

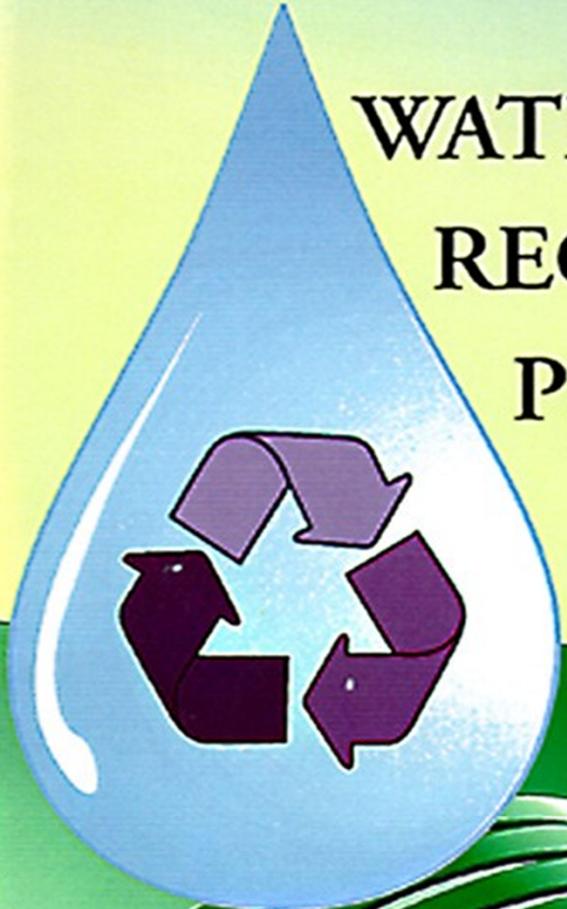
MONTEREY COUNTY

WATER

RECYCLING

PROJECTS

Est. 1998



**Would You
Use This
Water?
Would You
Eat These
Crops?**

**Bob Holden
MRWPCA**

Water Reuse Criteria Adopted

❖ California	1918 (1968)
• Arizona	1985
• North Carolina	1988
• Florida	1989
• Oregon	1990
• Texas	1990
• US EPA	1992
• Washington	1993
• Utah	1995
• Colorado	2000
• Idaho	2007
• Virginia	2008
• Massachusetts	2009

WHO Guidelines

- Irrigation of edible crops
- 1,000 fecal coliform / 100 mL

CDFA Leafy Green

Products Handler

Marketing Agreement

- Irrigation of edible portion of crops
- ≤ 126 generic E. coli / 100 mL

Food Crops Eaten Raw

State	Quality Limits
Arizona, Utah, US EPA	Non detect (50%) fecal coli/100 mL
Arkansas, Indiana, Kansas, Michigan, Montana, New Mexico, Oklahoma	Use Prohibited
California, Colorado (NC), Idaho, Oregon (NC), Washington (NC)	2.2 total coli/100 mL
Florida	Non detect (75%) fecal coli/100mL
Hawaii (NC), New Jersey (NC)	2.2 fecal coli/100 mL
New Mexico (NC)	1,000 fecal coli/100mL
Nevada (NC)	200 fecal coli/100 ml
Texas (NC)	20 fecal coli/100mL
Virginia	14 fecal/100mL

NC = No Contact with edible portion allowed

California Water Recycling Criteria

- Agricultural Uses -

Type of Use	Total Coliform Requirements	Treatment Required
Irrigation of fodder, fiber & seed crops, processed food crops, pasture for non-milking animals, orchards & vineyards (no contact with edible portion of crop)	None specified	<ul style="list-style-type: none">• Secondary
Irrigation of pasture for milking animals	23/100 mL	<ul style="list-style-type: none">• Secondary• Disinfection
Irrigation of food crops (no contact with edible portion of crop)	2.2/100 mL	<ul style="list-style-type: none">• Secondary• Disinfection
Irrigation of any food crop where reclaimed water comes in contact with the edible portion of the crop, including root crops	2.2/100 mL	<ul style="list-style-type: none">• Secondary• Filtration• Disinfection

Surface Water Standards

Class	Use	Standard
I	Water Supply	200 FC/100 mL
II	Shellfish	14 FC/100 mL
III	Recreation	200 FC/100 mL
IV	Agriculture	No Standard

Safety Studies & Guidelines

- Pomona Virus Study (1974)**
- Health Effects Study (1984, CSDLAC)**
- Monterey Wastewater Reclamation Study for Agriculture (1987)**
- Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture (1989, WHO)**
- EPA Reuse Guidelines (1992)**
- Use of Reclaimed Water and Sludge in Food Crop Production (1996, NCR)**
- Commodity Specific Food Safety Guidelines for the Production and Harvest of Lettuce and Leafy Greens (2008-2012, CDFA)**

