744 La Guardia Street, Building A, Salinas, CA 93905 | (831) 975-7775

Irrigation System Evaluation Report



Alfa y Omega Organic Farm
36.93863, -121.41279
5850 San Felipe Rd, Hollister, CA

Prepared by:
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May 2026

RESOURCE CONSERVATION DISTRICT OF MONTEREY COUNTY

744 La Guardia Street, Building A, Salinas, CA 93905 | (831) 975-7775

INTRODUCTION

Summary Information:

Evaluation Dates:	May 27, 2026
Landowner:	Richard Wist
Farm Operator (Tenant):	Emilia Santos (Alfa y Omega Organic Farm)
Evaluators:	Laura Murphy, Adrienne Carter, Aysha Peterson
Location:	36.93863, -121.41279 5850 San Felipe Road, Hollister, CA
Area:	~18 acres of production area (22 acres leased)
Crop:	Diversified vegetables on 40" wide beds
Irrigation Type:	Drip tape and sprinklers. Designed application rates unknown; in-field measured application rates reported below.

Introduction: In November 2024, Emilia Santos, the owner and operator of Alfa y Omega Organic Farm, began leasing this parcel. Due to an existing relationship, Santos asked the Resource Conservation District of Monterey County (RCDMC) Agroecology Team staff to provide technical assistance for various production related concerns including soil analysis, cover crop and compost application planning assistance, and an irrigation system assessment and training. Since then, various visits to the farm site and conversations have been held between RCDMC staff and Santos – as well as with partners from the San Benito Resource Conservation District (SBRCD) who supported the installation of a hedgerow at this site in 2025-26 and have begun taking a lead role in ongoing technical assistance, including coordination with NRCS – to develop plans and prepare for an irrigation system assessment and in-field training to familiarize Santos with the opportunities and limits of irrigation design and management for her parcel and to advise on potential upgrades. RCDMC Soil Scientist Murphy introduced the project to Dudek Project Director Gray on 2/3/2026 to inquire whether it may be eligible for support through the URCTA program and the farmer later connected directly with Dudek staff at an outreach event.

Associated Visits:

- 2024-11-08: Initial site visit and soil sampling by Peterson (Attachment 1)
- 2024-12-10: Water sample collected by Daniel Hoffman (TA partner from the National Center for Appropriate Technology (NCAT)) for testing (Attachment 2)
- 2025-09-11: Pump test conducted by Craig Evans (Attachment 3)
- 2026-02-03: Murphy introduced project to Dudek staff by email; subsequently participated in ongoing communications between Santos, Dudek staff, SBRCD and coordination with vendors including 2026-04-29 introductory site visit with Montenero from Sustainable Technologies re: solar powered pumping design.

Description of Site and Irrigation System: Santos farms a 22-acre parcel (according to her rental agreement), with about 18 acres of production area, located at 5850 San Felipe Road, Hollister, CA. The property has an agricultural well that is used solely by Santos to irrigate the farm. She typically grows mixed vegetable crops, often with multiple crop types and varieties planted within a single irrigation block.

The pump is operated by a 75 hp tractor PTO (see Figure 1). The grower's usual practice is to run the PTO at 530 rpm (slightly under the max upper limit of 540 rpm, according to the grower), but also to operate with the block entry pressure gauge at 10-15 psi. In our evaluation, we noted that this required a partially closed valve and advised the grower to reduce the PTO speed and open the valve fully to operate the system with higher energy efficiency.



Figure 1. Pump is operated by a 75 hp tractor PTO.

According to a pump efficiency test conducted by Craig Evans in June 2024, the pump operated at only 12% OPE with a flow rate of 203 gpm and a discharge pressure of 45 psi (Attachment 3). There is no pressure gauge or flowmeter installed at the well discharge.

The grower's usual practice is to open only drip or sprinklers during an irrigation set, not both at once. Blocks with drip tape are irrigated for 3 hours per set. Drip may be open in multiple blocks with wide separation across the ranch according to complex crop rotations. In the block of peppers evaluated here, dip lines were shallowly buried and included individual valves on each drip line, such that the farmer opens and/or closes individual drip lines based on the area to be irrigated. Water travels from the pump to 4 existing risers through underground mainline pipe. The grower does not have access to an irrigation system map or the original plans and we cannot confirm underground pipe configuration; however, they indicated that a mainline rupture near the well discharge had to be repaired in the prior season and they recall that the main line at that location was 6" diameter.

DRIP SYSTEM EVALUATION

On May 27, 2026, we completed an evaluation of the drip system with a focus on the areas illustrated in Figure 2, as this was the main area where drip irrigation was in use at the time of evaluation. The majority of the area of the evaluation was planted to peppers and beets. Other crops on the farm at the time included tomatoes, lettuce, squash and others.

