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CHEMICAL QUALITY OF WATER IN CONSERVATION AREA 2A AND ASSOCIATED CANALS

by

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Revised

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Revisions

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THE CHEMICAL QUALITY OF WATER IN CONSERVATION AREA 2A AND ASSOCIATED CANALS

| LIST OF TABLES | v |
|--|---|
| LIST OF FIGURES | vii |
| PURPOSE AND SCOPE | 1 |
| PREVIOUS WORK | 3 |
| HYDROLOGIC SETTING | |
| GENERAL | 15 |
| DRAWDOWN | 19 |
| METHODOLOGY | 21 |
| DATA | 24 |
| DISCUSSION | |
| QUALITY OF CANAL AND MARSH WATER | 37 |
| EFFECT OF DRAWDOWN ON WATER QUALITY | 45 |
| RELATIONSHIPS AMONG VARIOUS DATA | 47 |
| SUMMARY | 69 |
| BIBLIOGRAPHY | 71 |
| APPENDICES | |
| APPENDIX I | |
| SAMPLING AND CHEMICAL COMPOSITION MAPS FOR CA-2A, OCT. 11, 1972 - AUG. 22, 1973 | |
| October 11, 1972 Sampling Points Chloride | I-1 I-2 |
| February 13, 1973 Sampling Points Chloride Sodium Silica Nitrate Nitrite Ammonia Ortho-Phosphate | I-3 I-4 I-5 I-6 I-7 I-8 I-9 I-10 |

| June 26, 197 | 73 | |
|----------------------|---|--------------|
| Sampling Poi | ints | I-11 |
| Chloride | | I-12 |
| Sodium | | I-13 |
| Silica | | I-14 |
| Nitrate | | I-15 |
| Nitrite | | T-16 |
| Ammonia | | T-17 |
| Ortho-Phosph | nate | T-18 |
| or the thoop | | 1-10 |
| July 17 19: | 73 | |
| Sampling Poi | inte | T 10 |
| Alkalinity | | T 20 |
| Chlorido | ********** | 1-20 |
| Sodium | | 1-21 |
| Silian | * | 1-22 |
| Nitrata | • | 1-25 |
| Nitrate | • | 1-24 |
| Nitrite | **************************** | 1-25 |
| Ammonia | | 1-26 |
| Ortho-Phospi | nate | I-27 |
| | | |
| July 31, 197 | 73 | |
| Sampling Pot | ints | I-28 |
| Conductivity | 7 •••••• | I-29 |
| Alkalinity | | I-30 |
| Chloride | | I-31 |
| Sodium | •••••••••• | I-32 |
| Silica | | I-33 |
| Nitrate | | I-34 |
| Nitrite | | I-35 |
| Ammonia | | I-36 |
| Ortho-Phosph | nate | I-37 |
| | | |
| August 8, 19 | 973 | |
| Sampling Poi | Ints | I-38 |
| Alkalinity | | T-39 |
| Chloride | | T-40 |
| Sodium | •••••• | T_41 |
| Silica | | T_41 |
| Nitrato | | 1-42 |
| Nitrito | | 1-43 T 44 |
| Ammonio | | 1-44 T 4E |
| Annionia Annionia | •••••••• | 1-45 |
| ortno-Phospi | late | 1-46 |
| | 1077 | |
| August 14, | 1975 | T 45 |
| Sampling Po | Ints | 1-4/ |
| Alkalinity | | 1-48 |
| Chloride | ••••• | 1-49 |
| Sodium | • | 1-50 |
| Silica | •••••• | 1-51 |
| Nitrate | •••••• | I-52 |
| Nitrite | | I-53 |
| Ammonia | | I-54 |
| Ortho-Phospl | nate | I-55 |

•

| August 22, 1973 | |
|--|-------|
| Sampling Points | I-56 |
| Conductivity | I-57 |
| Alkalinity | I-58 |
| Chloride | I-59 |
| Sodium | I-60 |
| Silica | I-61 |
| Nitrate | I-62 |
| Nitrite | I-63 |
| Ammonia | I-64 |
| Ortho-Phosphate | I-65 |
| ······ | |
| APPENDIX II | |
| TABULATED CHEMICAL DATA | |
| | |
| Chemical Composition of water Collected in | т 1 |
| CA-2A Marsh - October 11, 1972 | 1-1 |
| Chemical Composition of Water in CA 2A | |
| Marsh November 11 1972 February 13 1973 | |
| $\frac{1973}{1000} = \frac{1073}{1000} = \frac{1000}{1000} = \frac{1000}{1000$ | TT_2 |
| June 20, 1975 | 11-2 |
| Chemical Composition of Water Collected At the | |
| Tailwater Side of S-7 Dumping Station - | |
| July 1073 | 11-3 |
| July, 1975 | 11-5 |
| Chemical Composition of Water in CA-2A and | |
| Associated Canals - July 17, 1973 | TT-4 |
| hobociacoa danaio oaij ing ipro monomo | |
| Chemical Composition of Water Collected at | |
| S-10 Discharge Gates - July 1973 | II-5 |
| 5×10 Disenarge Gates Gaty, 15/5 | |
| Chemical Composition of Water Collected in | |
| CA=2A Marsh - July 31, 1973 | II-6 |
| | |
| Chemical Composition of Water Collected in | |
| Hillshoro Canal and S-10 Discharge Canal - | |
| July 31 1973 | 11-7 |
| ouly 51, 1575 | / |
| Chemical Composition of Water Collected at | |
| S-10 Discharge Gates - August 2-17, 1973 | TT-8 |
| 5-10 Discharge Sates Ragast 2 17, 1970 1111 | |
| Chemical Composition of Water Collected in | |
| CA-2A and Adjacent Canals - August 8, 1973 | II-9 |
| | |
| Chemical Composition of Water Collected in | |
| CA-2A and Associated Canals - August 14, 1973 | II-10 |
| | |
| Chemical Composition of Water in CA-2A Marsh | |
| August 22, 1973 | II-11 |

V(revised)

LIST OF TABLES

•

| Table 1 | Chemical Composition of Hillsboro Canal Water (Parker, et al., 1955) | 4 |
|----------|--|----|
| Table 2 | Chemical Composition of North New River Canal Water (Parker, et al., 1955) | 5 |
| Table 3 | Chemical Composition of Nonartesian Groundwater in Western Palm Beach County (Parker, et al., 1955) | 6 |
| Table 4 | Chemical Composition of Agricultural Drainage (Parker, et al., 1955) | 9 |
| Table 5 | Non-Nutrient Parameters in Marsh Water | 25 |
| Table 6 | Non-Nutrient Parameters in Canal Water | 26 |
| Table 7 | Nutrients in Marsh Water | 27 |
| Table 8 | Nutrients in Canal Water | 28 |
| Table 9 | Averages of Means for All Analyses | 29 |
| Table 10 | Linear Regression - July S-7 Samples | 30 |
| Table 11 | Linear Regression - Hillsboro Canal at S-10 Structures, July and August | 31 |
| Table 12 | Comparison of Non-nutrient Water Chemistry in CA-2 Marsh Before and After Drawdown | 32 |
| Table 13 | Comparison of Nutrient Water Chemistry CA-2A Marsh Before and After Drawdown | 33 |
| Table 14 | Florida State Pollution Standards | 38 |
| Table 15 | Surface Water Criteria for Public Water Supplies, FWPCA | 39 |
| Table 16 | Drinking Water Standards, USPHS and WHO | 40 |
| Table 17 | Amount and Nutrient Content of Rainfall at Anderson- Cue Lake, Florida 1968 (Putnam, et al., 1972) | 41 |
| Table 18 | Nutrient Concentrations of Urban Runoff | 43 |
| Table 19 | Chemical Composition of Hillsboro and N. New River Water During July and August 1941–1943 (Parker, et al., 1955) | 48 |

| Table 20 | Chemical Composition of 10-day Composite Water Samples from North New River Canal at 26-Mile | |
|----------|---|----|
| | Bend, 1941 (Parker, et al., 1955) | 49 |
| Table 21 | Ultimate Analysis of Peat from Conservation Area 2A at Various Depths | 59 |

LIST OF FIGURES

| Figure | 1 | Variation in Groundwater Chloride Depth (Parker, et al., 1955) . | with | 8 |
|--------|----|---|---------------------------|----|
| Figure | 2 | Topography of CA-2A | | 17 |
| Figure | 3 | Conductivity Gradient Adjacent to September 17, 1973 | L-39, | 18 |
| Figure | 4 | Conservation Area 2A Rainfall and Gage 2-17 Levels, Nov. 1972-Aug | Stage g. 1973 | 34 |
| Figure | 5 | S-7, S-38, S-143, S-144, S-145, am Discharge, November 1972 thru N | nd S-146 Nov. 1973 | 35 |
| Figure | 6 | S-10 and S-11 Discharge, November August 1973 | 1972- | 36 |
| Figure | 7 | Chloride Concentrations August 8, | 1973 | 53 |
| Figure | 8 | Nitrate Concentrations " | •••• | 54 |
| Figure | 9 | Orthophosphate Concentrations " | •••• | 55 |
| Figure | 10 | Chloride Concentrations August 14 | , 1973 | 56 |
| Figure | 11 | Nitrate Concentrations " | • • • • • | 57 |
| Figure | 12 | Orthophosphate Concentrations " | •••• | 58 |
| Figure | 13 | Area Unaffected by High Conductivi High Chloride Water | ty and | 62 |
| Figure | 14 | Chloride Concentrations October 1 | 1, 1972 | 63 |
| Figure | 15 | Conductivity July 31, 1973 . | • • • • • • • • • • • • • | 64 |
| Figure | 16 | Chloride Concentrations July 31, | 1973 | 65 |
| Figure | 17 | Conductivity September 17, 1973 | | 66 |

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THE CHEMICAL QUALITY OF WATER IN CONSERVATION AREA 2A AND ASSOCIATED CANALS

ABSTRACT (Revised)

- 1. This study is the first detailed water-chemistry study within a conservation area. Chemical data was also collected during two months of the wet season from canal water flowing out of the agricultural area. During the eleven month period of investigation from October 1972-August 1973, 300 water samples were collected and over 2700 analyses were performed.
- Hillsboro and North New River Canal water nutrient levels during July and August exceeded the organic nitrogen concentrations of urban rumoff reported in the literature. Canal water nutrient levels were equivalent to urban canal water nutrient concentrations measured by a 1973 USGS study in South Florida.
- 3. Canal and marsh water exceeded Florida State Pollution Standards for specific conductance. Data strongly suggests that this is a permanent condition. Hillsboro Canal water exceeded FWPCA and WHO standards for ammonia on July 31, August 8 and 14.
- 4. The drawdown of CA-2A, February 9 July 1, 1973, had no determinable effect on the chemical composition of water refilling the CA-2A marsh.
- 5. Vegetation in the marsh absorbed the relatively high nutrient inputs introduced from canal inflows. Nutrients were at considerably lower levels in the marsh than in the canals even though sodium, chloride, and silica differed very little between marsh and canal; these relationships were true even for samples in the marsh collected close to the S-10 discharge gates.
- 6. Dissolved organic nitrogen and dissolved organic phosphate phosphorus concentrations did not vary significantly between canal and marsh suggesting that they are refractory and not available as a nutrient source for organisms.
- 7. The chemical complexion of Hillsboro and North New River Canal water is not significantly different, now, from what it was in the 1940's. Nitrate, alkalinity, chloride, sodium, specific conductance, and silica concentrations are, at present, within the range of values and in the same order of abundance as they were 30 years ago as determined by the U.S. Geological Survey. Values determined within this two month canal sampling period were at the high range of historical data.

- 8. A small northwestern section of CA-2A was unaffected by high conductivity and high chloride water prevalent over the rest of the area.
- 9. The order of abundance of inorganic ions for both canals and the marsh was bicarbonate (alkalinity) > chloride > sodium > SiO₂. The order of abundance for nutrients was different between canals and marsh. The labile nitrate and orthophosphate virtually disappeared after entering the marsh.
- 10. The concentrations of various ions showed linear relationships. Nitrate and nitrite concentrations in the Hillsboro Canal were linear during the July - August sampling period. Chloride and sodium in the Hillsboro Canal and CA-2A marsh exhibited a significant linear relationship suggesting little uptake by vegetation as the water passes from canal to marsh.
- 11. Nitrate rather than ammonia was the most prevalent form of inorganic nitrogen detected in canals during flow periods. Within the marsh ammonia exceeded nitrate in concentration.

PURPOSE AND SCOPE

The chemistry of water in CA-2A is a product of the modifying effects of lush vegetation, algal growth, rainfall dilution and evaporative concentration on water from an eclectic variety of sources. Water in Area 2 is derived from rainfall, seepage from CA-1, groundwater, agricultural drainage, and disbursements from CA-1. The water received by the Area 2A marsh from the ag-lands is prone to high nutrient contents because of decades of fertilizer usage and the nutrient rich nature of the Everglades peat. Groundwater in the agricultural region is highly alkaline and contains appreciable sodium and chloride due to connate water in a limestone bedrock.

The quality of water in CA-2A resulting from the complex interaction of multiple sources and modifying forces is important. The Pompano Beach-Fort Lauderdale area depends on water storage in CA-2A to recharge wellfields in times of stress. The maintenance of viable fish, wildlife, and waterfowl populations and a productive Everglades ecology depends on <u>quality</u> water.

The purpose of this research was threefold: First, to make a detailed examination of surface water quality within the CA-2A sawgrass marsh and in canals discharging water over the marsh. Second, to determine if the spring drawdown of CA-2A had any effect, beneficial or deleterious on water quality. Third, to examine relationships between various chemical constituents in the water.

Samples were collected from the CA-2A marsh and from adjacent canals which furnish water to the marsh. The Hillsboro Canal above the S-10

structures, the tailwater side of the S-10 structures, the S-10 discharge canal, the tailwater side of the S-7 pump station and canals adjacent to L-38E and L-35B were all sample sources.

This report covers the time period from October 11, 1972 through August 22, 1973. Canals were sampled only when water was actively flowing into CA-2A; for this reason they were sampled only during two months, July and August, 1973. Water was sampled from the marsh on the following dates:

> October 11, 1972 November 16, 1972 February 13, 1973 June 26, 1973 July 17, 1973 July 31, 1973 August 8, 1973 August 14, 1973 August 22, 1973

During the course of this study approximately 300 samples were collected and 2700 analyses performed. A major sample collection was made on February 13, 1973, which was four days after the drawdown began. Samples were collected on June 26, which was two weeks after the lowest water stages were recorded. Samples were collected at various times during July and August as CA-2A rapidly refilled from rainfall and S-10 discharge. Approximately one-third of the samples were collected and one-half of the analyses were run prior to any discharge from S-10.

PREVIOUS WORK

Water quality information on CA-2A, Hillsboro Canal and North New River water is sparse. Parker, et al. (1955) performed yeoman service during the years 1941 - 1945 in analyzing canal and groundwater in South Florida. The Hillsboro Canal near Deerfield Beach and the North New River Canal near Ft. Lauderdale showed wide fluctuations in chemical composition and maximum ranges for chemical components which were relatively high. The Hillsboro Canal showed dissolved-solids concentrations ranging from 98 ppm - 868 ppm and ${\rm CaCO}_{\rm Z}$ hardness ranged from 65 ppm - 388 ppm (Table 1). Bicarbonate rose as high as 442 ppm; chloride attained a maximum level of 285 ppm, and specific conductance reached 1560 µmhos/cm. Nitrate ranged from 0 - 2.4 ppm (.54 ppm as N). North New River Canal water was similar in composition. It contained dissolved solids ranging from 140 - 592 ppm; CaCO₃ hardness varied from 140 - 418 ppm; bicarbonate and chloride were as high as 384 and 148 ppm; specific conductance on occasion exceeded 1000 µmhos/cm. Nitrate ranged from 0-2.0 ppm (.45 ppm as N). Parker, et al. found, generally, that when discharge was high in the North New River Canal the concentration of dissolved matter was relatively low and when the discharge was low, the concentration was high.

