INNOVATIVE
CONSERVATION
PROGRAM
Metropolitan Water District
of Southern California

DISCLAIMER

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Testing Methods to Conserve Irrigation Water
Deliverable 4: Final Report (6/30/2019, $12,500)

In an effort to meet the ambitious goals set out by mandates from the CSU Chancellor's Office, CSU, Northridge (CSUN) has pursued various options for water conservation. A large portion of the University's water consumption occurs outdoors, thus, turf removal has been a primary strategy for meeting our water reduction goals. This is a great approach to water conservation, but dry, sandy soil compacts quickly and contributes to urban storm water runoff and water pollution. Thus, although turf does require water, healthy soil beneath acts as a bioremediation filter that prevents pollution from entering nearby sewers and recharges groundwater. Grassy fields also contribute to evaporative cooling, reducing heat island effects. Moreover, while drought tolerant plants can thrive in compacted dry soil, other life forms necessary for aiding in carbon sequestration in soil do not. Turf also plays a functional role on school grounds, as fields are necessary for many programmatic activities such as athletic events, among others.

Thus, the goal of this project is to examine effective and cost-efficient ways to reduce water required for irrigation, while still maintaining healthy soil. More specifically, this study seeks to understand how to increase the capacity for soil covered in turf grass to retain water, thereby, conserving irrigation water necessary to keep that grass alive. To examine this issue, three test plots were selected: One that was injected with hydrogel; one that received multiple applications of compost; and one control plot that was not altered. In the hydrogel condition, Aqua Cents® water absorbing hydrogels were injected into the turf grass plot using the hydrogel injection machine (Deliverable 2). The hydrogel was injected approximately 4 to 6 inches below the soil surface, into the root zone of the vegetation. In the compost application condition, one-quarter inch of compost was evenly applied to the surface of the land with a topdressing machine (Deliverable 1) every 5-6 weeks, allowing the soil to build with little to no visible impacts on the turf grass. The third turf grass plot received no treatment and served as a comparison (control) condition. The three sites selected were matched for the slope of the field (to control for water runoff), the frequency of use (to control for compaction), and tree cover (to control for evaporation).

Approximately every other week, student research assistants (supervised by Dr. Erica Wohldmann) visited each of the three plots to take soil moisture readings (Deliverable 3). To measure soil moisture, we purchased two DSMM500 Precision Digital Soil Moisture Meter with Probe (picture included below). Samples were taken twice on each data collection day, once in the morning and once in the late afternoon, because campus irrigation generally runs overnight, which could artificially increase the moisture readings in the morning. In addition, readings were taken at each site with two separate probes, and when the readings differed, an average of the two readings was recorded. To rule out the possibility that some locations differed from others, thereby, ensuring that the readings were representative of the entire field, the moisture probes were inserted into five different locations on each of the three test plots. All five readings were entered into a spreadsheet and were used to calculate an average daily reading (one in the morning, and a second in the afternoon). For the complete list of moisture readings, please see the table below. To select the sampling locations, we created a map of each field, and worked with our campus groundskeepers to flag the location of every water irrigation spout in each of the three test plots. Sampling locations were at least 5 feet away from an irrigation spout and, when possible, 10 feet. Moisture readings were taken in the exact same locations every time. Finally, data collection days were scheduled at least 72 hours after a rain event to allow moisture levels to drop sufficiently for the moisture probes to take accurate readings.

In addition to collecting the moisture readings described above, during each data collection day, researchers visibly assessed the health and quality of the soil and grass, including compaction, surface moisture and/or pooling of water, and browning and/or patchy grass.

We also examined the actual amount of irrigation water used on each test plot. This is reported below in terms of gallons/day/square foot, to normalize the data so as to be able to make between-plot comparisons. As mentioned in the report for Deliverable 3, because of an extremely wet winter, CSUN turned off all irrigation sprinklers on campus between December and early April. With no irrigation water used on campus during almost the entire study phase, the results for those months should be considered preliminary. However, due to a steady increase in temperature and lack of rain in Northridge, campus irrigation resumed in April. This report includes irrigation data for April, May, and the first 10 days of June.

Test Plot Characteristics: Observational data revealed that the test plot that received compost applications was greener and had fewer patches of browned and dead grass than either the hydrogel or control plots. However, this plot also had somewhat more compacted soil, suggesting that the grass roots in the compost plot are thicker and denser. Inserting the moisture probe was especially difficult in the compost plot relative to the other test plots. In May, when the most recent compost application occurred, the groundskeepers also aerated the soil. This improved compaction rates dramatically in June samples. We will continue to monitor the health of these fields in the coming months.