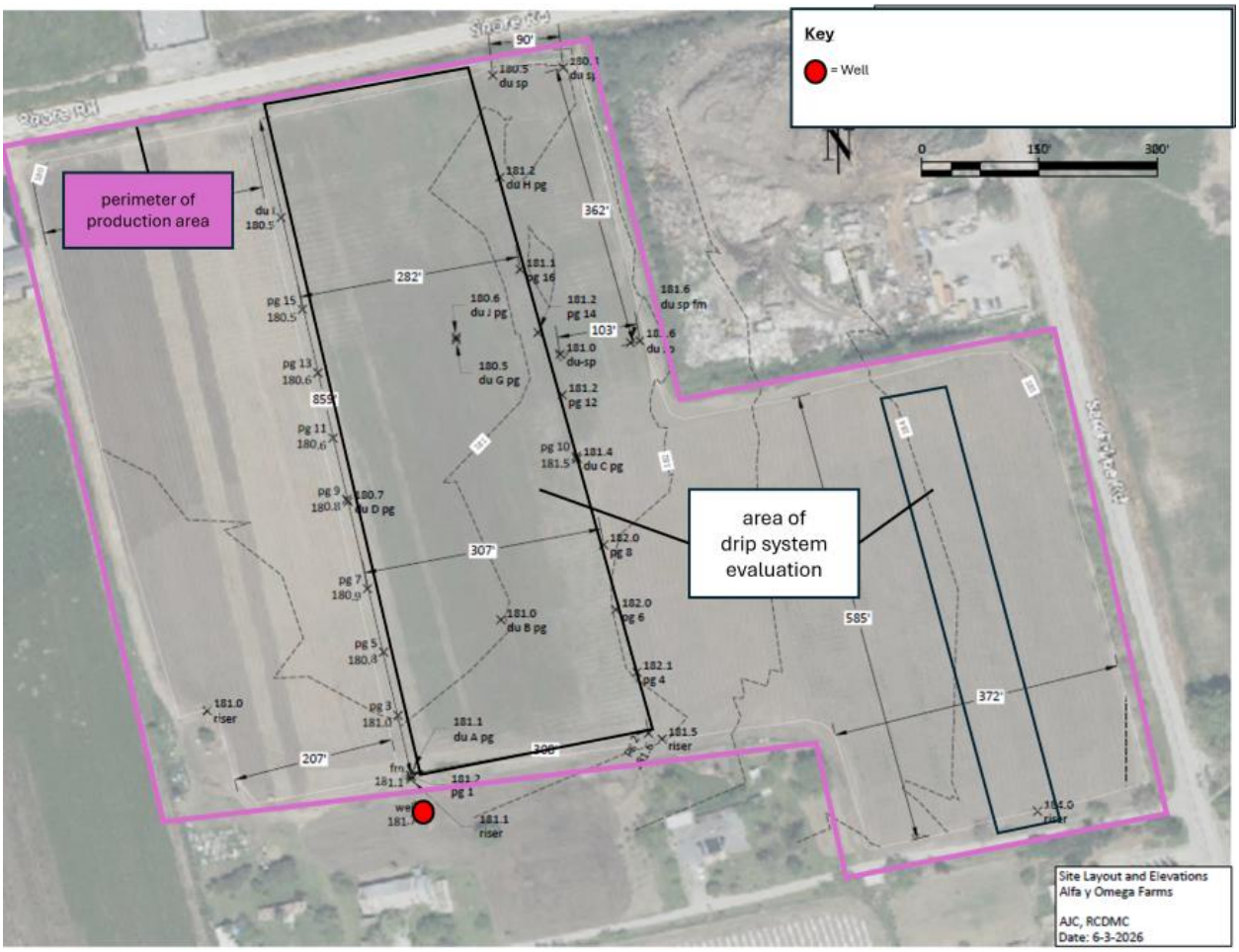


Figure 2. Map of area of farm included in the drip system evaluation. Of the indicated blocks, the larger area (left/west) was planted to peppers; the smaller area (right/east) was planted to beets. Also see Attachment 4.

The 3 areas evaluated were each fed by 4" surface layflat submains. Block 1 and 2 were configured as follows:

Plant rows per bed:	2	Between row spacing:	10"
In-row plant spacing:	14"	Bed width:	40"
Drip tape diameter:	5/8"	Tape wall thickness:	6 mil
Emitter spacing:	4"	Number of lines per bed:	1

Block 3 had 2 drip lines per bed and closer plant spacing (due to crop type). The grower is confident using 1 line per bed or transplanted crops, but prefers 2 lines per bed for direct-seeded crops to ensure good establishment.

The 3 areas evaluated are identified as Blocks 1, 2, and 3 (Figure 3) and each measure:

Block 1 =	307.5' long x 109 beds =	2.56 acres
Block 2 =	294.5' long x 111 beds =	2.50 acres
Block 3 =	585' long x 10 beds =	0.45 acres