Four factors were reported to cause the extreme fluctuations and the maximal values for dissolved ions. First, groundwater in the Everglades is highly mineralized (Table 3). The highly saline water is believed to be connate water, in part. High chloride, sodium and sulfate concentrations probably originate from relicit Pleistocene seawater which has never been

CHEMICAL COMPOSITION OF HILLSBORO CANAL WATER NEAR DEERFIELD BEACH (Parker, et al., 1955)

Analyses in PPM

| Dat | ie i | | Specific conduct- | Cal- | Magne - | Sodium | Bicar- | Sul- | Chlo- | Ni- | Dis- | Total hard- |
|--|---|--|--|--|---|--|--|---|--|--|---|--|
| of colle | rtion | Color | ance (K x 10 ⁵ at 25 C) | cium (Ca) | sium (Mg) | and po- tassium (Na + K) | bonate (HCO) | fate (SO ₄) | ride (Cl) | trate (NO3) | solved solids | ness 25 CaCO ₃ |
| 19 | 41 | | | | | | | | | | | |
| Mar. Apr. May July Aug. Sept. Oct. Nov. Dec. | 19 23 21 3 22 19 23 26 26 26 | 140 100 200 220 240 180 130 110 | 67.5 61.7 84.0 60.0 34.4 36.3 37.8 49.9 65.4 | 53 52 58 52 32 29 32 42 52 | 17 13 18 12 9.2 8.1 10 12 15 | 65 85 96 38 26 35 34 45 69 | 213 195 256 210 131 130 143 164 217 | 29 21 21 14 6.6 6.6 11 15 22 | 98 97 139 83 42 48 47 72 100 | 2.0 .5 1.0 .8 1.1 1.6 .6 | 368 366 459 323 180 192 205 268 366 | 202 135 219 179 118 106 121 154 191 |
| 194 | 42 | | | | | | | | | | | |
| Jan. Feb. May June July Aug. Sept. Oct. Nov. Dec. | 22 19 7 4 9 7 3 7 11 10 | 100 110 180 120 180 240 180 160 100 90 | 17.8 78.4 35.7 21.9 22.0 99.4 59.0 114 94.7 94.4 | 22 62 32 22 72 56 89 80 85 | 1.6 14 9.2 4.4 5.5 23 17 27 21 21 | 14 83 26 17 14 98 33 114 88 86 | 69 239 122 81 84 314 205 365 307 329 | 6.4 25 5.3 9.9 3.3 21 14 42 30 31 | 20 12 48 24 25 148 71 167 138 129 | .1 1.0 .4 .1 .2 .3 2.4 1.2 1.6 | 98 482 181 117 111 517 292 620 509 516 | 62 212 118 73 78 274 211 333 286 298 |
| 194 | 13 | | | | , | | | | | | | کا با م |
| Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct. Nov. Dec. | 7 4 4 1 5 2 7 5 2 7 2 30 31 | 100 90 65 65 80 120 90 186 170 300 240 190 150 | 94.7 116 103 123 120 147 144 115 51.2 59.3 113 52.2 | 80 98 98 103 104 106 106 106 109 99 55 54 25 46 | 21 23 17 22 27 26 29 26 13 15 7.4 | 90 113 95 125 121 182 166 104 86 30 43 12 40 | 325 374 336 360 377 384 395 442 394 190 194 72 156 | 22 34 37 43 35 52 47 21 34 16 16 5.6 12 | 136 172 147 198 285 255 152 134 60 80 38 79 | 2523409024422 | 509 625 560 657 841 796 573 268 304 124 268 | 286 339 314 348 350 376 372 374 354 191 196 93 164 |
| 194 | 4 | | | | | | | | | | | |
| Jan, 3 Feb, 2 Mar, 3 May May 3 July | 81 29 81 2 81 1 | 120 82 66 80 90 180 | 79.4 103 94.6 83.8 131 106 | 70 99 82 91 92 97 | 15 17 18 15 26 29 | 74 97 92 69 147 89 | 242 334 288 319 388 430 | 23 33 39 25 34 19 | 123 156 144 106 216 129 | .8 .5 .1 .1 .2 .2 | 425 567 517 464 706 575 | 226 317 278 288 336 361 |
| 194 | 5 | | | · - | | | | | | | | • |
| May 2 | 26 | 160 | 156 | 121 | 21 | 186 | 412 | 57 | 280 | -0 | 868 | 388 |

CHEMICAL COMPOSITION OF NORTH NEW RIVER CANAL WATER NEAR FT. LAUDERDALE

(Parker, et al., 1955)

Analyses in PPM

| Date of collection | Color | Specific conduct- ance (K x 10 ⁵ at 25 C) | Cal- cium (Ca) | Magne- sium (Mg) | Sodium and po- tassium (Na + K) | Bicar- bonate (HCO ₃) | Sul- fate (SO ₄) | Chio- ride (Cl) | Ni- trate (NO ₃) | Dis- solved solids | Total hard- ness caCO ₃ |
|--|--|---|---|--|--|--|--|---|---|--|--|
| 1941 | | | | | | | | | | | |
| Mar. 19 Apr. 22 May 21 July 3 Aug. 1 Aug. 22 Sept. 26 | 150 220 220 320 360 320 280 | 78.7 63.3 92.8 42.9 27.7 48.4 50.0 | 82 78 94 52 42 61 55 | 27 20 33 13 8.5 15 16 | 56 35 64 19 23 34 | 324 282 372 182 148 236 237 | 37 39 60 16 3.3 11 30 | 94 56 101 41 12 42 37 | 2.0 2.0 .8 .5 .2 .8 .4 | 458 369 536 231 140 269 289 | 316 277 370 183 140 214 203 |
| 1942 | t | | | | | | | | | | |
| Apr. 9 May 7 June 4 July 9 Aug. 6 Sept. 3 Oct. 8 Nov. 11 Dec. 10 | 160 220 220 360 240 220 180 100 50 | 103 74.9 88.7 31.9 79.0 84.2 94.4 72.2 50.8 | 108 88 99 46 90 93 106 74 54 | 36 21 30 7.4 24 29 33 21 16 | 62 41 56 5.0 37 36 48 47 29 | 387 320 348 160 329 315 368 280 190 | 83 30 76 3.7 44 70 81 37 36 | 105 72 90 15 63 69 83 74 50 | 1.6 1.5 .4 .1 .2 .1 1.8 .4 .4 | 586 411 523 156 420 452 534 391 279 | 418 306 370 145 323 351 400 271 201 |
| 1943 | | 1 | | | | | J. | | | | |
| Jan. 7 Feb. 4 Mar. 5 Mar. 31 May 5 June 3 July 8 July 8 July 8 Sept. 2 Nov. 30 | 75 50 40 40 85 120 150 160 90 | 68.5 59.3 65.9 52.5 51.9 81.3 104 95.2 75.1 58.1 | 72 64 67 58 60 83 106 94 82 79 | 20 17 19 17 16 27 36 31 24 16 | 43 34 95 26 23 49 67 64 20 21 | 269 227 250 204 203 318 384 362 300 268 | 33 38 36 38 34 42 78 50 38 26 | 70 56 148 46 45 86 116 109 78 44 | .4 .2 .5 .4 .2 .2 .3 .0 .4 | 371 321 489 286 278 444 592 526 391 319 | 262 230 245 214 216 318 412 362 303 263 |
| 1944 | | | | | | | | | 1 | | |
| Jan. 7 Jan. 31 Feb. 29 Mar. 31 May 1 June 1 June 30 | 80 70 85 62 85 50 90 | 53.5 55.2 64.2 62.9 70.8 54.5 79.1 | 61 76 91 84 79 60 89 | 16 16 17 16 23 14 22 | 23 14 23 28 42 34 47 | 235 248 315 286 290 220 345 | 2 26 3 23 2 22 5 29 5 54 2 29 2 36 | 46 42 45 51 63 50 | | 293 294 356 349 404 296 2435 | 233 256 297 276 292 292 207 312 |
| 1945 | | 1 | 1 | | | | | | | | 1 |
| May 25 Sept. 21 | 45 280 | 58.8 74.6 | 60 100 |) 15) 26 | 42 14 | 22 26 | 2 40 2 107 | 51 | 3 .8 3 .4 | 3 320 | 5 216 356 |

CHEMICAL COMPOSITION OF NON-ARTESIAN GROUND-WATER IN WESTERN PALM BEACH COUNTY

(Parker, et al., 1955)

| fotal hard- ness caCO | 1,008 626 | 515 500 1,158 | 466 | 1,118 460 | 677 | 734 | 908 | 1, 090 | 784 | 512 688 | 349 | 675 | 570 352 | 415 |
|--|--|---|----------------|---------------------|----------------|-------------|---|-------------|-------------|---|--------------|---|--|--|
| Dla - solved solide | 5,670 1,598 | 870 1, 229 2, 428 | 560 | 3,450 845 | 882 | 1,566 | 616 | 1, 302 | 851 | 830 | 191 | 959 | 1, 199 | 557 |
| NI- Inde (NO) | 13 | 9.6 | ٥. | Π | • | 9. | .2 | 2.5 | 4 | .1 | = | ٩. | °, °, | е, |
| Chlo- the (CI) | 2,300 | 169 340 670 | 41 | 1, 140 | 23 | 308 | 96 | 80 | 62 | 104 65 | 113 | 49 | 123 265 | 34 |
| Sul- fate (SO ₄) | 925 295 | 149 181 579 | 96 | 1199 | 66 | 25 | 143 | 531 | 127 | 51 | 170 | 320 | 319 | 54 |
| Ricar- bonate (HCO ₃) | 769 776 | 484 520 725 | 480 | 849 582 | 952 | 1, 319 | 744 | 609 | 765 | 751 740 | 414 | 588 | 622 621 | 550 |
| Sodium and po- tantum (Na + K) | 1,761 | 130 276 452 | 53 | 862 159 | 94 | 372 | 36 | 38 | 29 | 143 42 | 154 | 16 | 229 396 | 64 |
| Magne- atum (Mg) | 148 83 | 50 50 145 | 46 | 128 61 | 64 | 130 | 62 | 143 | 90 | 76 75 | 1.7 | 61 | 80 | 50 |
| Cat- clum (Ca) | 160 114 | 124 118 225 | 111 | 237 84 | 166 | 80 | 221 | 201 | 166 | 80 152 | 137 | 160 | 80 44 | 84 |
| (Fe) | 0,05 | 25 | .10 | .10 | .10 | .10 | . 10 | Е. | .10 | 9.9. | -01 | .10 | .15 | . 15 |
| Specific conduct- ance (K x 105 at 25 C) | 908 254 | 148 209 386 | 92,2 | 543 156 | 116 | 263 | 143 | 182 | 143 | 138 | 127 | 138 | 181 | 103 |
| Color | 360 360 | 180 180 320 | 140 | 520 280 | 260 | 260 | 220 | 180 | 400 | 60 280 | 280 | 280 | 98 J 80 J | 360 |
| Tem- ture (.F) | 76 | 75 | | | | | 11 | 75 | 11 | 73 | 80 | | 76 | |
| Depth (feet) | 35 35 | 47 47 36.4 | 20 | 18 45 | 14 | 20 | 13 | 22 | 20 | 60 12, 5 | 20 | 20 | 35.5 31 | 20 |
| Date of collection | Sept. 23, 1941 Sept. 22, 1941 | dodo do Sept. 23, 1941 | Sept. 10, 1941 | do | Sept. 12, 1941 | do | do | do | do | Sept. 22, 1941 | do | do | do | do |
| Location | Miami Locks Camp, U. S. Sugar Corp Belle Glade, State Prison Farm | Belle Glade, U. Z mile E. of Hilbboro Canal and 0.6 mile N. of State Hwy. 15 Rita Village, U. S. Sugar Corp | Point | Pahokee water tower | County line. | Beach Canal | State Hwy. ID, 3.8 miles N. of West Falm Beach Caral | Beach Canal | Beach Canal | State Hwy, 80, 0, 4 mile E. of North New River Canal | water plant. | State Hwy, 200 Let 14, 04 Intersection of | South Store Camp, a mus 3, of state riny. 80 and 3 miles W. of State Hwy. 25 Miami Locks, Plantation | Lake Harbor, at Atlanuc Loast Line IV, K, 7 station |
| Well no. | S- 350 S- 352 | 5- 356 5- 356 5- 358 | | s-1190 | 1021-0 | 2021-0 | 5-1204 | 19051-5 | 0047-0 | 5-1209 | 1101-2 | 3-1919 | 5-1215 | 0771-6 |

6

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completely flushed out of the Everglades area. Saline waters are found in wells located in five counties near the shores of Lake Okeechobee. They are related to the occurrence of muck soils and the low permeability of underlying muck and marl deposits. Generally, the dissolved solids increase with depth (Figure 1). At many places highly mineralized water lies only a few feet beneath the surface of the ground (Parker, et al., 1955).

The second factor causing wide variations in canal water composition is Lake Okeechobee water. Lake water has a beneficial effect on the canal water by diluting it, since Lake water contains fewer dissolved ions. Third, agricultural drainage is extremely high in dissolved solids (Table 4). Bicarbonate, chloride, sulfate and calcium levels may reach 649 ppm, 303 ppm, and 240 ppm, respectively. The fourth factor is sheetflow surface water from the Everglades marsh. This water has a beneficial effect on water quality because it is low in dissolved solids and dilutes the canal water (Parker, et al., 1955).

Hyde (1965) indicated that the Hillsboro Canal intersects an area south of Lake Okeechobee where the principal aquifer is "highly mineralized". Grantham and Sherwood (1968) described the quality of canal and groundwater in Broward County. They showed that the water was calcium bicarbonate in type and ranged from hard to very hard. They found high chlorides in the lower part of the Biscayne aquifer in inland areas and a seasonal variation in dissolved solids of canal water; the mineral content of the water was lower during the rainy season but increased during the dry season because of the increase in the percentage of ground water in the canals and drainage from swampy inland areas.

FIGURE 1

VARIATION IN GROUNDWATER CHLORIDE WITH DEPTH

(Parker, et al., 1955)



CHEMICAL COMPOSITION OF AGRICULTURAL DRAINAGE (Parker, et al., 1955)

••

| Location | Date | Color | Specific Conductance µmhos/cm x 10-1 | Ca | Mg | 8 + × | HCO. | Sol | 5 | NO3 | Dis. Solids | Total Hardness CaCO ₃ |
|--|---|--------------------------------|---|---------|---------|-------|------|-----|-----|-----|----------------|--|
| Drainage ditch 2.4 miles southeast of Canal Point ¹ | 3/14/41 | 280 | 233 | 147 | 84 | 236 | 649 | 267 | 294 | ı | 1,350 | 712 |
| Drainage ditch 5.5 miles southeast of Canal Point ¹ | qo | 440 | 240 | 178 | 67 | 231 | 728 | 308 | 303 | i | 1,480 | 843 |
| Drainage ditch 8.7 miles southeast of Canal Point ¹ | ę | 440 | 201 | 132 | 67 | 210 | 632 | 120 | 297 | ı | 1,140 | 605 |
| Drainage ditch at South Bay ² | 3/13/41 | 280 | 153 | 200 | 74 | 57 | 554 | 336 | 87 | 1.6 | 1,030 | 803 |
| Drainage ditch at Okeelanta ³ | 3/10/41 | 220 | 158 | 208 | 68 | 57 | 506 | 340 | 109 | 1.0 | 1,030 | 667 |
| Drainage ditch 18 miles south of South Bay ⁴ | 2/13/41 | 440 | I | 33 | 8.7 | I. | 78 | Г | 29 | I | t | 118 |
| Drainage ditch 27 miles south of | 7/28/40 | 160 | 92.2 | 110 | 24 | 56 | 390 | 34 | 66 | ı | 515 | 373 |
| South Bay ⁴ Do | 2/13/41 | 220 | I | 29 | 9.0 | 1.0 | 76 | 9.5 | 28 | 1 | 114 | 109 |
| At pumphouse on S 2At pumphouse 0.1 1 3West of State High 4Along SCS dike wee | tate Highway mile N. or r way 25 and st of State | ailroad south of Highway | bridge over No Bolles Canal. 25. | rth Nev | v River | Canal | | | | | | |

Oddly enough, Parker, et al., attempted to show the same seasonal variation in dissolved solids within the major Everglades canals, but were confronted with data indicating higher dissolved solids during the wetter part of the year. Parker writes:

"By May 1945, the accumulated deficiencies in precipitation for the year amounted to more than 11 inches in the Miami area. Because the summer rain ordinarily begins in late May or early June, it was decided to collect a series of samples of surface waters in the major Everglades canals prior to the rainy season. Another series was scheduled for collection in the early fall, which normally coincides with the end of the rainy season. It was anticipated that the samples collected in May would contain much larger amounts of dissolved salts than would the samples collected in September.

