October 24, 2018

CENTURY RIDGE TOWNHOME ASSOCIATION

STAGE II IRRIGATION AUDIT REPORT

WATER IN MOTION, INC.
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EXECUTIVE SUMMARY

Water in Motion (WiM) is partnering with Vermillion River Watershed Joint Powers Organization and the City of Lakeville to conduct Stage II Irrigation Audits in Lakeville, Minnesota. The audit at Century Ridge Townhome Association was conducted on August 10th, 2018. Century Ridge is one of two homeowner's associations participating in the Urban Water Conservation Pilot Program. The program is intended to reduce outdoor water use while simultaneously reducing costs to operate irrigation systems for communities in the City of Lakeville.

WiM completed the audit by conducting the following work:

- Gathering historical information about the system
- Discussing the current maintenance program
- Reviewing major system components including water supply assemblies and irrigation controls
- Assessing scheduling practices
- Operating each station of irrigation
- Conducting a catch-can test on one station

WiM did not observe significant concerns with the condition of the infrastructure of the irrigation system at Century Ridge with exception of observed wiring modifications in the irrigation controller. The irrigation system appears to run reliably and appears to be operating generally as installed in 2002. The design and operation of the irrigation system, however, is not as efficient as possible which causes high water usage and associated costs. Each building at Century Ridge has one station of irrigation operating the surrounding cool season turf. The irrigation schedule indicates the run times have been determined to accommodate for the exposed areas of stations.

The following high priority components of the irrigation system if improved or repaired, would decrease water usage and costs by increasing the efficiency or longevity of the irrigation system. The prioritized list of repairs and associated costs for Century Ridge can be found on page 29.

- Repair broken sprinklers.
- Move sprinklers for changes in landscape over time.
- Adjust sprinklers that are pitched, out of alignment, or have improper arc.
- Require matched application rates on each station of irrigation.
- Rewire the controller to allow each station to operate independently.
- Implement contemporary irrigation scheduling practices.
- Engage rain sensor.
- Replace PVC piping in water supply assembly with copper or galvanized steel piping.

There is not currently an irrigation maintenance program in place at Century Ridge. Current attention is being paid to basic spring start up, basic fall shut-down and break-fix repairs. In order to have optimum efficiency of the irrigation system regular, proactive maintenance must take place as opposed to the current break-fix approach.

There are also elements that, if improved, would increase the safety and ease of maintenance. These include:

- Remove the controller and electric connection from the water supply cabinet.
- Raise each valve box to final grade and remove debris.

PURPOSE AND METHODOLOGY

PURPOSE

The Vermillion River Watershed Joint Powers Organization and the City of Lakeville have partnered to work on an Urban Water Conservation Pilot Program. The program has been designed with the goal of reducing outdoor water use in the Lakeville community. Landscape irrigation audits are the first step in addressing identified high water using irrigation systems, primarily at homeowner associations. Water in Motion has conducted a Stage II Irrigation Audit in order to provide qualitative and quantitative data detailing the efficiency of the irrigation system.

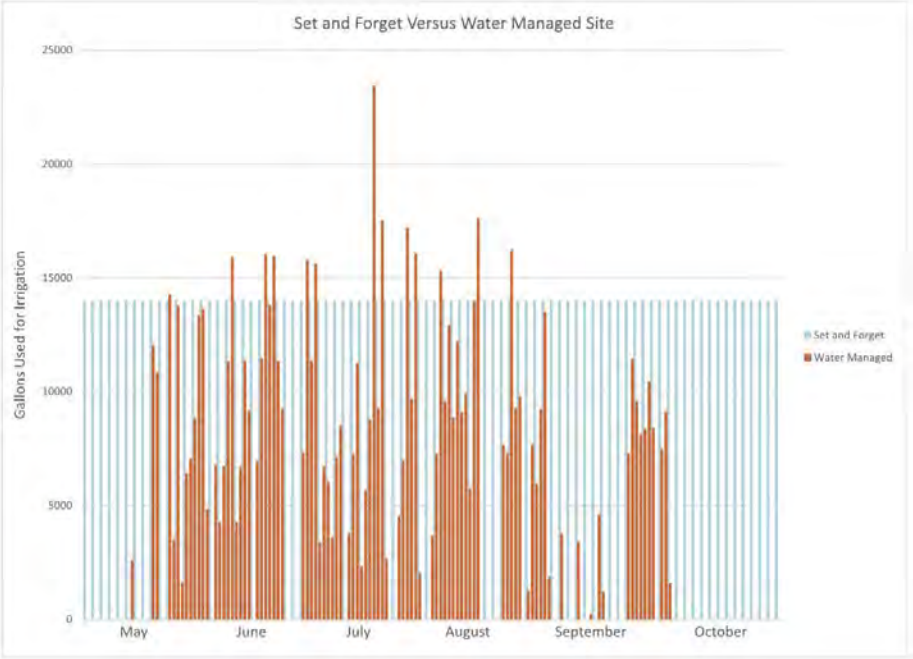
This report illustrates observations resultant of the August 10th, 2018 Stage II Audit that took place at Century Ridge Townhome Association.

METHODOLOGY

A Stage II Landscape Irrigation Audit is an intensive, systematic and defensible overview of an irrigation system. The analysis of the performance of the irrigation system is based on generally accepted practices, processes and formal auditing procedures. The audit is conducted by an EPA WaterSense Partner who is also a Certified Landscape Irrigation Auditor (CLIA). Water in Motion has catalogued major system characteristics and components including scheduled run time, station layouts, water flow, pipe sizing, nozzle selections, system wiring, and controls. Each station of irrigation was operated, observed and notes have been compiled in this report. At Century Ridge, one representative station was selected for catch-can analysis. This report includes the calculated application rates and distribution uniformity of the representative station.

GENERAL IRRIGATION SEASON

In Minnesota, most landscape irrigation takes place from late May through the end of September. However, April and early May, as well as the month of October, are generally reserved for seasonal start-up and shutdown routines. Well-managed landscape irrigation systems operate little, if at all, during the early and late season. Additionally, well-managed systems are adjusted regularly via periodic maintenance visits or by using SMART or remote irrigation controller technology.



The graph above represents the gallons used during an irrigation season of a water managed site versus a site that it started up in the spring and shut down in the fall with little to no adjustment of the irrigation schedule. The amount of water used for irrigation on the water managed site is 33% less than the "set and forget" site assuming every other day operation.

It is important to note Minnesota Law requires moisture-sensing technology, such as a rain sensor, to automatically interrupt irrigation during periods of sufficient rain events. Reference *Minnesota Statute 103G.298 Landscape Irrigation Systems* for more information.

BACKGROUND

Century Ridge Homeowner's Association consists of 13.59 total acres and is located north of 190th Street between Ipava Avenue and Dodd Boulevard in Lakeville, Minnesota.

Construction of the HOA began in 2002. Therefore, at the time of the audit the irrigation system was 16 years old. The current irrigation and landscaping service provider is TPC Landscaping. TPC starts the system in the spring and does fall shut down annually. Aside from these events, TPC is available to work on the irrigation system at Century Ridge upon request but does not have a contract to perform regular maintenance or water management.

The irrigation system is designed to irrigate the cool season turf at Century Ridge. Other than shrubs and perennials alongside buildings, the HOA landscape consists primarily of cool season turf and boulevard trees. Each building at Century Ridge has a station of irrigation watering the surrounding cool season turf. Turf areas in the greater lawn areas are irrigated by separate stations of irrigation.

AUDIT OBSERVATIONS

SYSTEM OVERVIEW

CONTROLLER	
Make and Model Number	Rain Bird ESP-LX Basic
Year Installed	2017
POINT OF CONNECTION	
Static Pressure	45 PSI
Backflow Preventer	2” Wilkins Zurn 975XL
MISCELLANEOUS	
Number of Stations	43
Sensors Installed	Rain Sensor – Non functional

IRRIGATION WATER SUPPLY

Century Ridge has two municipal water supply cabinets servicing the landscape irrigation system. Each water source is tapped from the municipal supply and sized to 2 inch pipe. The water supplies are located at 18970 Inlet Road and 18800 Inca Avenue. Both water supply cabinets contain water meters and Reduced Pressure Zone backflow assemblies (RPZs). Both RPZs were last tested on June 28, 2017 by TPC Landscaping. The water supplies are utilized simultaneously by the irrigation system. Therefore, when any one station of irrigation at Century Ridge is operating, both water supplies are activated.

