WATER RECYCLING AT MONROVIA NURSERY COMPANY, AZUSA, CALIFORNIA, AND DAYTON, OREGON —AN OVERVIEW

RICK WELLS

Monrovia Nursery Company
P. O. Box Q
Azusa, California 91702

During the early seventies, Monrovia Nursery Company, seeing the writing on the wall, began investigating the possibilities of controlling water runoff to conserve water, protect the environment, reduce regulatory constraints, and save money.

In 1969, the California legislature, upon recommendation from the State Water Resources Control Board, passed the Porter-Cologne Water Quality Control Act, and in 1972 Congress amended the Federal Water Pollution Control Act (which was originally drafted in 1956). The U.S. Environmental Protection Agency had delegated to the regional Boards the responsibility of setting water standards for their areas. The Los Angeles Water Quality Control Board set certain parameters for discharge water (Table 1), and in 1975 we were asked to monitor our discharges.

Table 1. Limits set by the Los Angeles Water Quality Control Board for constituents in discharge waters

Constituent	mg liter⁻¹
Suspended solids	75
Biological oxygen demand (BOD)	30
Oil and grease	15
Total dissolved solids	750
Nitrate N	10
Chloride	175
Chloride and sulfate	500
Total chromium	0 01
Surfactants	0 5
Total identifiable chlorinated hydrocarbons	0 004
Turbidity	75 ntu
Settleable solids	0 2 ml liter⁻¹

The Los Angeles Water Quality Control Board, following Federal clean water standards, set a limit of 45 ppm nitrate (10 ppm nitrogen) for waste water. Any nursery using a liquid constant feed system utilizing ammonium nitrate, feeding at a rate of 200 ppm nitrogen, would have 100 ppm nitrate in their runoff. Preliminary tests with a minor system of filtration of water for reuse proved to be unsatisfactory. For one thing, overhead irrigation with dirty water resulted in dirty, unsalable plants. Our research department undertook a study of all the possible ways of meeting these new standards including: diluting runoff enough with clean water to allow discharge into sewers, denitrification, collecting runoff and reusing on alternative field crops or acreage, and a complete water treatment and blending process which would allow reuse.

We already knew that irrigation runoff could not simply be filtered and reused. Conrad Skimina, our research director, conducted extensive research to study: the effects of water treatment chemicals on plants, disinfection of water (including chlorine and chloramine phytotoxicity), the effectiveness of flocculation chemicals and polymers on water clarification, salinity build-up, disposal or reuse of sludge, efficacy of sedimentation , design of the systems, runoff and water consumption, changes in the elemental constituents of the water, effects of herbicides, and costs of treatment.

A decision was made to recycle based on our concern for conservation of water and energy and was intended to reduce pollution and regulatory constraints. Recycling resulted in zero discharge and consequently did not require a discharge permit. Prior tests with plant growth response to treated/blended recycled water was generally favorable.

The culmination of all our studies and concerns was the construction of a water treatment plant in 1979 at a cost of 1.3 million dollars. The plant consists of seven sedimentation pits, an equalization reservoir, upflow clarifier, filter, blending pit, and storage reservoir. The water drains from irrigated beds into open ditches and canals which culminate in sedimentation pits. The sedimentation pits are actually small reservoirs where sand and silt are settled out and floating debris is baffled. The water, still laden with clay and some silt, overflows into pump pits where it is pumped to the equalization basin to allow further settling of silt. From this point, the water is pumped into a treatment building where the pH is adjusted prior to the addition of flocculation and coagulant aids. Clarification follows as a result of the settling of the flocculated clay. The water spills over the top of the upflow clarifier and is then disinfected with monochloramine. Next, the water is polished by a filtration process using gravel, sand, and anthracite coal. It is then blended at a ratio of one to one with fresh, fortified water to make up the losses due to percolation, evaporation, and plant use. The finished water flows into a 1.3 million gallon reservoir for reuse. The plant is capable of processing 2.3 million gallons of runoff per day (Figure 1).