CA Recycled Water History

Indirect Potable Reuse—1962

Recreational Lakes—1965

Irrigating Lettuce &
Strawberries—1967

Dual Plumbing Systems—1977

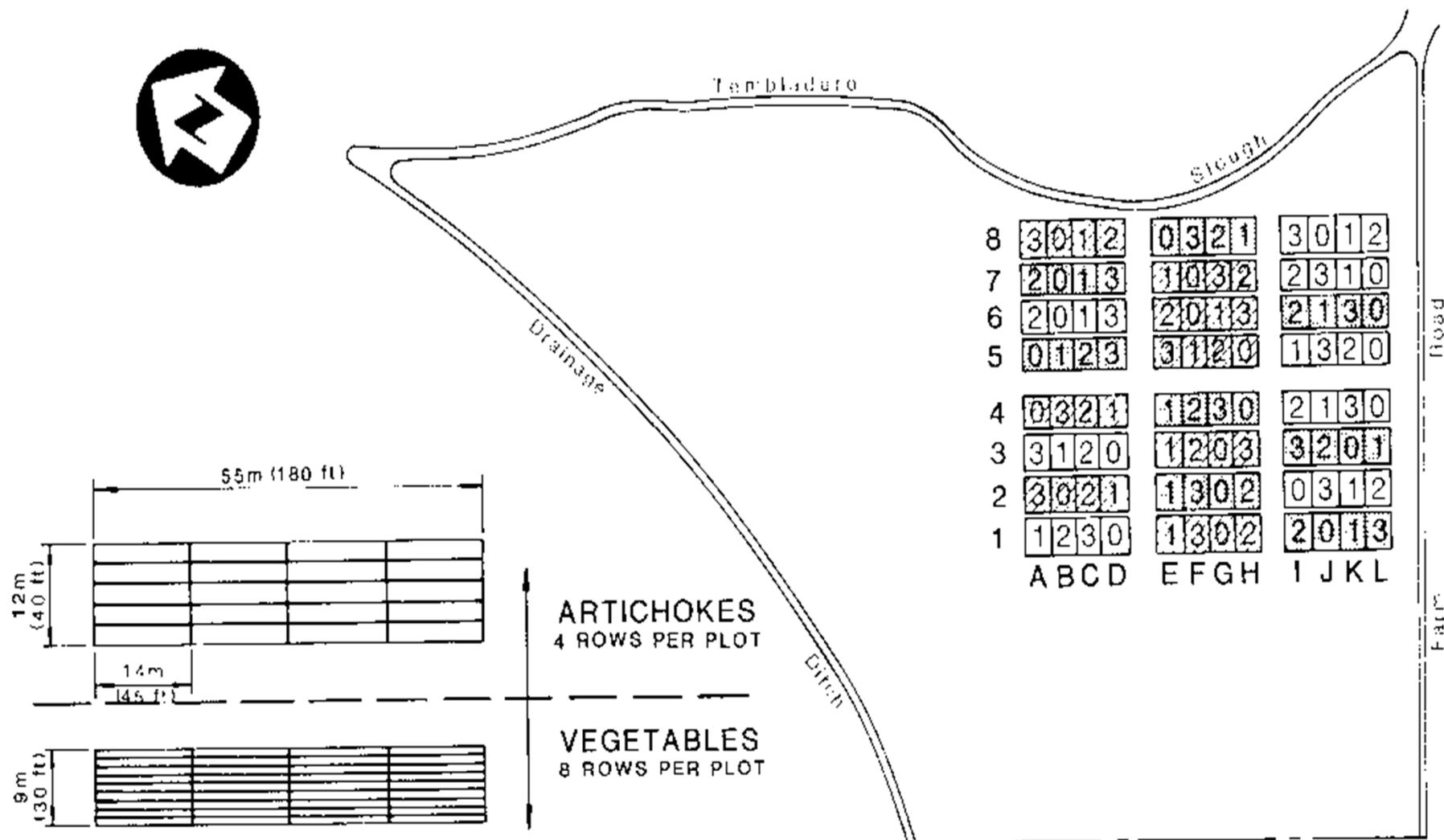
Uses of Recycled Water

- Agricultural Irrigation
- Landscape Irrigation
- Toilets & Urinals
- Construction & Concrete
- Street Sweeping
- Power Plants & Boilers
- Impoundments
- Cooling Towers
- Manufacturing
- Environmental Uses
- Groundwater Recharge
- Seawater Intrusion Barrier
- Indirect Potable Reuse
- Fire Fighting

MONTEREY FIELD RESEARCH

- Five Years of Field Research/Demo
- Three Water Types
- Four Fertilizer Rates
- Six Types of Food Crops
- Four Replications
- 96 Random Plots
- Thousands of Samples
- Analysis of Variance

SITE D EXPERIMENTAL DESIGN



NOTES:

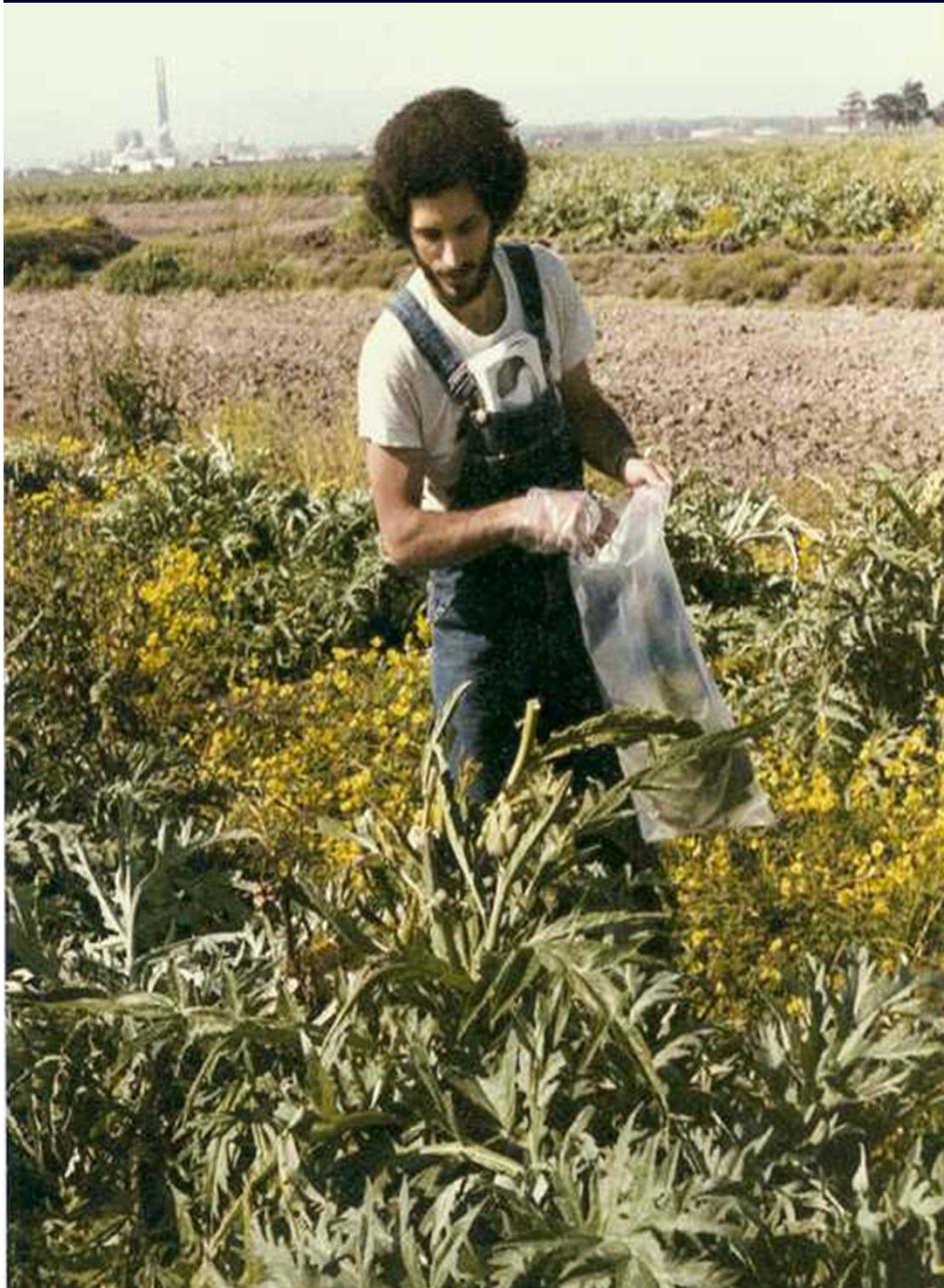
1. SPACING OF ROWS WAS DICTATED BY LOCAL EQUIPMENT SETTINGS. THEREFORE, THE PRIMARY UNITS OF SPACING IN THE EXPERIMENTAL COMPONENT IS IN THE ENGLISH SYSTEM.
2. SHADINGS INDICATE DIFFERENT WATER TYPES. NUMBERS REFER TO DIFFERENT FERTILIZER RATES.