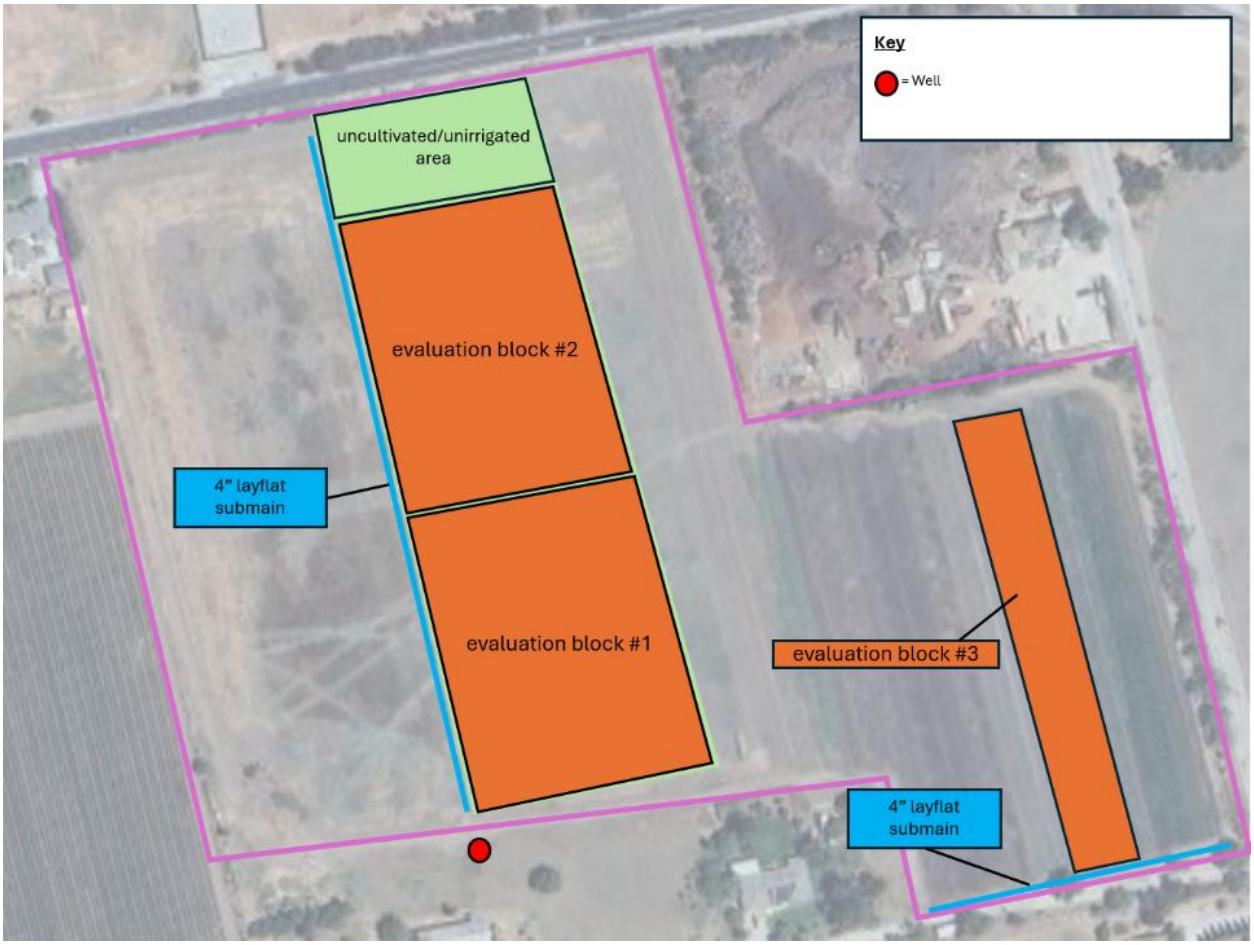


Figure 3. Irrigation blocks evaluated during drip system evaluation.

Three different kinds of drip tape were observed in use throughout the evaluation area: (1) tape with two blue lines ("blue"); (2) tape with two green lines ("green"); (3) tape with no color markers ("black"). Block 1 had a mix of blue and green tape; Block 2 had a mix of blue, green, and black tape; Block 3 had only green tape. Sites were selected within each block such that each type of tape present in a block was included within the evaluation (Figure 4).

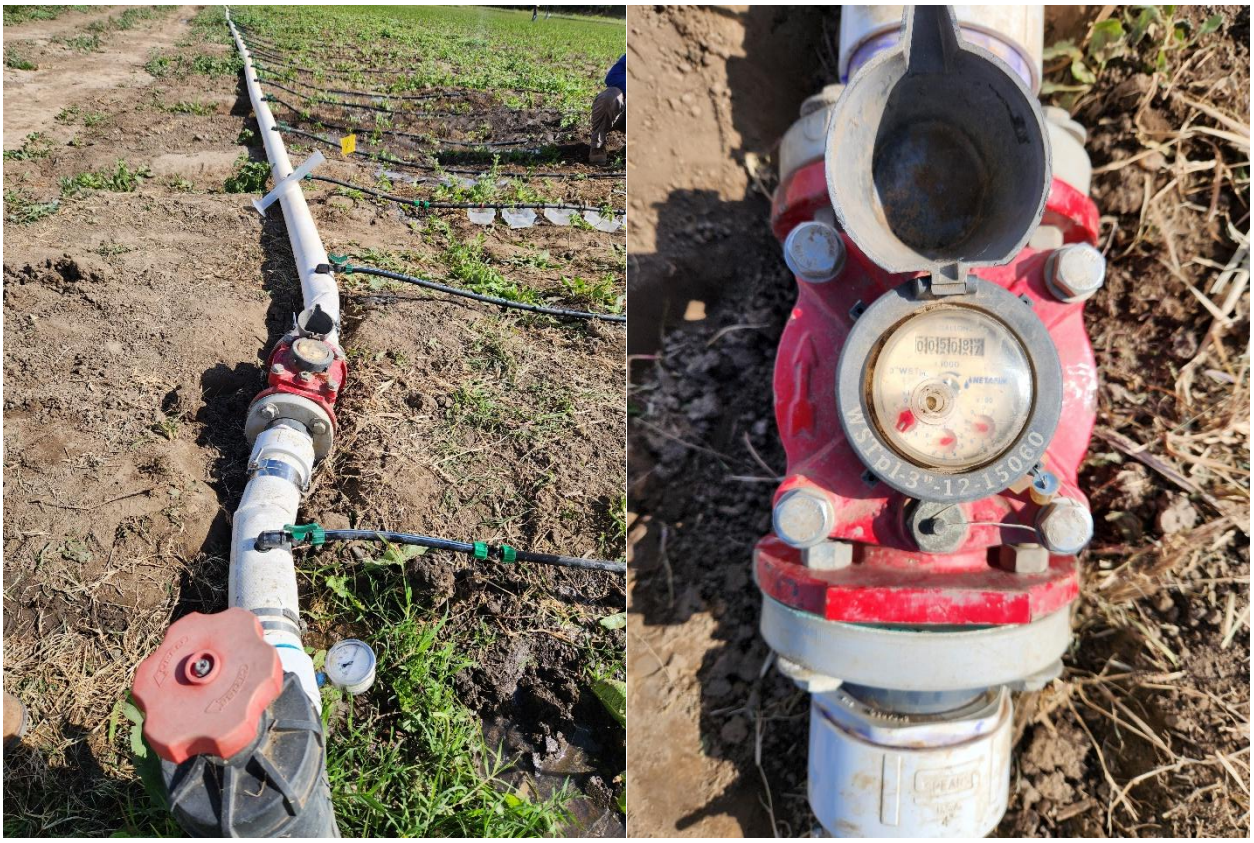
The evaluation included 11 Distribution Uniformity Test Sites with catch cans to measure single emitter flow rates and drip tape couplers with Schraeder valves to measure

pressures. We also installed drip tape couplers with Schraeder valves to check pressures at an additional 17 sites throughout the evaluation area.



