



How to design or check 63,000 acres of microirrigation systems each year

- A comprehensive and quick tool is needed.
- Many of the systems NRCS designs are too small to attract private industry interest.
- Many of the private industry designs don't have the information NRCS needs to quickly approve the design.

Microirrigation Systems Need for Design Verification

Criteria Examples

Uniformity of Application: Discharge in subunits or zones and along laterals shall not exceed a *total variation of 20 percent* of the design discharge rate.

Water Quality: The irrigation water supply shall be tested and assessed for physical, chemical and biological constituents to determine suitability and treatment requirements for use in a microirrigation system.

Filters. A filtration system (filter element, screen, strainer, or filtration) shall be provided at the system inlet.

Water Quantity: The water source must be capable of meeting the peak crop demand for the area to be irrigated.

Third Party Design Documents

- For purposes of both **technical** and **financial** assistance, NRCS must ensure designs meet standard 441
- In some instances, third party design are excellent, but fail to provide adequate documentation to enable NRCS compliance
- In some instances, third party designs are good starts, needing additional work to meet NRCS compliance
- In many instances, third party designs hardly ever provide block variability, a key NRCS criteria
- In many instances, third party designers shy away from providing adequate design documentation for small-scale micro designs (as they put it "not worth their efforts")

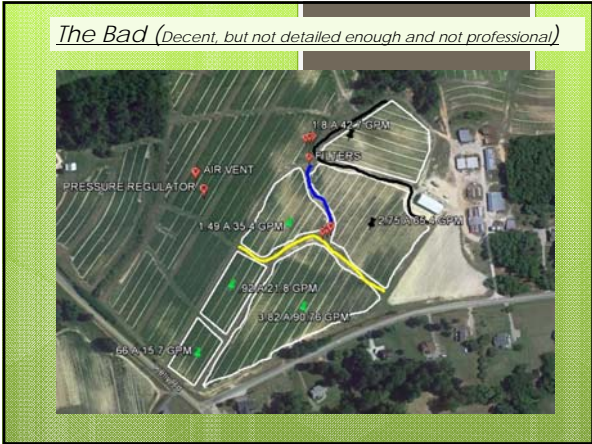
Overall, third party designs remind us of *The Good, The Bad, and The Ugly*



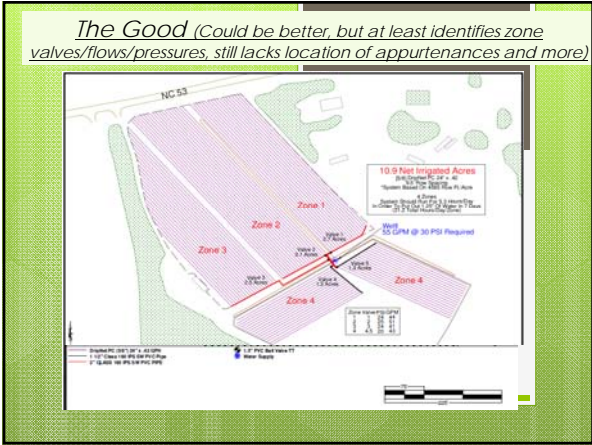
The Ugly (Back of the envelope type layout plans



The Bad (Decent, but not detailed enough and not professional)



The Good (Could be better, but at least identifies zone valves/flows/pressures, still lacks location of appurtenances and more)



The Good is usually supported by a detail hydraulics summary Report that provides flow/pressure variation.