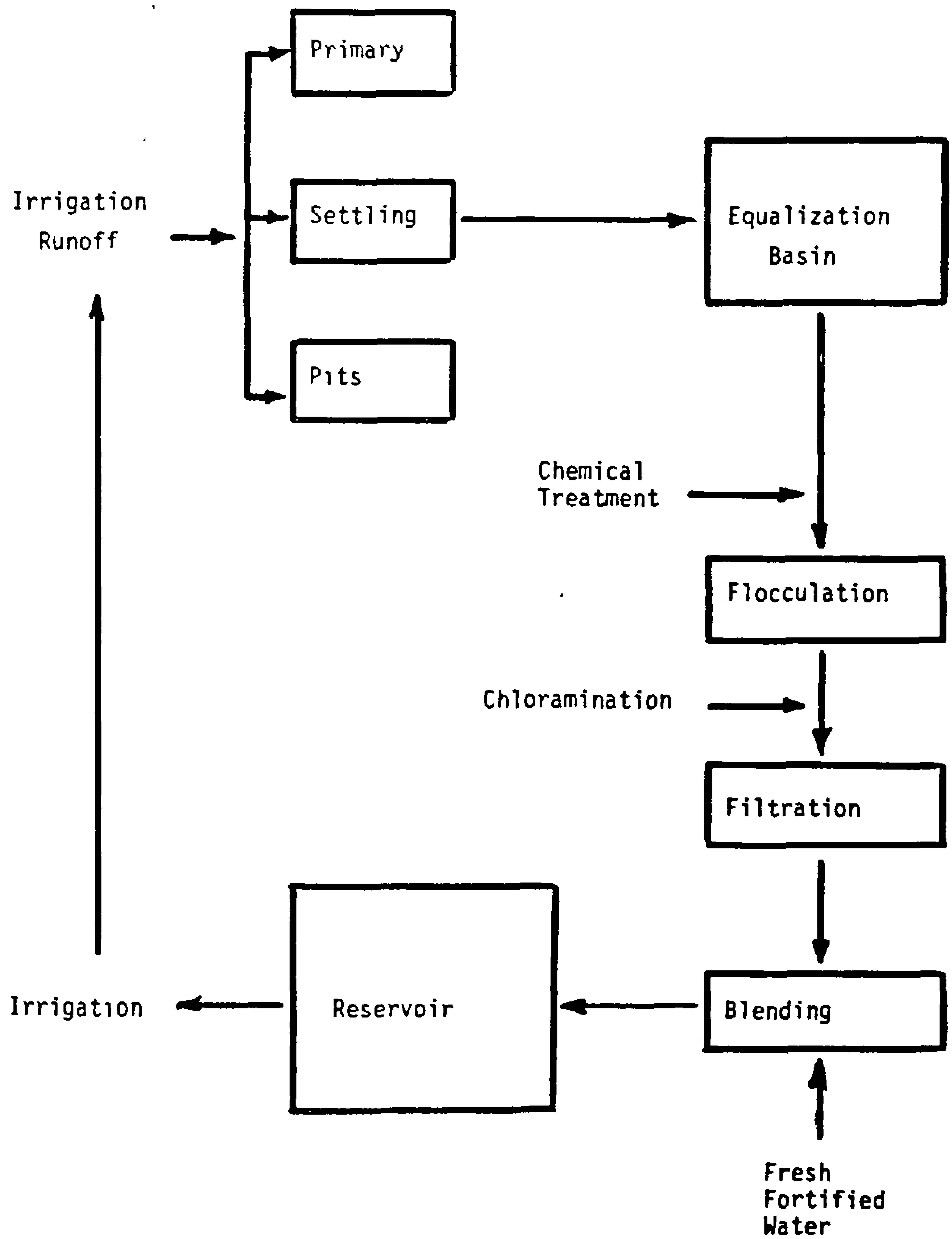

Figure 1. Schematic of water recycling and treatment (Azusa, California).

