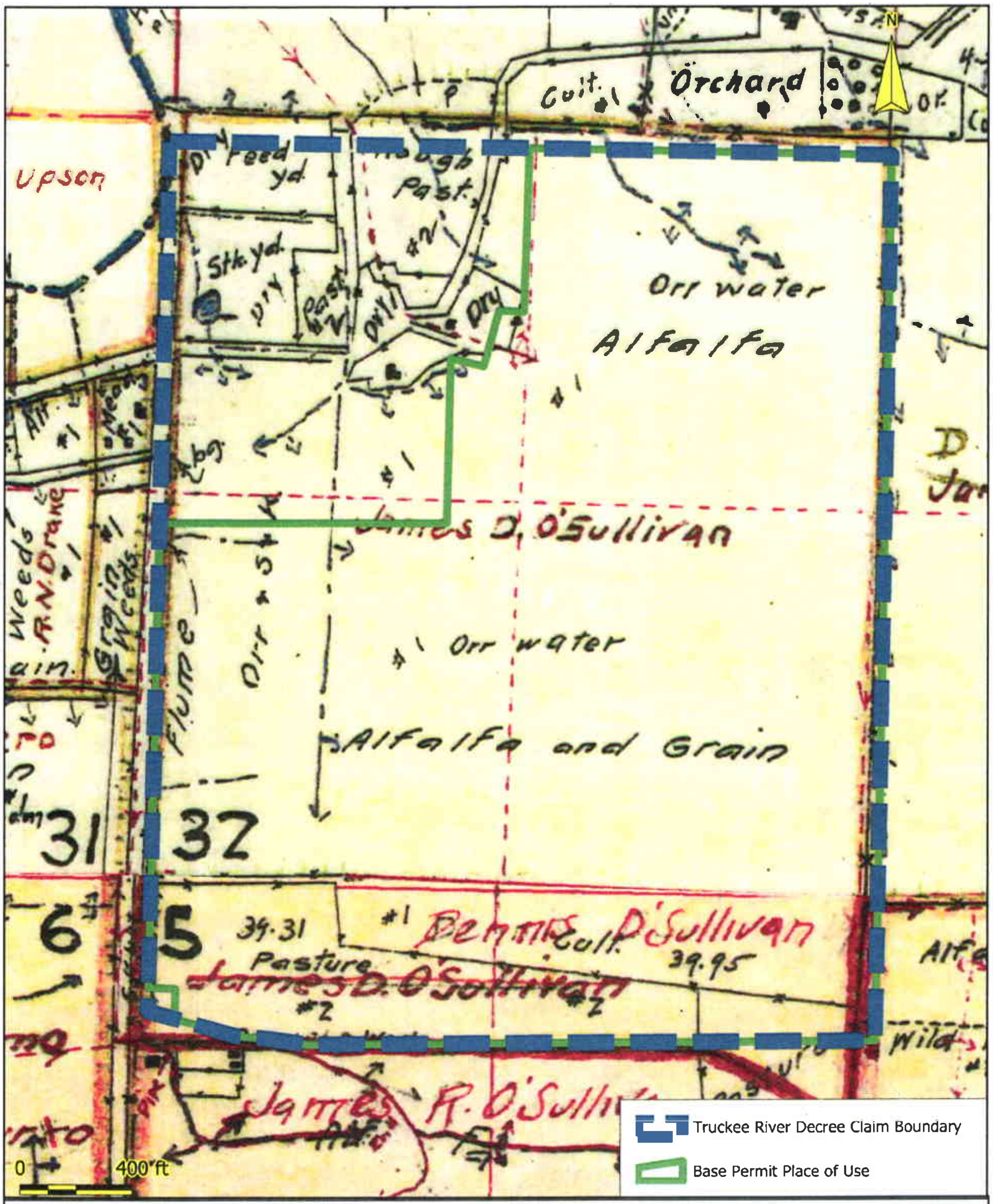
SCALE
2,500 0 5,000 10,000 FEET

12/9/2009
Project: 09-67N

SOURCES:
- 2006 USDA NAIP aerial photography (1m resolution);
- USGS NED elevation grid (10m);
- Permit POUs digitized from Truckee River Decree maps located on NDWR website (http://water.nv.gov/Adjudications/Mapping/Truckee/oddclaims.cfm) available as of 10/30/2009;
- Ditches digitized from 1913 planetable maps (various), 1939 and 1946 aerial photography, and 1994 USGS DOQ orthorectified aerial photograph mosaic.

Mahannah & Associates
PO Box 2494, Reno NV 89505
(775) 323-1804

EXHIBIT
tabbies
Tab 11



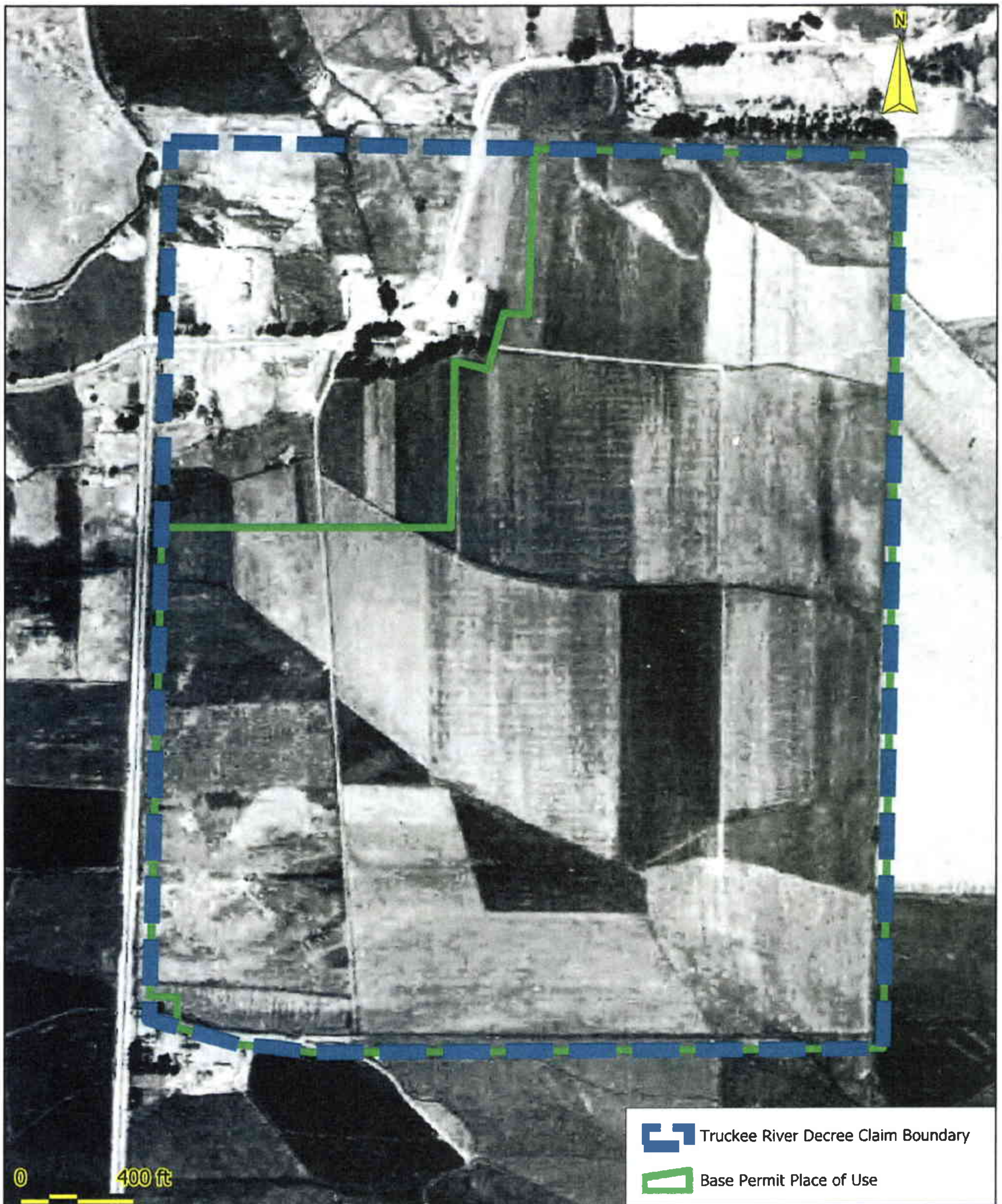
APPLICATION: 73791
BASE PERMIT: 42733
CLAIM NO.: 311
AREA: 155.81 AC
SOURCE: ORR DITCH

Detail A

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable maps, sheets 8 & 9
- Truckee River Decree map TR-062

EXHIBIT
Tab 12

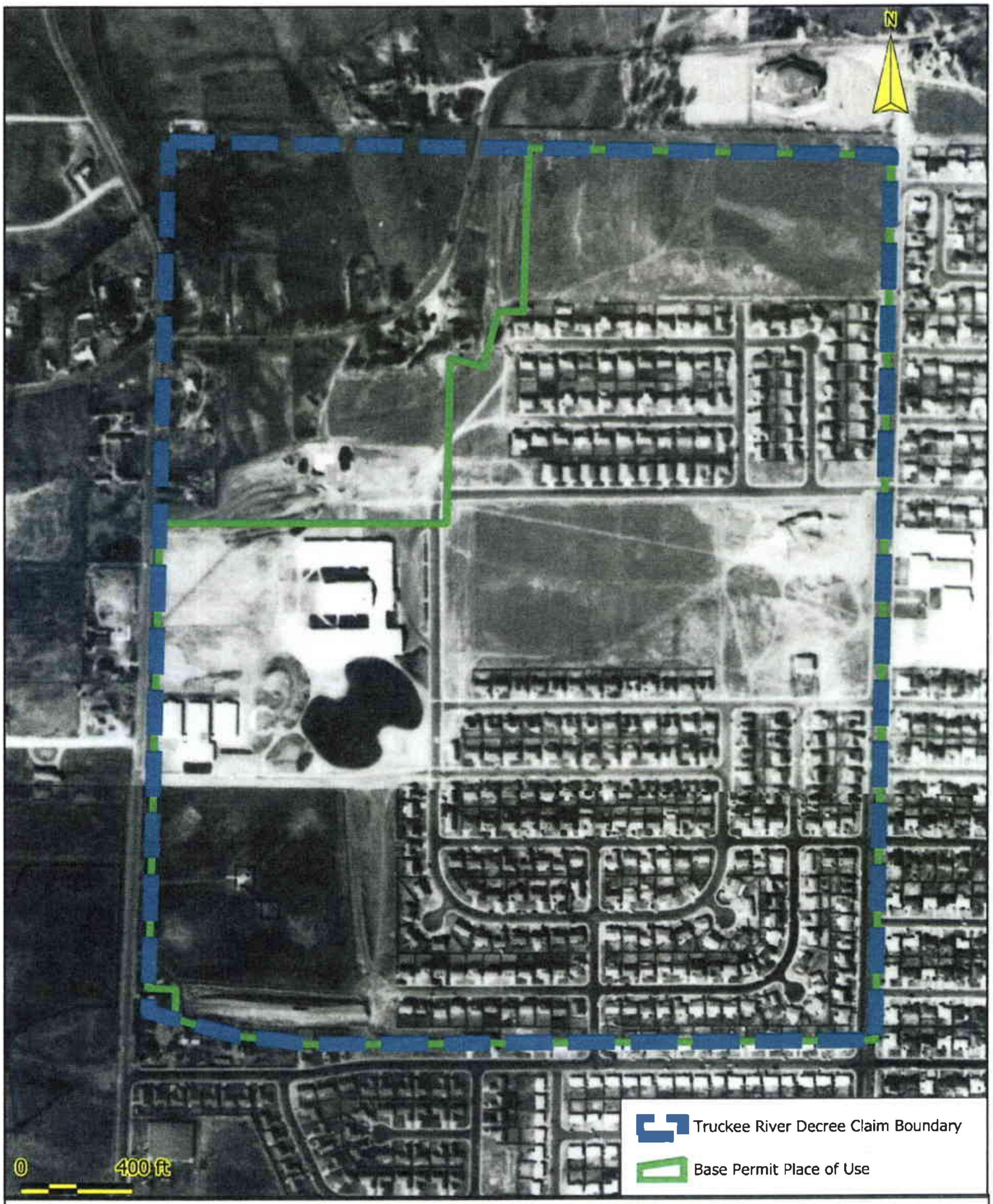


APPLICATION: 73791
BASE PERMIT: 42733
CLAIM NO.: 311
AREA: 155.81 AC
SOURCE: ORR DITCH

Detail A

SOURCES

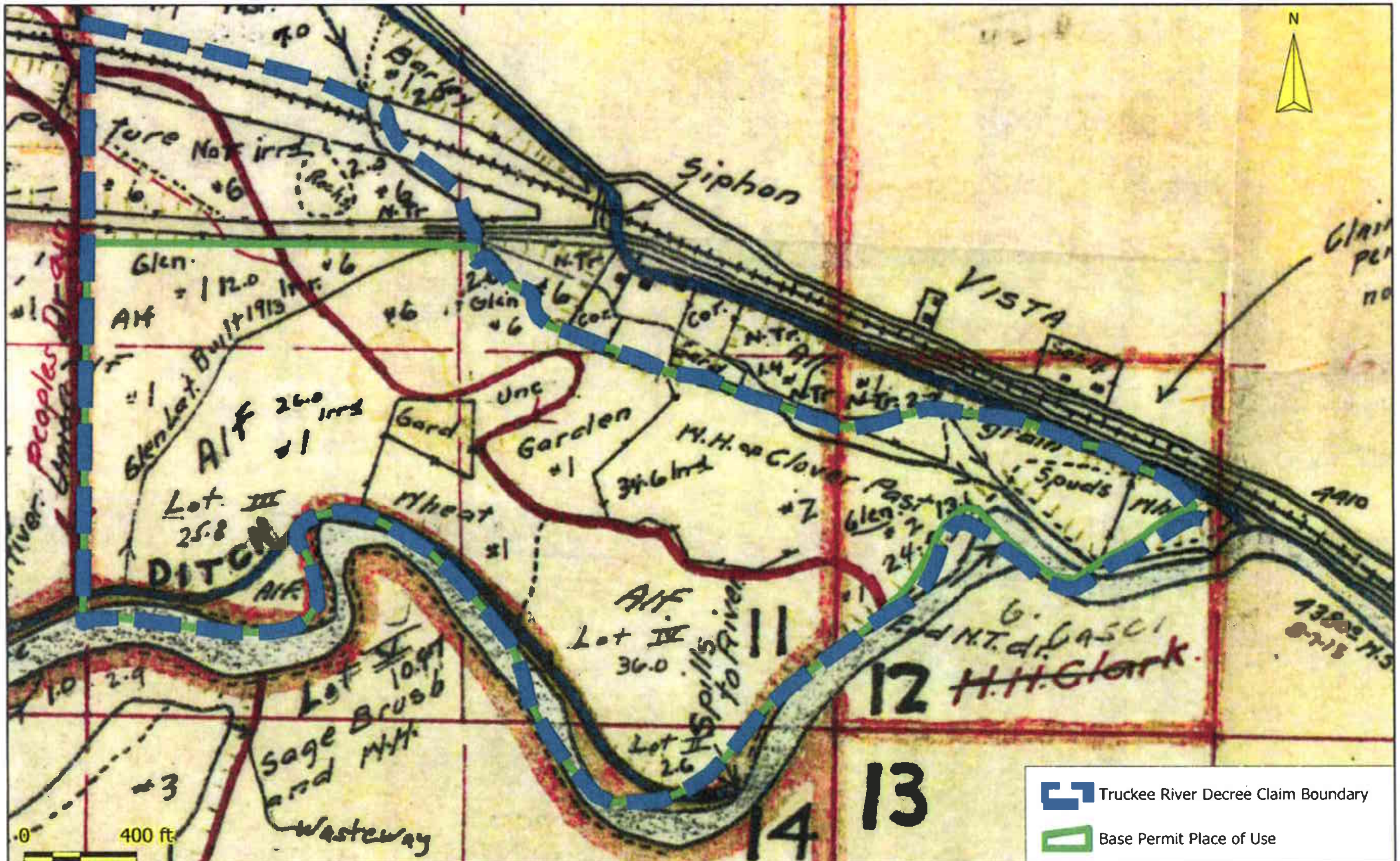
- 1939 aerial photograph USDA CDJ 18-88, 6/29/1939
- Truckee River Decree map TR-062



APPLICATION: 73791
BASE PERMIT: 42733
CLAIM NO.: 311
AREA: 155.81 AC
SOURCE: ORR DITCH

Detail A

SOURCES
- 1967 aerial photograph, FSA EW-X-2HH-35, 3/5/1967
- Truckee River Decree map TR-062



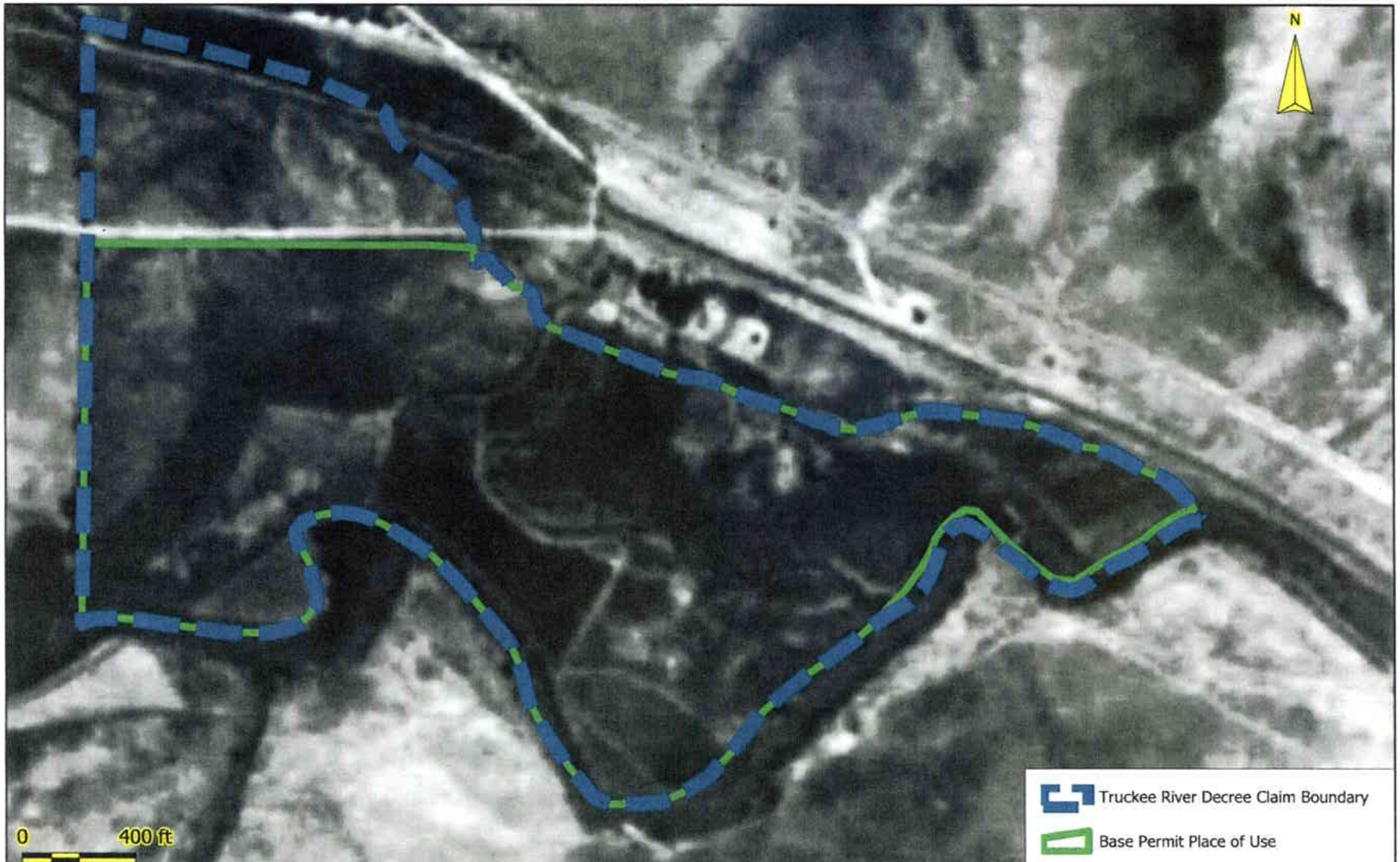
APPLICATION: 73792
BASE PERMIT: 42736
CLAIM NO.: 619
AREA: 90.76 AC

Detail B

SOURCE: GLENDALE DITCH

SOURCES
- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 15
- Truckee River Decree map TR-047

EXHIBIT
Tab B



APPLICATION: 73792
BASE PERMIT: 42736
CLAIM NO.: 619
AREA: 90.76 AC

Detail B

SOURCE: GLENDALE DITCH

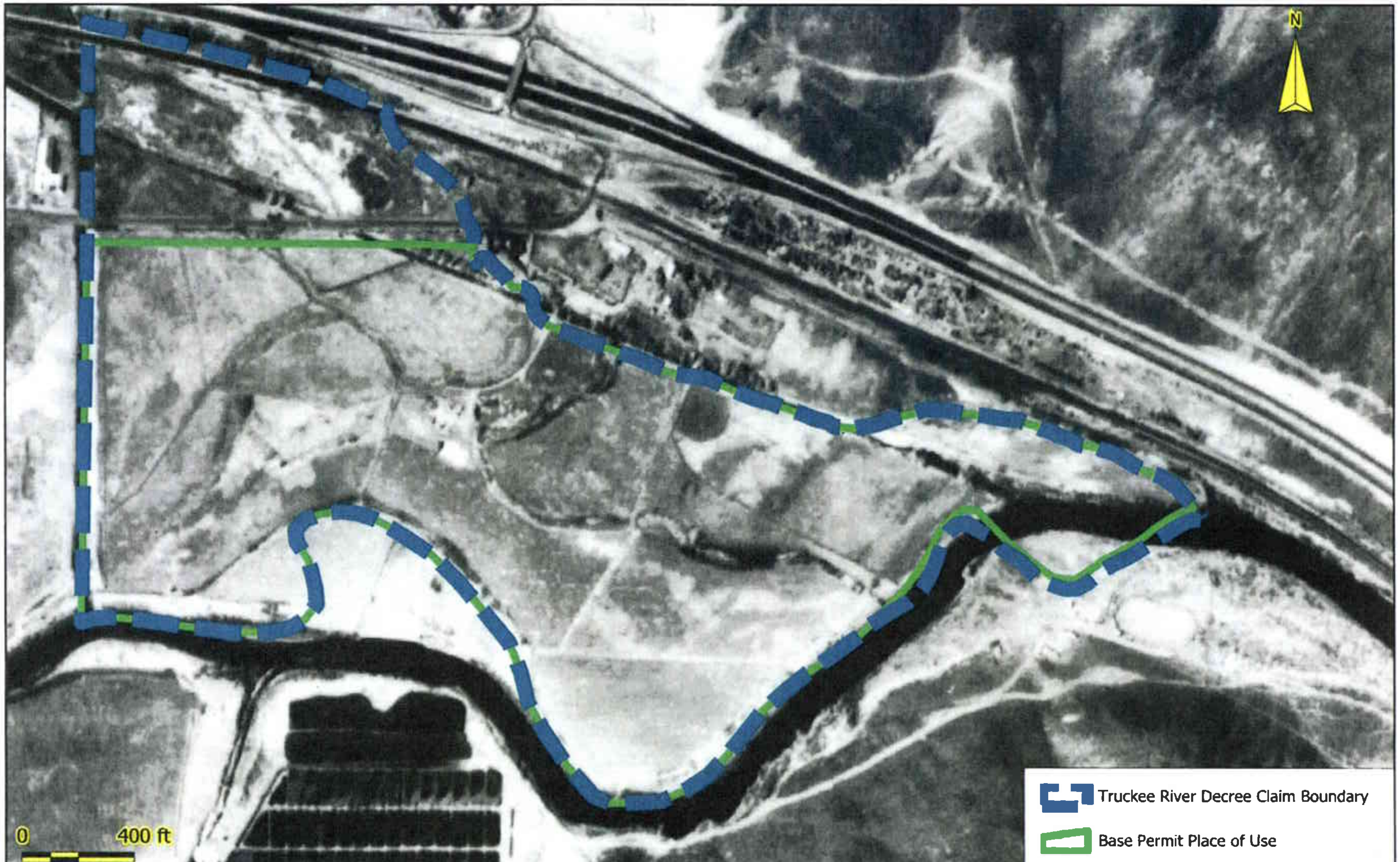
SOURCES
- 1946 aerial photograph, USGS GS-CV 2-106, 7/10/1946
- Truckee River Decree map TR-047