Figure 4. Locations of Distribution Uniformity test sites and Schraeder valves for taking pressures throughout the field. The color of each text box indicates the color of the drip tape used at each location.

A flow meter was installed at the entry to Block 1 to measure flow to Blocks 1 and 2 throughout the evaluation period.



Figures 5 (left) and 6 (right). 4" flow meter installed on layflat at entry to block, between beds 1 and 2. Given that the flow meter was installed after the first bed, for the evaluation of Block 1, it measured flow to 108 beds rather than to the full 109 beds. Flow meter readings were taken throughout the evaluation.

Block 1 evaluation: Block 1 irrigation began at 8:45am and ended about 10:30 am (the transition period between opening Block 2 and closing Block 1 was several minutes long).

The pressure gauge at the block entry was maintained at about 14 psi with the tractor PTO operating at 457 rpm.

At the end of the field closest to the 4" submain pressure began at 13.0 psi on Bed 1 and ended at 8.0 psi on Bed 109. At the furthest point away from the valve (the far end of Bed 109), the pressure was only 1.8 psi. The average flow meter instant read indicated 288 gpm.

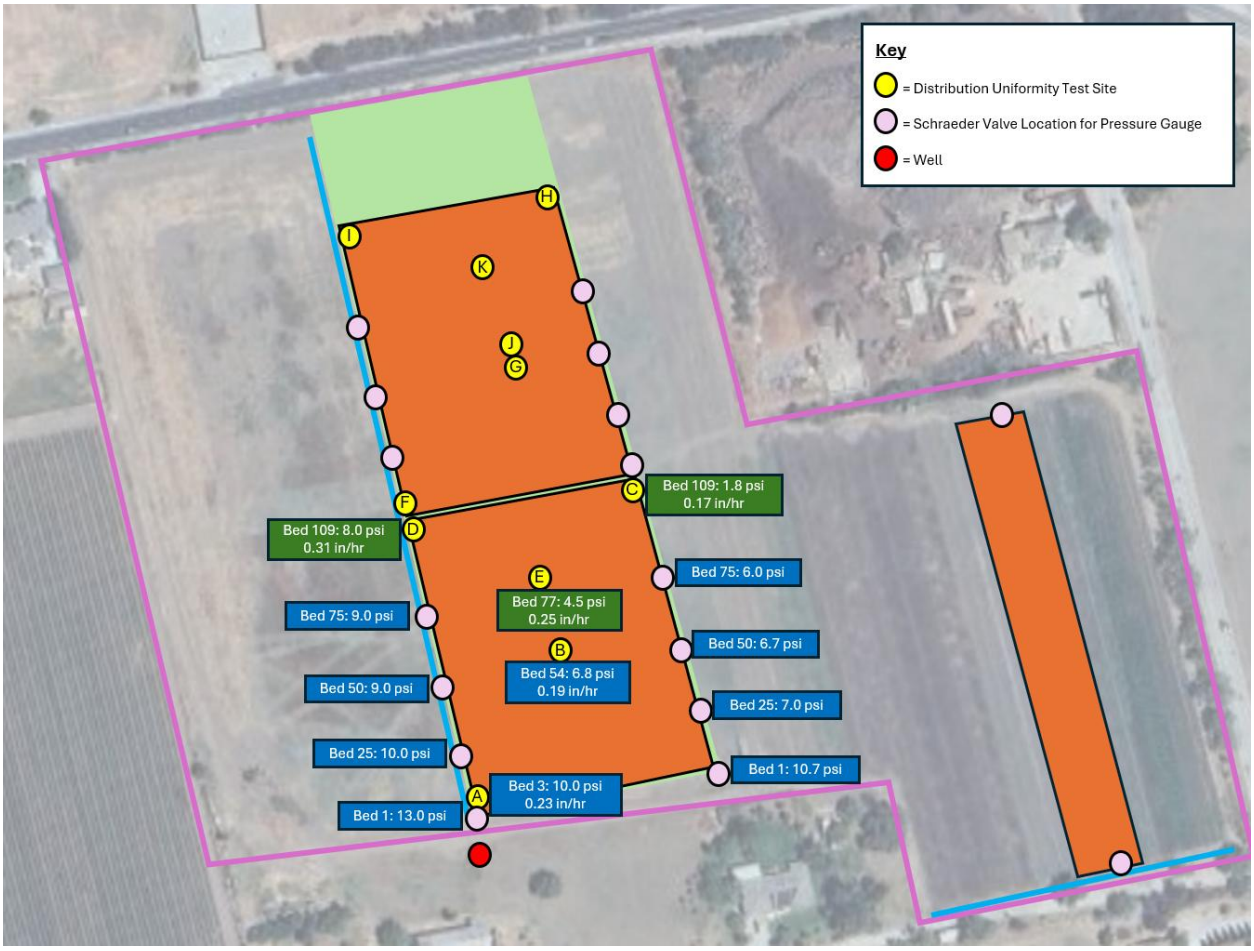


Figure 7. Evaluation of Block 1. The color of the text boxes indicates the color of the drip tape at each site.

Block 2 Evaluation: Evaluation of Block 2 began ~10:40 am. The pressure shown on the gauge at block entry went from 14 psi to 16.5 psi when switched from Block 1 to Block 2. Block 2 was located at a greater distance away from the same block entry and had two more drip lines (110 total beds). The average flow meter instant read indicated 271 gpm.



Figure 8. Evaluation of Block 2. The color of the text boxes indicates the color of the drip tape at each site.