In 1984, Monrovia Nursery Company undertook a careful expansion program by opening a new production facility in the Willamette Valley of northern Oregon. We knew from the start, despite water being plentiful and of excellent quality, that water management would be a primary concern. From day one, all development in Oregon was done with the plan of recycling 100 percent of our runoff. Only recently have the regulatory agencies (namely the Department of Environmental Quality and the Oregon Department of Agriculture) initiated an effort to address waste water discharge. They are now in the final stages of setting the parameters (which will need to be met by 1993) for many of the river basins. In addition to nitrogen, phosphorus (which is not listed on Los Angeles' parameters) is of concern because it is thought by some to be a contributing factor driving algae growth on rivers and lakes during the summer.

Because of the Oregon environment, there are a couple of additional alternatives to recycling which could be considered. They are: to allow for soil buffer strips around nurseries (especially small growers) to permit soil attentuation and absorption of potential runoff, use of artifical wetlands to filter nutrients from the runoff (natural denitrification), or the use of "pulse" irrigation (increased frequency and decreased duration of applications). The idea of "pulse" irrigation is now also being tried by many Southern California growers.

Our nursery in Oregon is situated on fairly flat land (2 to 3 percent slope) which necessitated the need for grading, graveling (6 in. thick), and tiling the growing beds. All canals and ditches are also graveled with "rip-rap" (a 6 in. diameter rock) to minimize erosion. All of this gravel acts as a crude filter and decreases the turbidity of the slow-moving water on its way back to the sedimentation or settling pit. At the settling pit, any remaining silt is settled out and floating debris is collected. In Oregon, the settling pit may be a formed concrete structure or an informal pit preceding a collection pond. The collection ponds are large (up to 30 acre-feet) and quiescent, allowing natural clarification to occur. The water is introduced and chlorinated at one end of the pond and pumped out of the other end. We try to maintain a residual of 3 to 5 ppm chlorine at this point. From the collection pond, the water is pumped to a reservoir where it is blended with fresh water; after blending, the chlorine residual will be 1 to 1½ ppm. The water is monitored and refortified prior to reuse (Figure 2).

