Case Study:
Landscape Irrigation Efficiency of Nine Model Homes

Brent Mecham, Ron Boyd
Northern Colorado Water Conservancy District
January 2004

Background:

After the severe drought experienced by all of Colorado during 2002, the interest in conserving water resources and dealing with various restrictions imposed by water providers created a desire for many homeowners to better manage their water supplies in terms of landscape maintenance. Not only were homeowners interested in conserving water, but also builders and developers who were impacted by declining new home sales due to the uncertainty of when a homeowner would be able to install landscaping and the associated watering restrictions.

In the early spring of 2003, there was a feeling that watering restrictions for the coming season could be even more severe than those experienced the previous year, primarily because precipitation had not been much above average, and most reservoirs were at record low levels with no immediate relief in sight. For the northern part of Colorado, relief came in the form of a blizzard in the latter part of March, followed by some very good spring rains. This case study began with a landscape contractor seeking to find useful work for his crew, and client who was a developer seeking information on how to better manage lawn watering. As a “green” builder, the developer had not yet addressed outdoor water usage in his goal to produce more environmentally friendly developments. If changes in landscape maintenance produced significant results, the developer agreed to consider retro-fitting all existing homes in his development with the technology to help reduce water demand. This opportunity to see if positive results could be obtained was exciting to both parties, and a study was initiated with the landscaper and the developer. The city water provider was also interested in the outcome of the study.

This case study has been a learning experience with many issues being discussed that can provide useful guidelines to improve irrigation management and promote water conservation.

The Study:

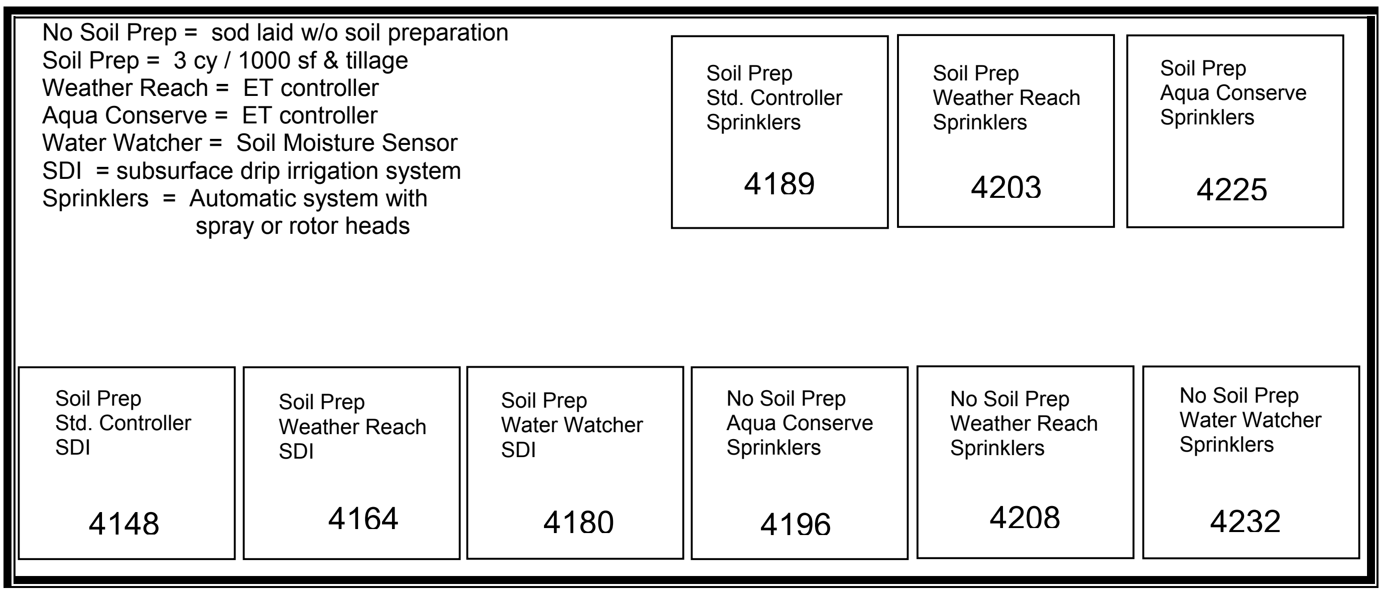
Nine single-family model homes in an entry-level housing development were selected for the study. Because no homes were occupied at the time, all water going through water meters was used for landscape irrigation. This made it easy to read the water meters and determine how much water was being applied to the lawn on a weekly basis. The Northern Colorado Water Conservancy District (District) monitored water usage by reading the water meters and comparing the readings to a water budget established for each home. A nearby weather station owned and operated by the District was utilized to track weather changes used for determining the amount of water necessary to maintain a healthy lawn.

Three model homes had sod installed without any soil preparation and had traditional sprinkler systems installed using rotor heads or pop-up, fixed-spray heads. Three other model homes had sub-surface drip irrigation to water the lawn areas. Prior to installation of the drip irrigation systems, soil preparation had been completed with the addition of compost and rototilling to a depth of 6 inches. The three remaining model homes had old sod removed, soil preparation and rototilling performed, and new sod installed. The thought here was to demonstrate to the developer that soil preparation should be included as a water conservation practice, and should not be ignored or overlooked as had been the prior practice. With these differences in place, water usage between homes with and without soil preparation could be monitored.

New irrigation control technology was also installed in seven of the model homes to control the irrigation of new lawns. The other two model homes had controllers that were manually operated by maintenance personnel employed by the developer. Maintenance crews were not included in the original discussion of what the study was hoping to accomplish and were advised to perform maintenance of the lawns in a normal and typical manner.

The technology selected by the landscaper to be tested included two homes using the Water Watcher soil moisture sensing system attached to the existing irrigation controller; two homes using the Aqua Conserve ET controller, which uses historical ET modified by real-time temperature; and three homes using Weather Reach units that use real-time weather measurements downloaded via a paging signal to determine an irrigation event. More information about how each technology works is included later in this document. Figure 1 shows the relative layout of the model homes and various treatments applied.