"Contrary to expectation, the concentrations found in the September samples, for a majority of the sampling locations, were considerably higher than the concentrations found in the May samples. Because the two series of single samples could not possibly reflect all the changes that took place in the Everglades canals during the period, it is impossible to explain satisfactorily why most of the September samples were more concentrated than the May samples and, at the same time, to explain why the reverse was true for other sampling locations."

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The Corps of Engineers study (1971) of water quality within the conservation areas, which took place during the October 1970 - February 1971 dry season, concluded that canal water north of the Park was nitrogen and phosphorus "low". Nitrate values from .01 - .10 ppm occurred 67 times whereas nitrate exceeded .10 ppm 22 times and .20 ppm 8 times. Orthophosphate was highly variable in amount and extremes ranged from .001 ppm to .102 ppm. Values of .01 or less were recorded 68 times in the 89 samples. The most frequent nitrogen to phosphorus ratios were from 5:1 to 20:1 (N/P).

The Corps report briefly analyzed historical data from the Conservation Areas of which 90% of the data were included in the period 1950 to present. Historical data showed that specific conductance, bicarbonate, calcium, nitrate, and orthophosphate have exhibited wide fluctuations rather than any strong trends. Northern stations showed poorer quality water than southerly canal stations. Two of their historical data points were of interest to this study: Hillsboro Canal at S-6 and Diversion Canal at S-143. The S-6 data is relevant to this study because water passing through the structure may be fed into CA-2A through the S-10 structures. Data for these stations are shown below:

Historical Data Values for Percentile Indicated

| | Sp. Con | luctance | (umhos/cm-25 ^o C) | Nitra | te (ppm | as NO ₃) |
|-----------------------------|-----------|----------|------------------------------|-------|---------|----------------------|
| | <u>10</u> | 50 | <u>90</u> | 10 | 50 | 90 |
| Hillsboro Canal at S-6 | 491 | 781 | 1114 | . 39 | 1.55 | 4.36 |
| Diversion Canal at S-143 | 450 | 738 | 1000 | .00 | .22 | .89 |

The Corps study concluded that "the poorer quality water in the north is due to extensive agricultural activities in the area south and east of Lake Okeechobee. The quality improvement as the water moves south probably is due to dilution by rainfall and self-purification during the slow journey through the 'sea of grass'."

In a mass nutrient survey of south Florida surface waters in September 1970, a high water period, and again in March 1971, a low water period, Freiberger (1972) found no significant differences in phosphorus, ammonia, nitrate, and nitrite between the wet season and dry season. Ammonia was the most prevalent form of nitrogen detected. In wilderness areas such as Everglades National Park, Big Cypress Swamp, and the water conservation areas phosphorus was scarce and was detected at only 10% of the sites sampled during the wet season and averaged about .01 mg/1 P-PO $_{A}$. During the dry season, the concentrations averaged about .07 mg/1. Five "gator hole" sites exhibited values between .18 - .67 mg/l P-PO, because of accumulated waste from concentrated fish and aquatic animals. The dry season ammonia concentration in Everglades National Park averaged 1.3 mg/l NH $_{\rm Z}$ -N, but the water conservation areas generally averaged .15 mg/1 NH_z-N. Nitrate nitrogen concentrations were generally negligible in both the wet and dry seasons. Nitrate showed little variation between wet and dry seasons and the concentration at most of the sites was below .20 mg/1 $\rm NO_3-N$. One marsh site and two canal sites were sampled in CA-2A. The marsh site at the 2-17 gauge evidenced <.01 ppm total phosphate, <.07 ppm ammonia, <.01 ppm nitrite and nitrate during both wet and dry season sampling periods. The canal sites at S-11B and S-145 revealed <.02 ppm total phosphate,

<.10 ppm ammonia, <.01 nitrite and <.13 nitrate during both wet and dry seasons. Waller (1973) reported conductivities ranging from 885 -1814 µmhos/cm in CA-2A on February 26, 1973.

McPherson (1973) revealed that concentrations of dissolved solids were higher in the northern part of the conservation areas, which included CA-2, than in the southern part. Conservation Area 2A expressed dissolved-solids concentrations between 500 - 600 mg/l from four stations during the period 1970 - 1972 compared with concentrations of from 172 - 289 mg/l at four stations in 3A over the same time period. McPherson indicated that high dissolved solids correlated with high intensity of agricultural practice. Concentrations of nitrogen and phosphorus varied more with season than with location. Most nitrogen was organic and most inorganic nitrogen was ammonia. Concentrations of total phosphorus in June, 1971, ranged from .02 - .22 mg/l.

| Penges of Avenagos for | Organic Nitrogen | .8 mg/1 - 4 mg/1 |
|------------------------|---------------------|------------------|
| Ranges of Averages for | NHz | .0545 mg/1 |
| All Conservation Areas | NO ₃ | 0.0 - 2.1 mg/1 |
| (McPherson, 1973). | Tot PO ₄ | .0205 mg/1 |
| | NO ₂ | .00507 |

Freiberger (1973) found that backpumping water into CA-3 through S-9 had the effect of decreasing dissolved oxygen by as much as 5.8 mg/l and increasing ammonia as much as .26 mg/l above S-9. He attributed the ammonia increase to the large ground water contribution that occurred with backpumping.

In summary, the following generalizations emerge from previously reported studies:

- Groundwater in the Everglades is highly mineralized and dissolved solids increase with depth. Canal water and groundwater are hard to very hard in quality. Bicarbonate is the single most abundant ion.
- Agricultural drainage and groundwater from land south of Lake Okeechobee contain relatively high levels of calcium, magnesium, sodium and potassium, bicarbonate, sulfate, chloride, nitrate, total CaCO₃ hardness, and dissolved solids. Specific conductance, likewise, achieves high values.
- North and northeastern conservation-area water exhibits higher dissolved solids than southern conservation area water.
- Historically, canal waters exhibit widely fluctuating levels of specific conductance, bicarbonate, calcium, nitrate, and orthophosphate rather than strong trends.
- 5. Some stations within the Conservation Areas exhibit a trend of high dissolved solids during the wet season. Other stations exhibit an opposite trend of high during wet and low during dry.
- Average nutrient concentrations in South Florida inland waters do not show significant seasonal variation.
- Nutrients vary more with season or water level than with location in the conservation areas.
- Organic nitrogen is the most abundant form of nitrogen in the conservation areas. Ammonia is the most abundant form of inorganic nitrogen. Nitrogen forms exceed phosphorus forms in concentration.

HYDROLOGIC SETTING

GENERAL

The S-10 structures and S-7 pumping station input surface water into Conservation Area 2A. The North New River Canal which intersects CA-2A at S-7, drains 233 sq. miles of agricultural and pasture land (CSFFCD, 1953). Water issuing from the S-10 gates is composed of CA-1 rim-canal water derived from the Hillsboro Canal and various canals north and east of S-5A pumping station, and marsh water, which is close to rainfall in purity. The Hillsboro Canal, alone, drains 218 sq. miles of agricultural land (CSFFCD_ 1953).

The flow of water as it passes from the S-10 structures towards the south is influenced by the gentle topographic slope of the area, hydraulic gradients, and biotopographic features. Various vegetational communities are probably more effective than regional slope in controlling the actual flow path of water because the topographic gradient is only .30 foot/mile between S-10C and S-11B. At low water, sawgrass ridges probably impede the flow of water and sloughs act as friction-free areas which ease the flow of water south.

Independent sloughs within CA-2A act as independent lake-like basins at very low water levels. Peat ridges effectively cut off flow from one slough to another. The peats of the Everglades have a low coefficient of permeability and water moves through them very slowly under low gradients. Parker, et al., (1955) reported that in a test pit five feet square by three feet deep ground water seeped in so slowly that the "pit" could be emptied by slow bailing with a pint can," even though the water table was

one foot below the surface.

The triangular northern-most section of CA-2A, which is topographically higher than the rest of the area (Figure 2) receives input from rainfall, seepage and probably some flow from S-10D. Hydraulic gradients may cause water to flow a short distance into the topographically higher area of CA-2A. Tailwater levels at the S-10 gates may exceed 14.2 feet thereby setting up a downhill movement of water towards the north. Figure 3 shows a conductivity gradient for surface water in the extreme northern section of CA-2A. The Hillsboro canal on the east side of L-39 contains high conductivity water. Since this area is relatively far away from S-10D and upslope from the latter structure, this gradient probably represents seepage under L-39 which is progressively diluted with rainwater with increasing distance west from the levee.

Evidence of seepage has recently been found between S-10A and S-10C. On January 29, 1974, a specific conductance value of 3240 µmhos/cm was measured one-eighth mile south of the discharge canal between 10A and C. Water in the discharge canal gave a specific conductance of 1660 µmhos/cm. On November 27 and December 17 this same marsh site gave conductance readings of 1940 and 2550 µmhos/cm, respectively. These values are high even for canal water and suggest the influence of seepage laden with groundwater.

Seepage out of CA-2A is a function of the underlying sediments and bedrock geology. Seepage out of CA-1 and CA-2A is relatively low compared with CA-2B and CA-3 for several reasons: 1) the peat sediments are thicker in CA-1 and CA-2A 2) clay sediments underlie peats and overlie bedrock in parts of CA-2A 3) bedrock in the Ft. Thompson formation changes from impermeable marls and dense fresh water limestones to solution-





riddled limestone and calcareous sandstone from north to south in the area.

Seepage rates for L-35B and L-36 north of the Pompano Canal were originally computed by the Corps of Engineers at 4 cubic feet per second per mile per foot of head (CSFFCD, 1958); however, 2 cfs/mile foot is the current seepage factor in use. Seepage from CA-2A on a monthly basis is approximately 3 - 49% of a given storage value for the beginning of the month (Gleason, personal files, 1973). Percent seepage correlates inversely with storage. A wet year will result in a small percentage loss from storage via seepage but a large absolute loss of water. Water releases are made into Conservation Area 3A through the S-11 structures, into the Pompano Canal through S-38, and into the North New River Canal through S-143 and S-34. Disbursements to the coastal areas raise ground water levels in the Dixie, Prospect, and Pompano well fields, serving the Pompano Beach - Fort Lauderdale area (Leach, et al., 1972).

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Releases to 2B through S-144, 145, 146 occur only infrequently. During the 12 year period 1961-1973, these structures discharged only 150,000 acre-feet of water into 2B.

The 1973 Drawdown

The drawdown of CA-2A was an attempt to thoroughly dry out CA-2A and thereby compact a thick flocculent "gyttja" which had accumulated over the bottom. The drawdown was begun on February 9, 1972 at a storage of 95,000 acre-feet as reported by the Corps of Engineers. The S-11 structures were kept open during each month except May. S-38 was opened periodically during March, April, May and June. The S-34 gates were periodically raised during April, May, and June. At the lowest point of the drawdown, June 7, 1973, the stage levels at the 2-17 and 112 gauges (Figure 2) were 10.41' and 8.04', respectively. The water table at the 2-17 and 112 gauges was .6' and 3.5', respectively, below the peat surface.

The lowest storage, which occurred on June 7, 1973, approximated 5,000 acre-feet as calculated by both the FCD Hydrology Department and the Corps of Engineers. Water was located in three places: small depressions filled with water in sloughs west of L-36, S-10 discharge canal, and in the peripheral canals inside CA-2A. Calculations indicated that free water should have existed in a small pocket adjacent to the S-11 structures. A flight over the area at the height of the drawdown revealed that free water did not exist in this area but water in this area may have been disguised as a thick hydrosol composed of water plus gyttja.

July rains and discharge from S-10 rapidly filled CA-2A during July. The S-10 structures were opened on July 24 and by the end of the month, storage had increased to a capacity six times the storage recorded on July 1. The entire 173 sq. miles was submerged by July 31 as revealed by helicopter survey while water sampling.

METHODOLOGY

Samples were collected by helicopter at a rate of 25 samples/2 hours. Specific conductance measurements were performed in the field. The water was immediately filtered at the time of collection through a $.45\mu$ filter, put into polyethylene bottles, and iced down in a dark box. Samples collected at pump stations or structures were collected on the discharge (tailwater) side. S-7 samples were collected several times a week, refrigerated at the station, and filtered when brought to the FCD laboratory on Monday and Thursday.

SiO₂, chloride and nutrient (nitrogen and phosphorus) analyses were performed using a Technicon Autoanalyzer. Total phosphate digestion utilized persulfate and total nitrogen digestion utilized Kjeldahl digestion. Alkalinity was determined by acid titration. Specific conductance was analyzed using a Hydrolab Surveyor conductivity meter and cell.

Samples were analyzed within a week - 10 days for alkalinity, chloride, sodium, SiO₂, orthophosphate, dissolved organic phosphate, nitrate, nitrite, ammonia and dissolved organic nitrogen. Early in the study (October and November) not all of these analyses were performed on every sample. Analyses are reported as ppm for chloride, sodium and SiO₂. Nitrate, nitrite, ammonia and dissolved organic nitrogen are given as ppm elemental nitrogen (N); orthophosphate and dissolved organic phosphate are likewise reported as ppm elemental phosphorus (P). Alkalinity and conductivity are reported as milliequivalents/liter and micromhos/cm-25°C, respectively.

USGS Standards #40 and #43 (July 20, 1973) were analyzed to check FCD working standards. The FCD analytical results with respect to analyses presented by 45 other laboratories are:

| Ion | USGS Std. No. | % Deviation from mean of all laboratories | Within 95% confidence internal |
|------------------|------------------|---|-----------------------------------|
| sio ₂ | 40 | .2 | yes |
| Na | 40 | 7.1 | no |
| C1 | 40 | 8.6 | no |
| NO3-N | 40 | ` 5.1 | yes |
| $\frac{10}{2}$ | 43 | .7 | yes |
| Na | 43 | 10.3 | no |
| C1 | 43 | 1.9 | yes 💈 |
| NO3-N | 43 | 0.9 | yes |

Accuracy is equal to precision for all analyses. For all the aforementioned analyses the accuracy and precision is taken as \pm 5% of the amount present except for alkalinity and conductivity. For the latter analyses, the accuracy and precision is \pm 10%.

Random samples were collected in many of the surveys. Random locations were selected by placing a grid with a 1/2 mile spacing over a map of CA-2A and using a two digit table of random numbers to locate points. The time of flight from a known point at 60 mph on a predetermined course was used to locate points in the field.

Linear regression curves between chemical parameters were calculated using the equations:

$$A = \Sigma XY - \frac{\Sigma X\Sigma Y}{N}$$

$$B = \Sigma X^{2} - \frac{(\Sigma Y)^{2}}{N}$$

$$C = \Sigma Y^{2} - \frac{(\Sigma Y)^{2}}{N}$$

$$Y = aX+b$$

$$a = \frac{A}{B} \qquad b = \frac{\Sigma Y - a\Sigma X}{N}$$

Pearson product-moment correlation coefficient = r

$$r = A$$

 $\sqrt{B \cdot C}$

This correlation coefficient varies between plus one (+1) and minus one (-1). A+1 value for the coefficient indicates a perfect direct linear correlation of data points with a straight line. A -1 value for the coefficient indicates a perfect inverse linear correlation of data points with a straight line. A value of zero (0) indicates no correlation between data points and the straight line computed by linear regression equation. Values of the coefficient less than -.9 or greater than +.9 were considered significant in this study.

DATA

Sample location and chemical composition maps for most all of the sampling surveys are located in Appendix I. Tabulated chemical data are shown in Appendix II. The average chemical composition of both canal and marsh water for all sampling excursions is shown in Tables 5, 6, 7 and 8. Linear regression analyses for samples collected at S-7 during July are expressed in Table 10. Linear regression analyses for samples collected in the Hillsboro Canal adjacent to the S-10 structures during July and August are displayed in Table 11.

Canal and marsh water samples are grouped in Table 9. The means of all canal and all marsh water analyses are averaged to represent a single mean for each chemical constituent. The water chemistry is divided into nutrient and non-nutrient categories.

