# Technical Report Documentation Page

**1. REPORT No.**

**2. GOVERNMENT ACCESSION No.**

**3. RECIPIENT'S CATALOG No.**

**4. TITLE AND SUBTITLE**

Effects of Reclaimed Water on Highway Plantings, Soils, and Irrigation Equipment

**5. REPORT DATE**

1987

**6. PERFORMING ORGANIZATION**

**7. AUTHOR(S)**

Harold Hunt and Ted Bakker

**8. PERFORMING ORGANIZATION REPORT No.**

**9. PERFORMING ORGANIZATION NAME AND ADDRESS**

State of California
Department of Transportation
Division of Construction
Office of Transportation Laboratory

**10. WORK UNIT No.**

**11. CONTRACT OR GRANT No.**

**12. SPONSORING AGENCY NAME AND ADDRESS**

**13. TYPE OF REPORT & PERIOD COVERED**

Final Report

**14. SPONSORING AGENCY CODE**

**15. SUPPLEMENTARY NOTES**

**16. ABSTRACT**

2. Objectives

1. To determine the effects of irrigation using reclaimed wastewater on soils located along California highways.
2. To determine the effects of irrigation using reclaimed wastewater on on ornamental landscape landscape vegetation located along California highways.
3. To determine the effects of irrigation using reclaimed wastewater on irrigation water distribution systems.
4. To develop guidelines for using reclaimed wastewater as an alternative to using potable water for irrigating ornamental highway landscaping.

**17. KEYWORDS**

**18. No. OF PAGES:**

145

**19. DRI WEBSITE LINK**

http://www.dot.ca.gov/hq/research/researchreports/1981-1988/87-13.pdf

**20. FILE NAME**

87-13.pdf

This page was created to provide searchable keywords and abstract text for older scanned research reports.
November 2005, Division of Research and Innovation

DND

87-13

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

State of California
Department of Transportation
Division of Construction
Office of Transportation Laboratory

# EFFECTS OF RECLAIMED WATER ON HIGHWAY PLANTINGS, SOILS, AND IRRIGATION EQUIPMENT

FINAL REPORT

Study Supervised by.....Mas Hatano, PE

Principal Investigator.....Bennett John, PE

Co-Investigators.....Ted Bakker, PE
David Sollenberger, PE
Harold Hunt

Report Prepared by.....Harold Hunt
Ted Bakker, PE

RAYMOND A. FORSYTH, PE
Chief, Office of Transportation Laboratory

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## NOTICE

The contents of this report reflect the views of the Office of Transportation Laboratory which is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Neither the State of California nor the United States Government endorse products or manufacturers. Trade or manufacturers' names appear herein only because they are considered essential to the object of this document.

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

# CONVERSION FACTORS

## English to Metric System (SI) of Measurement

| Quality | English unit | Multiply by | To get metric equivalent |
|---|---|---|---|
| Length | inches (in)or(") | 25.40<br>.02540 | millimetres (mm)<br>metres (m) |
| | feet (ft)or(') | .3048 | metres (m) |
| | miles (mi) | 1.609 | kilometres (km) |
| Area | square inches ($in^2$)<br>square feet ($ft^2$)<br>acres | $6.432 \times 10^{-4}$<br>.09290<br>.4047 | square metres ($m^2$)<br>square metres ($m^2$)<br>hectares (ha) |
| Volume | gallons (gal)<br>cubic feet ($ft^3$)<br>cubic years ($yd^3$) | 3.785<br>.02832<br>.7646 | litre (l)<br>cubic metres ($m^3$)<br>cubic metres ($m^3$) |
| Volume/Time (Flow) | cubic feet per second ($ft^3/s$ | 28.317 | litres per second 1/s) |
| | gallons per minute (gal/min) | .06309 | litres per second (1/s) |
| | pounds (lb) | .4536 | kilograms (kg) |
| | miles per hour (mph)<br>feet per second (fps) | .4470<br>.3048 | metres per second (m/s)<br>metres per second (m/s) |
| Acc | feet per second squared ($ft/s^2$) | .3048 | metres per second squared ($m/s^2$) |
| | acceleration due to force of gravity (G) ($ft/s^2$) | 9.807 | metres per second squared ($m/s^2$) |
| Density | ($lb/ft^3$) | 16.02 | kilograms per cubic metre ($kg/m^3$) |
| Force | pounds (lbs)<br>(1000 lbs) kips | 4.448<br>4448 | newtons (N)<br>newtons (N) |
| Thermal Energy | British termal unit (BTU) | 1055 | joules (J) |
| Mechanical Energy | foot-pounds (ft-lb)<br>foot-kips (ft-k) | 1.356<br>1356 | joules (J)<br>joules (J) |
| Bending Moment or Torque | inch-pounds (in-lbs)<br>foot-pounds (ft-lbs) | .1130<br>1.356 | newton-metres (Nm)<br>newton-metres (Nm) |
| Pressure | pounds per square inch (psi)<br>pounds per square foot (psf) | 6895<br>47.88 | pascals (Pa)<br>pascals (Pa) |
| Stress Intensity | kips per square inch square root inch (ksi$\sqrt{in}$) | 1.0988 | mega pascals$\sqrt{metre}$ (MPa$\sqrt{m}$) |
| | pounds per square inch square root inch (psi$\sqrt{in}$) | 1.0988 | kilo pascals$\sqrt{metre}$ (KPa$\sqrt{m}$) |
| Plane Angle | degrees (°) | 0.0175 | radians (rad) |
| Temperature | degrees fahrenheit (F) | $\frac{+F - 32}{1.8} = +C$ | degrees celsius (°C) |

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## GLOSSARY

Biochemical Oxygen Demand- The amount of oxygen required for microorganisms to oxidatively decompose a material in wastewater, expressed in milligrams per liter (mg/l).

Chemical Oxygen Demand- The amount of oxygen required to oxidize carbonaceous material in wastewater using dichromate or permanganate salts as oxidants expressed in milligrams per liter (mg/l).

Drip Irrigation System- An irrigation system which continuously supplies small amounts of water through small tubes and emitters to the plants being irrigated.

Electrical Conductivity- A measure of the salinity of water made by determining the resistance of the water to the flow of an electrical current, expressed in millimohs per centimeter (mmho/cm), or decisiemens per meter (dS/m).

Emitter- The part of a drip irrigation system which distributes the water to the plant being irrigated.

Enterovirus- A virus which lives and reproduces in the human intestinal tract. Some enteroviruses produce disease.

Macronutrients- Seven nutrient elements (N, P, S, K, Ca, Mg, Fe) required by plants in relatively large amounts.

Micronutrients- Nutrient elements (Cu, Mn, Zn, and etc.) required by plants in relatively small amounts.

Pathogen- A disease producing organism.

Phytotoxin- A substance which is toxic to plants.

Potable Water- Water suitable for drinking and other domestic purposes.

Reclaimed Wastewater- Water used for industrial or domestic purposes, treated to remove contaminants and reused.

Salinity- The total solids in water after all the carbonates have been converted to oxides, all bromides and iodides have been replaced by chloride, and all organic matter has been oxidized. Reported as grams per kilogram (g/kg).

Total Dissolved Solids- The sum of all the dissolved solids in a water sample, expressed in milligrams per liter (mg/l).



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## ACKNOWLEDGEMENTS

The authors wish to acknowledge the following people who assisted in this study. A. C. Chang, G. R. Bradford, J. E. Warneke, and R. Shepherd of the University of California at Riverside who were contracted to perform technical services. David Sollenberger and Jeff Gidley of the TRANSLAB who worked on this project. And Phyllis Vought who performed secretarial services for the project.

## Financial Disclosure Statement

This research is jointly funded by the State of California, Department of Transportation (CALTRANS) and the Federal Highway Administration (FHWA). The ceiling amount for this contract, R83HM22 is $185,700.



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

TABLE OF CONTENTS

1. INTRODUCTION..... 1

2. OBJECTIVES..... 4

3. CONCLUSIONS..... 5

4. RECOMMENDATIONS..... 6

5. IMPLEMENTATION..... 7

6. BACKGROUND ..... 8

6.1 Reclaimed Wastewater Quality..... 8

6.2 Reclaimed Wastewater Source Reliability..... 11

6.3 Reclaimed Wastewater and Potable Water Costs.. 11

6.4 Long-Term Use of Reclaimed Wastewater for Irrigation..... 12

7. METHODS AND PROCEDURES..... 16

7.1 Test and Control Sites..... 16

7.2 Vegetation Studies ..... 16

7.3 Soil Studies..... 17

7.4 Other Factors..... 18

7.5 Aesthetics..... 18

8. RESULTS AND DISCUSSION ..... 20

8.1 Reclaimed Wastewater Quality ..... 20

8.2 Soil Assessment..... 22

8.3 Elemental Contents of Leaf Tissue..... 23

8.4 Public Health Concerns..... 25

8.5 Aesthetics..... 29

8.6 Effects of Reclaimed Wastewater on Irrigation Equipment..... 30

8.7 Impacts of Reclaimed Wastewater Irrigation on Water Quality..... 31



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

9. GUIDELINES FOR THE USE OF RECLAIMED WASTEWATER FOR FOR HIGHWAY LANDSCAPE IRRIGATION..... 33

9.1 Choice of Vegetation..... 33

9.2 Cost of Irrigation Water..... 34

9.3 Reclaimed Wastewater Quality..... 34

9.4 Stability of Reclaimed Wastewater Supply..... 35

9.5 Measures to Protect Public Health..... 35

9.6 Equipment..... 36

9.7 Key of the Stages to Follow When Considering the Use of Reclaimed Wastewater for Irrigating Highway Landscaping..... 37

10. CITATIONS..... 40

APPENDIX.....
UCR Group Test Results



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

# 1. INTRODUCTION

Potable water is generally used to irrigate ornamental highway landscaping in urban areas where there is insufficient rainfall to properly maintain the the plants. The potable water used is part of the domestic water supply for the community in which the landscaping exists. However, a growing shortage of potable water in parts of California is causing an increase in the price of potable water.

To conserve potable water, Caltrans is considering using reclaimed wastewater to irrigate ornamental freeway landscaping in the drier parts of California. Wastewater is water that has already been used by a community. Community use degrades water by adding materials to the water which prevent its later use.

The purpose of this study is to determine if using reclaimed wastewater to irrigate ornamental freeway landscaping will damage landscape plants, soil, or irrigation systems, or if such use will degrade surface or groundwater quality. Reclaimed wastewater may contain higher concentrations of toxic metals and total dissolved solids (TDS) and may have higher salinity and higher chlorine concentrations than potable water. Additionally, reclaimed wastewater will contain higher nutrient levels than potable water.

At concentrations above safe levels, toxic metals may cause plants to die. At sublethal levels these metals may stunt plant growth. Because different plant species have different tolerances for various toxic metals, the amount of these metals in the soil may limit the species of plants that can be grown at a contaminated site. Toxic metals sometimes accumulate in plant



ClibPDF - www.fastio.com

tissues. Perennial ornamental landscape plants may have a greater tendency to accumulate toxic metals in their tissues than annual plant species. Soils may also accumulate toxic metals over time. This concerns Caltrans because irrigation with reclaimed wastewater will continue for several years.

Higher total dissolved solids and salinity levels may also negatively affect plant growth ( 1,2,3,4 ). As with toxic metals, high salinity levels may limit what plant species may grow at a site. It is well known that irrigation water can be a significant source of salt in a soil. Poor irrigation practices can render some soils too saline for agricultural use. Increased salinity can cause significant changes in soil structure. This concerns Caltrans, because irrigation with reclaimed wastewater will continue for several years, perhaps leading to a buildup of soil salinity, or other toxic ions such as boron ions.

Another concern is that high chlorine disinfectant concentrations in reclaimed wastewater will negatively affect freeway landscape plants. The concern is that the chlorine disinfectant will kill the plants or retard their growth (2,4).

The effect of reclaimed wastewater on the piping and other distribution system elements of irrigation systems is not known. One of the purposes of this research is to determine if the different physical and chemical properties of reclaimed wastewater will adversely affect irrigation systems.

The aesthetic appeal of freeway landscaping must be considered. The public expects freeway landscaping to be aesthetically pleasing. That decisions on aesthetics are subjective does not reduce the importance of this consideration.



ClibPDF - www.fastio.com

Wastewater treatment is commonly divided into three parts: primary treatment, secondary treatment, and advanced treatment. Primary treatment is the removal of most of the settleable solid materials from the wastewater. Secondary treatment is the oxidation of dissolved and colloidal organic materials in the wastewater. Advanced treatment is the reduction of inorganic minerals resulting from secondary treatment from the wastewater (2,5,6).

Part of this research was performed by A.C. Chang, G.R. Bradford, J.E. Warneke, and R. Shepherd of the University of California at Riverside (herein called the UCR group). The UCR group studied the soil and vegetation aspects of the use of reclaimed wastewater at the test sites. This research was performed under the provisions of a contract between the university and the California Department of Transportation. The rest of the study was performed by Caltrans personnel from the Transportation Laboratory (Translab).



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## 2. OBJECTIVES

1. To determine the effects of irrigation using reclaimed wastewater on soils located along California highways.

2. To determine the effects of irrigation using reclaimed wastewater on ornamental landscape vegetation located along California highways.

3. To determine the effects of irrigation using reclaimed wastewater on irrigation water distribution systems.

4. To develop guidelines for using reclaimed wastewater as an alternative to using potable water for irrigating ornamental highway landscaping.



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## 3. CONCLUSIONS

1. The use of tertiary treated reclaimed wastewater at the test sites had no negative impact on the soils of the test sites.

2. The use of tertiary treated reclaimed wastewater at the test sites had no negative impact on the landscape plant species of the test sites.

3. The use of tertiary treated reclaimed wastewater at the test sites had no negative impact on the irrigation equipment at the test sites.

4. The damage to irrigation equipment noted at the test sites was due to vandalism, and the lack of adequate maintenance effort.

5. The damage to the plants noted at the test sites was due to inadequate irrigation.

6. The use of tertiary treated reclaimed wastewater of reasonable quality should not degrade surface or ground water quality.

7. Guidelines were developed for using reclaimed wastewater as an alternative to using potable water.



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## 4. RECOMMENDATIONS

1. Reclaimed wastewater should be used whenever the criteria in the guidelines developed as part of this project are met.

2. Product research should be undertaken to determine the types of irrigation equipment that require the least amount of maintenance to effectively operate in the highway environment.

3. Guidelines for irrigation management should be developed and implemented. Developing these guidelines was not part of this project.

4. Research should be done to determine the best drought tolerant landscape species for various climate zones in California.



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## 5. IMPLEMENTATION

1. A copy of this report will be sent to the maintenance staff in each of the districts and in the appropriate headquarters offices.

2. The editors of the Highway Maintenance Manual, Highway Design Manual, and Environmental Handbook will be contacted to insure that the information presented in this report will be placed in the manuals.

3. During district assistance contacts and environmental review, use of reclaimed wastewater for irrigation will be mentioned when appropriate.

4. The results of this study will be presented in classes given by the Water Quality and Solid Waste Unit of the TransLab.



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

# 6. BACKGROUND

In order to minimize the construction of very large water transportation systems, with their associated adverse impacts, reuse of water should be given a greater emphasis. This should be done if water reuse can be accomplished without creating significant detrimental impacts on people, vegetation, animal life, food supplies, etc. Consequently, Caltrans studied the use of reclaimed wastewater for irrigating ornamental highway landscaping.

In selecting the landscape irrigation sites that were used in this study, three factors were considered. They were:

1- The quality of the reclaimed wastewater

2- The reliability of the reclaimed wastewater source

3- The length of time that wastewater has been used at the site.

## 6.1 Reclaimed Wastewater Quality

Reclaimed wastewater quality was a major determinant in the study site selection process. For convienience, water quality may be broken down into 3 components; physical, chemical and biological (3).

Physical water quality relates to such items as: the amount of suspended solids in the wastewater,the temperature, the color and the odor of the wastewater. The physical water quality is important in determining the types of irrigation equipment which can be used on a project, the impacts of the wastewater on the soil, and the public acceptance of reclaimed water use.



ClibPDF - www.fastio.com

Of greatest importance is the nature of the solids in the wastewater. The total solids content includes floating, suspended, and dissolved solids. Solid particles in the water may clog orifices in irrigation lines and emitters. The particles may also reduce soil permeability and change soil structure by clogging the soil pores.

The odors found in reclaimed wastewater are due to the aromatic products of the anaerobic decomposition of the organic materials in the wastewater. The color of the reclaimed wastewater depends on the level of water treatment, the age of the wastewater, and the organic content of the wastewater. The public will, generally, not accept irrigation water that looks dirty or smells bad. Consequently, the physical water quality of reclaimed irrigation wastewater must be good.

The chemical components of reclaimed wastewater can be divided into three units: gases, inorganic matter and organic matter. The gases found in reclaimed wastewater, aside from those gases which cause foul odors, are relatively unimportant for irrigation. A number of inorganic compounds are commonly found in reclaimed wastewater. Some of these compounds, particularly those containing nitrogen, phosphorus, and potassium are plant nutrients. Other compounds particularly those containing toxic metals and boron may be toxic to plants above threshold concentrations. Generally the aggregate of the dissolved compounds, the total dissolved solids, is more important than the concentrations of individual ions. Total dissolved solids levels above 750 mg/l can cause adverse salinity changes in soils. The ratio of calcium, sodium, magnesium and potassium ions to each other is important. If enough sodium ions are present in the wastewater sodium ions will replace the calcium and magnesium ions on clay particles in the soil and negatively affect soil structure (1,4).



ClibPDF - www.fastio.com

Biological water quality is concerned with the type and quantity of living organisms that are found in the water, eg. does the water contain any pathogenic organisms. A wastewater may contain a wide variety of organisms that may affect its use for irrigation. For instance, pathogenic bacteria and viruses in reclaimed wastewater may infect highway workers and the public, thus spreading disease. Plant pathogens may spread plant disease and damage the landscaping. Algae and bacteria which may clog irrigation systems may occur in wastewater. Public health agencies have regulations establishing acceptable levels of pathogenic organisms in reclaimed wastewater to protect the public and the highway workers from disease. The organisms commonly found in wastewater were considered in this study.

Reclaimed wastewater quality depends on the quality of the potable water source and the degree of treatment given to the wastewater in the reclamation process. Generally, if a potable municipal water supply is suitable for landscape irrigation, then properly treated reclaimed municipal wastewater will also be suitable for use in landscape irrigation. Exceptions to this generalization might be when salty groundwater infiltrates into a sewer system and/or when significant quantities of untreated industrial wastes are discharged into a sewer syatem before wastewater treatment. The problems created by the use of reclaimed wastewater that contains high concentrations of salts and/or toxic materials for landscape irrigation are difficult to evaluate because several years may pass before problems develop.

Wastewater being considered for use in landscape irrigation must be analyzed for the presence of toxic materials, pathogens and total dissolved solids concentrations using standard techniques prescribed by local and state health and water quality control agencies, prior to use. In California the use of reclaimed



ClibPDF - www.fastio.com

wastewater is controlled by the Department of Health Services (DOHS), the Water Resources Control Board (WRCB) and the Regional Water Quality Control Boards (RWQCB). Selected study sites were supplied with good quality reclaimed wastewater.

## 6.2 Reclaimed Wastewater Source Reliability

Reclaimed wastewater must be available for landscape irrigation, whenever watering is necessary, to insure that there is sufficient water for the plants. If the source of reclaimed wastewater is not reliable, then another reliable source of water must be available for use. This is normally a potable water source, such as a municipal water supply or a private well. Sites selected for this study had reliable supplies of reclaimed wastewater. One location that was considered as a potential study site was rejected because it lacked a reliable source of reclaimed wastewater. This site was located in Glendale and was to receive water from the Glendale wastewater treatment facility. The supply of wastewater was not reliable because water was not available for irrigation at critical times.

## 6.3 Reclaimed Wastewater and Potable Water Costs

Potable water costs have increased over the last 20 years due primarily to increasing energy costs and to increasing water demand. Reclaimed wastewater costs have also been rising due, also, to rising energy costs and, to some extent, the increases in water demand.

The cost of reclaimed wastewater has historically been lower than the cost of potable water. The cost difference between reclaimed wastewater and potable water depends mainly upon two factors. First, the cost of tertiary wastewater treatment required to



ClibPDF - www.fastio.com

prepare the wastewater for its intended use and second, the cost of the wastewater distribution system. In most cases, reclaimed wastewater must be pumped from the wastewater treatment plant to the irrigation site. Pumping reclaimed wastewater for long distances and/or against high heads increases its cost. Thus, if an irrigation site is located a long distance from the wastewater treatment plant, the cost of irrigating with reclaimed wastewater may be equal to, or greater than, the cost of irrigating with potable water. The study sites selected for this project were chosen so that the cost of using reclaimed wastewater was less than the cost of using potable water.

## 6.4 Long-Term Use of Reclaimed Wastewater for Irrigation

To help determine the long-term impacts of using reclaimed wastewater on plants and soils, sites where reclaimed wastewater has been used for several years were selected for study. Table 1 shows how long each site has been irrigated with reclaimed wastewater.

TABLE 1. The Length of Time That the Study Sites Have Been Irrigated With Reclaimed Wastewater (1986).

| Site | Period of Wastewater Irrigation. |
|---|---|
| 1 | 11 years |
| 2 | 9 years |
| 3 | 7 years |
| 4 | 3 years |
| 5 | 3 years |



ClibPDF - www.fastio.com

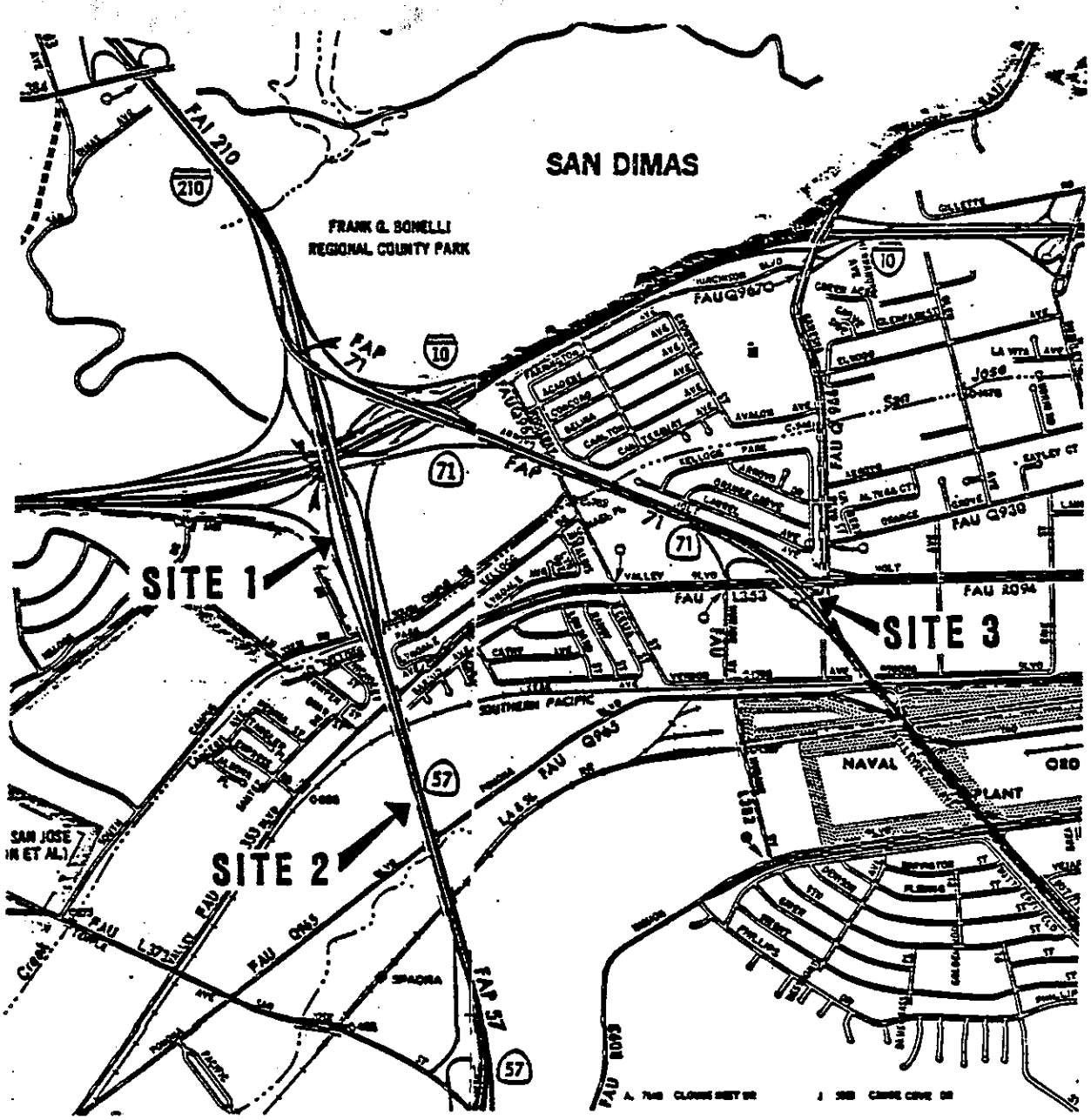


Figure 1, LOCATION OF STUDY SITES 1,2, AND 3



ClibPDF - www.fastio.com

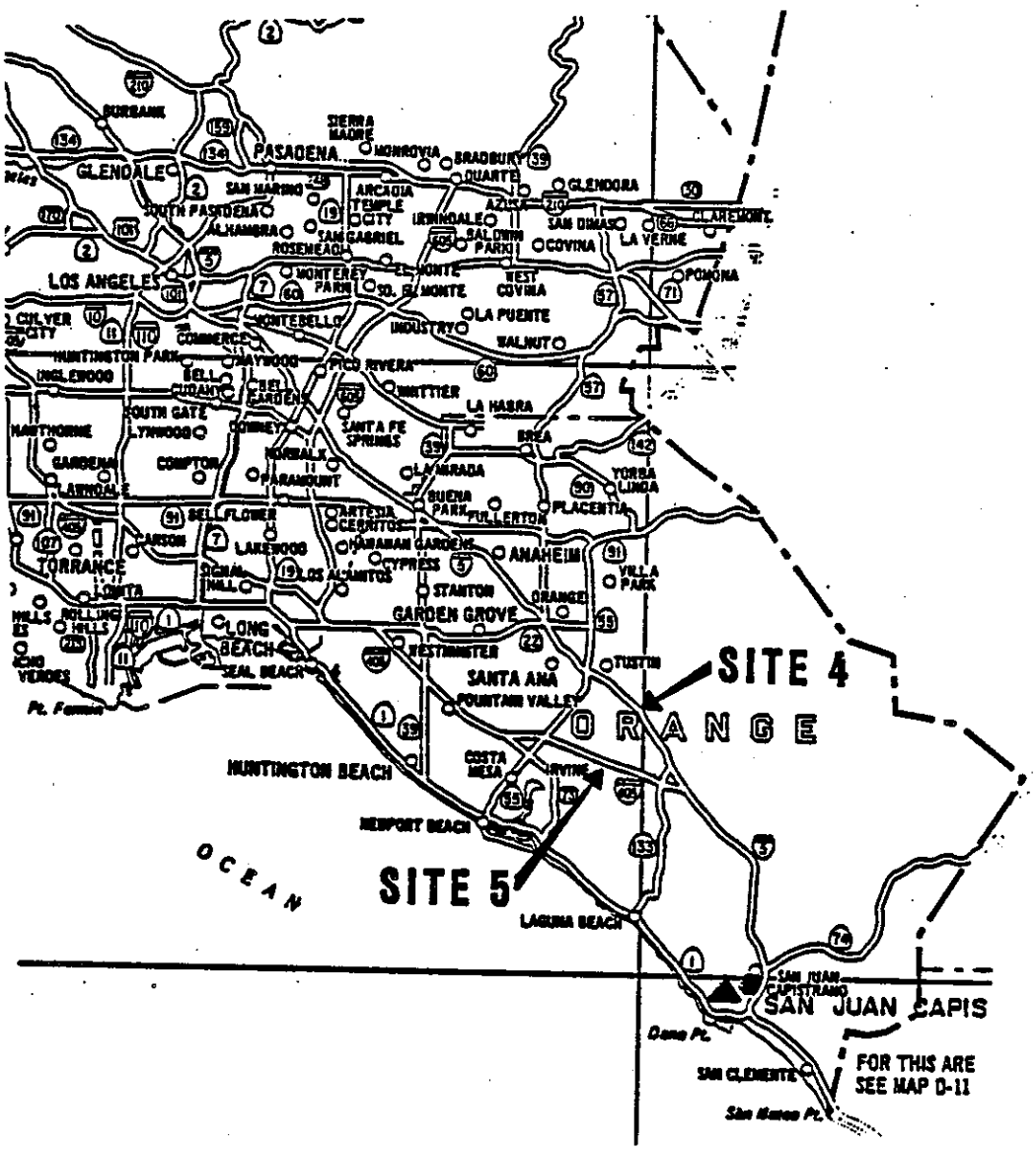


Figure 2, LOCATION OF STUDY SITES 4 AND 5



ClibPDF - www.fastio.com

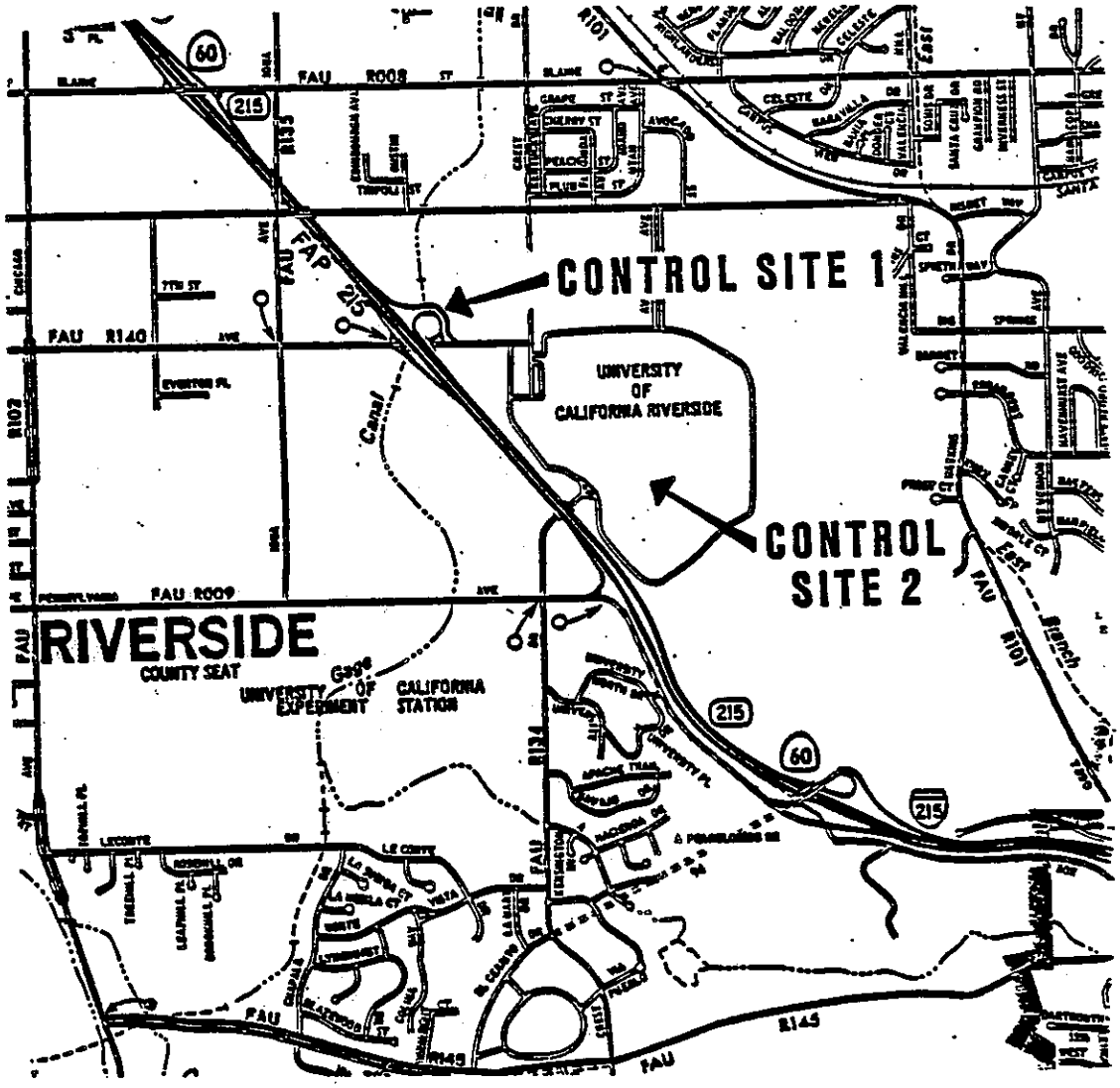


Figure 3, LOCATION OF THE CONTROL SITES



ClibPDF - www.fastio.com

made according to the methods of the US Soil Salinity Laboratory (9). The concentrations of trace metals was determined using spectrophotometery (7).