Block 3 Evaluation: After the DU evaluation was completed in Block 2, and while Block 2 was still being irrigated, the grower opened a distant block (Block 3) planted to beets to assess pressure distribution there. There were only 10 beds being irrigated with 2 drip lines per bed of double green line tape (a high flow tape per observations from catch can DU evaluations in Blocks 1 and 2). The beds were 585 feet long. Pressures near the 4" blue layflat submain were about 8 psi. No pressure registered on the gauges at the end of the beds. The grower operated this block by partially opening a 4" ball valve until a pressure gauge installed at the valve read 10 psi. Substantial leaks were noted at the heads of several beds and across the field of beets.



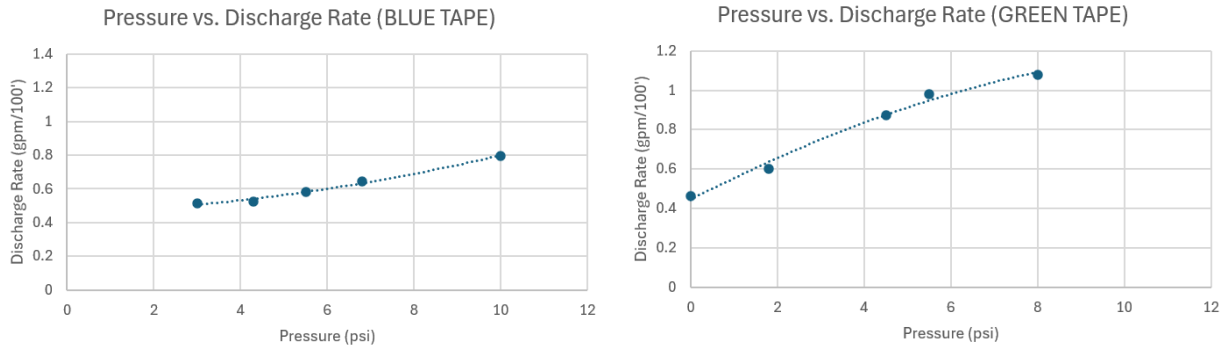
Figure 9. Evaluation of Block 3 was conducted while Block 2 was still being irrigated; this is consistent with the grower's typical irrigation practice. The color of the text boxes indicates the color of the drip tape at each site.

DRIP SYSTEM FINDINGS

Distribution Uniformity: Lower quarter distribution uniformity (DUlq) for Blocks 1 and 2 were found to be:
Block 1: 78%
Block 2: 79%

Drip Tape Application Rate: The grower does not have the original drip tape product label and we therefore do not know the designed application rate of the drip tape; however, based on in-field measurements, we identified application rates in the field and can approximate the design of the drip tape.

Of the 11 DU test sites, 5 sites had blue drip tape, 5 sites had green drip tape, and 1 site had black drip tape. Given that black drip tape was only evaluated at one site, there was not enough data to make a curve. Pressure versus discharge rate curves for both the blue and green drip tapes are shown below (Figures 10 and 11).



Figures 10 and 11: Charts illustrating pressure vs. discharge rates for blue (left) and green (right) drip tapes.

Given that drip tape is designed to be operated at 8 psi, we can approximate the following application rates:

Blue tape: ~0.7 gpm/100'
Green tape: ~ 1.1 gpm/100'
Black tape: ~0.7 gpm/100' @ 4psi. (This single point measurement indicates that this is in fact a high to very high flow tape, similar to the green tape.)

DRIP SYSTEM DISCUSSION & RECOMMENDATIONS

Typically, we hope for a DUlq of 90% or higher with drip tape on a flat field. Accordingly, DUlq values of 78% and 79% indicate room for improvement. Based on our observations in the field, some of the major reasons for the low DUlq include:

1. Leaks
2. Use of different types of drip tape within a block
3. Use of high flow drip tape
4. Length of drip lines
5. Inadequate submain sizing relative to demand from the number of drip lines operated per set

Leaks: During the evaluation, we observed many leaks in the drip line (Figures 12 and 13), partly associated with the practice of burying the drip line. The farmer irrigates to or beyond the point of surface saturation, and the practice of burying the drip tape appears unnecessary (assuming the purpose is to irrigate closer to the root zone and avoid evaporative losses) and may have increased damage to the drip tape relative to surface placement. We suspect that several notable pressure differences from the head to toe of the block were due primarily to drip tape leaks and advise against buried lines.

There were also leaks at the entry to some of the drip lines, where the drip tape was not well connected to the valve at the head of the line. This problem is attributable in part to intensive use of the valves at the head of each line, as the farmer opens and/or closes individual valves (rapidly) at each irrigation event, inevitably jostling the connections in the process. Re-design of irrigation blocks to include valves at a single submain connection point per block, rather than on each individual drip line, could help to avoid this problem.



Figures 12 (left) and 13 (right): Leaks within the drip system in Blocks 1 and 2 result in ponding.

Use of different types of drip tape: Use of 3 different types of drip tape throughout the farm is an obvious reason for low DUlq, and one that is easily remedied: we recommend that the farmer use the same type of drip tape throughout each individual block.

Use of high flow drip tape: Based on the curves developed for the blue and green drip tapes, we found that application rates were likely designed to be ~0.7 gpm/100' (blue) and ~1.1 gpm/100' (green). These are considered to be high (blue) and very high (green) flow rates for drip tape. Use of high or very high flow rate drip tape increases the flow demand for a given block size, which can result in greater friction losses and lower application rates at the far end of each line if the delivery lines (submain and drip tape) are improperly sized for the demand. Conversely, the use of high or very high flow rate drip tape reduces the number of lines that can be irrigated at once for a given submain diameter. (Furthermore, the soil infiltration rate is slow and high flow application rates result in undesirable conditions of surface ponding.)