APPLICATION: 73792
BASE PERMIT: 42736
CLAIM NO.: 619
AREA: 90.76 AC

Detail B

SOURCE: GLENDALE DITCH

SOURCES
- 1967 aerial photograph, FSA EW-X-1HH-73, 3/5/1967
- Truckee River Decree map TR-047

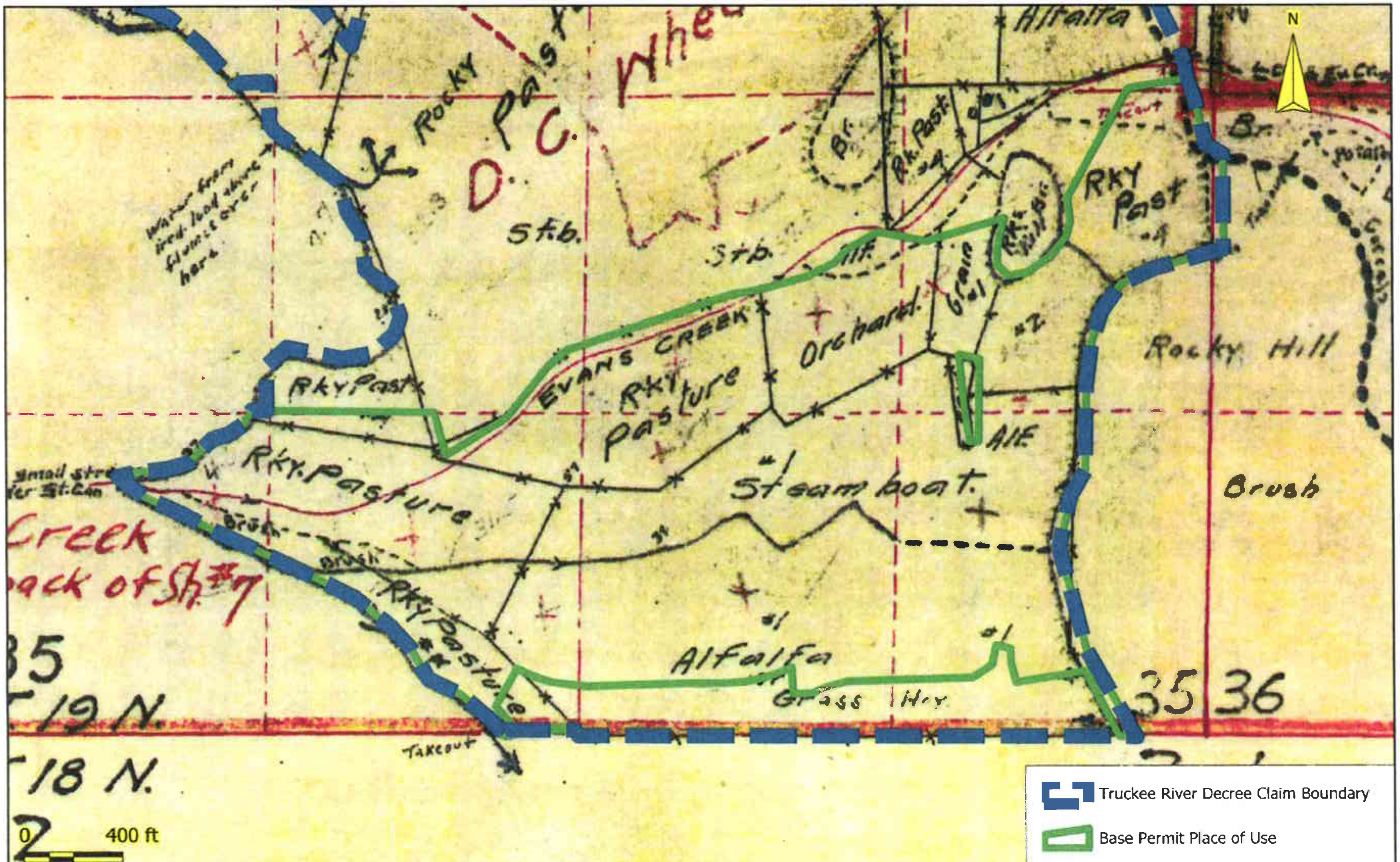


APPLICATION: **73792**
BASE PERMIT: **42736**
CLAIM NO.: **619**
AREA: **90.76 AC**

Detail B

SOURCE: GLENDALE DITCH

SOURCES
- 1977 aerial photograph, Great Basin Aerial Surveys 101005-6-9, 4/11/1977
- Truckee River Decree map TR-047



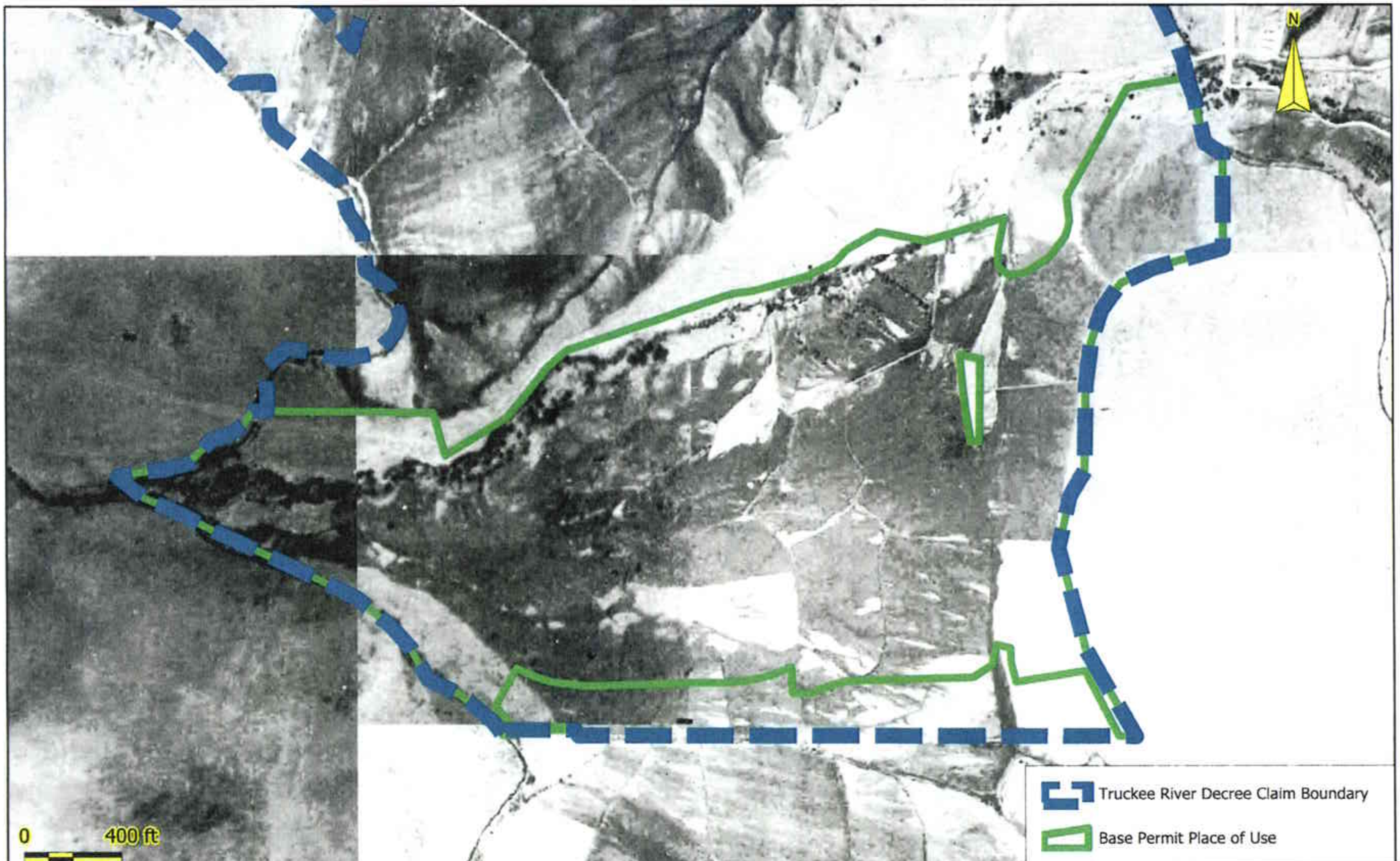
APPLICATION: 73797
BASE PERMIT: 29104
CLAIM NO.: 65
AREA: 40.3 AC

Detail C

SOURCE: STEAMBOAT DITCH

SOURCES
- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 6
- Truckee River Decree map TR-057

EXHIBIT
Tab 14

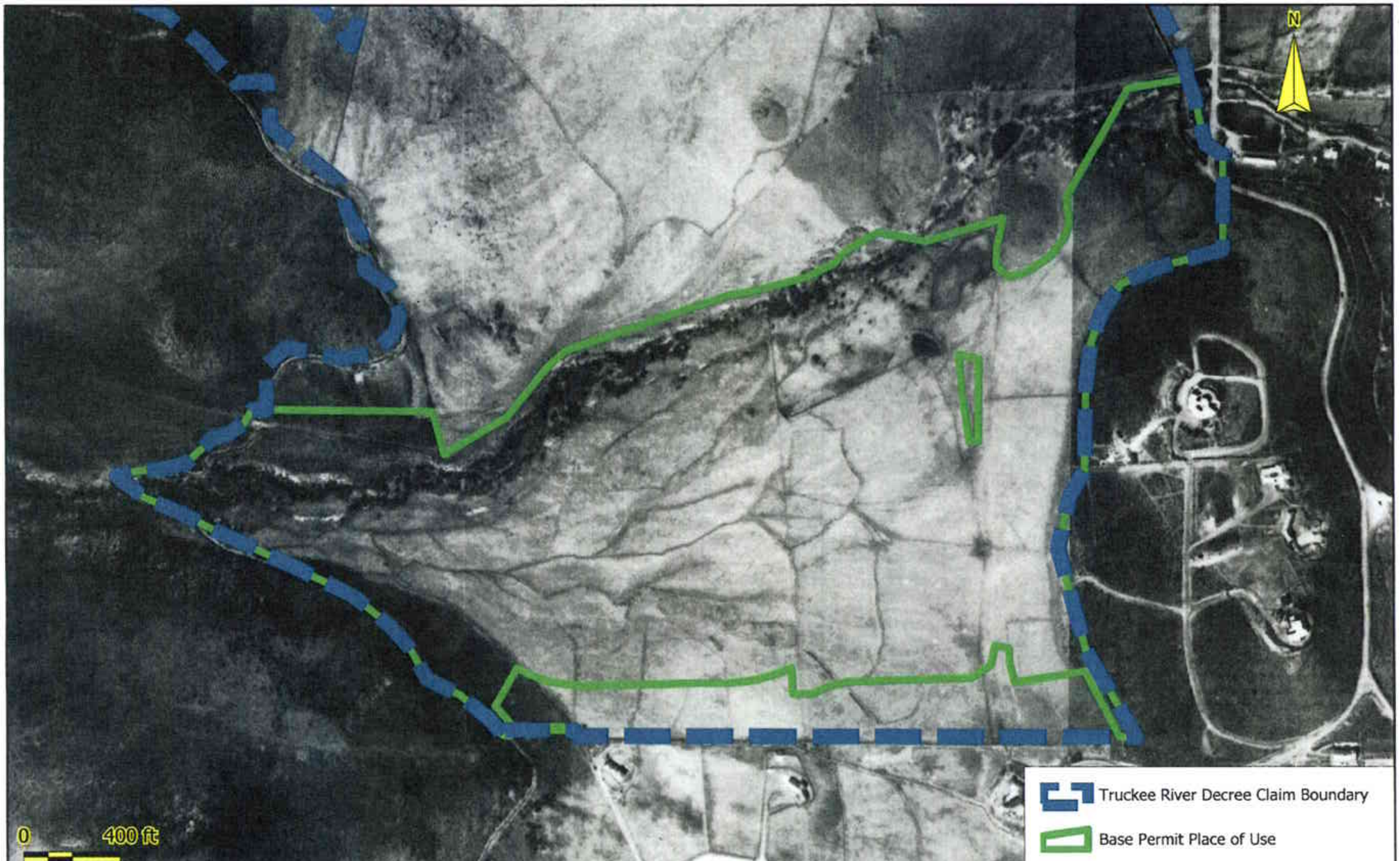


Detail C

APPLICATION: **73797**
BASE PERMIT: **29104**
CLAIM NO.: **65**
AREA: **40.3 AC**

SOURCE: STEAMBOAT DITCH

SOURCES
- 1939 aerial photograph, USDA CDJ-18-27, 6/29/1939
- Truckee River Decree map TR-057

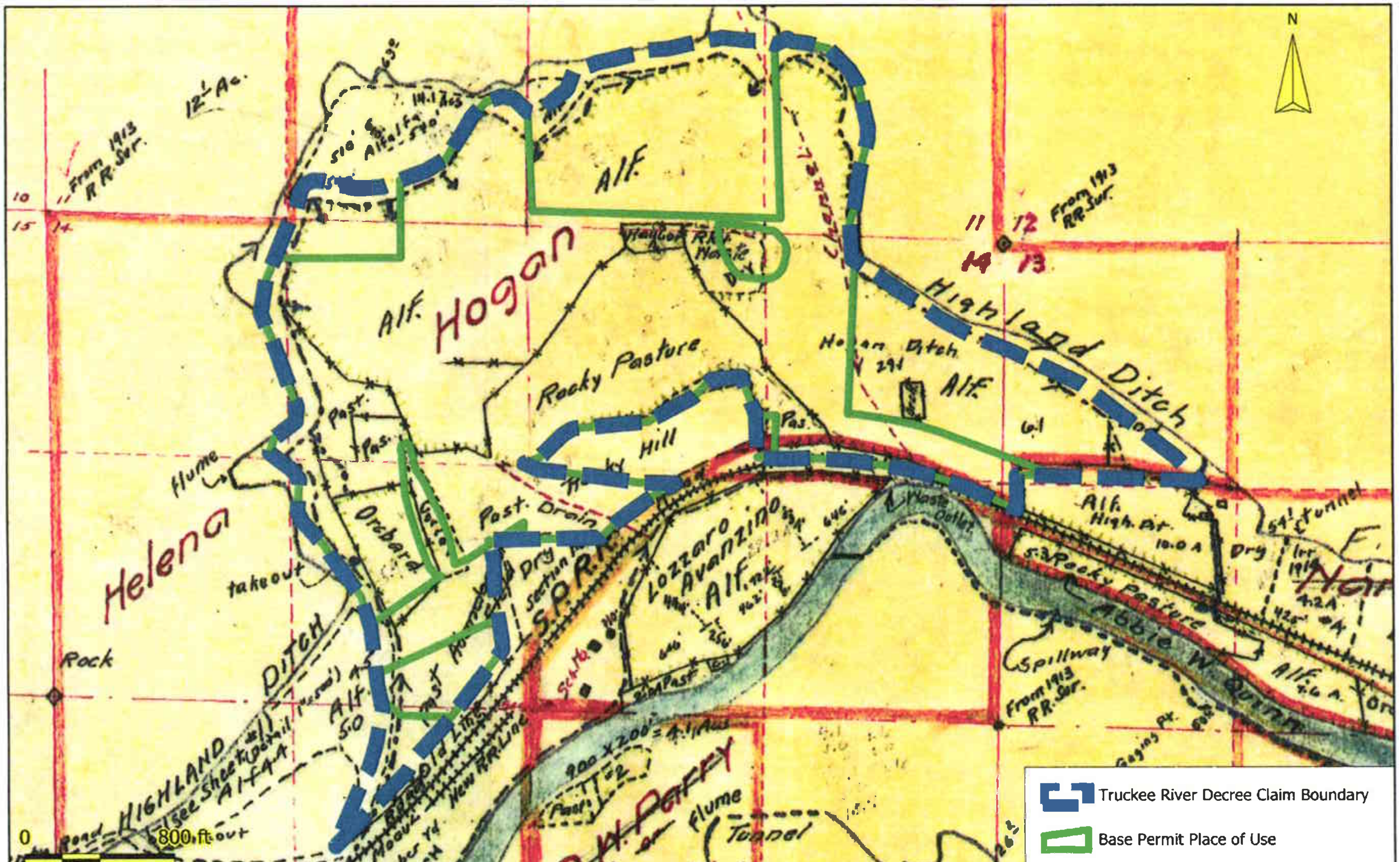


APPLICATION:	**73797**
BASE PERMIT:	**29104**
CLAIM NO.:	**65**
AREA:	**40.3 AC**

Detail C

SOURCE: STEAMBOAT DITCH

SOURCES
- 1967 aerial photograph, FSA EW-X-1HH-43/45, 3/5/1967
- Truckee River Decree map TR-057



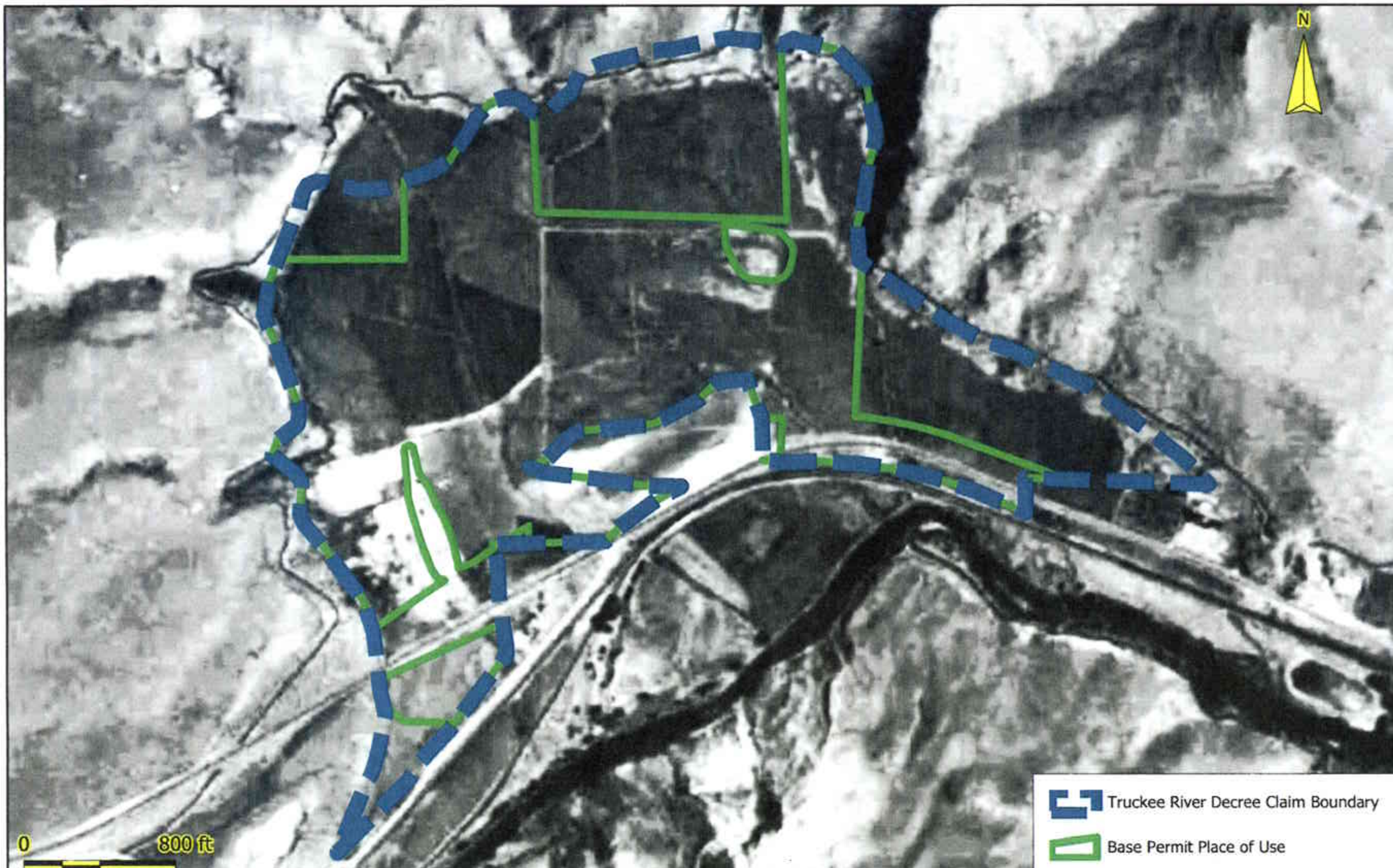
APPLICATION: 73799
BASE PERMIT: 35752
CLAIM NO.: 142
AREA: 112.88 AC

Detail D

SOURCE: **HOGAN DITCH**

SOURCES
- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 3
- Truckee River Decree map TR-070

EXHIBIT
Tab 15



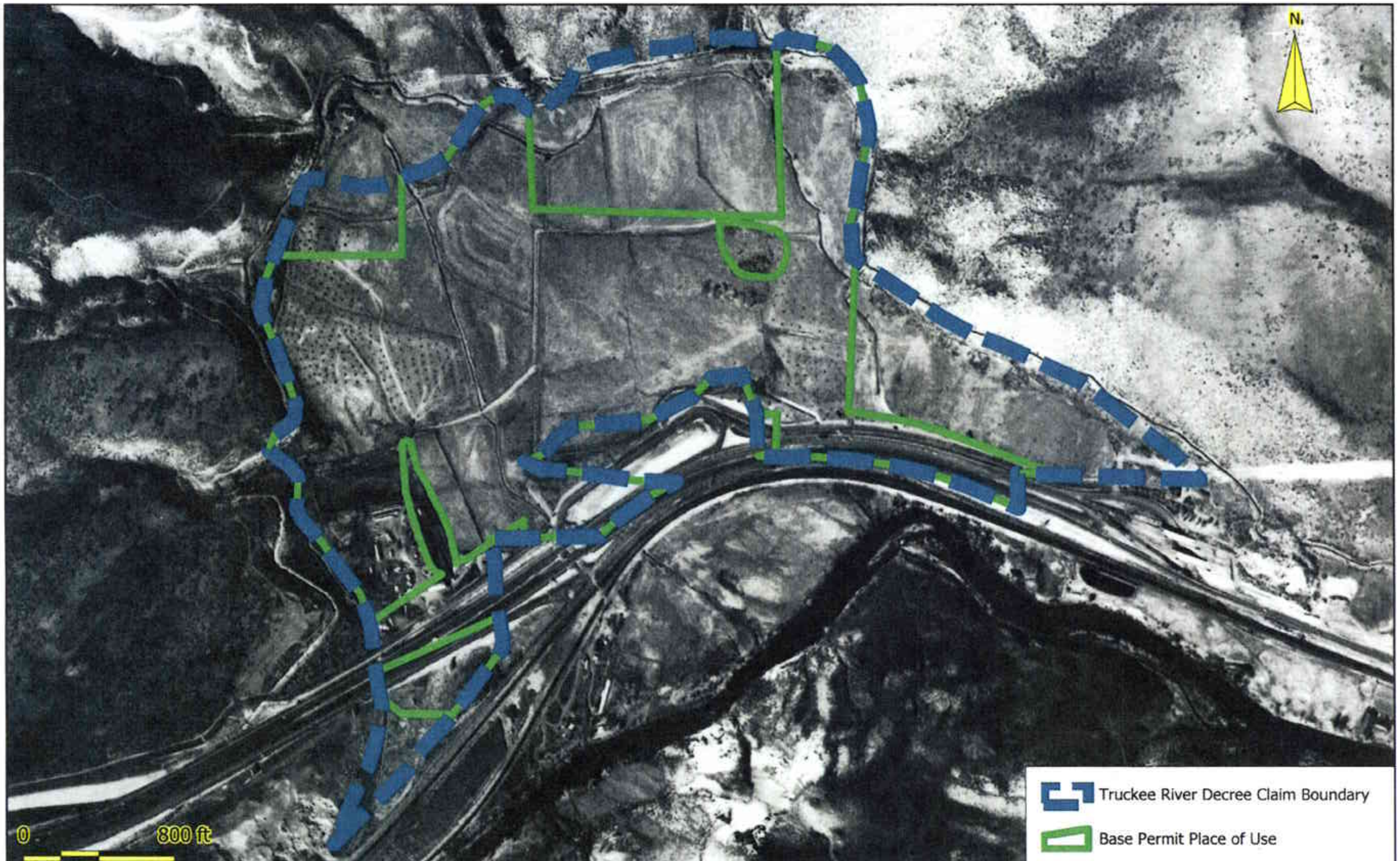
APPLICATION: 73799
BASE PERMIT: 35752
CLAIM NO.: 142
AREA: 112.88 AC