Zone Design Report					
Zone Name :	Value 1	Valve Description :	1.5" PVC Bal Valve TT		
Zone Head (D/S) :	22.00 (psf)	Zone Head (U/S) :	22.00 (psf)		
Total Zone Flow :	43.75 US gpm	Valve Headloss :	0.00 (psf)		
Allowable Flow	Actual Flow	Allowable Pressure	Actual Pressure		
US gpm	US gpm	(psf)	(psf)		
Minimum Outlet	0.42	0.42	12.00	12.55	
Maximum Outlet	0.42	0.42	25.00	24.84	
Outlet Variation (%)	0.00	0.00	52.00	48.43	
Coefficient of variation =	0.025	Mean Emittor Flow =	0.42	No. of Emittors per Plant = 1	
Ca =	100.0 (%)	Es =	98.82 (%)	Ds = 100.00 (%)	
Outlet Locations (K'V)	Minimum	30.7	148.3	Maximum	
36.1	31.5				
Zone Name :	Value 2	Valve Description :	1.5" PVC Bal Valve TT		
Zone Head (D/S) :	23.50 (psf)	Zone Head (U/S) :	23.50 (psf)		
Total Zone Flow :	50.53 US gpm	Valve Headloss :	0.00 (psf)		
Allowable Flow	Actual Flow	Allowable Pressure	Actual Pressure		
US gpm	US gpm	(psf)	(psf)		
Minimum Outlet	0.42	0.42	12.00	12.55	
Maximum Outlet	0.42	0.42	25.00	24.84	
Outlet Variation (%)	0.00	0.00	52.00	48.43	
Coefficient of variation =	0.025	Mean Emittor Flow =	0.42	No. of Emittors per Plant = 1	
Du =	100.0 (%)	Es =	98.82 (%)	Ds = 100.00 (%)	
Outlet Locations (K'V)	Minimum	147.8	174.3	Maximum	
48.4	31.5				



NRCS Microirrigation Design Tool History & Utility

- Work started in Idaho about a decade ago
- Integrated previous NRCS design components (i.e., lateral design, mainline design, pump design) into a complete design package
- The tool expanded and improved over time as new knowledge from researchers and manufacturers became available
- The tool is independent of manufacturers' components and can use any emitter type with known hydraulic characteristics

Basic Microirrigation System Components

- Control Head/ Filters/Injectors
- Mainline
- Manifolds
- Laterals/Emitter
- Flush lines
- Valves & etc.

Iron Bacteria



Water quality

Water quality is usually the most important consideration when determining whether a microirrigation system is physically feasible.

Calcium carbonates



Water Quality Factors

PHYSICAL FACTORS (Suspended solids)	CHEMICAL FACTORS (Precipitates & others)	BIOLOGICAL FACTORS (Bacterial growth)
Inorganic particles Sand Silt Clay Plastic Metal	Calcium &/or magnesium carbonates Calcium sulfate Heavy metals Hydroxides Carbonates Silicates Sulfates	Filaments
Organic Particles (Aquatic organisms) Zooplankton Snail Fish	Oil and other lubricants	Slimes
Organic Particles (Non-aquatic organisms) Insect larva Ant Fish Spider	Fertilizers Phosphate Aqueous Ammonia Iron, copper, zinc Manganese	Microbial ochre's Iron Sulfur Manganese





U.S. Department of Agriculture
Natural Resources Conservation Service

Microirrigation System Planning/Design Worksheet

Name: _____ Date: _____ Prepared by: _____
District: _____ County: _____ Engr Job Class: _____

Emitter Arrangement

Select an emitter arrangement: Single row Double row Pencil Wheel

Select an emitter type: _____

Select emitter outlet type: _____

Calibers per plant per day, F_{plant} (gall)	Irrigation interval, & (days)	Desired % wetted area, P_a (%)	Emitter spacing, S_e (ft)	Emitter wetted diameter, S_w (ft)	Recommended emitter spacing, S_r (in)	Selected emitter spacing, S_s (in)	Emitters per plant, e	Number of hoses or strings required	Actual percent wetted area, P_a

Emitter selection, Set Times, and Zones

Emitter Selection

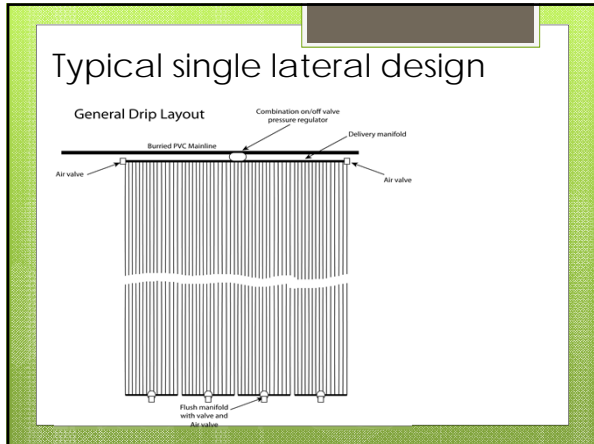
Estimated emitter flow rate, q (gpm/lineal ft)	Emitter coefficient of variation (CV)	Emitter exponent (K)	Emitter discharge coefficient (Kd)	Emitter barb loss coefficient (Kbl)	Minimum emitter pressure, P_e (psi)

Zone Determination

Field size (ac)	Number of zones, N_z (in)	Hours of operation per zone (hrs)	Required System Flow rate, Q_s (gpm)	Gross Water depth applied (in)

Use the following cells to adjust flow, set time, and/or pressure to obtain the required management scheme. Check the selected option.

