BEFORE THE DEPARTMENT OF WATER RESOURCES

OF THE STATE OF IDAHO

IN THE MATTER OF DISTRIBUTION OF WATER) TO VARIOUS WATER RIGHTS HELD BY OR FOR) THE BENEFIT OF A&B IRRIGATION DISTRICT,) AMERICAN FALLS RESERVOIR DISTRICT #2,) BURLEY IRRIGATION DISTRICT, MILNER) IRRIGATION DISTRICT, MINIDOKA IRRIGATION) DISTRICT, NORTH SIDE CANAL COMPANY,) AND TWIN FALLS CANAL COMPANY) ______________________________________)	**ORDER REGARDING PROTOCOL FOR DETERMINING MATERIAL INJURY TO REASONABLE IN-SEASON DEMAND AND REASONABLE CARRYOVER**

FINDINGS OF FACT

I. Procedural Background

1. On September 5, 2008, the Director of the Department of Water Resources ("Director" or "Department") issued a final order in this matter, in which he stated:

> Because of the need for ongoing administration, the Director will issue a separate, final order before the end of 2008 detailing his approach for predicting material injury to reasonable in-season demand and reasonable carryover for the 2009 irrigation season.

Final Order Regarding the Surface Water Coalition Delivery Call at 6, ¶ 25 ("Final Order").

2. On October 22, 2008, the Director sent a letter to water right holders warning of potential curtailment of ground water rights that divert from the Eastern Snake Plain Aquifer ("ESPA"). The letter stated, "IDWR computations predict that if the expected runoff [at the Heise Gage] is at least 85 percent of normal, no curtailment will be required. If the predicted runoff is the same as in 1977, the lowest runoff year on record (45 percent of normal), ground water rights with priority dates junior to May 12, 1977 could be subject to curtailment."

3. In November 2008, the Director requested that members of the Surface Water Coalition ("SWC")[1] provide the Department with the number of acres that were anticipated to be irrigated during the 2009 irrigation season in order to determine the SWC's reasonable irrigation needs.

[1] The seven members of the SWC are as follows: A&B Irrigation District ("A&B"); American Falls Reservoir District No. 2 ("AFRD2"); Burley Irrigation District ("BID"); Milner Irrigation District ("Milner"); Minidoka Irrigation District ("MID"); North Side Canal Company ("NSCC"); and Twin Falls Canal Company ("TFCC").

4. On May 4, 2009, the Director met with the parties to present the Draft Protocol for determining material injury to in-season shortages and reasonable carryover shortfalls. On June 1, 2009, a technical workshop regarding the draft protocol took place at the Department with representatives of the Department, SWC, the Magic Valley and North Snake Ground Water Districts ("Ground Water Districts"), and the City of Pocatello ("Pocatello") participating. Written questions and responses to the Draft Protocol were submitted by the parties to the Department through June 12, 2009.

5. On May 26, 2009, the Director announced that, effective June 30, 2009, he would be retiring after 33 years of service to the State as an employee of the Department.

6. On June 12, 2009, counsel for MID submitted a *Petition for Review of Director's Interlocutory Orders* and *Request for Hearing* ("Minidoka Petition"). The Minidoka Petition asserted that the Director's process in this matter was unlawful and should be dismissed. If the matter is not dismissed, Minidoka has requested a hearing on its Petition.

7. On June 12, 2009, IGWA provided its *Comments on Draft Protocol for Mitigation Computations* ("IGWA Comments"). In addition to raising a number of comments about the Draft Protocol, IGWA stated "that the current Director should defer to the newly appointed Director any adoption of a final Protocol. However, if the current Director intends to adopt a final Protocol, then, IGWA requests that IDWR address the areas of concern listed above and modify the methodology to incorporate the additional terms." *IGWA Comments* at 12.

8. On June 25, 2009, counsel for AFRD2 filed a *Notice of Appearance of Representative* with the Department In the Matter of the Mitigation Computations in Water District 120 for the Surface Water Coalition. On June 26, 2009, counsel for A&B, BID, Milner, NSCC, and TFCC filed a *Notice of Appearance of Representative* with the Department In the Matter of the Mitigation Computations in Water District 120 for the Surface Water Coalition.

II. Material Injury Projection For The 2009 Irrigation Season

9. On or about April 6, 2009, the United States Bureau of Reclamation ("USBR") and the United States Army Crops of Engineers ("USACE") issued their joint operating forecast ("Joint Forecast") for unregulated inflow from the Upper Snake River Basin projected at the Heise Gage. Because snowpack in the Upper Snake River Basin generally peaks in April, the Joint Forecast issued soon after April 1 is generally as accurate a forecast as is possible using current data gathering and forecasting techniques for the period April 1 through July 31. The Joint Forecast predicted unregulated inflow into the Upper Snake River Basin of 3,520,000 acre-feet, or 98.85% of the 30-year average.

10. Using the Joint Forecast, the natural flow supplies and storage allocations for the 2009 season are estimated for members of the SWC, and are shown in the table below in acre-feet. Storage supplies for 2009 are estimated as full allocations, less 2.3% evaporation losses. Natural flow supplies are calculated using regression relations developed from historic natural flow use and Heise runoff patterns.

	Projected 2009 Natural Flow	2009 Storage	Total 2009 Supply
A&B	11,800	134,500	146,300
AFRD2	108,000	385,500	493,500
BID	161,400	226,300	387,700
Milner	17,000	87,400	104,400
MID	143,100	366,300	509,400
NSCC	510,100	832,500	1,342,600
TFCC	863,900	233,700	1,097,600

11. The Upper Snake Basin had near normal temperatures during May 2009. The basin-wide precipitation for May was 85% of average. So far, June has been cool and very wet. As of June 29, 2009 the temperatures on the Snake Plain ranged from approximately 0.7° above average to 4.5° F below average. Month-to-date precipitation was at or above 350% of average for most locations along the Snake Plain. Twin Falls had received 4.85 inches of rain, which is a 4.05 inch departure from normal.

12. As of June 30, 2009, the day of allocation for storage water in Water District 01 has not yet occurred.

13. With anticipated full irrigation supplies (natural flow + storage) for members of the SWC, no shortfalls due to ground water depletions are projected during the 2009 season. The Director will continue to monitor runoff and storage levels, and adjust supplies and shortfall estimates if warranted.

III. Protocol For Determining Material Injury To Reasonable In-Season Demand And Reasonable Carryover

14. The May 2, 2005 Amended Order ("May 2005 Order") and its progeny used the concept of a minimum full supply to quantify the amount of water members of the SWC needed during an irrigation season to ensure a reasonable supply. The minimum full supply was established by reviewing diversion records over a 15-year period (1990-2004), and selecting a single year with the smallest annual diversion amount that had full headgate deliveries without leasing any storage space. The year that best fit this criterion was 1995.

15. The May 2005 Order and its progeny were the subject of a fourteen-day hearing before hearing officer Gerald F. Schroeder ("Hearing Officer"). In his April 29, 2008 *Opinion Constituting Findings Of Fact, Conclusions Of Law And Recommendation* ("Recommended Order"), the Hearing Officer did not disagree with the Director's need-based analysis. The Hearing Officer, did, however, provide recommendations to the Director if he were to employ this type of analysis moving forward.

Predictions of need should be based on an average year of need, subject to adjustment up or down depending upon the particular water conditions for the irrigation season. This is the initial concept behind the minimum full supply. The development of an acceptable baseline subject to adjustment for changing conditions retains the value of having senior rights while providing some level of protection against unnecessary curtailment. The concept is good, but the minimum full supply identified by the Director has no defenders from the parties. A brief summary of objections to the Director's minimum full supply can be stated:

> a. It is based on a wet year. To get to an average moisture year an adjustment would be necessary to determine how much greater the minimum full supply would be if the weather equated to an average year when an adequate amount of water was delivered.
>
> b. It is based on a decade old year that does not reflect current efficiencies such as the increased use of sprinkler irrigation and computer monitoring or changes in the amount of land irrigated.
>
> c. It has an emphasis on supply rather than need. That is the amount of water that provided full headgate deliveries. Those may or may not have been needed in that wet year.

Recommended Order at 48.

16. In the Final Order, the Director recognized the Hearing Officer's recommendations and stated his intention of adjusting his future analysis for determining the SWC's reasonable irrigation needs, which will be termed reasonable in-season demand ("RISD").

17. As will be explained in detail below, RISD is the amount of water used in a previous irrigation season with average climatic characteristics and average total water supplies sufficient to satisfy the consumptive use requirements of crops; and with water application systems, delivery efficiencies, and project acreages representative of current conditions. The reference irrigation season used for the RISD is called the "baseline year."

18. The Protocol developed by the Department is draft in nature, in that it is subject to modification based on ongoing input from the parties and the Department; new science; new data; or new modeling concepts. The protocol for determining injury to in-season demand and reasonable carryover should be based on the best available science and the Director's best professional judgment as manager of the State's water resources.

19. Unless otherwise stated, all examples of implementation of the Protocol pertain to the TFCC and the 2002 irrigation season.

A. Terminology and Definitions:

a. **Actual Crop Water Need**: The numerical difference between the value of evapotranspiration ("ET") volume and the effective precipitation adjustment factor. NDVI or ETIdaho can be used for calculating ET.

b. **Advanced Wide Field Sensor ("AWiFS")**: Sensor on board the Indian Remote Sensing ("IRS") earth observation satellite, RESOURCESAT-1. AWiFS collects four spectral bands at a pixel size of 56 meters.

c. **Baseline Demand**: The total volume of water diverted at the headgate for the current baseline year. The initial Baseline Demand year is 2006.

d. **Baseline Year**: A previous or historic irrigation season with normal climatic characteristics and average total water supplies sufficient to satisfy the beneficial use requirements of crops; and with water application systems, delivery efficiencies, and project acreages representative of current conditions.

e. **Beneficial Use**: A calculated volume of water for a SWC entity equal to the crop water need divided by the project efficiency, plus *diversion adjustment factor* ("DAF").

f. **Carryover**: Unused water in a reservoir at the end of the irrigation year, which is retained or stored for future use.

g. **Consumptive Irrigation Requirement**: The amount of water, excluding in-season effective rainfall and antecedent soil moisture, required to meet the ET requirement of a crop. Expressed as a volume, rate, or depth. Synonymous with crop water need when expressed as a volume.

h. **Consumptive Use**: *See* Evapotranspiration/ET. Abbreviated CU.

i. **Crop Water Need**: The volume of water required for optimal growth, by all crops supplied with surface water, by the surface water user; it is the product of the area of planted crops and ET less the effective precipitation adjustment. Synonymous with volumetric consumptive irrigation requirement.

j. **Day of Allocation**: When the Water District 01 watermaster is able to issue allocations to storage spaceholders after the reservoir system has achieved its maximum physical fill, maximum water-right accrual, and any excess spill past Milner Dam has ceased.

k. **Demand Shortfall**: For the initial calculation it is equal to the difference of the baseline demand and the forecast supply. For in-season calculations demand shortfall is equal to the difference of reasonable in-season demand and forecast supply.

l. **Diversion Adjustment Factor ("DAF")**: The amount of water diverted in excess of the amount for meeting the crop water need which is necessary for proper system operation when on-farm demand is diminished during unforeseen climate conditions, such as wet or cool spells, or other conditions that are a valid beneficial use of an irrigation right not accounted for in the baseline project efficiency.

m. **Effective Precipitation**: That part of total rainfall that satisfies crop ET requirements. Includes precipitation that does not leave the soil surface as runoff or contribute to subsurface drainage.

n. **Effective Precipitation Adjustment**: The portion of the ET requirement for a SWC entity that is supplied by effective precipitation, calculated as the rainfall depth residing in the root zone multiplied by the cropped area.

o. **Eligible Carryover**: The gross storage allocation minus the total storage use plus any non-SWC storage use, included in the storage use.

p. **ETIdaho**: Comprehensive ET data and calculation procedures specific to Idaho crops and weather stations developed by the University of Idaho and documented in *Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho*, R.G. Allen and C.W. Robison (2007).

q. **Evapotranspiration ("ET")**: Amount of water transpired by an actively growing plant plus water evaporated from soil in the area of the plant. Synonymous with consumptive use.

r. **Forecast Supply**: The combined volume of water available due to anticipated natural flows and total storage (predicted fill and carry over) at the headgate of the SWC entity.

s. **IGWA**: Idaho Ground Water Appropriators, Inc.

t. **Irrigation Efficiency**: The percentage of diverted irrigation water that is stored in the soil and available for consumptive use by the crop. This efficiency reflects losses from distribution system seepage, operational spill, surface runoff, and wind drift from sprinkler irrigated fields.

u. **Irrigation Requirement**: The amount of water required to be diverted to the irrigation system per unit of time to meet the consumptive irrigation requirement. This is calculated as the consumptive irrigation requirement, minus effective precipitation; divided by the irrigation efficiency.

v. **Irrigation Season**: April 1 through October 31.

w. **Irrigation Year**: November 1 through October 31.

x. **Landsat Imagery**: The Landsat program is the longest running enterprise for acquisition of imagery of Earth from space. The first Landsat satellite was launched in 1972; the most recent, Landsat 7, was launched on April 15, 1999. Landsat 5, was launched on March 1, 1984, is still operational, and has greatly exceeded its designed life expectancy of three years. Landsat 5 and Landsat 7 both collect six spectral bands at a pixel size of 30 meters. Both Landsat 5 and Landsat 7 also have a thermal band with a pixel size of 120 meters and 60 meters, respectively.

y. **Mapping Evapotranspiration at high Resolution with Internalized Calibration (METRIC)**: Is a satellite-based image-processing procedure to compute and map ET.

z. **Minimum Full Supply**: As developed in the May 2, 2005 Order, the minimum amount of water the surface water users need to meet their crop requirements, below which curtailment is necessary if the minimum is not met as a consequence of junior ground water depletions. The minimum full supply as initially determined was to be subject to change according to conditions.

aa. **Normalized Difference Vegetation Index ("NDVI")**: Is a linear combination of red and near-infrared spectral bands. NDVI is very highly correlated to the weight of standing green biomass. NDVI can be used to calculate ET with Landsat or AWiFS imagery.

bb. **Project Efficiency**: The ratio of crop water need to headgate diversions. Synonymous with irrigation efficiency.

cc. **Reasonable Carryover**: A calculated volume of unused reservoir storage water at the end of the irrigation year that represents an amount of unused reservoir storage water that would have been available historically for the same climatic and water supply conditions, but without the depletive effects of ground water pumping on river reach gains.

dd. **Reasonable Carryover Deficit**: The numerical difference between reasonable carryover and eligible carryover, calculated at the conclusion of the irrigation season.

ee. **Reasonable Carryover Shortfall**: Amount of the reasonable carryover deficit from the previous season required as replacement water or mitigation, necessary when a demand shortfall is determined by the Director.

ff. **Reasonable In-Season Demand ("RISD")**: The cumulative volume of water projected to be diverted by the *surface water user* for the entire irrigation season. It is calculated as the cumulative *actual crop water need* divided by the *project efficiency* plus the *effective precipitation adjustment*, plus the *over-diversion adjustment factor*, for the portion of the irrigation season that has already occurred, and the cumulative *baseline demand* for the remainder of the season

gg. **Reference ET**: The rate water would be removed from soil and plant surface if readily available for an uncut crop of alfalfa.

hh. **Surface Water User**: Member of the SWC.

ii. **Time of Need**: The period when water supplies and requirements are known with the greatest degree of certainty prior to the end of the season in October, but before storage supplies have been fully utilized. This is generally during the month of September after the peak demand months. The exact date is not precise and will vary from year-to-year depending on the various climatic conditions encountered during the growing season, as well as crops grown and their planting and harvest dates.

jj. **SWC**: Surface Water Coalition.

B. Reasonable In-Season Demand ("RISD")

Selecting RISD

20. Determining RISD will consider factors described by the Hearing Officer for selecting an average year as a baseline irrigation supply. Other factors to be considered by the Director are the availability of pertinent data and analytical tools that will enable the most accurate assessment of water needs of the SWC. One analytical tool used by the Department is ET calculated by the METRIC process. METRIC ET data are available for 2000 and 2006 for the SWC area. METRIC ET data for 2008 will be processed in the future and incorporated. Selection of a baseline for this issuance of the Protocol is limited to those years with METRIC ET. The Protocol will be revised and new baseline years established as new data become available.

21. Selection of RISD is approached by analyzing the factors enumerated in the Recommended Order for establishing an average annual irrigation supply, or RISD. These include variables relating to climate, available water supply, and current practices. Identification of potential baseline years is limited to the 2000 irrigation year and after, to ensure modern irrigation practices are captured.

Climate

22. Precipitation. Inspection of parameters representing climatic conditions is done to evaluate what years in the most recent record have normal conditions, relative to the last nineteen years. Figure 1, below, shows the precipitation recorded during the growing season at the National Weather Service's Twin Falls weather station. Since 2000, the year 2006 received the nearest to normal of growing season (April through September) precipitation relative to the 1990 through 2008 average, with 5.22 inches out of 4.79 inches for the average, or 109% of average. Other years approaching average are 2003 and 2004, with 122% and 87% of average, respectively.

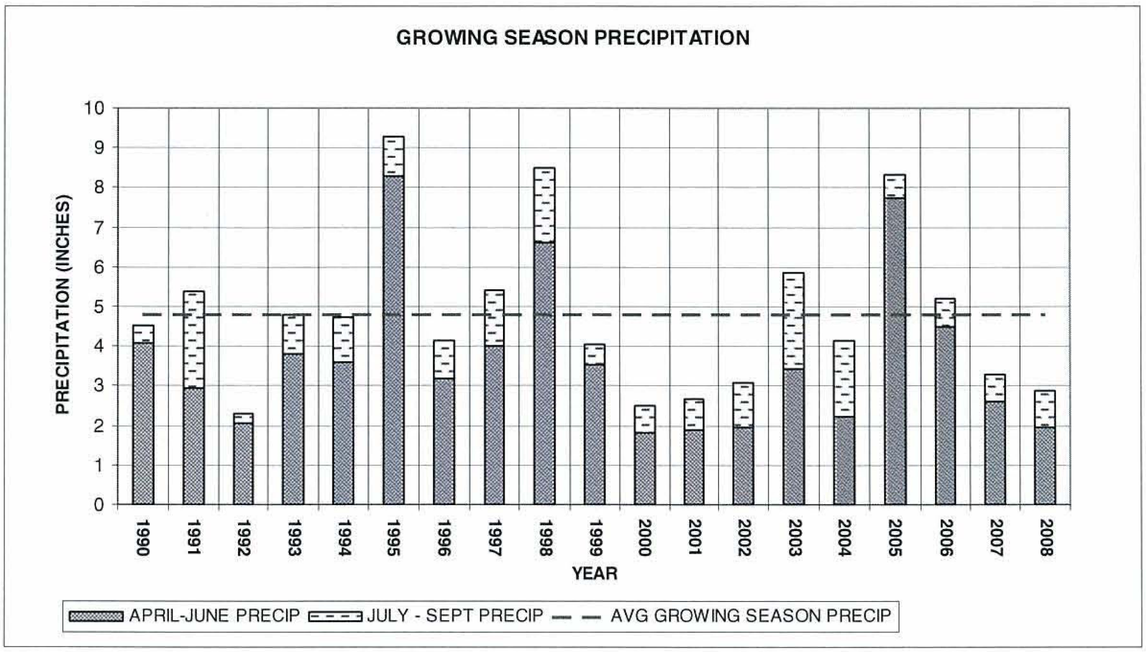


Figure 1: Growing Season Precipitation at Twin Falls Weather Station 1990–2008.

23. Evapotranspiration. The use of reference ET data calculated using ETIdaho for the Twin Falls (Kimberly) AgriMet site as an indicator of overall crop water needs for a season is appropriate for purposes of comparison of average water need between seasons. The ETIdaho method includes the contribution of effective precipitation in the reference ET calculation, and is a better measure of the actual reference ET as opposed to the traditional potential ET, or the amount of ET the reference crop would use if water was not limiting. Total April through October reference ET for the period of record from the Twin Falls (Kimberly) AgriMet site is shown below in Figure 2. Since 2000, only the years 2004 and 2006 are close to the average of the period of record for the Twin Falls (Kimberly) AgriMet site, at 100% and 104% of the 1991 through 2008 average, respectively.

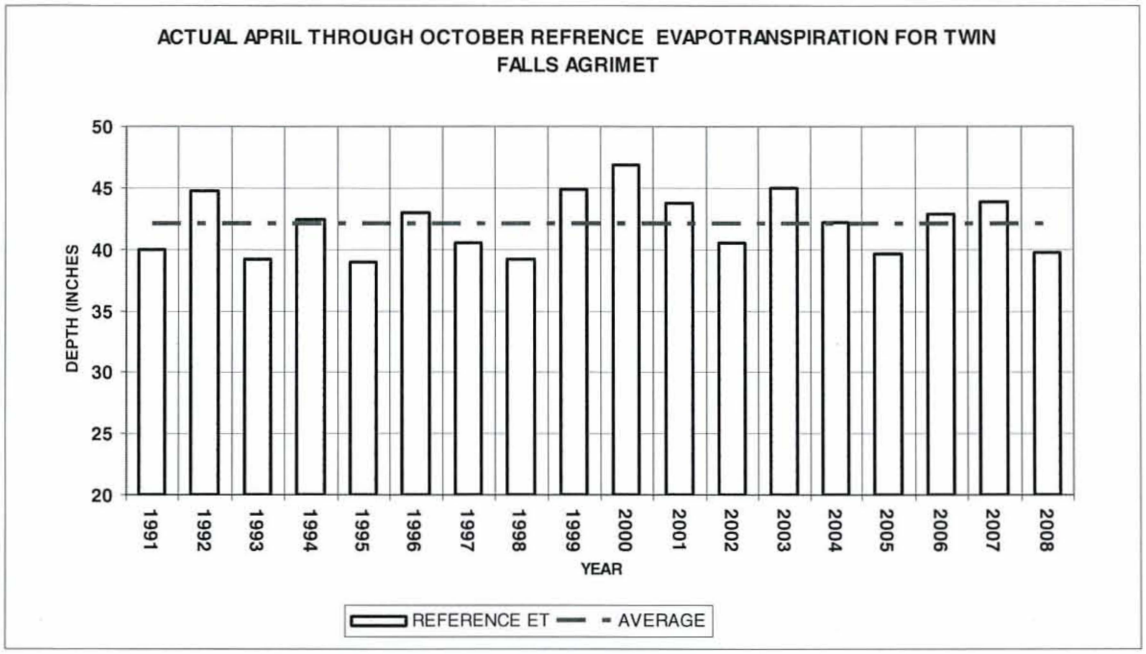


Figure 2: Actual Reference ET for Twin Falls (Kimberly) AgriMet using ETIdaho methodology.

24. Growing Degree Days. Growing degree days provide another way to characterize the length and type of growing season. Growing degree days are an arithmetic accumulation of daily mean temperature above a certain base temperature. These growth units are a simple method of relating plant growth and development to air temperatures. Different plant species have different base temperatures below which they do not grow. At temperatures above this base, the amount of plant growth is approximately proportional to the amount of heat or temperature accumulated. A higher annual growing degree day value indicates a higher rate of plant growth. Table 1, below, shows growing degree days accumulated for April through September for the Twin Falls (Kimberly) AgriMet site. Several years were above average for this parameter: 2000, 2001, 2006, and 2007; with 2002, 2004, and 2008 close to or average. Inspection of weekly crop reports from the U.S. Department of Agriculture's National Agricultural Statistics Service ("USDA NASS") indicate that 2006 had temperatures that were higher than average in May as indicated by growing degree days three times normal.[2] This would lead to accelerated crop growth and earlier maturity and harvest for crops.

Year	April to Sept	%of Average	Year	April to Sept	%of Average
1991	2,095	86%	2000	2,591	107%
1992	2,611	107%	2001	2,601	107%
1993	2,005	83%	2002	2,466	101%
1994	2,517	104%	2003	2,585	106%
1995	2,258	93%	2004	2,429	100%

[2] http://www.nass.usda.gov/Statistics_by_State/Idaho/Publications/Crop_Progress_&_Condition.

1996	2,419	100%	2005	2,320	95%
1997	2,478	102%	2006	2,602	107%
1998	2,422	100%	2007	2,658	109%
1999	2,295	94%	2008	2,383	98%
				Average:	2,430

Table 1: Growing Degree Days for Twin Falls (Kimberly) AgriMet Site.

