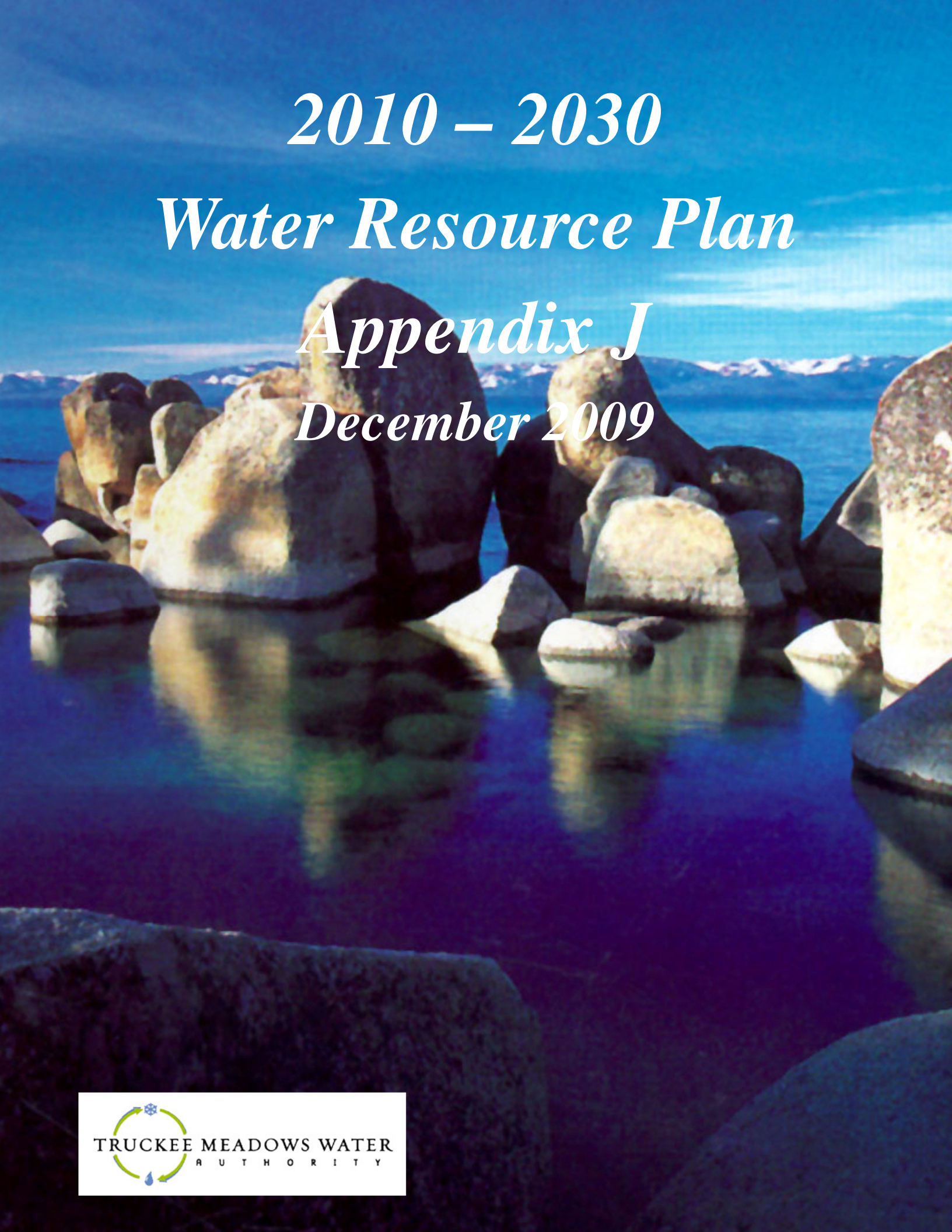

2010 – 2030
Water Resource Plan
Appendix J
December 2009

TRUCKEE MEADOWS WATER AUTHORITY

Appendix J:
Peak Week Analysis

TRUCKEE MEADOWS WATER AUTHORITY

STAFF REPORT

TO: Mark Foree, Jeff Tissiser, Kim Mazeres, John Erwin, Scott Estes, Paul Miller
FROM: Shawn Stoddard, PhD, Senior Planner
DATE: April 1, 2009
SUBJECT: **Residential Twice-a-Week Watering Analysis**

CONCLUSIONS

Based on analyses of daily water use data collected between June and August 2008 in order to examine the effectiveness of twice-a-week watering and its impact on peak operations within system zones, it can be concluded that:

1. A change from twice-a-week water to a 3-day or non-assigned day watering is not expected to increase peak day or peak use water use.
2. More than half of all services are watering more than two times a week.
3. A change from twice a week watering is expected to reduce peak day water use.
4. Average daily water use is lower for services watering more than twice a week compared to those watering twice a week.
5. Similar changes in water use are expected to occur at the distribution system level that are consistent with expected system wide changes.