The results of the soil constituent testing were compared among the various sites and over time for each individual site. The data were statistically analyzed by using the Student T test to make the comparisons.

### 7.4 Other Factors

The other factors considered in this study, such as the possibility of reclaimed wastewater damaging irrigation equipment, were studied via a literature search, site visits, and contacts with irrigation specialists. These aspects were subjectively evaluated by Caltrans personnel.

### 7.5 Aesthetics

The study of aesthetics is very subjective. The idea of what constitutes beauty (which is what aesthetics is concerned about) differs from culture to culture and, within a culture, from person to person. In a pluralistic society such as we have in the United States, defining what is beautiful can be treacherous.

However, some general aesthetic standards related to freeway landscaping can be developed, and must be developed, to judge the impact of using reclaimed wastewater on highway landscaping. The following criteria were used to evaluate the aesthetic appeal of the test sites:

1. The vegetation should appear alive during the proper season.



ClibPDF - www.fastio.com

2. The vegetation should not appear to be discolored.

3. The vegetation should appear to be the proper size and shape for its age.

4. The number of unsightly weeds visible at a site should be kept to a minimum.

5. The amount of bare ground visible at a site should be kept to a minimum.

6. The reclaimed wastewater should not have an unpleasant odor.

7. The reclaimed wastewater should not appear to be dirty.

8. The irrigation lines should not appear obtrusive.

The aim of these criteria is to describe a "natural looking" clean stand of vegetation. All of these criteria are subjective and individuals may disagree about the condition of the same vegetation stand.

Each test site was evaluated using these criteria, and an overall impression of the site was developed. The following overall categories were used to describe the test sites, Poor, Fair, Good. A literature search and a limited inspection of other sites where reclaimed wastewater was used to irrigate landscaping were performed to determine if reclaimed wastewater was being used with good aesthetic results.



ClibPDF - www.fastio.com

# 8. RESULTS AND DISCUSSION

## 8.1 Reclaimed Wastewater Quality

Two different sources of reclaimed wastewater were used for irrigation during this study. Sites 1,2, and 3 in Pomona received their reclaimed wastewater from the Pomona Water Reclamation Plant. Sites 4 and 5 in Irvine received their reclaimed wastewater from the Irvine Ranch Water District. The control sites both received their potable irrigation water from the city of Riverside's municipal water system. Water quality data for these water systems are included in Tables 1,2, and 3 of the appendix. Historical data indicate that the chemical composition of the reclaimed wastewater has not changed much over the years.

Both of the reclaimed wastewaters contain plant nutrients. There are enough plant nutrients in the two reclaimed wastewaters to supply adequate fertilizer for ornamental landscape plants. The potable water used to irrigate the control sites contained insignificant amounts of plant nutrients.

Reclaimed wastewaters are usually higher in total dissolved solids than potable water (10). In this study, the total dissolved solids concentrations of both the reclaimed wastewaters was higher than the potable water control. The two reclaimed wastewaters also differed from one another. The total dissolved solids concentration of the Pomona wastewater was 559 to 581 mg/l. That of the Irvine wastewater was 767 to 909 mg/l. The total dissolved solids concentration of the potable control water averaged 278 mg/l.



ClibPDF - www.fastio.com

Looking at total dissolved solids alone, even sensitive plants might be irrigated with the two wastewaters tested without experiencing any injuries, if proper irrigation management is used. Because Caltrans planted only tolerant plants at the test sites, no damage caused by the total dissolved solids concentration was expected, and none was found.

The two reclaimed wastewaters contained two potentially harmful common ions. Sodium ions and chlorine ions existed in high enough concentrations to warrant attention. The range of the sodium ion concentration in the two reclaimed wastewaters was 104 to 171 mg/l. Sensitive plant species may be harmed when the concentration exceeds 115 mg/l. The chlorine ion concentration in the two reclaimed wastewaters was 90 to 159 mg/l. Sensitive plant species may be harmed when the chlorine ion concentration exceeds 178 mg/l. The chlorine ion concentration was close enough to the level at which sensitive plant species may be damaged to warrant care in species selection. This is because chlorine ion may become concentrated in the soil, if improper irrigation practices are used. Because only tolerant plant species were planted at the test site, no damage from sodium ions or chlorine ions was expected and none occurred.

The potentially harmful trace element boron existed in the two reclaimed wastewaters. The boron concentration of the two reclaimed wastewaters was 0.35 to 0.80 mg/l. A few sensitive plant species may be harmed by boron at these concentrations. Because only tolerant plant species were planted at the test sites, no damage from boron was expected and none occurred.

The reclaimed wastewater used at the Pomona test sites was analyzed to determine the trace element content of the water. Tables.1,2, and 3 of the appendix show the results of this



ClibPDF - www.fastio.com

analysis. The trace metal concentrations in this reclaimed wastewater were less than the trace metal concentrations recommended by the National Academy of Science (1).

## 8.2 Soil Assessment

The soils at the test sites consisted of fills of unknown origins which, due to lack of adequate time, have not developed soil horizons. The soils were gravelly and compacted.

The constituents present in soil saturation extracts are usually used to determine soil salinity. Tables 4 through 10 of the appendix show the chemical composition at the various test and control sites.

Statistical analysis using the Student T-test indicated that soil salinity levels at sites irrigated with water from the same source were not significantly different. This is probably because, the same irrigation management protocol was followed for all sites used in the same community. The soil salinity at each site varied widely over time. This is probably because the irrigation protocols for the various sites were not consistently followed.

Nevertheless, the soil salinities at the wastewater irrigation sites in both Pomona and Irvine were suited for all ornamental landscape species, except for those species which are the most salt sensitive. No damage was done to the soils at the test sites by the salinity of the wastewater.

Roadside soils are often contaminated by metallic pollutants generated by automobiles. The metals are products of tire wear, automobile wear, and combustion. Elevated concentrations of zinc



ClibPDF - www.fastio.com

and lead were found in the soils of all the freeway sites sampled. The freeway reference site exhibited elevated concentrations of these metals along with the test sites. The lead and zinc concentrations exhibited typical patterns for metal contamination in roadside soils (11). That is, the lead and zinc concentrations at the surface of the soil were several times higher than those deeper in the soil profile. Tables 11 through 17 of the appendix show the heavy metal concentrations of the soils sampled.

The soil samples taken at the reference site on Route 57 in Pomona also exhibited elevated heavy metal concentrations despite being unlandscaped and unirrigated. The toxic metal concentrations at this site were the same as those of the nearby Pomona test sites, which were irrigated with reclaimed wastewater. The second reference site on the California Polytechnic University Pomona Campus, which was irrigated with reclaimed wastewater for more than 10 years prior to the sampling, exhibited considerably lower heavy metal contents than did the freeway sites. Consequently, it was concluded that the reclaimed wastewater was less important in determining the toxic metal content of the soil than other factors.

## 8.3 Elemental Contents of Leaf Tissue

The elemental contents of leaf tissue are frequently used to diagnose nutrient deficiency and elemental phytotoxicity (toxicity to plants) in plants. A low concentration of a nutrient element in leaf tissue is an indicator of a deficiency of that element. Similarly, a high concentration of a toxic element is an indicator of a phytotoxicity problem.

The leaves analyzed in this study exhibited a wide variation in elemental concentrations. The results of the analyses are



ClibPDF - www.fastio.com

presented in Tables 18 through 39 of the appendix. For the most part, the elemental concentrations obtained from leaves at the test sites were in the same order of magnitude as those from the control sites.

Because leaves found on eucalyptus trees at the test sites were abnormal, their elemental concentrations are illustrated in figures 1-9 of the appendix. The results indicate little possibility of nutrient deficiency or phytotoxicity due to elements imported to the irrigation site by the reclaimed wastewater. The leaf concentrations of some potentially toxic elements in the tested leaves from the control sites versus test sites were not significantly different .

The elemental concentrations of damaged leaves versus healthy leaves were compared at Sites 1, 3 and 4, to determine if any significant differences in elemental concentrations could be found. The results are in tables 40 and 41 of the appendix. The results indicate little clear-cut evidence that phytotoxicity was occurring.

During the course of the study the rate of application of water to the test sites was not proper. This was due to equipment problems and/or faulty irrrigation management. There were long periods of time when no irrigation water was applied. At times the water was applied in limited quantities so that only the uppermost layer of soil was moistened. Consequently, the landscape plants at the test sites were stressed by drought. The drought stress is the most likely cause of damage to the landscape plants at the test sites. It is not likely that the damage to landscape plants was caused by using reclaimed wastewater. The California Polytechnic University at Pomona has used reclaimed wastewater from the Pomona Water Reclamation Plant for over ten years without causing damage to landscape plants.



ClibPDF - www.fastio.com

## 8.4 Public Health Concerns

It has long been known that municipal wastewater carries pathogenic (i.e. disease producing) organisms. The sources of the pathogens in the wastewater are the population served by the sewage system, and the wild and domestic animals whose waste enters the sewage system. Many illnesses are known to be transmitted by wastewater. Table 2 lists selected organisms that may be present in wastewater from American communities (12).

Pathogenic bacteria may survive from one day to several months in the soil. The variability of survival time depends on such factors as the soil temperature, moisture, pH, and the nature of the soil biota. (4, 13, 14). Enteroviruses (viruses of the human intestinal tract) may survive up to 170 days in soils (4, 13,14). Again, the length of time that enteroviruses survive in the soil depends on the conditions of the soil environment. Some resting stages of parasites may remain viable in soil for several months. The spread of these parasites occurs when a person comes into contact with the resting stage in the soil (4, 13, 13). Hookworms are particularly adapted to be spread in this way.

Long-term application of pathogen laden wastewater at a site may lead to an accumulation of pathogens at the soil surface. The pathogens usually will not enter the groundwater unless the soil contains large cracks or channels. The soil usually acts as a filter preventing their downward movement. Although, under some circumstances, they may travel some distance down through the soil (15).

Pathogens in the soil may be transported from a site by a variety of means. Birds, insects and other animals may transport



ClibPDF - www.fastio.com

pathogens from the site. Storm runoff from a pathogen-contaminated site may also transport pathogens from the site. Of course, if pathogen-laden irrigation water is sprayed onto roadways,sidewalks or yards, pathogens may be directly spread. Human or domestic animal consumption of pathogen-laden irrigation water may directly cause disease. Workers who deal with pathogen-laden wastewater may also contract disease from the wastewater (4,15).

There are several measures which can be taken to protect public health and the health of the maintenance workers. The primary method of protecting the public health is to obtain reclaimed wastewater which is as pathogen-free as possible.



ClibPDF - www.fastio.com

Table 2. Selected Pathogenic Organisms That May Be Present In Wastewater. (after Clark, 12)

| Organisms | Disease |
|---|---|
| Enteroviruses | Gastroenteritis, heart anamolies meningitis, and others |
| Rotaviruses | Gastroenteritis |
| Parovirus-like agents | Gastroenteritis |
| Hepatitis A | Infectious hepatitis |
| Adenoviruses | Respiratory disease, conjunctivitis, and others |
| *Escherichia coli* | Gastroenteritis |
| *Salmonella* | Typhoid fever, salmonellosis |
| *Shigella* | Shigellosis |
| *Balantidium coli* | Balantidiasis |
| *Entamoeba histolytica* | Amebic dysentery |
| *Giardia lamblia* | Giardiasis |
| *Ascaris lubricoides* | Ascaris worm infection |
| *Ancylostoma duodenale* | Hookworm infection |
| *Necator americanus* | Hookworm infection |
| *Ancylostoma braziliense* | Cutaneous larva migrans |
| *Ancylostoma caninum* | Cutaneous larva migrans |
| *Strongyloides stercoralis* | Threadworm infection |
| *Toxocara* spp. | Viscaral larval migrans |
| *Trichuris trichiura* | Trichuriasis |
| *Taenia* spp. | Tapeworm infection |
| *Enterobius vermicularis* | Pinworm infection |
| *Hymenolepis nana* | Tapeworm infection |
| *Echinococcus granulosus* (dog tapeworm) | Unilocular echinococcosis |
| *Echinococcus multilocularis* | Alveolar hydatid disease |



ClibPDF - www.fastio.com

Wastewater treatment reduces the concentration of pathogens in the wastewater. Primary treatment will not effectively remove bacteria or viruses from sewage. Good secondary treatment will remove more than 90% from the wastewater (4). However, after secondary treatment the wastewater may still contain enough viruses, parasites and bacteria to pose a health risk. Consequently, the wastewater used in Caltrans projects should receive tertiary treatment and be disinfected.

The design of the irrigation system itself can limit the possibility of infection due to wastewater contact. Human and animal contact with wastewater may be minimized by taking the following steps. The irrigation system should be designed so that wastewater used for irrigation does not leave the irrigation site. The spray patterns of the sprinklers used in the system should be known. The sprinklers should be located so that the wastewater is only sprayed on the ground being irrigated, and not on nearby sidewalks, roadways, yards or buildings. Additionally, the landscaping should be designed so that the wastewater will not flow off the irrigation site, but will stay on the ground being irrigated. Each of the irrigation system components should be distinctively painted, and the irrigation site fenced to reduce the possibility of entry. Signs warning the public that unpotable water is being used for irrigation should be posted. If there is a significant non-English speaking population in the vicinity of the wastewater irrigation site, signs in the appropriate language should be posted.

The irrigation program itself may be designed to reduce the possibility of infection due to wastewater contact. Pathogens usually do best in soil that is wet. Irrigation should be done in such a fashion that the soil surface dries out after irrigation episodes. The amount of wastewater applied should be controlled so that the water reaches the root zones of the plants, but will not run off the site.



ClibPDF - www.fastio.com

## 8.5 Aesthetics

None of the test sites was subjectively evaluated as good. Sites 1,2,and 3 were rated as fair. Sites 4 and 5 were rated as poor.

Site 1 contained damaged ivy. The plants appeared dry and stunted. Site 1 also contained a relatively large proportion of bare ground and weedy species coverage.

Site 2 contained some damaged trees. The damaged trees had dry leaves and looked spindly. There was also a relatively large proportion of bare ground.

Site 3 contained some dead iceplant. Some of the rest of the iceplant appeared spindly and unhealthy. There was also a high proportion of bare ground.

Despite the damage at the first three sites the sites were rated fair because passing motorists would be presented with a generally pleasing view. The damage was minor and localized.

Sites 4 and 5 were rated poor. Both sites had discolored and damaged eucalyptus trees, misshapen pine trees, and large amounts of bare ground. Both sites had a dry unhealthy appearance.

Although none of the test sites received a good rating, reclaimed wastewater can be used for irrigation and produce aesthetically pleasing landscapes. Reclaimed wastewater is used in many places in California for landscaping. Wastewater from the Pomona Water Reclamation Plant is used to irrigate landscaping at the Pomona Campus of California Polytechnic University. Inspection of the campus revealed that the landscape is aesthetically pleasing. Wastewater from the Irvine water reclamation plant is used in the Irvine area with a pleasing aesthetic effect.



ClibPDF - www.fastio.com

To insure a pleasing aesthetic effect the landscaping must be properly maintained. The fair to poor results that occurred in this project are likely to have been produced by poor irrigation management. It appears that the watering interval was too infrequent or the amount of water applied was too small to properly maintain the plants.

## 8.6 Effects of Reclaimed Wastewater on Irrigation Equipment

During the course of the study, researchers noted that there were problems with the irrigation equipment at the test sites. However, the problems were not the result of the reclaimed water damaging the irrigation equipment. Rather, the problems appear to be related to a lack of maintenance effort and vandalism.

Among the problems noted were: sprinklers and irrigation lines broken and/or stolen by vandals; irrigation lines destroyed by rodents; improper installation of irrigation equipment; improper types of equipment used; and lack of maintenance due to a shortage of maintenance personnel. In no case was there any damage noted that could be attributed to the use of reclaimed wastewater.

The literature indicates that using reclaimed wastewater may cause clogging problems in some irrigation systems (16). Drip irrigation systems are more particularly prone to clogging problems. The clogging may be caused by two different conditions. First, particulate matter may fill holes in the emitter and plug it up. Wastewater which has received tertiary treatment contains less particulate matter than wastewater which has only undergone secondary treatment. Second, clogging may be caused by bacterial slimes which form in irrigation lines and emitters. These slimes form when bacteria grow in irrigation systems by utilizing the nutrients in the irrigation water. The slimes can plug the



ClibPDF - www.fastio.com

orifices of emitters and clog them. Slimes can also grow densely enough in irrigation lines to reduce water flow or even completely clog the irrigation line.

The California Polytechnic University at Pomona Campus has irrigated landscaping with reclaimed wastewater from the Pomona Water Reclamation Plant for ten years. This is the same wastewater source that was used at the Pomona test sites for this project. The Pomona plant produces wastewater with low levels of particulate matter because of tertiary treatment. Therefore, this wastewater has a reduced probability to clog irrigation equipment. The university also has a preventive maintenance program staffed with full time irrigation specialists. Because of the good quality wastewater, preventive maintenance program, and trained staff, the university has had no significant problems with equipment damage due to using reclaimed wastewater. If Caltrans were to make a similar effort to maintain irrigation equipment, no significant problems would be expected.

Experiments performed by the University of Hawaii at Manoa using secondary treated wastewater from the Mililani wastewater treatment plant showed that wastewater containing high levels of particulates can be used in drip irrigation systems. The effluent used in the Hawaiian experiments was of generally lower quality than the wastewater used in this study. To prevent clogging due to the high levels of particulates, the Hawaiian workers found that they had to use larger sized emitter orifices and properly designed irrigation systems (16).

## 8.7 Impacts of Reclaimed Wastewater Irrigation on Water Quality

During the course of the study, the question of the impacts of wastewater on water quality was raised. Because there is a wide



ClibPDF - www.fastio.com

variance in the quality of reclaimed wastewater, no single answer can be provided. The reclaimed wastewaters used in this study were of good quality. No degrading of water quality was noted during the study. The reclaimed wastewater produced by the Irvine wastewater plant is used to provide recreational water in the Irvine area.

The reclaimed wastewaters used at the test sites contain enough nutrients that fertilization is not necessary to maintain the landscape plants. If fertilizer would be added to the plantations, then the fertilizer might run off the site during storm events. The nutrient rich runoff could pollute surface waters, or seep into groundwater.



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## 9. GUIDELINES FOR THE USE OF RECLAIMED WASTEWATER FOR HIGHWAY LANDSCAPE IRRIGATION

The following guidelines are provided to assist Caltrans maintenance personnel in determining when irrigation may be done with reclaimed wastewater, and how reclaimed wastewater systems should be established. These guidelines are not designed to be a checklist. They are designed to be intelligently applied according to the specific conditions of the proposed site.

### 9.1 Choice of Vegetation

The choice of vegetation is important when reclaimed wastewater is being considered for irrigation. If improper plant species are chosen, then the plantation may either grow poorly, or fail completely.

Because reclaimed wastewater tends to have a higher total dissolved solids than potable water, plants should be selected that are not highly sensitive to salinity. Table 42 of the appendix is a list of landscape plant species that are salt-tolerant.

Similarly, reclaimed wastewater may have a higher concentration of boron than potable water. Consequently, boron-sensitive plants should not be used in plantations irrigated with reclaimed wastewater. Table 43 of the appendix is a list of landscape plants that are boron-tolerant.

The amount of water used for irrigation may be significantly reduced by using landscape plants that are able to grow well with little or no irrigation required. The plant species that are drought-resistant differ with the different areas of California.



ClibPDF - www.fastio.com

The differences are due to the differing amounts of rainfall in the different parts of the state. Species that require little or no irrigation should be used whenever possible.

## 9.2 Cost of Irrigation Water

Reasonable use of reclaimed wastewater requires that the cost of using reclaimed wastewater for landscape irrigation be cheaper than using potable water for landscape irrigation. The costs of delivering water to the plants should be compared. These costs include the initial price of the water, the cost of transporting the water to the irrigation site, the cost of the equipment (which includes the cost of signs and etc., which notify the public that reclaimed wastewater is being used), and the cost of maintenance. If the total cost of using wastewater is higher than the cost of using potable water, then potable water should be used.

## 9.3 Reclaimed Wastewater Quality

The reclaimed wastewater used should be of high quality. Low quality reclaimed wastewater should not be used. The use of low quality reclaimed wastewater can cause plugging problems in equipment, and can create a public health hazard by carrying pathogens. All reclaimed wastewater used for irrigation should meet the standards of Title 22 Environmental Health of the Social Security Code. The intent of Title 22 is to provide standards for the quality of reclaimed wastewater so as to protect public health.

Only reclaimed wastewater that has undergone advanced treatment should be used for irrigating freeway landscaping. Tertiary treatment of reclaimed wastewater reduces the amount of



ClibPDF - www.fastio.com

particulates in the wastewater, and can, by disinfecting the water, reduce the number of pathogens in the wastewater. Thus, tertiary treatment reduces the probability of clogging problems occurring in irrigation systems, and reduces the possibility of disease being spread via the reclaimed wastewater.

Prior to being considered for use in irrigating highway landscaping, all reclaimed wastewater supplies should be analyzed. The total dissolved solids content, the pH, the odor, the color, the contents of nutrient and toxic elements, and the level of pathogenic viruses and bacteria should be checked. The levels of pathogens should meet the requirements of Title 22. The reclaimed wastewater should not have a strong odor or color. The reclaimed wastewater will likely be used in an urban area, and may be used near businesses or homes. Odiferous or dirty looking water is not acceptable in this environment. The total dissolved solids, pH, nutrient, and toxic elemental contents should all be within the acceptable range for the landscape species used.

## 9.4 Stability of Reclaimed Wastewater Supply

All reclaimed wastewater supplies considered for use should be reliable. That is, there should be sufficient quantities of water available to adquately irrigate the landscape plants whenever irrigation is necessary. If the supply of irrigation water is not stable, then the landscape plantation may be damaged by lack of reclaimed wastewater.

## 9.5 Measures to Protect Public Health

All raw domestic sewage contains considerable quantities of pathogens. For the use of reclaimed wastewater to be safe, the water must be disinfected, and the public must be kept away from the water.



ClibPDF - www.fastio.com

All reclaimed wastewater lines, sprinkler heads, valves, and emitters should be distinctly marked, so that the public will know that the water being used is not potable. All areas where reclaimed wastewater is used should be clearly signed to notify the public that reclaimed wastewater is being used and that the water is not potable. Care should be taken to erect signs in languages other than English, where a significant portion of the population does not read in English.

Where reclaimed wastewater is used, fencing should be used to segregate the plantation from public thoroughfares. Fencing will reduce the likelihood that people will enter the site and drink the water. Fencing is also likely to reduce the amount of vandalism by reducing the number of people who access the plantation.

## 9.6 Equipment

The equipment for irrigating with good quality reclaimed wastewater does not significantly differ from the irrigation equipment required to irrigate with potable water systems. The major difference between irrigating with potable water and irrigating with reclaimed wastewater that relates to irrigation equipment is that the pressure of the wastewater may be significantly lower than the pressure of potable water. Consequently, pumps may be necessary to increase the pressure, or the irrigation system may be designed to operate with low pressure.

Because the level of nutrients in the reclaimed wastewater is higher than the level of nutrients that is found in potable water, there may be an increased possibility for drip irrigation systems to clog due to bacterial growth.



ClibPDF - www.fastio.com

Chlorination or some other method to retard bacterial growth may be necessary to prevent clogging. If the reclaimed wastewater is disinfected for public health purposes, there may be enough residual disinfectant in the reclaimed wastewater to prevent bacterial growth in the irrigation system.

The type and amount of disinfectant used to disinfect the reclaimed wastewater should be determined during the initial study of the wastewater source. The residual of the disinfectant in the reclaimed wastewater at the irrigation site should be determined when the system is installed. At that point, it should be determined if there is enough disinfectant in the water to retard bacterial growth. The level of the disinfectant required to retard bacterial growth differs with the type of disinfectant used. Therefore, each reclaimed wastewater system must be examined separately. Another point that should be considered, is the effect of the disinfectant on the vegetetion that will be irrigated.

Drip irrigation systems that use reclaimed wastewater and develop clogging problems may be aided by installing 80 mesh filter srceens ( which have 175 micron openings) prior to use. The filters prevent larger particles from travelling into the irrigation lines and clogging them. Emitters that are designed to be cleared by flushing, at higher pressure may aid in eliminating clogging problems.

## 9.7 Key of the Stages to Follow When Considering the Use of Reclaimed Wastewater for Irrigating Highway Landscaping

1a. Cost of reclaimed wastewater at the source is higher than potable water ----------Use potable water



ClibPDF - www.fastio.com

1b. Cost of reclaimed wastewater at the source is less than potable water.---------- Go To 2

2a Cost of transporting the reclaimed wastewater raises the cost of using wastewater higher than using potable water.----------Use Potable Water

2b. Cost of transporting the reclaimed wastewater does not raise the cost of using wastewater higher than using potable water----------Go To 3

3a. The reclaimed wastewater has tertiary treatment----Go to 4

3b. The reclaimed wastewater has not undergone tertiary treatment----------Use Potable Water

4a. The reclaimed wastewater meets Title 22 standards--Go To 5

4b. The reclaimed wastewater does not meet Title 22 standards----------Use Potable Water

5a. The source of the reclaimed wastewater is reliable----Go To 6

5b. The source of reclaimed wastewater is not reliable --------Use Potable Water

6. Perform physical and chemical analysis on ---------Go To 7 the reclaimed wastewater, or obtain analysis.

7a. Physical analysis indicates that the reclaimed wastewater has no distinct color. ----------Go to 8

7b. Physical analysis indicates that the reclaimed wastewater has a distinct color.----------Use Potable Water



ClibPDF - www.fastio.com

8a. Physical analysis indicates that the reclaimed wastewater has no distinct odor. ----------Go to 9

8b. The wastewater stinks.----------Use Potable Water

9. Select landscape plant species that can thrive in the wastewater with its various constituents.------- Go To 10

10. Design the irrigation system paying special attention to: the operating pressure of the system, the possibility of emitter clogging, and the necessity of segregating the system from the public. Insure that any site-specific factors that would influence the design of the system are considered.---Go To 11

11. Insure that the contract correctly conveys the contract design to the prospective contractors.----------Go To 12

12. Insure that the Resident Engineer understands the special features of irrigation system.----------Go To 13

13. Install the irrigation system.----------Go To 14

14. Plant the landscape plants.----------Go To 15

15. Properly maintain the irrigation system.



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

## 10. CITATIONS


1. U.S. Environmental Protection Agency. 1986. Quality Criteria for Water. Environmental Protection Agency. 402 pp.

2. Warren, Charles E. 1971. Biology and Water Pollution Control. W. B. Saunders. Philadelphia. 434 pp.

3. Pound, Charles E. and Ronald W. Crites. 1975. Characteristics of Municipal Effluents in Norum, Edward ed. Wastewater Resource Manual. The irrigation Association. Silver Springs, MD.

