CASE STUDY

LNC TRIAL:

CALIFORNIA STATE UNIVERSITY, FULLERTON CAMPUS
PRACTICE SOFTBALL FIELD

DESERT CONTROL

CALIFORNIA STATE UNIVERSITY FULLERTON 1957

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Desert Control Americas (DCAM) produces a novel soil amendment called Liquid Natural Clay (LNC). LNC is an organic certified, all-natural soil amendment, which improves sandy soil characteristics, including water holding capacity and soil structure—offering the potential to meaningfully reduce irrigation requirements in treated areas. Previous results have shown that LNC typically provides water savings in the magnitude of 25%-35%, with some results as high as 60%. Treatments are typically effective over long periods, requiring partial refreshments of approximately 25% of the original application volume at estimated intervals of 3-5 years.

In an effort to conserve water resources, California State University- Fullerton (CSUF) collaborated with DCAM to conduct a field trial of LNC on 0.55 acres of their practice softball field beginning on August 14, 2024. This case study reviews the results of the trial and explores the potential benefits of expanding the implementation of LNC to all sports fields on the CSUF campus.

LNC field trials at CSUF were extremely successful, achieving a 60% reduction in irrigation requirements while maintaining turf quality. Wetting agents, which are typically applied roughly every 2 weeks, were not used throughout the trial period. Extrapolating the results of the trial to describe the potential impact of LNC over all sports fields at CSUF, water savings are estimated to be approximately 13.3 million gallons per year— enough water for the yearly water needs of roughly 264 average American households.

Given the high cost of water, the financial impact of such a treatment is estimated to provide operational expense (OpEx) savings of roughly $100,000 per year with a return on investment in just over 7 months (835% over a 5 year treatment life).

LNC provides a significant opportunity to reduce greenhouse gas emissions. Its lifecycle impact at CSUF is calculated to equal approximately 16,000 kg of carbon dioxide equivalent emissions per year.

60%

IRRIGATION REDUCTION

835%

RETURN ON INVESTMENT

$490k

5-YEAR NET SAVINGS

Irrigation for CSUF's sports fields is typically informed by the evapotranspiration (ET) rate reported by the Irvine weather station. ET is a measure of the amount of water that evaporates from the ground and is an effective means of calculating the volume of irrigation water required to maintain healthy turf. This value is typically calculated using a combination of temperature, humidity, sunlight, wind, and other factors, and is measured in inches of water. The weather station used by CSUF to collect this data reports to a public database[1], and this data is used to establish a baseline irrigation volume against which "water savings" are calculated within this case study. Results from the trial period are compared against daily ET values from the same time. Annualized baseline water consumption is derived from ET data averaged from January 2020 to December 2023. Units for water are converted from inches and provided in units of both gallons (gal) and centum cubic feet (CCF).

To safely reduce irrigation volumes without compromising turf health, CSUF relied upon readings from soil moisture sensors deployed within the LNC treated area. Irrigation events in this area were triggered upon soil moisture content reaching a minimum threshold of 10%. Because LNC increases water retention in the soil, irrigation events became significantly less frequent— reducing from a baseline weekly irrigation to a frequency of approximately once per three weeks. There is no isolated water meter that reports irrigation volumes for only the LNC treated area, however CSUF's Landscape Services Manager, Hans Mickelson, reports that irrigation volumes have reduced by approximately 60%. It is worth noting that such reductions were achieved during particularly hot summer months when temperatures exceeded 100°F[1].

Water costs are calculated using data provided to DCAM by CSUF. In the 12-month period between July 2023 to June 2024, the average price per CCF was $4.83. This average price is applied evenly for all water-related cost calculations provided in this assessment. It is worth noting that water costs in Southern California frequently accelerate at a rate significantly exceeding that of inflation.

Electricity is used by CSUF to pressurize and distribute water resources across campus. The exact ratio of electrical consumption per unit of water (described as kilowatt hours (kWh) per CCF) is not known by CSUF, so DCAM's standard ratio of 1.5083 kWh/CCF is applied. The average cost per kWh is $0.159, as provided to DCAM by CSUF. Emissions related to this electrical consumption are calculated using CSUF's energy mix of 60% electricity from their onsite natural gas turbine, 22.5% from the California grid, and 17.5% from their onsite solar PV panels.