The water supply at 18800 Inca Avenue is assembled with copper and brass piping. This water supply cabinet also houses the irrigation controller and the electric supply. While the transformer is located inside a weather-proof box, wiring is exposed. See Figures 1 and 3.

A portion of the water supply assembly piping at 18970 Inlet Road is PVC and includes a pressure reducing valve in the water supply cabinet. The remainder of the assembly is comprised of brass and copper. The water supply cabinet hood is broken. See Figures 8, 9 and 10.

CONTROLLER

Both the municipal water supply and irrigation controller are located inside the 18800 Inca Avenue water supply cabinet. See Figure 1. The controller is a Rain Bird ESP-LX Basic (Figure 5). The controller has a wireless rain sensor receiver that is disconnected. There are two wireless rain sensors mounted on the roofline of 18802 Inca Avenue, directly west of the controller (Figure 7). The most recent rain sensor was installed in 2017 and was not functional at the time of the audit. WiM was informed this rain sensor was not functional following installation and another sensor was not installed. The controller was not upgraded with SMART technology nor operating on weather-based scheduling at the time of the audit.

The controller is traditionally wired and contains two 12 station modules. Each module contains more than 12 field wires, hardwired to valves in the field, each operating one or more stations. See Figure 6. There are 24 programmed stations, the programmed irrigation schedule at the time of the audit is below.

IRRIGATION SCHEDULE

At the time of the audit the following programming was present in Controller 1 at Century Ridge. There are four programs available for scheduling: A, B, C and D. These programs can operate multiple times or once during an irrigation cycle, indicated by the “Start Times”. These irrigation cycles can be programmed to take place at various times in a month, generally irrigation operates on “Odd/Even” cycles. Seasonal adjust is available to adjust the run times assigned to each station. A program operating at 70% indicates the run time will decrease by 30% of what is scheduled in that program.

The controller had scheduling in Programs A and B at the time of the audit on August 10th, 2018.

IRRIGATION CONTROLLER PROGRAMS			
PROGRAM	START TIME	ODD/EVEN DAYS	SEASONAL ADJUST
A	9:00 PM	Even – No Monday	100%
B	9:00 PM	Odd – No Monday	100%
C	OFF	-	-
D	OFF	-	-

IRRIGATION STATION RUN TIMES		
STATION	PROGRAM	RUN TIME
1A	A	45
2A	A	45
3A	A	45
4A	A	45
5A	A	45
6A &9A	A	45
7A	A	45
8A	A	45
10A	A	45
11	A	45
12A	A	45
13A	A	45
14A	A	45
15A	A	45
16A	A	45
17A	A	45
18A	A	45
19A	A	45
20A	A	45
21	A	45
22A	B	60
23	B	60
24	B	60
1B	A	45
2B	A	45
3B	A	45

4B	A	45
5B	A	45
6B & 9B	A	45
7B	A	45
8B	A	45
10B	A	45
12B	A	45
13B	A	45
14B	A	45
15B	A	45
16B	A	45
17B	A	45
18B	A	45
19B	A	45
20B	A	45
22B	B	60
6C & 9C	A	45

GENERAL AUDIT OBSERVATIONS

All sprinklers at Century Ridge are rotor-style. There are a mix of brands and models present, indicating a break-fix approach to maintenance since installation. The most common brand of rotor at Century Ridge is Rain Bird. However, there are also Hunter, Toro and Irritrol rotors present throughout the site. Examples of rotor models present include Rain Bird 5000, Rain Bird 5004, Rain Bird 3500, Hunter PGP, Hunter PGJ, Toro Super 800 and Irritrol 450 R. Most stations of irrigation had mixed rotor nozzles and application rates. Therefore, most stations did not have matched application rates.

The nozzle of various rotors are not suitable to the landscape they were intended to irrigate. Most often, the arc angle is correct; however, the rotor should be adjusted. For example, a 180° nozzle is correct, but the arc causes the rotor to distribute water mostly on the pavement. See Figure 12. In some cases, the nozzle selection is incorrect and either does not irrigate the intended landscape or irrigates hardscape. For instance, a 180° nozzle is placed in a corner and is irrigating the landscape as well as the parking lot adjacent.

WiM was informed that on occasion sump pumps operate in the HOA to remove water that has accumulated in the basements of homes. Saturated soils or runoff could be a contributing factor. At the time of the audit, there was evidence of over-watering at Century Ridge. Many areas of the HOA were saturated, in some areas to an extreme. When operating a station of irrigation, runoff occurs quickly. This could be attributed to compact and/or clayey soils or soils that are already saturated. The current irrigation schedule does not adjust to accommodate for this runoff.

Each building at Century Ridge has one irrigation station surrounding the building. The additional stations irrigate cool season turf along roads or in between buildings. Rotors throwing into wooded areas is common, particularly on stations serving the greater landscape. See Figure 17. WiM also observed rotors throwing into conifers throughout the HOA (Figure 22). Damage to the conifers can be seen where the tree is hit by the stream of water.

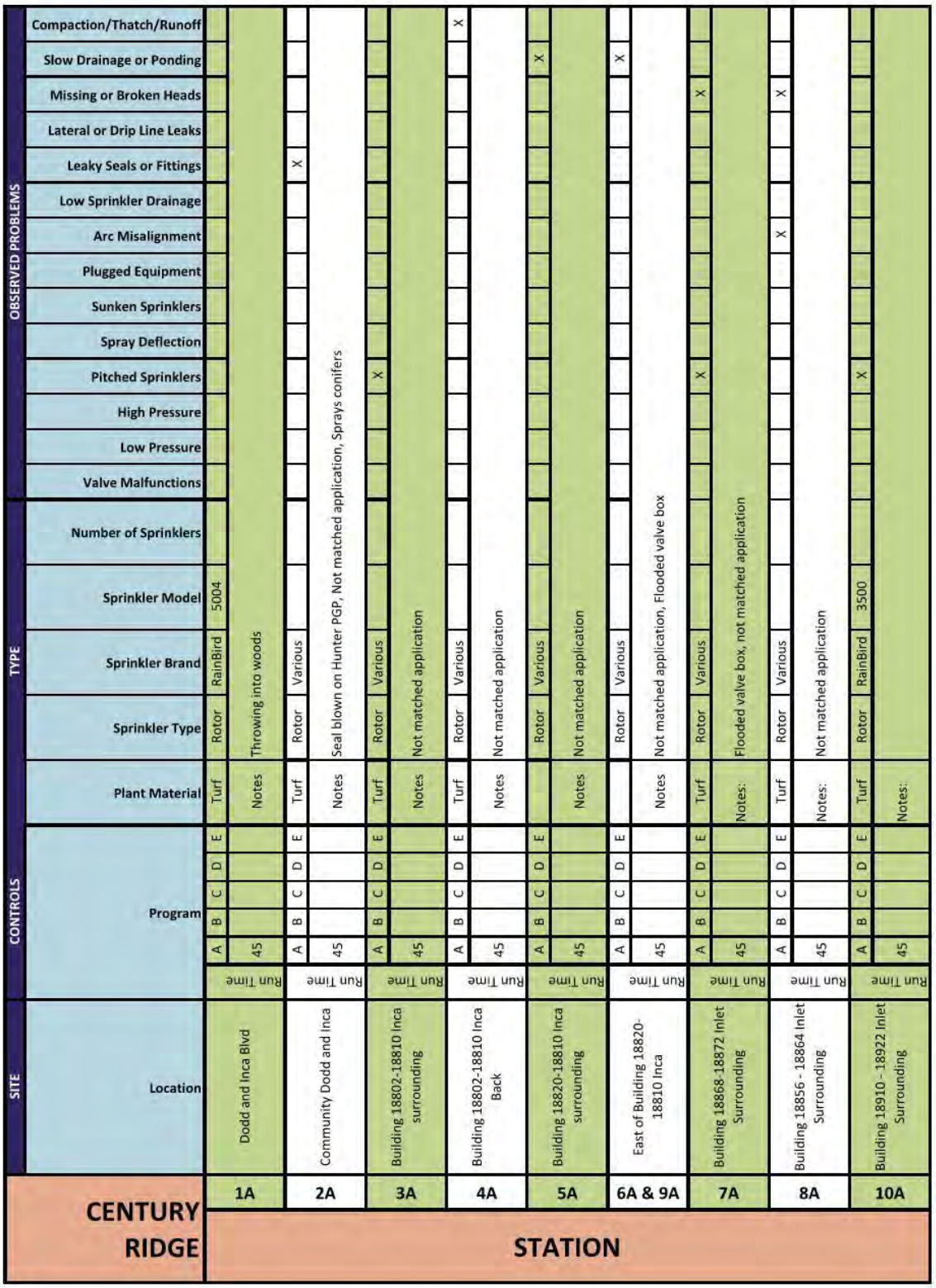
It was difficult or impossible to locate valve boxes. Nearly all valve boxes were sunken or overgrown with cool season turf. The valve boxes that were visible were oftentimes not flush with the landscape (Figure 18). The valve boxes that were inspected during the audit were oftentimes had debris such as soil, rock or water surrounding the valve (Figure 11).