RANDOMIZED SPLIT PLOTS

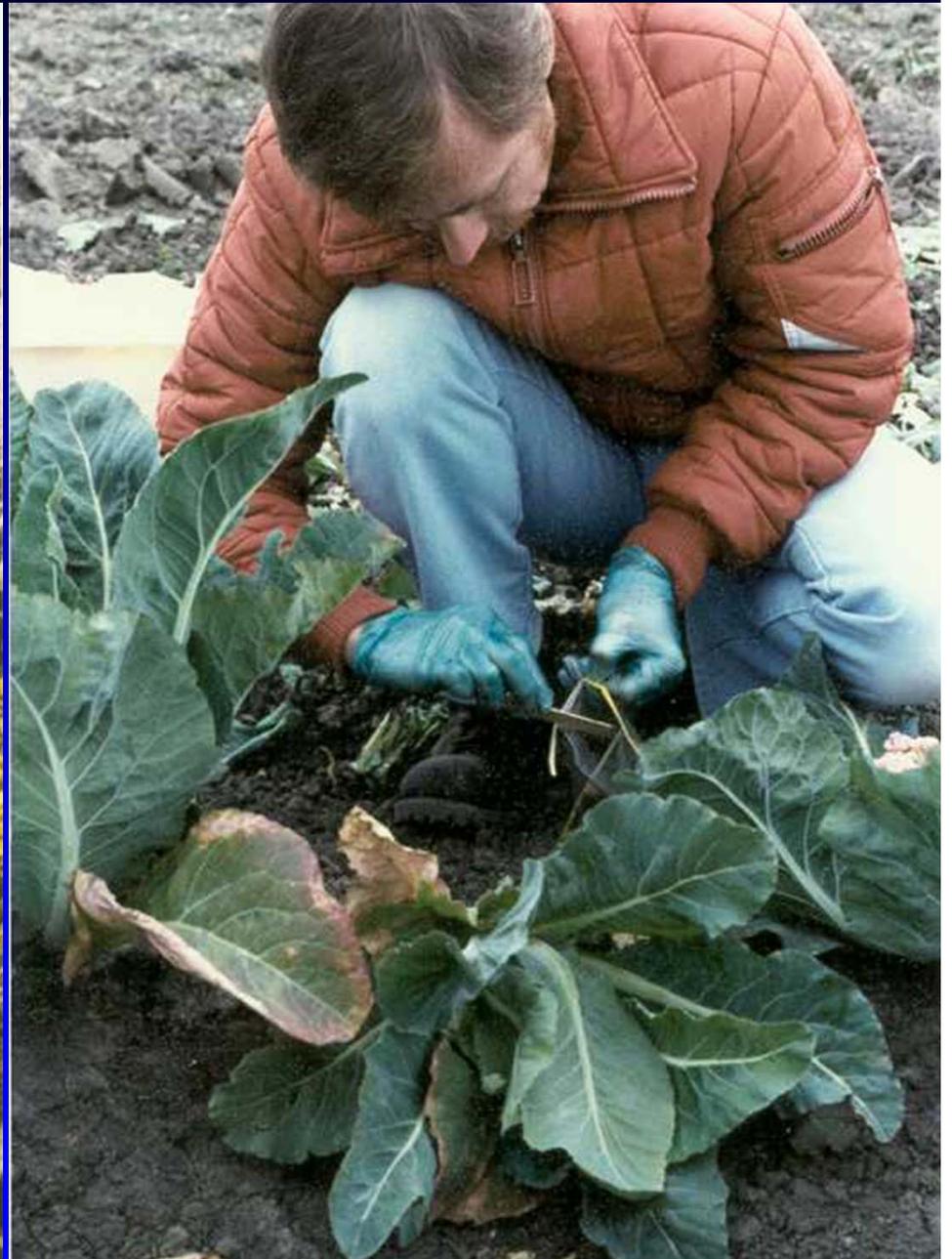
Castroville, 1976-1987



Microbial Analyses



Virus Assay

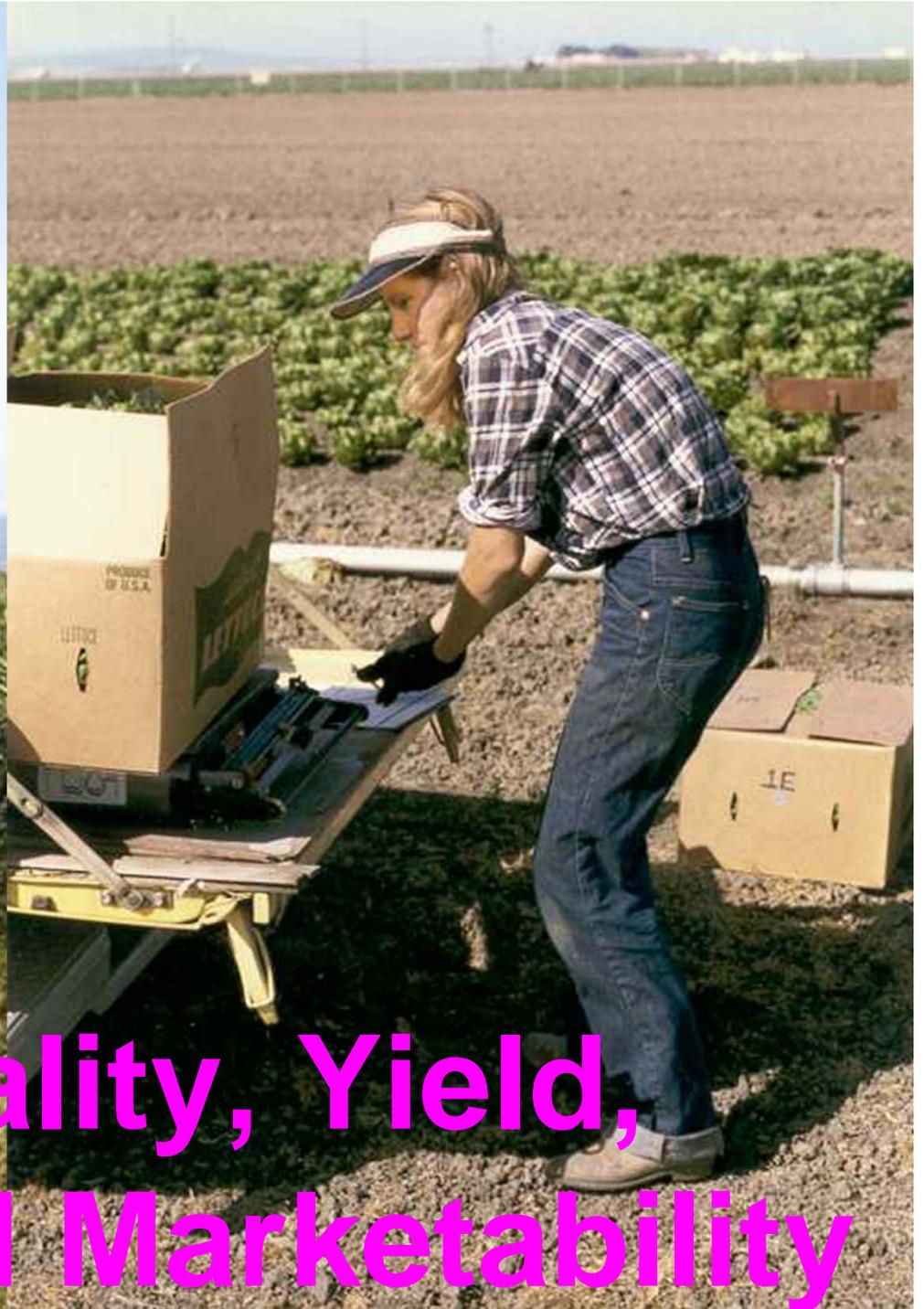


VIRUS SURVIVAL TESTING

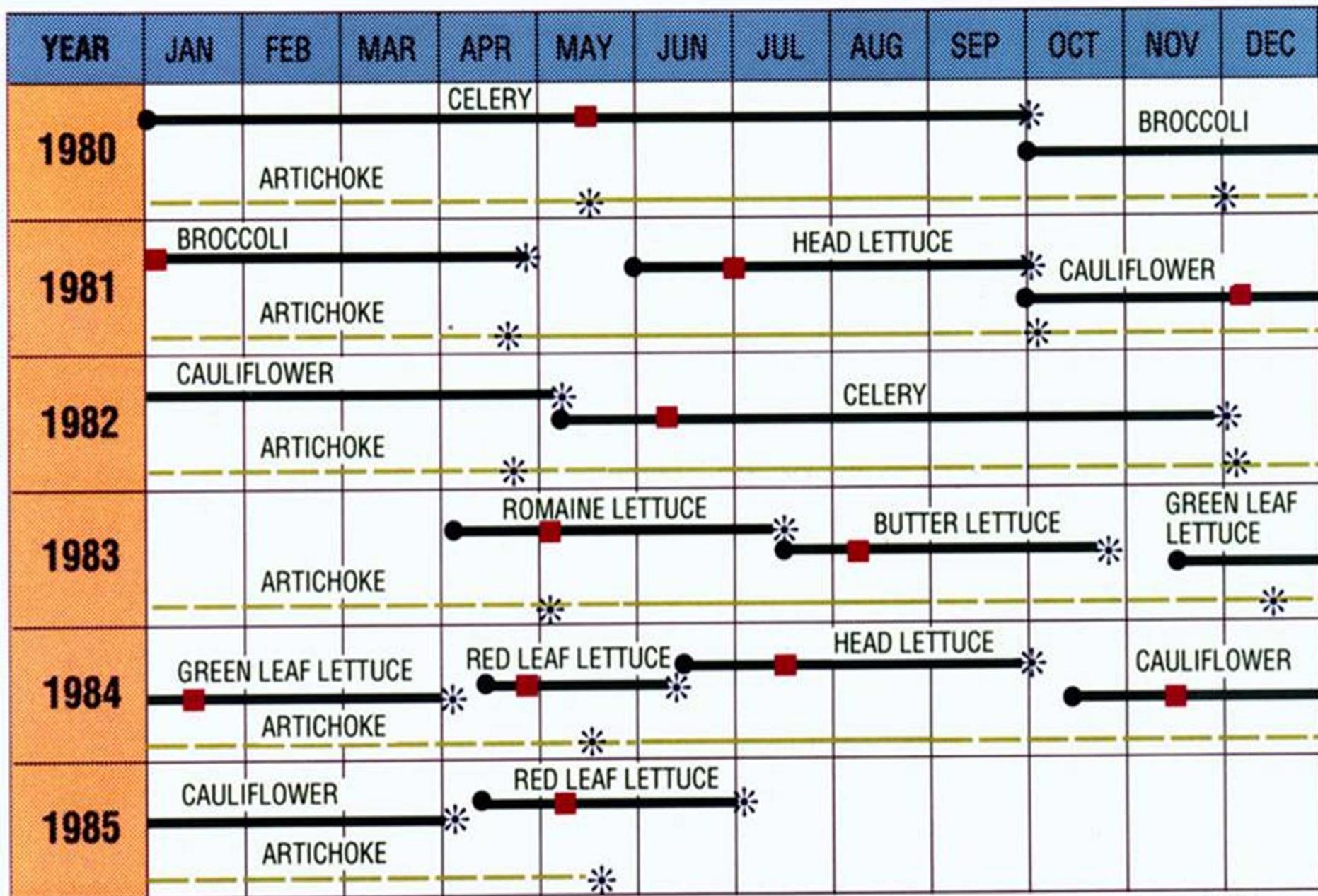


DOUBLE-RING INFILTROMETER





**Crop Quality, Yield,
Storage, and Marketability**



LEGEND:

-  Vegetable
-  Artichoke
-  Cut Back Artichoke Regrowth

- ACTIVITY:**
-  Planting Date
 -  Harvest Date
 -  Field Preparation

Monterey Wastewater Reclamation Study for Agriculture

FINAL REPORT - April 1987