Marsh water chemistry before and after the drawdown is exhibited in Tables 12 and 13. Values in these tables represent the averages of mean concentrations of each chemical parameter for various sampling days.

Conservation Area 2A rainfall and stage levels at the 2-17 gage for the period November 1972 - August 1973 are shown in Figure 4. Discharges from S-7, S-38, S-143, S-144, S-145 and S-146, November 1972 through November 1973 are shown in Figure 5. S-10 and S-11 discharges for the time period November 1972 - August 1973 are presented in Figure 6.
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|---|--|
| щ | |
| B | |
| F | |

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NON-NUTRIENT PARAMETERS IN CANAL WATER

| | ; | | ច | Na | Si02 | Alk. | Condu |
|---|---------|-------------------|-----------|-----------|-----------|------------|-------------|
| Date | 9. 2 | Samples | udd | mdd | udd | meg/1 | micro |
| July S-10 Discharge | ഹ | Mean Std. Dev. | 185 22 | 166 28 | 19 3.5 | 5.4 1.9 | |
| August S-10 Dis. | 13 | Mean Std. Dev. | 189 33 | 144 27 | 21 2.9 | 5.6 1.3 | |
| July S-7 Discharge | 39 | Mean Std. Dev. | 147 10 | | 17 2 | 7.4 .7 | |
| July 17 L38E & L35B Canals | 4 | Mean Std. Dev. | 134 10 | 102 11 | 14 1.7 | 7.8 .4 | |
| July 31 Hillsboro Canal in vicinity of SlO structures | 6 | Mean Std. Dev. | 175 29 | 140 29 | 19 4.4 | 5.9 | 1189 154 |
| July 31 L38E & L35B Canals | 9 | Mean Std.Dev. | 138 7 | 96 11 | 18 1.1 | 7.4 | 1088 87 |
| August 8 Hillsboro Canal | 8 | Mean Std. Dev. | 202 18 | 159 20 | 24 4.8 | 6.1 .90 | |
| August 14 Hillsboro Canal | 8 | Mean Std. Dev. | 194 23 | 136 15 | 21 1.3 | 5.8 .9 | |

iductivity :romhos/cm-25^oC.

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|-----|--|
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| TAB | |

NUTRIENTS IN MARSH WATER

| | | | N03-N | N02-N | NH ₃ -N | DisOrgN | 0-P04-P | Disorg PO4-P |
|---------------|-------|-------------------|-------------------------------|--|--------------------|------------|--------------------------------|------------------|
| Date | No. S | amples | mğa | рЪт | шdд | mdd | mdd | mdd |
| Nov. 16, 1972 | 9 | Mean Std. Dev. | <.002 - | <.004 - | | 1 1 | <00 4 - | т ғ [°] |
| Feb. 13, 1973 | 32 | Mean Std. Dev. | <pre><.017 >.000 </pre> | <.001 - | .05 | | <.001 | 10.> |
| June 26, 1973 | 13 | Mean Std. Dev. | <.008 <u>></u> .000 - | <.010 <u>></u> .006 | .12 | | .013 | 1 9 |
| July 17, 1973 | 22 | Mean Std. Dev. | .12 .22 | <.009 <u>></u> .007 .012 | .05 .13 | .37 .14 | .003 | |
| July 31, 1973 | 30 | Mean Std. Dev. | <.063 >.058 ≤.226 >.221 | <.025 <u>></u> .018 .060 <u>-</u> .018 | .03 09 | 2.2 .5 | .00 4 .016 | - |
| Aug. 8, 1973 | 17 | Mean Std. Dev. | <008 - | <008 - | - 10.> | | .010 .018 | 10.10 |
| Aug. 14, 1973 | 11 | Mean Std. Dev. | <.008 - | <.008 - | .03 | 2.6 .3 | <.022 <u>></u> .020 .034 | .012 .011 |
| Aug. 22, 1973 | 29 | Mean Std. Dev. | <008 - | <.008 - | 04 | 2.3 .3 | <.013 <u>></u> .011 .021 | .016 010. |

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| July S-10 Discharge August S-10 Dis. July S-7 Discharge L35B Canals July 31 Hillshorn | 9 4 33 39 39 39 39 39 39 39 39 39 39 39 39 | <u>Samples</u> Rean Std. Std. Std. Std. Std. Mean | Dev. | N03-N Ppma 1.8 .68 .63 .63 .06 .37 .05 .37 .37 .37 .37 .37 .37 .37 .37 | NO ₂ -N <u>Ppm</u> .14 .089 .057 .036 .036 .012 | NH ₃ -N Pppm | DisOrgN 2.3 2.5 .35 .35 .35 .35 .35 .36 .10 .10 | 0-P04-P ppm 4 .079 .068 .041 .089 .089 .12 .002 .003 | Dis0rg P0 ₄ -P Ppm 01 .01 .02 .02 .02 .03 .03 .03 .03 |
|---|--|--|------|--|---|--------------------------------|---|---|---|
| of S-10 structures July 31 L38E & | n u | Std. Std. Mean | Dev. | | .09 .078 | | ς. 5 2,2 2,2 | .063 | 10. 20. 20. |
| August 8 Hillsboro Canal | œ | std. Std. | Dev. | 37 | .034 .11 .067 | .14 .54 .27 | ۱۱ در | .049 .090 .045 | 20. 20. |
| August 14 Hillsboro Canal | 8 | Mean Std. | Dev. | .25 | .058 .019 | .23 .23 | 2.7 .9 | .053 | .014 .031 |

AVERAGES OF MEANS FOR ALL ANALYSES

Non-Nutrient Parameters in Canal Water July - Aug. 1973

| <u>Conductivity</u> | 1139 |
|---------------------|------|
| Alkalinity | 6.4 |
| <u>S10</u> 2 | 6L . |
| R | 131 |
| 5 | 171 |
| No. Samples | 92 |

Non-Nutrient Parameters in CA2A Marsh Water Oct. 11, 1972 - August 22, 1973

| <u>Conductivity</u> | 1094 |
|---------------------|------|
| Alkalinity | 4.7 |
| <u>510</u> 2 | 61 |
| Na | 139 |
| 5 | 176 |
| <u>ko. Samples</u> | 209 |

Nutrients in Canal Water July - August 1973

| DisOrgP04-P | <.014 ≥.012 |
|--------------------|-------------|
| 0-P04-P | .069 |
| DisOrgN | 2.0 |
| NH ₃ -N | .37 |
| NO2-N | .097 |
| NO3-N | 96. |
| No. Samples | 92 |

DisOrgP04-P 0-- p04-0 DisorgN Nutrients in CA2A Marsh Mater Nov. 16, 1972 - August 22, 1973 NH₃-N NO2-N NO3-N

29

<.011 2.008

.007

<.029 <u>></u>.022 <.009 <u>></u>.004 <.046 <u>></u>.044 1.9

No. Samples 166

| TABI |
|------|
| E 10 |

LINEAR REGRESSION EQUATIONS AND CORRELATION COEFFICIENTS FOR

JULY S-7 SAMPLES

| | NO3 | NO ₂ | NH ₃ | DisOrgN | 0-P04 | CI | Na | si0 ₂ | Alk. |
|-------------------|--------------------------|-------------------------|-------------------------|------------------------|--------------------------|--------------------------|------------------------|-------------------------|------|
| NO3 | × | | | | | | | | |
| NO2 | y=.0338x +.0364 r=.59 | × | | | | | | | |
| NH ₃ | y=.0963x +.247 r=.49 | y=2.34x +.176 r=.68 | × | | | | | | |
| DisOrgN | y=.722x +.591 r=.50 | y=18.8x +.0836 r=.72 | y=4.97x437 r=.65 | × | | | | | |
| 0-P0 ₄ | y=.162x049 r=.88 | y=1.67x0233 r=.46 | y=.228x +.0240 r=.18 | y=0738x +.302 r=22 | × | | | | |
| Cl | y=3.03x +143 r=.21 | y=53.1x +143 r=.18 | y=41.0x +131 r=.43 | y=4.74x +140 r=.32 | y=-20.7x +151 r=28 | × | | | |
| Na | y=.546x +99.2 r=.03 | y=56.2x +95.1 r=.18 | y=70.7x +72.1 r=.68 | y=6.22x +88.3 r=.36 | y=-32.4x +105 r=37 | y=.760x -11.9 r=.70 | × | | |
| S102 | y=.548x +16.1 r=.17 | y=33.1x +13.8 r=.54 | y=16.1x +10.3 r=.77 | y=1.91x +12.7 r=.61 | y=-14.4x +23.7 r=0747 | y=.0788x +4.98 r=+.37 | y=.150x +1.62 r=.76 | × | |
| Alk | y=826x +8.17 r=80 | y≖-9.02x +8.12 r=-44 | y=2.52x +6.60 r=.21 | y=635x +8.47 r=56 | y=-5.10x +7.93 r=88 | y=.00795x +6.21 r=.11 | y=104x +19.8 r=11 | y=.0275x +6.93 r=.08 | × |

| Aliky | 510 ₂ : | Na | 9 | 04-0 | | ی¥ ع | 2.10 | | |
|------------------------|-----------------------|-------------------------|-------------------------|------------------------|-------------------------|-------------------------|------------------------|--------------------------|------------------|
| | | | | | | | | X | NO ₃ |
| , 122 | | | | | | | × | y=.0766x +.0353 r=.92 | NO2 |
| | | | | | | X | y=.988x +.324 r=.32 | y=.0647x +.363 r=.24 | NH3 |
| | | | | | x | y=1.63x +1.87 r=.58 | y=3.48x +2.11 r=.38 | y=.246x +2.23 r=.35 | DisorgN |
| | | | | × | y=.0124x +.050 r=.17 | y=.116x +.0325 r=.58 | y=.291x +.044 r=.45 | y=.0289x +.0478 r=.55 | 0-P04 |
| | | | × | у=202x +162 г=.34 | y=23.7x +1111 r=.53 | y=78.9x +143 r=.70 | y=-1.24x +18i r=72 | y=372x +180 r=01 | 5 |
| | | × | y=.854x -16.3 r=.92 | y=257x +115 r=.47 | y=8.98x +111 r=.23 | y=53.1x +116 r=.48 | y=39.7x +135 r=.91 | y=4.83x +134 r=.16 | 7 |
| | × | y=.0816x +8.76 r=.63 | y=.0999x +2.33 r=.76 | y=37.0x +17.2 r=.51 | y=2.27x +13.5 r=.57 | y=11.6x +15.0 r=.76 | y=3.61x +19.6 r=.07 | y≖.101x +20.1 r=.0261 | si0 ₂ |
| × | y=001x +6.19 r=27 | y=0055x +6.93 r=14 | y=.00338 +5.62 r=.10 | y=9.44x +5.36 r=.41 | y=.650x +4.50 r=.38 | y=2.61x +4.86 r=.56 | y=1.75x +5.93 r=.12 | y=.169x +5.92 r=.14 | Alk |
| y=12.8x +1058 r=,10 | y=24.4x +700 r=.60 | y=2.78x +806 r=.63 | y=3.23x +666 r=.68 | y=1376x +1017 r=.52 | y=96.8x +906 r≖.38 | y=396x +1001 r=.70 | y=340x +1095 r=.22 | y=54.5x +1058 r=.43 | Cond. |

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LINEAR REGRESSION EQUATIONS AND CORRELATION COEFFICIENTS FOR HILLSBORD CANAL SAMPLES AT S-10 STRUCTURES

JULY-AUGUST

 31

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COMPARISON OF NON-NUTRIENT WATER CHEMISTRY IN CA-2 MARSH BEFORE AND AFTER DRAWDOWN

| Drawdown |
|----------|
| the |
| \$ |
| Prior |

| Conductivity micromhos/cm-25 ⁰ C. | ı | | Conductivity <u>micromhos/cm-25⁰C</u> . | 686 |
|---|---------------------|------------|---|---------------------|
| A1k meg/1 | • | | Alk meg/1 | 4.7 |
| SiO ₂ Ppm | 16 | nwob | SiO ₂ | 20 |
| Na Ppm | 109 | Post-Drawo | Na Ppm | 144 |
| | 144 | | L) mdd | 192 |
| <u>Samples</u> | Average of Means | | amples | Average of Means |
| No. of S | 81 | | No. of S | 128 |

COMPARISON OF NUTRIENT WATER CHEMISTRY CA-2A MARSH BEFORE AND AFTER DRAWDOWN

Prior to the Drawdown

| DisOrgPO4-P ppm | ·.01 |
|--------------------|---------------------|
| 0-P04-P ppm | <.003 >.000 |
| DisOrgN ppm | ı |
| NH3-N ppm | .000 .06 |
| NO2-N ppm |) <.003 <u>></u> |
| No 3-N ppm | >.000 <u>~</u> 000 |
| amples | Average of Means |
| No. of Se | , وا |

Post-Drawdown

| No. of Sa | <u>mples</u> | NO3-N ppm | NO2-N ppm | NH3-N ppm | DisOrgN ppm | 0-P04-P | DisOrgP04-P ppm |
|-----------|---------------------|--|----------------|--------------|----------------|-------------|--------------------|
| 128 | Average of Means | 036 2.030 | <.011 2.005 | .04 | 1.9 | 600. | 01 |



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FIGURE



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DISCUSSION

QUALITY OF CANAL AND MARSH WATERS

The quality of marsh and canal waters as evaluated, using standards promulgated by four organizations, was good with two exceptions. Florida State Pollution Standards, Federal Water Pollution Control Administration Standards, United States Public Health Service Standards and World Health Organization Standards were used in the evaluation (Tables 14, 15, and 16). Water emanating from S-7 and Hillsboro Canal water adjacent to the S-10 structures exceeded Florida standards for specific conductance on July 31, the only day of conductivity measurement (Table 6); data obtained from the USGS (Personal communication, Bradley Waller, 1973) indicated excessive values on February 26, 1973. Specific conductance at these times was twice the maximum prescribed level. Excessively high conductivity is believed to be year-round and constant condition for water in canals feeding CA-2A.

On July 31, August 8 and August 14, Hillsboro Canal samples exceeded Federal Water Pollution Control Administration and World Health Organization Standards for ammonia (Appendix II). The significance of ammonia values in excess of the .5 ppm standard but below 1 ppm is questionable. The ammonia in rainfall sometimes exceeds standard values as shown in Table 17.