Soil Moisture Readings: As can be seen in the table below, the compost plot (26.85%) continues to retain more moisture than either the hydrogel plot (19.08%) or the control plot (19.95%). These preliminary results suggest compost applications may be more effective for retaining ground moisture between watering than water absorbing polymers. CSUN Grounds has expanded the compost application program to other parts of campus and the hydrogel injection scheduled for this summer has been put on hold based on these results.

	November	**December**	**January**	**February**	**March**	**April**	**May**	**June**	**Avg.**
Hydrogel	23.31	21.646	20.519	21.3375	20.5825	13.05983	16.9245	15.24	19.08
Compost	28.844	39.947	26.5765	38.27	22.534	16.7485	22.2885	19.59	26.85
Control	26.43667	21.667	20.091	19.9515	18.02417	15.775	23.383	14.31	19.95

Water Usage Data: To determine the amount of irrigation water used on each of the three test plots, we obtained a Water Usage Report using CSUN's Rain Master Control System. Dr. Wohldmann identified the appropriate stations (connected system of sprinklers) to monitor, the output of each sprinkler (based on actual calibration data), and the average run time. The total gallons of irrigation water used on each of the three plots was divided by the number of days in each month, and by the square footage of each plot so that proper comparisons between plots could be made. Below are the gallons of irrigation water used per day per square foot.

	Compost	Hydrogel	Control	SierraQuad
November	0.052	0.059	0.125	0.046
December	0.019	0.043	0.040	0.046
April	0.060	0.029	0.150	0.040
May	0.030	0.016	0.086	0.018
June	0.061	0.062	0.287	0.064
Average	**0.045**	**0.042**	**0.138**	**0.043**

As can be seen in the table above, both the compost and hydrogel plots required substantially less water than the control plot, with little to no difference between the two experimental plots. However, higher moisture levels in the compost plot compared to the hydrogel plot suggests the amount of irrigation water currently being used to maintain this plot could be reduced. That is, because both the hydrogel and control plots are healthy at a soil moisture rate of 19-20%, then irrigation water could be reduced until the soil moisture rate in the compost plot looks similar.

In addition to comparing the three test plots, we examined the irrigation water needs of two grassy fields that were previously injected with hydrogel. These fields, East Field and Sierra Quad, received hydrogel injections in 2016. Thus, the biodegradable polymers are three years old. To understand how effective they are at conserving irrigation water, Dr. Wohldmann obtained the total irrigation water used between 2016-2019 on each plot, divided that by the total number of days in this study phase, and again by the square footage of each field. Unfortunately, due to construction on campus, data for the East Field plot were not available after the report delivered in April. Thus, only the new results for the Sierra Quad are reported below.

2016 Hydrogel Plot	Avg. (as of 4/19)	Avg. (between 4/19-6/19)
East Field	0.046	0.041
Sierra Quad	0.059	

As can be seen in the table above, the previous hydrogel injections are still effective at conserving water. In fact, the average gallons used/day/square foot is similar to that of the two experimental plots described above. While the hydrogel polymers are expected to biodegrade within 5-7 years, the rate of degradation appears rather slow. Still, because the process of injection is somewhat costly and temporary, and because the results of this study suggest compost applications are as effective for conserving irrigation water, we recommend other organizations consider the use of compost on functional tuff grass.

Final Summary: Taken together, the results of this study suggest that compost applications are as effective as hydrogel injections for maintaining visibly healthy grass and soil, for retaining moisture in soil, and for conserving irrigation water. In addition, the test plot treated with compost applications had fewer brown and dead patches of grass. Thus, when possible, we recommend compost applications over hydrogel injections to maintain healthy soil and conserve irrigation water. Compost applications are also a better option because they're more cost effective and sustainable than hydrogel. One-hundred percent of campus green waste is collected and composted onsite by CSUN grounds so no materials need to be purchased. CSUN employees then spread the finished compost on turf around campus so no outside contractor is required, as with hydrogel injections. This closed loop process is less expensive and uses fewer resources, as materials do not need to be purchased and delivered to campus in heavy trucks that generate emissions.

These results support previous findings that applying compost to soil increases its ability to retain water and decreases evaporative loss (Maynard, 1994). In addition to the benefits compost has on water conservation in soil, mulching grass and tree clippings for compost diverts these materials from the landfill while also reducing greenhouse gasses that contribute to climate change. Moreover, compost promotes a biologically healthy soil by providing food for earthworms, soil insects, and beneficial microorganisms.