4. Asano, Takashi and G. Stuart Pettygrove. March-April 1987. Using Reclaimed Municipal Wastewater for Iiirgation. California Agriculture. pp. 15-18.

   (2) Warren. op. cit.

   (4) Asano and Pettygrove. op. cit.

   (2) Warren. op. cit.

5. Sanks, R. L. 1975. A Primer on Conventional Sanitary Treatment Processes. In Norum, Edward ed. Wastewater Resource Manual. The Irrigation Association. Silver Springs, MD.

6. Asano, Takashi, Robert G. Smith, and George Tchobanoglous. 1984. Municipal Wastewater: Treatment and Reclaimed Water Characteristics. In Pettygrove, G. Stuart and Takashi Asano. ed. Irrigation With Reclaimed Wastewater- A Guidance Manual. State of California State Water Resources Control Board.




ClibPDF - www.fastio.com

(3) Pound and Crites. op. cit.

(1) EPA.op. cit.

(4) Asano and Pettygrove. op. cit.

7. Chang, A. C., et. al. 1987. Final Report Effects of Trace Elements on the Performance of Wastewater Irrigated Landscape Plants. California Department of Transportation, Translab. Sacramento.

8. Chang, A. C., et. al. 1986. Evaluating the Effects of Wastewater Irrigation on The Performance of Ornamental Plants Along Highways in Los Angeles/Orange County Metropolitan Area. California Department of Transportation, Translab, Sacramento

(7) Chang, et. al. 1987. op. cit.

(8) Chang, et. al. 1986. op. cit.

9. U. S. Salinity Laboratory. 1954. Diagnosis and Improvement of Saline and Alkali Soils. U. S. Department of Agriculture Handbook No. 60. 160 pp.

(7) Chang, et. al. 1987. op. cit.

10. California Department of Transportation, District 11. 1984. Reclaimed Water for Irrigation of Highway Landscaping on Interstate 5 in San Diego County P.M. 32.0 to 55.0. Caltrans San Diego, CA.

(1) EPA. op. cit.



ClibPDF - www.fastio.com

11. Wang, Tzn-Siang et al .1980. Transport Deposition and Control of Heavy Metals in Highway Runoff. U. of Washington Seattle.

12. Clark, C. Scott. Dec. 1987. Potential and Actual Biological Related Health Risks of Wastewater Industry Employment. Jnl of the WPCF 59: 12.

(4) Crook, James. 1984. Health and Regulatory Considerations. in Pettygrove and Asano op. cit.

13. Crook, James. July. 1985. Water Reuse in California. Jnl. of the AWWA. pp. 60-71.

14. Bryan, Frank. 1975. Health Hazards from Land Application of Wastes. In Norum, Edward ed. Wastewater Resource Manual. The Irrigation Association. Silver Springs Md.

(4) Crook. 1984. op. cit.

(13) Crook. 1985 op. cit.

(14) Bryan. op. cit.

(4) Crook. 1984. op. cit.

(13) Crook. 1985. op. cit.

(14) Bryan. op. cit.

15. Frankenberger, W. T. 1984. Fate of Wastewater Constituents in Soil and Groundwater. In Pettygrove and Asano op. cit.



ClibPDF - www.fastio.com

(4) Crook. 1984. op. cit.

(15) Frankenberger. op. cit.

(12) Clark. op. cit.

(4) Crook. 1984. op. cit.

16. M^cDonald, Donald R. et. al. 1984. Improved Emmitter and Network System for Wastewater Reuse in Drip Irrigation. University of Hawaii Manoa. Honolulu.

(16) M^cDonald, et. al. op. cit.1984.



ClibPDF - www.fastio.com

# APPENDIX

## UCR GROUP TEST RESULTS

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

TABLE OF CONTENTS

Table 1. Effluent Quality of Pomona Water Reclamation Plant.....1

Table 2. Quality of Reclaimed Wastewater - Irvine Ranch Water District .....2

Table 3. Quality of Irrigation Water At Riverside and UCR - 1986.....3

Table 4. Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 1.....4

Table 5. Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 2.....5

Table 6. Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 3.....6

Table 7. Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 4.....7

Table 8. Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 5.....8

Table 9. Chemical Composition of Irrigated Soil Along Highway Rights-of-Way in Riverside (University Ave. Off-On Ramp of Hwy. 60).....9

Table 10. Chemical Composition of Irrigated Soil at UCR Campus..10

Table 11. Heavy Metal Contents of Soils at Site 1.....11

Table 12. Heavy Metal Contents of Soils at Site 2.....12

Table 13. Heavy Metal Contents of Soils at Site 3.....13

Table 14. Heavy Metal Contents of Soils at Site 4.....14

Table 15. Heavy Metal Contents of Soils at Site 5.....15

Table 16. Heavy Metal Contents of Soils at Riverside.....16

Table 17. Heavy Metal Contents of Soils at UCR.....17

Table 18. Elemental Contents of Eucalyptus Leaf at Site 1.....18

Table 19. Elemental Contents of Eucalyptus Leaf at Site 2.....20

Table 20. Elemental Contents of Eucalyptus Leaf at Site 3.....21

Table 21. Elemental Contents of Eucalyptus Leaf at Site 4.....23

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

Table 22. Elemental Contents of Eucalyptus Leaf at Site 5.....25

Table 23. Elemental Contents of Eucalyptus Leaf at Riverside....27

Table 24. Elemental Contents of Eucalyptus Leaf at UCR.....29

Table 25. Elemental Contents of Oleander Leaf at Site 1.....31

Table 26. Elemental Contents of Oleander Leaf at Site 2.....33

Table 27. Elemental Contents of Oleander Leaf at Site 5.....34

Table 28. Elemental Contents of Oleander Leaf at UCR.....36

Table 29. Elemental Contents of Acacia Leaf at Site 3.....38

Table 30. Elemental Contents of Acacia Leaf at Site 4.....40

Table 31. Elemental Contents of Acacia Leaf at Riverside.....42

Table 32. Elemental Contents of Acacia Leaf at UCR.....44

Table 33. Elemental Contents of Ice Plants at Site 3.....46

Table 34. Elemental Contents of Ice Plants at Site 4.....48

Table 35. Elemental Contents of Ice Plants at Site 5.....50

Table 36. Elemental Contents of Ice Plants at Riverside.....52

Table 37. Elemental Contents of Ice Plants at UCR.....54

Table 38. Elemental Contents of Ivy Leaf at Site 1.....56

Table 39. Elemental Contents of Ivy Leaf at UCR.....58

Table 40. Elemental Contents (in mg/kg dry wt) of Damaged and Green Leaf at Selected Study Sites.....60

Table 41. Elemental Contents of Healthy and Damaged Leaves of Ornamental Plants at Site 4.....61

Table 42. Relative Salt Tolerance of Landscape Plants.....62

Table 43. Relative Boron Tolerance of Landscape Plants.....63

Figure 1. Ranges of Ca Levels in Leaves of Eucalyptus at the Study Sites.....64

Figure 2. Ranges of Na Levels in Leaves of Eucalyptus at the Study Sites.....65

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

Figure 3. Ranges of P Levels in Leaves of Eucalyptus at the Study Sites.....66

Figure 4. Ranges of Fe Levels in Leaves of Eucalyptus at the Study Sites.....67

Figure 5. Ranges of Mn Levels in Leaves of Eucalyptus at the Study Sites.....68

Figure 6. Ranges of B Levels in Leaves of Eucalyptus at the Study Sites.....69

Figure 7. Ranges of Cd Levels in Leaves of Eucalyptus at the Study Sites.....70

Figure 8. Ranges of Cu Levels in Leaves of Eucalyptus at the Study Sites.....71

Figure 9. Ranges of Zn Levels in Leaves of Eucalyptus at the Study Sites.....72

ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

Effluent Quality of Pomona Water Reclamation Plant - Table 1

| Constituent | Unit | 1976 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | | 7.1 | 7.1 | 7.0 | 7.1 | 7.0 | 7.1 | - | 7.2 | 7.3 | 7.1 |
| TDS | mg/L | 559 | 567 | 570 | 564 | 547 | 561 | 566 | 562 | 581 | 567 |
| As | g/L | 47 | 3 | 4 | 4 | 4 | <2 | 1.8 | <1 | 0.8 | <2.1 |
| B | mg/L | 0.8 | 0.8 | 0.7 | 0.6 | 0.6 | 0.6 | 0.53 | 0.43 | 0.40 | 0.35 |
| Cd | g/L | 2 | 3 | 3 | 2 | <2 | <2 | 1 | <1 | <1 | <1 |
| Cr | mg/L | 0.03 | 0.01 | <0.01 | <0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.01 | <0.01 |
| Cu | mg/L | 0.02 | 0.02 | <0.02 | <0.01 | 0.01 | 0.02 | 0.01 | 0.02 | 0.02 | 0.02 |
| Pb | mg/L | 0.03 | 0.02 | <0.02 | 0.03 | <0.02 | <0.01 | 0.1 | <0.02 | <0.01 | <0.01 |
| Hg | g/L | <2 | <1 | <0.2 | <0.1 | <0.1 | <0.2 | 0.2 | <0.1 | <0.1 | <0.1 |
| Ni | mg/L | 0.04 | 0.04 | 0.04 | 0.06 | 0.05 | 0.06 | 0.04 | 0.04 | 0.04 | 0.02 |
| Se | g/L | <4 | <3 | <3 | 4 | 2 | <2 | 3.2 | <2 | <2 | <4 |
| Ag | g/L | <2 | <1 | <3 | <1 | <2 | <1 | 1 | <2 | 2 | <2 |
| Zn | mg/L | 0.06 | 0.08 | 0.11 | 0.11 | 0.06 | 0.07 | 0.05 | 0.06 | 0.06 | 0.07 |
| $F^-$ | mg/L | 0.63 | 0.55 | 0.57 | 0.57 | 0.58 | 0.57 | 0.61 | 0.52 | 0.50 | 0.64 |
| $CN^-$ | mg/L | <0.02 | 0.02 | 0.02 | 0.02 | <0.01 | <0.01 | 0.32 | <0.01 | <0.01 | <0.1 |
| Phenols | mg/L | 0.009 | 0.005 | 0.006 | 0.006 | 0.004 | <0.001 | 0.004 | 0.006 | 0.003 | <0.002 |
| $Cl^-$ | mg/L | 102 | 106 | 105 | 103 | 101 | 104 | 108 | 90 | 92 | 96 |
| $SO_4^=$ | mg/L | 113 | 112 | 123 | 118 | 106 | 134 | 113 | 129 | 127 | 116 |
| N (Total) | mg/L | 17.7 | 17.5 | 16.5 | 15.7 | 14.7 | 12.6 | 17.4 | 14.0 | 13.6 | 15.8 |
| $PO_4$ | mg/L | - | - | - | - | - | - | 6.4 | 4.9 | 4.6 | 4.3 |
| $Ca^{++}$ | mg/L | - | - | - | - | - | - | 62 | 64 | 66 | 67 |
| $Mg^{++}$ | mg/L | - | - | - | - | - | - | 48 | 45 | 51 | 52 |
| $Na^+$ | mg/L | - | - | - | - | - | - | 106 | 105 | 105 | 104 |
| $K^+$ | mg/L | - | - | - | - | - | - | 12 | 11 | 11 | 13 |
| SAR† | - | - | - | - | - | - | - | 3.1 | 3.03 | 2.99 | 2.98 |

†Sodium Adsorption Ratio (SAR) = $Na/\sqrt{(Ca+Mg)/2}$ where Na, Ca, and Mg are respectively concentrations of sodium, calcium and magnesium ions of the water in milliequivalence per liter.

ClibPDF - www.fastio.com

Table 2
Quality of Reclaimed Wastewater — Irvine Ranch Water District

| Constituent[1] | 1981 | | 1982 | | 1983 | | 1984 | | 1985 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Range | Mean | Range | Mean | Range | Mean | Range | Mean |
| pH | 6.3 -7.4 | 6.9 | 6.6 -7.2 | 6.8 | 6.8 -7.4 | 7.2 | 6.9 -7.6 | 7.3 | 6.8 -7.5 | 7.2 |
| TDS | 682 -902 | 767 | 743 -1050 | 884 | 679 -1042 | 909 | 825 -1001 | 907 | 735 -876 | 810 |
| Ca | 58 -76 | 64 | 42 -92 | 67 | 40 -101 | 80 | 74 -93 | 84 | 61 -89 | 72 |
| Mg | 22 -41 | 29 | 25 -43 | 32 | 23 -44 | 35 | 32 -39 | 36 | 30 -39 | 34 |
| Na | 68 -168 | 138 | 132 -201 | 171 | 123 -196 | 165 | 153 -185 | 166 | 134 -158 | 149 |
| K | 7 -24 | 14 | 8 -29 | 13 | 5 -16 | 12 | 12 -17 | 14 | 13 -16 | 14 |
| $Cl^-$ | 129 -183 | 151 | 119 -183 | 159 | 124 -185 | 157 | 141 -174 | 152 | 122 -151 | 137 |
| $SO_4^=$ | 108 -331 | 259 | 214 -472 | 324 | 208 -402 | 330 | 312 -356 | 325 | 225 -334 | 285 |
| $PO_4$ | 0.20-0.62 | 0.35 | 0.26-0.54 | 0.42 | 0.31-0.50 | 0.47 | 0.90-0.68 | 0.52 | 0.31-0.52 | 0.42 |
| N (total) | 1 -17 | 11 | 1 -25 | 16 | 9 -17 | 13 | 9 -19 | 15 | 11 -22 | 16 |
| B | 0.56-0.76 | 0.65 | 0.49-0.81 | 0.63 | 1.44-0.58 | 0.49 | 0.40-0.50 | 0.47 | 0.20-0.54 | 0.39 |

[1]All measurements are in mg/L except pH



ClibPDF - www.fastio.com

Table 3
Quality of Irrigation Water at Riverside and UCR† - 1986

| Constituent | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| pH | 7.4 | 7.5 | 7.5 | 7.5 | 7.6 | 7.6 | 7.5 | 7.5 | 7.7 | 7.4 | 7.4 | 7.2 |
| TDS | 256 | 242 | 324 | 279 | 296 | 266 | 269 | 264 | 238 | 280 | 247 | 377 |
| Ca | 49 | 44 | 61 | 55 | 54 | 46 | 48 | 45 | 37 | 52 | 42 | 78 |
| Mg | 7 | 7 | 10 | 8 | 8 | 7 | 7 | 7 | 4 | 7 | 5 | 10 |
| Na | 23 | 25 | 40 | 27 | 40 | 40 | 39 | 42 | 43 | 35 | 37 | 37 |
| K | 3 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 3 | 3 | 3 |
| $Cl^-$ | 15 | 11 | 32 | 17 | 29 | 26 | 25 | 27 | 21 | 20 | 17 | 35 |
| $SO_4^=$ | 46 | 39 | 60 | 57 | 54 | 43 | 44 | 42 | 38 | 53 | 52 | 73 |
| $PO_4$ | - | - | - | - | - | - | - | - | - | - | - | - |
| N (total) | | | | | | | | | | | | |
| B | 0.1 | 0.1 | 0.1 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 | 0.1 | 0.1 | 0.1 |

†All measurements were in mg/L except pH, source of the information: City of Riverside - Water Department.



ClibPDF - www.fastio.com

Table 4
Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 1

| Date | Depth (cm) | pH | EC (mmho/cm) | Cations (meq/L) | | | | Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ | $Cl^{-}$ | $NO_3^{-}$ | $HCO_3^{-}$ | $SO_4^{=}$ |
| August, 1985 | 0-5 | 7.3 | 1.2 | 4.9 | 1.5 | 1.0 | 4.8 | 1.9 | 3.2 | 3.3 | 2.6 |
| | 5-15 | 7.2 | 1.2 | 4.4 | 1.3 | 1.0 | 5.2 | 2.7 | 2.0 | 2.8 | 3.7 |
| | 15-30 | 7.3 | 0.9 | 3.3 | 0.7 | 0.6 | 4.0 | 1.7 | 0.9 | 2.6 | 2.9 |
| March, 1986 | 0-5 | 7.2 | 0.7 | 3.1 | 0.7 | 1.0 | 1.9 | 0.4 | 0.8 | 3.5 | 1.1 |
| | 5-15 | 7.1 | 0.6 | 2.0 | 0.6 | 0.8 | 2.5 | 0.3 | 0.8 | 3.2 | 1.1 |
| | 15-30 | 7.2 | 0.6 | 2.1 | 0.5 | 0.4 | 3.4 | 0.4 | 0.8 | 2.9 | 1.3 |
| June, 1986 | 0-5 | 7.4 | 0.7 | 3.1 | 1.3 | 0.9 | 3.4 | 1.6 | 1.6 | 3.6 | 0.7 |
| | 5-15 | 7.4 | 0.6 | 2.2 | 0.9 | 0.6 | 3.1 | 1.1 | 1.4 | 2.6 | 0.7 |
| | 15-30 | 7.3 | 0.5 | 1.2 | 0.5 | 0.4 | 3.3 | 0.9 | 0.8 | 2.2 | 0.5 |
| September, 1986 | 0-5 | 7.5 | 1.5 | 5.9 | 2.5 | 0.7 | 7.2 | 4.6 | 1.5 | 3.8 | 3.0 |
| | 5-15 | 7.3 | 1.7 | 6.4 | 2.8 | 0.6 | 7.5 | 5.5 | 2.5 | 3.8 | 3.0 |
| | 15-30 | 7.3 | 4.7 | 3.2 | 14.3 | 1.2 | 16.2 | 23.8 | 0.2 | 3.3 | 7.9 |
| December, 1986 | 0-5 | 7.4 | 0.7 | 3.2 | 0.7 | 0.4 | 5.2 | 1.4 | 0.7 | 2.9 | 1.0 |
| | 5-15 | 7.5 | 1.0 | 4.2 | 1.4 | 0.7 | 6.5 | 2.5 | 0.4 | 4.5 | 1.4 |
| | 15-30 | 7.3 | 1.1 | 4.2 | 1.5 | 0.7 | 6.6 | 2.9 | 0.3 | 3.7 | 1.6 |
| March, 1987 | 0-5 | 6.7 | 0.8 | 1.9 | 1.1 | 0.5 | 4.8 | 1.3 | 1.7 | 2.4 | 1.0 |
| | 5-15 | 6.9 | 0.9 | 2.4 | 1.2 | 0.7 | 4.7 | 1.0 | 0.5 | 3.1 | 1.2 |
| | 15-30 | 7.0 | 0.8 | 2.3 | 1.1 | 0.6 | 5.2 | 1.4 | 0.1 | 3.0 | 1.4 |
| June, 1987 | 0-5 | 7.2 | 1.5 | 4.5 | 1.7 | 0.6 | 7.1 | 5.3 | 0.5 | 2.1 | 3.6 |
| | 5-15 | 7.3 | 1.2 | 3.7 | 1.6 | 0.9 | 5.3 | 2.3 | 1.8 | 4.2 | 1.5 |
| | 15-30 | 7.3 | 1.9 | 5.4 | 2.5 | 0.8 | 9.3 | 9.3 | 0.1 | 3.5 | 3.3 |

ClibPDF - www.fastio.com

Table 5
Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 2

| Date | Depth (cm) | pH | EC (dS/m) | Cations (meq/L) | | | | Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ | $Cl^{-}$ | $NO_3^{-}$ | $HCO_3^{-}$ | $SO_4^{=}$ |
| August, 1986 | 0.5 | 7.5 | 1.9 | 15.6 | 5.3 | 1.0 | 4.0 | 1.4 | 0.8 | 3.8 | 16.1 |
| | 5-15 | 7.4 | 1.4 | 9.0 | 5.3 | 0.5 | 2.2 | 0.6 | 0.5 | 3.0 | 12.2 |
| | 15-30 | 7.4 | 2.0 | 11.5 | 7.7 | 0.5 | 4.3 | 1.6 | 0.3 | 2.7 | 15.9 |
| March, 1986 | 0-5 | 7.4 | 0.6 | 5.1 | 1.6 | 0.4 | 9.7 | 0.3 | 0.7 | 4.4 | 0.9 |
| | 5-15 | 7.5 | 0.4 | 1.9 | 0.7 | 0.3 | 9.4 | 0.3 | 0.5 | 3.4 | 0.6 |
| | 15-30 | 7.6 | 0.4 | 2.0 | 0.6 | 0.2 | 8.6 | 0.2 | 0.4 | 2.7 | 0.5 |
| June, 1986 | 0-5 | 7.7 | 0.5 | 1.8 | 1.1 | 0.7 | 0.8 | 0.4 | 1.2 | 2.5 | 0.2 |
| | 5-15 | 7.8 | 0.4 | 1.4 | 1.0 | 0.3 | 1.3 | 0.2 | 0.4 | 2.4 | 0.1 |
| | 15-30 | 7.7 | 0.8 | 3.9 | 3.0 | 0.3 | 2.9 | 0.5 | 0.2 | 1.9 | 3.5 |

ClibPDF - www.fastio.com

Table 6
Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 3

| Date | Depth (cm) | pH | EC (dS/m) | Cations (meq/L) | | | | Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ | $Cl^{-}$ | $NO_3^{-}$ | $HCO_3^{-}$ | $SO_4^{=}$ |
| August, 1985 | 0-5 | 6.3 | 2.6 | 7.5 | 5.4 | 1.1 | 12.7 | 17.8 | 0.9 | 2.4 | 6.2 |
| | 5-15 | 6.6 | 1.6 | 4.5 | 2.1 | 0.6 | 9.3 | 6.3 | 0.5 | 3.2 | 6.0 |
| | 15-30 | 6.9 | 1.5 | 5.7 | 1.6 | 0.4 | 7.8 | 7.4 | 0.5 | 2.5 | 5.7 |
| March, 1986 | 0-5 | 6.6 | 0.8 | 4.6 | 1.1 | 0.6 | 4.9 | 1.5 | 0.3 | 3.3 | 1.5 |
| | 5-15 | 6.7 | 0.8 | 3.1 | 0.6 | 0.5 | 5.7 | 1.3 | 0.3 | 3.4 | 1.8 |
| | 15-30 | 7.1 | 0.8 | 3.6 | 0.9 | 0.4 | 5.2 | 1.7 | 0.3 | 4.3 | 1.4 |
| June, 1986 | 0-5 | 6.4 | 2.8 | 12.9 | 9.7 | 1.4 | 10.0 | 10.5 | 0.2 | 2.4 | 5.5 |
| | 5-15 | 6.6 | 1.7 | 6.4 | 3.8 | 0.8 | 8.2 | 5.7 | 0.3 | 2.0 | 5.8 |
| | 15-30 | 6.8 | 1.9 | 6.8 | 1.9 | 0.4 | 8.2 | 2.5 | 0.2 | 1.9 | 6.6 |
| September, 1986 | 0-5 | 6.8 | 2.7 | 16.7 | 6.3 | 0.7 | 9.4 | 9.0 | 0.2 | 2.0 | 6.2 |
| | 5-15 | 6.7 | 2.7 | 7.0 | 4.6 | 0.6 | 14.6 | 20.0 | 0.2 | 2.4 | 4.0 |
| | 15-30 | 6.2 | 3.3 | 8.1 | 5.6 | 1.0 | 18.9 | 26.4 | 0.1 | 1.3 | 3.3 |
| December, 1986 | 0-5 | 6.6 | 4.2 | 33.1 | 10.2 | 0.8 | 16.5 | 12.8 | 0.1 | 1.5 | 8.6 |
| | 5-15 | 6.3 | 4.2 | 24.9 | 8.0 | 0.8 | 20.3 | 19.9 | 0.1 | 1.5 | 8.2 |
| | 15-30 | 6.6 | 2.3 | 5.7 | 3.2 | 0.5 | 12.8 | 16.6 | 0.1 | 2.3 | 2.1 |
| March, 1987 | 0-5 | 6.5 | 2.6 | 13.5 | 7.8 | 0.6 | 11.0 | 3.6 | 0.1 | 2.2 | 8.4 |
| | 5-15 | 6.6 | 1.0 | 2.1 | 1.4 | 0.4 | 6.3 | 0.8 | 0.1 | 2.8 | 3.0 |
| | 15-30 | 6.8 | 1.3 | 2.4 | 1.6 | 0.4 | 9.3 | 4.0 | 0.1 | 3.7 | 3.2 |
| June, 1987 | 0-5 | 6.5 | 1.5 | 3.1 | 2.4 | 0.4 | 6.6 | 3.0 | 0.1 | 2.2 | 4.8 |
| | 5-15 | 6.6 | 2.1 | 11.7 | 3.0 | 0.6 | 9.9 | 2.9 | 0.1 | 2.7 | 5.2 |
| | 15-30 | 6.8 | 1.5 | 2.7 | 1.9 | 0.5 | 9.5 | 5.7 | 0.2 | 4.4 | 2.8 |



ClibPDF - www.fastio.com

Table 7
Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 4

| Date | Depth (cm) | pH | EC (dS/m) | Cations (meq/L) | | | | Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ | $Cl^{-}$ | $NO_3^{-}$ | $HCO_3^{-}$ | $SO_4^{=}$ |
| August, 1985 | 0.5 | 7.1 | 3.8 | 14.1 | 10.0 | 0.7 | 24.8 | 20.8 | 0.7 | 5.2 | 18.3 |
| | 5-15 | 7.4 | 2.8 | 10.7 | 6.1 | 0.5 | 18.8 | 14.9 | 0.6 | 4.2 | 11.3 |
| | 15-30 | 7.6 | 2.2 | 9.2 | 6.2 | 0.4 | 15.8 | 10.4 | 0.4 | 3.6 | 9.6 |
| March, 1986 | 0-5 | 7.1 | 0.8 | 2.1 | 0.8 | 0.4 | 8.4 | 1.1 | 0.2 | 5.1 | 1.5 |
| | 5-15 | 7.3 | 0.8 | 1.2 | 0.5 | 0.3 | 7.8 | 1.4 | 0.2 | 4.4 | 1.6 |
| | 15-30 | 7.3 | 0.9 | 1.1 | 0.4 | 0.4 | 7.2 | 2.0 | 0.2 | 4.0 | 2.4 |
| June, 1986 | 0-5 | 6.7 | 3.3 | 13.6 | 10.0 | 1.7 | 17.3 | 23.4 | 0.5 | 3.6 | 3.2 |
| | 5-15 | 7.5 | 1.2 | 2.2 | 1.3 | 0.3 | 8.5 | 5.0 | 0.2 | 4.1 | 1.1 |
| | 15-30 | 7.9 | 1.0 | 1.5 | 1.0 | 0.2 | 7.8 | 1.3 | 0.2 | 3.3 | 2.4 |
| September, 1986 | 0-5 | 7.2 | 1.7 | 3.5 | 2.4 | 0.6 | 11.5 | 7.5 | 0.1 | 4.0 | 2.9 |
| | 5-15 | 7.4 | 1.4 | 2.7 | 2.0 | 0.6 | 8.8 | 5.5 | 0.9 | 2.9 | 2.0 |
| | 15-30 | 7.3 | 1.2 | 2.2 | 1.8 | 0.4 | 8.4 | 3.9 | 0.5 | 3.8 | 1.8 |
| December, 1986 | 0-5 | 6.8 | 1.7 | 4.4 | 2.8 | 0.3 | 12.3 | 6.2 | 0.1 | 4.0 | 3.9 |
| | 5-15 | 7.4 | 1.5 | 3.9 | 2.2 | 0.3 | 10.5 | 5.0 | 0.2 | 4.7 | 2.7 |
| | 15-30 | 7.4 | 1.4 | 4.0 | 2.6 | 0.4 | 9.7 | 4.5 | 0.3 | 4.7 | 2.8 |
| March, 1987 | 0-5 | 6.9 | 1.7 | 3.1 | 2.7 | 0.5 | 11.2 | 10.7 | 0.1 | 2.9 | 1.8 |
| | 5-15 | 7.0 | 1.0 | 1.9 | 1.6 | 0.4 | 7.2 | 2.4 | 0.2 | 3.8 | 1.0 |
| | 15-30 | 7.0 | 1.2 | 2.6 | 2.2 | 0.4 | 8.5 | 2.5 | 0.1 | 3.9 | 2.9 |
| June, 1987 | 0-5 | 7.0 | 1.8 | 3.8 | 3.3 | 0.5 | 11.3 | 11.4 | 0.5 | 2.9 | 3.4 |
| | 5-15 | 7.0 | 1.6 | 3.3 | 3.0 | 0.4 | 10.5 | 7.6 | 0.2 | 3.6 | 3.3 |
| | 15-30 | 7.2 | 1.0 | 2.9 | 2.1 | 0.6 | 9.7 | 4.6 | 0.1 | 3.5 | 3.8 |