Specific conductance of marsh water parallels that of the canals since the canals provide a magnanamous amount of water to the marsh. Florida standards were exceeded on July 31 and August 22, the only two

FLORIDA STATE POLLUTION STANDARDS

(403 F.S., Chapter 17-3)

The following water quality standards shall be the criteria for pollution when concentrations exceed following limitations:

Fluorides

Chlorides Turbidity Dissolved Oxygen Dissolved Solids Specific Conductance Radioactive Substances Cyanide or cyanates Copper Zinc Chrominium Phenolic compounds Lead Iron Arsenic Oils and Grease рΗ Detergents Mercury

250 ma/1 50 Jackson Units 4.0 ppm 1000 mg/l at any time 500 µ mhos/cm 1000 u curies none detectable .5 mg/1 1.0 mg/1 .50 mg/l hexavalent .001 mg/1 .05 mg/1 .30 mg/1 .05 mg/1 15 mg/1 6.0 <8.5 .5 mg/1 none detectable

1.4 to 1.6 (Class I)

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SURFACE WATER CRITERIA FOR PUBLIC WATER SUPPLIES

(Federal Water Pollution Control Administration, 1968)

| Constituent or Characteristic | Permissible Criteria | Desirable <u>Criteria</u> |
|--|--|------------------------------|
| Physical: Color (color units) Odor Temperature | 75 - | <10 Virtually absent |
| Turbidity | - | Virtually absent |
| Microbiological: | 10,000/1001 | <100/100 ml |
| Coliform organisms Fecal coliforms | 2,000/100 ml | <20/100 ml |
| Inorganic chemicals: Alkalinity Armonia | (mg/1) | (mg/1) <0.01 |
| Arsenic | 0.05 | Absent |
| Barium | 1.0 | do |
| Boron Cadmium | 0.01 | do |
| Chloride | 250 | <25 |
| Chromium, hexavalent | 0.05 | Absent |
| Copper Dissolved oxygen | 1.0 >4 (monthly mean) >3 (individual sample) | Near saturation |
| Fluoride | _ | - |
| Hardness | - | - Virtually absent |
| load | 0.05 | Absent |
| Manganese (filterable) | 0.05 | do |
| Nitrates plus nitrites pH (range) Phosphorus | 10 (as N) 6.0-8.5 | Virtually absent _ _ |
| Selenium | 0.01 | Absent |
| Silver | 0,05 | do |
| Sulfate | 250 | <50 |
| Total dissolved solids | 500 | <200 |
| Uranyl ion Zinc | 5 5 | Absent Virtually absent |
| Radioactivity: Gross beta Radium-226 Strontium-90 | (pc/1) 1,000 3 10 | (pc/1) <100 <1 <2 |
| | | |

DRINKING WATER STANDARDS

| Determination | USPHS | WHO |
|---|---|--|
| Coliform bacteria, per 100 ml | Bacterial 1.0 | 0.05 ^a 1.0 ^b |
| Turbidity, silica scale units Color, cobalt scale units Odor, maximum threshold number | Physical 5 15 3 | - |
| Alky benzene sulfonate Ammonia Arsenic Barium Cadmium Calcium Carbon chloroform extract Chloride Chromium (hexavalent) Copper Cyanide Fluoride Iron Lead Magnesium Magnesium + sodium sulfate Manganese Nitrate, as NO3 Phenolic compounds (Potassium) Selenium | Chemical (mg/liter) 0.5 0.05° 1.0° 0.2 250 0.5° 1.0 0.2 $1.6^{-3.4^{\circ}}$ 0.3 0.05° - 0.05 45 0.001 0.01° | - 0.5ª 0.2a,b - 0.05a 200b - 350a 0.05a,b 3.0a 0.1a,b 1.0b 0.1a,b 125a 100b 0.1a 50a 0.01a 0.01a |
| Silver (Sodium) Sulfate (Sulfur) Total Solids Zinc | 0.05 ^c 250 500 5.0 | 250 ^a 1500 ^b 5.0 ^a |
| Radium-226 Alpha emitters Strontium-90 Beta Emitters | Radiological (pc/liter) 3 [°] 10 [°] 100 [°] |]a,b |

^a WHO European Standards of 1961.
 ^b WHO International Standards of 1958.
 ^c Mandatory. Others are recommended by USPHS.

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AMOUNT AND NUTRIENT CONTENT OF RAINFALL AT ANDERSON-CUE LAKE, FLORIDA, 1968 (PUTNAM, et al., 1972)

| Date | Amount ¹ | TON | NH ₃ -N | NO ₃ -N | 0.PO, | t-PO4 |
|-------|---------------------|------|--------------------|--------------------|-------|-------|
| | Inches | mg/1 | mg/1 | mg/1 | μg/1 | µg/1 |
| 2-19 | 1.00 | | 0.46 | 0.40 | 230 | |
| 2-26 | 0.25 | _ | 0.23 | 0.94 | 20 | |
| 3-4 | 0.35 | | 0.80 | 0.26 | 25 | |
| 3-11 | 1.20 | 0.57 | 0.86 | 0.24 | 18 | — |
| 4-15 | 0.65 | 0.67 | 0.33 | 0.27 | 2.2 | |
| 5-6 | 0.45 | 0.64 | 0.10 | 0.30 | 28 | |
| 5-13 | 0.75 | 0.33 | 0.0 | 0.15 | 20 | — |
| 5-27 | 3.35 | 0.11 | 0.02 | 0.05 | | |
| 6-24 | 6.65 | 0.24 | 0.02 | 0.14 | 9. | 30 |
| 7-5 | 4 00 | 0.39 | 0.05 | 0.09 | 10 | 30 |
| 7-25 | 4.65 | 0.01 | 0.01 | 0.08 | 8 | |
| 8-2 | 0.85 | 0.50 | | 0.29 | | 20 |
| 8-19 | 210 | 0.84 | 0.14 | 0.22 | 33 | 70 |
| 9.3 | 10.85 | 0.07 | | 0.09 | | 20 |
| 9-16 | 4 30 | 0.07 | 0.11 | 0.16 | 5 | |
| 10.11 | 2.85 | 0.12 | 0.05 | 0.11 | 12 | |
| 10.19 | 370 | 0.11 | 0.21 | 0.04 | 4 | |
| 11_11 | 3.60 | 0.23 | 0.07 | 0.05 | 25 | 30 |
| 12-9 | 2.25 | 0.54 | 0.18 | 0.11 | 18 | |
| | | | | | | |
| | | | | | | |

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days this type of analysis was performed.

The nitrate nitrogen and orthophosphate phosphorus in canal water did not exceed standards. However, water containing .96 ppm NO₃-N and .070 ppm O-PO₄ as P may constitute a threat to the ecology of the northern section of the conservation area even though these values are 3-5X average rainfall values. This caveat is supported by several observations. Periphyton survey during August, 1973, revealed that the heaviest and most abundant accumulations of blue-green algae were found adjacent to the S-10 structures. The periphyton closest to the structures was dominated by <u>Microcoleus lyngbyaceous</u> which appears only infrequently in "normal" Everglades periphyton. Rank cattail replaces sawgrass in a continuous band several miles deep along L39 south of the structures; this band shows up distinctly on ERTS photographs. Water hyacinth, <u>Pistia</u>, and <u>Lemna</u> blooms were most abundant adjacent to the structures.

Canal water emanating from the agricultural-lands was compared with urban runoff from various locations in the United States. Average nitrogen concentrations in canal water exceeded mean organic nitrogen levels in urban runoff. However, the phosphorus concentrations in urban runoff far exceeded the mean value of .070 ppm orthophosphate in canal water (Table 18).

43(revised)

| | Table 1 | 18 | | |
|----------|----------------|----|-------|--------|
| Nutrient | Concentrations | of | Urban | Runoff |

| Location | Soluble Phosphate as mg/L-P | Total Phosphate as mg/L-P | Organic Nitrogen as mg/L-N |
|--|--------------------------------|------------------------------|-------------------------------|
| Durham, N.C. ^a 1969~1970 | | .58 ^b | |
| Ann Arbor ^c 1965 | . 8 ^d | | 1.0 ^d |
| Cincinnati 1962-1963 | .8 ^c | 1.1 ^e | 1.7¢ |
| Tulsaf 1968-1969 | 1.15 | | . 85 |

- a. Bryan, E.H. 1970 Quality of Stormwater Drainage from Urban Land Areas in North Carolina, Water Resources Research Institute of UNC, Report No. 37.
- b. Mean of seventeen samples.
- c. Data from other studies reported in: Federal Water Quality Adminstration, 1970. Storm Water Pollution from Urban Land Activity. Water Pollution Control Research Series 11034 FKL of the FWQA.
- d. Mean value.

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- e. Values reported in (a).
- f. Data collected in study cited in (c). Fifteen sites examined.

Canal water nutrient concentrations during July and August were equivalent to urban canal water nutrient concentrations measured in a recent USGS study (Freiberger, 1973). The USGS data for the South New River Canal at S-13 (an urban area) are compared below with Hillsboro and North New River Canal nutrient concentrations.

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| | USGS Urban Canal Water | This study Hillsboro & N. New River Canal Water (July & August) |
|--------------------------------------|---------------------------|--|
| Ammonia (NH ₃ -N) | .450 | .37 |
| Nitrite (NO ₂ -N) | .033 | .097 |
| Nitrate (NO ₃ -N) | .28 | .96 |
| Organic Nitrogen (N) | 1.41 | 2.0 |
| Ortho Phosphate (PO ₄ -P) | .085 | .070 |
| Total Phosphate (PO ₄ -P) | .091 | >.081 <.084 |

THE EFFECT OF THE DRAWDOWN ON WATER QUALITY

Predrawdown samples were collected on October 11, November 16, 1972, and February 13, 1973. All samples collected on June 26 and later were procured after the minimum stage of the drawdown and therefore reflect the post-dessication period.

Nitrate was approximately four times greater and phosphorus was more than twice as great after the drawdown than before. Increases of up to 40% were noted in non-nutrient parameters after the drawdown in comparison with predrawdown concentrations. The higher nitrate concentrations after the dry-out were due to one set of samples collected on July 17 which revealed a mean nitrate concentration of .12 ppm. These samples were taken from small pools just beginning to fill after the drawdown. Very likely the high nitrates were leached out of dried and mineralized peat; increased concentrations of all forms of nitrogen were described by McPherson (1973) as the result of the first summer rains flushing nutrients into ponded water.

The increased phosphorus values and slightly higher concentrations of chloride, sodium and silica appearing in the water after the drawdown were the results of several factors: 1) the refilling of the area with high nutrient and high dissolved solids water emanating primarily from the S-10 structures; 2) the absence of any dilution of the S-10 discharges by water already stored in the area; 3) biased sampling of evaporative concentrations of salts after the drawdown and an artifact of sampling close to the S-10 structures.

The experimental dessication of Lake Apopka bottom sediments, i.e., an experimental drawdown, has had favorable preliminary results with respect to the effects of sediment drying on refill water quality. Fox, et al. (1973) report:

"Peat and muck sediments from Lake Apopka, Florida, have been allowed to dry in plexiglas columns and metal tanks in an effort to simulate the effects of lake drawdown. Variables used include depth of sediment, method of drainage, and drying time. Sediment parameters being monitored include nutrient forms, water loss, rate of consolidation, and plant germination. Following drying periods, the simulations are refilled and monitored for water quality using standard limnological techniques. Results to date show that consolidation varies with drying time, with fifty per cent consolidation after six months. Sediment changes have been largely a result of water loss, with little change in nutrient forms or amount of organic material. <u>Preliminary indications are that nutrients are more readily available</u> from undried as opposed to dried sediments."

The research of Fox, et al. suggests that compaction of the flocculent material in CA-2A should make nutrients in the bottom sediments less available to the overlying water.

RELATIONSHIPS AMONG VARIOUS DATA

A comparison of our two months of wet season canal data with previous work suggests that the chemical complexion of Hillsboro and North New River Canal water has changed little during the thirty-year period from the early 1940's to the young 1970's. The range of values found in this study are within the range of values found by Parker, et al. (1955) in 1941-1943 (Tables 19 and 20). Bicarbonate, chloride, sodium, silica, and nitrate are in the same order of abundance now as they were then.

Our canal data are towards the higher range of values found in historical data. A comparison of our data with historical analyses reported in the Corps of Engineers study (1971) for the Hillsboro Canal at S-6 and the Diversion Canal at S-143 indicate that our specific conductance and nitrate values exceeded 90th percentile values for both parameters at both locations (i.e., more than 90% of all historical samples had values less than our values). The highest nitrate concentration (as NO_3) reported by Parker, et al. was 2.4 ppm; this was equivalent to .54 ppm NO_3 -N and was about one-half of the average NO_3 -N concentration found in our canal study.

Differences in nitrogen values between previous work and this study are puzzling. Our <u>average</u> canal-water nitrate nitrogen values were considerably higher than Parker's but they were also 6-9X greater than <u>average</u> values reported in Freiberger's (1972) work and approximately 5-10X <u>average</u> nitrate values found in the Corps of Engineers study (1971).

Chemical Composition of Hillsboro and North New River Canal Water During July and August 1941-1943 (Parker, et al., 1955)

Analyses in PPM

Hillsboro Canal Near Deerfield Beach

| | | Specific Conductance µmhos/cm | Sodium and Potassium | Bicarbonate | Chloride | Nitrate (NO ₃) |
|------|------|-------------------------------------|----------------------------|-------------|----------|-------------------------------|
| 1941 | July | 600 | 58 | 210 | 83 | 1.0 |
| | Aug. | 344 | 26 | 131 | 42 | .8 |
| 1942 | July | 220 | 14 | 84 | 25 | .1 |
| | Aug. | 994 | 98 | 314 | 148 | .2 |
| 1943 | July | 1440 | 166 | 395 | 255 | .9 |
| | Aug. | 1150 | 104 | 442 | 152 | • 0 |

North New River Canal Near Ft. Lauderdale

| 1941 | July | 429 | 19 | 182 | 41 | .5 |
|------|------|------|-----|-----|-----|----|
| | Aug. | 277 | • 9 | 148 | 12 | .2 |
| 1942 | July | 319 | 5.0 | 160 | 15 | .1 |
| | Aug. | 790 | 37 | 329 | 63 | .2 |
| 1943 | July | 1040 | 67 | 384 | 116 | .3 |
| | Aug. | 952 | 64 | 362 | 109 | .0 |

Chemical Composition of 10-Day Composite Water Samples from North New River Canal at 26-Mile Bend, 1941 (Parker, et al., 1955)

Analyses in PPM

| | Sp. Cond. umhos/cm. | Silica | Bicarbonate | Sodium | Chloride | Nitrate (as NO ₃) |
|-------------|------------------------|--------|-------------|--------|----------|----------------------------------|
| March 1-10 | 1100 | 20 | 382 | 77 | 119 | 2.2 |
| March 11-20 | 985 | 16 | 356 | 74 | 115 | 1.3 |
| March 21-24 | | | | | | |
| 28-31 | 1000 | 16 | 366 | 81 | 119 | 1.1 |
| Apr. 1-8 | 977 | 15 | 360 | 79 | 118 | 1.2 |
| Apr. 14-16 | | | | | | |
| 19-20 | 587 | 7.8 | 245 | 31 | 43 | 1.7 |
| Apr. 21-27 | | | | | | |
| 29-30 | 938 | 16 | 358 | 70 | 98 | 1.1 |
| May 1–3 | | | | | | |
| 5-9 | 986 | 16 | 363 | 74 | 112 | 1.5 |
| May 11–13 | | | | | | |
| 16-17 | | | | | | |
| 19-20 | 920 | 17 | 358 | 65 | 95 | 1.9 |
| May 21-31 | 1050 | 18 | 396 | 82 | 124 | 1.4 |
| June 2,4-7, | | | | | | |
| 11 | 1250 | 22 | 462 | 101 | 154 | 2.0 |
| June 17-19 | | | | | | |
| 21,23 | 861 | 12 | 330 | 62 | 93 | 1.6 |
| July 3-9 | 552 | 9.4 | 218 | 37 | 51 | 1.3 |
| July 11-20 | 264 | 5.6 | 138 | 8.9 | 13 | 1.2 |
| July 21-27 | | | | | | |
| 29-31 | 258 | 8.3 | 140 | 8.8 | 12 | .8 |
| Aug. 2-7 | 277 | 8.1 | 145 | 10 | 16 | .7 |
| Aug. 11-12 | | | | | | |
| 14-20 | 478 | 13 | 228 | 24 | 38 | .6 |
| Aug. 22-25 | | | | | | |
| 27, | | | | | | |
| 29-31 | 774 | 18 | 326 | 52 | 76 | 1.0 |
| Sept. 1-10 | 957 | 19 | 376 | 70 | 103 | 1.4 |
| Sept. 11-13 | | | | | | |
| 16-20 | 1020 | 21 | 392 | 75 | 110 | 1.5 |
| Sept. 21-26 | | | | | | |
| 28-30 | 722 | 14 | 267 | 47 | 69 | 2.2 |
| Oct. 1-5 | 808 | 18 | 310 | 58 | 85 | 1.1 |

Nitrate rather than ammonia was the most prevalent form of inorganic nitrogen detected in our canal study. Both Freiberger (1972) and McPherson (1972) found ammonia as the dominant form of inorganic nitrogen. All aforementioned previous studies sampled largely from canals; the difference may be that in this study samples were collected only while the canals were actively draining the agricultural lands, whereas the Corps study occurred during the dry season and the USGS studies were long term averages. Organic nitrogen was the most abundant form of nitrogen found in canal and marsh water in this research; McPherson (1972) reached the same conclusion.

Nutrient concentrations in the marsh were considerably below those in adjacent canal water (Table 7). The highest average nitrate, nitrite, and ammonia concentrations in the marsh occurred at the beginning of wet season rains. Nitrate was highest, .12 ppm, on July 17. Nitrite was greatest, approximately .021 ppm, on July 31. The highest average ammonia concentration, .12 ppm, was measured on June 26 (Table 7).