Available Water Supply

25. The unregulated inflow at the Heise Gage on the Snake River is a good indicator of the total available irrigation water supply for a season. Particularly the April through July volume represents the amount available for diversion into storage reservoirs and also serves as a surrogate for natural flow supplies. Figure 3, below, shows the Heise runoff volumes from 1990-2008. The 30-year average is shown in this case to be consistent with common forecasting practices. Since the 2000 irrigation season, the years 2006 and 2008 have had nearly average runoff conditions.

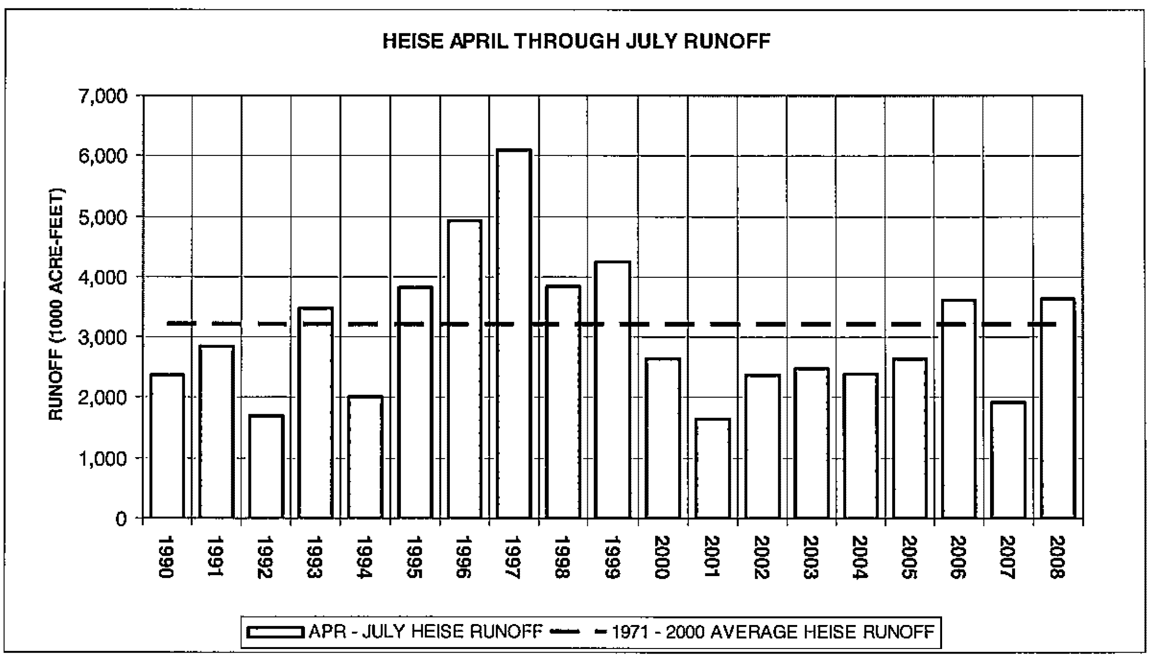


Figure 3: April through July unregulated flow volume at Heise.

26. Graphs of total season diversions by SWC members for 1990 through 2008 are shown in Figures 4 through 10. The average of the annual diversions for 1990 through 2008 is shown on these graphs. Recognizing that there were years with supply limitations (2001-2005 and 2007), the average shown is likely biased towards being lower than without those drought years. Given that, one general conclusion that can be drawn from inspection of the total diversions is that no single year represents an average diversion year for every SWC member.

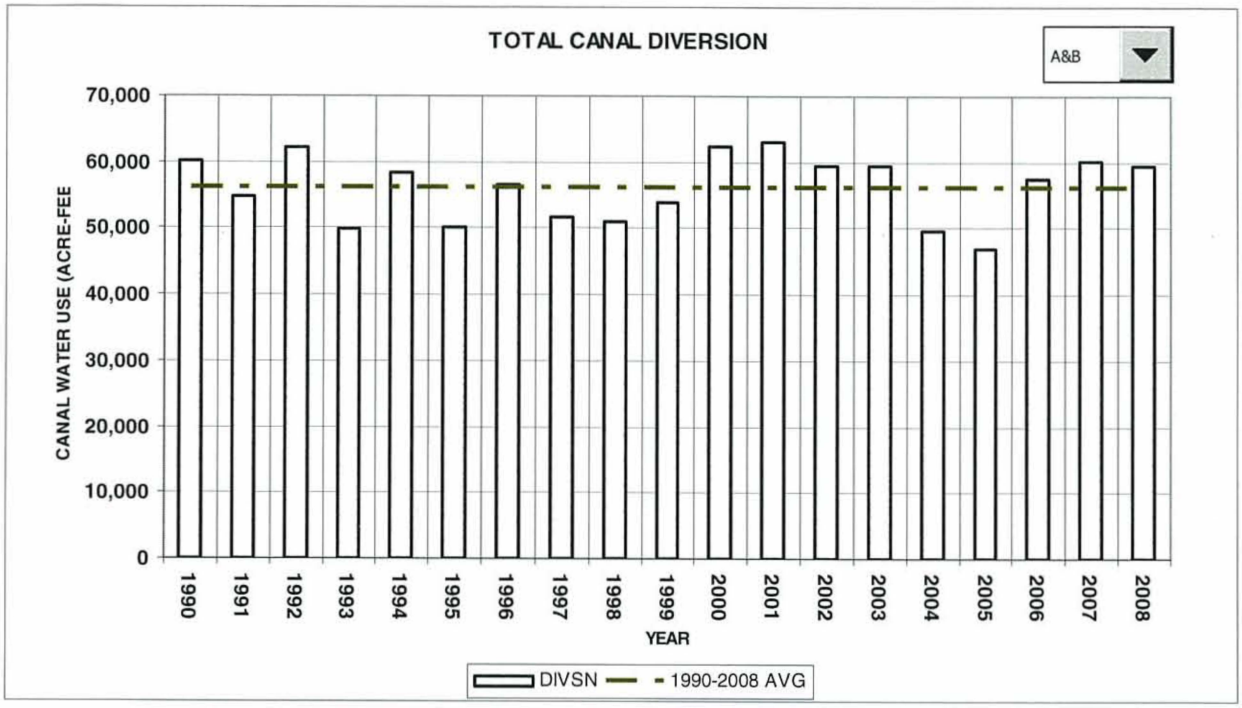


Figure 4: 1990-2008 Diversions Volumes for A&B.

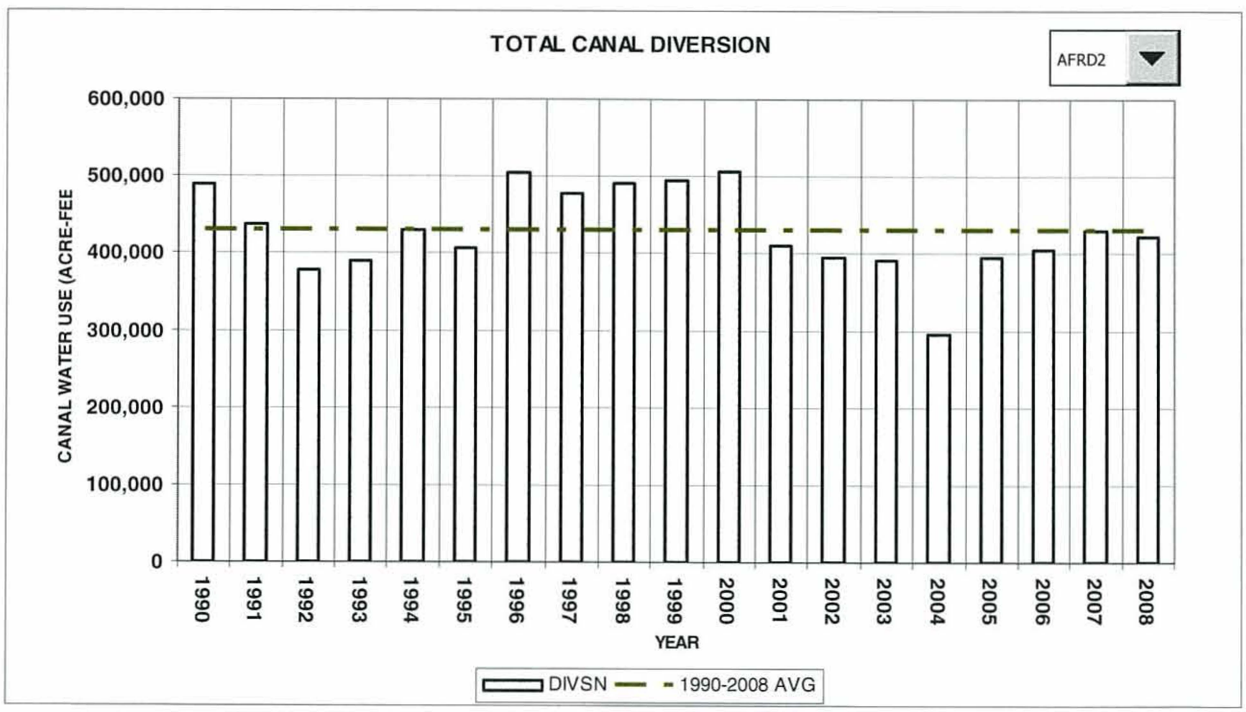


Figure 5: 1990-2008 Diversions Volumes for AFRD2.

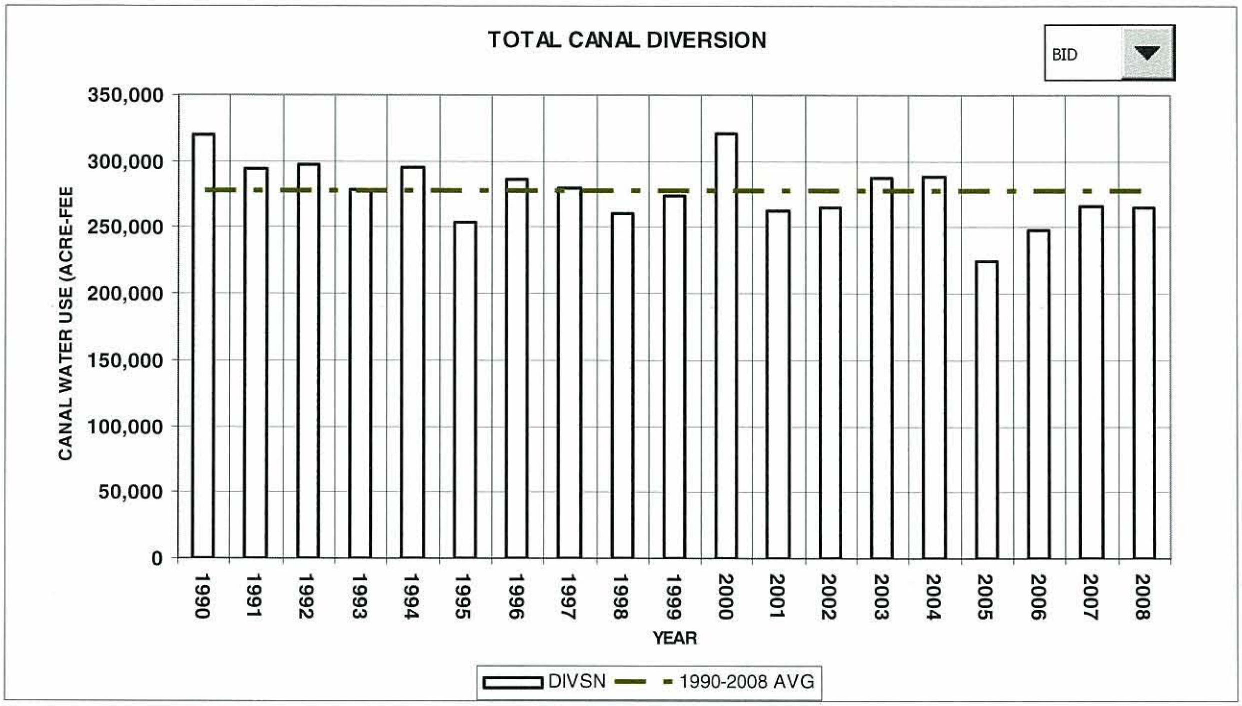


Figure 6: 1990-2008 Diversions Volumes for BID.

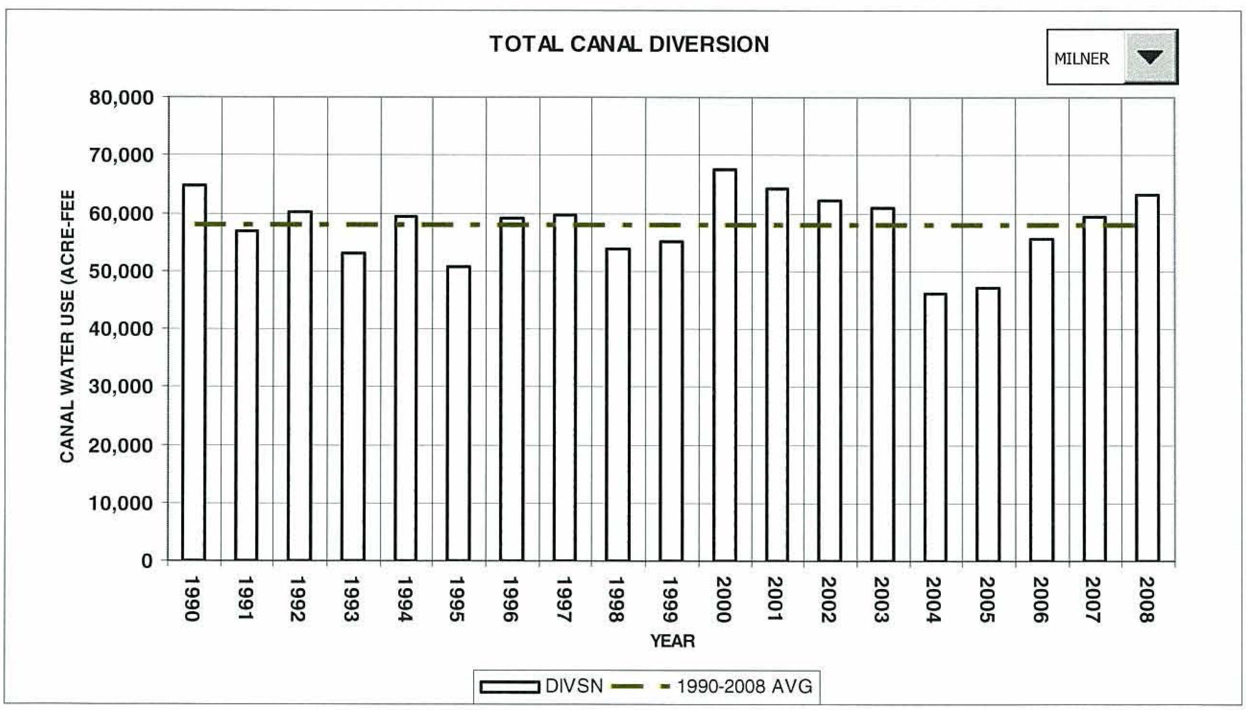


Figure 7: 1990-2008 Diversions Volumes for Milner.

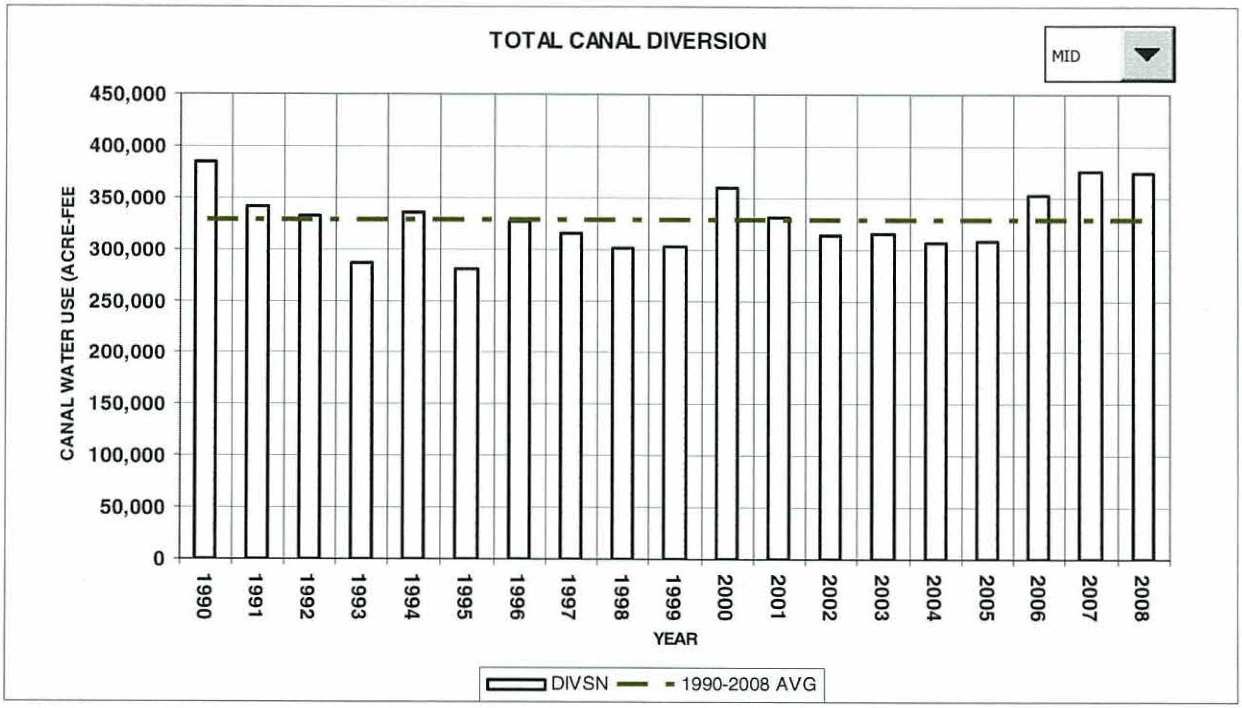


Figure 8: 1990-2008 Diversions Volumes for MID.

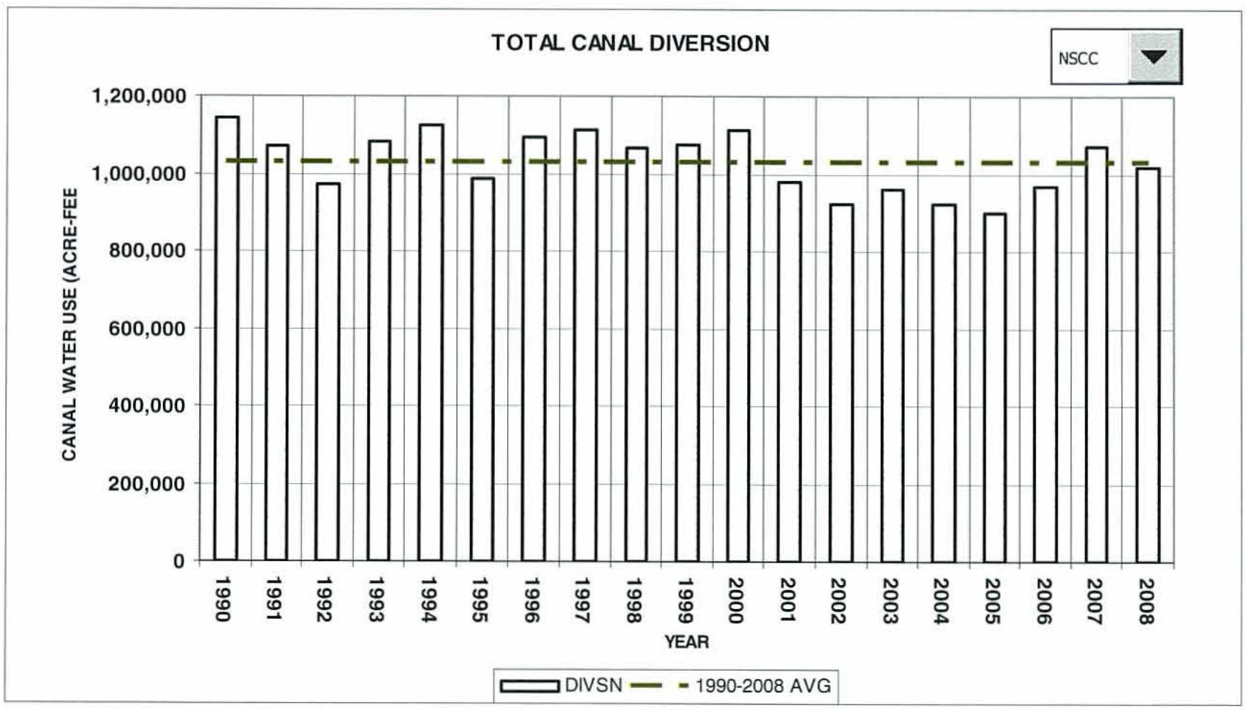


Figure 9: 1990-2008 Diversions Volumes for NSCC.

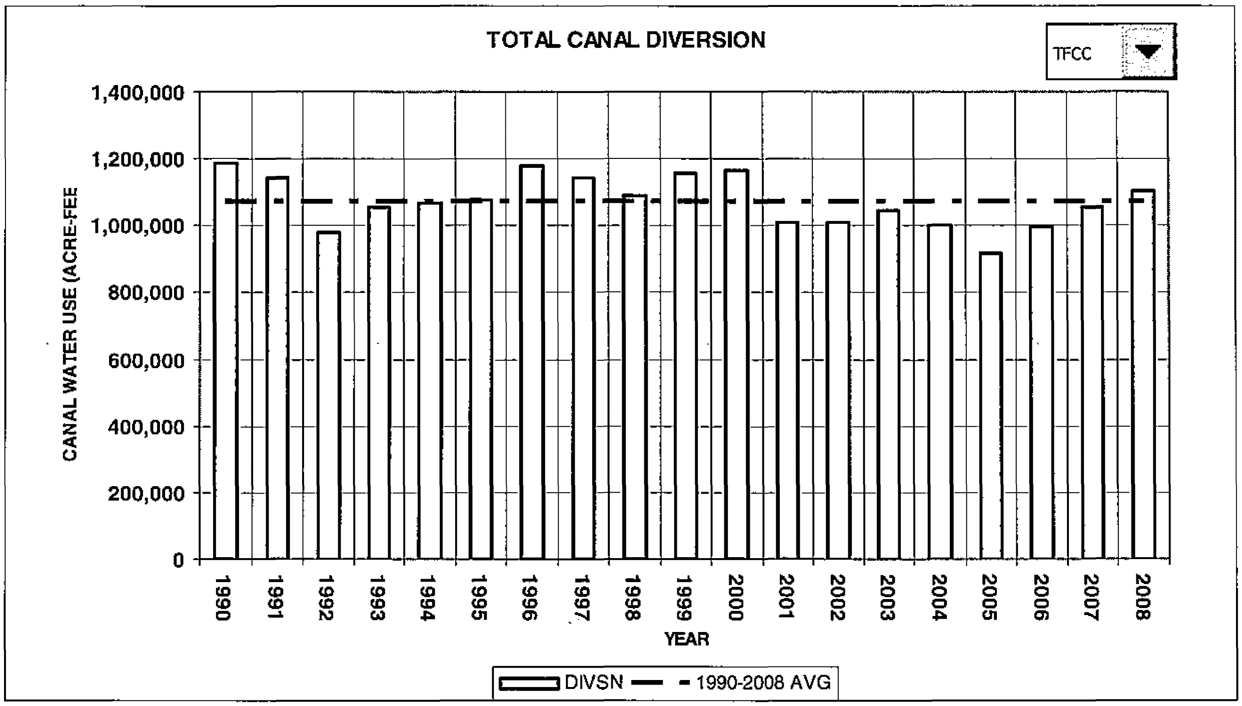


Figure 10: 1990-2008 Diversions Volumes for TFCC.

Current Practices

27. Choosing a year with conditions most representative of the present has the limitation that if it is too long ago, those conditions may not be the same. Conditions that must be consistent are the net area of the irrigated crops, farm application methods—such as flood/furrow or sprinkler irrigation—and the conveyance system from the river to the farm. The type of sprinkler systems must be nearly the same between the baseline year and the current year, whether sideroll systems, hand lines, or center pivot.

28. In general, review of the expert reports filed by the parties for use at the January 2008 hearing on the SWC delivery call, indicates that current on-farm application systems have moved towards use of more sprinkler systems since 2002. Selection of a baseline year for the SWC should be limited to the last five years available that exhibit average climatic and supply conditions in order to have the best representation of current irrigation practices.