prepared for **Monterey Regional Water Pollution Control Agency**



MONTEREY
WASTEWATER
RECLAMATION
STUDY FOR
AGRICULTURE

ENGINEERING-SCIENCE
DESIGN • RESEARCH • PLANNING

860 BANCROFT WAY • BERKELEY, CALIFORNIA 94710 • 415.848.7370
OFFICES IN PRINCIPAL CITIES

ES

MWRSA Results

- No Natural Virus (effluent, crop, or soil)
- Seeded Virus (Polio) – 5 log (99.999%) reduction
- No parasites in effluent
- Total & Fecal Coliform—equal in plant, soil, and aerosols irrigated with well & recycled waters
- Workers Safe (Medical Exams)

MWRSA Results

- Heavy metals—plants & soil—equal for well & recycled waters—No accumulation
- Crop Quality, Yield (some increases), Storage, and Marketability –Unaffected
- Soil Permeability – Unaffected

Safe for Food Crops Eaten Raw

After MWRSA

Strawberries

Grown with Recycled Water

- Grow better than predicted (chloride)
- Sweeter
- Majority of crop

Water Quality & Operations Committee



**The production of clean and safe water for
agriculture**

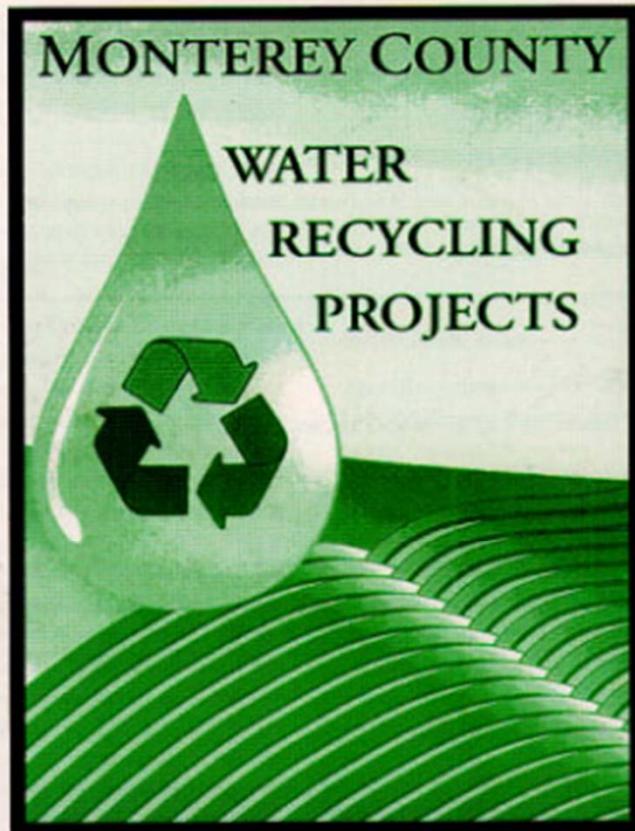
Water Quality & Operations Committee

- Growers (6 incl. chair)**
- County Health (1)**
- County Water Res. (1)**
- Producer (1)**