Figure 1. Model Homes with Various Treatments



Weekly meter readings were taken during the irrigation season starting at the beginning of May and concluding at the end of October. During that time, sprinkler system audits or performance evaluations were conducted on each of the homes with traditional sprinkler systems. Results of those audits will be presented later. Water budgets for each of the homes were calculated based on the landscape area being irrigated, allowing for an irrigation efficiency of 80%, which increases the overall budget by 25%. A weather station located approximately 3 miles from the development was used for calculating water demand for the turfgrass. The ASCE Standardized Penman Monteith equation was used for calculating grass reference ET (which is for a cool season grass that is 12 cm or 5 inches tall). A .90 crop coefficient was applied to determine the water requirement for Kentucky Bluegrass lawns mowed at 3 inches. The accumulated grass water requirement for the study period was 26.69 inches.

The water budget equation used is as follows:

$$WB = \frac{ET_o \times K_c \times Area \times .623}{I.E.}$$

Where:

WB	=	Water Budget in gallons of water
ET_O	=	Grass Reference ET
Kc	=	Crop coefficient for 3-inch tall, cool season turf
Area	=	Area of landscape in square feet
.623	=	Constant to convert inches of water into gallons
I.E.	=	Irrigation Efficiency of .80 (80%)

Results:

The results comparing water usage for different treatments are presented below. The anticipated and hoped-for reduction in water usage did not occur. However, valuable information was collected that will provide guidance for future projects and the use of technology that will hopefully help achieve the desired savings of water. The following table lists each model home by street number address with the amount of water budgeted for the irrigation season. Note: *Individual water budgets are included with graphs of the monthly water required compared to water applied in the Appendix.*

Address	Treatment	Lawn Area (s.f.)	Water Budget (gallons)	Water Applied (gallons)	Excess (%)
4148	SDI, soil prep., Std. controller	4,235	79,245	93,988	19
4164	SDI, soil prep., WR controller	4,476	83,754	92,588	11
4180	SDI, soil prep., WW sensor	3,637	68,055	90,665	33
4189	Sprinkler, soil prep., std. controller	3,788	70,881	104,319	47
4196	Sprinkler, no soil prep., AC controller	3,551	66,446	130,439	96
4203	Sprinkler, soil prep., WR controller	3,476	65,042	95,612	47
4208	Sprinkler, no soil prep., WR controller	3,809	71,273	110,833	56
4225	Sprinkler, soil prep., AC controller	4,010	75,035	110,015	47
4232	Sprinkler, no soil prep., WW sensor	3,185	59,597	74,111	24
Average		3,796	71,036	100,284	41

As can be seen, each home used water in excess (most of them significantly) of the amount allocated in the water budget. As a reminder, the water budget allows for 25% more water to compensate for a less-than-perfect sprinkler system. Therefore, the amounts shown as “excess”, is the amount used over the additional 25% in the allowance. The following table compares water usage between using traditional sprinkler systems and sub-surface drip irrigation, doing soil preparation and not doing soil preparation.

	Drip Irrigation	Sprinkler		Soil Prep	No Soil Prep
EXCESS	21%	53%	**EXCESS**	34%	59%

Although there was excess water used, there are benefits that can be achieved with doing proper soil preparation and having an efficient irrigation system. It should be understood that an efficient irrigation system is really dependent upon how well it is designed, installed, maintained and ultimately managed. If any one of these aspects is weak, it affects the whole system. A discussion of observations follows to partially explain these results.

Observations:

The observations discussed will cover a variety of subjects, including expectations of how the landscape should appear, communications between the participating parties, the installation, operation, and support of the technology, sprinkler system performance, and recommendations for improvement.

Landscape Appearance:

From the developer's perspective, the appearance of the landscape is critical for a positive first impression as potential buyers visit model homes. In most neighborhoods, the lawn must look very green, as well as neatly clipped and trimmed. The appearance of the yard is a major part of the first impression for a potential buyer as they walk up to the front door of the model home for a tour. Although it would be difficult to measure, the impact is real upon their experience. As the old saying goes, "there is never a second chance for a first impression." The developer wants the yard to appear perfect, meaning there is no tolerance for brown spots, or "dead" looking grass. This is also important because a potential buyer may drive by the home many times during the decision-making process and the outside appearance becomes critical. Therefore, maintaining a "perfect" look is a much higher priority than conserving water—even during times of drought or water shortages. In fact, a poor looking landscape has more of a negative effect on potential buyers than having no landscaping at all.

A few other appearance issues were noted during this study. Homes that received soil preparation prior to landscaping had much healthier looking lawns than homes that did not receive soil preparation before the installation of landscaping. Even with the addition of fertilizer, landscaping at homes without soil preparation never looked as good as the others. Because of over-watering on all the properties, the impact of soil preparation on the reduction of water was not evaluated, but it should be noted that amending the soil has an impact on the quality, or look, of turfgrass. The grass not only appeared to be healthier, but grew much faster and thicker at homes that had soil preparation than at homes without soil preparation.

An important best management practice is to conduct proper soil preparation that includes the addition and incorporation of organic matter into existing soil by rototilling. The purpose of this preparation is to loosen the soil adequately for improved and deeper root development. The only practical way to perform proper soil preparation is to do so before any landscaping is in place. Soil preparation at three of the homes after the removal of old sod and prior to the installation of new sod proved, in reality, to be impractical. The landscaper was not able to incorporate the organic soil amendments as well as would normally be expected because the existing sprinkler system remained in place thereby forcing heavy equipment to work around sprinkler heads and underground piping.

Communication:

The lack of communication among all parties became an obvious obstacle to achieving the desired results of reducing water usage. As contracted, the landscaper installed new irrigation technology or performed soil preparations at some of the homes, but there was not any long-term maintenance agreement to ensure the devices were working properly. The maintenance personnel were only minimally included in discussions of what was to be achieved. The District was primarily involved to monitor water usage. It was assumed that management and scheduling of irrigation systems was part of the monitoring tasks. It was never clearly defined as to who would be responsible for programming the controllers, and as a result there were periods when the lawns did not look as good as expected. This led to frustration on the part of the developer who wanted great looking lawns more than the conservation of a small amount of water. Maintenance personnel were caught in the middle by trying to accommodate the study, and by keeping the yards looking as good as possible. Because maintenance personnel worked directly with the developer, as much water as necessary to maintain a good looking lawn was used.