On output ports of the irrigation controller where best practice is to hardwire a single station of irrigation, WiM found multiple stations of irrigation operating. The station map below indicates which stations operate together, indicated by “A”, “B”, and “C”.

STATION MAP

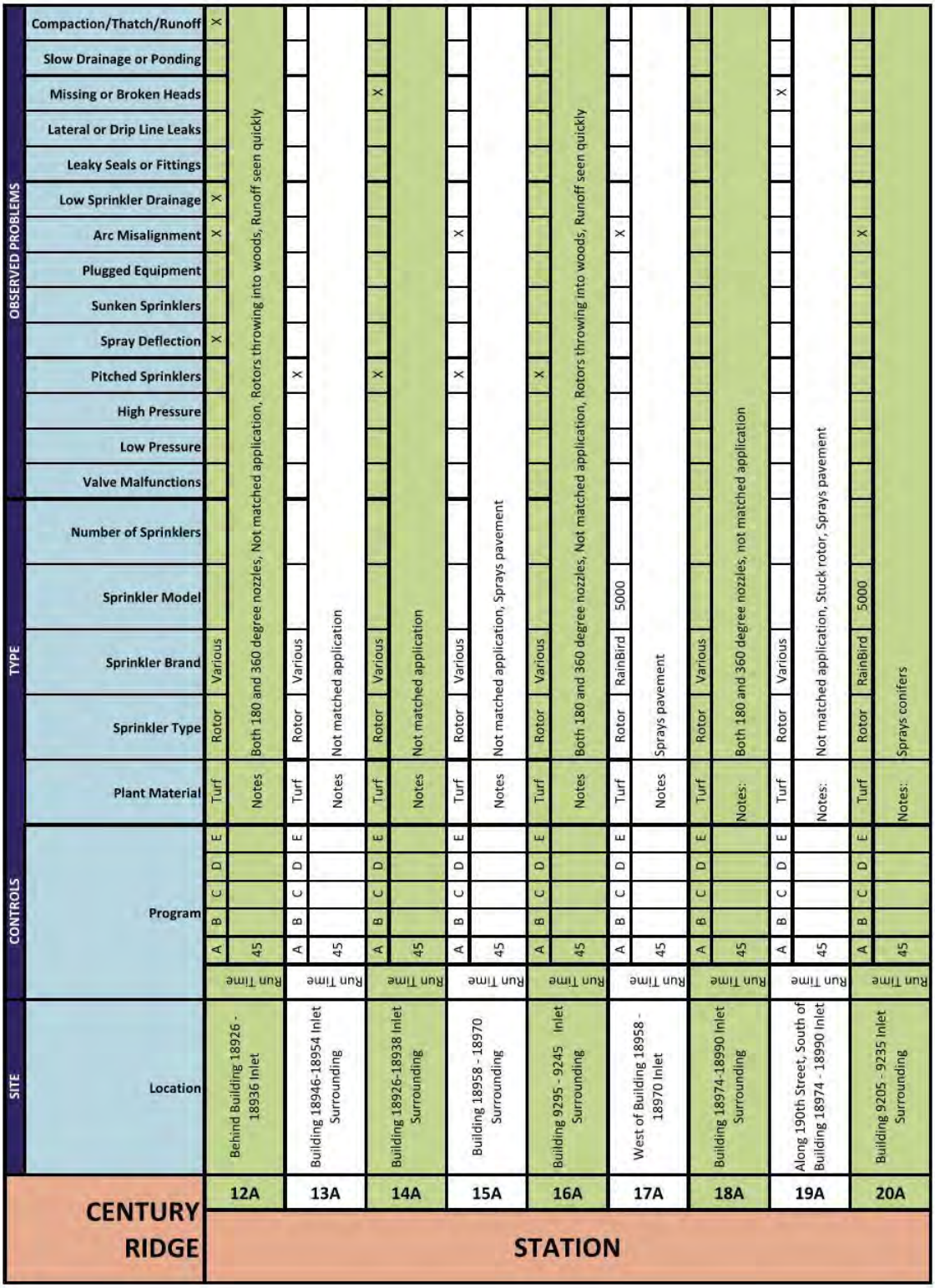

24
23
Inca Ave
Dodd Blvd
WS1
C
3A
5A
4A
3B
1B
2B
4B
5B
6A & 9A
8A
7A
2
A
22B
21
6C &
9C
6B & 9B
1
A
20B
10A
8
B
7
B
19B
10B
18B
12A
14A
17B
16B
13A
WS2
12B
15B
14B
17A
15A
18A
11
13B
16A
190th St
19A
20A
22A
Inlet Rd