Food Safety Study

- No viable microorganisms of public health concern
- Cryptosporidium and Giardia similar or lower than from raw or treated drinking water sources
- No E. coli 0157:H7 or Legionella in raw sewage
- Salmonella, Cryptosporidium & Cyclospora absent or in low numbers in raw sewage

for



Water Quality and Operations Committee

August 1998

sponsored by

Monterey County Water Resources Agency
and
Monterey Regional Water Pollution Control Agency

**Recycled
water
safe for
edible
crops**

MONITORING PROGRAM

Constituents	Recycled Water	Disinfected River Water	Storage Pond	Monitoring Station A1
Metals, Toxics, Pesticides & Inorganics	--	--	Annually	--
Agronomic	Monthly	Monthly	Monthly	--
TDS (Total Dissolved Solids)	Weekly	Monthly	--	--
Specific Conductance	Daily	Daily	Daily	Continuous
pH	Daily	Daily	Daily	Weekly
Total Suspended Solids	Daily	Weekly	--	--
Turbidity	Continuous	Daily	Daily	Weekly
Settleable Solids	Daily	Weekly	Weekly	--
BOD	Weekly	--	--	--
Chlorine Residual	Continuous	Continuous	Continuous	Continuous
Total Coliform	Daily	Daily	Daily	Daily
Fecal Coliform	Daily	Daily	Daily	Daily
Generic E. coli	Daily	Daily	Daily	Daily
Total and Fecal Coliform & Clostridium (County Health)	Bi-Weekly	Bi-Weekly	Bi-Weekly	--
Cyclospora, Helminth, E. Coli 0157H7, Legionella, Shigella, Giardia, Cryptosporidium, Salmonella and viruses	--	3/Year	4/Year	--

Red – Regulatory Requirement
Green – Irrigation Suitability
Blue – Food Safety

Monterey County Water Recycling Projects

Crisis Management Plan

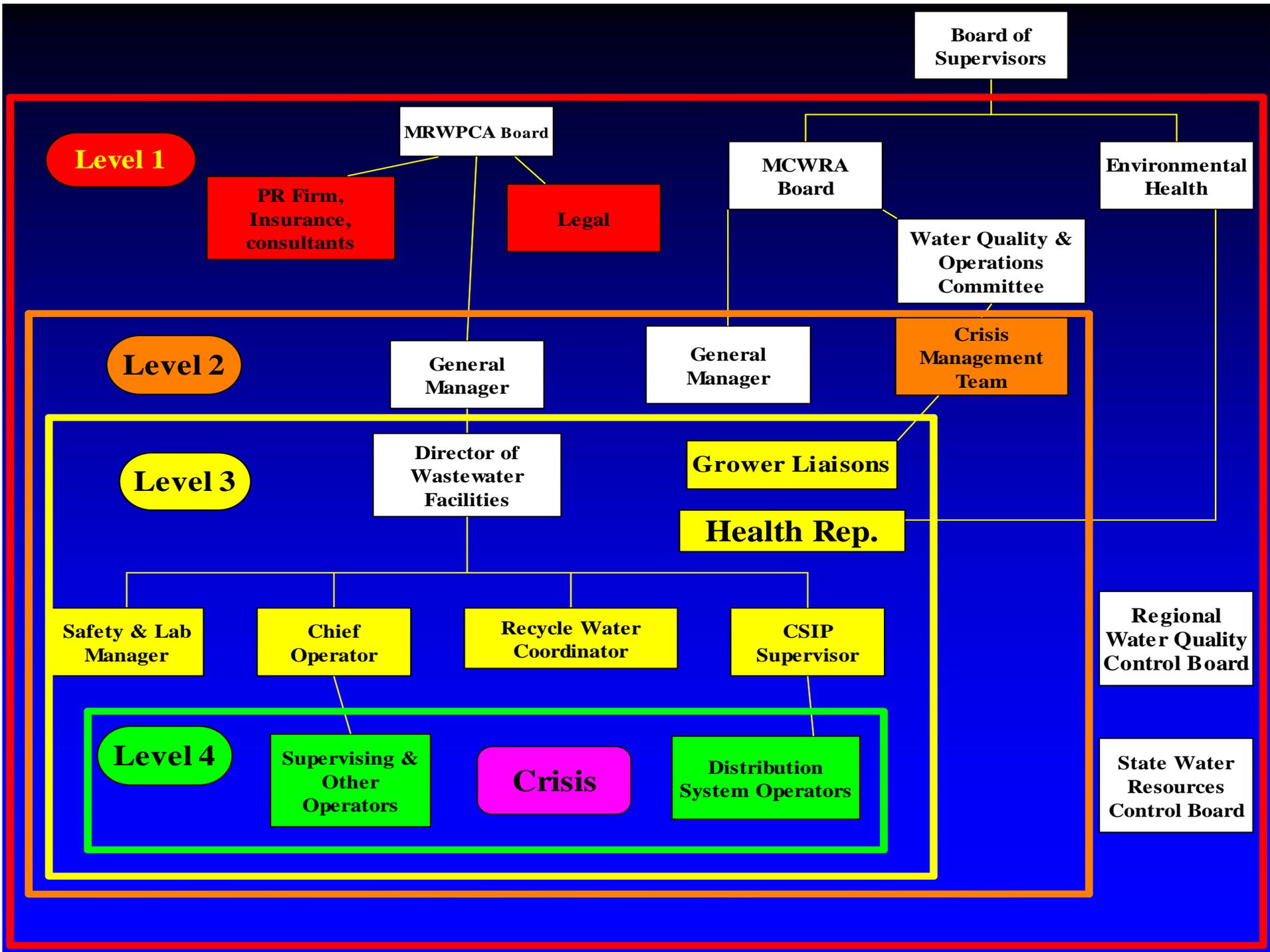
Approved by Water Quality &
Operations Committee 2/20/03