Installation, Operation, and Support:

The District was more actively involved in the management of the irrigation controllers because of previous experience with various technologies on other demonstration sites. The landscaper purchased the irrigation control systems, and the field personnel for the landscaper installed the systems according to instructions provided with the products. Upon completion of the installation, the installer was asked which system was the easiest to install and make operational. According to the installer, the soil moisture-sensing system was easier than the other systems to install and make operational.

The mention of various products by brand name does not constitute an endorsement of the product. For more information about the irrigation control technologies used in this study, visit the websites listed here:

> The Aqua Conserve controller uses historical water use information to change the irrigation schedule. With an additional sensor, the historical information can be modified to reflect current weather conditions. www.aquaconserve.com
>
> The Water Watcher system interfaces with existing sprinkler controllers and uses stainless steel probes to monitor soil moisture. Depending on the moisture in the soil, it will determine if water needs to be applied. www.waterwatcher.com
>
> The Weather Reach unit connects to the existing controller and receives real-time weather data downloaded via a paging signal from a nearby weather station. When a predetermined threshold for irrigation is reached, the sprinkler system is activated. www.weatherreach.com

In all cases when using technology, a basic understanding of plants, soils, and sprinkler systems is needed. To ensure proper irrigation schedules are created, the following information is required:

- To create a schedule for applying the appropriate amount of water to each landscape area, the actual precipitation or application rate of each sprinkler zone is needed. The best way to determine the application rate is to conduct a sprinkler system performance test, or audit, to gather the necessary information. Audits were performed by the District, as well as the city water provider and will be discussed in the section entitled “Sprinkler System Performance.” Two of the homes in this study had standard irrigation controllers. Maintenance personnel determined the irrigation schedule without any input from the landscaper or the District.

- To know how much water to apply and how frequently to apply it, the irrigation manager needs to know the water usage requirements for the lawn or other plants, how deep the root systems are, and what type of soil the plants are growing in.

All of these factors are used to create irrigation schedules that will meet the needs of the landscape without wasting water. Making changes as needed is part of irrigation management. The landscaper invested extra time and effort in learning to operate the controllers and the technology, when in reality the maintenance personnel should have been more involved. In most cases, maintenance personnel will be operating the systems and will actually have more impact on how much water is used. Because two of the products were purchased via the Internet, there was little or no on-site support available. Communications via telephone or email hampered the resolution of challenges and problems. Weather Reach did have a manufacturer representative visit the site to help provide training and follow-up to maximize the potential of its product.

Ongoing support will probably be required for a period of time as new technology is introduced into the market place, and until landscape and maintenance industries gain the necessary skills to use the products correctly. On one of the homes with sub-surface drip irrigation, it was eventually discovered that the original landscaper had incorrectly wired the valve. As a result, the landscape became very stressed before the situation was resolved. Originally, blame was placed on the technology and it took some extra trouble-shooting to discover the real problem. Because it was "essential" that the grass look green and healthy, maintenance personnel resorted to hand-watering with a hose and sprinkler. This was acceptable except the faucet from the house next door with a different treatment was used to apply the extra water, thereby eschewing the amount of water being applied when meter readings were taken to determine water usage.

In order for trust and confidence to be established in using technology for irrigation management, there will need to be outstanding support and service from the distributor or manufacturer of equipment to the contractor, and from the contractor to the homeowner. Support and service will have as much impact on product reliability as the product itself.

Sprinkler System Performance:

Probably the most notable issue in this study was the poor performance of the sprinkler systems that had been installed. Sprinklers came on as scheduled, but applied water very unevenly. A recommended best management practice is to have distribution uniformity (DU) of at least 55% for pop-up spray heads, and at least 70% for rotor heads. Sprinkler system audits were performed at each house and the results were very discouraging for brand new sprinkler systems. The DU ranged from 12% to 65% for individual zones. The overall average at all homes combined is approximately 40%. This lack of uniformity would explain why there were so many dry spots in the lawns. The remedy was to increase run times in hopes that "flood irrigation" would help solve the problem. However, even with the increased run times the brown spots did not completely disappear, causing frustration for the developer.

In evaluating the sprinkler systems, the basic design was fair, installation could have been improved, and long-term maintenance should have been considered. The bottom line is these were brand new sprinkler systems installed on a shoestring budget provided by the developer. The expectation of the developer was a well-designed and efficient sprinkler system at a very low price. However, the end result was a good design with good sprinkler products that were installed incorrectly. As a follow-up, the District focused on one yard with an overall DU of 35%. Each head was adjusted for proper height, tilt, arc adjustment, and nozzle. After working to optimize the performance of the sprinkler system, the overall DU improved to 50%, making it barely acceptable. A major part of the problem has been identified as a wide fluctuation in water pressure for the sprinkler heads to operate correctly. As an experiment, late in the season the nozzles for the front yard were changed to a different type of nozzle (MP Rotator manufactured by Walla Walla Sprinkler

Company www.mprotator.com) and the DU improved for the three zones in the front yard from 57% after the system was fine-tuned in the late summer, to 73% without relocating any sprinkler heads. Improved, high uniformity is essential for improved irrigation efficiency. High efficiency is achievable when a system is designed, installed, and maintained correctly.

The grass with the sub-surface drip irrigation system did not perform as well as anticipated. There were problems with wiring of the valves and controllers on two of the three systems so irrigation was irregular in the beginning. Even after those problems were corrected, there were numerous dry areas in the lawn scattered throughout the yards. Upon investigation of the dry areas, no single item could be identified as to why the dry spots persisted. Many of the dry areas were on top of the emitter tubing. Two things that were noted were variations in the emitter tubing spacing and depths that frequently comes in the backfilling and final grading process, especially in large open areas even when great care is taken to install the system correctly. Other studies or projects have reported very high efficiency when using sub-surface drip irrigation systems for lawns. Possible explanations for the dry areas could be plugged or malfunctioning emitters, unknown substances within the soil itself, over-compaction in certain areas, or the possibility that the grass roots died or never developed in certain areas due to problems with having the irrigation systems work properly with the controllers. Any number of things could have contributed to the problem. The actual area of the brown spots compared to the whole yard was perhaps 1 to 2%, but were very noticeable when compared to the dark green grass surrounding them. In general, people are frustrated by brown spots and will increase irrigation run times in an attempt to get enough water on those areas, thereby over-watering the rest of the yard needlessly. Controller run times for drip zones need to be correctly identified based upon flow of the emitters and the emitter tubing spacing. Because the tubing is buried in the soil below the grass, it is impossible to perform an audit to measure application rates and distribution uniformity.

