Tres Rios
Demonstration Constructed Wetland Project

1996/1997 Operation & Water Quality Report

For: Mike Gritzuk, P.E.
Mario Saldamondo, P.E.
Paul Kinshella, P.E.

Prepared By: Roland Wass, P.E.

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Introduction

The Tres Rios Demonstration Constructed Treatment Wetlands have been operational since August, 1995. During that time it has successfully polished almost 2 million gallons a day of secondary-advanced treated municipal wastewater. The Project has been in cooperation with the US Bureau of Reclamation (BoR) with both monetary and intellectual inputs from the Arizona Department of Water Resources (ADWR), Arizona Game and Fish (AZ G&F), the Arizona Department of Environmental Quality (ADEQ), Maricopa County (MC), US Environmental Protection Agency (US EPA), Corps of Engineers (COE), Arizona State University (ASU), and the University of Arizona (U of A). Since start-up the Project has utilized the continuing contribution of some of the Nation's leading wetland experts: Robert Knight (CH2MHill), Robert Kadlec (Wetland Management Services), Robert Gearheart (Humbolt State University), Bob Bastian (US EPA), and Eric Stiles (BoR). To address local concerns we have had active participation from local municipalities including the residents of Holly Acres.

The Demonstration Project consists of approximately 11 acres of emergent marsh, free-water surface wetlands, and is located adjacent to and within the confines of the City of Phoenix/SROG 91st Avenue Wastewater Treatment Plant (See Aerial Photographs Appendix A). There are currently three operational wetlands sites: Cobble (4 acres), Hayfield (6 acres), and the Research Cells (1 acre). The formal Demonstration Project is a two-year, $3.5 million study funded by the US BoR, SROG, ADWR, and AZ G&F with three primary objectives; 1) To determine if wetland systems can polish pre-treated wastewater to a level which will meet perceived future discharge requirements, 2) Develop scale-up parameters for an approximately 800 acre system, and 3) Determine the net environmental benefit such a system and associated riparian habitat would have in the Salt/Gila, and Agua Fri River area.

Two years of data have been collected from these facilities and the following section provides a brief overview of the results.

Demonstration Basin (Cobble & Hayfield Sites) Water Quality Comparison: 1995/96 vs. 1996/97

Monthly mean water quality values were used to develop annual statistics for two time periods, August 1995 through July 1996, and August 1996 through June 1997 to determine if differences exist between the first and second years of operations. In general, monthly mean concentrations of suspended solids, cBOD, and the nitrogen species were highest in year one in all basins. NO_2+NO_3-N was higher in year one in all Demonstration Basins except in H1 where the 1995/96 annual average could not be differentiated from Year 2. A summary table showing the average, maximum, minimum, and standard deviation for the two years of operations of the Cobble and Hayfield Site Wetlands are located in Appendices D and E respectively.

Only two parameters, Alkalinity and TDS were consistently higher in 1996/97 in all basins. This is likely a reflection of the slow, but persistent concentration of salts due to evaporative mechanisms and cycling of inorganic and organic materials. Chloride however, a conservative compound that was expected to behave similarly, was approximately equal between the two time periods in all Demonstration Basins.

A clear trend in phosphorous removal or concentration is not apparent in the Tres Rios Demonstration Basin data. Mean concentrations of PO_4-P were greater in Year-1 in each basin except C2, where it was greater during the second year of operations. A trend in Total-P is even more unclear. In H1, Total-P was greater the first-year, in H2 the two year means were close to equal, and in the Cobble Site, both basins exhibited larger mean Total-P concentrations in Year 2. Higher Total-P in the Hayfield site during the first-year could suggest leaching from the site sediments which were historically used for agriculture. One would not to expect to see this in the Cobble Site however, because the bottom material is sand, gravel, and cobble. The Year 2 increase in Total-P observed in the Cobble Site Wetlands could be due to liberation of phosphorous from decaying vegetation.

Chemical oxygen demand was greater during the first-year of operation in the Hayfield site basins, but approximately equal for both years in the Cobble. The same can be said of TOC, except that the only basin exhibiting no change between Year 1 and Year 2 was Cobble Basin C1. An increase in COD, TOC, and for that matter, cBOD was expected as the systems mature, but this has not been the case. The lack of concentration of these constituents could imply, among other things that the systems have not reached maturity, or that lightly-loaded, arid land wetlands may not behave as do those found in higher latitudes or are operated under higher mass loadings. Unfortunately, time is what is probably needed in order to provide insight regarding this issue.

Standard deviations were also computed for each parameter for the 1995/96 and 1996/97 data periods. A look at the variability between the two years can provide some insight into those constituents which have stabilized and/or which may need some more time. In all, 13 parameters were considered:

Alkalinity	TSS	TDS	Cl-	TKN	NO_2+NO_3-N
PO_4-P	Total-P	COD	cBOD	NH_4	Total-N
TOC					

Those parameters which had a greater standard deviation during the first-year of operations include TSS, TDS, TOC, and Total-N. Those with larger standard deviations the second year are restricted to PO_4-P and Total-P. The variability in TSS in Year 1 is probably related to vegetative cover, or more specifically, the lack thereof. During plant establishment the first year, in particular the Fall of 1995, plant cover was not as dense as Year 2. This allowed more direct sunlight into the column which likely promoted algae development. More variable first-year TSS measurements could be easily attributed to this phenomena as it is based on the growth and senesce of algae in the water column. Higher variability in the first-year TOC measurements could be a result of leaching from site sediments (particularly the Hayfield). Higher Total-N variability is probably a function of NO_2+NO_3-N buildup during the time period (Aug. 1995 - Jan. 1996) these systems were developing denitrifying conditions.

If one makes the argument that a lower standard deviation implies that the basins are reaching a state of equilibrium, then the Tres Rios Basins are reaching a 2-year equilibrium with respect to solids, salts, organic carbon, and some nitrogen species. Using the same argument, the Tres Rios Basins are in dis-equilibrium with respect to the phosphorous species, alkalinity, COD, cBOD, TKN, and NH_4. Table 1 shows on a basin and parameter-specific basis, which parameters had a greater standard deviation during the second year of operations (1996/97). Care must be taken in using this approach since it does not consider other factors such as operational changes or weather influences.

Table 1. Conventional water quality parameters monitored at the Tres Rios Demonstration Wetlands exhibiting a greater standard deviation during the second year of operations, August 1996 through June 1997.

Basin	Parameter
Cobble Site: Basin C1	Alkalinity, PO_4-P, Total-P, COD
Cobble Site: Basin C2	PO_4-P, Total-P, cBOD
Hayfield Site: Basin H1	TKN, NH_4, PO_4-P, Total-P, cBOD
Hayfield Site: Basin H2	NH_4, PO_4-P, Total-P

Bacterial water quality has degraded at three of the four Demonstration basins from 1995/96 to 1996/97. Interestingly, Hayfield Basin H1 shows an annual mean decrease in both Total Coliform and E. coli bacteria during 1996/97, while C1, C2, and H2 show higher annual averages. The premise that bacterial quality is related to wildlife usage can probably be justified at the Tres Rios Demonstration Wetlands.

Finally, biomonitoring using *Cerriodaphnia dubia* as a test organism has shown an absence of true toxicity in the wetland effluents for both year 1 and year 2. Reproduction of test organisms in wetland effluent has not changed appreciably form year to year either. However, more sensitive test organisms do indicate toxicity in the wetland effluents in dilution's as low as 40%. This information is being collected by the USGS under the guidance of Larry Barber, the results of which are expected to be more fully examined in the November 1997 Technical Advisory Review Panel Meeting.

The remainder of this Report will now provide the bulk of the data collected during the Demonstration Project, August 1995 through July 1997. Data since startup has been included because of its influence on subsequent wetland performance. Both the Hayfield and Cobble Site Demonstration wetlands are considered, and the following sections provide: Hydraulic Operations and Water Balance Results, Physical and Chemical Water Quality, Bacterial Water Quality, Heavy Metals, Biomonitoring, Tracer Testing, Vector Control, Vegetation, and Site Developments. The main body provides summary data and discussions of the above topics, while the appendices provide the reader with complete data sets and graphical representations.

To aide in the interpretation of the water quality data presented herein, the reader is encouraged to make use of plots and data tables located in the Appendices. In particular, Appendix B - Hydraulics, contains long-term plots which show operating conditions for each basin e.g., Hydraulic Loading Rate, Hydraulic Retention Time, and Emergent Area Depth, which can be helpful in interpreting water quality trends. Finally, Appendices D and E provide sets of tables for the Hayfield and Cobble Site Wetlands which include the monthly operational settings and provide the monthly average concentration of all conventional water quality parameters monitored for the 23 month period of record.

Tres Rios Demonstration Wetlands: Hydraulics

Operating Depths

The Research Plan indicated that a range of depths from 0.5 to 2.0 ft. would be tested in the Hayfield and Cobble Site wetland emergent areas. To date, two operational depth phases have been completed at the Hayfield Site Basins (1.0 and 1.5 ft), and one at the Cobble Site (1.0 ft).

Emergent Area depths in the Cobble Site have ranged from 0.43 ft to a maximum of 1.3 feet (Table 2). Much of the operational data has been collected at a depth of approximately 1.0 ft (December 1995 - April, 1997). In April 1997, the Cobble Site depths were reduced to simulate a summer low flow condition. Although the target depth was to be 0.5 ft, flow rates were such that only 0.7 ft could be achieved. A plot of the average emergent area depths for the Cobble site is shown in Appendix B. One can see that depths for April 1997 through July 1997 are variable, a result of vegetation re-establishment efforts undertaken at this site which are detailed later in this paper.

Table 2. Operational depth history for the Cobble Site Basins C1 & C2. Note that during June and July 1997, depths in Basin C2 reflect the drying of that basin to promote bulrush re-growth.

Month	Depth (ft)	Month	Depth	Month	Depth
August 1995	C1 = 0.42 C2 = 0.62	May 1996	C1 = 0.97 C2 = 0.98	Feb. 1997	C1 = 1.03 C2 = 0.98
Sept. 1995	C1 = 0.66 C2 = 0.60	June 1996	C1 = 0.93 C2 = 0.99	Mar. 1997	C1 = 0.94 C2 = 0.97
Oct. 1995	C1 = 1.04 C2 = 0.92	July 1996	C1 = 0.75 C2 = 1.00	Apr. 1997	C1 = 0.61 C2 = 0.84
Nov. 1995	C1 = 0.85 C2 = 0.73	August 1996	C1 = 1.05 C2 = 0.98	May 1997	C1 = 0.60 C2 = 0.77
Dec. 1995	C1 = 1.00 C2 = 0.97	Sept. 1996	C1 = 1.09 C2 = 0.99	June 1997	C1 = 0.74 C2 = 0.14
Jan. 1996	C1 = 0.99 C2 = 0.98	Oct. 1996	C1 = 1.36 C2 = 1.33	July 1997	C1 = 0.63 C2 = 0.29
Feb. 1996	C1 = 1.02 C2 = 0.99	Nov. 1996	C1 = 1.01 C2 = 0.99		
Mar. 1996	C1 = 0.98 C2 = 0.98	Dec. 1996	C1 = 0.98 C2 = 0.99		
Apr. 1996	C1 = 0.96 C2 = 0.98	Jan. 1997	C1 = 1.03 C2 = 0.99		

Hayfield Site depths have been maintained in a more strict regime. Monthly average depths for these two basins are shown in Table 3. As can be seen, three distinct operating periods are present. The first four months were used to establish the vegetation and water depths were variable. The first operational depth of 1.0 ft began in December 1995 and continued through February 1997. In April, 1997 basins levels were brought up to 1.5 feet. This depth will be maintained through September 1997 to facilitate a tracer experiment, after which time, levels will be dropped to approximately 0.7 ft where they will remain until at least October 1997.

Table 3. Operational depth history for the Hayfield Site Basins H1 & H2. The startup phase is erratic and includes the first four months. After that time, a steady 1.0 ft depth has been maintained in both basins. In late March and the first of April 1997, depths were lowered as far as loading rate would allow.

Month	Depth (ft)	Month	Depth	Month	Depth
August 1995	H1 = 1.09 H2 = 1.19	May 1996	H1 = 0.99 H2 = 1.00	Feb. 1997	H1 = 0.99 H2 = 0.99
Sept. 1995	H1 = 0.47 H2 = 0.57	June 1996	H1 = 0.99 H2 = 0.99	Mar. 1997	H1 = 1.02 H2 = 1.18
Oct. 1995	H1 = 0.88 H2 = 1.04	July 1996	H1 = 1.03 H2 = 1.01	Apr. 1997	H1 = 1.46 H2 = 1.47
Nov. 1995	H1 = 0.67 H2 = 0.85	August 1996	H1 = 1.00 H2 = 1.00	May 1997	H1 = 1.50 H2 = 1.50
Dec. 1995	H1 = 0.96 H2 = 0.97	Sept. 1996	H1 = 1.00 H2 = 1.00	June 1997	H1 = 1.51 H2 = 1.50
Jan. 1996	H1 = 0.98 H2 = 0.98	Oct. 1996	H1 = 0.97 H2 = 0.98	July 1997	H1 = 1.50 H2 = 1.49
Feb. 1996	H1 = 0.99 H2 = 0.98	Nov. 1996	H1 = 0.98 H2 = 0.99		
Mar. 1996	H1 = 0.98 H2 = 0.99	Dec. 1996	H1 = 0.99 H2 = 0.99		
Apr. 1996	H1 = 0.97 H2 = 1.00	Jan. 1997	H1 = 0.98 H2 = 0.99		

Depth (Conjectures)

1. Higher depths allowed more fish to access dense growth in bank areas. This is probably a transient condition since macrophytic growth will likely move up the bank fill those areas in. It does however contribute to mosquito larval control in that newly inundated areas are less dense and allow mosquito fish access. Further, it allows, at least for a period of time, fish to have access to all sides of the vegetated zones.

2. Greater depths allow easier access to wildlife that wish to utilize islands.

3. Depth change (1.0 - 1.5 ft) did not appear to impact the detention time of tracer material in basin H1(trials indicate that τa is roughly 78% of the nHRT), but the degree of mixing was greater at 1.5 ft depth. In basin H2, preliminary tracer results indicate that both detention time and mixing characteristics were a function of depth.

4. Basin C1 has more storage upstream than the downstream sections.

5. Depth can be significantly altered by wildlife such as that seen by Beaver in H2.

6. Depth has not had an impact on the water quality parameters monitored to date. Since depth has not been varied over a broad range, this statement should be used with caution.

Hydraulic Loading Rate & Nominal Hydraulic Retention Time (HLR & nHRT)

Definitions:

Hydraulic loading rates for the Tres Rios Demonstration Wetlands are based upon inlet flow rate, e.g.

$$HLR = (\text{Inlet Flow Rate}) / (\text{Surface Area of Basin}) \quad [L/Time].$$

Nominal hydraulic loading rates have been defined as,

nHRT = (Basin Volume)/(Inlet Flow Rate) [time].

Cobble Site
Basin C1 has received a range of HLR's from 0.7 ft/d to a maximum of 2.5 ft/d. From a historical perspective, Basin C1 received a HLR of 1.1 ft/d from November 1995 through March 1996, 0.9 ft/d from April 1996 through July 1996, 0.7 ft/d from August 1996 through October 1996, 1.2 ft/d from November 1996 through April 1997, 1.1 ft/d during May and June 1997, and as of July 1997 C1 was receiving 2.5 ft/d. C1 loading rates were higher than all other basins due to the high infiltration losses associated with this un-lined basin, and the latest HLR reflects a vegetation maintenance strategy.

Basin C2 has been operated such that two distinct periods are discernible. The first period (0.2 ft/d) started in February 1996 and lasted through September 1996. The second period (approx. 0.9 ft/d) lasts from November 1996 through May 1997. After that time, hydraulics were manipulated to optimize re-growth of vegetation. A complete listing of monthly average HLR for the Cobble Site Basins are supplied in Appendix B, while nominal hydraulic retention times (nHRT) corresponding to these loading rates are presented in Table 4.

Table 4. Monthly average nominal hydraulic retention times for the Cobble Site Operations, August 1995 - July 1997. Note, vegetation management resulted in unequal retention times during June and July, 1997. (NR = Not Recorded)

Month	nHRT (d)	Month	nHRT (d)	Month	nHRT (d)
August 1995	C1 = NR	May 1996	C1 = 1.5	Feb. 1997	C1 = 2.0
	C2 = NR		C2 = 7.0		C2 = 2.0
Sept. 1995	C1 = NR	June 1996	C1 = 1.5	Mar. 1997	C1 = 2.0
	C2 = NR		C2 = 6.9		C2 = 2.0
Oct. 1995	C1 = 1.2	July 1996	C1 = 1.4	Apr. 1997	C1 = 2.1
	C2 = 2.2		C2 = 6.8		C2 = 2.0
Nov. 1995	C1 = 1.9	August 1996	C1 = 1.1	May 1997	C1 = 1.8
	C2 = 3.7		C2 = 7.1		C2 = 2.0
Dec. 1995	C1 = 1.7	Sept. 1996	C1 = 1.1	June 1997	C1 = 1.7
	C2 = 4.1		C2 = 6.7		C2 = 6.2
Jan. 1996	C1 = 1.9	Oct. 1996	C1 = 1.2	July 1997	C1 = 4.1
	C2 = 5.6		C2 = 1.4		C2 = 12.0
Feb. 1996	C1 = 1.8	Nov. 1996	C1 = 2.0		
	C2 = 7.6		C2 = 2.0		
Mar. 1996	C1 = 1.5	Dec. 1996	C1 = 2.0		
	C2 = 6.9		C2 = 2.0		
Apr. 1996	C1 = 1.5	Jan. 1997	C1 = 2.0		
	C2 = 6.7		C2 = 2.0		

The loading rates applied to the Hayfield basins are more typical of constructed treatment wetlands than those of the Cobble Site. After hydraulic control was obtained from the planting contractor in October, 1995, the Hayfield site has been operated at HLR's between 0.2 and 0.5 ft/d. Loading rates to both H1 and H2 were coordinated in February 1996 at 0.2 ft/d. This rate was continued in H1 until August 1996, and in H2 until July 1996. In September 1996, H1 loading was increased until a 0.5 ft/d rate was achieved. HLR to H2 was increased to 0.3 ft/d in July and stayed that way until September 1996 when a gradual increase to 0.4 and ultimately to 0.5 ft/d was accomplished. Both H1 and H2 have had a constant 0.5 ft/d loading rate since November 1996. Graphical and tabular forms of this information are available in Appendix B, while the corresponding operational monthly average nHRT's corresponding to these loading rates are presented in Table 5.

Table 5. Monthly average nominal hydraulic retention times (nHRT) for the Hayfield Site Operations, August 1995 - July 1997. (NR = Not Recorded)

Month	nHRT (d)	Month	nHRT (d)	Month	nHRT (d)
August 1995	H1 = NR H2 = NR	May 1996	H1 = 7.4 H2 = 7.0	Feb. 1997	H1 = 3.4 H2 = 3.2
Sept. 1995	H1 = NR H2 = NR	June 1996	H1 = 7.3 H2 = 7.0	Mar. 1997	H1 = 3.4 H2 = 3.3
Oct. 1995	H1 = 5.5 H2 = 3.1	July 1996	H1 = 6.8 H2 = 6.6	Apr. 1997	H1 = 3.4 H2 = 3.3
Nov. 1995	H1 = 4.6 H2 = 2.9	August 1996	H1 = 4.3 H2 = 6.6	May 1997	H1 = 4.3 H2 = 4.1
Dec. 1995	H1 = 5.6 H2 = 4.1	Sept. 1996	H1 = 3.3 H2 = 6.6	June 1997	H1 = 4.3 H2 = 4.1
Jan. 1996	H1 = 7.7 H2 = 4.9	Oct. 1996	H1 = 3.3 H2 = 4.2	July 1997	H1 = 4.3 H2 = 4.1
Feb. 1996	H1 = 8.3 H2 = 7.8	Nov. 1996	H1 = 3.4 H2 = 3.3		
Mar. 1996	H1 = 7.0 H2 = 7.0	Dec. 1996	H1 = 3.4 H2 = 3.3		
Apr. 1996	H1 = 7.2 H2 = 7.1	Jan. 1997	H1 = 3.4 H2 = 3.3		

Loading Rate (Conjectures)

1. Loading rate appears important with respect to wetland startup. Systems receiving high loading rates (0.9 - 1.1 ft/d) took longer to establish denitrifying conditions than those receiving more conventional rates (0.2 - 0.4 ft/d).

2. Loading Rate may also have had an impact on CS vegetation. High HLR resulted in large mass loading of Chlorine.

Evapotranspiration (Et) Losses

Evapotranspiration is not measured at the site, rather an approximation is obtained from the Arizona Meteorological Network (AZMET) weather station located 1 mile North of McDowell Rd. on Cotton Lane in Litchfield Park, Arizona. AZMET provides reference evapotranspiration values (Eto) which are determined using a weather-based model known as the Penman Equation. Eto can be converted to "actual" evapotranspiration using a multiplicative factor know as a "crop-coefficient" (Kc). Because the wetlands are continuously saturated, the assumption that Kc = 1.0 is used.

Since Et is estimated from off-site, the rates are applied equally to all basins subject to the amount of surface area each basin possesses. Table 6 indicates the percentage lost to Et. Note they are identical with the exception of Cobble Basin C1. This is the un-lined basin that at times loses up to 75% of the incoming water to infiltration and may indicate an error in estimating the basin surface area or other factors used in the water balance.

Infiltration Losses

Infiltration losses are solved for from the water balance. At the Hayfield Site Basins, infiltration losses have been extremely stable since startup. This site is characterized by fine sediments deposited during flood events of the Salt River. Long-Term average infiltration loss from Basin H1 = 0.06 ft/d, while Basin H2 = 0.09 ft/d. These rates are very similar to that experienced by the lined Cobble Basin C2 = 0.06 ft/d. The other Cobble Basin (C1), located within the Salt River Floodway and constructed on well-draining sand, gravel, and cobble has behaved differently. In the long-term, C1 has lost an average of 0.74 ft/d to subsurface flow. At times, this represents almost 75% of the incoming wastewater. Interestingly, this basin (C1) has an unsaturated zone directly beneath it. This was substantiated in April 1997 when subsurface sampling devices were installed by USGS and Tres Rios staff. At that time, the subsurface was saturated to approximately 3 feet below the sediment surface, and then unsaturated to the local groundwater table (approx. 13 feet below ground surface.).

Table 6. Hydraulic losses (% of Influent) from the Cobble and Hayfield Site Basins From 10/95 - 7/97. Note, the Et data are obtained from AZMET and their Litchfield Park, AZ weather-station, while infiltration is estimated from the water balance.

Loss	C1 (Un-Lined)	C2 (Lined)	H1	H2
Surface Flow	19%	87%	80%	71%
Evapotranspiration	3%	4%	4%	4%
Infiltration	72%	8%	16%	19%

One will notice that H1 is the only basin where the losses add to 100%. This could be the result of poor outlet measurements, e.g. misreading the weir staff gage or taking a reading during filling or draining. It was also discovered that at times, inlet flows at the pump station were changed before readings were taken at the basin outlets. Additionally, errors can be introduced into the water balance because Et is estimated and then a rate developed based upon the wetted surface area of a given basin. If this rate or area are incorrect, it could conceivably influence the water balance, and result in the findings presented in Table 6.

One of the more interesting infiltration patterns noted at the Tres Rios system is that of the un-lined Cobble basin C1. During startup, infiltration rates were extremely high (estimated at 6 ft/d). After filling and vegetation establishment the first year (Fall 1995), the basin began to seal itself and infiltration losses dropped to an estimated 1.68 ft/d on 10/18/95 and further to 0.892 ft/d one month later. This trend continued through February 1996, and reached a minimum of 0.4 ft/d. Subsequently, infiltration rates began to increase throughout the summer (1996), and reached a sustained maximum of almost 1.5 ft/d from late July 1996 through October 1996. During the winter of 1996/1997, the C1 infiltration rate dropped considerably and has remained steady at approximately 0.7 ft/d throughout the Spring and Summer of 1997.

Of interest is the fact that the time period of increased infiltration coincides with the time of vigorous bulrush growth. If one assumes that the initial sealing of C1 was due to organic and inorganic deposition which filled voids in the bottom material, one might propose that the vigorous vegetative growth disrupted this layer and kept these spaces free. This would explain the winter sealing, and summer increase in infiltration. Lending justification to this argument is that during the Summer of 1997 bulrush growth in the Cobble Site was extremely reduced when compared to the Summer 1996 growing season. During that time, May 1996 through July 1996, C1 experienced an average infiltration loss of 0.97 ft/d, while for the same time period in 1997, C1 only averaged 0.65 ft/d rate.

Tres Rios Demonstration Wetlands: Temperature, pH, Dissolved Oxygen (DO), & Electrical Conductivity Results

Temperature

Temperature measurements are made at the inlet and outlet of each Demonstration Basin (C1, C2, H1, H2, & HS) biweekly. These measurements are recorded approximately 4 inches below the water surface with a Hanna pH/Temperature meter. Data presented in this report have been reduced to monthly averages for the time period August 1995 through July 1997. For the Demonstration Project period of record, maximum water temperatures have been recorded at the inlet structures to both sites, CS Inlet Max. = 31.8 °C, and HS Inlet Max. = 32.8 °C, which reflects the thermal character of the conventionally treated wastewater used.

Minimum temperatures at these two points are identical CS Inlet = HS Inlet = 22.2 °C. After conventional treatment, wastewater temperatures tended to drop due to evaporation, evapotranspiration and shading while within the treatment wetlands. Table 7 provides the average, maximum, and minimum difference in water temperature between the inlet and outlet structures.

Table 7. Temperature difference (°C) between wetland inlet and outlets for the Tres Rios Demonstration Basins. The dates maximum and minimum differences occurred are provided in ( ).

Statistic	Basin C1	Basin C2	Basin H1	Basin H2	HS EFF
Average	7.9	8.1	8.5	8.2	8.4
Maximum Difference	13.5 *(12/96)*	14.3 *(1/96)*	14.4 *(1/96)*	13.2 *(1/96)*	13.6 *(1/96)*
Minimum Difference	0.7 *(8/95)*	3.1 *(8/95)*	0.8 *(8/95)*	1.0 *(8/95)*	0.0 *(8/95)*
	4.8 *(7/97)*	4.9 *(5/97)*	4.1 *(7/97)*	4.3 *(7/97)*	3.6 *(9/95)*

The overall average temperature difference between wetland inlets and outlets is approximately 8 °C, with Basin C1 having the least amount of difference at 7.9 °C, and Basin H1 having the greatest at 8.5 °C. The maximum inlet/outlet differences in temperature all occurred in January 1996 for basins C2, H1, H2, while the C1 maximum temperature difference occurred in 12/96. Minimum temperature differences all occurred during startup in August, 1995. After almost two years of operation, the minimum temperature difference at the C1, H1, and H2 occurred during July 1997, with a minimum difference at C2 recorded during May 1997.

Maximum temperature differences appear to occur during the winter months (high temperature effluent from Plant 3A, subsequent cooling in wetland), while the minimum temperature difference occurs during the summer. In fact, temperature differences between inlet and outlet is related to the time of year and maybe to the amount of vegetative cover (at least during vegetation startup). As can be seen in Table 7, the minimum temperature difference occurred during August 1995, just after startup. At this time, the vegetation was just beginning to cover and shade the water surface. As the macrophytes established themselves, the temperature differences grew greater. Currently, the minimum temperature difference is almost 4.5 times less than that during startup.

On an annual basis, all flows (inlet and outlet) from all Demonstration wetland basins exhibit a temporal pattern. At the Cobble Site Inlet, Maximum water temperatures occurred in August 1995 and 1996, while minimum water temperatures occurred in January 1996, and February 1997. Cobble Site outlet temperatures were maximum during August 1995, and July 1996, while minimum temperatures were recorded in January 1996, and January 1997. Monthly maximum and minimum temperatures at the Hayfield Site Inlet were recorded during the same months as the Cobble Site. These data are presented in Tabular and Graphical form in Appendix C.

pH

For the first year, pH measurements were obtained daily at the Inlet and Outlets of all Demonstration Basins. In August, 1996, this practice was curtailed to twice a week. These measurements are made in moving water approximately 4 inches below the surface. Data presented in this report represent the monthly averages obtained.

After 24 months of operation the Cobble Site monthly average inlet and outlet pH values are all circumneutral which is also the case at the Hayfield site. The highest pH values obtained for both sites occurred during startup in the Fall of 1995. At this time, the emergent vegetation had not filled-in and shaded the basins. As a result, algae production was high which could have caused slightly alkaline pH measurements to be obtained. Table 8 gives a summary of the monthly average, and extreme pH values for both the Cobble and Hayfield Site wetlands.

Table 8. Average, Maximum, and Minimum monthly-average pH values for inlet and outlet flows at the Tres Rios Demonstration Basins. Months where extremes occurred are in ( ).

Statistic	CS Inlet	C1	C2	HS Inlet	H1	H2
Average	6.9	7.2	7.3	7.0	7.1	7.2
Maximum	7.1 *(12/95, 1/96, 11/96, 12/96, 2/97)*	7.9 *(9/95)*	8.5 *(8/95)*	7.1 *(1/96, 11/96)*	8.0 *(8/95)*	8.4 *(8/95)*
Minimum	6.8 *(7/96, 8/96, 9/96, 10/96, 7/97)*	6.9 *(9/96)*	7.0 *(5/96, 6/96, 7/96, 8/96, 9/96, 10/96)*	6.8 *(9/95, 9/96)*	6.8 *(8/96, 9/96)*	6.9 *(9/96, 10/96)*

A complete listing of monthly inlet and outlet pH average values is provided in Appendix C, as are long-term average and raw data plots covering the time period from August 3, 1995 through August 1, 1997.

Dissolved Oxygen (D.O.)

Dissolved oxygen measurements are typically obtained in the first 1 to 3 hours after sunrise. As such, the values recorded may be biased low, due to the diurnal D.O. sag experienced during the night. These measurements were all made with a YSI D.O. meter in moving water approximately 4 inches below the surface.

Table 9 provides the average, maximum, and minimum of all 24 average monthly D.O. values. Upon inspection one sees that the highest D.O. levels were recorded at HS EFF, the combined discharge point of the Hayfield Site. This point has consistently high D.O. readings which are attributable to the elevation difference between wetland outlets (H1 & H2 EFF) and the combined measurement point, HS EFF (approx. 15 ft.).

Table 9. Summary of the monthly average D.O. readings obtained at the inlets and outlets of the Cobble and Hayfield Site Wetlands. Months where extremes occurred are denoted in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF	HS Inlet	H1 EFF	H2 EFF	HS EFF
Average	3.9	3.2	2.5	3.5	2.4	2.0	6.3
Maximum	8.3 *(10/95)*	12.1 *(12/95)*	8.5 *(12/95)*	6.2 *(10/95)*	7.9 *(1/96)*	5.8 *(1/96)*	11.6 *(12/95)*
Minimum	2.7 *(7/96, 4/97)*	0.2 *(6/96, 7/96)*	0.2 *(7/96)*	2.5 *(7/96)*	0.2 *(7/96)*	0.3 *(7/96)*	3.4 *(6/96)*

As with the temperature extremes, the D.O. follows a temporal pattern. In general, the highest wetland effluent D.O. values are recorded in December and January, while the lowest appear to occur during the summer months. An explanation could be that at higher summer water temperatures the solubility of oxygen is decreased, and the aerobic biological activity is high which would result in low D.O. readings.

When inspecting plots of the monthly average inlet and outlet dissolved oxygen (see Appendix C), three distinct periods are apparent. First, the startup phases in both Demonstration Sites are characterized by the largest D.O. readings collected. This period lasted from August 1995 through approximately May/June 1996. After this time one can see the first of two D.O. sags which correspond to the first (1996) and second (1997) summer low D.O. periods. During the first year of operations, these appear to begin in March/April, 1996 and last through October, 1996. The second year is not complete, but the low D.O. period again seems to begin around March, 1997 and has stayed depressed to date. At both sites, a rise in D.O. is apparent from roughly November through February, and can be seen in both years with the first-year being much more pronounced than year 2. This trend can also be readily seen in the plots of the raw D.O. data included in Appendix C.

Conductivity

Conductivity measurements are obtained from the inlet and outlets of the Demonstration basins at the time the other physical parameters are measured. A summary of monthly average conductivity measurements are provided in Table 10.

Table 10. Long-Term Average, maximum, and minimum Conductivity measurements (υS/cm) for the inlet and outlets at the Hayfield and Cobble Site Demonstration Wetlands. The time-period includes October 1995 through July 1997 and the months in which extremes occurred are denoted in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF	HS Inlet	H1 EFF	H2 EFF
Average	1514	1528	1550	1511	1556	1540
Maximum	1853 *(7/97)*	1970 *(7/97)*	1992 *(7/97)*	1814 *(7/97)*	1875 *(7/97)*	1850 *(7/97)*
Minimum	1364 *(11/95)*	1373 *(11/95)*	1356 *(1/97)*	1363 *(11/95)*	1381 *(11/95)*	1371 *(11/95)*

Monthly average conductivity at the inlets is only slightly smaller than the outlets, while the maximum difference is at the Hayfield site where H1 EFF is 45 υS/cm higher than the inlet. In all cases, the increase should be expected due to the evaporative concentration of anions and cations. Maximum monthly average conductivity measurements at both inlets and outlets occurred in July 1997. Apparently, this reflects an overall increasing trend in TDS noted at both the conventional treatment works (91st Ave. WWTP) and the treatment wetlands. With the exception of C2 EFF, minimum conductivity was recorded during November, 1995.

Tabular summaries and graphical displays of these data are located in Appendix C. Plots of conductivity for the Cobble and Hayfield sites each show a similar pattern, one which depicts a gradual increase beginning October 1995. By May 1996, this trend increased somewhat and continued through September/October, 1996. The summer increase is likely caused by increased evapotranspiration, hence increased concentration of salts. From November, 1996 through April, 1997 the trend is somewhat constant, however, from May 1997 - July 1997, conductivity at both sites increased dramatically (approx. 400 υS). As stated above, this apparently coincides with findings that TDS has increased in the wastewater delivered to the 91st Avenue WWTP.

Tres Rios Demonstration Basin Physical Parameters: Diurnal variation in Temperature, pH, D.O. and Conductivity

Diurnal monitoring was conducted in February, 1997 to assess what if any patterns could be discerned between daylight and nighttime for the Demonstration Basins of the Hayfield and Cobble Sites. The parameters measured include: Temperature, pH, D.O., and Conductivity. The actual measurements were made on February 21 and 22, 1997 during the following time periods:

Cobble Basins	Hayfield Basins
2/21/97 2:30pm	2/21/97 2:50pm
2/22/97 12:30am	2/22/97 1:00am
2/22/97 6:00am	2/22/97 6:15am
2/22/97 2:30pm	2/22/97 3:15pm

In general it is easier to see a diurnal trend in the Cobble Site data. It could be that since this site is less densely vegetated and more exposed than the Hayfield, that the forces which bring about diurnal fluctuations (temperature, solar intensity, wind) are also more pronounced. A series of plots are located at the end of Appendix C which present these data for both the Hayfield and Cobble Site Wetlands.

In the Cobble Site, diurnal fluctuations in Temperature, D.O., and conductivity all exist. Temperature fluctuates such that the highest temperatures occur during the daylight hours, while minimum temperatures are present at night. The same can be said for pH, low (acidic) at night, and high (alkaline) during the day. This can likely be explained by biological activity. During the day, algae are producing O_2, and consuming CO_2. The loss of CO_2 affects the carbonate equilibrium which causes a shift to the left (consuming $[H^+]$) and results in higher pH values. Conversely, at night the algae will consume O_2 and produce CO_2. The CO_2 production causes a shift to the right (adding $[H^+]$) which lowers the pH. Interestingly, the only parameter monitored that exhibited an increase at night was the conductivity. Inspection of the Cobble Site Diurnal conductivity plot shows this trend is not only apparent at the wetland outlets, but in the influent as well. At the Hayfield Site, diurnal patterns were less obvious, but nonetheless present.

Tres Rios Demonstration Basins: Monthly Water Quality Performance

Water quality performance is based upon the sampling and analysis of the following wastewater constituents:

Alkalinity	PO_4-P
TSS	Total-P
TDS	COD
Cl^-	cBOD
TKN	NH_4-N
NO_2+NO_3-N	TOC

From August 1995 through July 1996, the above parameters were sampled for on a weekly basis and the data were reduced to a monthly average. After that time, sampling frequency was switched to once per month which is used to represent the overall monthly water quality exiting a given wetland basin.

Water quality samples were collected as "grabs" upstream of both the inlet and outlet weirs, approximately 4 to 6" below the water surface. At the Cobble Site the sample points include CS Inlet, C1 EFF, and C2 EFF, while at the Hayfield Site the points are HS Inlet, H1 EFF, and H2 EFF. HS EFF is the combined discharge point for the Hayfield site, and is sampled as a QA/QC step (see aerial photographs of sample points in Appendix A). All analyses except TKN are conducted at the City of Phoenix Compliance Laboratory adhering to chain of custody procedures and standard methods for the examination of water and wastewater.

The following text will present a monthly average summary of the weekly and monthly water quality data obtained. A complete set of tables and plots of these data are provided in Appendix D for the Cobble Site and Appendix E for the Hayfield Site.

Cobble Site Results

Alkalinity

Alkalinity has varied between 150 and 200 mg/L since startup. A slight increase is noted during the summer of 1996 and is probably due to evaporative concentration.

On a monthly basis, outlet alkalinity averaged slightly higher than the inlet. For the 23 month period, the average inlet alkalinity was 175.2 mg/L, while the outlet alkalinity averaged C1 = 181.9 and C2 = 177.5 mg/L. The difference between maximum and minimum monthly average alkalinity was reasonably constant at the Cobble Site Inlet and C2 EFF (approx. 46 and 43 mg/L respectively), but C1 EFF was less, 34 mg/L. Table 11 shows a summary of these data.

Table 11. Cobble Site long-term monthly average and extreme Alkalinity (mg/L) results for the 23 month period beginning in August, 1995. Months where extremes occurred are denoted in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	175.2	177.5	181.9
Maximum	202.3 *(9/95)*	196.0 *(3/97)*	202.0 *(8/96)*
Minimum	156.0 *(6/97)*	161.8 *(10/97)*	158.6 *(1/96)*

Total Suspended Solids (TSS)

Monthly TSS concentrations at the Cobble Site basins have, for the most part been below 10 mg/L until May 1996, after which, they have been below 5 mg/L with only one excursion. The excursion occurred during the month of July 1996 at the outlet to C1 (TSS = 48 mg/L). Table 12 shows the summary data, while tables and plots of the monthly values are located in Appendix D.

Table 12. Cobble Site long-term monthly average TSS values (mg/L) for the period August 1995 through June 1997 with months extremes occurred in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	2.9	4.5	2.2
Maximum	8.0 *(3/96)*	48.0 *(7/96)*	9.0 *(10/95)*
Minimum	1.0 *(8/96)*	0.5 *(9/96, 2/97, 3/97)*	0.5 *(11/96, 1/97, 3/97)*

Total Dissolved Solids (TDS)

If the August 1995 TDS value is left out, monthly TDS concentrations for the Cobble Site basins show a gradual increase from startup through present day operations (approx. 200 mg/L). Also, an increase is notable during the summer of 1996 which is likely a function of evaporative concentration. Table 13 provides summary statistics of the 23 months of TDS values collected at the inlet and outlets of the Cobble Site, while complete a complete data set is presented in Appendix D.

Table 13. Cobble Site long-term average monthly TDS values (mg/L) for the period August 1995 through June 1997. Month(s) extremes occurred in are provided in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	873.1	877.3	885.7
Maximum	986.0 *(6/97)*	962.0 *(6/97)*	1010.0 *(8/96)*
Minimum	769.5 *(10/95)*	751.6 *(10/95)*	766.8 *(10/95)*

Chloride (Cl^-)

Wetland effluent Chloride values at the Cobble Site have closely tracked the inlet concentration. An expected increase due to evaporation is present and is denoted by an average increase in concentration of 1% in C1 and 2% in C2. Also apparent is the overall increase in Cl^- during the summer months which can be seen in plots located in the appendices. Summary statistics of the monthly Cl^- values at the Cobble site are shown in Table 14.

Table 14. Cobble Site long-term average monthly Cl- (mg/L) for the period August 1995 through June, 1997. Month(s) extremes occurred are in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	248.5	252.2	252.1
Maximum	310.0 *(6/97)*	315.0 *(7/96)*	338.0 *(7/96)*
Minimum	189.0 *(2/97)*	192.0 *(2/97)*	196.0 *(2/97)*

Total Kjeldahl Nitrogen (TKN: Organic-N + NH_4-N)

Monthly TKN values for the Cobble Site show that during startup, C1 produced higher TKN values than the inlet, while C2 produced lower. This is likely a function of the wetland "seasoning" period and high HLR delivered to C1 in order to maintain a standing body of water. The C1 trend continued through August 1996, after which time, the inlet has always been higher in TKN than both outlets (see plots in

Appendix D). In general, the wetland effluent has been trending down in TKN since startup. Table 15 provides summary statistics for the monthly data collected through June 1997.

Table 15. Cobble Site long-term average monthly TKN values (mg/L) for the data period August 1995 through June 1997. Months where extremes occurred are provided in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	3.2	1.9	1.6
Maximum	5.4 *(2/96)*	3.7 *(12/95)*	2.4 *(8/95, 9/95)*
Minimum	1.8 *(6/97)*	1.0 *(2/97)*	0.9 *(2/97)*

Nitrite Plus Nitrate Nitrogen (NO_2+NO_3-N)

Nitrite plus nitrate concentrations increased from startup through May 1996 in C1 and from startup through January 1996 in C2. The difference in "seasoning" times for denitrification appears to be related to the HLR. As HLR is increased, the time to develop denitrifying conditions in the wetlands increased. After May 1996, little or no NO_2+NO_3 was observed exiting either of these basins. This continued throughout the summer of 1996 until October when concentrations again began to rise. They reached a peak of close to 2.8 mg/L in December, 1996, and then returned to non-detectable concentrations by March 1997. The peak which occurred during the winter of 1996/1997 may be a function of ; 1) Low temperatures, hence biological activity is at its lowest, 2) High Inlet Loading from the conventional process, and/or 3) Internal generation from the decay of plant biomass. Table 16 provides the summary statistics for Cobble Site NO_2+NO_3-N concentrations , while a complete data set and graphical information is provided in Appendix D.

Table 16. Cobble Site long-term average monthly NO_2+NO_3-N (mg/L) inlet and outlet statistics for the data period August 1995 through June 1997. Months maximum and minimum values were obtained are in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	2.8	2.0	1.7
Maximum	5.4 *(5/96)*	5.6 *(1/96)*	6.3 *(1/96)*
Minimum	1.0 *(9/96, 3/97)*	0.0 *(3/97)*	0.0 *(5/97)*

Ammonia - N (NH_4-N)

Ammonia nitrogen has been effectively transformed or metabolized in the wetland basins since startup. The highest wetland effluent values were obtained during the first month (August 1995) of monitoring, and has continued in a downward trend through June 1997. The Cobble Site inlet NH_4-N concentration shows an overall decreasing trend which can be seen in the plots located in Appendix D. Summary statistics of the monthly NH_4-N values are provided below in Table 17.

Table 17. Cobble Site long-term average monthly NH_4-N (mg/L) statistics for the period August 1995 through June 1997. Note, minimum values for the wetland effluents C1 and C2 are based upon calculating and averaging 1/2 the detection limit (0.5 mg/L). Months where extreme values occurred are shown in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	1.6	0.8	0.6
Maximum	3.1 *(11/95)*	2.3 *(8/95)*	2.6 *(8/95)*
Minimum	0.7 *(6/97)*	0.2 *(6/97)*	0.3 *(13 months)*

Total Nitrogen (Total-N: Organic + NO_2+NO_3-N + NH_4-N)

Total-N exiting the Cobble Site wetlands follows the trend set up by the NO_2+NO_3-N, in that one notes an initial increase throughout the first fall and winter (1995) followed by an abrupt reduction in the Spring and Summer of 1996. Also depicted in long-term plots (Appendix D), is the increase previously noted during the winter of 1996 and 1997. Table 18 provides summary statistics and show that in the long-term, average wetland effluent Total-N values are almost 1/2 of the inlet concentration.

Table 18. Cobble Site long-term average monthly Total-N values (mg/L) for the period August 1995 through June 1997. Months where extreme values occurred are shown in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	6.0	3.9	3.3
Maximum	8.3 *(12/95)*	8.1 *(12/95)*	8.0 *(1/96)*
Minimum	3.8 *(7/96)*	1.2 *(3/97)*	1.0 *(9/96)*

Total Organic Carbon (TOC)

Since startup, a slight increase is notable in TOC exiting the Cobble Site basins. In most cases, TOC in the wetland effluent has been less than 10 mg/L, with three excursions C1 to > 10 mg/l, C1 > 11 mg/L, and C2 > 19 mg/L. Inlet TOC concentrations tracked the outlet concentrations during startup through March 1996, but after June 1996 have been greater (Plot Appendix D). As can be seen in Table 19, the long-term average TOC inlet and outlet concentrations differ by less than 0.5 mg/L.

Table 19. Cobble Site summary of long-term average monthly TOC values (mg/L) for the data period August 1995 through June 1997. Maximum and minimum months are provided in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	9.0	8.6	8.6
Maximum	11.4 *(1/97)*	11.4 *(7/96)*	19.1 *(4/96)*
Minimum	6.5 *(9/95)*	7.0 *(8/95, 9/95, 2/97)*	6.6 *(3/97)*

Carbonaceous Biological Oxygen Demand (cBOD)

Out of 23 months of monitoring, Cobble Site wetland effluent cBOD levels have been below that of those at CS Inlet (see Plot Appendix D). Long-Term monthly averages are CS Inlet = 3.0 mg/L, while C1 EFF = 2.2 mg/l and C2 EFF = 1.8 mg/L (Table 20). It was expected that over time, the wetland would begin to produce a higher internal BOD load, but evidence for this does not yet exist.

Table 20. Cobble Site long-term average monthly cBOD values and summary statistics for the data period August 1995 through June 1997. Note that the detection level was 2.0 mg/L, therefore, values of 1.0 mg/L = 1/2 the detection limit. The months maximum and minimum cBOD concentrations occurred are shown in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	3.0	2.2	1.8
Maximum	5.0 *(2/96, 3/96, 11/96, 1/97)*	8.0 *(7/96)*	3.0 *(3/96)*
Minimum	1.0 *(7/96, 8/96, 10/96, 6/96)*	1.0 *(8/96 - 10/96, 12/96 - 3/97, 6/97)*	1.0 *(8/96, 10/96 - 4/97)*

Chemical Oxygen Demand (COD)

The chemical oxygen demand of waters entering and exiting the Cobble Site wetlands has been fairly constant with a couple of notable exceptions that occurred in C1. In June 1996, October 1996, and April 1997, effluent from C1 had a COD of > 100.0 mg/L with the 10/96 sample > 200 mg/L, (See plot Appendix D). Otherwise, COD values at this site have been close to 50 mg/L. Table 21 presents the average monthly value as well as minimum and maximum, and show that the unlined basin C1 increased in COD, while the lined basin C2 decreased.

Table 21. Cobble Site long-term average monthly COD values (mg/L) and extremes for the data period August 1995 through June 1996. *Note: Detection level for this date = 7 mg/L, and 1/2 that value was used for calculations. Maximum and minimum months are shown in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	44.2	48.9	36.9
Maximum	71.0 *(1/96)*	212.0 *(10/96)*	80.8 *(12/95)*
Minimum	16.0 *(12/96)*	9.0 *(12/96)*	3.5* *(12/96)*

Phosphorous (Total-P and PO_4-P)

Phosphorous, both total and ortho do not change much in character or concentration from inlet to outlet in both Cobble Site basins C1 and C2. Tables 22 and 23 will demonstrate this for the reader, as well as, the plots and tabular data located in Appendix D.

Table 22. Cobble Site long-term average monthly Total-P (mg/L) summary statistics for August 1995 through June 1997. Months where maximum and minimums occurred are shown in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	3.5	3.7	3.9
Maximum	4.7 *(2/97)*	4.7 *(2/97)*	5.8 *(11/96)*
Minimum	1.6 *(11/96)*	1.5 *(9/96)*	2.0 *(3/97)*

Table 23. Cobble Site long-term average monthly PO_4-P (mg/L) concentrations and summary statistics for August 1995 through June 1997. Months where extremes occurred are provided in ( ).

Statistic	CS Inlet	C1 EFF	C2 EFF
Average	3.0	2.9	3.2
Maximum	4.2 *(4/96)*	4.2 *(1/96, 10/96)*	5.1 *(4/97)*
Minimum	0.0 *(1/97)*	0.0 *(1/97)*	0.0 *(1/97)*

Hayfield Site Results

Alkalinity

Alkalinity in the Hayfield Site effluents and inlet flow has varied between 150 and 200 mg/L since startup, with the wetland discharges (H1 EFF and H2 EFF) showing a slight elevation during the summer months, but decreases in the winter (Appendix E). As is shown Table 24, the long-term monthly average of the wetland discharges is approximately 11 mg/L higher than the inlet.

Table 24. Hayfield Site long-term average monthly Alkalinity (mg/L) and summary statistics during the data period August 1996 through June 1997.

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	172.8	181.9	180.1
Maximum	186.5 *(4/96)*	202.8 *(6/96)*	202.0 *(8/96)*
Minimum	148.0 *(12/95)*	140.0 *(12/95)*	153.8 *(10/95)*

At the Hayfield Site Inlet and outlets, Alkalinity appears to be influenced on a temporal basis. Maximum values occur in the summer months, while minimums occur in the winter. As was seen at the Cobble Site, this is likely due to evaporative concentration during high temperature/solar intensity time periods.

Total Suspended Solids (TSS)

As a general comment, TSS has been decreasing since startup (See plot in Appendix E). Initial monthly average effluent TSS values for both H1 and H2 were greater than 9.0 and 12.0 mg/L respectively. These levels dropped to below 4.0 mg/L in April 1996, and for the most part, have stayed equal to or below 2.0 mg/L since July 1996. The long-term monthly average shows a difference between inlet and outlets of less than 0.5 mg/L (Table 25).

Table 25. Hayfield Site long-term monthly average TSS values and statistics (mg/L) for the period August 1995 through June 1997. Monthly maximum and minimum dates are provided in ( ).

Statistic	HS Inlet	H1	H2
Average	3.2	2.8	2.5
Maximum	9.0 *(3/96)*	9.0 *(8/95)*	12.3 *(8/95)*
Minimum	1.0 *(6/97)*	0.5 *(8/96,11/96,1/97 - 4/97)*	0.5 *(1/97, 2/97)*

Inspection of Table 25 shows that the maximum TSS concentrations exited the Hayfield Site basins during the first month of operations. At this time, vegetation was still being established and a large percentage of the water surface was exposed to direct sunlight. This condition likely promoted the growth of algae in the water column which were detected as suspended solids.

Total Dissolved Solids (TDS)

As shown on a plot of Hayfield Site TDS in Appendix E, the concentration between inlet and outlets do not differ greatly. However, the curves diverge during the summer months due to evaporative concentration, with the inlet having less TDS than the outlet discharges. In an overall sense TDS has been increasing in both the source water and wetland discharges. Inspection of Table 26 shows that the maximum TDS concentration recorded at all sample points occurred in June 1997, while the minimum values occurred two months after startup (10/95).

Table 26. Hayfield Site long-term monthly average TDS statistics (mg/L) for startup through June 1997. The month(s) that extreme values occurred are provided in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	872.6	898.3	895.2
Maximum	978.0 *(6/97)*	1030.0 *(6/97)*	1020.0 *(6/97)*
Minimum	761.2 *(10/95)*	732.8 *(10/95)*	741.0 *(10/95)*

Chloride (Cl^-)

Plots of Chloride show almost a sinusoidal pattern with maximum occurring during the summer and minimum occurring during the winter months (Appendix E). This is very likely an evaporative concentration, as Cl^- is typically considered a conservative constituent. A look at the percent increase of the Cl^- in the outlets versus the inlets shows that H1 is 4% and H2 is 5% more concentrated. This is a little higher than that observed at the Cobble site and a possible explanation may be that since the Hayfield Site basins appear to have more dense vegetated stands, evapotranspiration is higher, hence the concentration of a conservative element should also be higher.

On a long-term monthly average basis, the Hayfield basins show an average increase in Cl^- over the inlet of 13 mg/L. Interestingly, the maximum Cl^- values occur at the same time the TDS did, June 1997 (Table 27).

Table 27. Hayfield Site long-term monthly Cl^- summary for the period August 1995 through June 1997. The times maximum or minimum values were obtained are shown in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	246.5	260.5	258.3
Maximum	317.0 *(6/97)*	322.0 *(6/97)*	326.0 *(6/97)*
Minimum	180.0 *(1/97)*	195.0 *(2/97)*	197.0 *(2/97)*

Total Kjeldahl Nitrogen (TKN: Organic-N + NH_4-N)

TKN concentrations leaving the Hayfield Site wetlands have always been below that of the inlet (Plot in Appendix E). For the 23 month period of record, wetland effluent TKN has shown a gradual decrease from startup through April 1997. Departures from this trend occurred in Basin H1 in April and May 1997, and in Basin H2 during 7/96, 10/96, and 5/97. As can be seen in Table 28, effluent TKN concentrations are approximately 1/2 of the inlet on a long-term average basis.

Table 28. Hayfield Site TKN long-term monthly average and summary statistics for the data period August 1995 through June 1997. Months exhibiting extremes are shown in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	3.2	1.4	1.5
Maximum	4.2 *(12/95)*	2.2 *(5/97)*	2.1 *(8/95)*
Minimum	1.7 *(6/97)*	0.9 *(9/96)*	1.0 *(12/96)*

Nitrite Plus Nitrate Nitrogen (NO_2+NO_3-N)

The inorganic forms of nitrogen, NO_2+NO_3-N have varied in the inlet and outlet streams of the Hayfield site from non-detectable to > 5.0 mg/L (See plot in Appendix E). The initial stages show a startup phenomena in which denitrifying conditions were not present. This resulted in a buildup of NO_2+NO_3-N from August 1995 through January 1996. Subsequently, NO_2+NO_3-N concentrations in the wetland effluents dropped dramatically. These levels stayed depressed through September 1996, after which, they increased to almost 4.5 mg/L. The second buildup incorporated the time period from October 1996 through February 1997, and is probably a temperature effect. Low temperatures cause decreased biological activity, hence low denitrification rates.

On a long-term monthly average basis, the wetland effluents have been approximately 1.0 mg/L less than the inlet. Maximum NO_2+NO_3-N concentrations from the wetland basins occurred during the winter of initial startup (12/96, 1/97), and are probably a function of the wetland "seasoning" period, and reduced biological activity. Minimum concentrations are noted during the spring and summer months (Table 29).

Table 29. Hayfield Site NO_2+NO_3-N long-term average monthly concentration and summary statistics (mg/L) for the data period August 1995 through June 1997. Times when maximum or minimum values occurred are shown in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	2.7	1.7	1.7
Maximum	5.5 *(2/97)*	5.0 *(1/96)*	5.3 *(1/96)*
Minimum	0.8 *(9/96)*	0.0 *(5/97)*	0.0 *(5/97)*

Ammonia-N (NH_4-N)

Ammonia nitrogen has been consistently and efficiently transformed or removed in the Hayfield Wetland basins since startup in August 1995 (See Plot in Appendix E). The highest NH_4-N concentrations were observed in May 1997 and could be a function of several: 1) Source water (Plant 3A) [NH_4-N] increased in 5/97, 2) Plant biomass from winter senescence was actively decomposing which could be liberating NH_4-N, and 3) A depth change from 1.0 to 1.5 ft occurred during April and May 1997 which may or may not have had an impact on NH_4-N.

From a monthly average standpoint, source water to the Hayfield wetlands has been 3 times higher in NH_4-N than the discharges. Maximum wetland NH_4-N effluent concentrations in both H1 and H2 occurred during May 1997 (Table 30).

Table 30. Hayfield Site NH_4-N long-term monthly average and statistics (mg/L) for the data period August 1995 through June 1997. Months in which maximum and minimum concentrations were observed are shown in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	1.8	0.4	0.5
Maximum	3.2 *(11/95)*	2.2 *(5/97)*	2.1 *(5/97)*
Minimum	0.7 *(6/97)*	0.3 *(1/96 - 10/96, 12/96 - 4/97)*	0.2 *(7/97)*

Total Nitrogen (Total-N: Organic-N + NO_2+NO_3-N + NH_4-N)

Total nitrogen concentrations at the Hayfield site reflect the trends shown in the individual nitrogen species plots located in Appendix E. Nitrogen buildup during the initial seasoning period is evident, as is the subsequent decrease caused by denitrification. One can also see the increase in Total-N during the winter of 1996/1997. Lastly, Total Nitrogen at the wetland basins has averaged 3.1 and 3.2 mg/L for H1 EFF and H2 EFF respectively (Table 31).

Table 31. Hayfield Site Total Nitrogen (mg/L) long-term monthly average and summary statistics for the data period August 1995 through June 1997. Months in which extremes occur are provided in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	5.8	3.1	3.2
Maximum	8.4 *(2/97)*	6.9 *(1/96)*	7.1 *(12/96, 1/97)*
Minimum	3.7 *(7/96)*	1.1 *(8/96,9/96)*	1.2 *(5/96, 8/96)*

Total Organic Carbon (TOC)

Hayfield Site inlet and outlet TOC values track one another closely for the majority of the 23 month period of record with the exception of a 7 month period from September 1996 through March 1997. During that time, inlet TOC values were roughly 2.0 mg/L higher than the outlet points (See plot in Appendix E). This time period coincides with a depth of 1.0 feet in the emergent area. In addition this period coincides with a nHRT of approximately 3.0 days with a HRT of 0.5 ft/d. Operations before and after this time period were characterized by a longer retention time, nHRT > 4 days.

On a monthly average basis, the Hayfield Inlet and outlets differ by less than 1.0 mg/L, and the between basin difference is < 0.5 mg/L. Table 32 shows the summary statistics for this parameter.

Table 32. Hayfield Site TOC (mg/L) long-term monthly average and summary statistics for the data period August 1995 through June 1997. Months in which extremes occur are shown in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	9.0	8.2	8.3
Maximum	11.7 *(1/97)*	10.1 *(9/96)*	10.1 *(4/96)*
Minimum	6.5 *(9/95)*	6.6 *(2/97)*	6.6 *(2/97)*

Carbonaceous Biological Oxygen Demand (cBOD)

With the exception of H2 = 5.6 mg/L (Oct. 95) and H1 = 4.0 mg/L (Aug. 1995, Sept. 1996), cBOD from the Hayfield wetlands has been equal to or below 3.0 mg/L (See plot Appendix E). Interestingly, the exceptions noted were also the maximum cBOD concentrations exiting the wetlands (Table 33).

Table 33. Hayfield Site cBOD (mg/L) long-term monthly average and statistic summary for the period August 1995 through June 1997. Months of maximum and minimum cBOD are shown in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	3.2	2.1	1.9
Maximum	6.0 *(11/96)*	4.0 *(8/95, 9/96)*	5.6 *(10/95)*
Minimum	1.0 *(10/96, 3/97, 6/97)*	1.0 *(12/95, 8/96, 10/96 - 2/97, 4/97)*	1.0 *(9/96 - 4/97, 6/97)*

Chemical Oxygen Demand (COD)

Chemical oxygen demand has in general, been below 80 mg/L for both the inlet and outlets. A large exception is notable on the plot of Hayfield COD in Appendix E, which occurred in Basin H2 during December 1995 (H2 = > 120 mg/L COD). Otherwise, inlets and outlets have tracked one another fairly closely. Inspection of Table 34 shows that the long-term monthly average at the Hayfield inlet is only around 3.0 mg/L lower than the outlets. *Note: Detection Level = 7.0 mg/L.

Table 34. Hayfield Site COD (mg/L) long-term monthly average and summary statistics for the period August 1995 through June 1997. Months with maximum and minimum values are provided in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	36.2	39.2	39.8
Maximum	58.0 *(11/96)*	75.5 *(5/96)*	125.0 *(12/95)*
Minimum	16.0 *(12/96)*	3.5* *(12/96)*	3.5* *(12/96)*

Phosphorous (Total-P and PO_4-P)

As was the case at the Cobble Site, the Hayfield Wetlands Phosphorous compounds do not change appreciably in form or concentration from inlet to outlets. Tables 35 and 36 will show this, as well as, the plots and tabular data located in Appendix E.

Table 35. Hayfield Site long-term monthly average Total-P (mg/L) and summary statistics for August 1995 through June 1997. Months in which extremes occurred are shown in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	3.5	3.6	3.8
Maximum	4.6 *(2/97)*	4.4 *(5/97)*	4.7 *(11/96)*
Minimum	1.9 *(11/96)*	2.0 *(6/97)*	2.1 *(6/97)*

Table 36. Hayfield Site long-term monthly average PO_4-P (mg/L) and summary statistics for August 1995 through June 1997. Months in which extremes occurred are shown in ( ).