ClibPDF - www.fastio.com

Table 8
Chemical Composition of Reclaimed Wastewater Irrigation Soil at Site 5

| Date | Depth (cm) | pH | EC (mmho/cm) | Cations (meq/L) | | | | Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ | $Cl^{-}$ | $NO_3^{-}$ | $HCO_3^{-}$ | $SO_4^{=}$ |
| August, 1985 | 0.5 | 7.5 | 4.7 | 27.6 | 17.3 | 0.9 | 26.8 | 17.3 | 14.8 | 3.0 | 17.3 |
| | 5-15 | 7.7 | 2.4 | 6.6 | 4.0 | 0.3 | 16.0 | 6.7 | 7.6 | 2.7 | 10.8 |
| | 15-30 | 7.8 | 2.3 | 3.4 | 3.2 | 0.1 | 17.0 | 5.4 | 5.3 | 2.2 | 9.2 |
| March, 1986 | 0-5 | 7.6 | 1.0 | 5.1 | 1.8 | 0.4 | 9.9 | 2.3 | 0.8 | 5.0 | 0.9 |
| | 5-15 | 7.6 | 1.1 | 1.7 | 0.6 | 0.3 | 9.6 | 3.2 | 0.9 | 4.4 | 0.8 |
| | 15-30 | 7.6 | 1.0 | 1.5 | 0.6 | 0.4 | 8.9 | 2.3 | 0.8 | 3.5 | 1.0 |
| June, 1986 | 0-5 | 7.3 | 1.3 | 7.3 | 6.2 | 0.6 | 20.4 | 13.0 | 0.2 | 4.9 | 4.3 |
| | 5-15 | 7.7 | 0.9 | 2.0 | 1.1 | 0.2 | 12.0 | 5.4 | 0.3 | 4.1 | 3.9 |
| | 15-30 | 7.9 | 0.7 | 1.7 | 1.1 | 0.1 | 9.7 | 1.0 | 0.2 | 3.3 | 4.2 |
| September, 1986 | 0-5 | 7.6 | 1.0 | 1.5 | 1.1 | 0.1 | 8.0 | 2.1 | 0.1 | 3.8 | 1.9 |
| | 5-15 | 7.6 | 1.4 | 2.2 | 1.8 | 0.2 | 9.8 | 8.8 | 0.3 | 3.1 | 1.3 |
| | 15-30 | 7.8 | 1.2 | 1.3 | 1.2 | 0.1 | 10.0 | 3.0 | 0.1 | 4.9 | 2.1 |
| December, 1986 | 0-5 | 7.3 | 2.3 | 7.3 | 4.4 | 0.3 | 12.7 | 15.6 | 0.3 | 3.2 | 2.1 |
| | 5-15 | 7.7 | 0.9 | 2.8 | 1.4 | 0.1 | 6.7 | 1.1 | 0.2 | 3.5 | 2.0 |
| | 15-30 | 7.8 | 1.1 | 2.3 | 1.2 | 0.1 | 9.8 | 1.8 | 0.2 | 4.1 | 3.0 |
| March, 1987 | 0-5 | 7.2 | 1.1 | 1.3 | 1.4 | 0.1 | 8.6 | 1.8 | 0.1 | 3.7 | 2.4 |
| | 5-15 | 7.1 | 1.1 | 1.8 | 1.7 | 0.1 | 7.9 | 2.3 | 0.1 | 4.0 | 2.6 |
| | 15-30 | 7.0 | 1.2 | 1.9 | 1.9 | 0.1 | 8.6 | 5.2 | 0.1 | 4.1 | 1.9 |
| June, 1987 | 0-5 | 7.6 | 1.4 | 2.8 | 2.4 | 0.2 | 10.1 | 1.4 | 0.1 | 3.4 | 4.8 |
| | 5-15 | 7.5 | 1.0 | 1.7 | 1.4 | 0.2 | 8.1 | 3.9 | 0.2 | 3.2 | 2.4 |
| | 15-30 | 7.5 | 2.1 | 3.0 | 3.0 | 0.2 | 16.0 | 13.9 | 0.1 | 2.6 | 4.1 |



ClibPDF - www.fastio.com

Table 9
Chemical Composition of Irrigated Soil Along Highway Right-of-Ways in Riverside
(University Ave. Off-On Ramp of Hwy. 60)

| Date | Depth (cm) | pH | EC (dS/m) | Cations (meq/L) | | | | Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ | $Cl^{-}$ | $NO_3^{-}$ | $HCO_3^{-}$ | $SO_4^{=}$ |
| August, 1985 | 0.5 | 7.1 | 1.6 | 8.4 | 2.8 | 1.1 | 13.2 | 10.1 | 1.6 | 5.0 | 4.2 |
| | 5-15 | 7.1 | 1.3 | 5.3 | 1.6 | 0.6 | 10.8 | 6.7 | 1.2 | 3.5 | 3.6 |
| | 15-30 | 7.0 | 1.2 | 4.1 | 1.2 | 0.4 | 9.7 | 4.7 | 0.9 | 3.2 | 3.2 |
| March, 1986 | 0-5 | 7.3 | 0.9 | 6.7 | 1.4 | 0.7 | 6.9 | 2.0 | 0.3 | 5.2 | 1.6 |
| | 5-15 | 7.2 | 0.7 | 1.7 | 0.5 | 0.4 | 5.6 | 2.2 | 0.3 | 3.3 | 1.3 |
| | 15-30 | 7.1 | 0.7 | 1.2 | 0.4 | 0.3 | 5.5 | 3.1 | 0.3 | 2.3 | 1.0 |
| June, 1986 | 0-5 | 7.4 | 0.9 | 4.6 | 1.7 | 0.4 | 7.4 | 2.1 | 1.1 | 4.8 | 0.8 |
| | 5-15 | 7.4 | 0.6 | 3.6 | 1.3 | 0.5 | 7.4 | 2.3 | 0.8 | 4.1 | 0.9 |
| | 15-30 | 7.5 | 0.7 | 2.7 | 1.0 | 0.3 | 6.6 | 2.0 | 0.6 | 3.5 | 0.5 |
| September, 1986 | 0-5 | 7.5 | 1.3 | 4.9 | 2.9 | 0.7 | 8.5 | 3.1 | 2.7 | 4.6 | 1.7 |
| | 5-15 | 7.5 | 0.8 | 4.0 | 1.6 | 0.3 | 5.6 | 0.3 | 0.1 | 3.4 | 1.3 |
| | 15-30 | 7.4 | 0.9 | 5.4 | 1.9 | 0.4 | 4.7 | 1.8 | 0.5 | 2.9 | 0.9 |
| December, 1986 | 0-5 | 7.4 | 1.1 | 3.8 | 1.3 | 0.2 | 10.2 | 1.4 | 0.1 | 5.9 | 1.5 |
| | 5-15 | 7.3 | 1.1 | 5.1 | 1.6 | 0.5 | 6.5 | 2.8 | 0.1 | 3.5 | 1.5 |
| | 15-30 | 7.4 | 1.8 | 5.5 | 2.1 | 0.9 | 11.3 | 8.5 | 0.5 | 3.4 | 2.6 |
| March, 1987 | 0-5 | 6.9 | 1.0 | 3.3 | 1.8 | 0.3 | 6.4 | 2.7 | 0.1 | 3.7 | 2.2 |
| | 5-15 | 7.1 | 2.2 | 6.1 | 2.8 | 0.5 | 12.7 | 13.7 | 0.1 | 4.5 | 1.8 |
| | 15-30 | 7.0 | 2.8 | 5.8 | 3.2 | 2.6 | 14.7 | 10.8 | 1.0 | 2.8 | 0.9 |
| June, 1987 | 0-5 | 7.1 | 2.2 | 5.0 | 3.0 | 0.5 | 13.2 | 12.3 | 0.6 | 3.8 | 2.7 |
| | 5-15 | 7.1 | 1.7 | 5.1 | 2.2 | 0.4 | 8.5 | 7.2 | 0.1 | 3.9 | 2.8 |
| | 15-30 | 7.1 | 2.0 | 4.8 | 2.5 | 1.1 | 10.0 | 11.0 | 2.1 | 3.0 | 2.2 |



ClibPDF - www.fastio.com

Table 10
Chemical Composition of Irrigated Soil at UCR Campus

| Date | Depth (cm) | pH | EC (dS/m) | Cations (meq/L) | | | | Anions (meq/L) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | $Ca^{++}$ | $Mg^{++}$ | $K^{+}$ | $Na^{+}$ | $Cl^{-}$ | $NO_3^{-}$ | $HCO_3^{-}$ | $SO_4^{=}$ |
| August, 1985 | 0-5 | 7.3 | 0.7 | 4.4 | 1.1 | 0.5 | 2.7 | 1.1 | 0.9 | 3.7 | 1.3 |
| | 5-15 | 7.2 | 0.5 | 2.9 | 0.6 | 0.4 | 2.2 | 0.9 | 0.4 | 2.4 | 0.9 |
| | 15-30 | 7.2 | 0.5 | 2.1 | 0.4 | 0.2 | 1.8 | 0.8 | 0.1 | 2.1 | 0.8 |
| March, 1986 | 0-5 | 7.3 | 0.6 | 8.3 | 1.1 | 0.6 | 1.2 | 0.5 | 0.4 | 3.1 | 1.0 |
| | 5-15 | 7.3 | 0.4 | 2.6 | 0.5 | 0.3 | 1.5 | 0.4 | 0.4 | 1.8 | 0.9 |
| | 15-30 | 7.3 | 0.3 | 1.6 | 0.3 | 0.3 | 1.2 | 0.2 | 0.2 | 1.6 | 0.6 |
| June, 1986 | 0-5 | 7.4 | 0.7 | 4.9 | 1.3 | 0.6 | 3.0 | 1.9 | 0.6 | 3.0 | 1.2 |
| | 5-15 | 7.3 | 0.5 | 4.2 | 0.8 | 0.3 | 2.1 | 1.2 | 0.3 | 2.0 | 0.6 |
| | 15-30 | 7.4 | 0.3 | 3.9 | 0.5 | 0.1 | 1.8 | 0.6 | 0.2 | 1.7 | 0.3 |
| September, 1986 | 0-5 | 7.6 | 0.9 | 5.9 | 1.6 | 0.3 | 4.5 | 2.1 | 0.1 | 2.7 | 1.5 |
| | 5-15 | 7.6 | 0.7 | 4.1 | 1.0 | 0.4 | 4.3 | 0.7 | 0.1 | 3.2 | 0.7 |
| | 15-30 | 7.5 | 0.6 | 3.7 | 0.8 | 0.4 | 3.6 | 0.8 | 0.1 | 3.1 | 0.5 |
| December, 1986 | 0-5 | 7.5 | 0.5 | 3.3 | 0.9 | 0.4 | 3.1 | 0.6 | 0.1 | 3.0 | 0.8 |
| | 5-15 | 7.5 | 0.5 | 2.9 | 0.7 | 0.5 | 3.7 | 0.5 | 0.2 | 3.0 | 0.8 |
| | 15-30 | 7.5 | 0.5 | 2.6 | 0.7 | 0.5 | 4.4 | 0.7 | 0.1 | 3.4 | 1.0 |
| March, 1987 | 0-5 | 7.4 | 0.5 | 1.9 | 0.7 | 0.3 | 2.8 | 0.7 | 0.1 | 3.4 | 0.4 |
| | 5-15 | 7.4 | 0.6 | 2.3 | 0.8 | 0.6 | 2.9 | 0.8 | 0.1 | 3.3 | 0.4 |
| | 15-30 | 7.2 | 0.5 | 2.0 | 0.8 | 0.5 | 2.7 | 0.7 | 0.1 | 2.5 | 0.4 |
| June, 1987 | 0-5 | 7.3 | 0.7 | 2.4 | 0.8 | 0.4 | 3.5 | 1.3 | 0.1 | 2.8 | 1.0 |
| | 5-15 | 7.2 | 0.7 | 2.4 | 0.8 | 0.4 | 3.6 | 1.4 | 0.3 | 2.4 | 0.9 |
| | 15-30 | 7.3 | 0.7 | 2.5 | 0.9 | 0.3 | 3.8 | 1.4 | 0.1 | 2.6 | 1.2 |



ClibPDF - www.fastio.com

Table 11
Heavy Metal Contents of Soils at Site 1

| Date | Depth | Cd | Cr | Cu | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| | (cm) | (mg/kg) | | | | | |
| August, 1985 | 0-5 | 3.4 | 39 | 29 | 42 | 42 | 83 |
| | 5-15 | 3.4 | 40 | 29 | 45 | 22 | 75 |
| | 15-30 | 3.0 | 36 | 23 | 42 | 11 | 67 |
| March, 1986 | 0-5 | 2.2 | 32 | 25 | 37 | 33 | 91 |
| | 5-15 | 2.1 | 32 | 24 | 36 | 25 | 84 |
| | 15-30 | 2.0 | 32 | 23 | 34 | 10 | 76 |
| June, 1986 | 0-5 | 1.8 | 35 | 20 | 41 | 30 | 88 |
| | 5-15 | 2.6 | 43 | 25 | 44 | 35 | 105 |
| | 15-30 | 3.2 | 33 | 25 | 36 | 17 | 104 |
| September, 1986 | 0-5 | 3.2 | 33 | 29 | 33 | 56 | 95 |
| | 5-15 | 2.5 | 29 | 25 | 25 | 35 | 76 |
| | 15-30 | 1.0 | 28 | 24 | 23 | 29 | 73 |
| December, 1986 | 0-5 | 2.1 | 32 | 29 | 43 | 45 | 92 |
| | 5-15 | 2.0 | 32 | 28 | 44 | 17 | 82 |
| | 15-30 | 2.3 | 37 | 27 | 49 | 9 | 77 |
| March, 1987 | 0-5 | 2.0 | 40 | 29 | 43 | 45 | 92 |
| | 5-15 | 1.7 | 38 | 28 | 38 | 18 | 80 |
| | 15-30 | 1.6 | 44 | 26 | 33 | 14 | 73 |
| June, 1987 | 0-5 | 2.0 | 38 | 30 | 62 | 43 | 108 |
| | 5-15 | 1.6 | 38 | 30 | 64 | 23 | 99 |
| | 15-30 | 1.6 | 35 | 30 | 62 | 13 | 89 |



ClibPDF - www.fastio.com

Table 12
Heavy Metal Contents of Soils at Site 2

| Date | Depth | Cd | Cr | Cu | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| | (cm) | (mg/kg) | | | | | |
| August, 1985 | 0-5 | 7.4 | 50 | 38 | 49 | 38 | 91 |
| | 5-15 | 7.7 | 52 | 38 | 51 | 24 | 102 |
| | 15-30 | 6.3 | 52 | 36 | 50 | 15 | 100 |
| March, 1986 | 0-5 | 6.6 | 43 | 32 | 41 | 45 | 133 |
| | 5-15 | 6.4 | 43 | 30 | 43 | 32 | 128 |
| | 15-30 | 6.4 | 43 | 29 | 43 | 15 | 129 |
| June, 1986 | 0-5 | 7.2 | 53 | 31 | 48 | 33 | 134 |
| | 5-15 | 6.6 | 49 | 30 | 44 | 26 | 131 |
| | 15-30 | 5.8 | 52 | 34 | 44 | 16 | 126 |



ClibPDF - www.fastio.com

Table 13
Heavy Metal Contents of Soils at Site 3

| Date | Depth | Cd | Cr | Cu | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| | (cm) | (mg/kg) | | | | | |
| August, 1985 | 0-5 | 4.1 | 47 | 34 | 39 | 122 | 114 |
| | 5-15 | 3.0 | 40 | 24 | 40 | 74 | 74 |
| | 15-30 | 2.2 | 30 | 23 | 36 | 35 | 70 |
| March, 1986 | 0-5 | 4.7 | 33 | 28 | 34 | 232 | 148 |
| | 5-15 | 4.9 | 35 | 28 | 39 | 54 | 128 |
| | 15-30 | 1.9 | 30 | 23 | 29 | 40 | 85 |
| June, 1986 | 0-5 | 5.4 | 38 | 28 | 34 | 218 | 157 |
| | 5-15 | 5.6 | 36 | 25 | 38 | 81 | 134 |
| | 15-30 | 2.1 | 28 | 18 | 29 | 14 | 78 |
| September, 1986 | 0-5 | 5.8 | 39 | 31 | 40 | 149 | 205 |
| | 5-15 | 3.8 | 29 | 23 | 31 | 57 | 87 |
| | 15-30 | 2.4 | 25 | 19 | 28 | 33 | 70 |
| December, 1986 | 0-5 | 6.0 | 55 | 31 | 56 | 145 | 175 |
| | 5-15 | 2.6 | 45 | 24 | 43 | 28 | 88 |
| | 15-30 | 1.2 | 31 | 19 | 29 | 16 | 66 |
| March, 1987 | 0-5 | 4.5 | 44 | 30 | 36 | 176 | 166 |
| | 5-15 | 4.4 | 51 | 28 | 46 | 45 | 99 |
| | 15-30 | 3.8 | 46 | 29 | 43 | 24 | 92 |
| June, 1987 | 0-5 | 5.7 | 46 | 32 | 44 | 228 | 182 |
| | 5-15 | 3.0 | 41 | 25 | 36 | 46 | 113 |
| | 15-30 | 1.8 | 37 | 23 | 32 | 24 | 94 |



ClibPDF - www.fastio.com

Table 14
Heavy Metal Contents of Soils at Site 4

| Date | Depth | Cd | Cr | Cu | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| | (cm) | (mg/kg) | | | | | |
| August, 1985 | 0-5 | 1.8 | 18 | 12 | 15 | 31 | 59 |
| | 5-15 | 1.7 | 18 | 11 | 16 | 22 | 56 |
| | 15-30 | 1.7 | 18 | 10 | 18 | 22 | 46 |
| March, 1986 | 0-5 | 2.1 | 20 | 18 | 14 | 35 | 103 |
| | 5-15 | 1.5 | 16 | 13 | 10 | 20 | 64 |
| | 15-30 | 1.4 | 14 | 12 | 9 | 15 | 54 |
| June, 1986 | 0-5 | 2.2 | 35 | 21 | 18 | 41 | 139 |
| | 5-15 | 1.3 | 27 | 14 | 14 | 21 | 77 |
| | 15-30 | 1.1 | 26 | 12 | 12 | 18 | 57 |
| September, 1986 | 0-5 | 2.6 | 25 | 22 | 15 | 53 | 128 |
| | 5-15 | 2.0 | 23 | 18 | 11 | 36 | 90 |
| | 15-30 | 2.0 | 20 | 14 | 9 | 34 | 65 |
| December, 1986 | 0-5 | 1.6 | 26 | 23 | 17 | 35 | 101 |
| | 5-15 | 1.2 | 21 | 17 | 12 | 20 | 73 |
| | 15-30 | 1.1 | 19 | 15 | 11 | 15 | 65 |
| March, 1987 | 0-5 | 1.8 | 30 | 23 | 17 | 45 | 107 |
| | 5-15 | 1.0 | 23 | 16 | 12 | 20 | 72 |
| | 15-30 | 1.0 | 20 | 14 | 9 | 18 | 64 |
| June, 1987 | 0-5 | 1.7 | 30 | 23 | 18 | 42 | 130 |
| | 5-15 | 0.9 | 25 | 18 | 14 | 24 | 89 |
| | 15-30 | 0.8 | 21 | 13 | 12 | 14 | 63 |



ClibPDF - www.fastio.com

Table 15
Heavy Metal Contents of Soils at Site 5

| Date | Depth | Cd | Cr | Cu | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| | (cm) | (mg/kg) | | | | | |
| August, 1985 | 0-5 | 0.9 | 18 | 9 | 13 | 101 | 47 |
| | 5-15 | 0.8 | 18 | 9 | 14 | 34 | 38 |
| | 15-30 | 0.7 | 19 | 9 | 16 | 11 | 37 |
| March, 1986 | 0-5 | 0.6 | 16 | 13 | 9 | 395 | 110 |
| | 5-15 | 0.3 | 14 | 11 | 9 | 156 | 66 |
| | 15-30 | 0.3 | 14 | 10 | 8 | 57 | 44 |
| June, 1986 | 0-5 | 0.7 | 29 | 13 | 12 | 406 | 132 |
| | 5-15 | 0.5 | 27 | 10 | 12 | 266 | 81 |
| | 15-30 | 0.3 | 28 | 9 | 12 | 28 | 38 |
| September, 1986 | 0-5 | 0.3 | 16 | 10 | 6 | 228 | 79 |
| | 5-15 | 0.3 | 14 | 9 | 7 | 59 | 43 |
| | 15-30 | 0.4 | 14 | 9 | 7 | 29 | 37 |
| December, 1986 | 0-5 | 0.5 | 16 | 12 | 9 | 326 | 91 |
| | 5-15 | 0.3 | 14 | 9 | 9 | 65 | 46 |
| | 15-30 | 0.3 | 14 | 9 | 10 | 13 | 38 |
| March, 1987 | 0-5 | 0.1 | 19 | 12 | 10 | 301 | 79 |
| | 5-15 | 0.1 | 21 | 11 | 11 | 64 | 51 |
| | 15-30 | 0.1 | 19 | 9 | 9 | 23 | 50 |
| June, 1987 | 0-5 | 0.2 | 18 | 9 | 11 | 255 | 73 |
| | 5-15 | 0.1 | 19 | 10 | 12 | 62 | 49 |
| | 15-30 | 0.1 | 22 | 11 | 14 | 19 | 48 |



ClibPDF - www.fastio.com

Table 16
Heavy Metal Contents of Soils at Riverside

| Date | Depth | Cd | Cr | Cu | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| | (cm) | (mg/kg) | | | | | |
| August, 1985 | 0-5 | 0.4 | 12 | 10 | 10 | 86 | 89 |
| | 5-15 | 0.2 | 12 | 10 | 11 | 35 | 87 |
| | 15-30 | 0.1 | 11 | 9 | 11 | 24 | 72 |
| March, 1986 | 0-5 | 0.2 | 10 | 11 | 6 | 54 | 92 |
| | 5-15 | 0.1 | 9 | 10 | 6 | 41 | 71 |
| | 15-30 | 0.1 | 8 | 10 | 5 | 51 | 84 |
| June, 1986 | 0-5 | 0.2 | 11 | 10 | 5 | 75 | 111 |
| | 5-15 | 0.1 | 11 | 10 | 5 | 48 | 99 |
| | 15-30 | 0.1 | 10 | 11 | 5 | 29 | 94 |
| September, 1986 | 0-5 | 0.6 | 10 | 13 | 5 | 88 | 104 |
| | 5-15 | 0.5 | 9 | 12 | 5 | 46 | 82 |
| | 15-30 | 0.5 | 7 | 12 | 4 | 38 | 77 |
| December, 1986 | 0-5 | <0.1 | 12 | 12 | 6 | 68 | 99 |
| | 0-15 | <0.1 | 12 | 16 | 7 | 44 | 93 |
| | 15-30 | <0.1 | 12 | 60 | 6 | 16 | 65 |
| March, 1987 | 0-5 | <0.1 | 15 | 13 | 7 | 89 | 114 |
| | 5-15 | <0.1 | 13 | 12 | 6 | 46 | 88 |
| | 15-30 | <0.1 | 11 | 10 | 5 | 28 | 76 |
| June, 1987 | 0-5 | <0.1 | 13 | 14 | 6 | 80 | 133 |
| | 5-15 | <0.1 | 12 | 11 | 6 | 26 | 74 |
| | 15-30 | <0.1 | 10 | 10 | 5 | 18 | 66 |



ClibPDF - www.fastio.com

Table 17
Heavy Metal Contents of Soils at UCR

| Date | Depth | Cd | Cr | Cu | Ni | Pb | Zn |
|---|---|---|---|---|---|---|---|
| | (cm) | (mg/kg) | | | | | |
| August, 1985 | 0-5 | 0.9 | 14 | 9 | 10 | 88 | 118 |
| | 5-15 | 0.5 | 9 | 5 | 8 | 17 | 70 |
| | 15-30 | 0.1 | 8 | 6 | 8 | 8 | 57 |
| March, 1986 | 0-5 | 0.9 | 15 | 11 | 5 | 105 | 176 |
| | 5-15 | 0.2 | 7 | 5 | 2 | 13 | 64 |
| | 15-30 | 0.1 | 4 | 13 | 2 | 4 | 50 |
| June, 1986 | 0-5 | 0.4 | 12 | 8 | 4 | 59 | 120 |
| | 5-15 | 0.1 | 9 | 5 | 2 | 16 | 73 |
| | 15-30 | 0.1 | 7 | 4 | 1 | 6 | 60 |
| September, 1986 | 0-5 | 0.3 | 11 | 10 | 4 | 76 | 112 |
| | 5-15 | 0.2 | 8 | 8 | 3 | 17 | 72 |
| | 15-30 | 0.1 | 7 | 6 | 2 | 10 | 60 |
| December, 1986 | 0-5 | <0.1 | 14 | 10 | 5 | 75 | 137 |
| | 5-15 | <0.1 | 9 | 7 | 4 | 13 | 68 |
| | 15-30 | <0.1 | 7 | 6 | 3 | 8 | 59 |
| March, 1987 | 0-5 | <0.1 | 13 | 10 | 5 | 64 | 113 |
| | 5-15 | <0.1 | 9 | 7 | 3 | 10 | 66 |
| | 15-30 | <0.1 | 8 | 6 | 3 | 7 | 59 |
| June, 1987 | 0-5 | 0.3 | 16 | 11 | 5 | 62 | 155 |
| | 5-15 | <0.1 | 8 | 7 | 3 | 14 | 66 |
| | 15-30 | <0.1 | 6 | 5 | 2 | 5 | 60 |



ClibPDF - www.fastio.com

Table 18
Elemental Contents of Eucalyptus Leaf at Site 1

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 6200-14600 | 10320 | 3180 | 7260-12800 | 10312 | 1901 | 6270-18400 | 11518 | 5132 | 10400-20400 | 13480 | 4150 |
| Mg | 2100-3700 | 2780 | 700 | 1750-3750 | 2874 | 745 | 1720-3340 | 2624 | 671 | 1990-3320 | 2694 | 521 |
| Na | 1300-2550 | 1870 | 565 | 2110-3040 | 2790 | 706 | 1390-2650 | 1838 | 504 | 1450-2440 | 1770 | 401 |
| K | 4500-7850 | 6110 | 1525 | 6650-10700 | 7004 | 2085 | 4770-6710 | 5410 | 800 | 4470-9350 | 6496 | 2068 |
| B | 78-152 | 121 | 28 | 93-174 | 124 | 36 | 66-87 | 76 | 9 | 77-157 | 109 | 30 |
| Cu | 13-24 | 17 | 5 | 6-24 | 10 | 8 | 4-6 | 4.4 | 0.9 | 6-7 | 6.2 | 0.4 |
| Cd | 1.2-2.6 | 1.7 | 0.6 | 0.3-5.1 | 1.7 | 2.0 | 0.1-2.1 | 1.0 | 0.8 | 0.3-1.5 | 0.8 | 0.5 |
| Zn | 19-35 | 26 | 6 | 24-32 | 30 | 3 | 19-52 | 30 | 13 | 20-33 | 25 | 4.8 |
| P | 750-3830 | 2090 | 1228 | 1190-1850 | 1474 | 289 | 1120-3130 | 1774 | 785 | 1400-3330 | 2042 | 746 |
| Fe | 120-162 | 140 | 16 | 182-262 | 216 | 30 | 90-134 | 117 | 20 | 113-204 | 153 | 33 |
| Mn | 36-85 | 61 | 23 | 60-177 | 91 | 49 | 65-154 | 107 | 39 | 100-224 | 147 | 49 |



ClibPDF - www.fastio.com

Table 18 (continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 8310-30100 | 14086 | 9224 | 7860-26700 | 13792 | 7803 | 5330-20600 | 11238 | 5682 | 4810-17200 | 9636 | 4807 |
| Mg | 1500-4000 | 2540 | 932 | 1980-4940 | 3244 | 1200 | 1390-3390 | 2860 | 834 | 2080-3760 | 2606 | 677 |
| Na | 970-2840 | 1714 | 751 | 1710-3720 | 2810 | 993 | 1250-3710 | 2256 | 908 | 1940-3110 | 2438 | 477 |
| K | 4060-7340 | 6198 | 1436 | 3010-5440 | 4552 | 1032 | 3130-6110 | 4166 | 744 | 6120-9770 | 7330 | 1435 |
| B | 84-170 | 140 | 35 | 108-169 | 148 | 25 | 113-195 | 148 | 31 | 84-140 | 113 | 21 |
| Cu | 4-12 | 6.6 | 3.4 | 4-5 | 4.4 | 0.5 | 4-5 | 4.6 | 0.5 | 4-8 | 6.0 | 1.6 |
| Cd | 0.1-1.1 | 0.7 | 0.4 | 0.5-1.9 | 1.0 | 0.6 | 0.1-3.8 | 1.4 | 1.5 | 0-0.5 | 0.3 | 0.2 |
| Zn | 21-36 | 28.0 | 6.8 | 18-45 | 26.2 | 9.6 | 16-32 | 22.2 | 6.1 | 14-38 | 22.8 | 9.8 |
| P | 1510-3310 | 2062 | 905 | 901-3990 | 2064 | 1283 | 1080-3850 | 2158 | 1043 | 1660-3130 | 2400 | 695 |
| Fe | 138-208 | 177 | 31 | 137-243 | 193 | 53 | 104-178 | 152 | 28 | 134-291 | 200 | 63 |
| Mn | 58-240 | 137 | 72 | 92-183 | 132 | 46 | 57-160 | 130 | 49 | 78-197 | 124 | 53 |