Conclusion:

Results from the study may indicate a dismal failure for showing water conservation, but key issues that affect the success of water management and conservation programs and how they must work together have been illustrated. Clearly identifying reasonable expectations and having consensus among the parties involved is essential before implementing any plan. This observation in itself is nothing new, but the experiences gained from this study reinforce the need to include this step in implementing any plan to improve the management of water resources. New technology to aid in improved water management cannot compensate for poor performing sprinkler systems or the lack of proper horticulture practices.

Energy should be invested in fixing and correcting sprinkler systems that do not meet minimum performance standards before, or when, new technology is installed in order to achieve improved irrigation efficiency. Along with changes in landscape water management, there is a need for landscape installation improvement, as well as long-term landscape maintenance practices. This study once again reinforces the tenants of Xeriscaping or Water Wise Landscaping as essential in making landscapes as water-efficient as possible. The use of water budgeting is also a recommended practice to help determine the effectiveness of water management decisions, and to assist in focusing on areas needing improvement.

Northern Colorado Water Conservancy District

Water Budget Worksheet

Model Home

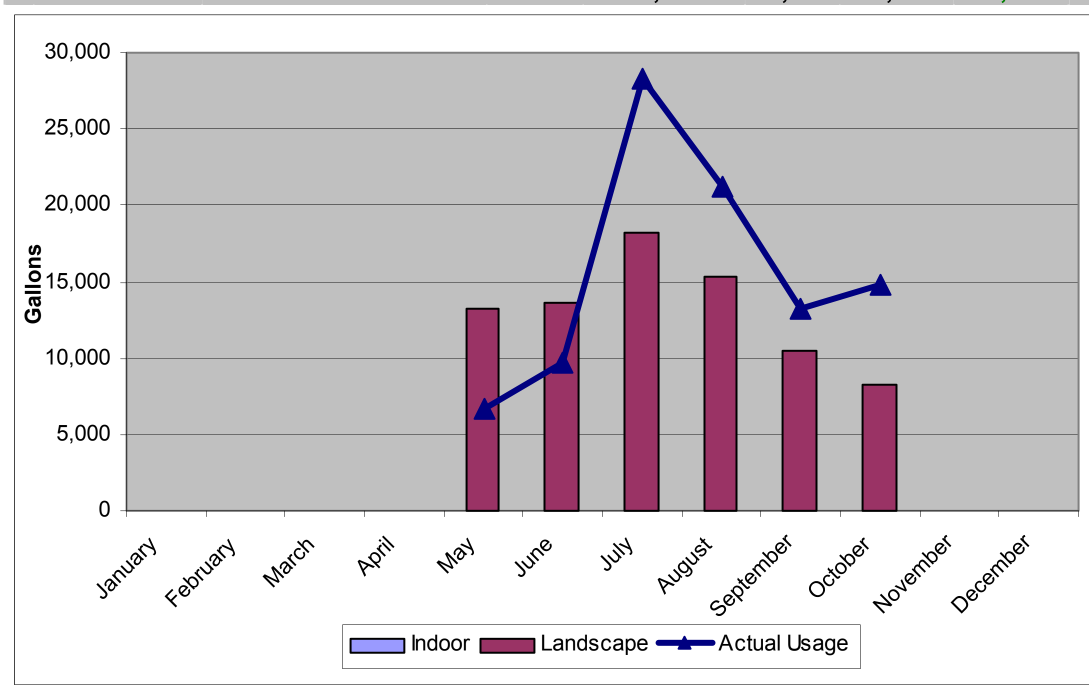
Site Name:	**4148 Florence**		**Ave. Indoor Usage**
Description	**Kc**	**Sq Ft.**	
turf area	**0.9**	**4,235**	
		4,235	

Subsurface drip irrigation
Standard controller
Good soil preparation
Reported irrigation efficiency is 90%
Traditional quality lawn

Irrigation Efficiency **80%**

Monthly Water Usage Worksheet (Gallons)

Month	**Ref ET**	**Water Allocation Indoor**	**Water Allocation Landscape**	**Water Allocation Total**	**Actual Usage**	**Water Saved**	**Excess Usage**
January							
February							
March							
April							
May	4.46 In		13,256	13,256	6,735	6,521	
June	4.61 In		13,684	13,684	9,685	3,999	
July	6.15 In		18,254	18,254	28,333		10,079
August	5.15 In		15,288	15,288	21,191		5,903
September	3.53 In		10,477	10,477	13,286		2,809
October	2.79 In		8,285	8,285	14,758		6,473
November							
December							
Year Total	26.69 In		79,245	79,245	93,988	10,521	25,264