Statistic	HS Inlet	H1 EFF	H2 EFF
Average	3.1	3.0	3.1
Maximum	4.3 *(10/95)*	4.4 *(12/95)*	4.4 *(12/95)*
Minimum	0.0 *(1/97)*	0.0 *(1/97)*	0.0 *(1/97)*

Tres Rios Demonstration Wetlands: Bacteria Monitoring Results

Bacterial levels have been monitored in the source water and wetland discharges since August 1995. Samples are obtained on the same day and in the same manner as the conventional parameters just presented. Analysis is conducted on-site at the 91st Ave. WWTP process laboratory using the 51-Well Quanti-Tray method for determining the most probable number of Total Coliform and E. coli bacteria present. Please note that the bacteria concentrations presented herein are typically on the conservative side which can be attributed to the dilution's used during enumeration. Often times the dilution was insufficient to produce a real number, instead a ">" value was presented. For those instances where this has occurred, the number associated with the ">" has been used for calculation purposes. An example is the maximum number of Total Coliform's exiting both C1 and C2 as shown in Table 37. These numbers were presented by the analyst as > 200500 and > 20050 respectively in the raw data, but for calculation purposes; 200,500 and 20,500 were used.

Review of the long-term plots of bacterial concentrations located in Appendix F, show that it is apparent that at the Cobble site, bacteria levels did not greatly increase for 5 months after startup. At the Hayfield site this time is a little shorter, approximately 3 months. These increases coincide with the first observations of wildlife utilizing the systems.

Table 37. Summary of Total Coliform and E. coli (mpn/100 mL) values for the Tres Rios Demonstration Wetlands Cobble Site for the period August 1995 through August 1997.

Statistic	CS Inlet	C1 EFF	C2 EFF
	Total Coliform Bacteria	Total Coliform Bacteria	Total Coliform Bacteria
Average	36	33,694	13,578
Maximum	201	200,500	20,050
Minimum	0	135	200
	E. coli Bacteria	E. coli Bacteria	E. coli Bacteria
Average	2	5403	3438
Maximum	31	30,600	20,050
Minimum	0	3	0

Table 38. Summary of Total Coliform and E. coli (mpn/100 mL) values for the Tres Rios Demonstration Wetlands Hayfield Site for the period August 1995 through August 1997.

Statistic	HS Inlet	H1 EFF	H2 EFF
	Total Coliform Bacteria	Total Coliform Bacteria	Total Coliform Bacteria
Average	49	14,599	44,085
Maximum	201	36,500	200,500
Minimum	0	200	200
	E. coli Bacteria	E. coli Bacteria	E. coli Bacteria
Average	2	3432	21,034
Maximum	16	23,787	200,500
Minimum	0	37	67

Of particular interest in Tables 37 and 38 is the fact that average Total Coliform and E. coli bacteria are highest in Basins C1 and H2. As it happens, these basins are the closest, at each site, to mature riparian vegetation stands, and it is thought that wildlife from these areas impacts the bacterial quality of the wetlands.

To further the investigation as to whether wetland bacterial levels are re-growth from the Plant 3A source water or are a function of wildlife pressures, bacterial levels were assessed along the flow path of Hayfield basin H1 on 5/20/96. The results of this endeavor gave limited evidence that bacterial populations in the wetland systems are the result of wildlife input and not re-growth from the plant. These data are provided at the end of Appendix F and show that instead of a gradual increase in bacterial populations as a function of distance down the flow-path, the population of Total Coliform's increases dramatically and stays that way. E. coli bacteria do increase sequentially in the first four interior deep zones, but drop in the fifth. Had this been a function of bacterial re-growth from the plant, populations should have risen gradually and then stayed elevated. This, however, was not the case during this monitoring attempt.

Tres Rios Demonstration Wetlands: Heavy Metal Monitoring Results

An attempt to monitor total metals on a monthly basis has been underway since October 1995, however, several months have been missed for any one of a myriad of reasons. The months missed include: 11/95, 6/96, 9/964/97, and 6/97. For samples collected before July 1997, inlet and outlet grab samples were obtained on the same day. In order to account for the detention time between flows entering and exiting the basins, the July 1997 Hayfield Site metal samples were obtained four (4) days apart (Approx. 1 nHRT).

Table 39. The number of times, out of a possible 17 months, heavy metals have been analyzed for and detected above detection levels in the influent to and effluent from the Tres Rios Hayfield Site Demonstration Wetlands (e.g. number of times sampled/number of times above detection level). The average concentration, if detected is provided on the bottom of each row. *Note: the Hg detection's are suspect as they were found very near the detection limit and did not occur on the same sampling day.

Point	Ag	Se	B	Zn	Pb	Ni	Cu	Cr	Cd	As	Hg
HS	2/0	9/2	2/2	17/14	6/1	14/14	17/17	14/11	3/1	2/2	17/0
Inlet		1ppb	380ppb	28ppb	1ppb	8.1ppb	2.9ppb	1.7ppb	2ppb	3.5ppb	
H1	2/0	9/1	2/2	17/10	6/0	14/14	17/14	14/7	3/0	2/2	17/0
EFF		1ppb	350ppb	28ppb		6.5ppb	1.6ppb	1.3ppb		3.5ppb	
H2	2/0	9/1	2/2	17/10	6/1	14/14	17/13	14/9	3/0	2/2	17/1*
EFF		1ppb	365ppb	25ppb	2ppb	5.8ppb	1.6ppb	1.3ppb		3.5ppb	0.2ppb
HS	2/0	9/2	2/2	17/11	6/3	14/14	17/14	14/8	3/0	2/2	17/1*
EFF		1ppb	340ppb	35ppb	3.7ppb	7.4ppb	2.5ppb	1.3ppb		3.5ppb	0.2ppb

Table 40. The number of times, out of a possible 16 months, heavy metals have been analyzed for and detected above detection levels in the influent to and effluent from the Tres Rios Cobble Site Demonstration Wetlands (e.g. number of times sampled/number of times above detection level). The average concentration, if detected is provided on the bottom of each row. *Note: the Hg detection's are suspect as they occurred very near the detection limit.

Point	Ag	Se	B	Zn	Pb	Ni	Cu	Cr	Cd	As	Hg
CS	2/0	8/2	2/2	16/12	5/3	14/14	16/16	13/10	2/0	2/2	16/0
Inlet		1ppb	380ppb	28ppb	0.8ppb	5.9ppb	2.2ppb	1.8ppb		3.5ppb	
C1	2/0	8/1	2/2	16/13	5/2	13/13	16/15	13/9	2/1	2/2	16/1
EFF		1ppb	360ppb	25ppb	0.9ppb	6.0ppb	2.6ppb	1.8ppb	1ppb	3.5ppb	0.2ppb
C2	2/0	8/0	2/2	16/11	5/2	13/13	16/13	13/8	2/0	2/2	16/1
EFF			350ppb	29ppb	0.9ppb	6.4ppb	2.0ppb	1.6ppb		3.5ppb	0.3ppb

Sometimes the wetland basins appear as a metal sink, and at other times they act as generator. To avoid an explanation of this phenomena at this time, this paper will only report the number of times a constituent has been detected in either the inflow or discharge from the Demonstration Wetlands and the corresponding average value. As time has not permitted a full review of the metals data, raw information is provided to the reader in Appendix G.

Tres Rios Demonstration Wetlands: Biomonitoring Results

Biomonitoring samples were typically collected during the first week of each month since November 1995. Sampling consists of collecting Four-Liter aliquots at the inlet to each Tres Rios Demonstration site, HS Inlet or CS Inlet, which are used to represent the Plant 3A effluent. At roughly the same time, 4-L samples are obtained at the wetland effluent sample points, H1, H2, C1, or C2 discharge structures. Only one Demonstration Site inlet and one Demonstration Basin outlet are sampled in any one month.

Toxicity evaluation procedures used are those specified in the 91st Avenue WWTP's National Pollutant Discharge Elimination System permit; "Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms" (EPA/600/489/001, USEPA EMSL, Cincinnati, Ohio, March 1989 and its supplement EPA/600/489/001a), and the update (EPA/600/491/002, USEPA ORD, Cincinnati, Ohio, July, 1994). The specific test performed is the Chronic Static-Renewal 7-day survival and reproduction test using *Ceriodaphnia dubia.*

End points used to describe organism survival and reproduction as defined by Aquatic Consulting and Testing Inc., Tempe, Arizona are as follows:

- **LC_{50} or EC_{50}** - Value represents a point estimate of the effluent concentration that would adversely affect 50% of the test organisms.
- **No Observable Effect Concentration (NOEC)** - The highest concentration of effluent to which organisms were exposed which caused no statistically significant adverse effect on the observed parameters (e.g. survival, growth, or reproduction).
- **Lowest Observable Effect Concentration (LOEC)** - The lowest concentration of effluent to which organisms were exposed which caused a statistically significant adverse effect on the observed parameters (e.g. survival, growth, or reproduction).
- **Inhibition Concentration (IC)** - The point estimate of the effluent concentration that causes a given percent reduction in the reproduction or growth of the test organisms.

To date, wetland discharges have been tested 22 times and have exhibited toxicity on two occasions (See Appendix H). First, a data inversion between the 90% and 100% dilution's was present in the January 1996 test of effluent from Basin C2. This did not effect the Survival of the test organism, but the Reproduction results were, NOEC = 75% (TUc = 1.33). If the inversion is eliminated, the NOEC = 100% (TUc = 1.00). The second toxic samples were the result of a Malathion Fogging Event conducted by Maricopa County Vector Control Staff. This took place during the October 1996 biomonitoring test in which all test organisms did not survive.

The number of young produced in each dilution is also tracked. Table 41 provides summary statistics for the number of young produced in 100% wetland effluent, while Appendix H contains plots of this information and a comparison between the Wetland effluents and the Plant 3A source water. Briefly, the number of young produced in 100% dilution's from both the Plant and Wetlands are very similar. Out of 17 months, Plant 3A had more young produced in the 100% dilution 8 times, an equal number of young were produced 2 times, and the wetlands had more young produced in the 100% dilution 7 times.

Table 41. Tres Rios Biomonitoring Summary statistics for the number of young produced in 100% wetland effluent. Data period is January 1996 through July 1997. NA = Not Applicable

Statistic	Value	Basin	Date	Laboratory
Average	205.3	NA	NA	NA
Maximum	362	H2	June 1996	City of Phoenix
Maximum	249	H1	August 1996	ACT*
Minimum	135	C2	January 1996	ACT*

***ACT = Aquatic Consulting and Testing, Tempe, Arizona.**

Tres Rios Demonstration Wetlands: Tracer Testing Results

The Hayfield site was designed such that both basins have approximately the same surface area and % open water. H1 is has its open water configured into 5 narrow deep-zones, Basin H2 however, has its 20% open water configured into two large interior deep zones with waterfowl islands. Tracer testing has been conducted at a HLR = 0.5 ft/d, and two emergent area depths of 1.0 and 1.5 ft in both basins. In the very near future, tracer testing will be conducted at a third and final depth of 0.5 ft. Table 42 provides a summary of the nominal (nHRT) and tracer (τ_a) detention times resulting from these efforts, while Appendix I provides graphical results. The reader should use caution if applying these results, as these data are still provisional and subject to change.

Testing is conducted using NaBr, which is dissolved prior to dumping into the inlet splitter box immediately down stream of the inlet weir. The target peak concentration for these tests has been 15 mg/L Br^-. Samples are collected at the outlet weir using an automatic sampler configured to take 1-L every twenty four hours. The duration of the tests have all been approximately (3)x(nHRT). Analysis for tests H1A and H2A were completed using Ion Chromatography at the City of Phoenix Compliance Laboratory.

Tests H1B and H2B were conducted using an ion specific electrode by USGS staff overseen by Larry Barber in the Boulder Colorado offices.

Table 42. Tracer testing summary of the Hayfield Site Basins H1 and H2. Basin H1 has 5 internal deep zones, while Basin H2 has only two, with islands. Both basins have approximately 20% of their surface area as open-water deep zones. All test were conducted at a HLR = 0.5 ft/d.

Test	Depth (ft)	nHRT (d)	τ_a (d)
H1 A	1.0	3.35	2.66 (79% of nHRT)
H1 B	1.5	4.24	3.30 (78% of nHRT)
H2 A	1.0	3.25	2.34 (72% of nHRT)
H2 B	1.5	4.1	4.38 (107% of nHRT)

Tres Rios Demonstration Wetlands: Vector Control Results

Tres Rios Wetland systems are free-water surface constructed wetlands in which treatment detention times can range from 2 to 30 days. They are configured such that densely vegetated shallow emergent zones alternate with open-water deep-zones. Two species of bulrush serve as the primary vegetation, *Scirpus validus* (soft-stem bulrush) and *S. olneyi* (three-square bulrush), while assorted grasses and emergent macrophytes occupy littoral and shore-line areas. Soft-Stem grows up straight and has a mature density of between 200 and 300 stems per square meter, while Three-Square bulrush tends to lodge and thatch itself. Three-square densities have been noted as high as 800 stems per square meter which provides outstanding habitat for musk-rats and avian species including the threatened and endangered Yuma Clapper Rail. Additionally, this high density habitat can preclude mosquito fish from accessing larvae. Larval dipping experience indicates that larvae are more prevalent in Three-Square and grass zones versus Soft-Stem zones. Predation by fish is the likely the reason for this since they are consistently seen in Soft-Stem but not Three-Square stands.

Adult mosquito populations are often high, > 1000 mosquitoes per trap night with a maximum of > 10,000. Although some generation takes place in the basins, other areas likely contribute. Numerous wet and moist areas exist within and around the 91st Ave. WWTP which could serve as breeding areas for mosquitoes. Currently, the largest trap counts are found at the Cobble Site, whereas in the past they had occurred at the Hayfield Basins.

Vector Control at Tres Rios

Mosquitoes are a natural component of wetland systems, as such, it is not unreasonable to assume that breeding can and does occur in the Tres Rios Demonstration Constructed Wetland basins. Mosquito control to date has been a combination of larval and adult treatments. Larval control agents include the use of large populations of mosquito fish (*Gambusia affinis*), two formulations of *Bacillus thuringiensis israeliensis* (VectoBac (BTi): Liquid or Granular), and granular *Bacillus sphaericus* (VectoLex (BS)). Results indicate the most effective larval control agent to be *B. sphaericus*. Adult control includes Ultra Low Volume (ULV) fogging with 98% malathion (1 oz. per acre), and promoting bat and insectivorous bird nesting and roosting at the wetland sites.

Large larval populations were first noted in January, 1996 in the Research Cell basins during an outbreak that was successfully treated using a liquid suspension of BTi. Since that time, larval and adult mosquitoes have been present at Tres Rios. During the Summer of 1996, Maricopa County Vector Control (MCVC) sampled adult mosquitoes and subjected them to arbovirus testing at the State Department of Health. Of 17 samples submitted, two were positive for St. Louis Encephalitis (SLE). Subsequently, MCVC applied malathion twice (9/25/96 & 10/4/96) to the 91st Ave WWTP and Tres Rios Wetland Sites. This was immediately effective in controlling adult mosquito populations, but they did rebound (Table 43).

Table 43. Maricopa County Pre- and Post-Adult Mosquito Control Efforts during the 1996 SLE virus detection at the Tres Rios Wetlands.

Sample Point	1st ULV + 2 Days Collection Date 9/27/96	1st ULV + 7Days Collection Date 10/2/96	2nd ULV + 5 Days Collection Date 10/9/96
83rd. Ave. E. of Hayfield	37	230	110
Corral E. of Hayfield	16	140	15
Picnic Area (Hayfield)	20	830	880
East of HS EFF (Riparian)	52	1250	740
SE corner Research Cell Site	148	4280	560
Center of Cobble Site	144	1475	450
W. end of Cobble Site	172	1350	No Catch

Although malathion was immediately effective against adult populations, some undesirable effects were experienced. Non-target macroinvertebrates were killed and vegetation appeared chlorotic after application. Further, adult populations rebounded quickly which may imply breeding and larval development were still occurring in the wetland basins. However, since other macroinvertebrates were affected, one would expect the malathion to kill mosquito larvae developing in the water column as well. This was somewhat substantiated in that the biomonitoring tests conducted on basins C2 and H2 during the week of September 31, 1996 (this time-period incorporated the ULV application date) showed toxic water exiting the wetland basins. This could mean that the wetland basins attracted adult mosquitoes from breeding sites located in the river or surrounding agriculture and livestock facilities.

After the SLE event, mosquito populations did not become problematic again until the first week of February 1997, when the first mosquito bite was recorded at the 91st Ave. WWTP. Spring of 1997 saw large populations of larval and adult mosquitoes at all three Tres Rios Wetland Sites and the use of granular larval treatments were first tried. The first agent used was VectoBac (Abbott Laboratories), an endospore from *Bacillus thuringiensis israeliensis* (BTi) coated on pieces of "corn-cob" . Unfortunately, Tres Rios staff lacked the proper application equipment so it was applied by means of manually broadcasting the material into the basins which resulted in poor coverage and poor treatment.

In May 1997, MCVC staff indicated that a new agent would soon be available from Abbott Laboratories. The material was *Bacillus sphaericus* (BS) and is currently sold under the trade name of VectoLex. This material was applied in a side-by-side test at the Hayfield site on June 23, 1997. BS was applied at a rate of 10 lb/acre with a granular applicator to H1 while BTi was applied using the same rate and method to H2. On the day of application, basin H1 had an average of 15 larvae per dip with > 10% being pupae, while Basin H2 had a 5 larvae per dip average with 15% as pupae. Ten days after treatment H1 had an average of < 2 larvae per dip and no pupae, while H2 had < 6 larvae per dip but some pupae. Both larval and pupae counts remained low (count < 4 per dip and Pupae < 10%) in basin H1 for roughly 25 days. On 7/25/97 (32 days after application of VectoLex) larval counts were > 14 larvae per dip with approximately 7% as pupae, so VectoLex was applied again on 8/1/97. By 8/5/97 larval counts were back down to 2 per dip and no pupae were present. H2 had the initial BTi treatment and larvae were > 5 per dip and pupae were present 10 days after treatment. By 7/15/97 conditions had not improved so VectoLex was applied. This reduced larval dip counts to < 2 with no larvae. As of 8/5/97, H2 has approximately 6 larvae per dip with < 5% as pupae.

Given the reduced numbers in the VectoLex treated Hayfield basins, it was decided to treat all the Tres Rios Wetland Sites. As of 7/17/97, the Cobble and Hayfield Wetlands have all been treated with VectoLex and larval numbers are reduced.

Mosquito Control Agents Used at Tres Rios

Mosquito Fish (*Gambusia affinis*) - LARVAL CONTROL

This species was first taken in Arizona in 1926 (Miller & Lowe, 1967). It is very adaptable and its name is derived from its voracious appetite for mosquito larvae. It has been introduced into waters of almost every continent, and many oceanic islands. It takes approximately 24 days for young to develop, and broods range from a few young to more than 300. A single female may produce up to 5 broods in a single lifetime (Krumholz, 1948).

The predatory activities of *G. affinis* are not restricted to mosquito and other insect larva, but include the young fish of its own and other species. This can make its introduction undesirable in instances where native fish such as the Gila topminnow (*Poeciliopsis occidentalis occidentalis*) wish to be bred.

The use of *G. affinis* at Tres Rios began during the Fall of 1995. Small populations were introduced into the Hayfield Wetlands where they flourished. Over time, these basins were used to stock the remaining Tres Rios Wetlands such that currently, 100's of mosquito fish inhabit all operating wetlands at the site. They are extremely effective at controlling mosquito larvae populations as long as they have access to the organisms. To date, access of fish to larvae is documented in Soft-Stem Bulrush and some of the grasses which grow at the waters edge. Effective larval control in Three-Square bulrush by *G. affinis* has not been achieved as yet.

Biological Larvacide's

Bacillus thuringiensis H-14 (Trade-Name: VectoBac, BTi) - LARVAL CONTROL

VectoBac comes in two formulations, both of which have been used at the Tres Rios Site(s). This includes a liquid suspension (VectoBac 12AS) and a granular formulation (VectoBac (G & CG)) which uses corn-cob particles as a substrate. It works very fast as long as the agent reaches the organisms. Typically, it takes 24 hours after treatment for complete mortality, however, the residual is not very long and likely is on the order of 3 to 5 days. BTi is specific to mosquito larvae while other macroinvertebrates (beneficial predators) find it nutritious.

Application of the liquid form was conducted in three ways: 1) Spraying from a small liquid applicator, 2) Injected into downstream side of open-water zones using a perforated PVC manifold system, and 3) Drip-Fed into the wetland inlet over the course of 8 hours. Target dosage rate, approximately 500 mL/acre (20 oz. / Acre).

To date, application of VectoBac 12AS has only really been effective at the Research Cell site. The first success was localized (10 to 20 m^2 areas) application with a small sprayer for infestations which occurred in Research Cells 2, 3, 5, and 7 during January 1996. When basins were totally infected with larvae this method could not maintain effective control primarily because the applicator took too much time to cover the site. What does appear to work better in these basins is an 8 hour drip feed set up at the inlet structure, which appears to treat the entire surface area of each basin.

Drip feeding at the inlet was also tried at the larger Cobble and Hayfield basins, but with much less effectiveness. It is likely that the hydraulics associated with internal deep-zones, sorption to plants and soils, and consumption by macro-invertebrates do not allow the agent to pass the first emergent zone in these basins. To circumvent this problem a manifold was constructed and the large basins treated by injecting the agent along the downstream edge of each internal deep-zone. This appeared to be marginally effective but requires a large investment in time and staff effort. Currently, the only basins receiving liquid VectoBac treatments are the Research Cells.

Bacillus sphaericus serotype H5a5b (Trade-name: VectoLex) - LARVAL CONTROL

B. sphaericus is another bacterial larvacide specific to *Culex* and other mosquito larvae. It has been formulated on a smaller, denser granular that can be broadcast further (30 - 40 m) and appears to penetrate dense vegetation better. BS does not kill as fast as BTi, but complete mortality can occur in 48 to 72 hours. The added benefit of BS is its residual activity. Whereas BTi is effective for 3 to 5 days, BS appears to control larval development for up to 25 days post application.

Application can be by hand, but to ensure coverage, use of a power granular applicator or aerial means is recommended. This allows BS to applied at a rate of 10 lbs/acre in a manner of minutes to the large demonstration site basins. BS was first applied at Tres Rios in the Hayfield Site Basin H1 on June 23, 1997. It's performance was very encouraging so as of July 17, 1997 all Demonstration Basins have been treated with BS and larval/pupae counts are depressed.

ULV Fogging with Malathion - ADULT CONTROL
ULV or ultra low volume fogging is a method employed to control outbreaks of adult mosquitoes. The compound of choice appears to be 98% pure malathion at a rate of 1- 2 ounces per acre. Fogging is typically conducted in the early morning under low wind and moderate temperature conditions. It is immediately effective, but is not selective to mosquitoes, hence mosquito predators, vegetation, and wetland visitors may be adversely impacted as well.

Fogging has been conducted twice by MCVC at Tres Rios in September and October, 1996. If one were to contract that service out to a typical contractor, it is likely each fogging event would cost approximately $7,000. After consultation with Bureau of Reclamation Biologists, it might be better to use a pyrethrin-based fogging agent instead of malathion. Apparently, pyrethrin-based agents are inactivated upon contact with water and may be less likely to kill non-target organisms.

Bat & Avian Mosquito Predators - ADULT CONTROL
Both bats and certain avian species can significantly impact adult mosquito populations by preying upon them. This makes it especially important to provide mature riparian corridors in association with wetland basins to encourage avian colonization. The Hayfield site is currently developing such vegetation. Additionally, Bat-Houses have been constructed and installed to encourage bats to inhabit the Tres Rios sites. Not only would bats aide in mosquito control, but the numerous endangered bat species that inhabit Arizona and this could provide potential critical habitat. Unfortunately, this has not been successful to date and the only resident bat population noted to date consists of a single individual located in a new structure on the 91st AVE. WWTP. Finally, something to keep in mind when attracting bats is the potential for rabies and contact with wastewater treatment staff and wetland visitors.

Operational/Water Level Management - LARVAL CONTROL
Operationally, their may be several options to consider which include fluctuating water levels and even drying wetland basins out. To date the only operational strategy for mosquito control employed involved raising and lowering the water levels in Cobble Basins C1 & C2. This was conducted during August, 1996 and consisted of raising water levels approximately 0.5 feet so as get the water surface above the very dense mats of Three-Square Bulrush and provide access to mosquito fish. No quantifiable data was collected, but fish were observed in areas where they had not been before. In a full-scale system, it may be desirable or necessary to take basins out of service for O&M or a lack of water. This could be used as a mosquito control tool in that basins experiencing an infestation could be drained and dried.

Application
Liquid and granular formulations have been used at Tres Rios with the granular applications being more effective in the large Demonstration size wetlands at the Cobble and Hayfield sites. Liquid application of VectoBac has been effective at the smaller Research Cell basins.

Application of granular Larvacide's has been accomplished using two methods. The first was to manually broadcast the material from the banks. This results in coverage of the first 20 to 30 feet of the wetland perimeter, and was deemed ineffective. In June 1997 it was decided that a power Mist Duster be purchased to apply *B. sphaericus* granules. After consulting several Southern California sites the Maruyama MD 150 DX was purchased for approximately $600. This device was delivered as a back-pack, but was installed on a pick-up truck for use at Tres Rios. Larvacide's can now be applied by driving the truck around the perimeter of the basin(s) with the whole treatment process taking approximately 20 minutes per site. With larger basins, it may be desirable to use aerial application, but this has not been attempted at Tres Rios yet.

Liquid Larvacide's have been also been applied using two methods. The first involved the use of a small hand sprayer. This is effective and appropriate for small areas located along the banks. Drip-feed into the wetland inlets has also been attempted. The drip-method consists of setting up a reservoir to trickle the agent into the incoming water over a period of 6 to 8 hours. This has not been effective in the larger basins, but some degree of control can be maintained in the small (1200 m^2) Research Cells.

Mosquito Larvacide Costs

VectoLex has the advantage of having a 25 day residual, whereas VectoBac has only a three to five day effectiveness. When looking at costs, the VectoBac is cheaper, but the cost savings disappear when treatment over an entire mosquito season is considered. Table 44 shows the cost per treatment and cost per season of using granular formulations of either VectoBac or VectoLex. It was assumed that the Mosquito treatment season would last from March through September, approximately 186 days. Cost estimates for the materials were obtained from the Fenimore Chemicals March 1997 price list.

Table 44. Tres Rios Mosquito Larvacide Material Cost Estimate.

Agent	$/lbs	Residual (d)	Applications (#)	Trtmt Cost ($) 10lb/acre	Trtmt Cost ($) 15 lb/acre	Trtmt Cost ($) 20 lb/acre	Season Cost ($) 10lb/acre	Season Cost ($) 15 lb/acre	Season Cost ($) 20 lb/acre
BTi(g)	1.75	5	37	$14,000	$21,000	$28,000	$520,800	$781,200	$1,041,600
BS(g)	3.85	25	7	$30,800	$46,200	$61,600	$229,152	$343,728	$458,304

BTi(g) = VectoBac **Mosquito Season = 186 days (March - September)**
BS(g) = VectoLex **Treatment Area = 800 acres**

Mosquito Larvae Monitoring

Mosquito larvae are monitored in each basin by dipping. For each wetland basin, six dipping stations consisting of approximately 20 feet of bank are monitored on a routine basis (4 to 6 times per month). Dipping consists of penetrating the vegetation in a rapid but stealthy manner to obtain a surface water sample. The number of larvae and pupae are counted. This is repeated at each station three times with the reported count being the average of the three dips.

Adult Mosquito Monitoring

Adult mosquito monitoring is conducted at Tres Rios as a cooperative effort between Aquatic Consulting and Testing, Tempe, Arizona (ACT) and Tres Rios staff. CO_2 traps using dry-ice are set out weekly (Wednesday night) from approximately 3:00 pm until 6:00 am the next morning. Trapped adults are collected and sent to ACT for enumeration and identification. This program began in May, 1997 and is currently underway. All three Wetland sites, the WWTP and the immediate surrounding area are monitored. An aerial photograph showing the location of these sites is presented as Figure 1 of Appendix J.

Larval & Adult Mosquito Monitoring Results

Larval

Figures 2 through 6 in Appendix J present a summary of the mosquito larvae monitoring conducted during the Spring and Summer of 1997. Figures 2 and 5 present the long-term efforts as well as when specific larvacide treatments were applied. Table 45 shows the specific treatments applied to the Cobble and Hayfield Demonstration basins with the exception of the latest which occurred on 8/5/97 at the Demonstration Basins C1 C2, and H2.

Table 45. Tres Rios Demonstration Basin Mosquito Larval Treatments. BTi (g) is granular VectoBac applied at a rate of 10 lbs/acre, while BS (g) is the VectoLex applied at the same rate. Mechanical application of granules first occurred on the 6/23/97 BS (g) and BTi (g) applications at the Hayfield.

Date	**3/17/97**	**3/27/97**	**4/7/97**	**4/23/97**	**5/15/97**	**7/1/97**	**7/17/97**	**8/8/97**
Treatment	BTi(g)	BTi(g)	BTi(g)	BTi(g)	BTi(g)	BTi(g)	BS(g)	BS(g)
Basin C1	X	X	X	X	X	X	X	X
Basin C2	X	X	X		X	X	X	X
Date	**3/18/97**	**3/27/97**	**4/7/97**	**5/15/97**	**6/23/97**	**6/23/97**	**7/16/97**	**8/1/97**
Treatment	BTi(g)	BTi(g)	BTi(g)	BTi(g)	BS(g)	BTi(g)	BS(g)	BS(g)
Basin H1	X	X	X	X	X			X
Basin H2	X	X	X	X		X	X	

Table 45 Continued. Tres Rios Demonstration Basin Mosquito Larval Treatments.

Date	**9/4/97**		
Treatment	BS(g)		
Basin C1	X		
Basin C2	X		
Date	**8/8/97**	**8/27/97**	**9/4/97**
Treatment	BS(g)	BS(g)	BS(g)
Basin H1		X	X
Basin H2	X		X

Inspection of Figures 2 and 5 in Appendix J show that larval counts drop rapidly after treatment with a larvacide but rebound rather quickly when VectoBac was used. Since June 1997, larval basin larval counts have been below 200 and with the exception of one occurrence in both the Cobble (150 larvae, C1: 7/3/97) and Hayfield (105 larvae, H1: 7/25/97) sites have been below 100 larvae. Whole-Basin larval counts are calculated as the total average of 18 dips e.g., three dips taken at 6 stations located along the perimeter of the basin.

Figures 3, 4, 6, and 7 show the average number of larvae and the percentage of those larvae which have developed to pupae. This percentage is significant since the larvacide treatments used only effect early 1st through 4th instar individuals. If the larvae pupate, they no longer feed and will not be effected by the larvacide, hence development to adult will likely occur. What is immediately striking is the fact that in all basins, pupae were routinely present from March through mid June, 1997. This coincides with the period when BTi(g) was the control agent. Subsequent to BS(g) applications, little or no pupae have been present (Figures 6 & 7, Appendix J).

<u>Adult Mosquito Monitoring</u>

Adult mosquito count data is summarized in Appendix J, Figures 8 and 9. These show a gradual increase throughout the summer at the Cobble Site, but a decline in the Hayfield and Research Cells as summer progresses. This is likely a result of the improved control methods and agents implemented in June, 1997. To date the mosquito counts have been slightly higher at the Cobble site versus those obtained at the Hayfield and are likely due to some inattention those basins were given by Tres Rios Staff in June 1997. With the exception of the Cobble Site, North and East WWTP Fence-line traps, total mosquito counts have dropped from June through August 1997. Total counts and monthly averages and maximums are presented in Table 46.

The most prevalent mosquitoes appear to be *Culex sp.*, but to date, the following additional mosquito genus's have been identified by ACT: *Psorophora, Aedes, Anopheles, and Culex.* When one compares the larval species and adult species trapped at the Tres Rios Demonstration Basin sites an anomaly appears to be present which may suggest migration of adults from areas off-site. At the Cobble site, larval counts consistently show higher numbers of *Culex tarsalis*, and low numbers of *C. salinarius*, whereas the adult counts show the opposite, high adult counts of *C. salinarius* and low counts of *C. tarsalis* (Please refer to Figures 10 and 11 in Appendix J.

Table 46. Tres Rios Cobble and Hayfield Site Adult Mosquito Counts. Adults were collected by means of a CO_2 trap set out from approximately 3:00pm Wednesday afternoon until 6:00am Thursday morning.

Trap	1	2	3	4	5	6	7	8	9	10
Date										
6/5/97	888	600	852	7056	3456	2344	35	4	NA	NA
6/12/97	1836	52	11	2376	10144	1064	6	1	NA	NA
6/19/97	784	1404	1608	1020	1312	1056	7	1	932	2624
6/26/97	1832	852	1096	1192	1572	4000	24	4	342	1172
Avg.	**1335**	**727**	**892**	**2911**	**4121**	**2116**	**18**	**3**	**637**	**1898**
Max.	**1836**	**1404**	**1608**	**7056**	**10144**	**4000**	**35**	**4**	**932**	**2624**
7/3/97	1296	6688	633	2360	1980	3504	86	1	361	636
7/10/97	1176	NC	365	1456	NC	NC	NC	NC	438	NC
7/17/97	1408	3608	323	3624	1948	2264	104	11	320	185
7/26/97	608	2384	67	566	448	752	66	6	305	32
7/31/97	2320	1512	66	1288	2120	1000	27	15	NC	49
Avg.	**1362**	**3548**	**291**	**1859**	**1633**	**1880**	**71**	**8**	**356**	**226**
Max.	**2320**	**6688**	**633**	**3624**	**2120**	**3504**	**104**	**15**	**438**	**636**
8/7/97	4102	1300	294	1104	NC	680	45	8	468	270
8/14/97	1856	2680	868	1412	328	3320	31	6	215	121
8/21/97	2912	2280	238	1020	3024	1628	15	12	504	76
8/28/97	1808	1288	166	156	900	776	34	19	152	60
Avg.	**2670**	**1887**	**392**	**923**	**1417**	**1601**	**31**	**11**	**335**	**132**
Max.	**4102**	**2680**	**868**	**1412**	**3024**	**3320**	**45**	**19**	**504**	**270**

Trap 1 = North of Effluent Channel in Trees
2 = Between Basins C2 & C2
Trap 3 = South Fence of Research Cell Site
4 = Picnic tables at Hayfield Site
Trap 5 = D.S. of Hayfield Discharge (Trees)
6 = North Fenceline of Hayfield Site
Trap 7 = North Fenceline of 91st Ave. WWTP
8 = NE Fenceline of WWTP along 91st Ave.
Trap 9 = S. of Hayfield Site (Trees)
10 = 83rd. Ave Alignment near SRP Tail-Water

NC = No Count NA = Not Sampled

Tres Rios Demonstration Wetlands: Vegetation

Two species of Bulrush comprise the dominant vegetation in the Tres Rios Demonstration Wetlands. Soft-Stem Bulrush (*Scirpus validus*) from Kingman, AZ, and Three-Square Bulrush (*S. olneyi*) from the Casa Grande, AZ area were originally planted on 3-foot centers in staggered rows. Both vegetation species have thrived in the Hayfield site for two full growing seasons, but in the Cobble Site and Research Cell No. 12, both suffered slow re-growth and heavy predation after the Winter 1996/1997 senescence.

Vegetated Area

Vegetated areas within both the Cobble and Hayfield Site Wetlands have been monitored using color infrared aerial photography during the course of the Demonstration Project. The Bureau of Reclamation Phoenix Area Office has created a 3-dimensional model from these data and have tracked vegetative cover.

At the time of this report, aerial information from the Cobble Site is available for two dates, 4/8/96 and 2/10/97, while the Hayfield Site has it for three, 4/8/96, 8/8/96, and 2/10/97. Table 47, shows that total vegetated area has increased from March 1996 to February 1997. Interestingly, the Hayfield data from the August 1996 estimate is lower than in the March 1996 and February 1997.

Table 47. Tres Rios Demonstration Basin total vegetated area estimates from Phoenix Area Office Bureau of Reclamation Aerial Survey Data.

Date	Basin	Vegetative Area (Acres)
4/8/96	C1	1.82
2/10/96	C1	1.91
4/8/96	C2	1.91
2/10/96	C2	2.02
4/8/96	H1	2.48
8/8/96	H1	2.29
2/10/97	H1	2.67
4/8/96	H2	2.36
8/8/96	H2	2.28
2/10/97	H2	2.43

With the exception of Cobble Site Basin C1, the area occupied by soft-stem bulrush has decreased while the three-square area has increased. Table 48 shows the individual species and their respective changes in area occupied in the Cobble Site basins, while Table 49 shows the same information for the Hayfield Site.

Table 48. The change in area *S. validus* and *S. olneyi* occupy in the Tres Rios Cobble Site Basins over the time period April, 1996 to February 1997. Data obtained from the Phoenix Area Office of the Bureau of Reclamation.

Date	Basin	Species		Area (Acres)
4/8/96	C1	*S. validus*		0.95
2/10/97	C1	*S. validus*		0.99
			CHANGE =	**+ 0.04 acres**
4/8/96	C1	*S. olneyi*		0.87
2/10/97	C1	*S. olneyi*		0.92
			CHANGE =	**+ 0.05 acres**
4/8/96	C2	*S. validus*		0.97
2/10/97	C2	*S. validus*		0.92
			CHANGE =	**- 0.05 acres**
4/8/96	C2	*S. olneyi*		0.94
2/10/97	C2	*S. olneyi*		1.1
			CHANGE =	**+ 0.16 acres**

Vegetation densities have been assessed on two occasions, June 1996 and then again in February 1997. The results suggest that *S. olneyi* grows in more dense stands than does *S. validus*. This can have potentially serious ramifications with respect to vector control objectives, but the density is what affords habitat value. Plant densities were first estimated using a full, 1-meter square frame. This frame could be broken down such that one side could be removed and forced into the bulrush from an interior deep zone. The frame was rotated and the missing side re-affixed. Bulrush stems within the frame were then counted and the average stem densities found are reported in Table 50. The second estimate utilized a 0.25-meter square frame. Field personnel (Volunteers from Arizona State University), entered the upstream-most emergent area and cut bulrush to approximately 4 inches above the water surface. The 0.25-meter frame was then placed over the cut areas and the stems residing within were counted, the results of which are also provided in Table 50.

Table 49. The change in area *S. validus* and *S. olneyi* occupy in the Tres Rios Hayfield Site Basins over the time period April, 1996 to February 1997. Data obtained from the Phoenix Area Office of the Bureau of Reclamation.

Date	Basin	Species		Area (Acres)
4/8/96	H1	*S. validus*		0.94
8/8/96	H1	*S. validus*		0.99
2/10/97	H1	*S. validus*		0.76
			CHANGE =	**- 0.18 acres**
4/8/96	H1	*S. olneyi*		1.54
8/8/96	H1	*S. olneyi*		1.30
2/10/97	H1	*S. olneyi*		1.91
			CHANGE =	**+ 0.37 acres**
4/8/96	H2	*S. validus*		1.08
8/8/96	H2	*S. validus*		1.08
2/10/97	H2	*S. validus*		1.04
			CHANGE =	**- 0.04 acres**
4/8/96	H2	*S. olneyi*		1.28
8/8/96	H2	*S. olneyi*		1.20
2/10/97	H2	*S. olneyi*		1.39
			CHANGE =	**+ 0.11 acres**

Table 50. Plant density estimates from the Hayfield Basin H1. Two separate estimates were made, one in June 1996 and the other in February 1997.

Date	Vegetation Type / Location	Average Density (stems/m^2)
June 30, 1996	*S. validus* (First Emergent Zone)	194
June 30, 1996	*S. onleyi* (First Emergent Zone)	629
February 22, 1997	*S. validus* (First Emergent Zone)	309
February 22, 1997	*S. onleyi* (First Emergent Zone)	679
February 22, 1997	S. *validus* (Last Emergent Zone)	152
February 22, 1997	S. *onleyi* (Last Emergent Zone)	863

Cobble Site Vegetation Die-Back

As noted at the beginning of this section, the vegetation in the Cobble Site basins and Research Cell No. 12 did not come out of normal senesce in the Spring and early Summer of 1997. A gradient is evident at the Cobble Site such that vegetation fitness gets progressively better as one moves from upstream to downstream. The following is a series of events which describes what has happened.

1) Mid-December, 1996: Soft-Stem (SS) bulrush senescence in what appears to be a normal manner.

2) Late December 1996 / First Week of January 1997: Three-Square (3S) Bulrush senesces for the first time.

3) Mid-January 1997: Senesced SS is "pushed" over horizontally. Did not appear to be normal lodging, instead it looked as though it had been forced over by a wind event.

4) May 9, 1997: First shoots of 3S observed re-growing in Cobble Basins, C2 "better" than C1. Shoots appeared chlorotic and thin when compared to new growth in Hayfield Site.

5) June 12, 1997: First shoots of SS observed on rhizomes removed from the Cobble Site for

analysis by USDA Agriculture Alga Specialist. Found anaerobic bacteria (Blue green *Microcystis*) with 3S, Aerobic bacteria (Diatom species) associated with SS rhizome.

Remedial Action 1: Dry basin to aerate soils.

6) May 29, 1997: Water turned off to C2 to dry basin and aerate soils. Took 6 days to get a dry crust in emergent areas. Deep Zones maintained water and fish, frogs, etc. were healthy.

7) June 14, 1997: Added water to deep zones via water truck because fish were stressed.

8) June 18, 1997: Water to C2 restored because last emergent area too dry. Prior to whole basin filling, water was added to deep zones were filled. This seemed to prevent erosion as entire basin filled. Depth after filling varied between 0 and 0.5 ft.

Results of Remedial Action 1: Bulrush began to re-grow (very slowly and still chlorotic and thin) in areas where dead vegetation was still present. No re-growth in areas completely denuded. An investigation of these denuded areas found that very few if any viable roots and rhizomes were present. Suspect Muskrat predation.

Remedial Action 2: Eliminate Chlorine from Cobble Site Source Water

9) June 26, 1997: Bisulfite is first used to de-chlorinate Cobble Site source water. Problems ensued with the chemical feed pump and plumbing. Complete de-chlorination not achieved until Week of July 7, 1997.

10) July 10, 1997: Vegetative cover survey completed on C1 and C2 (Tables 51 and 52).

Table 51. Cobble Site Basin C1 Vegetative Cover Survey July 10, 1997. (3S = *S. olneyi*, SS = *S. validus*)

Zone / Species	% Open Water	% Dead Vegetation	% New Growth	% Predation of New Growth
First / 3S	50	90	10	20
First / SS	5	95	5	80
Second / 3S	25	90	10	70
Second / SS	50	95	5	80
Third / 3S	70	40	60	80
Third / SS	70	90	10	80
Fourth / 3S	25	50	50	10
Fourth / SS	10	85	15	20

Table 52. Cobble Site Basin C2 Vegetative Cover Survey July 10, 1997. (3S = *S. olneyi*, SS = *S. validus*)

Zone / Species	% Open Water	% Dead Vegetation	% New Growth	% Predation of New Growth
First / 3S	60	90	10	80
First / SS	10	95	5	50
Second / 3S	50	85	15	80
Second / SS	0	70	30	60
Third / 3S	50	50	50	10
Third / SS	0	60	40	No estimate
Fourth / 3S	5	40	60	No estimate
Fourth / SS	0	70	30	No estimate

From this time onward, some transplanting was attempted with limited success. Although the transplanted vegetation grew, almost 80% was or is currently being eaten by muskrats. As of the writing of this Report, vegetation is re-growing in both Cobble Basins. The basins are still experiencing grazing pressure, but some areas are beginning to fill and sustain a standing crop. As it was at the onset of this incident, the downstream areas of both C1 and C2 have healthier, denser stands of vegetation than does the upstream emergent zones.

Tres Rios Demonstration Wetlands: Special Projects

USGS Biomonitoring

Larry Barber from the USGS Boulder Colorado Office has contributed a great deal to the data collection and site development efforts of the Demonstration Project. In January 1997, duplicate biomonitoring samples have been sent to Dr. Barber and a colleague for MICROTOX assay and THMFP. A summary of these results will be presented at the November 1997 Tres Rios Technical advisory Review Panel Meeting. Personal communication with Dr. Barber indicates that both the Plant 3A source water and Wetland effluents exhibit toxicity to the MICROTOX test organism at the 40% dilution.

Cobble Site Subsurface Sample Points and Groundwater Wells

In April 1997, Dr. Barber arranged for the USGS to install a total of 18 subsurface sample points within the unlined Cobble Basin C1. These are arranged in arrays of 6 that start at the soil:water interface and at intervals extend to approximately 20 feet below the sediment surface. During installation these sample points produced water from the soil:water interface to approximately 3 feet, after which the soils appeared to be unsaturated and no water was produced. At approximately 13 feet, a saturated zone was encountered which continued to the deepest sample point. These will be used to assess the character of wetland water as it percolates vertically and ultimately joins the native groundwater underlying the site.

In July 1997, four shallow groundwater wells were installed such that they ring the Cobble Site basins. These wells are all approximately 20 feet deep and screened the entire depth except for the top 5 feet. Groundwater was encountered between 15 and 20 below ground surface at each well site during installation. These wells will be monitored in conjunction with the subsurface sample points in C1 to assess the water table surface and migration of wetland water into the native groundwater.

Hayfield Site Development

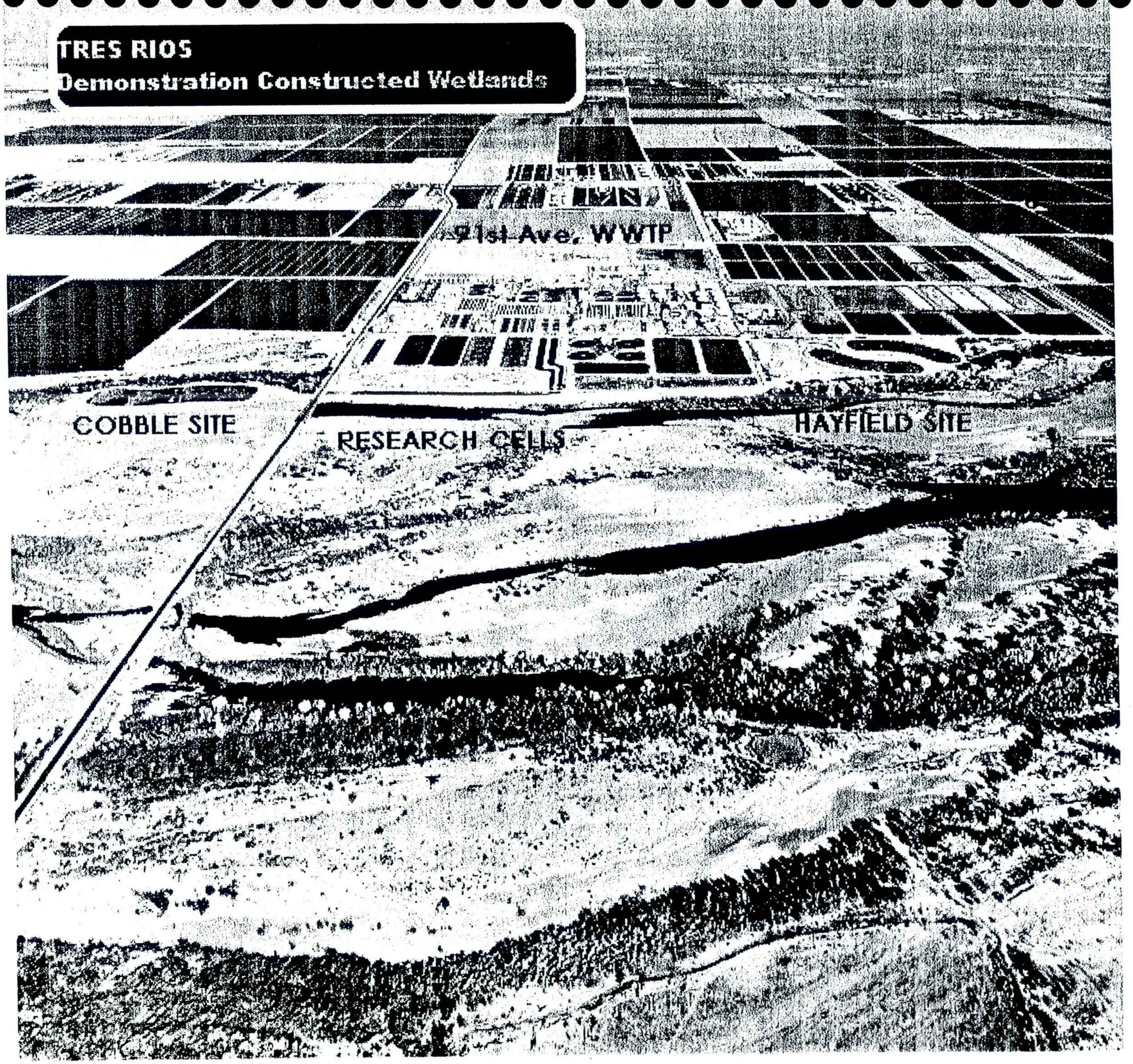
Several activities and projects have been completed at the Hayfield Site Wetlands. In terms of site amenities, two viewing blinds have been constructed (Boy Scout Eagle Projects), a Ramada has been constructed (ASCE YMF), and a trail leading the Hayfield Lower Riparian Area was established (Luke AF Base Volunteers and Phoenix Zoo Volunteers).

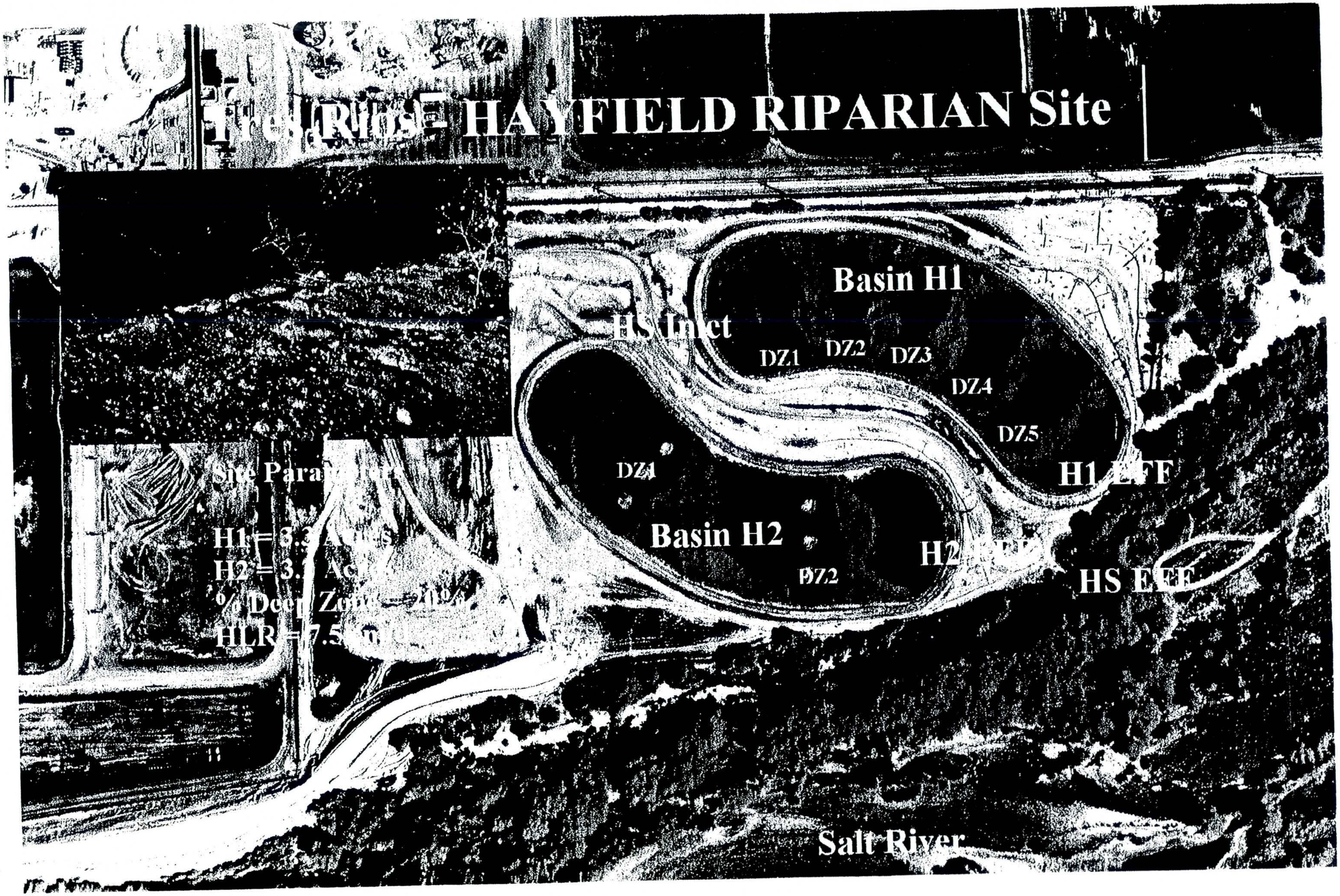
Encouragement and planting of broadleaf riparian vegetation has also been initiated at the Hayfield Site. Volunteer Cottonwood and Willow trees have been established by means of flood irrigating during the time of Cottonwood/Willow seed generation. This has been quite successful and dense stands of first-year and 1-year old trees are evident. To compliment the volunteer growth, over 50 broadleaf riparian trees and shrubs were planted March 24, 1997. The vegetation planted include: Gooding Willow (*Salix goodingii*), Cottonwood (*Populus fremontii*), Sycamore (*Plantanus wrightii*), Arizona Ash (*Fraxinus velutina var. glabra*), Elderberry (*Sambucus mexicana*), Quail-Brush (*Atriplex lentiformis*), and Mountain Hackberry (*Celtis reticulata*).

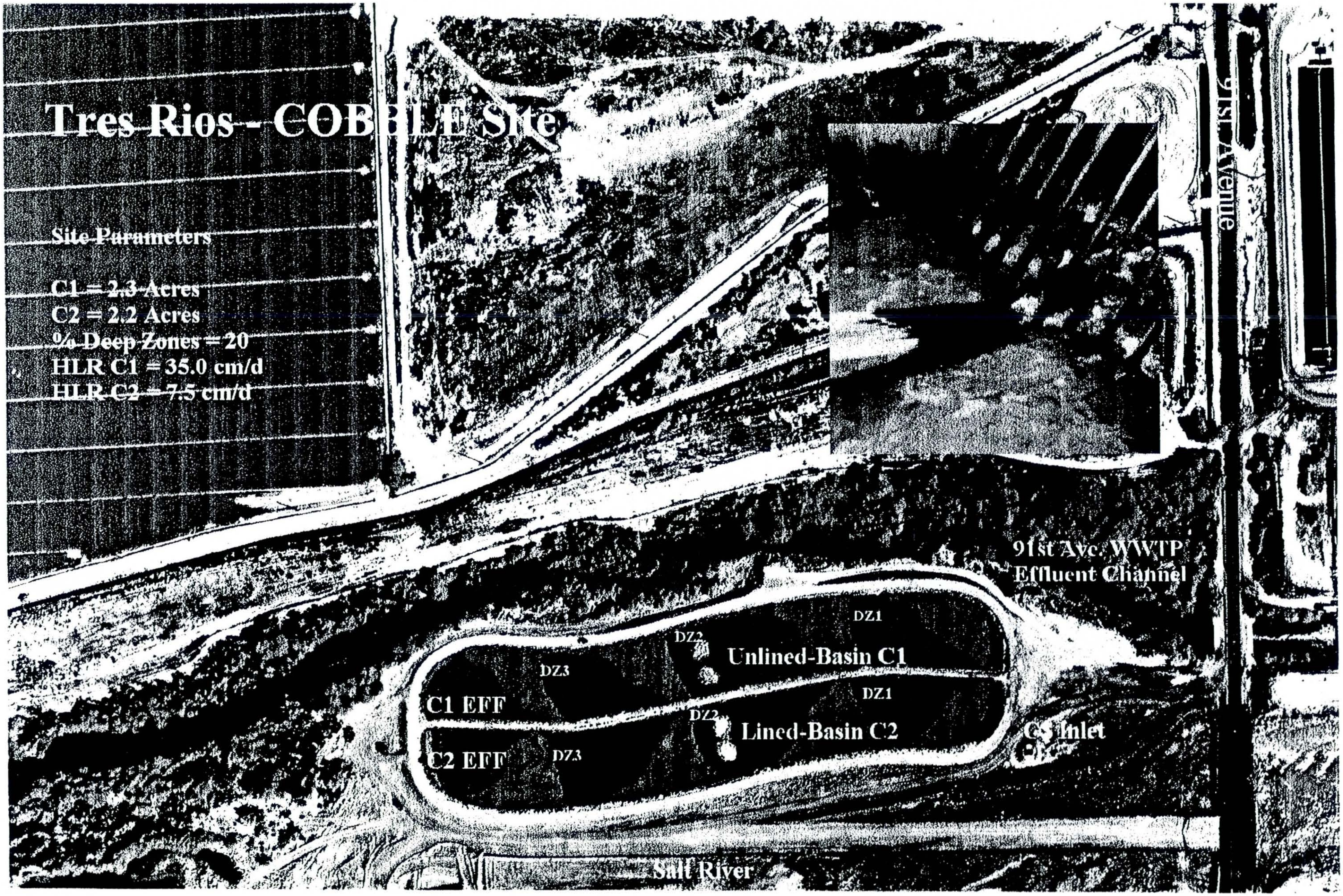
Summary

The Tres Rios Demonstration Constructed Wetlands have been in operation for almost 24 months. Much has been learned about the water quality performance of these systems, but new issues have arisen. It is hoped that over the course of the next two years research will address: Inorganic and Organic Bioaccumulation potentials, vector control strategies, impacts on local groundwater and surface water, and vegetation diversity, fitness, and management.

