

MEMORANDUM

DATE: September 15, 2009

TO: Water Right File 36-8538

FROM: Shelley W. Keen *SWK*

RE: Annual Diversion Volume Limit

IDWR issued Permit 36-8538 in 1990 for the diversion of ground water to serve a dairy of 700 milking cows and 800 replacement cattle. The permit holder submitted proof of beneficial use in October of 1992. The North Snake Ground Water District did not begin reporting annual diversion volume data for this dairy until 2002, and IDWR did not conduct a beneficial use field examination until 2009. According to the field examiner, the dairy now diverts 110 AF annually. However, the current annual volume cannot be used for licensing because it does not reflect water usage at the time proof of beneficial use was submitted. The dairy now has 1,700 milking cows and 150 replacement animals, a much different mix than permitted. The permit holder also submitted information indicating that the dairy changed its cleanup and cooling methods in the 1990s to reduce water usage, and then gradually increased water usage as it added animals. Consequently, the challenge in determining an annual diversion volume limit when licensing this right is to determine what likely occurred at the dairy by 1992 when proof of beneficial use was submitted.

IDWR customarily divides dairy water use into two broad categories, "stockwater" for the water the animals drink and "commercial" for the other water uses at the dairy. The commercial component includes things like corral misters, cleanup water, and operation of the plate cooler.

IDWR has three estimates for the stockwater component of this dairy in 1992. The permit holder submitted information suggesting the 700 milking cows and 800 replacement animals used 41.67 AF annually, based on 41.7 gpd per milking cow, 14.0 gpd per dry cow, and 9.4 gpd per heifer. The field examiner estimated 38.2 AF based on IDWR rough standards of 35.0 gpd per milking cow and 12 gpd per non-milker. IDWR's dairy spreadsheet, which is normally used to evaluate the "reasonableness" of applications for new water rights, suggests the same number of animals would have needed about 28.9 AF.

To estimate the stockwater need for a dairy, the spreadsheet relies on a varying amount of water per animal per day, depending on the time of year and the amount of milk produced per animal. The dairy spreadsheet method is based on data published by Dean E. Falk, Extension Dairy Specialist, University of Idaho, at <http://www.oneplan.org/Stock/DairyWater.asp>.

The permit holder's numbers are at the high end of the range published by Falk for hot months and, therefore, probably inflate the estimate of the volume of water actually used by the herd.

The field examiner's volume recommendation is probably more realistic than the permit holder's estimate. Because it accounts for the seasonal variation in water consumption, the dairy spreadsheet is probably the most credible of the three methods. Therefore, I recommend using 28.9 AF for the stockwater contribution to the overall water volume used at the dairy in the early 1990s.

Estimating the volume of water for used for the commercial component of the dairy is more difficult than estimating the stockwater component. The permit holder's information indicates 35.8 AF per year for the milking parlor and 29.8 AF per year for cooling. The field examiner estimated 30.57 AF, but it was based on the dairy's current washing and cooling methods, not on the less efficient methods apparently employed by the dairy in the early 1990s. The dairy spreadsheet suggests a commercial component of 35.1 AF, but all the inputs needed for the dairy spreadsheet are not completely evident in the file, and estimates were employed for corral misters and other items.

The biggest differences between the dairy spreadsheet and the permit holder's information were the permit holder's 14.11 AF for the plate cooler vs. the spreadsheet's 6.3 and the permit holder's 15.7 AF for the water-cooled compressor and vacuum pump, which the dairy spreadsheet does not even address. For the plate cooler, the dairy spreadsheet uses 8 gallons of water per day per milking cow, which is the figure recommended by Dean E. Falk, Extension Dairy Specialist, University of Idaho, in "Fresh Water Considerations for Dairy Farms." The basis for the permit holder's higher plate cooler estimate is not evident. I reviewed the permit holder's inputs for the parlor estimate, and they seem reasonable. The plate cooler figure, however, should be based on the dairy spreadsheet unless the permit holder can show that 8 gallons per day per milking cow is too low. Lacking information to the contrary, IDWR will have to rely on the permit holder's recommendation for the cooling water for the vacuum pump and compressor. It is worth noting, however, that the cooling water tends to be recycled for other purposes in modern dairies, whereas the permit holder added the cooling water to the requirements for stockwatering and parlor use.

Based on this review, the annual volume limit for License 36-8538 should be:

Stockwater	28.9 AF
Parlor	35.8 AF
Plate cooler	6.3 AF
<u>Other cooling</u>	<u>15.7 AF</u>
Total	86.7 AF

Dean E. Falk
Extension Dairy Specialist
University of Idaho

Dairy cows and milking facilities require a reliable high quality water supply. Dairy production is changing with larger production units being planned and constructed. These dairy facilities require a water supply that can deliver high quality water to the cows at all times in sufficient amounts to meet both physiological and sanitation needs of the facility.