Detail D

SOURCE: HOGAN DITCH

SOURCES

- 1946 aerial photograph, USGS GS-CV 2-90, 7/10/1946
- Truckee River Decree map TR-070

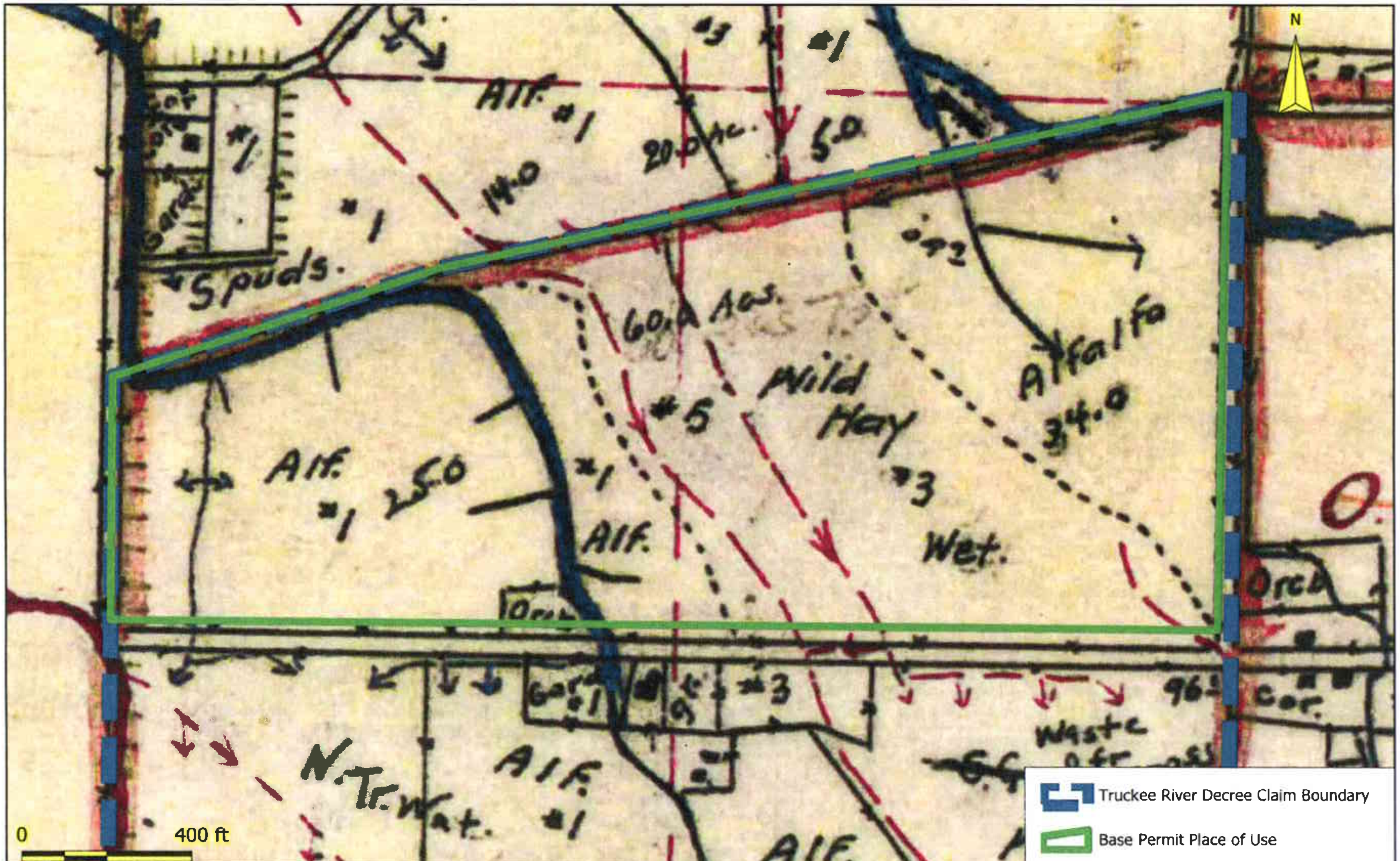


APPLICATION: 73799
BASE PERMIT: 35752
CLAIM NO.: 142
AREA: 112.88 AC

Detail D

SOURCE: HOGAN DITCH

SOURCES
- 1967 aerial photograph, FSA EW-X-1HH-54, 3/5/1967
- Truckee River Decree map TR-070



APPLICATION: 73852
BASE PERMIT: 27759
CLAIM NO.: 579/580
AREA: 130.83 AC

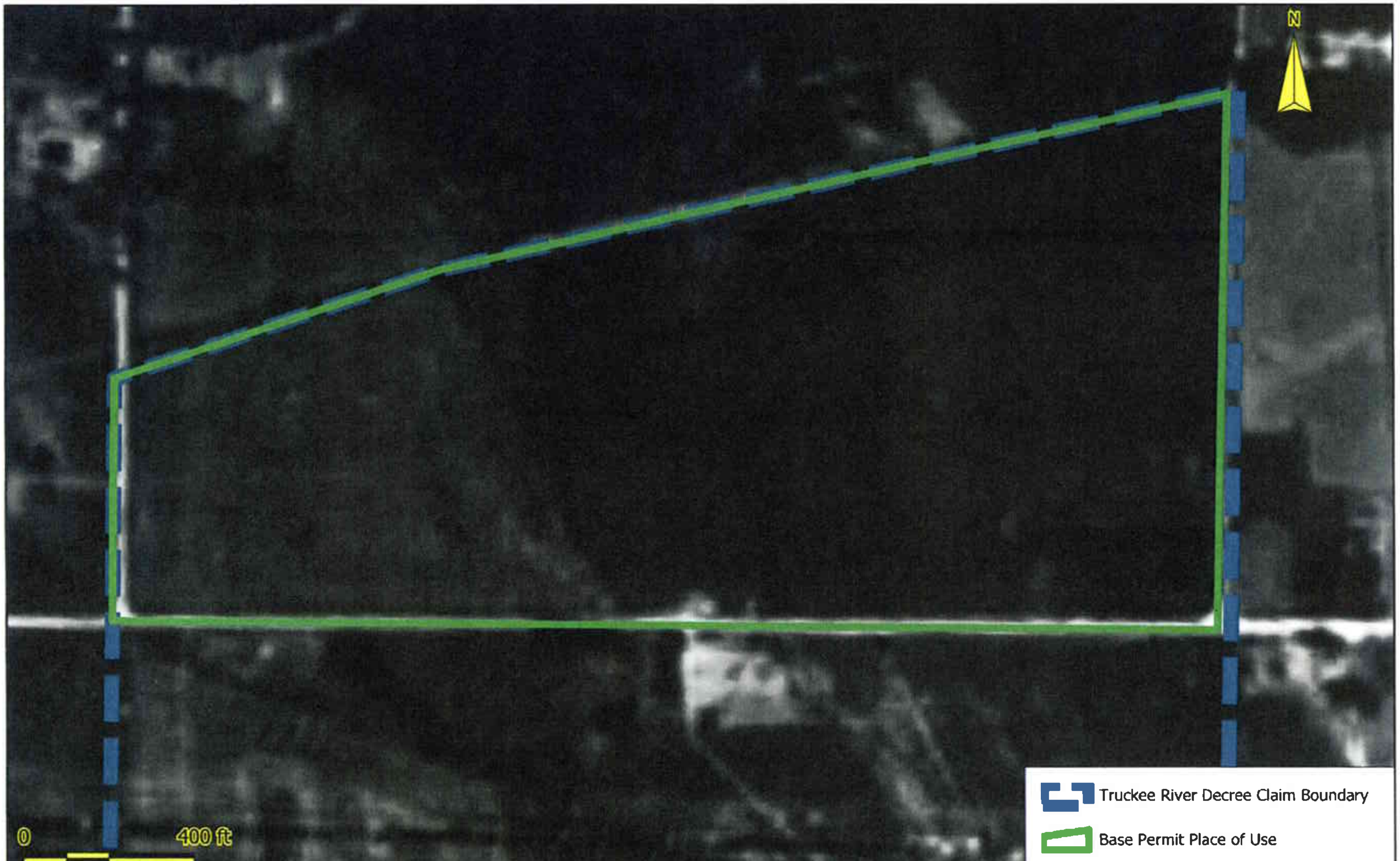
Detail E

SOURCE: NORTH TRUCKEE DITCH

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 15
- Truckee River Decree map TR-077

EXHIBIT
tabbies
Tab 16



APPLICATION: 73852
BASE PERMIT: 27759
CLAIM NO.: 579/580
AREA: 130.83 AC

Detail E

SOURCE: NORTH TRUCKEE DITCH

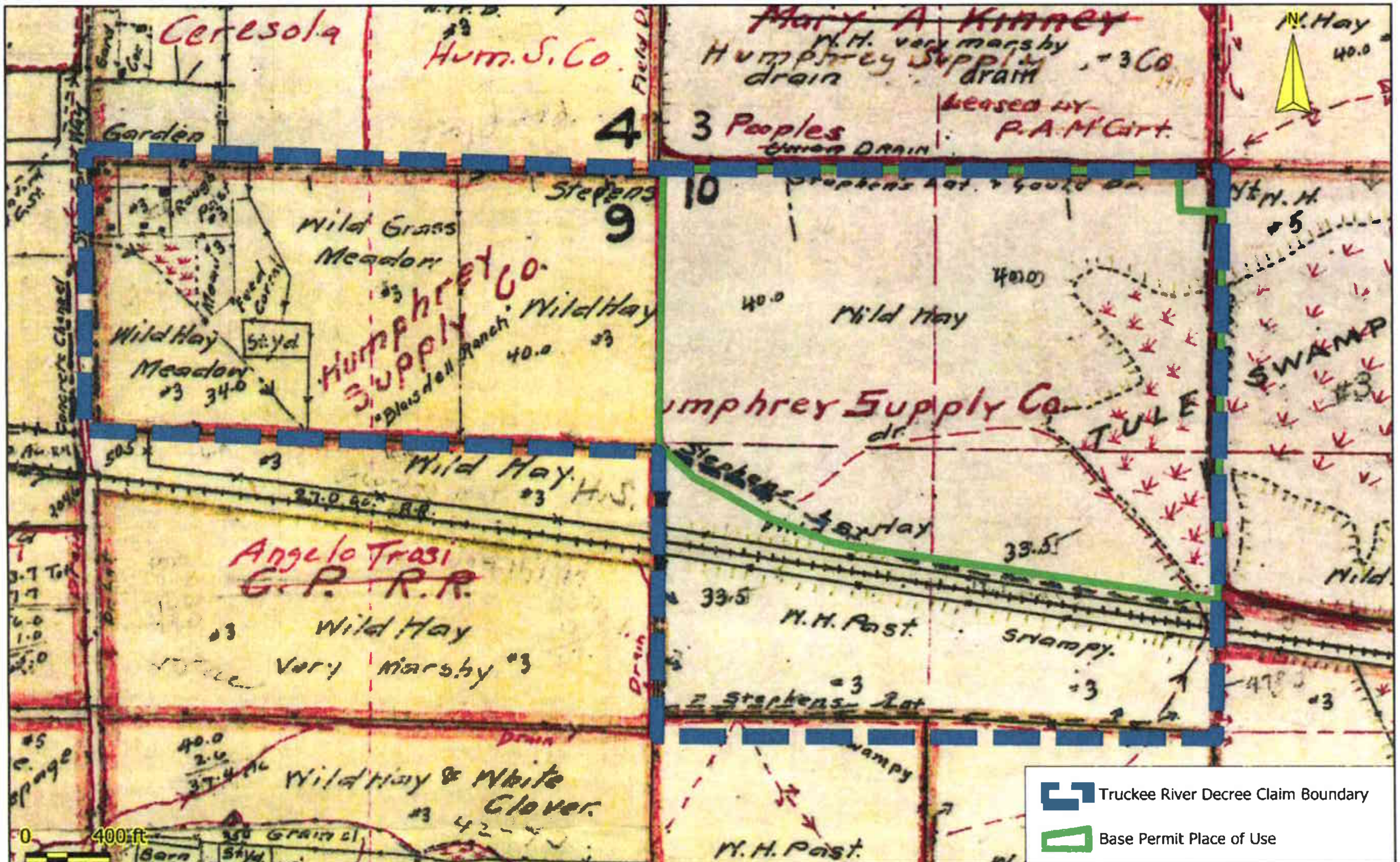
SOURCES
- 1946 aerial photograph, USGS GS-CV 2-106, 7/10/1946
- Truckee River Decree map TR-077

APPLICATION: 73852
BASE PERMIT: 27759
CLAIM NO.: 579/580
AREA: 130.83 AC

Detail E

SOURCE: NORTH TRUCKEE DITCH

SOURCES
- 1967 aerial photograph, FSA EW-X-1HH-73, 3/5/1967
- Truckee River Decree map TR-077



APPLICATION: 73853
BASE PERMIT: 42727
CLAIM NO.: 611
AREA: 95.93 AC

Detail F

SOURCE: NORTH TRUCKEE DITCH

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable maps, sheets 9 and 15
- Truckee River Decree map TR-081

EXHIBIT

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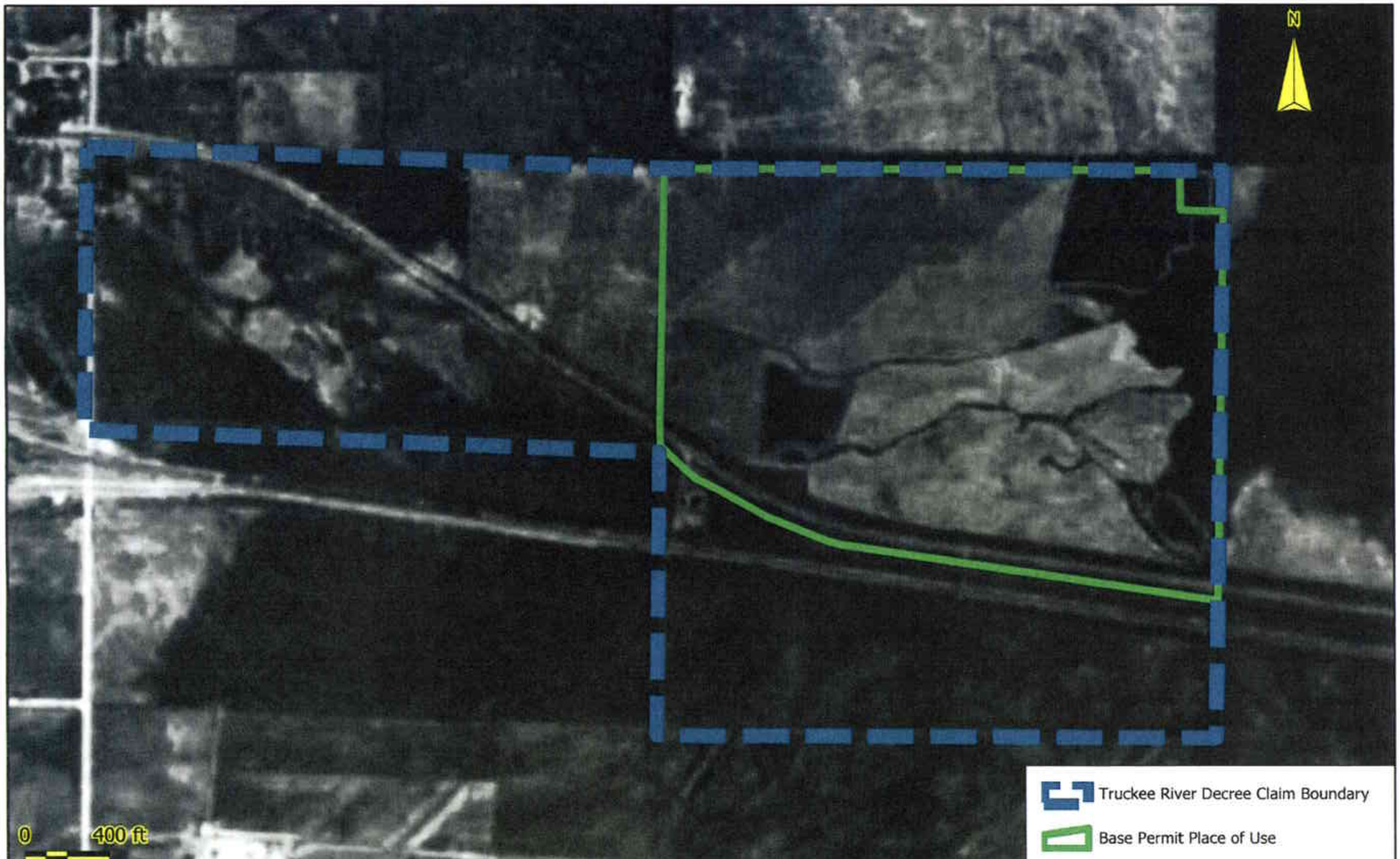
tabbies



APPLICATION: 73853
BASE PERMIT: 42727
CLAIM NO.: 611
AREA: 95.93 AC

Detail F

SOURCE: NORTH TRUCKEE DITCH

SOURCES

- 1946 aerial photograph, USGS GS-CV 2-106, 7/10/1946
- Truckee River Decree map TR-081

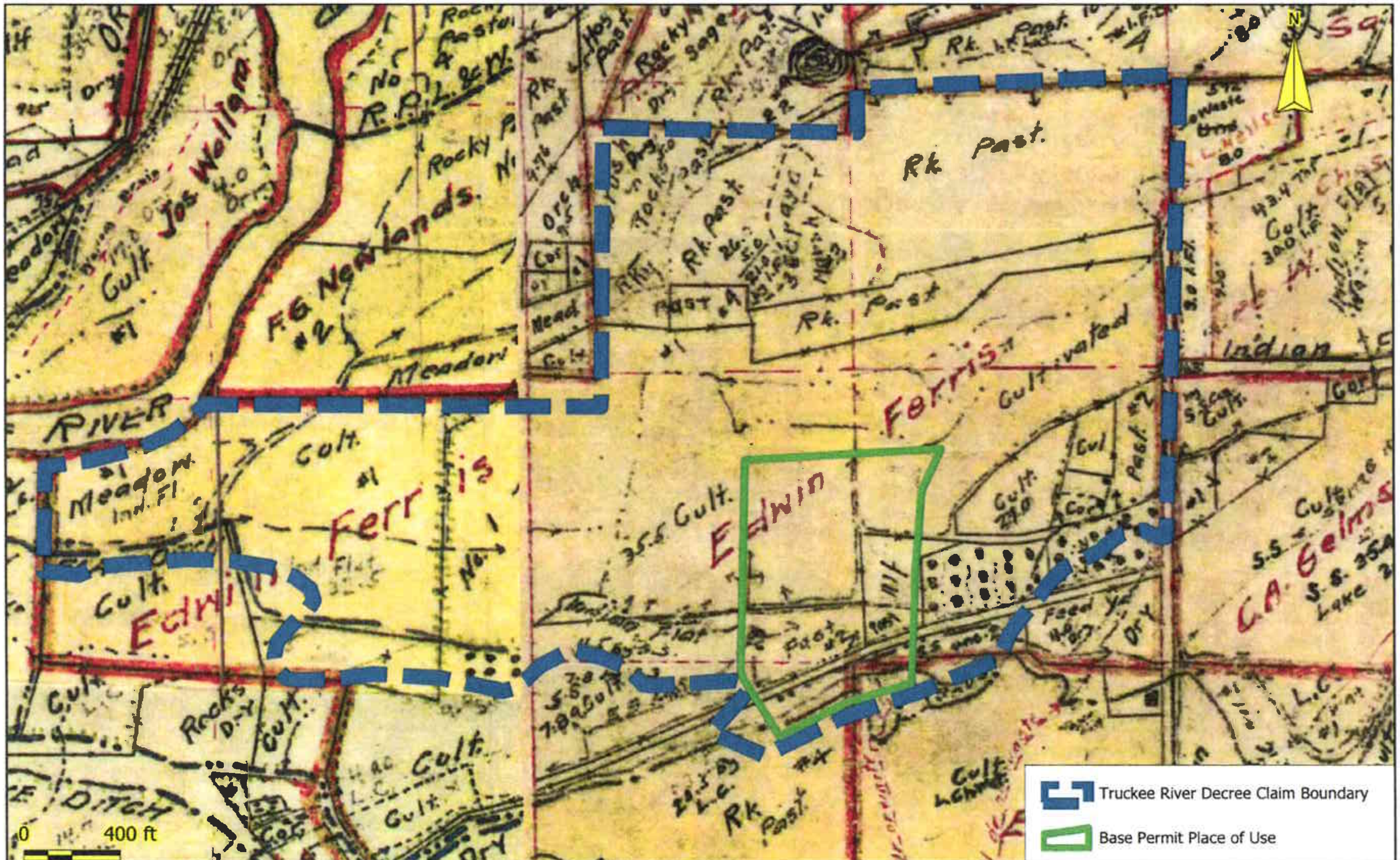
APPLICATION: 73853
BASE PERMIT: 42727
CLAIM NO.: 611
AREA: 95.93 AC

Detail F

SOURCE: NORTH TRUCKEE DITCH

SOURCES

- 1967 aerial photograph, FSA EW-X-1HH-71, 3/5/1967
- Truckee River Decree map TR-081