Figure 14 illustrates that, in Blocks 1 and 2, a 4" submain can support up to 95 drip lines of the blue tape before exponential increases in pressure losses related to friction are realized horizontally through the field, but only 61 drip lines of the green tape. Block 1 has 109 beds each with 1 drip line, and Block 2 has 111 beds each with 1 drip line; accordingly, both the blue and green tapes have designed flow rates that are too high for the size of the area irrigated. We recommend using a lower flow drip tape to reduce pressure losses and irrigate Blocks 1 and 2 more uniformly.

Example	Designed flow rate of drip tape (gpm/100')	Description	gpm/ line at 300'	gpm/ acre	Maximum # lines per 4" submain (200 gpm)	Inches per hour of irrigation	Hours of irrigation to apply 1"
A	0.3	low	0.9	39	222	0.09	12
B	0.5	medium	1.5	65	133	0.14	7
C	0.7	high	2.1	91	95	0.20	5
D	1.1	very high	3.3	143	61	0.32	3

Figure 14. Examples of 4 different kinds of drip tapes and the maximum number of lines that can be irrigated on a 4" layflat submain before exponential pressure loss occurs in a 300' long field (approximate length of Blocks 1 and 2). Example C illustrates the blue tape; Example D illustrates the green tape.

Figure 15, illustrates that, in Block 3, the 4" submain is large enough to deliver flow to up to 33 lines of green tape before losing pressure horizontally through the field. However, we observed 0 psi at the far end of Block 3 – see next section for discussion about this ("Length of drip lines").

Example	Designed flow rate of drip tape (gpm/100')	Description	gpm/ line at 585'	gpm/ acre	Maximum # lines per 4" submain (200 gpm)	Inches per hour of irrigation	Hours of irrigation to apply 1"
A	0.3	low	1.8	39	114	0.09	12
B	0.5	medium	2.9	65	68	0.14	7
C	0.7	high	4.1	91	49	0.20	5
D	1.1	very high	6.4	143	31	0.32	3

Figure 15. Examples of 4 different kinds of drip tapes and the maximum number of lines that can be irrigated on a 4" layflat submain before exponential pressure loss occurs in a 585' long field (approximate length of Block 3). Example D illustrates the green tape that is used in Block 3.

Note: Crop ET in this area may require up to 2.5 inches per week (or more, for certain crops and heat wave conditions). It would require approximately 30 hours of irrigation per week to meet this demand with 1 line per 40" bed of 0.35 gpm/100' drip tape. If the pump can produce 200 gm of flow, up to 5 acres of drip in this configuration could be irrigated at one time. If the entire farm (18 acres) was in active cultivation and required irrigation, the peak demand would thus require up to 90 hours of irrigation per week. At 0.5 gpm/100', 3 acres may be irrigated at once with 200 gpm of production, each set requiring 18 hours per week; and 6 sets would require 108 hours of irrigation per week. These practical considerations may be significant to factor in to a system re-design, depending on the pumping conditions and availability of energy (for example, in the case of direct solar pumping).

Length of drip lines: As with any pipe, drip tape loses pressure exponentially after a certain length; for 5/8" tape with a flow rate of 1.1 gpm/100', this limit is less than 350 ft. Block 3 is 585 ft. long and we observed this: the pressure at the end of the lines was 0 psi even though there was 8 psi of pressure at the start of the field (next to the submain). Although using a very low flow drip tape may remedy this situation, it may be impractical for the grower to use a drip tape with such low flow rate in only Block 3, as they would have to purchase a different type of drip tape for that block (~0.35 gpm/100'), keep track of multiple different kinds of drip tape, and also manage irrigation set duration according to unique application rates. An alternative approach would be to redesign Block 3 to have shorter bed lengths, such that one type of low-medium flow drip tape can be used consistently throughout all blocks on the farm.

Other irrigation efficiency notes: It is important to note that while DU is an important factor in irrigation efficiency, it does not encompass over-/under-application of water or efficiency of pump use. It was clear during our evaluation that water is likely being overapplied, as the farmer explained that their typical practice is to apply water until there is ponding in the furrows. We recommend installing a flow meter at the pump to facilitate the farmer managing irrigation applications according to crop demand, based on evapotranspiration rates.

Additionally, an independent pump test provider (during a test on 9/11/25) indicated that the tractor does not have the power to run the pump at its full capacity and is only operating the pump at about half capacity. A power system upgrade would support more efficient pump operation and simultaneously support increased system capacity.

SPRINKLER SYSTEM EVALUATION

On May 28, 2026, we completed an evaluation of the sprinkler system with a focus on the areas illustrated in Figure 16, as this was the main area where sprinkler irrigation was in use at the time of evaluation. The area of the evaluation was planted to broccolini. Rain on the day of the evaluation made field conditions very difficult to complete work and curtailed the time available to collect data and make observations.



Figure 16. Field condition during sprinkler system evaluation.