To calculate emissions from their natural gas turbine, the value of 7.42 standard cubic feet (SCF) of natural gas per kWh electricity was used[2]. Emissions factors related to the stationary combustion of natural gas were multiplied by 60% per kWh (CSUF's ratio of electricity derived from natural gas)[3]. For emissions related to electricity from the grid, factors for California (CAMX grid) are similarly multiplied by the percentage of electricity derived from this source (22.5%)[4]. Emissions from the remaining 17.5% of electricity, which is derived from solar PV, is assumed to be zero. Global warming potentials for CH_4 and N_2O are set as 29.8 and 273, respectively[5].

Each 1,000 gallons of municipal drinking water requires an average of 2.069 kWh upstream energy inputs for treatment and distribution[6]. This 2.069 kWh value is multiplied by electrical emissions factors for California to derive upstream emissions of CSUF water consumption[4]. Values for municipal and CSUF emissions are added together for combined emissions including individual greenhouse gasses, CO_2 equivalent emissions (CO_2e), and acidification potential from SO_2.

The final section includes a 5-year financial model estimate, including costs for irrigation, electricity, and wetting agents. Annual inflation rate of 2.5% for electricity and wetting agents, and 6% for water are included. Wetting agents cost $11,000/yr with an anticipated usage reduction of 75%. A 60% reduction in irrigation volume was experienced in the trial. LNC cost is $4,047 per acre with a 5 year anticipated useful lifespan before re-application may be required.

Return-on-investment is net savings divided by investment cost. Discount rate is 5% for net present value (NPV) calculation[7]. After a one-time up-front payment for LNC, the number of months to financial break-even is calculated as investment cost divided by one-twelfth of the first year's gross savings.

It is worth noting that this calculation is performed based on the year's average monthly irrigation rate, however actual irrigation rates fluctuate significantly between the winter and summer months. As such, the timing of LNC application will influence the actual break-even period wherein an application in the spring will provide faster returns on investment than that predicted by the model.

For comparison, volumes of water that may be saved are contextualized relative to the indoor water needs of the average American household. This is based on a daily usage of 138 gallons multiplied by 365 days per year[8]. All figures represented herein are for illustrative purposes and results are not guaranteed. Please see DCAM's service agreement for further information, including LNC longevity, reapplication parameters, product efficacy, and options and terms for warranties on LNC. These factors may influence the investment cost of LNC and the cost savings it may facilitate.

DESERT CONTROL

LNC treatment resulted in a 60% reduction in irrigation requirements within the trial area. Over the trial period of approximately 3.5 months, the equivalent of almost a quarter million gallons of water per acre of turf was saved. Annualized per acre water savings opportunity is estimated to exceed 880,000 gallons of water per year. This is enough to meet the yearly indoor water needs of approximately 18 average American households per acre of turf treated. Field uniformity improved with water more evenly distributed across the treated area— benefiting the quality and visual appeal of turf within the practice softball field. No negative effects have been reported. Turf durability and resilience to typical field usage are reported to meet or exceed expectations. Increased hydrophilic soil properties have allowed CSUF to forego the application of wetting agents in the treated area. Wetting agents, synthetic chemical surfactants frequently used in turf management to improve water retention, are typically applied at a frequency of approximately once every two weeks, representing a significant operational burden.