APPLICATION: 73855
BASE PERMIT: 55383
CLAIM NO.: 356/357
AREA: 61.73 AC

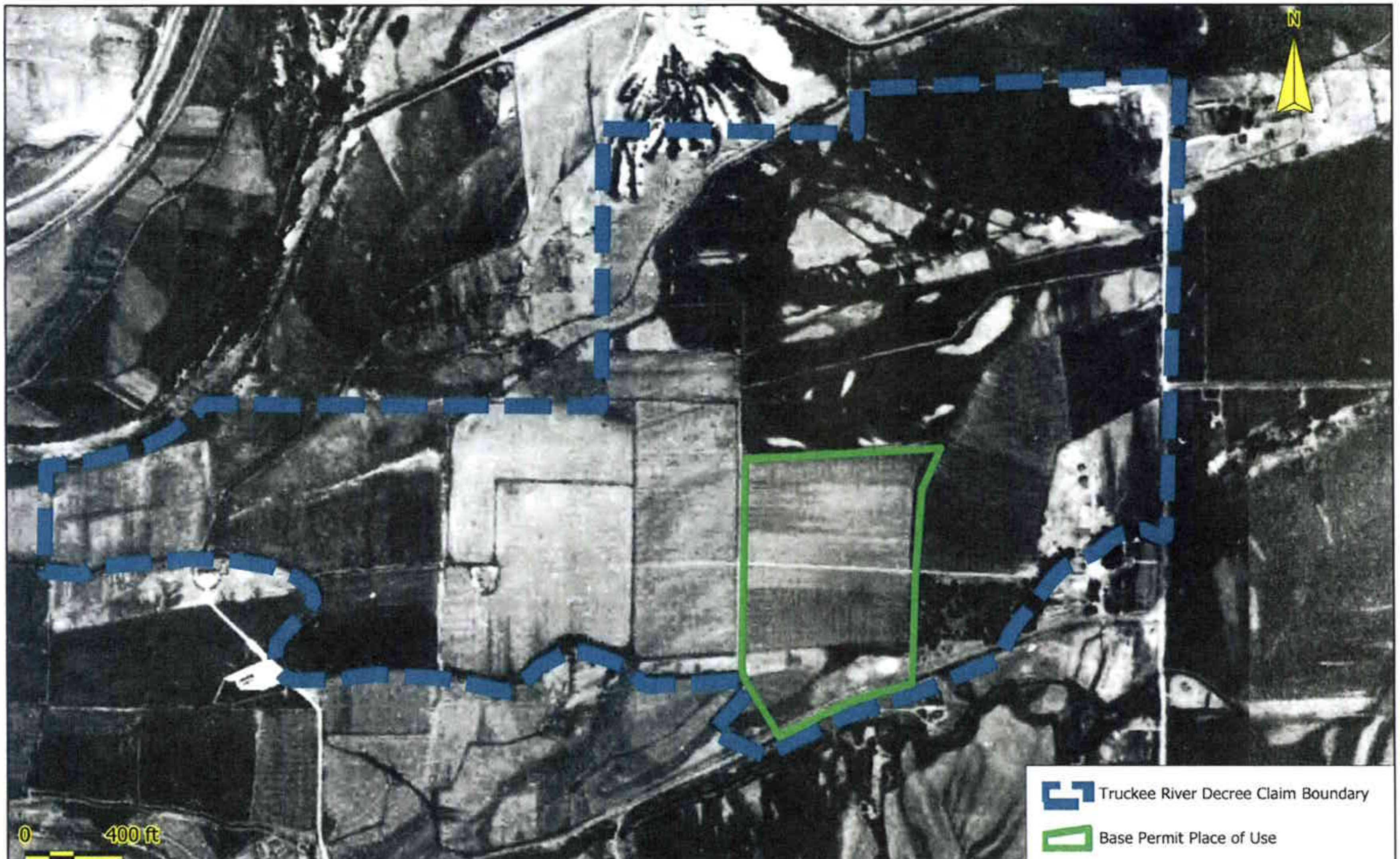
Detail G

SOURCE: INDIAN FLAT DITCH

SOURCES
- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable maps, sheets 4 and 5
- Truckee River Decree map TR-123

EXHIBIT
Tab 18

tabbies

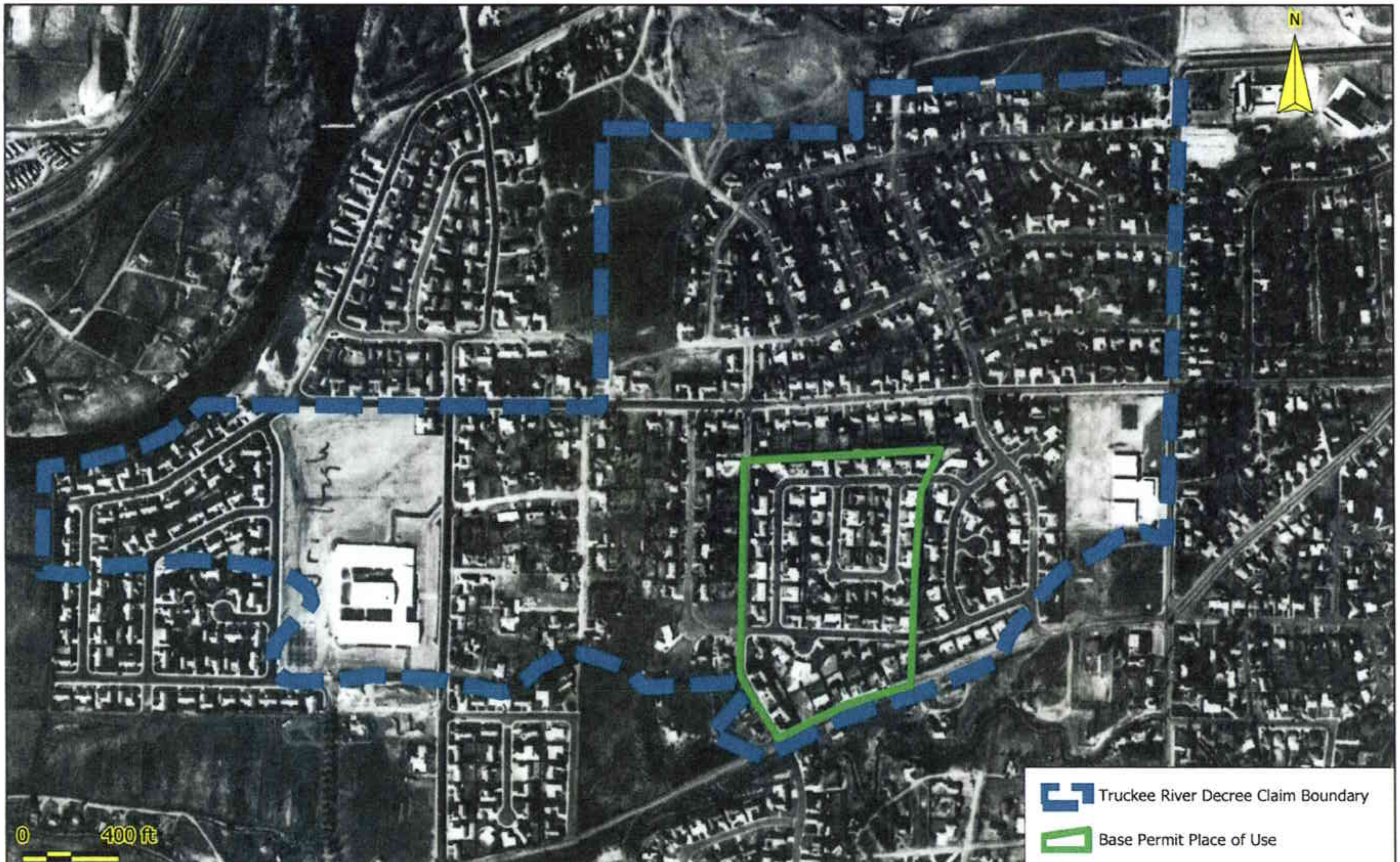


APPLICATION: 73855
BASE PERMIT: 55383
CLAIM NO.: 356/357
AREA: 61.73 AC

Detail G

SOURCE: INDIAN FLAT DITCH

SOURCES
- 1939 aerial photograph, USDA CDJ-18-10, 6/29/1939
- Truckee River Decree map TR-123

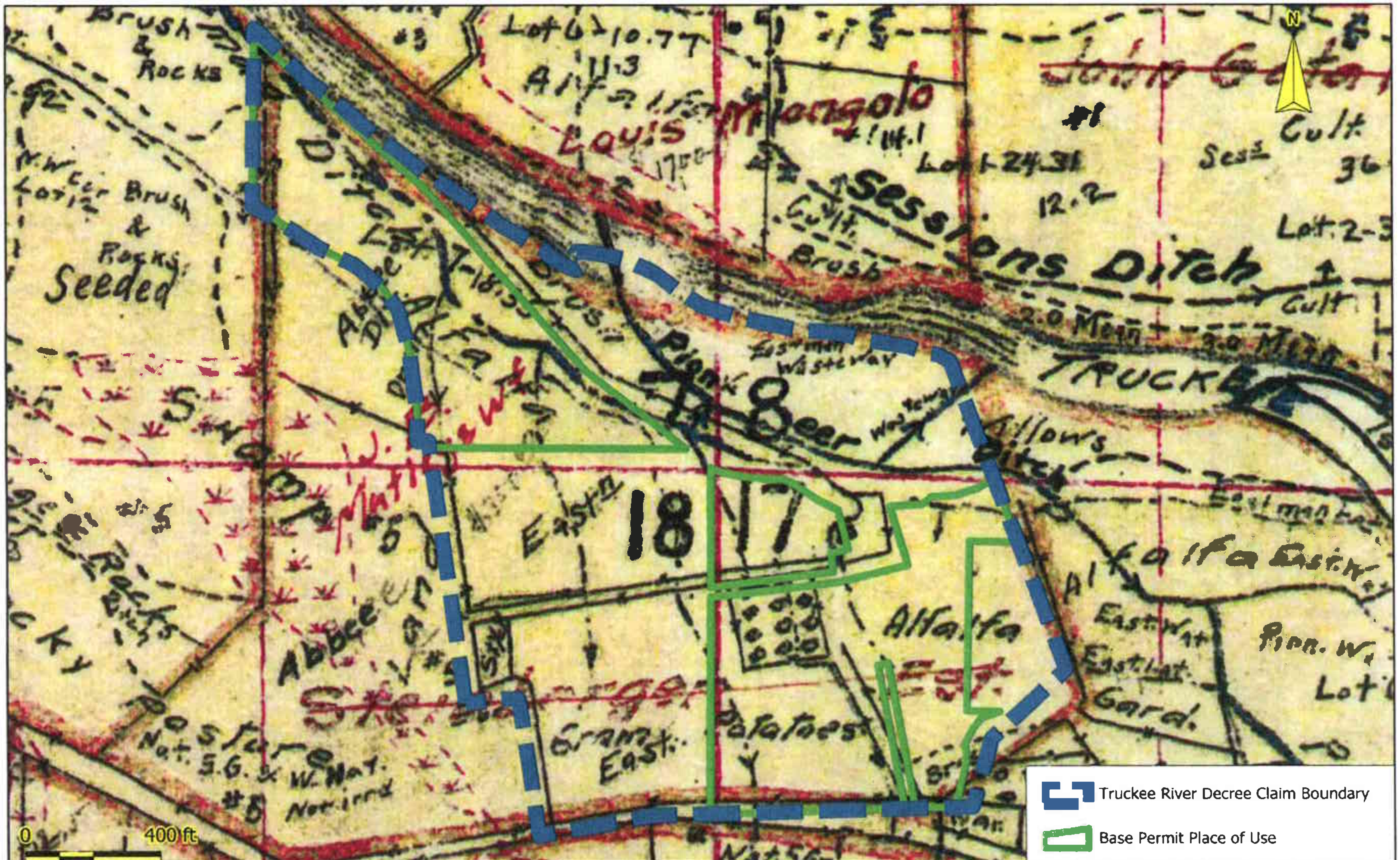


APPLICATION: **73855**
BASE PERMIT: **55383**
CLAIM NO.: **356/357**
AREA: **61.73 AC**

Detail G

SOURCE: INDIAN FLAT DITCH

SOURCES
- 1967 aerial photograph, FSA EW-X-1HH-69, 3/5/1967
- Truckee River Decree map TR-123



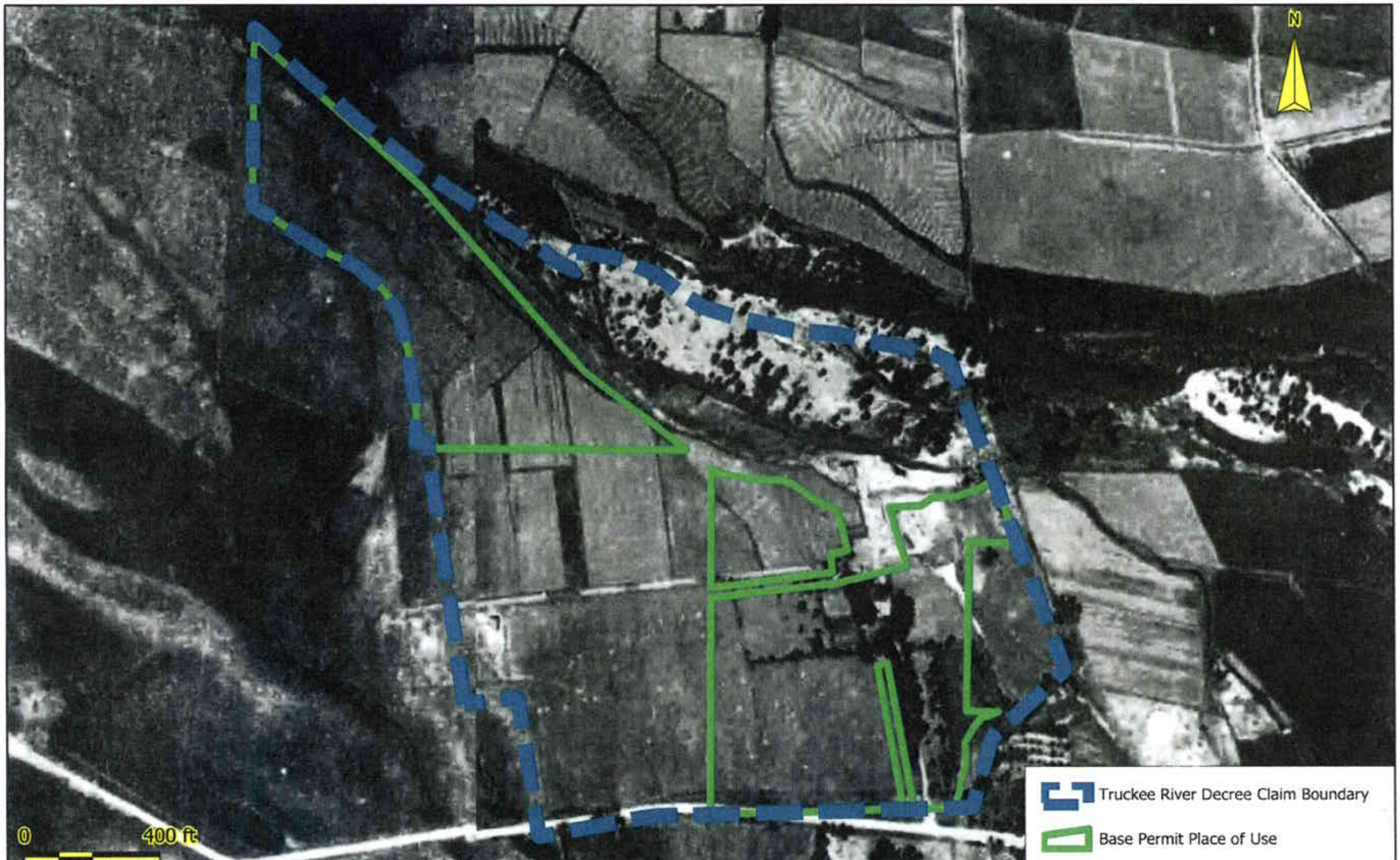
APPLICATION: 73865
BASE PERMIT: 50015
CLAIM NO.: 522/524
AREA: 35.41 AC

Detail H

SOURCE: EASTMAN DITCH

SOURCES
- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 9
- Truckee River Decree map TR-053

EXHIBIT
Taub 19



APPLICATION:	**73865**
BASE PERMIT:	**50015**
CLAIM NO.:	**522/524**
AREA:	**35.41 AC**

Detail H

SOURCE: EASTMAN DITCH

SOURCES

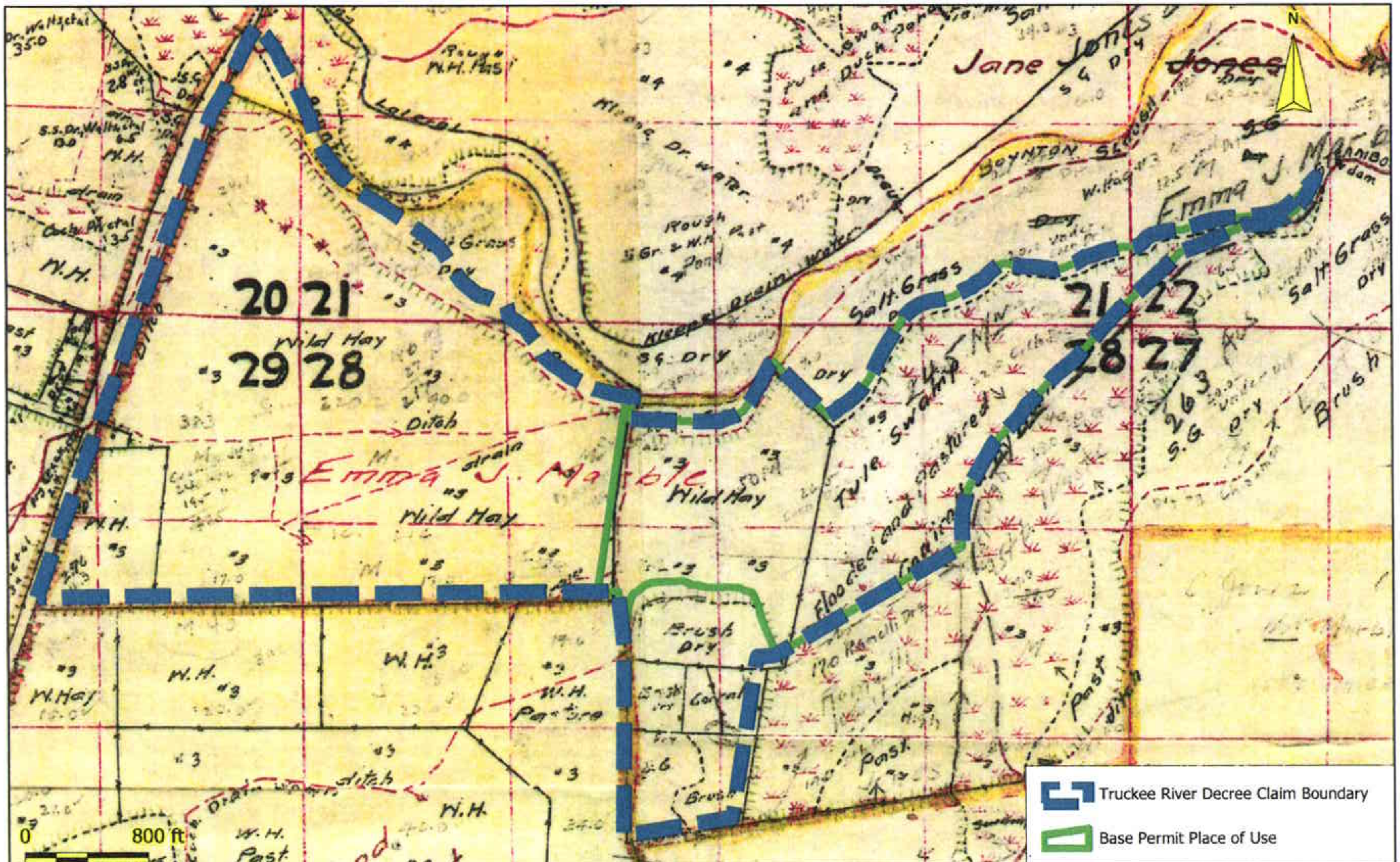
- 1939 aerial photograph, USDA CDJ-18-86, 6/29/1939
- Truckee River Decree map TR-053

APPLICATION: **73865**
BASE PERMIT: **50015**
CLAIM NO.: **522/524**
AREA: **35.41 AC**

Detail H

SOURCE: **EASTMAN DITCH**

SOURCES
- 1967 aerial photograph, FSA EW-X-1HH-71, 3/5/1967
- Truckee River Decree map TR-053



APPLICATION:	**73869**
BASE PERMIT:	**57013**
CLAIM NO.:	**485/489**
AREA:	**86.11 AC**

Detail I

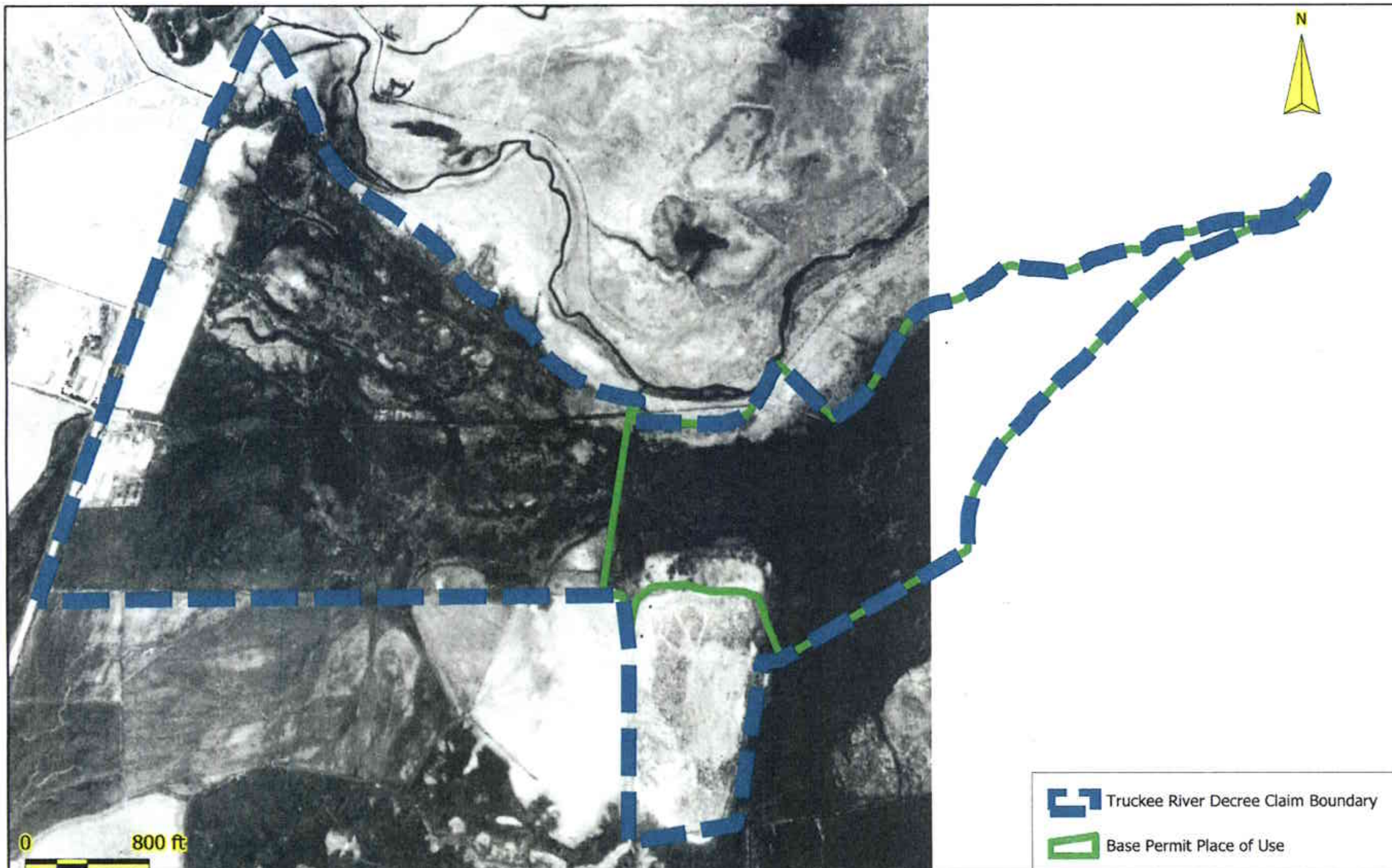
SOURCE: COCHRAN DITCH

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 10
- Truckee River Decree map TR-039