APPENDIX A - Aerial Site Maps & Sample Points


TRES RIOS
Demonstration Constructed Wetlands
91st Ave. WWTP
COBBLE SITE
RESEARCH CELLS
HAYFIELD SITE

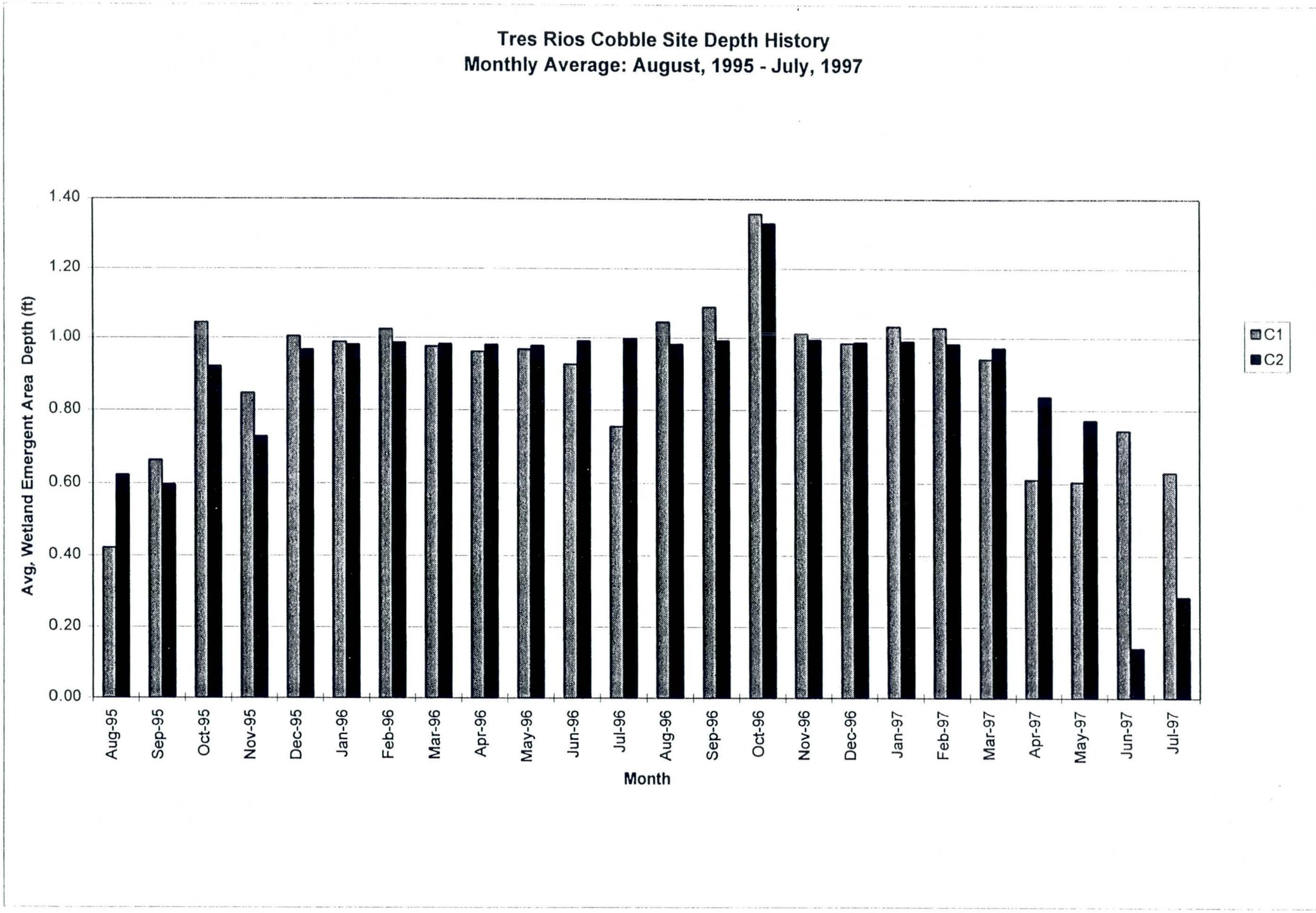

HAYFIELD RIPARIAN Site
Basin H1
DZ1
DZ2
DZ3
DZ4
DZ5
H1 EFF
DZ1
Basin H2
DZ2
HS EFF
Salt River


Tres Rios - COBBLE Site
Site Parameters
C1 = 2.3 Acres
C2 = 2.2 Acres
% Deep Zones = 20
HLR C1 = 35.0 cm/d
HLR C2 = 7.5 cm/d
91st Avenue
91st Ave. WWTP
Effluent Channel
DZ1
DZ2
Unlined-Basin C1
DZ3
DZ1
C1 EFF
DZ2
Lined-Basin C2
Inlet
C2 EFF
DZ3
Salt River

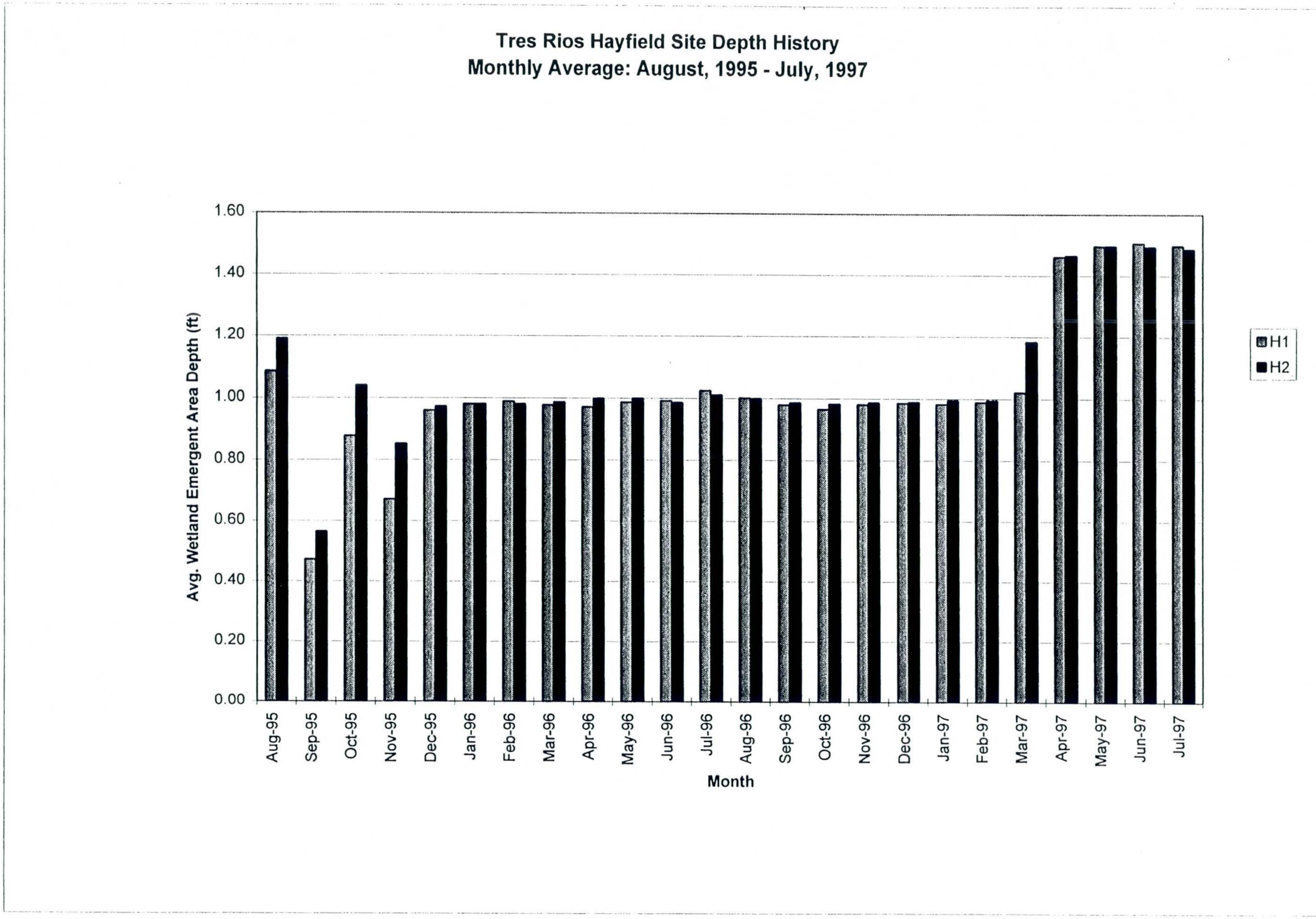
APPENDIX B - Hydraulics

Hayfield/Cobble Site Operating Depths
Data Period: August, 1995 - July, 1997

Date	C1 Depth (ft)	C2 Depth (ft)	H1 Depth (ft)	H2 Depth (ft)
Aug-95	0.42	0.62	1.09	1.19
Sep-95	0.66	0.60	0.47	0.57
Oct-95	1.04	0.92	0.88	1.04
Nov-95	0.85	0.73	0.67	0.85
Dec-95	1.00	0.97	0.96	0.97
Jan-96	0.99	0.98	0.98	0.98
Feb-96	1.02	0.99	0.99	0.98
Mar-96	0.98	0.98	0.98	0.99
Apr-96	0.96	0.98	0.97	1.00
May-96	0.97	0.98	0.99	1.00
Jun-96	0.93	0.99	0.99	0.99
Jul-96	0.75	1.00	1.03	1.01
Aug-96	1.05	0.98	1.00	1.00
Sep-96	1.09	0.99	0.98	0.99
Oct-96	1.36	1.33	0.97	0.98
Nov-96	1.01	0.99	0.98	0.99
Dec-96	0.98	0.99	0.99	0.99
Jan-97	1.03	0.99	0.98	0.99
Feb-97	1.03	0.98	0.99	0.99
Mar-97	0.94	0.97	1.02	1.18
Apr-97	0.61	0.84	1.46	1.47
May-97	0.60	0.77	1.50	1.50
Jun-97	0.74	0.14	1.51	1.50
Jul-97	0.63	0.29	1.50	1.49



Tres Rios Cobble Site Depth History
Monthly Average: August, 1995 - July, 1997
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Avg. Wetland Emergent Area Depth (ft)
C1
C2
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month



Tres Rios Hayfield Site Depth History
Monthly Average: August, 1995 - July, 1997
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Avg. Wetland Emergent Area Depth (ft)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
H1
H2

Tres Rios Demonstration Project
Hydraulic Loading Rate and Hydraulic Retention Times

C1

Date	HLR (ft/d)	HLR (cm/d)	nHRT (d)
Aug-95	NR	NR	NR
Sep-95	NR	NR	NR
Oct-95	0.7	22.7	1.2
Nov-95	1.1	35.0	1.9
Dec-95	1.1	32.1	1.7
Jan-96	1.1	35.0	1.9
Feb-96	1.1	32.2	1.8
Mar-96	0.9	28.0	1.5
Apr-96	0.9	27.4	1.5
May-96	0.9	27.9	1.5
Jun-96	0.9	27.6	1.5
Jul-96	0.9	26.1	1.4
Aug-96	0.7	21.0	1.1
Sep-96	0.7	20.5	1.1
Oct-96	0.7	22.1	1.2
Nov-96	1.2	36.3	2.0
Dec-96	1.2	37.2	2.0
Jan-97	1.2	37.3	2.0
Feb-97	1.2	37.5	2.0
Mar-97	1.2	37.3	2.0
Apr-97	1.2	37.8	2.1
May-97	1.1	33.2	1.8
Jun-97	1.1	32.1	1.7
Jul-97	2.5	74.8	4.1

C2

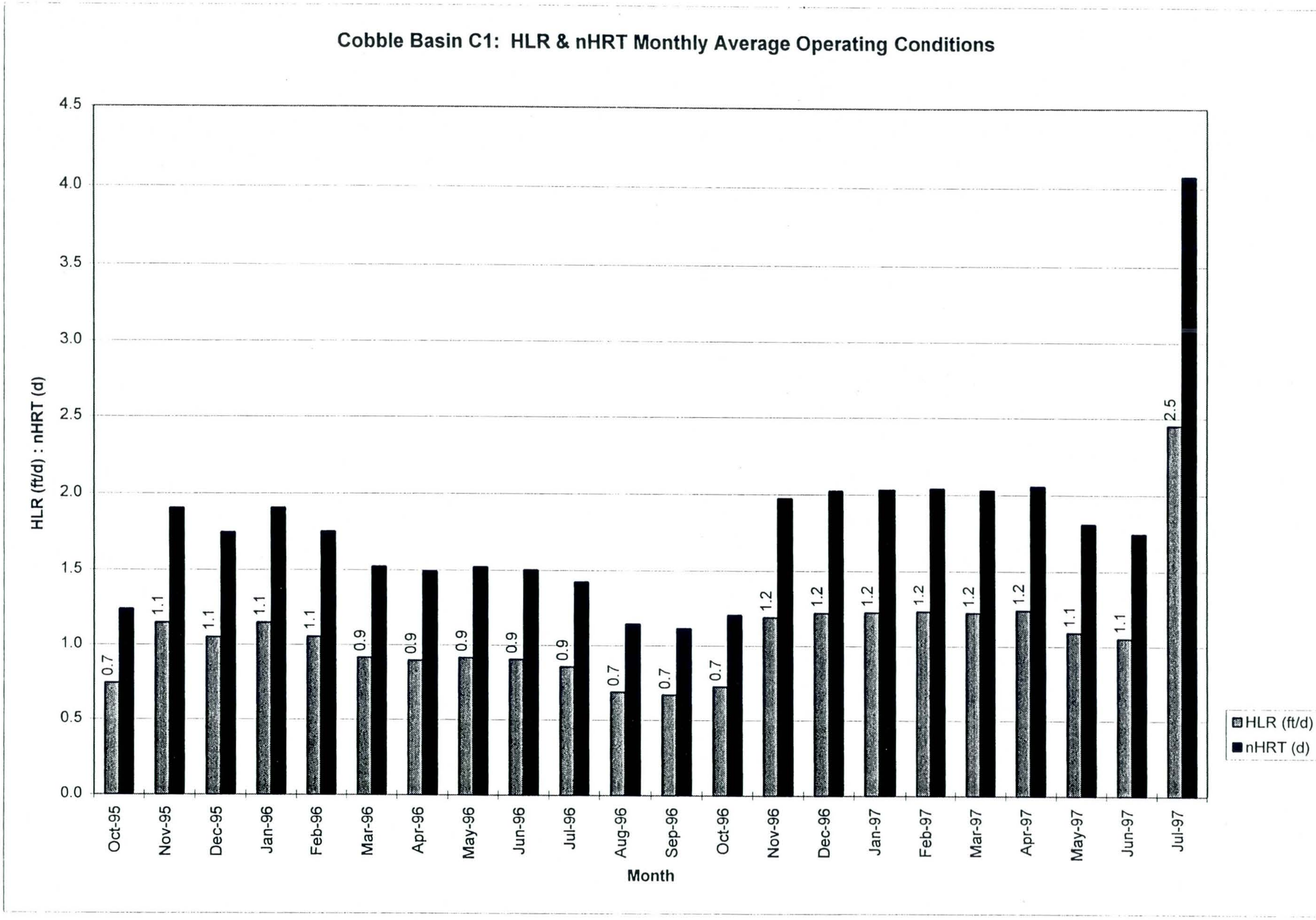
Date	HLR (ft/d)	HLR (cm/d)	nHRT (d)
Aug-95	NR	NR	NR
Sep-95	NR	NR	NR
Oct-95	0.9	27.2	2.2
Nov-95	0.5	15.4	3.7
Dec-95	0.5	14.6	4.1
Jan-96	0.3	9.2	5.6
Feb-96	0.2	6.7	7.6
Mar-96	0.2	7.3	6.9
Apr-96	0.2	7.5	6.7
May-96	0.2	7.2	7.0
Jun-96	0.2	7.3	6.9
Jul-96	0.2	7.4	6.8
Aug-96	0.2	7.2	7.1
Sep-96	0.2	7.6	6.7
Oct-96	1.2	35.3	1.4
Nov-96	0.9	25.9	2.0
Dec-96	0.8	25.2	2.0
Jan-97	0.8	25.0	2.0
Feb-97	0.8	25.1	2.0
Mar-97	0.8	25.2	2.0
Apr-97	0.8	24.9	2.0
May-97	0.7	22.8	2.0
Jun-97	0.1	3.4	6.2
Jul-97	0.2	5.0	12.0

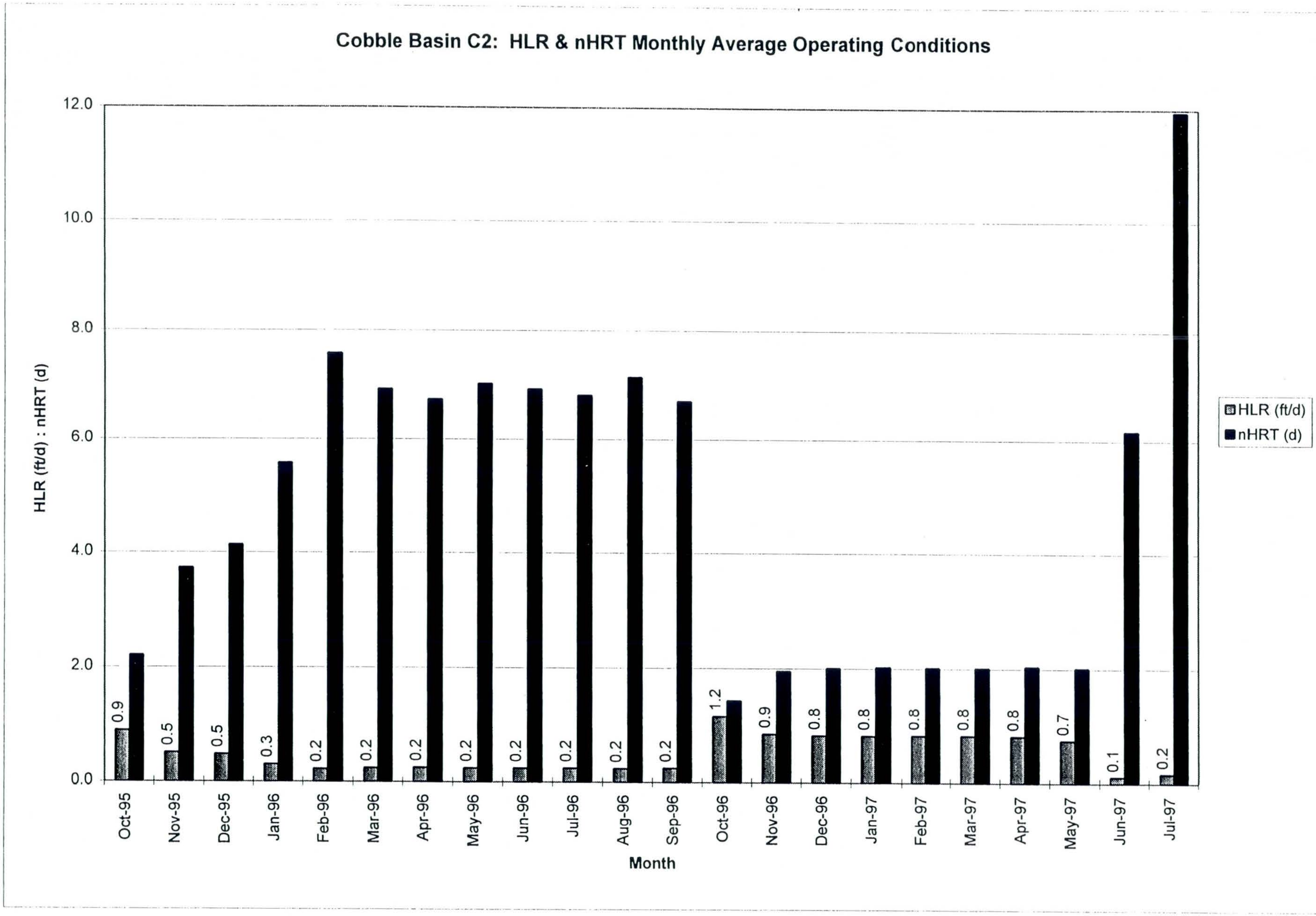
H1

Date	HLR (ft/d)	HLR (cm/d)	nHRT (d)
Aug-95	NR	NR	NR
Sep-95	NR	NR	NR
Oct-95	0.3	9.1	5.5
Nov-95	0.4	11.3	4.6
Dec-95	0.3	10.6	5.6
Jan-96	0.2	6.6	7.7
Feb-96	0.2	6.2	8.3
Mar-96	0.2	7.2	7.0
Apr-96	0.2	7.0	7.2
May-96	0.2	6.8	7.4
Jun-96	0.2	6.9	7.3
Jul-96	0.2	7.5	6.8
Aug-96	0.4	12.8	4.3
Sep-96	0.5	15.1	3.3
Oct-96	0.5	15.1	3.3
Nov-96	0.5	15.1	3.4
Dec-96	0.5	15.1	3.4
Jan-97	0.5	14.8	3.4
Feb-97	0.5	14.9	3.4
Mar-97	0.5	14.7	3.4
Apr-97	0.5	14.7	3.4
May-97	0.5	14.7	4.3
Jun-97	0.5	14.7	4.3
Jul-97	0.5	14.7	4.3

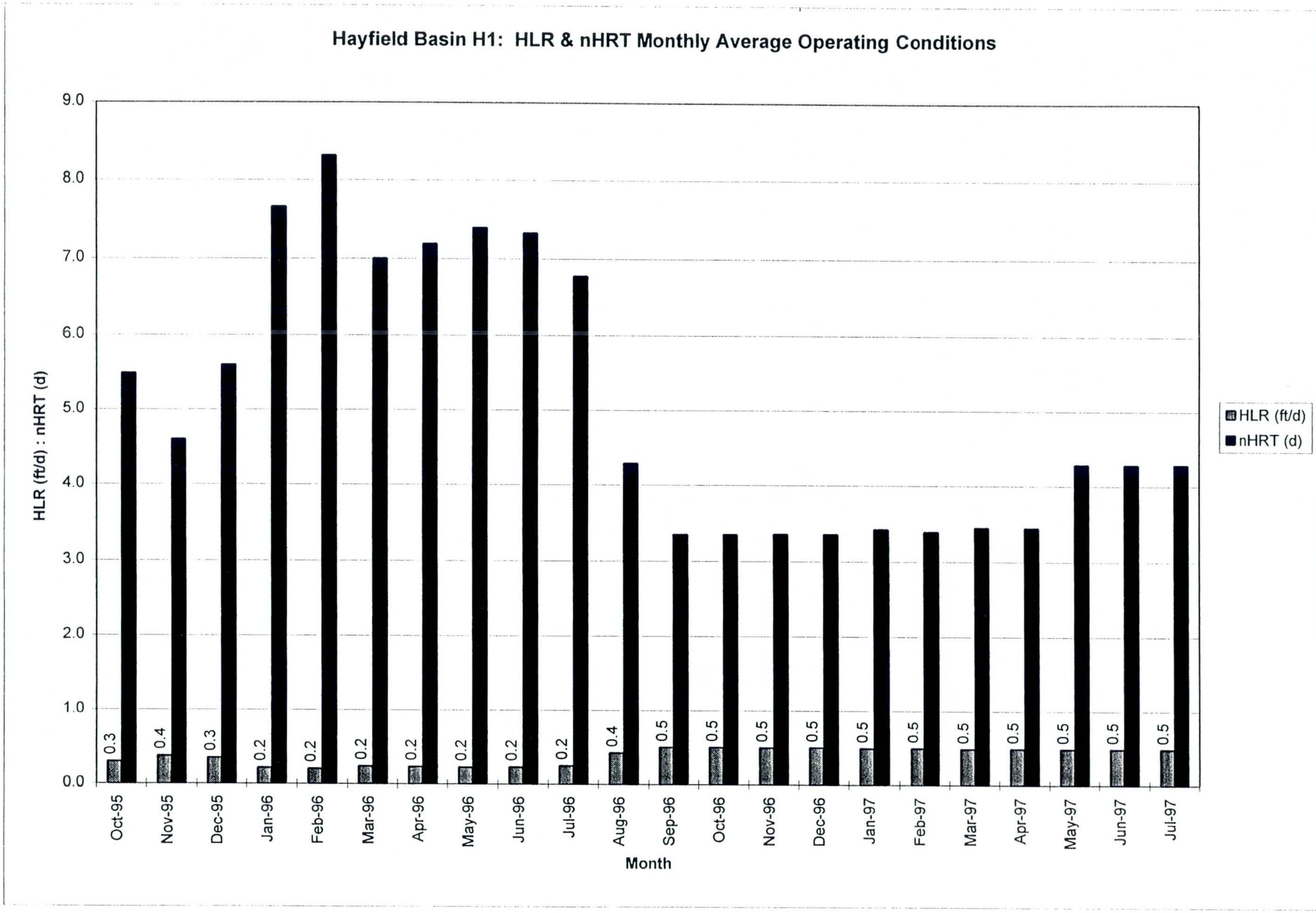
H2

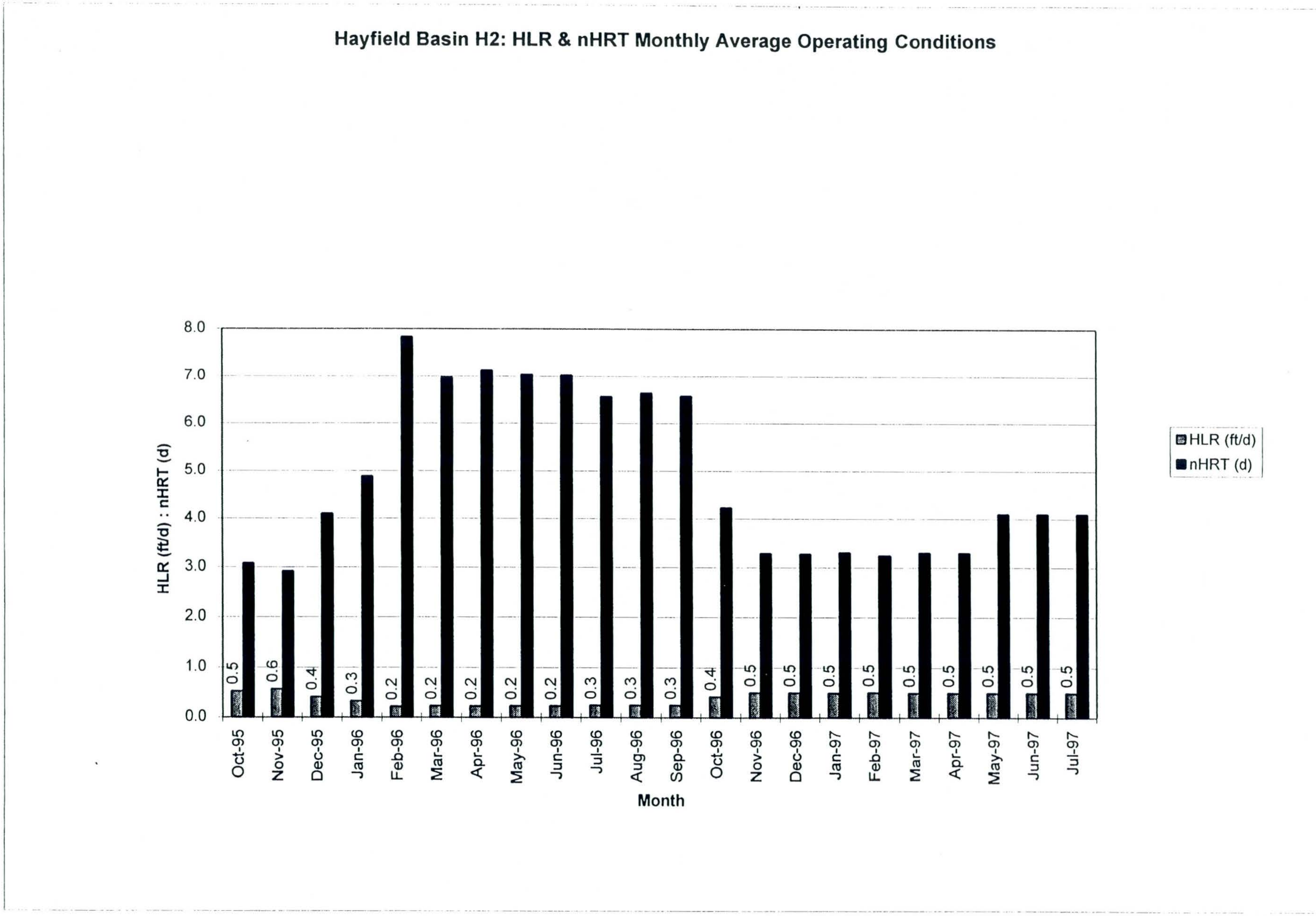
Date	HLR (ft/d)	HLR (cm/d)	nHRT (d)
Aug-95	NR	NR	NR
Sep-95	NR	NR	NR
Oct-95	0.5	16.2	3.1
Nov-95	0.6	17.5	2.9
Dec-95	0.4	12.8	4.1
Jan-96	0.3	10.4	4.9
Feb-96	0.2	6.7	7.8
Mar-96	0.2	7.3	7.0
Apr-96	0.2	7.1	7.1
May-96	0.2	7.2	7.0
Jun-96	0.2	7.2	7.0
Jul-96	0.3	7.7	6.6
Aug-96	0.3	7.6	6.6
Sep-96	0.3	7.7	6.6
Oct-96	0.4	13.0	4.2
Nov-96	0.5	15.4	3.3
Dec-96	0.5	15.4	3.3
Jan-97	0.5	15.3	3.3
Feb-97	0.5	15.6	3.2
Mar-97	0.5	15.3	3.3
Apr-97	0.5	15.3	3.3
May-97	0.5	15.3	4.1
Jun-97	0.5	15.3	4.1
Jul-97	0.5	15.3	4.1


Cobble Basin C1: HLR & nHRT Monthly Average Operating Conditions
HLR (ft/d) : nHRT (d)
Month
HLR (ft/d)
nHRT (d)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.7
1.1
1.1
1.1
1.1
0.9
0.9
0.9
0.9
0.9
0.7
0.7
0.7
1.2
1.2
1.2
1.2
1.2
1.2
1.1
1.1
2.5
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97

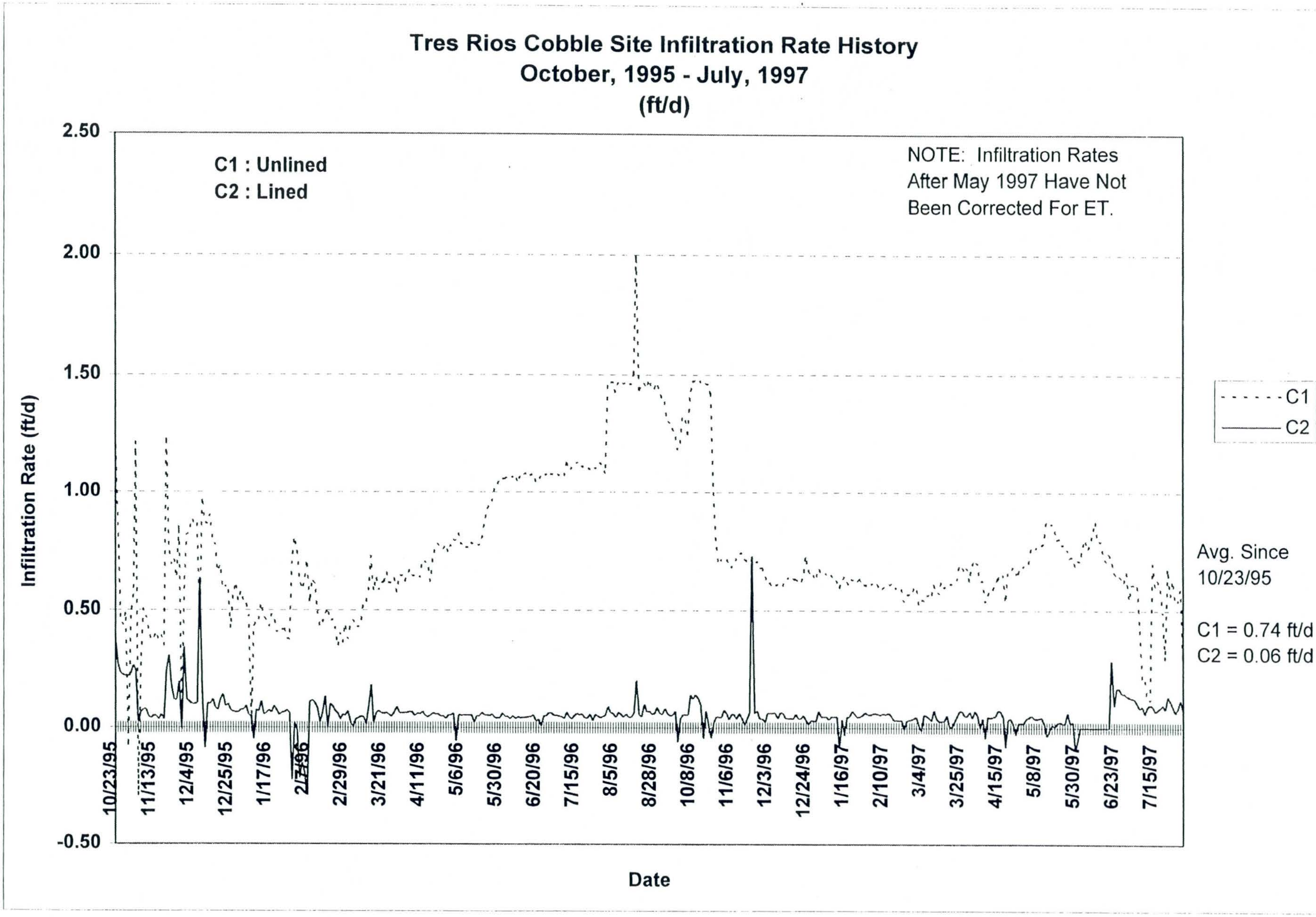


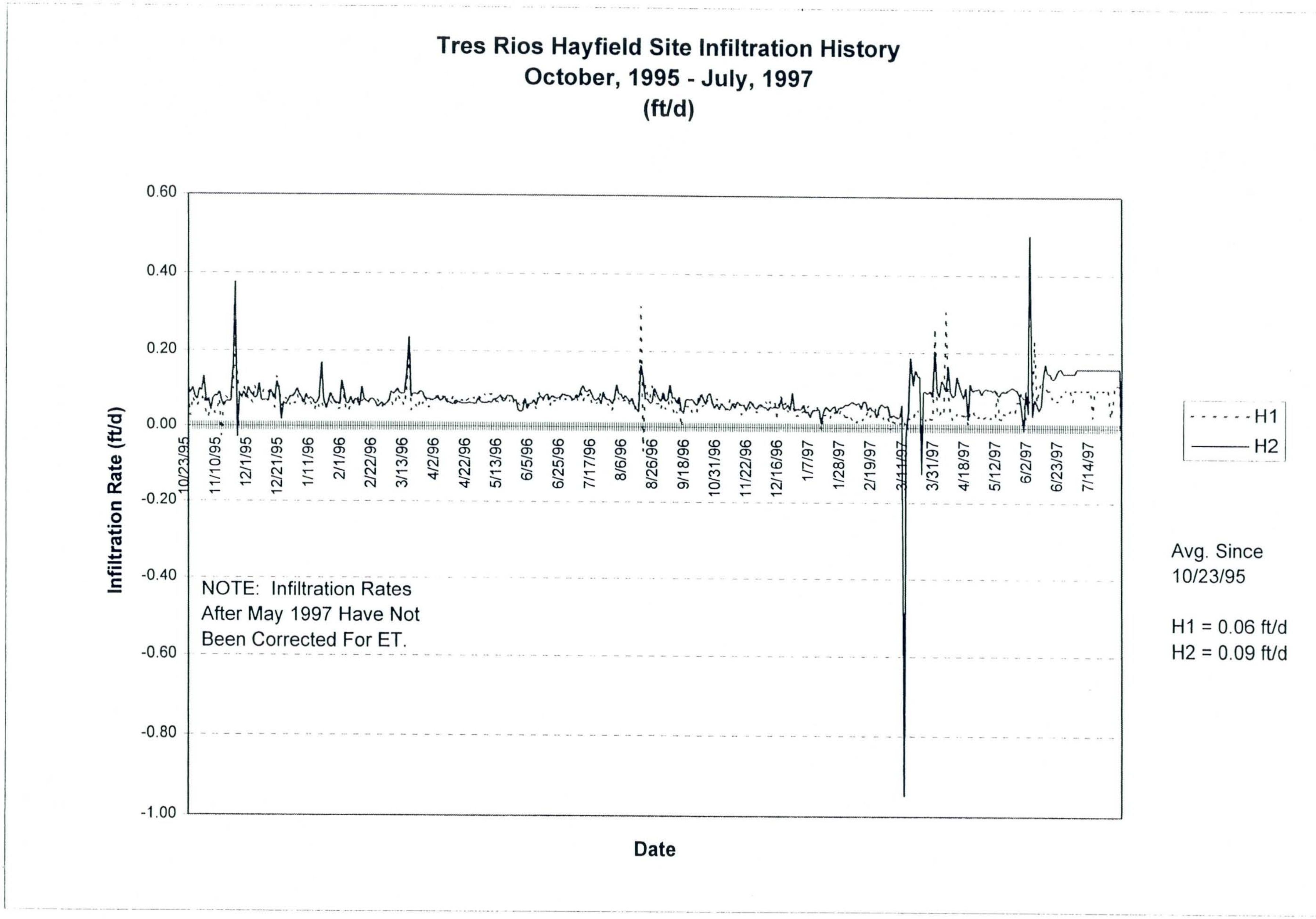
Cobble Basin C2: HLR & nHRT Monthly Average Operating Conditions
HLR (ft/d) : nHRT (d)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0.9
0.5
0.5
0.3
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.2
1.2
0.9
0.8
0.8
0.8
0.8
0.8
0.7
0.1
0.2
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
HLR (ft/d)
nHRT (d)


Hayfield Basin H1: HLR & nHRT Monthly Average Operating Conditions
HLR (ft/d) : nHRT (d)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.3
0.4
0.3
0.2
0.2
0.2
0.2
0.2
0.2
0.2
0.4
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
HLR (ft/d)
nHRT (d)



Hayfield Basin H2: HLR & nHRT Monthly Average Operating Conditions
HLR (ft/d) : nHRT (d)
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0.5
0.6
0.4
0.3
0.2
0.2
0.2
0.2
0.2
0.3
0.3
0.3
0.4
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
0.5
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
HLR (ft/d)
nHRT (d)


Tres Rios Cobble Site Infiltration Rate History
October, 1995 - July, 1997
(ft/d)
C1 : Unlined
C2 : Lined
NOTE: Infiltration Rates After May 1997 Have Not Been Corrected For ET.
Infiltration Rate (ft/d)
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
C1
C2
Avg. Since 10/23/95
C1 = 0.74 ft/d
C2 = 0.06 ft/d
10/23/95
11/13/95
12/4/95
12/25/95
1/17/96
2/7/96
2/29/96
3/21/96
4/11/96
5/6/96
5/30/96
6/20/96
7/15/96
8/5/96
8/28/96
10/8/96
11/6/96
12/3/96
12/24/96
1/16/97
2/10/97
3/4/97
3/25/97
4/15/97
5/8/97
5/30/97
6/23/97
7/15/97
Date

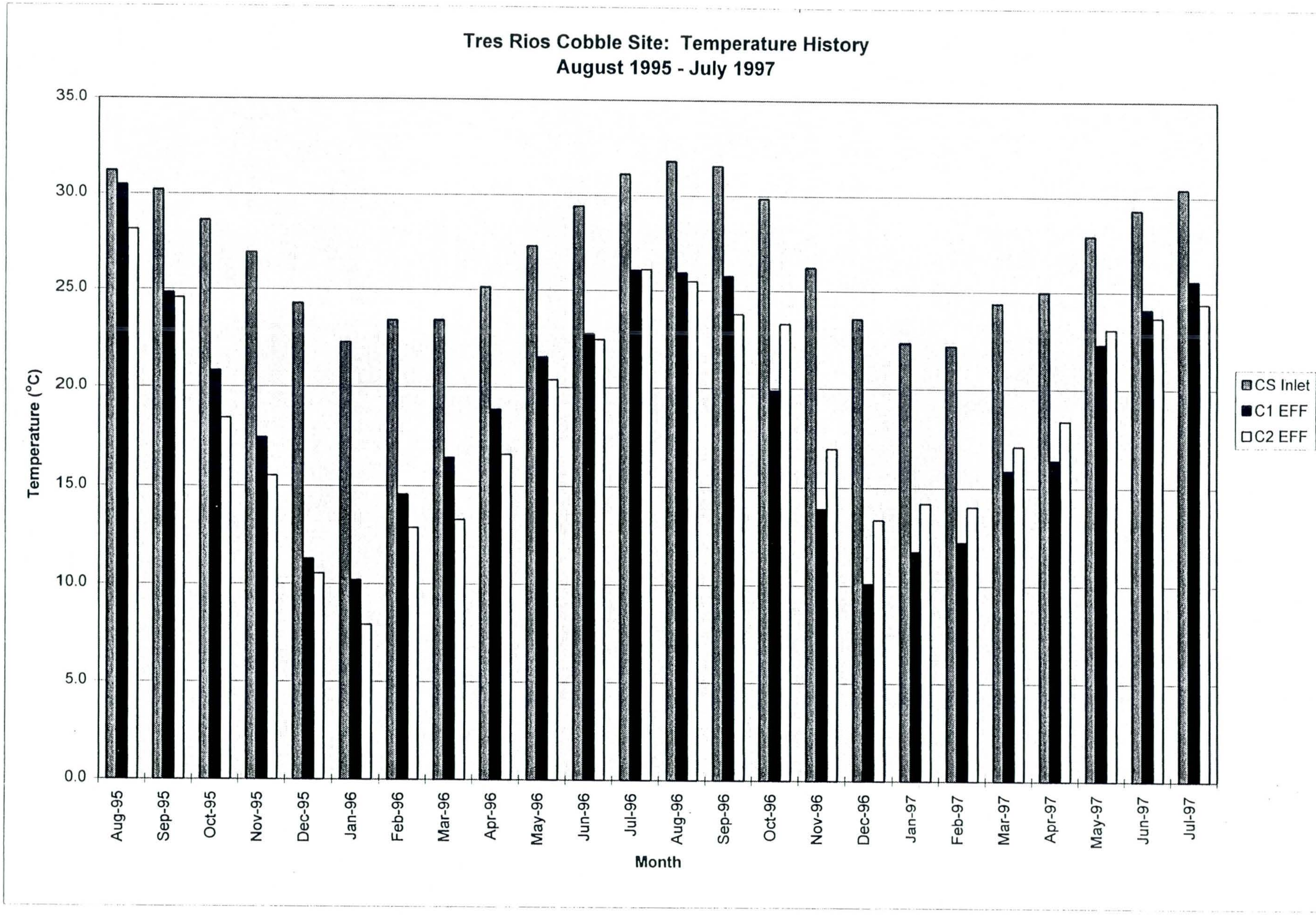

Tres Rios Hayfield Site Infiltration History
October, 1995 - July, 1997
(ft/d)
Infiltration Rate (ft/d)
0.60
0.40
0.20
0.00
-0.20
-0.40
-0.60
-0.80
-1.00
10/23/95
11/10/95
12/1/95
12/21/95
1/11/96
2/1/96
2/22/96
3/13/96
4/2/96
4/22/96
5/13/96
6/5/96
6/25/96
7/17/96
8/6/96
8/26/96
9/18/96
10/31/96
11/22/96
12/16/96
1/7/97
1/28/97
2/19/97
3/11/97
3/31/97
4/18/97
5/12/97
6/2/97
6/23/97
7/14/97
Date
H1
H2
NOTE: Infiltration Rates After May 1997 Have Not Been Corrected For ET.
Avg. Since 10/23/95
H1 = 0.06 ft/d
H2 = 0.09 ft/d

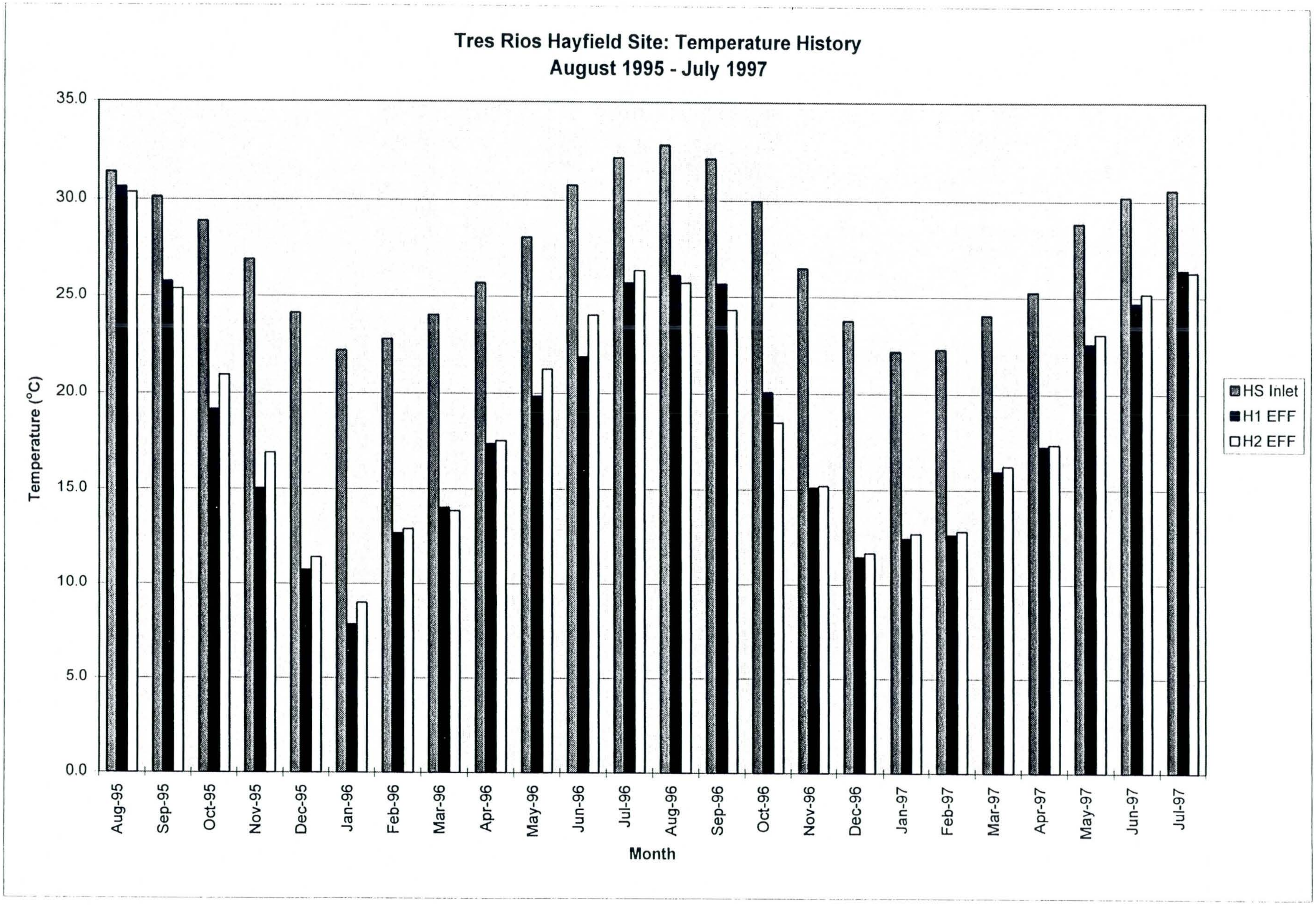
APPENDIX C - pH, Temp., D.O., & Cond.

Tres Rios Demonstration Project
Monthly Average Influent and Effluent Temperatures

Sample Date	Temp. (°C) Monthly Avg. CS Inlet	C1 EFF	C2 EFF
Aug-95	31.2	30.5	28.1
Sep-95	30.2	24.8	24.6
Oct-95	28.6	20.8	18.4
Nov-95	26.9	17.4	15.5
Dec-95	24.3	11.3	10.5
Jan-96	22.3	10.2	7.9
Feb-96	23.4	14.6	12.9
Mar-96	23.4	16.4	13.3
Apr-96	25.1	18.9	16.6
May-96	27.3	21.5	20.4
Jun-96	29.4	22.7	22.5
Jul-96	31.1	26.1	26.1
Aug-96	31.8	26.0	25.5
Sep-96	31.6	25.8	23.8
Oct-96	29.9	19.9	23.3
Nov-96	26.2	13.9	17.0
Dec-96	23.6	10.1	13.4
Jan-97	22.4	11.8	14.2
Feb-97	22.2	12.2	14.0
Mar-97	24.4	15.9	17.1
Apr-97	25.0	16.4	18.4
May-97	27.9	22.3	23.0
Jun-97	29.3	24.1	23.7
Jul-97	30.4	25.6	24.4
Maximum	**31.8**	**30.5**	**28.1**
Minimum	**22.2**	**10.1**	**7.9**

Sample Date	Temp. (°C) Monthly Avg. HS Inlet	H1 EFF	H2 EFF	HS EFF
Aug-95	31.4	30.6	30.4	31.4
Sep-95	30.2	25.8	25.4	26.5
Oct-95	28.9	19.2	20.9	20.1
Nov-95	26.9	15.0	16.9	16.2
Dec-95	24.1	10.7	11.4	11.1
Jan-96	22.2	7.8	9.0	8.6
Feb-96	22.8	12.7	12.9	12.7
Mar-96	24.0	14.0	13.9	14.2
Apr-96	25.7	17.4	17.6	17.4
May-96	28.1	19.9	21.2	20.0
Jun-96	30.8	21.9	24.0	22.0
Jul-96	32.2	25.7	26.4	25.7
Aug-96	32.8	26.1	25.7	25.9
Sep-96	32.2	25.7	24.3	25.1
Oct-96	30.0	20.1	18.5	19.5
Nov-96	26.5	15.1	15.2	15.1
Dec-96	23.8	11.5	11.7	11.4
Jan-97	22.2	12.5	12.7	12.5
Feb-97	22.3	12.6	12.8	12.6
Mar-97	24.1	16.0	16.3	15.9
Apr-97	25.3	17.3	17.4	17.3
May-97	28.9	22.6	23.1	22.5
Jun-97	30.2	24.7	25.2	24.6
Jul-97	30.6	26.5	26.3	25.8
Maximum	**32.8**	**30.6**	**30.4**	**31.4**
Minimum	**22.2**	**7.8**	**9.0**	**8.6**


Tres Rios Cobble Site: Temperature History
August 1995 - July 1997
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Temperature (°C)
CS Inlet
C1 EFF
C2 EFF
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month



Tres Rios Hayfield Site: Temperature History
August 1995 - July 1997
Temperature (°C)
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
HS Inlet
H1 EFF
H2 EFF

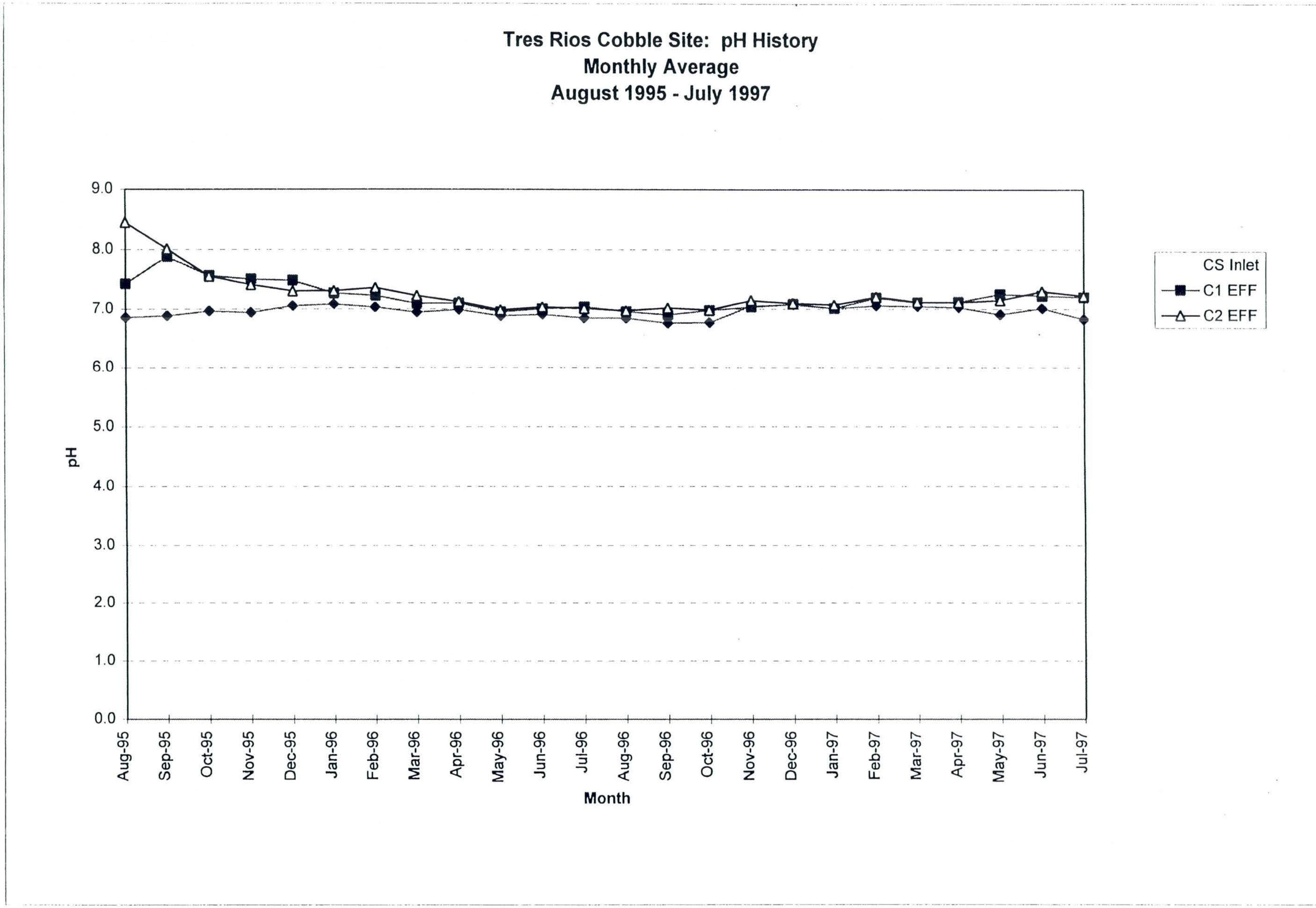
Tres Rios Demonstration Project
Monthly Average Influent and Effluent pH

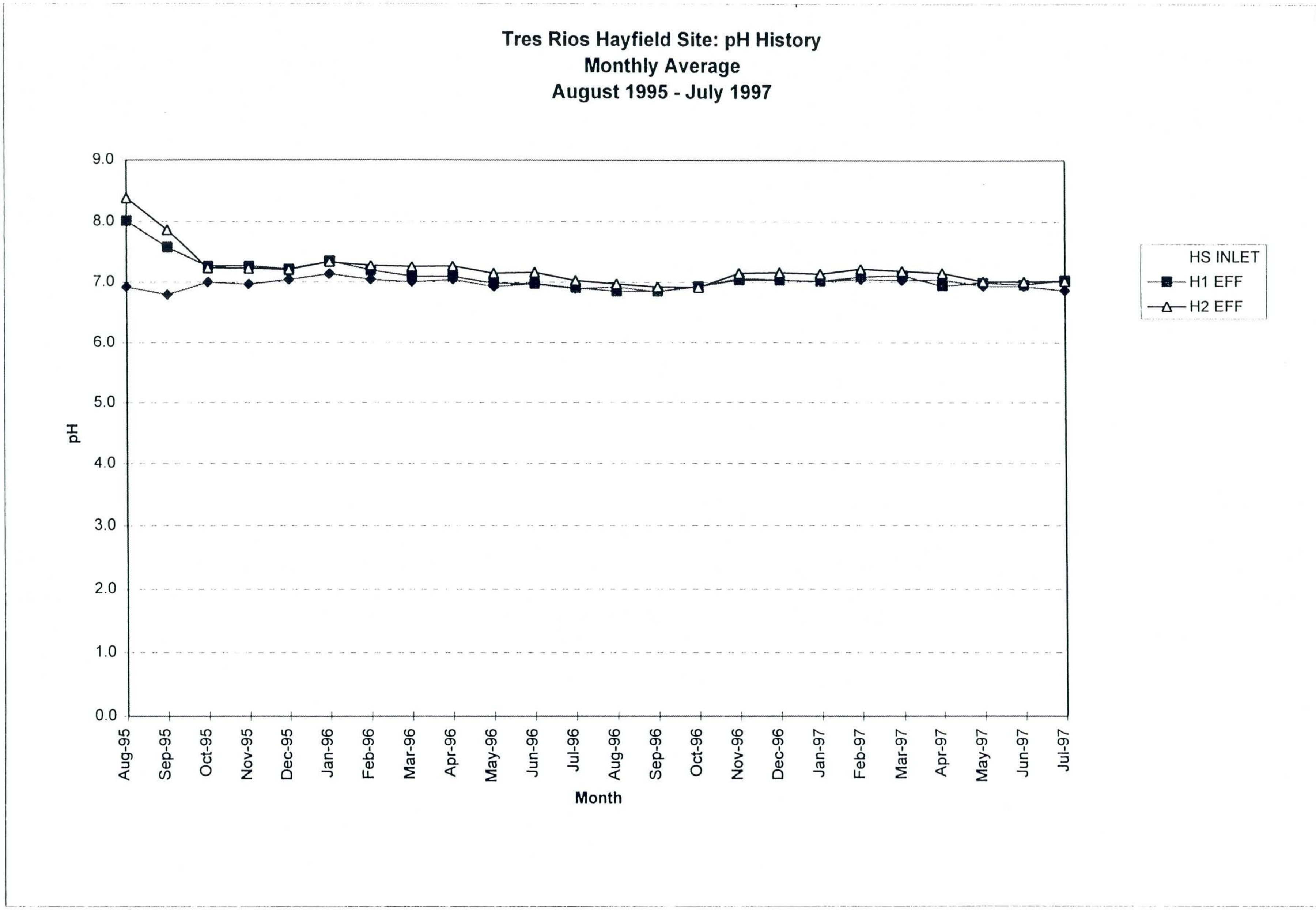
COBBLE SITE
pH : Daily

Sample Date	CS Inlet	C1 EFF	C2 EFF
Aug-95	6.9	7.4	8.5
Sep-95	6.9	7.9	8.0
Oct-95	7.0	7.6	7.6
Nov-95	6.9	7.5	7.4
Dec-95	7.1	7.5	7.3
Jan-96	7.1	7.3	7.3
Feb-96	7.0	7.2	7.4
Mar-96	6.9	7.1	7.2
Apr-96	7.0	7.1	7.1
May-96	6.9	7.0	7.0
Jun-96	6.9	7.0	7.0
Jul-96	6.8	7.0	7.0
Aug-96	6.8	7.0	7.0
Sep-96	6.8	6.9	7.0
Oct-96	6.8	7.0	7.0
Nov-96	7.1	7.0	7.1
Dec-96	7.1	7.1	7.1
Jan-97	7.0	7.0	7.1
Feb-97	7.1	7.2	7.2
Mar-97	7.0	7.1	7.1
Apr-97	7.0	7.1	7.1
May-97	6.9	7.2	7.2
Jun-97	7.0	7.2	7.3
Jul-97	6.8	7.2	7.2
Average	**6.9**	**7.2**	**7.3**
Maximum	**7.1**	**7.9**	**8.5**
Minimum	**6.8**	**6.9**	**7.0**

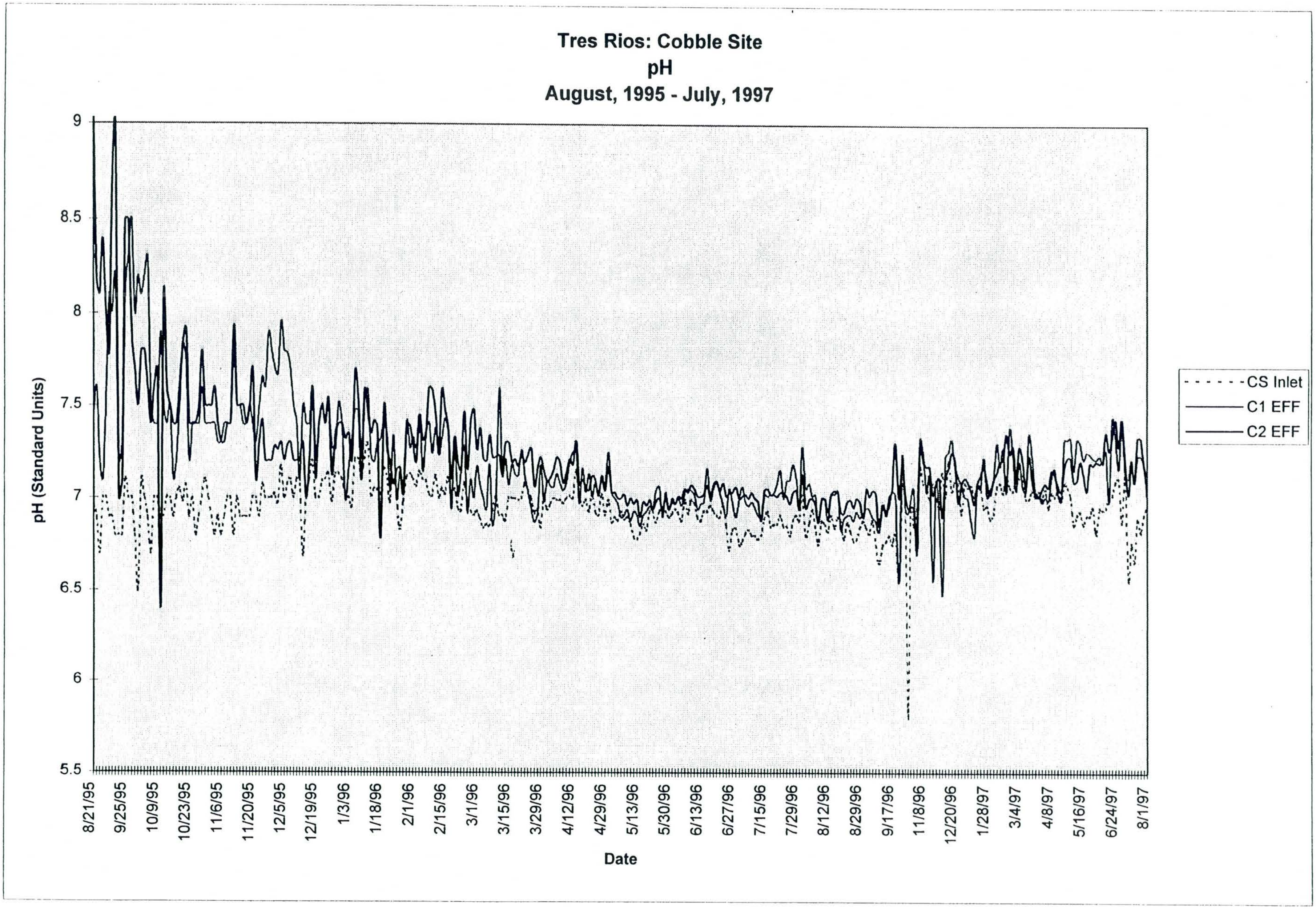
HAYFIELD SITE
pH : Daily

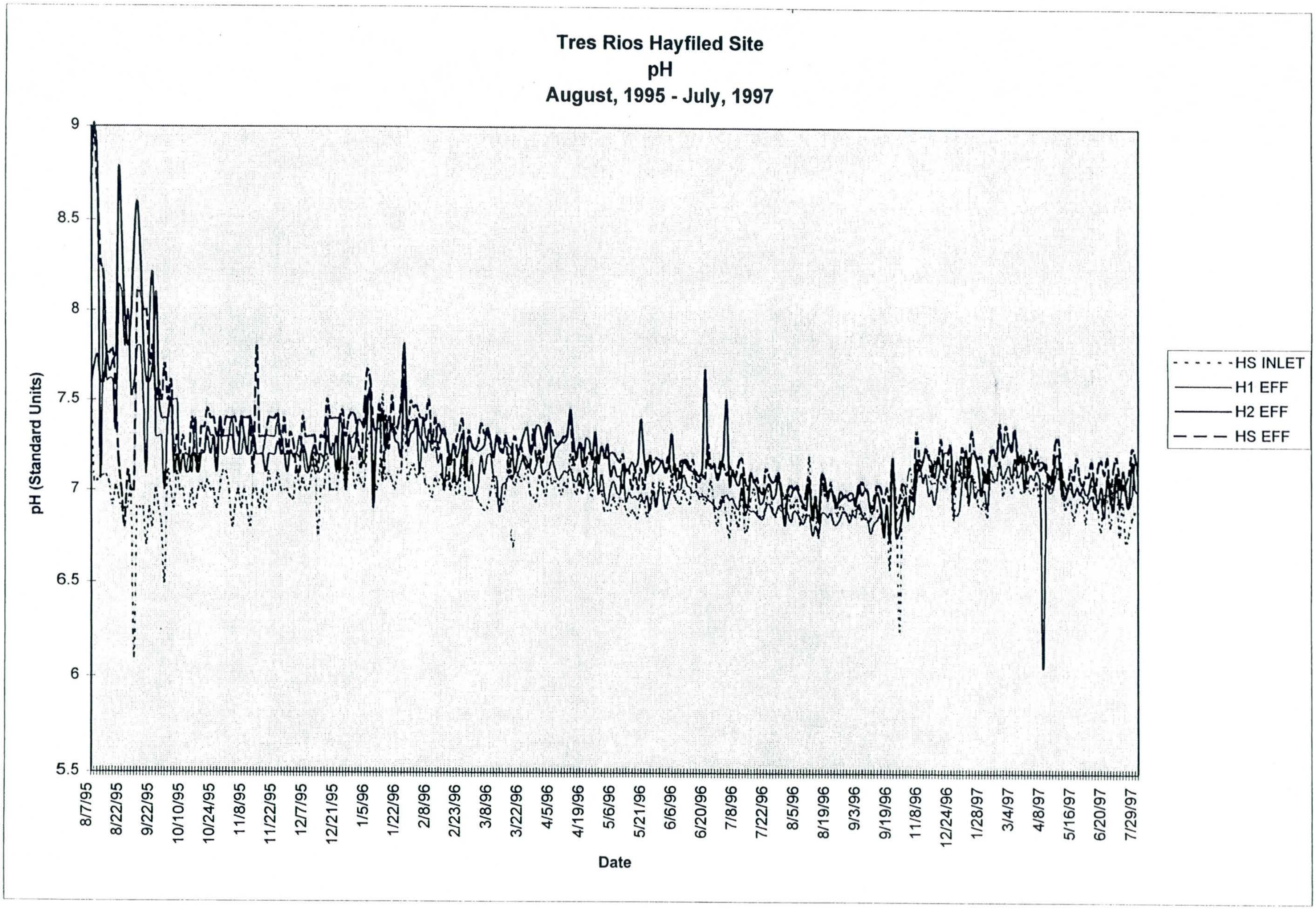
Sample Date	HS INLET	H1 EFF	H2 EFF	HS EFF
Aug-95	6.9	8.0	8.4	7.0
Sep-95	6.8	7.6	7.9	7.6
Oct-95	7.0	7.3	7.2	7.3
Nov-95	7.0	7.3	7.2	7.4
Dec-95	7.0	7.2	7.2	7.3
Jan-96	7.1	7.3	7.3	7.4
Feb-96	7.0	7.2	7.3	7.3
Mar-96	7.0	7.1	7.3	7.2
Apr-96	7.0	7.1	7.3	7.3
May-96	6.9	7.0	7.1	7.1
Jun-96	7.0	7.0	7.2	7.1
Jul-96	6.9	6.9	7.0	7.1
Aug-96	6.9	6.8	7.0	7.0
Sep-96	6.8	6.8	6.9	7.0
Oct-96	6.9	6.9	6.9	7.0
Nov-96	7.1	7.0	7.1	7.2
Dec-96	7.0	7.0	7.2	7.2
Jan-97	7.0	7.0	7.1	7.2
Feb-97	7.0	7.1	7.2	7.3
Mar-97	7.0	7.1	7.2	7.2
Apr-97	7.0	6.9	7.1	7.2
May-97	6.9	7.0	7.0	7.1
Jun-97	6.9	7.0	7.0	7.1
Jul-97	6.9	7.0	7.0	7.1
Average	**7.0**	**7.1**	**7.2**	**7.2**
Maximum	**7.1**	**8.0**	**8.4**	**7.6**
Minimum	**6.8**	**6.8**	**6.9**	**7.0**