Flow rate	Set Time	Pressure
Selected emitter flow rate, q_s (gph)	Average operating pressure, P_a (psi)	Set Time to meet water requirements, T_s (hrs)
Set Time	Emitter flow rate, q_e (gph)	Average operating pressure, P_a (psi)
Pressure	Average operating pressure, P_a (psi)	Emitter flow rate, q_e (gph)
	Set Time to meet water requirements, T_s (hrs)	Gross Water depth applied (in)



U.S. Department of Agriculture
Natural Resources Conservation Service

Microirrigation System Planning/Design/Evaluation Worksheet

Name: _____ Date: _____ Prepared by: _____
District: _____ County: _____ Eng. Job Class: _____

Lateral Hydraulics

Enter selected Emitter Information	Lateral Hose information	Field Information	Tools
Coefficient of Variation (CV): 0.025	Inside diameter (in): 0.875	Lateral length (ft): 1114	Estimate max length
Emitter spacing (in): 0.438	Emitter spacing (in): 26	End pressure (psi): 15	Manifold location
Emitter discharge coefficient (Cd): 0.800	Emitters/Flush: 1	Slope (% +/-): -0.05	Emitter evaluator
Minimum pressure for emitter flow rate (psi): 1.00	Flushing velocity (ft/s): 1.00	Use Pressure (psi): 14	Bank Losses
	Flushing end pressure (psi): 3		+ & K Calculator

Single Lateral

Buttons: Solve for a set Inlet Pressure, Solve for a set Average Pressure, Solve for a set End Pressure, Piped lateral design

Instructions

- Solve for a fixed and pressure (i.e. pressure regulator)
- Solve for a fixed end pressure
- Solve for the desired average pressure
- Fixed lateral (the manifold some other place than the head of the field)

In all cases an estimated end pressure needs to be supplied as a starting point. Then press the corresponding button. For paired laterals the end pressure must also be specified.

Occurring at station				Occurring at station				Occurring at station			
Maximum Pressure (psi)	Maximum Flow rate (gph)	Desired Average Pressure (psi)	Actual Average Pressure (psi)	Minimum Pressure (psi)	Minimum Flow rate (gph)	Total Friction loss (psi)	Pressure variation (psi)	Lateral Flow Variation (%)	Lateral Uniformity (EM)	Lateral Efficiency (%)	EM (ft)
14.00	0.210	13.17	0.204	12.91	0.20	1.33	1.09	3.67	96.16		

*The above pressures pertain to operating pressures not flushing pressures



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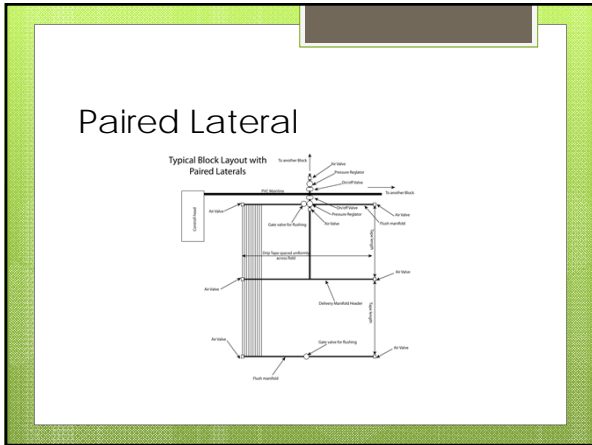
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14.00	0.210	13.17	0.204	12.91	0.20	1.33	1.09	3.67	96.16		