STATIONS 1A – 10A



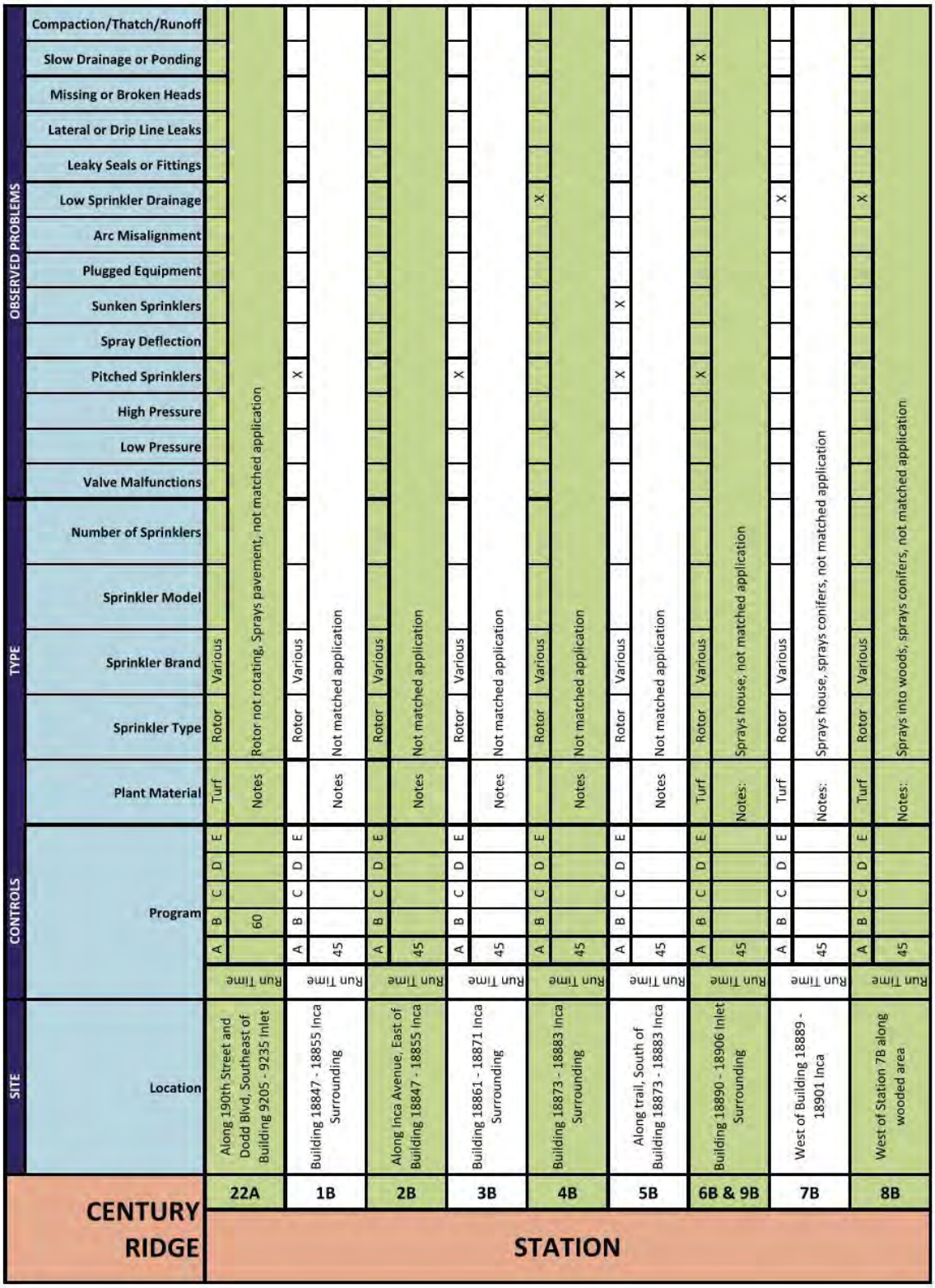
CENTURY RIDGE	STATION	SITE	CONTROLS	TYPE	OBSERVED PROBLEMS
		Location	Program	Plant Material / Sprinkler Type / Sprinkler Brand / Sprinkler Model / Number of Sprinklers	Valve Malfunctions / Low Pressure / High Pressure / Pitched Sprinklers / Spray Deflection / Sunken Sprinklers / Plugged Equipment / Arc Misalignment / Low Sprinkler Drainage / Leaky Seals or Fittings / Lateral or Drip Line Leaks / Missing or Broken Heads / Slow Drainage or Ponding / Compaction/Thatch/Runoff
	1A	Dodd and Inca Blvd	Run Time: A 45; B; C; D; E	Turf; Rotor; RainBird; 5004	Notes: Throwing into woods
	2A	Community Dodd and Inca	Run Time: A 45; B; C; D; E	Turf; Rotor; Various	Notes: Seal blown on Hunter PGP, Not matched application, Sprays conifers; Leaky Seals or Fittings: X
	3A	Building 18802-18810 Inca surrounding	Run Time: A 45; B; C; D; E	Turf; Rotor; Various	Notes: Not matched application; Pitched Sprinklers: X
	4A	Building 18802-18810 Inca Back	Run Time: A 45; B; C; D; E	Turf; Rotor; Various	Notes: Not matched application; Compaction/Thatch/Runoff: X
	5A	Building 18820-18810 Inca surrounding	Run Time: A 45; B; C; D; E	Turf; Rotor; Various	Notes: Not matched application; Slow Drainage or Ponding: X
	6A & 9A	East of Building 18820-18810 Inca	Run Time: A 45; B; C; D; E	Turf; Rotor; Various	Notes: Not matched application, Flooded valve box; Slow Drainage or Ponding: X
	7A	Building 18868-18872 Inlet Surrounding	Run Time: A 45; B; C; D; E	Turf; Rotor; Various	Notes: Flooded valve box, not matched application; Pitched Sprinklers: X; Missing or Broken Heads: X
	8A	Building 18856 - 18864 Inlet Surrounding	Run Time: A 45; B; C; D; E	Turf; Rotor; Various	Notes: Not matched application; Arc Misalignment: X; Missing or Broken Heads: X
	10A	Building 18910 - 18922 Inlet Surrounding	Run Time: A 45; B; C; D; E	Turf; Rotor; RainBird; 3500	Notes: Pitched Sprinklers: X

STATIONS 12A – 20A



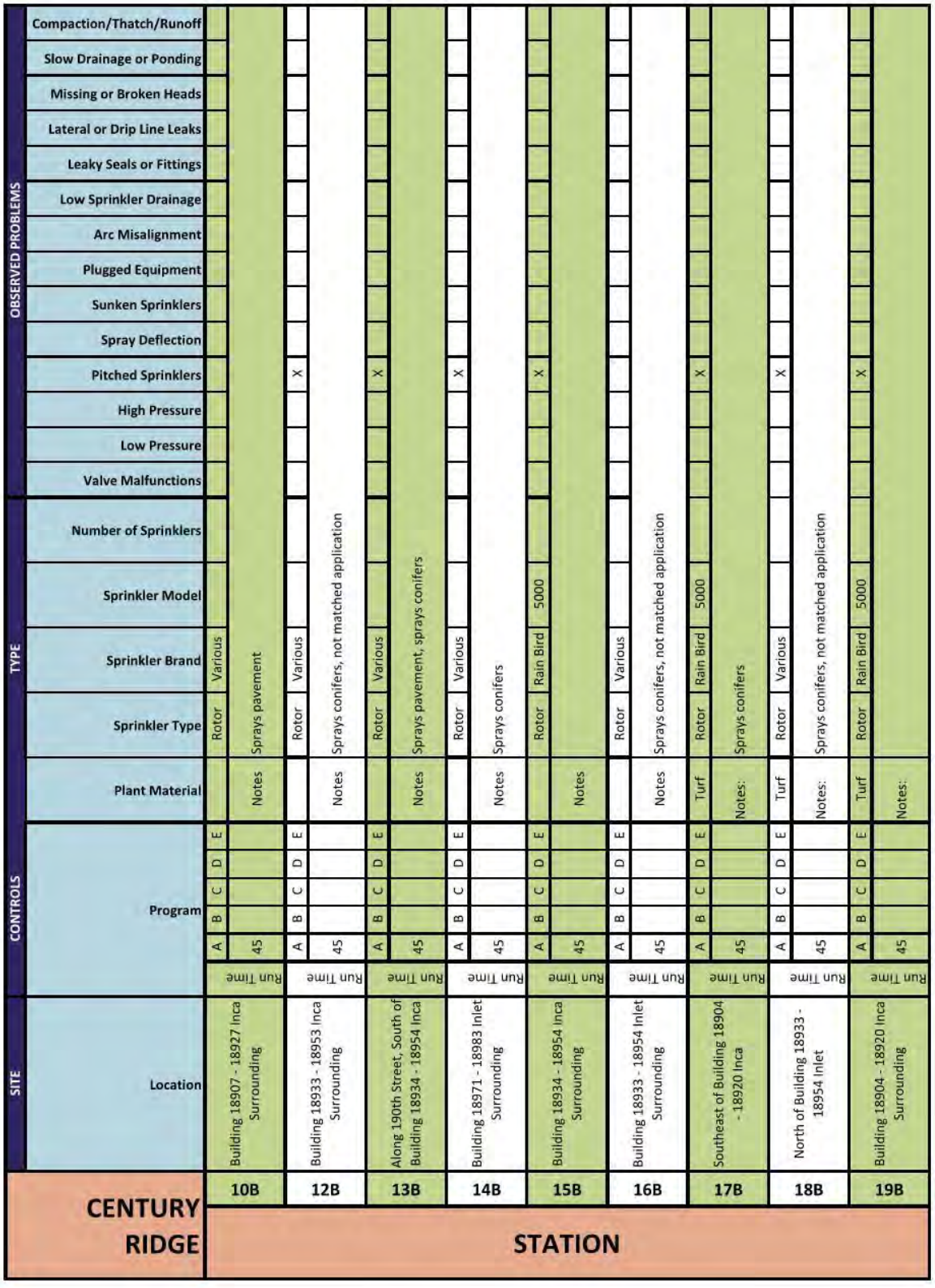
CENTURY RIDGE	STATION	SITE	CONTROLS						TYPE					OBSERVED PROBLEMS											
		Location		Program					Plant Material	Sprinkler Type	Sprinkler Brand	Sprinkler Model	Number of Sprinklers	Valve Malfunctions	Low Pressure	High Pressure	Pitched Sprinklers	Spray Deflection	Sunken Sprinklers	Plugged Equipment	Arc Misalignment	Low Sprinkler Drainage	Leaky Seals or Fittings	Lateral or Drip Line Leaks	Missing or Broken Heads	Slow Drainage or Ponding	Compaction/Thatch/Runoff
	12A	Behind Building 18926 - 18936 Inlet	Run Time	A	B	C	D	E	Turf	Rotor	Various							X			X	X					X
			45						Notes	Both 180 and 360 degree nozzles, Not matched application, Rotors throwing into woods, Runoff seen quickly																
	13A	Building 18946-18954 Inlet Surrounding	Run Time	A	B	C	D	E	Turf	Rotor	Various						X										
			45						Notes	Not matched application																	
	14A	Building 18926-18938 Inlet Surrounding	Run Time	A	B	C	D	E	Turf	Rotor	Various						X								X		
			45						Notes	Not matched application																	
	15A	Building 18958 - 18970 Surrounding	Run Time	A	B	C	D	E	Turf	Rotor	Various						X				X						
			45						Notes	Not matched application, Sprays pavement																	
	16A	Building 9295 - 9245 Inlet Surrounding	Run Time	A	B	C	D	E	Turf	Rotor	Various						X										
			45						Notes	Both 180 and 360 degree nozzles, Not matched application, Rotors throwing into woods, Runoff seen quickly																	
	17A	West of Building 18958 - 18970 Inlet	Run Time	A	B	C	D	E	Turf	Rotor	RainBird	5000									X						
			45						Notes	Sprays pavement																	
	18A	Building 18974-18990 Inlet Surrounding	Run Time	A	B	C	D	E	Turf	Rotor	Various																
			45						Notes:	Both 180 and 360 degree nozzles; not matched application																	
	19A	Along 190th Street, South of Building 18974 - 18990 Inlet	Run Time	A	B	C	D	E	Turf	Rotor	Various														X		
			45						Notes:	Not matched application, Stuck rotor, Sprays pavement																	
	20A	Building 9205 - 9235 Inlet Surrounding	Run Time	A	B	C	D	E	Turf	Rotor	RainBird	5000										X					
			45						Notes:	Sprays conifers																	