Tres Rios Cobble Site: pH History
Monthly Average
August 1995 - July 1997
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
pH
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
CS Inlet
C1 EFF
C2 EFF



Tres Rios Hayfield Site: pH History
Monthly Average
August 1995 - July 1997
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
pH
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
HS INLET
H1 EFF
H2 EFF


Tres Rios: Cobble Site
pH
August, 1995 - July, 1997
pH (Standard Units)
9
8.5
8
7.5
7
6.5
6
5.5
8/21/95
9/25/95
10/9/95
10/23/95
11/6/95
11/20/95
12/5/95
12/19/95
1/3/96
1/18/96
2/1/96
2/15/96
3/1/96
3/15/96
3/29/96
4/12/96
4/29/96
5/13/96
5/30/96
6/13/96
6/27/96
7/15/96
7/29/96
8/12/96
8/29/96
9/17/96
11/8/96
12/20/96
1/28/97
3/4/97
4/8/97
5/16/97
6/24/97
8/1/97
Date
CS Inlet
C1 EFF
C2 EFF



Tres Rios Hayfiled Site
pH
August, 1995 - July, 1997
pH (Standard Units)
9
8.5
8
7.5
7
6.5
6
5.5
8/7/95
8/22/95
9/22/95
10/10/95
10/24/95
11/8/95
11/22/95
12/7/95
12/21/95
1/5/96
1/22/96
2/8/96
2/23/96
3/8/96
3/22/96
4/5/96
4/19/96
5/6/96
5/21/96
6/6/96
6/20/96
7/8/96
7/22/96
8/5/96
8/19/96
9/3/96
9/19/96
11/8/96
12/24/96
1/28/97
3/4/97
4/8/97
5/16/97
6/20/97
7/29/97
Date
HS INLET
H1 EFF
H2 EFF
HS EFF

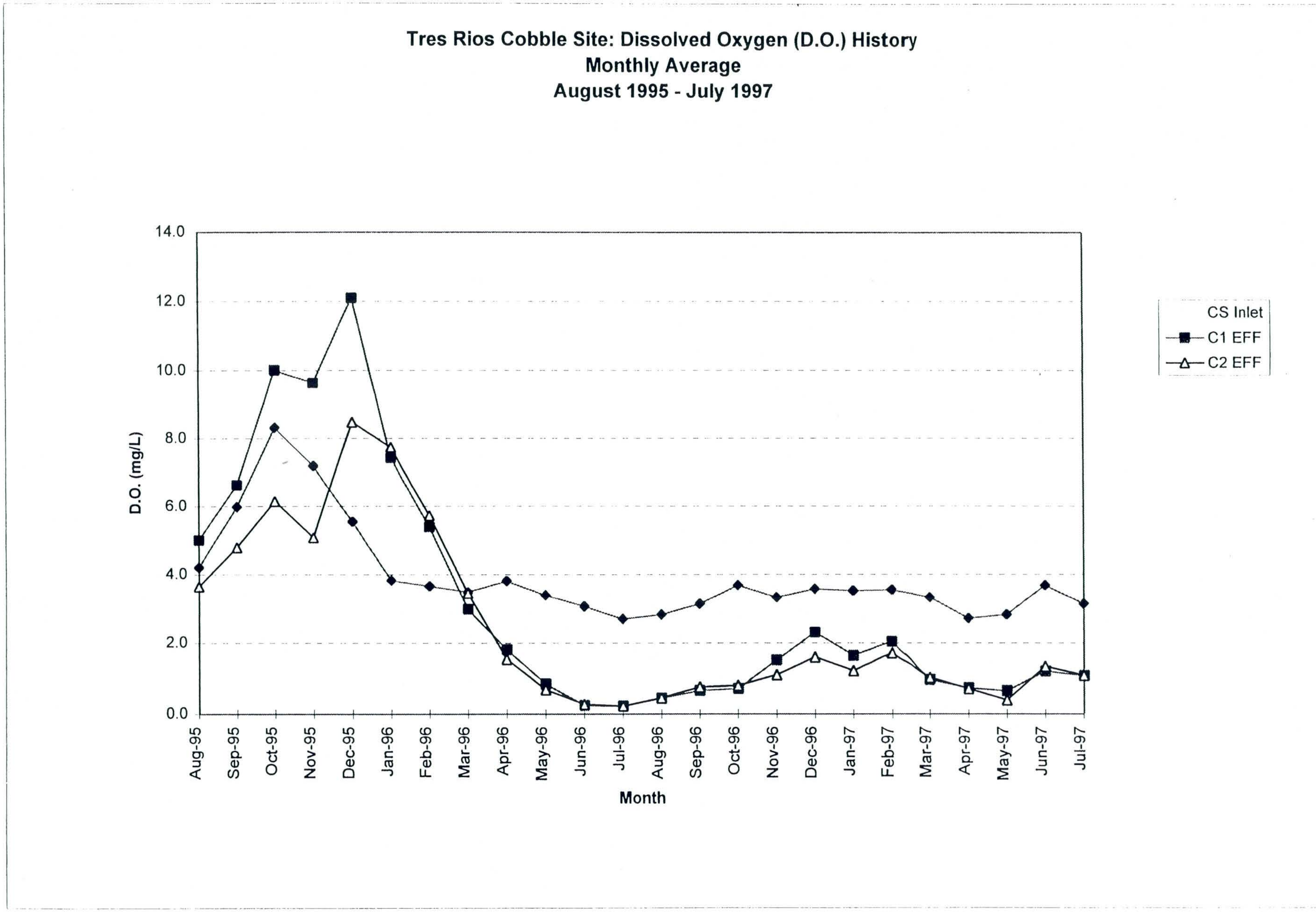
Tres Rios Demonstration Project
Monthly Average Influent and Effluent Dissovled Oxygen (D.O.)

COBBLE SITE
D.O. (mg/L) : Monthly Avg.

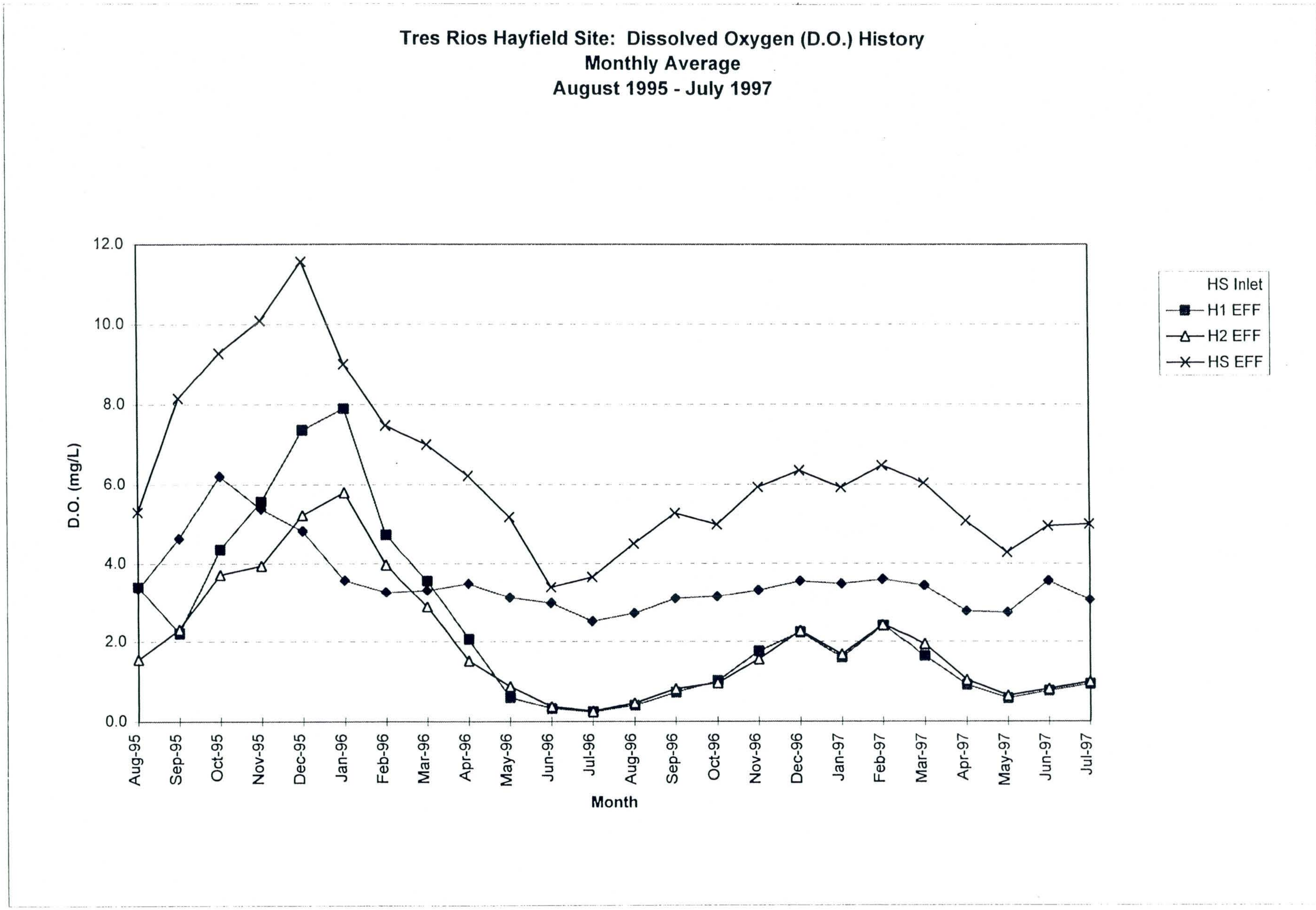
Sample Date	CS Inlet	C1 EFF	C2 EFF
Aug-95	4.2	5.0	3.7
Sep-95	6.0	6.6	4.8
Oct-95	8.3	10.0	6.1
Nov-95	7.2	9.6	5.1
Dec-95	5.5	12.1	8.5
Jan-96	3.8	7.4	7.7
Feb-96	3.7	5.4	5.7
Mar-96	3.5	3.0	3.4
Apr-96	3.8	1.8	1.5
May-96	3.4	0.8	0.7
Jun-96	3.1	0.2	0.3
Jul-96	2.7	0.2	0.2
Aug-96	2.8	0.4	0.5
Sep-96	3.1	0.7	0.8
Oct-96	3.7	0.7	0.8
Nov-96	3.3	1.5	1.1
Dec-96	3.6	2.3	1.6
Jan-97	3.5	1.6	1.2
Feb-97	3.6	2.0	1.7
Mar-97	3.3	1.0	1.0
Apr-97	2.7	0.7	0.7
May-97	2.8	0.7	0.4
Jun-97	3.7	1.2	1.3
Jul-97	3.1	1.1	1.1
Average	**3.9**	**3.2**	**2.5**
Maximum	**8.3**	**12.1**	**8.5**
Minimum	**2.7**	**0.2**	**0.2**

HAYFIELD SITE
D.O. (mg/L) : Monthly Avg.

Sample Date	HS Inlet	H1 EFF	H2 EFF	HS EFF
Aug-95	3.4	3.4	1.6	5.3
Sep-95	4.6	2.2	2.3	8.2
Oct-95	6.2	4.4	3.7	9.3
Nov-95	5.4	5.6	3.9	10.1
Dec-95	4.8	7.4	5.2	11.6
Jan-96	3.6	7.9	5.8	9.0
Feb-96	3.3	4.7	4.0	7.5
Mar-96	3.3	3.6	2.9	7.0
Apr-96	3.5	2.1	1.5	6.2
May-96	3.1	0.6	0.9	5.2
Jun-96	3.0	0.3	0.4	3.4
Jul-96	2.5	0.2	0.3	3.7
Aug-96	2.7	0.4	0.5	4.5
Sep-96	3.1	0.7	0.8	5.3
Oct-96	3.2	1.0	1.0	5.0
Nov-96	3.3	1.8	1.6	5.9
Dec-96	3.6	2.2	2.3	6.4
Jan-97	3.5	1.6	1.7	5.9
Feb-97	3.6	2.4	2.4	6.5
Mar-97	3.4	1.6	1.9	6.0
Apr-97	2.8	0.9	1.0	5.1
May-97	2.7	0.6	0.6	4.3
Jun-97	3.6	0.8	0.8	5.0
Jul-97	3.1	0.9	1.0	5.0
Average	**3.5**	**2.4**	**2.0**	**6.3**
Maximum	**6.2**	**7.9**	**5.8**	**11.6**
Minimum	**2.5**	**0.2**	**0.3**	**3.4**



Tres Rios Cobble Site: Dissolved Oxygen (D.O.) History
Monthly Average
August 1995 - July 1997
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
D.O. (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
CS Inlet
C1 EFF
C2 EFF



Tres Rios Hayfield Site: Dissolved Oxygen (D.O.) History
Monthly Average
August 1995 - July 1997
12.0
10.0
8.0
6.0
4.0
2.0
0.0
D.O. (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
HS Inlet
H1 EFF
H2 EFF
HS EFF

Tres Rios
D.O. (mg/L) Summary

D.O. August, 1995 - July, 1997

	CS Inlet	C1 EFF	C2 EFF
Average	3.9	3.4	2.8
Max	10.1	16.7	13.7
Min	0.4	0.07	0.05

	HS Inlet	H1 EFF	H2 EFF	HS EFF
Average	3.5	2.7	2.2	7.1
Max	7.5	12.1	8.8	15
Min	0.5	0.1	0.1	1.6

D.O. May - July 1996

	CS Inlet	C1 EFF	C2 EFF
Average	3.04	0.43	0.39
Max	4.6	1.3	1.3
Min	2.3	0.07	0.05

	HS Inlet	H1 EFF	H2 EFF	HS EFF
Average	2.86	0.38	0.50	4.07
Max	4.4	2	2.1	5.8
Min	0.8	0.1	0.1	1.6

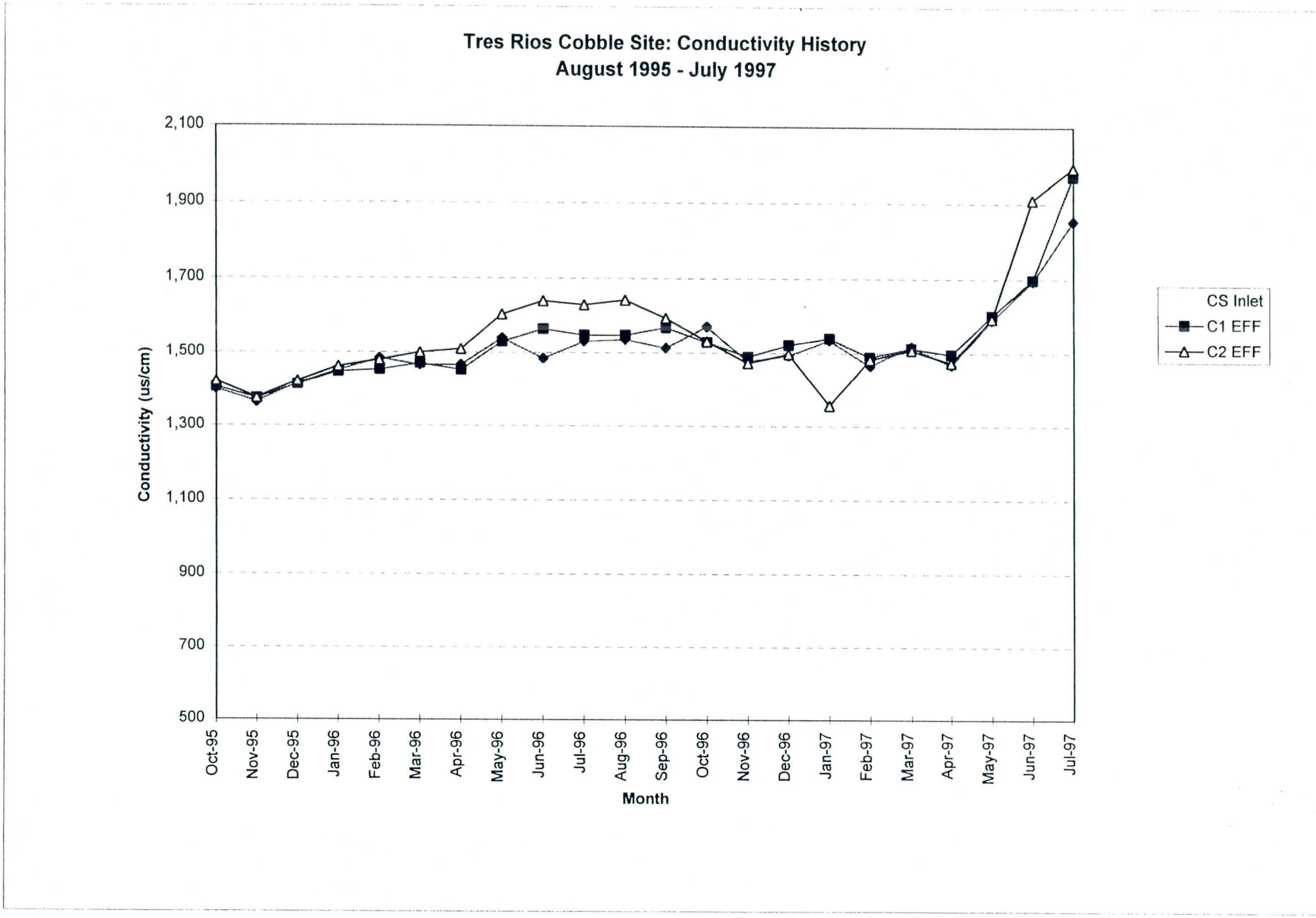
Tres Rios Demonstration Project
Monthly Average Influent and Effluent Conductivity

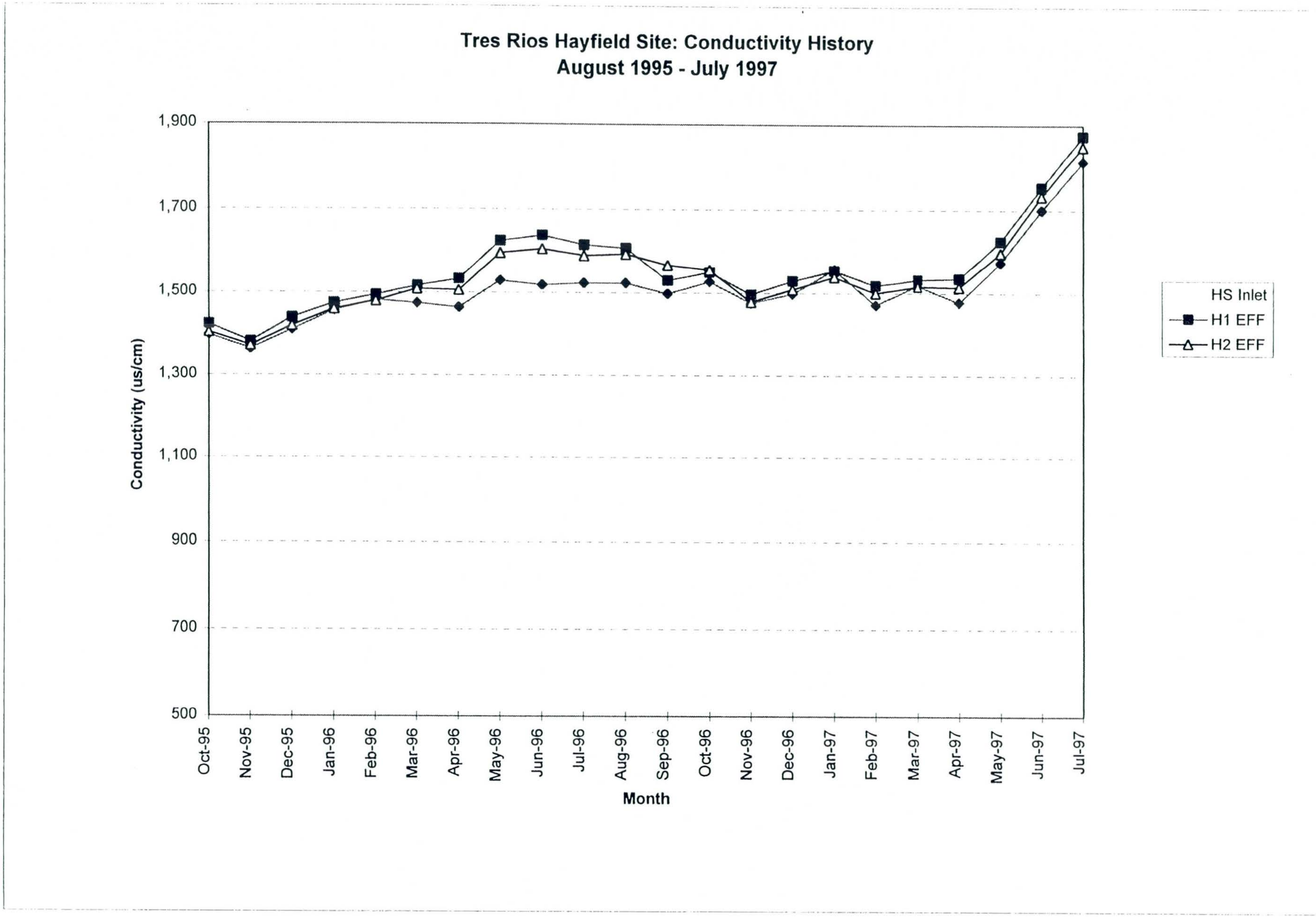
COBBLE SITE
Conductivity (uS)
Monthly Average

Sample Date	CS Inlet	C1 EFF	C2 EFF
Oct-95	1,399	1,405	1,421
Nov-95	1,364	1,373	1,375
Dec-95	1,414	1,412	1,422
Jan-96	1,451	1,447	1,462
Feb-96	1,484	1,453	1,480
Mar-96	1,466	1,470	1,500
Apr-96	1,466	1,453	1,509
May-96	1,539	1,530	1,603
Jun-96	1,484	1,564	1,640
Jul-96	1,531	1,548	1,630
Aug-96	1,536	1,548	1,642
Sep-96	1,513	1,568	1,593
Oct-96	1,571	1,530	1,532
Nov-96	1,478	1,490	1,473
Dec-96	1,493	1,523	1,498
Jan-97	1,535	1,540	1,356
Feb-97	1,465	1,489	1,482
Mar-97	1,518	1,514	1,508
Apr-97	1,467	1,497	1,474
May-97	1,589	1,602	1,593
Jun-97	1,695	1,698	1,910
Jul-97	1,853	1,970	1,992
Average	**1,514**	**1,528**	**1,550**
Maximum	**1,853**	**1,970**	**1,992**
Minimum	**1,364**	**1,373**	**1,356**

HAYFIELD SITE
Conductivity (uS)
Monthly Average

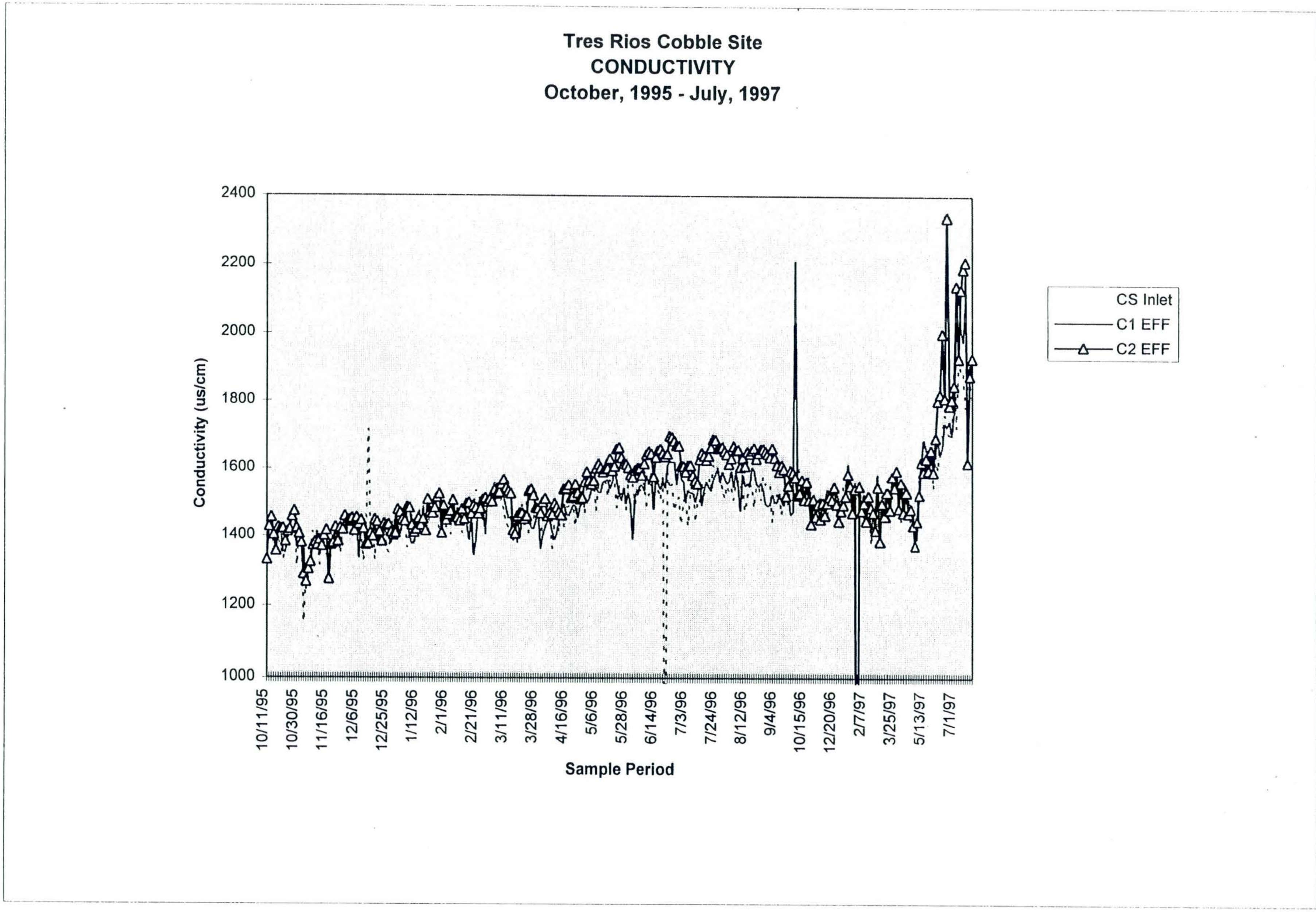
Sample Date	HS Inlet	H1 EFF	H2 EFF
Oct-95	1,397	1,423	1,404
Nov-95	1,363	1,381	1,371
Dec-95	1,410	1,439	1,420
Jan-96	1,457	1,474	1,460
Feb-96	1,482	1,494	1,479
Mar-96	1,474	1,516	1,508
Apr-96	1,464	1,533	1,505
May-96	1,529	1,624	1,595
Jun-96	1,518	1,637	1,604
Jul-96	1,523	1,614	1,589
Aug-96	1,523	1,607	1,593
Sep-96	1,498	1,530	1,567
Oct-96	1,527	1,550	1,556
Nov-96	1,475	1,497	1,478
Dec-96	1,498	1,529	1,509
Jan-97	1,557	1,554	1,539
Feb-97	1,471	1,518	1,500
Mar-97	1,519	1,533	1,516
Apr-97	1,478	1,535	1,514
May-97	1,574	1,624	1,597
Jun-97	1,700	1,754	1,734
Jul-97	1,814	1,875	1,850
Average	**1,511**	**1,556**	**1,540**
Maximum	**1,814**	**1,875**	**1,850**
Minimum	**1,363**	**1,381**	**1,371**


Tres Rios Cobble Site: Conductivity History
August 1995 - July 1997
Conductivity (us/cm)
2,100
1,900
1,700
1,500
1,300
1,100
900
700
500
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
CS Inlet
C1 EFF
C2 EFF

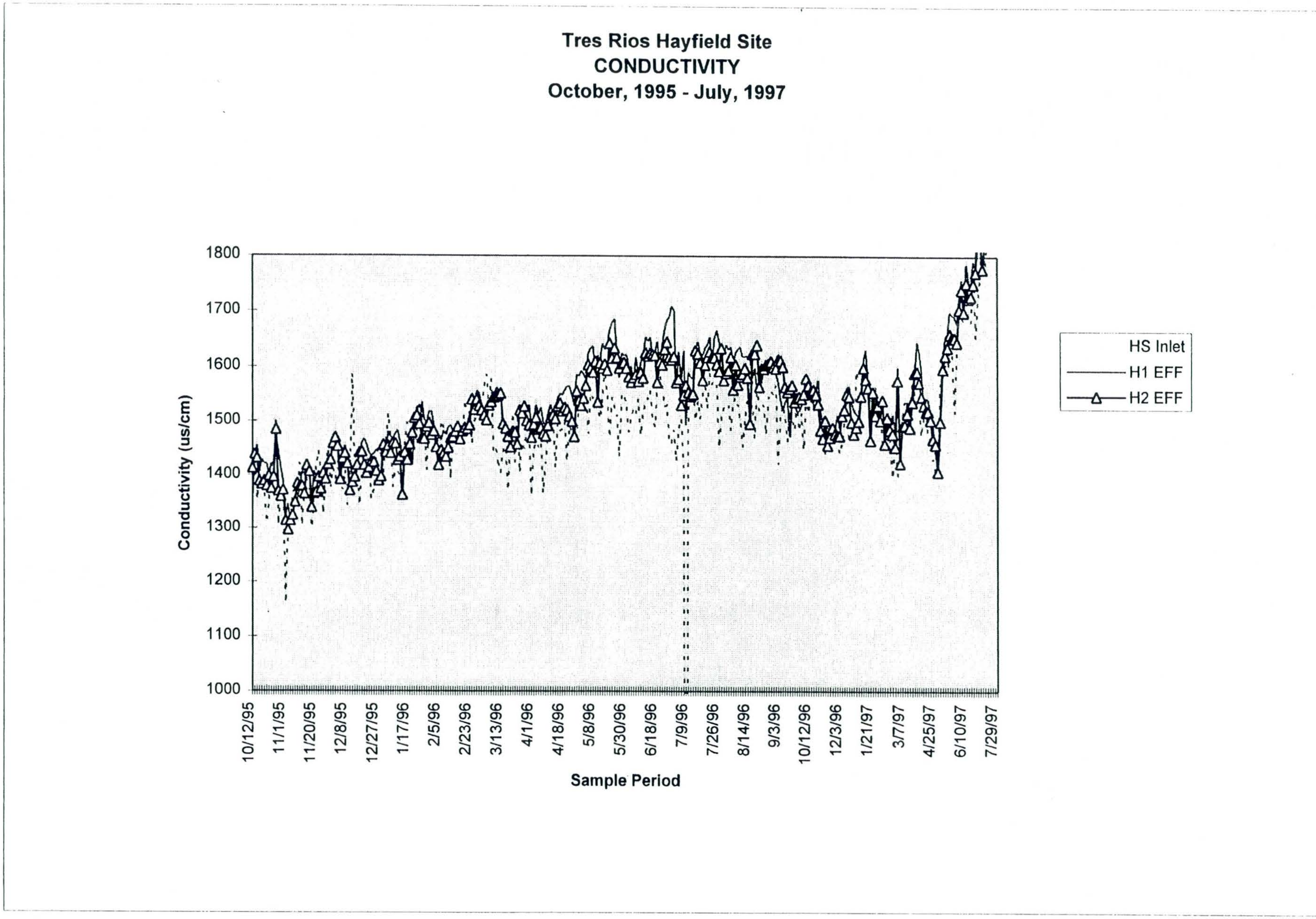

Tres Rios Hayfield Site: Conductivity History
August 1995 - July 1997
Conductivity (us/cm)
1,900
1,700
1,500
1,300
1,100
900
700
500
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month
HS Inlet
H1 EFF
H2 EFF

Tres Rios
Conductivity (us/cm) Summary
August, 1995 - July, 1996

Site	Average	Max	Min
CS Inlet	1495	1936	583
C1 EFF	1506	2212	1244
C2 EFF	1537	2340	148
HS Inlet	1495	1893	1160
H1 EFF	1545	1941	1311
H2 EFF	1528	1921	1297
HS EFF	1514	1704	1200



Tres Rios Cobble Site
CONDUCTIVITY
October, 1995 - July, 1997
Conductivity (us/cm)
2400
2200
2000
1800
1600
1400
1200
1000
10/11/95
10/30/95
11/16/95
12/6/95
12/25/95
1/12/96
2/1/96
2/21/96
3/11/96
3/28/96
4/16/96
5/6/96
5/28/96
6/14/96
7/3/96
7/24/96
8/12/96
9/4/96
10/15/96
12/20/96
2/7/97
3/25/97
5/13/97
7/1/97
Sample Period
CS Inlet
C1 EFF
C2 EFF


Tres Rios Hayfield Site
CONDUCTIVITY
October, 1995 - July, 1997
Conductivity (us/cm)
1800
1700
1600
1500
1400
1300
1200
1100
1000
10/12/95
11/1/95
11/20/95
12/8/95
12/27/95
1/17/96
2/5/96
2/23/96
3/13/96
4/1/96
4/18/96
5/8/96
5/30/96
6/18/96
7/9/96
7/26/96
8/14/96
9/3/96
10/12/96
12/3/96
1/21/97
3/7/97
4/25/97
6/10/97
7/29/97
Sample Period
HS Inlet
H1 EFF
H2 EFF

APPENDIX D - Cobble Site WQ Data & Plots

Cobble Site: Annual WQ Statisitics (1995/96 & 1996/97)

Statisitc	ALKALINITY EPA 310.1 (mg/L)	TSS (mg/L)	TDS EPA 160.1 (mg/L)	Cl EPA 300.0 EPA 325.2 (mg/L)	TKN EPA 351.2 (mg/L)	NO2 - N EPA 300.0 (mg/L)	NO3 - N EPA 300.0 (mg/L)	NO2+NO3 - N EPA 353.2 (mg/L)	PO4 - P EPA 300.0 (mg/L)	TOTAL P EPA 200.7 (mg/L)	COD (mg/L)	cBOD sm17 5210B (mg/L)	NH4 - N EPA 350.3 (mg/l)	TOC EPA 415.1 (mg/L)	TOTAL-N (mg/L)	Sulfate EPA 375.2)
CS INLET 1995/96																
Average	177.89	3.45	838.66	250.83	3.42	0.42	2.59	2.89	3.38	3.75	45.16	3.12	1.98	8.60	6.29	0.00
Maximum	202.25	8.00	910.00	299.00	5.38	1.97	3.75	5.37	4.15	4.44	71.00	5.00	3.13	10.78	8.28	0.00
Minimum	161.00	2.00	769.50	211.25	2.30	0.05	1.20	1.26	2.20	2.90	20.00	1.00	1.20	6.50	3.80	0.00
Std. Dev.	10.19	1.51	43.24	25.54	0.87	0.70	0.93	1.24	0.66	0.48	15.56	1.28	0.53	1.26	1.54	NR
CS INLET 1996/97																
Average	172.36	2.36	910.73	245.70	3.01	0.08	2.90	2.74	2.49	3.24	43.09	2.80	1.18	9.47	5.75	83.91
Maximum	196.00	3.00	986.00	310.00	4.20	0.25	5.20	5.20	3.90	4.70	68.00	5.00	2.00	11.40	8.10	228.00
Minimum	156.00	1.00	868.00	189.00	1.80	0.05	1.00	1.00	0.00	1.60	16.00	1.00	0.70	7.70	4.00	0.00
Std. Dev.	11.50	0.67	34.99	38.85	0.65	0.07	1.41	1.36	1.31	1.03	14.91	1.62	0.39	1.08	1.49	98.66
C1 EFF 1995/96																
Average	174.17	7.59	854.00	252.19	2.46	0.70	2.50	3.09	3.11	3.82	44.80	3.03	1.13	8.83	5.53	0.00
Maximum	192.00	48.00	956.00	315.00	3.65	1.80	4.96	5.64	4.23	4.48	100.00	8.00	2.30	11.40	8.13	0.00
Minimum	161.80	1.25	751.60	201.75	1.63	0.05	0.05	0.05	1.50	2.40	27.00	1.50	0.25	7.00	2.10	0.00
Std. Dev.	9.27	12.93	65.03	35.85	0.57	0.63	1.52	1.83	0.96	0.69	19.08	1.73	0.66	1.32	1.93	NR
C1 EFF 1996/97																
Average	181.18	1.05	902.73	252.30	1.30	0.07	1.06	0.90	2.70	3.61	53.27	1.27	0.42	8.34	2.20	83.18
Maximum	196.00	2.00	962.00	310.00	1.70	0.25	2.60	2.60	4.20	4.70	212.00	2.00	1.60	9.20	3.90	226.00
Minimum	163.00	0.50	858.00	192.00	1.00	0.03	0.05	0.03	0.00	1.50	9.00	1.00	0.21	7.00	1.23	0.00
Std. Dev.	10.64	0.52	33.67	35.24	0.19	0.07	0.99	0.97	1.35	1.13	58.07	0.47	0.41	0.65	0.96	97.54
C2 EFF 1995/96																
Average	178.48	3.27	869.28	258.64	1.75	0.23	2.01	2.27	3.04	3.92	42.03	2.25	0.68	9.24	4.02	0.00
Maximum	198.25	9.00	980.00	338.00	2.40	0.58	5.90	6.30	4.15	5.22	80.75	3.00	2.60	19.06	8.00	0.00
Minimum	158.60	1.38	766.80	212.00	1.00	0.05	0.05	0.05	1.00	3.33	15.75	1.75	0.25	6.75	1.05	0.00
Std. Dev.	12.74	2.16	68.73	38.38	0.48	0.21	1.95	2.04	1.06	0.47	16.88	0.39	0.71	3.27	2.30	NR
C2 EFF 1996/97																
Average	185.90	0.95	905.40	243.33	1.32	0.05	1.27	1.03	3.36	3.99	30.75	1.20	0.43	7.86	2.35	74.40
Maximum	202.00	2.00	1010.00	320.00	2.20	0.05	2.80	2.80	5.10	5.80	49.00	2.00	1.50	8.90	3.90	227.00
Minimum	163.00	0.50	840.00	196.00	0.90	0.03	0.05	0.03	0.00	2.00	3.50	1.00	0.25	6.60	0.95	0.00
Std. Dev.	10.77	0.44	46.91	42.73	0.42	0.01	1.14	1.13	1.63	1.23	12.81	0.42	0.39	0.67	1.06	98.23

Tres Rios Cobble Site
Monthly Average Water Quality Performance
8/95 - 4/97

Aug-95 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	182.33	180.00	186.00
TSS (mg/L)	3.67	3.00	2.00
TDS EPA 160.1 (mg/L)	827.67	956.00	920.00
Cl EPA 300.0 (mg/L)	243.33	294.00	268.00
TKN EPA 351.2 (mg/L)	2.80	2.30	2.40
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	1.57	2.20	0.70
NO2+NO3 - N EPA 353.2 (mg/L)	1.57	2.20	0.70
PO4 - P EPA 300.0 (mg/L)	2.43	1.50	1.00
TOTAL P EPA 200.7 (mg/L)	3.80	2.40	3.80
COD (mg/L)	32.67	27.00	30.00
cBOD sm17 5210B (mg/L)	2.33	3.00	2.00
NH4 - N EPA 350.3 (mg/l)	1.93	2.30	2.60
TOC EPA 415.1 (mg/L)	7.00	7.00	7.00
TOTAL-N (mg/L)	4.37	4.50	3.10
Depth (cm)		8.86	13.07
HLR (cm/d)		NA	NA
HRT (d)		NA	NA

Sep-95 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	202.25	176.75	181.75
TSS (mg/L)	2.00	2.25	3.50
TDS EPA 160.1 (mg/L)	785.00	777.5	783.00
Cl EPA 300.0 (mg/L)	247.50	242.5	245.00
TKN EPA 351.2 (mg/L)	2.48	2.55	2.38
NO2 - N EPA 300.0 (mg/L)	NA	NA	NA
NO3 - N EPA 300.0 (mg/L)	NA	NA	NA
NO2+NO3 - N EPA 353.2 (mg/L)	3.08	3.825	3.23
PO4 - P EPA 300.0 (mg/L)	NA	NA	NA
TOTAL P EPA 200.7 (mg/L)	3.18	2.85	3.95
COD (mg/L)	41.25	40.5	47.00
cBOD sm17 5210B (mg/L)	1.75	2	2.25
NH4 - N EPA 350.3 (mg/l)	1.70	1.69	1.35
TOC EPA 415.1 (mg/L)	6.50	7	6.75
TOTAL-N (mg/L)	5.55	6.375	5.60
Depth (cm)		14.83	13.33
HLR (cm/d)		NA	NA
HRT (d)		NA	NA

Oct-95 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	173.40	161.80	165.60
TSS (mg/L)	3.20	7.60	9.00
TDS EPA 160.1 (mg/L)	769.50	751.60	766.80
Cl EPA 300.0 (mg/L)	239.40	229.00	233.20
TKN EPA 351.2 (mg/L)	2.92	2.72	2.24
NO2 - N EPA 300.0 (mg/L)	0.05	1.00	0.40
NO3 - N EPA 300.0 (mg/L)	1.20	2.40	3.10
NO2+NO3 - N EPA 353.2 (mg/L)	1.26	2.41	3.23
PO4 - P EPA 300.0 (mg/L)	3.10	1.85	1.95
TOTAL P EPA 200.7 (mg/L)	4.22	4.46	5.22
COD (mg/L)	20.00	32.40	25.80
cBOD sm17 5210B (mg/L)	3.20	2.40	2.60
NH4 - N EPA 350.3 (mg/l)	1.82	1.70	1.12
TOC EPA 415.1 (mg/L)	7.80	7.60	7.40
TOTAL-N (mg/L)	4.04	5.21	5.55
Depth (cm)		31.82	28.04
HLR (cm/d)		22.70	27.20
HRT (d)		1.20	2.20

Nov-95 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	169.75	172.00	168.50
TSS (mg/L)	3.25	5.25	5.50
TDS EPA 160.1 (mg/L)	813.25	807.25	816.50
Cl EPA 300.0 (mg/L)	219.75	201.75	213.25
TKN EPA 351.2 (mg/L)	3.70	3.33	1.98
NO2 - N EPA 300.0 (mg/L)	0.20	0.68	0.45
NO3 - N EPA 300.0 (mg/L)	2.63	2.65	3.35
NO2+NO3 - N EPA 353.2 (mg/L)	2.83	3.33	3.80
PO4 - P EPA 300.0 (mg/L)	3.58	3.43	3.28
TOTAL P EPA 200.7 (mg/L)	3.38	3.40	3.33
COD (mg/L)	25.50	36.00	15.75
cBOD sm17 5210B (mg/L)	3.50	4.00	2.25
NH4 - N EPA 350.3 (mg/l)	3.13	1.85	0.53
TOC EPA 415.1 (mg/L)	8.00	8.00	7.25
TOTAL-N (mg/L)	6.53	6.65	5.78
Depth (cm)		24.63	22.18
HLR (cm/d)		35.00	15.40
HRT (d)		1.90	3.70

Dec-95 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	161.00	177.00	168.25
TSS (mg/L)	3.00	3.25	2.00
TDS EPA 160.1 (mg/L)	807.50	816.50	825.50
Cl EPA 300.0 (mg/L)	211.25	211.00	212.00
TKN EPA 351.2 (mg/L)	4.28	3.65	1.83
NO2 - N EPA 300.0 (mg/L)	0.26	1.05	0.39
NO3 - N EPA 300.0 (mg/L)	3.75	3.43	4.53
NO2+NO3 - N EPA 353.2 (mg/L)	4.00	4.48	4.90
PO4 - P EPA 300.0 (mg/L)	4.10	3.65	4.15
TOTAL P EPA 200.7 (mg/L)	3.63	3.93	3.70
COD (mg/L)	34.75	39.00	80.75
cBOD sm17 5210B (mg/L)	4.50	2.00	1.75
NH4 - N EPA 350.3 (mg/l)	2.43	1.45	0.25
TOC EPA 415.1 (mg/L)	8.30	8.60	7.95
TOTAL-N (mg/L)	8.28	8.13	6.73
Depth (cm)		30.63	29.47
HLR (cm/d)		32.10	14.60
HRT (d)		1.70	4.10

Jan-96 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	179.00	164.20	158.60
TSS (mg/L)	3.60	3.60	2.60
TDS EPA 160.1 (mg/L)	844.00	830.40	850.00
Cl EPA 300.0 (mg/L)	236.00	225.00	227.60
TKN EPA 351.2 (mg/L)	3.72	2.40	1.70
NO2 - N EPA 300.0 (mg/L)	0.08	0.69	0.41
NO3 - N EPA 300.0 (mg/L)	3.62	4.96	5.90
NO2+NO3 - N EPA 353.2 (mg/L)	3.66	5.64	6.30
PO4 - P EPA 300.0 (mg/L)	3.76	4.20	3.80
TOTAL P EPA 200.7 (mg/L)	3.72	4.20	3.90
COD (mg/L)	71.00	34.60	29.20
cBOD sm17 5210B (mg/L)	3.20	2.20	2.40
NH4 - N EPA 350.3 (mg/l)	2.40	1.18	0.40
TOC EPA 415.1 (mg/L)	9.24	8.80	9.20
TOTAL-N (mg/L)	7.38	8.04	8.00
Depth (cm)		30.15	29.88
HLR (cm/d)		35.00	9.20
HRT (d)		1.90	5.60

Tres Rios Cobble Site
Monthly Average Water Quality Performance
8/95 - 4/97

Feb-96			
Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	177.50	175.25	168.00
TSS (mg/L)	3.25	9.00	2.00
TDS EPA 160.1 (mg/L)	866.50	841.50	845.25
Cl EPA 300.0 (mg/L)	258.67	253.00	246.00
TKN EPA 351.2 (mg/L)	5.38	2.43	2.08
NO2 - N EPA 300.0 (mg/L)	0.22	0.20	0.58
NO3 - N EPA 300.0 (mg/L)	1.90	1.50	1.83
NO2+NO3 - N EPA 353.2 (mg/L)	1.83	1.93	2.30
PO4 - P EPA 300.0 (mg/L)	3.20	3.03	3.20
TOTAL P EPA 200.7 (mg/L)	4.10	3.45	3.70
COD (mg/L)	46.00	44.75	38.50
cBOD sm17 5210B (mg/L)	5.00	3.75	2.75
NH4 - N EPA 350.3 (mg/l)	2.30	0.88	0.70
TOC EPA 415.1 (mg/L)	10.78	9.70	9.88
TOTAL-N (mg/L)	7.20	4.35	4.38
Depth (cm)		31.23	30.08
HLR (cm/d)		32.20	6.70
HRT (d)		1.80	7.60

Mar-96			
Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	180.00	171.25	177.50
TSS (mg/L)	8.00	2.50	4.25
TDS EPA 160.1 (mg/L)	823.50	837.00	864.50
Cl EPA 300.0 (mg/L)	247.25	244.50	258.75
TKN EPA 351.2 (mg/L)	4.10	2.23	1.30
NO2 - N EPA 300.0 (mg/L)	0.05	0.48	0.05
NO3 - N EPA 300.0 (mg/L)	2.65	2.85	1.25
NO2+NO3 - N EPA 353.2 (mg/L)	2.65	3.33	1.25
PO4 - P EPA 300.0 (mg/L)	4.10	4.23	3.83
TOTAL P EPA 200.7 (mg/L)	4.40	4.48	3.83
COD (mg/L)	63.25	59.25	57.25
cBOD sm17 5210B (mg/L)	5.00	2.50	3.00
NH4 - N EPA 350.3 (mg/l)	1.95	0.66	0.25
TOC EPA 415.1 (mg/L)	10.20	9.38	9.43
TOTAL-N (mg/L)	6.75	5.55	2.55
Depth (cm)		29.75	29.95
HLR (cm/d)		28.00	7.30
HRT (d)		1.50	6.90

Apr-96			
Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	186.25	169.00	191.00
TSS (mg/L)	2.40	1.80	1.80
TDS EPA 160.1 (mg/L)	840.00	862.80	880.80
Cl EPA 300.0 (mg/L)	249.25	240.75	263.50
TKN EPA 351.2 (mg/L)	3.18	1.80	1.48
NO2 - N EPA 300.0 (mg/L)	1.97	1.80	0.05
NO3 - N EPA 300.0 (mg/L)	3.00	4.03	1.04
NO2+NO3 - N EPA 353.2 (mg/L)	4.02	4.82	1.07
PO4 - P EPA 300.0 (mg/L)	4.15	4.05	3.85
TOTAL P EPA 200.7 (mg/L)	4.44	4.38	4.10
COD (mg/L)	61.80	43.80	46.40
cBOD sm17 5210B (mg/L)	3.20	2.20	2.20
NH4 - N EPA 350.3 (mg/l)	2.08	0.46	0.25
TOC EPA 415.1 (mg/L)	9.72	10.18	19.06
TOTAL-N (mg/L)	7.20	6.62	2.55
Depth (cm)		27.99	28.54
HLR (cm/d)		27.40	7.50
HRT (d)		1.50	6.70

May-96			
Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	169.00	163.50	183.25
TSS (mg/L)	2.75	1.25	3.25
TDS EPA 160.1 (mg/L)	882.50	896.50	933.50
Cl EPA 300.0 (mg/L)	269.00	269.00	286.67
TKN EPA 351.2 (mg/L)	2.95	1.63	1.13
NO2 - N EPA 300.0 (mg/L)	1.67	1.67	0.05
NO3 - N EPA 300.0 (mg/L)	3.73	3.37	0.33
NO2+NO3 - N EPA 353.2 (mg/L)	5.37	5.00	0.33
PO4 - P EPA 300.0 (mg/L)	3.47	3.17	3.63
TOTAL P EPA 200.7 (mg/L)	3.83	4.35	4.15
COD (mg/L)	53.50	40.25	42.25
cBOD sm17 5210B (mg/L)	1.75	1.50	1.75
NH4 - N EPA 350.3 (mg/l)	1.35	0.53	0.25
TOC EPA 415.1 (mg/L)	8.45	8.65	8.88
TOTAL-N (mg/L)	8.20	6.43	1.40
Depth (cm)		25.66	25.92
HLR (cm/d)		27.90	7.20
HRT (d)		1.50	7.00

Jun-96			
Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	176.25	187.25	198.25
TSS (mg/L)	3.25	3.63	1.38
TDS EPA 160.1 (mg/L)	894.50	933.00	965.50
Cl EPA 300.0 (mg/L)	289.50	300.75	311.75
TKN EPA 351.2 (mg/L)	3.20	2.05	1.53
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	2.98	0.05	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	2.98	0.05	0.05
PO4 - P EPA 300.0 (mg/L)	3.10	3.10	3.30
TOTAL P EPA 200.7 (mg/L)	3.45	3.53	3.55
COD (mg/L)	49.25	40.00	40.50
cBOD sm17 5210B (mg/L)	3.00	2.75	2.00
NH4 - N EPA 350.3 (mg/l)	1.53	0.25	0.25
TOC EPA 415.1 (mg/L)	8.98	9.60	9.10
TOTAL-N (mg/L)	6.18	2.10	1.58
Depth (cm)		28.20	30.21
HLR (cm/d)		27.60	7.30
HRT (d)		1.50	6.90

Jul-96			
Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	178.00	192.00	195.00
TSS (mg/L)	3.00	48.00	2.00
TDS EPA 160.1 (mg/L)	910.00	938.00	980.00
Cl EPA 300.0 (mg/L)	299.00	315.00	338.00
TKN EPA 351.2 (mg/L)	2.30	2.40	1.00
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	1.50	0.05	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	1.50	0.05	0.05
PO4 - P EPA 300.0 (mg/L)	2.20	2.00	1.50
TOTAL P EPA 200.7 (mg/L)	2.90	4.40	3.80
COD (mg/L)	43.00	100.00	51.00
cBOD sm17 5210B (mg/L)	1.00	8.00	2.00
NH4 - N EPA 350.3 (mg/l)	1.20	0.60	0.25
TOC EPA 415.1 (mg/L)	8.20	11.40	9.00
TOTAL-N (mg/L)	3.80	2.45	1.05
Depth (cm)		23.01	30.43
HLR (cm/d)		26.10	7.40
HRT (d)		1.40	6.80

Tres Rios Cobble Site
Monthly Average Water Quality Performance
8/95 - 4/97

Aug-96 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	174.00	181.00	202.00
TSS (mg/L)	1.00	2.00	1.00
TDS EPA 160.1 (mg/L)	910.00	904.00	1010.00
Cl EPA 300.0 (mg/L)	289.00	289.00	320.00
TKN EPA 351.2 (mg/L)	2.50	1.20	1.00
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	2.30	0.05	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	2.30	0.05	0.05
PO4 - P EPA 300.0 (mg/L)	2.30	3.30	4.00
TOTAL P EPA 200.7 (mg/L)	3.10	4.60	5.30
COD (mg/L)	57.00	34.00	49.00
cBOD sm17 5210B (mg/L)	1.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.00	0.25	0.25
TOC EPA 415.1 (mg/L)	9.10	9.00	8.60
TOTAL-N (mg/L)	4.80	1.25	1.05
Depth (cm)		31.85	29.84
HLR (cm/d)		21.00	7.20
HRT (d)		1.10	7.10

Sep-96 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	160.00	164.00	184.00
TSS (mg/L)	3.00	0.50	1.00
TDS EPA 160.1 (mg/L)	906.00	858.00	936.00
Cl EPA 300.0 (mg/L)	268.00	252.00	292.00
TKN EPA 351.2 (mg/L)	3.00	1.20	0.90
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	1.00	0.20	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	1.00	0.20	0.05
PO4 - P EPA 300.0 (mg/L)	3.20	2.80	2.40
TOTAL P EPA 200.7 (mg/L)	3.40	1.50	3.60
COD (mg/L)	35.00	27.00	25.00
cBOD sm17 5210B (mg/L)	4.00	1.00	2.00
NH4 - N EPA 350.3 (mg/l)	1.40	0.50	0.25
TOC EPA 415.1 (mg/L)	10.10	8.00	8.20
TOTAL-N (mg/L)	4.00	1.40	0.95
Depth (cm)		28.07	25.60
HLR (cm/d)		20.50	7.60
HRT (d)		1.10	6.70

Oct-96 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	178.00	179.00	183.00
TSS (mg/L)	2.00	1.00	1.00
TDS EPA 160.1 (mg/L)	934.00	914.00	866.00
Cl EPA 300.0 (mg/L)	254.00	278.00	259.00
TKN EPA 351.2 (mg/L)	4.20	1.60	1.70
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	3.50	1.10	1.60
NO2+NO3 - N EPA 353.2 (mg/L)	3.50	1.10	1.60
PO4 - P EPA 300.0 (mg/L)	3.60	4.20	3.80
TOTAL P EPA 200.7 (mg/L)	4.00	4.60	4.30
COD (mg/L)	48.00	212.00	43.00
cBOD sm17 5210B (mg/L)	1.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.50	0.25	0.50
TOC EPA 415.1 (mg/L)	10.70	9.00	8.90
TOTAL-N (mg/L)	7.70	2.70	3.30
Depth (cm)		41.38	40.54
HLR (cm/d)		22.10	35.30
HRT (d)		1.20	1.40

Nov-96 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	196.00	188.00	193.00
TSS (mg/L)	3.00	1.00	0.50
TDS EPA 160.1 (mg/L)	872.00	878.00	840.00
Cl EPA 300.0 (mg/L)	201.00	213.00	199.00
TKN EPA 351.2 (mg/L)	3.70	1.30	1.40
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	2.30	2.40	1.50
NO2+NO3 - N EPA 353.2 (mg/L)	2.30	2.40	1.50
PO4 - P EPA 300.0 (mg/L)	1.50	3.70	4.80
TOTAL P EPA 200.7 (mg/L)	1.60	4.20	5.80
COD (mg/L)	59.00	37.00	37.00
cBOD sm17 5210B (mg/L)	5.00	2.00	1.00
NH4 - N EPA 350.3 (mg/l)	0.80	0.60	0.25
TOC EPA 415.1 (mg/L)	9.70	7.80	8.00
TOTAL-N (mg/L)	6.00	3.70	2.90
Depth (cm)		30.84	30.32
HLR (cm/d)		36.3	25.9
HRT (d)		2	2

Dec-96 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	168.00	173.00	176.00
TSS (mg/L)	3.00	1.00	1.00
TDS EPA 160.1 (mg/L)	900.00	866.00	870.00
Cl EPA 300.0 (mg/L)	248.00	256.00	245.00
TKN EPA 351.2 (mg/L)	2.90	1.30	1.10
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	5.20	2.60	2.80
NO2+NO3 - N EPA 353.2 (mg/L)	5.20	2.60	2.80
PO4 - P EPA 300.0 (mg/L)	3.50	2.60	2.80
TOTAL P EPA 200.7 (mg/L)	3.80	2.50	3.00
COD (mg/L)	16.00	9.00	3.50
cBOD sm17 5210B (mg/L)	3.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	0.80	0.25	0.25
TOC EPA 415.1 (mg/L)	9.90	7.90	7.30
TOTAL-N (mg/L)	8.10	3.90	3.90
Depth (cm)		30.01	30.1
HLR (cm/d)		37.2	25.2
HRT (d)		2	2