Orthophosphate levels in the marsh were highest during high water periods of August probably because of S-10 discharge and the overflowing of nutrient-absorbing compartments near the discharge points; average orthophosphate values ranged from <.001 ppm - .010 ppm. Phosphate values approaching those found by Freiberger in residual ponds in Everglades National Park, .18 - .67 ppm PO_A -P, were never found in CA-2A.

Water in the CA-2A area is the calcium bicarbonate type, as mentioned in the previous literature. Alkalinity measurements clearly indicated this fact. Bicarbonate was the most abundant ion found in the analyses. Averages of the mean bicarbonate concentrations were 287 ppm

and 390 ppm for marsh and canal waters, respectively, using the conversion factor of 61 ppm HCO_{z} /meq-Alk (Table 9).

The high bicarbonate concentrations cannot be explained by entrapment of ancient seawater because bicarbonate is much higher than chloride in concentration. The bicarbonate is generally higher than that of seawater which doesn't exceed 28 ppm as elemental carbon or approximately 120 ppm as bicarbonate (Horne, 1969). The high bicarbonate is probably of indigeneous origin. Decaying peat probably facilitates the solution of the underlying limestone by furnishing acidic carbon dioxide gas. The action of the acid then converts insoluble CaCO₃ to soluble Ca(HCO₃)₂ (Parker, et al., 1955).

The Na/Cl weight ratio for Hillsboro Canal water and CA-2A marsh water varies between .76 and .85. The Na/Cl weight ratio for seawater is .55. Thus, if highly mineralized groundwater in the canals is derived from connate seawater, the water has probably undergone enrichment in sodium through a number of known processes (Leach, et al., 1972); (Parker, et al., 1955).

A comparison between marsh water nutrient levels and canal water nutrient levels indicated several interesting points. First, vegetation in the marsh is apparently absorbing the relatively high nutrient inputs introduced from canal inflows. Though sodium, chloride, and silica differ very little between marsh and canal, nutrients are at considerably lower levels in the marsh than in the canals (Table 9). Nitrate, nitrite, ammonia and orthophosphate in the marsh are one-thirtieth, one-twentieth, one-ninth, and one-eighth, respectively, of corresponding levels in canals. The disparity between canal and marsh water can be seen graphically in Figures 7 - 12; this disparity exists even after considerable flow from S-10. Second, dissolved organic nitrogen and organic phosphate phosphorus concentrations do not vary significantly between canal and marsh, suggesting that they are refractory and are not used as a nutrient source for organisms.

The order of abundance of fixed nitrogen compounds differed between canal and marsh. In canal water, the order of abundance was organic nitrogen > nitrate > ammonia > nitrite, whereas in the marsh, nitrate and ammonia exchanged places (Table 9).

Orthophosphate exceeded dissolved organic phosphorus more than fourfold in canal water but dropped to a near equal concentration within the marsh. The reason for this is clearly the uptake of orthophosphate by organisms; dissolved organic phosphorus appears to remain unchanged. (Table 9)

A significant linear relationship existed between nitrate and nitrite concentrations in Hillsboro Canal water during the July - August sampling period. The same relationship did not hold for water entering CA-2A through S-7 pumping station (Tables 10 and 11). The linear regression relationship is a function of either denitrification or nitrification reactions proceeding in the water on ammonia and nitrate derived from leached fertilizers and decomposing peat. The Everglades peats are nitrogen-rich and range from 2.7-3.8 N on a dry weight basis according to Bureau of Mines analyses (Table 21).

Chloride and sodium entering the marsh from the S-10 structures evidence a strong linear relationship (Table 11). This strong relationship is also found in the marsh as denoted by the following linear regression equations and high correlation coefficients:













ULTIMATE ANALYSIS OF PEAT FROM CONSERVATION AREA 2A AT VARIOUS DEPTHS

DATA IN PERCENTAGES OF DRY WEIGHT

| | Peat | Peat | Peat |
|--------------|---------------|-----------------|-----------------------|
| | (As Received) | (Moisture Free) | (Moisture & Ash Free) |
| 0-6 inches | | | <u> </u> |
| Hydrogen | 5.6 | 4.9 | 5.6 |
| Carbon | 44.2 | 49.5 | 57.0 |
| Nitrogen | 2.9 | 3.3 | 3.8 |
| Oxygen | 35.0 | 28.6 | 32.8 |
| Sulphur | 0.7 | 0.7 | 0.8 |
| Ash | 11.6 | 13.0 | |
| | 100.0 | 100.0 | 100.0 |
| 26-32 inches | | | |
| Hydrogen | 5.9 | 5.4 | 5.7 |
| Carbon | 51.8 | 57.3 | 60.8 |
| Nitrogen | 2.7 | 3.0 | 3.2 |
| Oxygen | 34.1 | 28.1 | 29.8 |
| Sulphur | 0.4 | 0.5 | 0.5 |
| Ash | 5.1 | 5.7 | |
| | 100.0 | 100.0 | 100.0 |
| 64-70 inches | | | |
| Hydrogen | 3.3 | 2.9 | 5.7 |
| Carbon | 27.7 | 29.0 | 56.2 |
| Nitrogen | 1.3 | 1.4 | 2.7 |
| Oxygen | 21.3 | 18.0 | 34.9 |
| Sulphur | 0.3 | 0.3 | 0.5 |
| Ash | 46.1 | 48.4 | |
| | 100.0 | 100.0 | 100.0 |

| Sampling Date | Linear Regression Equation | Correlation Coefficient (r) | |
|-----------------|-------------------------------|--------------------------------|--|
| July 31, 1973 | y = .808x - 5.56 | .99 | |
| August 8, 1973 | y = .773x + 5.34 | .93 | |
| August 14, 1973 | y = .868x - 17.7 | .99 | |
| August 22, 1973 | y = .764x - 12.1 | .92 | |

These data strongly suggest that chloride and sodium are unaffected by vegetation in the marsh, a relationship suggested by Gleason (1972) in his work on Taylor Slough, Everglades National Park. Oddly enough, water entering CA-2A at S-7 does not exhibit a significant linear relationship between Na and Cl.

The average of mean silica concentrations for canal and marsh waters are identical - 19 ppm (Table 9). These data suggest that high silica concentrations in the marsh are stable. Abundant siliceous vegetation and diatoms in the marsh are apparently not able to lower the SiO₂ concentration. Silica in most bodies of water is kept low by uptake through diatoms. Seawater contains not more than 6 ppm SiO₂. The periphyton in CA-2A contains diatoms but increases in the diatom population allowable by high silica may be prohibited by "nutrient limitations". The diatoms may be unable to keep up with the high SiO₂ inputs because of a shortage of nitrogen or phosphorus compounds.

Silica entering the area has two likely sources: (1) decomposition of silica-rich peat (2) groundwater. Silica in peatlands drained by the Hillsboro and New River Canals contains approximately 2.2% SiO₂ by dry weight (Miller, 1918). Organically-deposited opaline silica is usually very soluble though sawgrass silica is not amorphous. Closely associated organic matter is known to enhance the solubility of even highly insoluble quartz silica. The silica content of ground water in Broward County is high (Grantham and Sherwood, 1968). Toward the agricultural lands ground water is even more highly mineralized (Parker, et al., 1955).

Some support for the hypothesis that periphyton are precipitating $CaCO_3$, thereby reducing the alkalinity and conductivity of the marsh water, is found in Table 9. Though chloride, sodium and SiO₂ in both the marsh and canal are very similar, the alkalinity difference represents a bicarbonate difference of 103 ppm. Bicarbonate would naturally undergo a reduction with CaCO₃ precipitation. Examination of abundant <u>Micro-coleus lyngbyaceous</u>, a blue-green alga abundant around the S-10 structures during August, indicated that CaCO₃ crystals were forming between and around the algal filaments. However, the vegetation in the marsh may reduce the alkalinity and conductivity of the water by simply absorbing carbon dioxide or bicarbonate from the water during photosynthesis.

A small northwest section was unaffected by high-conductivity and high-chloride water prevalent over the rest of CA-2A (Figure 13). This can be seen by examining Figures 14 - 17 which show that low concentrations of ions in this area were stable during both wet and dry seasons. The isolated area is uphill and more than three miles distance from both S-7. and S-10D; it is also far enough away from CA-1 to be unaffected by high-conductivity seepage water. Possibly this area which has chloride values less than 65 ppm has been affected only by rainwater in its past history. Chloride values for Taylor Slough, a small slough in Everglades National Park, which in the past received only water from rainfall, ranged from 15 ppm - 40 ppm throughout the length of the slough, July 27,






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1971 (Gleason, 1972).

The boundary between canal water flowing into the marsh and indigeneous water was clearly marked by a contrast between water containing high and low dissolved solids on July 31, eight days after the S-10 structures were opened (Figures 15 and 16). The 112 gauge is the only gauge which had responded to the discharge at that time; the 2-17 and 2-15 gauges had not sensed the rising water level. The rate of expansion of the bubble was approximately one mile per day from S-10C towards the S-11 structure.

By September, the area below the latitude of the S-10 gates was fairly homogeneously high in dissolved solids. The boundary between the water input by S-7 and the water emanating from S-10 was not clear. The thick sawgrass southeast of S-7 apparently resisted some movement of the high salinity water through it; a small patch of respectably "soft" water was found (Figure 17).

Water emanating from S-7 possessed a significantly higher alkalinity than water issuing from the S-10 structures. The difference corresponds to about 120 ppm bicarboante using the conversion factor of 61 ppm $HCO_q/meq-Alk$.

Our July and August canal data confirm Parker, et al.'s contention that high dissolved solids occur in some Everglades canals concurrently with the wet season and high discharge conditions. Our specific conductance values for the North New River and Hillsboro Canals are at the high side of historical ranges. The reason for this unreasonable relationship is not clear. Several factors may be involved: 1) flushing of high conductance groundwater into the canals during active drainage of the ag-lands 2) active dissolution of the underlying bedrock as water

67

is drained out of bedrock, which is overlain by peats, within the ag-lands. More long term data is needed to clarify the relationship.

SUMMARY

The chemical quality of Conservation Area 2A and adjacent supply canals was good with two exceptions: 1) Specific Conductance of marsh and canal water exceeded water quality standards 2) Ammonia in canals frequently exceeded standards. A comparison of our two months of wet-season canal data with previous work suggested that the Hillsboro and North New River Canals have not changed their chemical complexion since the 1940's. A comparison of water analyses, then and now, showed that the water has always been hard and has contained bicarbonate, chloride, sodium, silica, and nitrate in the same order of abundance.

Our canal data were towards the higher range of historical data. Nitrate was 5-10X concentrations found in previous studies. Nitrate rather than ammonia was the most abundant form of inorganic nitrogen. Sampling canals only when they were actively draining adjacent ag-lands may possibly explain these differences.

The Everglades marsh had a purifying or "kidney" effect on agricultural drainage discharged over the marsh. Nutrients decreased to levels below detection limits in the marsh and alkalinity also showed a slight reduction perhaps due to $CaCO_3$ precipitation. The marsh exhibited no effect on chloride, sodium, or silica. Dissolved organic nitrogen and organic phosphate phosphorus concentrations did not change as a result of flow through the marsh. This result suggests that they were not usable as nutrient substrates for organisms over the time period encompassed by treatment in the study (1 month).

69

The drawdown of CA-2A, dehydration of flocculent "gyttja," and oxidation of surface soils did not have an obvious determinable effect, either beneficial or deleterious, on the chemical quality of water refilling the basin. Water refilling the basin appeared to derive its personality primarily from Hillsboro Canal water less any significant concentrations of nutrients.

Sodium and chloride concentrations of water entering the marsh through the S-10 structures and in the marsh exhibited a strong direct linear relationship.

BIBLIOGRAPHY

- BOYD, C. E. and HESS, L.W. 1970. Factors influencing shoot production and mineral nutrient levels in <u>Typha Latifolia</u>. Ecology 51, 296-300.
- 2. BROWNING, JAN. 1972. In Depth Report, CSFFCD, Volume 1, No. 2.
- Central and Southern Florida Flood Control Project. 1953, Part I, Supplement 13.
- Central and Southern Florida Flood Control Project. 1953, Part I, Supplement 9.
- 5. Central and Southern Florida Flood Control Project. 1958, Part I, Supplement 27.
- Corps of Engineers. 1971. Water Quality Study Everglades National Park. Department of the Army, Jacksonville District, Jacksonville, Florida.
- 7. Federal Water Pollution Control Administration, 1969. Water Pollution Aspects of Urban Runoff. Final Report. Proj. No. 120 Washington, D. C.
- FOX, J. L., KEIRN, M. A., BREZONIK, P. L. 1973. Effects of sediment drying on refill water quality. Abstracts of papers submitted for the thirty-sixth meeting of the American Society of Limnology and Oceanography, Inc., University of Utah, Salt Lake City, Utah, June 11-14, 1973.
- FREIBERGER, H. J. 1972. Nutrient survey of surface waters in southern Florida during a wet and dry season, September 1970 -March 1971. U. S. Geological Survey Open File Report 72008.
- FREIBERGER, H. J. 1973. Effects of backpumping from South New River Canal at pump station S-9 on quality of water in water conservation area 3, Broward County, Florida. USGS Open-File Report 73026.
- GLEASON, P. J. 1972. The origin, sedimentation, and stratigraphy of a fresh water calcitic mud located in the southern fresh-water Everglades. Ph.D. Thesis, Pennsylvania State University.
- 12. GLEASON, P. J. 1973. Calculations on FCD water budget for CA-2A. Personal files.
- GRANTHAM, R. G. and C. B. SHERWOOD. 1968. Chemical quality of waters of Broward County, Florida. State of Florida Division of Geology Report of Investigations No. 51.

- 14. HORNE, R. A. 1969. Marine Chemistry. Wiley Interscience, N. Y.
- 15. HYDE, L. W. 1965. Principal aquifers in Florida. Florida Division of Geology Map Series No. 16.
- JOYNER, B. 1971. Appraisal of chemical and biological conditions of Lake Okeechobee, Florida 1969-70. USGS Open File Report 71006.
- LEACH, S. D., KLEIN, H., HAMPTON, E. R. 1972. Hydrologic effects of water control and management of southeastern Florida. Florida Bureau of Geology Report of Investigations No. 60.
- McPHERSON, B. F. 1973. Water quality in the conservation areas of the central and southern Florida flood control district. 1970-72 U.S. Geological Survey Open File Report 72008.
- MILLER, C. F. 1918. Inorganic composition of peat and of the plant from which it was formed. Jour. Agri. Research 13: 605-609.
- 21. Palm Beach County Planning, Zoning and Building Department. 1972. Land Use Plan.
- 22. PARKER, G. G., FERGUSON, G. E., LOVE, S. K. 1955 Water resources of southeastern Florida with special reference to the geology and groundwater of the Miami area. U. S. Geological Survey Water Supply Paper 1255.
- PUTNAM, H. D., BREZONIK, P. L., and SHANNON, E. E., 1972. Eutrophication factors in North Central Florida lakes. Environmental Protection Agency, Water Pollution Control Research Series 16010 DON 02/72.
- 24. WALLER, BRADLEY. 1973. Personal Communication, Letter dated August 29, 1973.