[†]Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 19
Elemental Contents of Eucalyptus Leaf at Site 2

| Element† | August 1986 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 6700-20000 | 13700 | 5390 | 6780-39900 | 18436 | 12722 | 7370-28200 | 10254 | 8784 | 9200-23000 | 13620 | 5774 |
| Mg | 2200-3400 | 2700 | 476 | 1900-5390 | 3414 | 1253 | 1840-4300 | 3262 | 912 | 2240-4780 | 3144 | 1034 |
| Na | 240-1370 | 702 | 513 | 1050-2480 | 1766 | 637 | 721-1480 | 1012 | 371 | 563-2640 | 1619 | 941 |
| K | 5600-13300 | 7940 | 3260 | 4380-9060 | 6326 | 2108 | 3790-5690 | 4980 | 753 | 5310-14600 | 9014 | 3445 |
| B | 64-136 | 94 | 31 | 92-128 | 114 | 17 | 63-141 | 105 | 28 | 37-113 | 81 | 33 |
| Cu | 7-18 | 11 | 5 | 4-6 | 5 | 1 | 4-5 | 4.2 | 0.4 | 5-8 | 6.8 | 1.3 |
| Cd | 0.1-7.6 | 2.2 | 3.1 | 0.1-3.2 | 1.3 | 1.3 | 0.1-4.0 | 1.5 | 1.7 | 0.1-1.9 | 0.8 | 0.8 |
| Zn | 10-68 | 25 | 24 | 10-48 | 25 | 14 | 11-67 | 31 | 22 | 12-43 | 27 | 14 |
| P | 710-1320 | 904 | 253 | 887-1300 | 1130 | 190 | 726-2500 | 1212 | 737 | 1010-2340 | 1526 | 503 |
| Fe | 112-285 | 201 | 100 | 148-326 | 227 | 67 | 92-177 | 135 | 36 | 107-276 | 182 | 76 |
| Mn | 93-201 | 164 | 45 | 81-185 | 120 | 56 | 90-203 | 141 | 57 | 102-321 | 177 | 99 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 20
Elemental Contents of Eucalyptus Leaf at Site 3

| Element[1] | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 6200-21600 | 11980 | 5750 | 0430-18900 | 16006 | 5124 | 9700-24400 | 18560 | 6534 | 6620-21700 | 14264 | 5731 |
| Mg | 1360-2650 | 2060 | 560 | 2000-3310 | 2478 | 461 | 1640-2800 | 2478 | 479 | 1580-2050 | 2178 | 495 |
| Na | 400-1060 | 760 | 273 | 985-1490 | 1173 | 207 | 741-1260 | 1005 | 188 | 1000-1660 | 1318 | 265 |
| K | 8550-12400 | 10250 | 1393 | 7330-10200 | 8584 | 1154 | 5010-9110 | 6534 | 1634 | 6200-15000 | 9522 | 3525 |
| B | 77-219 | 120 | 56 | 90-164 | 125 | 27 | 109-196 | 141 | 35 | 55-169 | 124 | 50 |
| Cu | 6-16 | 10 | 4 | 2-7 | 4 | 2 | 3-5 | 3.6 | 0.9 | 5-7 | 6 | 0.7 |
| Cd | 0.1-2.2 | 0.8 | 0.9 | 0.1-0.3 | 0.2 | 0.2 | 0-0.3 | 0.2 | 0.1 | 0.1-0.4 | 0.1 | 0.1 |
| Zn | 14-22 | 16 | 3 | 14-21 | 17 | 3 | 12-22 | 18 | 3.8 | 18-26 | 23 | 6 |
| P | 860-1730 | 1190 | 361 | 847-1780 | 1335 | 439 | 830-1980 | 1465 | 589 | 1110-2100 | 1562 | 355 |
| Fe | 116-240 | 200 | 62 | 140-256 | 199 | 49 | 133-204 | 164 | 26 | 73-161 | 125 | 32 |
| Mn | 31-128 | 68 | 40 | 39-130 | 90 | 47 | 40-207 | 107 | 63 | 27-147 | 90 | 50 |



ClibPDF - www.fastio.com

Table 20 :(continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 5070-27300 | 12964 | 8517 | 9730-19100 | 12942 | 3991 | 8790-20300 | 12998 | 4454 | 10300-20000 | 15900 | 4270 |
| Mg | 1560-2236 | 2236 | 629 | 2010-3640 | 2628 | 634 | 1460-4480 | 2572 | 1183 | 2310-4160 | 3248 | 727 |
| Na | 352-815 | 540 | 198 | 1110-4010 | 2228 | 1166 | 1080-1710 | 1284 | 263 | 1250-3540 | 2088 | 891 |
| K | 4680-16200 | 9662 | 4010 | 5160-12000 | 8274 | 2734 | 2260-12900 | 7190 | 4141 | 4660-14200 | 6364 | 2780 |
| B | 79-185 | 113 | 43 | 104-199 | 145 | 39 | 117-221 | 172 | 37 | 102-220 | 172 | 57 |
| Cu | 4-8 | 5.8 | 1.5 | 4-6 | 5.0 | 0.7 | 2-6 | 4.6 | 1.7 | 6-7 | 6.2 | 0.4 |
| Cd | <0.1-0.2 | 0.1 | 0.1 | 0.1-0.5 | 0.3 | 0.2 | 0-0.2 | 0.1 | 0.1 | 0-0.2 | 0.1 | 0.1 |
| Zn | 14-22 | 18.4 | 4.0 | 16-28 | 20.4 | 4.6 | 14-22 | 17.2 | 3.3 | 16-38 | 23.0 | 9.5 |
| P | 706-2120 | 1226 | 564 | 602-1400 | 1043 | 291 | 606-2320 | 1565 | 660 | 912-1930 | 1345 | 435 |
| Fe | 104-275 | 171 | 66 | 100-171 | 135 | 28 | 179-303 | 221 | 48 | 79-159 | 125 | 33 |
| Mn | 21-125 | 63 | 43 | 42-107 | 66 | 25 | 46-132 | 87 | 36 | 46-231 | 180 | 76 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 21
Elemental Contents of Eucalyptus Leaf at Site 4

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 3900-9600 | 6060 | 2300 | 2970-11100 | 7150 | 3046 | 6010-12600 | 10422 | 3022 | 5340-12000 | 10548 | 3016 |
| Mg | 2500-3900 | 2890 | 585 | 2220-3450 | 2892 | 516 | 1550-2700 | 2246 | 487 | 2250-3000 | 3036 | 744 |
| Na | 670-4900 | 2054 | 1690 | 1370-3650 | 2508 | 1068 | 708-2070 | 1294 | 571 | 710-2280 | 1401 | 758 |
| K | 3500-8500 | 5230 | 1950 | 3720-10100 | 6044 | 2612 | 2710-4330 | 3596 | 594 | 2720-4000 | 3468 | 605 |
| B | 110-235 | 171 | 56 | 112-165 | 135 | 20 | 95-195 | 139 | 45 | 96-260 | 164 | 70 |
| Cu | 9-14 | 11 | 2 | 4-8 | 7 | 2 | 6-7 | 6.6 | 0.5 | 5-6 | 5.4 | 0.5 |
| Cd | 0.3-1.0 | 0.7 | 0.3 | 0.1-0.8 | 0.4 | 0.3 | 0.2-0.4 | 0.3 | 0.1 | 0.1-0.4 | 0.2 | 0.1 |
| Zn | 14-31 | 19 | 7 | 12-25 | 19 | 6 | 16-34 | 22 | 7 | 13-25 | 20 | 5 |
| P | 700-1980 | 1210 | 494 | 603-1390 | 951 | 306 | 404-993 | 769 | 250 | 752-1350 | 1046 | 254 |
| Fe | 84-145 | 106 | 24 | 126-139 | 131 | 6 | 98-192 | 133 | 37 | 92-166 | 117 | 29 |
| Mn | 44-177 | 112 | 57 | 63-199 | 112 | 54 | 104-276 | 177 | 79 | 80-299 | 190 | 97 |



ClibPDF - www.fastio.com

Table 21 (continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 4210-13600 | 8880 | 3421 | 5050-16700 | 10218 | 4511 | 3730-12800 | 7990 | 3259 | 2860-9820 | 6646 | 2499 |
| Mg | 2750-3590 | 2912 | 502 | 2320-4160 | 2996 | 723 | 2410-3970 | 3338 | 652 | 2060-3590 | 3152 | 635 |
| Na | 661-1300 | 1100 | 380 | 1770-2840 | 2292 | 382 | 1770-3850 | 2624 | 761 | 2140-4650 | 3312 | 1223 |
| K | 3190-4650 | 3822 | 656 | 3560-4400 | 4060 | 388 | 3110-6530 | 4626 | 1275 | 4630-9150 | 6900 | 2014 |
| B | 97-189 | 144 | 40 | 104-276 | 176 | 66 | 98-199 | 152 | 44 | 70-218 | 143 | 67 |
| Cu | 4-7 | 5.2 | 1.3 | 4-5 | 4.2 | 0.4 | 5-7 | 6.0 | 1.0 | 5-11 | 8.0 | 2.4 |
| Cd | 0.1-0.4 | 0.3 | 0.2 | 0-0.6 | 0.2 | 0.2 | 0.1-0.7 | 0.3 | 0.3 | 0-0.2 | 0.1 | 0.1 |
| Zn | 16-29 | 22.0 | 5.1 | 10-24 | 16.2 | 5.2 | 13-34 | 22.0 | 7.8 | 9-25 | 18.2 | 6.6 |
| P | 954-2040 | 1477 | 444 | 598-1970 | 1125 | 507 | 917-1480 | 1181 | 213 | 1210-1700 | 1430 | 220 |
| Fe | 90-211 | 135 | 48 | 89-252 | 138 | 65 | 103-200 | 127 | 45 | 78-191 | 117 | 45 |
| Mn | 72-176 | 125 | 40 | 100-211 | 137 | 51 | 84-228 | 125 | 59 | 67-145 | 97 | 43 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 22
Elemental Contents of Eucalyptus Leaf at Site 5

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 4000-7500 | 5500 | 1263 | 11200-26000 | 18580 | 5307 | 7730-21700 | 14326 | 6337 | 8770-15200 | 12574 | 2611 |
| Mg | 1400-2300 | 1760 | 378 | 2980-5350 | 4146 | 888 | 1640-3790 | 2832 | 814 | 2250-3950 | 2950 | 628 |
| Na | 3700-6500 | 4320 | 1221 | 1680-3260 | 2608 | 810 | 817-2870 | 1757 | 735 | 1220-4170 | 2308 | 1116 |
| K | 5700-9700 | 7140 | 1608 | 6030-10200 | 6380 | 2191 | 4020-8600 | 5568 | 2100 | 5210-12900 | 7884 | 3047 |
| B | 50-270 | 111 | 90 | 182-566 | 320 | 156 | 109-397 | 211 | 116 | 60-247 | 165 | 64 |
| Cu | 10-19 | 14 | 4 | 7-11 | 9 | 2 | 5-9 | 6.4 | 1.7 | 6-8 | 7 | 1 |
| Cd | 0.6-2.2 | 1.3 | 0.7 | 0.1-1.3 | 0.6 | 0.5 | 0-0.3 | 0.1 | 0.1 | 0-0.3 | 0.2 | 0.1 |
| Zn | 18-25 | 19 | 3 | 40-85 | 59 | 18 | 38-77 | 49 | 16 | 24-55 | 40 | 14 |
| P | 570-1090 | 866 | 211 | 879-1830 | 1302 | 409 | 998-1480 | 1186 | 183 | 920-1800 | 1432 | 366 |
| Fe | 73-171 | 108 | 40 | 133-200 | 169 | 29 | 98-136 | 120 | 15 | 90-136 | 111 | 23 |
| Mn | 141-297 | 187 | 69 | 156-264 | 202 | 51 | 145-174 | 155 | 22 | 88-204 | 143 | 44 |



ClibPDF - www.fastio.com

Table 22 (continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 4910-20200 | 10172 | 6220 | 5560-18200 | 10090 | 5595 | 4520-18900 | 12066 | 6816 | 4340-12900 | 8428 | 3157 |
| Mg | 2130-3620 | 2680 | 618 | 2320-4210 | 3018 | 737 | 2120-5490 | 3550 | 1362 | 2350-5040 | 3258 | 1075 |
| Na | 1010-6120 | 2848 | 2080 | 1310-4990 | 3350 | 1315 | 1370-4400 | 3212 | 1342 | 2360-7250 | 5190 | 1922 |
| K | 4180-12400 | 7700 | 3500 | 3780-8670 | 6576 | 1930 | 4280-6870 | 5394 | 1112 | 5920-14100 | 9778 | 3393 |
| B | 100-564 | 279 | 188 | 99-474 | 278 | 177 | 102-437 | 238 | 126 | 105-163 | 136 | 24 |
| Cu | 5-12 | 8.4 | 2.5 | 6-8 | 7.0 | 0.7 | 5-8 | 7.0 | 1.4 | 8-12 | 10.2 | 1.6 |
| Cd | <0.1-0.3 | 0.1 | 0.1 | 0-0.5 | 0.3 | 0.3 | 0.1-0.7 | 0.3 | 0.2 | 0-0.2 | 0.1 | 0.1 |
| Zn | 25-36 | 31.8 | 4.4 | 32-39 | 36.0 | 3.2 | 36-70 | 45.0 | 14.4 | 19-42 | 28.8 | 10.8 |
| P | 782-1160 | 980 | 178 | 846-1920 | 1267 | 413 | 887-1350 | 1072 | 176 | 1150-2130 | 1684 | 431 |
| Fe | 113-198 | 141 | 34 | 116-234 | 147 | 49 | 80-194 | 125 | 43 | 76-167 | 120 | 35 |
| Mn | 54-147 | 103 | 37 | 76-202 | 124 | 51 | 62-244 | 137 | 82 | 60-202 | 126 | 88 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 23
Elemental Contents of Eucalyptus Leaf at Riverside

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 5900-15500 | 10080 | 4050 | 4930-18500 | 10934 | 6138 | 9120-25500 | 17264 | 5793 | 12800-28400 | 19360 | 6429 |
| Mg | 1610-2250 | 1890 | 261 | 1610-2750 | 1968 | 451 | 590-2590 | 1804 | 798 | 1350-2850 | 1992 | 720 |
| Na | 640-3630 | 2315 | 1380 | 914-4220 | 2137 | 1367 | 610-3220 | 1953 | 1159 | 824-3850 | 2457 | 1321 |
| K | 4150-11800 | 9330 | 2980 | 4670-14900 | 9206 | 4200 | 4960-8410 | 6983 | 1885 | 5560-10600 | 7348 | 1908 |
| B | 148-272 | 209 | 53 | 110-174 | 143 | 24 | 151-340 | 230 | 78 | 152-283 | 230 | 60 |
| Cu | 8-16 | 11 | 3 | 4-9 | 7 | 3 | 5-9 | 6.4 | 1.7 | 5-8 | 7 | 1.4 |
| Cd | 0.1-0.5 | 0.2 | 0.2 | 0.1-0.5 | 0.2 | 0.2 | <0.1 | <0.1 | 0 | 0-0.1 | <0.1 | 0 |
| Zn | 17-35 | 24 | 8 | 15-27 | 23 | 5 | 15-42 | 23 | 11 | 16-43 | 27 | 11 |
| P | 1020-1540 | 1308 | 192 | 1110-1360 | 1226 | 94 | 801-1310 | 978 | 214 | 779-1360 | 1028 | 210 |
| Fe | 67-139 | 103 | 33 | 94-147 | 115 | 26 | 93-215 | 123 | 52 | 93-225 | 145 | 61 |
| Mn | 21-94 | 60 | 29 | 20-130 | 69 | 42 | 49-182 | 103 | 49 | 61-211 | 129 | 56 |



ClibPDF - www.fastio.com

Table 23 (continued)

| Element[f] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 3950-13400 | 8730 | 3356 | 3590-15400 | 8782 | 4736 | 6690-14000 | 9020 | 3708 | 7560-19500 | 14932 | 5617 |
| Mg | 1550-2060 | 1812 | 188 | 1670-2550 | 2180 | 358 | 1190-2200 | 1738 | 418 | 1230-2990 | 2046 | 727 |
| Na | 586-3290 | 2053 | 1177 | 1260-4940 | 2702 | 1667 | 623-4220 | 2217 | 1710 | 678-4210 | 2009 | 1621 |
| K | 4570-13900 | 8476 | 3599 | 5340-16800 | 9402 | 4835 | 4510-8170 | 5996 | 1414 | 4710-10500 | 6788 | 2540 |
| B | 95-216 | 131 | 49 | 134-229 | 178 | 36 | 144-287 | 198 | 54 | 125-253 | 200 | 55 |
| Cu | 7-11 | 8.6 | 1.7 | 3-9 | 5.8 | 2.2 | 4-13 | 7.4 | 3.4 | 7-9 | 7.6 | 0.9 |
| Cd | <0.1 | <0.1 | 0 | 0 | 0 | 0 | 0-0.4 | 0.1 | 0.2 | 0 | 0 | 0 |
| Zn | 18-28 | 23.0 | 3.6 | 13-23 | 19.2 | 3.8 | 13-24 | 20.6 | 4.5 | 16-33 | 22.6 | 7.2 |
| P | 1090-1600 | 1280 | 197 | 1060-1550 | 1280 | 179 | 950-1440 | 1117 | 199 | 850-1390 | 1067 | 199 |
| Fe | 73-99 | 84 | 10 | 73-143 | 106 | 25 | 79-154 | 108 | 34 | 110-250 | 158 | 54 |
| Mn | 22-61 | 46 | 15 | 24-102 | 70 | 34 | 27-110 | 66 | 33 | 60-185 | 130 | 65 |

[f]Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 24
Elemental Contents of Eucalyptus Leaf at UCR

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 10000-26500 | 17560 | 6620 | 16300-25900 | 21760 | 3728 | 9060-29900 | 17892 | 8983 | 13100-25400 | 20620 | 5141 |
| Mg | 1740-3220 | 2560 | 564 | 1940-3410 | 2746 | 690 | 1500-3070 | 2340 | 698 | 1760-3050 | 2498 | 543 |
| Na | 320-474 | 403 | 60 | 794-1280 | 972 | 197 | 532-723 | 610 | 71 | 614-1070 | 753 | 188 |
| K | 9160-12700 | 10790 | 1360 | 8240-14900 | 10828 | 2456 | 6500-11100 | 8280 | 1726 | 7420-14000 | 10064 | 2661 |
| B | 218-445 | 205 | 93 | 143-251 | 181 | 41 | 132-242 | 179 | 42 | 98-301 | 199 | 72 |
| Cu | 8-14 | 12 | 3 | 2-8 | 5 | 2 | 3-6 | 4 | 1.2 | 4-13 | 6.2 | 3.8 |
| Cd | 0.3-1.4 | 0.9 | 0.5 | 0.1-0.6 | 0.2 | 0.2 | <0.1 | <0.1 | 0 | <0.1 | <0.1 | 0 |
| Zn | 16-33 | 21 | 7 | 11-31 | 20 | 7 | 10-21 | 15 | 5 | 13-25 | 19 | 6 |
| P | 625-1720 | 1180 | 410 | 801-3700 | 1856 | 1200 | 807-2010 | 1138 | 496 | 959-1990 | 1336 | 431 |
| Fe | 121-251 | 155 | 56 | 127-245 | 166 | 50 | 82-162 | 133 | 31 | 96-201 | 155 | 42 |
| Mn | 68-117 | 92 | 20 | 57-207 | 104 | 62 | 39-187 | 111 | 60 | 72-194 | 138 | 46 |



ClibPDF - www.fastio.com

Table 24 (continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 6410-20700 | 13162 | 5477 | 5900-15100 | 11632 | 4236 | 10300-23000 | 14460 | 4917 | 10500-23500 | 16800 | 5980 |
| Mg | 1270-2730 | 1908 | 536 | 1600-2820 | 2272 | 549 | 2180-2670 | 2316 | 210 | 2320-2800 | 2464 | 191 |
| Na | 251-431 | 345 | 69 | 942-1440 | 1204 | 186 | 542-1100 | 953 | 234 | 747-1170 | 967 | 165 |
| K | 8210-15300 | 10670 | 2085 | 8620-10600 | 9870 | 806 | 4090-7630 | 5894 | 1522 | 5720-8390 | 7102 | 1198 |
| B | 121-198 | 167 | 29 | 90-288 | 162 | 76 | 130-269 | 216 | 65 | 128-240 | 193 | 46 |
| Cu | 2-7 | 3.2 | 2.2 | 4-7 | 5.4 | 1.1 | 3-5 | 4.0 | 0.7 | 5-7 | 5.4 | 0.9 |
| Cd | <0.1 | <0.1 | 0 | 0.1-0.3 | 0.2 | 0.1 | 0-0.3 | 0.1 | 0.1 | 0 | 0 | 0 |
| Zn | 13-24 | 15.0 | 5.3 | 9-25 | 16.2 | 5.8 | 9-28 | 15.0 | 6.8 | 9-19 | 13.0 | 14.2 |
| P | 847-2090 | 1328 | 517 | 906-2330 | 1635 | 640 | 817-1580 | 1171 | 342 | 857-1830 | 1372 | 457 |
| Fe | 82-128 | 101 | 20 | 84-171 | 117 | 42 | 86-242 | 132 | 64 | 84-110 | 95 | 14 |
| Mn | 45-211 | 96 | 66 | 46-217 | 99 | 60 | 51-179 | 103 | 54 | 105-156 | 135 | 22 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 25
Elemental Contents of Oleander Leaf at Site 1

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 32700-38500 | 35920 | 2335 | 31200-40200 | 35580 | 3284 | 27800-51900 | 37840 | 8930 | 24900-38500 | 29400 | 5577 |
| Mg | 3000-4600 | 3740 | 655 | 2970-4030 | 3340 | 493 | 1640-3300 | 2472 | 593 | 2370-3100 | 2706 | 270 |
| Na | 910-2200 | 1202 | 525 | 475-2000 | 1141 | 584 | 1130-1990 | 1436 | 358 | 1020-1810 | 1338 | 381 |
| K | 7500-14400 | 11500 | 2835 | 10500-16800 | 13260 | 2682 | 7480-13100 | 9988 | 2031 | 13700-15200 | 14240 | 643 |
| B | 102-132 | 118 | 12 | 85-114 | 98 | 12 | 76-100 | 83 | 10 | 39-70 | 55 | 15 |
| Cu | 14-22 | 18 | 3 | 6-10 | 8 | 2 | 5-10 | 7 | 2 | 8-12 | 10 | 2 |
| Cd | 0.1-1.6 | 0.9 | 0.6 | 0.3-1.3 | 0.7 | 0.4 | 0.1-0.4 | 0.4 | 0.3 | 0.1-0.9 | 0.3 | 0.3 |
| Zn | 18-39 | 27 | 8 | 22-37 | 25 | 7 | 17-26 | 21 | 4 | 17-39 | 24 | 9 |
| P | 1570-2360 | 1968 | 305 | 1520-3040 | 2406 | 567 | 2080-3760 | 2800 | 649 | 1810-2250 | 1936 | 189 |
| Fe | 81-223 | 142 | 65 | 146-232 | 192 | 36 | 64-142 | 106 | 30 | 88-143 | 115 | 24 |
| Mn | 29-69 | 48 | 15 | 30-63 | 47 | 15 | 26-53 | 38 | 10 | 30-43 | 35 | 5 |



ClibPDF - www.fastio.com

Table 25(continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 29600-42300 | 35300 | 5286 | 20300-34800 | 27440 | 5693 | 22500-36600 | 30600 | 5348 | 16100-24100 | 20060 | 3777 |
| Mg | 3440-4630 | 3830 | 512 | 2280-4150 | 3104 | 778 | 1640-3280 | 2470 | 600 | 2650-3120 | 2858 | 191 |
| Na | 1340-2310 | 1602 | 426 | 1600-2700 | 2148 | 478 | 1110-2460 | 1628 | 582 | 943-3190 | 2001 | 924 |
| K | 10800-17300 | 15100 | 2527 | 9640-15300 | 12988 | 2208 | 6890-11800 | 9564 | 1994 | 15600-17000 | 16500 | 624 |
| B | 92-112 | 100 | 8 | 101-166 | 126 | 26 | 104-148 | 131 | 17 | 45-79 | 64 | 12 |
| Cu | 5-11 | 7.0 | 2.4 | 7-12 | 9.0 | 1.9 | 5-7 | 6.2 | 0.8 | 7-12 | 9.4 | 2.1 |
| Cd | 0.2-1.0 | 0.5 | 0.3 | 0.1-0.7 | 0.3 | 0.2 | 0.1-0.9 | 0.4 | 0.3 | 0-0.6 | 0.2 | 0.2 |
| Zn | 15-29 | 24.6 | 5.5 | 16-23 | 17.8 | 2.9 | 14-27 | 20.0 | 6.0 | 17-19 | 17.8 | 0.8 |
| P | 1740-2690 | 2080 | 359 | 1970-2450 | 2236 | 189 | 2050-2850 | 2424 | 303 | 2050-2370 | 2190 | 156 |
| Fe | 131-195 | 159 | 30 | 101-134 | 122 | 14 | 77-157 | 106 | 31 | 94-167 | 139 | 30 |
| Mn | 20-67 | 43 | 17 | 26-51 | 39 | 11 | 26-53 | 38 | 11 | 25-44 | 34 | 7 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 26
Elemental Contents of Oleander Leaf at Site 2

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 26100-35100 | 30640 | 3620 | 26200-41100 | 36200 | 6586 | 21500-35200 | 28800 | 6138 | 24400-38300 | 29140 | 5704 |
| Mg | 3350-4000 | 3760 | 243 | 3320-4540 | 3892 | 443 | 1720-2910 | 2312 | 541 | 2460-3940 | 3164 | 777 |
| Na | 260-340 | 308 | 38 | 270-380 | 321 | 54 | 553-659 | 590 | 43 | 612-712 | 657 | 42 |
| K | 9800-14700 | 11560 | 2217 | 11000-14800 | 12140 | 1526 | 7530-12500 | 9738 | 2004 | 9870-17500 | 13042 | 3329 |
| B | 76-120 | 90 | 18 | 63-104 | 90 | 16 | 67-101 | 82 | 13 | 31-61 | 48 | 12 |
| Cu | 11-18 | 14 | 3 | 8-10 | 9 | 1 | 6-12 | 8.6 | 2.4 | 9-14 | 11.2 | 2.2 |
| Cd | 0.8-1.3 | 1.0 | 0.2 | 0.6-1.0 | 0.8 | 0.2 | 0.4-0.6 | 0.4 | 0.1 | 0.2-0.8 | 0.6 | 0.2 |
| Zn | 20-24 | 22 | 2 | 21-28 | 25 | 3 | 19-27 | 22 | 3.5 | 22-39 | 28 | 8 |
| P | 1290-2170 | 1676 | 336 | 1670-2370 | 1978 | 306 | 1770-2460 | 2014 | 316 | 1430-2400 | 1878 | 369 |
| Fe | 91-151 | 124 | 27 | 160-262 | 214 | 38 | 83-126 | 97 | 17 | 96-136 | 111 | 15 |
| Mn | 38-61 | 53 | 9 | 56-90 | 69 | 17 | 34-95 | 53 | 24 | 39-72 | 54 | 12 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 27
Elemental Contents of Oleander Leaf at Site 5

| Element[1] | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 31600-44900 | 38600 | 4846 | 24700-38600 | 32480 | 6123 | 21900-42600 | 28920 | 8021 | 24700-33000 | 27540 | 3269 |
| Mg | 4000-5800 | 5040 | 684 | 3520-5220 | 4370 | 693 | 2210-3010 | 2762 | 319 | 3500-4160 | 3828 | 266 |
| Na | 660-850 | 738 | 71 | 543-817 | 646 | 112 | 732-1250 | 961 | 190 | 767-801 | 790 | 14 |
| K | 7300-10200 | 8600 | 1125 | 10400-15400 | 12420 | 1906 | 8950-13500 | 10292 | 1852 | 11000-13200 | 12140 | 856 |
| B | 133-227 | 178 | 36 | 119-160 | 138 | 19 | 114-127 | 122 | 5 | 68-77 | 72 | 4 |
| Cu | 14-21 | 16 | 3 | 7-12 | 9 | 2 | 5-14 | 8.2 | 3.5 | 6-10 | 7.6 | 1.5 |
| Cd | 0.5-1.4 | 0.9 | 0.4 | 0.2-0.4 | 0.3 | 0.1 | 0-0.1 | 0.1 | 0.04 | 0-0.1 | <0.1 | 0 |
| Zn | 16-32 | 24 | 7 | 23-40 | 30 | 7 | 25-52 | 33 | 12 | 23-25 | 24 | 1 |
| P | 1460-2190 | 1752 | 343 | 2110-3350 | 2542 | 502 | 1470-3190 | 2026 | 683 | 1880-2120 | 2012 | 95 |
| Fe | 92-169 | 116 | 35 | 143-166 | 158 | 9 | 112-178 | 138 | 27 | 86-121 | 103 | 14 |
| Mn | 56-95 | 68 | 15 | 49-65 | 54 | 8 | 35-71 | 56 | 15 | 35-50 | 42 | 6 |



ClibPDF - www.fastio.com

Table 27 (continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 21400-30000 | 27540 | 7310 | 13300-21200 | 18840 | 3228 | 13400-23800 | 17200 | 4112 | 18100-21400 | 19440 | 1403 |
| Mg | 3100-5190 | 4036 | 840 | 2400-3500 | 3128 | 427 | 1970-3120 | 2500 | 465 | 2140-4540 | 3304 | 1100 |
| Na | 1130-1350 | 1288 | 86 | 1170-1660 | 1404 | 188 | 1010-1340 | 1152 | 131 | 843-1140 | 1035 | 117 |
| K | 10000-15700 | 12920 | 2086 | 8920-11900 | 10408 | 1135 | 6270-9120 | 8280 | 1193 | 9580-15300 | 12436 | 2375 |
| B | 106-126 | 114 | 9 | 105-121 | 113 | 6 | 64-105 | 90 | 16.3 | 59-122 | 83 | 26 |
| Cu | 6-13 | 8.0 | 2.8 | 9-15 | 11.8 | 2.4 | 5-9 | 6.8 | 1.5 | 8-12 | 9.8 | 1.8 |
| Cd | 0.1-0.3 | 0.2 | 0.1 | 0-0.2 | 0.1 | 0.1 | 0-0.2 | 0.1 | 0.1 | 0-0.7 | 0.2 | 0.3 |
| Zn | 22-29 | 26.2 | 2.8 | 23-31 | 27.4 | 3.6 | 23-31 | 25.2 | 3.3 | 18-21 | 18.6 | 1.3 |
| P | 2010-2380 | 2194 | 158 | 2330-3040 | 2656 | 264 | 1900-3170 | 2322 | 495 | 1860-2290 | 2032 | 178 |
| Fe | 92-131 | 110 | 18 | 100-160 | 124 | 23 | 94-133 | 110 | 17 | 80-144 | 103 | 24 |
| Mn | 27-48 | 37 | 8 | 30-59 | 44 | 11 | 27-45 | 37 | 7 | 31-41 | 36 | 5 |