These conclusions result from the initial analyses of the data since the data is being analyzed to evaluate if peak day factors can be derived for the various classes of customers which will be reported at a future time.

FINDINGS

1. A change from twice a week watering is not expected to change total water used during the peak week.
2. A change from twice a week watering is expected to decrease the amount of water used on peak day.
3. Average daily water use during the peak week showed that services that watered 3 or 4 times per week had a lower daily water use than the services that watered 2 times a week.
4. Examination of metered customers shows that the services that only watered twice during peak week had the highest water use on peak day.
5. During peak week 40% of sampled services watered two days or less, of which 39% were metered services and 47% were flat rate services.
6. During peak week 54% of sampled services watered 3 or 4 times a week, of which 54% were metered services and 48% were flat rate services.

7. Average water use in gallons on peak day is 2,579 for the flat-rate, checker services and 962 for the RMWS.

DISCUSSION

Data Collections

During the summer of 2008, daily meter reads were collected for 8 weeks, between June 23 to August 17, 2008. Data was collected between 9 pm and 2 am each night, resulting in water use that is approximating midnight to midnight use. 12,404 residential water services were studied as reported here.

	Sample	Services, June 2008	Percent of Services Sampled
RMWS	11,106	65,857	17%
RFWS		8,149	
SUFR		2,859	
CHECK	1,298		12%
Total	12,404	76,865	16%

The 16% overall sample is significant and can be used to describe current water use patterns for RMWS, RFWS, and SUFR customers.

Peak Day and Peak Week Statistics

Peak Day was July 9, 2008 with a consumption of 131.121 million gallons. Peak week was July 7 to 13 with a total consumption 828.070 million gallons.

Average daily water use on peak day was 1,131 gallons on Wednesday July 9 and 1,161 gallons on Thursday, the day following peak. A t-test was performed on the two means and the means are not statistically different. Daily average water use for peak week:

Date	Check	RMWS	Total
July 7	1,116	530	592
July 8	2,451	546	746
July 9*	2,579	962	1,131
July 10	2,447	1,011	1,161
July 11	1,153	542	606
July 12	2,343	938	1,085
July 13	2,562	1,072	1,228
Total	14,655	5,604	6,551
Average Day	2,093	800	935

* Peak Day

Average daily water use during the peak week showed that services that watered 3 or 4 times had a lower daily water use than the services that watered twice-a-week. Examination of the metered

customers shows that the services that only watered twice during peak week had the highest water use on peak day. Reasons for flat rate services watering 5 or 6 days a week may relate to the fact that properties are larger and/or possibly have irrigation leaks.

Days Watered	Check Obs.	Check Means	RMWS Obs.	RMWS Means	Total Obs.	Total Means
0	0	0	1	40	1	40
1	34	805	261	627	295	648
2	607	2,734	4,347	1,094	4,954	1,295
3	413	2,573	3,777	880	4,190	1,048
4	216	2,347	2,231	884	2,447	1,013
5	22	3,090	396	978	418	1089
6	6	3,946	93	881	99	1,066
Total	1,298	2579	11,106	962	12,404	1,131

For this study, a watering day is calculated as any day for which the total water used was greater than the average daily water use for that week. For any given week, average daily water used is between the average indoor use and average of days that are greater than the indoor water use. This is the result of irrigation use being several times higher than the indoor use for any given water service. Percentage breakdown of watering days during peak week shows that 47% of flat rate and 39% of metered services water only twice a week.

Days Watered	Check Obs.	Check Percentage	RMWS Obs.	RMWS Percentage	Total Obs.	Total Percentage
0	0	0.00%	1	0.01%	1	0.01%
1	34	2.62%	261	2.35%	295	2.38%
2	607	46.76%	4,347	39.14%	4,954	39.94%
3	413	31.82%	3,777	34.01%	4,190	33.78%
4	216	16.64%	2,231	20.09%	2,447	19.73%
5	22	1.69%	396	3.57%	418	3.37%
6	6	0.46%	93	0.84%	99	0.80%
Total	1,307	100.00%	11,176	100.00%	12,404	100.00%

Peak week statistics do not indicate if the amount of water used is dependent on the number of water days.