STATIONS 22A – 8B



CENTURY RIDGE	SITE	CONTROLS								TYPE												OBSERVED PROBLEMS											
STATION	Location	Run Time	Program							Plant Material	Sprinkler Type	Sprinkler Brand	Sprinkler Model	Number of Sprinklers	Valve Malfunctions	Low Pressure	High Pressure	Pitched Sprinklers	Spray Deflection	Sunken Sprinklers	Plugged Equipment	Arc Misalignment	Low Sprinkler Drainage	Leaky Seals or Fittings	Lateral or Drip Line Leaks	Missing or Broken Heads	Slow Drainage or Ponding	Compaction/Thatch/Runoff
			A	B	C	D	E																										
22A	Along 190th Street and Dodd Blvd, Southeast of Building 9205 - 9235 Inlet			60						Turf	Rotor	Various																				
										Notes	Rotor not rotating, Sprays pavement, not matched application																					
1B	Building 18847 - 18855 Inca Surrounding		A	B	C	D	E																										
		Run Time	45							Turf	Rotor	Various						X														
										Notes	Not matched application																					
2B	Along Inca Avenue, East of Building 18847 - 18855 Inca		A	B	C	D	E																										
		Run Time	45							Turf	Rotor	Various																				
										Notes	Not matched application																					
3B	Building 18861 - 18871 Inca Surrounding		A	B	C	D	E																										
		Run Time	45							Turf	Rotor	Various						X														
										Notes	Not matched application																					
4B	Building 18873 - 18883 Inca Surrounding		A	B	C	D	E																										
		Run Time	45							Turf	Rotor	Various											X									
										Notes	Not matched application																					
5B	Along trail, South of Building 18873 - 18883 Inca		A	B	C	D	E																										
		Run Time	45							Turf	Rotor	Various						X		X												
										Notes	Not matched application																					
6B & 9B	Building 18890 - 18906 Inlet Surrounding		A	B	C	D	E																										
		Run Time	45							Turf	Rotor	Various						X														X
										Notes:	Sprays house, not matched application																					
7B	West of Building 18889 - 18901 Inca		A	B	C	D	E																										
		Run Time	45							Turf	Rotor	Various											X									
										Notes:	Sprays house, sprays conifers, not matched application																					
8B	West of Station 7B along wooded area		A	B	C	D	E																										
		Run Time	45							Turf	Rotor	Various											X									
										Notes:	Sprays into woods, sprays conifers, not matched application																					

STATIONS 10B – 19B



CENTURY RIDGE	STATION	SITE	CONTROLS								TYPE						OBSERVED PROBLEMS												
			Program																										
		Location		A	B	C	D	E			Plant Material	Sprinkler Type	Sprinkler Brand	Sprinkler Model	Number of Sprinklers	Valve Malfunctions	Low Pressure	High Pressure	Pitched Sprinklers	Spray Deflection	Sunken Sprinklers	Plugged Equipment	Arc Misalignment	Low Sprinkler Drainage	Leaky Seals or Fittings	Lateral or Drip Line Leaks	Missing or Broken Heads	Slow Drainage or Ponding	Compaction/Thatch/Runoff
	10B	Building 18907 - 18927 Inca Surrounding	Run Time	45							Notes	Sprays pavement	Various																
	12B	Building 18933 - 18953 Inca Surrounding	Run Time	45							Notes	Sprays conifers, not matched application	Various						X										
	13B	Along 190th Street, South of Building 18934 - 18954 Inca	Run Time	45							Notes	Sprays pavement, sprays conifers	Various						X										
	14B	Building 18971 - 18983 Inlet Surrounding	Run Time	45							Notes	Sprays conifers	Various						X										
	15B	Building 18934 - 18954 Inca Surrounding	Run Time	45							Notes		Rain Bird	5000					X										
	16B	Building 18933 - 18954 Inlet Surrounding	Run Time	45							Notes	Sprays conifers, not matched application	Various																
	17B	Southeast of Building 18904 - 18920 Inca	Run Time	45							Notes:	Sprays conifers	Rain Bird	5000					X										
	18B	North of Building 18933 - 18954 Inlet	Run Time	45							Notes:	Sprays conifers, not matched application	Various						X										
	19B	Building 18904 - 18920 Inca Surrounding	Run Time	45							Notes:		Rain Bird	5000					X										

STATIONS 20B – 24

CENTURY RIDGE STATION	SITE: Location	Run Time (Program A)	Program B	Program C	Program D	Program E	Plant Material	Sprinkler Type	Sprinkler Brand	Sprinkler Model	Number of Sprinklers	Valve Malfunctions	Low Pressure	High Pressure	Tilted Sprinklers	Spray Deflection	Sunken Sprinklers	Plugged Equipment	Arc Misalignment	Low Sprinkler Drainage	Leaky Seals or Fittings	Lateral or Drip Line Leaks	Missing or Broken Heads	Slow Drainage or Ponding	Compaction/Thatch/Runoff	Notes
20B	Building 18911 - 18919 Inlet Surrounding	45						Rotor	Various						X		X									Sprays homes, Sprays conifers
22B	East of Building 18858 - 18878 Inca		60					Rotor	Various						X											Dry spots evident, Broken rotor
6C & 9C	Building 18889 - 18901 Inca Surroudning	45						Rotor	Various						X		X									Sprays house, Not matched application
11	Southwest of Building 18933 - 18953 Inca	45						Rotor	Various						X					X						Sprays house, Not matched application
21	Building 18858 - 18878 Inca Surrounding	45						Rotor	Rain Bird	5000					X											Sprays house
23	Building 18819 - 18827 Inca Surrounding and east to Dodd Blvd		60					Rotor	Rain Bird	5000					X											Rotor does not rotate
24	Building 18831 - 18843 Surrounding		60				Turf	Rotor	Various																	Sprays conifers, Not matched application
							Turf																			
							Turf																			

REPRESENTATIVE CATCH-CAN TEST

EXPLANATION

A catch-can test was performed on a representative station of irrigation at Century Ridge. Station 6A & 9A is composed of two rows of rotors with every rotor rotating 360 degrees. All stations of irrigation at Century Ridge are composed of rotors, rotating generally at either 90, 180 or 360 degrees. Station 6A & 9A were selected for the catch can test because it had a variety of rotor brands and models present and there are trees present in the station area. There are a wide variety of rotor brands and models present throughout Century Ridge. Many of the other stations at Century Ridge also have trees, shrubs, signs or other objects that deflect irrigation water away from the intended landscape.