29. Estimates of irrigated acres from hearing exhibits, and as found by the Hearing Officer in his Recommended Order, show a trend of decreasing irrigated acreage.

Selection of the Baseline Year and RISD

30. The use of 2006 as the baseline year would satisfy more of the Hearing Officer's recommendations than 2008; in that 2006 has average growing precipitation and actual reference ET, whereas 2008 only met average growing degree days.

31. Comparison of 2006 diversions to the 1990-2008 average in Table 2, below, shows that all SWC members but TFCC and Milner were average or above average, keeping in mind that the average includes years of limited supply.

	1990-2008 AVERAGE (AF)	2006 TOTAL DIVERSION (AF)	2006 % OF AVERAGE
A&B	50,000	57,491	115%
AFRD2	405,600	404,220	100%
BID	220,200	244,483	111%
MILNER	50,800	48,497	95%
MID	314,300	352,268	112%
NSCC	988,200	967,346	98%
TFCC	1,075,900	995,822	93%
		AVERAGE:	103%

Table 2: SWC Diversions for 2006 and 1990 through 2008 Average.

32. Figure 11, below, shows the daily natural flow supply and total daily diversions for Water District 01 in 2006. Beginning at the end of June, the total daily natural flow supply in 2006 for Water District 01 is approximately 10% below the average of 1988 through 2008. The average is shown as the blue dashed line in Figure 11.

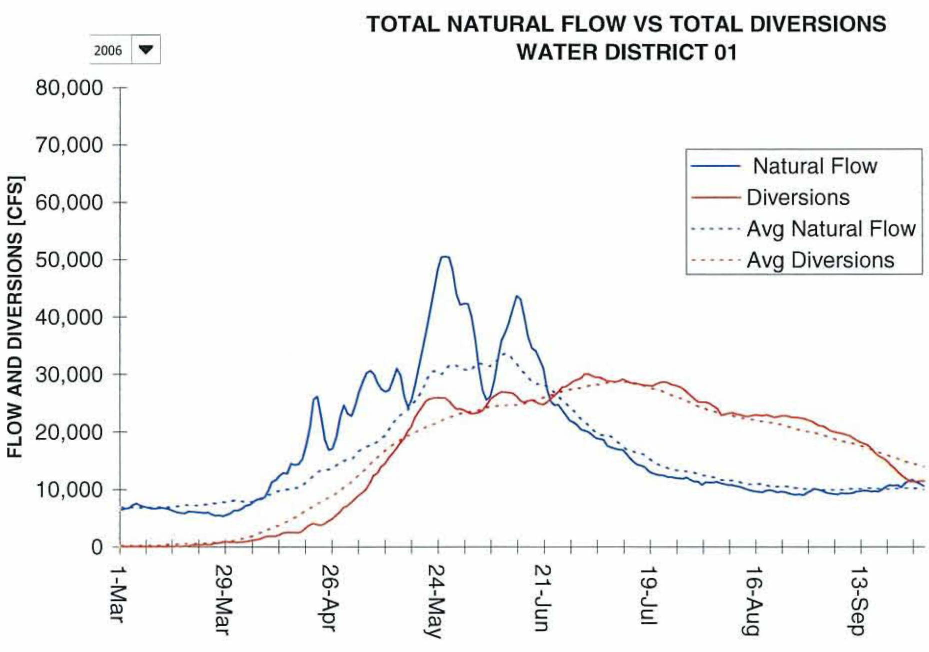


Figure 11: Water District 01 Natural Flow and Total Diversions, 2006.

33. TFCC is highly dependent on natural flow, and, as such, the reduced total natural flow supply in Water District 01, beginning at the end of June in 2006, would have likely led to increased conservation measures by TFCC to preserve storage supplies for the end of the season. This is shown in Figure 12, with diversions reduced from mid-August through September in 2006 compared to the average diversion rate.

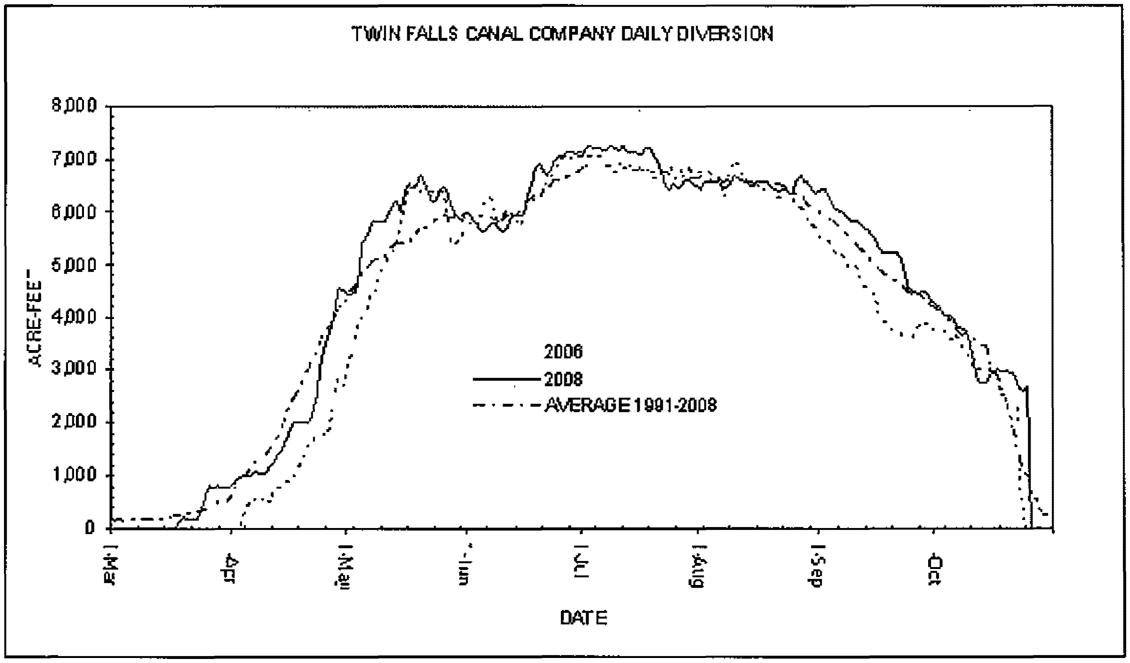


Figure 12: TFCC Daily Diversion for Recent Years with Average Heise Runoff.

34. The ability for TFCC to be satisfied with reduced diversions in late August would also be possible since many crops finished earlier than normal. The August 27, 2006 USDA NASS crop weather reports show ten percent more spring wheat was harvested than normal, and twenty percent more alfalfa had received a third cutting than normal. Table 3, below, shows the average monthly temperatures for 2006. Average monthly high and low temperatures were higher than normal from May through July in 2006, which supports better crop growing conditions, earlier maturation dates, and earlier harvest.

	May		June		July		August	
	Low	Hi	Low	Hi	Low	Hi	Low	Hi
2006	43.5	72.5	53.6	82.1	61.7	92.4	54.0	85.8
2008	42.9	70.1	49.9	79.1	59.9	91.2	57.4	88.0
Average	41.2	67.7	48.0	77.0	52.8	85.0	51.1	84.1
2006 % Average	106%	107%	112%	107%	117%	109%	106%	102%
2008 % Average	104%	104%	104%	103%	113%	107%	112%	105%

Table 3: Average Monthly Temperatures at Twin Falls Weather Station for 2006 and 2008.

35. In light of a more condensed growing season for 2006, it would have been possible for TFCC to operate more efficiently. With a longer, more normal growing season than 2006, water running through canals leads to additional seepage losses and lower efficiencies. Although analysis to assess diversion patterns have not yet been completed for Milner, which also exhibited below average diversions in 2006 for the otherwise average conditions of reference ET and growing season precipitation, it is reasonable to assume operation conditions for Milner were similar to TFCC. As such, the 2006 diversion is appropriate for use as RISD if allowance is provided for higher diversions in a longer, more normal growing season than 2006. A "diversion adjustment factor" is described in Findings 52 and 53 for this purpose.

C. In-season Adjustments to RISD

36. The Protocol uses RISD from the chosen baseline year as the projected annual supply for each SWC entity during the year of evaluation. Given that the year being evaluated will likely be different from the baseline year in terms of climate and system operations, a process is necessary to adjust for those differences. As stated by the Hearing Officer: "The concept of a baseline is that it is adjustable as weather conditions or practices change, and that those adjustments will occur in an orderly, understood protocol." Recommended Order at 51.

Assessment of Water Balance Studies

37. Water balance approaches to address the quantity of water needed by members of the SWC were presented in testimony, reports, and exhibits at the hearing. The methodology used for water balance studies provided by the SWC and the ground water users' experts is summarized in equation form as set forth in Equation 1, below:

(1) $$Q = \left[\left(\frac{ET_c \times F_c}{E_a} \right) - P_e \right] \times A_{ID} + S_{loss}$$

Where:

Q = irrigation entity diversion requirement,
ET_c = consumptive use of each crop,
F_c = fraction of area of each crop in irrigation entity,
E_a = field application efficiency,
P_e = estimated effective rainfall during growing season,
A_{ID} = irrigated area in irrigation entity, and
S_{loss} = seepage loss from canals.

38. The variables described above were common to both the SWC and ground water users' water balance analyses, with the following exceptions. The ground water users did not account for effective precipitation (P_e). Ex. 3007 at 17-19.[3] Analysis by the ground water users

[3] All citations to "Ex." are in reference to exhibits admitted during the January 2008 hearing on the SWC delivery call.

included a reduction in the diversion requirement for supplemental ground water used within SWC service areas. *Id.* at 17.

39. Another component not shown or considered by the parties is the operation loss, or project return flows. SWC experts recognized the lack of data necessary to estimate this factor: "Operational losses and returns within the delivery system were not included in the irrigation diversion estimate since no consistent measured operational waste records are available." Ex. 8000, Vol. 2 at 9-7.

40. The areal extent of the SWC is large. Obtaining field measurements of canal seepage losses on the vast network of canals and laterals would be an insurmountable undertaking if the true value were desired. The same would be true for determining the true value of farm or field application efficiency. Measuring farm runoff and deep percolation losses out of the crop root zone at a field level scale is not practical given the time and resources necessary to complete such a task. Lacking measured data for canal seepage losses, farm runoff, and deep percolation, these parameters must be estimated.

41. Estimating parameters in a water balance study involves the exercise of judgment by the individual carrying out the study. Differences in judgment affect the numerical results. As stated by the Hearing officer: "The irony in this case is that surface water and ground water expert testimony used much of the same information and in some respects the same approaches and came up with a difference of 869,000 acre-feet for an average diversion budget analysis of SWC districts for the period from 1990 through 2006. Sullivan Rebuttal Report, November 7, 2007, page 17. The total under the SWC analysis is 3,274,948 acre-feet as compared to the Pocatello analysis of . . . 2,405,861 [acre-feet]." Recommended Order at 49.

42. The Hearing Officer also found that the average annual surface irrigation requirements based on 1990 through 2006 for NSCC as calculated by experts for the SWC and ground water users differed by 473,217 acre-feet. Annual average requirements based on the 1990 through 2006 period for TFCC vary by 310,000 acre-feet. These discrepancies do not indicate errors in formulations or calculations, but do demonstrate the range of values in the total irrigation demand that are possible if contributing components to that total demand are calculated using different methods, or with different estimates of unknown parameters as determined by the judgment and experience of the individual carrying out the study.

43. A further example of the range of possible values for seepage loss is shown by comparison of the SWC and ground water users' expert reports. In the SWC's Ex. 8201, Pocatello's expert analysis of average annual canal seepage loss is presented as 338,984 acre-feet for NSCC. In the same exhibit, the SWC's expert analysis of average annual seepage loss for NSCC is reported as 586,136 acre-feet. *Id.*

44. In a 1979 study published by the Idaho Water Resource Research Institute, R.G. Allen and C.E. Brockway determined that conveyance losses for the 1977 diversion volume of 794,930 acre-feet on NSCC were 286,012 acre-feet for 755 miles of canals. Ex. 3060 at 193. Brockway and B.A. Claiborne estimated conveyance losses to be 326,418 acre-feet for the same NSCC system, based on the 1974 diversion volume of 1,117,240 acre-feet. Ex. 3059 at 26.

45. The above seepage loss estimates were all calculated using the Worstell procedure, but range in magnitude by a factor of 1.8 for the two estimates with the highest, but similar, average diversion volumes. Clearly, the magnitudes of the conveyance losses are very sensitive to input parameters selected for use in that procedure.

Project Efficiency

46. Given that the water balance method for estimating annual diversion requirements is subject to varying results based on the range of parameters used as input, an equivalent approach is to assume that unknown parameters (seepage losses, on-farm application losses, and system operational loss) are practically constant at a level that varies within the range of potential error of an estimated value. Irrigation or project efficiency can be used to incorporate this assumption of constant values of the unknown parameters.

47. Project efficiency is calculated as set forth in Equation 2, below:

(2)

$$E_P = \left(\frac{(ET_c \times F_c - P_e) A_{ID}}{Q_D} \right)$$

Where:

E_p = project efficiency,
ET_c = consumptive use of each crop,
F_c = fraction of area of each crop in irrigation entity,
A_{ID} = irrigated area in irrigation entity,
P_e = estimated effective rainfall during growing season, and
Q_D = irrigation entity diversion.

48. ET has been estimated by experts for the parties using theoretically based equations that calculate ET for an individual crop, thus necessitating crop distribution maps for each year.

49. A more direct method for obtaining ET is the METRIC model, which uses satellite imagery and does not require crop distribution maps. One limitation of the METRIC model is limited data sets for limited years. Use of the preliminary 2006 METRIC ET data generated for each SWC member can be used in a revised method to calculate the project efficiency with the 2006 diversions and effective precipitation, as set forth in Equation 3, below. The revised project efficiency is equal to the ratio of crop water need to demand. Crop water need is calculated by Equation 4, below. Effective precipitation is calculated using the ETIdaho model. METRIC ET replaces the term ET_c x F_c in Equation 2 above, and results are shown in Table 4 for the 2006 irrigation season from April through October. Table 4, below, also includes project efficiencies for the average season demand calculated by the parties.

(3) $$E_P = \frac{CWN}{BD}$$

(4) $$CWN = (ET_M - P_e) \times A_{ID}$$

Where:

E_p = project efficiency,
CWN = crop water need for baseline year,
BD = baseline demand, equal to the season diversion for the baseline year,
ET_M= ET calculated by METRIC,
P_e = effective precipitation, and
A_{ID} = irrigated area in irrigation entity.

	Ex. 3007 (Pocatello)	IDWR	Brockway Affidavit July 12, 2006; Ex. 8000 (SWC)
A&B	48%	56%	48%
AFRD2	31%	35%	37%
BID	40%	39%	34%
Milner	42%	50%	51%
MID	43%	45%	48%
NSCC	52%	37%	35%
TFCC	42%	43%	41%

Table 4: Calculated Project Efficiency[4] Comparison for each SWC Entity.

50. Results in Table 4 show that project efficiencies calculated by Equation 3 are within the range of values derived using average demand analysis values from the expert reports, with the exception of A&B and TFCC. The Department's values tend to range closer to the SWC values. The A&B efficiency calculated by the Department is 8% higher than both parties' expert analyses averaged values, and may be due to use of preliminary acreage data in the METRIC analysis resulting in overstating ET. The Department's value for TFCC is slightly greater than the values computed by the other experts, but is within the range of expected accuracy for this technique.

51. Project efficiencies shown in Table 4 are computed for the entire irrigation season. Project efficiency varies from month to month during the season, and will typically be lower during the beginning and ending of the season. Project efficiencies will be calculated on a

4 The Department's calculations are based on preliminary mean METRIC ET data for 2006 and are subject to revision when final data are available.

monthly basis as shown in Equation 5, below, for use in adjusting RISD during the year of evaluation.

$$(5) \qquad E_{P\,monthly} = \frac{CWN_{monthly}}{BD_{monthly}}$$

Where:

$Ep_{monthly}$ = monthly project efficiency,
$CWN_{monthly}$ = monthly crop water need for the baseline year, and
$BD_{monthly}$ = monthly baseline demand, equal to the monthly diversion for the baseline year.

Diversion Adjustment Factor

52. Monthly project efficiencies in Equation 5, above, are calculated for the baseline year and will undoubtedly have unique characteristics that are not repeated in the year of evaluation. To account for season-to-season variability in project efficiencies, and specifically to account for wet and/or cool periods when diversions are still required to keep the system operational, but farm deliveries have diminished—compared to the baseline year—Equation 6, as set forth below, will be used.

$$(6) \qquad DAF_{monthly} = BD_{monthly} - \frac{ET_{monthly}}{E_{P_{monthly}}}, DAF_{monthly} \geq 0$$

Where:

$DAF_{monthly}$ = monthly diversion adjustment factor,
$BD_{monthly}$ = monthly baseline demand,
$ET_{monthly}$ = monthly evapotranspiration calculated by NDVI, or ETIdaho methods, and
$Ep_{monthly}$ = monthly project efficiency from Equation 5.

53. DAF is limited to positive values, and those times when the diversions to date have been used for fulfillment of the senior calling right. Diversions for power production, recharge, wheeled water, and storage deliveries to non-SWC entities will be excluded in calculating DAF. DAF is added to the irrigation requirement for comparison to the current supply forecast for assessment of demand shortfalls.

Effective Precipitation Adjustment

54. The ETIdaho water balance program, described in *Evapotranspiration and Consumptive Irrigation Water Requirements for Idaho*,[5] is a recognized standard of practice in developing a water balance that is specific to Idaho soils and crop types with their associated root growth stage characteristics including, leaf canopy size, rooting depth, and harvesting dates. The ETIdaho program considers all aspects of an irrigated crop water balance: crop transpiration; soil

[5] Richard G. Allen and Clarence W. Robison, Revised April 2007, University of Idaho.

evaporation; effective precipitation available to meet transpiration and evaporation; soil moisture storage; and evaporation losses in winter. Use of this program with AgriMet weather station data provides a reproducible calculation of the monthly effective precipitation for irrigated crop lands. The effective precipitation adjustment is calculated, below, in Equation 7.

(7) $EPA_{monthly} = Pe_{monthly} \times A_{ID}$

Where:

$EPA_{monthly}$ = monthly effective precipitation adjustment,
$Pe_{monthly}$ = monthly effective precipitation from the ETIdaho program, and
A_{ID} = irrigated are of irrigation entity.

55. AgriMet weather data are available from the Rupert and Twin Falls (Kimberly) stations for use with the closest SWC entity. Using AgriMet data from Rupert for A&B, BID, Milner, and MID provide a reasonable representation of the climate conditions for those entities and are consistent with common standards of practice. Using AgriMet data from Twin Falls (Kimberly) for AFRD2, NSCC, and TFCC provides a reasonable representation of the climate conditions for those entities and is consistent with common standards of practice.

56. Crop distributions required for the ETIdaho model will be the average distributions presented in Ex. 3026, and will be updated periodically to reflect current practices.

<u>Irrigation Requirement</u>

57. As set forth below in Equations 8 and 9, using the baseline year to establish monthly project efficiencies enables use of those efficiencies to calculate monthly demand, defined as the irrigation requirement in the year of evaluation if ET is known. The irrigation requirement is equal to the ratio of monthly ACWN to monthly Ep, where ACWN is calculated utilizing Equation 9, below.

(8) $IR_{monthly} = ACWN_{monthly}/Ep_{monthly}$

Where:

$IR_{monthly}$ = irrigation requirement,
$ACWN_{monthly}$ = actual crop water need, and
$Ep_{monthly}$ = monthly project efficiency

(9) $ACWN_{monthly} = ET_{monthly} \times A_{ID} - EPA_{monthly}$

Where:

$ET_{monthly}$ = monthly evapotranspiration calculated by NDVI, or ETIdaho methods,
A_{ID} = irrigated area in irrigation entity, and
$EPA_{monthly}$ = monthly effective precipitation adjustment.

58. Calculation of ET will be done utilizing the NDVI method, which is discussed, below, in Section E. Because this method depends on satellite imagery, and cloudy periods can result in gaps of the continuous calculations, backup methods using standard theoretical equations as employed in ETIdaho will be done in parallel during the season. Satellite based methods such as NDVI are preferred as they do not require crop distribution information and are a measurement of actual physical properties.

Summary of In-season Adjustments

59. Initially, at the start of the irrigation season, RISD is just the baseline demand, or total season diversions for the baseline year. When adjusted in-season, RISD is calculated by Equation 10, below.

$$RISD_{july/sep} = \sum_{i=1}^{n}(IR_i + DAF_i) + \sum_{i=n+1}^{7} BD_i \quad (10)$$

Where:

$RISD_{july/sep}$ = reasonable in season demand at specified evaluation points of July or September during the irrigation season,
IR = irrigation requirement for month i,
DAF = Diversion adjustment factor for month i,
BD = baseline demand for month i,
i = index variable, and
n = upper bound of summation, equal to the month calculation occurs, where April = 1, May =2, ... October = 7.

D. Calculation of Demand Shortfall

60. Equation 11, below, is used to determine the amount of predicted demand shortfall during the irrigation season.

$$DS_{july/sep} = RISD_{july/sep} - FS_{july/sep} \quad (11)$$

Where:

$DS_{july/sep}$ = demand shortfall for specified evaluation points in July or September,
$RISD_{july/sep}$ = Reasonable in-season demand from Equation 10, and
$FS_{july/sep}$ = forecasted supply for remainder of season after specified evaluation point in July or September.

61. The amount calculated represents the volume that junior ground water users will be required to provide members of the SWC that have been found to be materially injured by the Director. The amounts will be calculated in April, July, and September, as detailed in the Section G, below.

E. Normalized Difference Vegetation Index Evapotranspiration

62. In-season ET will be computed using the NDVI ET method currently in final development by Dr. Rick Allen, University of Idaho. The NDVI ET method is based on the relationship between NDVI and METRIC ET. METRIC is a satellite-based energy balance model for computing and mapping ET. NDVI is a commonly used index developed for remote sensing data that shows relative amounts of green biomass. The NDVI ET method is being developed because a less time consuming process than METRIC is needed to compute in-season ET.

F. Preliminary Analysis: Irrigation Entities Evapotranspiration Data

63. ET data were developed by Dr. Allen for 2000 and 2006, using the METRIC satellite-based energy balance model. METRIC is calibrated to USBR AgriMet weather data. METRIC processed a series of Landsat images from 2000 and 2006 to develop monthly and seasonal ET images. Landsat is a joint U.S. Geological Survey and National Aeronautics and Space Administration satellite that collects images of the earth on a 16-day cycle.

64. USDA's Farm Service Agency Common Land Unit ("CLU") county shapefiles were already processed by the Department and attributed as irrigated, semi-irrigated, or non-irrigated. The CLU shapefiles were made available on the Department website so they could be used in the process to develop a final classification of the land irrigated by each irrigation entity.

65. At the time of the ET analysis, the BID classification was completed, so that shapefile was used to compute the ET for BID. For the other six irrigation entities, a Geographic Information System ("GIS") clipped the processed CLU shapefile to the boundary of each irrigation entity and output a CLU shapefile for each irrigation entity. Then a GIS analyst analyzed the CLU shapefile for each irrigation entity with the 2000 and 2006 METRIC ET monthly and seasonal images to develop a mean ET rate in millimeters for the irrigated land in each SWC entity. This analysis is considered preliminary because the ET volumes will be recomputed when the final shapefiles are completed for the SWC entities. Mixed irrigation (land irrigated with both surface water and ground water) will be processed estimating a contribution of 70% surface water and 30% from ground water. This is consistent with the ESPA Modeling Committee's treatment of mixed source lands in version 1.1 of the ESPA Model. The ratio may be revised as the ESPA Model is updated.

G. Overview of Draft Protocol for Determining RISD and Predicting Demand Shortfall

66. This section will provide an overview of how the Director will determine RISD and subsequently predict demand shortfalls, if any. As will be shown below, there are eleven steps that the Director will take in making this assessment.

67. Step 1: By April 1, members of the SWC will provide electronic shape files to the Department delineating the total irrigated acres within their water delivery boundary or indicate that the existing electronic shape file from the previous year has not varied by more than 5%; provided that the total acreage count does not exceed the number of acres to be irrigated within the decreed place of use. If this information is not provided on time, the Department will use its own methods to determine the total irrigated acres. The Department will publish electronic shape files for each member of the SWC for the current water year for review by the parties.