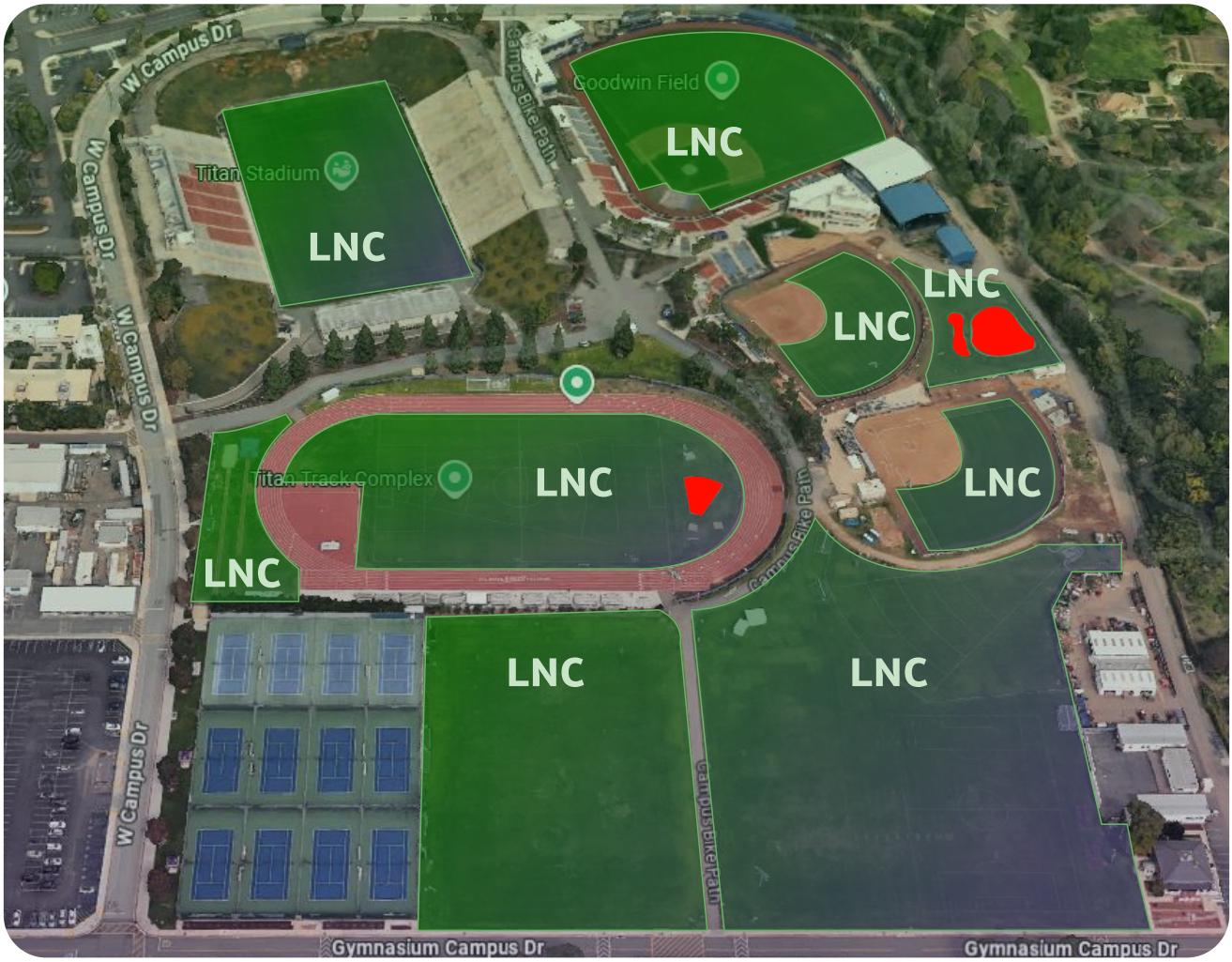
For the trial period of August 14, 2024, until the date of this writing, November 25, 2024, the total ET reported by the Irvine weather station is 15.16 inches. Over an area of 0.55 acres, this means that without LNC treatment, irrigation volume would have equaled 226,412 gallons or 303 CCF of water. With a 60% irrigation reduction, the actual irrigation volume with LNC treatment was 90,565 gallons (121 CCF), translating to a savings of 135,847 gallons (182 CCF). The financial impact of such savings over this period is estimated at approximately $920.