EXHIBIT

Tab 20



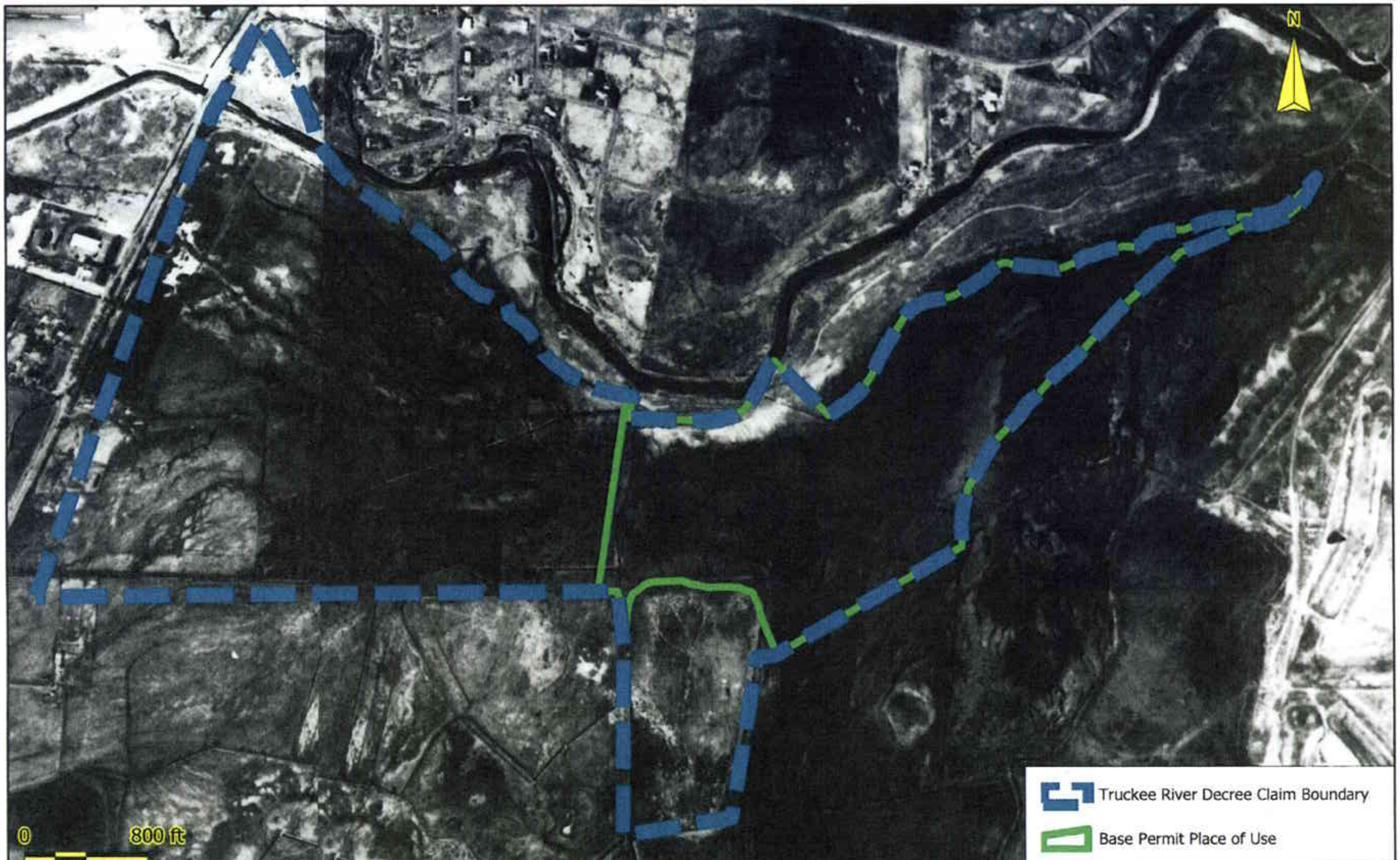
APPLICATION: 73869
BASE PERMIT: 57013
CLAIM NO.: 485/489
AREA: 86.11 AC

Detail I

SOURCE: COCHRAN DITCH

SOURCES
- 1939 aerial photograph, USDA CDJ-18-84, 6/29/1939
- Truckee River Decree map TR-039

EXHIBIT
Tab 80

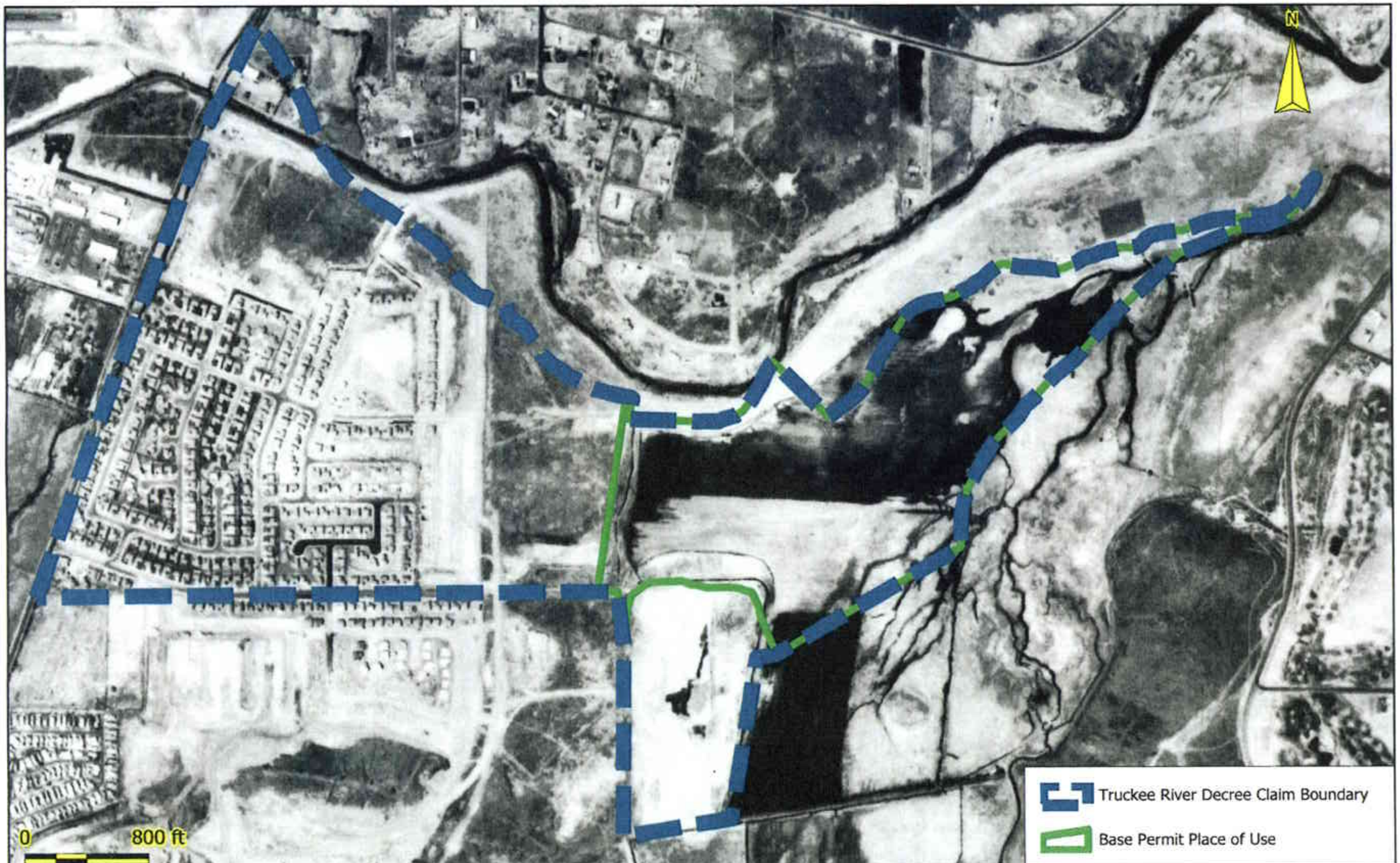


APPLICATION: 73869
BASE PERMIT: 57013
CLAIM NO.: 485/489
AREA: 86.11 AC

Detail I

SOURCE: COCHRAN DITCH

SOURCES
- 1967 aerial photograph, FSA EW-X-1HH-43/45, 3/5/1967
- Truckee River Decree map TR-039



APPLICATION: 73869
BASE PERMIT: 57013
CLAIM NO.: 485/489
AREA: 86.11 AC

Detail I

SOURCE: COCHRAN DITCH

SOURCES
- 1977 aerial photograph, Great Basin Aerial Surveys, 101005 5-7, 4/11/1977
- Truckee River Decree map TR-039

APPLICATION: 73870
BASE PERMIT: 57309
CLAIM NO.: 583
AREA: 100.97 AC
SOURCE: SESSIONS DITCH

Detail J

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 9
- Truckee River Decree map TR-086

EXHIBIT
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APPLICATION: 73870
BASE PERMIT: 57309
CLAIM NO.: 583
AREA: 100.97 AC
SOURCE: SESSIONS DITCH

Detail J

SOURCES

- 1939 aerial photograph, USDA CDJ-18-86, 6/29/1939
- Truckee River Decree map TR-086

APPLICATION: 73870
BASE PERMIT: 57309
CLAIM NO.: 583
AREA: 100.97 AC
SOURCE: SESSIONS DITCH

Detail J

SOURCES

- 1967 aerial photograph, FSA EW-X-1HH-71, 3/5/1967
- Truckee River Decree map TR-086

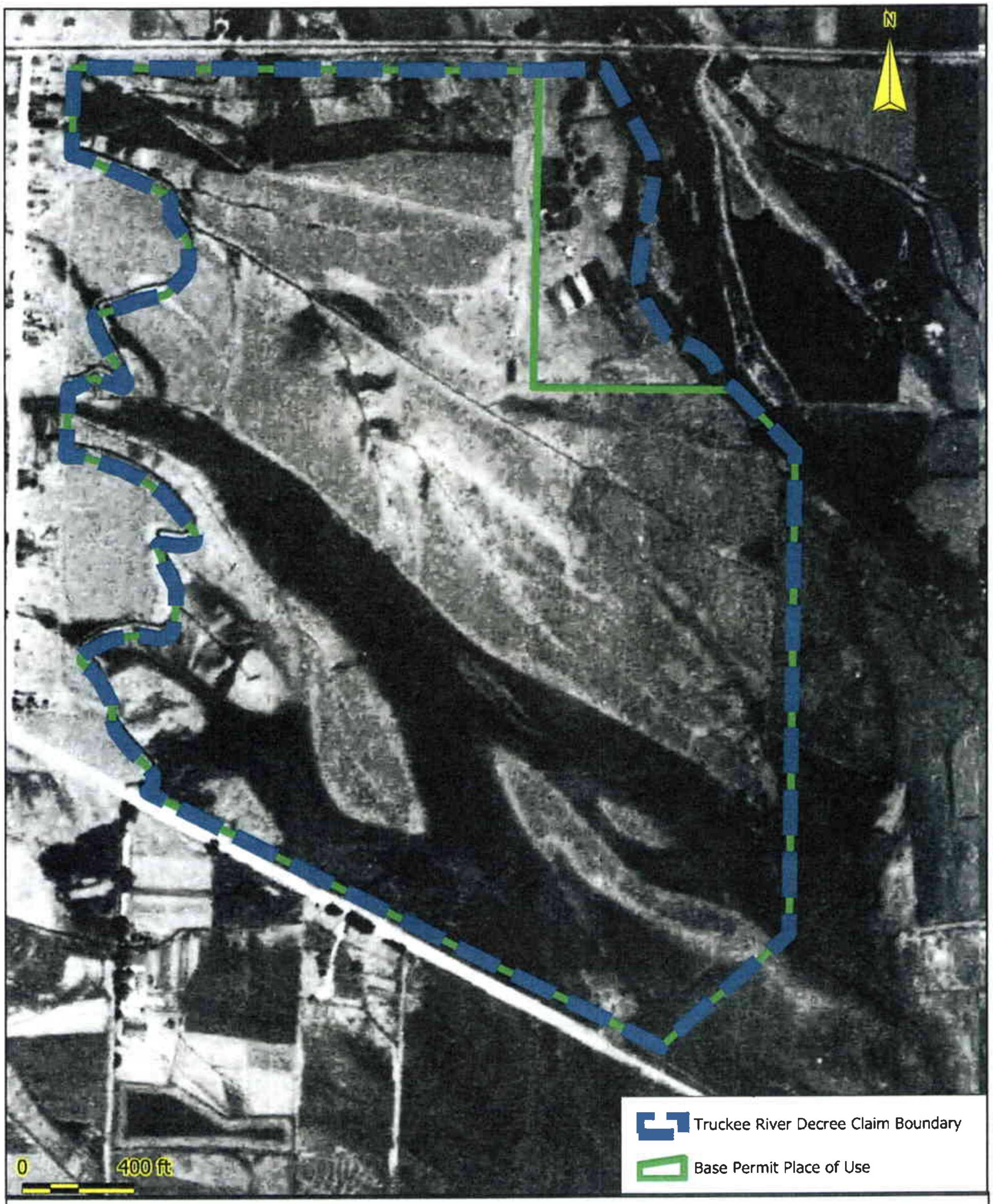
APPLICATION: 73908
BASE PERMIT: 25118
CLAIM NO.: 514
AREA: 141.91 AC
SOURCE: ABBEE DITCH

Detail K

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 9
- Truckee River Decree map TR-116

EXHIBIT
tabbies
Tab 22

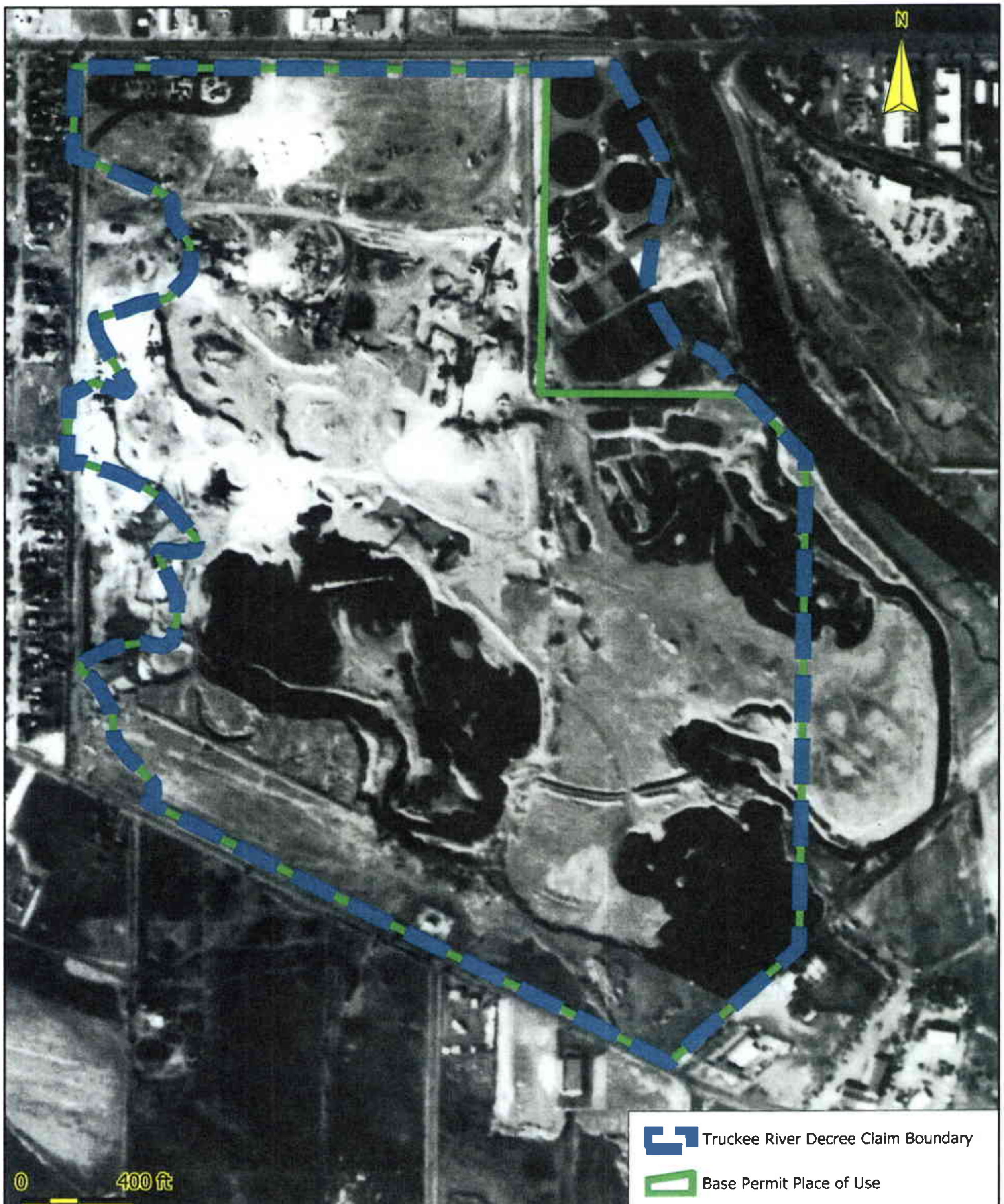


APPLICATION: **73908**
BASE PERMIT: **25118**
CLAIM NO.: **514**
AREA: **141.91 AC**
SOURCE: **ABBEE DITCH**

Detail K

SOURCES

- 1939 aerial photograph, USDA CDJ-18-86, 6/29/1939
- Truckee River Decree map TR-116

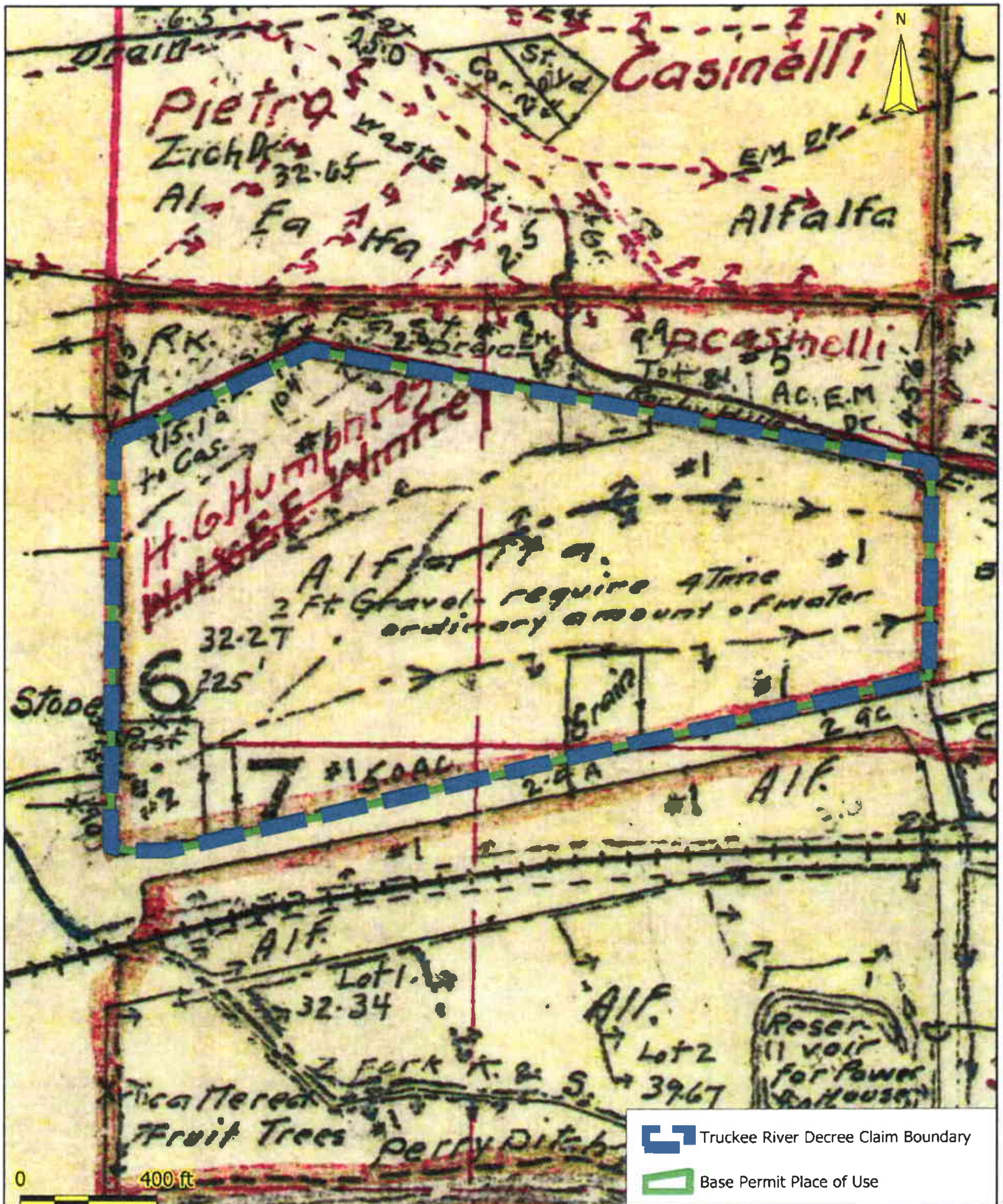


APPLICATION: 73908
BASE PERMIT: 25118
CLAIM NO.: 514
AREA: 141.91 AC
SOURCE: ABBEE DITCH

Detail K

SOURCES

- 1967 aerial photograph, FSA EW-X-1HH-71, 3/5/1967
- Truckee River Decree map TR-116



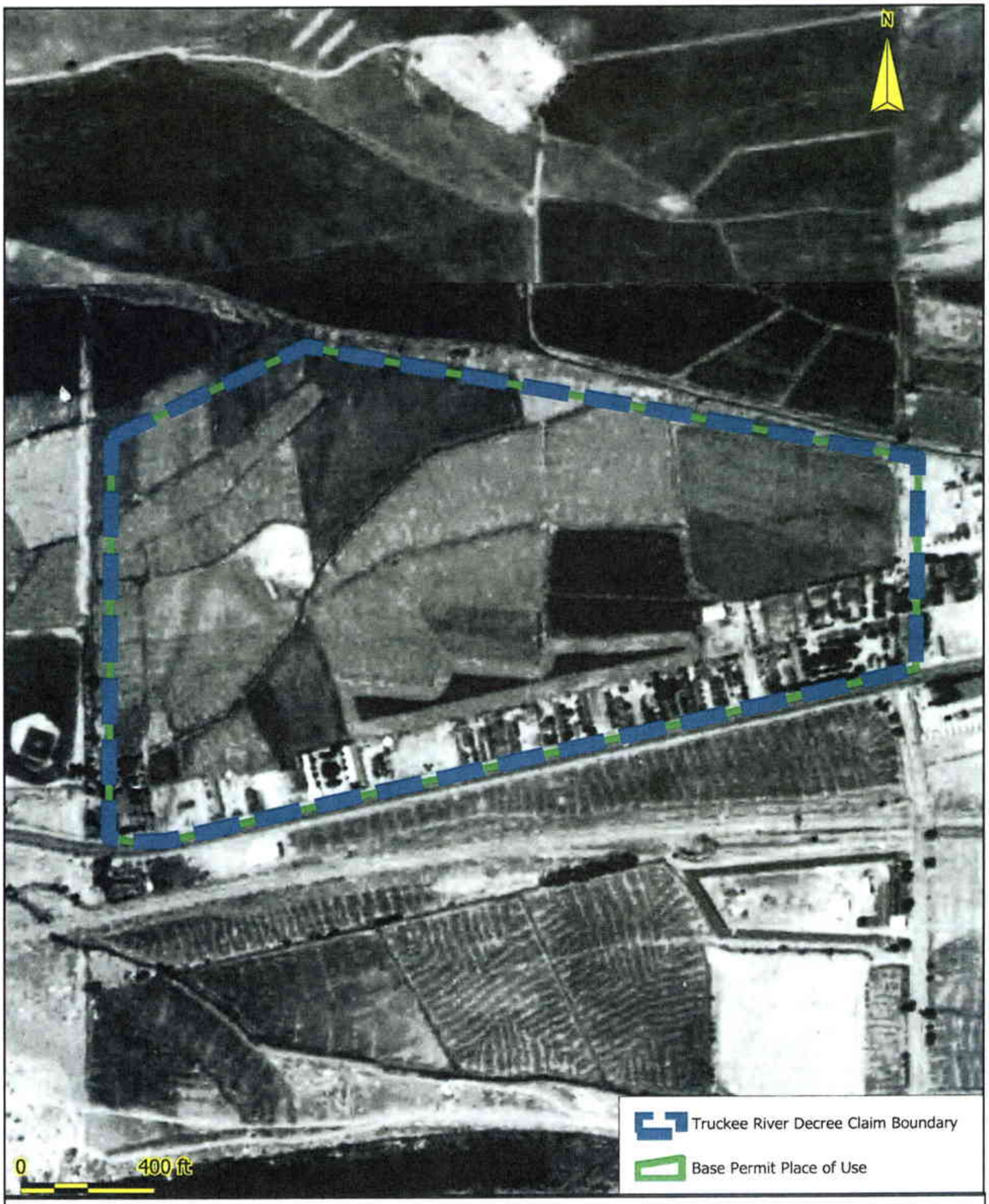
APPLICATION: **73909**
BASE PERMIT: **24132**
CLAIM NO.: **409**
AREA: **59.25 AC**
SOURCE: **S&K DITCH**