Northern Colorado Water Conservancy District

Water Budget Worksheet

Model Home

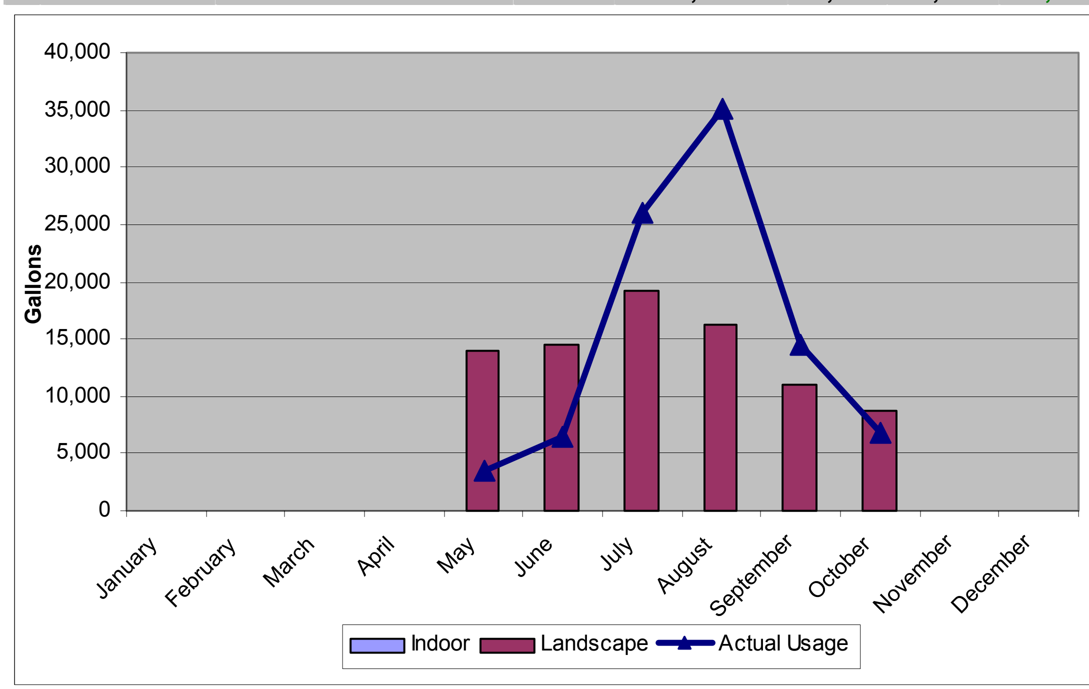
Site Name:	4164 Florence		Ave. Indoor Usage
Description	**Kc**	**Sq Ft.**	
turf area	0.9	4,476	
		4,476	

Subsurface drip irrigation
WR ET controller
Good soil preparation
Reported irrigation efficiency is 90%
Traditional lawn quality

Irrigation Efficiency 80%

Monthly Water Usage Worksheet (Gallons)

Month	Ref ET	Water Allocation Indoor	Water Allocation Landscape	Water Allocation Total	Actual Usage	Water Saved	Excess Usage
January							
February							
March							
April							
May	4.46 In		14,011	14,011	3,510	10,501	
June	4.61 In		14,463	14,463	6,524	7,939	
July	6.15 In		19,293	19,293	26,071		6,778
August	5.15 In		16,158	16,158	35,043		18,885
September	3.53 In		11,073	11,073	14,560		3,487
October	2.79 In		8,757	8,757	6,880	1,877	
November							
December							
Year Total	26.69 In		83,754	83,754	92,588	20,316	29,150



Northern Colorado Water Conservancy District

Water Budget Worksheet

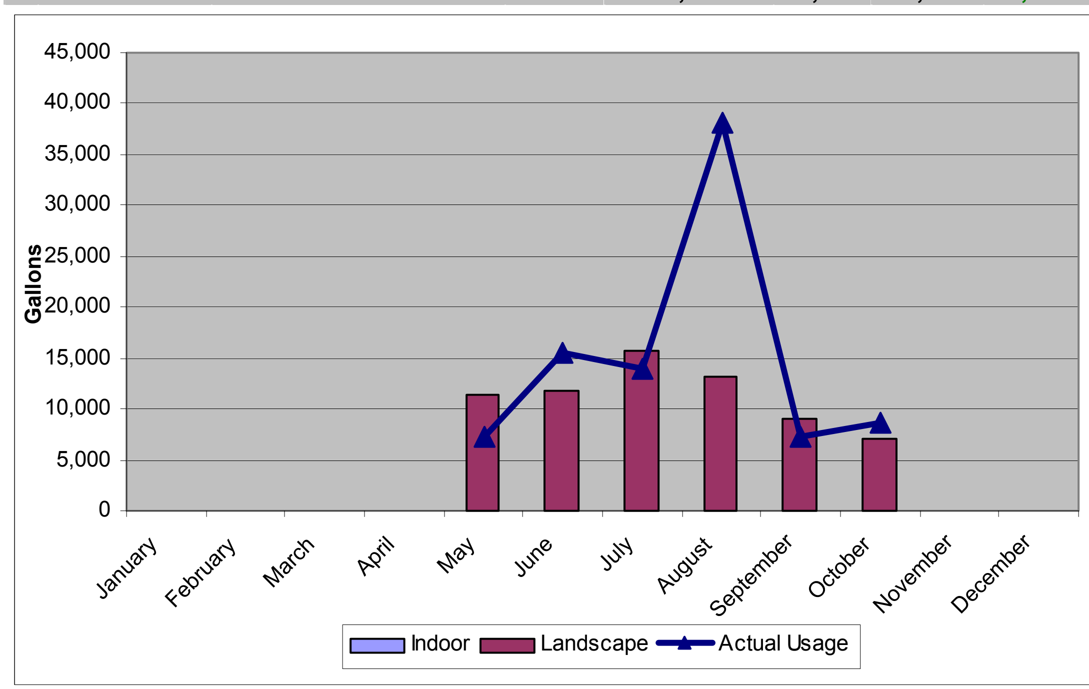
Site Name:	4180 Florence		Ave. Indoor Usage
Description	**Kc**	**Sq Ft.**	
turf area	0.9	3,637	
		3,637	

Subsurface drip irrigation
WW Soil Moisture Sensor
Good soil preparation
Reported irrigation efficiency is 90%
Traditional lawn quality

Irrigation Efficiency 80%

Monthly Water Usage Worksheet (Gallons)

Month	Ref ET	Water Allocation: Indoor	Water Allocation: Landscape	Water Allocation: Total	Actual Usage	Water Saved	Excess Usage
January							
February							
March							
April							
May	4.46 In		11,385	11,385	7,176	4,209	
June	4.61 In		11,752	11,752	15,500		3,748
July	6.15 In		15,677	15,677	13,980	1,697	
August	5.15 In		13,129	13,129	38,133		25,004
September	3.53 In		8,997	8,997	7,301	1,696	
October	2.79 In		7,115	7,115	8,565		1,450
November							
December							
Year Total	26.69 In		68,055	68,055	90,655	7,602	30,202