[†]Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 28
Elemental Contents of Oleander Leaf at UCR

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 26000-47600 | 38520 | 8620 | 23100-38600 | 30380 | 5876 | 21200-37800 | 30640 | 6624 | 20100-26500 | 22560 | 2550 |
| Mg | 2850-3350 | 3140 | 264 | 2470-3470 | 3048 | 440 | 1960-2800 | 2340 | 323 | 2020-2220 | 2136 | 81 |
| Na | 650-1500 | 1230 | 342 | 948-1370 | 1095 | 164 | 1010-1600 | 1356 | 299 | 657-1010 | 897 | 139 |
| K | 10900-12000 | 13020 | 2200 | 11800-17200 | 16040 | 4335 | 7770-15700 | 10808 | 3160 | 13900-18000 | 17860 | 3272 |
| B | 97-202 | 165 | 46 | 100-145 | 112 | 19 | 88-121 | 103 | 13 | 40-66 | 51 | 9 |
| Cu | 8-20 | 13 | 6 | 7-11 | 8 | 2 | 5-7 | 6 | 0.7 | 6-7 | 7 | 0.4 |
| Cd | 0.1-2.1 | 0.8 | 0.8 | 0.1-0.6 | 0.2 | 0.2 | 0-0.1 | <0.1 | 0 | 0-0.1 | <0.1 | 0 |
| Zn | 23-45 | 37 | 10 | 24-49 | 32 | 10 | 24-43 | 35 | 8 | 19-24 | 22 | 2 |
| P | 910-1580 | 1322 | 286 | 1260-1700 | 1558 | 172 | 1080-1750 | 1396 | 248 | 1350-1710 | 1578 | 152 |
| Fe | 178-229 | 202 | 24 | 166-209 | 188 | 16 | 85-141 | 113 | 21 | 96-139 | 115 | 18 |
| Mn | 39-64 | 52 | 10 | 32-44 | 37 | 5 | 24-46 | 33 | 8 | 26-35 | 30 | 4 |



ClibPDF - www.fastio.com

Table 28 (continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 25000-43400 | 33840 | 7867 | 18000-29700 | 24360 | 4185 | 19500-29600 | 24900 | 3726 | 17200-28900 | 21680 | 4430 |
| Mg | 2810-3600 | 3160 | 379 | 2290-2920 | 2590 | 258 | 1820-2620 | 2270 | 311 | 1920-2500 | 2294 | 239 |
| Na | 1270-1900 | 1660 | 237 | 1360-2070 | 1682 | 320 | 1210-2560 | 1860 | 554 | 1090-1680 | 1418 | 262 |
| K | 14500-23200 | 18120 | 3771 | 12800-17900 | 14940 | 1872 | 5590-11000 | 8786 | 2179 | 16200-22600 | 18720 | 2720 |
| B | 89-117 | 104 | 12 | 82-135 | 112 | 22 | 71-113 | 100 | 17 | 79-95 | 85 | 7 |
| Cu | 4-9 | 6.0 | 2.0 | 6-11 | 7.8 | 2.2 | 3-6 | 4.6 | 1.1 | 7-13 | 9.0 | 2.5 |
| Cd | <0.1-0.4 | 0.1 | 0.1 | 0 | 0 | 0 | 0-0.2 | 0.1 | 0.1 | 0 | 0 | 0 |
| Zn | 22-36 | 29.0 | 5.6 | 24-31 | 28.8 | 2.9 | 19-33 | 25.6 | 5.3 | 21-25 | 23.4 | 1.5 |
| P | 1430-2080 | 1730 | 235 | 1670-1890 | 1796 | 99 | 1360-1770 | 1650 | 179 | 1750-2370 | 2064 | 284 |
| Fe | 115-143 | 129 | 12 | 127-132 | 130 | 2 | 88-131 | 109 | 16 | 83-149 | 115 | 26 |
| Mn | 32-50 | 36 | 8 | 20-32 | 27 | 5 | 24-39 | 33 | 6 | 25-47 | 35 | 8 |

[†]Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 29
Elemental Contents of Acacia Leaf at Site 3

| Element | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 21700-29400 | 25660 | 3305 | 30600-39800 | 35660 | 4148 | 25500-43800 | 33620 | 6989 | 20400-31100 | 23960 | 4308 |
| Mg | 1050-1500 | 1360 | 178 | 1050-1610 | 1294 | 265 | 881-1490 | 1148 | 270 | 935-1460 | 1217 | 208 |
| Na | 700-1450 | 1108 | 311 | 1100-1560 | 1428 | 186 | 698-1110 | 910 | 149 | 805-1440 | 1155 | 210 |
| K | 8000-11100 | 10400 | 920 | 7180-15800 | 11748 | 3918 | 7930-11000 | 9180 | 1183 | 7760-8640 | 8240 | 344 |
| B | 53-81 | 67 | 11 | 35-69 | 48 | 14 | 40-52 | 43 | 7 | 19-35 | 28 | 6 |
| Cu | 13-23 | 17 | 4 | 5-16 | 11 | 6 | 6-9 | 7.8 | 1.1 | 7-10 | 8.8 | 1.1 |
| Cd | 0.1-1.1 | 0.5 | 0.5 | 0.1-1.4 | 0.7 | 0.7 | <0.1 | <0.1 | 0 | <0.1 | <0.1 | 0 |
| Zn | 21-23 | 23 | 2 | 17-20 | 22 | 5 | 11-23 | 16 | 5 | 19-27 | 24 | 3.4 |
| P | 1320-2170 | 1734 | 317 | 977-2520 | 1713 | 652 | 896-2020 | 1241 | 458 | 1170-1770 | 1424 | 216 |
| Fe | 85-131 | 104 | 17 | 120-159 | 132 | 21 | 91-188 | 120 | 46 | 86-102 | 117 | 38 |
| Mn | 34-46 | 38 | 5 | 33-66 | 48 | 13 | 40-90 | 70 | 25 | 42-92 | 59 | 21 |

ClibPDF - www.fastio.com

Table 29 (continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 27500-40200 | 34980 | 5280 | 15500-29700 | 22640 | 5562 | 15600-24400 | 18980 | 3348 | 17700-26000 | 20100 | 3373 |
| Mg | 1600-1910 | 1712 | 117 | 903-1370 | 1160 | 228 | 734-1190 | 942 | 204 | 1010-1450 | 1276 | 174 |
| Na | 762-1640 | 1358 | 347 | 1480-1920 | 1668 | 201 | 1210-1680 | 1418 | 188 | 1190-1890 | 1546 | 319 |
| K | 9620-13800 | 11704 | 1510 | 7780-8930 | 8578 | 466 | 5010-9300 | 7256 | 1940 | 6240-8900 | 7292 | 1499 |
| B | 71-79 | 76 | 3 | 41-81 | 54 | 17 | 43-70 | 59 | 10 | 65-89 | 76 | 10 |
| Cu | 4-8 | 6.0 | 1.6 | 5-8 | 7.2 | 1.3 | 5-7 | 6.2 | 0.8 | 9-17 | 10.6 | 3.8 |
| Cd | <0.1-0.2 | 0.1 | 0.1 | 0-0.1 | 0.04 | 0.05 | 0-0.1 | 0.04 | 0.05 | 0 | 0 | 0 |
| Zn | 17-28 | 22.8 | 4.1 | 11-16 | 13.4 | 1.8 | 9-11 | 10.0 | 1.0 | 16-19 | 17.2 | 1.3 |
| P | 1360-2210 | 1816 | 373 | 1210-1970 | 1396 | 323 | 660-1330 | 852 | 272 | 1170-1810 | 1548 | 265 |
| Fe | 91-138 | 114 | 21 | 72-159 | 106 | 33 | 73-146 | 107 | 30 | 98-119 | 105 | 9 |
| Mn | 38-64 | 46 | 11 | 38-57 | 43 | 8 | 34-84 | 48 | 20 | 37-64 | 48 | 11 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 30
Elemental Contents of Acacia Leaf at Site 4

| Element[†] | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 18300-33800 | 24300 | 7160 | 24200-53700 | 38720 | 10911 | 25600-40100 | 32060 | 5543 | 16700-26000 | 21200 | 4139 |
| Mg | 1050-2000 | 1520 | 336 | 1070-2120 | 1350 | 493 | 904-1250 | 1096 | 134 | 947-1590 | 1237 | 292 |
| Na | 470-1200 | 722 | 296 | 1020-1440 | 1148 | 178 | 605-917 | 690 | 129 | 763-2090 | 1059 | 577 |
| K | 6700-9000 | 8160 | 924 | 8200-10000 | 9256 | 658 | 6100-9190 | 7060 | 1248 | 4600-6950 | 5778 | 882 |
| B | 38-69 | 57 | 12 | 44-58 | 52 | 6 | 51-66 | 55 | 7 | 30-51 | 38 | 8 |
| Cu | 11-19 | 16 | 4 | 5-7 | 6 | 1 | 5-7 | 6 | 0.7 | 5-6 | 5.2 | 0.4 |
| Cd | 0.1-1.6 | 0.9 | 0.6 | 0.1-0.4 | 0.1 | 0.2 | 0-0.1 | <0.1 | 0 | <0.1 | <0.1 | 0 |
| Zn | 13-19 | 16 | 2 | 11-14 | 13 | 1 | 8-11 | 9.6 | 0.9 | 11-17 | 13 | 2.3 |
| P | 1230-1790 | 1550 | 224 | 1400-2000 | 1704 | 216 | 1070-1540 | 1276 | 180 | 1200-1530 | 1378 | 141 |
| Fe | 73-100 | 89 | 12 | 64-109 | 86 | 22 | 61-82 | 74 | 11 | 59-110 | 73 | 21 |
| Mn | 33-78 | 54 | 18 | 54-74 | 65 | 8 | 52-87 | 67 | 15 | 40-72 | 51 | 13 |



ClibPDF - www.fastio.com

Table 30 (continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 25500-34400 | 29120 | 4527 | 12700-19600 | 15780 | 2918 | 14000-21900 | 17760 | 3071 | 15700-17600 | 16480 | 795 |
| Mg | 1270-1890 | 1516 | 242 | 929-1420 | 1148 | 207 | 817-1320 | 1097 | 249 | 1040-1420 | 1262 | 182 |
| Na | 567-833 | 662 | 110 | 1390-2090 | 1652 | 289 | 766-1400 | 1095 | 225 | 917-1160 | 1048 | 97 |
| K | 7360-9960 | 8500 | 1064 | 5950-7740 | 6804 | 796 | 3780-6440 | 4566 | 1103 | 5270-7110 | 6766 | 778 |
| B | 66-93 | 80 | 12 | 61-85 | 75 | 10 | 63-116 | 88 | 26 | 40-87 | 61 | 17 |
| Cu | 4-6 | 4.8 | 0.8 | 4-7 | 5.2 | 1.3 | 4-5 | 4.6 | 0.5 | 5-9 | 6.4 | 1.5 |
| Cd | <0.1-0.1 | <0.1 | <0.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Zn | 11-14 | 12.6 | 1.5 | 8-10 | 9.0 | 0.7 | 6-8 | 7.0 | 0.7 | 10-12 | 10.8 | 0.8 |
| P | 1840-2370 | 2028 | 211 | 1400-1890 | 1666 | 214 | 815-1420 | 1072 | 224 | 1340-1970 | 1540 | 251 |
| Fe | 82-100 | 87 | 7 | 57-81 | 65 | 11 | 51-71 | 57 | 8 | 73-87 | 80 | 6 |
| Mn | 50-78 | 58 | 12 | 38-64 | 45 | 11 | 32-63 | 46 | 12 | 43-63 | 52 | 8 |

[†]Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 31
Elemental Contents of Acacia Leaf at Riverside

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 8700-18000 | 12820 | 3530 | 6220-18800 | 11400 | 5190 | 6570-14300 | 9466 | 2946 | 6195-16900 | 9680 | 3836 |
| Mg | 2320-4230 | 3200 | 800 | 2050-3750 | 2718 | 778 | 2110-2530 | 2334 | 151 | 1770-3040 | 2274 | 505 |
| Na | 2470-4920 | 3560 | 980 | 2260-2980 | 2752 | 292 | 1310-2790 | 2370 | 805 | 1670-2620 | 1940 | 395 |
| K | 11100-12200 | 11520 | 460 | 11400-14400 | 12300 | 1233 | 5820-8340 | 6706 | 1097 | 10200-16800 | 13320 | 2347 |
| B | 101-144 | 124 | 18 | 67-99 | 82 | 12 | 63-87 | 75 | 11 | 42-53 | 47 | 4 |
| Cu | 15-24 | 17 | 4 | 7-24 | 14 | 6 | 6-12 | 9 | 2 | 6-11 | 8 | 2 |
| Cd | 0.5-0.8 | 0.7 | 0.1 | 0.1-2.5 | 0.9 | 1.0 | 0-0.1 | <0.1 | 0 | <0.1 | <0.1 | 0 |
| Zn | 34-56 | 44 | 9 | 26-48 | 35 | 9 | 34-42 | 39 | 3 | 20-34 | 26 | 6 |
| P | 994-1460 | 1205 | 165 | 1010-1200 | 1078 | 78 | 831-925 | 872 | 34 | 1220-1760 | 1498 | 226 |
| Fe | 89-264 | 166 | 71 | 114-191 | 146 | 31 | 81-152 | 124 | 27 | 66-104 | 83 | 15 |
| Mn | 24-39 | 31 | 6 | 16-29 | 23 | 6 | 15-44 | 26 | 13 | 20-28 | 25 | 3 |



ClibPDF - www.fastio.com

Table 31 (continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 7350-15900 | 10414 | 3951 | 3460-10400 | 7482 | 2733 | 5280-9160 | 7426 | 1720 | 4340-9080 | 6676 | 2314 |
| Mg | 1600-3700 | 2610 | 937 | 1750-3600 | 2528 | 765 | 1740-3040 | 2302 | 470 | 1950-2630 | 2218 | 300 |
| Na | 1390-2090 | 1820 | 201 | 2280-3260 | 2782 | 384 | 1140-2540 | 2096 | 561 | 1330-3710 | 2168 | 928 |
| K | 11800-14400 | 13040 | 1074 | 7540-12400 | 7880 | 3899 | 5350-7740 | 6124 | 940 | 8080-13400 | 11256 | 1943 |
| B | 72-89 | 80 | 8 | 55-78 | 66 | 8 | 47-82 | 63 | 14 | 45-84 | 65 | 16 |
| Cu | 5-7 | 5.4 | 0.9 | 4-8 | 6.4 | 1.5 | 5-10 | 7.0 | 1.9 | 8-12 | 10.2 | 1.6 |
| Cd | <0.1-0.1 | <0.1 | <0.1 | 0-0.1 | 0 | 0 | 0-0.2 | 0.1 | 0.1 | 0 | 0 | 0 |
| Zn | 20-35 | 26.6 | 5.8 | 21-41 | 30.0 | 7.3 | 20-33 | 27.0 | 5.8 | 15-33 | 24.4 | 8.3 |
| P | 942-1200 | 1095 | 118 | 733-1200 | 973 | 188 | 721-906 | 845 | 72 | 1400-2340 | 1854 | 337 |
| Fe | 72-102 | 85 | 12 | 113-164 | 139 | 19 | 104-238 | 180 | 59 | 92-172 | 136 | 35 |
| Mn | 19-23 | 21 | 2 | 12-38 | 23 | 10 | 17-46 | 27 | 12 | 19-34 | 26 | 6 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 32
Elemental Contents of Acacia Leaf at UCR

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Devi-ation | Range | Mean | Std. Devi-ation | Range | Mean | Std. Devi-ation | Range | Mean | Std. Devi-ation |
| Ca | 10600-15000 | 12820 | 2033 | 7470-16300 | 12714 | 3678 | 8730-16000 | 12634 | 2802 | 8770-14100 | 10812 | 2014 |
| Mg | 2400-2800 | 2600 | 177 | 1980-3250 | 2614 | 565 | 1770-3750 | 2558 | 732 | 2190-2760 | 2456 | 249 |
| Na | 3300-6800 | 4560 | 1417 | 2400-4540 | 3322 | 958 | 2050-3520 | 2686 | 546 | 2950-4280 | 3690 | 935 |
| K | 7700-11200 | 9640 | 1394 | 8100-10400 | 9242 | 966 | 5160-7860 | 6330 | 1283 | 10600-17800 | 13020 | 2811 |
| B | 125-261 | 178 | 52 | 89-155 | 114 | 26 | 70-122 | 95 | 21 | 45-69 | 54 | 10 |
| Cu | 7-13 | 10 | 2 | 8-12 | 10 | 2 | 4-7 | 6 | 1 | 7-10 | 8 | 1 |
| Cd | 0.1-0.2 | 0.1 | 0.04 | 0.1-0.3 | 0.1 | 0.1 | 0-0.1 | <0.1 | 0 | <0.1 | <0.1 | 0 |
| Zn | 21-30 | 24 | 4 | 21-33 | 27 | 5 | 24-32 | 28 | 3 | 22-31 | 36 | 4 |
| P | 1050-1330 | 1150 | 115 | 1030-1610 | 1174 | 246 | 832-1070 | 911 | 102 | 1230-1900 | 1494 | 292 |
| Fe | 118-240 | 176 | 62 | 127-190 | 162 | 23 | 84-170 | 122 | 32 | 89-128 | 104 | 17 |
| Mn | 21-60 | 32 | 15 | 16-40 | 28 | 9 | 17-35 | 25 | 8 | 16-30 | 26 | 8 |



ClibPDF - www.fastio.com

Table 32(continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 9040-20000 | 13244 | 4670 | 6430-13700 | 7938 | 3302 | 4870-10900 | 7552 | 2785 | 5550-8410 | 6886 | 1250 |
| Mg | 1850-3200 | 2520 | 583 | 1850-3030 | 2184 | 494 | 1580-2390 | 1928 | 314 | 2050-2850 | 2492 | 292 |
| Na | 3490-5910 | 4532 | 1033 | 2370-4710 | 3668 | 907 | 1950-3390 | 2488 | 563 | 2380-4470 | 3808 | 822 |
| K | 8630-13700 | 10982 | 2193 | 5230-11400 | 7832 | 2679 | 4240-6820 | 5306 | 1010 | 8310-13900 | 10552 | 2541 |
| B | 64-128 | 92 | 25 | 62-100 | 83 | 16 | 73-129 | 100 | 26 | 53-78 | 69 | 11.0 |
| Cu | 3-5 | 3.8 | 0.8 | 3-17 | 8.4 | 5.3 | 3-7 | 5.6 | 1.7 | 9-20 | 13.8 | 4.3 |
| Cd | <0.1-0.1 | <0.1 | <0.1 | 0-0.2 | 0.1 | 0.1 | 0-0.1 | 0.1 | 0.1 | 0-0.8 | 0.2 | 0.3 |
| Zn | 12-20 | 16 | 3.5 | 11-27 | 18.0 | 6.2 | 12-27 | 19.8 | 6.6 | 18-24 | 20.6 | 2.4 |
| P | 1000-1190 | 1112 | 70 | 904-1670 | 1118 | 312 | 639-1030 | 799 | 159 | 1480-2910 | 2014 | 556 |
| Fe | 98-114 | 105 | 6 | 72-135 | 94 | 27 | 66-107 | 91 | 20 | 128-166 | 151 | 19 |
| Mn | 13-28 | 20 | 7 | 12-29 | 19 | 6 | 13-22 | 19 | 4 | 15-35 | 22 | 8 |

[†]Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 33
Elemental Contents of Ice Plants at Site 3

| Element[†] | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 36100-41100 | 38000 | 2580 | 38500-54900 | 48360 | 6958 | 35400-43800 | 37920 | 3388 | 36700-51400 | 44340 | 5680 |
| Mg | 7000-8200 | 7600 | 542 | 7260-9850 | 8527 | 1109 | 7800-9110 | 8642 | 546 | 7040-8910 | 7940 | 795 |
| Na | 20300-26500 | 23380 | 2325 | 25800-35900 | 32500 | 5126 | 29900-35500 | 32180 | 2234 | 21900-26300 | 24540 | 1919 |
| K | 13100-17500 | 15840 | 1766 | 14300-22100 | 17020 | 3448 | 12900-20300 | 17540 | 2855 | 16000-20000 | 17080 | 1559 |
| B | 102-153 | 122 | 20 | 61-78 | 66 | 8 | 62-68 | 67 | 7 | 34-51 | 44 | 6 |
| Cu | 11-22 | 14 | 5 | 2-9 | 6 | 3 | 5-6 | 5.4 | 0.5 | 6-8 | 7 | 0.7 |
| Cd | 0.7-2.3 | 1.6 | 0.6 | 0.9-2.2 | 1.4 | 0.5 | 0.4-0.8 | 0.5 | 0.2 | 0.3-0.6 | 0.5 | 0.1 |
| Zn | 40-61 | 47 | 8 | 41-53 | 47 | 5 | 52-70 | 58 | 8 | 50-73 | 62 | 11 |
| P | 1330-1580 | 1394 | 105 | 1590-2200 | 1880 | 244 | 1540-1990 | 1810 | 165 | 1390-1730 | 1546 | 131 |
| Fe | 54-62 | 57 | 3 | 72-88 | 80 | 7 | 52-70 | 51 | 13 | 51-72 | 61 | 9 |
| Mn | 46-113 | 78 | 26 | 45-107 | 86 | 25 | 40-99 | 55 | 29 | 44-86 | 64 | 16 |



ClibPDF - www.fastio.com

Table 33 (continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 41800-54000 | 47380 | 5336 | 27100-43700 | 33840 | 6600 | 25400-29400 | 27920 | 1624 | 32000-40500 | 37560 | 3366 |
| Mg | 6820-8780 | 7614 | 914 | 6390-9510 | 7826 | 1183 | 7660-9600 | 8388 | 801 | 9530-12200 | 11026 | 969 |
| Na | 19200-28300 | 22780 | 3478 | 27400-43500 | 32240 | 6604 | 23700-28300 | 25460 | 3100 | 24500-30400 | 28440 | 2452 |
| K | 14200-17900 | 16000 | 1508 | 11600-21400 | 15000 | 3786 | 12700-15200 | 13640 | 984 | 13500-16300 | 15340 | 1220 |
| B | 60-86 | 73 | 9 | 79-95 | 87 | 7 | 26-66 | 52 | 16 | 52-119 | 81 | 25 |
| Cu | 3-5 | 4.2 | 0.8 | 3-5 | 4.0 | 0.7 | 3-5 | 3.8 | 0.8 | 8-15 | 11.0 | 3.1 |
| Cd | 0.8-1.0 | 0.9 | 0.1 | 0.5-1.1 | 0.7 | 0.2 | 0.1-0.9 | 0.4 | 0.3 | 0-0.8 | 0.4 | 0.4 |
| Zn | 43-67 | 56.4 | 9.2 | 28-59 | 38.0 | 12.3 | 32-48 | 36.8 | 6.4 | 41-60 | 51.2 | 8.2 |
| P | 1450-1910 | 1592 | 183 | 1450-1900 | 1676 | 178 | 1280-1540 | 1392 | 103 | 1570-1860 | 1720 | 140 |
| Fe | 53-87 | 62 | 14 | 41-53 | 48 | 5 | 40-82 | 51 | 18 | 70-99 | 86 | 12 |
| Mn | 56-87 | 74 | 12 | 42-76 | 59 | 14 | 32-74 | 51 | 18 | 83-125 | 107 | 16 |

[†]Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 34
Elemental Contents of Ice Plants at Site 4

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 25000-38400 | 28960 | 5649 | 28500-40500 | 34060 | 5059 | 29100-37600 | 32240 | 3275 | 37000-49300 | 43840 | 4762 |
| Mg | 8100-9500 | 8840 | 546 | 10300-11700 | 10760 | 546 | 8580-9010 | 8824 | 188 | 9450-10300 | 9720 | 386 |
| Na | 18000-22700 | 19800 | 2045 | 29000-36300 | 32699 | 3341 | 31400-34800 | 31800 | 2214 | 28500-32400 | 29440 | 1673 |
| K | 14800-18800 | 16380 | 1585 | 18600-27400 | 22640 | 3124 | 9930-21500 | 16546 | 4477 | 11900-20000 | 14860 | 3501 |
| B | 58-74 | 66 | 7 | 52-71 | 64 | 8 | 54-59 | 57 | 2 | 40-47 | 43 | 3 |
| Cu | 8-18 | 12 | 4 | 4-9 | 5 | 2 | 4-6 | 5 | 0.7 | 5-6 | 5.4 | 0.5 |
| Cd | 0.2-1.8 | 0.8 | 0.6 | 0-2.7 | 0.8 | 1.1 | 0-0.8 | 0.3 | 0.3 | 0.2-0.5 | 0.3 | 0.1 |
| Zn | 27-38 | 34 | 5 | 46-120 | 62 | 32 | 37-52 | 42 | 6 | 33-42 | 38 | 4 |
| P | 1810-2380 | 1988 | 241 | 2500-3770 | 2938 | 621 | 1960-3190 | 2376 | 483 | 1610-2420 | 1892 | 311 |
| Fe | 50-60 | 54 | 4 | 64-95 | 77 | 12 | 35-38 | 36 | 2 | 46-61 | 53 | 5 |
| Mn | 54-78 | 57 | 14 | 51-132 | 83 | 36 | 66-88 | 79 | 10 | 78-133 | 100 | 23 |



ClibPDF - www.fastio.com

Table 34(continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 19200-41000 | 28680 | 8168 | 22300-27100 | 24240 | 1784 | 10900-25100 | 18400 | 5117 | 25800-37100 | 30760 | 5439 |
| Mg | 7270-9140 | 8176 | 809 | 8190-10400 | 9206 | 833 | 5630-9280 | 7550 | 1297 | 9460-13100 | 10808 | 1404 |
| Na | 19800-27000 | 21780 | 3035 | 26100-30100 | 28520 | 1525 | 14400-25300 | 18820 | 4216 | 21600-28100 | 23800 | 2538 |
| K | 10500-20400 | 16140 | 4061 | 12400-21700 | 17020 | 3972 | 8760-13800 | 11472 | 2258 | 18500-22100 | 21020 | 1480 |
| B | 59-71 | 64 | 5 | 57-101 | 74 | 18 | 40-81 | 60 | 18 | 44-68 | 56 | 9 |
| Cu | 4-5 | 4.6 | 0.5 | 3-6 | 4.6 | 1.1 | 3-5 | 4.2 | 0.8 | 4-23 | 12.6 | 7.2 |
| Cd | <0.1-0.5 | 0.2 | 0.2 | 0-0.6 | 0.2 | 0.3 | 0-0.1 | 0 | 0 | 0-0.4 | 0.1 | 0.1 |
| Zn | 23-36 | 28.4 | 5.2 | 19-33 | 25.4 | 5.3 | 21-24 | 22.2 | 1.1 | 25-40 | 32.2 | 6.5 |
| P | 1480-2170 | 1804 | 259 | 1890-2430 | 2168 | 202 | 1670-2810 | 2270 | 517 | 2300-2590 | 2462 | 141 |
| Fe | 42-70 | 55 | 10 | 42-52 | 47 | 4 | 42-60 | 50 | 7 | 57-78 | 66 | 8 |
| Mn | 33-85 | 50 | 27 | 33-86 | 46 | 22 | 18-70 | 41 | 19 | 35-132 | 74 | 50 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 34(continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 19200-41000 | 28680 | 8168 | 22300-27100 | 24240 | 1784 | 10900-26100 | 18400 | 5117 | 25800-37100 | 30760 | 5439 |
| Mg | 7270-9140 | 8176 | 809 | 8190-10400 | 9206 | 833 | 5630-9280 | 7550 | 1297 | 9460-13100 | 10808 | 1404 |
| Na | 19800-27000 | 21780 | 3035 | 26100-30100 | 28520 | 1525 | 14400-25300 | 18820 | 4216 | 21600-28100 | 23800 | 2538 |
| K | 10500-20400 | 16140 | 4861 | 12400-21700 | 17020 | 3972 | 8760-13800 | 11472 | 2258 | 18500-22100 | 21020 | 1480 |
| B | 59-71 | 64 | 5 | 57-101 | 74 | 18 | 40-81 | 60 | 18 | 44-68 | 56 | 9 |
| Cu | 4-5 | 4.6 | 0.5 | 3-6 | 4.6 | 1.1 | 3-5 | 4.2 | 0.8 | 4-23 | 12.6 | 7.2 |
| Cd | <0.1-0.5 | 0.2 | 0.2 | 0-0.6 | 0.2 | 0.3 | 0-0.1 | 0 | 0 | 0-0.4 | 0.1 | 0.1 |
| Zn | 23-36 | 28.4 | 5.2 | 19-33 | 25.4 | 5.3 | 21-24 | 22.2 | 1.1 | 25-40 | 32.2 | 6.5 |
| P | 1480-2170 | 1804 | 259 | 1890-2430 | 2168 | 202 | 1670-2810 | 2270 | 517 | 2300-2590 | 2462 | 141 |
| Fe | 42-70 | 55 | 10 | 42-52 | 47 | 4 | 42-60 | 50 | 7 | 57-78 | 66 | 8 |
| Mn | 33-85 | 50 | 27 | 33-85 | 46 | 22 | 18-70 | 41 | 19 | 35-132 | 74 | 50 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table .35
Elemental Contents of Ice Plants at Site 5

| Element[f] | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 23400-32700 | 28540 | 4785 | 27300-46300 | 36800 | 6921 | 29800-40900 | 37000 | 5520 | 37300-57400 | 49380 | 8981 |
| Mg | 8100-10600 | 9500 | 1057 | 7980-9860 | 8996 | 670 | 7320-9480 | 8330 | 918 | 7850-10700 | 9328 | 1105 |
| Na | 26600-53500 | 38640 | 10569 | 41700-5340 | 45780 | 4525 | 39800-49200 | 42320 | 3946 | 30300-50200 | 36140 | 8379 |
| K | 4300-5700 | 4980 | 516 | 5830-10800 | 8206 | 1883 | 5180-9700 | 7574 | 1987 | 5470-9630 | 7858 | 1626 |
| B | 95-169 | 135 | 27 | 70-94 | 81 | 11 | 54-121 | 84 | 27 | 46-122 | 73 | 31 |
| Cu | 9-12 | 10 | 1 | 4-11 | 7 | 3 | 5-7 | 6 | 1 | 6 | 6 | 0 |
| Cd | 0.3-0.7 | 0.5 | 0.2 | 0.1-1.3 | 0.4 | 0.5 | 0-0.1 | 0.1 | 0.1 | <0.1 | <0.1 | 0 |
| Zn | 23-34 | 28 | 5 | 30-62 | 45 | 12 | 44-66 | 52 | 9 | 46-51 | 49 | 2 |
| P | 850-1300 | 1058 | 173 | 1670-2510 | 2252 | 334 | 1650-2010 | 1778 | 137 | 1150-1410 | 1226 | 105 |
| Fe | 41-60 | 50 | 9 | 70-79 | 74 | 3 | 35-57 | 43 | 8 | 43-62 | 55 | 8 |
| Mn | 23-47 | 35 | 10 | 46-72 | 56 | 12 | 22-35 | 30 | 5 | 33-62 | 46 | 12 |



