Appendix P
Irrigation Water Quality Guidelines

This appendix provides guidelines for irrigation water quality. It draws heavily on the Australian Water Quality Guidelines for Fresh and Marine Waters, published in November 1992 by the Australian and New Zealand Environmental and Conservation Council.

For a more detailed account and explanation of the rationale behind the levels set out in this appendix, readers are referred to Section 5.1 (Irrigation) of Chapter 5 (Agricultural Water Uses) of the above publication.

Table P1 - Summary of Guidelines for Irrigation Water Quality

Parameter	Guideline (mg/L, unless otherwise stated)	Comment
Chloride	30-700 (Tables P2, P3, P4)	Maximum concentration should be set according to sensitivity of crop
Sodium	Crops Table P5	
Total dissolved solids	Tables P6, P7	
*Heavy Metals and Trace Irons**		
Aluminium	5.0	High toxicity in acid soils
Arsenic	0.1	
Beryllium	0.1	
Boron	0.5-6.0	Table P8
Cadmium	0.01	Higher toxicity in acid soils
Chromium	1.0	Limit chromium (VI) concentration to 0.1 mg/L.
Cobalt	0.05	
Copper	0.2	
Fluoride	1.0	
Iron	1.0	
Lead	0.2	
Lithium	2.5	Citrus 0.075 mg/L
Manganese	2.0	If acid soils, limit to 0.2 mg/L.
Mercury	0.002	
Molybdenum	0.01	
Nickel	0.2	
pH ($CaCl_2$)	4.5-9.0	
Selenium	0.02	

Table P1 - Summary of Guidelines for Irrigation Water Quality		
Parameter	**Guideline (mg/L, unless otherwise stated)**	**Comment**
Uranium	0.01	
Vanadium	0.1	
Zinc	2.0	1 mg/L is recommended for sandy soil below pH 6
Pesticides		
Insecticides	-	No guidelines recommended
Herbicides	Table P9	
Radioactivity	Gross Alpha 0.1 Bq/L. Gross Beta 0.1 Bq/L	

* Higher maximum concentrations may be recommended in neutral to alkaline soils.

Table P2 - Chloride Tolerance of Fruit and Woody Crops by Root Uptake			
Rootstocks	**Chloride in Irrigation Water (mg/L)**	**Cultivars**	**Chloride in Irrigation Water (mg/L)**
Grapes	710-960	Boysenberry	250
Stone-fruits (peaches, plums etc)	180-600	Blackberry	
Strawberries	110-180	Raspberry	

Sources: Westcot and Ayers (1984); CCREM (1991)

Table P3 - Chloride Concentrations in Irrigation Water causing Foliar Damage		
Sensitivity	**Chloride (mg/L)**	**Affected Crop**
Sensitive	<178	Almond, Apricot, Plum
Moderately sensitive	178-355	Grape, Pepper, Potato, Tomato
Moderately Tolerant	355-710	Alfalfa, Barley, Corn, Cucumber
Tolerant	>710	Cauliflower, Cotton, Safflower, Sesame, Sorghum, Sugar-beet, Sunflower

Sources: Westcot and Ayers (1984)

Table P4 - Tolerance of Chloride Sensitive Crops to Chloride in Irrigation Water		
Crop	**Irrigation Method**	**Maximum Chloride Concentrations (mg/L)**
Citrus	Overhead Sprinklers	100
	Under-tree Sprinklers	265
Stone-fruit	Overhead Sprinklers	70
	Under-tree Sprinklers	175
Vines	-	350
Tobacco	Overhead Sprinklers	30

Source: Callinan (1970), Jones (1972), AWRC (1969)

Table P5 - Tolerance of Crop to Sodium			
Tolerance	***SAR of Irrigation Water**	**Crop**	**Condition**
Very sensitive	2-8	Deciduous fruits, nuts, citrus, avocado	Leaf tip burn, leaf scorch
Sensitive	8-18	Beans	Stunted, soil structure favourable
Moderately tolerant	18-46	Clover, oats, tall fescue, rice	Stunted due to nutrition and soil structure
Tolerant	46-102	Wheat, lucerne, barley, tomatoes, beets, tall wheat grass, crested grass, fairway grass	Stunted due to poor soil structure

Source: Hart (1974)

* SAR - Sodium Adsorption Ratio (the relative proportions of sodium ions to calcium and magnesium ions in the water).