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Paired lateral output

Uphill length (ft)						Downhill length (ft)					
438.1						671.9					
Maximum Pressure (psi)	Maximum Flow rate (gph)	Average Pressure P _a (psi)	Average Flow rate q _a (gph)	Minimum Pressure P _v (psi)	Minimum Flow rate q _v (gph)	Maximum Pressure (psi)	Maximum Flow rate (gph)	Average Pressure P _a (psi)	Average Flow rate q _a (gph)	Minimum Pressure P _v (psi)	Minimum Flow rate q _v (gph)
14.00	0.210	13.86	0.209	13.78	0.208	14.00	0.210	13.83	0.209	13.78	0.208

Int. Pressure (psi)	Lateral flow rate (gpm)	Lateral Flow Variation (%)	Lateral Emission Uniformity EU _a (%)
14	1.93	0.71	95.61

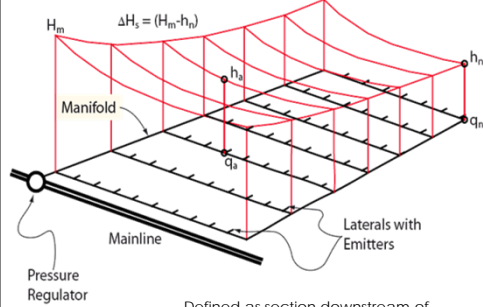
Explanation notes:

Manifold/Block Design

- shall be designed to provide discharge to any applicator in an irrigation subunit or zone operated simultaneously such that they will not exceed a total variation of 20 percent of the design discharge rate.



Block/manifold



Defined as section downstream of the pressure regulation

Manifold Design

Number of Outlets	Normal manifold length (ft)	Lateral or riser spacing (ft)	Average lateral flow rate (gpm)	Equivalent lateral length (ft)	Starting pressure to manifold (psi)	Manifold slope (%)	Length of pipe before the manifold (ft)	Manifold slope (%)	Emitter spacing (ft)	Average emitter pressure (psi)	Lateral to base EU (%)	Desired System EU (%)
1114		1.93		12				0.45	13			

System EU needs to be 0.204

Point Row Definitions

Definition #	Starting Row Number	Ending Row Number	Length
Definition 1			
Definition 2			
Definition 3			
Definition 4			
Definition 5			
Definition 6			
Definition 7			
Definition 8			

Mainifold Computations

Total flow (gpm)	Outlet Pressure (psi)	Pipe Diameter (in)	Outlet Pressure (psi)	Rotation (in)	Manifold length (ft)
1114					

Other sections

- Mainline
- Pumps
- Appurtenances

Microirrigation Design

Project name: 8/23/2013
Project Location:

Water Quality AnalysisWater requirements

Set Time/ System CapacityBlock Hydraulics

Flushing

This is used for checking water quality, determining water requirements, set times, determining the Emissions Uniformity (EU) and the flow variation for the entire block. The block need not be rectangular and the assumption is made that all laterals share the same slope. The slope can vary down the lateral but all laterals will have the same variation.

The image shows a software interface for microirrigation design. It features a 3D terrain model on the left, two line graphs on the right showing hydraulic performance (likely pressure or flow rate vs. distance), and a data table at the bottom left. The interface is titled 'Microirrigation Design' and includes fields for project name and location.

Drip Design Summary

Date: 10/06/2012
Project Name: _____
Checked by: _____

Block Summary

Block flow rate (gpm)	185.04	Max Pressure	15.82	Max Emitter Flow	0.222
Inlet Pressure (Psi)	16.42	Avg Pressure	13.99	Avg Emitter Flow	0.21
Flow variation (%)	15.92	Min Pressure	13.12	Min Emitter Flow	0.204
Block EU (%)	84.95				

Selected Emitter

Type	Cv	K	K _s	Design Pressure	Emitters per block
	0.025	0.45	0.004	14	

Hose/Lateral

Diameter	Length	Slope	Topography	Point Rise	Beginning	Ending	Length
inches	ft	%	Station	ft	Station	Station	ft
0.875	1114	-2.8					

Mainfold

Inlet position	Number of outlets	Lateral spacing	Outlet Line	Class. before manifold	Slope	Topography	Pipe diameter	End	Outlet	Outlet	Outlet	C factor	Outlet
ft		ft	inches	ft	%	Station	inches	ft	ft	ft	ft		ft
1	55	2.07	0.5	-0.5					48	2.28	148		48
									96	3.33	148		96

... To an Engineer if it works it does not have enough features YET!

Dilbert