Detail L

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 9
- Truckee River Decree map TR-088

EXHIBIT
Tab 23

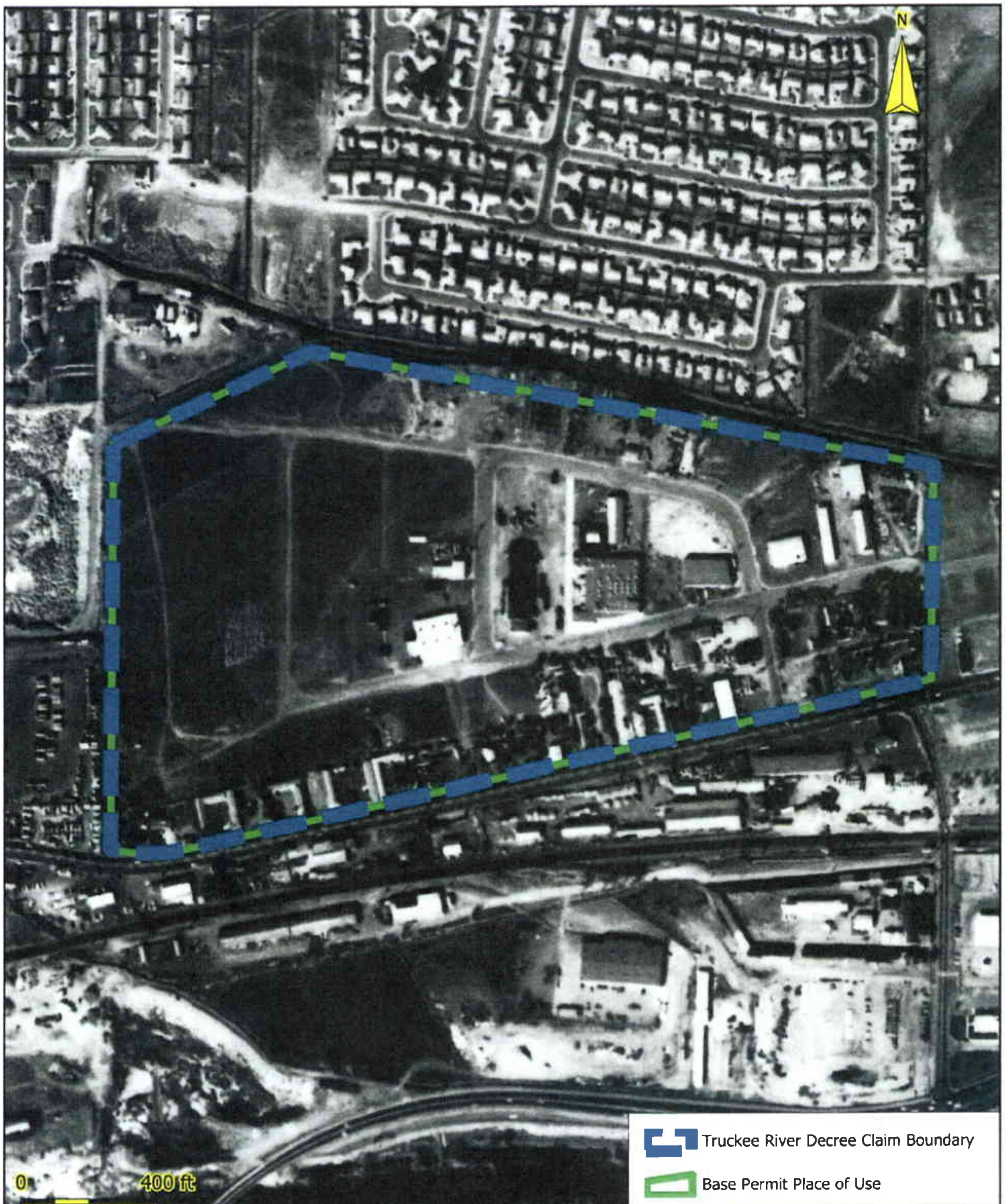


APPLICATION: **73909**
BASE PERMIT: **24132**
CLAIM NO.: **409**
AREA: **59.25 AC**
SOURCE: **S&K DITCH**

Detail L

SOURCES

- 1939 aerial photograph, USDA CDJ-18-86, 6/29/1939
- Truckee River Decree map TR-088

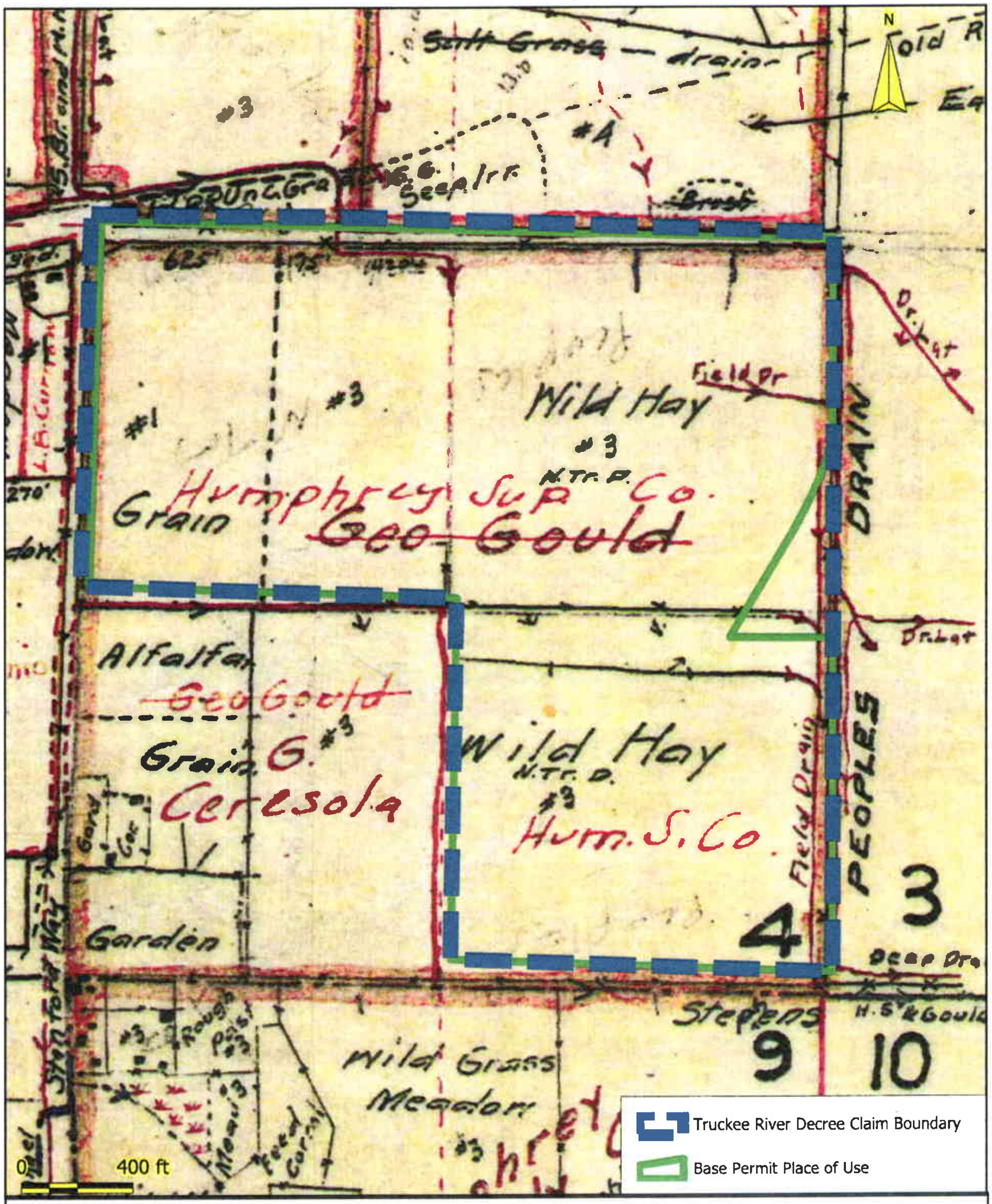


APPLICATION: 73909
BASE PERMIT: 24132
CLAIM NO.: 409
AREA: 59.25 AC
SOURCE: S&K DITCH

Detail L

SOURCES

- 1967 aerial photograph, FSA EW-X-1HH-71, 3/5/1967
- Truckee River Decree map TR-088



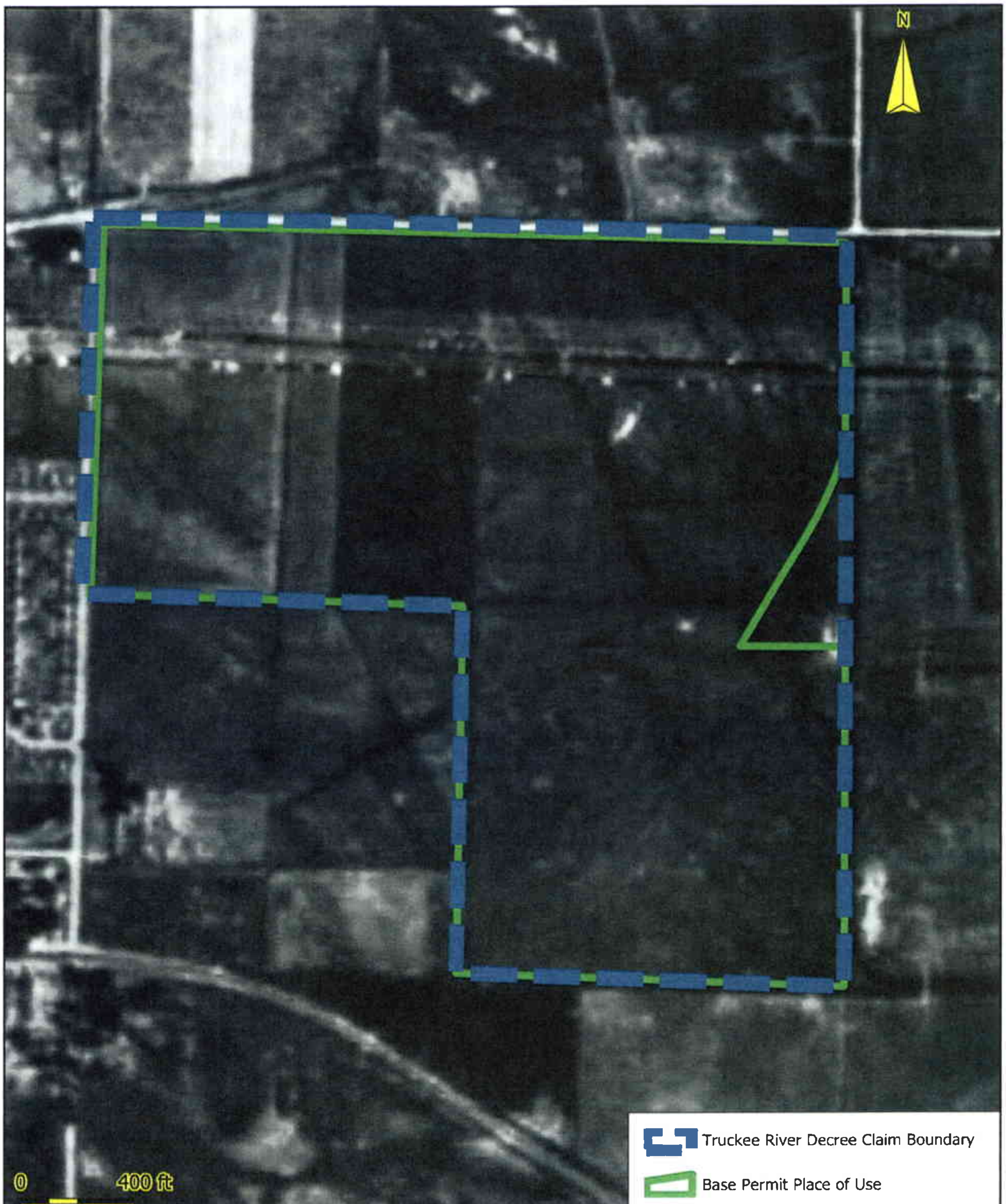
APPLICATION: 73917
BASE PERMIT: 27755
CLAIM NO.: 532/533
AREA: 114.06 AC
SOURCE: NORTH TRUCKEE DITCH

Detail M

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 9
- Truckee River Decree map TR-078

EXHIBIT
Tab 24



APPLICATION: 73917
BASE PERMIT: 27755
CLAIM NO.: 532/533
AREA: 114.06 AC
SOURCE: NORTH TRUCKEE DITCH

Detail M

SOURCES
- 1946 aerial photograph, USGS GS-CV 2-106, 7/10/1946
- Truckee River Decree map TR-078

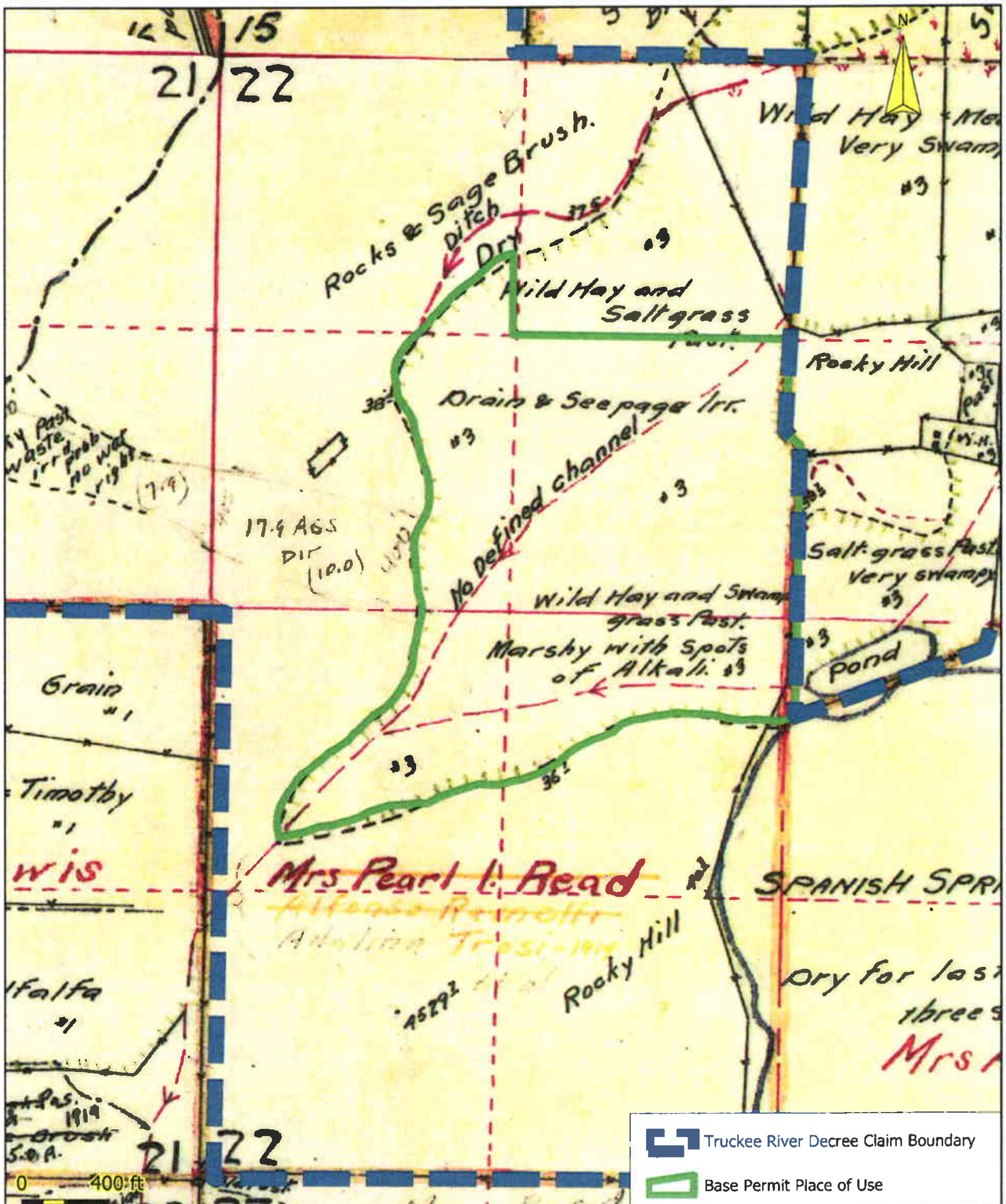
EXHIBIT
tabbies®
Tab 24

APPLICATION:	**73917**	
BASE PERMIT:	**27755**	
CLAIM NO.:	**532/533**	
AREA:	**114.06 AC**	
SOURCE:	**NORTH TRUCKEE DITCH**	

Detail M

SOURCES

- 1967 aerial photograph, FSA EW-X-1HH-73, 3/5/1967
- Truckee River Decree map TR-078



APPLICATION: 73986
BASE PERMIT: 58559
CLAIM NO.: 346/347
AREA: 68.46 AC
SOURCE: ORR DITCH

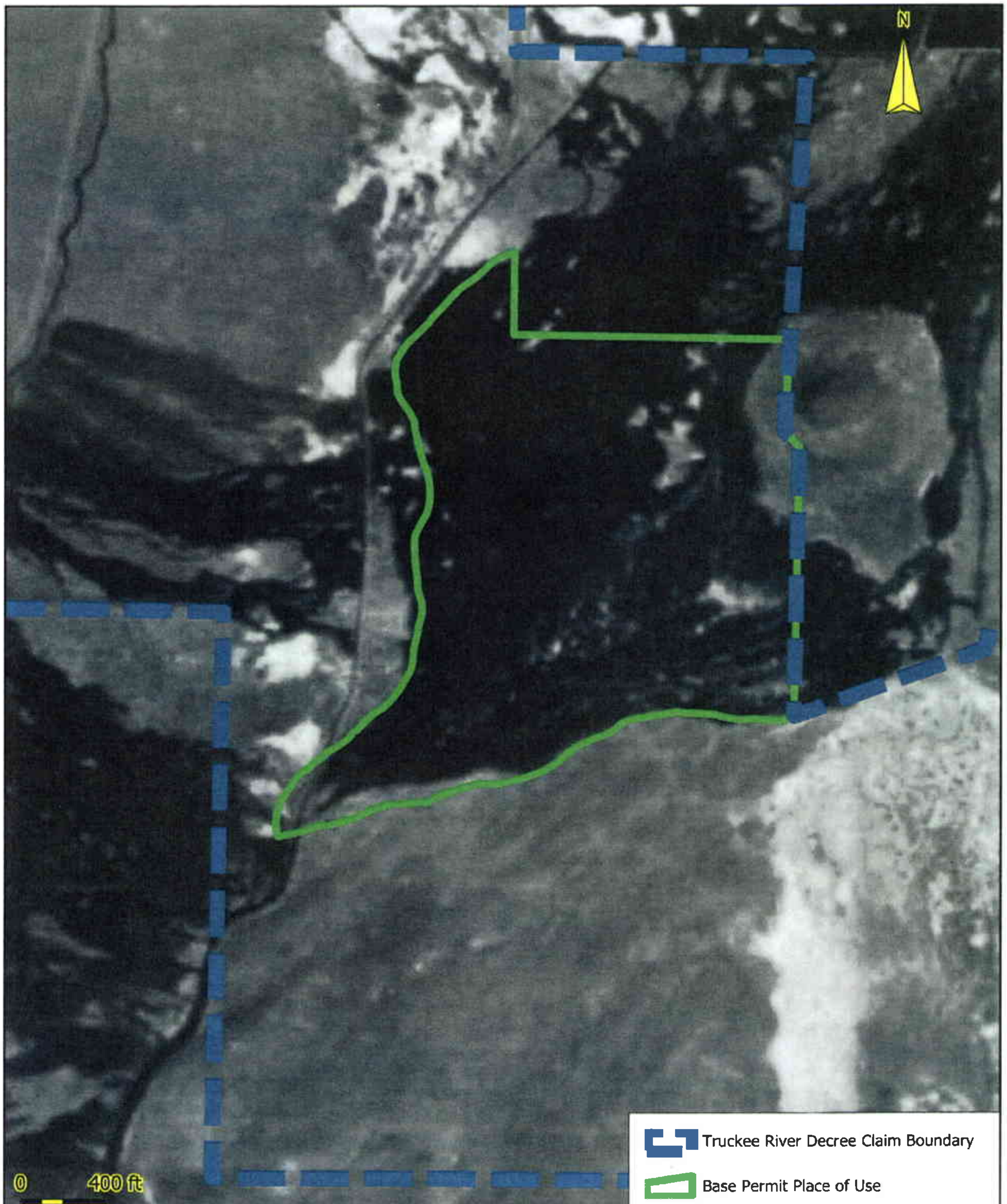
Detail N

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable maps, sheets 13 & 14
- Truckee River Decree map TR-014

EXHIBIT

Tab 25



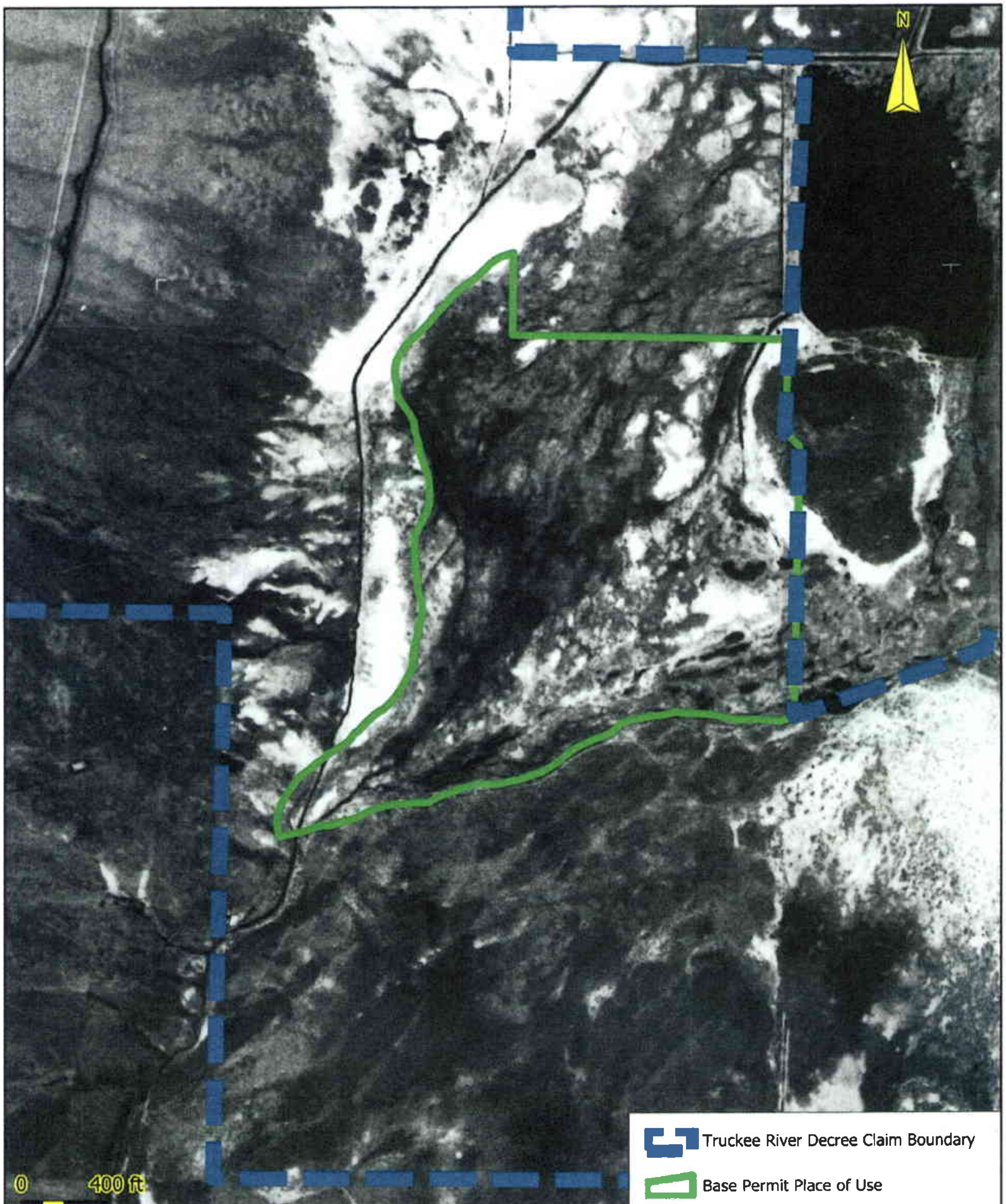
APPLICATION: 73986
BASE PERMIT: 58559
CLAIM NO.: 346/347
AREA: 68.46 AC
SOURCE: ORR DITCH