Analysis of Total Water Use

Additional notes on developing the regression models are included in the last pages of this memo.

Regression analysis of the entire data set showed that as a customer class, the total amount of water used by a water service during the 8 week study period was not dependent on the total number of watering days during the study period. The water used during the study period was

best explained by other factors such as; flat rate or meter rate, type of single family home, lot size, and service size.

Analysis by Distribution System

Further analysis on distribution systems within the study area was conducted to detect if changes in the assigned watering days will have negative impacts on TMWA's ability to deliver water to its customers in certain geographic areas. The following table lists the distribution systems included in the study.

System Name	Samples	Total Services	Percent Sampled
Caughlin	424	1,440	29
D'andrea	144	362	40
Daniel Webster	87	390	23
Gravity Zones	3,318	28,229	12
Highland	505	2,244	24
Hunter Creek	22	429	6
Hunter Lake	567	1,482	38
Lakeside/Plumas	885	2,139	41
Northwest	3,792	9,111	42
Pyramid	115	1,493	8
Satellite Hills	163	509	32
Seventh Street	696	3,920	19
Skyline	381	1,491	26
Spanish Springs #1	3	32	9
Spanish Springs #2	486	4,772	10
Sparks Gravity	106	863	12
Vista	449	2,643	17
Total	12,143	61,549	19.7

All the regression models, listed below, have low R^2 values which means the models only explain a low percent of the variation in the total water use. However, the models are statistically significant and are useful in measuring the relationship between total water use and total watering days. The models show that in general there is not relationship between total water use and total number of watering days. A few distributions systems that show exception to this general conclusion are discussed.

The Hunter Lake model shows that total water use will decrease with each addition of watering day. Stated another way, if for example, a water service were to water one more day in the eight week period, total water use for that water service would decrease 624 gallons.

The Northwest System model shows that total water use will increase of 232 gallons for each additional day a water service would water, whether during the peak week or any other week during the 8 weeks examined. This system data also showed that most customers water 2 or 3 times per week, and any additional watering days would not likely increase the peak day.

The Spanish Springs #2 model shows total water use will increase of 335 gallons for each additional day a water service would water, whether during the peak week or any other week during the 8 weeks examined.

While some of the systems show a possible increase in water use with the addition of another watering days, the results can still be insignificant when compared with the low R^2 values. In the cases where the total number of watering days is significant the model does not have a very good ability to predict the total amount of water used.

Summary of distribution system regressions:

System Name	Samples	R^2 OLS / R^2 Robust	F-Statistic	Watering Days
Caughlin	424	.44 / .61	84.24 / 166	NS
D'andrea	144	.11 / .08	10.15 / 7.23	NS
Daniel Webster	87	.37 /.42	9.69 / 11.57	NS
Gravity Zones	3,318	.46 / .81	411 / 1990	NS
Highland	505	.24 / .22	32.99 / 30.69	NS
Hunter Creek	22	.71 /.96	9.93 / 80.10	NS
Hunter Lake (1)	567	.24 / .24	31.94 /30.71	S - decreasing
Lakeside/Plumas	885	.33 / .83	64.75 / 611	NS
Northwest (2)	3,792	.35	523.94	S - increasing
Pyramid (3)	115	.30 / .27	13.38 / 11.34	--
Satellite Hills (4)	163	.04 / .04	2.82 / 2.75	--
Seventh Street	696	.04 / .20	7.52 / 35.42	NS
Skyline	381	.44 / .55	45.39 / 67.74	NS
Spanish Springs #1 (5)	3			
Spanish Springs #2 (6)	486	.35 / .45	67.56 / 101.27	S - increasing
Sparks Gravity	106	.06 / .05	3.40 / 2.95	NS
Vista	449	.15 / .18	27.94 / 34.87	NS

NS – Not Significant total watering days.

(1) **Hunter Lake** shows that for each additional watering day added to the study period, total water use will be reduced by 624 gallons.

(2) **Northwest** system required a modified model, total water use = *f*(flate rate, landarea, totwtdays, s100, s150, s200, constant). Total watering days is results in an increase of 232 gallons for each additional watering day in the eight week period.

(3) **Pyramid** system regression was not useful, the results were not conclusive.

(4) **Satellite Hills** regressions have no significances.

(5) **Spanish Springs #1** does not have enough data for a regression.

(6) **Spanish Springs #2** model shows an increase of 335 gallon for each additional watering day in the eight week period.