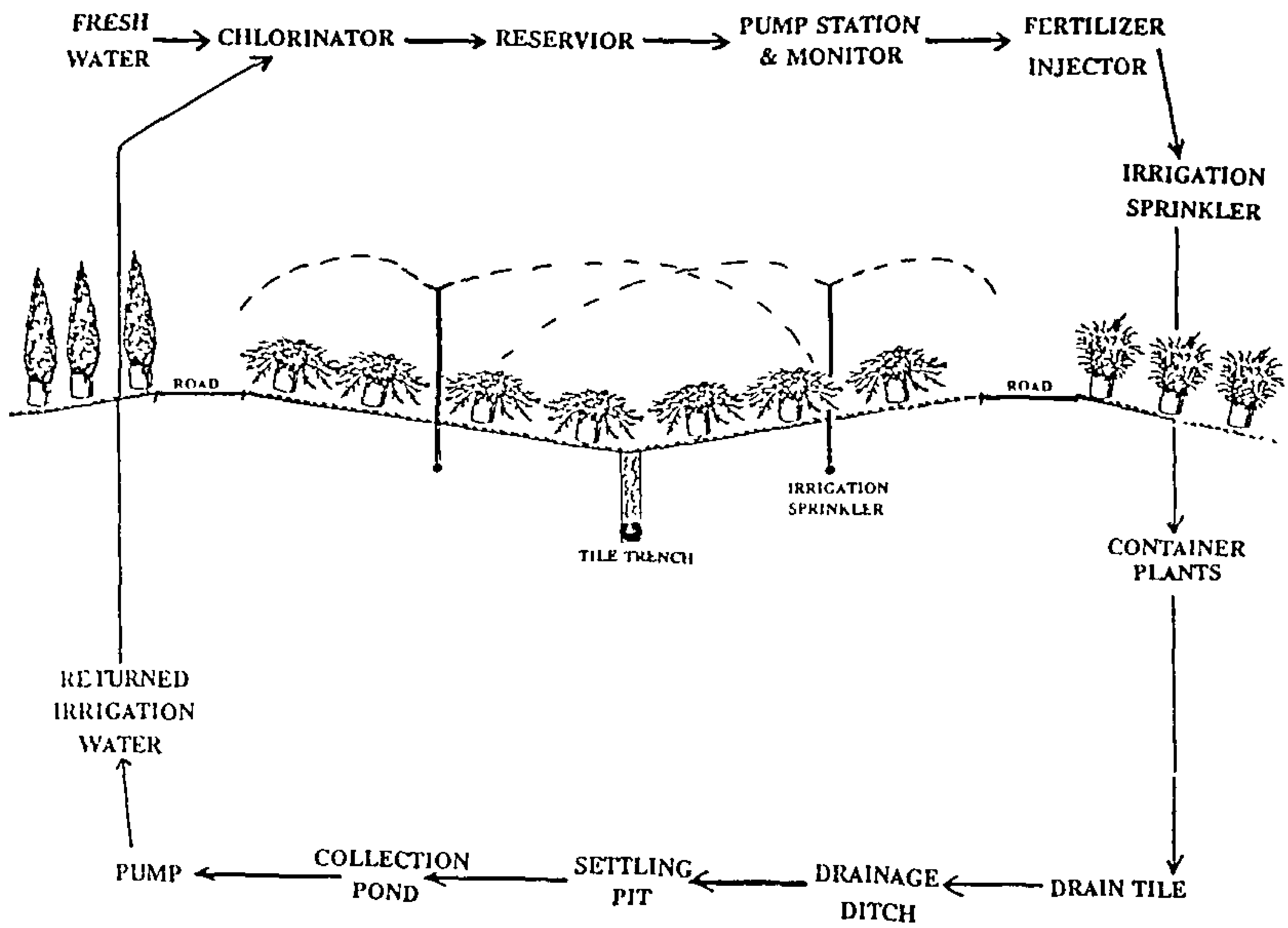

Figure 2. Schemetic of water recycling and treatment. (Dayton, Oregon)

In California, recycled water is used on everything except cuttings, liners, azaleas, and camellias. In Oregon, it is used on the entire nursery with the exception of cutting propagation. When we began recycling, we studied 106 cultivars to compare their growth and color under actual recycled water to that of fresh fortified water. A random sample of 31 of these cultivars were tested in depth and showed an overall mean growth of 106% compared with 100% for the fresh fortified water. Some cultivars did show plant response decreases which may have been due to phytotoxicity to specific compounds found in leachates or to traces of herbicides (Table 2).

Table 2. Plant response to recycled[z] vs non-cycled water[y]

Plant	% Relative growth[x], recycled water
Actinidia deliciosa (syn *A. chinensis*)	159[w]
Araucaria heterophylla	96
Arbutus unedo 'Compacta'	95
Berberis thunbergii 'Atropurpurea'	171
Brunfelsia pauciflora 'Floribunda'	85
Buxus microphylla var *japonica*	100
Cedrus deodara	104
Cinnamomum camphora	94
Crassula argentea	120
Cryptomeria japonica 'Nana'	100
Cupressus sempervirens 'Glauca'	100
C macrocarpa 'Donard Gold'	90
Ensete ventricosum	111
Gelsemium sempervirens	73
Hibiscus mutabilis 'Rubrus'	91
H rosa-sinensis 'Ross Estey'	85
Juniperus chinensis 'Keteleeri	120
J chinensis 'Robusta Green'	92
J sabina 'Broadmoor'	100
J scopulorum 'Pathfinder'	110
J virginiana 'Cupressifolia'	100
Magnolia grandiflora	102
Mahonia aquifolium 'Compacta'	102
Nerium oleander 'Cherry Ripe'	95
Osmanthus heterophyllus 'Variegatus'	110
Pinerus canariensis	95
P thunbergiana	95
Platycladus orientalis 'Aureus Nanus'	84
Prunus caroliniana 'Bright 'n Tight'	160
Raphiolepis indica 'Enchantress'	94
Syzygium paniculatum	73