Northern Colorado Water Conservancy District

Water Budget Worksheet

Model Home

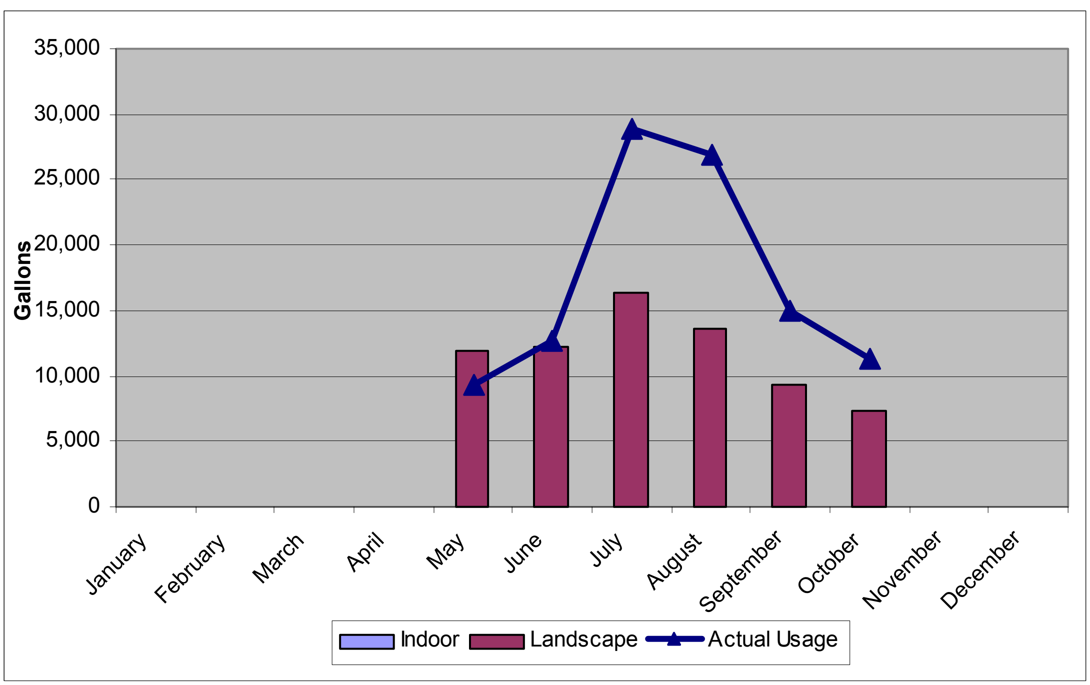
Site Name:	4189 Florence		Ave. Indoor Usage
Description	**Kc**	**Sq Ft.**	
turf area	0.9	3,788	
		3,788	

New soil prep & sod
Standard controller
Rotor DU = 54%
Spray DU = 31%
Traditional lawn quality

Irrigation Efficiency 80%

Monthly Water Usage Worksheet (Gallons)

Month	Ref ET	Water Allocation: Indoor	Water Allocation: Landscape	Water Allocation: Total	Actual Usage	Water Saved	Excess Usage
January							
February							
March							
April							
May	4.46 In		11,857	11,857	9,397	2,460	
June	4.61 In		12,240	12,240	12,729		489
July	6.15 In		16,328	16,328	28,817		12,489
August	5.15 In		13,674	13,674	26,975		13,301
September	3.53 In		9,371	9,371	15,036		5,665
October	2.79 In		7,411	7,411	11,365		3,954
November							
December							
Year Total	26.69 In		70,881	70,881	104,319	2,460	35,899



Northern Colorado Water Conservancy District

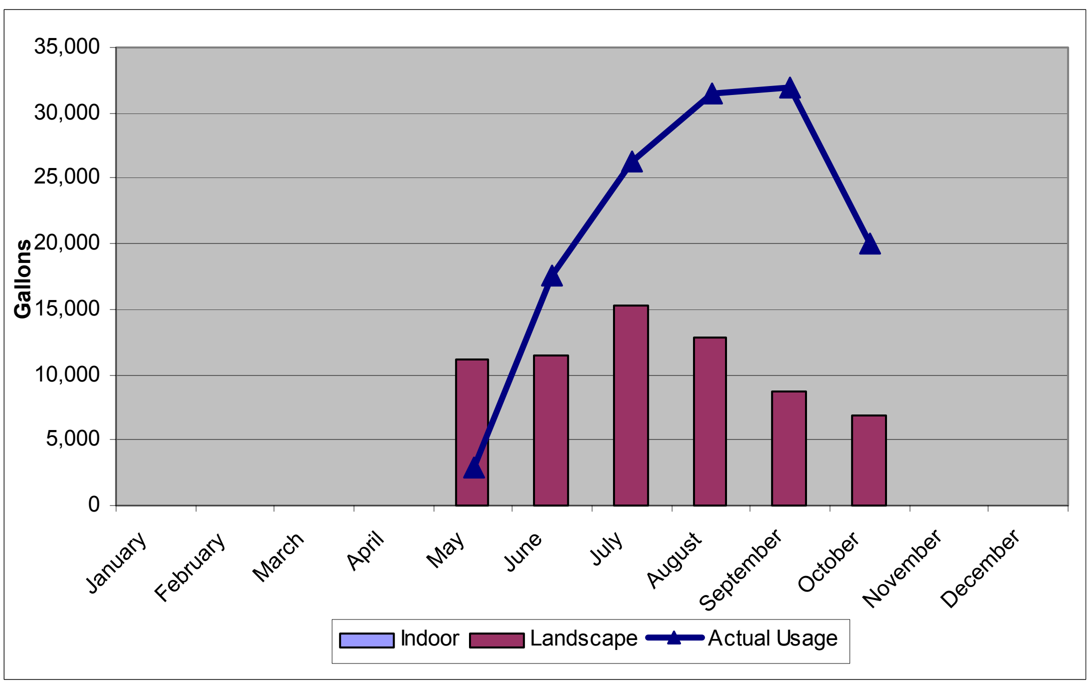
Water Budget Worksheet

Model Home

Site Name:	4196 Florence		Ave. Indoor Usage	
Description	**Kc**	**Sq Ft.**		
turf area	0.9	3,551		No soil prep
				Aqua Cons. Controller
				Overall DU = @35%
				Traditional lawn quality
		3,551		
	Irrigation Efficiency	80%		