68. If the acreage count is more than the irrigated acreage limit of the water right, further investigation is required to determine the reason for the use of water on excess lands. Junior ground water users should not be required to provide replacement water to lands that are irrigated in excess of the decreed place of use. If the acreage count is under reported by more than five percent of the irrigated acreage limit of the water right, then an assessment must be made of the impact of this reduction in use of the water right on any mitigation requirement.

69. Step 2: Starting at the beginning of April, the Department will calculate the cumulative ET volume for all land irrigated with surface water within the boundaries of each member of the SWC.

- Values of ET will be calculated from Landsat 5 imagery utilizing the NDVI approach for estimating ET.

- Cumulative in-season ET values will be calculated for each member of the SWC, approximately once a month.

- Two contingency plans—discussed below as "Contingency Plan A" and "Contingency Plan B"—will be in place to allow for the continued calculation of ET should a short-term or long-term interruption in service from Landsat 5 occur.

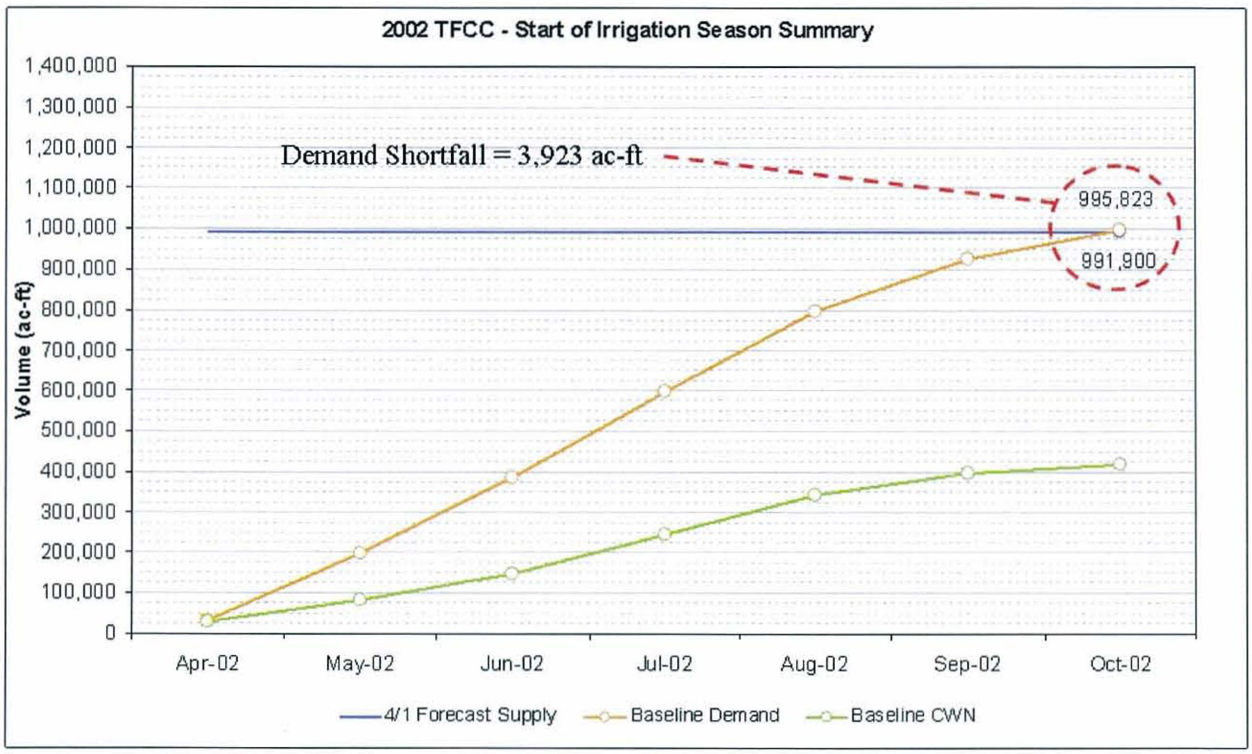
    a) Contingency Plan A: this plan represents a stop-gap method for acquiring ET data for those times when Landsat 5 imagery is temporarily unavailable. This would include instances when Landsat 5 imagery is unusable due to cloud cover, image corruption, or temporary satellite malfunctions. In these limited instances replacement imagery would be acquired by the Department and utilized to complete the NVDI approach for estimating ET.

        - Landsat 7;
        - Other sources, such as AWiFS.

b) Contingency Plan B: this plan represents a method for acquiring ET data for those times when satellite imagery utilized in the NDVI approach for estimating ET is unavailable for an extended period of time. Should this event occur during an irrigation season, ET would be estimated utilizing the ETIdaho approach, which is a non-satellite imagery based method. Contingency Plan B needs to be run continuously throughout the irrigation season in order to be available when needed.

70. Step 3: Typically within the first week of April, the USBR and USACE issue their Joint Forecast that predicts an unregulated inflow volume at the Heise Gage for the period April 1 through July 31.

71. Step 4: Within fourteen (14) days after issuance of the Joint Forecast, the Director will predict and publish a *forecast supply* for the water year and will compare the forecast supply to a *baseline demand* to determine if a *demand shortfall* is anticipated for the upcoming irrigation season. Separate *forecast supplies*, *baseline demands*, and *demand shortfalls* will be determined for each member of the SWC. *See* Figure 13, below, for an example.[6]



[6] For the purposes of the illustrative example (Figures 13-16) TFCC was selected as the water user and 2002 was selected as the irrigation season. Actual crop water need ("ACWN") for the example was calculated utilizing the ETIdaho method, whereby ACWN = (Reference ET*Crop Coeff.*Area of Crops)-(Effective Precipitation*Area of Crops). Forecast supply was calculated utilizing historic natural flow and historic reservoir storage data. Refer to spreadsheet *Protocol Outline.xls* for detailed calculations relating to the example, located at: http://www.idwr.idaho.gov/News/WaterCalls/Surface%20Coalition%20Call/default.htm

Figure 13: TFCC Example for Irrigation Year 2002, Initial Shortfall Prediction.

72. Step 5: Within fourteen (14) days from issuance of the *forecast supply*, junior ground water users are required to provide evidence, to the satisfaction of the Director, establishing their ability to secure and provide a volume of storage water equal to the total amount of predicted shortfall for injured members of the SWC. If junior ground water users cannot provide this information, the Director will issue an order curtailing junior ground water users.

73. Any volume of water in excess of the *reasonable carryover shortfall* shall be provided to the SWC at the *time of need.*

74. Step 6: Within fourteen (14) days after the publication of the *Day of Allocation* report, the portion of the *demand shortfall* equal to the *reasonable carryover shortfall* shall be made available to injured members of the SWC, limited to the shortfall in RISD and empty storage space for that entity. The *reasonable carryover shortfall* is not provided to members of the SWC until after the *Day of Allocation.*

75. Step 7: Approximately halfway through the irrigation season (within the first two weeks of July) the Director will, for each member of the SWC: (1) evaluate the *actual crop water needs* of the members of the SWC up to that point in the irrigation season; (2) determine an *effective precipitation adjustment* for each month up to that point in the irrigation season; (3) determine a *diversion adjustment factor*; and (4) publish a revised *forecast supply.*

76. This information will be used to calculate an *irrigation requirement*, recalculate RISD, and adjust the *demand shortfall* for each member of the SWC. RISD will be calculated utilizing the baseline *project efficiency*, the cumulative *actual crop water needs*, and the *effective precipitation adjustment* and *diversion adjustment factor* values determined up to that point in the irrigation season. *See* Figure 14, below. The Director will then publish the *reasonable in-season demand* and revised *demand shortfall* values.

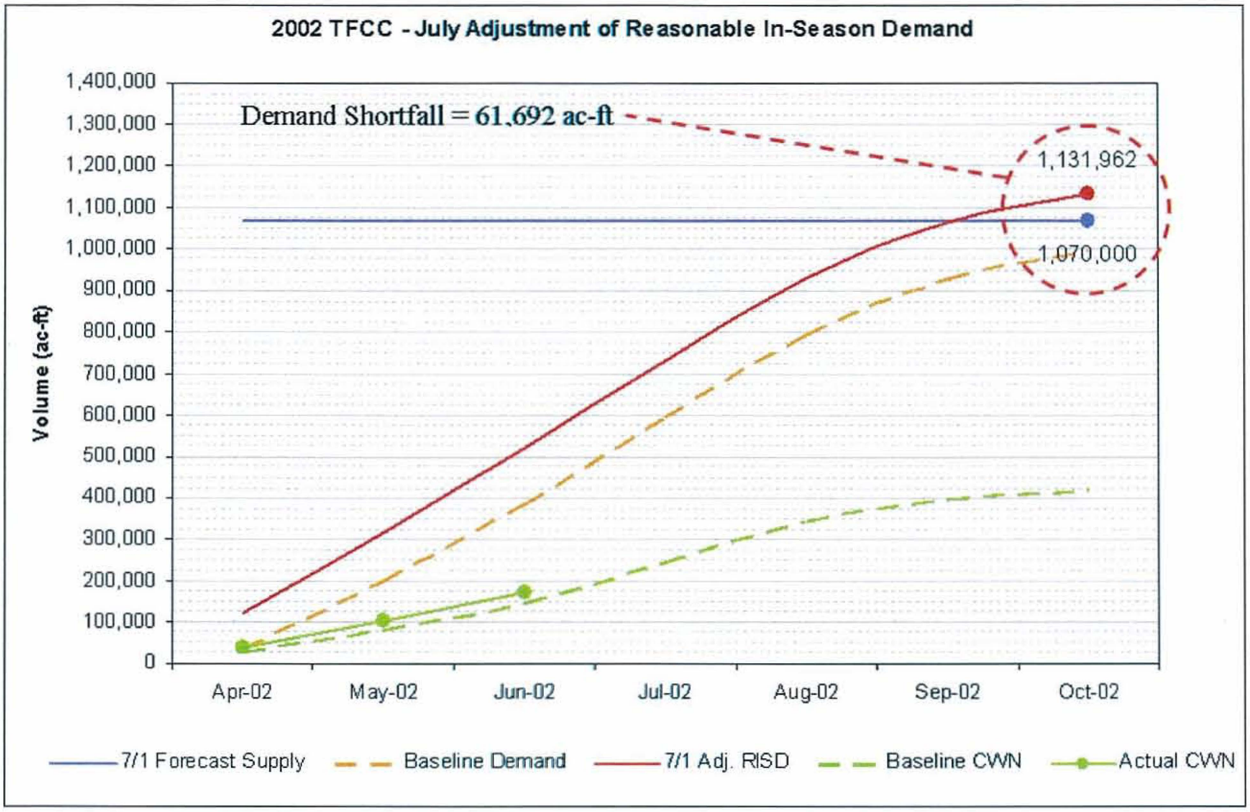


Figure 14: TFCC Example for Irrigation Year 2002, July Adjustment of RISD and Demand Shortfall Prediction.

77. Step 8: If the calculations from Step 7 indicate that water, in addition to that already secured and provided by junior ground water users is required, junior ground water users will have fourteen (14) days from the date the revised values are published to provide evidence to the satisfaction of the Director that they have obtained and/or secured the additional volume of water.

78. Any volume of water in excess of the *reasonable carryover shortfall* shall be provided to the SWC at the *time of need.*

79. Step 9: Approximately three-quarters of the way through the irrigation season (within the first two weeks of September) the Director will, for each member of the SWC: (1) evaluate the *actual crop water needs* of the members of the SWC up to that point in the irrigation season; (2) determine an *effective precipitation adjustment* for each month up to that point in the irrigation season; (3) determine a *diversion adjustment factor*; and (4) publish a revised *forecast supply*.

80. This information will be used to calculate an *irrigation requirement*, recalculate RISD, and adjust *demand shortfall* for each member of the SWC. RISD will be calculated utilizing the baseline *project efficiency,* the cumulative *actual crop water needs*, and the *effective precipitation adjustment* and *diversion adjustment factor* values determined up to that point in

the irrigation season. *See* Figure 15, below. The Director will then publish the *reasonable in-season demand* and revised *demand shortfall* values.

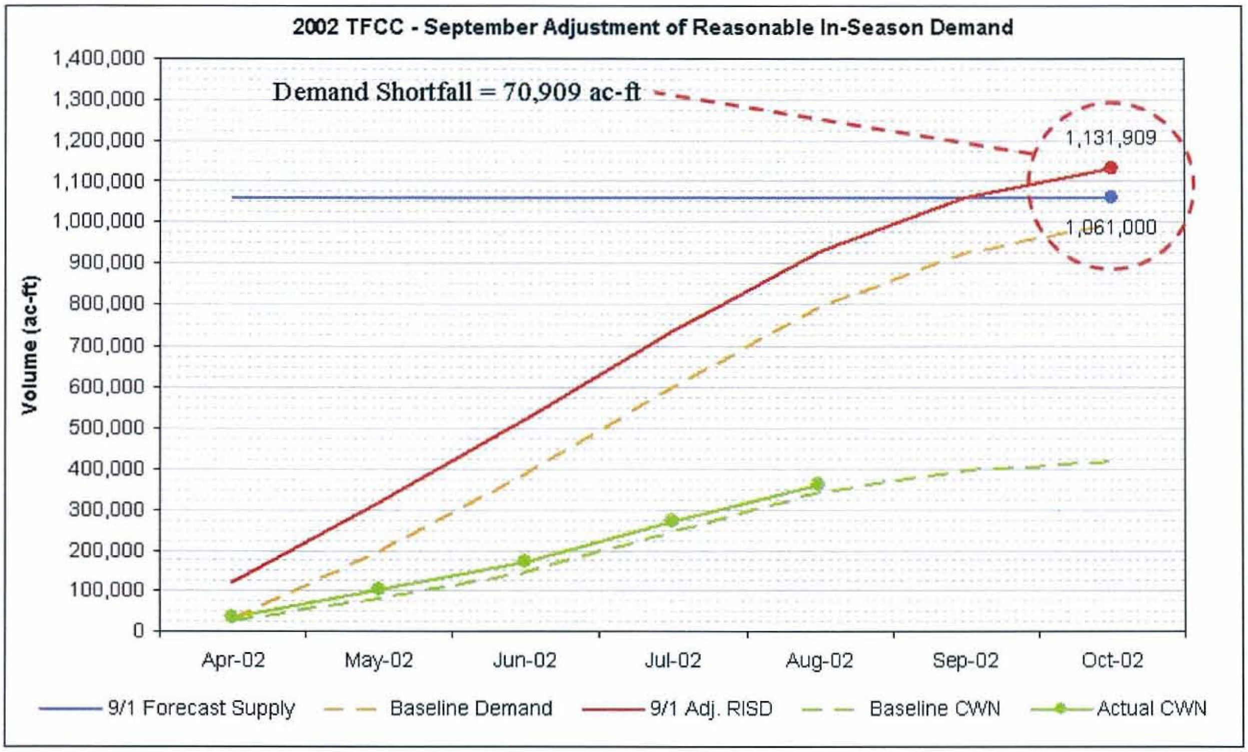


Figure 15: TFCC Example for Irrigation Year 2002, September Adjustment of RISD and Demand Shortfall Prediction.

81. Step 10: If the calculations from Step 9 indicate that water, in addition to that already secured and provided by junior ground water users is required, junior ground water users will have seven (7) days from the date the revised values are published to provide evidence to the satisfaction of the Director that they have obtained and/or secured the additional volume of water.

82. Any volume of water in excess of the *reasonable carryover shortfall* shall be provided to the SWC at the *time of need*.

83. Step 11: Following the end of the irrigation season, the Department will determine (on or about November 30) the total actual volumetric demand and total actual *crop water need* for the entire irrigation season. This information will be used to evaluate whether the predicted *demand shortfalls* were adequate and determine final injury, actual carryover, and reasonable carryover. *See* Figure 16, below.

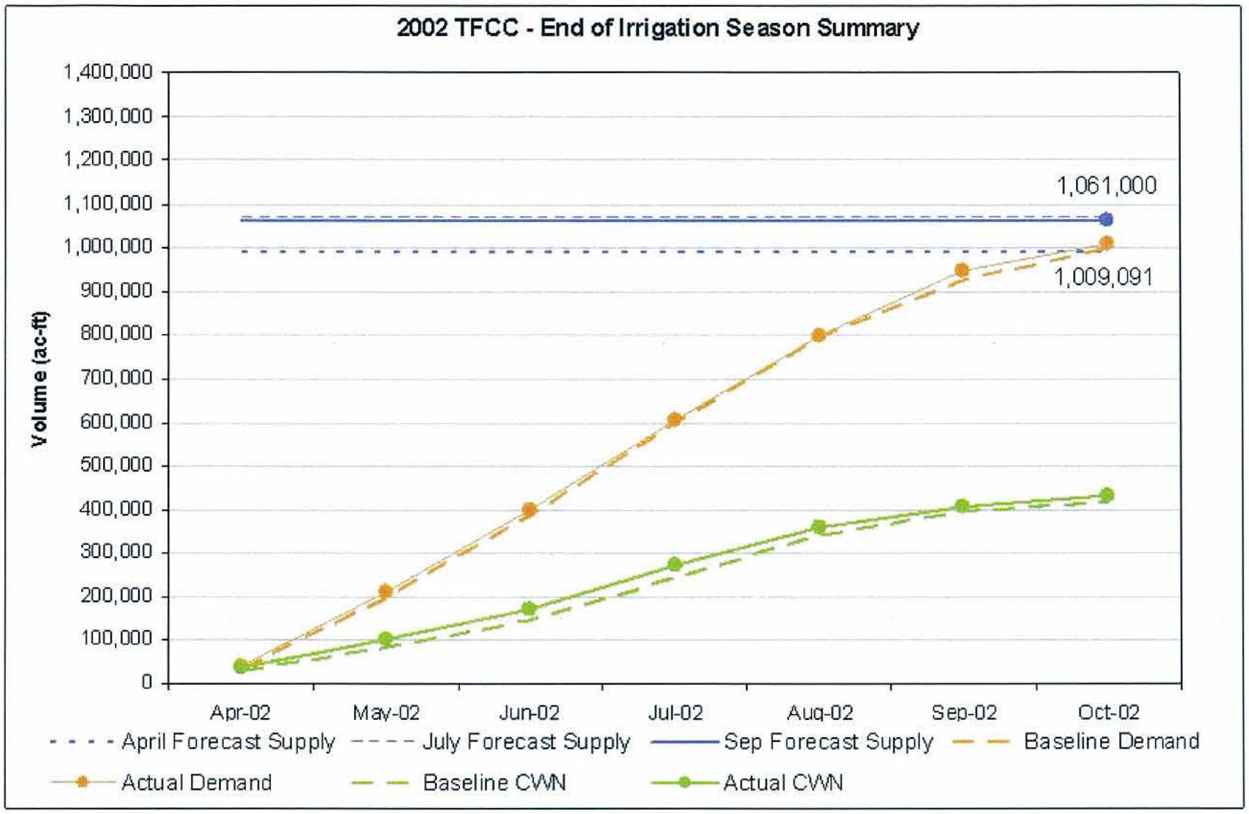


Figure 16: TFCC Example for Irrigation Year 2002, End of Irrigation Season Summary.

H. Adjustment of Forecast Supply

<u>April 1</u>

84. Typically within the first week of April, the USBR and the USACE issue their Joint Forecast that predicts an unregulated inflow volume at the Heise Gage from April 1 to July 31 for the forthcoming year. With data from 1990 through the previous water year, a regression equation is developed for each SWC member by comparing the actual Heise natural flow to the natural flow diverted. The regression equation will be used to predict the natural flow diverted for the upcoming irrigation season. The actual natural flow volume that will be used in the *forecast supply* will be one standard error below the regression line, which necessarily underestimates the available supply. *See* Figure 17, below.

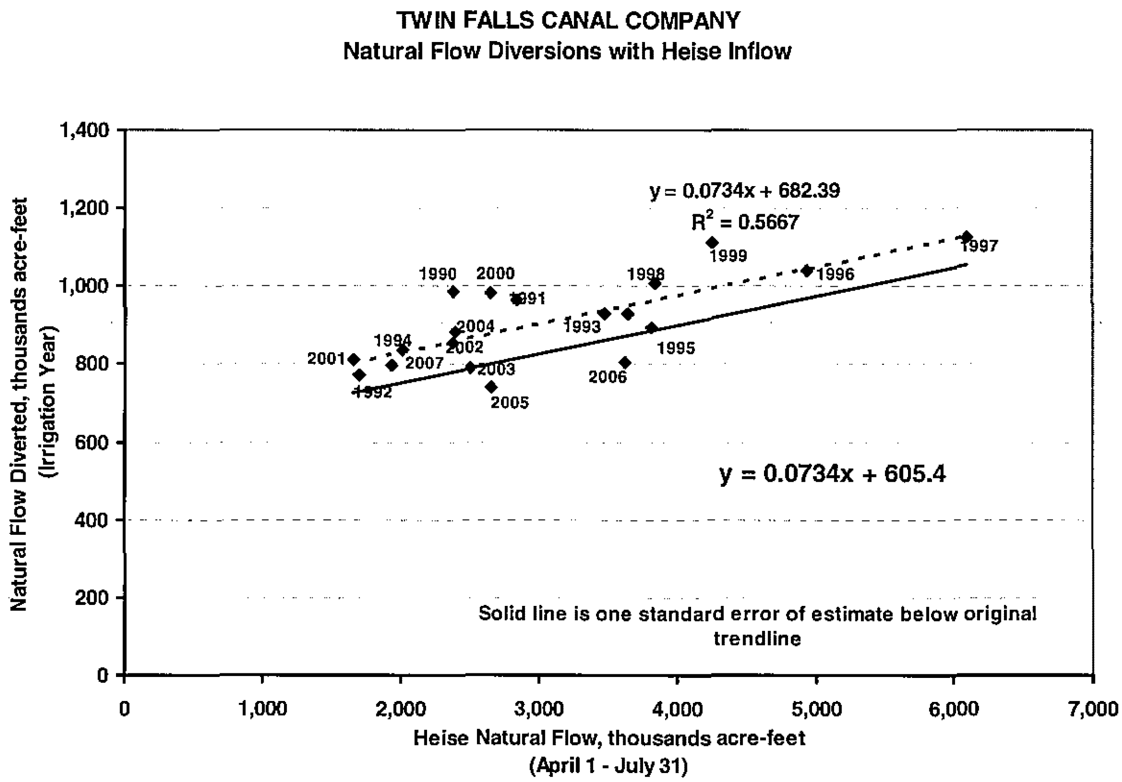


Figure 17: Historical Heise Natural Flow as Compared to the Natural Flow Diverted by TFCC.

85. The storage allocation for each member of the SWC will be estimated following the Joint Forecast. The reservoir fill and allocation will be predicted by using data from a similar year. The *forecast supply* is the sum of the estimated storage allocation and the predicted natural flow diversion. This volume will be used in the shortfall calculations until better data is available later in the irrigation season.

Early to Mid-July

86. In early to mid-July, an adjustment to the *forecast supply* will be made. The reservoirs will typically have filled to their peak capacity for the season and the storage water will have been allocated. The water rights accounting model will be used to compute the natural flow diverted by each member of the SWC as of the new forecast date. The natural flow diversion for the remainder of the irrigation season will be estimated based on a historical year with similar gains in the Blackfoot to Milner reach. Figure 18 is a graph of the reach gains, using 2002 as an example. In this case, 2001 has the most similar reach gains. Therefore, the natural flow diverted in 2001 would be used to predict the natural flow diversions for the remainder of the 2002 season. The adjusted *forecast supply* is the sum of the actual natural flow diversions, the predicted natural flow diversions, and the storage allocation.