ClibPDF - www.fastio.com

Table 35(continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 42700-47120 | 47120 | 2928 | 24400-32900 | 27700 | 2745 | 19800-33800 | 26780 | 5266 | 33200-41600 | 36982 | 3518 |
| Mg | 9410-10100 | 9648 | 306 | 8390-11100 | 10020 | 1041 | 7410-11800 | 7320 | 3544 | 9960-12400 | 11732 | 1031 |
| Na | 33500-40700 | 37040 | 2931 | 33300-43900 | 38340 | 3786 | 32600-44600 | 35840 | 4958 | 29100-39200 | 34860 | 3807 |
| K | 8100-14700 | 12020 | 2440 | 8460-15400 | 11230 | 2913 | 6820-12200 | 9392 | 2168 | 7690-14400 | 11378 | 2591 |
| B | 72-103 | 85 | 12 | 62-112 | 78 | 20 | 53-120 | 83 | 32 | 83-123 | 103 | 16 |
| Cu | 4-5 | 4.8 | 0.4 | 5-6 | 5.4 | 0.5 | 4-6 | 5.2 | 0.8 | 9-16 | 12.8 | 3.1 |
| Cd | <0.1-0.1 | <0.1 | <0.1 | 0-0.1 | 0 | 0 | 0 | 0 | 0 | 0-0.2 | 0.1 | 0.1 |
| Zn | 44-58 | 51.2 | 5.4 | 36-47 | 41.0 | 5.5 | 36-64 | 49.8 | 11.2 | 39-63 | 51.4 | 9.1 |
| P | 1690-2500 | 2262 | 364 | 1990-2820 | 2306 | 328 | 1510-1900 | 1702 | 160 | 1400-2300 | 1850 | 328 |
| Fe | 42-64 | 53 | 9 | 44-56 | 49 | 5 | 43-54 | 48 | 4 | 70-91 | 76 | 10 |
| Mn | 42-67 | 54 | 12 | 17-28 | 24 | 4 | 17-41 | 31 | 9 | 35-78 | 56 | 16 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 36
Elemental Contents of Ice Plants at Riverside

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 31300-55900 | 45360 | 8930 | 35200-44300 | 37620 | 3870 | 36000-51600 | 42300 | 6398 | 38100-52800 | 44700 | 5630 |
| Mg | 5870-10100 | 7830 | 1541 | 5010-7890 | 6300 | 1082 | 5440-7390 | 6538 | 741 | 6240-7110 | 6716 | 340 |
| Na | 36700-69500 | 51020 | 8960 | 36700-55300 | 42200 | 7636 | 42900-61000 | 61840 | 7764 | 38400-50800 | 43460 | 5972 |
| K | 20700-31200 | 27460 | 4030 | 10200-18900 | 15060 | 3596 | 7810-26000 | 18862 | 7364 | 10200-23100 | 14640 | 5279 |
| B | 77-143 | 108 | 24 | 58-118 | 88 | 27 | 62-110 | 83 | 18 | 73-109 | 88 | 13 |
| Cu | 10-18 | 15 | 4 | 8-9 | 8 | 0.5 | 6-11 | 9 | 2 | 6-8 | 7 | 1 |
| Cd | 0.6-1.3 | 0.8 | 0.3 | 0.3-10 | 0.6 | 0.3 | <0.1 | <0.1 | - | <0.1 | <0.1 | - |
| Zn | 38-101 | 61 | 25 | 27-44 | 41 | 11 | 33-75 | 52 | 16 | 43-77 | 56 | 13 |
| P | 2080-2450 | 2260 | 135 | 1790-2400 | 2170 | 233 | 1490-3240 | 2370 | 621 | 1600-3120 | 2052 | 608 |
| Fe | 84-97 | 85 | 8 | 74-82 | 79 | 3 | 47-54 | 51 | 3 | 74-147 | 96 | 29 |
| Mn | 54-86 | 70 | 13 | 29-40 | 33 | 5 | 32-47 | 38 | 7 | 38-61 | 50 | 8 |



ClibPDF - www.fastio.com

Table 36 (continued)

| Element† | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 39300-49000 | 43700 | 4076 | 24100-41800 | 33460 | 6443 | 26200-33800 | 29880 | 3122 | 21500-29300 | 24520 | 2506 |
| Mg | 6240-7280 | 6112 | 764 | 5050-7040 | 6288 | 814 | 4900-6390 | 5574 | 716 | 5520-7320 | 6382 | 893 |
| Na | 36900-44000 | 40180 | 2950 | 30600-50900 | 41680 | 7319 | 32900-40600 | 37340 | 3063 | 40800-57400 | 48500 | 6948 |
| K | 11200-23900 | 16140 | 4915 | 14000-21800 | 16720 | 3112 | 8110-11900 | 10336 | 1765 | 12900-21600 | 17240 | 3520 |
| B | 89-131 | 113 | 16 | 105-143 | 122 | 18 | 77-143 | 98 | 28 | 92-110 | 101 | 6 |
| Cu | 5-8 | 6.6 | 1.1 | 6-10 | 7.4 | 1.7 | 4-5 | 4.4 | 0.5 | 8-10 | 9.0 | 1.0 |
| Cd | <0.1-0.2 | <0.1 | <0.1 | 0.1-0.5 | 0.3 | 0.2 | 0-0.1 | 0.1 | 0.1 | 0 | 0 | 0 |
| Zn | 45-83 | 60.0 | 18.1 | 37-55 | 45.2 | 8.6 | 26-64 | 38.0 | 15.0 | 34-47 | 40.2 | 4.8 |
| P | 1680-2330 | 2046 | 287 | 1700-2010 | 1808 | 119 | 1360-2110 | 1612 | 291 | 1950-3110 | 2454 | 503 |
| Fe | 92-107 | 96 | 11 | 70-100 | 85 | 13 | 46-60 | 52 | 6 | 96-136 | 122 | 18 |
| Mn | 27-34 | 32 | 3 | 26-52 | 34 | 10 | 35-40 | 37 | 2 | 28-87 | 54 | 28 |

†Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 37
Elemental Contents of Ice Plants at UCR

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 39100-49000 | 43500 | 3985 | 47600-80300 | 60360 | 12314 | 38800-66700 | 50800 | 11511 | 50400-58000 | 54320 | 3670 |
| Mg | 8150-9500 | 8710 | 575 | 6640-8950 | 8066 | 1029 | 5660-8030 | 7586 | 1417 | 7140-7780 | 7370 | 296 |
| Na | 36400-46000 | 39780 | 3870 | 36300-43700 | 39840 | 4324 | 42500-62700 | 50240 | 9650 | 34800-39200 | 37160 | 2101 |
| K | 7750-12500 | 9470 | 2325 | 4590-8760 | 6594 | 1529 | 5050-9800 | 7358 | 1890 | 4570-6240 | 5616 | 824 |
| B | 214-544 | 321 | 132 | 60-155 | 104 | 35 | 75-147 | 94 | 30 | 63-94 | 77 | 15 |
| Cu | 8-29 | 14 | 8 | 3-12 | 7 | 5 | 5-7 | 6 | 1 | 5-7 | 6 | 1 |
| Cd | 0.1-3.5 | 1.0 | 1.4 | 0.1-1.3 | 0.5 | 0.6 | <0.1 | <0.1 | - | 0-0.3 | <0.1 | 0 |
| Zn | 20-36 | 30 | 10 | 16-36 | 23 | 8 | 21-27 | 24 | 3 | 20-36 | 29 | 6 |
| P | 1330-1720 | 1524 | 147 | 1380-1840 | 1616 | 212 | 1140-1940 | 1572 | 316 | 1410-1700 | 1562 | 108 |
| Fe | 73-129 | 100 | 20 | 76-111 | 92 | 15 | 52-78 | 62 | 11 | 80-110 | 90 | 12 |
| Mn | 45-157 | 112 | 49 | 92-96 | 94 | 3 | 49-153 | 95 | 44 | 50-121 | 96 | 33 |



ClibPDF - www.fastio.com

Table 37 (continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1907 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 50100-68300 | 62400 | 4325 | 37500-56400 | 46700 | 6084 | 35600-48500 | 41320 | 5364 | 40600-46300 | 43780 | 2378 |
| Mg | 7190-10300 | 8640 | 1225 | 6780-9710 | 8414 | 1324 | 6050-9000 | 7376 | 1224 | 7900-12200 | 9938 | 1885 |
| Na | 37900-57600 | 43940 | 8800 | 35200-57600 | 44380 | 10721 | 27900-48300 | 37280 | 9435 | 35800-50000 | 43580 | 6615 |
| K | 6460-9400 | 7638 | 1123 | 5830-10100 | 7148 | 1727 | 4790-7230 | 5856 | 1206 | 4470-9390 | 6576 | 2501 |
| B | 78-131 | 93 | 22 | 110-141 | 126 | 12 | 90-128 | 107 | 15 | 88-143 | 112 | 22 |
| Cu | 3-5 | 4.2 | 0.8 | 4-6 | 5.0 | 0.7 | 4-6 | 4.6 | 0.9 | 7-14 | 9.8 | 2.8 |
| Cd | <0.1-0.1 | <0.1 | <0.1 | 0.1-0.3 | 0.1 | 0.1 | 0-0.1 | 0 | 0 | 0 | 0 | 0 |
| Zn | 21-40 | 30.6 | 7.9 | 20-30 | 25.8 | 3.7 | 21-30 | 25.2 | 3.3 | 24-26 | 25.2 | 0.8 |
| P | 1120-1880 | 1558 | 274 | 1200-1960 | 1740 | 274 | 907-1690 | 1370 | 356 | 1390-2260 | 1704 | 342 |
| Fe | 69-76 | 69 | 6 | 58-74 | 67 | 7 | 50-61 | 56 | 4 | 79-96 | 87 | 8 |
| Mn | 50-168 | 98 | 62 | 39-167 | 100 | 55 | 25-138 | 74 | 58 | 41-166 | 83 | 72 |

[†]Concentrations of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 38
Elemental Contents of Ivy Leaf at Site 1

| Element[1] | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 16300-26600 | 20760 | 3915 | 14300-20700 | 16980 | 2694 | 16300-19900 | 17940 | 1571 | 20900-25600 | 23280 | 1839 |
| Mg | 1600-2400 | 1920 | 295 | 1320-2020 | 1566 | 295 | 975-1530 | 1207 | 204 | 1350-1850 | 1622 | 191 |
| Na | 2650-7900 | 5530 | 2275 | 1160-2640 | 1662 | 570 | 992-1360 | 1198 | 147 | 504-1200 | 934 | 262 |
| K | 10100-14200 | 13120 | 3175 | 11000-15900 | 12640 | 1901 | 11600-13800 | 12460 | 1016 | 10200-13100 | 11460 | 1159 |
| B | 92-100 | 97 | 4 | 64-78 | 72 | 6 | 79-89 | 84 | 4 | 50-65 | 55 | 6 |
| Cu | 10-28 | 16 | 7 | 4-12 | 7 | 3 | 5-6 | 5.4 | 0.5 | 6-7 | 6.8 | 0.4 |
| Cd | 1.0-3.1 | 2 | 1 | 0.9-3.0 | 1.8 | 0.9 | 0.4-1.1 | 0.8 | 0.3 | 1.0-3.1 | 1.9 | 1.0 |
| Zn | 24-36 | 30 | 5 | 18-36 | 25 | 8 | 19-27 | 24 | 5 | 25-50 | 36 | 9 |
| P | 1600-2650 | 1990 | 397 | 1720-2390 | 1900 | 281 | 1750-1870 | 1798 | 54 | 1530-1880 | 1724 | 147 |
| Fe | 92-136 | 107 | 21 | 94-161 | 133 | 32 | 72-101 | 86 | 11 | 90-129 | 111 | 14 |
| Mn | 24-68 | 46 | 19 | 24-40 | 31 | 7 | 15-33 | 23 | 7 | 34-89 | 63 | 25 |



ClibPDF - www.fastio.com

Table 38 (continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 24400-29600 | 26420 | 1936 | 10200-14700 | 12380 | 2073 | 10200-14300 | 11920 | 1525 | 17200-26600 | 21260 | 3708 |
| Mg | 1850-2300 | 2088 | 170 | 1340-1930 | 1612 | 212 | 780-1460 | 1116 | 258 | 1300-1790 | 1598 | 150 |
| Na | 1800-3520 | 2646 | 582 | 1780-4140 | 2600 | 902 | 1500-2580 | 2038 | 490 | 1535-2260 | 1859 | 265 |
| K | 10400-16500 | 14120 | 2670 | 10100-12900 | 11340 | 1137 | 7650-10100 | 8918 | 1074 | 9670-15000 | 11894 | 2166 |
| B | 82-100 | 91 | 7 | 80-129 | 106 | 22 | 69-91 | 80 | 8 | 90-103 | 100 | 2 |
| Cu | 5-10 | 7.2 | 1.8 | 6-10 | 7.6 | 1.5 | 3-5 | 4.2 | 0.8 | 6-9 | 7.6 | 1.1 |
| Cd | 0.4-3.0 | 1.8 | 1.6 | 0.5-1.6 | 1.0 | 0.4 | 0.4-1.8 | 1.0 | 0.5 | 1.2-4 | 1.9 | 1.2 |
| Zn | 27-56 | 44.8 | 12.2 | 15-36 | 24.0 | 7.6 | 16-31 | 21.0 | 6.0 | 25-56 | 38.6 | 15.3 |
| P | 1410-2350 | 1834 | 417 | 1760-2320 | 2084 | 216 | 1300-1770 | 1466 | 193 | 1540-2120 | 1880 | 245 |
| Fe | 89-151 | 122 | 26 | 69-95 | 81 | 11 | 73-170 | 104 | 40 | 126-198 | 169 | 29 |
| Mn | 40-75 | 61 | 15 | 10-29 | 20 | 8 | 7-41 | 21 | 13 | 38-113 | 28 | 11 |

[†]Concentration of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 39
Elemental Contents of Ivy Leaf at UCR

| Element† | August 1985 | | | December 1985 | | | March 1986 | | | June 1986 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 14300-20500 | 18340 | 2630 | 11300-19600 | 15280 | 3155 | 19400-28500 | 22380 | 3634 | 19400-23300 | 20740 | 1604 |
| Mg | 1740-2500 | 2290 | 360 | 1390-1810 | 1526 | 173 | 1350-2480 | 1780 | 476 | 1780-2390 | 2024 | 252 |
| Na | 1400-1670 | 1560 | 124 | 471-944 | 695 | 168 | 788-1120 | 961 | 134 | 1060-1440 | 1232 | 147 |
| K | 14500-18200 | 16200 | 1465 | 3050-13600 | 8922 | 3806 | 11200-14700 | 13020 | 1365 | 13800-15800 | 14900 | 728 |
| B | 106-197 | 161 | 37 | 30-61 | 48 | 11 | 50-83 | 64 | 13 | 51-98 | 64 | 19 |
| Cu | 13-17 | 14 | 2 | 5-12 | 7 | 3 | 6-7 | 6.8 | 0.4 | 7-8 | 7.2 | 0.4 |
| Cd | 0.1-1.0 | 0.4 | 0.4 | 0.1-0.9 | 0.3 | 0.3 | 0-0.2 | 0.1 | 0.1 | 0-0.1 | 0.1 | 0.1 |
| Zn | 45-75 | 53 | 12 | 30-66 | 52 | 13 | 55-76 | 63 | 8 | 40-62 | 53 | 5 |
| P | 1460-1740 | 1630 | 102 | 1100-2100 | 1608 | 400 | 1500-1940 | 1758 | 182 | 1370-1630 | 1474 | 104 |
| Fe | 92-164 | 123 | 26 | 62-180 | 104 | 45 | 87-167 | 132 | 37 | 109-190 | 143 | 36 |
| Mn | 17-33 | 26 | 6 | 12-40 | 25 | 13 | 15-33 | 24 | 7 | 26-48 | 37 | 8 |



ClibPDF - www.fastio.com

Table 39 (continued)

| Element[†] | September 1986 | | | December 1986 | | | March 1987 | | | June 1987 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation | Range | Mean | Std. Deviation |
| Ca | 19000-24400 | 21100 | 2309 | 10300-12300 | 11760 | 838 | 10000-14100 | 12560 | 1527 | 15100-19400 | 16620 | 1899 |
| Mg | 1680-2170 | 1972 | 222 | 1610-2020 | 1744 | 164 | 1250-1830 | 1478 | 241 | 1500-2150 | 1816 | 306 |
| Na | 1740-2030 | 1912 | 125 | 1200-1890 | 1514 | 252 | 1470-1820 | 1638 | 136 | 626-1140 | 800 | 211 |
| K | 14900-22800 | 18380 | 2861 | 10400-13000 | 12280 | 1071 | 8540-10700 | 9520 | 830 | 14300-16800 | 15700 | 1022 |
| B | 74-88 | 80 | 7 | 43-85 | 63 | 18 | 48-70 | 57 | 9 | 48-85 | 60 | 15 |
| Cu | 5-7 | 6.0 | 1.0 | 6-8 | 7.0 | 1.0 | 4-6 | 5.6 | 0.9 | 7-13 | 9.2 | 2.5 |
| Cd | 0.1-0.4 | 0.2 | 0.1 | 0-0.2 | 0.1 | 0.1 | 0-0.1 | 0.1 | 0.1 | 0-0.3 | 0.1 | 0.1 |
| Zn | 38-58 | 46.6 | 10.0 | 25-37 | 32.2 | 4.5 | 28-50 | 39.6 | 9.8 | 28-54 | 37.6 | 10.6 |
| P | 1670-2010 | 1850 | 141 | 1550-1800 | 1672 | 94 | 1270-1600 | 1424 | 120 | 1560-1930 | 1726 | 146 |
| Fe | 101-151 | 126 | 20 | 92-123 | 102 | 13 | 88-130 | 114 | 17 | 185-219 | 202 | 17 |
| Mn | 27-50 | 36 | 10 | 16-66 | 30 | 20 | 15-30 | 23 | 6 | 18-44 | 28 | 11 |

[†]Concentration of elements are expressed in mg/kg dry wt.



ClibPDF - www.fastio.com

Table 40
Elemental Contents (in mg/kg dry wt) of Damaged and Green Leaf at Selected Study Sites

| Location | Element | December, 1985 | | September, 1986 | |
|---|---|---|---|---|---|
| | | Damaged Leaf | Green Leaf | Damaged Leaf | Green Leaf |
| Irvine II | Na | 2840 | 1680 | 3308 | 1010 |
| | B | 259 | 565 | 257 | 368 |
| | Zn | 64 | 40 | 31 | 34 |
| Pomona I | Na | 2195 | 3210 | 1840 | 1960 |
| | B | 163 | 101 | 154 | 112 |
| | Zn | 28 | 32 | 22 | 33 |



ClibPDF - www.fastio.com

Table 41
Elemental Contents of Healthy and Damaged
Leaves of Ornamental Plants in Site I

| Element | Bottle Brush (Irvine I) | | Eucalyptus (Irvine I) | | Eucalyptus (Irvine II) | |
|---|---|---|---|---|---|---|
| | Healthy | Damaged | Healthy | Damaged | Healthy | Damaged |
| Ca | 7200 | 4320 | 6560 | 6300 | 7800 | 11910 |
| Mg | 2240 | 1930 | 3412 | 3820 | 2445 | 3285 |
| Na | 2550 | 1520 | 4573 | 3900 | 1875 | 2230 |
| K | 9480 | 14600 | 5837 | 5090 | 7320 | 10960 |
| P | 1080 | 1010 | 977 | 1100 | 1370 | 1885 |
| B | 125 | 88 | 129 | 81 | 201 | 176 |
| Al | 179 | 87 | 113 | 105 | 138 | 124 |
| Fe | 302 | 111 | 95 | 178 | 143 | 108 |
| Cu | 12 | 8 | 7 | 6 | 8 | 8 |
| Cd | 1.8 | 0.6 | 0.4 | 0.1 | 0.1 | 0.1 |
| Zn | 12 | 11 | 24 | 24 | 38 | 61 |
| Pb | 16 | 0.9 | 4 | 2 | 4 | 10 |

†All measurements are in mg/kg d.w.



ClibPDF - www.fastio.com

Table 42 Relative salt tolerance of landscape plants [a,b]

Very sensitive[c]
(Max. $EC_W$ = 0.7-1.4 mmho/cm or dS/m)

Star jasmine *(Trachelospermum jasminoides)*
Pyrenees cotoneaster *(Cotoneaster congestus)*
Oregon grape *(Mahonia Aquifolium)*
Photinia *(Photinia x Fraseri)*

Sensitive[c]
(Max $EC_W$ = 1.4-2.7 mmho/cm or dS/m)

Pineapple guava *(Feiojoa Sellowiana)*
Chinese holly, cv. Burford *(Ilex cornuta)*
Rose, cv. Grenoble *(Rosa sp.)*
Glossy abelia *(Abelia x grandiflora)*
Southern yew *(Podocarpus macrophyllus)*
Tulip tree *(Liriodendron Tulipifera)*
Algerian ivy *(Hedera canariensis)*
Japanese pittosporum *(Pittosporum obira)*
Heavenly bamboo *(Nandina domestica)*
Chinese hibiscus *(Hibiscus Rosa-sinensis)*
Laurustinus, cv. Robustum *(Viburnum Tinus)*
Strawberry tree, cv. Compact *(Arbutus Unedo)*
Crape Myrtle *(Lagerstroemia indica)*

Moderately sensitive[c]
(Max. $EC_W$ = 2.7-4.0 mmho/cm or dS/m)

Glossy privet *(Ligustrum lucidum)*
Yellow sage *(Lantana camara)*
Orchid tree *(Bauhinia purpurea)*
Southern Magnolia *(Magnolia grandiflora)*
Japanese boxwood *(Buxus microphylla var. japonica)*
Dodonaea, cv. atropurpurea *(Dodonaea viscosa)*
Oriental arborvitae *(Platycladus orientalis)*
Thorny elaeagnus *(elaeagnus pungens)*
Spreading juniper *(Juniperus chinensis)*
Xylosma *(Xylosma congestum)*

Moderately sensitive[c](cont.)

Japanese black pine *(Pinus Thunbergiana)*
Indian hawthorn *(Raphiolepis indica)*
Pyrachantha, cv. Graberi *(Pyracantha Fortuneana)*
Cherry Plum *(Prunes cerasifera)*

Moderately tolerant[c]
(Max. $EC_W$ = 4.0-5.5 mmho/cm or dS/m)

Weeping bottlebrush *(Callistemon viminalis)*
Oleander *(Nerium oleander)*
European fan palm *(Chamaerops humilis)*
Blue dracaena *(Cordyline indivisa)*
Spindle tree, cv. Grandiflora *(Euonymus japonica)*
Rosemary *(Rosmarinus officianalis)*
Aleppo pine *(Pinus halepensis)*
Sweet gum *(Liquidambar Styraciflua)*

Tolerant[c]
(Max. $EC_W$ >5.5 mmho or dS/m)

Brush cherry *(Syzygium paniculatum)*
CenizNatal plum *(Carissa grandiflora)*
Natal plum *(Carissa grandiflora)*
Evergreen Pear *(Pyrus kawakamii)*
Bougainvillea *(Bougainvillea spectabilis)*
Italian stone pine *(Pinus pinea)*

Very tolerant[c]
(Max. $EC_W$ > 6.8 mmho/cm or dS/m)

White iceplant *(Delosperma alba)*
Rosea iceplant *(Drosanthemum hispidum)*
Purple iceplant *(Lampranthus productus)*
Croceum iceplant *(Hymenocyclus croceus)*

Purple iceplant *(Lampranthus productus)*
Croceum iceplant *(Hymenocyclus croceus)*

a. Data adapted from Maas (13).
b. Species are listed in order of increasing tolerance based on appearance as well as growth reduction.
c. $EC_W$ = Electrical conductivity of the irrigation water. Salinitiesexceeding the maximum permissible water salinity (Max. $EC_W$) may cause leaf burn, loss of leaves, and/or excessive stunting. The maximum values shown were derived from maximum permissible $EC_e$ data by a factor of $EC_e = 1.5EC_W$. This relationship should be valid for normal irrigation practices. The electrical conductivity of the irrigation water can be designated as mmho/cm or dS/m (see Table 3-1).



ClibPDF - www.fastio.com

Table 43 Relative boron tolerance of agricultural crops and landscape plants[a,b]

**Agricultural crops**

Very sensitive (<0.5 mg/L)

Lemon *(Citrus limon)*
Blackbery *(Rubus sp.)*

Sensitive (0.5 - 1.0 mg/L)

Avocado *(Persea americana)*
Grapefruit *(Citrus x paradisi)*
Orange *(Citrus sinensis)*
Apricot *(Prunus Persica)*
Peach *(Prunus Persica)*
Cherry *(Prunus avium)*
Plum *(Prunus domestica)*
Persimmon *(Diospyros kaki)*
Fig, kadota *(Ficus carica)*
Grape *(Vitis vinifera)*
Walnut *(Juglans regia)*
Pecan *(Carya illinoinesis)*
Cowpea *(Vigna unguiculata)*
Onion *(Allium Cepa)*
Garlic *(Allium sativum)*
Sweet potatoe *(Ipomea Batatas)*
Wheat *(Triticum aestivum)*
Barley *(Hordeum vulgare)*
Sunflower *(Helianthus annus)*
Bean, mung *(Vigna radiata)*
Sesame *(Sesanum indicum)*
Lupine *(Lupinus Hartwegii)*
Strawberry *(Fragaria sp.)*
Artichoke, Jerasulem *(Helianthus tuberosus)*
Bean, Kidney *(Phaseolus vulgaris)*
Bean, lima *(Phaseolus lunatus)*
Peanut *(Archis hypogaea)*

Moderately sensitive (1.0 - 2.0 mg/L)

Pepper, red *(Capsicum annum)*
Pea *(Pisum sativa)*
Carrot *(Daucus carota)*
Radish *(Raphanus sativus)*
Potato *(Solanum tuberosum)*
Cucumber *(Cucmis sativus)*

Moderately tolerant (2.9-4.0 mg/L)

Lettuce *( Lactuca sativa)*
Cabbage *(Brassica oleracea capitata)*
Celery *(Apium graveolens)*
Turnip *(Brassica rapa)*
Bluegrass, Kentucy *(Poa pratensis)*
Oats *(Avena sativa)*
Corn *(Zea Nats)*
Artichoke *(Cynara Scolymus)*
Tobacco *(Nicotinana Tabacum)*
Mustard *(Brassica juncea*
Clover, sweet *(Melitoltus indica )*
SquaMuskmelon *( Cucumis melo)*

Tolerant (4.0-6.0 mg/L)

Sorghum *(sorghum bicolor)*
Tomato *(Lycopersicon Lycoperscium)*
Alfalfa *(Nedicago sativa)*
Vetch, purple *(Vicia benghalensis)*
Parsley *(Petroselinum crispum)*
Beet, red *(Beta vulgaris)*
Sugarbeet *(Beta vulgaris)*

**Agricultural crops** (continued)

Very tolerant (6.0-15.0 mg/L)

Cotton *(Gossypium hirsutum)*
Asparagus *(Asparagus officinalis)*

**Ornamentals**

Very Sensative (<0.5 mg/L)

Oregon grape *(Mahonia Aquifolium)*
Photina *(Photinia x Fraseri)*
Xylosma *(Xylosma congestum)*
Thorny elaeagnus *(Elaeagnus pungens)*
Lauristinus *(Viburnum Tinus)*
Wax-leaf privet *(Lingustrum japonicum)*
Pineapple guava *(Feijoa Sellowiana)*
Spindle tree *(Euonymus japonica)*
Japanese pittosporum *(Pittosporum Tobira)*
Chinese holly *(Ilex cornuta)*
Juniper *(Juniperus chinensis)*
Yellow sage *(Lantana Camara)*
American elm *(Ulmus americana)*

Sensitive (0.5 - 1.0 mg/L)

Zinnia *(Zinnia elegans)*
Pansy *(Viola tricolor)*
Violet *(Viola odorate)*
Larkspur *(Delphinum sp.)*
Glossy abelia *(Abelia x grandiflora)*
Rosemary *(Rosemarinus officinalis)*
Oriental aborovitae *(Platycladus orientalis)*
Geranium *(Pelargonium x hortorum)*

Moderately sensitive (1.0-2.0 mg/L)

Gladioli *(Gladiolus sp.)*
Marigold *( Calendula officinalis)*
Poinsettia *(Euphorbia pulcherrima)*
China aster *(Callistephus chinesis)*
Gardenia *(Gardenis sp.)*
Southern yew *(Podocarpus macrophyllus)*
Bruch cherry *(Syzygium paniculatum)*
Blue dracaena *(Cordyline indivisa)*
Ceniza *(Leucophyllum frutescens)*

Moderately tolerant (2.0- 4.9 mg/L)

Bottlebrush *(Callistemon citrinus)*
California poppy *(Eschsholzia californica)*
Japanese boxwood *(Buxus microphylla)*
Oleander *(Nerium oleander)*
Chinese hibiscus *(Hibiscus Rosa-sinensis)*
Sweetpea *(Lathyrus odoratus)*
Carnation *(Dianthus Caryophzyllus)*

Tolerant (6.0-8.0 mg/L)

Indian hawthorn *(Raphiolopis indica)*
Natal plum *(Carissa grandiflora)*
Oxalis *(Oxalis Bowiei)*

a. Data taken from Maas (13).
b. Maximum concentrations tolerated in soil water without yield or vegetative growth reductions. Boron tolerances vary depending upon climate soil conditions and crop varieties. Maximum concentrations tolerated in the applied irrigation water are approximately equal to these values for soil-water or slightly less.