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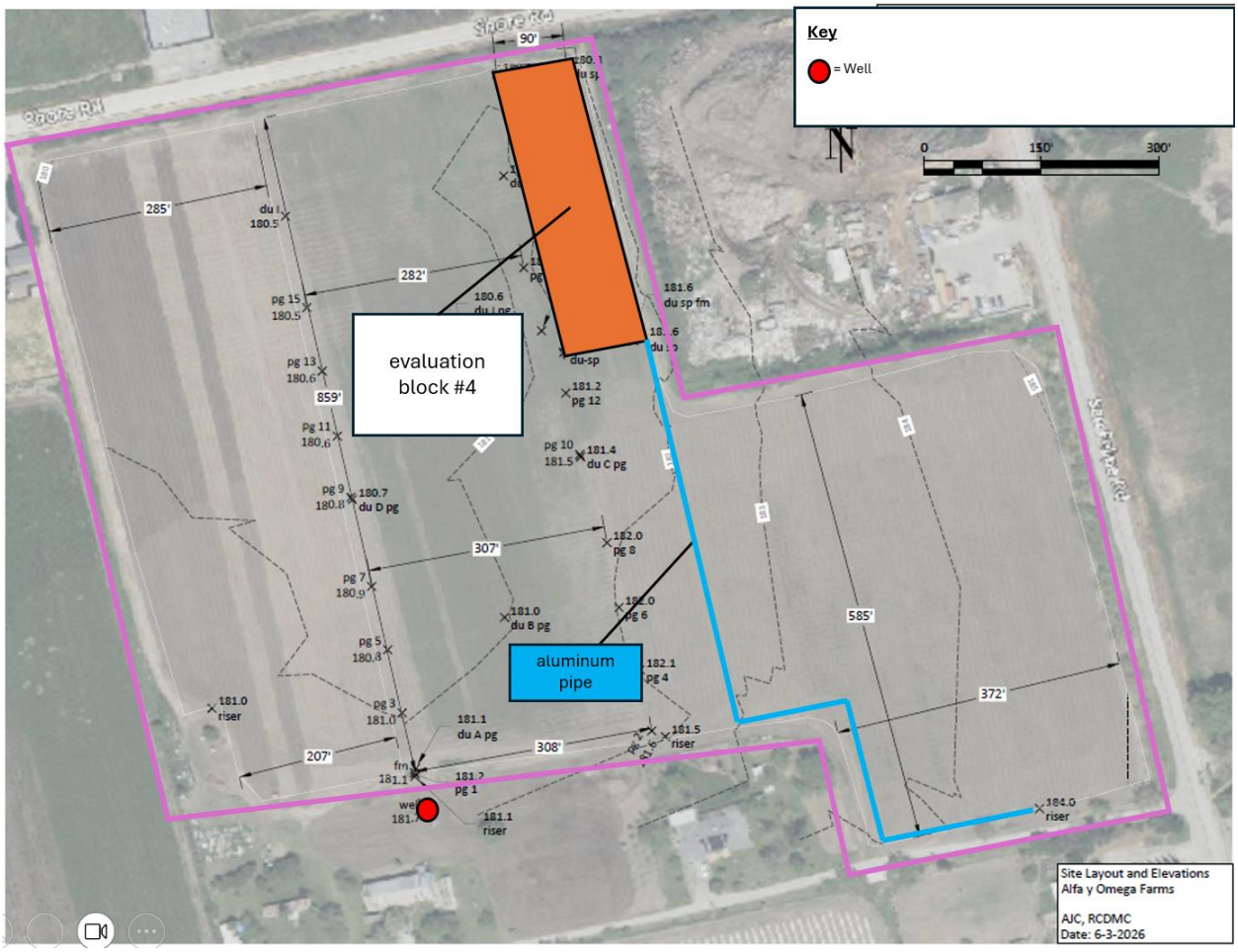


Figure 17. Map of area of farm included in the sprinkler system evaluation. The area was planted to broccolini. Also see Attachment 4.

The area evaluated was fed by 3" aluminum hook and latch pipe (Figure 17). A subset of 10 sprinkler nozzles measured during the evaluation had the following diameters:
8 x 7/64"
2 x 1/8"
Of the 8 nozzles that were 7/64" in diameter, 1 was noticeably larger, indicating significant wear. The grower indicated that the sprinkler system was rented.

The evaluation included 4 Test Sites where a 3 gallon bottle was filled and timed to measure single nozzle flow rates and a pressure gauge fitted with a Pitot tube was used to measure pressures. Block 4 irrigation began at 10:00 am and ended about 10:45 am.

The tractor PTO operating the pump ran at the maximum limit (according to farmer practice) of 540 rpm, delivering the maximum flow and pressure possible for the current pumping configuration. Initially, 4 lines of pipe (12 pipes per line) were open, which the farmer indicated had functioned on prior irrigation events. However, the system did not achieve adequate pressure to operate the sprinklers and one line was removed. After this, the system stabilized at a flow rate of about 105 gpm with 40 sprinkler heads in operation (covering an area of approximately 0.9 acre). This suggests an average sprinkler head flow rate of approximately 2.6 gpm. However, the measured flow rate varied from 1.6 gpm to 2.8 gpm, with a median value of 1.8 gpm. The anticipated flow rate for a 7/64 impact sprinkler nozzle at 40 psi is about 2.2 gpm. The pressures measured in the block ranged from 25 to 30 psi, well below the optimal operating pressure of 40 to 60 psi for impact sprinklers.