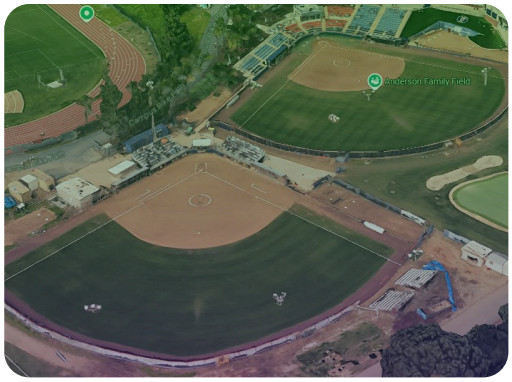
Scenario	Water (Gallons)	Water (CCF)	Water Cost	Electricity Cost	Combined Cost
Baseline	808,386	1,081	$5,216	$259	$5,475
Treated	323,355	432	$2,087	$104	$2,190
Saved	485,032	648	$3,130	$155	$3,285

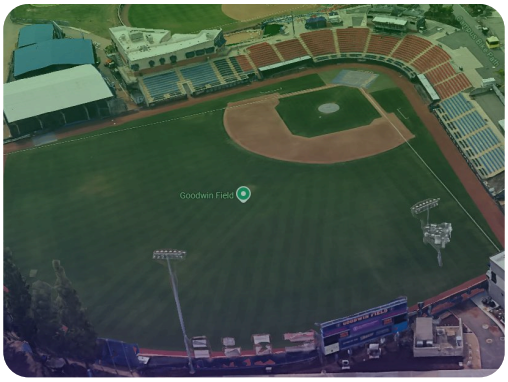
To infer the impact of LNC treatment for the trial area over the course of a year, average ET values dating from January 2020 to December 2023 can be applied. The average annual ET over this period is 54.13 inches. Applying this value to 0.55 acres, the average annual irrigation untreated volume is calculated as 808,386 gallons (1,081 CCF). With LNC treatment and sustained 60% water savings, the total annual irrigation volume can be estimated at 323,355 gallons (432 CCF). This correlates to a water savings of 485,032 gallons (648 CCF), representing savings of $3,285.

Scenario	Water (Gallons)	Water CCF	Water Cost	Electricity Cost	Combined Cost
Baseline	808,386	1,081	$5,216	$259	$5,475
Treated	323,355	432	$2,087	$104	$2,190
Saved	485,032	648	$3,130	$155	$3,285

The potential impact of LNC, if it were applied to all CSUF sports fields, is significant. This area is approximately 15.06 acres, as pictured below. Certain areas, such as the shotput area in the track and field area, baseball and softball diamonds, and the sand trap and artificial turf greens of the golf area are excluded.







Using the previously calculated average ET of 54.13 inches and the total area of 15.06 acres, the average annual untreated irrigation volume for CSUF's sports fields can be estimated as 22,135,092 gallons (29,590 CCF). With LNC treatment and a 60% reduction in irrigation volume, the total irrigation requirement under the same environmental conditions is estimated at 8,854,037 gallons (11,836 CCF). This suggests a potential water savings of 13,271,055 gallons, or 17,754 CCF over an average year with avoided costs of $89,957. This volume of water saved is equivalent to the annual consumption of approximately 264 average American households.

Scenario	Water (Gallons)	Water CCF	Water Cost	Electricity Cost	Combined Cost
Baseline	22,135,092	29,590	$142,832	$7,096	$149,929
Treated	8,854,037	11,836	$57,133	$2,839	$59,972
Saved	13,281,055	17,754	$85,699	$4,258	$89,957

While water is itself a vital natural resource, its conservation is correlated with significant reductions in electrical power consumption. This occurs in two stages, as municipalities must consume electricity to treat and distribute water while CSUF also uses electricity to further pressurize and distribute water around campus. This section explores consumed and avoided electrical power under each previously described scenario while correlating each outcome to its respective climate change impact and acidification (SO_2) values.