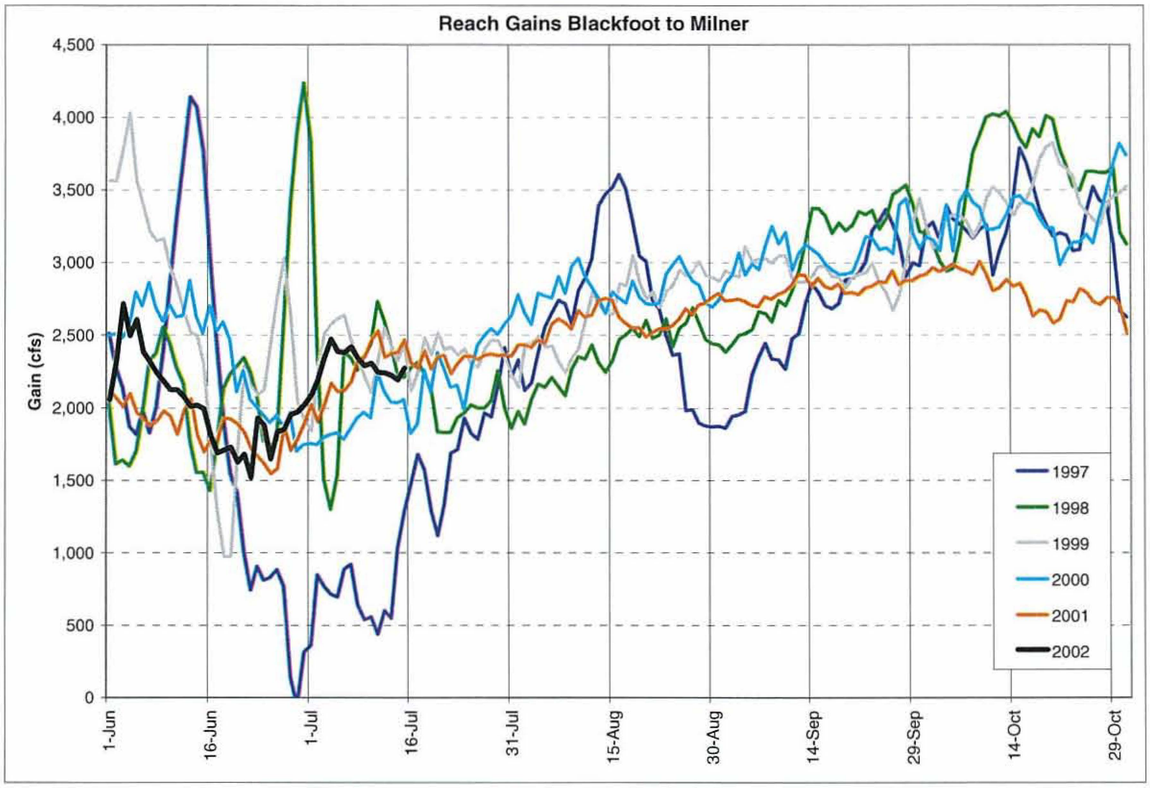


Figure 18: Example reach gain analysis for 2002.

__Early to Mid-September__

87. The July procedure will be repeated in September with the updated water rights accounting data.

I. Reasonable Carryover

88. As stated in the Final Order, if reasonable carryover is owed, it should be provided during the season of need when it can be put to beneficial use, not the season before. *Final Order* at 11, ¶ 16. Additionally, mitigation for reasonable carryover should not be provided for more than one year. *Id.*

89. In the May 2005 Order, reasonable carryover was premised on providing sufficient end-of-year storage to ensure an adequate supply of water in the ensuing year if supplies were inadequate. The lowest years of supply in recent history occurred in 2002 and 2004. The minimum full supply was considered to be the 1995 supply in the May 2005 Order. The difference between the minimum full supply and lowest historic supply was considered as the amount necessary to get through one year in times of shortage. This amount was fixed as the 1995 supply volume minus the average of the 2002 and 2004 supply volumes. If the 1995 supply was less than the average of 2002 and 2004 supply, reasonable carryover was zero.

90. Guidance from the Hearing Officer for calculating reasonable carryover is general in nature, and recommendation of a specific algorithm is lacking. The guidance provided does imply historic conditions must be considered during the time Palisades was operational but before ground water pumping became an influence on the system supply. As found by the Hearing Officer:

> The average rate of fill should be determined over a sufficient number of years to encompass wet and dry years. It would seem that this calculation should begin with the year in which Palisades was first fully operational. That would encompass the entire reservoir system as it now exists and include years when the effect of ground water pumping was minimal.

Recommended Order at 64.

91. The determinations of the Hearing Officer, together with CM Rule 42.01.g, suggest that historic carryover should be assessed relative to historic water conditions when the impacts of ground water pumping were negligible, and then project the amount of historic carryover onto current water conditions. River and reservoir operations models perform that simulative task. The Department currently uses the Upper Snake River Planning Model for river operations studies, but it only provides coarse approximations of storage use, and is not detailed enough to include individual canal diversions. The constraints as far as time and resources to add the complexity and new data parameters for an adequate operations model are prohibitive at this time.

92. Another approach for predicting historic behavior given current conditions is through regression. Regression is a method of developing a relationship between a response variable (Y) and one or more explanatory variables (X), with the objective of predicting the response variable for given values of the explanatory variables.

93. The first step in development of a regression model requires selection of the response variable (Y) to be predicted; in this case, carryover held by each SWC entity. The next step is selection of the explanatory variables (X) by which (Y) should be predictable. Explanatory variables (X) should have been measured concurrently in the past with (Y), so that the prediction equation may be established, and they will continue to be observed in the future so that (Y) may be predicted from them as necessary.

94. Selection of the explanatory variables is by a subjective method based on analysis of the physical phenomena which indicate effect on (Y) by the (X) variables. Criteria for selection are necessarily subjective, as the reasons for deciding to record the (X) and (Y) phenomenon in the first place were based on subjective criteria.

95. Application of the regression to predict reasonable carryover is accomplished by modeling the historic response of carryover for each member of the SWC for the selected explanatory variables when the effects of ground water pumping were not impacting SWC supplies. The assumption is made that any change in carryover patterns in the post ground water pumping period is due to the effects of ground water depletions. Thus, when the explanatory

variables are used in the regression equation for the post ground water pumping period, they will predict the amount of carryover to be expected if ground water influence had not occurred.

96. The pre-ground water influenced period is considered to be the period from 1964 through 1986, and is termed the calibration period. Concurrently measured variables are available starting in 1964 through the present. The period does undoubtedly have some impacts occurring due to ground water depletions. The years in the calibration period when this would have been most prominent were the 1980s. However, during the period from 1979 through 1986, TFCC leased 20,000 acre-feet or more per year to the rental pool. Ex. 4126. MID, A&B, and NSCC also contributed quantities of water to the rental pool during that period. *Id.* These leases to the rental pool indicate storage supplies were plentiful, and carryover amounts were not affected by diminishing supplies.

97. The prediction period is years 1989 through 2008. This period is used to test the regression models for predictive validity, such as verifying that explanatory variable ranges are not appreciably different from the calibration period. The years 1987 and 1988 are excluded since reservoir restrictions on Jackson Lake improperly affected carryover supplies.

<u>Selection of Variables for Potential Use in the Predictive Model</u>

98. Carryover shortfalls can be caused by a large number of factors, including, but not limited to: out of basin leases, low snowpack, and hot/dry summers. CM Rule 42.01.g states: "In determining a reasonable amount of carry-over storage water, the Director shall consider the average annual rate of fill of storage reservoirs and the average annual carry-over for prior comparable water conditions and the projected water supply for the system." Thus, the regression model for determining reasonable carryover attempts to take into account those conditions listed above that impact carryover shortfalls, as well as correcting for changes in rental uses over the years.

99. Carryover variation from season-to-season depends on water supply, growing season climatic conditions, type of crops grown, project efficiency, and the operations strategy of the manager. Explanatory variables that represent each of these factors are listed below.

- <u>Water Supply</u>:

  a. Heise April through July unregulated inflow volume ("HEISE100AF")
     Heise unregulated runoff depicts the system water supply for the season, and serves as a surrogate for the natural flow supply. Increased Heise runoff equates to increased carryover.
  b. Storage allocation volume ("ALLOC")
     Storage allocation reflects the water supply for the year, and also contains information about the previous season's carryover amount. High carryover in a low runoff year would result in a higher allocation than if carryover were not available from the previous year.

- Growing Season Climate:

  a. Palmer Drought Severity Index ("PDSI") for September, Idaho NOAA Region 7
  The monthly PDSI measures the abnormality of weather conditions for a region. Index values are more negative for extreme drought and more positive for extreme wet spells. Calculation of the PDSI incorporates temperature, precipitation, and the region-wide soil moisture situation. Use of the September PDSI reflects the type of growing season that occurred, in that cumulative depletions to soil moisture over the growing season are embedded in the September index value.

  b. Regional Crop Evapotranspiration ("ETR")
  The Twin Falls weather service office is the closest weather station to the SWC region with the longest continuous record of temperature data. These daily data readings are available from 1964 to the present. This station is used as the source of temperatures in the Ref-ET program available at: http://www.kimberly.uidaho.edu/ref-et/. Computed ET data from the Ref-ET program is weighted by the region wide crop distribution for Idaho District 80 of the USDA NASS to provide an estimate of the crop water use for the SWC, historically.

- Project Efficiency:

  Canal Diversion ("DIVERSION")
  Canal diversions are used to represent the effect of increased project efficiency leading to increased carryover. Inspection of charts showing carryover and diversions (*see* footnote 8) show that carryover increases with decreased diversions during the calibration period, which is then reflected in the regression model.

100. No quantification of the operation strategy or management decisions are attempted since records of this type are not normally kept in standard format suitable for use in a numerical model. Undoubtedly, throughout an irrigation season, an irrigation manager makes conscious decisions to preserve as much storage water as possible as carryover to ensure against future shortages, but without shorting supplies to farmers in the current growing season. The influence of these types of decisions is reflected to some extent in the regional PDSI, as drought usually causes a human response. Beyond this, no other attempt is made to capture operational decisions.

101. The explanatory variables above have been used to develop a separate regression model for each SWC entity. The different explanatory variables above are not always influential in the response variable, and are not included in every regression model. The reasons for the absence or presence of influence from the explanatory variables (X) on the response variable (Y) results because of the unique characteristics of each SWC canal, such as earlier priorities, gravity versus pump points of diversion, and areal extent of system. The contribution

of each explanatory variable is measured and a decision to include it or not include it in the predictive model is made based on the stepwise regression procedure.

102. Figures depicting the carryover response variable with the explanatory variables used for each SWC entity are shown in Attachment A. Note that some data, such as adjustments, are still preliminary and will be finalized for later inclusion. Additional variables will be explored for inclusion as comments from parties are incorporated.

103. Carryover used as the response variable is calculated as the gross storage allocation minus the total storage use as reported in the Water District 01 annual reports. Adjustments were made to the historic carryover records used as the response variable (Y) as necessary to create a consistent record for the calibration period versus the prediction period. Adjustments made were as follows:

- The Minidoka Credit is added to AFRD2, BID, and MID if assigned a credit in that year;
- The Minidoka Credit is subtracted from the supplying canals (NSCC and TFCC) if appropriate per the requirements of the Minidoka Credit agreement in place for the season;
- Wheeled water is added back to the carryover;
- Any storage leased out to private parties by the SWC is added back to the carryover, including flow augmentation water prior to the Nez Perce agreement. No adjustment is made after the Nez Perce agreement went into effect.

104. Table 5, below, shows the resulting predictive regression models for each SWC canal. The R^2 value is also shown, which is a measure of how much of the variability in the carryover is due to the variability of explanatory variables in the calibration period. An R^2 of 0.80 means 80% of the variability in the calibration period carryover is explained by the explanatory variables.

	EQUATION	**R^2**
A&B	CRY = 74654 + 0.929 ALLOC + 7.23 HEISE100AF - 2835 ETR - 0.648 DIVERSION	0.883
AFRD2	CRY = 728797 + 0.976 ALLOC + 35.2 HEISE100AF - 29645 ETR - 0.300 DIVERSION	0.852
BID	CRY = 38752 + 0.610 ALLOC + 32.2 HEISE100AF + 6860 PDSI - 0.530 DIVERSION	0.886
MID	CRY = 60650 + 0.640 ALLOC + 51.9 HEISE100AF + 8297 PDSI - 0.661 DIVERSION	0.810
Milner	CRY = 129838 + 1.12 ALLOC + 6.97 HEISE100AF - 6238 ETR	0.926
NSCC	CRY = - 120451 + 0.950 ALLOC + 64.1 HEISE100AF + 27434 PDSI - 0.472 DIVERSION	0.930
TFCC	CRY = 337465 + 0.406 ALLOC + 26.1 HEISE100AF + 4622 PDSI - 12336 ETR	0.811

Explanatory variable units:	Response variable units:
ALLOC = acre-feet HEISE100AF = 100 acre-feet ETR = inches PDSI= unitless DIVERSION = acre-feet	CRY = acre-feet

Table 5: Predictive Regression Model Equations for SWC Entities.

105. Model errors will always be present with any model, as they are all abstractions. There are recognized deficiencies with this approach. The selected explanatory variables do not completely explain the variation in the carryover amount, as indicated in the R^2 value. Also, there are measurement errors inherent in the explanatory values themselves, which impart error to the models. Assumptions listed below that form the basis for regression cannot generally be met in hydrologic settings:

- The explanatory variables are statistically independent;
- The variance of the response variable does not change with changes in magnitude of the explanatory variables;
- The observed values of the response variable are uncorrelated events.

106. The approach outlined above does meet accepted criteria for predictive models. Summaries of statistical validity tests are too complex for discussion here, but are included on the Department's website:

http://www.idwr.idaho.gov/News/WaterCalls/Surface%20Coalition%20Call/mit_present/PDFs/REVISED%20ANALYSIS.pdf

Steps for Calculating Reasonable Carryover and Reasonable Carryover Deficits

107. The steps for calculating reasonable carryover and reasonable carryover deficits are discussed below:

Preliminary Accounting Complete

108. Step 1: At the end of the irrigation season, the Department will compile explanatory variables for the season:

a. April through July Heise unregulated flow (100 acre-feet);
b. Region-wide crop ET for April through September in inches calculated with ASCE Penman-Monteith equation:
    i. Use previous season crop distribution for USDA NASS District 80;
    ii. Use daily maximum and minimum temperature for Twin Falls weather service office; and
    iii. Default wind and dewpoint temperature data for Twin Falls from ETIdaho.

c. PDSI for September for Idaho Region 7 from NOAA;
d. Each SWC entity's preliminary storage allocation from Part 2 of the Water District 01 storage report issued after reservoirs storage finished filling; and
e. SWC preliminary diversions from Water District 01.

109. Step 2: Using the entity-specific equation from Table 5 with necessary explanatory variables, calculate the preliminary reasonable carryover for members of the SWC.

110. Step 3: For each SWC entity, obtain the actual preliminary carryover from Water District 01 daily accounting or weekly storage report for the last day of the irrigation year (October 31).

111. Step 4: Adjust actual preliminary carryover from the following to obtain the eligible carryover:

a. Subtract Minidoka credits from supply canals, NSCC and TFCC;
b. Add Minidoka credits to receiving canals MID, BID, and AFRD2;
c. Add wheeled water volumes to actual preliminary carryover;
    i. Identified wheeled water items are:
        1. Southwest Irrigation District storage deliveries;
        2. IGWA rentals for conversion acres;
        3. Storage water delivered for recharge; and
        4. Artesian Irrigation, Salmon Falls Irrigation storage delivered through TFCC and Milner.
d. Add any Water Mitigation Corporation agreement transfer volume to assigned receiving canals, and subtract that like volume from MID.

112. Step 5: Subtract eligible carryover from Step 4 from preliminary reasonable carryover calculated in Step 2:

a. If the difference is positive, a reasonable carryover deficit exists. Junior ground water users are put on notice that this amount will be owed during next season, fourteen (14) days after the publication of the *Day of Allocation* report by Water District 01 in an amount not to exceed a demand shortfall for a SWC member.
b. If the difference is negative, notice of this computation is provided to IGWA.

Final Accounting Complete

113. Step 6: After Water District 01 finalizes its accounting (typically in February or March), repeat Steps 1.d, 1.e, and 2 to get final reasonable carryover.

114. Step 7: Obtain final STORAGE ALLOCATED and STORAGE USED from Table 23 of Water District 01's Final Storage Report.

115. Step 8: Calculate actual final carryover by subtracting STORAGE USED from STORAGE ALLCOATED.

116. Step 9: Calculate Final Eligible Carryover as in Step 4.

117. Step 10: Repeat Step 5 with final reasonable and eligible carryover values.

118. Step 11: Provide revised notice of reasonable carryover shortfall amounts due with April forecasted demand shortfalls, limited to the shortfall in RISD and empty storage space for that entity. Step 11 integrates with Step 6, discussed above in Finding of Fact 74.

119. An example of these steps is applied below to carryover from the final end 2001 season accounting for TFCC at the start of the 2002 season for 2002 shortfall:

Step 6:

Explanatory variables:

ALLOC=209,758 acre-feet
HESIE100AF=1,659 100 acre-feet
PDSI = -5.05
ETR = 34.40 inches

CARRYOVER = 337465 + 0.406 ALLOC + 26.1 HEISE100AF + 4622 PDSI - 12336 ETR = 18,419 acre-feet

Step 7:

STORAGE USED= 201,198.4 acre-feet
ALLOC = 209,758

Step 8:

Gross Carryover = STORAGE USED – ALLOC
= 209,758 - 201,198.4
= 8559.6 acre-feet

Step 9:

Minidoka Credit supply = 7,517 acre-feet
Artesian Irrigation wheeled water = 1874.5 acre-feet

Eligible Final Carryover = 8559.6 + 1874.5 – 7517
= 2917.1 acre-feet

Step 10:

Reasonable Carryover Deficit = 18,419 – 2917.1
= 15,502 acre-feet

Step 11:

Reasonable carryover deficit is positive, thus the deficit is a shortfall owed by junior ground water users if a demand shortfall exists.

CONCLUSIONS OF LAW

1. Idaho Code § 42-602 states that, "The director of the department of water resources shall have discretion and control of the distribution of water from all natural sources . . . . The director of the department of water resources shall distribute water . . . in accordance with the prior appropriation doctrine." According to the Hearing Officer, "It is clear that the Legislature did not intend to grant the Director broad powers to do whatever the Director might think right. However, it is clear also that the Legislature [in Idaho Code § 42-602] did not intend to sum up water law in a single sentence of the Director's authority." *Recommended Order* at 38. The Idaho Supreme Court has recently stated, "Given the nature of the decisions which must be made in determining how to respond to a delivery call, there must be some exercise of discretion by the Director." *American Falls Res. Dist. No. 2 v. Idaho Dept. Water Resources*, 143 Idaho 862, 875, 154 P.3d 433, 446 (2007). The CM Rules incorporate all principles of the prior appropriation doctrine as established by Idaho law. CM Rule 20.03. The scope of the Director's authority to manage the State's water resources in conjunctive administration is not solely limited to the CM Rules. CM Rule 5.

2. Because of changes in irrigation practices and other efficiencies, what is needed to irrigate crops may be less than the decreed or licensed quantity. Beneficial use cannot occur on acres that have been hardened or are otherwise not irrigated. As a result, in-season demand must be tempered by principles of reasonableness, optimum development of water resources in the public interest, and full economic development. CM Rule 20 and 42; *Schodde v. Twin Falls Land and Water Co.*, 224 U.S. 107 (1912); *American Falls* at 876-77, 154 P.3d at 447-48. "An appropriator is not entitled to command the entirety of large volumes of water in a surface or ground water source to support his appropriation contrary to the public policy of reasonable use of water as described in this rule." CM Rule 20.03.

3. Any protocol for determining material injury to RISD and reasonable carryover must be based on the best available science in conjunction with the Director's best professional judgment as the manager of the State's water resources. A purpose of the protocol and the enumeration of its steps is to provide a more transparent and deliberative process that will assist the parties in planning.

4. As discussed in the Findings of Fact, RISD is a determination of need for members of the SWC and a requirement that junior ground water users must provide replacement water if material injury is found to members of the SWC.

5. Within fourteen (14) days of issuance of the Joint Forecast, the Director shall issue his *forecast supply*, notifying the parties if a *demand shortfall* exists to RISD. If a *demand shortfall* exists, junior ground water users shall have fourteen (14) days from the issuance of the *forecast supply* to provide evidence, to the satisfaction of the Director, establishing their ability to secure a volume of storage water equal to the entire amount of the predicted *demand shortfall*. If, after the *Day of Allocation*, reservoir storage space held by members of the SWC has not filled, and a *demand shortfall* still exists, junior ground water users shall be required to provide the *reasonable carryover shortfall* to injured members of the SWC within fourteen (14) days of the *Day of Allocation* in an amount not to exceed the *demand shortfall*. If junior ground water users do not comply with these steps, the Director shall order curtailment of junior ground water rights.

6. Within the first two weeks of July (approximately halfway through the irrigation season), the Director shall publish a revised *forecast supply*, taking into account factors that have occurred during the season-to-date for purposes of determining if a *demand shortfall* to RISD exists. If a *demand shortfall exists*, junior ground water users shall have fourteen (14) days from the issuance of the revised *forecast supply* to provide evidence, to the satisfaction of the Director, establishing that they have secured a volume of storage water equal to the entire amount of the predicted *demand shortfall*. If junior ground water users do not comply with these steps, the Director shall order curtailment of junior ground water rights.

7. Within the first two weeks of September (approximately three-quarters through the irrigation season), the Director shall publish a revised *forecast supply*, taking into account factors that have occurred during the season-to-date for purposes of determining if a *demand shortfall* to RISD exists. If a *demand shortfall* cxists, junior ground water users shall have seven (7) days from the issuance of the revised *forecast supply* to provide evidence, to the satisfaction of the Director, establishing that they have secured a volume of storage water equal to the entire amount of the predicted *demand shortfall*. This water shall be made available to the SWC entity having the shortfall at the *time of need*.

8. "There is no statutory provision for obtaining a decreed right to 'carryover' water." *American Falls* at 878, 154 P.3d at 449. The authorization for ordering the right to a reasonable amount of carryover water is found in CM Rule 42.01.g, which states in pertinent part: "the holder of a surface water storage right shall be entitled to maintain a reasonable amount of carry-over storage to assure water supplies for future dry years. In determining a reasonable amount of carry-over storage water, the Director shall consider the average annual rate of fill of storage reservoirs and the average annual carry-over for prior comparable water conditions and the projected water supply for the system."

9. While CM Rule 42.01.g contemplates reasonable carryover for future dry years, the Hearing Officer determined that "requiring curtailment to reach beyond the next irrigation season involves too many variables and too great a likelihood of irrigation water being lost to

irrigation use to be acceptable within the standards implied in *AFRD#2*." *Final Order* at 11, ¶ 16. Therefore, a senior may only seek curtailment of juniors to provide reasonable carryover for a period of one year. This is consistent with the Idaho Supreme Court's determination in *American Falls*, that the right to carryover storage is not unfettered: "the Court foresaw abuses that could occur when one is allowed to carryover water despite detriment to others. Concurrent with the right to use water in Idaho 'first in time,' is the obligation to put that water to beneficial use. To permit excessive carryover of stored water without regard to the need for it, would be in itself unconstitutional." *American Falls* at 880, 154 P.3d at 451.

10. The determination of the amount of reasonable carryover to be obtained by curtailment of junior ground water users is left to the discretion of the Director. *American Falls* at 880, 154 P3d at 451. As explained in the Findings of Fact, if a reasonable carryover shortage is found, junior ground water users will be responsible for providing replacement water to materially injured members of the SWC.

11. At the end of the irrigation season, the Director shall calculate the preliminary reasonable carryover for each member of the SWC and provide the parties with notice of preliminary carryover deficits. In conjunction with the Director's issuance of his April *forecast supply* for *demand shortfall*, the Director shall update his preliminary reasonable carryover determination.

12. Within fourteen (14) days following the *Day of Allocation*, junior ground water users shall provide to each member of the SWC any *reasonable carryover shortfall*, limited to the shortfall in RISD and empty storage space for that entity.

13. On May 26, 2009, after 33 years of service to the Department, the Director announced his retirement, effective June 30, 2009. The Director, in conjunction with Department staff, was responsible for developing the protocol for determining material injury to RISD and reasonable carryover. The developed protocol is based on the best available science and the Director's best professional judgment. The Director encourages the parties to continue working with the Department in further development and refinement of the protocol.

14. The protocol is subject to modification based on ongoing input from the parties and the Department, new science, new data, or new modeling concepts. The protocol for determining injury to in-season demand and reasonable carryover should be based on the best available science and the Director's best professional judgment as manager of the State's water resources.

15. In the Final Order, the Director stated that he would issue a separate, final order for determining material injury to RISD and reasonable carryover. *Final Order* at 6, ¶ 25. At the time the Final Order was issued on September 5, 2008, the Director did not anticipate his retirement at this time.

16. Recognizing that the Director will not hold his position after June 30, 2009, and for purposes of economy and to prevent prejudice, this Order is being issued as an interlocutory order in accordance with Department Rule of Procedure 710, IDAPA 37.01.01.710.