[z] 50% processed runoff and 50% fresh fortified make-up water
[y] Fresh, fortified water
[x] Compared with 100% for non-cycled water
[w] Means of 14 replicates

Recycling results in 50% water conservation which, with a constant fertilization system, also translates to a 50% savings of most nutrients. Our research department found that all nutrient elements increased in recycled water with the exception of nitrogen and iron. Nitrogen remains relatively constant and iron decreases (Table 3). This negates the need to add many of these nutrients to the fresh makeup water.

Table 3. Percent change in constituents in processed runoff water

Compared with fortified fresh water (blend water)	Constituent	Compared with reservoir water[z] (irrigation water)
140	H	100
-0 4	pH	-0.3
11	EC	7
-45	NH_4N	-20
38	No_3N	8
0 6	Total N	-0.6
0	P	25
17	K	2
184	Ca	54
189	Mg	44
14	Fe	14
50	Cu	0
150	Zn	67
360	Mn	92
113	Na	55
3	B	-6
6	NTU[y]	-3

[z] 50% processed runoff + 50% fresh fortified water
[y] Nephelometric turbidity units

Another added benefit that our research department has documented is an 82% reduction in *Poa annua* seed germination. This is due to a slight residual of the herbicides we use in our system.

Of primary concern with any system designed to reuse water for plant irrigation is the possible build up of unwanted salts. Fortunately, our fresh water supply is of excellent quality, being low in salinity, sodium, and boron. Even with the additional fortification of the water, all elements fall into satisfactory levels for good water quality. Salinity in the system increases on the average of 18% per cycle. This increase, however, is at a decreasing rate since it is blended with lower salinity, fresh, fortified water. Theoretically, the system will reach equilibrium by the seventh cycle (Table 4). The increase in salinity may range from 0% in the winter to 28% per cycle occasionally in the summer.

Table 4. Theoretical conductivity trends of re-cycled water

Recycling sequence	Run-off + 18% / cycle	MHO'S x 10^5 make-up water	Mean of 50/50 blend applied water
0	—	120	120
1	142	120	131
2	155	120	137
3	162	120	141
4	166	120	143
5	169	120	144
6	170	120	145
7	171	120	146[z]
8	171	120	146

[z] Equilibrium

Allocation of costs for operating the treatment plant in California is: energy, 47.8%; chemicals, 38.4%; equipment maintenance, 5.1%; and labor, 8.7%. It presently costs $417.00 to process one million gallons of water or $135.00 per acre foot. Oregon costs are, of course, much lower.

If the water regulatory agencies in your area have not addressed waste water management practices or set parameters to meet clean water standards, rest assured they will soon. But why wait? Our industry does more to beautify and cleanse the environment than any other. We, the producers of living, green plants, want always to be perceived as the "good guys".

Finally, I would like to thank Conrad Skimina, Research Director for Monrovia Nursery Company, for his help in preparing this paper.

CLAYTON FULLER: In pond areas not plastic lined, will settling of pollutants occur and will this be a problem in 20 to 25 years if core samples are taken? Will we (nursery businesses) be in the same situation as the gas station operator with a leak?

RICK WELLS: That is a good question. In California all reservoirs are concrete lined and all the sludge is used in our soil mix and disposed of that way. In Oregon we are placing pilot wells around the perimeter to look for contaminants. It may be necessary to line the ponds in the future.