APPENDIX I

SAMPLING AND CHEMICAL COMPOSITION MAPS FOR

CA-2A

OCTOBER 11, 1972 - AUGUST 22, 1973

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APPENDIX II

TABULATED CHEMICAL DATA

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CHEMICAL COMPOSITION OF WATER COLLECTED IN CA-2A MARSH - OCTOBER 11, 1972

| Sample No. | Si0 ₂ | <u>C1</u> |
|------------|------------------|-----------|
| A1 | 33.2 | 243 |
| A2 | 13.8 | 121 |
| A3 | 0.5 | 44 |
| B1 | 2.8 | 61 |
| B2 | 3.7 | 58 |
| B3 | 10.2 | 112 |
| B4 | 21.9 | 153 |
| B5 | 23.9 | 179 |
| C1 | 21.6 | 166 |
| C2 | 21.8 | 131 |
| C3 | 26.6 | 179 |
| C4 | 23.7 | 182 |
| C5 | 20.6 | 131 |
| C6 | 11.0 | 105 |
| C7 | 12.2 | 112 |
| C8 | 8.8 | 74 |
| D1 | 17.9 | 152 |
| D2 | 11.6 | 121 |
| D3 | 16.7 | 118 |
| D4 | 21.6 | 114 |
| D5 | 28.9 | 169 |
| D6 | 24.4 | 131 |
| D7 | 21.6 | 115 |
| D8 | 9.2 | 72 |
| D9 | 6.2 | 96 |
| E1 | 8.7 | 80 |
| E2 | 18.7 | 81 |
| E3 | 21.9 | 110 |
| E4 | 26.8 | 123 |
| E5 | 24.8 | 121 |
| E6 | 20.6 | 141 |
| E7 | 19.2 | 152 |
| G1 | 14.8 | 86 |
| G2 | 15.4 | 72 |
| G3 | 23.1 | 115 |
| G4 | 21.6 | 113 |
| G5 | 25.1 | 118 |
| G6 | 22.5 | 137 |
| H1 | 22.8 | 139 |
| H2 | 25.3 | 118 |
| H3 | 16.9 | 82 |
| 1 | 21.6 | 134 |
| J1 | 18.4 | 122 |
| J2 | 19.3 | 106 |
| J3 | 9.7 | 75 |
| J4 | 8.9 | 63 |
| J5 | 7.6 | 57 |
| J6 | 7.0 | 47 |
| J7 | 7.9 | 53 |

11-1

CHEMICAL COMPOSITION OF WATER IN CA-2A MARSH --NOVEMBER 11, 1972, FEBRUARY 13, 1973, JUNE 26, 1973

Analyses in PPM-ALK in Meq/1

| Date | Samp1e | <u>NO3 -</u> N | NO2-N | <u>NH3-N</u> | <u>0-P04-P</u> | DisOrgPO4-P | <u>C1</u> | Na | Si02 | Sp. Cond. |
|----------|--------|----------------|-------|-----------------|----------------|-------------|-----------|-----|------|-----------|
| 11/16/72 | C1 | <.002 | <.004 | <• ⁴ | <.004 | | 180 | | 23 | |
| 11/16/72 | C2 | <.002 | <.004 | <• ⁴ | <.004 | | 134 | | 21 | |
| 11/16/72 | C3 | <.002 | <.004 | <• ⁴ | <.004 | | 155 | | 22 | |
| 11/16/72 | C4 | <.002 | <.004 | <•4 | <.004 | | | | | |
| 11/16/72 | C5 | <.002 | <.004 | <• ⁴ | <.004 | | 175 | | 20 | |
| 11/16/72 | C6 | <.002 | <.004 | <•4 | <.004 | | 131 | | 17 | |
| 2/13/73 | C1 | .13 | .006 | .05 | <.001 | <.007 | 314 | 215 | 16 | |
| 2/13/73 | C2 | | .004 | .04 | <.001 | <.011 | 400 | 223 | | |
| 2/13/73 | C3 | | | | .006 | | | 169 | | |
| 2/13/73 | C4 | .001 | .003 | .03 | <.001 | | 202 | 138 | 4.6 | |
| 2/13/73 | C5 | <.010 | <.001 | .07 | <.001 | <.009 | 146 | 101 | 7.0 | |
| 2/13/73 | C6 | <.002 | 2.001 | .04 | <.001 | <.005 | 145 | 93 | 6.0 | |
| 2/13/73 | D1 | <.004 | <.001 | .03 | <.001 | <.003 | 144 | 102 | 10.0 | |
| 2/13/73 | D2 | <.031 | <.001 | .04 | <.001 | <.002 | 135 | 95 | 5.9 | |
| 2/13/73 | D3 | <.001 | < 001 | .02 | <.001 | <.002 | 148 | 102 | 7.7 | |
| 2/13/73 | D4 | <.019 | <.001 | .08 | <.001 | <.002 | 190 | 127 | 11 | |
| 2/13/73 | D5 | <.008 | <.001 | .09 | <.001 | <.002 | 228 | 159 | 13 | |
| 2/13/73 | D6 | <.059 | 2.001 | .11 | <.001 | <.002 | 162 | 114 | 15 | |
| 2/13/73 | D7 | 2.006 | 2.001 | .04 | 2.001 | <.002 | 136 | 94 | 6.7 | |
| 2/13/73 | D8 | 2.003 | 2.001 | .03 | 2.001 | .004 | 210 | 137 | 6.0 | |
| 2/13/73 | F1 | 2.003 | 2.001 | .03 | 2.001 | <.002 | 141 | 97 | 6.6 | |
| 2/13/73 | E2 | <.001 | 2.001 | .03 | <.001 | <.005 | 136 | 91 | 12 | |
| 2/13/73 | F3 | <.018 | <.001 | .07 | <.001 | <.002 | 234 | 156 | 16 | |
| 2/13/73 | F4 | ,012 | 2.001 | .05 | <.001 | <.002 | 151 | 107 | 9.6 | |
| 2/13/73 | F5 | <.059 | 2.001 | .06 | <.001 | <.002 | 127 | 84 | 6.4 | |
| 2/13/73 | F1 | 2.006 | 2.001 | .06 | < 001 | <.002 | 147 | 115 | 18 | |
| 2/13/73 | F2 | 2.011 | <.001 | .04 | <.001 | <.002 | 159 | 115 | 18 | |
| 2/13/73 | F3 | < 052 | <.001 | .39 | .003 | .000 | 118 | 91 | 18 | |
| 2/13/73 | F4 | < 009 | <.001 | .07 | <.001 | <.002 | 109 | 79 | 11 | |
| 2/13/73 | F5 | < 001 | <.001 | .02 | <.001 | <.002 | 95 | 65 | 7.6 | |
| 2/13/73 | F6 | <.005 | <.001 | .03 | <.001 | <.002 | 89 | 61 | 1.2 | |
| 2/13/73 | S146 | <.014 | <.001 | .06 | <.001 | <.002 | 80 | 53 | 5.2 | |
| 2/13/73 | S145 | <.013 | <.001 | .05 | <.001 | <.003 | 84 | 63 | 7.5 | |
| 2/13/73 | S144 | <.013 | <.001 | .04 | <.001 | <.002 | 91 | 69 | 9.8 | |
| 2/13/73 | G1 | <.001 | <.001 | .03 | .003 | .000 | 138 | 95 | 18 | |
| 2/13/73 | S11A | <.001 | <.001 | .06 | <.001 | <.002 | 123 | 90 | 14 | |
| 2/13/73 | S11B | <.012 | <.001 | .07 | <.001 | <.002 | 113 | 80 | 14 | |
| 2/13/73 | S11C | <.011 | <.001 | .13 | <.001 | <.002 | 145 | 101 | 13 | |
| 6/26/73 | CI | .000 | .06 | .07 | | | 252 | 195 | 27 | 1200 |
| 6/26/73 | C2 | <.008 | <.004 | .08 | .04 | | 529 | 419 | 19 | 2100 |
| 6/26/73 | C3 | <.008 | <.008 | .12 | <.001 | | 376 | 261 | 30 | 1575 |
| 6/26/73 | C5 | <.008 | <.004 | .08 | .01 | | 404 | 299 | 49 | 1750 |
| 6/26/73 | C6 | <.008 | <.004 | ,19 | | | 341 | 266 | 37 | 1500 |
| 6/26/73 | C7 | <.008 | < 004 | | <.001 | | 168 | 126 | 30 | 700 |
| 6/26/73 | E5 | <.008 | < 004 | .13 | < 001 | | 577 | 349 | 40 | 1650 |
| 6/26/73 | E4 | <.008 | <.004 | .09 | <.001 | | 345 | 251 | 36 | 1300 |
| 6/26/73 | E3 | <.008 | <.004 | .06 | <.001 | | 138 | 106 | 13 | 950 |
| 6/26/73 | E2 | | .02 | | <.001 | | 240 | 161 | 12 | 750 |
| 6/26/73 | E1 | <.008 | <.004 | .26 | | | 187 | 143 | 14 | 810 |
| 6/26/73 | 63 | <.008 | <.004 | .11 | <.001 | | 294 | 209 | 31 | 1300 |
| 6/26/73 | G4 | <.008 | <.004 | .10 | ~01 | | 508 | 326 | 36 | 1950 |

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CHEMICAL COMPOSITION OF WATER IN CA-2A AND ASSOCIATED CANALS - JULY 17, 1973

L38E and L35B Canals

Analyses in PPM-ALK in Meq/1

| $\frac{4-P}{2} \stackrel{C1}{\longrightarrow} \stackrel{Na}{\longrightarrow} \stackrel{SiO_2}{\longrightarrow} \stackrel{Alk.}{\longrightarrow}$ | 146 115 16 8.2 | 124 97 12 7.4 | 138 107 14 7.9 | 126 89 13 7.5 | 127 99 7.0 1.9 | 91 74 9.7 2.2 | 91 76 13 2.8 | 322 242 11 3.6 | 302 225 15 3.9 | 230 160 15 4.7 | 293 179 21 4.6 | 218 179 25 6.0 | 120 96 6.4 1.4 | 182 161 23 2.9 | 121 100 6.9 2.1 | 170 130 13 3.0 | 151 120 27 2.8 | 119 86 3.7 .77 | 109 79 8.6 5.0 | 89 66 6.4 I.O | 103 78 9 . 2 2.9 | 100 76 10 2.3 | 103 9.3 1.9 | 119 86 12 6.9 | 51 43 14 2.2 | |
|--|----------------|---------------|----------------|---------------|----------------|---------------|-------------------|----------------|----------------------------|-------------------|----------------|----------------|----------------|-------------------|-----------------|----------------|----------------|----------------|----------------|---------------|-------------------------|-------------------|-------------|---------------|--------------|--|
| Dis Org P(| .01 | 10.2 | <.01 | <.01 | .02 | <.01 | .01 | | •0 [•] | .02 | .01 | •03 | <.01 | <.01 | <.01 | <.01 | <01 | 0 4 | <.01 | .02 | <.01 | 10.> | .01 | <.01 | •<•01 | |
| 0-P04 -P | .006 | <.002 | .005 | <.002 | <.002 | <.002 | <.002 | <.002 | | .005 | <.002 | .003 | .003 | .015 | .005 | +00° | .013 | .002 | <.002 | <.002 | <.002 | <.002 | .002 | •003 | .003 | |
| Dis Org N | 3 8 | 64* | .25 | • 33 | MAKSH • 56 | •43 | •+3 | .18 | .75 | 4 th • | •41 | .31 | • 06 | • 45 | .25 | .40 | •42 | • 39 | • 39 | | .35 | .22 | .23 | .26 | 14. | |
| NH ₃ -N | .20 | <.01 | • 05 | <.01 | +0. | <.01 | ••01 | <.01 | • 0.7 | •06 | .01 | • 06 | .60 | .02 | .16 | .01 | <.01 | <.01 | <.01 | | .05 | •03 | .05 | 10.> | ••01 | |
| NO ₂ - N | .043 | •014 | .027 | .022 | 600. | .007 | <*00 ⁺ | +00 *> | < • 00 1 | <*00 ⁺ | +00 *> | •014 | .055 | <*00 ⁺ | .006 | +00+> | <•00₽ | +00.> | •000 | .011 | .012 | <*00 ⁺ | • 009 | •00• | +00+> | |
| NO ₃ -N | •46 | °33 | •34 | • 34 | •064 | .034 | <.016 | •23 | •002 . | • 35 • | . 6003 | .073 | 1.0 | .045 | • 35 | • 400* | · +00•> | * +00* > | 600 ° | • 0 + + | .027 | •18 | •079 | .020 | .083 | |
| Sample # | 16 | 17 | 30 | 31 | 7 | 80 | 6 | 10 | 11 | 12 | 13 | 14 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 32 | |

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CHEMICAL COMPOSITION OF WATER COLLECTED AT S-10 DISCHARGE GATES - JULY, 1973

Analyses in PPM-ALK in Meq/1

| Sample # | Date | N0~-N | N- ON | NHN | Dis Org N | I d- 0d-0 |)is Ore PO -F | 10 | Na | SiO | A1k. |
|------------|---------|--------------|-------|------|--------------|-----------|---------------|-----|-----|-----|-------------|
| | | 0 | 7 | 3 | - - | 4 | . 4 | | | 2 | |
| 6100701 | 7/24/73 | 6 † • | .028 | • 05 | • 66 | •079 | • 03 | | 205 | 17 | 2•3 |
| G100702 | 7/24/73 | 1.6 | .078 | | | • 002 | <.01 | | 175 | 21 | ی • و |
| GC20707-44 | 7/31/73 | 1.5 | .15 | .16 | 2•3 | .026 | <.01 | 161 | 128 | 15 | 4°-4 |
| GC20707-48 | 7/31/73 | 2.9 | •23 | •73 | 3 . 2 | .17 | .01 | 205 | 164 | 24 | 7.0 |
| GC20707-49 | 7/31/73 | 2.4 | •20 | .42 | 3 . 2 | .12 | • 02 | 189 | 160 | 20 | 6.5 |

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| OF WATER | JULY 31, |
| CHEMICAL COMPOSITION | IN CA-2A MARSH - |

Analyses in PPM-ALK in Meq/1

| nd. /cm) | | | | | | | | | | | | | | | | | | | | | | | | | | 11 | -6 | > | | | |
|--------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------------|-------|-------|-------|-------|--------------|--------------|------------|-------|---------|--------------|--------------|-------|-------|-------|-------|---------------------|--------------|------|-------|
| Sp. Co (umhos | 1050 | 1300 | 540 | 220 | 1200 | 240 | 700 | 006 | 610 | 1200 | 760 | 730 | 770 | 100 | 540 | 390 | 590 | 610 | 1100 | 540 | 0 11 11 | 550 | 550 | 830 | 840 | 1100 | 480 | 790 | 1300 | 1500 | 660 |
| AIk | 5.3 | 5.4 | 2.6 | 1.0 | 5.2 | 1.0 | 3.1 | 4 8 | 3°0 | 5,3 | 3.4 | † † | 6 . 0 | 3.6 | 4°] | 2.1 | 9 . 4 | 3.7 | 6 0 | 3.2 | 3.4 | 3 ° 0 | 3 ° 2 | 3.2 | 7.7 | 6.1 | 3 t | 6 • 3 | 7.4 | 8°3 | 4°0 |
| si02 | 22 | 22 | 16 | 7.1 | 19 | 10 | 16 | 15 | 19 | 21 | 17 | 14 | 14 | 12 | 8.2 | 6.1 | 10 | 6 . 6 | 14 | 8.3 | 5.4 | 4.5 | 8.0 | 7.1 | 13 | 16 | 9°2 | 16 | 19 | 31 | 13 |
| Na | 119 | 166 | 48 | 21 | 172 | 24 | 67 | 121 | 54 | 164 | 118 | 79 | 88 | 78 | 76 | 60 | 72 | 65 | 146 | 80 | 76 | 80 | 76 | 97 | 06 | 154 | 45 | 138 | 148 | 166 | 87 |
| CI | 140 | 219 | 65 | 28 | 208 | 32 | 96 | 150 | 66 | 211 | 146 | 117 | 125 | 16 | 102 | 81 | 102 | 63 | 182 | 116 | 103 | 109 | 100 | 131 | 133 | 195 | 55 | 168 | 192 | 209 | 130 |
| DisOrgPO ₄ -P | <.01 | <.01 | <.01 | <.01 | <.01 | .01 | <.01 | <.01 | <.01 | <.01 | .01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | .01 | <.01 | <.01 | <.01 | .01 | <.01 | . 10. | .03 | | .01 |
| 0-P04-P | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | •006 | .002 | .003 | .005 | <.002 | <.002 | .005 | •003 | <.002 | <.002 | <.002 | .006 | .086 | | <.002 |
| DisOrgN-N | 2.4 | 2.0 | 2.4 | 2.0 | 2.7 | 2.5 | 2.5 | 1.8 | 2.3 | | 2.6 | 1.9 | 2.0 | 2.4 | 2.3 | 2.0 | 1.9 | 1.9 | 2.5 | 2.0 | 2.0 | 1.7 | 1.8 | 1.3 | 2.0 | 3.1 | 1.2 | 2.5 | 3 • 9 | 3.1 | 2.4 |
| N- ² HN | <.01 | 10. | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | .01 | .01 | <.01 | <.01 | <.01 | •03 | 60. | •03 | •03 | <.01 | •03 | <.01 | .02 | <.01 | • 02 | <.01 | <.01 | <.01 | <.01 | * 0 * | .15 | .47 | <.01 |
| NO2-N | <.008 | <_008 | <.008 | <.008 | •048 | <.008 | <.008 | <.008 | <.008 | .013 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | .023 | <.008 | <.008 | <-008 | <.008 | <.008 | <.008 | <.008 | <.008 | | .18 | .28 | <.008 |
| NO3-N | <.008 | <.008 | <.008 | <-008 | .16 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | .016 | <.008 | 600. | e00e> | .013 | <.008 | <.008 | <.008 | <.008 | <-008 | <.008 | | 1.2 | • 35 | <.008 |
| | 1 | 2 | ŝ | 44 | n | 9 | 7 | 80 | 6 | 14 | 19 | 23 | 25 | 26 | 27 | 28 | 29 | 30 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 4] | 42 | 43 | 44 | 45 | 46 |