Table P6 - General Guidelines for Salinity of Irrigation Water			
Class	**Comment**	**Electrical Conductivity (μS/cm)**	**TDS (mg/L)***
1	Low salinity water can be used with most crops on most soils and with all methods of water application with little likelihood that a salinity problem will develop. Some leaching is required, but this occurs under normal irrigation practices except in soils of extremely low permeability.	0-280	0-175

Table P6 - General Guidelines for Salinity of Irrigation Water			
Class	**Comment**	**Electrical Conductivity (μS/cm)**	**TDS (mg/L)***
2	Medium-salinity water can be used if moderate leaching occurs. Plants with medium salt tolerance can be grown, usually without special measures for salinity control. Sprinkler irrigation with the more-saline waters in this group may cause leaf scorch on slat-sensitive crops, especially at high temperatures in the daytime and with low application rates.	280-800	175-500
3	High-salinity water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required, and the salt tolerance of the plants to be irrigated must be considered.	800-2,300	500-1,500
4	Very high-salinity water is not suitable for irrigation water under ordinary conditions. For use, soils must be permeable, drainage adequate, water must be applied in excess to provide considerable leaching, and salt-tolerant crops should be selected.	2,300-5,500	1,500-3,500
5	Extremely high-salinity water may be used only on permeable, well-drained soils under good management, especially in relation to leaching and for salt-tolerant crops, or for occasional emergency use.	>5,500	>3,500

Source: Hart (1974)

* TDS (mg/L) = 0.68 x electrical conductivity (μS/cm).

Table P7 - Relative Tolerance of Crop Plants to Saline Irrigation Water							
Water Class	**EC (μS/cm)**	**TDS (mg/L)**	**Suggested Plant**				**Precautions for Irrigation Uses**
			Pastures and Fodders	**Fruit**	**Vegetables**	**Ornamentals**	
1 / 2	0-800	0-500	Ladino Clover Red Clover Alsike Clover White Dutch Clover Subterranean Clover	Persimmon Loquat Passionfruit Strawberry Avocado Almond Apricot Peach Plum Lemon Grapefruit Orange Grape Walnut	Parsnips Green beans Celery Radish Cucumber Squash Peas Onion Carrot Potatoes Sweet Corn Lettuce French beans	Violet African Violet Primula Gardenia Begonia Azalea Camellia Magnolia Fuchsia Dahlia	Avoid wetting leaves on hot, dry days
3	800-2,000	500-1,500	Cocksfoot Perennial ryegrass	Mulberry Apple Pear Raspberry] Quince	Cauliflower Bell pepper Cabbage Broccoli Tomato Broad beans Field beans Sweet potato Artichoke	Geranium Gladiolus Bauhinia Zinnia Rose Aster Poinsettia Musa Podocarpus	Avoid wetting leaves during daytime. Avoid light, frequent waterings. Water quickly and use continuous-wetting sprinklers if wetting the leaves.

Table P7 - Relative Tolerance of Crop Plants to Saline Irrigation Water							
Water Class	**EC (μS/cm)**	**TDS (mg/L)**	**Suggested Plant**				**Precautions for Irrigation Uses**
			Pastures and Fodders	**Fruit**	**Vegetables**	**Ornamentals**	
4	2,300-5,500	1,500-3,500	Oats (hay) Wheat (hay) Rye (hay) Lucerne Sudan grass *Paspalum dilatatum* Strawberry clover Sweet clovers Millet Wimmera ryegrass Rhodes grass Couch grass Barley Bridsfoot trefoil	Olive Fig Pomegranate Cantaloupe	Spinach Asparagus Kale Garden beets Gherkins	Stock Chrysanthemum Carnation Hibiscus Oleander Bougainvillea Vinca Aust. Hop bush Coprosma (green and variegated) Japanese pepper *Fiscus. Spp.* In gen *Fiscus hilli* False acacia Qld pyramid tree NZ Christmas Bush False mahogany Rottnest ti-tree *C. cuppressiformis* Rottnest cyprus *Acacia longifolia* Buffalo grass Kikuyu grass Portulaca Mesembryanthemum Boobyalla Morrel Swamp yate York gum	Avoiding wetting leaves of most plants where possible. Adequate leaching necessary.

Table P7 - Relative Tolerance of Crop Plants to Saline Irrigation Water							
Water Class	**EC (μS/cm)**	**TDS (mg/L)**	**Suggested Plant**				**Precautions for Irrigation Uses**
			Pastures and Fodders	**Fruit**	**Vegetables**	**Ornamentals**	
5	>5,500	3,500	Seashore paspalum *Puccinella ciliata* Saltwater couch	Date palm		Couch grass Bamboo Kondinin blackbutt Canary palm *Paspalum vaginatum* Salt sheoaks Salt river gum Tamarisks (evergreen and deciduous) Saltbushes	Do not wet leaves where possible. Excellent drainage and leaching essential.