Soil Moisture Data Collected

	Date	Time	%1	%2	%3	%5	%6	%7
Hydrogel Plot	11.27.18	12:00 PM	22.69	23.93	none	none	none	23.31
	12.04.18	10:45	22.33	23.2	22.6	23.66	21.13	22.584
	12.18.18	12:30	22.1	18.68	21.36	19.3	22.1	20.708
	01.11.19	8:45AM	23.81	20.06	22.75	22.65	20.01	21.856
	01.11.19	12:15PM	22.43	18.35	22.68	21.3	21.81	21.314
	01.25.19	8:10AM	16.46	17.06	17.38	20.01	23.93	18.968
	01.25.19	1:25PM	18.01	18.51	18.26	20.98	23.93	19.938
	02.08.19	8:35AM	22.63	19.51	20.8	19.25	22.76	20.99
	02.08.19	1:35PM	24.23	21.66	22.66	21.33	24.2	22.816
	02.22.19	8:55AM	20.6	21.31	18.76	22.7	17.83	20.24
	02.22.19	1:30PM	21.43	18	24.03	20	23.06	21.304
	03.14.19	8:15AM	20.73333	20.23333	20.46667	19.26667	23.53333	20.84666667
	03.14.19	2:10PM	24.06667	21.6	19.63333	21.66667	24.46667	22.28666667
	03.29.19	8:38AM	20.23333	15.15	21.06667	21.06667	16.23333	18.75
	03.29.19	1:29PM	21.36667	20.3	21.73333	15.96667	22.86667	20.44666667
	04.12.19	8:45AM	14.43333	16.76667	9.1	11.8	17.56667	13.93333333
	04.12.19	12:48PM	10.83333	11.7	8.133333	8.166667	9.466667	9.66
	04.26.19	8:15AM	15.86	13.06	12.2	13.36	18.03	14.5
	04.26.19	12:00PM	15.6	12.26	11.4	15.83	15.63	14.14
	05.09.19	9:45AM	20.93	14.83	13.16	12.33	20.3	16.31
	05.09.19	3:35PM	23.3	10.46	12.3	14.4	22.8	16.65
	05.21.19	9:15AM	16.6	23.36	16.1	17.83	16.6	18.09
	05.21.19	11:45AM	15.73	16.2	15.5	17.2	18.56	16.64
	06.04.19	9:30AM	15.9	12.6	15.1	14.3	17	14.98
	06.04.19	2:45PM	14.5	14.9	14.2	16.3	17.6	15.5
Compost Plot	11.27.18	10:00 AM	25.16	23.23	23.13	45.75	26.95	28.84
	12.04.18	11:10 AM	29.28	25.63	46.61	48.93	84.35	46.96
	12.18.18	12:00PM	47.1	25.05	40.26	26.4	25.86	28.79
	01.11.19	8:10AM	23.55	27.21	26.6	25.48	24.13	25.39
	01.11.19	11:45AM	29.86	24.8	25.6	41.5	38	37.95
	01.25.19	8:50AM	23.16	23.56	23.1	27.86	23.9	24.31
	01.25.19	2:10PM	24.41	23.15	24.11	24.25	27.3	24.64
	02.08.19	8:45AM	44.86	22.98	43.61	45.58	27.96	36.99
	02.08.19	1:15PM	48.65	42.7	46.3	47.75	48.4	46.76
	02.22.19	8:15AM	49.03	22.15	45.76	39.81	27.3	36.81
	02.22.19	1:10PM	24.7	23.21	41.06	46.83	26.76	32.51
	03.14.19	8:24AM	28.06667	22.1	25.13333	25.46667	24.16667	24.98666667
	03.14.19	2:35PM	24.53333	23.16667	25.9	24.9	23.53333	24.40666667
	03.29.19	8:25AM	19.9	18.8	20.46667	20.2	20.16667	19.90666667
	03.29.19	1:15PM	21.33333	22.83333	20.63333	21.53333	17.84667	20.836
	04.12.19	8:10AM	16.36667	15.5	15.73333	18.43333	14.76667	16.16
	04.12.19	12:15PM	10.26667	12.3	13.8	14.16667	12.56667	12.62
	04.26.19	8:40AM	17.6	19.16	25.4	23.33	16.6	20.42
	04.26.19	12:30PM	16.9	18.46	16.26	21.13	16.23	17.8
	05.09.19	9:45AM	21.3	22.23	26.63	24.46	21.83	23.29
	05.09.19	3:20PM	16.4	22.56	27.93	27.23	16.5	22.12
	05.21.19	9:30AM	20.9	21.73	29.3	22.63	15.5	22.01
	05.21.19	11:35AM	21.26	18.06	27.66	26.4	15.26	21.73
	06.04.19	8:20AM	21.3	14.9	19.2	22	19.2	19.32
	06.04.19	2:15PM	15.6	22	20.9	23.4	17.4	19.86
Control Plot	11.27.18	11:00 AM	25.12	25.56	28.63	n/a	n/a	26.43
	12.04.18	10:10 AM	22.96	23.2	22.6	23.66	21.13	22.71
	12.18.18	11:45 AM	21.3	20.16	19.55	20.81	21.3	20.62
	01.11.19	9:05AM	21.83	21.65	21.4	20.48	18.6	20.79
	01.11.19	12:30PM	22.53	23.36	22.31	22.66	20.5	22.27
	01.25.19	8:30AM	17.16	20.02	18.65	19.26	16.76	18.37
	01.25.19	1:40PM	19.31	20.83	16.98	20.08	17.45	18.93
	02.08.19	8:15AM	19.23	19.65	20.23	20.86	18.31	19.65
	02.08.19	1:00PM	19.53	23.12	20.83	21.2	19.73	20.88
	02.22.19	8:40AM	20.08	18.01	20.26	19.51	16.85	18.94
	02.22.19	1:20PM	19.71	22.58	20.1	21.66	17.58	20.32
	03.14.19	8:35AM	21.1	24	19.33333	20	20.56667	21
	03.14.19	2:20PM	18.5	18.96667	22.06667	21.03333	19.43333	20
	03.29.19	8:10AM	15.5	16.53333	14.08333	16.3	16.63333	15.81
	03.29.19	1:00PM	16.76667	13.3	16.2	16.96667	13.2	15.28666667
	04.12.19	8:35AM	12.1	9.5	12.16667	14.66667	12.2	12.12666667
	04.12.19	12:30PM	10.66667	9.433333	14.33333	12.8	10.13333	11.47333333
	04.26.19	8:30AM	21.53	22.63	24.66	18.83	19.23	21.38
	04.26.19	12:20PM	19.73	23.56	25	2.23	20.1	18.12
	05.09.19	9:10AM	24.26	24.5	26.1	25.3	20.46	24.12
	05.09.19	3:00PM	23.9	24.4	26	26.3	22.8	24.68
	05.21.19	8:45AM	22.66	24.3	24.1	18.13	22.6	22.36
	05.21.19	11:30AM	22.4	20.53	23.83	23.63	21.46	22.37
	06.04.19	8:55AM	15.6	18.4	12.2	13.2	16.8	15.24
	06.04.19	3:15PM	14.1	14.8	10.6	13.5	13.9	13.38