17. The Director recognizes the relief requested in the Minidoka Petition. Because the Minidoka Petition was filed under the assumption that this interlocutory order would be a final order, the Director will deny the Minidoka Petition without prejudice. After issuance of this Order, any party may petition for review consistent with IDAPA 37.01.01.711.

ORDER

Based upon and consistent with the foregoing, the Director hereby orders as follows:

The Minidoka Petition is DENIED without prejudice.

Pursuant to Department Rule of Procedure 710, IDAPA 37.01.01.710, this is an interlocutory order and is not subject to review by reconsideration or appeal. The Director may review this interlocutory order pursuant to Rule 711, IDAPA 37.01.01.711.

Dated this 30th day of June 2009.

DAVID R. TUTHILL, JR.
Director

CERTIFICATE OF SERVICE

I HEREBY CERTIFY that on this 30th day of June 2009, the above and foregoing, was served by the method indicated below, and addressed to the following:

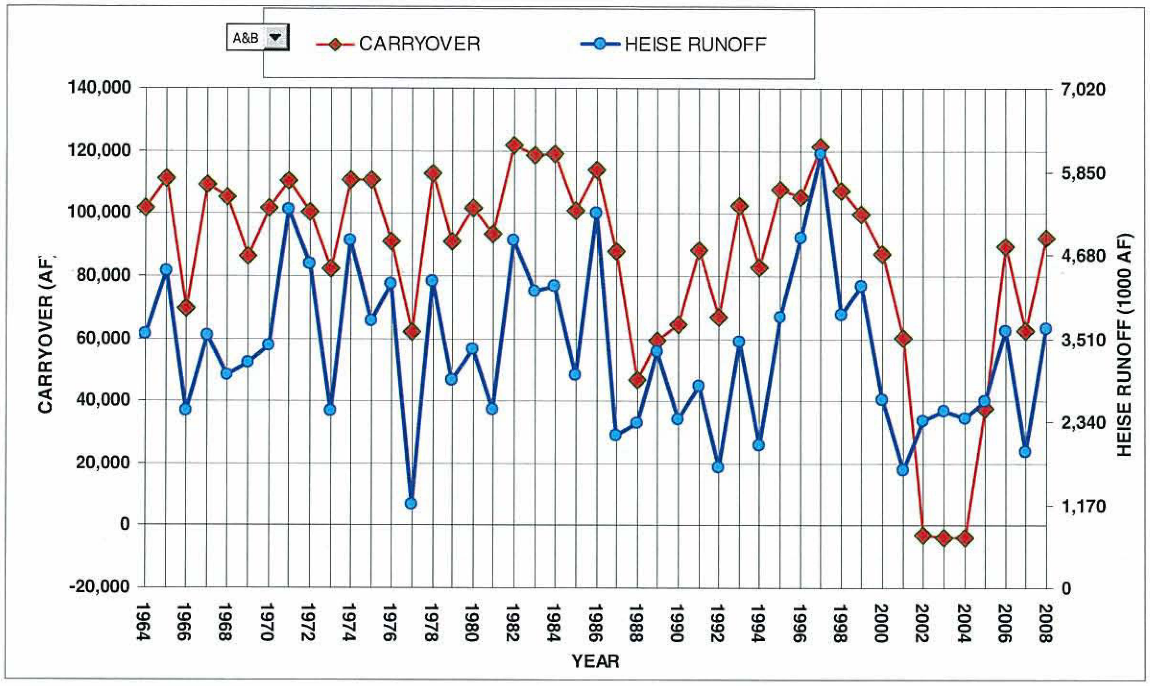
John K. Simpson BARKER ROSHOLT & SIMPSON, LLP P.O. Box 2139 Boise, ID 83701 jks@idahowaters.com	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Travis L. Thompson Paul L. Arrington BARKER ROSHOLT & SIMPSON, LLP P.O. Box 485 Twin Falls, ID 83303 tlt@idahowaters.com pla@idahowaters.com	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
C. Thomas Arkoosh CAPITOL LAW GROUP, PLLC P.O. Box 32 Gooding, ID 83339 tarkoosh@capitollawgroup.net	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
W. Kent Fletcher FLETCHER LAW OFFICE P.O. Box 248 Burley, ID 83318 wkf@pmt.org	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Randall C. Budge Candice M. McHugh Thomas J. Budge RACINE OLSON P.O. Box 1391 Pocatello, ID 83204-1391 rcb@racinelaw.net tjb@racinelaw.net	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Candice M. McHugh RACINE OLSON 101 Capitol Blvd., Ste. 208 Boise, ID 83702 cmm@racinelaw.net	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Kathleen Carr US Dept. Interior 960 Broadway Ste 400 Boise, ID 83706	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☐ Email

Matt Howard US Bureau of Reclamation 1150 N Curtis Road Boise, ID 83706-1234 mhoward@pn.usbr.gov	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Sarah A. Klahn William A. Hillhouse Mitra M. Pemberton WHITE JANKOWSKI 511 16th St., Ste. 500 Denver, CO 80202 sarahk@white-jankowski.com billh@white-jankowski.com mitrap@white-jankowski.com	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Dean A. Tranmer City of Pocatello P.O. Box 4169 Pocatello, ID 83205 dtranmer@pocatello.us	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Michael C. Creamer Jeffrey C. Fereday GIVENS PURSLEY LLP P.O. Box 2720 Boise, ID 83701-2720 mcc@givenspursley.com jcf@givenspursley.com	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Lyle Swank IDWR—Eastern Region 900 N. Skyline Drive Idaho Falls, ID 83402-6105 lyle.swank@idwr.idaho.gov	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email
Allen Merritt Cindy Yenter IDWR—Southern Region 1341 Fillmore St., Ste. 200 Twin Falls, ID 83301-3033 allen.merritt@idwr.idaho.gov cindy.yenter@idwr.idaho.gov	☒ U.S. Mail, postage prepaid ☐ Hand Delivery ☐ Overnight Mail ☐ Facsimile ☒ Email

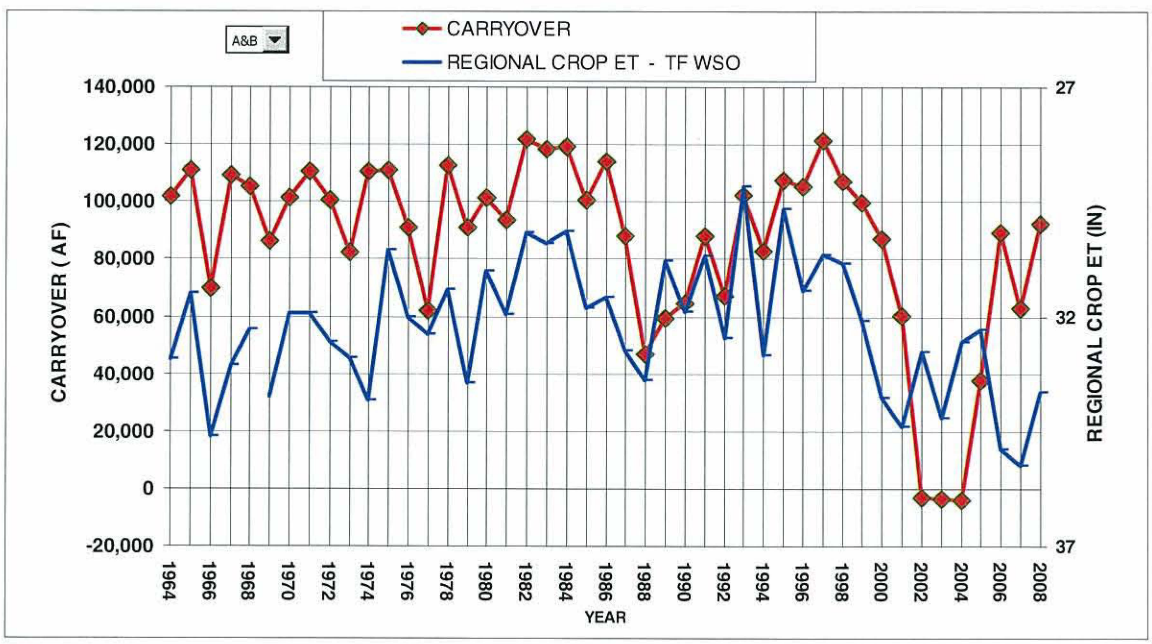
Victoria Wigle
Administrative Assistant to the Director

Attachment A

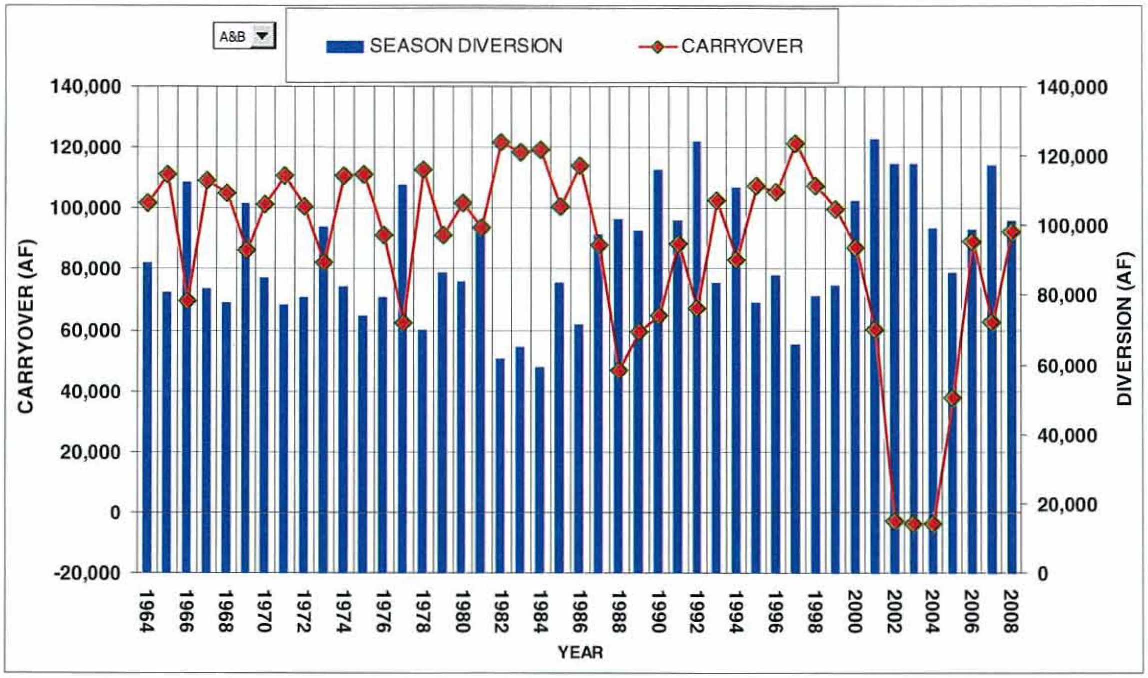
Figure 1. Explanatory variables for A&B Irrigation District.



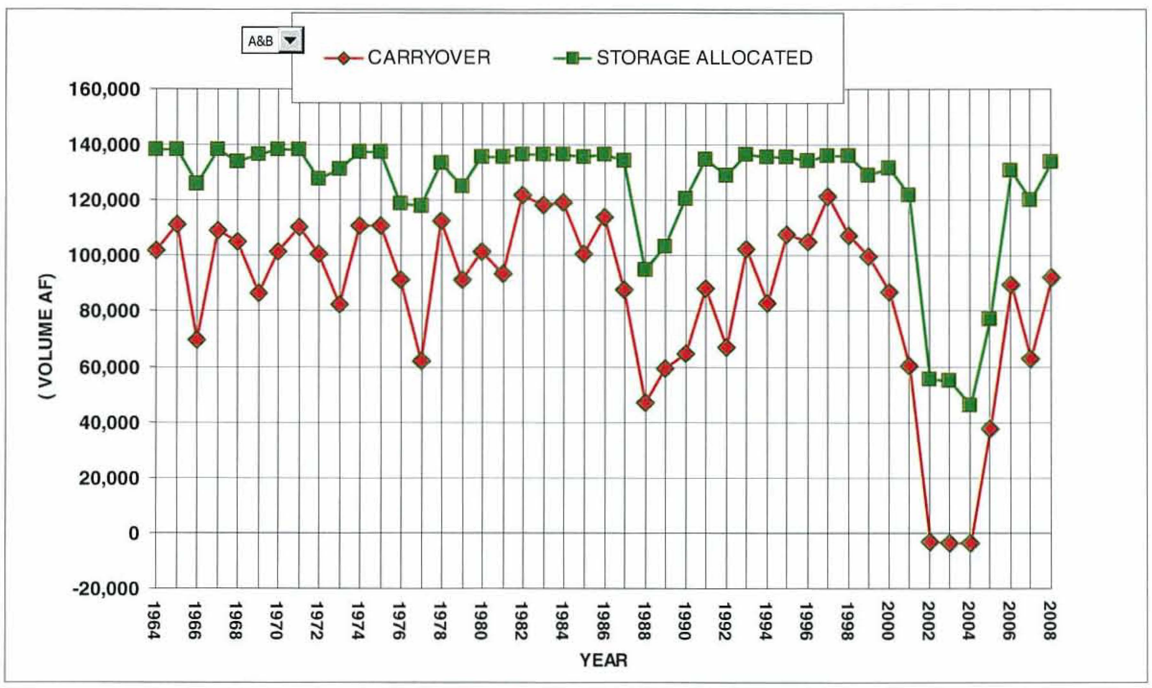
a) **End of irrigation year carryover and April through July unregulated Heise runoff.**



b) **Ending irrigation year carryover and regional April through September potential crop evapotranspiration.**

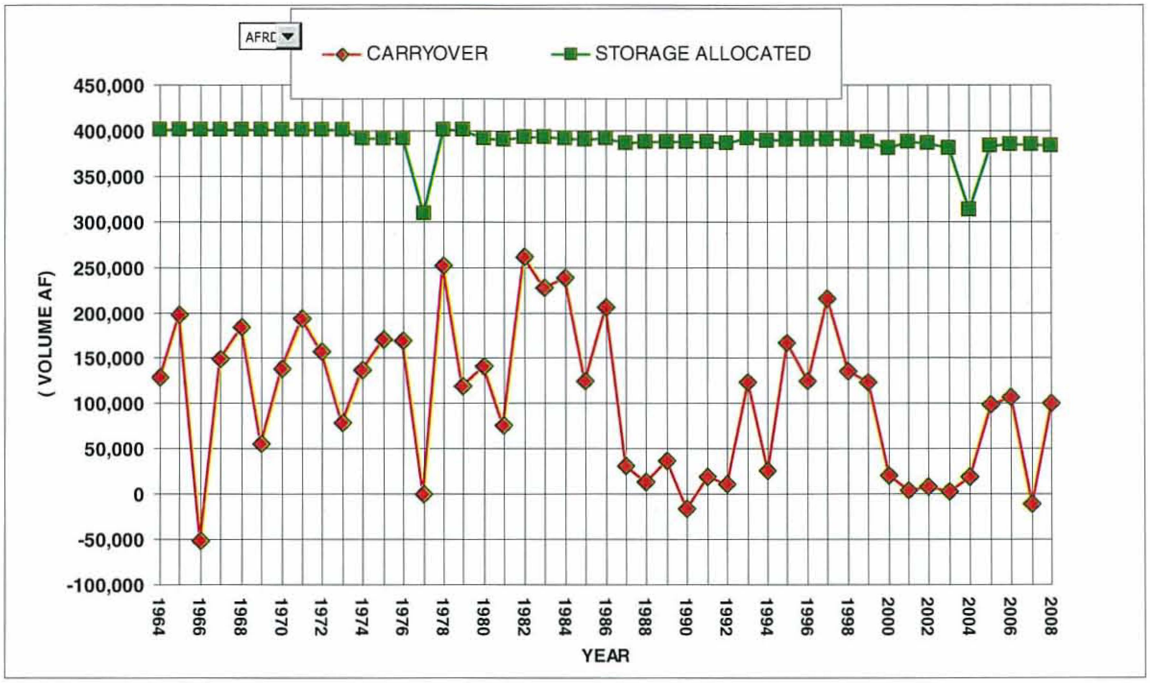


c) **End of irrigation year carryover and irrigation year diversions.**

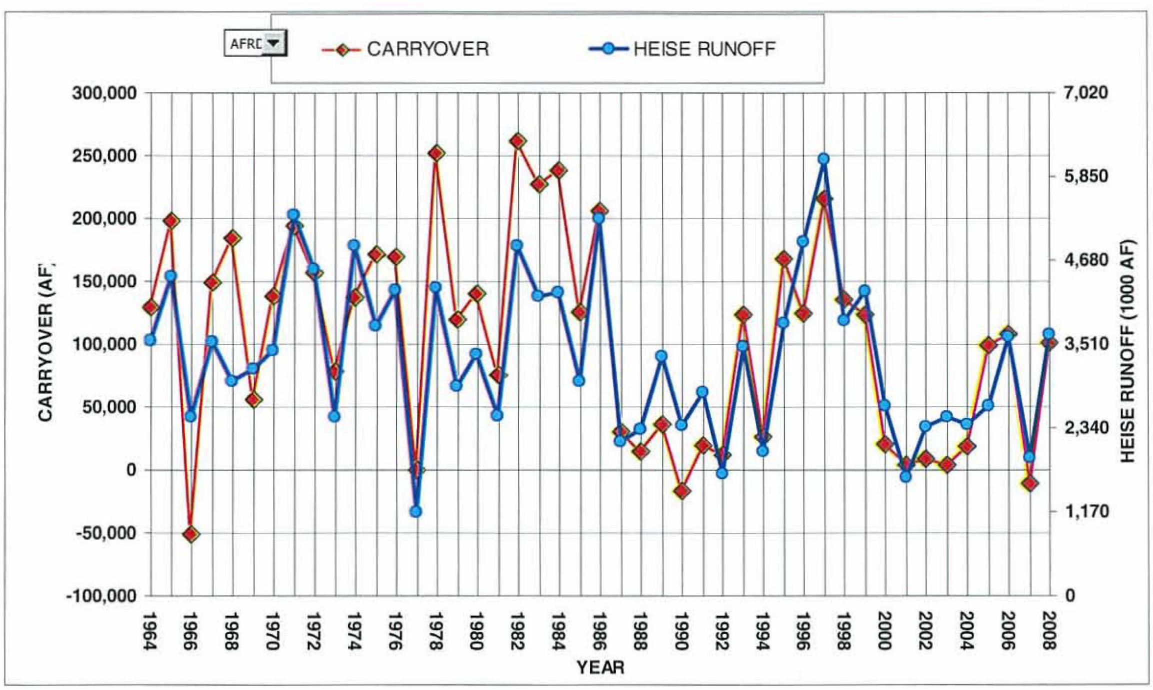


d) **End of irrigation year carryover and gross storage allocation.**

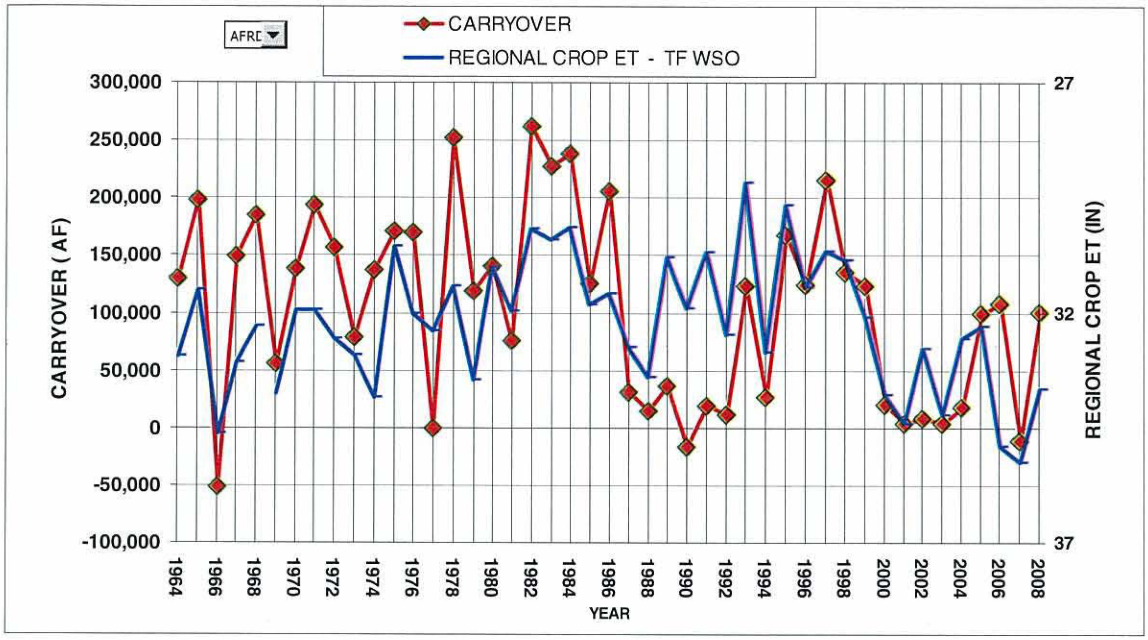
Figure 2. Explanatory variables for American Falls Reservoir District #2.



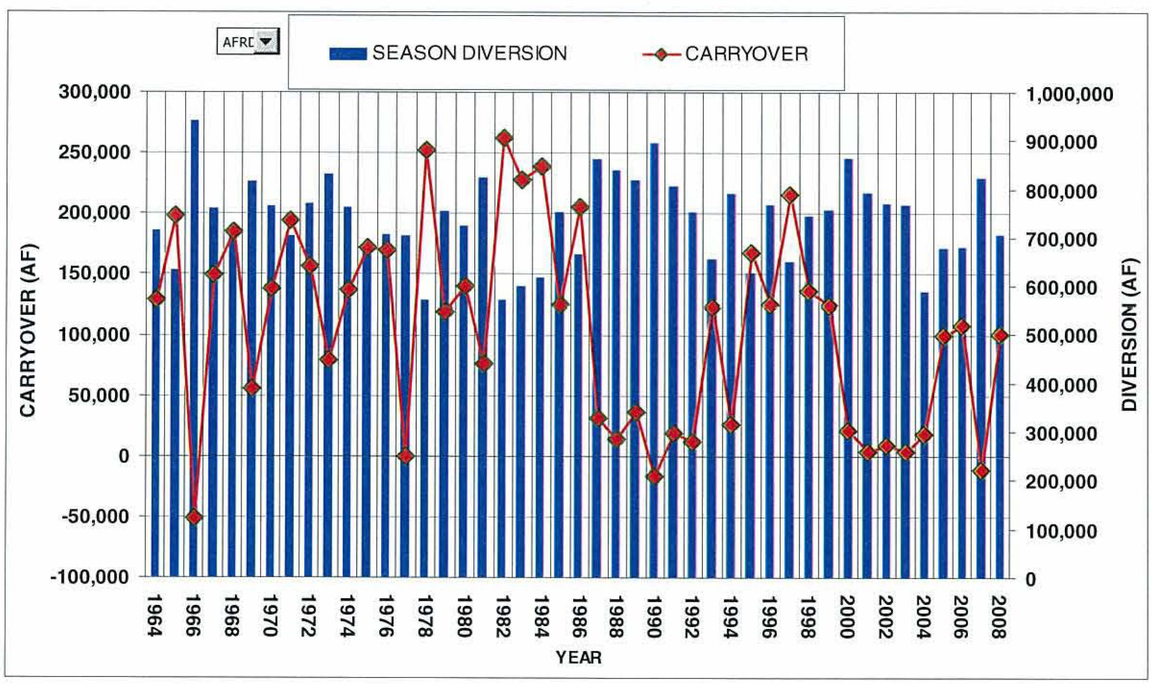
a) End of irrigation year carryover and gross storage allocation.



b) End of irrigation year carryover and April through July unregulated Heise runoff.