CSUF

Scenario	Range	Electricity (kWh)	CO_2 (kg)	SO_2 (kg)	NOx (kg)	CO_2e (kg)
Baseline	Trial area (period)	456.5	133.82	0.00	0.02	139.88
	Trial area (annum)	1630.0	477.79	0.00	0.08	499.42
	Sports fields (annum)	44,631.1	13,082.74	0.14	2.15	13,674.98
Treated	Trial area (period)	182.6	55.53	0.00	0.01	55.95
	Trial area (annum)	654.0	191.12	0.00	0.03	199.77
	Sports fields (annum)	17,852.4	5,233.09	0.05	0.86	5,469.99
Conserved	Trial area (period)	273.9	80.29	0.00	0.01	83.93
	Trial area (annum)	978.0	286.67	0.00	0.05	299.65
	Sports fields (annum)	26,778.6	7,849.64	0.08	1.29	8,204.99

MUNICIPAL

Scenario	Range	Electricity (kWh)	CO_2 (kg)	SO_2 (kg)	NOx (kg)	CO_2e (kg)
Baseline	Trial area (period)	456.5	133.82	0.00	0.02	139.88
	Trial area (annum)	1630.0	477.79	0.00	0.08	499.42
	Sports fields (annum)	44,631.1	13,082.74	0.14	2.15	13,674.98
Treated	Trial area (period)	182.6	55.53	0.00	0.01	55.95
	Trial area (annum)	654.0	191.12	0.00	0.03	199.77
	Sports fields (annum)	17,852.4	5,233.09	0.05	0.86	5,469.99
Conserved	Trial area (period)	273.9	80.29	0.00	0.01	83.93
	Trial area (annum)	978.0	286.67	0.00	0.05	299.65
	Sports fields (annum)	26,778.6	7,849.64	0.08	1.29	8,204.99

COMBINED

Scenario	Range	Electricity (kWh)	CO_2 (kg)	SO_2 (kg)	NOx (kg)	CO_2e (kg)
Baseline	Trial area (period)	925.0	239.51	0.01	0.12	272.66
	Trial area (annum)	3,302.5	855.14	0.03	0.43	973.50
	Sports fields (annum)	90,428.6	23,415.42	0.76	11.85	26,656.09
Treated	Trial area (period)	370.0	95.80	0.00	0.05	109.06
	Trial area (annum)	1,321.0	342.06	0.01	0.17	389.40
	Sports fields (annum)	36,171.4	9,366.17	0.30	4.74	10,662.43
Conserved	Trial area (period)	555.0	143.71	0.00	0.07	163.59
	Trial area (annum)	1,981.5	513.09	0.02	0.26	584.10
	Sports fields (annum)	54,257.1	14,049.25	0.46	7.11	15,993.65

These calculations show that treating approximately 15 acres of sports fields with LNC carries a nearly 16,000 kg CO_2e reduction in lifecycle greenhouse gas emissions related to irrigation. This is a significant reduction that carries a meaningful environmental benefit while supporting any carbon reduction ambitions that CSUF may have.

The following table provides financial impact estimations for CSUF's implementation of LNC on their total sports field area of 15.06 acres. Inputs for this table are described in the methods section of this assessment.

UNTREATED

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Irrigation volume	29,590	29,590	25,590	25,590	25,590	147,951
OPERATING EXPENSES						
Irrigation	$142,832	$151,401	$160,486	$170,115	$180,322	$805,155
Electricity	$7,096	$7,274	$7,455	$7,642	$7,833	$37,300
Wetting Agents	$11,000	$11,275	$11,557	$11,846	$12,142	$57,820
Total Yearly	$160,928	$169,950	$179,498	$189,602	$200,296	$900,274
Cumulative	$160,928	$330,878	$510,376	$699,978	$900,274	$900,274

LNC TREATED

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Irrigation volume	11,836	11,836	11,836	11,836	11,836	59,180
OPERATING EXPENSES						
Irrigation	$57,133	$60,561	$64,194	$68,046	$72,129	$322,062
Electricity	$2,838	$2,909	$2,952	$3,057	$3,133	$14,920
Wetting Agents	$2,750	$2,819	$2,889	$2,961	$3,035	$14,455
Total Yearly	$62,721	$66,289	$70,066	$74,064	$78,297	$351,437
Cumulative	$62,721	$129,010	$199,075	$273,139	$351,437	$351,437
CAPITAL EXPENSES						
LNC Cost	$58,717	-	-	-	-	$58,717
COMBINED EXPENSES						
Total Yearly	$121,438	$66,289	$70,066	$74,064	$78,297	$410,154
Cumulative	$121,438	$187,727	$257,792	$331,856	$410,154	$410,154