SET-UP

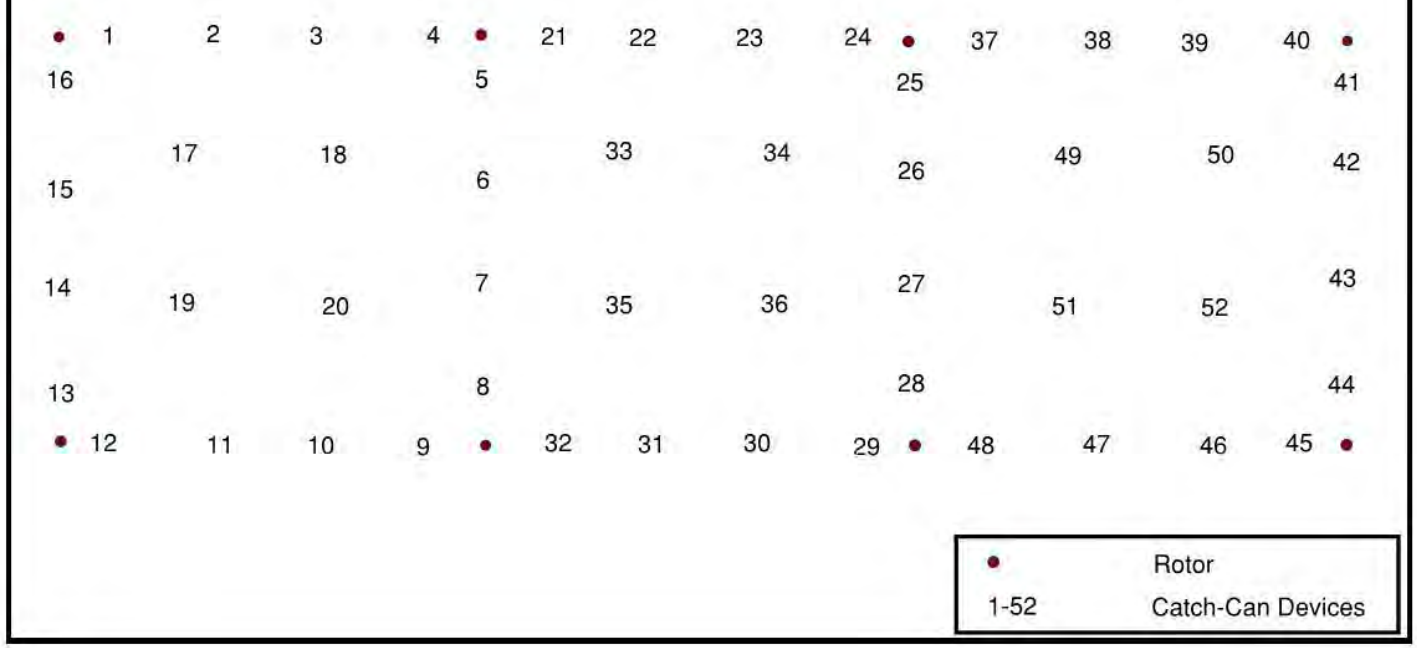
A total of 52 catch-cans were arranged between eight rotor-style sprinklers based on the distance between the rotors, in this case an average of 30 feet. The catch-cans were evenly spaced. The arrangement can be seen below and in Figure 23.

SITE: CENTURY RIDGE STATION: 6A

TEST DATA

Test Run Time	30	min	Meter Start	N/A	gallons
Wind	0-2	mph	Meter Stop	N/A	gallons
Pressure	45	psi	Total	Unable to determine	gallons

CATCH CAN MAP



SITE: CENTURY RIDGE

STATION		TEST STATION		
Sprinkler Type	Rotor	Station Number	6A & 9	
Sprinkler Brand	Rainbird	Catch Device Area	11.039063	in^2
Sprinkler Model	5000 2.0	Test Run Time	30	min

CATCH DEVICE VOLUMES

1	0.1	17	0.09	33	0.05	49	0.08	65	
2	0.1	18	0.15	34	0.15	50	0.06	66	
3	0.1	19	0.1	35	0.1	51	0.09	67	
4	0.05	20	0.1	36	0.08	52	0.08	68	
5	0.1	21	0.05	37	0.06	53		69	
6	0.1	22	0.1	38	0.1	54		70	
7	0.1	23	0.09	39	0.08	55		71	
8	0.1	24	0.06	40	0.03	56		72	
9	0.09	25	0.08	41	0.05	57		73	
10	0.1	26	0.07	42	0.06	58		74	
11	0.1	27	0.07	43	0.06	59		75	
12	0.06	28	0.04	44	0.05	60		76	
13	0.05	29	0.04	45	0.05	61		77	
14	0.07	30	0.08	46	0.08	62		78	
15	0.09	31	0.09	47	0.08	63		79	
16	0.07	32	0.05	48	0.05	64		80	

Number of Catch Devices	52	1/4 of Number of Catch Devices	13
Total Catch Volume	4.08	Total Low Quarter	0.64
Average Volume [V_{avg}]	0.078461538	Average Low Quarter [V_{avg}]	0.049230769

Calculate Distribution Uniformity	Calculate Net Precipitation Rate
$Du_{lq} = \frac{\text{Average Lower Quarter } [V_{lq}]}{\text{Average Volume } [V_{avg}]} = \frac{0.0492308 \text{ mL}}{0.0784615} =$ **0.627451**	$PR_{net} = \frac{3.66 \times V_{avg}}{t_R \times A_{CD}} = \frac{3.66 \times 0.0784615 \text{ mL}}{30 \text{ min} \times 11.039063 \text{ in}^2} =$ **0.00086713**

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The distribution uniformity of Station 6A & 9A at Century Ridge is 0.627, the calculations for which can be seen above. The average calculated distribution of a typical landscape irrigation system is between 0.55 and 0.75. The distribution uniformity of this representative station of irrigation is average.

Given that this station is representative of the irrigation system at Century Ridge, the irrigation water is likely being distributed relatively evenly across the landscape. This station of irrigation is comprised of all 360° rotors. Other stations contain nozzles with different arcs or rotors with different application rates. These stations will have a lower distribution uniformity than Station 6A & 9A. It is therefore likely that the distribution uniformity is not as high as 0.627 as many stations of irrigation have a variety of rotor models and nozzles.

SUMMARY

RECOMMENDED ACTIONS

Recommended actions are presented individually and in bundle format. The intent of presenting actions in a bundled format is to illustrate cost savings that may be realized by authorizing similar system improvements during a single mobilization.

The financial information presented below is intended for budgeting purposes only. Project electives, variables and market conditions can affect the cost of work.

ITEM	PRIORITY	DESCRIPTION	ESTIMATED COST	ADDITIONAL INFORMATION
A	High	Repair or replace sprinklers that are sunken, pitched, leaking, or clogged to improve performance. One broken sprinkler can waste hundreds of gallons per irrigation cycle, and up to thousands of gallons per week.	$4,455 - $5,245	
B	High	Place irrigation controller inside in a weather-resistant pedestal outside of the water supply cabinet.	$1,800 - $2,400	Powder-coated cabinet; Does not include cost to move electrical connection
C	High	Adjust sprinkler alignment to irrigate the landscape only. Whenever possible, avoid watering concrete, asphalt, fences and buildings.	$1,700 - $2,000	Assuming 95% of sprinklers need adjustment

D	High	Relocate sprinklers that are placed in locations that do not irrigate the intended landscape.	$450 - $550	
E	High	Reinstall and engage rain sensor on system. Assure that rain sensor installation occurs in a clear location, where rainfall hits the device from all sides and is not blocked by buildings, landscape structures, trees, or plants. A hard-wired device is preferred but not always practical. If a wireless device is used it may be more reliable if an external antenna is installed.	$350 - $450	
F	High	Rewire controller to operate the 43 valves present on the site separately. Currently at Century Ridge there are stations operating alongside one or two other stations. WiM recommends installing two 12 station modules in the ESP-LX Basic controller. The 43 stations can then be operated separately after rewiring.	$350 - $450	Assuming there are no field wiring issues
G	High	Adjust the irrigation schedule to reduce underwatering, overwatering and runoff during an irrigation cycle.	$600 - $1,000	
H	Medium	Move or cap the sprinklers currently placed in wooded areas. The irrigation water applied to this landscape is unnecessary and could damage the trees.	$450 - $550	Assuming 5% of sprinklers
I	Medium	Adjust sprinklers so they are not spraying directly into conifers. The stream of water will oftentimes damage tree growth.	$1,800 – $2,400	Assuming 5% of sprinklers
J	Medium	Replace the water supply PVC pipe in the water supply closet at 18970 Inlet Road with copper or galvanized steel pipe. Both copper and galvanized steel are more durable than PVC pipe, which is more likely to break causing leaks and a repair to the water supply assembly.	$500 - $800	