ADDITIONAL NOTES ON REGRESSION ANALYSIS OF TOTAL WATER USE

A regression analysis is conducted to determine if the amount of water used would change with a change in the number of watering days. The hypothesis is that the total amount of water used during the study is positively related to the number of watering days if there is an increase water use as the number of watering days increase. The total amount of water used is also a function of other variables as defined below:

Variable Name	**Description**	**Expected Effect**
UseStudyTotal	Total gallons of water used during the study period	Dependent variable
TotWtrDays	Sum of the watering days during the study period	Positive, if increase in days causes an increase in water use. Negative, if increase in days causes a decrease in water use. Zero, if the number of days have no effect on the total water use.
Landarea	The size of parcel measured in square feet.	Positive, as the lot size increases the total water use is expected to increase.
Flatrate	Dummy variable: 1 for Check meter, 0 for RMWS	Positive, amount of water used above a metered service.
Condo	Dummy variable: 1 for condo or townhouse, 0 otherwise.	Negative, condos are expected to use less water than a single family home.
S100	Dummy variable: 1 for 1" service, 0 otherwise.	Positive, 1" services are expected to use more water than a ¾" water service.
S150	Dummy variable: 1 for 1 ½" service, 0 otherwise.	Positive, 1 ½" services are expected to use more water than a ¾" water service.
S200	Dummy variable: 1 for 2" service, 0 otherwise.	Positive, 2" services are expected to use more water than a ¾" water service.
Constant	Regression intercept	Positive, baseline water use for a ¾" metered water service.

The regression model UseStudyTotal = f(TotWtrDays, Landarea, Flatrate, Condo, S100, S150, S200, Constant) will allow the testing of the relationship between each variable and the total water use.

Ordinary Least Squares (OLS) was first used to estimate the defined model. The resulting models did not have very strong predicting power with an adjusted R^2 of 29%. Further testing for heteroskedasticity, resulted in a positive test and that OLS could not be used to estimate the desired model.

To correct the heteroskedasticity a Robust Regression model was estimated. The resulting model 1, (results shown below) has an adjusted R^2 of 70%, F-statistic of 3987. This is a significant model and provides good predictions of the total water used.

All the variables have the expected signs as described above, t-ratios showed that each variable is significant with the exception of total watering days. The sign on total watering days is negative, but not significantly different from zero.

The conclusion is that the total number of watering days do not contribute to explaining the total amount of water used.

To further test the effects of total watering days on the model, a second model was estimated without the total watering days. If total watering days are important to total water use, then Model 2 will have a lower R^2 and lower F-statistic. Model 2 showed no change in R^2 and an increase in the F-statistic from 3987 to 4650. This test confirms the conclusion that total watering days do not explain the total amount of water used during the study period.

Model 1:

```
Robust regression                                   Number of obs =   12141
                                                    F(  7, 12133) = 3987.01
                                                    Prob > F      =  0.0000
                                                    Adjusted R2:  = .69682
------------------------------------------------------------------------------
usestudyto~l |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
    flatrate |   28889.49   666.5585    43.34   0.000     27582.93    30196.05
       condo |  -10254.33   1448.795    -7.08   0.000     -13094.2   -7414.461
    landarea |   3.103418   .0239097   129.80   0.000     3.056551    3.150285
  totwtrdays |    -4.1123   37.59729    -0.11   0.913    -77.80899    69.58439
        s100 |   4030.203   491.2352     8.20   0.000     3067.304    4993.103
        s150 |   24944.82    2677.96     9.31   0.000      19695.6    30194.05
        s200 |   29772.85   1893.342    15.73   0.000      26061.6    33484.11
       _cons |   13270.58   907.0822    14.63   0.000     11492.55    15048.61
------------------------------------------------------------------------------
```

Model 2:

Robust regression - total water use is not dependent on the number of watering days.

Robust regression

Number of obs	= 12141
F(6, 12134)	= 4649.67
Prob > F	= 0.0000
Adjusted R2:	= .69674

usestudyto~l	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
flatrate	28905.92	664.8098	43.48	0.000	27602.78	30209.05
condo	-10266.78	1448.89	-7.09	0.000	-13106.84	-7426.728
landarea	3.101865	.0238973	129.80	0.000	3.055022	3.148707
s100	4034.714	490.2639	8.23	0.000	3073.719	4995.71
s150	25367.16	2677.227	9.48	0.000	20119.37	30614.95
s200	29820.67	1893.179	15.75	0.000	26109.74	33531.6
_cons	13190.08	301.8604	43.70	0.000	12598.38	13781.77