SAVINGS

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Irrigation volume	17,754	17,754	17,754	17,754	17,754	88,770
OPERATING EXPENSE SAVINGS						
Irrigation	$85,699	$90,841	$96,291	$102,069	$108,193	$483,093
Electricity	$4,258	$4,364	$4,473	$4,585	$4,700	$22,380
Wetting Agents	$8,250	$8,456	$8,668	$8,884	$9,106	$43,365
Total Yearly	$98,207	$103,661	$103,432	$115,538	$121,999	$548,837
Cumulative	$98,207	$201,868	$311,300	$426,838	$548,837	$548,837
CAPITAL EXPENSES						
LNC Cost	($58,717)	-	-	-	-	($58,717)
NET SAVINGS						
Total Yearly	$39,490	$103,661	$109,432	$115,538	$121,199	$490,121
Cumulative	$39,490	$143,151	$252,583	$368,122	$490,121	$490,121

FINANCIAL ESTIMATIONS

NPV	$428,913
ROI	835%
Break-even (months)	7.17

It is worth noting that LNC “top-ups” to maintain product efficacy following initial application typically occur at intervals of 3-5 years. These reapplications generally require approximately 25% of the original application volume and are priced accordingly. Consequently, the return on investment in years following reapplications is likely to significantly exceed that of the initial application period.

As described in the methods section, the model calculates break-even period based on annualized average irrigation volume distributed evenly across each month. Total average annual ET is 54.13 inches, which, when applied evenly throughout the year, corresponds to 4.51 inches per month. In actuality, monthly averages range from 2.02 inches in December to 7.11 inches in July. Under this model, a break-even period of 7.17 months corresponds to an irrigation output of 32.36 inches (1,175 CCF/ac, 17,692 CCF over all sports fields). Using true monthly averages, a minimum break-even period of approximately 5.5 months could be achieved if LNC is applied in April— thereby taking advantage of the months in which evapotranspiration and irrigation rates are highest.

Initial LNC trials at CSUF have yielded significantly positive results, showing a 60% reduction in irrigation requirements for the practice softball field while maintaining turf quality and reducing demands for wetting agents. If LNC is applied to approximately 15 acres of CSUF's sports fields and water savings remains at 60%, models indicate that CSUF could save approximately 17,750 CCF of water, 54,250 kWh of electricity, 16,000 kg of CO_2 equivalent emissions, and $100,000 in related costs per year. Over a 5-year period, LNC may offer cumulative net savings of nearly $500,000 and a return on investment of greater than 800% with a break-even period of approximately 7 months.

Across 23 California State University (CSU) campuses, DCAM estimates that there are approximately 1,450 acres of irrigated turf and landscaping— including 550 acres of sports fields. Detailed analysis of soil texture, irrigation practices, and water pricing is required to estimate the compatibility and impact of LNC application for each unique geography, however it is likely that LNC may present significant economic and environmental advantages for a meaningful portion of CSU's portfolio.

The following tables represent modeled financial, resource, and climate change impacts under the scenario of 30% irrigation reduction. All other variables remain the same as in previous estimations and are described in the methods section of this assessment.

RESOURCE CONSUMPTION

Scenario	Water (Gallons)	Water (CCF)	Water Cost	Electricity Cost	Combined Cost
Baseline	22,135,092	29,590	$142,832	$7,096	$149,929
Treated	15,494,564	20,713	$99,983	$4,967	$104,950
Saved	6,640,527	8,877	$42,850	$2,129	$44,979

RESOURCE IMPACT

	CSUF		MUNICIPAL		TOTAL	
Scenario	Electricity (kWh)	Emissions (kg CO_2e)	Electricity (kWh)	Emissions (kg CO_2e)	Electricity (kWh)	Emissions (kg CO_2e)
Baseline	44,631	13,675	45,798	12,981	90,429	26,656
Treated	31,242	9,572	32,058	9,087	63,300	18,659
Saved	13,389	4,102	13,739	3,894	27,129	7,997