Jan-97 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	181.00	163.00	163.00
TSS (mg/L)	3.00	1.00	0.50
TDS EPA 160.1 (mg/L)	888.00	888.00	912.00
Cl EPA 300.0 (mg/L)	210.00	230.00	200.00
TKN EPA 351.2 (mg/L)	3.30	1.20	1.00
NO2 - N EPA 300.0 (mg/L)	0.16	0.03	0.03
NO3 - N EPA 300.0 (mg/L)	2.00	1.40	1.40
NO2+NO3 - N EPA 353.2 (mg/L)	2.20	1.40	1.40
PO4 - P EPA 300.0 (mg/L)	NA	NA	NA
TOTAL P EPA 200.7 (mg/L)	3.90	4.30	4.20
COD (mg/L)	42.00	21.00	20.00
cBOD sm17 5210B (mg/L)	5.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.10	0.25	0.25
TOC EPA 415.1 (mg/L)	11.40	8.10	7.40
TOTAL-N (mg/L)	5.50	2.60	2.40
SO4 (mg/L)	210	190.00	190.00
Br- (mg/L)	0.5	0.40	0.40
Depth (cm)		31.46	30.19
HLR (cm/d)		37.3	25
HRT (d)		2	2

Tres Rios Cobble Site

Monthly Average Water Quality Performance

8/95 - 4/97

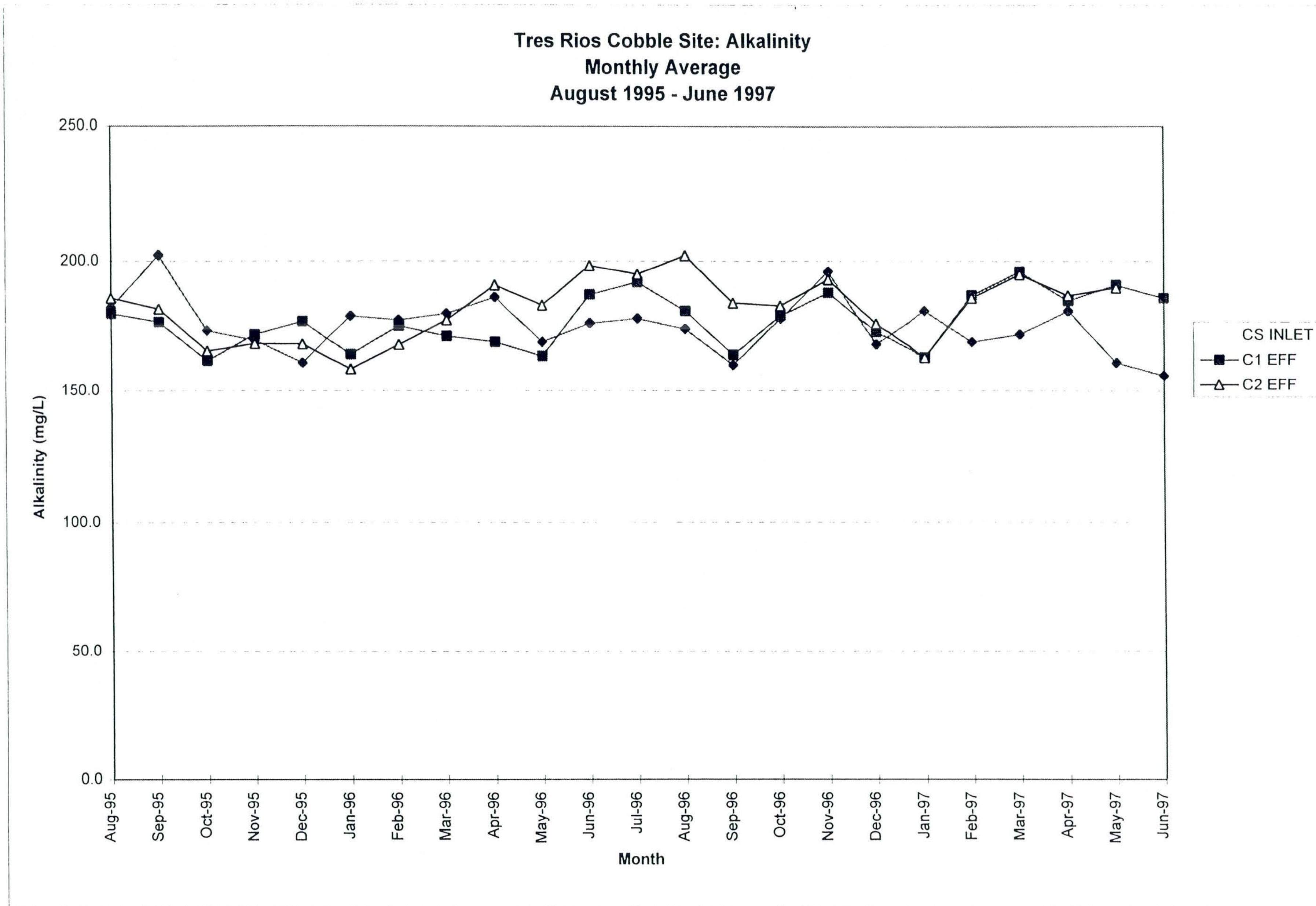
Feb-97 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	169.00	187.00	186.00
TSS (mg/L)	2.00	0.50	1.00
TDS EPA 160.1 (mg/L)	884.00	882.00	892.00
Cl EPA 300.0 (mg/L)	189.00	192.00	196.00
TKN EPA 351.2 (mg/L)	2.80	1.00	0.90
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	5.00	1.50	2.70
NO2+NO3 - N EPA 353.2 (mg/L)	5.00	1.50	2.70
PO4 - P EPA 300.0 (mg/L)	3.90	4.10	4.00
TOTAL P EPA 200.7 (mg/L)	4.70	4.70	4.80
COD (mg/L)	48.00	43.00	36.00
cBOD sm17 5210B (mg/L)	4.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.50	0.25	0.25
TOC EPA 415.1 (mg/L)	7.70	7.00	6.60
TOTAL-N (mg/L)	7.80	2.50	3.60
SO4 (mg/L)	228	226.00	227.00
Depth (cm)		31.36	29.97
HLR (cm/d)		37.3	25.1
HRT (d)		2	2

Mar-97 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	172.00	196.00	195.00
TSS (mg/L)	2.00	0.50	0.50
TDS EPA 160.1 (mg/L)	926.00	924.00	910.00
Cl EPA 300.0 (mg/L)	NR	NR	NR
TKN EPA 351.2 (mg/L)	3.40	1.20	1.50
NO2 - N EPA 300.0 (mg/L)	NR	NR	NR
NO3 - N EPA 300.0 (mg/L)	NR	NR	NR
NO2+NO3 - N EPA 353.2 (mg/L)	1.04	0.03	0.07
PO4 - P EPA 300.0 (mg/L)	NR	NR	NR
TOTAL P EPA 200.7 (mg/L)	3.80	2.80	2.00
COD (mg/L)	38.00	31.00	36.00
cBOD sm17 5210B (mg/L)	NR	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.20	0.25	0.25
TOC EPA 415.1 (mg/L)	9.70	8.60	7.70
TOTAL-N (mg/L)	4.44	1.23	1.57
Depth (cm)		28.67	29.62
HLR (cm/d)		37.3	25.2
HRT (d)		2	2

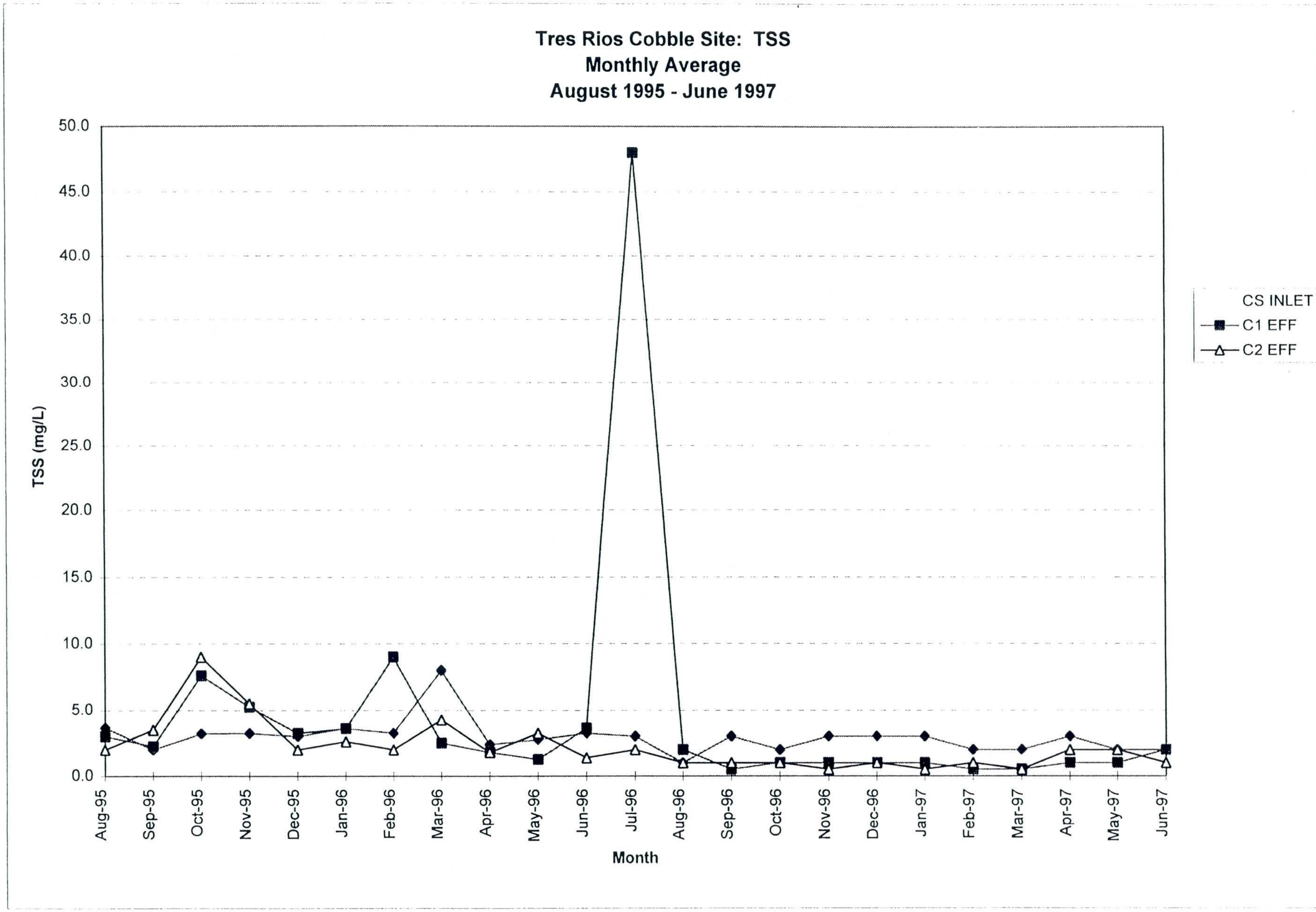
Apr-97 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	181.00	185.00	187.00
TSS (mg/L)	3.00	1.00	2.00
TDS EPA 160.1 (mg/L)	868.00	900.00	892.00
Cl EPA 300.0 (mg/L)	228.00	243.00	239.00
TKN EPA 351.2 (mg/L)	2.40	1.30	1.50
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	2.70	0.05	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	2.70	0.05	0.05
PO4 - P EPA 300.0 (mg/L)	3.10	1.50	5.10
TOTAL P EPA 200.7 (mg/L)	NR	NR	NR
COD (mg/L)	68.00	106.00	30.00
cBOD sm17 5210B (mg/L)	2.00	2.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.00	0.25	0.50
TOC EPA 415.1 (mg/L)	9.00	9.20	8.20
TOTAL-N (mg/L)	5.10	1.35	1.55
SO4 (mg/L)	174	193.00	187.00
Depth (cm)		18.64	25.5
HLR (cm/d)		37.8	24.9
HRT (d)		2.1	2

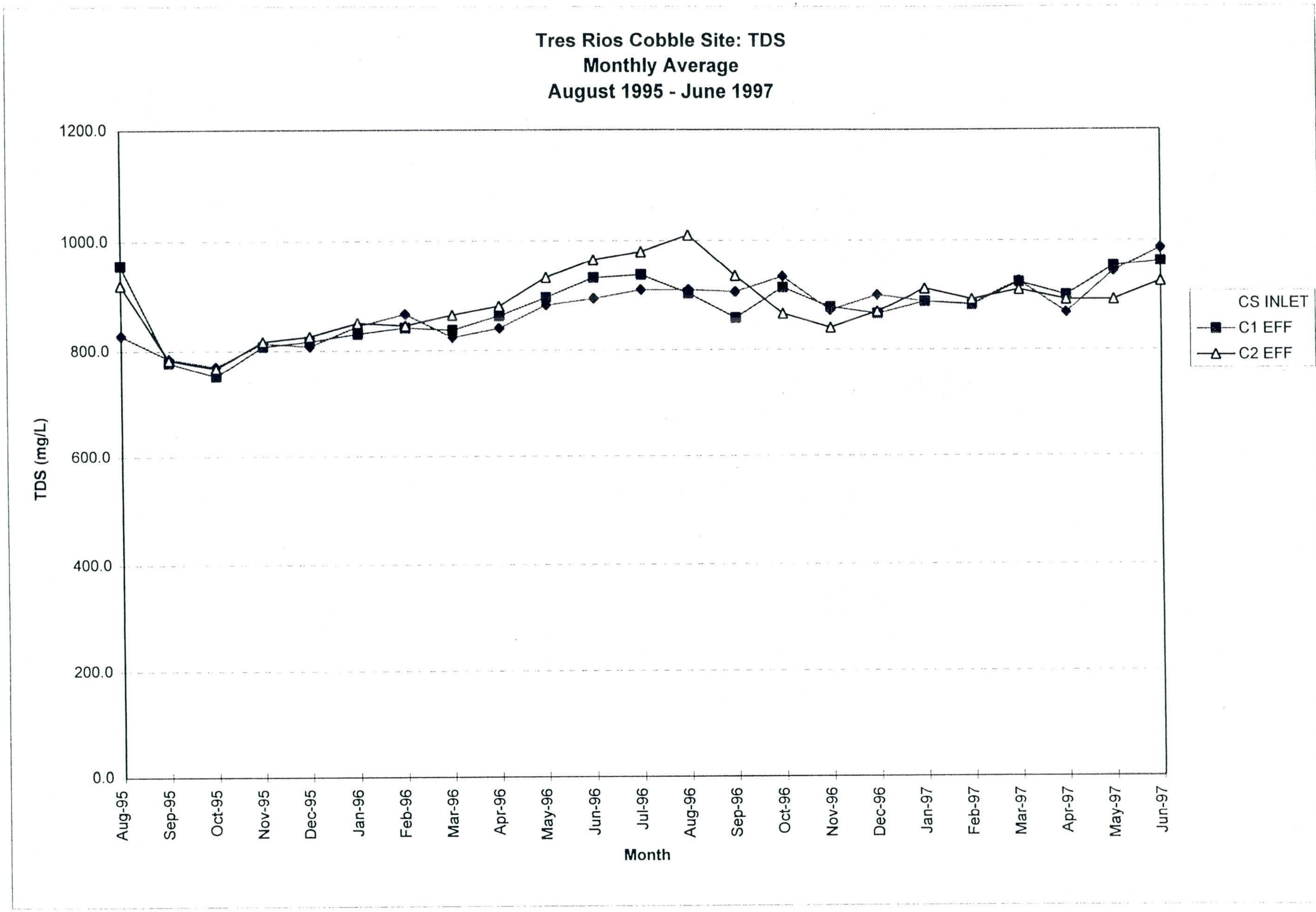
May-97 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	161.00	191	190
TSS (mg/L)	2.00	1	1
TDS EPA 160.1 (mg/L)	944.00	954	926
Cl EPA 300.0 (mg/L)	260.00	260	240
TKN EPA 351.2 (mg/L)	3.10	1.7	2.2
NO2 - N EPA 300.0 (mg/L)	NA	NA	NA
NO3 - N EPA 300.0 (mg/L)	NA	NA	NA
NO2+NO3 - N EPA 353.2 (mg/L)	2.60	0.03	0.03
PO4 - P EPA 300.0 (mg/L)	NA	NA	NA
TOTAL P EPA 200.7 (mg/L)	2.30	4.2	2.9
COD (mg/L)	29.00	33	28
cBOD sm17 5210B (mg/L)	2.00	2	2
NH4 - N EPA 350.3 (mg/l)	2.00	1.6	1.5
TOC EPA 415.1 (mg/L)	8.70	8.6	7.7
TOTAL-N (mg/L)	5.70	1.73	2.23
SO4 (mg/L)	150	150	140
Depth (cm)		18.28	23.47
HLR (cm/d)		33.2	22.8
HRT (d)		1.8	2

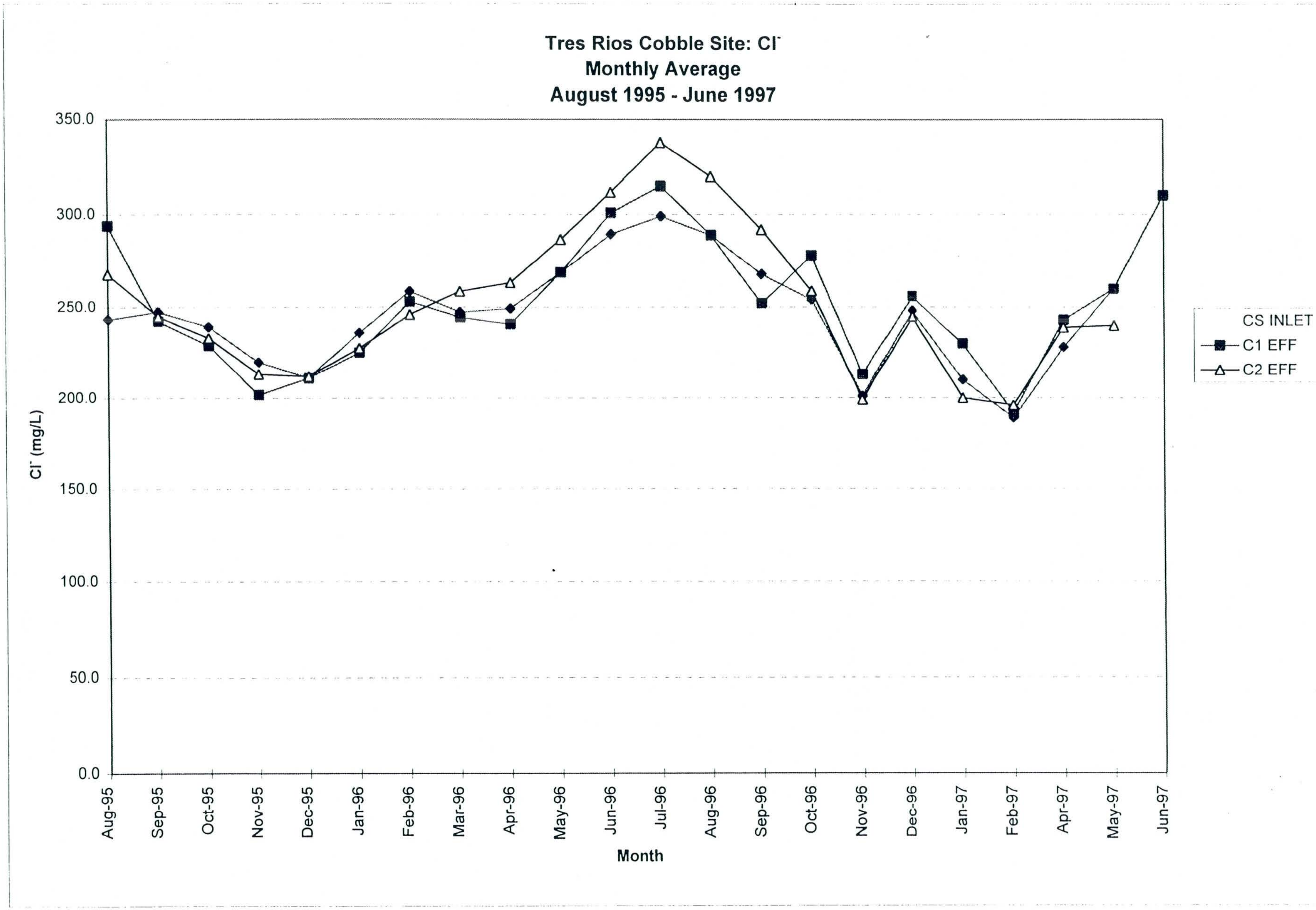
Jun-97 Parameter	CS INLET	C1 EFF	C2 EFF
ALKALINITY EPA 310.1 (mg/L)	156.00	186	N
TSS (mg/L)	2.00	2	O
TDS EPA 160.1 (mg/L)	986.00	962	
Cl EPA 300.0 (mg/L)	310.00	310	S
TKN EPA 351.2 (mg/L)	1.80	1.3	A
NO2 - N EPA 300.0 (mg/L)	0.25	0.25	M
NO3 - N EPA 300.0 (mg/L)	2.10	0.25	P
NO2+NO3 - N EPA 353.2 (mg/L)	2.35	0.5	L
PO4 - P EPA 300.0 (mg/L)	1.30	2.1	E
TOTAL P EPA 200.7 (mg/L)	1.80	2.7	
COD (mg/L)	34.00	33	
cBOD sm17 5210B (mg/L)	1.00	1	
NH4 - N EPA 350.3 (mg/l)	0.70	0.21	
TOC EPA 415.1 (mg/L)	8.20	8.5	
TOTAL-N (mg/L)	4.15	1.8	
SO4 (mg/L)	161	156	
Depth (cm)		22.56	4.27
HLR (cm/d)		32.1	3.4
HRT (d)		1.7	6.2

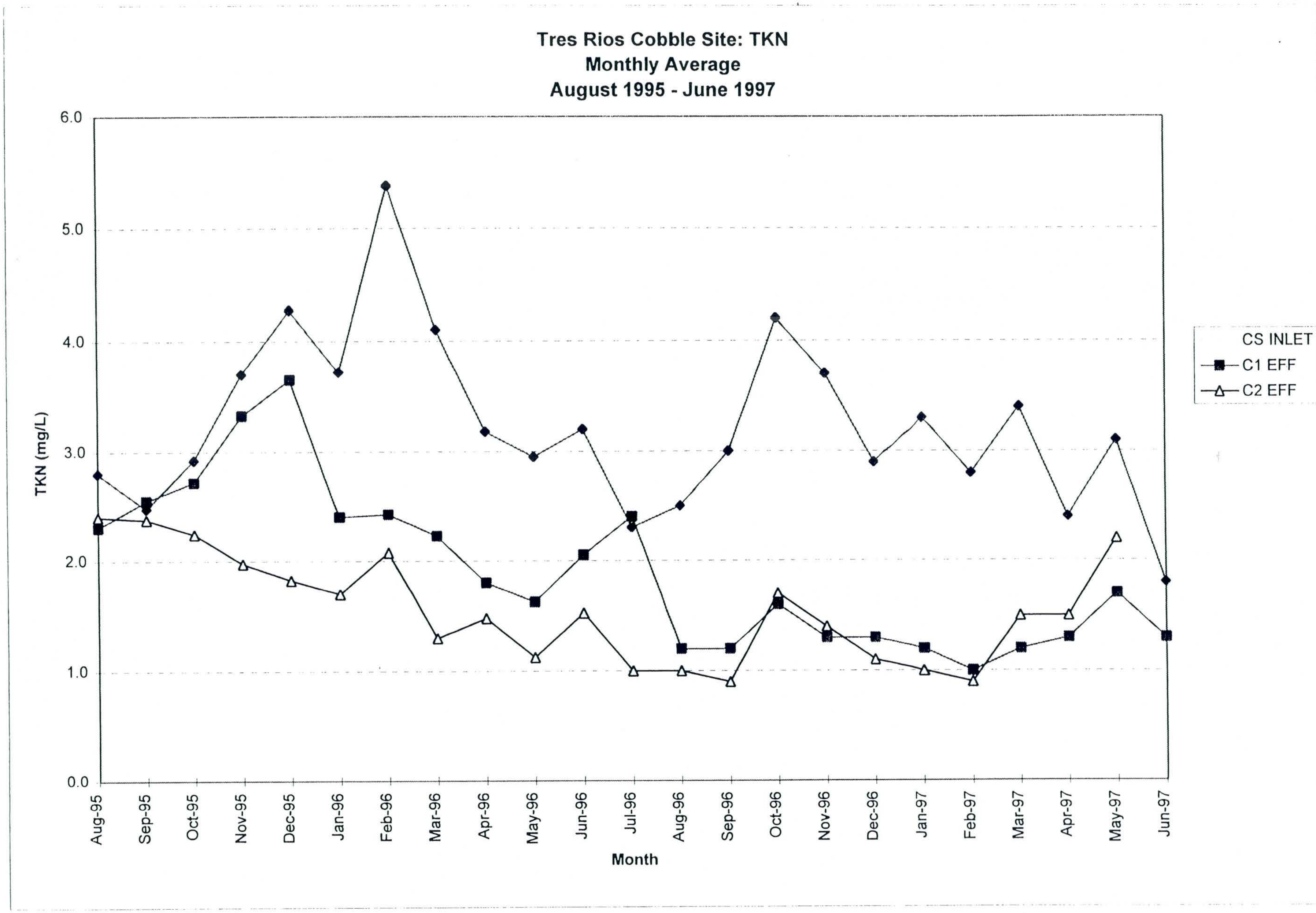


Tres Rios Cobble Site: Alkalinity
Monthly Average
August 1995 - June 1997
250.0
200.0
150.0
100.0
50.0
0.0
Alkalinity (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF

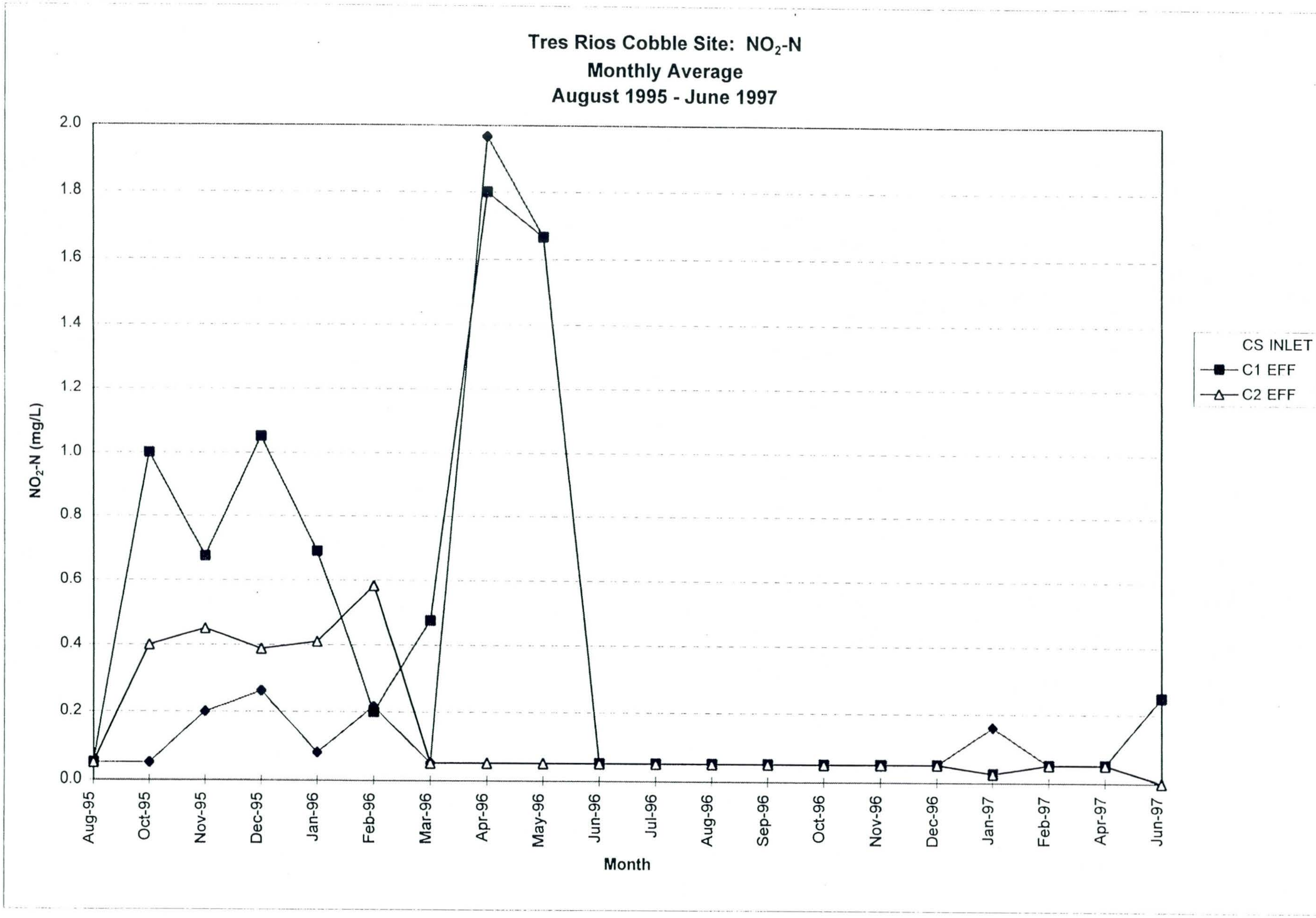

Tres Rios Cobble Site: TSS
Monthly Average
August 1995 - June 1997
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
TSS (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF


Tres Rios Cobble Site: TDS
Monthly Average
August 1995 - June 1997
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
TDS (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF

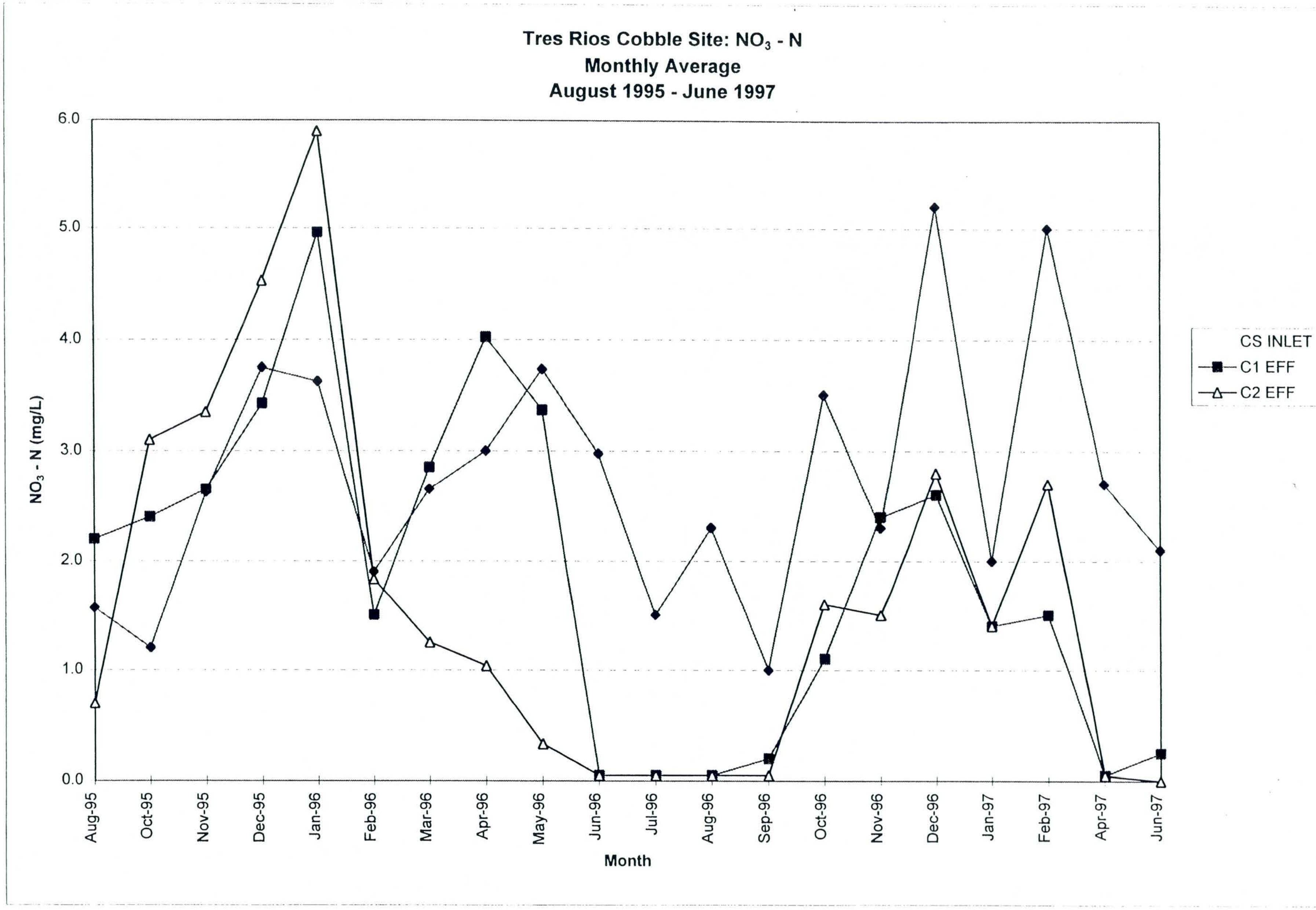

Tres Rios Cobble Site: Cl⁻
Monthly Average
August 1995 - June 1997
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Cl⁻ (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF



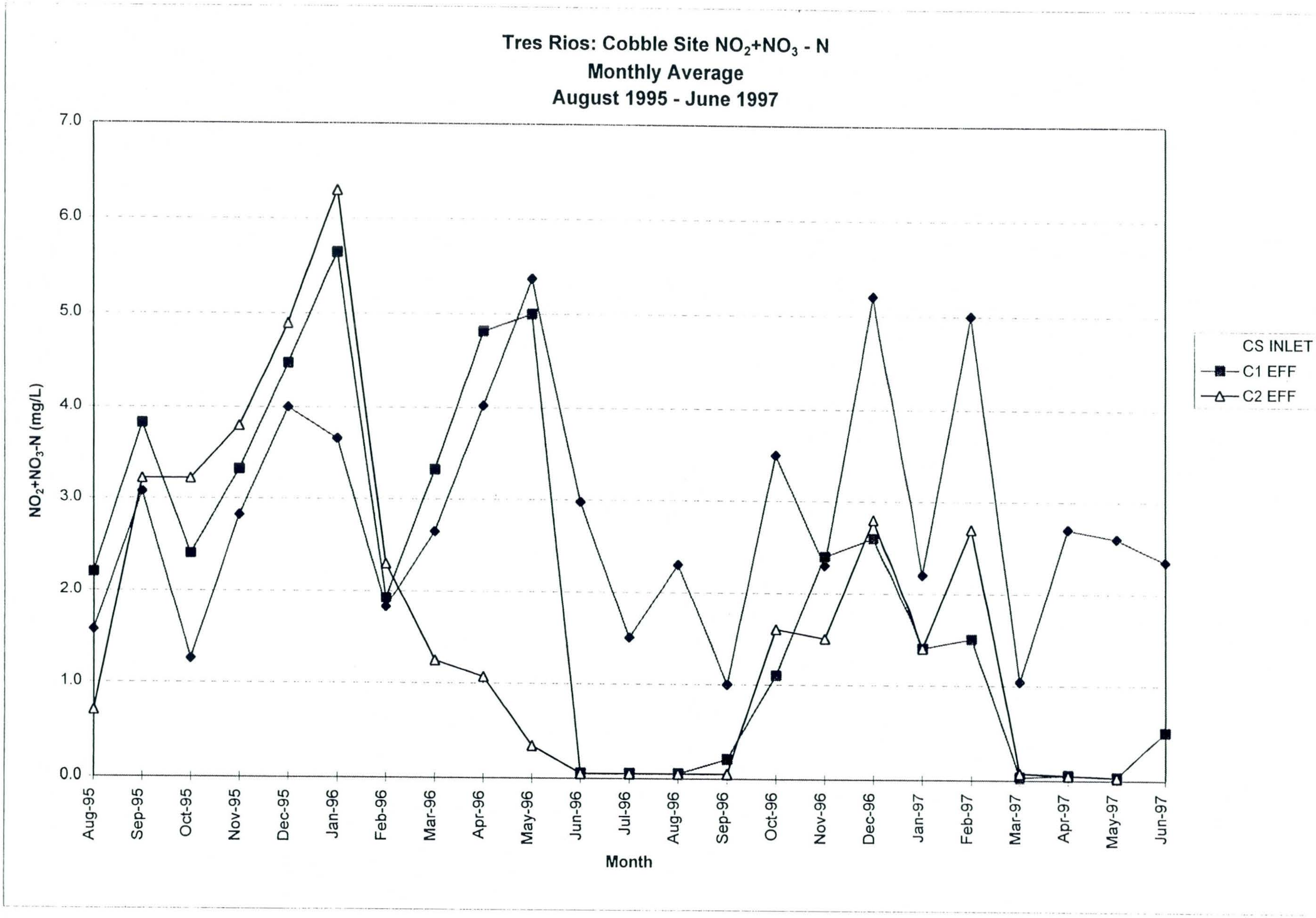
Tres Rios Cobble Site: TKN
Monthly Average
August 1995 - June 1997
TKN (mg/L)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF



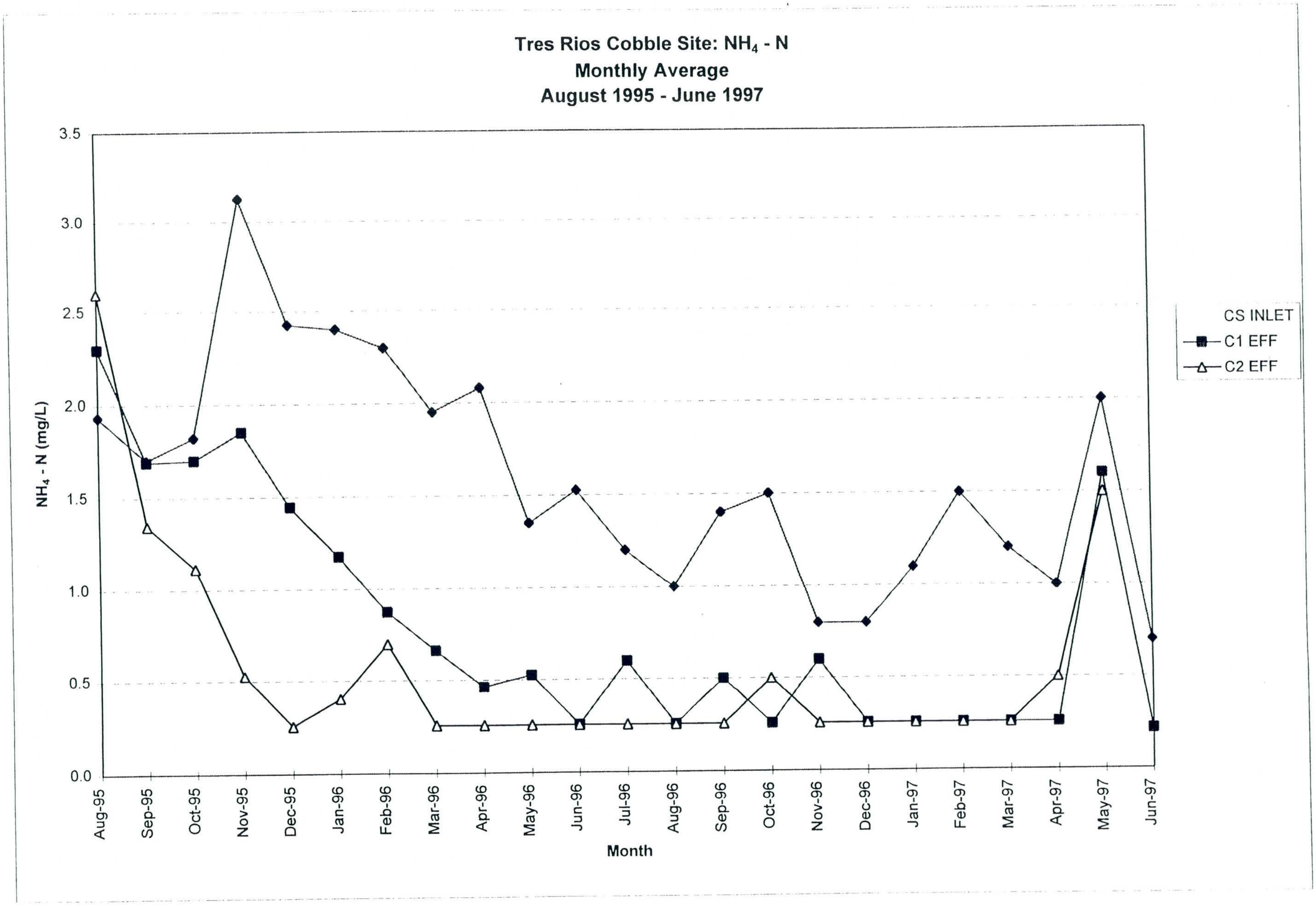
Tres Rios Cobble Site: NO2-N
Monthly Average
August 1995 - June 1997
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
NO2-N (mg/L)
Aug-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Apr-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF



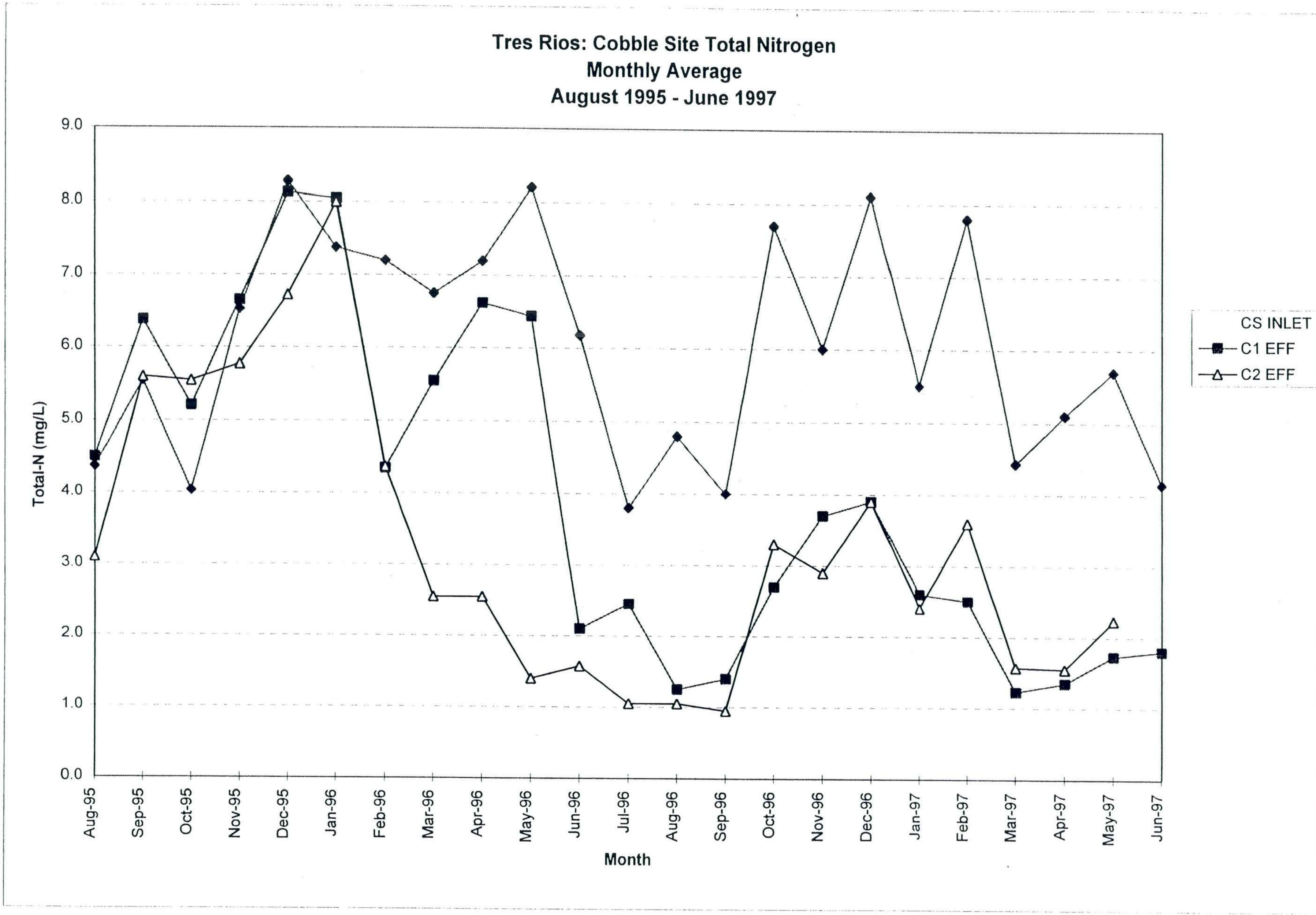
Tres Rios Cobble Site: NO_3 - N
Monthly Average
August 1995 - June 1997
NO_3 - N (mg/L)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Aug-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Apr-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF



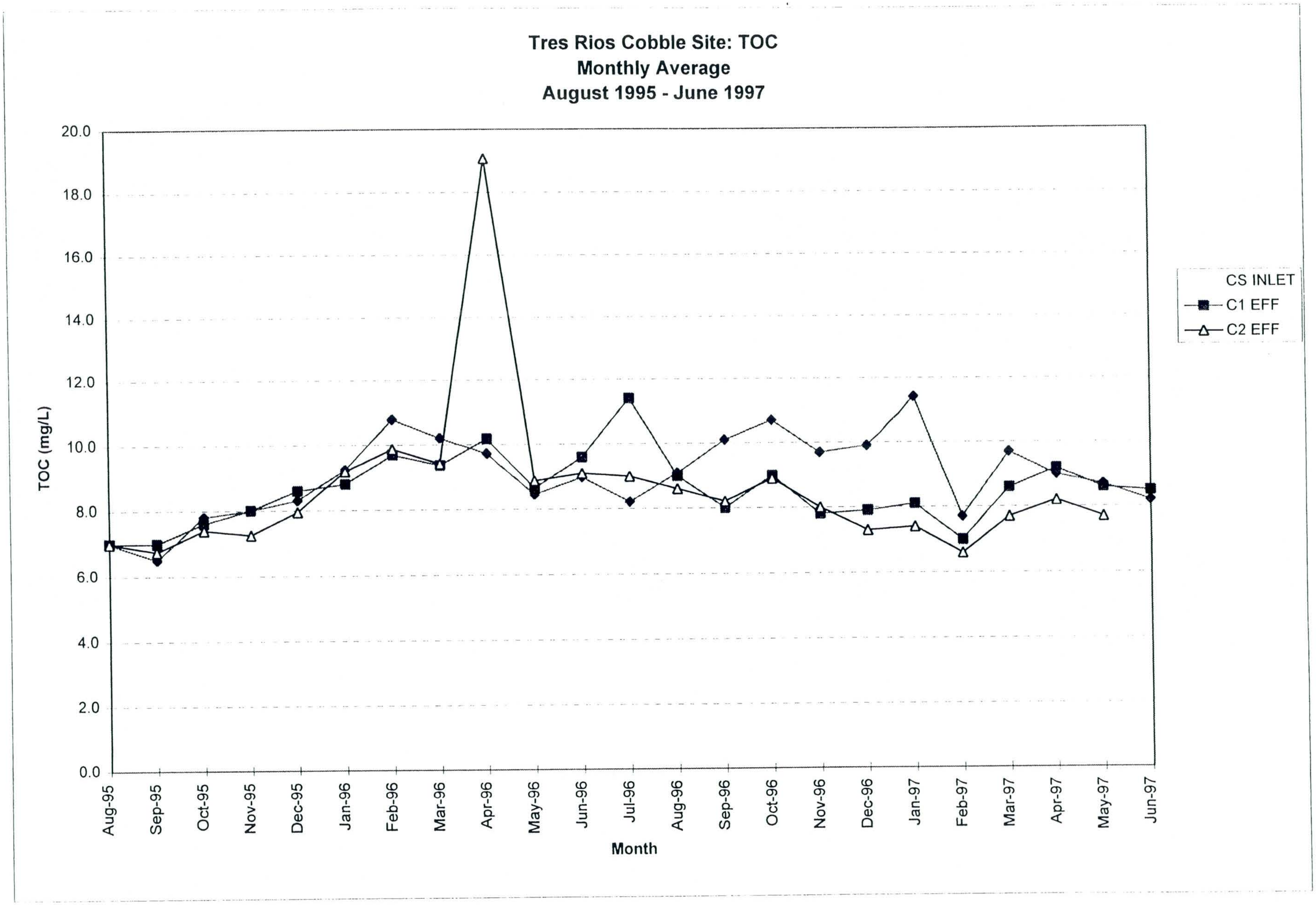
Tres Rios: Cobble Site NO_2+NO_3 - N
Monthly Average
August 1995 - June 1997
NO_2+NO_3-N (mg/L)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF



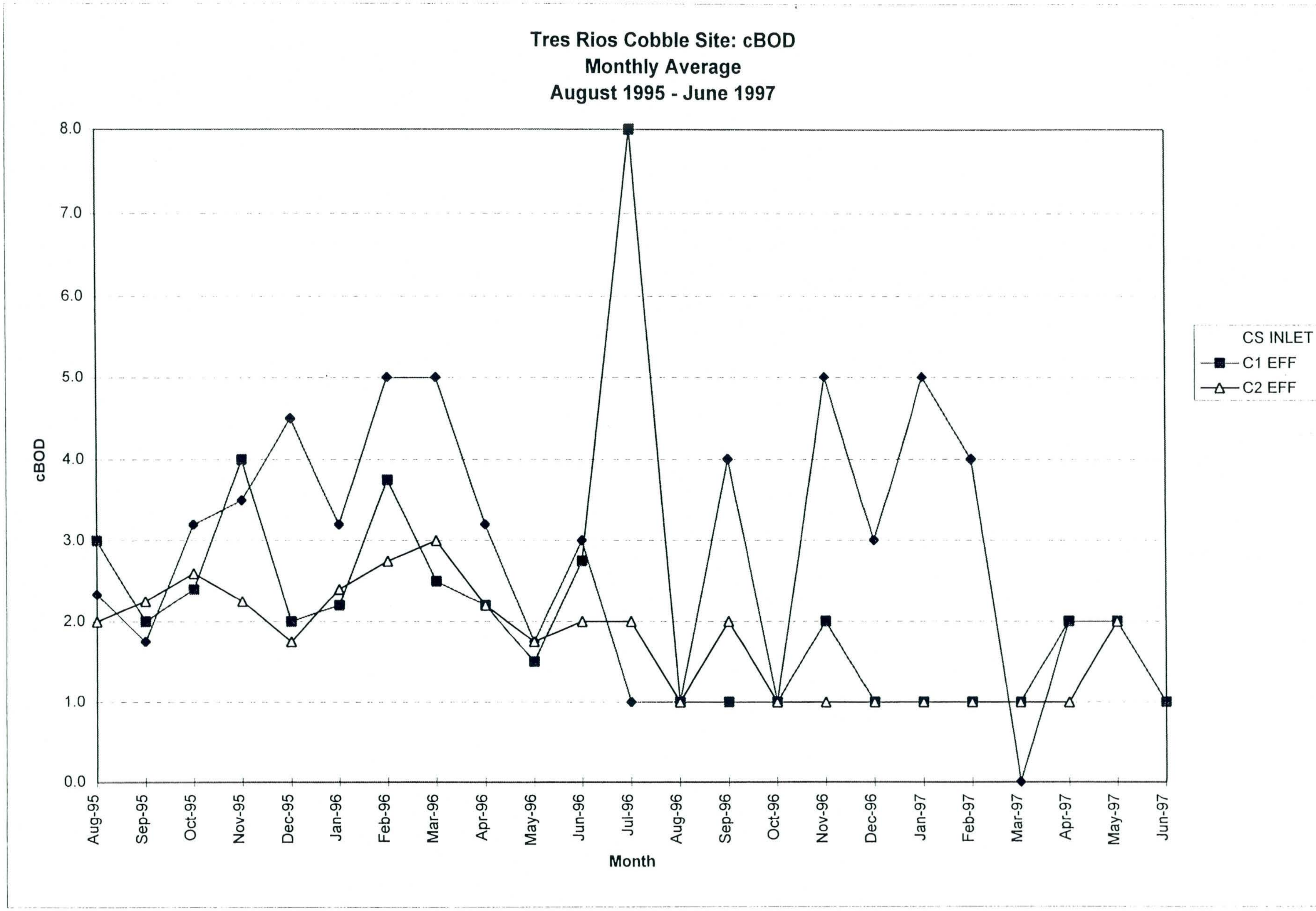
Tres Rios Cobble Site: NH_4 - N
Monthly Average
August 1995 - June 1997
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
NH_4 - N (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF



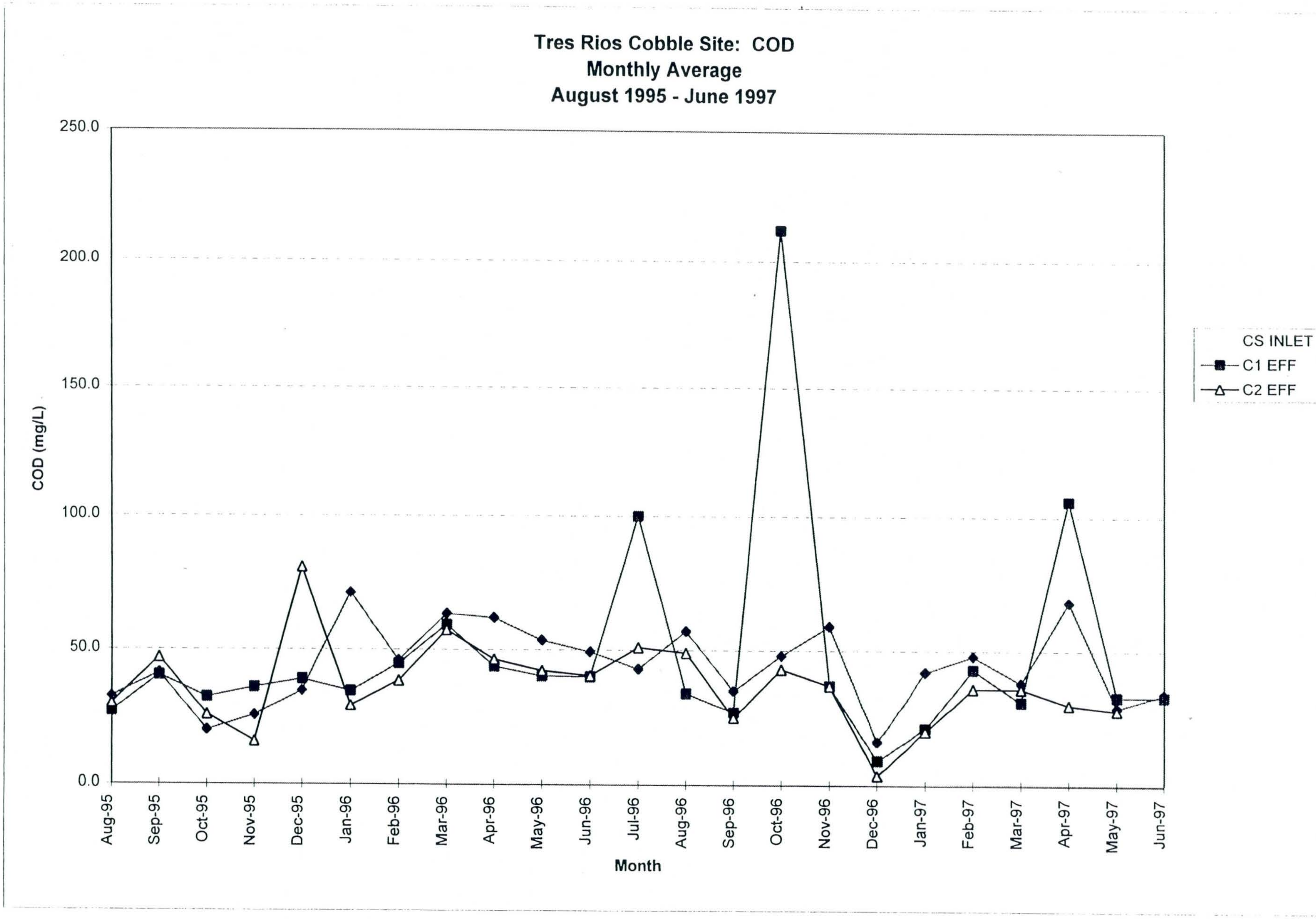
Tres Rios: Cobble Site Total Nitrogen
Monthly Average
August 1995 - June 1997
Total-N (mg/L)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF

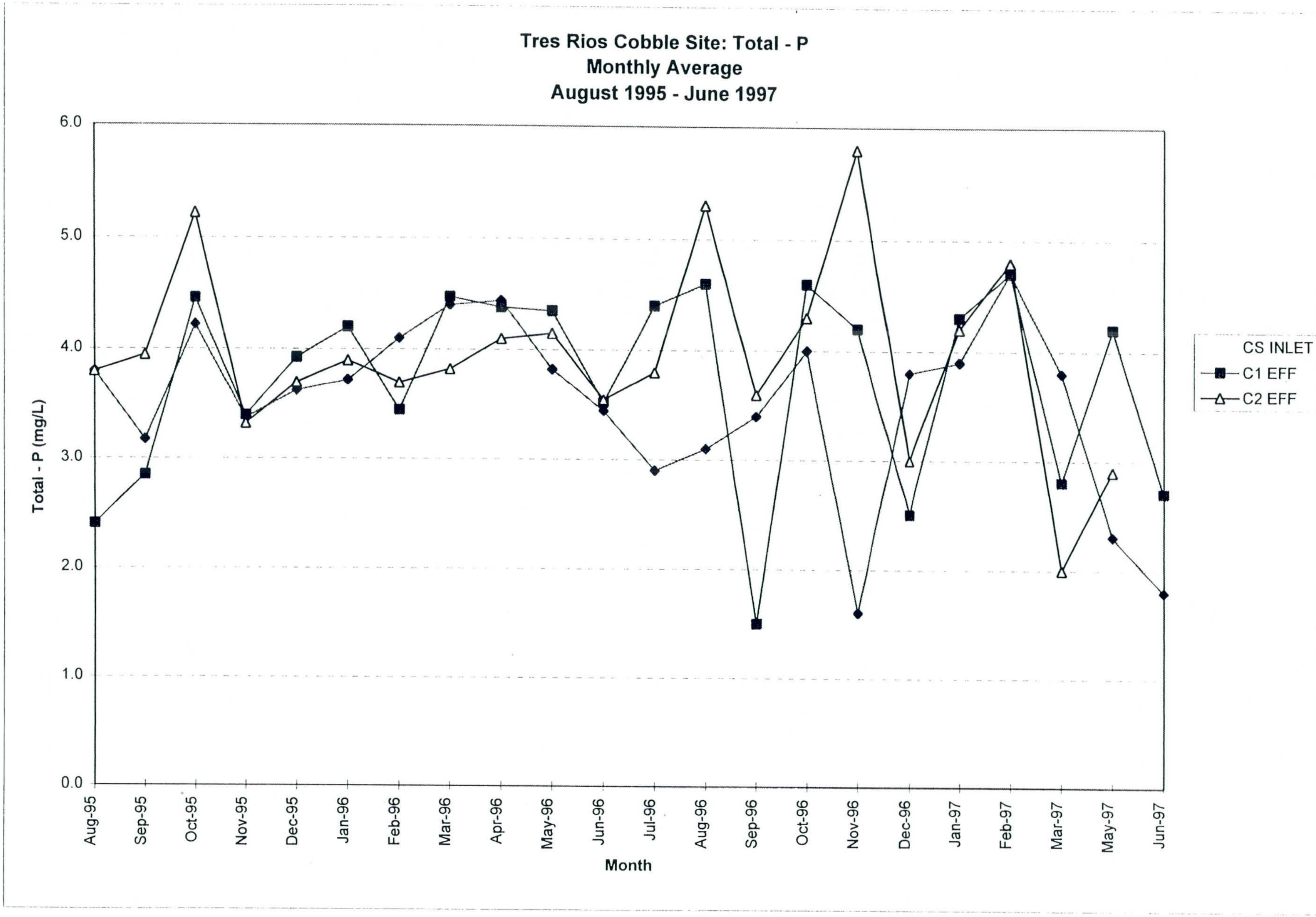


Tres Rios Cobble Site: TOC
Monthly Average
August 1995 - June 1997
TOC (mg/L)
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF

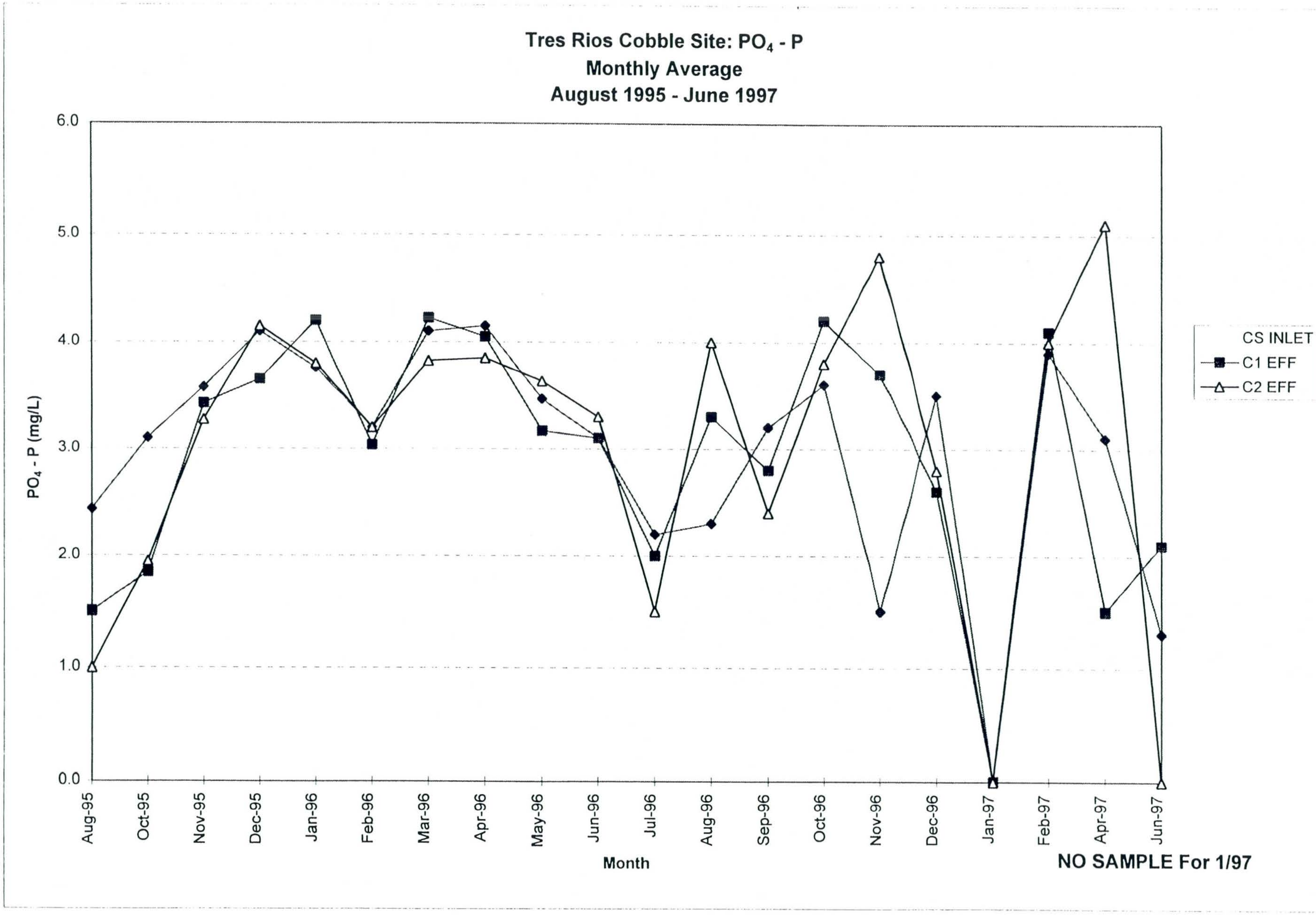


Tres Rios Cobble Site: cBOD
Monthly Average
August 1995 - June 1997
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
cBOD
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF

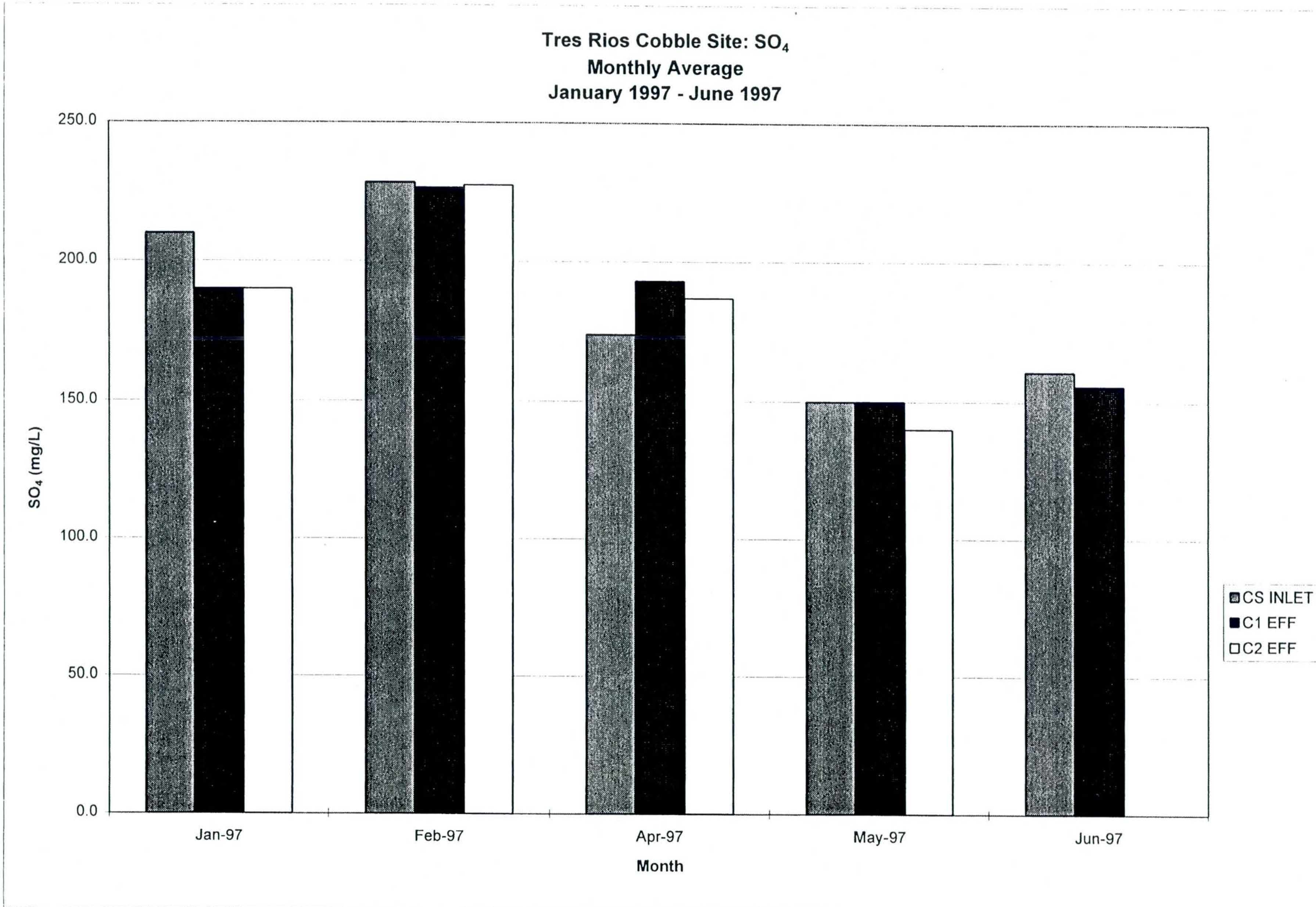

Tres Rios Cobble Site: COD
Monthly Average
August 1995 - June 1997
COD (mg/L)
250.0
200.0
150.0
100.0
50.0
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF

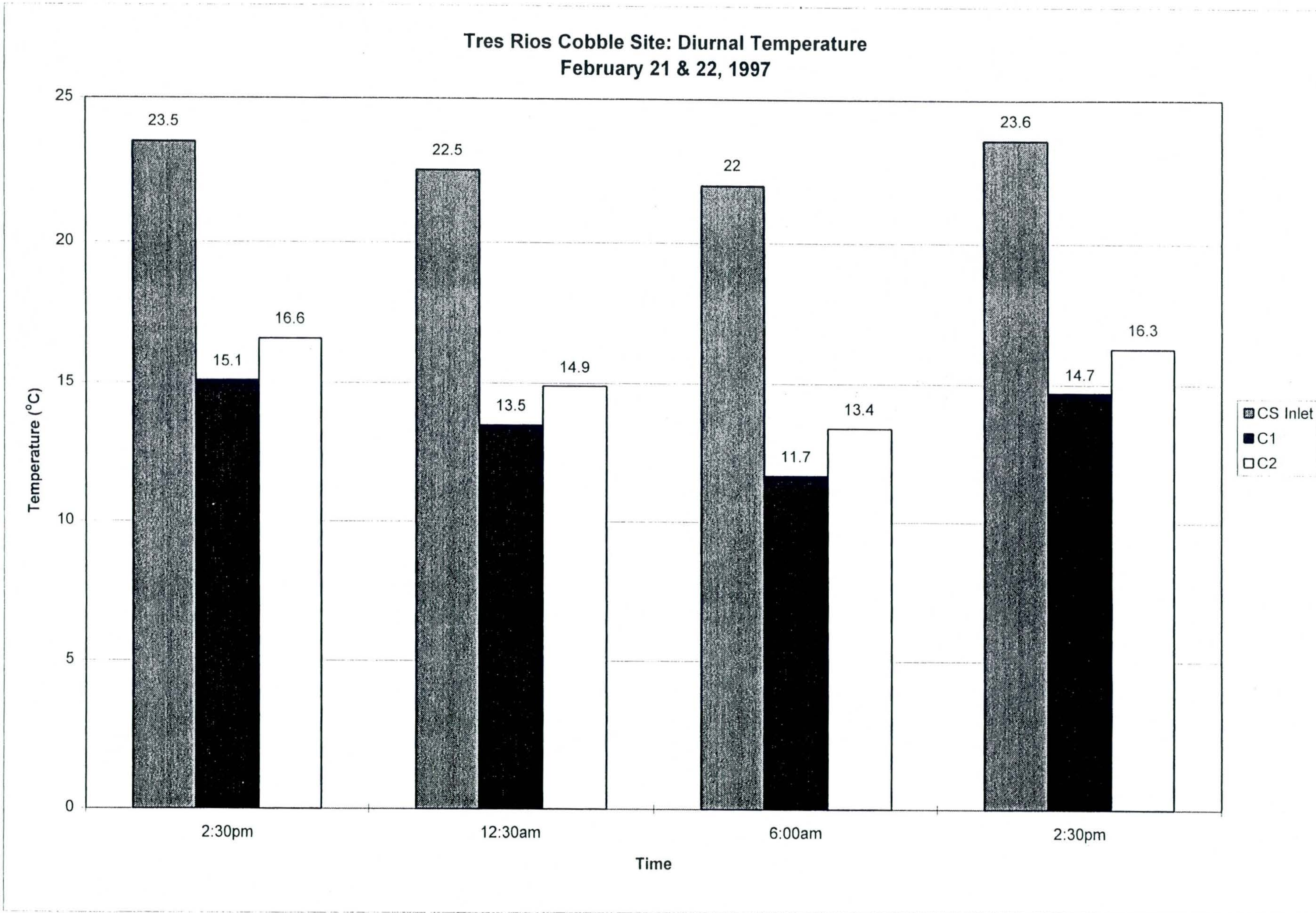


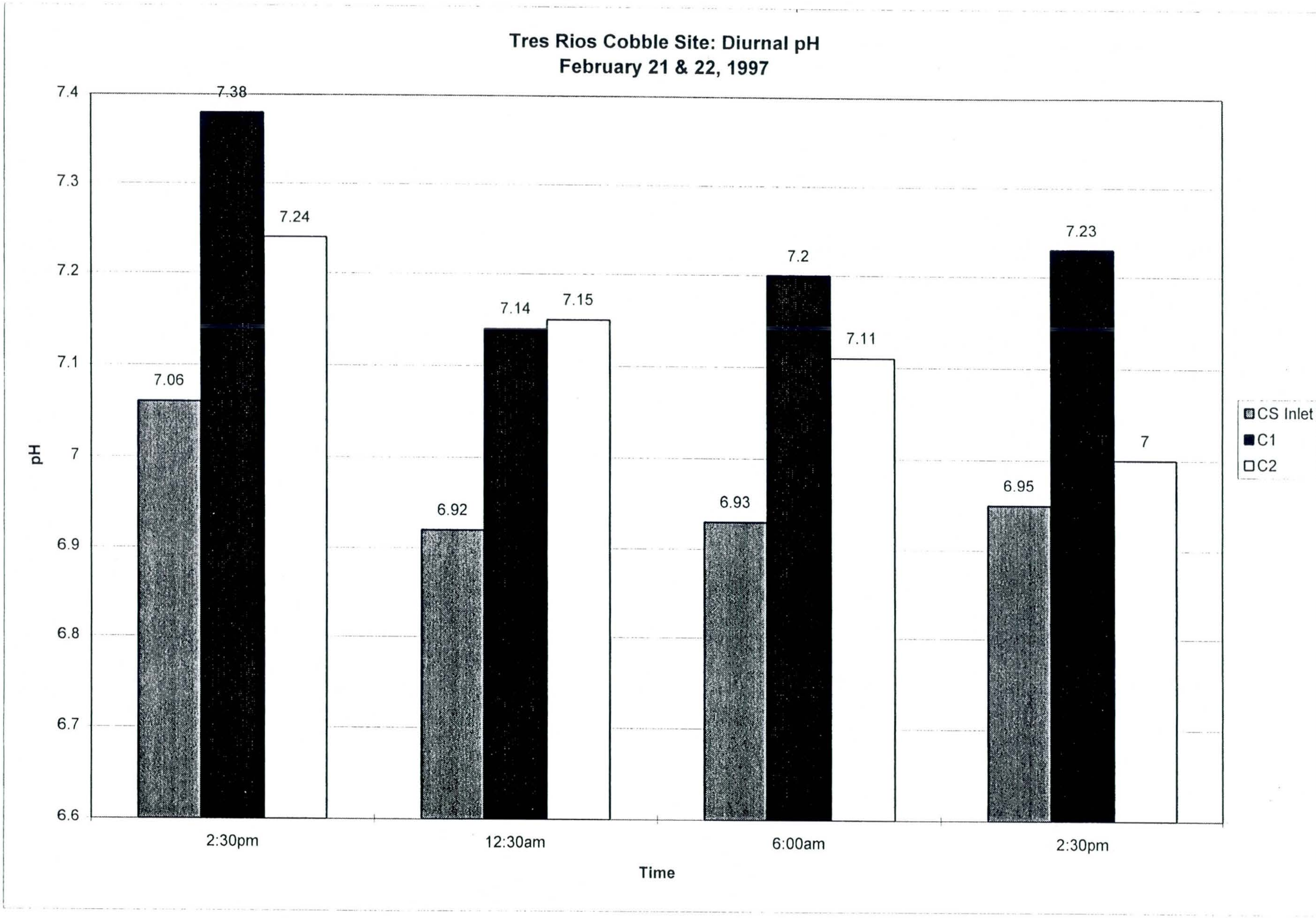
Tres Rios Cobble Site: Total - P
Monthly Average
August 1995 - June 1997
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Total - P (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF



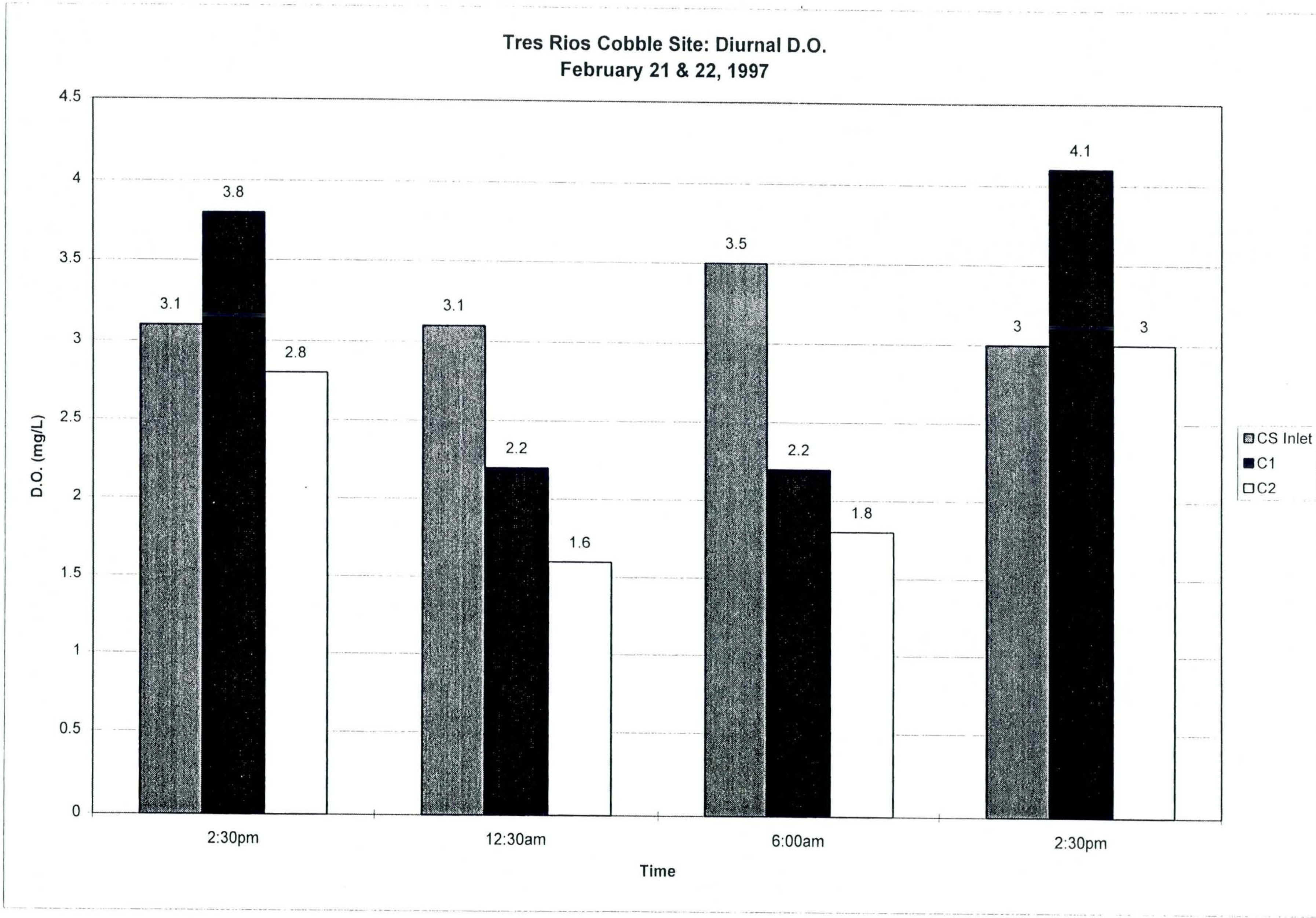
Tres Rios Cobble Site: PO4 - P
Monthly Average
August 1995 - June 1997
6.0
5.0
4.0
3.0
2.0
1.0
0.0
PO4 - P (mg/L)
Aug-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Apr-97
Jun-97
Month
NO SAMPLE For 1/97
CS INLET
C1 EFF
C2 EFF


Tres Rios Cobble Site: SO_4
Monthly Average
January 1997 - June 1997
250.0
200.0
150.0
100.0
50.0
0.0
SO_4 (mg/L)
Jan-97
Feb-97
Apr-97
May-97
Jun-97
Month
CS INLET
C1 EFF
C2 EFF

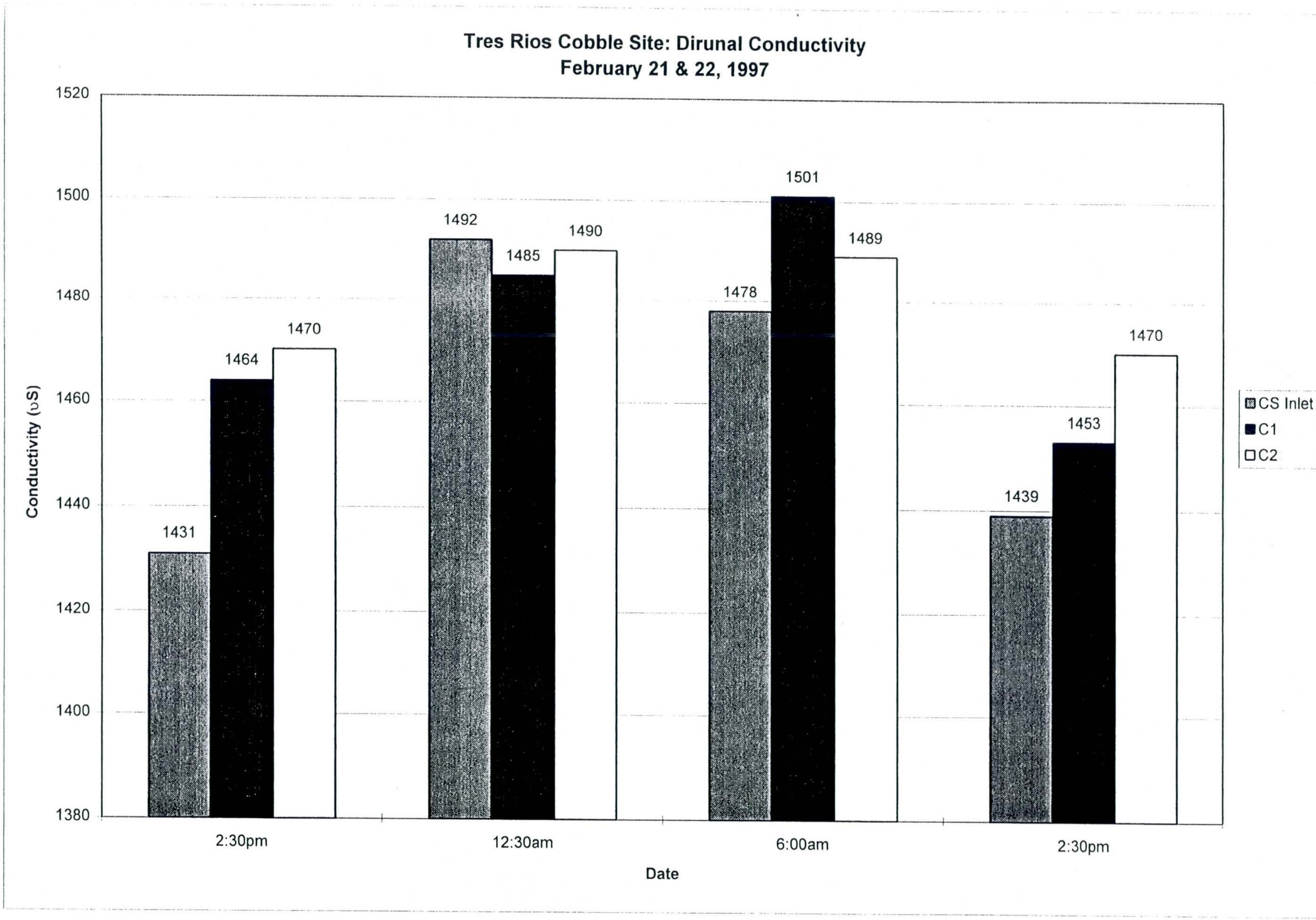

Tres Rios Cobble Site: Diurnal Temperature
February 21 & 22, 1997
Temperature (°C)
25
20
15
10
5
0
23.5
15.1
16.6
22.5
13.5
14.9
22
11.7
13.4
23.6
14.7
16.3
2:30pm
12:30am
6:00am
2:30pm
Time
CS Inlet
C1
C2



Tres Rios Cobble Site: Diurnal pH
February 21 & 22, 1997
7.4
7.3
7.2
7.1
7
6.9
6.8
6.7
6.6
pH
7.06
7.38
7.24
6.92
7.14
7.15
6.93
7.2
7.11
6.95
7.23
7
2:30pm
12:30am
6:00am
2:30pm
Time
CS Inlet
C1
C2



Tres Rios Demonstration Constructed Wetland Project


Tres Rios Cobble Site: Dirunal Conductivity
February 21 & 22, 1997
1520
1500
1480
1460
1440
1420
1400
1380
Conductivity (υS)
1431
1464
1470
1492
1485
1490
1478
1501
1489
1439
1453
1470
2:30pm
12:30am
6:00am
2:30pm
Date
CS Inlet
C1
C2

APPENDIX E - Hayfield Site WQ Data & Plots

Hayfield Site: Annual WQ Statisitics (1995/96 & 1996/97)

Statisitc	ALKALINITY EPA 310.1 (mg/L)	TSS (mg/L)	TDS EPA 160.1 (mg/L)	Cl EPA 300.0 EPA 325.2 (mg/L)	TKN EPA 351.2 (mg/L)	NO2 - N EPA 300.0 (mg/L)	NO3 - N EPA 300.0 (mg/L)	NO2+NO3 - N EPA 353.2 (mg/L)	PO4 - P EPA 300.0 (mg/L)	TOTAL P EPA 200.7 (mg/L)	COD (mg/L)	cBOD sm17 5210B (mg/L)	NH4 - N EPA 350.3 (mg/l)	TOC EPA 415.1 (mg/L)	TOTAL-N (mg/L)	Sulfate EPA 375.2)
HS INLET 1995/96																
Average	175.23	3.76	843.52	247.13	3.33	0.27	2.48	2.67	3.52	3.76	36.58	3.41	2.13	8.53	5.97	0.00
Maximum	186.50	9.00	886.50	288.00	4.23	1.72	3.83	4.05	4.25	4.50	48.25	5.50	3.20	10.75	8.28	0.00
Minimum	148.00	1.75	761.20	212.00	2.30	0.05	0.90	1.11	2.40	3.00	21.25	2.00	0.80	6.50	3.70	0.00
Std. Dev.	10.43	1.83	39.96	23.43	0.60	0.49	1.02	1.05	0.58	0.46	9.10	1.16	0.63	1.23	1.37	NR
HS INLET 1996/97																
Average	170.18	2.55	904.36	245.70	2.98	0.10	2.86	2.72	2.60	3.21	35.82	3.00	1.44	9.41	5.70	85.55
Maximum	186.00	3.00	978.00	317.00	3.80	0.30	5.40	5.50	4.10	4.60	58.00	6.00	2.50	11.70	8.40	231.00
Minimum	154.00	1.00	844.00	180.00	1.70	0.05	0.80	0.80	0.00	1.90	16.00	1.00	0.70	7.90	3.80	0.00
Std. Dev.	10.55	0.69	40.44	43.87	0.65	0.09	1.59	1.56	1.39	0.95	13.13	1.73	0.57	1.22	1.62	100.22
H1 EFF 1995/96																
Average	181.49	4.03	869.83	260.00	1.66	0.12	1.71	1.69	3.32	3.66	47.71	2.59	0.40	8.69	3.35	0.00
Maximum	202.75	9.00	992.00	321.00	1.90	0.60	4.90	5.00	4.35	4.23	75.50	4.00	0.89	10.10	6.88	0.00
Minimum	140.00	2.00	732.80	211.75	1.35	0.05	0.05	0.05	1.95	3.03	21.20	1.00	0.25	7.20	1.45	0.00
Std. Dev.	17.68	1.84	73.50	35.10	0.17	0.16	1.82	1.82	0.72	0.44	19.58	0.78	0.21	1.04	1.92	NR
H1 EFF 1996/97																
Average	182.27	1.36	929.27	261.00	1.19	0.07	1.94	1.66	2.60	3.58	29.95	1.60	0.47	7.57	2.85	97.55
Maximum	200.00	6.00	1030.00	322.00	2.20	0.25	4.40	4.40	3.80	4.40	65.00	4.00	2.20	8.80	5.40	280.00
Minimum	160.00	0.50	866.00	195.00	0.90	0.03	0.05	0.03	0.00	2.00	3.50	1.00	0.25	6.60	1.05	0.00
Std. Dev.	12.31	1.64	53.99	38.66	0.38	0.07	1.86	1.78	1.18	0.78	14.93	1.07	0.58	0.73	1.68	115.48
H2 EFF 1995/96																
Average	178.44	3.77	866.02	258.13	1.70	0.15	1.96	2.05	3.35	3.76	48.35	2.59	0.52	8.69	3.76	0.00
Maximum	195.50	12.33	976.00	313.00	2.13	0.70	5.20	5.34	4.35	4.36	125.00	5.60	1.20	10.12	7.10	0.00
Minimum	153.80	1.25	741.00	207.25	1.25	0.05	0.05	0.05	1.95	2.50	16.75	1.50	0.25	7.50	1.22	0.00
Std. Dev.	13.38	3.06	67.98	35.48	0.28	0.19	2.21	2.18	0.80	0.50	25.97	1.21	0.35	0.83	2.32	NR
H2 EFF 1996/97																
Average	182.00	1.18	927.09	258.60	1.25	0.07	1.57	1.34	2.69	3.75	30.50	1.18	0.41	7.82	2.59	86.36
Maximum	202.00	2.00	1020.00	326.00	1.60	0.25	3.70	3.70	4.00	4.70	47.00	2.00	2.10	8.80	4.80	230.00
Minimum	158.00	0.50	880.00	197.00	1.00	0.03	0.05	0.03	0.00	2.10	3.50	1.00	0.19	6.60	1.15	0.00
Std. Dev.	12.30	0.56	46.55	41.06	0.20	0.07	1.42	1.38	1.24	0.88	13.66	0.40	0.56	0.62	1.29	100.76

Tres Rios Hayfield Riparian Site
Monthly Average Water Quality Performance
8/95 - 6/97

Aug-95			
Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	184.00	194.67	186.33
TSS (mg/L)	3.67	9.00	12.33
TDS EPA 160.1 (mg/L)	852.67	888.67	864.67
Cl EPA 300.0 (mg/L)	256.00	263.67	269.67
TKN EPA 351.2 (mg/L)	3.03	1.77	2.13
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	1.37	0.17	0.65
NO2+NO3 - N EPA 353.2 (mg/L)	1.37	0.17	0.65
PO4 - P EPA 300.0 (mg/L)	3.93	2.43	2.33
TOTAL P EPA 200.7 (mg/L)	4.20	3.03	2.50
COD (mg/L)	33.00	41.67	42.00
cBOD sm17 5210B (mg/L)	2.33	4.00	4.33
NH4 - N EPA 350.3 (mg/l)	2.95	0.53	1.20
TOC EPA 415.1 (mg/L)	7.00	8.33	8.00
TOTAL-N (mg/L)	4.40	1.93	2.78
Depth (cm)		26.88	29.49
HLR (cm/d)		NA	NA
HRT (d)		NA	NA

Sep-95			
Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	172.00	175.75	186.75
TSS (mg/L)	1.75	4.25	2.25
TDS EPA 160.1 (mg/L)	781.75	815.50	812.50
Cl EPA 300.0 (mg/L)	247.50	255.00	260.00
TKN EPA 351.2 (mg/L)	2.80	1.90	1.85
NO2 - N EPA 300.0 (mg/L)	NA	NA	NA
NO3 - N EPA 300.0 (mg/L)	NA	NA	NA
NO2+NO3 - N EPA 353.2 (mg/L)	3.10	0.98	2.43
PO4 - P EPA 300.0 (mg/L)	NA	NA	NA
TOTAL P EPA 200.7 (mg/L)	3.10	3.03	3.85
COD (mg/L)	37.00	70.00	48.00
cBOD sm17 5210B (mg/L)	2.00	3.25	1.75
NH4 - N EPA 350.3 (mg/l)	2.03	0.89	1.15
TOC EPA 415.1 (mg/L)	6.50	8.25	7.75
TOTAL-N (mg/L)	5.90	2.88	4.28
Depth (cm)		11.52	12.92
HLR (cm/d)		NA	NA
HRT (d)		NA	NA

Oct-95			
Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	176.20	166.80	153.80
TSS (mg/L)	3.40	3.60	6.20
TDS EPA 160.1 (mg/L)	761.20	732.80	741.00
Cl EPA 300.0 (mg/L)	248.60	247.20	235.20
TKN EPA 351.2 (mg/L)	3.02	1.68	1.92
NO2 - N EPA 300.0 (mg/L)	0.05	0.60	0.70
NO3 - N EPA 300.0 (mg/L)	0.90	3.00	3.80
NO2+NO3 - N EPA 353.2 (mg/L)	1.11	3.35	3.95
PO4 - P EPA 300.0 (mg/L)	4.25	1.95	1.95
TOTAL P EPA 200.7 (mg/L)	4.10	3.14	4.02
COD (mg/L)	23.40	21.20	36.40
cBOD sm17 5210B (mg/L)	3.00	2.40	5.60
NH4 - N EPA 350.3 (mg/l)	1.84	0.65	0.75
TOC EPA 415.1 (mg/L)	7.40	7.20	8.20
TOTAL-N (mg/L)	3.91	5.05	6.05
Depth (cm)		26.75	31.70
HLR (cm/d)		9.10	16.20
HRT (d)		5.50	3.10

Nov-95			
Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	180.50	174.50	166.50
TSS (mg/L)	4.00	4.25	2.75
TDS EPA 160.1 (mg/L)	825.25	810.50	804.25
Cl EPA 300.0 (mg/L)	214.50	211.75	208.75
TKN EPA 351.2 (mg/L)	3.78	1.60	1.68
NO2 - N EPA 300.0 (mg/L)	0.28	0.09	0.16
NO3 - N EPA 300.0 (mg/L)	2.65	3.15	4.78
NO2+NO3 - N EPA 353.2 (mg/L)	2.93	3.20	4.93
PO4 - P EPA 300.0 (mg/L)	3.45	3.25	3.43
TOTAL P EPA 200.7 (mg/L)	3.58	3.35	3.30
COD (mg/L)	21.25	22.25	16.75
cBOD sm17 5210B (mg/L)	3.75	2.25	1.50
NH4 - N EPA 350.3 (mg/l)	3.20	0.49	0.46
TOC EPA 415.1 (mg/L)	8.00	7.25	7.50
TOTAL-N (mg/L)	6.70	4.80	6.60
Depth (cm)		19.51	24.79
HLR (cm/d)		11.30	17.50
HRT (d)		4.60	2.90

Dec-95			
Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	148.00	140.00	163.50
TSS (mg/L)	4.00	2.75	2.75
TDS EPA 160.1 (mg/L)	816.00	836.50	839.00
Cl EPA 300.0 (mg/L)	212.00	212.00	207.25
TKN EPA 351.2 (mg/L)	4.23	1.75	1.98
NO2 - N EPA 300.0 (mg/L)	0.24	0.15	0.18
NO3 - N EPA 300.0 (mg/L)	3.83	4.43	5.00
NO2+NO3 - N EPA 353.2 (mg/L)	4.05	4.55	5.13
PO4 - P EPA 300.0 (mg/L)	4.10	4.35	4.35
TOTAL P EPA 200.7 (mg/L)	3.58	3.90	4.10
COD (mg/L)	27.00	23.75	125.00
cBOD sm17 5210B (mg/L)	4.50	1.00	1.50
NH4 - N EPA 350.3 (mg/l)	2.33	0.46	0.38
TOC EPA 415.1 (mg/L)	8.80	7.80	7.83
TOTAL-N (mg/L)	8.28	6.30	7.10
Depth (cm)		29.27	29.67
HLR (cm/d)		10.60	12.80
HRT (d)		5.60	4.10

Jan-96			
Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	182.60	174.40	167.20
TSS (mg/L)	4.00	5.20	5.60
TDS EPA 160.1 (mg/L)	852.60	836.00	858.40
Cl EPA 300.0 (mg/L)	231.00	226.80	225.80
TKN EPA 351.2 (mg/L)	3.30	1.88	1.74
NO2 - N EPA 300.0 (mg/L)	0.10	0.13	0.17
NO3 - N EPA 300.0 (mg/L)	3.56	4.90	5.20
NO2+NO3 - N EPA 353.2 (mg/L)	3.62	5.00	5.34
PO4 - P EPA 300.0 (mg/L)	3.48	3.90	4.22
TOTAL P EPA 200.7 (mg/L)	3.66	4.08	4.10
COD (mg/L)	33.00	38.40	31.80
cBOD sm17 5210B (mg/L)	3.40	2.80	2.60
NH4 - N EPA 350.3 (mg/l)	2.34	0.32	0.25
TOC EPA 415.1 (mg/L)	9.14	8.46	8.72
TOTAL-N (mg/L)	6.92	6.88	7.08
Depth (cm)		29.91	29.90
HLR (cm/d)		6.60	10.40
HRT (d)		7.70	4.90

Tres Rios Hayfield Riparian Site
Monthly Average Water Quality Performance
8/95 - 6/97

Feb-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	179.50	180.50	176.00
TSS (mg/L)	3.75	4.50	2.75
TDS EPA 160.1 (mg/L)	869.00	857.25	853.50
Cl EPA 300.0 (mg/L)	246.67	259.67	254.67
TKN EPA 351.2 (mg/L)	4.15	1.68	1.58
NO2 - N EPA 300.0 (mg/L)	0.32	0.05	0.17
NO3 - N EPA 300.0 (mg/L)	1.77	0.67	0.90
NO2+NO3 - N EPA 353.2 (mg/L)	1.78	0.68	1.03
PO4 - P EPA 300.0 (mg/L)	2.90	3.27	3.13
TOTAL P EPA 200.7 (mg/L)	3.73	3.58	3.55
COD (mg/L)	46.25	36.25	49.25
cBOD sm17 5210B (mg/L)	5.50	2.75	2.50
NH4 - N EPA 350.3 (mg/l)	2.43	0.25	0.25
TOC EPA 415.1 (mg/L)	10.75	10.00	9.33
TOTAL-N (mg/L)	5.93	2.35	2.60
Depth (cm)		30.18	29.92
HLR (cm/d)		6.20	6.70
HRT (d)		8.30	7.80

Mar-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	178.75	179.25	175.25
TSS (mg/L)	9.00	4.25	2.25
TDS EPA 160.1 (mg/L)	849.00	863.50	855.00
Cl EPA 300.0 (mg/L)	229.25	256.75	259.25
TKN EPA 351.2 (mg/L)	4.05	1.78	1.50
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	2.55	1.35	0.61
NO2+NO3 - N EPA 353.2 (mg/L)	2.55	1.35	0.61
PO4 - P EPA 300.0 (mg/L)	3.60	3.98	4.05
TOTAL P EPA 200.7 (mg/L)	4.33	4.13	4.08
COD (mg/L)	48.25	58.50	52.25
cBOD sm17 5210B (mg/L)	5.25	2.50	2.00
NH4 - N EPA 350.3 (mg/l)	2.20	0.25	0.25
TOC EPA 415.1 (mg/L)	10.08	9.38	9.65
TOTAL-N (mg/L)	6.60	3.13	2.11
Depth (cm)		29.81	30.10
HLR (cm/d)		7.20	7.30
HRT (d)		7.00	7.00

Apr-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	186.50	197.00	195.50
TSS (mg/L)	2.60	2.80	2.80
TDS EPA 160.1 (mg/L)	874.80	889.20	882.40
Cl EPA 300.0 (mg/L)	245.75	261.25	257.50
TKN EPA 351.2 (mg/L)	3.30	1.60	1.56
NO2 - N EPA 300.0 (mg/L)	1.72	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	2.88	0.39	0.44
NO2+NO3 - N EPA 353.2 (mg/L)	3.76	0.33	0.37
PO4 - P EPA 300.0 (mg/L)	4.10	3.80	3.85
TOTAL P EPA 200.7 (mg/L)	4.50	4.23	4.36
COD (mg/L)	44.00	65.00	45.20
cBOD sm17 5210B (mg/L)	3.20	2.60	2.80
NH4 - N EPA 350.3 (mg/l)	2.26	0.25	0.32
TOC EPA 415.1 (mg/L)	9.24	10.02	10.12
TOTAL-N (mg/L)	7.06	1.93	1.93
Depth (cm)		28.28	29.07
HLR (cm/d)		7.00	7.10
HRT (d)		7.20	7.10

May-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	164.00	190.25	187.75
TSS (mg/L)	3.00	2.25	1.25
TDS EPA 160.1 (mg/L)	875.50	942.00	948.00
Cl EPA 300.0 (mg/L)	268.00	290.67	299.67
TKN EPA 351.2 (mg/L)	2.90	1.35	1.25
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	3.80	0.63	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	3.80	0.63	0.05
PO4 - P EPA 300.0 (mg/L)	3.50	3.63	3.77
TOTAL P EPA 200.7 (mg/L)	3.85	4.08	4.08
COD (mg/L)	45.00	75.50	46.25
cBOD sm17 5210B (mg/L)	3.00	1.50	2.25
NH4 - N EPA 350.3 (mg/l)	1.58	0.25	0.25
TOC EPA 415.1 (mg/L)	8.20	9.23	9.05
TOTAL-N (mg/L)	6.53	1.90	1.22
Depth (cm)		26.17	26.49
HLR (cm/d)		6.80	7.20
HRT (d)		7.40	7.00

Jun-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	175.75	202.75	193.75
TSS (mg/L)	4.00	3.50	2.25
TDS EPA 160.1 (mg/L)	886.50	974.00	957.50
Cl EPA 300.0 (mg/L)	278.25	314.25	306.75
TKN EPA 351.2 (mg/L)	3.15	1.50	1.28
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	2.55	0.05	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	2.55	0.05	0.05
PO4 - P EPA 300.0 (mg/L)	2.97	3.13	3.30
TOTAL P EPA 200.7 (mg/L)	3.50	3.60	3.65
COD (mg/L)	40.75	65.00	41.25
cBOD sm17 5210B (mg/L)	3.00	3.00	2.25
NH4 - N EPA 350.3 (mg/l)	1.68	0.25	0.25
TOC EPA 415.1 (mg/L)	8.95	10.10	8.98
TOTAL-N (mg/L)	5.70	1.55	1.33
Depth (cm)		30.24	30.07
HLR (cm/d)		6.90	7.20
HRT (d)		7.30	7.00

Jul-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	175.00	202.00	189.00
TSS (mg/L)	2.00	2.00	2.00
TDS EPA 160.1 (mg/L)	878.00	992.00	976.00
Cl EPA 300.0 (mg/L)	288.00	321.00	313.00
TKN EPA 351.2 (mg/L)	2.30	1.40	2.00
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	1.40	0.05	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	1.40	0.05	0.05
PO4 - P EPA 300.0 (mg/L)	2.40	2.80	2.50
TOTAL P EPA 200.7 (mg/L)	3.00	3.80	3.50
COD (mg/L)	40.00	55.00	46.00
cBOD sm17 5210B (mg/L)	2.00	3.00	2.00
NH4 - N EPA 350.3 (mg/l)	0.80	0.25	0.70
TOC EPA 415.1 (mg/L)	8.30	8.30	9.20
TOTAL-N (mg/L)	3.70	1.45	2.05
Depth (cm)		31.25	30.82
HLR (cm/d)		7.50	7.70
HRT (d)		6.80	6.60

Tres Rios Hayfield Riparian Site
Monthly Average Water Quality Performance
8/95 - 4/97

Aug-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	169.00	198.00	202.00
TSS (mg/L)	2.00	0.50	2.00
TDS EPA 160.1 (mg/L)	866.00	934.00	906.00
Cl EPA 300.0 (mg/L)	285.00	309.00	315.00
TKN EPA 351.2 (mg/L)	2.50	1.00	1.40
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	1.70	0.05	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	1.70	0.05	0.05
PO4 - P EPA 300.0 (mg/L)	2.30	3.10	3.50
TOTAL P EPA 200.7 (mg/L)	3.10	3.80	4.40
COD (mg/L)	24.00	32.00	45.00
cBOD sm17 5210B (mg/L)	3.00	1.00	2.00
NH4 - N EPA 350.3 (mg/l)	1.00	0.25	0.25
TOC EPA 415.1 (mg/L)	8.90	8.80	8.80
TOTAL-N (mg/L)	4.20	1.05	1.45
Depth (cm)		30.51	30.47
HLR (cm/d)		12.80	7.60
HRT (d)		4.30	6.60

Sep-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	167.00	170.00	173.00
TSS (mg/L)	3.00	2.00	1.00
TDS EPA 160.1 (mg/L)	906.00	908.00	928.00
Cl EPA 300.0 (mg/L)	269.00	267.00	283.00
TKN EPA 351.2 (mg/L)	3.00	0.90	1.10
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	0.80	0.20	0.05
NO2+NO3 - N EPA 353.2 (mg/L)	0.80	0.20	0.05
PO4 - P EPA 300.0 (mg/L)	3.30	3.00	2.60
TOTAL P EPA 200.7 (mg/L)	3.40	2.90	3.10
COD (mg/L)	36.00	24.00	26.00
cBOD sm17 5210B (mg/L)	5.00	4.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.90	0.25	0.25
TOC EPA 415.1 (mg/L)	10.40	7.60	8.00
TOTAL-N (mg/L)	3.80	1.10	1.15
Depth (cm)		25.26	25.44
HLR (cm/d)		15.10	7.70
HRT (d)		3.30	6.60

Oct-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	177.00	181.00	183.00
TSS (mg/L)	3.00	2.00	1.00
TDS EPA 160.1 (mg/L)	886.00	942.00	890.00
Cl EPA 300.0 (mg/L)	253.00	271.00	256.00
TKN EPA 351.2 (mg/L)	3.80	1.00	1.60
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	3.70	1.90	1.40
NO2+NO3 - N EPA 353.2 (mg/L)	3.70	1.90	1.40
PO4 - P EPA 300.0 (mg/L)	3.60	3.50	3.40
TOTAL P EPA 200.7 (mg/L)	4.10	4.20	4.00
COD (mg/L)	52.00	35.00	38.00
cBOD sm17 5210B (mg/L)	1.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.80	0.25	0.25
TOC EPA 415.1 (mg/L)	10.80	7.20	7.60
TOTAL-N (mg/L)	7.50	2.90	3.00
Depth (cm)		29.45	29.96
HLR (cm/d)		15.10	13.00
HRT (d)		3.30	4.20

Nov-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	156.00	179.00	183.00
TSS (mg/L)	3.00	0.50	1.00
TDS EPA 160.1 (mg/L)	844.00	880.00	890.00
Cl EPA 300.0 (mg/L)	202.00	215.00	210.00
TKN EPA 351.2 (mg/L)	3.70	1.10	1.20
NO2 - N EPA 300.0 (mg/L)	0.10	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	1.90	3.50	2.70
NO2+NO3 - N EPA 353.2 (mg/L)	2.00	3.50	2.70
PO4 - P EPA 300.0 (mg/L)	1.40	3.40	4.00
TOTAL P EPA 200.7 (mg/L)	1.90	3.90	4.70
COD (mg/L)	58.00	31.00	47.00
cBOD sm17 5210B (mg/L)	6.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	2.00	0.50	0.25
TOC EPA 415.1 (mg/L)	9.70	6.80	7.50
TOTAL-N (mg/L)	5.70	4.60	3.90
Depth (cm)		29.9	30.1
HLR (cm/d)		15.1	15.4
HRT (d)		3.4	3.3

Dec-96 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	171.00	175.00	174.00
TSS (mg/L)	2.00	1.00	1.00
TDS EPA 160.1 (mg/L)	926.00	866.00	880.00
Cl EPA 300.0 (mg/L)	257.00	258.00	259.00
TKN EPA 351.2 (mg/L)	2.70	1.00	1.00
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	5.40	2.90	2.80
NO2+NO3 - N EPA 353.2 (mg/L)	5.40	2.90	2.80
PO4 - P EPA 300.0 (mg/L)	4.00	2.50	2.60
TOTAL P EPA 200.7 (mg/L)	4.00	2.70	2.50
COD (mg/L)	16.00	3.50	3.50
cBOD sm17 5210B (mg/L)	3.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	0.90	0.25	0.25
TOC EPA 415.1 (mg/L)	10.10	7.20	7.20
TOTAL-N (mg/L)	8.10	3.90	3.80
Depth (cm)		30.04	30.15
HLR (cm/d)		15.1	15.4
HRT (d)		3.4	3.3

Jan-97 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	181.00	160.00	158.00
TSS (mg/L)	3.00	0.50	0.50
TDS EPA 160.1 (mg/L)	910.00	874.00	922.00
Cl EPA 300.0 (mg/L)	180.00	250.00	240.00
TKN EPA 351.2 (mg/L)	3.40	1.10	1.10
NO2 - N EPA 300.0 (mg/L)	0.16	0.03	0.03
NO3 - N EPA 300.0 (mg/L)	2.10	4.20	2.70
NO2+NO3 - N EPA 353.2 (mg/L)	2.30	4.20	2.70
PO4 - P EPA 300.0 (mg/L)	NA	NA	NA
TOTAL P EPA 200.7 (mg/L)	3.90	3.90	4.20
COD (mg/L)	45.00	19.00	19.00
cBOD sm17 5210B (mg/L)	5.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.10	0.25	0.25
TOC EPA 415.1 (mg/L)	11.70	7.10	7.50
TOTAL-N (mg/L)	5.70	5.30	3.80
SO4 (mg/L)	210	190.00	190.00
Br- (mg/L)	< 0.3	0.30	< 0.3
Depth (cm)		29.95	30.3
HLR (cm/d)		14.8	15.3
HRT (d)		3.4	3.3

Tres Rios Hayfield Riparian Site
Monthly Average Water Quality Performance
8/95 - 4/97

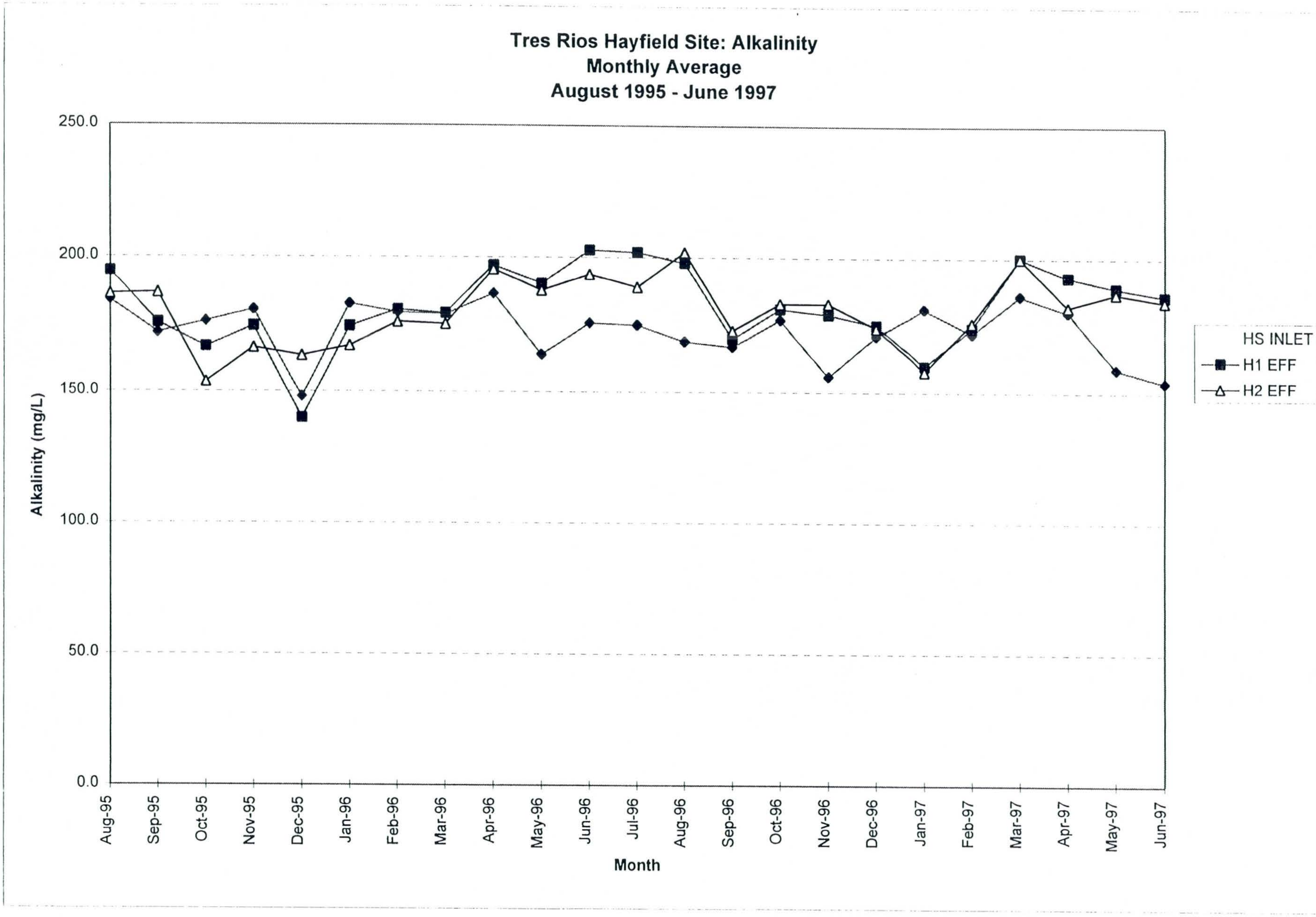
Feb-97 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	172.00	174.00	176.00
TSS (mg/L)	2.00	0.50	0.50
TDS EPA 160.1 (mg/L)	876.00	898.00	906.00
Cl EPA 300.0 (mg/L)	191.00	195.00	197.00
TKN EPA 351.2 (mg/L)	2.90	1.00	1.10
NO2 - N EPA 300.0 (mg/L)	0.30	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	5.20	4.40	3.70
NO2+NO3 - N EPA 353.2 (mg/L)	5.50	4.40	3.70
PO4 - P EPA 300.0 (mg/L)	4.10	3.80	3.80
TOTAL P EPA 200.7 (mg/L)	4.60	4.20	4.40
COD (mg/L)	37.00	21.00	17.00
cBOD sm17 5210B (mg/L)	3.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	1.50	0.25	0.25
TOC EPA 415.1 (mg/L)	8.80	6.60	6.60
TOTAL-N (mg/L)	8.40	5.40	4.80
SO4 (mg/L)	231	234.00	230.00
Depth (cm)		30.15	30.3
HLR (cm/d)		14.9	15.6
HRT (d)		3.4	3.2

Mar-97 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	186.00	200.00	200.00
TSS (mg/L)	3.00	0.50	1.00
TDS EPA 160.1 (mg/L)	954.00	964.00	934.00
Cl EPA 300.0 (mg/L)	NR	NR	NR
TKN EPA 351.2 (mg/L)	3.80	1.00	1.30
NO2 - N EPA 300.0 (mg/L)	NR	NR	NR
NO3 - N EPA 300.0 (mg/L)	NR	NR	NR
NO2+NO3 - N EPA 353.2 (mg/L)	1.00	0.50	0.31
PO4 - P EPA 300.0 (mg/L)	NR	NR	NR
TOTAL P EPA 200.7 (mg/L)	2.80	3.80	3.90
COD (mg/L)	40.00	32.00	24.00
cBOD sm17 5210B (mg/L)	1.00	NR	1.00
NH4 - N EPA 350.3 (mg/l)	1.50	0.25	0.25
TOC EPA 415.1 (mg/L)	8.60	7.20	8.00
TOTAL-N (mg/L)	4.80	1.50	1.61
Depth (cm)		31.11	36.1
HLR (cm/d)		14.7	15.3
HRT (d)		3.4	3.3

Apr-97 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	180.00	193.00	182.00
TSS (mg/L)	3.00	0.50	2.00
TDS EPA 160.1 (mg/L)	872.00	916.00	912.00
Cl EPA 300.0 (mg/L)	233.00	243.00	240.00
TKN EPA 351.2 (mg/L)	2.50	1.30	1.20
NO2 - N EPA 300.0 (mg/L)	0.05	0.05	0.05
NO3 - N EPA 300.0 (mg/L)	2.70	0.05	0.50
NO2+NO3 - N EPA 353.2 (mg/L)	2.70	0.05	0.50
PO4 - P EPA 300.0 (mg/L)	3.20	2.50	2.60
TOTAL P EPA 200.7 (mg/L)	NR	NR	NR
COD (mg/L)	19.00	65.00	40.00
cBOD sm17 5210B (mg/L)	2.00	1.00	1.00
NH4 - N EPA 350.3 (mg/l)	0.90	0.25	0.25
TOC EPA 415.1 (mg/L)	8.60	8.50	8.40
TOTAL-N (mg/L)	5.20	1.35	1.70
SO4 (mg/L)	176	203.00	201.00
Depth (cm)		44.6	44.72
HLR (cm/d)		14.7	15.3
HRT (d)		3.4	3.3

May-97 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	159.00	189	187
TSS (mg/L)	3.00	1	2
TDS EPA 160.1 (mg/L)	930.00	1010	1010
Cl EPA 300.0 (mg/L)	270.00	280	260
TKN EPA 351.2 (mg/L)	2.80	2.2	1.6
NO2 - N EPA 300.0 (mg/L)	NA	NA	NA
NO3 - N EPA 300.0 (mg/L)	NA	NA	NA
NO2+NO3 - N EPA 353.2 (mg/L)	2.60	0.03	0.03
PO4 - P EPA 300.0 (mg/L)	NA	NA	NA
TOTAL P EPA 200.7 (mg/L)	2.30	4.4	4.2
COD (mg/L)	29.00	32	35
cBOD sm17 5210B (mg/L)	3.00	3	2
NH4 - N EPA 350.3 (mg/l)	2.50	2.2	2.1
TOC EPA 415.1 (mg/L)	8.00	8.3	8.4
TOTAL-N (mg/L)	5.40	2.23	1.63
SO4 (mg/L)	160	280	160
Depth (cm)		45.72	45.72
HLR (cm/d)		14.7	15.3
HRT (d)		4.3	4.1

Jun-97 Parameter	HS INLET	H1 EFF	H2 EFF
ALKALINITY EPA 310.1 (mg/L)	154.00	186	184
TSS (mg/L)	1.00	6	1
TDS EPA 160.1 (mg/L)	978.00	1030	1020
Cl EPA 300.0 (mg/L)	317.00	322	326
TKN EPA 351.2 (mg/L)	1.70	1.5	1.2
NO2 - N EPA 300.0 (mg/L)	0.05	0.25	0.25
NO3 - N EPA 300.0 (mg/L)	2.20	0.25	0.25
NO2+NO3 - N EPA 353.2 (mg/L)	2.25	0.5	0.5
PO4 - P EPA 300.0 (mg/L)	1.50	1.6	1.7
TOTAL P EPA 200.7 (mg/L)	2.00	2	2.1
COD (mg/L)	38.00	35	41
cBOD sm17 5210B (mg/L)	1.00	2	1
NH4 - N EPA 350.3 (mg/l)	0.70	0.5	0.19
TOC EPA 415.1 (mg/L)	7.90	8	8
TOTAL-N (mg/L)	3.95	2	1.7
SO4 (mg/L)	164	166	169
Depth (cm)		46	45.72
HLR (cm/d)		14.7	15.3
HRT (d)		4.3	4.1