The data reported in the literature for water consumption for dairy facilities varies considerably. For example, in three different studies the water needs for lactating cow consumption, and milking center cleaning range between 40 to 50 gallons fresh water per cow per day. In these studies the free stall units were flushed with recycled lagoon water in all areas except the milk parlor and milk room. This concept reduces the amount of water that is introduced into the waste management system.

Texas data illustrates that water use on eleven dairy farms varied widely, depending on the type of manure removal system and other factors. The greatest variable was the use of sprinkler cow wash systems and/or flush systems versus manual manure removal. The total amount of fresh water used for sanitation and manure removal averaged 39.6 gallons per cow per day. The mean value for each farm ranged from 12.3 to 69.2 gallons per cow per day. The water used for cattle drinking water troughs on seven of the dairies studied averaged 28.7 ± 12.0 gallons per cow per day. Thus the Texas data average fresh water use per cow per day for sanitation and drinking was 68.3 gallons. Their data showed wide differences in water use for facilities that flushed or had cow sprinklers versus those that used manual cleanup. The average water use for milking parlors and holding pens without flush or cow sprinklers averaged 19.9 ± 14.0 gallons per cow per day. In contrast, milking parlors and holding pens with sprinkler cow washers used an average of 47.1 ± 17.7 gallons per cow per day.

Calculating Herd Requirements for Fresh Water

It is possible to estimate fresh water use on individual dairies, even with the wide variation reported in the literature. Estimates for total requirements can be developed for drinking water, wash pen sprinklers (if used), and milk house and parlor. Water needs can be estimated by completing Worksheet 1 with information found in Tables 1-4.

Drinking Water Needs

Drinking water needs can be determined by using the information found in Table 1 and Table 2. Table 1 shows a typical herd makeup assuming a uniform year around calving, 13 month calving interval, a 33% replacement rate (1/2 supplying a calf), 50% female calves and males sold at birth for a 100 lactating cow herd.

MAILED
OCT 20 1994

Water intakes for dairy cattle are influenced by several factors including dry matter intake, milk production, ambient temperature, and sodium intake. However, Table 2 provides a good estimate of water intake based upon size, milk production and temperature. The data from the water intake table when matched with the herd makeup table will estimate herd drinking water.

Wash Pen Needs

The wash pen can be a large user of fresh water on typical dairies. The amount used is dependent on line pressure, sprinkler orifice, number of sprinklers and minutes per day used. Table 3 shows the gallons per minute per sprinkler with different line pressure in pounds per square inch. The number of sprinklers in the wash pen, the minutes used per day and the nozzle discharge will determine water used in the wash pen.

Milk House and Parlor Needs

Milk house and parlor waste can be estimated from data found in Table 4.

Summary

Dairies under construction or expanding must evaluate their water needs to ensure that a water source is capable of supplying the production needs of the facility. The information provided in this article can aid in that estimation.

RECEIVED MCA

OCT 20 1994

Worksheet 1. Calculating Daily Herd Requirements for Fresh Water

Drinking Water Estimates (see Table 1 & 2)

	Number	Estimated Use (gallons per day)	
		Individual per day	Total
Milking Cows	_____	_____	_____
Dry Cows	_____	_____	_____
Heifers			
16-24 mo	_____	_____	_____
13-15 mo	_____	_____	_____
9-12 mo	_____	_____	_____
5-8 mo	_____	_____	_____
3-4 mo	_____	_____	_____
0-2 mo	_____	_____	_____

Total herd drinking water used

A. _____

Wash Pen Estimate (see Table 3)

1 - Sprinkler discharge per nozzle

2 - Number of nozzles

3 - Minutes per day used

Total wash pen water used

(Line 1 x line 2 x line 3)

B. _____

Milk house and Parlor Estimate (see Table 4)

	Water per operation	Gallons per day
Bulk tank	_____	_____
Pipeline	_____	_____
Backflush	_____	_____
Cleanup	_____	_____
(Parlor, milk house and holding pen)		
Cow prep	_____	_____
Plate cooler	_____	_____
(ignore if water recycled)		
Total milk house and parlor water used		C. _____

TOTAL FRESH WATER ESTIMATE (A + B + C)

MICROFILMED
OCT 20 1994

Table 1. Herd Makeup

Category	Number	% of Herd	Average Weight (lbs)
Milking Cows	83	83	1400
Dry Cows	17	17	1550
Total Mature Cows	100		
Heifers			
16-24 mo	42	38	1050
13-15 mo	13	12	800
9-12 mo	19	17	600
5-8 mo	19	17	400
3-4 mo	9	8	250
0-2 mo	9	8	150
Total Replacements	111		