EC: Electrical Conductivity

Note:

The plant and water groupings are not meant to be rigid, but merely provide a general guide. Plants are arranged in approximate order of salt tolerance in each column, with the least tolerant at the top. Soil texture and drainage may be extremely important. Plants listed as suitable for saline water will grow better with less-saline water.

Source: Hart (1974)

Table P8 - Relative Tolerance of Agricultural Crops to Boron		
Tolerance*	**Concentration of boron in soil water (mg/L)****	**Agricultural Crop**
Very sensitive	<0.5	Blackberry
Sensitive	0.5-1.0	Peach, cherry, plum, grape, cowpea, onion, garlic, sweet potato, wheat, barley, sunflower, mung bean, sesame, lupin, strawberry, Jerusalem artichoke, kidney beans, lima beans
Moderately sensitive	1.0-2.0	Red pepper, pea, carrot, radish, potato, cucumber
Moderately tolerant	2.0-4.0	Lettuce, cabbage, celery, turnip, Kentucky bluegrass, oat, corn, artichoke, tobacco, mustard, clover, squash, musk melon.
Tolerant	4.0-6.0	Sorghum, tomato, alfalfa, purple, vetch, parsley, red beet, sugar-beet.
Very Tolerant	6.0-15.0	Asparagus

* Tolerance will vary with climate, soil conditions and crop varieties; values are to be used as a guideline only.

** Maximum concentrations tolerated in irrigation water without reduction in yield or vegetative growth are approximately equal to soil water values.

Table P9 - Herbicides Registered for Use in or near waters (mg/L)			
Herbicide	**Residue Limits in Irrigation Water**	**Hazard to Crops from Residue in Water****	**Crop Injury Threshold in Irrigation Water (mg/L)**
Acrolein	0.1	+	Flood or furrow: beans 60, corn 60, cotton 80, soybeans 20, sugar-beets 60. Sprinkler: corn 60, soybeans 15, sugar-beets 15
AF 100	*	+	Beets (rutabag) >3.5, corn 3.5
Amitrol	0.002	++	Lucerne 1600, beans 1200, carrots 1600, corn 3000, cotton 1600, grains sorghum >800,
Aromatic solvents (Xylene)	*	+	Oats 2400, potatoes 1300, wheat 1200.
Asulam	*	++	
Atrazine	*	++	
Bromazil	*	+++	
Chlorthiamid	*	++	
Copper sulfate	*	+	Apparently above concentrations used for weed control (see irrigation criterion for copper)
2,4-D	*	++	Field beans 3..5-10, grapes 0.7-1.5, sugar-beets 1.0-10
Dicamba	*	++	Cotton 0.18
Dichlobenil	*	++	Lucerne 10, corn >10, soybean 1.0, sugar-beets 1.0-10, corn 125, beans 5
Diquat	*	+	
Diuron	0.002	+++	
2,2-DPA (Dalapon)	0.004	++	Beets >70, corn <0.35
Fosamine	*	+++	
Fluometuron	*	++	Sugar-beets, alfalfa, tomatoes, squash >2.2
Glyphosate	*	+	
Hezaxinone	*	+++	
Karbutilate	*	+++	

Table P9 - Herbicides Registered for Use in or near waters (mg/L)			
Herbicide	**Residue Limits in Irrigation Water**	**Hazard to Crops from Residue in Water****	**Crop Injury Threshold in Irrigation Water (mg/L)**
Molinate	*	++	
Paraquat	*	+	Corn >10, field beans 0.1, sugar-beets <1.0
Picloram	*	+++	
Propanil	*	++	Alfalfa 0.15, brome grass (eradicated) 0.15
Simazine	*	++	
2,4,5-T	*	++	Potatoes, alfalfa, garden peas, corn, sugar-beets, wheat, peaches, grapes, apples, tomatoes
TCA	*	+++	>0.5
Terbutryne	*	++	
Triclopyr	*	++	

* Guideline not set except as a general limit (0.1 mg/L) for specific herbicides in Tasmania and all herbicides in New South Wales.
** Hazard from residue at the expected minimum concentrations" + = low, ++ = moderate, +++ = high.
> Damage may occur at higher than this level.

Sources: NHMRC (1985), Hart (1974)m, CCREM (1991), Demint et al (1975), Bruns et al. (1972), Comes and Kelly (1979).