Images for Deliverable 1: Acquire Topdressing Machine (Compost Spreader)

Image submitted for Deliverable 2: Hydrogel Injection

Image Submitted for Deliverable 3: Soil Moisture Data Collection and Analysis

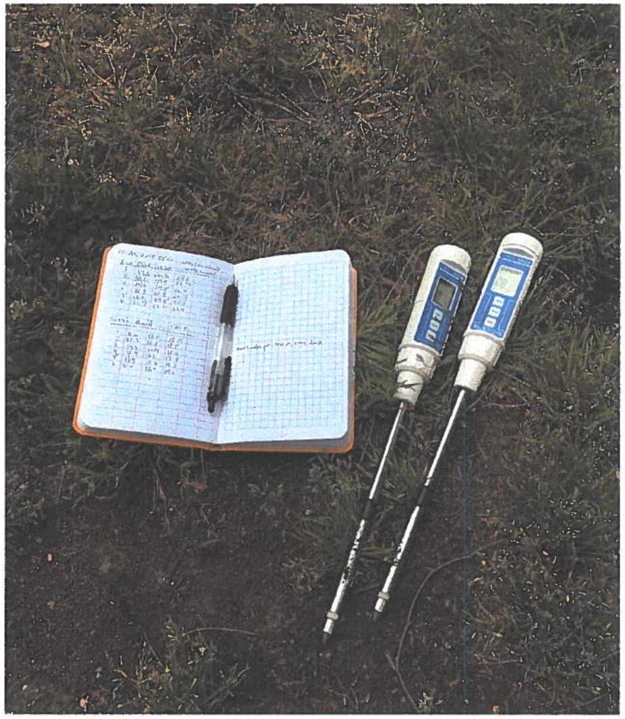

Image Submitted for Deliverable 3: Soil Moisture Data Collection and Analysis