Monthly Water Usage Worksheet (Gallons)

Month	Ref ET	Water Allocation Indoor	Landscape	Total	Actual Usage	Water Saved	Excess Usage
January							
February							
March							
April							
May	4.46 In		11,115	11,115	2,876	8,239	
June	4.61 In		11,474	11,474	17,617		6,143
July	6.15 In		15,306	15,306	26,349		11,043
August	5.15 In		12,819	12,819	31,555		18,736
September	3.53 In		8,785	8,785	31,995		23,210
October	2.79 In		6,947	6,947	20,047		13,100
November							
December							
Year Total	26.69 In		66,446	66,446	130,439	8,239	72,233



Northern Colorado Water Conservancy District

Water Budget Worksheet

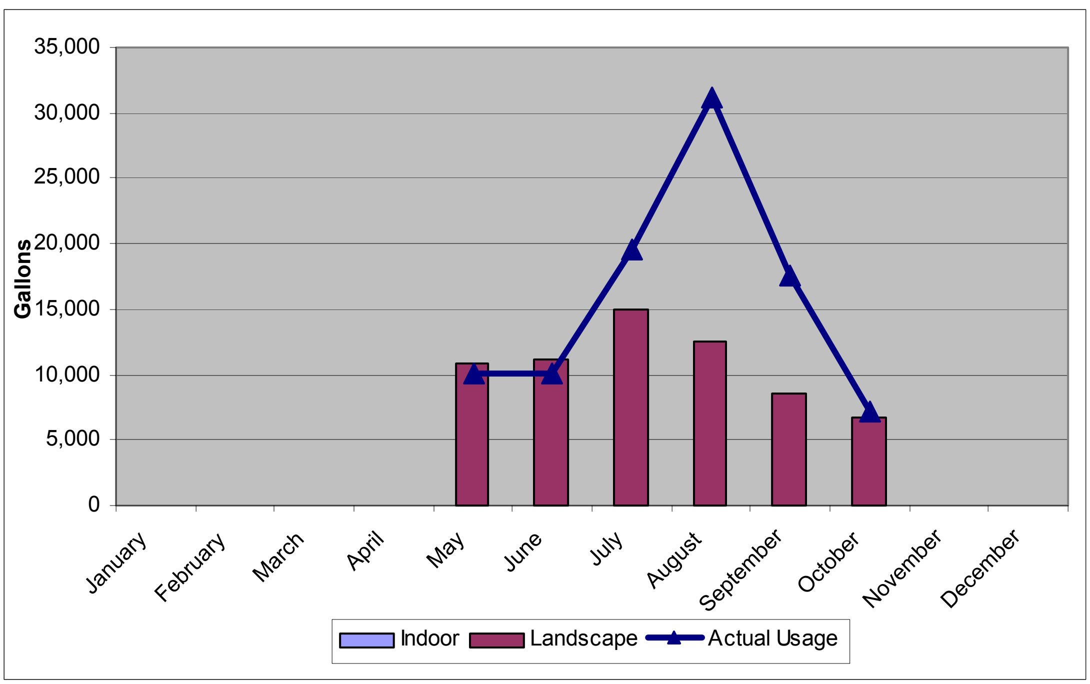
Site Name:	4203 Florence		Ave. Indoor Usage
Description	**Kc**	**Sq Ft.**	
turf	0.9	3,476	
		3,476	

New soil prep & sod
WR ET controller
Rotor DU = 46%
Spray DU = 42%
Overall @ 45%
Traditional lawn quality

Irrigation Efficiency 80%

Monthly Water Usage Worksheet (Gallons)

Month	Ref ET	Water Allocation: Indoor	Water Allocation: Landscape	Water Allocation: Total	Actual Usage	Water Saved	Excess Usage
January							
February							
March							
April							
May	4.46 In		10,881	10,881	10,084	797	
June	4.61 In		11,232	11,232	10,046	1,186	
July	6.15 In		14,983	14,983	19,546		4,563
August	5.15 In		12,548	12,548	31,177		18,629
September	3.53 In		8,599	8,599	17,586		8,987
October	2.79 In		6,800	6,800	7,173		373
November							
December							
Year Total	26.69 In		65,042	65,042	95,612	1,982	32,552



Northern Colorado Water Conservancy District

Water Budget Worksheet

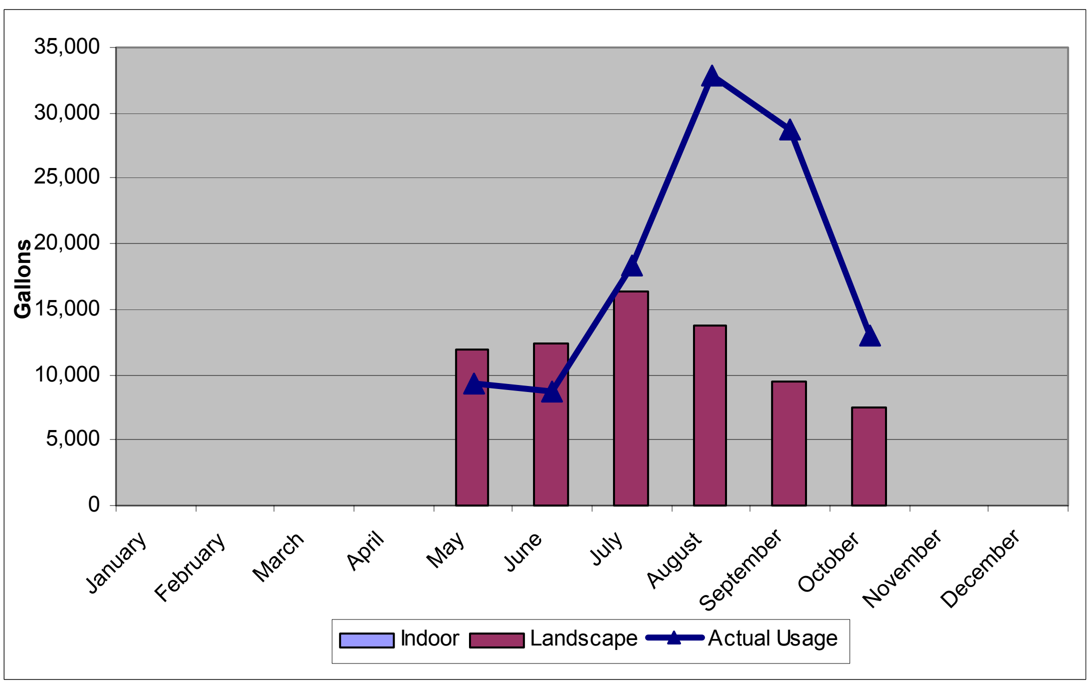
Site Name:	4208 Florence		Ave. Indoor Usage
Description	**Kc**	**Sq Ft.**	
turf area	0.9	3,809	
		3,809	