Detail N

SOURCES

- 1946 aerial photograph, USGS GS-CV 2-110, 7/10/1946
- Truckee River Decree map TR-014

EXHIBIT
Tab 25

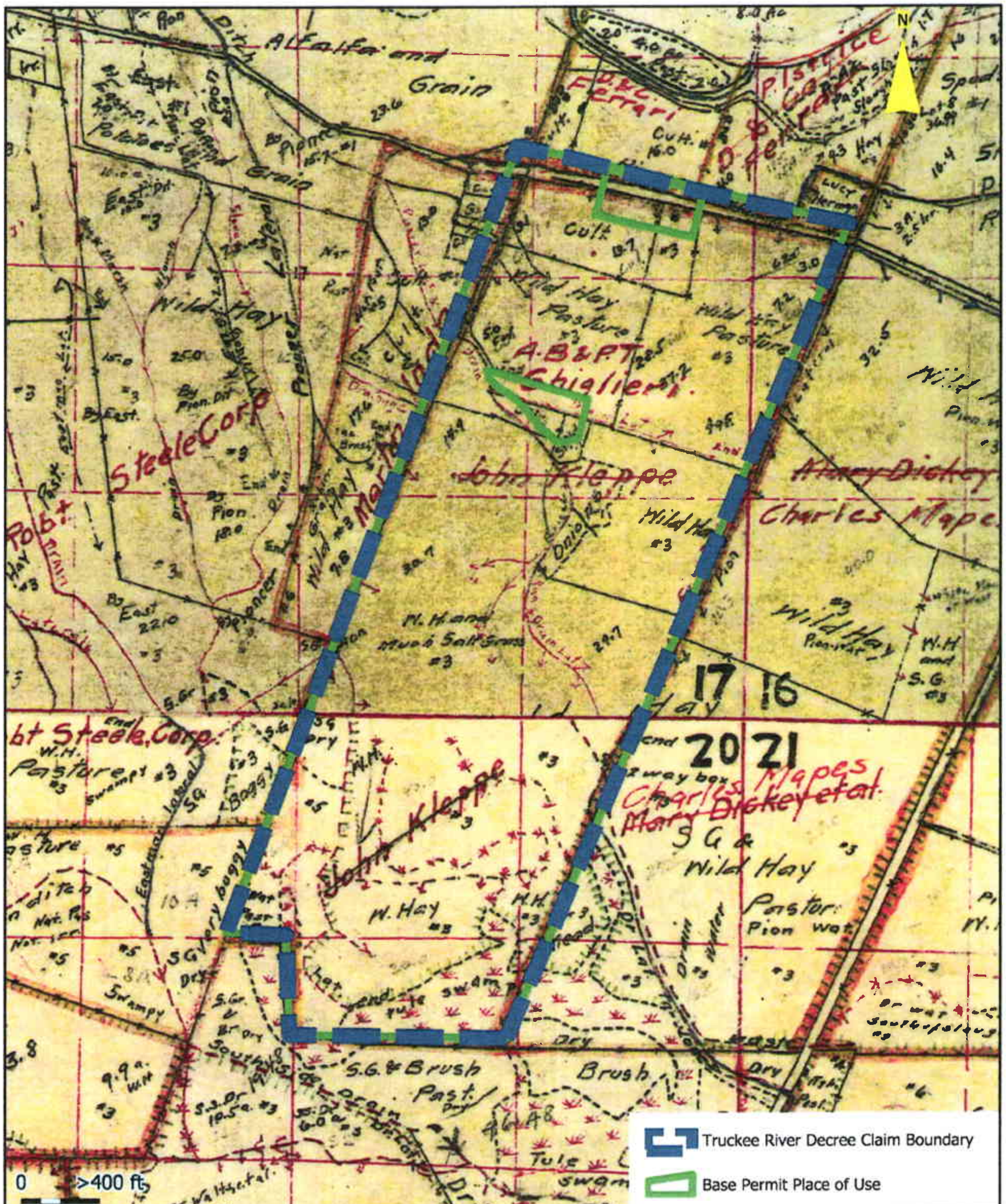


APPLICATION: 73986
BASE PERMIT: 58559
CLAIM NO.: 346/347
AREA: 68.46 AC
SOURCE: ORR DITCH

Detail N

SOURCES

- 1967 aerial photograph, FSA EW-X-2HH-33, 3/5/1967
- Truckee River Decree map TR-014



APPLICATION: 74077
BASE PERMIT: 23118
CLAIM NO.: 600
AREA: 137 AC
SOURCE: PIONEER DITCH

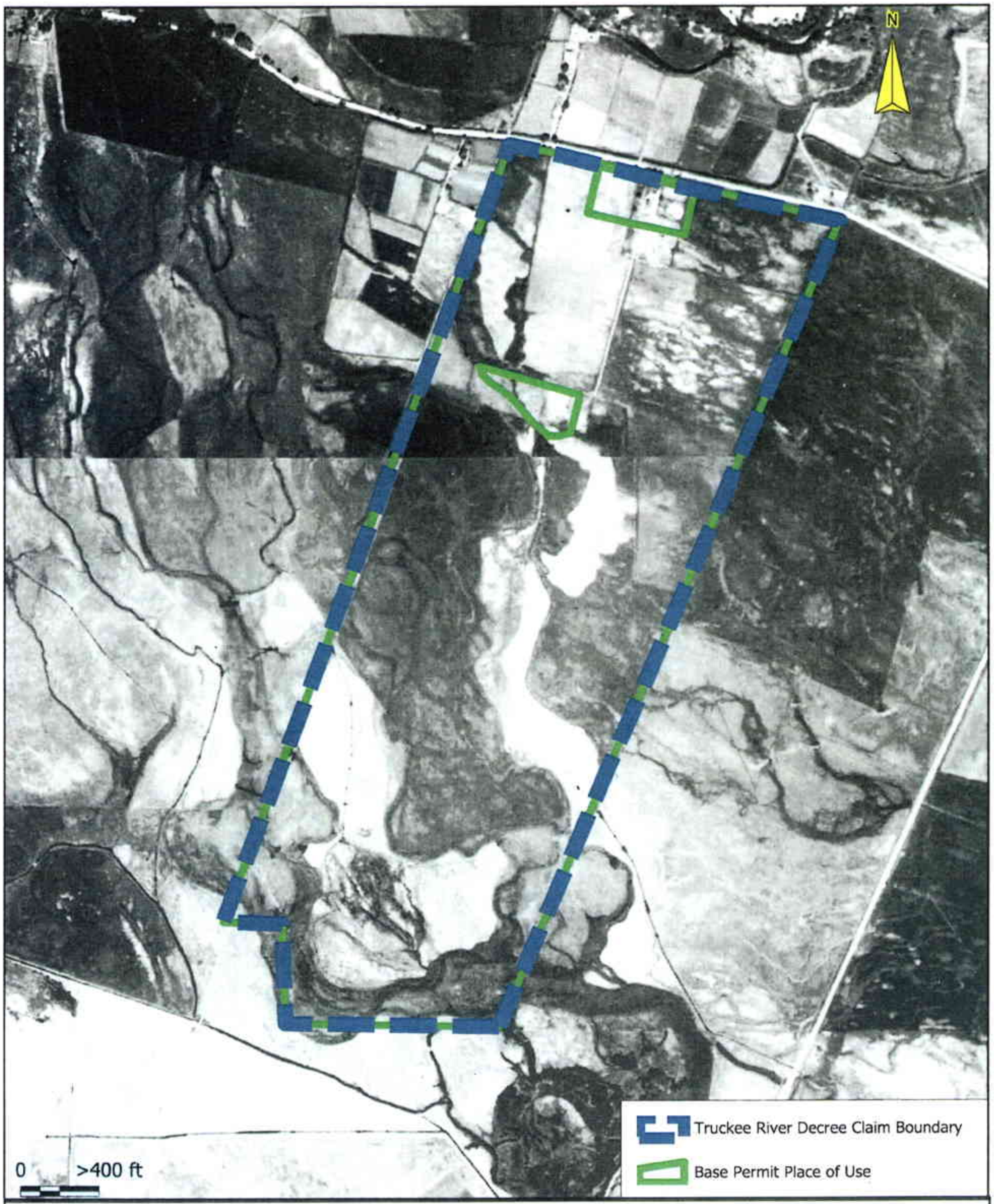
Detail O

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable maps, sheets 9 & 10
- Truckee River Decree map TR-048

EXHIBIT

Tab 26



APPLICATION: **74077**
BASE PERMIT: **23118**
CLAIM NO.: **600**
AREA: **137 AC**
SOURCE: **PIONEER DITCH**

Detail O

SOURCES
- 1939 aerial photograph, USDA CDJ-18-85/86, 6/29/1939
- Truckee River Decree map TR-048

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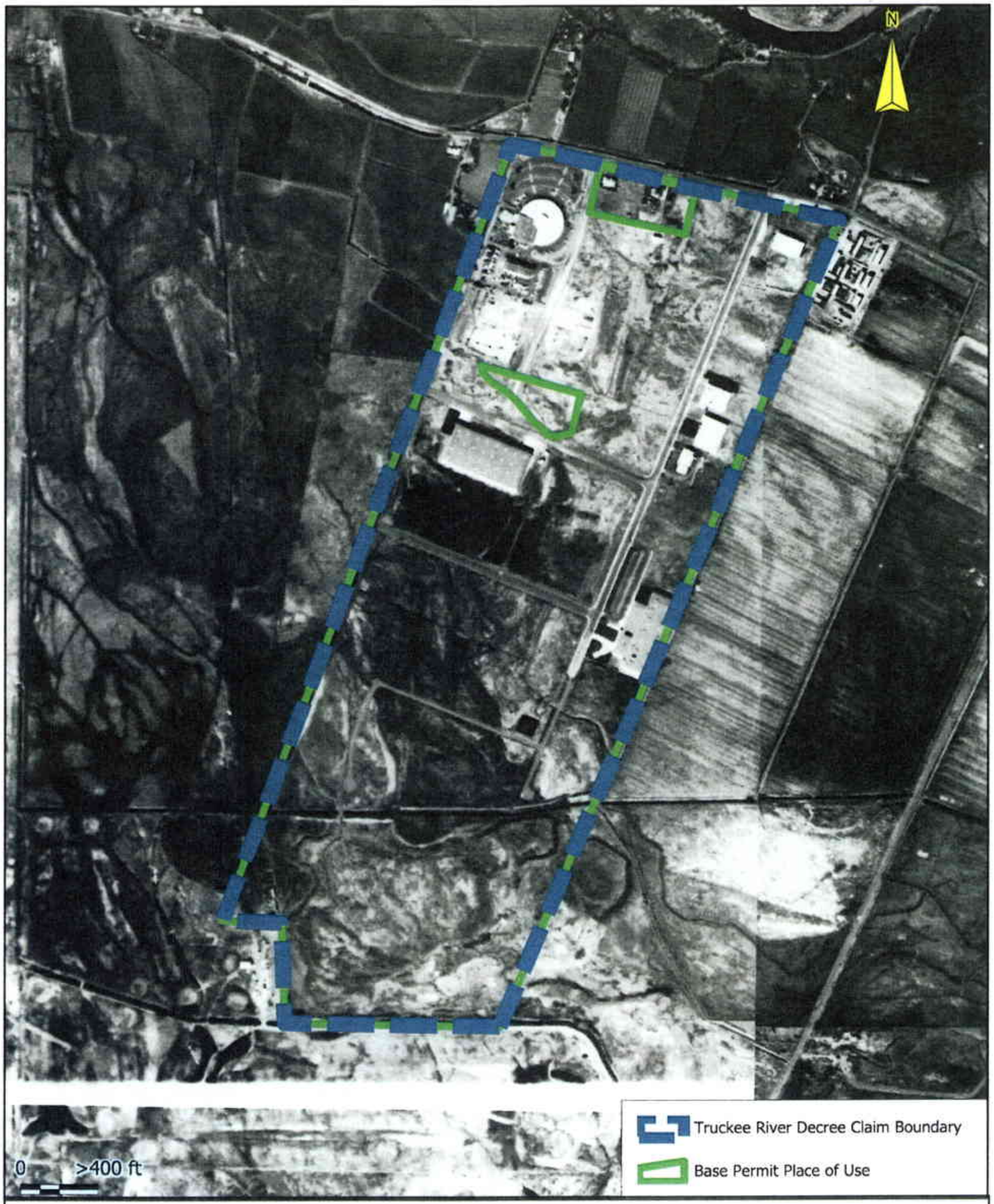
tabbies
Tab 26

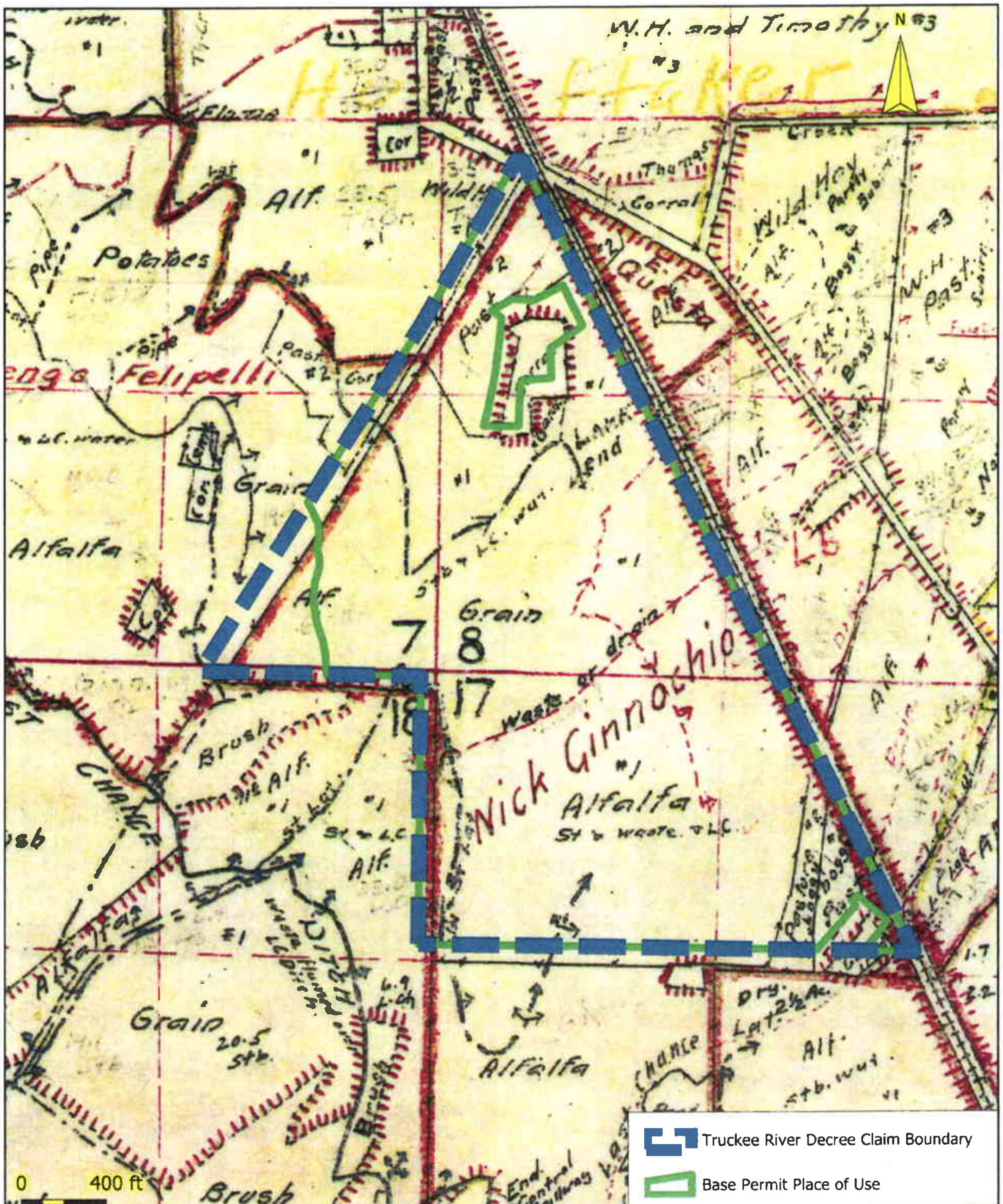


APPLICATION: **74077**
BASE PERMIT: **23118**
CLAIM NO.: **600**
AREA: **137 AC**
SOURCE: **PIONEER DITCH**

Detail O

SOURCES

- 1967 aerial photograph, FSA EW-X-1HH-43/45, 3/5/1967
- Truckee River Decree map TR-048



APPLICATION: 74082
BASE PERMIT: 46361
CLAIM NO.: 80
AREA: 137.56 AC
SOURCE: STEAMBOAT DITCH

Detail P

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 11
- Truckee River Decree map TR-006

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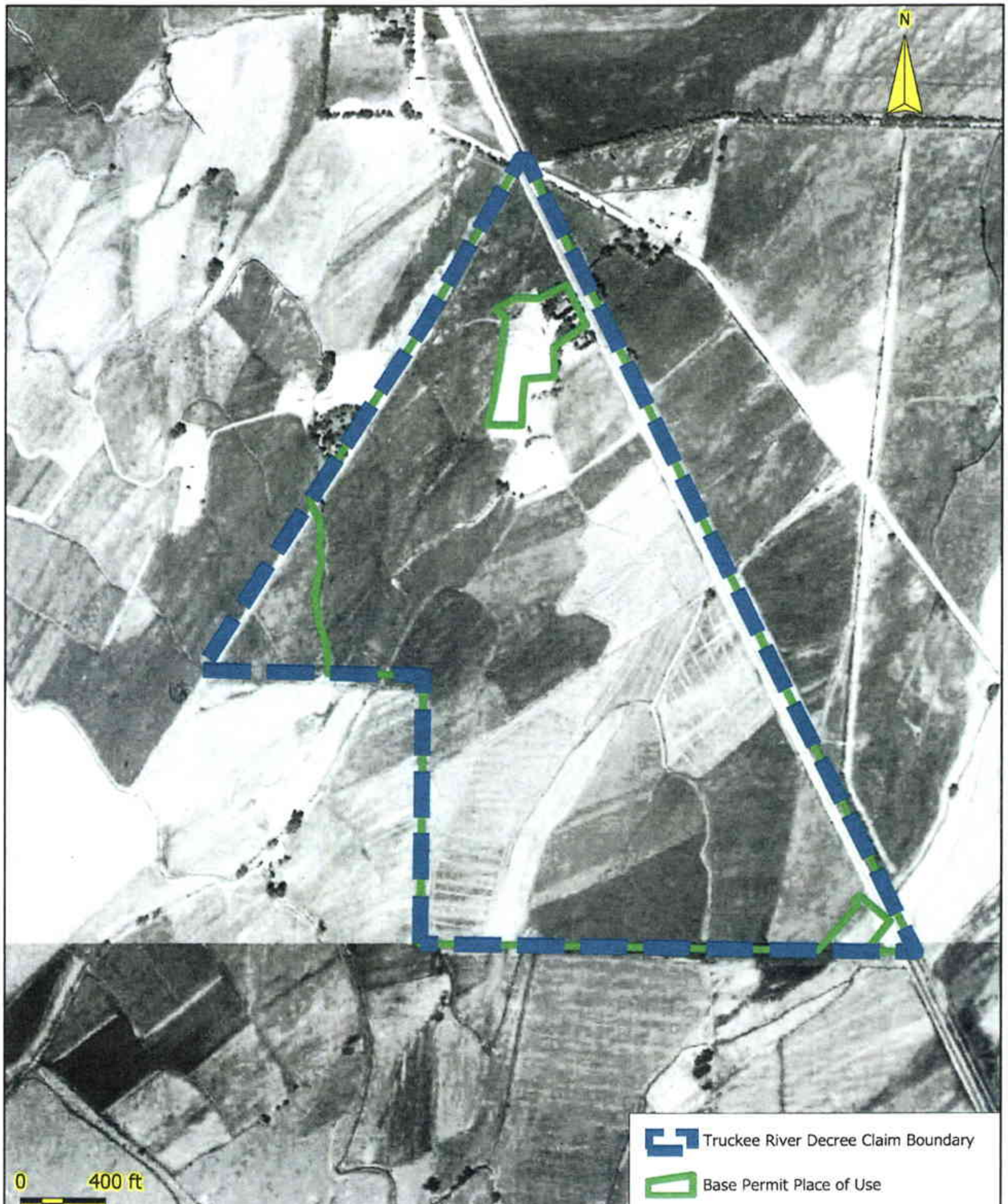
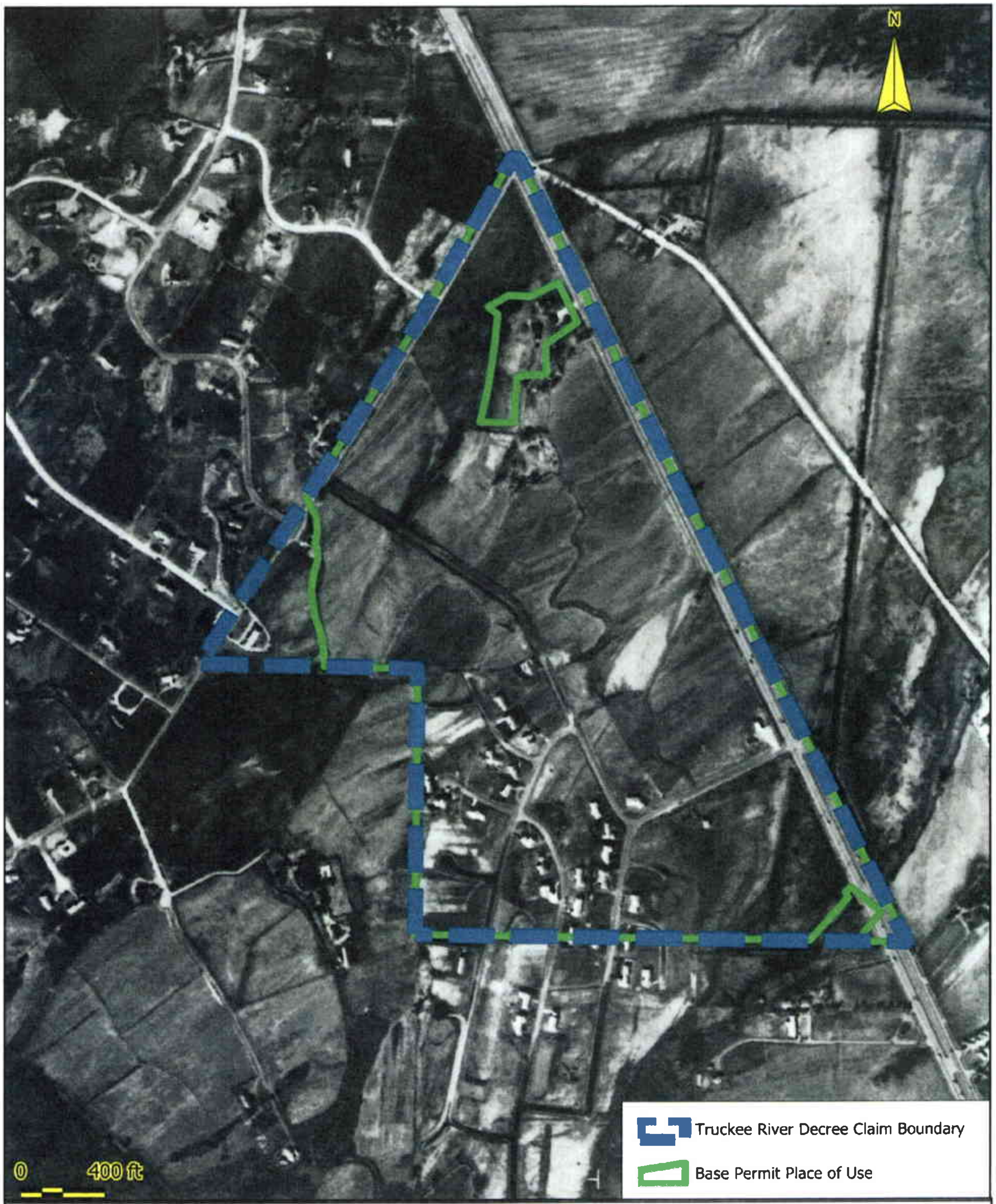