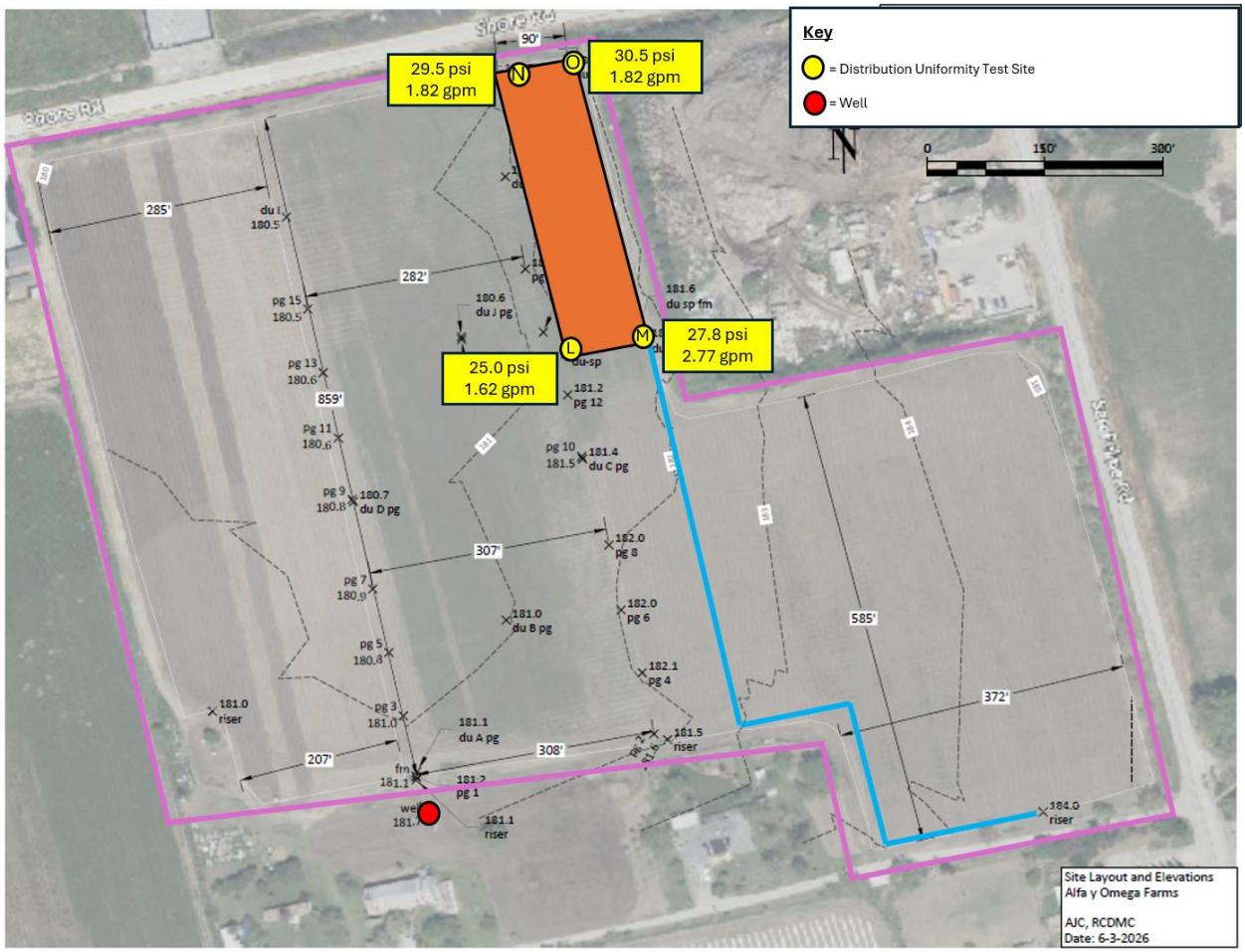


Figure 18. Evaluation of Block 4.




Figures 19 (left) and 20 (right). Substantial leaks and ponding noted within block 4 and along the conveyance pipe from the riser to the block during the evaluation.

SPRINKLER SYSTEM DISCUSSION & RECOMMENDATIONS

Assuming that most of the sprinkler heads were operating near the median flow rate of 1.8 gpm during the evaluation, the system delivery rate would have been about 72 gpm. However, a rate of 105 gpm was observed entering the block with the installed flow meter. This may indicate that up to 30% of the flow entering the block was lost to leaks. It also appears that up to half of the flow delivered by the pump was lost to leaks between pipes in the 1,000 foot long 3" aluminum surface conveyance line that delivered water from the riser to the block.

We recommend attention to the following items:

1. Length of conveyance line relative to size and flow rate demand.

At flow rates above 110 gpm, flow velocity in a 3" pipe exceeds the 5 ft/sec threshold causing steep pressure losses due to friction. It would be optimal to employ a larger diameter conveyance line which may be placed on the surface, or installed as a buried main line with riser valves located conveniently near each block irrigated by sprinkler.

2. Leaks

Ensure that pipe gaskets are in good condition and that pipes are well-fitted to avoid leaks between pipes. Alternatively, use pipe with fewer or tighter connection points to reduce potential for water losses (i.e Rain-tite or Yelomine surface pipe or buried PVC main lines).

3. Inconsistent nozzle sizes and high pressure demand design

Overall uniformity will be improved by maintaining a system with uniform parts. Replace mismatched nozzles. Also consider replacing the overall system with nozzles that are designed to operate at lower pressure conditions. This may increase the area that can be irrigated at one time by sprinkler, despite relatively low flow and pressure conditions.

SUMMARY OF RECOMMENDATIONS

1. Save drip tape labels so that designed/target application rate is known and TA providers can better support system management.
2. Avoid leaks in drip lines by not burying drip tape. Avoid cutting tape with field implements. Montior the system during operation and repair leaks as they are observed.
3. Use the same drip tape consistently throughout each individual field. Determine which tape to use by considering irrigation system limits for flow and pressure, overall block size, crop and ET demand, hours available to irrigate and soil infiltration rate.
4. Use a low or medium flow drip tape. Tape with a designed flow rate of approximately 0.45 gpm/100' should be adequate for most purposes at this location.
5. Redesign irrigation blocks such that:
    a. The farmer opens valves on the submain rather than on each individual drip line during each irrigation event;
    b. The farmer can use the same drip tape throughout the farm (to help avoid mixing of different tapes), with relatively consistent bed length throughout the farm;
    c. Block 3 and surrounding area have shorter runs, ideally <450'; alternatively use 7/8" tape with a low to medium flow rate in block 3.
    d. Conveyance lines are suitably sized to deliver water to blocks according to the flow and pressure demands of the block; conversely determine irrigation block size according to the limits of the flow and pressure available to deliver from pump and through existing conveyance lines.
6. Install flow meter at pump. Monitor during irrigation events to ensure system is operating at the expected rate for each block to diagnose potential major leaks or blockages. Maintain irrigation records alongside other crop production records.
7. Implement new system for powering pump such that it can be operated at maximum efficiency. Consider an engine that can operate at the designed pump rate of 1100 rpm. Alternatively, replace the pump with a new electric (solar powered or grid connected) pump outfitted with a VFD to allow for irrigating a range of block sizes with either drip or sprinkler at optimum efficiency.
8. Employ additional tools such as tensiometers and irrigation schedule software (i.e. CropManage) to optimize irrigation management.