Tres Rios Hayfield Site: Alkalinity
Monthly Average
August 1995 - June 1997
250.0
200.0
150.0
100.0
50.0
0.0
Alkalinity (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
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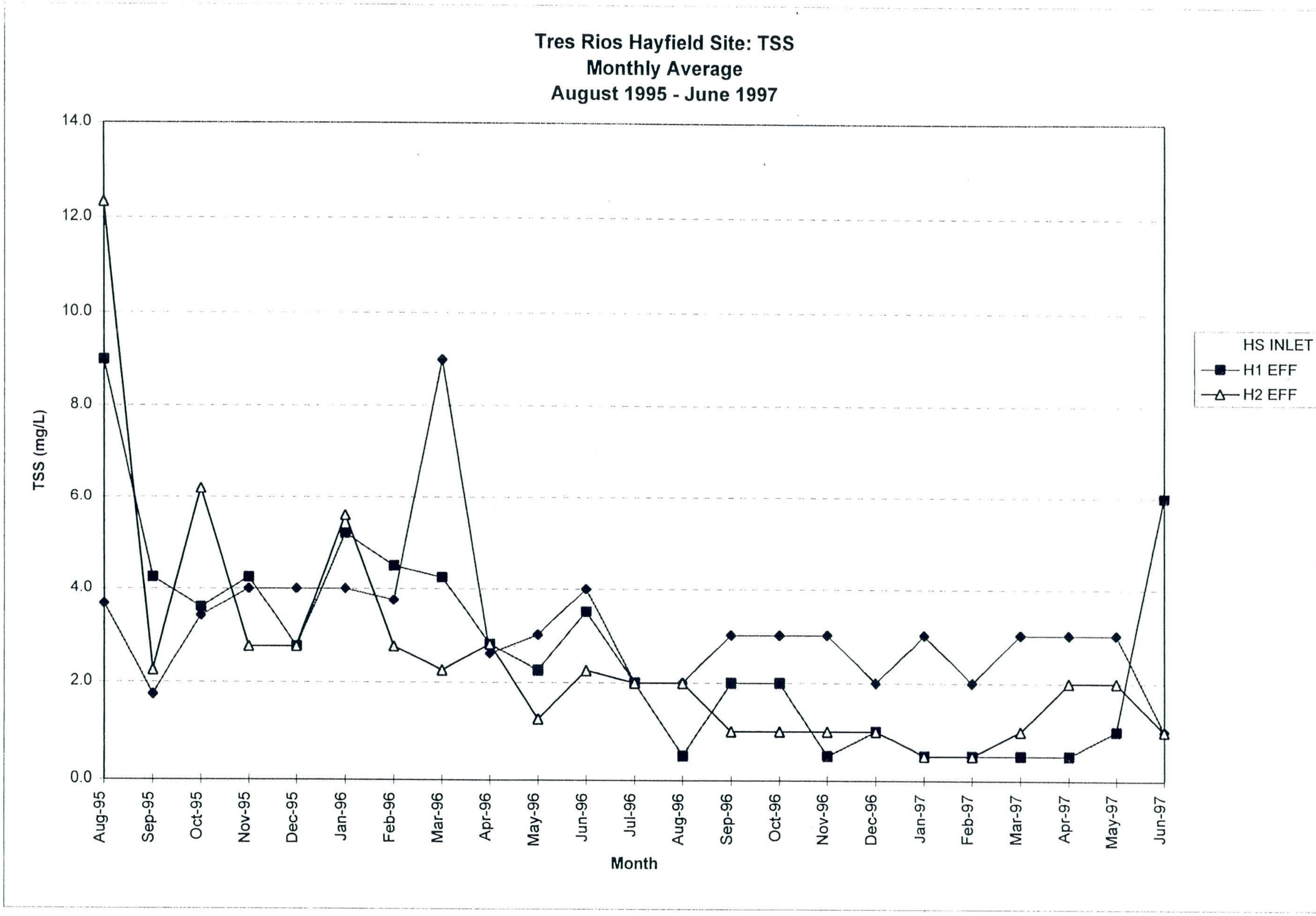
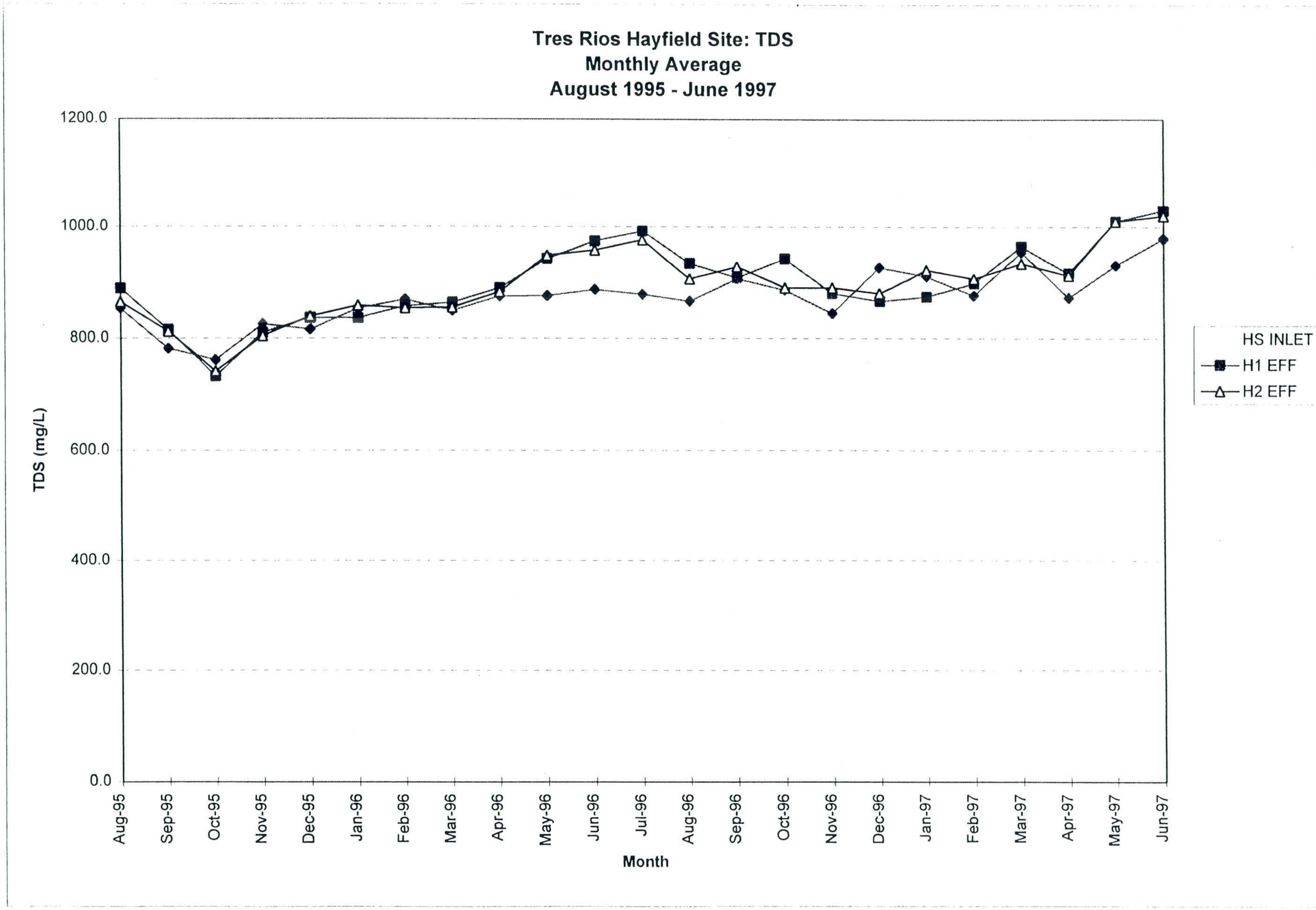
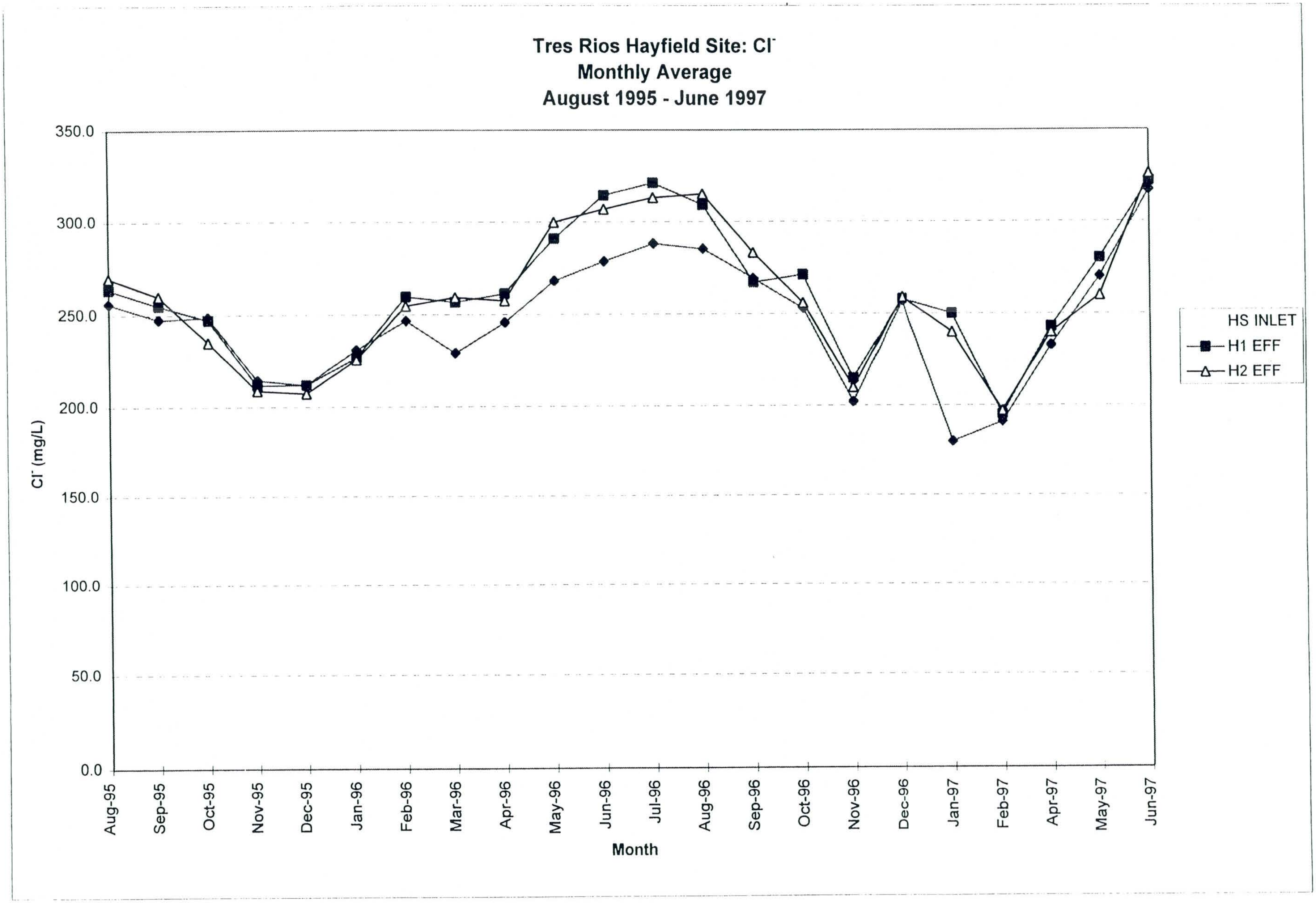
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

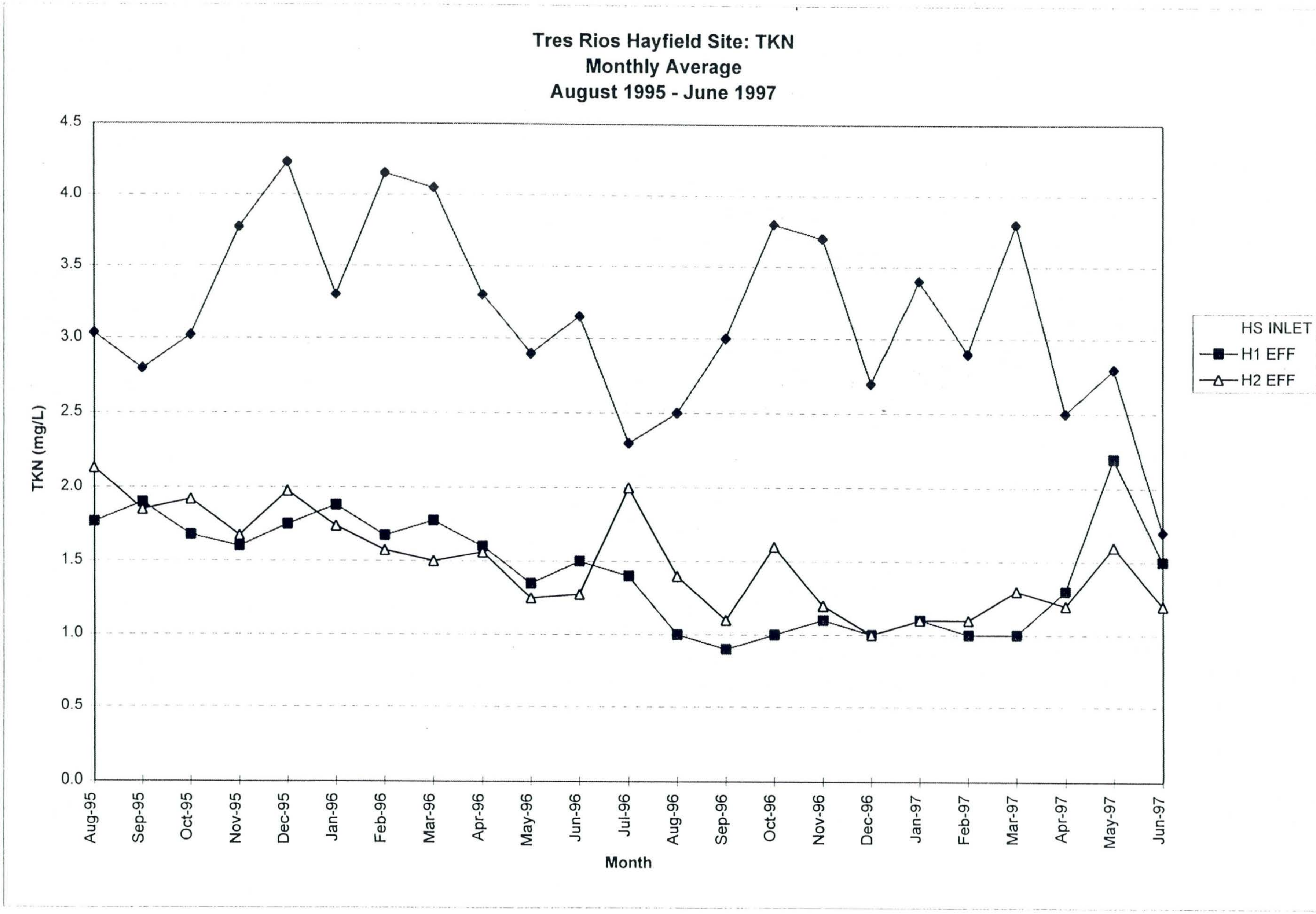


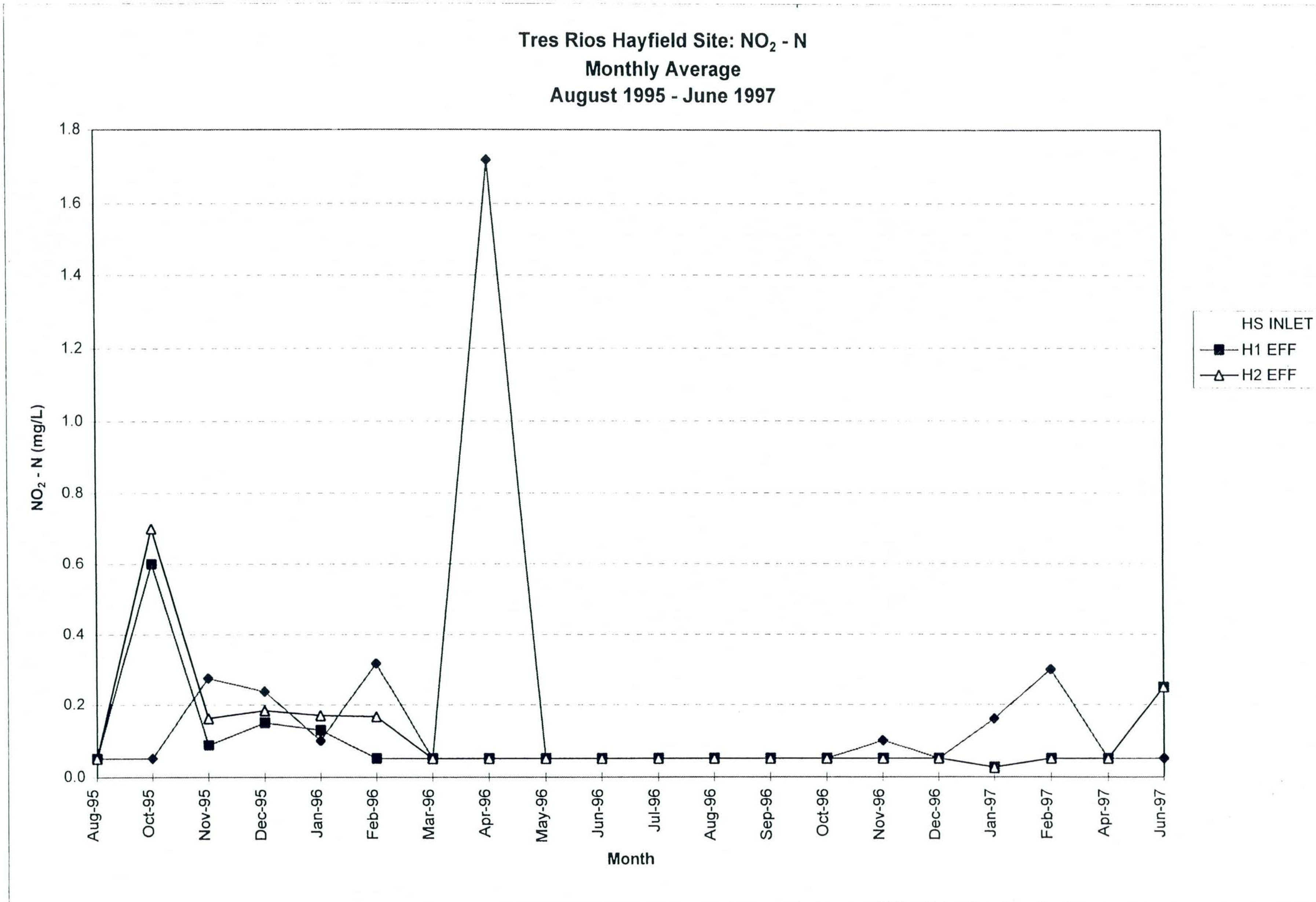
Tres Rios Hayfield Site: TSS
Monthly Average
August 1995 - June 1997
TSS (mg/L)
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF


Tres Rios Hayfield Site: TDS
Monthly Average
August 1995 - June 1997
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0
TDS (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

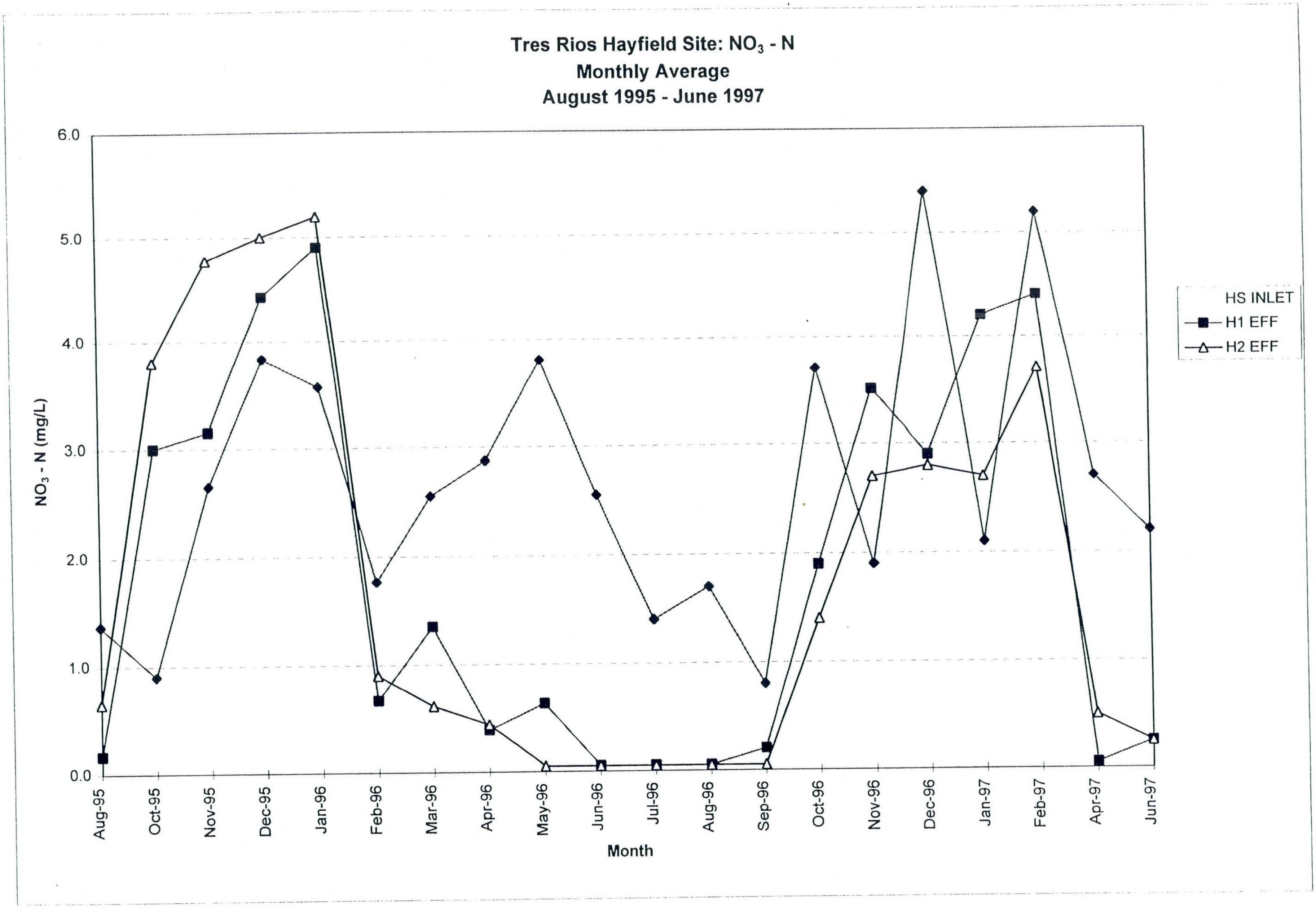


Tres Rios Hayfield Site: Cl⁻
Monthly Average
August 1995 - June 1997
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Cl⁻ (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

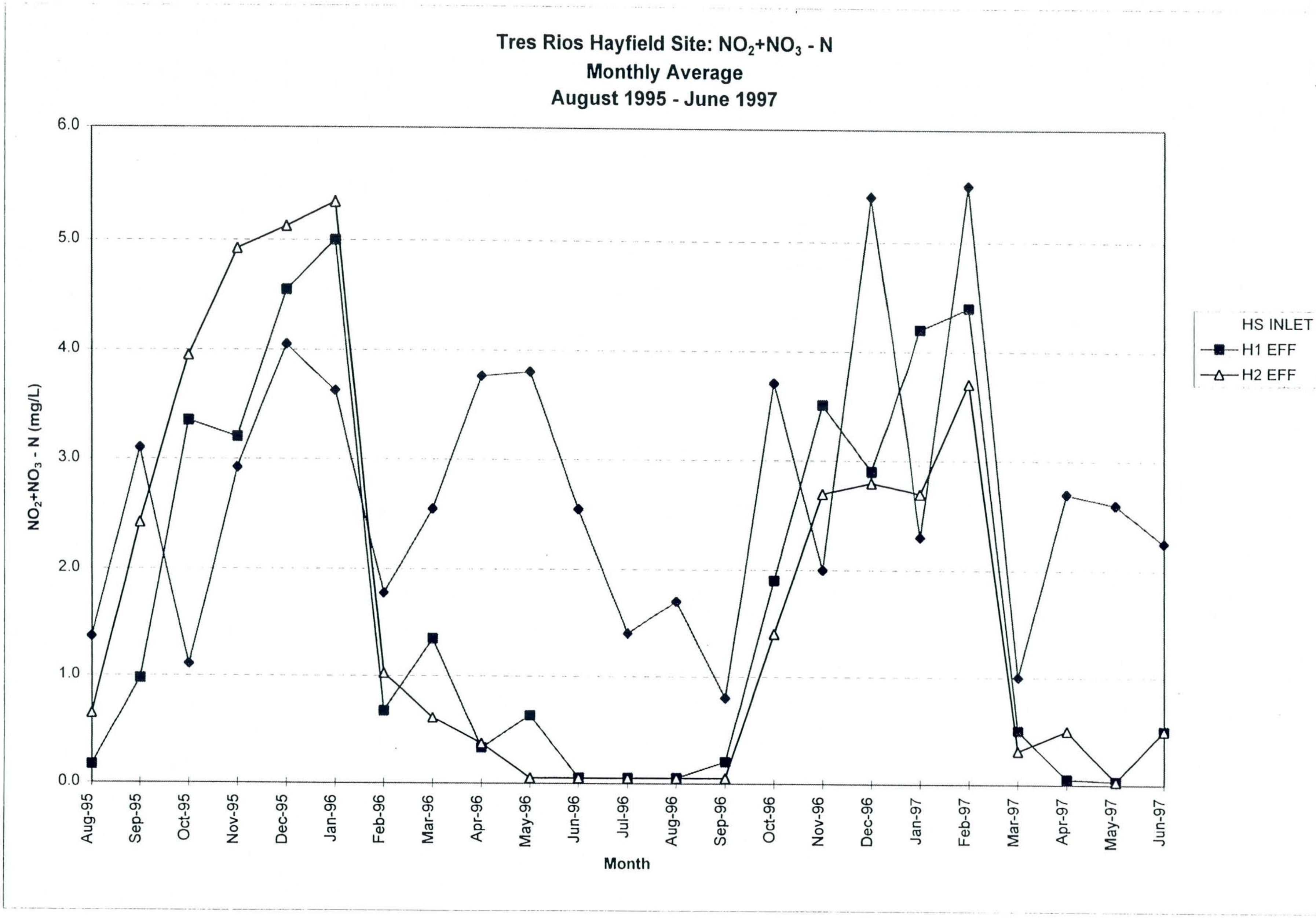

Tres Rios Hayfield Site: TKN
Monthly Average
August 1995 - June 1997
TKN (mg/L)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF



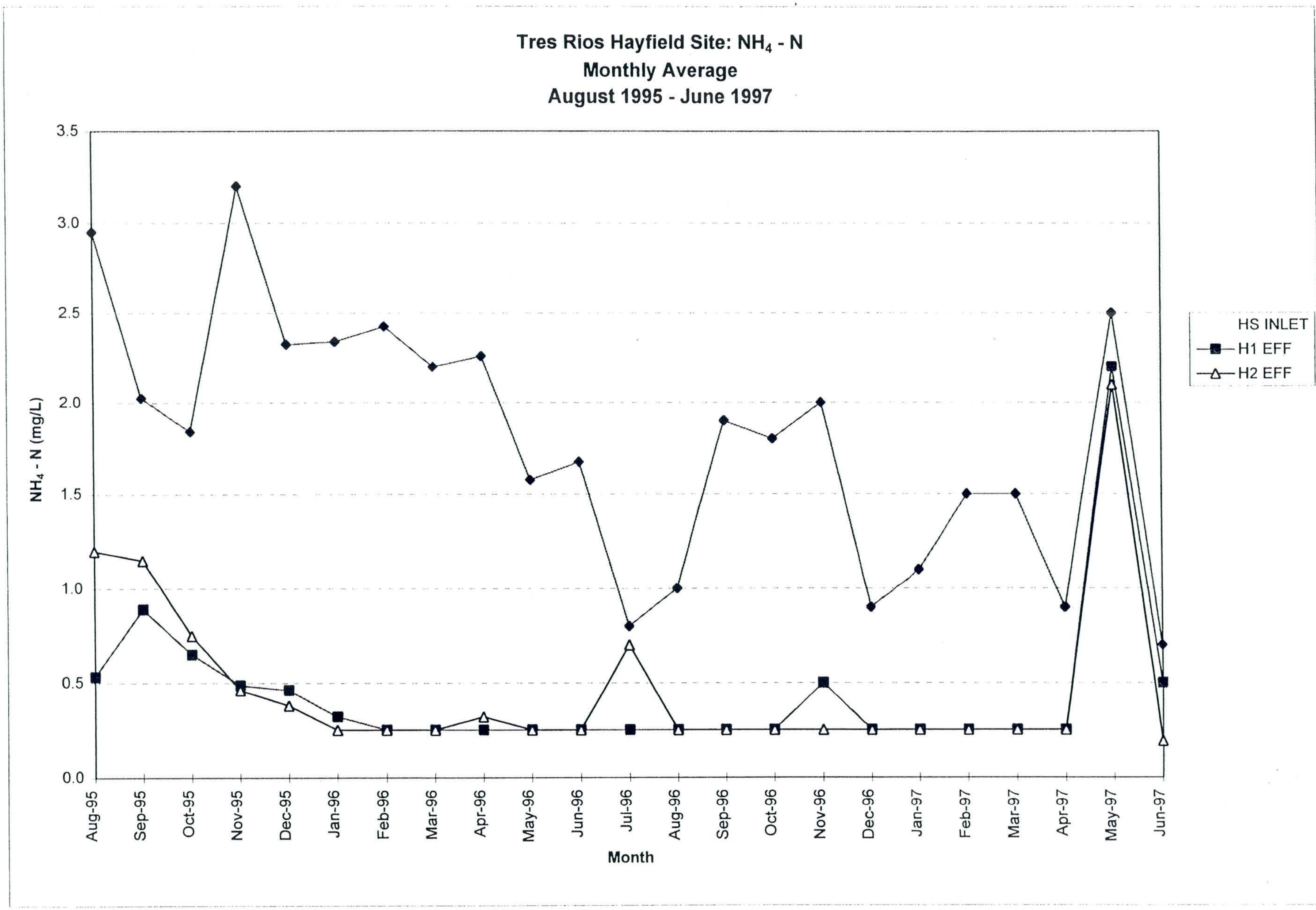
Tres Rios Hayfield Site: NO_2 - N
Monthly Average
August 1995 - June 1997
NO_2 - N (mg/L)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
Aug-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Apr-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF



Tres Rios Hayfield Site: NO_3 - N
Monthly Average
August 1995 - June 1997
6.0
5.0
4.0
3.0
2.0
1.0
0.0
NO_3 - N (mg/L)
Aug-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Apr-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF



Tres Rios Hayfield Site: NO_2+NO_3 - N
Monthly Average
August 1995 - June 1997
6.0
5.0
4.0
3.0
2.0
1.0
0.0
NO_2+NO_3 - N (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF


Tres Rios Hayfield Site: NH4 - N
Monthly Average
August 1995 - June 1997
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
NH4 - N (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
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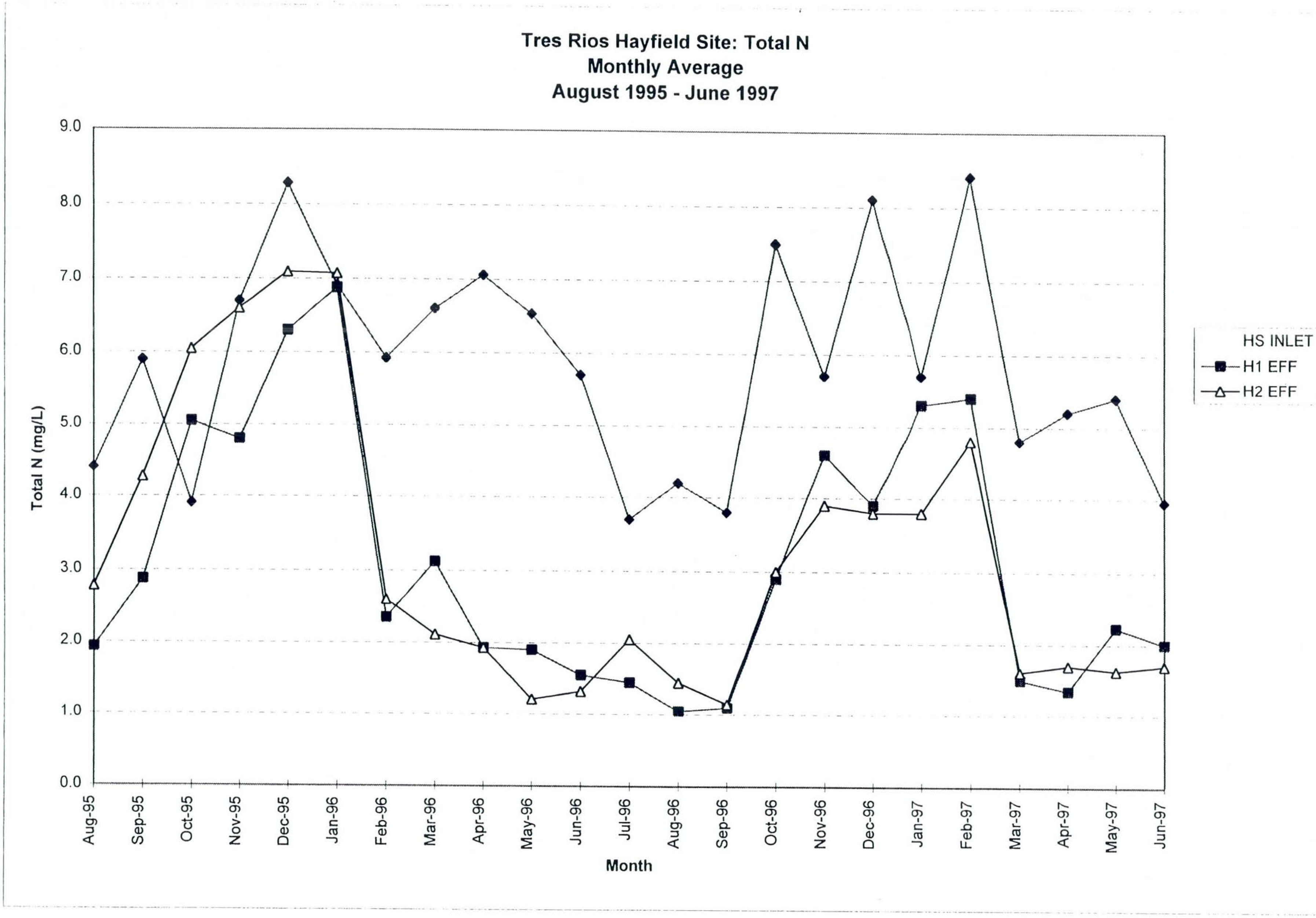
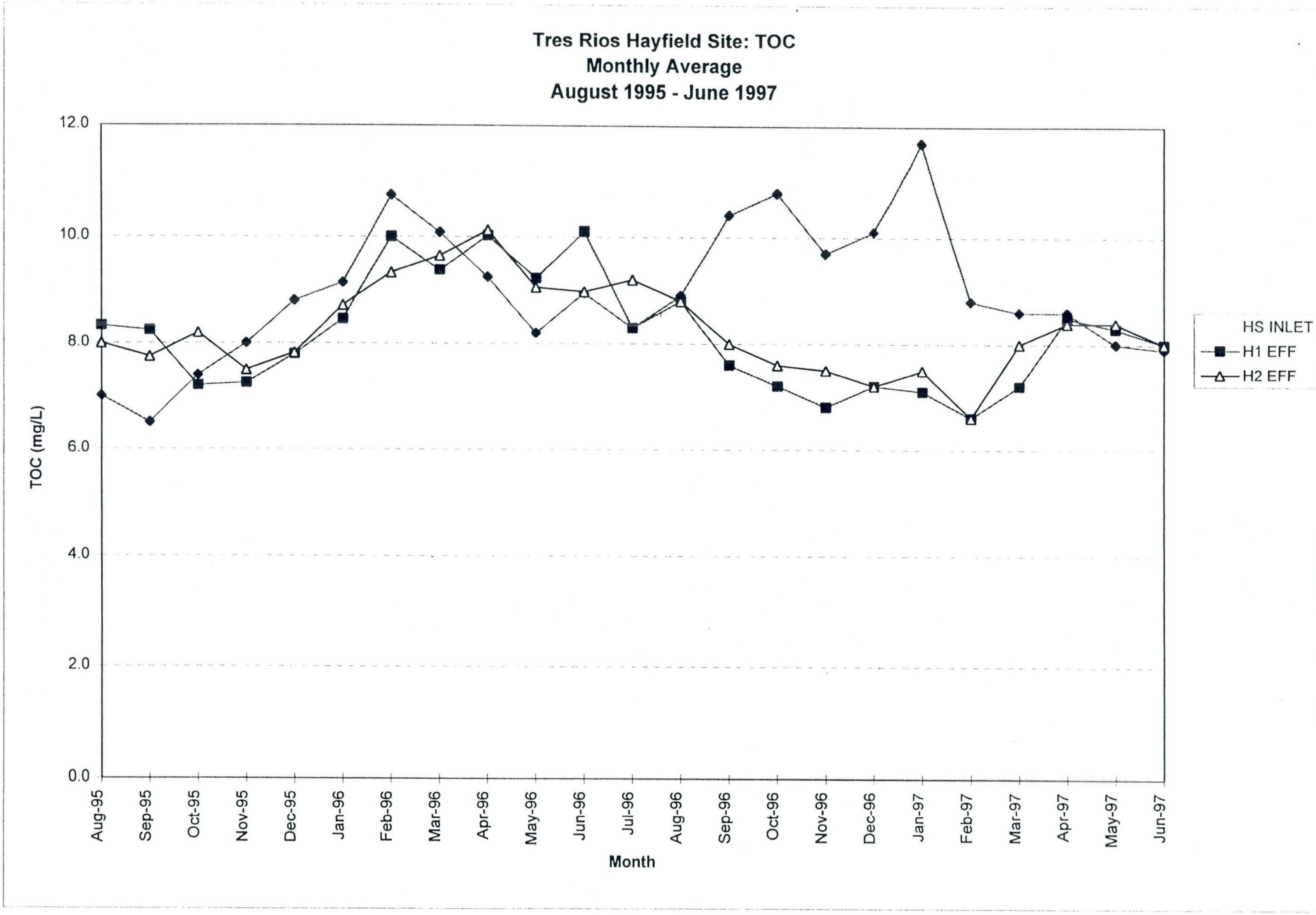
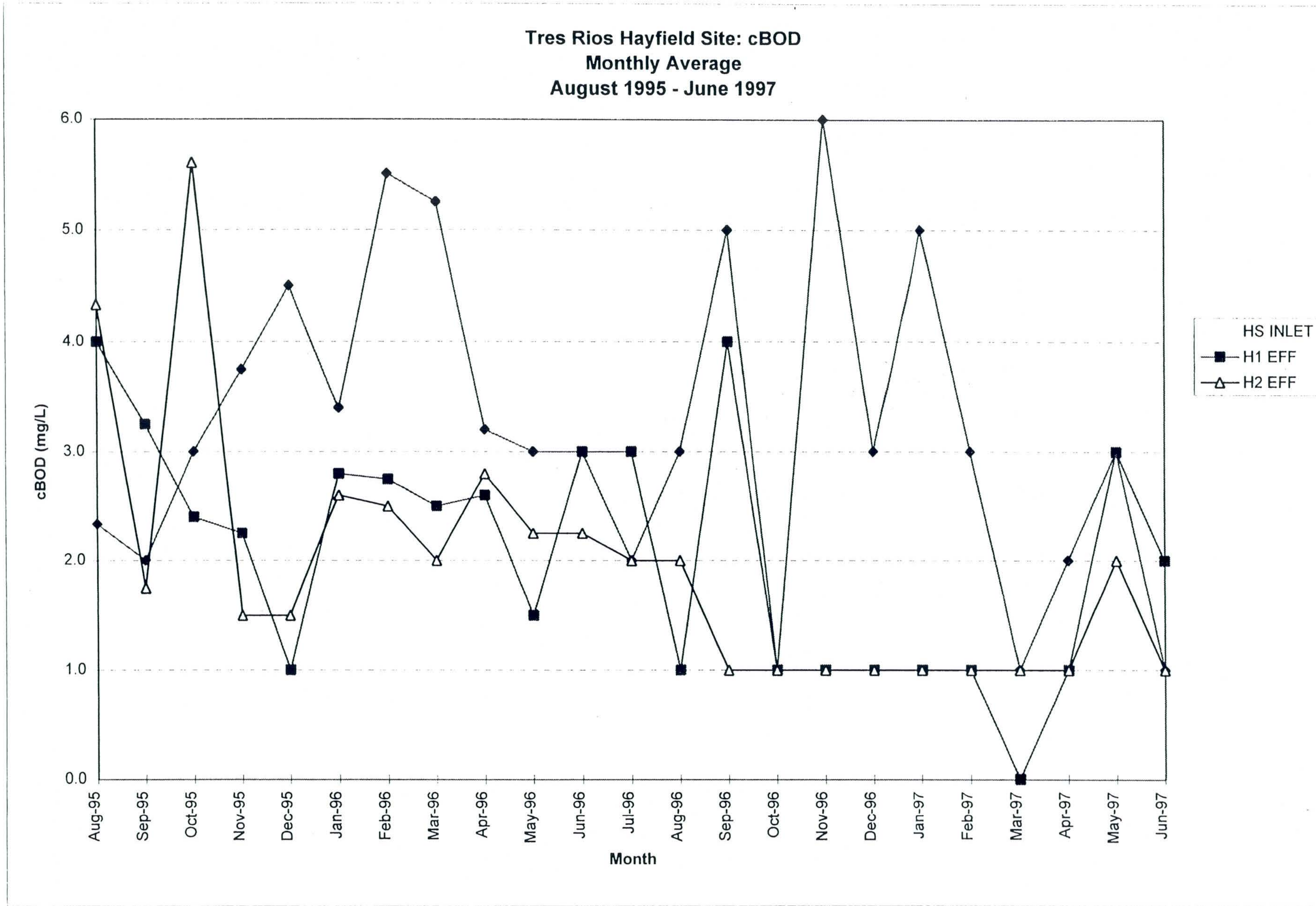
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

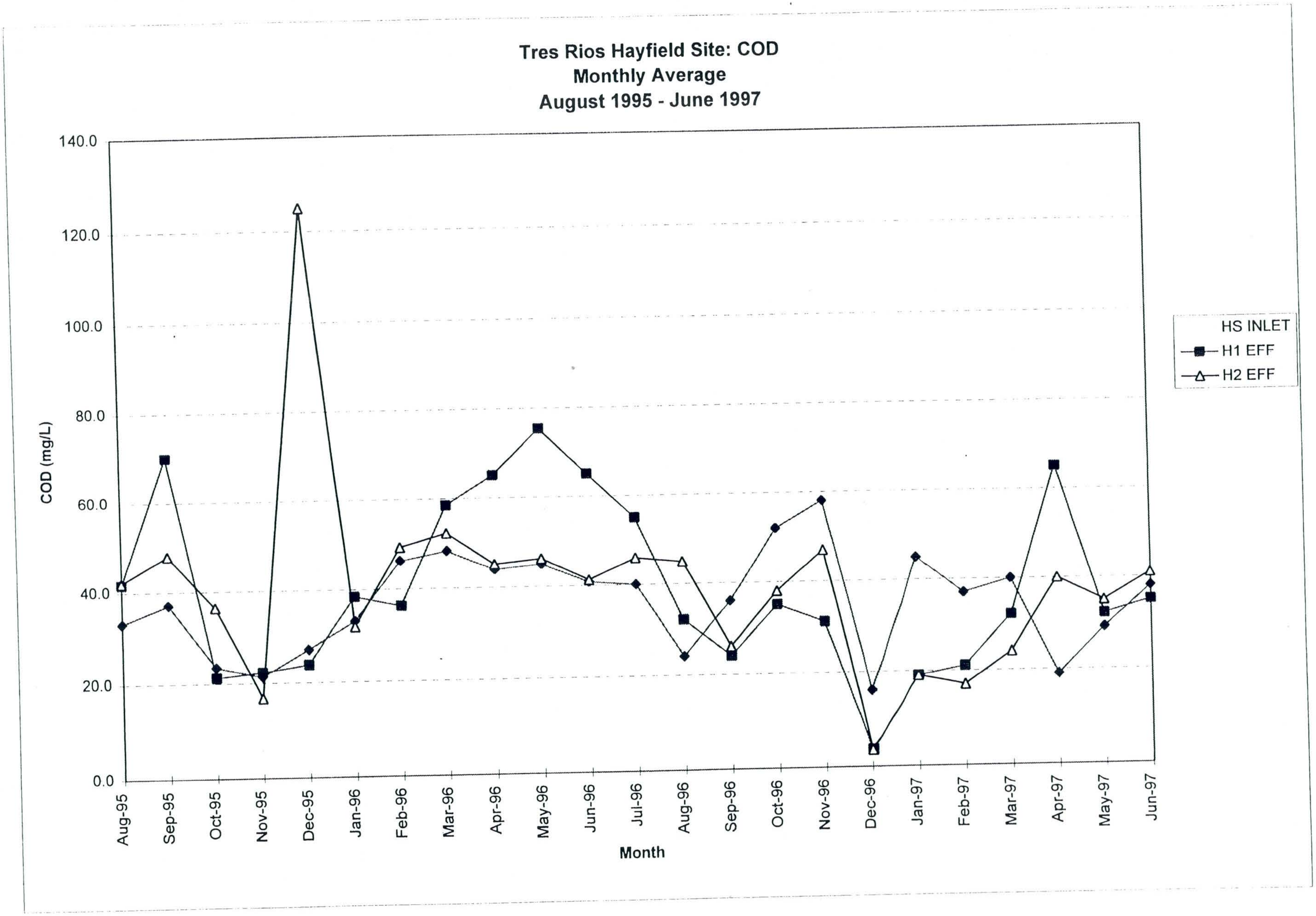


Tres Rios Hayfield Site: Total N
Monthly Average
August 1995 - June 1997
Total N (mg/L)
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

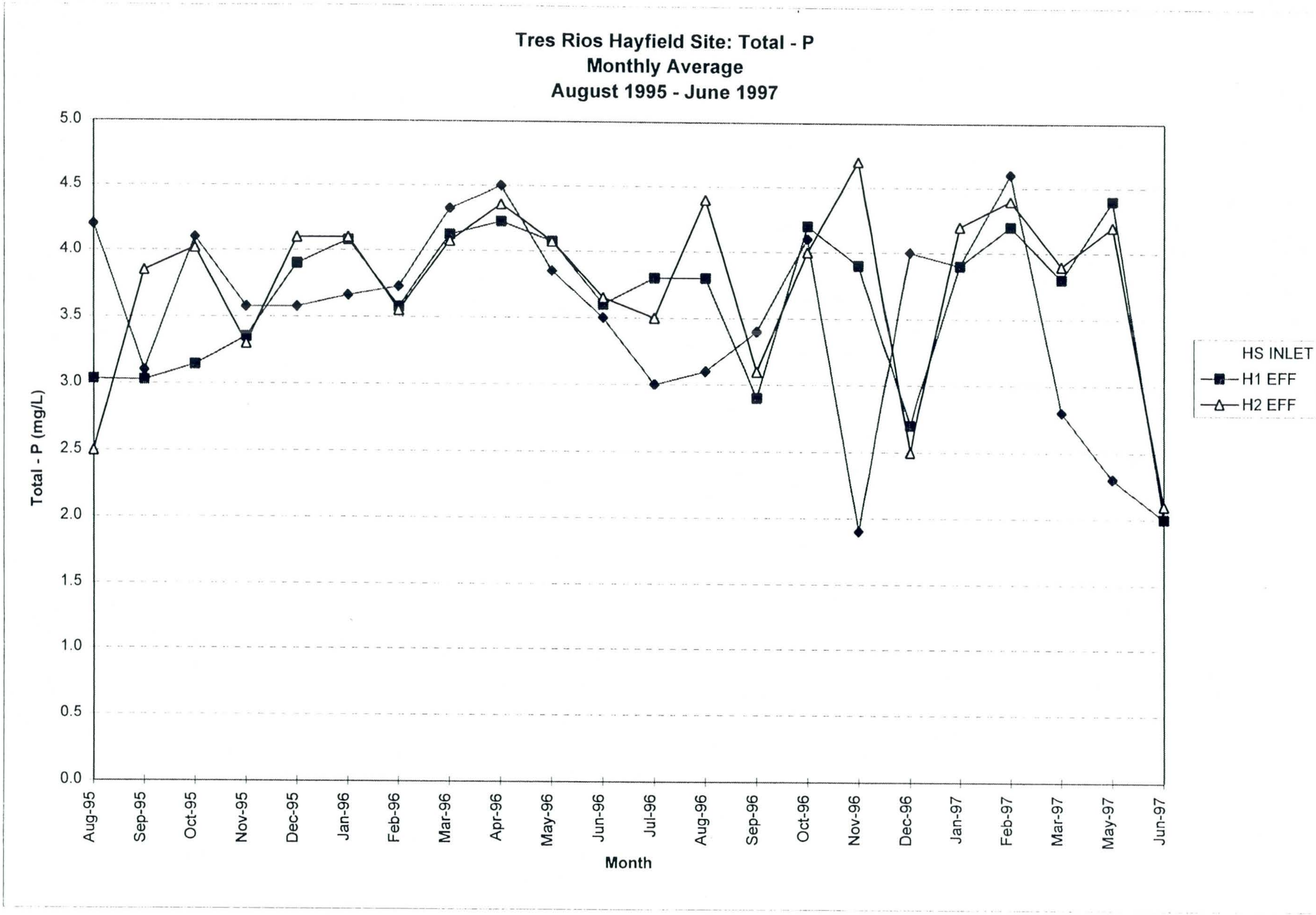


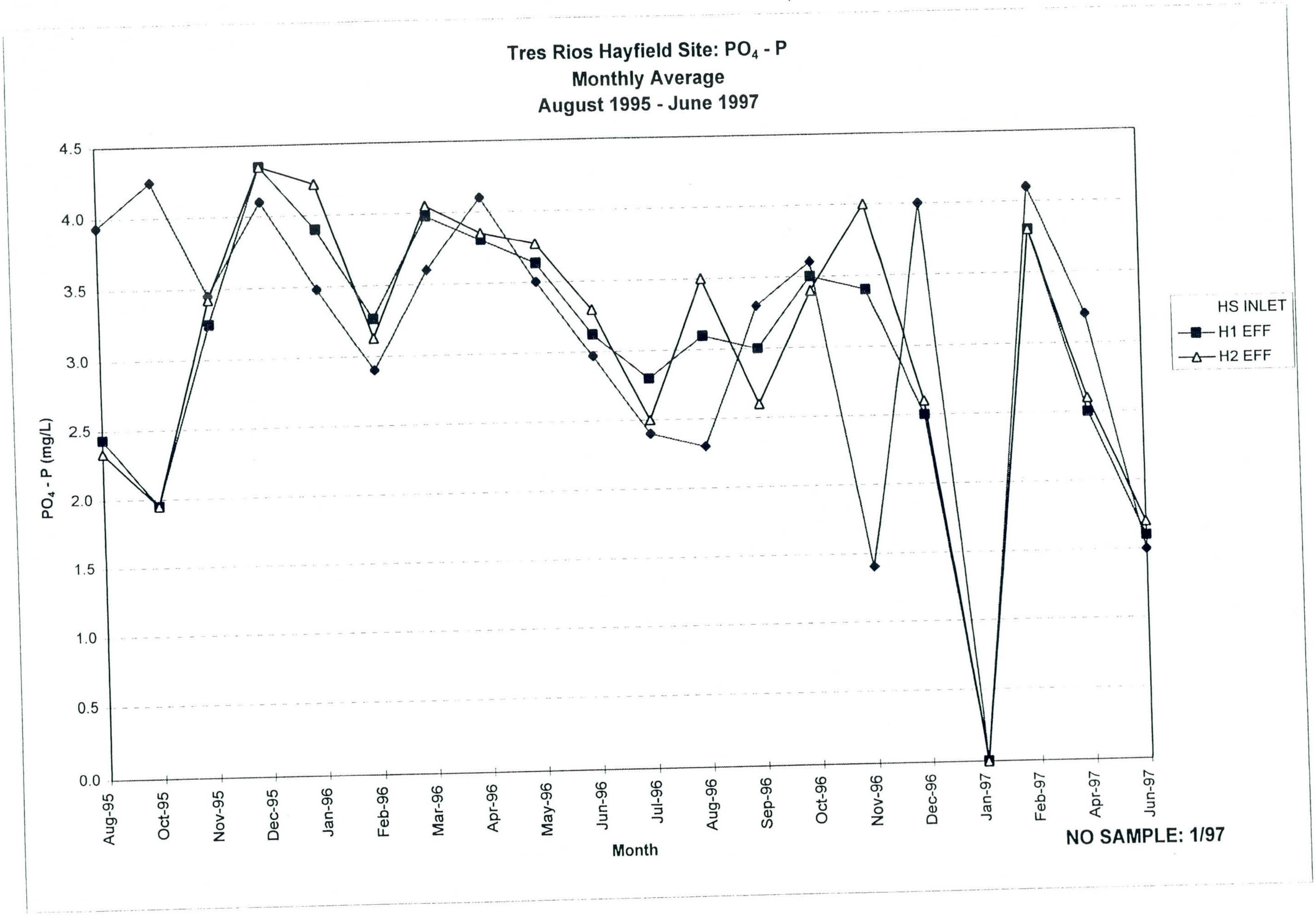
Tres Rios Demonstration Constructed Wetland Project


Tres Rios Hayfield Site: cBOD
Monthly Average
August 1995 - June 1997
cBOD (mg/L)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

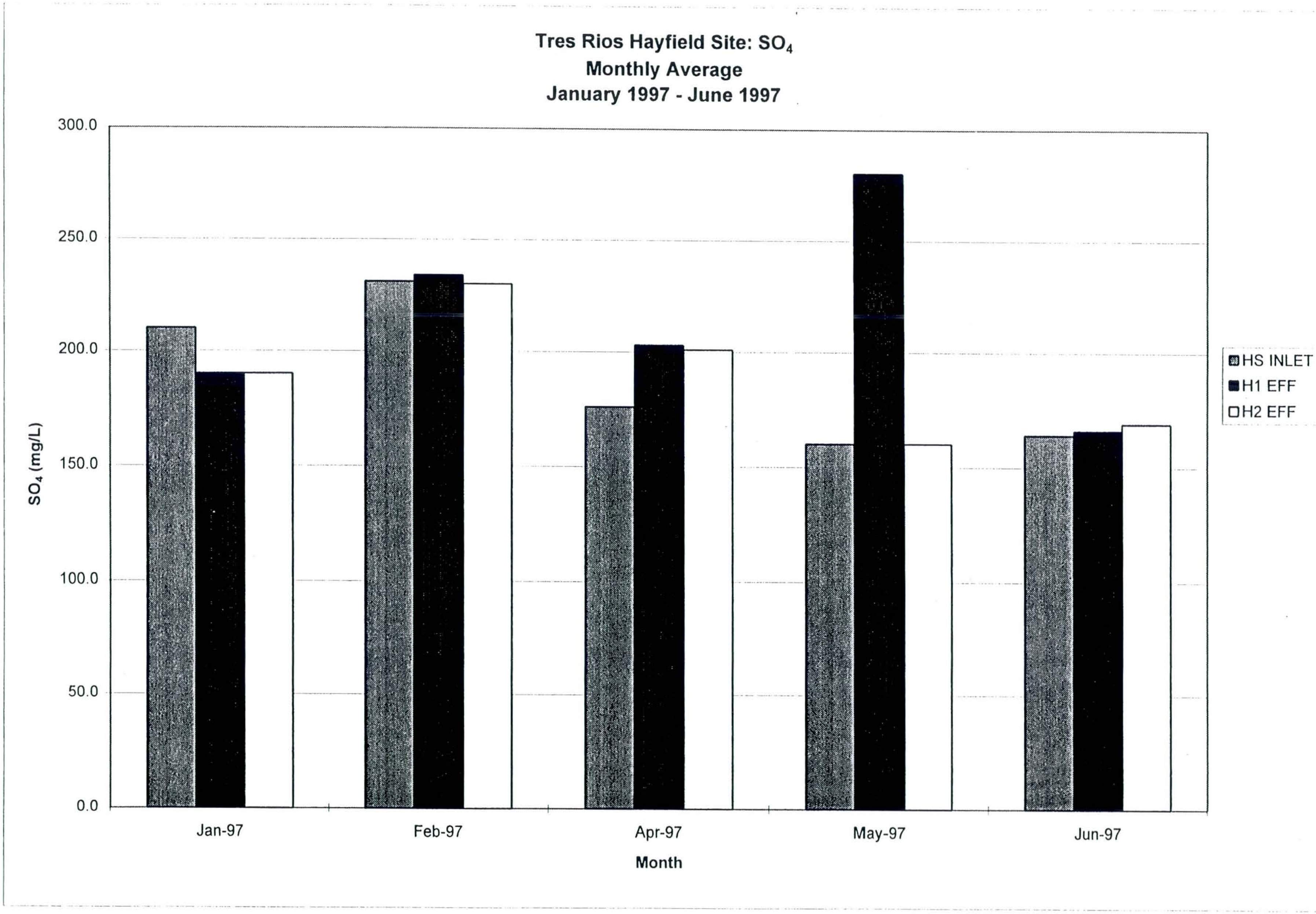


Tres Rios Hayfield Site: COD
Monthly Average
August 1995 - June 1997
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
COD (mg/L)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

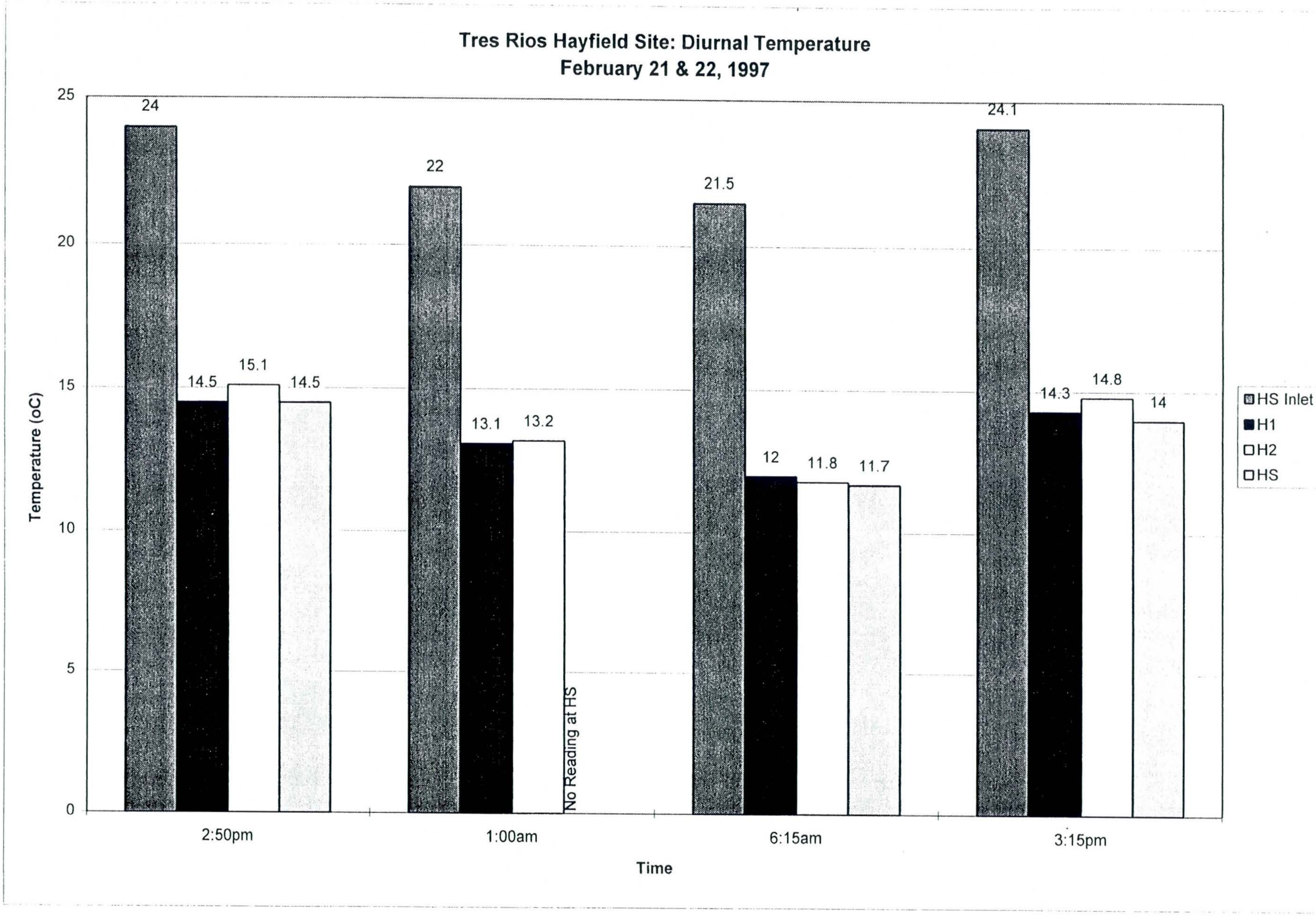

Tres Rios Hayfield Site: Total - P
Monthly Average
August 1995 - June 1997
Total - P (mg/L)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