No soil prep
WR ET controller
Rotor DU = 39%
Spray DU = 28%
Overall DU @ 37%

Irrigation Efficiency 80%

Monthly Water Usage Worksheet (Gallons)

Month	Ref ET	Water Allocation Indoor	Water Allocation Landscape	Water Allocation Total	Actual Usage	Water Saved	Excess Usage
January							
February							
March							
April							
May	4.46 In		11,923	11,923	9,337	2,586	
June	4.61 In		12,308	12,308	8,778	3,530	
July	6.15 In		16,418	16,418	18,316		1,898
August	5.15 In		13,750	13,750	32,825		19,075
September	3.53 In		9,423	9,423	28,658		19,235
October	2.79 In		7,452	7,452	12,919		5,467
November							
December							
Year Total	26.69 In		71,273	71,273	110,833	6,116	45,675



Northern Colorado Water Conservancy District

Water Budget Worksheet

Model Home

Site Name: 4225 Florence

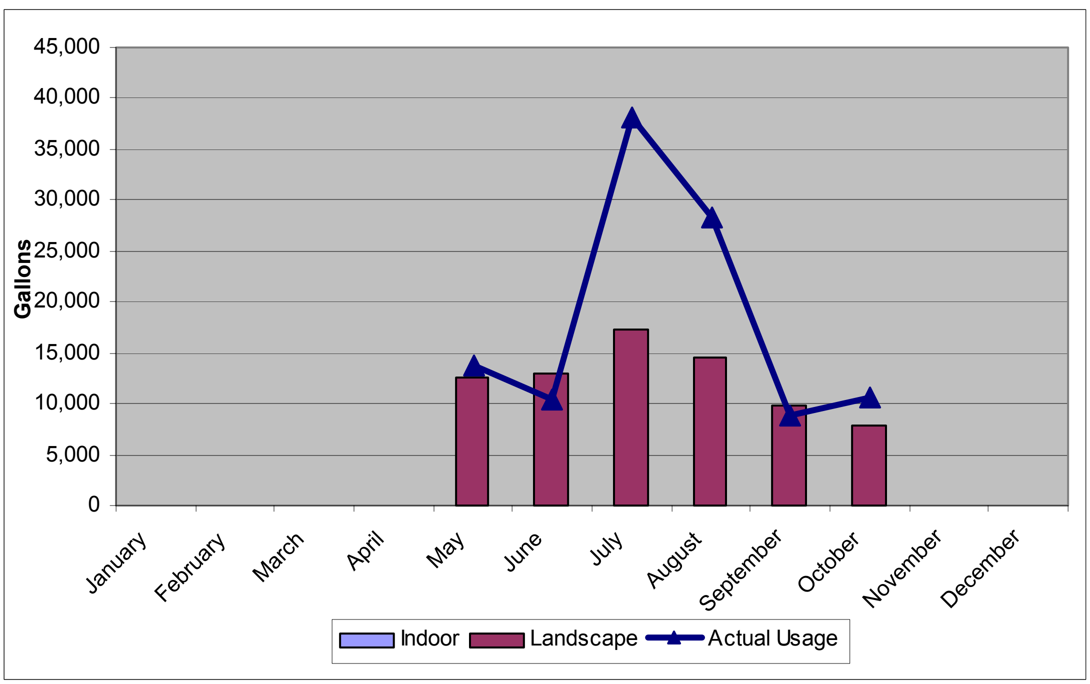
Description	Kc	Sq Ft.	Ave. Indoor Usage
Turf	0.9	4,010	
		4,010	

Irrigation Efficiency 80%

New soil prep & sod
Aqua Cons. Controller
Rotor DU = 37%
Spray DU = 32%
Overall DU @ 35%
Traditional lawn quality

Monthly Water Usage Worksheet (Gallons)

Month	Ref ET	Water Allocation: Indoor	Water Allocation: Landscape	Water Allocation: Total	Actual Usage	Water Saved	Excess Usage
January							
February							
March							
April							
May	4.46 In		12,552	12,552	13,809		1,257
June	4.61 In		12,957	12,957	10,441	2,516	
July	6.15 In		17,285	17,285	38,112		20,827
August	5.15 In		14,475	14,475	28,284		13,809
September	3.53 In		9,920	9,920	8,763	1,157	
October	2.79 In		7,845	7,845	10,606		2,761
November							
December							
Year Total	26.69 In		75,035	75,035	110,015	3,673	38,654



Northern Colorado Water Conservancy District

Water Budget Worksheet

Site Name: 4232 Florence

Description	Kc	Sq Ft.
turf area	0.9	3,185
		3,185

Ave. Indoor Usage

No soil preparation
WW Soil Moisture Sensor
Rotor DU = 49%
Spray DU = 28%
Overall DU = @42%
Traditional lawn quality

Irrigation Efficiency 80%

Monthly Water Usage Worksheet (Gallons)

Month	Ref ET	Water Allocation: Indoor	Water Allocation: Landscape	Water Allocation: Total	Actual Usage	Water Saved	Excess Usage
January							
February							
March							
April							
May	4.46 In		9,970	9,970	4,527	5,443	
June	4.61 In		10,291	10,291	6,912	3,379	
July	6.15 In		13,728	13,728	15,115		1,387
August	5.15 In		11,497	11,497	29,265		17,768
September	3.53 In		7,879	7,879	9,325		1,446
October	2.79 In		6,231	6,231	8,967		2,736
November							
December							
Year Total	26.69 In		59,597	59,597	74,111	8,822	23,336