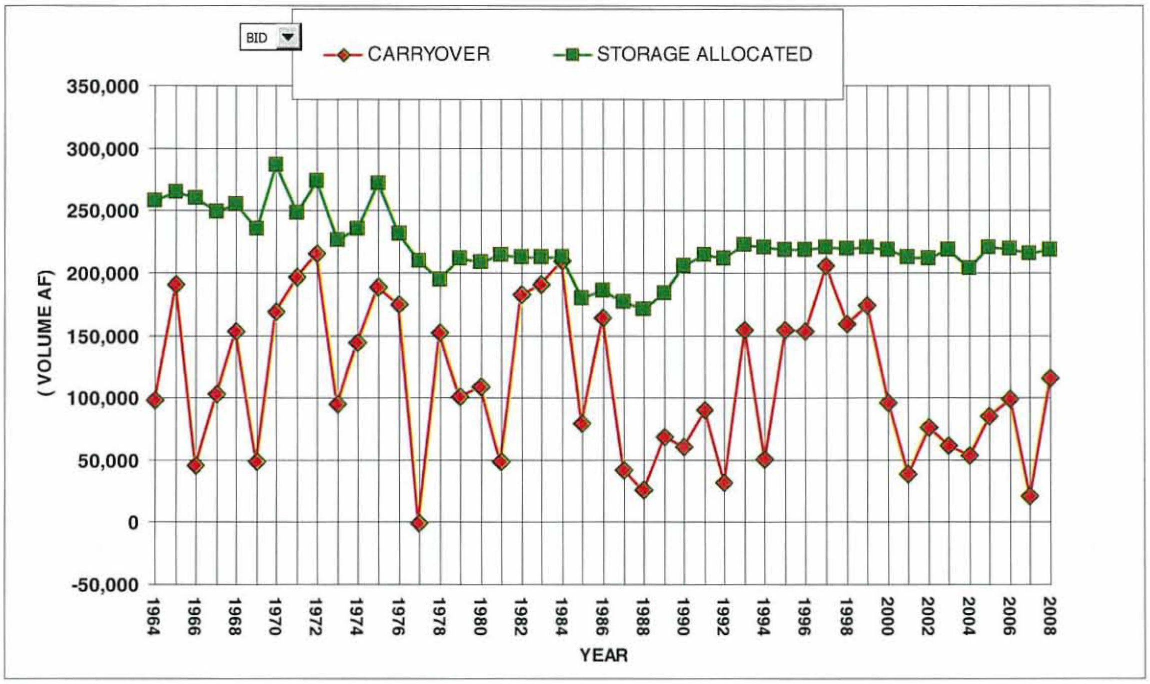


c) Ending irrigation year carryover and regional April through September potential crop evapotranspiration.

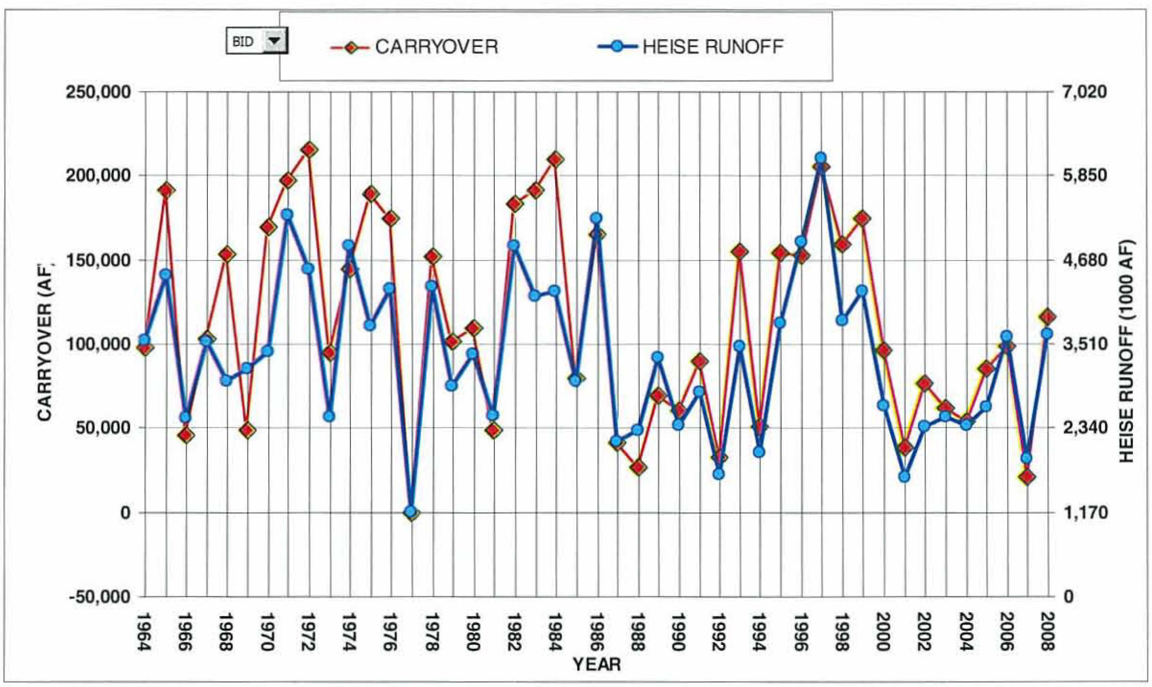


d) End of irrigation year carryover and irrigation year diversions.

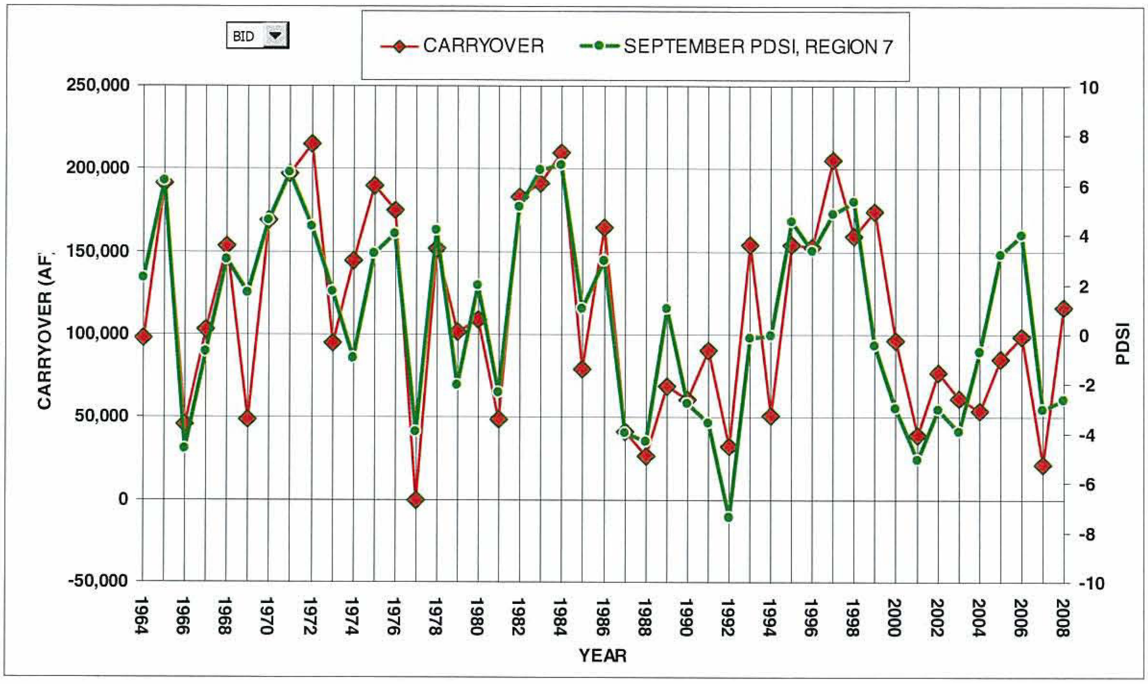
Figure 3. Explanatory variables for Burley Irrigation District.



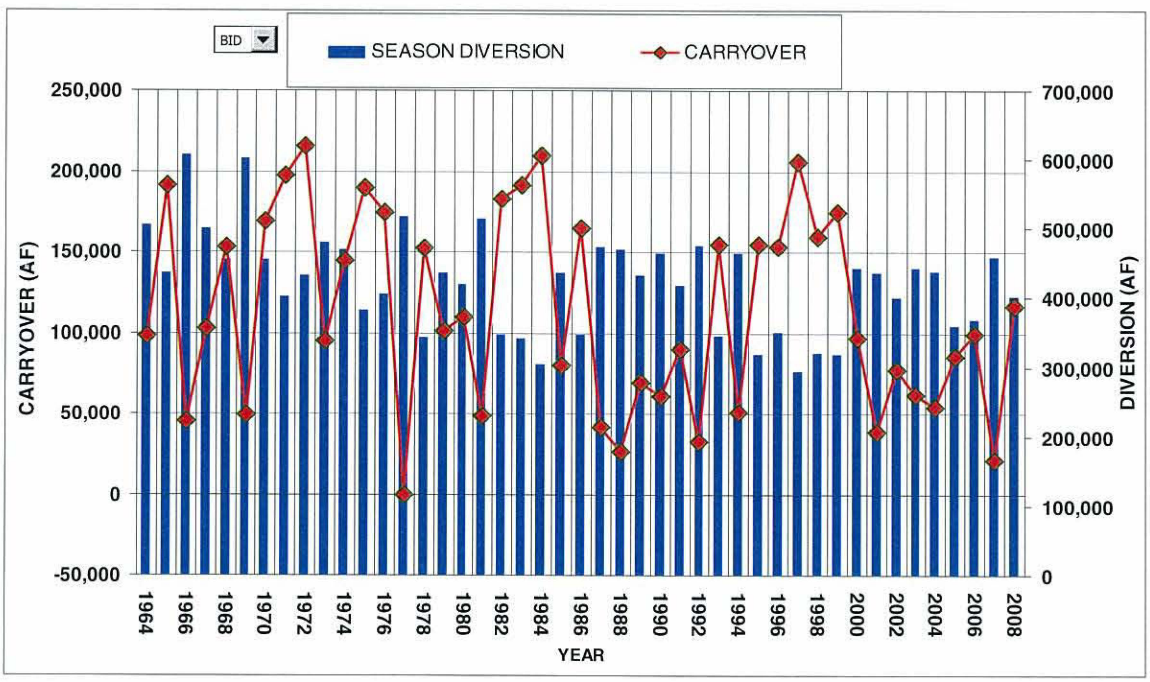
a) End of irrigation year carryover and gross storage allocation.



b) End of irrigation year carryover and April through July unregulated Heise runoff.

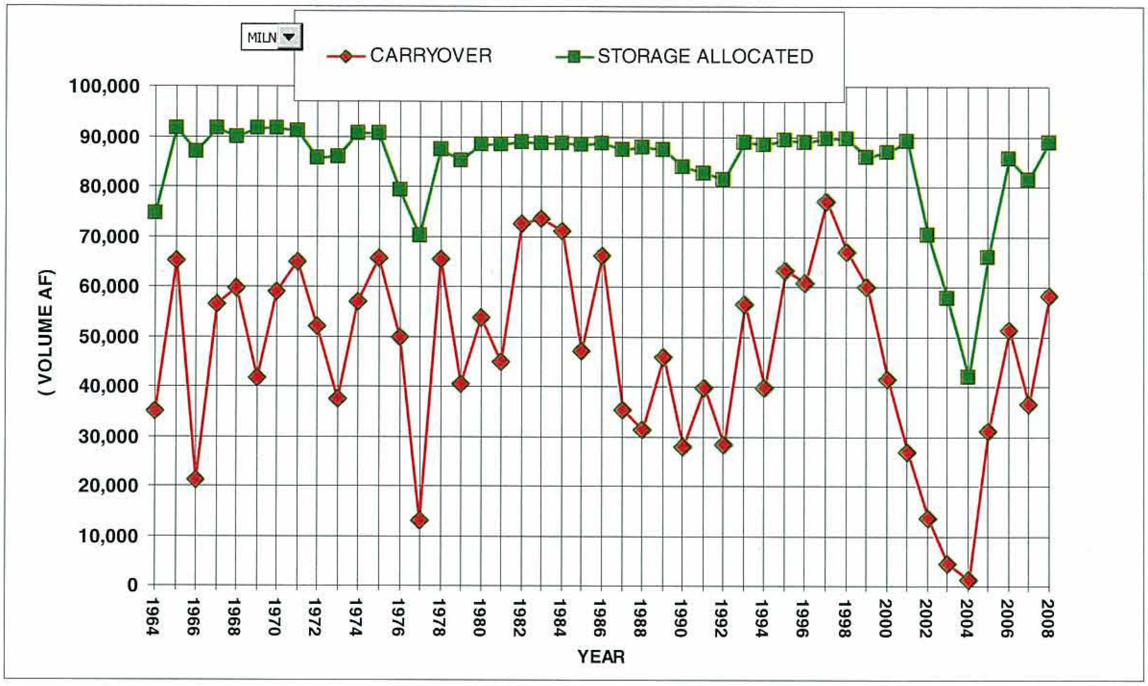


c) End irrigation year carryover and September Palmer drought severity index.

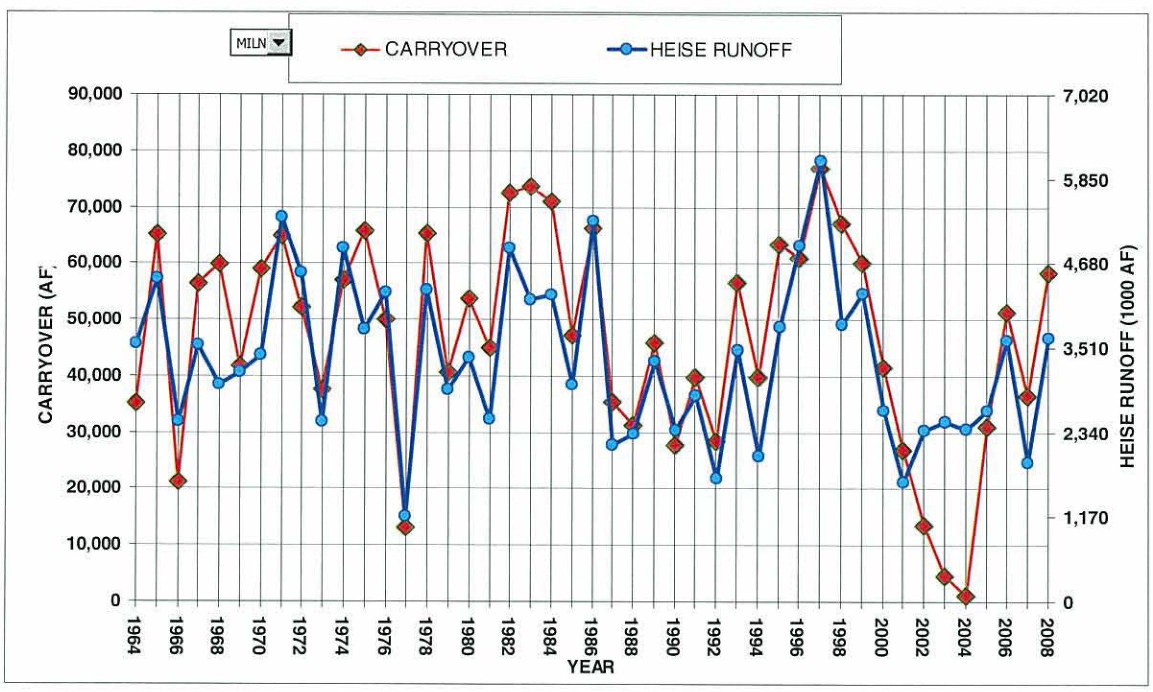


d) End of irrigation year carryover and irrigation year diversions.

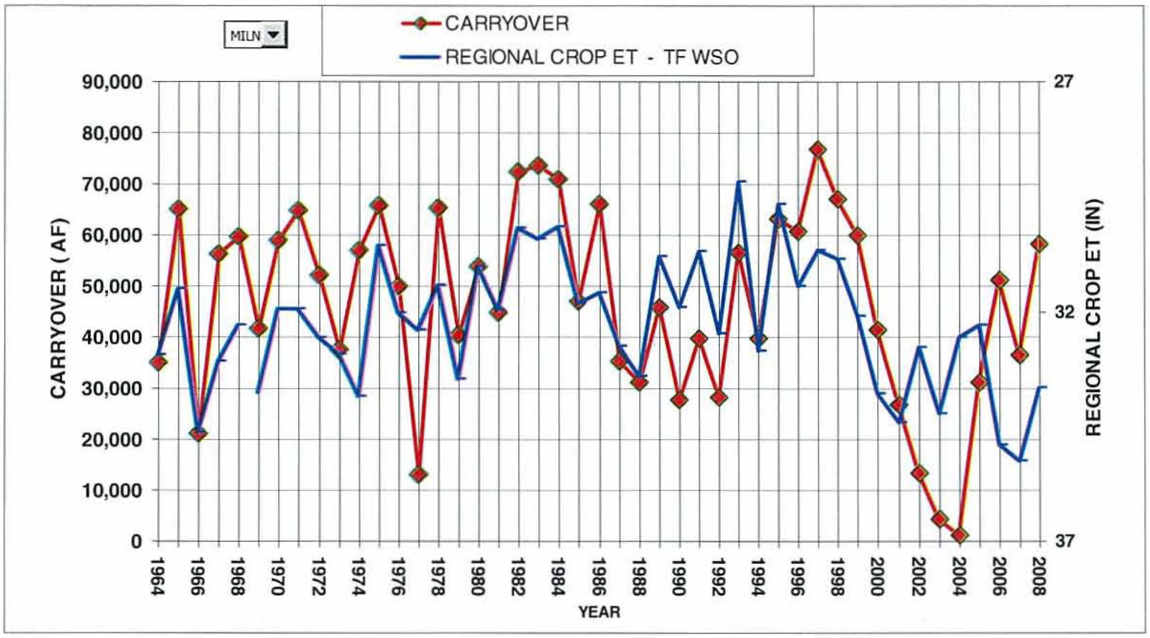
Figure 4. Explanatory variables for Milner Irrigation District.



a) End of irrigation year carryover and gross storage allocation.

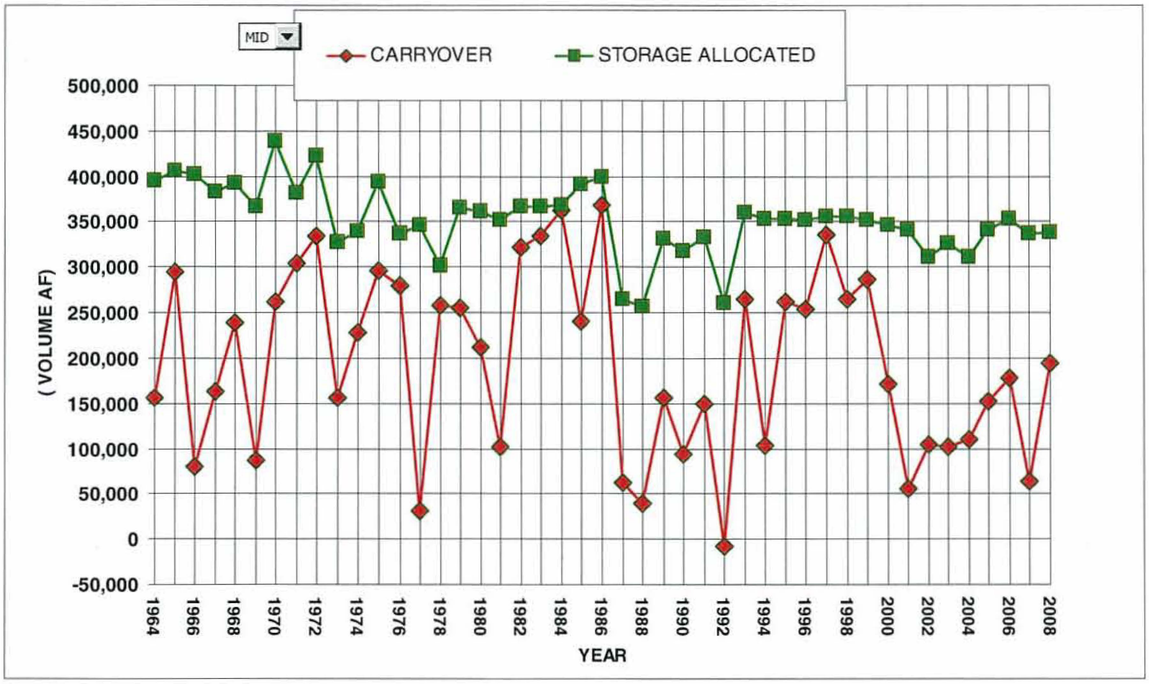


b) End of irrigation year carryover and April through July unregulated Heise runoff.

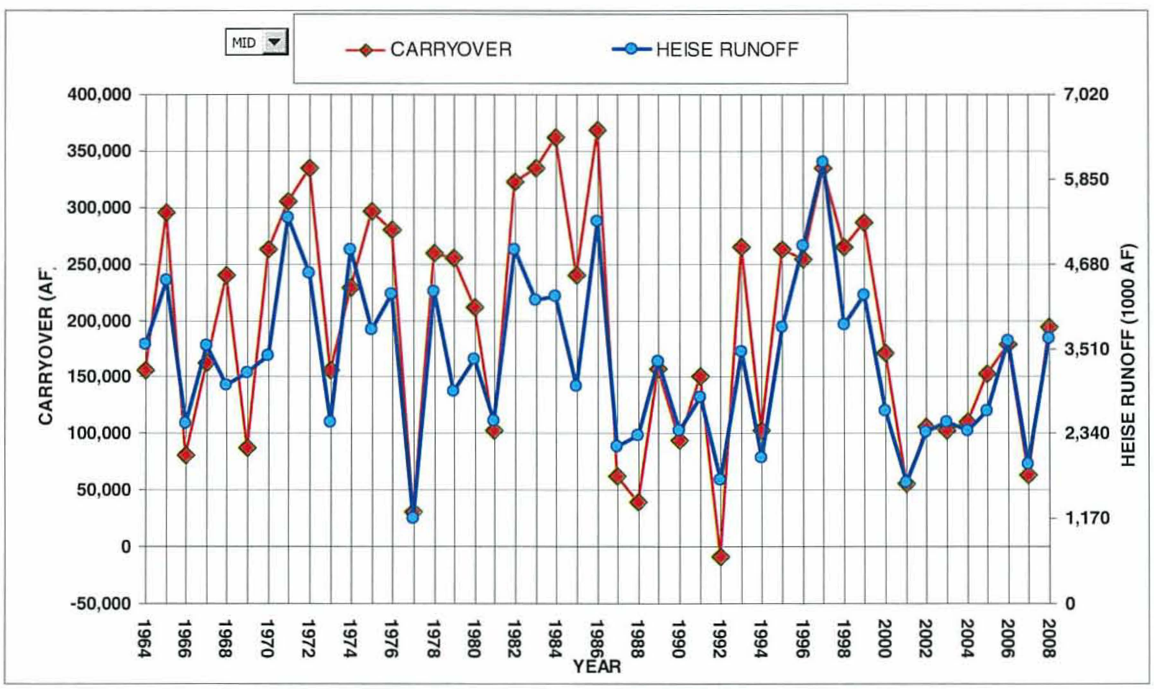


c) End of irrigation year carryover and regional April through September potential crop evapotranspiration.

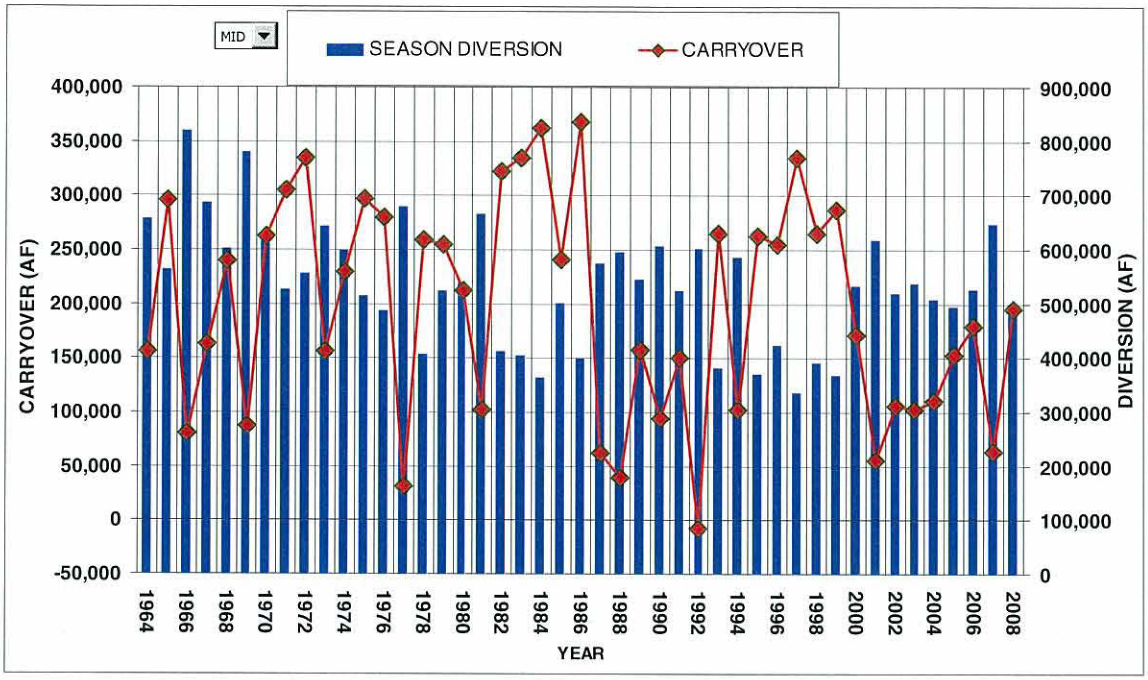
Figure 5. Explanatory variables for Minidoka Irrigation District.