K	Medium	Homogenize sprinklers to one brand and select model families from that brand in order to practice matched application rate nozzling.	$10,000 - $12,000	Assuming 25% of sprinklers
L	Medium	Sprinkler to sprinkler coverage should be maintained in all areas of the irrigated property. Align sprinklers in such a way that the end of the spray of one sprinkler reaches the next sprinkler per best practice and manufacturer recommendations. Responsible addition of sprinklers on deficient stations may be a remedy to stations lacking proper performance.	$1,200 - $1,500	Assuming addition of 20 sprinklers
M	Medium	Locate and raise valve boxes to finish grade and clean excessive sediment and/or turf intrusion. Valve boxes should be clearly visible and easily accessible to the service technician.	$2,500 - $3,000	Assuming all valve boxes
N	Medium	Match application rates of each rotor nozzle within a station of irrigation to avoid over or under watering. Quarter-circle sprinklers should emit half of the amount of water as half-circle sprinklers. Likewise, a full-circle sprinkler should emit double the amount of water as a half-circle sprinkler. For instance, if the corner sprinklers in a square area deliver 2 gallons of water per minute, the sprinklers along the edge of the square should deliver 4 gallons of water per minute, and the full sprinklers in the center should deliver 8 gallons of water per minute. Application rates should be matched on all irrigation stations. This can be achieved by ensuring consistency in sprinkler selection and by installing nozzles appropriate for the arc of coverage of each sprinkler.	$4,000 - $5,000	Assuming 75% of sprinklers

O	Medium	Utilize the Rain Bird ESP-LX SMART technology option available to properly program the irrigation controller. SMART controllers automatically adjust irrigation schedules in response to changing weather conditions. When properly programed, the ESP-LX controller in SMART mode can improve moisture balance in the soil and reduce water waste.	$3,500 - $4,000	Stand-alone SMART controls
P	Low	Consider remote central control of the irrigation system by a trained water manager. A water manager ensures irrigation efficiency by adjusting the schedule as needed based on the weather and seasonal changes. A water manager also monitors flow and can respond quickly to irrigation running outside of the designated schedule and high flow warnings that could indicate a break in a mainline or valve.	$3,500 - 4,500 $7,000 - $8,000	Annual water management fee Hardware updates
Q	Low	Redesign and installation of a new irrigation system at Century Ridge. The current design has one station irrigating around one building. This design cannot distribute the appropriate amount of water on the landscape. The north side of a building will need less irrigation applied to the turf than the south side of a building. Therefore, the irrigation contractor is forced to apply excess irrigation to the north side to ensure the south side of the building is to the HOA's standards. This design also does not account for slope and other plant material, such as a tree canopy.	$11,000 - $15,000	Does not include installation
R	Low	Install flow sensors on each water supply and integrate into controller. When a high flow warning is triggered and indicates a break the controller is capable of shutting down the system, saving water and cost of potential damage.	$3,000 - $4,000	Assuming controller is capable of accepting flow data

S	Low	Repair water supply cabinet hood at 18970 Inlet Road.	$120 - $300	

The following table combines individual recommendations into bundles of actions to reduce costs of design and implementation of improvements. By completing work during a single mobilization, the installer will be more efficient, reducing the cost of work that might otherwise be engaged via separate mobilizations.

BUNDLE	ITEMS	EXPLANATION	ESTIMATED COST SAVINGS
1	A, C, D, H, I, K, N	Completing all sprinkler work simultaneously will allow the contractor to move systematically through the HOA and do any necessary work as it appears while moving through the stations.	5 – 10%
2	B, E, F, G	Controller work being completed in one service call will reduce the time spent on each task and will reduce the likelihood that the contractor will need to redo a task, such as rewiring the controller.	3 – 5%
3	J, R, S	Combining water supply cabinet tasks will reduce the time spent on individual tasks.	2 – 5%

SAMPLE IRRIGATION SCHEDULE

A sample schedule is below. To account for runoff at Century Ridge, the sample schedule illustrates an approach to applying water in short "bursts", known as cycle-and-soak.

IRRIGATION CONTROLLER PROGRAMS			
PROGRAM	START TIME	ODD/EVEN DAYS	SEASONAL ADJUST
A	9:30 PM	Odd – Not Monday	Adjusted throughout the irrigation season
	1:00 AM	"	"
	5:00 AM	"	"
B	9:30 PM	Even – Not Monday	Adjusted throughout the irrigation season
	1:00 AM	"	"
	5:00 AM	"	"
C	-	-	-
D	-	-	-

IRRIGATION STATION RUN TIMES		
STATION	PROGRAM	RUN TIME
1A	A	8
2A	A	7
3A	A	8
4A	A	8
5A	A	8
6A &9A	A	8
7A	A	8
8A	A	8
10A	A	8
11	A	8

12A	A	8
13A	A	8
14A	A	8
15A	A	8
16A	A	8
17A	A	6
18A	A	7
19A	A	6
20A	A	7
21	A	8
22A	B	8
23	B	9
24	B	8
1B	A	8
2B	A	6
3B	A	8
4B	A	8
5B	A	6
6B & 9B	A	8
7B	A	5
8B	A	5
9B	A	8
10B	A	8
12B	A	8
13B	A	9
14	A	8
15B	A	8

16B	A	8
17B	A	9
18B	A	9
19B	A	8
20B	A	8
22B	B	9
6C & 9C	A	8

PROACTIVE MAINTENANCE

MAINTENANCE

Maintenance is the regular, proactive application of a best practice-based process to preserve the integrity of a constructed system or device.

Maintenance of a landscape irrigation system includes:

- Raising, straightening and adjusting sprinkler emission devices
- Minor moving of sprinklers to accommodate growth in the landscape
- Testing and record-keeping of plumbing protection equipment, pumps and other controls
- Scheduling adjustments to accommodate a maturing landscape, realities of soil conditions and changing weather
- Interaction with the landscape maintenance provider, acting in the best interests of the client and the needs of the landscape
- Note and plan for more intensive tasks as the landscape matures or project-based changes in the landscape
- Regular reporting in clear, concise fashion of findings and outcomes to the client or client representative

REPAIR

Repair is overcoming damage or a fault, utilizing best practices or manufacturer recommendation in the application of parts and techniques to keep a device, assembly or system in working condition.

Repair of a landscape irrigation system includes:

- Replacement of failed or damaged equipment
- Overcoming deficiencies in the original installation
- Overcoming naturally-occurring damage
- Overcoming damage by others

RETROFIT

Retrofit of a system is installing a component or accessory that was not included at the time of manufacture or assembly.

Retrofit is not generally part of routine maintenance. For budgeting purposes, retrofit(s) should be separately proposed from maintenance and repair budgets and be prioritized in agreed-to between the client and the service vendor.

Some retrofits are inexpensive and bear great reward such as installation of basic rain sensing technology. Other retrofits may involve great expense and planning such as re-installation of a station of sprinklers to overcome original design deficiency or changes/growth of landscape.

OUTLINE OF A RECOMMENDED LANDSCAPE IRRIGATION MAINTENANCE PROGRAM

A properly designed and installed irrigation system requires periodic maintenance and continual scheduling adjustments to accommodate the needs of the landscape and best stewardship practices.

The frequency of maintenance interval can vary based on many factors. A practical service interval for maintenance of a landscape irrigation system at a homeowner association is once every two weeks.

A qualified service provider will specialize in landscape irrigation as a profession either exclusively or, as a properly capitalized division, adequately equipped and staffed to efficiently furnish maintenance. A landscape irrigation service technician generally has a minimum of five years' experience in the industry and may carry several credentials including Certified Irrigation Contractor or Certified Irrigation Technician. In Minnesota, a well-qualified irrigation Service Technician may also hold a Power Limited Technician License, Backflow Tester License and accreditation or degree in horticulture.

A comprehensive landscape irrigation maintenance program will be minimally based on the following approach:

- Spring system start, walk-through and repair
- Bi-weekly proactive system walk-through, adjustment and repair
- Autumn shut-down

In four-season climates, the spring system start can be the most intensive of all maintenance events including, re-setting sprinkler emission devices resultant of freeze-thaw conditions, testing of equipment and sensors and initial scheduling of irrigation.