ClibPDF - www.fastio.com

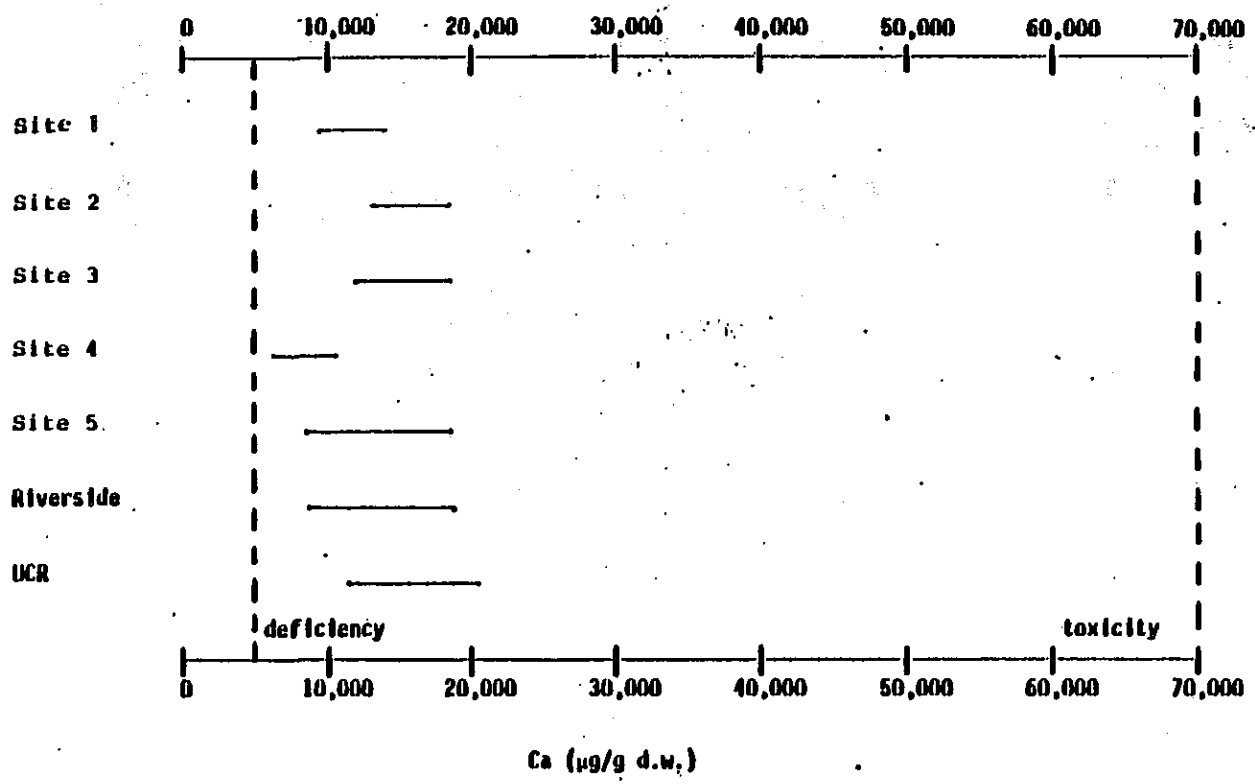


Figure 1. Ranges of Ca levels in leaves of Eucalyptus at the study site.



ClibPDF - www.fastio.com

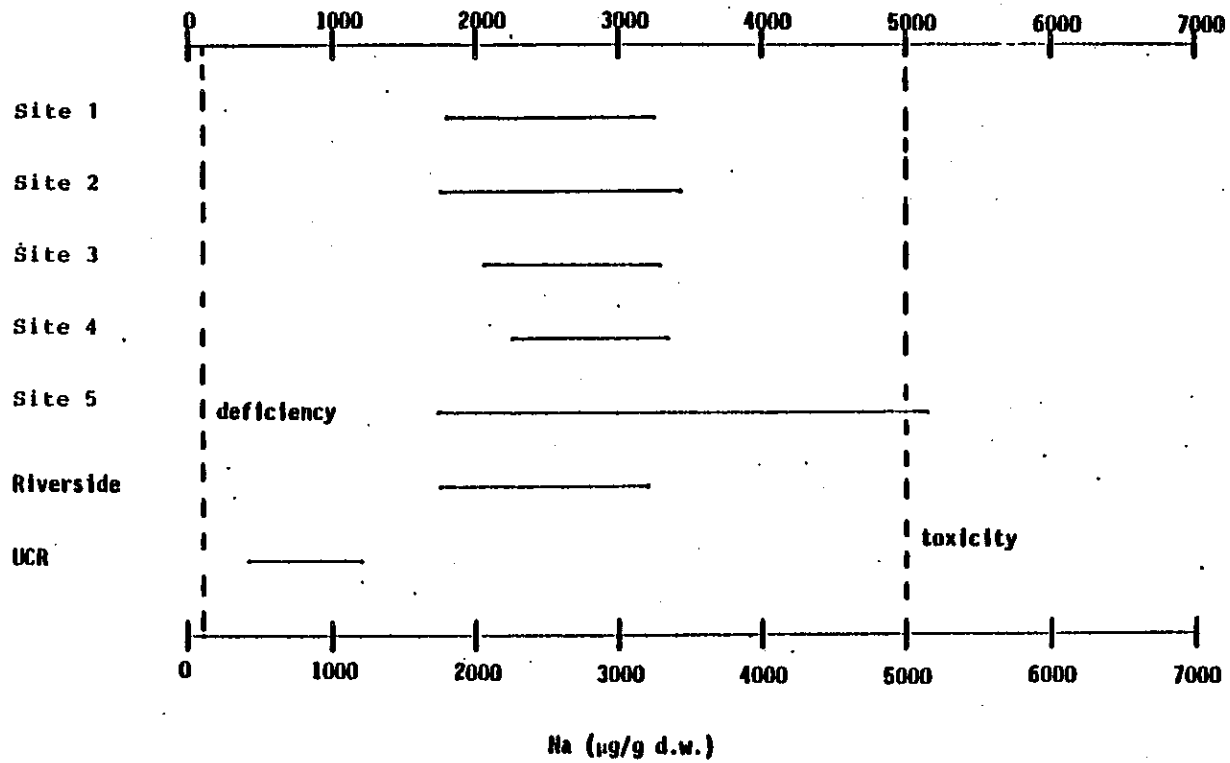


Figure 2. Ranges of Na levels in leaves of Eucalyptus at the study sites.



ClibPDF - www.fastio.com

ClibPDF - www.fastio.com

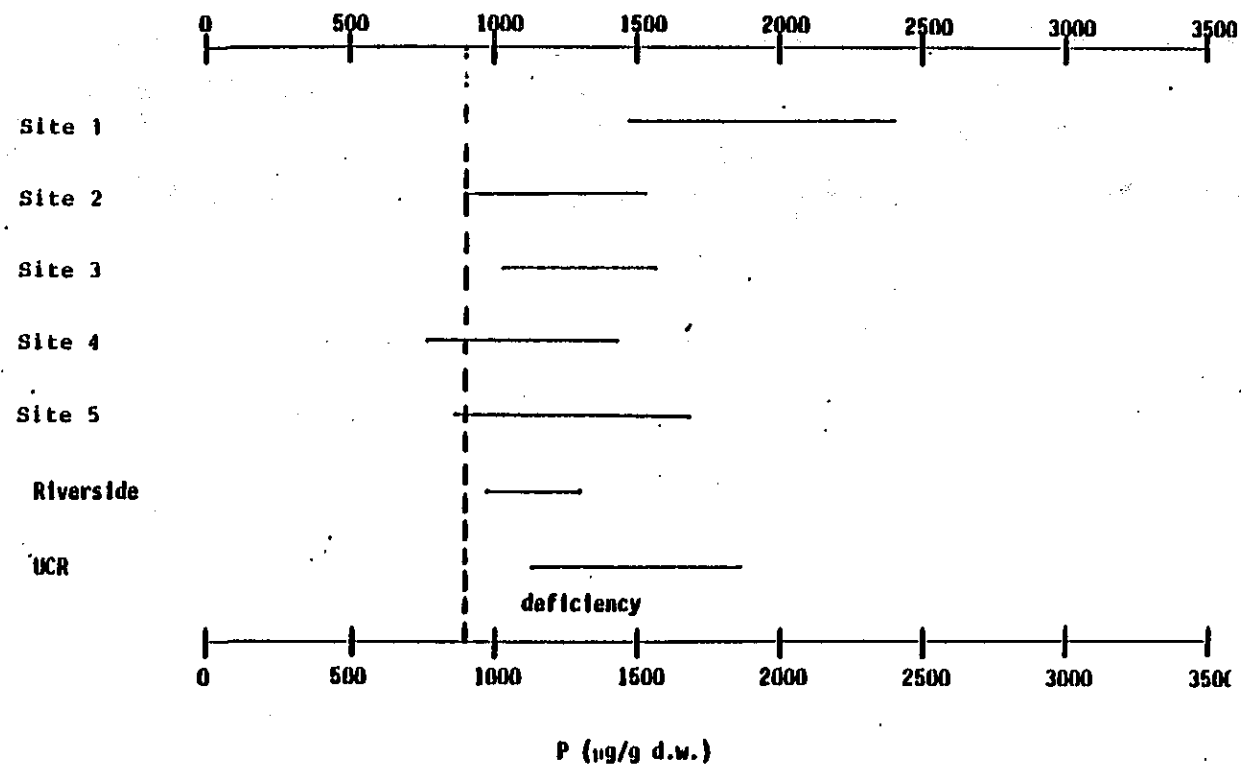


Figure 3. Ranges of P levels in leaves of Eucalyptus at the study sites.

ClibPDF - www.fastio.com

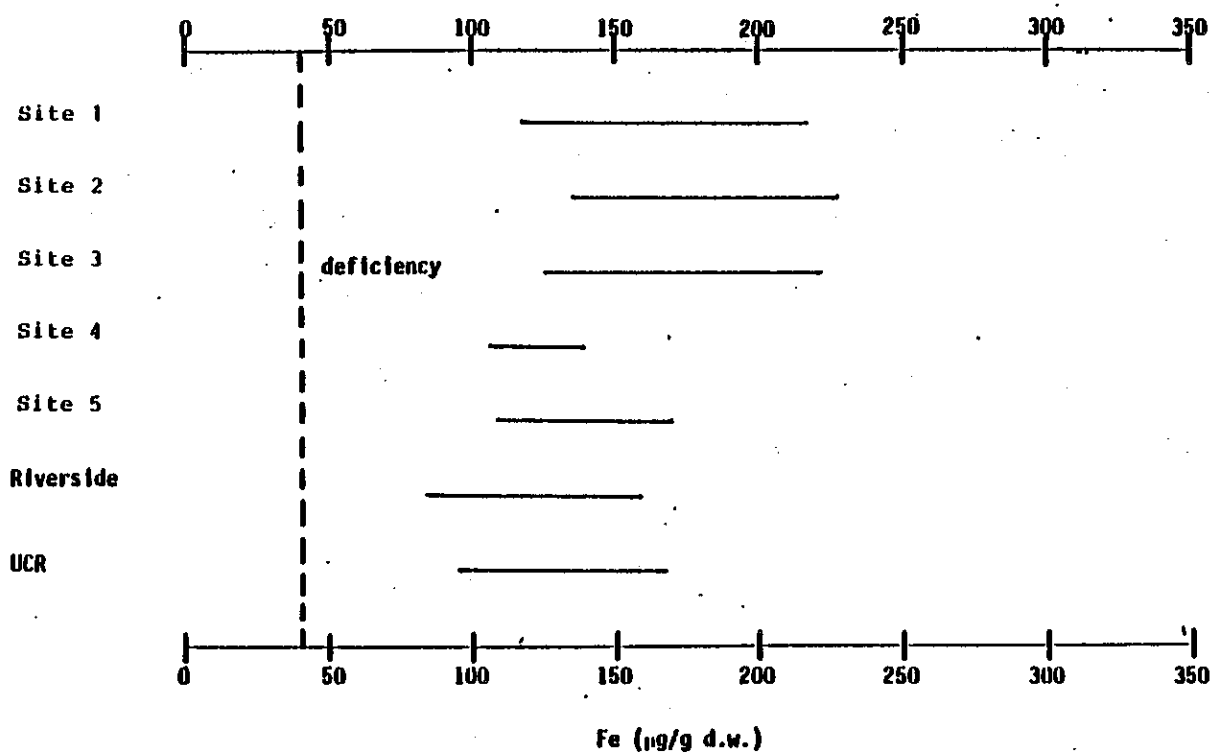


Figure 4 Ranges of Fe levels in leaves of Eucalyptus at the study sites.

ClibPDF - www.fastio.com

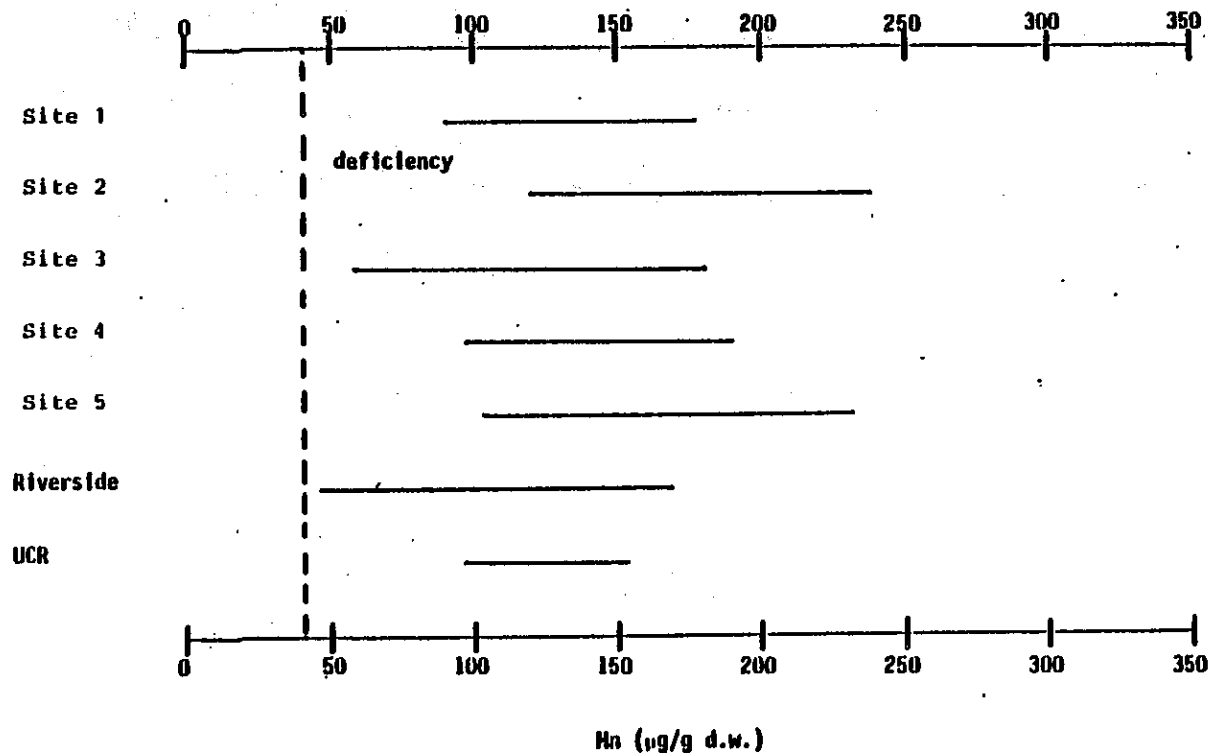


Figure 5 Ranges of Mn levels in leaves of Eucalyptus at the study sites.

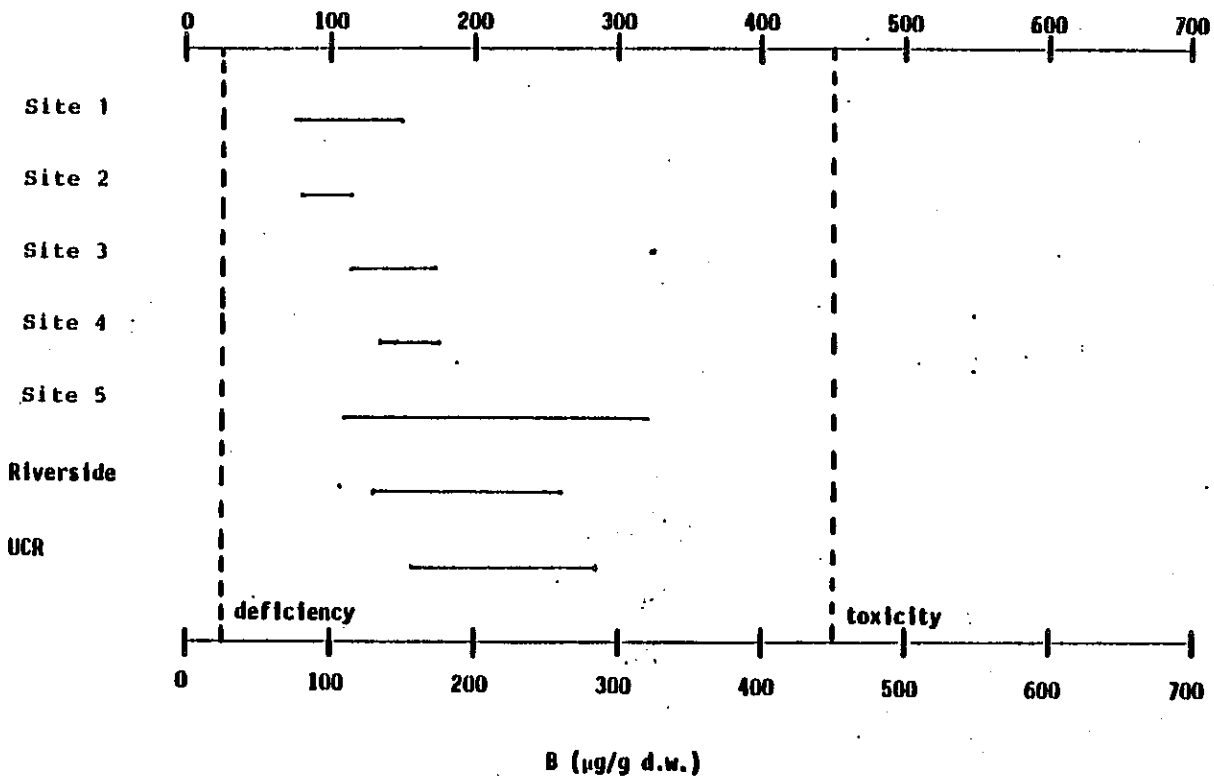


Figure 6 Ranges of B levels in leaves of Eucalyptus at the study sites.



ClibPDF - www.fastio.com

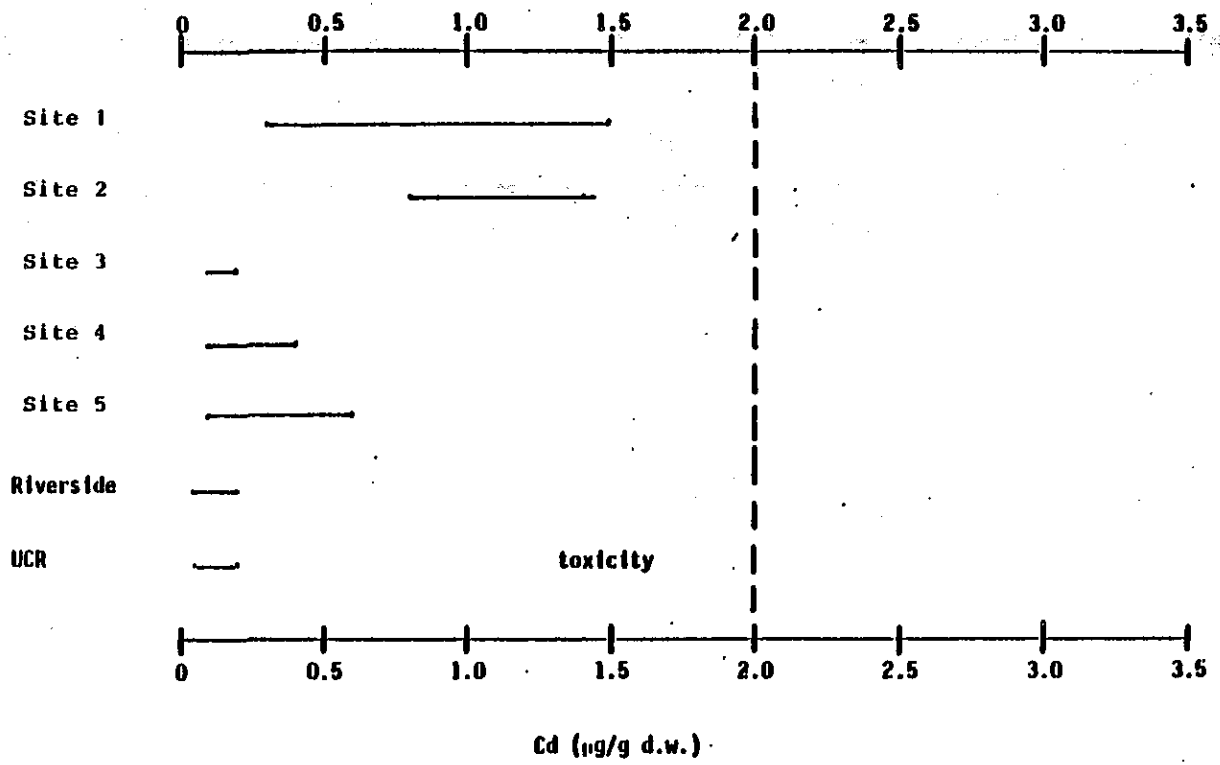


Figure 7 Ranges of Cd levels in leaves of Eucalyptus at the study sites.

ClibPDF - www.fastio.com

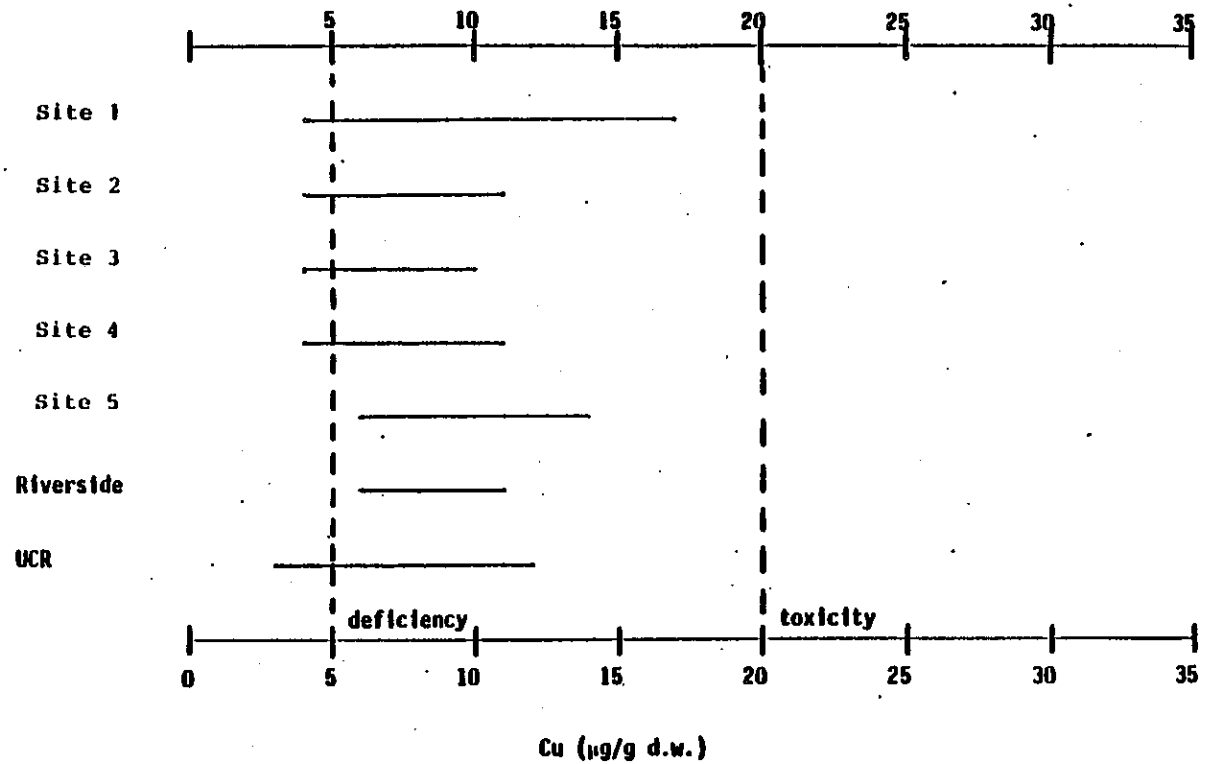


Figure 8 Ranges of Cu levels in leaves of Eucalyptus at the study sites.



ClibPDF - www.fastio.com

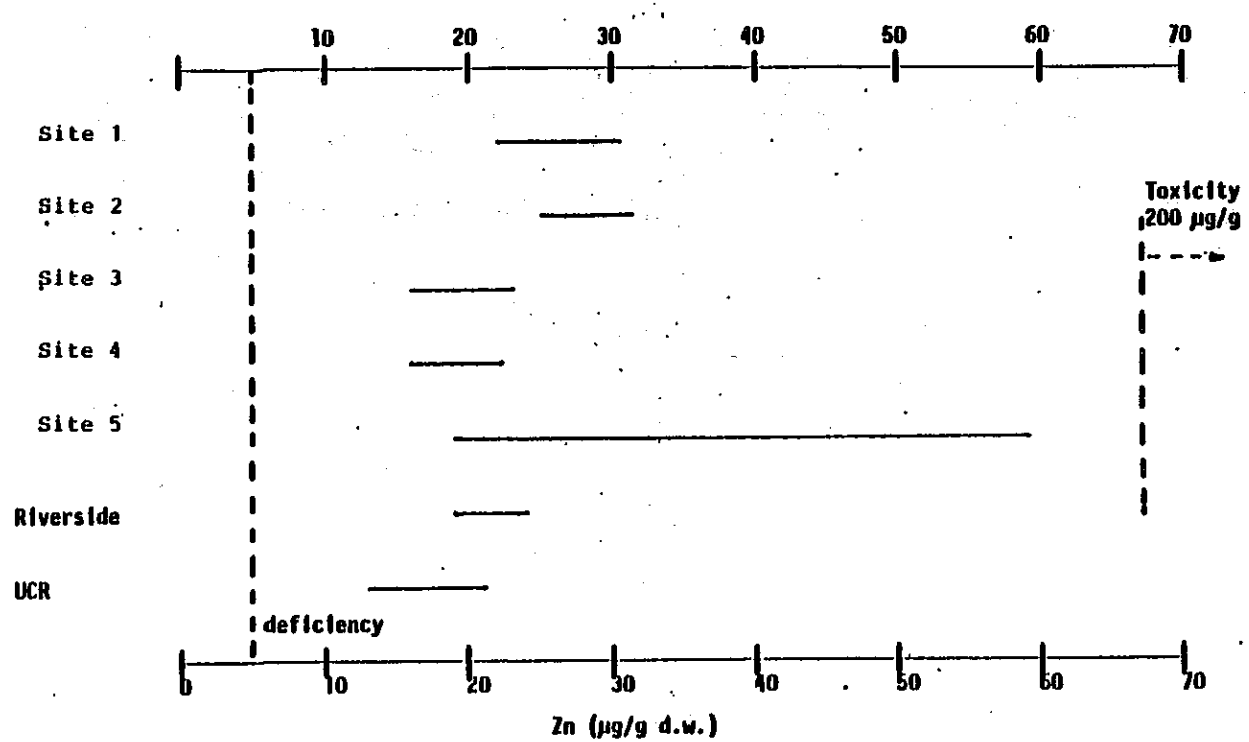


Figure 9 Ranges of Zn levels in leaves of Eucalyptus at the study sites.

ClibPDF - www.fastio.com