Table 2. Water Intake for Dairy Cattle

Weight (lb)	Milk (lb)	Temperature (F)		
		40° & below	60°	80°
(Lactating cows)		-----gallons/day-----		
1400	20 ²	12.0	14.5	17.9
	60 ²	22.0	26.1	24.7
	80 ²	27.0	31.9	38.7
	100 ²	32.0	37.7	45.7
(Dry cows)				
1400 ¹	-	9.7	12.0	16.2
1600 ¹	-	10.4	12.8	17.3
(Heifers)				
1200 ¹	-	8.7	10.8	14.5
800	-	6.3	7.9	10.6
400	-	3.7	4.6	6.1
200	-	2.0	2.5	3.3

¹Maintenance and pregnancy.

²Maintenance and milk production.

NOT RECORDED

OCT 20 1994

Table 3. Nozzle discharge - Gallons per minute

psi	Nozzle diameter in inches				
	1/8	9/64	5/32	11/64	3/16
40	2.96	3.74	4.61	5.54	6.64
45	3.13	3.99	4.91	5.91	7.03
50	3.30	4.18	5.15	6.19	7.41
55	3.46	4.37	5.39	6.48	7.77

Table 4. Standard Volumes of Milk house and Parlor Waste

Washing operation	Water volume
Bulk tank	
450-2000 gallon	46 gallons/wash
3000-4000 gallon	78 gallons/wash
5000 + gallon	116 gallons/wash
Silo tank	126 gallons/wash
Pipeline	
<16 parlor stalls	60 gallons/wash
16> parlor stalls	140 gallons/wash
Backflush	.5 gal/cow/milking
Parlor/milk house/holding pen cleanup	400 - 900 gallons/wash
Cow prep	
automatic	1-4 gal/wash/day
manual	.25 - 5 gal/wash/day
Plate cooler (ignore if water is recycled)	8 gal/cow/day

RECEIVED

OCT 20 1994

Introduction

The Dairy Worksheet was originally created by Marci Sterling in May 1992 to accompany Adjudication Memo #36.

Jim Johnson appended the "Theoretical Flow Estimation Worksheet".

In February 1997, Cindy Zimmerman modified the spreadsheet to include consideration for recycling cooler plate water for clean-up and cow washing; and adjusted the Theoretical Flow Estimation Worksheet to calculate combined rate of diversion from multiple wells. Cooler plate annual volume usage is based upon Dr. Dean Falk's paper "Fresh Water Considerations for Dairy Farms", Table 4, 8 gallons per milking cow per day. Cooler plate flow rate is calculated as 8 gal/cow/day times the length of milking times number of milkings per day.

Input text is in blue. Please record all modifications on this page.

March 10, 1997:

Formula for calculating rate of diversion and annual volume of corral misters added for 45-07680 & 45-07684. Formulas are:

Rate of diversion: $(\# \text{ heads} \times \text{gph}) / (\text{gal/hr/cfs})$

Annual volume: $(\# \text{ heads} \times \text{gph/head} \times \text{hrs/day} \times \text{days/yr}) / (\text{gal/day/AF})$

FILE NUMBER 36-8538
REVIEWER Shelley Keen
DATE September 14, 2009

DAIRIES: WATER USE WORKSHEET

REQUIRED DAIRY DATA

NUMBER OF MILKING CATTLE 700
NUMBER OF DRY CATTLE 110
NUMBER OF REPLACEMENT CATTLE: 0-2 MONTHS 115
3-4 MONTHS 115
5-8 MONTHS 115
9-12 MONTHS 115
13-15 MONTHS 115
16-24 MONTHS 115
ENTER 1 FOR MANUAL COW WASHING, 2 FOR AUTOMATIC COW WASHING,
OR 3 IF SPRINKLERS ARE USED TO FLUSH HOLDING PEN AND WASH COWS 3
IF SPRINKLERS ARE USED: NUMBER OF SPRINKLERS IN HOLDING PEN 500
NOZZLE DISCHARGE (USE 5.0 GPM IF UNKNOWN) 5.00
TOTAL OPERATION TIME OF SPRINKLERS (MIN/DAY) 8
NUMBER OF MILKINGS PER DAY 3
AVG. LBS. OF MILK PRODUCED PER DAY PER ANIMAL (IDAHO AVG IS 70 LBS.) 70
ARE THERE SEPARATE PUMPS FOR COMMERCIAL AND STOCKWATER USES? N
IF SO: HOW MANY HOURS PER DAY DOES THE STOCKWATER PUMP RUN? 12.0
HOW MANY HOURS PER DAY DOES THE COMMERCIAL PUMP RUN? 12.0
IF ONLY ONE PUMP, HOW MANY TOTAL HOURS PER DAY DOES IT RUN? 12.0
IS A PLATE COOLER USED? Y
IS PLATE COOLER WATER LATER RECYCLED FOR OTHER USES? (IF NO PLATE
COOLER, LEAVE BLANK) N
ARE CORRAL MISTERS USED IN HOLDING PEN? Y
IF USING CORRAL MISTERS: NUMBER OF MISTERS (IF UNKNOWN,
ASSUME 1 MISTER FOR EVERY 5 COWS) 300
NOZZLE DISCHARGE (USE 5 GPH IF UNKNOWN) 5.00
SPRAY INTERVAL (EX - 2 MIN ON EVERY 5 MIN = 2/5) 2/5
OPERATION TIME OF MISTERS (HRS/DAY) 10
DAYS PER YEAR MISTERS ARE USED 90
ENTER A TOTAL VOLUME IN GPD FOR MISCELLANEOUS WATER USES NOT
INDIVIDUALLY CALCULATED BELOW (EX - RESTROOMS, WASHING MACHINES) 0