Crisis Management Plan

Well Site # 12 - 11B1	32	0	0
Well Site # 13 - 11M3	37	0	0
MS Site # 14 - B5	24		1534
Well Site # 15 - 14A1	29	118	339
Well Site # 16 - 14L3	0	0	0
Well Site # 17 - 15A1	41	10	1661
Well Site # 19 - 15C2	39	0	1679

System Overview
7/18/07 AM
DEFAULT
Login Logout
PFI FLOW

THICKENER BLEND LOG
Date: 7/18/07
Operator: [Name]
Shift: [Shift]
Flow: [Flow]
pH: [pH]
Temperature: [Temp]
[Handwritten notes and data in a grid format]



**No documented
case of illness
EVER due to
Recycled Water**

(WRA & SWRCB)

Minimize Coliform

- Lower turbidities
- Higher chlorine residuals (T11)
- Minimizing birds and algae
- Superdosing
- Discourage Wild animals
- Improve Sampling (lower observed values)

Presumptives

Total
Coliform

Fecal
Coliform

O157:H7

E. coli



Cauliflower transplant chlorine residual study



Storage pond before rope

A photograph of a large storage pond with a concrete curb and a rope barrier. The pond is filled with blue-green water. In the background, there are utility poles, trees, and industrial buildings, including a large brown tank and a white tank. The sky is clear and blue.

Storage pond with rope



**Algae on
chlorine
contact
basin
walls
before
cover**

Covered chlorine contact basin





Stainless Steel Grab Sampler





Bleach



Flush





Regrowth

Lab Testing

- No chlorine residual after two months
- Non-detect for total & fecal coliform & E. coli

Field Testing—Unused turnouts & well surge tanks

- Non-detect for total & fecal coliform & E. coli



Lab and Field Regrowth Studies

Total Samples 1998-2013

	Total	Fecal	E. coli
Chlorine contact basins	7,197	6,912	2,816
Storage pond	3,537	3,535	1,377
Distribution System	2,030	2,027	1,681

% Total Values >2 1998-2013

	Total	Fecal	E. coli
Chlorine contact basins	1.96%	0.16%	0.04%
Storage pond	4.24%	0.34%	0.22%
Distribution System	1.03%	0.15%	0.06%

Pathogens Never Detected in MRWPCA Recycled Water 1997-2013

E. coli O157:H7

Salmonella

Legionella

Helminth

Shigella

Culturable virus

Culturable Cryptosporidium

Pathogens 1997-2013

	Samples	Detected	Max /L
Cyclospora	58	1	0.34
Giardia	58	11	0.5
Cryptosporidium	58	31	13.4
Infective Crypto	28	0	<0.29

Clostridium perfringens: 171 Sample sets
4.9 To >6.6 Log Reduction Primary-Pond

September 2006 Spinach E. coli Incident



**CNN
arrives:
What's the
story?**

**Would you use
reclaimed water?**

**Would you eat these
crops?**

Yes!

- **Safe!**
- **Meets Leafy Greens & Organic Farming**
- **Diversity—Independent Source**
- **Sustainable—Drought Tolerant Supply**
- **Inexpensive as New Water Source**
- **Plant Nutrients**
- **No Yield Loss**





Questions?

***“Changing Wastewater
To Safe Water”***

Bob Holden

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