APPLICATION: 74082
BASE PERMIT: 46361
CLAIM NO.: 80
AREA: 137.56 AC
SOURCE: STEAMBOAT DITCH

Detail P

SOURCES
- 1939 aerial photograph, USDA CDJ-18-79, 6/29/1939
- Truckee River Decree map TR-006

EXHIBIT
Tab 27

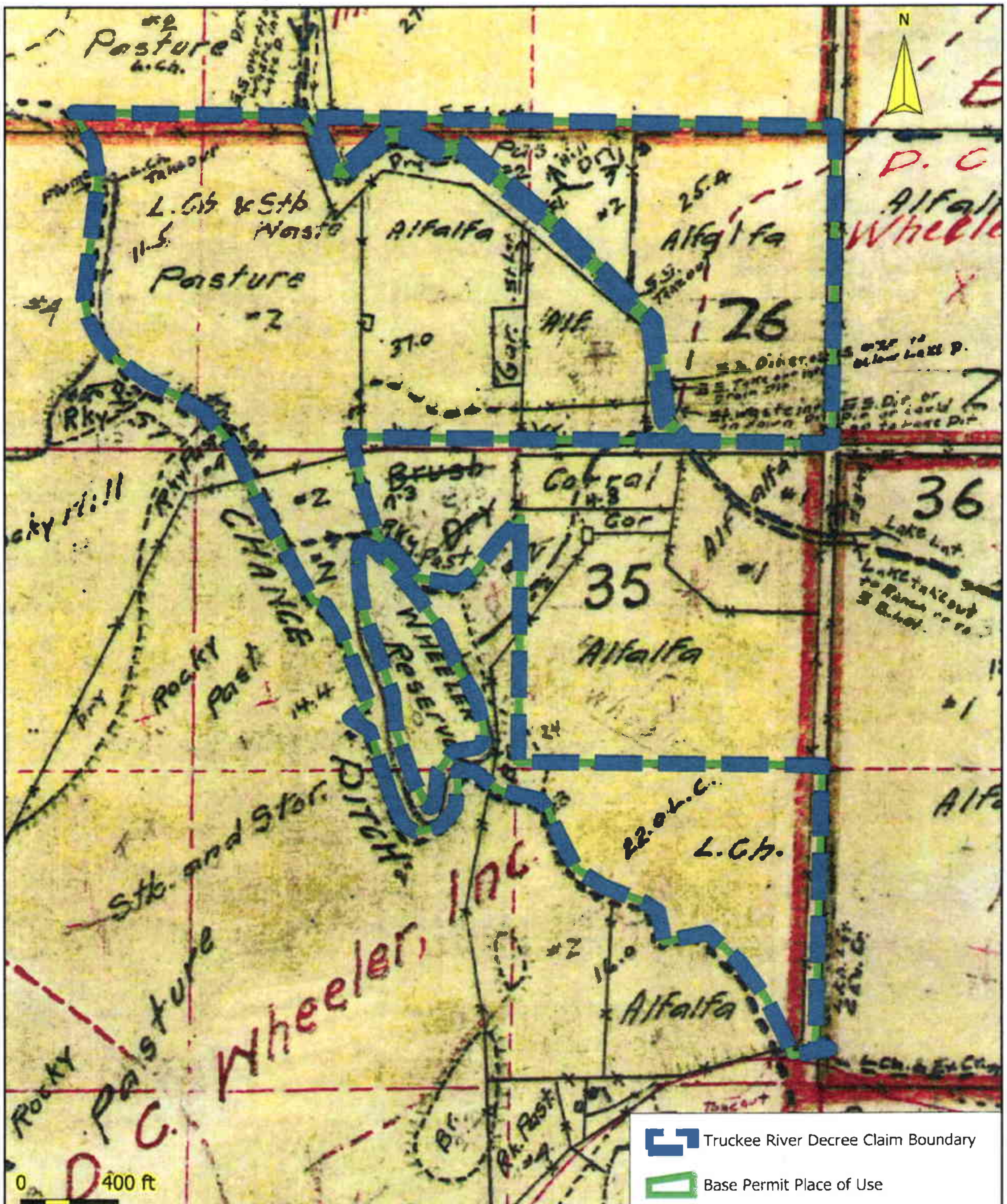


APPLICATION: 74082
BASE PERMIT: 46361
CLAIM NO.: 80
AREA: 137.56 AC
SOURCE: STEAMBOAT DITCH

Detail P

SOURCES

- 1967 aerial photograph, FSA EW-X-2HH-74, 3/5/1967
- Truckee River Decree map TR-006



APPLICATION: **74196**
BASE PERMIT: **24614**
CLAIM NO.: **181**
AREA: **35.7 AC**
SOURCE: **LAST CHANCE DITCH**

Detail Q

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 6
- Truckee River Decree map TR-057

EXHIBIT
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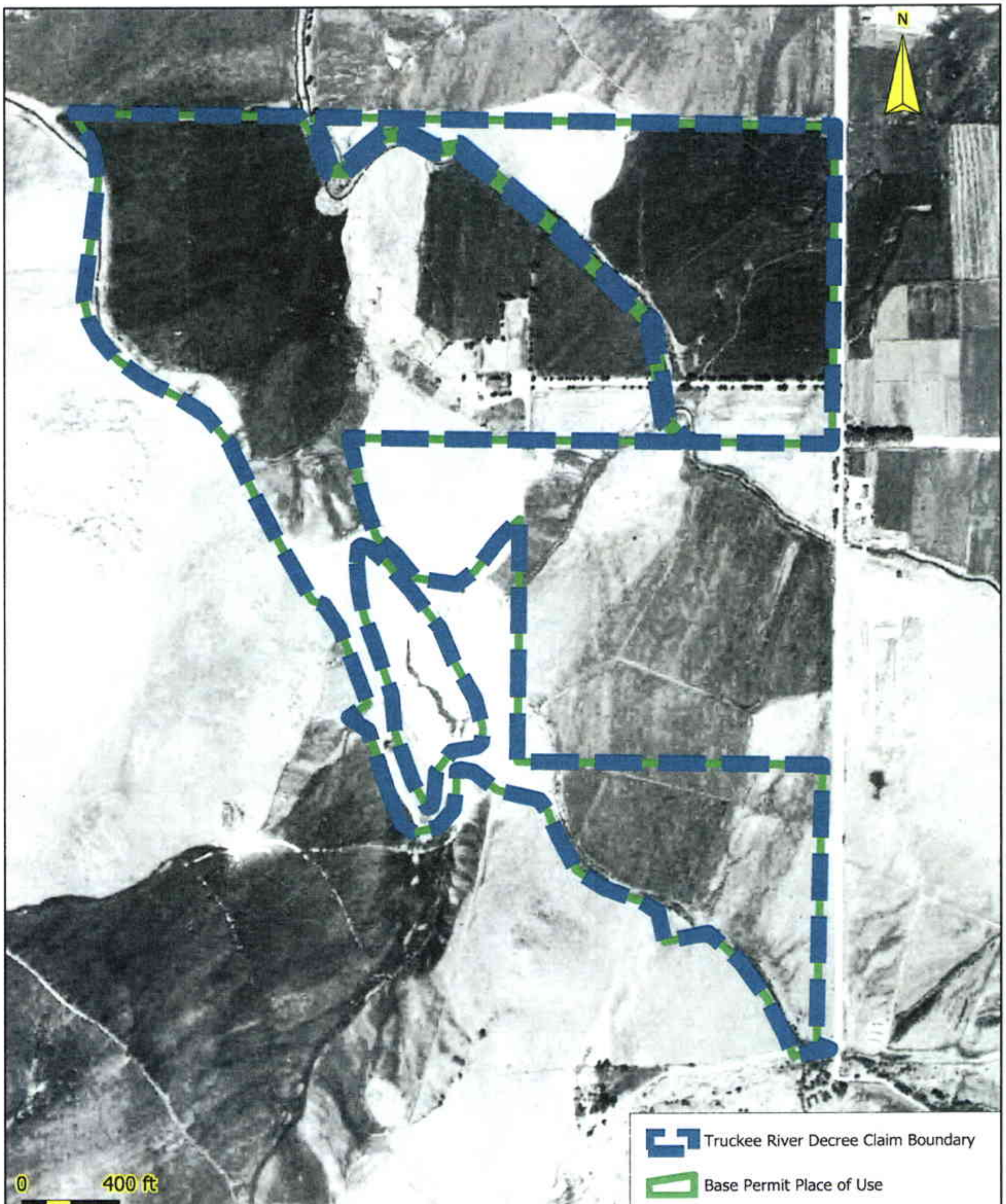

APPLICATION: 74196
BASE PERMIT: 24614
CLAIM NO.: 181
AREA: 35.7 AC
SOURCE: LAST CHANCE DITCH

Detail Q

SOURCES

- 1939 aerial photograph, USDA CDJ-18-27, 6/29/1939
- Truckee River Decree map TR-057

EXHIBIT
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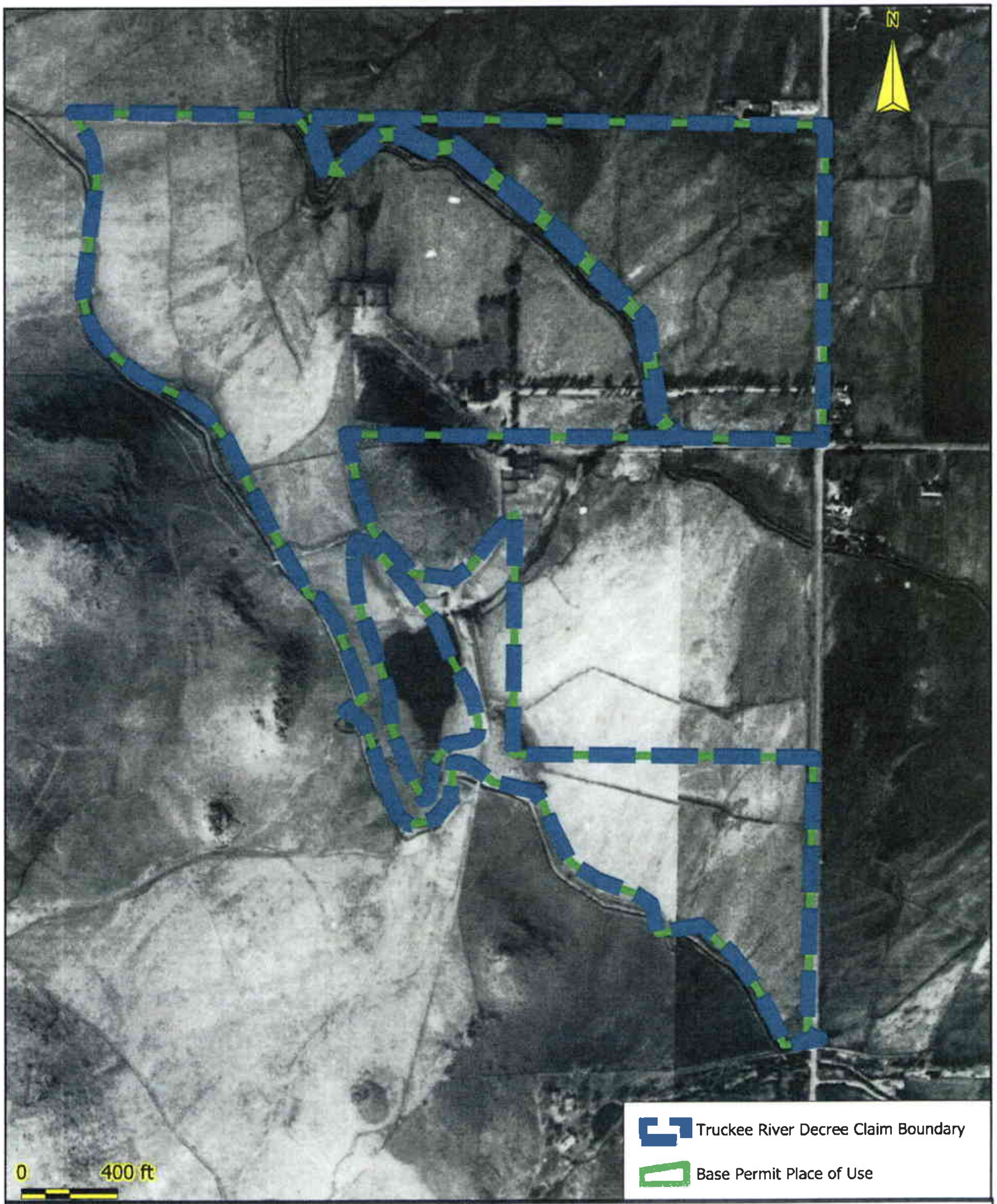
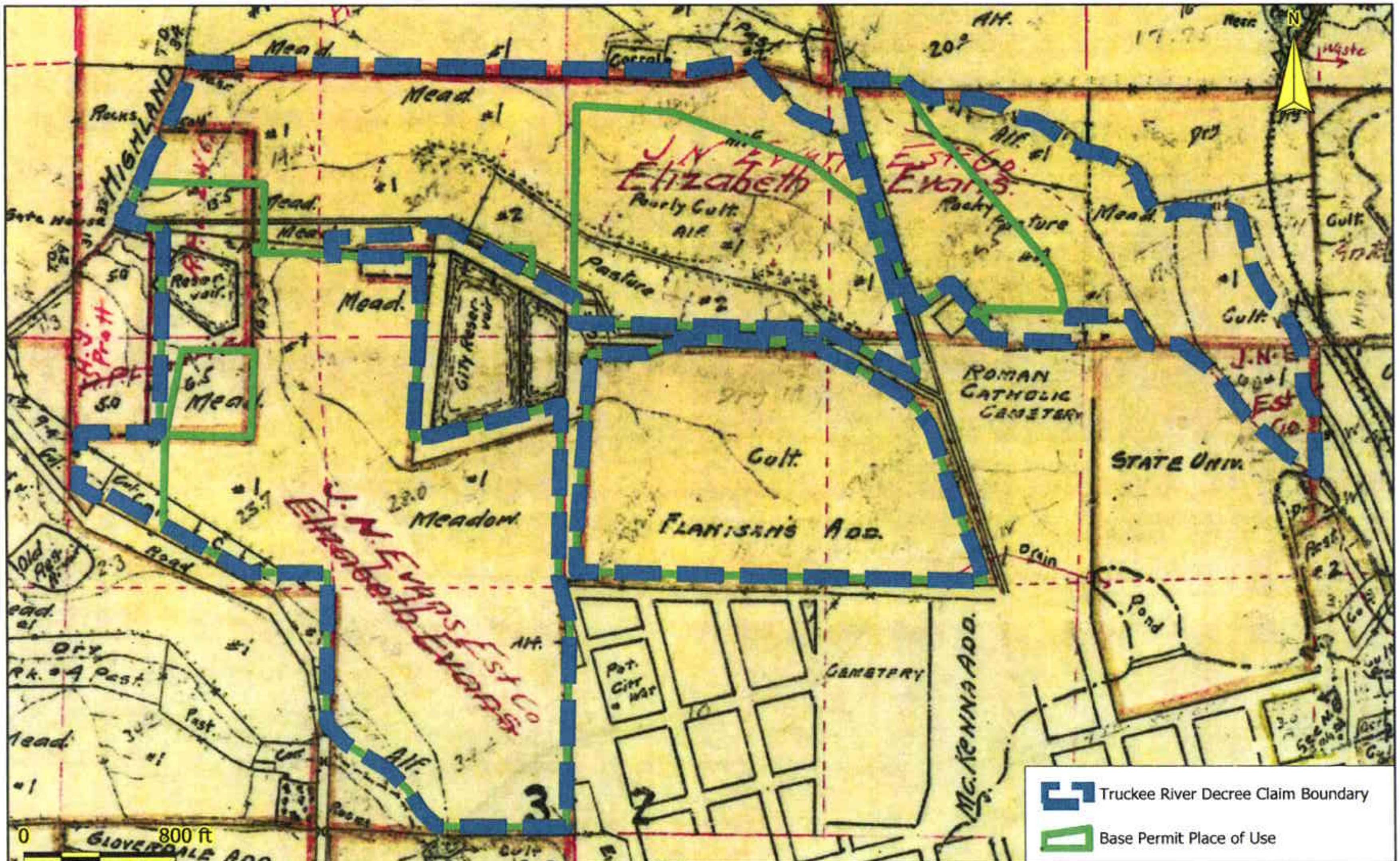


APPLICATION: **74196**
BASE PERMIT: **24614**
CLAIM NO.: **181**
AREA: **35.7 AC**
SOURCE: **LAST CHANCE DITCH**

Detail Q

SOURCES

- 1967 aerial photograph, FSA EW-X-1HH-43/45, 3/5/1967
- Truckee River Decree map TR-057



APPLICATION:	**74200**
BASE PERMIT:	**38212**
CLAIM NO.:	**130**
AREA:	**208.84 AC**

Detail R

SOURCE: HIGHLAND DITCH

SOURCES

- 1913 USRS (USBOR) Truckee River Adjudication Survey planetable map Sheet 5
- Truckee River Decree map TR-100

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APPLICATION: 74200
BASE PERMIT: 38212
CLAIM NO.: 130
AREA: 208.84 AC

Detail R

SOURCE: HIGHLAND DITCH

SOURCES
- 1939 aerial photograph, USDA CDJ-18-11, 6/29/1939
- Truckee River Decree map TR-100

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APPLICATION: 74200
BASE PERMIT: 38212
CLAIM NO.: 130
AREA: 208.84 AC

Detail R

SOURCE: HIGHLAND DITCH

SOURCES
- 1967 aerial photograph, FSA EW-X-1HH-69, 3/5/1967
- Truckee River Decree map TR-100

HMS HISTORY MAPPING SERVICES

Water Rights Research & Mapping
Industrial Archeology

November 17, 2009

Chris Mahannah, Principal
Mahannah & Associates
566 Ridge Ave
Reno NV 89501

RE: Description of Truckee Meadows Water Right POU Mapping

Per your request the following is a description of the techniques and sources used to produce the exhibits for the Truckee Meadows Water Right POU Mapping project:

HMS was contracted by Mahannah & Associates on 10/6/2009 to provide digital GIS datasets to describe the Place of Use (POU) for a list of water right applications located in the Reno/Truckee Meadows area, Nevada. The purpose of the datasets was to spatially locate the POUs for the base water right permits, and provide maps and aerial photographs to portray historic use of water on those properties.

The project included the development for three groups of datasets:

A. Decree claim and permit boundaries
B. 1913 Truckee River Adjusdication Suvey planetable maps
C. Historic Aerial Photography

Decree claim and permit boundaries

A list of water right applications to be identified was supplied by Mahannah & Associates. Digital copies of the Truckee River Decree maps were downloaded from the NDWR website: (http://water.nv.gov/Adjudications/Mapping/Truckee/oddclaims.cfm) on 10/30/2009 as .DWF (Design Web Format) files. The .DWF files were converted to Autocad .DWG drawing files using CADwizz software. In most cases during the .DWF to .DWG conversion the parcels and permit boundaries converted as vector lines, however the claim boundaries converted as colored shapes. In these situations the claim boundaries were digitized as closely as to possible to match the colored shapes. The layers for the claim boundaries, permits, and parcels were then cleaned and digitally cut and pasted onto a new Autocad drawing using the USDA 2006 NAIP Washoe County-South aerial photograph as a base. This provided rectification and georeferencing for the layers. The claim boundary and permit polygons were cleaned again, and then attributed and exported as separate ESRI .SHP files. The final .SHP files were imported into a Manifold Systems project using the projection Nevada State Plane West, NAD83 (feet).

1913 USRS (USBOR) Truckee River Adjudication Survey maps

A full set of encapsulated planetable map copies for the Truckee River Decree was supplied by Mahannah & Associates. Sixteen of the maps that covered the POU areas were scanned at a

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resolution of 400x400 and saved as .JPG files. The planetable map images were rectified and georeferenced using Global Mapper software. The technique used is referred to as a "polynomial" method where control points on the target image to be rectified (in this case the planetable map images) are matched to corresponding points on a reference image (1955 quadrangle map images). The program then 'rubbersheets' the target image to match the reference image. All section corners on the planetable images were matched to section corners on the USGS quadrangle images for the georeferencing. In some cases where a permit boundary straddled two planetable maps the images were trimmed and merged in Global Mapper. As a reference image to rectify and georeference the images the best match for precision, mapped ground features, and Public Land Survey grid was found to be the circa-1955 15' USGS quadrangle maps. Georeferenced digital images of the maps were located and downloaded from the University of Nevafda-Reno Keck Library site (ftp://nas.library.unr.edu/Keck). The five maps used were the 1:62,500 (15 minute) Reno, Mount Rose, Virginia City, Wadsworth, and Spanish Springs quadrangles. A mosaic was created in Global Mapper by clipping the collars from the map images and merging the images together into a single .ECW file.

Historic Aerial Photographs

Historic aerial photographs were collected from Mahannah & Associates and HMS in-house files, and appropriate photographs were identified that documented the historic irrigation practices on the properties prior to urban development. Aerial photographs were scanned at HMS using a Widecom 936C wide format color scanner. All 10"x10" photographs were scanned at a resolution of 1000x1000. The 1967 photographs (24"x24") were scanned at a resolution of 800x800 due to their large size. The rectification and georeferencing was again done using Global Mapper software. As a reference image the 1994 USGS DOQ orthorectified images (B/W) were used. The 1994 DOQ images represented the oldest set of orthorectified aerial photograph images that are available for the Truckee Meadows, which increased the probability of locating control points in common with the historic aerial photography. Digital copies of the 1994 DOQs were downloaded from the UNR-Keck website and were merged into a single mosaic. The historic aerial photograph image rectifications were typically done using 6-12 control points evenly distributed over the target image. The resultant images were visually checked against the 1994 DOQ and 2006 NAIP images for drift, and rebuilt if the variances became significant. The individual images for the 1939, 1946, and 1967 photograph sets were trimmed and merged into mosaics using Global Mapper.

Sincerely,

Andrew E. Stroud

Andrew E. Stroud
Water Rights/Mapping Specialist