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|----|-------|-------|-------|--------------|------------|---------------|-----|-----|------|--------------|-------------------------|
| | NO3-N | NO2-N | NH3-N | DisOrgN-N | 0-P04-P | DisOrgPO4-P | 5 | Na | Si02 | A1k | Sp. Cond. (umhos/cm) |
| 10 | 2.6 | .28 | .29 | | .067 | <.01 | 150 | 120 | 16 | 4 . 8 | 1100 |
| 11 | 1.5 | .15 | .16 | 2.4 | .026 | <.01 | 161 | 128 | 15 | 4.7 | 1100 |
| 12 | .056 | <.008 | .012 | 2.4 | <.002 | <.01 | 181 | 144 | 16 | 5.1 | 1100 |
| 13 | 2.8 | •28 | .36 | 3.3 | .082 | <.01 | 146 | 116 | 16 | 4 . 8 | 1100 |
| 15 | 2.9 | .23 | •73 | 3.2 | .17 | .01 | 205 | 164 | 24 | 7.0 | 1400 |
| 16 | 2.4 | .20 | .42 | 3.1 | .12 | • 02 | 189 | 160 | 20 | 6 . 5 | 1200 |
| 17 | 2.7 | .20 | •96 | 3.0 | .17 | <.01 | 210 | 173 | 24 | 7.0 | 1500 |
| 18 | 2.9 | •24 | .61 | 3.3 | .17 | .02 | 199 | 166 | 24 | 6.7 | 1100 |
| 40 | 2.7 | • 30 | • + 3 | 1.8 | 160 | •03 | 130 | 87 | 13 | 6.1 | 1100 |
| | | | | | | | | | | | |
| | | | | L38E | and L35B | Canals | | | | | |
| 20 | .67 | .095 | .23 | 2.7 | .086 | | 141 | 100 | 19 | 7.8 | 1100 |
| 21 | -64 | .058 | •14 | 2.0 | .080 | +0. | 139 | 86 | 18 | 6.9 | 1200 |
| 22 | 1.3 | .11 | .24 | 2.0 | .050 | .02 | 146 | 118 | 18 | 7.5 | 1100 |
| 24 | .80 | .092 | .36 | 2.5 | .10 | <.01 | 140 | 100 | 19 | 7.3 | 930 |
| 31 | .086 | .019 | <.01 | 2.0 | +00. | <.01 | 128 | 86 | 16 | 7.6 | 1100 |
| 39 | .82 | .093 | • 38 | 1.9 | .15 | | 132 | 06 | 18 | 7.5 | 1100 |

CHEMICAL COMPOSITION OF WATER COLLECTED IN HILLSBORD CANAL AND S-10 DISCHARGE CANAL - JULY 31, 1973

Analyses in PPM-ALK in Meq/1

11-7

| COLLECTED | 2-17, 1973 |
|------------------------|------------------------|
| OF WATER | - AUGUST |
| CHEMICAL COMPOSITION (| T S-10 DISCHARGE GATES |
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|--------------|-------------|---------|--------------------|----------|--------------------|------------|---------|-------------|-----|-----|------|-----|
| Sample No | · Structure | Date | NO ₃ -N | NO2-N | NH ₃ -N | DisOrg N | 0-P04-P | Dis Org PO4 | | Na | Si02 | Alk |
| G10081 | S10A | 8/2/73 | 1.2 | .15 | .21 | 3.0 | .026 | •02 | 171 | 144 | 17 | |
| G10082 | S10C | 8/2/73 | 1.6 | .18 | .55 | 2,5 | .10 | .02 | 203 | 167 | 21 | |
| G10083 | S10D | 8/2/73 | 2.1 | .18 | .81 | | .096 | .07 | 214 | 167 | 23 | |
| S101 0-08093 | S10A | 8/9/73 | ++• | .076 | .32 | 2.7 | .043 | .01 | 186 | 134 | 20 | 5.4 |
| S102 " | S10C | 8/9/73 | | .066 | •45 | 2.6 | .087 | <.01 | 208 | 151 | 21 | 6.1 |
| S103 " | S10D | 8/9/73 | • 83 | .10 | • 6 • | 2.8 | .15 | <.01 | 195 | 167 | 23 | 7.7 |
| S101 0-08133 | S10A | 8/13/73 | .17 | .047 | .41 | 2.2 | • 0+3 | <.01 | 159 | 121 | 19 | 4.7 |
| S102 " | S10C | 8/13/73 | .13 | .033 | •24 | 2.4 | .038 | ••01 | 164 | 128 | 19 | 5.0 |
| S103 " | S10D | 8/13/73 | .32 | •077 | •46 | 2.8 | .071 | <.01 | 218 | 164 | 24 | 6.1 |
| S101 0-08173 | S10A | 8/17/73 | <.008 | <.008 | .042 | 1.8 | <.002 | .012 | 114 | 75 | 15 | 3.1 |
| S102 " | S10C | 8/17/73 | .14 | .052 | •48 | 2.4 | .036 | • 03 | 207 | 150 | 20 | 5.8 |
| S103 " | S10D | 8/17/73 | •68 | .109 | | | .063 | .02 | 234 | 160 | 25 | 6.1 |
| | | | | | | | | | | | | |
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CHEMICAL COMPOSITION OF WATER COLLECTED IN CA-2A AND ADJACENT CANALS - AUGUST 8, 1973 Hillsboro Canal at S-10 Structures and S-10 Discharge Canal

Analyses in PPM-ALK in Meq/1

| | | | | | | | | | | | | | | 11-9 | | | | | | | | | | | | | |
|--------------------------|-----|------|------|-----|------|------|------|------|--|-------------|-------|---------|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|
| Alk | 6.6 | 6.8 | 6.8 | 6.7 | 5.4 | 4.2 | 6.3 | 6.3 | | | 5.4 | с. т | -t - | 5.6 | 5.2 | 5.5 | 5.4 | 4°9 | 5.1 | 6.4 | 3.7 | 5.3 | 6.0 | 6.2 | 6.0 | 6 t | 5,8 |
| SiO2 | 24 | 24 | 32 | 23 | 19 | 16 | 26 | 25 | | | 18 | 17 | 18 | 20 | 20 | 19 | 19 | 15 | 27 | 27 | 19 | 33 | 20 | 20 | 21 | 26 | 26 |
| Na | 178 | 174 | 173 | 165 | 142 | 120 | 150 | 171 | | | 150 | 129 | 135 | 145 | 122 | 143 | 148 | 128 | 162 | 160 | 111 | 155 | 159 | 166 | 144 | 171 | 180 |
| 5 I | 212 | 221 | 218 | 210 | 180 | 175 | 187 | 214 | | | 176 | 154 | 160 | 175 | 158 | 175 | 188 | 210 | 203 | 150 | 205 | 199 | 213 | 191 | 201 | 202 | 212 |
| DisOrgPO ₄ -P | .02 | •03 | <.01 | .02 | .01 | .01 | .02 | .02 | | ea 2A Marsh | .01 | <.01 | .03 | •02 | .01 | .01 | .02 | <.01 | <.01 | •02 | <.01 | | •03 | .02 | <.01 | •01 | <.01 |
| 0-P04-P | .11 | .10 | .15 | .13 | .051 | .005 | •084 | .088 | | vation Are | •002 | <.002 | <.002 | .033 | <.002 | <.002 | .023 | <.002 | <.002 | .017 | <.002 | | .017 | -064 | <.002 | <.002 | <.002 |
| DisOrgN-N | | | | | | | | | | Conser | | | | | | | | | | | | | | | | | |
| NH3-N | .67 | | • 74 | .65 | .28 | .027 | •70 | •69 | | | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | <•01 | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | • 01 |
| NO2-N | .11 | .12 | .11 | .10 | .058 | •008 | .20 | •21 | | | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 |
| NO3-N | .75 | • 83 | .75 | .61 | • 30 | •017 | 1.1 | 1.1 | | | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <-008 | <.008 |
| | 17 | 23 | 25 | 26 | 27 | 28 | 34 | 35 | | | 11 | 12 | 13 | 14 | 15 | 16 | 18 | 19 | 20 | 21 | 22 | 24 | 29 | 30 | 31 | 32 | е е |

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| IN CA-2A | 973 |
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| COLLECTED | JGUST 14, 1 |
| POSITION OF WATER | CIATED CANALS - AL |
| CHEMICAL CON | AND ASSC |

Hillsboro Canal and Discharge Canal at S-10 Structures

Analyses in PPM-ALK in Meq/1 DisOrgN-N 0-P0,-P Dis OrgP0.-P C1

| | | | | | | | | | | | | | | | | | | | | | | | | | I | -1 | 0 |
|---------------------------|---|-------------|-------------|------------------------|------|------|------|-------|--------------|------------|-------|--------------|-------|-------|-------|--------|-------|--------------|-------|-------|-------|-------|-------|-------|--------------|-------|-------|
| Alk | | 6.7 | 6 .0 | 6.0 | 6.0 | 4.2 | 4.5 | 6.7 | 6.7 | | 5.6 | 4 . 5 | 5.0 | 5°3 | 5.0 | + + | 6.1 | 5 ° 3 | 5.2 | 6.2 | 6.3 | 6.3 | 6.5 | 6.4 | 6 , 6 | 7.0 | ₽°₽ |
| Si02 | | 22 | 20 | 21 | 22 | 19 | 20 | 20 | 23 | | 21 | 18 | 20 | 23 | 19 | 18 | 22 | 22 | 20 | 24 | 24 | 21 | 23 | 26 | 29 | 27 | 18 |
| Na | ł | 145 | 135 | 135 | | 113 | 120 | 151 | 151 | | 141 | 116 | 125 | 152 | 122 | 124 | 152 | 147 | 135 | 165 | 168 | 148 | 162 | 156 | 166 | 166 | 112 |
| CI | ł | 209 | 211 | 212 | | 157 | 165 | 202 | 204 | | 203 | 166 | 175 | 210 | 155 | 158 | 193 | 193 | 188 | 208 | 203 | 202 | 186 | 187 | 201 | 197 | 76 |
| Dis OrgPO ₄ -P | | .001 | .002 | 00 ⁺ | .006 | .005 | .005 | •003 | .091 | a 2A Marsh | .001 | | .005 | | .001 | | | .002 | .012 | .012 | •033 | .022 | +00- | .005 | .016 | •019 | •030 |
| 0-P04-P | | .11 | .003 | .082 | .080 | .028 | .028 | 160. | •003 | vation Are | <.002 | < 002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | .066 | .11 | .081 | •019 | <.002 | <.002 | .025 | •019 | .028 |
| DisOrgN-N | | 2.3 | 2.4 | 2.5 | 2.5 | 2.1 | 2.1 | 2.4 | 6 * † | Conser | 2.5 | 2.0 | 2.5 | 2.7 | 2.5 | 2.3 | 2.5 | 2.5 | 2.4 | 2.4 | 2.9 | 2.7 | 2.9 | 2.9 | 3.1 | 3.1 | 2.4 |
| NH3-N | | .85 | •48 | 946 | • 43 | .30 | .30 | .80 | .82 | | <.01 | <.01 | <.01 | <.01 | <.01 | <.01 | 10. | <.01 | .13 | •29 | •06 | <.01 | 10.> | <.01 | <.01 | <.01 | <.01 |
| N02-N | ł | •0.74 | •071 | .069 | .067 | .026 | .031 | • 064 | .065 | | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 |
| N− ² −N | | . 33 | •31 | .31 | .31 | •084 | .10 | •26 | •27 | | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <-008 | <-008 | <.008 | <.008 | <.008 | <.008 | <.008 |
| | | 38 | 39 | 40 | 41 | 42 | 43 | 44 | 46 | | 36 | 37 | 45 | 47 | 48 | 49 | 50 | 51 | 52 | 53 | 54 | 55 | 56 | 57 | 58 | 59 | 60 |

CHEMICAL COMPOSITION OF WATER IN CA-2A MARSH - AUGUST 22, 1973

Analyses in PPM-ALK in Meq/1

| ÷. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | • |
|----------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------------|-------|-------|-------|-------|-------|-------|-------|--------------|-------|-------|-------|-------|-------|-------|
| Sp. Con | 920 | 1200 | 1380 | 1390 | 1400 | 1420 | 1420 | 1430 | 1210 | 1010 | 1280 | 1030 | 1060 | 910 | 1200 | 1240 | 1300 | 1080 | 1280 | 1250 | 1350 | 1210 | 1250 | 1100 | 1350 | 410 | 780 | 1230 | 1100 |
| Alk. | 4°3 | t.9 | 6.2 | 5.9 | 5.9 | 6.2 | 6.1 | 6.0 | 6°† | 4°3 | 5,2 | 4°3 | 4°6 | 8°. | 5,3 | 5.4 | 5.7 | 4°2 | 5.4 | 5,5 | 6.1 | 5.2 | 5 ° 3 | 4°8 | 6.1 | | | | |
| Si02 | 18 | 20 | 24 | 26 | 24 | 25 | 26 | 25 | 22 | 19 | 20 | 18 | 20 | 17 | 26 | 27 | 28 | 18 | 22 | 22 | 27 | 22 | 25 | 18 | 29 | 16 | 21 | 20 | 19 |
| Na | 108 | 131 | 145 | 155 | 164 | 163 | 164 | 162 | 127 | 101 | 134 | 101 | 107 | 06 | 133 | 131 | 143 | 105 | 130 | 133 | 140 | 124 | 128 | 116 | 147 | 40 | 82 | 96 | 88 |
| 5 | 147 | 185 | 207 | 207 | 213 | 219 | 215 | 214 | 183 | 150 | 194 | 151 | 160 | 140 | 185 | 183 | 199 | 160 | 190 | 192 | 204 | 184 | 188 | 173 | 245 | 61 | 120 | 143 | 133 |
| Dis Org PO ₄ -P | •019 | .033 | .032 | .036 | .032 | .029 | .033 | .033 | .021 | .020 | .018 | .012 | 010 | +00° | 600 ° | .010 | 600. | •008 | .007 | .006 | •000 | .012 | •008 | .005 | 600° | •002 | .002 | .015 | .011 |
| 0-P04-P | .025 | .087 | •039 | •046 | .020 | .028 | .037 | .035 | .005 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | <.002 | .008 | <.002 |
| Dis Org N | 2.1 | 2.4 | 2.7 | 2.6 | 2.5 | 2.5 | 2.6 | 2.4 | 2.3 | 2.4 | 2.4 | 2.0 | 2.2 | 1.9 | 2.4 | 2.4 | 2.6 | 2.1 | 2.5 | 2.6 | 2.7 | 2.4 | 2.4 | 2.2 | 2.7 | 1.5 | 2.0 | 1.6 | 1.7 |
| NH ₃ -N | •0+ | •23 | .02 | .02 | <.01 | <.01 | .01 | .01 | •01 | .01 | • 01 | .02 | .01 | .02 | •07 | .02 | .01 | .03 | • 0 1 | 01 | .02 | +0. | •06 | .01 | • 05 | <.01 | <.01 | <.01 | <.01 |
| NO ₂ -N | <.008 | <.008 | <.008 | <.008 | .013 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 |
| NO ₃ -N | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 | <.008 |
| Sample # | 80 | 86 | 88 | 68 | 06 | 16 | 92 | 93 | 46 | 95 | 96 | 97 | 98 | 66 | 100 | 101 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 116 | 117 | 118 | 119 |