CALCULATIONS

DIVERSION RATE (CFS):

STOCKWATER
MILKING CATTLE (BASED ON MILK PRODUCTION) ****
DRY CATTLE @17.0 GPD/HD ****
REPLACEMENT CATTLE ****
TOTAL 0.19

COMMERCIAL
TOTAL 0.19

TOTAL DIVERSION RATE 0.19

DIVERSION VOLUME (AFA):

STOCKWATER
MILKING CATTLE 22.6
DRY CATTLE 1.7
REPLACEMENT CATTLE 4.7
TOTAL 28.9

COMMERCIAL
WASHING OF BULK TANK AND RELATED EQUIPMENT 0.6
BACKFLUSH 1.2
PARLOR/MILKHOUSE/HOLDING PEN CLEANUP 3.0
CATTLE WASHING BASED UPON METHOD OF WASHING 22.4
PLATE COOLER 6.3
CORRAL MISTERS 1.7
MISCELLANEOUS USES 0.0
TOTAL 35.1

TOTAL DIVERSION VOLUME 64.0

CONSUMPTIVE USE VOLUME (AFA)(assuming 100% consumptive):

STOCKWATER 28.9
COMMERCIAL 35.1
TOTAL CONSUMPTIVE USE 64.0

THEORETICAL FLOW ESTIMATION WORKSHEET

REQUIRED PUMP INFORMATION

	PUMP 1	PUMP 2	PUMP 3	PUMP 4	PUMP 5
PUMP HORSEPOWER (HP)	7.50	7.50	0.00	0.00	0.00
PUMP EFFICIENCY (%)	70	70	70	70	70
LIFT (FT)	173	197	0	0	0
DISCHARGE PRESSURE (PSI)	40	40	0	0	0
FRICTION LOSSES (FT)	3.0	3.0	0.0	0.0	0.0
HOURS PER DAY PUMP OPERATES	12.0	12.0	0.0	0.0	0.0

CALCULATIONS

THEORETICAL FLOW RATE (CFS) *	0.17	0.16	0.00	0.00	0.00
DIVERSION VOLUME (AFA) **	62.3	57.2	0.0	0.0	0.0

* IF PUMP EFFICIENCY IS UNKNOWN, 70% MAY BE ASSUMED.
** DIVERSION VOLUME IS THE ABSOLUTE MAXIMUM VOLUME BASED ON THE
THEORETICAL FLOW RATE ASSUMING PUMP RUNS EVERY DAY OF THE YEAR.

EVALUATION OF EQUIVALENT IRRIGATED ACREAGE

IRRIGATION RIGHT (BEFORE CHANGE)

DIVERSION RATE CFS
ACRES OF IRRIGATION ACRES
DIVERSION VOLUME AC-FT/AC
CONSUMPTIVE USE VOLUME AC-FT/AC
IRRIGATION IS BEING CONVERTED FOR WHICH PORTION OF THE
DAIRY OPERATION - STOCKWATER (S), COMMERCIAL (C), OR
BOTH (B)?

CALCULATIONS

IRRIGATION DIVERSION RATE PER ACRE	#DIV/0!	CFS/AC
REDUCTION OF IRRIGATION BASED ON DIVERSION RATE	#DIV/0!	ACRES
REDUCTION OF IRRIGATION BASED ON DIVERSION VOLUME	#DIV/0!	ACRES
REDUCTION OF IRRIGATION BASED ON CONSUMPTIVE USE	#DIV/0!	ACRES