A good maintenance provider will document repairs separately from maintenance and in a way that the client can comprehend and track in contrast to budget.

A good maintenance provider will apply maintenance to keep the original installation in tact including use of original equipment.

Whether or not a landscape irrigation controller is equipped with "SMART" weather or soil-moisture technology, regular attention paid to and adjustment of the irrigation system controller to accommodate realities of the landscape and current weather conditions is a vital function of a good landscape irrigation maintenance program.

In four-season climates, a good landscape irrigation maintenance program will include a documented approach to winterization of irrigation equipment including protected storage of backflow prevention devices, any pump equipment and other equipment.

In addition to a checklist of tasks to be performed, maintenance visits should include attendance to and documentation of items reported to vendor by the client. A list of routine tasks to illustrate the vendor's approach to maintenance should be included with the vendor's budget proposal.

A good maintenance provider will document and propose improvements and rationale. If approved, a good provider will have the capability to self-perform the improvements.

BUDGET FOR COMPREHENSIVE MAINTENANCE

Setting a budget to properly maintain a landscape irrigation system includes several assessments including:

- System condition considering best practices and manufacturer recommendations
- System complexity
- Available system records
- System age
- Condition of the landscape
- Expectations of the owner
- Consideration for use of resources

A well-communicated maintenance program will include a fixed budget for application of maintenance and a separate parts and labor budget estimate for repairs. The repair budget can only be estimated to give the client a reference for annual budgeting.

If a list of prioritized system improvements/retrofits is in place, a budget to implement improvements will be included in a comprehensive landscape irrigation maintenance program.

FIGURES

Figure 1 (above): Irrigation water supply cabinet at 18800 Inca Avenue

Figure 2 (above right): Electric supply in water supply cabinet at 18800 Inca Avenue

Figure 3 (right): Reduced pressure zone assembly (RPZ) in water supply cabinet at 18800 Inca Avenue

Figure 4 (above): Irrigation controller

Figure 5 (above right): Electric supply to irrigation controller

Figure 6 (right): Wiring in modules of irrigation controller

Figure 7 (below): Non-functional wireless rain sensors mounted at 18800 Inca Avenue

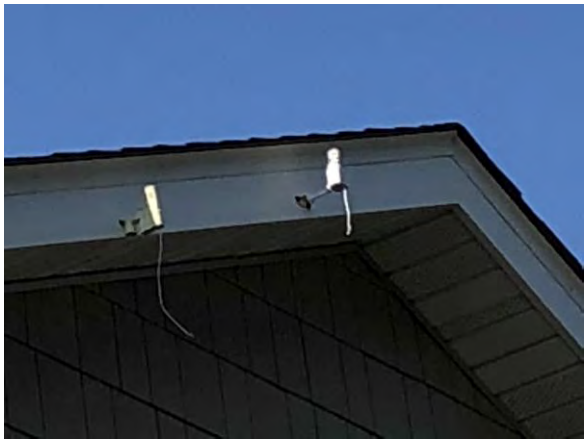

Figure 8 (above): Water supply assembly at 18970 Inlet Avenue

Figure 9 (above right): PVC product water pipe at 18970 Inlet Avenue

Figure 10 (right): Pressure reducing valve at 18970 Inlet Avenue

Figure 11 (below): Typical valve box and field wiring

Figure 12 (above): Rotor spraying onto pavement

Figure 13 (above right): Rotor spraying over sidewalk

Figure 14 (right): Pitched rotor

Figure 15 (below): Pitched rotor

Figure 16 (above): Missing sprinkler in corner, dry spot evident

Figure 17 (above right): Rotor now located in the woods, spraying into the woods

Figure 18 (right): Valve boxes sunken and askew

Figure 19 (below): Rotor unable to pop up due to landscaping

Figure 20 (above): Rotor not rotating, dry areas beginning to appear

Figure 21 (above right): Broken rotor

Figure 22 (right): Rotor spraying into conifer

Figure 23 (below): Catch-can test

GLOSSARY

Arc – The area a part-circle sprinkler irrigates, expressed in degrees of a circle. For example, a 90-degree arc provides quarter-circle coverage, while a 180-degree arc provides half-circle coverage.

Backflow Preventer – A mechanical assembly installed to protect the potable water supply from potentially contaminated irrigation water.

Best Management Practices – An irrigation BMP is a voluntary irrigation practice that is both economical and practical and is designed to reduce water consumption and protect water quality while maintaining plant health at the desired level.

Certified Landscape Irrigation Auditor – The Certified Landscape Irrigation Auditor is involved in the analysis of landscape irrigation water use. Auditors collect site data, make maintenance recommendations and perform water audits. Through their analytical work at the site, these irrigation professionals develop monthly irrigation base schedules.

Controller – An automatic timing device that sends an electric signal for automatic valves to open or close according to a set irrigation schedule.

Cycle-and-Soak – Allows the user to divide a station's run time into more usable, shorter duration cycles. Cycle-and-soak is particularly applicable for slopes and tight soil (such as clay) and helps prevent excessive runoff. The cycle time is entered into the controller as a fraction of the station's watering time, and the soak time as the minimum soak required before the watering of the next portion. The total number of cycles is determined by taking the total programmed station run time and dividing it by the cycle time.

Distribution Uniformity – (Also referred as "Performance") Measure of the uniformity of irrigation water over an area.

EPA WaterSense Partner – WaterSense is a voluntary, public-private partnership program sponsored by the U.S. Environmental Protection Agency. WaterSense works to protect the future of national water supplies by promoting water-efficient products, practices and professionals. EPA WaterSense Partners are committed to bringing water-efficient products and practices to the market.

Fixed Arc Nozzles – Rotor style sprinkler where the arc stays static and is non-adjustable.

Hydrozone – Grouping of plants with similar water requirements so that they can be irrigated with a common zone.

Maintenance – The work of keeping something in operating condition.

Matched Application Rates – Refers to sprinklers that apply water at the same rate per hour no matter the arc of coverage or part of a circle they cover.

Microclimate – The unique environmental conditions in a particular area of the landscape. Factors include amount of sunlight or shade, soil type, slope and wind.

MSMT – A "multi-stream, multi-trajectory" sprinkler that uses individual, rotating streams of water to distribute irrigation water.

Municipal Water – Domestic or drinking water. It can be used as a source of irrigation water, but once water enters an irrigation system (and passes through the backflow device) it is no longer considered potable.

Nozzle – The final opening through which water passes from the sprinkler or emitter. Nozzle shape, size, and placement has a direct effect on the distance, watering pattern, and distribution efficiency.

Pitched Sprinkler Head – A sprinkler that is slanted or tilted.

Point of Connection – Location where irrigation system is connected to a (potable) water supply.

Rain Sensor – A device that automatically interrupts irrigation events during periods of sufficient moisture.

Rotor Sprinkler – A type of sprinkler where a primary stream of water is distributed back and forth across the area being watered.

Runoff – Portion of precipitation, snow melt or irrigation, that flows over the soil, eventually making its way to surface water supplies.

Spray Sprinkler – A sprinkler that does not rotate.

Sprinkler to Sprinkler Coverage – Single sprinklers generally do not provide even distribution of water throughout their range of throw. When overlapping coverage is provided, the weak areas from one sprinkler are supplemented by the strong areas from another sprinkler. Overlapping coverage also reduces time necessary to complete an irrigation cycle from the perspective of total water required.

Station/Zone/Circuit – Section of an irrigation system served by a single point of control. Also known as a Hydrozone, optimally comprised of similar sprinkler types and plant material types and applying water onto a consistent topography or microclimate.

Topography – The arrangement of the natural and artificial physical features of an area.

Valve Box – A protective container installed around an underground valve to allow operation or maintenance access to underground pipeline valves.

Variable Arc Nozzles – Rotor style sprinkler where the arc can be adjusted to more accurately apply irrigation to nonconvention landscape areas.

Water in Motion was pleased to compose this report. Our company specializes not only in system audits, but also design, consultations, and education. Should Century Ridge choose to implement some or all of our recommendations, we will be pleased to support with suggested processes, prioritization and measures of success.

Please contact Cara Donovan or Rich Koechlein at 763-559-1010.