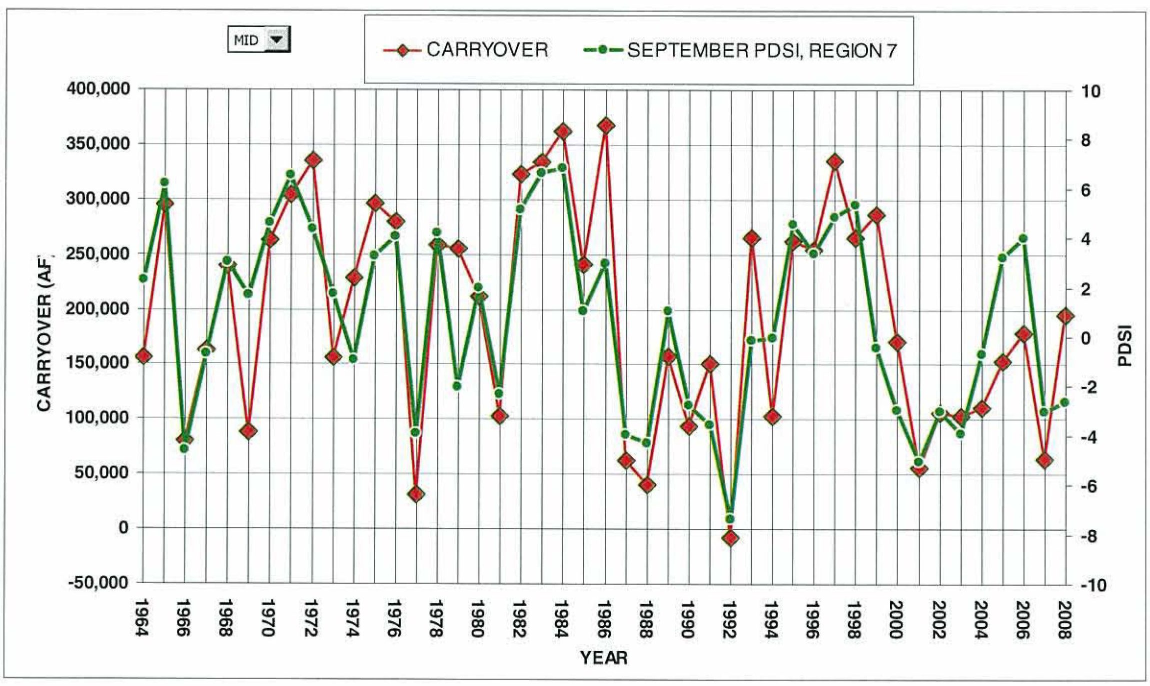
a) End of irrigation year carryover and gross storage allocation.



b) End of irrigation year carryover and April through July unregulated Heise runoff.

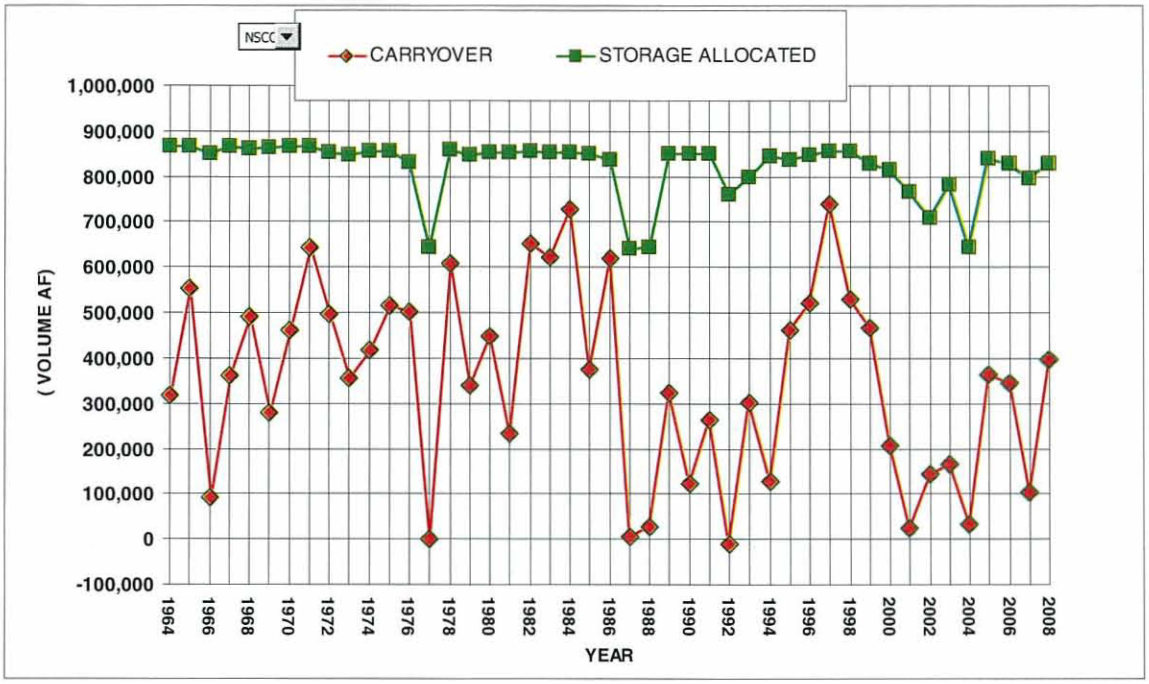


c) End of irrigation year carryover and irrigation year diversions.

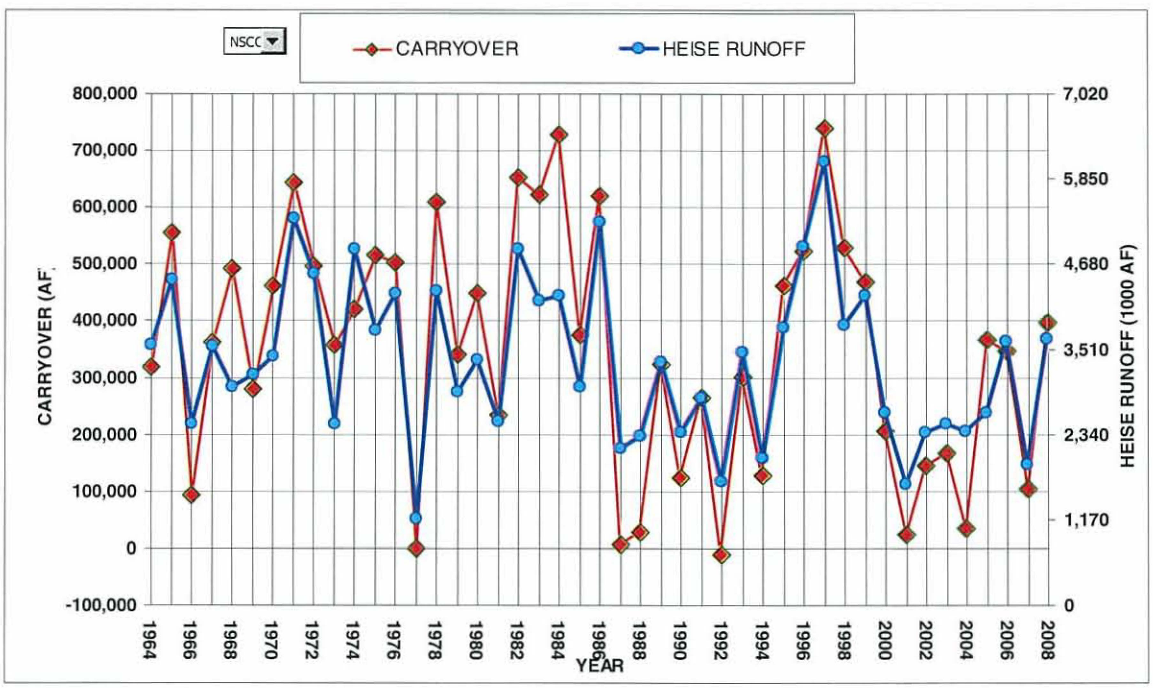


d) End irrigation year carryover and September Palmer drought severity index.

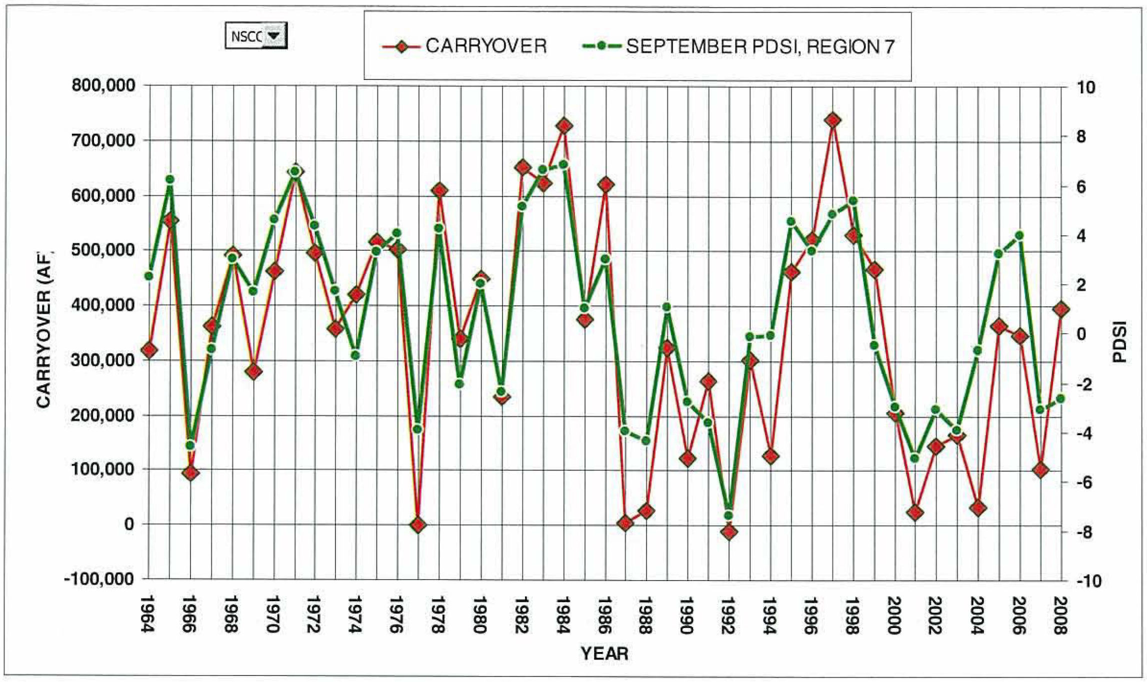
Figure 6. Explanatory variables for North Side Canal Company.



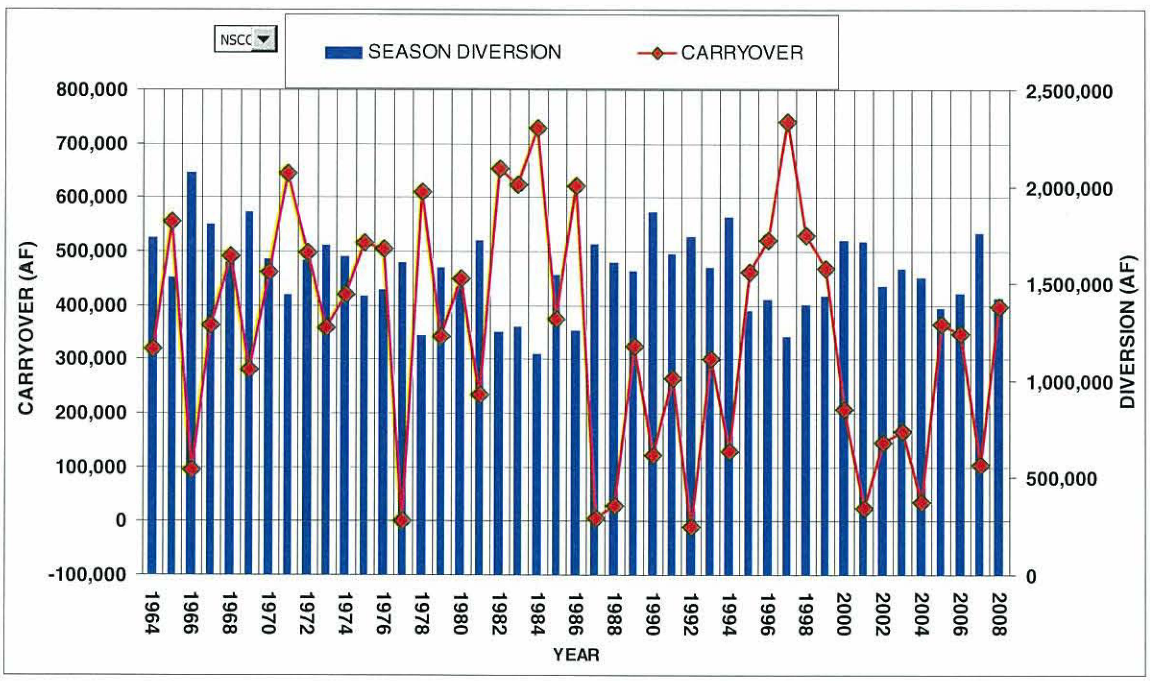
a) End of irrigation year carryover and gross storage allocation.



b) End of irrigation year carryover and April through July unregulated Heise runoff.

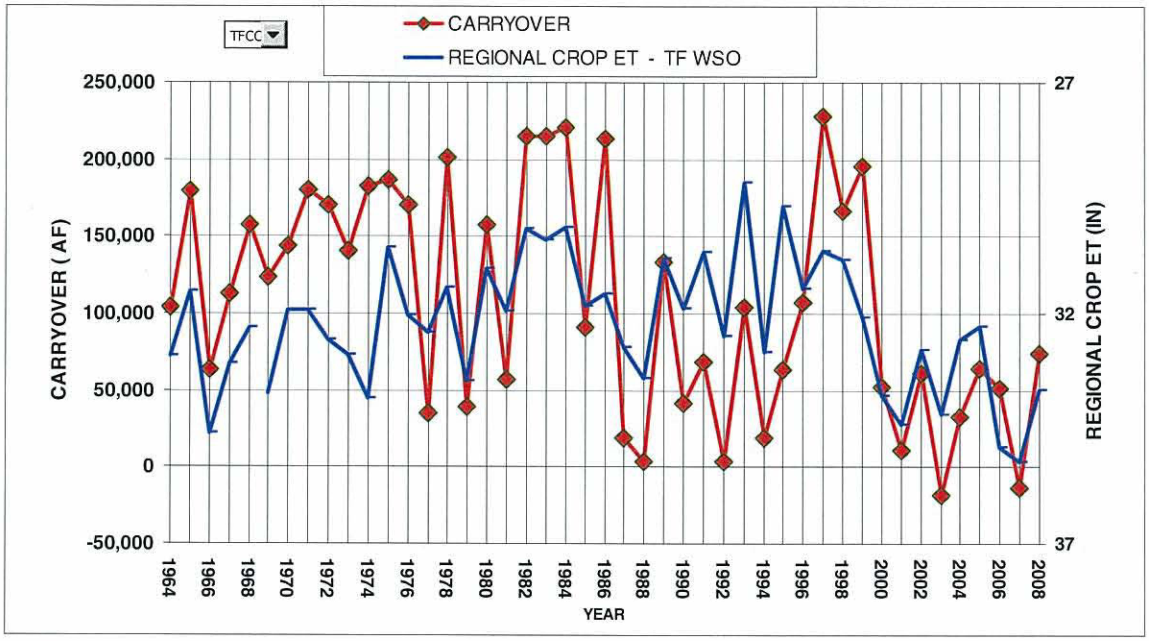


c) End irrigation year carryover and September Palmer drought severity index.

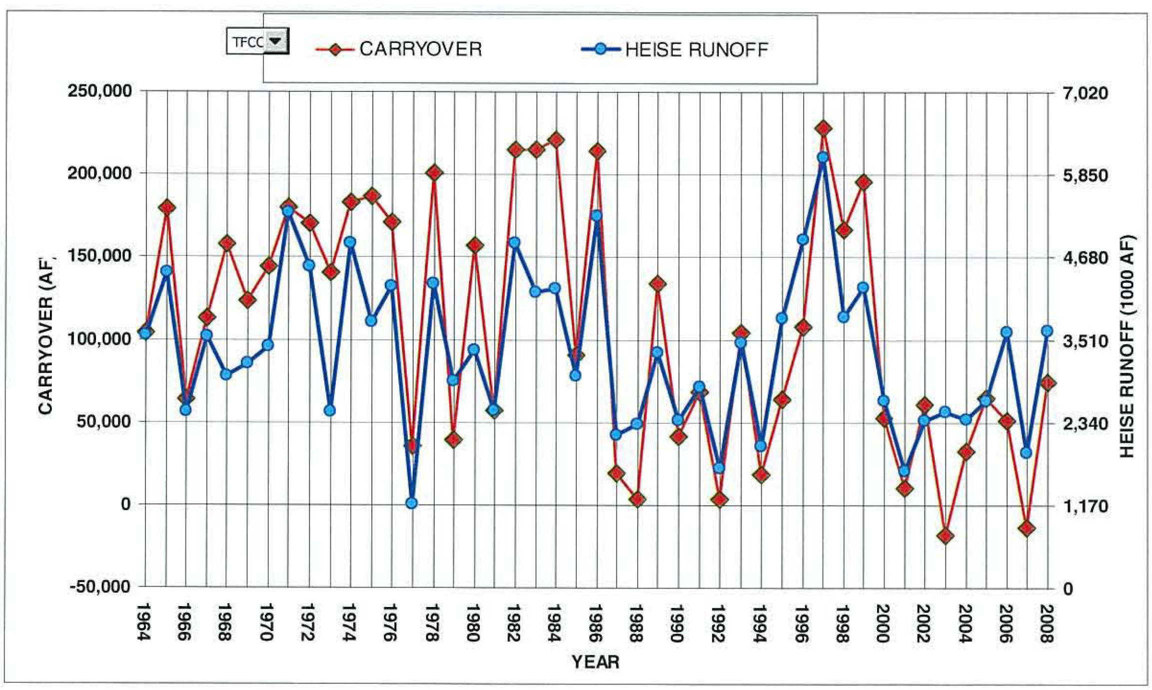


d) End of irrigation year carryover and irrigation year diversions.

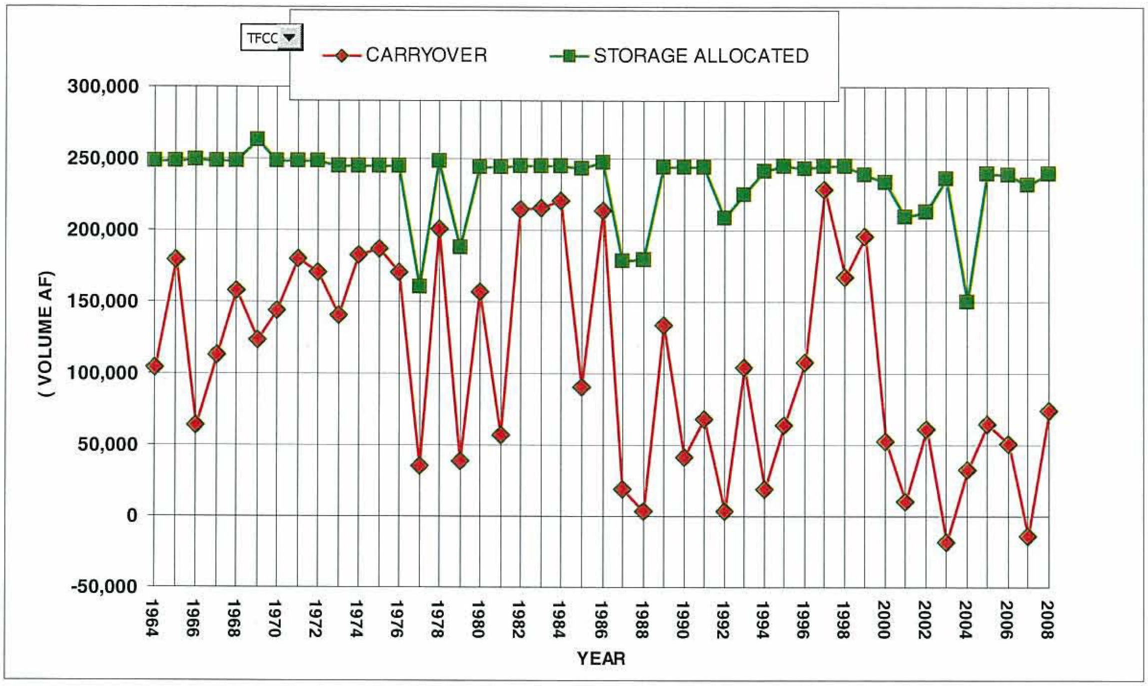
Figure 7. Explanatory variables for Twin Falls Canal Company



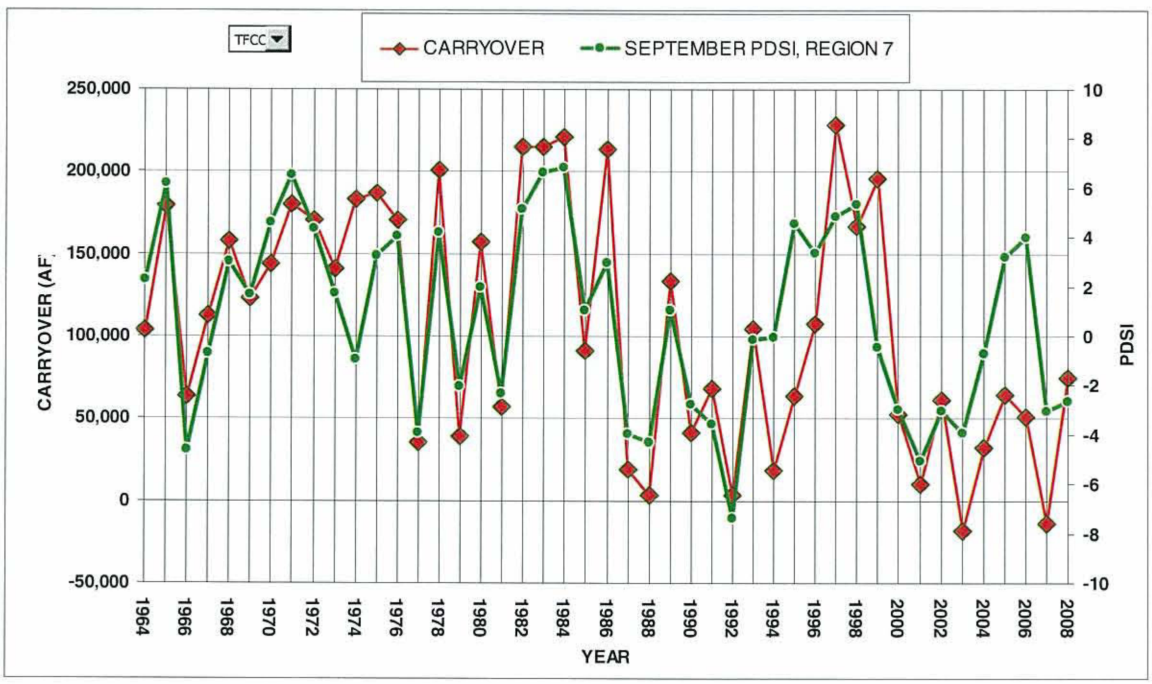
a) Ending irrigation year carryover and regional April through September potential crop evapotranspiration.



b) End of irrigation year carryover and April through July unregulated Heise runoff.



c) End of irrigation year carryover and gross storage allocation.



d) End irrigation year carryover and September Palmer drought severity index.