FINANCIAL OUTLOOK

UNTREATED

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Irrigation volume	29,590	29,590	25,590	25,590	25,590	147,951
OPERATING EXPENSES						
Irrigation	$142,832	$151,401	$160,486	$170,115	$180,322	$805,155
Electricity	$7,096	$7,274	$7,455	$7,642	$7,833	$37,300
Wetting Agents	$11,000	$11,275	$11,557	$11,846	$12,142	$57,820
Total Yearly	$160,928	$169,950	$179,498	$189,602	$200,296	$900,274
Cumulative	$160,928	$330,878	$510,376	$699,978	$900,274	$900,274

LNC TREATED

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Irrigation volume	20,713	20,713	20,713	20,713	20,713	103,565
OPERATING EXPENSES						
Irrigation	$99,982	$105,981	$112,340	$119,080	$126,225	$563,609
Electricity	$4,967	$5,091	$5,219	$5,349	$5,483	$26,110
Wetting Agents	$2,750	$2,819	$2,889	$2,961	$3,035	$14,455
Total Yearly	$107,699	$113,891	$120,448	$127,391	$134,744	$604,173
Cumulative	$107,699	$221,591	$342,039	$469,430	$604,173	$604,173
CAPITAL EXPENSES						
LNC Cost	$58,717	-	-	-	-	$58,717
COMBINED EXPENSES						
Total Yearly	$166,416	$113,891	$120,448	$127,391	$134,744	$662,890
Cumulative	$166,416	$280,308	$400,755	$528,146	$662,890	$662,890

SAVINGS

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Irrigation volume	8,877	8,877	8,877	8,877	8,877	44,385
OPERATING EXPENSE SAVINGS						
Irrigation	$42,849	$45,420	$48,146	$51,034	$54,096	$241,547
Electricity	$2,129	$2,182	$2,237	$2,293	$2,350	$11,190
Wetting Agents	$8,250	$8,456	$8,668	$8,884	$9,106	$43,365
Total Yearly	$53,228	$56,059	$59,050	$62,211	$65,553	$296,101
Cumulative	$53,228	$109,287	$168,337	$230,548	$296,101	$296,101
CAPITAL EXPENSES						
LNC Cost	($58,717)	-	-	-	-	($58,717)
NET SAVINGS						
Total Yearly	($5,489)	$56,059	$59,050	$62,211	$65,553	$237,384
Cumulative	($5,489)	$50,570	$109,620	$171,831	$237,384	$237,384

FINANCIAL ESTIMATIONS

NPV	**$428,913**
ROI	**835%**
Break-even (months)	**7.17**

As shown above, modeling suggests that at 30% irrigation reduction— one half that of the trial— treating all sports fields with LNC would still result in an ROI of greater than 400% over a 5-year period with a break-even of 13.24 months. Similarly to the 60% irrigation reduction model, break-even time is optimized by LNC application in April as it leverages months in which irrigation is at its highest. OpEx savings for CSUF begin at $53,228 in year one with an inflationary increase to $65,553 in year 5. The total lifecycle greenhouse gas emissions reduction at 30% reduced irrigation is approximately 8,000 kg CO_2e, roughly 4,100 kg of which can be attributed to CSUF's scope 1 and 2 emissions.

Overall, modeling indicates that even at substantially more modest irrigation reduction rates, LNC still offers CSUF strong economic and environmental opportunities.

1. https://cimis.water.ca.gov/WSNReportCriteria.aspx

2. https://www.eia.gov/tools/faqs/faq.php?id=667&t=8

3. https://www.epa.gov/system/files/documents/2024-02/ghg-emission-factors-hub 2024.xlsx

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5. https://ghgprotocol.org/sites/default/files/2024-08/Global-Warming-Potential Values%20%28August%202024%29.pdf

6. https://www.epa.gov/watersense/data-and-information-used watersense#Embedded%20Energy%20in%20Water%20and%20Wastewater

7. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/safety-policy-division/meeting documents/discount-rates-and-risk-modeling_synapse_101123.pdf

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www.desertcontrol.com