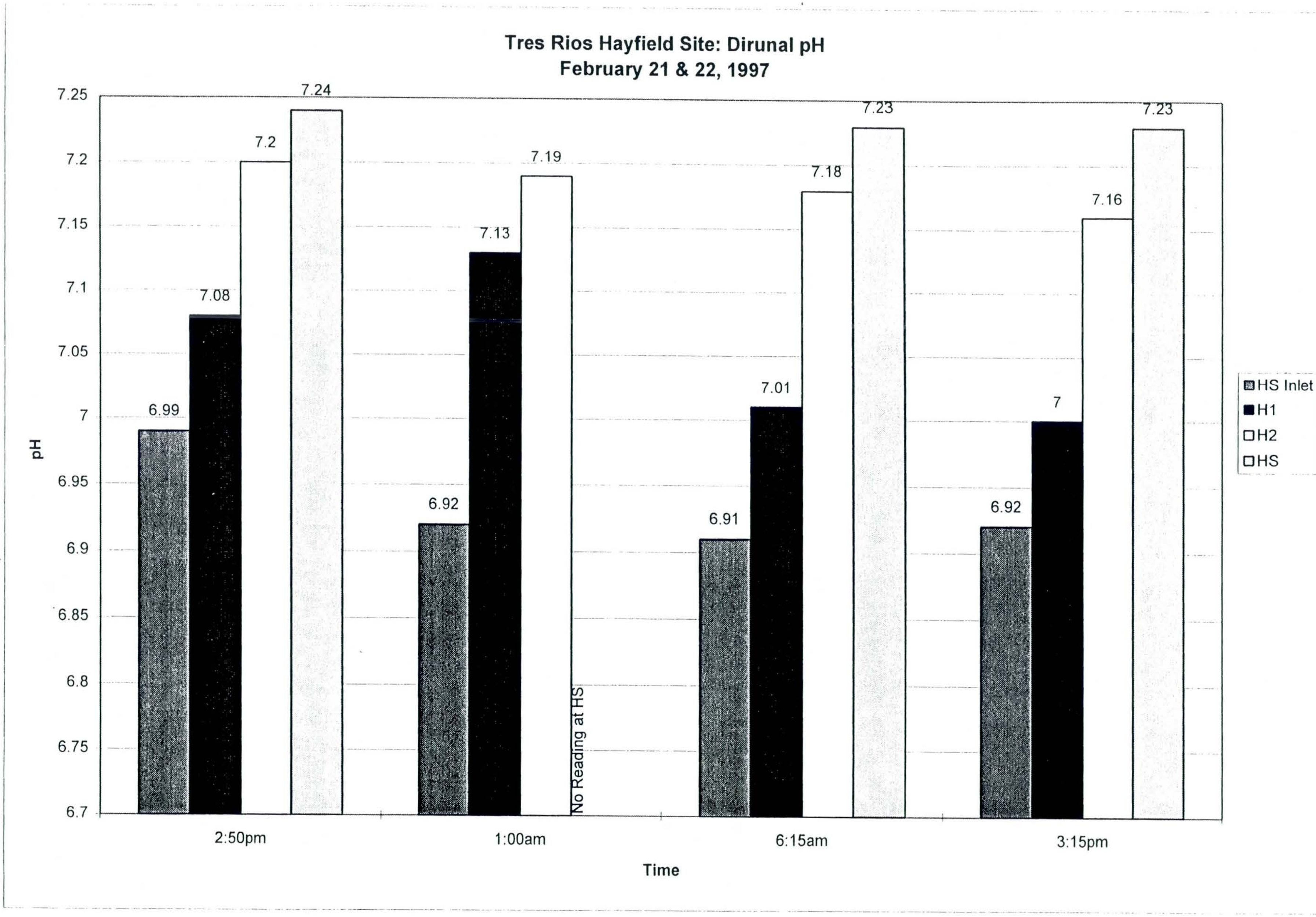


Tres Rios Demonstration Constructed Wetland Project

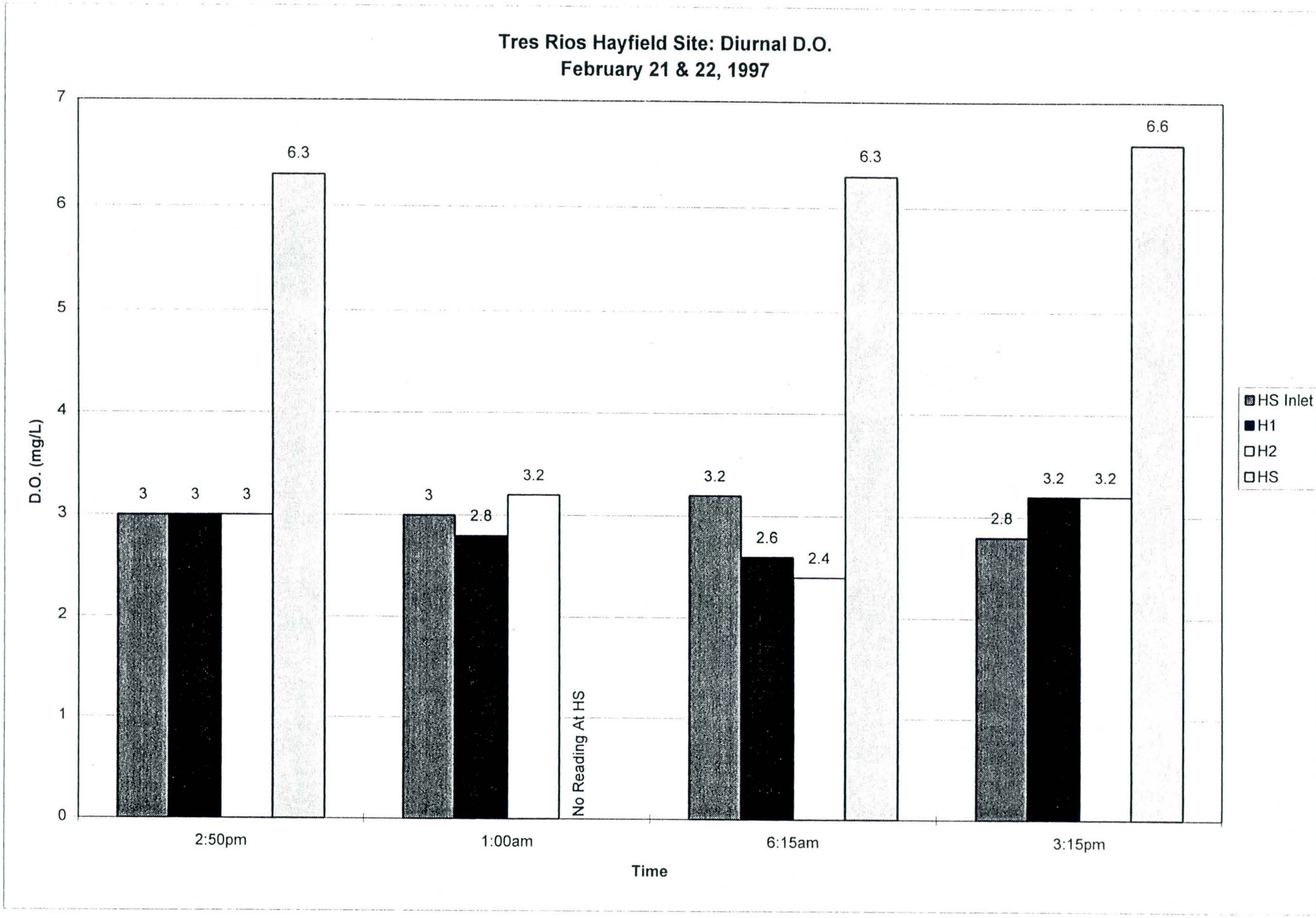


Tres Rios Hayfield Site: SO4
Monthly Average
January 1997 - June 1997
300.0
250.0
200.0
150.0
100.0
50.0
0.0
SO4 (mg/L)
Jan-97
Feb-97
Apr-97
May-97
Jun-97
Month
HS INLET
H1 EFF
H2 EFF

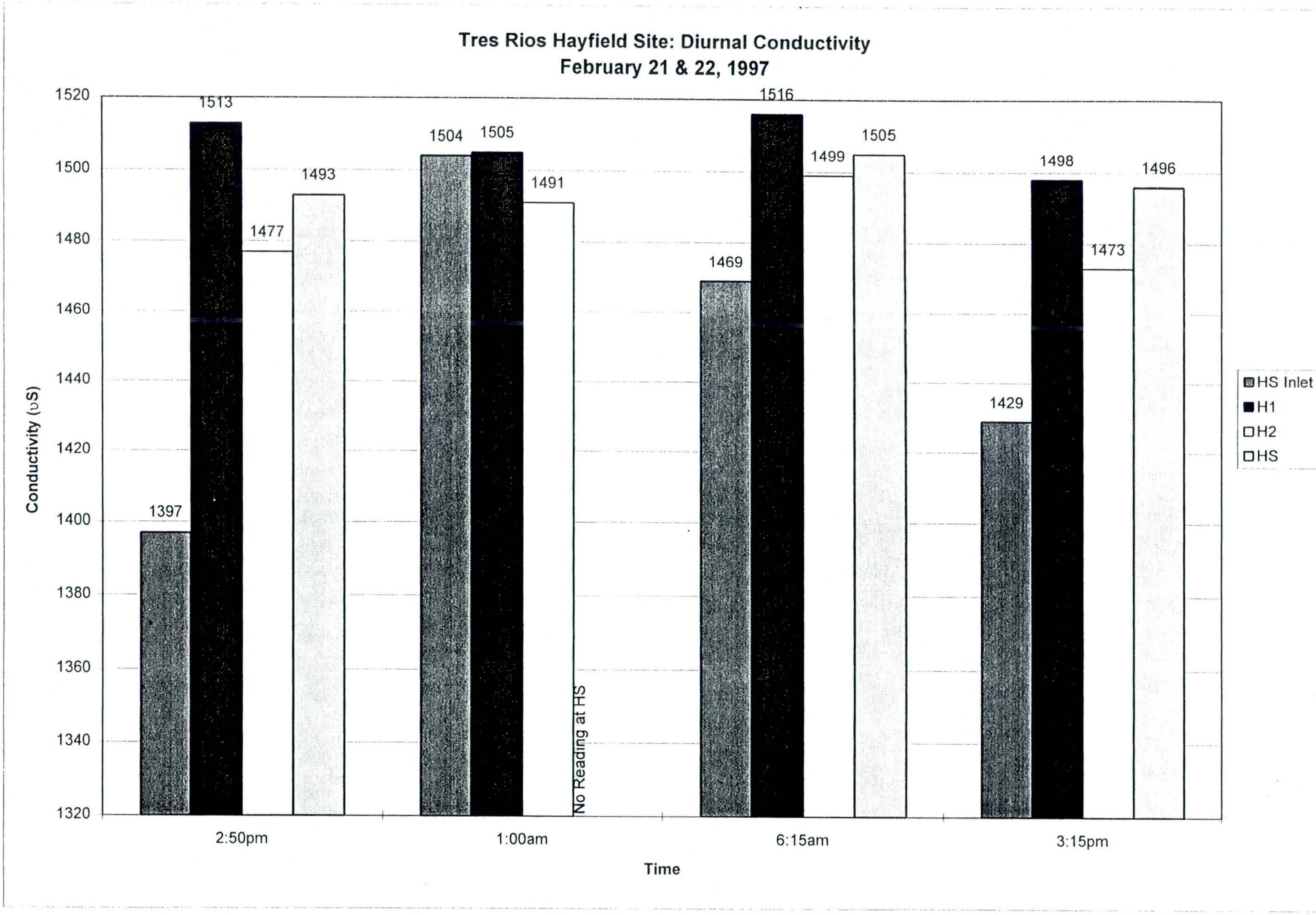

Tres Rios Hayfield Site: Diurnal Temperature
February 21 & 22, 1997
Temperature (oC)
25
20
15
10
5
0
24
14.5
15.1
14.5
22
13.1
13.2
No Reading at HS
21.5
12
11.8
11.7
24.1
14.3
14.8
14
2:50pm
1:00am
6:15am
3:15pm
Time
HS Inlet
H1
H2
HS



Tres Rios Hayfield Site: Dirunal pH
February 21 & 22, 1997
pH
Time
2:50pm
1:00am
6:15am
3:15pm
6.99
7.08
7.2
7.24
6.92
7.13
7.19
No Reading at HS
6.91
7.01
7.18
7.23
6.92
7
7.16
7.23
HS Inlet
H1
H2
HS
7.25
7.2
7.15
7.1
7.05
7
6.95
6.9
6.85
6.8
6.75
6.7



Tres Rios Hayfield Site: Diurnal D.O.
February 21 & 22, 1997
D.O. (mg/L)
0
1
2
3
4
5
6
7
3
3
3
6.3
3
2.8
3.2
No Reading At HS
3.2
2.6
2.4
6.3
2.8
3.2
3.2
6.6
2:50pm
1:00am
6:15am
3:15pm
Time
HS Inlet
H1
H2
HS



Tres Rios Hayfield Site: Diurnal Conductivity
February 21 & 22, 1997
Conductivity (υS)
1520
1500
1480
1460
1440
1420
1400
1380
1360
1340
1320
1397
1513
1477
1493
1504
1505
1491
No Reading at HS
1469
1516
1499
1505
1429
1498
1473
1496
2:50pm
1:00am
6:15am
3:15pm
Time
HS Inlet
H1
H2
HS

APPENDIX F - Hayfield & Cobble Site Bacteria

Tres Rios Demonstration Project
Bacteria Data

CS INLET

Date	Total Colif./100 mL (TC)	E. Coli /100 mL (EC)
Aug-95	5	1
Sep-95	2	1
Oct-95	1	0
Nov-95	76	20
Dec-95	101	1
Jan-96	5	0
Feb-96	7	0
Mar-96	3	0
Apr-96	17	0
May-96	13	0
Jun-96	17	0
Jul-96	0	0
Aug-96	0	1
Sep-96	200	31
Oct-96	24	1
Nov-96	3	0
Dec-96	0	0
Jan-97	22	3
Feb-97	0	0
Mar-97	4	0
Apr-97	6	0
May-97	145	0
Jun-97	14	0
Jul-97	24	0
Aug-97	201	3
Average	**36**	**2**
Maximum	**201**	**31**
Minimum	**0**	**0**

C1 EFF

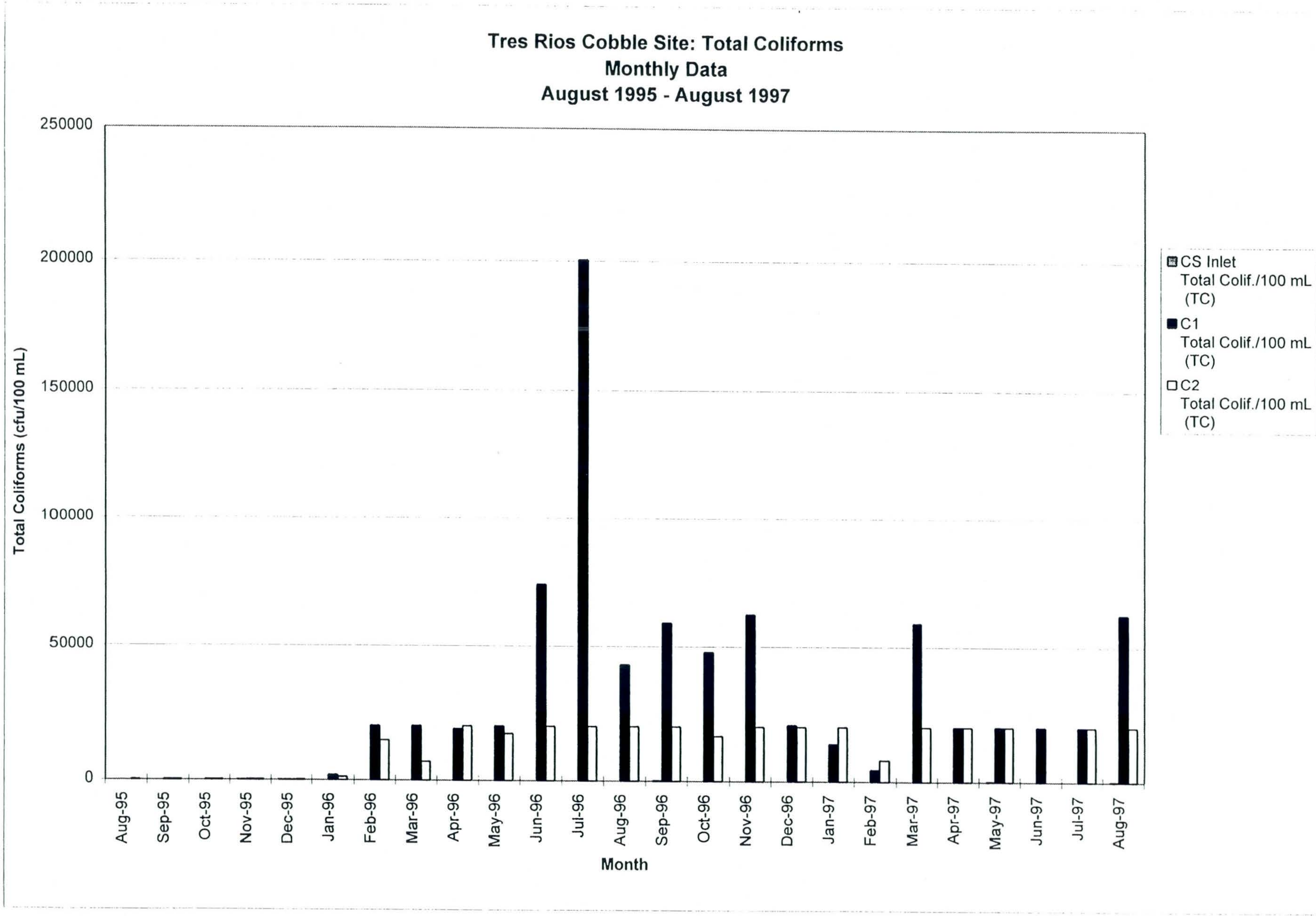
Date	Total Colif./100 mL (TC)	E. Coli /100 mL (EC)
Aug-95	NA	NA
Sep-95	152	29
Oct-95	189	57
Nov-95	200	14
Dec-95	135	3
Jan-96	1828	508
Feb-96	20050	5127
Mar-96	20050	6828
Apr-96	18930	3978
May-96	20050	565
Jun-96	74125	1250
Jul-96	200500	15000
Aug-96	42900	2000
Sep-96	59100	1000
Oct-96	47800	30600
Nov-96	62400	22200
Dec-96	20700	7500
Jan-97	13700	5300
Feb-97	4200	1000
Mar-97	59100	3100
Apr-97	20050	640
May-97	20050	200
Jun-97	20050	1780
Jul-97	20000	20000
Aug-97	62400	1000
	33694	**5403**
	200500	**30600**
	135	**3**

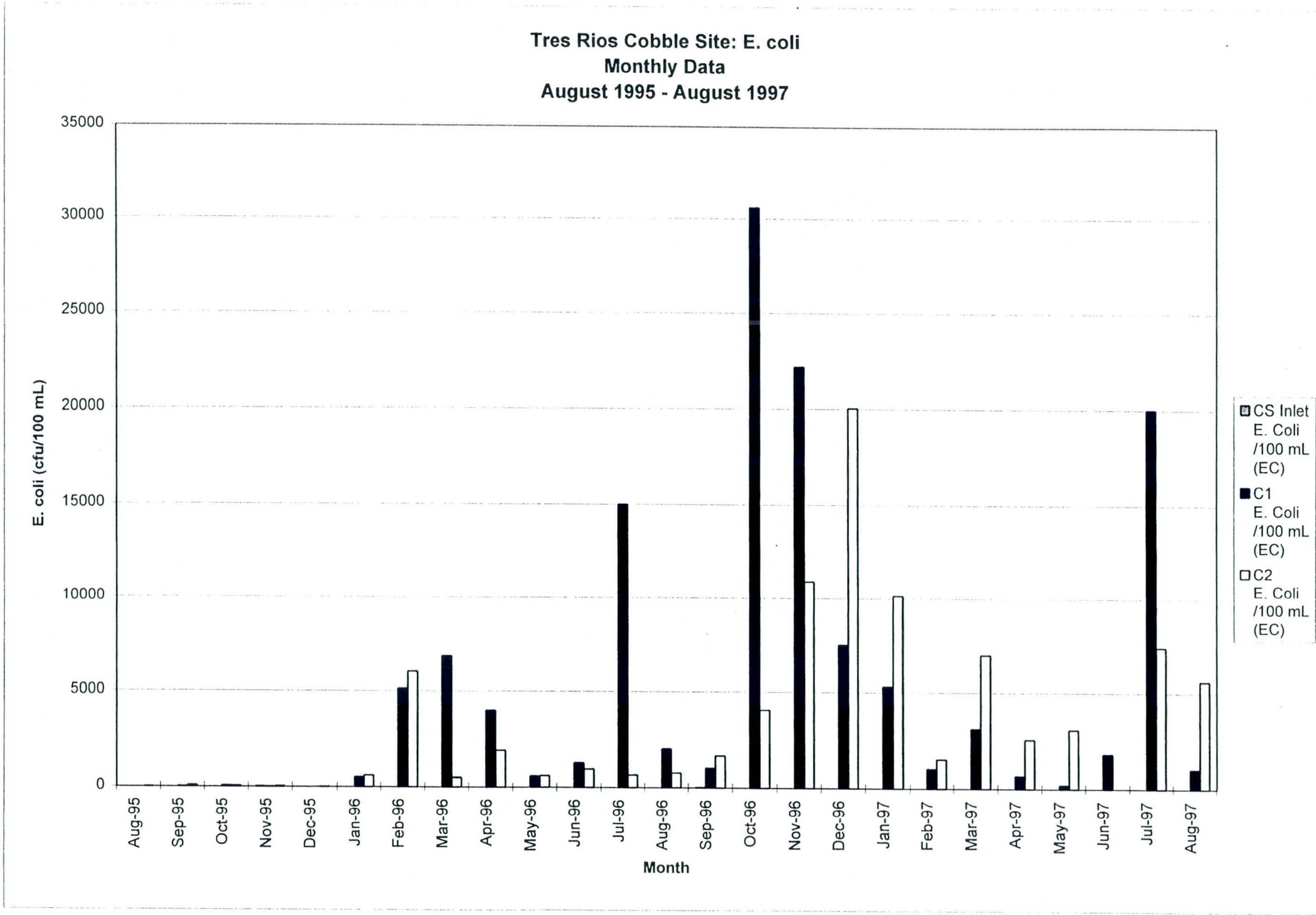
C2 EFF

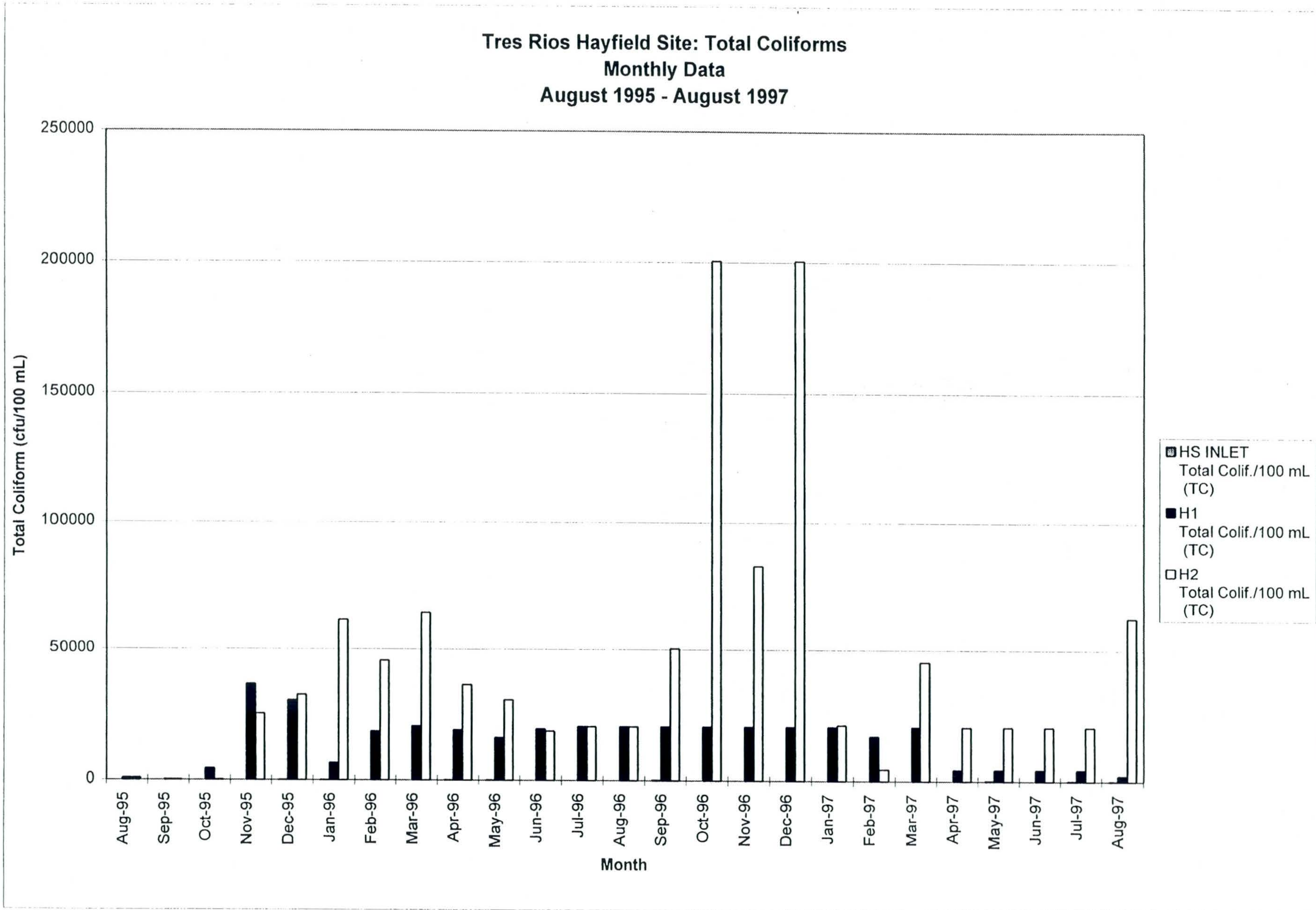
Date	Total Colif./100 mL (TC)	E. Coli /100 mL (EC)
Aug-95	200	9
Sep-95	200	84
Oct-95	200	45
Nov-95	200	36
Dec-95	200	18
Jan-96	1201	596
Feb-96	14647	6020
Mar-96	6840	485
Apr-96	20050	1896
May-96	17250	593
Jun-96	20050	938
Jul-96	20050	640
Aug-96	20050	750
Sep-96	20050	1640
Oct-96	16520	4060
Nov-96	20050	10910
Dec-96	20050	20050
Jan-97	20050	10130
Feb-97	7820	1500
Mar-97	20050	6970
Apr-97	20050	2540
May-97	20050	3060
Jun-97	AMPLE BASI	0
Jul-97	20000	7380
Aug-97	20050	5600
	13578	**3438**
	20050	**20050**
	200	**0**

Tres Rios Demonstration Project
Bacteria Data

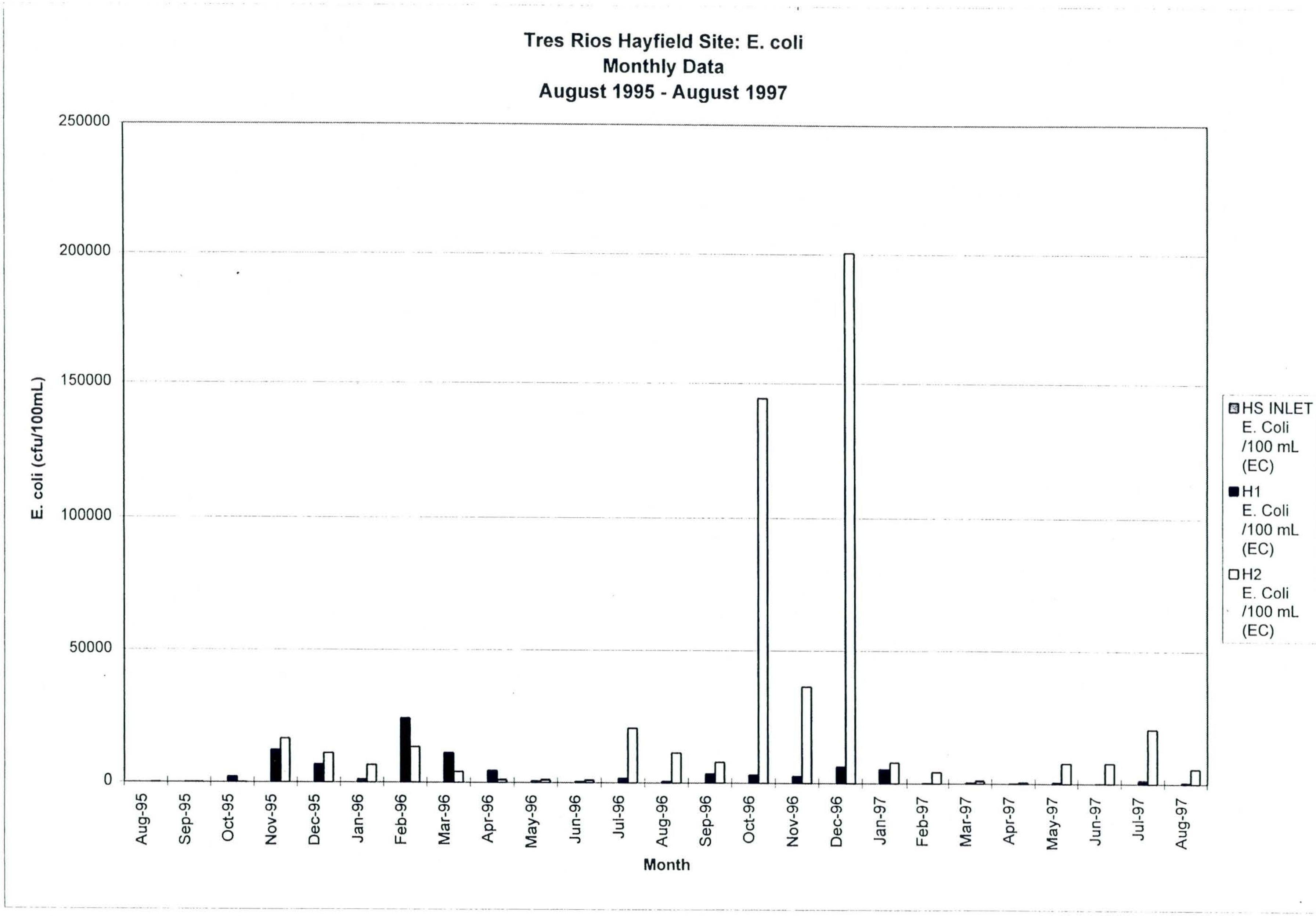
HS INLET			H1 EFF			H2 EFF		
Date	Total Colif./100 mL (TC)	E. Coli /100 mL (EC)	Date	Total Colif./100 mL (TC)	E. Coli /100 mL (EC)	Date	Total Colif./100 mL (TC)	E. Coli /100 mL (EC)
Aug-95	1	1	Aug-95	800	37	Aug-95	800	74
Sep-95	0	0	Sep-95	200	99	Sep-95	200	67
Oct-95	2	0	Oct-95	4160	1880	Oct-95	200	82
Nov-95	24	2	Nov-95	36500	11800	Nov-95	24875	16025
Dec-95	90	0	Dec-95	30200	6500	Dec-95	32300	10633
Jan-96	75	0	Jan-96	6316	1024	Jan-96	61500	6300
Feb-96	23	0	Feb-96	18183	23787	Feb-96	45583	13027
Mar-96	14	0	Mar-96	20050	10737	Mar-96	64267	3833
Apr-96	62	0	Apr-96	18636	4192	Apr-96	36280	1000
May-96	106	0	May-96	15803	663	May-96	30475	1000
Jun-96	4	0	Jun-96	19168	443	Jun-96	18283	860
Jul-96	0	0	Jul-96	20050	1500	Jul-96	20050	20050
Aug-96	0	0	Aug-96	20050	640	Aug-96	20050	10910
Sep-96	200	16	Sep-96	20050	3240	Sep-96	50400	7500
Oct-96	6	0	Oct-96	20050	2880	Oct-96	200500	144500
Nov-96	1	0	Nov-96	20050	2380	Nov-96	83100	36400
Dec-96	1	0	Dec-96	20050	5910	Dec-96	200500	200500
Jan-97	5	0	Jan-97	20050	5040	Jan-97	20700	7500
Feb-97	27	1	Feb-97	16520	200	Feb-97	4200	4000
Mar-97	19	0	Mar-97	20050	420	Mar-97	45300	1000
Apr-97	31	0	Apr-97	4010	128	Apr-97	20050	530
May-97	201	0	May-97	4010	542	May-97	20050	7380
Jun-97	14	0	Jun-97	4010	128	Jun-97	20050	7380
Jul-97	200	15	Jul-97	4010	1060	Jul-97	20000	20000
Aug-97	109	14	Aug-97	2005	576	Aug-97	62400	5300
Average	**49**	**2**		**14599**	**3432**		**44085**	**21034**
Maximum	**201**	**16**		**36500**	**23787**		**200500**	**200500**
Minimum	**0**	**0**		**200**	**37**		**200**	**67**


Tres Rios Cobble Site: Total Coliforms
Monthly Data
August 1995 - August 1997
Total Coliforms (cfu/100 mL)
250000
200000
150000
100000
50000
0
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
Month
CS Inlet Total Colif./100 mL (TC)
C1 Total Colif./100 mL (TC)
C2 Total Colif./100 mL (TC)


Tres Rios Cobble Site: E. coli
Monthly Data
August 1995 - August 1997
35000
30000
25000
20000
15000
10000
5000
0
E. coli (cfu/100 mL)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
Month
CS Inlet E. Coli /100 mL (EC)
C1 E. Coli /100 mL (EC)
C2 E. Coli /100 mL (EC)



Tres Rios demonstration Constructed Wetland Project



Tres Rios Hayfield Site: E. coli
Monthly Data
August 1995 - August 1997
250000
200000
150000
100000
50000
0
E. coli (cfu/100mL)
Aug-95
Sep-95
Oct-95
Nov-95
Dec-95
Jan-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Aug-97
Month
HS INLET E. Coli /100 mL (EC)
H1 E. Coli /100 mL (EC)
H2 E. Coli /100 mL (EC)

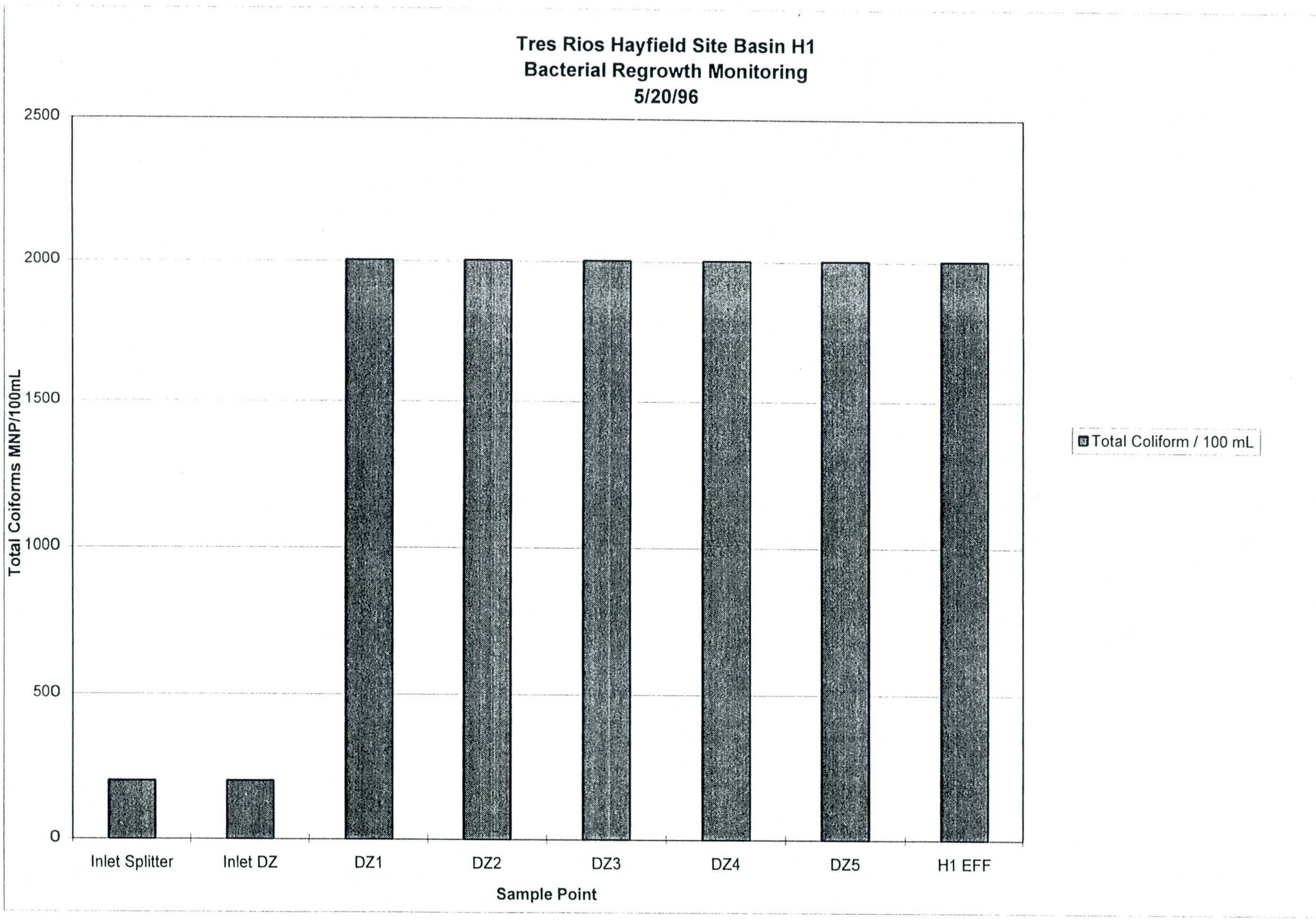
Tres Rios Demonstration Constructed Wetland Project
Bacterial Regrowth Monitoring in Hayfield Basin H1

Chlorine Readings (mg/L)

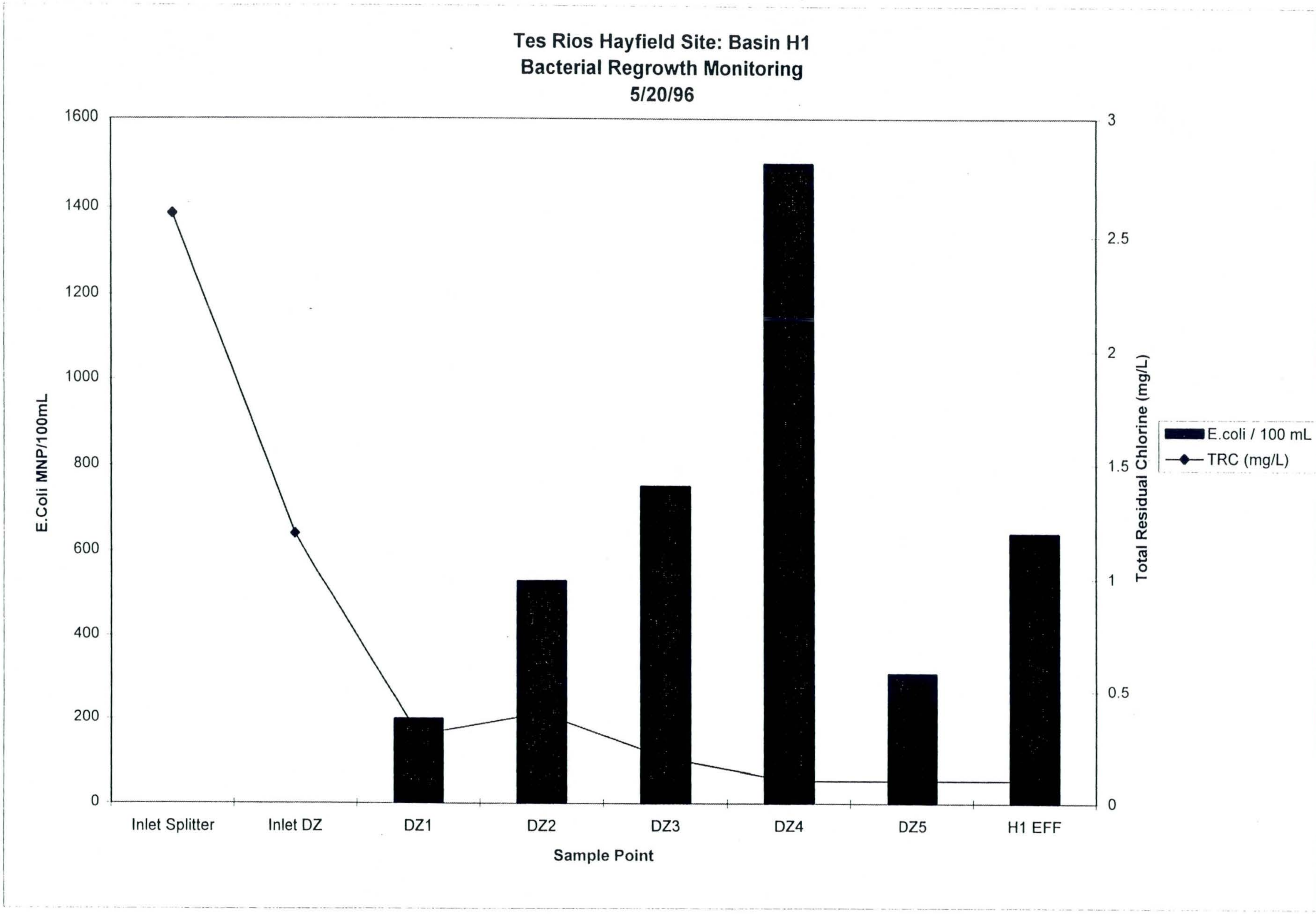
Inlet Splitter	2.6
Inlet DZ	1.2
DZ1	0.3
DZ2	0.4
DZ3	0.2
DZ4	0.1
DZ5	0.1
H1 EFF	0.1

		Total Coliforms per 100mL		**E. Coli per 100mL**		
Sample Point	% Distance	1/10	1/100	1/10	1/100	RC (mg/L)
Inlet Splitter	Inlet Splitter	200	0	0	0	2.6
Inlet DZ	0%	200	0	0	0	1.2
DZ1	17%	2005	20050	10	200	0.3
DZ2	33%	2005	20050	222	530	0.4
DZ3	50%	2005	20050	254	750	0.2
DZ4	67%	2005	20050	831	1500	0.1
DZ5	83%	2005	20050	254	310	0.1
H1 EFF	100%	2005	14450	306	640	0.1

NOTES:
Readings with a ">" are used at their given numerical value



Tres Rios Hayfield Site Basin H1
Bacterial Regrowth Monitoring
5/20/96
Total Coiforms MNP/100mL
2500
2000
1500
1000
500
0
Inlet Splitter
Inlet DZ
DZ1
DZ2
DZ3
DZ4
DZ5
H1 EFF
Sample Point
Total Coliform / 100 mL



Tes Rios Hayfield Site: Basin H1
Bacterial Regrowth Monitoring
5/20/96
E.Coli MNP/100mL
1600
1400
1200
1000
800
600
400
200
0
Total Residual Chlorine (mg/L)
3
2.5
2
1.5
1
0.5
0
E.coli / 100 mL
TRC (mg/L)
Inlet Splitter
Inlet DZ
DZ1
DZ2
DZ3
DZ4
DZ5
H1 EFF
Sample Point

APPENDIX G - Hayfield & Cobble Site Heavy Metals

Tres Rios Demonstration Wetlands
Hayfield Site Heavy Metal Monitoring
Raw Data

NA = Not analyzed for.

Sample Point	Date	Lab ID	Ag EPA 272.2 (ug/L)	Se EPA 270.2 (ug/L)	B EPA 200.7 (ug/L)	Zn EPA 200.7 (ug/L	Pb EPA 239.2 (ug/L)	Ni EPA 249.2 (ug/L)	Cu EPA 220.2 (ug/L)	Cr EPA 218.2 (ug/L)	Cd EPA 213.2 (ug/L)	As EPA 206.2 (ug/L)	Hg EPA 245.1 (ug/L)
HS Inlet	10/31/95	50026787	< 0.8	< 3.0	390	20	< 0.5	9	2.7	2.9	< 0.03	4	< 0.20
HS Inlet	12/20/95	50031175	NA	< 3.0	NA	20	NA	NA	2.7	NA	NA	NA	< 0.20
HS Inlet	1/30/96	60002911	NA	< 1.0	NA	< 10.0	NA	NA	2	NA	NA	NA	< 0.20
HS Inlet	2/27/96	60005656	NA	< 1.0	NA	20	NA	NA	7.5	NA	NA	NA	< 0.20
HS Inlet	3/27/96	60008813	NA	NA	NA	< 10.0	NA	10	9.7	1.3	NA	NA	< 0.20
HS Inlet	4/30/96	60012439	NA	NA	NA	20	NA	5	2	1.3	NA	NA	< 0.20
HS Inlet	5/29/96	60015054	< 0.2	1	370	< 10	< 10	33	1	2	2	3	< 0.20
HS Inlet	7/30/96	60020480	NA	NA	NA	20	NA	8	1	1	NA	NA	< 0.20
HS Inlet	8/27/96	60023246	NA	NA	NA	20	NA	5	1	< 1	NA	NA	< 0.20
HS Inlet	10/29/96	60028964	NA	NA	NA	30	NA	4	2	2	NA	NA	< 0.20
HS Inlet	11/26/96	60032168	NA	NA	NA	20	NA	4	7	3	NA	NA	< 0.20
HS Inlet	12/19/96	60033992	NA	NA	NA	20	NA	4	2	1	NA	NA	< 0.20
HS Inlet	1/28/97	70002023	NA	NA	NA	60	NA	6	1	3	NA	NA	< 0.20
HS Inlet	2/25/97	70004359	NA	< 1	NA	40	1	8	2	1	NA	NA	< 0.20
HS Inlet	3/25/97	70006721	NA	< 1	NA	50	< 2	7	2	< 4	NA	NA	< 0.20
HS Inlet	5/27/97	70011759	NA	< 1	NA	30	< 1	4	1	< 1	NA	NA	< 0.20
HS Inlet	7/8/97	70015693	NA	1	NA	40	< 1	7	2	0.7	< 0.1	NA	< 0.20
HS Inlet Duplicate	5/29/96	60015058	< 0.2	< 1	370	< 10	< 10	8	1	1	< 0.1	4	< 0.20
H1 EFF	10/31/95	50026788	< 0.8	< 3.0	360	< 10.0	< 0.5	7	1	< 2.0	< 0.03	4	< 0.20
H1 EFF	12/20/95	50031176	NA	< 3.0	NA	20	NA	NA	1.6	NA	NA	NA	< 0.20
H1 EFF	1/30/96	60002912	NA	< 1.0	NA	< 10.0	NA	NA	1.5	NA	NA	NA	< 0.20
H1 EFF	2/27/96	60005657	NA	< 1.0	NA	< 10	NA	NA	1.5	NA	NA	NA	< 0.20
H1 EFF	3/27/96	60008814	NA	NA	NA	< 10.0	NA	8	1.9	1	NA	NA	< 0.20
H1 EFF	4/30/96	60012440	NA	NA	NA	< 10	NA	6	1	< 1	NA	NA	< 0.20
H1 EFF	5/29/96	60015055	< 0.2	< 1	340	< 10	< 1	8	1	2	< 0.1	3	< 0.20
H1 EFF	7/30/96	60020481	NA	NA	NA	40	NA	7	< 1	< 1	NA	NA	< 0.20
H1 EFF	8/27/96	60023247	NA	NA	NA	20	NA	5	< 1	< 1	NA	NA	< 0.20
H1 EFF	10/29/96	60028965	NA	NA	NA	20	NA	6	1	1	NA	NA	< 0.20
H1 EFF	11/26/96	60032169	NA	NA	NA	30	NA	6	6	1	NA	NA	< 0.20
H1 EFF	12/19/96	60033993	NA	NA	NA	20	NA	4	2	1	NA	NA	< 0.20
H1 EFF	1/28/97	70002024	NA	NA	NA	40	NA	6	< 1	1	NA	NA	< 0.20
H1 EFF	2/25/97	70004360	NA	1	NA	40	< 1	8	1	2	NA	NA	< 0.20
H1 EFF	3/25/97	70006722	NA	< 1	NA	< 30	< 2	7	1	< 4	NA	NA	< 0.20
H1 EFF	5/27/97	70011760	NA	< 1	NA	20	< 1	7	1	< 1	NA	NA	< 0.20
H1 EFF	7/12/97	70015694	NA	< 1	NA	30	< 1	6	1	< 0.5	< 0.2	NA	< 0.20
H1 EFF Dup.	12/20/95	50031182	NA	< 3.0	NA	20	NA	NA	2.3	NA	NA	NA	0.2
H1 EFF Dup.	7/30/96	60020484	NA	NA	NA	< 10	NA	6	< 1	< 1	NA	NA	< 0.20
H1 EFF Dup.	1/28/97	70002030	NA	NA	NA	140	NA	6	< 1	1	NA	NA	< 0.20
H2 EFF	10/31/95	50026789	< 0.8	< 3.0	410	< 10.0	< 0.5	3	0.5	< 2.0	< 0.03	4	< 0.20
H2 EFF	12/20/95	50031177	NA	< 3.0	NA	20	NA	NA	1.6	NA	NA	NA	< 0.20
H2 EFF	1/30/96	60002913	NA	< 1.0	NA	20	NA	NA	1.6	NA	NA	NA	< 0.20
H2 EFF	2/27/96	60005658	NA	< 1.0	NA	< 10	NA	NA	1.1	NA	NA	NA	< 0.20
H2 EFF	3/27/96	60008815	NA	NA	NA	< 10	NA	9	3.2	1.4	NA	NA	< 0.20
H2 EFF	4/30/96	60012441	NA	NA	NA	< 10	NA	6	< 1	< 1	NA	NA	< 0.20
H2 EFF	5/29/96	60015056	< 0.2	< 1	320	10	< 1	7	< 1	1	< 0.1	3	< 0.20
H2 EFF	7/30/96	60020482	NA	NA	NA	< 10	NA	7	< 1	2	NA	NA	< 0.20
H2 EFF	8/27/96	60023248	NA	NA	NA	< 10	NA	6	1	1	NA	NA	< 0.20
H2 EFF	10/29/96	60028966	NA	NA	NA	30	NA	5	1	1	NA	NA	< 0.20
H2 EFF	11/26/96	60032170	NA	NA	NA	20	NA	4	5	1	NA	NA	< 0.20
H2 EFF	12/19/96	60033994	NA	NA	NA	30	NA	4	2	1	NA	NA	< 0.20
H2 EFF	1/28/97	70002025	NA	NA	NA	40	NA	8	1	2	NA	NA	0.2
H2 EFF	2/25/97	70004361	NA	1	NA	< 30	2	4	1	1	NA	NA	< 0.20
H2 EFF	3/25/97	70006723	NA	< 1	NA	40	< 2	6	< 1	< 4	NA	NA	< 0.20
H2 EFF	5/27/97	70011761	NA	< 1	NA	20	< 1	6	1	< 1	NA	NA	< 0.02
H2 EFF	7/12/97	70015695	NA	< 1	NA	20	< 1	6	1	< 0.5	< 0.1	NA	< 0.20
H2 EFF Dup.	8/27/96	60023250	NA	NA	NA	< 10	NA	6	1	< 1	NA	NA	< 0.20
H2 EFF Dup.	2/25/97	70004366	NA	2	NA	40	3	4	3	< 1	NA	NA	< 0.20
HS EFF	10/31/95	50026790	< 0.8	< 3.0	370	< 10.0	< 0.5	4	1.2	< 2.0	< 0.03	4	< 0.20
HS EFF	12/20/95	50031178	NA	< 3.0	NA	40	NA	NA	2.7	NA	NA	NA	0.2

Tres Rios Demonstration Wetlands
Hayfield Site Heavy Metal Monitoring
Raw Data

NA = Not analyzed for.

Sample Point	Date	Lab ID	Ag EPA 272.2 (ug/L)	Se EPA 270.2 (ug/L)	B EPA 200.7 (ug/L)	Zn EPA 200.7 (ug/L	Pb EPA 239.2 (ug/L)	Ni EPA 249.2 (ug/L)	Cu EPA 220.2 (ug/L)	Cr EPA 218.2 (ug/L)	Cd EPA 213.2 (ug/L)	As EPA 206.2 (ug/L)	Hg EPA 245.1 (ug/L)
HS EFF	1/30/96	60002914	NA	< 1.0	NA	30	NA	NA	2	NA	NA	NA	< 0.20
HS EFF	2/27/96	60005659	NA	< 1.0	NA	< 10	NA	NA	2.9	NA	NA	NA	< 0.20
HS EFF	3/27/96	60008816	NA	NA	NA	< 10	NA	11	1.2	1	NA	NA	< 0.20
HS EFF	4/30/96	60012442	NA	NA	NA	< 10	NA	11	< 1	< 1	NA	NA	< 0.20
HS EFF	5/29/96	60015057	< 0.2	< 1	310	40	< 10	7	< 1	1	< 0.1	3	< 0.20
HS EFF	7/30/96	60020483	NA	NA	NA	20	NA	8	< 1	< 1	NA	NA	< 0.20
HS EFF	8/27/96	60023249	NA	NA	NA	< 10	NA	11	1	< 1	NA	NA	< 0.20
HS EFF	10/29/96	60028967	NA	NA	NA	30	NA	5	2	1	NA	NA	< 0.20
HS EFF	11/26/96	60032171	NA	NA	NA	20	NA	10	8	1	NA	NA	< 0.20
HS EFF	12/19/96	60033995	NA	NA	NA	30	NA	4	6	3	NA	NA	< 0.20
HS EFF	1/28/97	70002026	NA	NA	NA	60	NA	7	1	1	NA	NA	< 0.20
HS EFF	2/25/97	70004362	NA	1	NA	< 30	1	4	2	1	NA	NA	< 0.20
HS EFF	3/25/97	70006724	NA	1	NA	40	< 2	7	1	< 4	NA	NA	< 0.20
HS EFF	5/27/97	70011762	NA	< 1	NA	40	5	8	2	1	NA	NA	< 0.02
HS EFF	7/12/97	70015696	NA	< 1	NA	30	5	6	2	< 0.5	< 0.1	NA	< 0.20
HS EFF Dup.	1/30/96	60002918	NA	< 1.0	NA	30	NA	NA	4.8	NA	NA	NA	< 0.20
HS EFF Dup.	10/29/96	60028968	NA	NA	NA	30	NA	5	2	2	NA	NA	< 0.20
HS EFF Dup.	3/25/97	70006728	NA	< 1.0	NA	70	< 2	8	1		NA	NA	< 0.20

Tres Rios Demonstration Wetlands
Cobble Site Heavy Metal Monitoring
Raw Data

NA = Not analyzed for.

Sample Point	Date	Lab ID	Ag EPA 272.2 (ug/L)	Se EPA 270.2 (ug/L)	B EPA 200.7 (ug/L)	Zn EPA 200.7 (ug/L	Pb EPA 239.2 (ug/L)	Ni EPA 249.2 (ug/L)	Cu EPA 220.2 (ug/L)	Cr EPA 218.2 (ug/L)	Cd EPA 213.2 (ug/L)	As EPA 206.2 (ug/L)	Hg EPA 245.1 (ug/L)
CS Inlet	10/31/95	50026791	< 0.8	< 3.0	370	< 10.0	0.5	10	3.4	2	< 0.03	4	< 0.20
CS Inlet	12/20/95	50031179	NA	< 3.0	NA	< 10.0	NA	NA	2.7	NA	NA	NA	< 0.20
CS Inlet	1/30/96	60002915	NA	< 1.0	NA	< 10.0	NA	NA	1.8	NA	NA	NA	< 0.20
CS Inlet	2/27/96	60005653	NA	< 1.0	NA	20	NA	NA	1.1	NA	NA	NA	< 0.20
CS Inlet	3/27/96	60008810	NA	NA	NA	< 10.0	NA	5	2.7	2.3	NA	NA	< 0.20
CS Inlet	4/30/96	60012436	NA	NA	NA	10	NA	8	2	1	NA	NA	< 0.20
CS Inlet	5/29/96	60015051	< 0.2	1	390	20	< 1	9	1	1	< 0.1	3	< 0.20
CS Inlet	7/30/96	60020477	NA	NA	NA	20	NA	8	2	2	NA	NA	< 0.20
CS Inlet	8/27/96	60023243	NA	NA	NA	20	NA	4	2	1	NA	NA	< 0.20
CS Inlet	10/29/96	60028961	NA	NA	NA	20	NA	4	2	2	NA	NA	< 0.20
CS Inlet	11/26/96	60032172	NA	NA	NA	20	NA	5	6	< 1	NA	NA	< 0.20
CS Inlet	12/19/96	60033989	NA	NA	NA	20	NA	4	2	4	NA	NA	< 0.20
CS Inlet	1/28/97	70002027	NA	NA	NA	70	NA	6	1	1	NA	NA	< 0.20
CS Inlet	2/25/97	70004363	NA	1	NA	50	1	8	2	2	NA	NA	< 0.20
CS Inlet	3/25/97	70006725	NA	< 1	NA	30	< 2	7	1	< 4	NA	NA	< 0.20
CS Inlet	5/27/97	70011763	NA	< 1	NA	40	1	4	2	< 1	NA	NA	< 0.20
CS Inlet Dup.	2/27/96	60005660	NA	< 1.0	NA	20	NA	NA	0.6	NA	NA	NA	< 0.20
C1 EFF	10/31/95	50026792	< 0.8	< 3.0	390	< 10.0	0.8	10	5.1	2	< 0.03	4	< 0.20
C1 EFF	12/20/95	50031180	NA	< 3.0	NA	20	NA	NA	2.4	NA	NA	NA	0.2
C1 EFF	1/30/96	60002916	NA	< 1.0	NA	20	NA	NA	2.1	NA	NA	NA	< 0.20
C1 EFF	2/27/96	60005654	NA	< 1.0	NA	20	NA	NA	6.4	NA	NA	NA	< 0.20
C1 EFF	3/27/96	60008811	NA	NA	NA	< 10.0	NA	6	2.5	1.6	NA	NA	< 0.20
C1 EFF	4/30/96	60012437	NA	NA	NA	10	NA	8	2	1	NA	NA	< 0.20
C1 EFF	5/29/96	60015052	< 0.2	< 1	330	10	< 1	6	1	1	1	3	< 0.20
C1 EFF	7/30/96	60020478	NA	NA	NA	20	NA	11	2	4	NA	NA	< 0.20
C1 EFF	8/27/96	60023244	NA	NA	NA	20	NA	6	2	< 1	NA	NA	< 0.20
C1 EFF	10/29/96	60028962	NA	NA	NA	30	NA	3	2	1	NA	NA	< 0.20
C1 EFF	11/26/96	60032173	NA	NA	NA	20	NA	5	5	3	NA	NA	< 0.20
C1 EFF	12/19/96	60033990	NA	NA	NA	20	NA	4	2	2	NA	NA	< 0.20
C1 EFF	1/28/97	70002028	NA	NA	NA	60	NA	6	2	1	NA	NA	< 0.20
C1 EFF	2/25/97	70004364	NA	1	NA	< 30	< 1	3	1	< 1	NA	NA	< 0.20
C1 EFF	3/25/97	70006726	NA	< 1	NA	40	< 2	6	< 1	< 4	NA	NA	< 0.20
C1 EFF	5/27/97	70011764	NA	< 1	NA	40	1	5	2	< 1	NA	NA	< 0.20
C1 EFF Dup.	3/27/96	60008817	NA	NA	NA	< 10.0	NA	5	2.2	1.2	NA	NA	< 0.20
C1 EFF Dup.	11/26/96	60032175	NA	NA	NA	30	NA	4	5	< 1	NA	NA	< 0.20
C2 EFF	10/31/95	50026793	< 0.8	< 3.0	370	< 10.0	0.8	5	1.8	2.7	< 0.03	4	< 0.20
C2 EFF	12/20/95	50031181	NA	< 3.0	NA	20	NA	NA	1.2	NA	NA	NA	0.3
C2 EFF	1/30/96	60002917	NA	< 1.0	NA	30	NA	NA	4	NA	NA	NA	< 0.20
C2 EFF	2/27/96	60005655	NA	< 1.0	NA	20	NA	NA	3.6	NA	NA	NA	< 0.20
C2 EFF	3/27/96	60008812	NA	NA	NA	< 10.0	NA	16	2.1	1.1	NA	NA	< 0.20
C2 EFF	4/30/96	60012438	NA	NA	NA	10	NA	8	1	< 1	NA	NA	< 0.20
C2 EFF	5/29/96	60015053	< 0.2	< 1	330	< 10	< 1	7	1	1	< 0.1	3	< 0.20
C2 EFF	7/30/96	60020479	NA	NA	NA	< 10	NA	8	< 1	1	NA	NA	< 0.20
C2 EFF	8/27/96	60023245	NA	NA	NA	< 10	NA	6	1	< 1	NA	NA	< 0.20
C2 EFF	10/29/96	60028963	NA	NA	NA	20	NA	3	1	3	NA	NA	< 0.20
C2 EFF	11/26/96	60032174	NA	NA	NA	30	NA	3	5	1	NA	NA	< 0.20
C2 EFF	12/19/96	60033991	NA	NA	NA	30	NA	4	2	2	NA	NA	< 0.20
C2 EFF	1/28/97	70002029	NA	NA	NA	40	NA	6	< 1	1	NA	NA	< 0.20
C2 EFF	2/25/97	70004365	NA	< 1	NA	40	1	5	1	< 1	NA	NA	< 0.20
C2 EFF	3/25/97	70006717	NA	< 1	NA	60	< 2	6	< 1	< 4	NA	NA	< 0.20
C2 EFF	5/27/97	70011765	NA	< 1	NA	20	< 1	6	1	< 1	NA	NA	< 0.20
C2 EFF Duplicate	4/30/96	60012443	NA	NA	NA	< 10	NA	7	1	< 1	NA	NA	< 0.20
C2 EFF Duplicate	12/19/96	60033996	NA	NA	NA	30	NA	4	4	2	NA	NA	< 0.20
C2 EFF Duplicate	5/27/97	70011766	NA	< 1	NA	30	< 1	5	1	< 1	NA	NA	< 0.20

APPENDIX H - Hayfield & Cobble Site Biomonitoring

Tres Rios Demonstration Wetland Effluent
Chronic Biomonitoring Reproduction Results

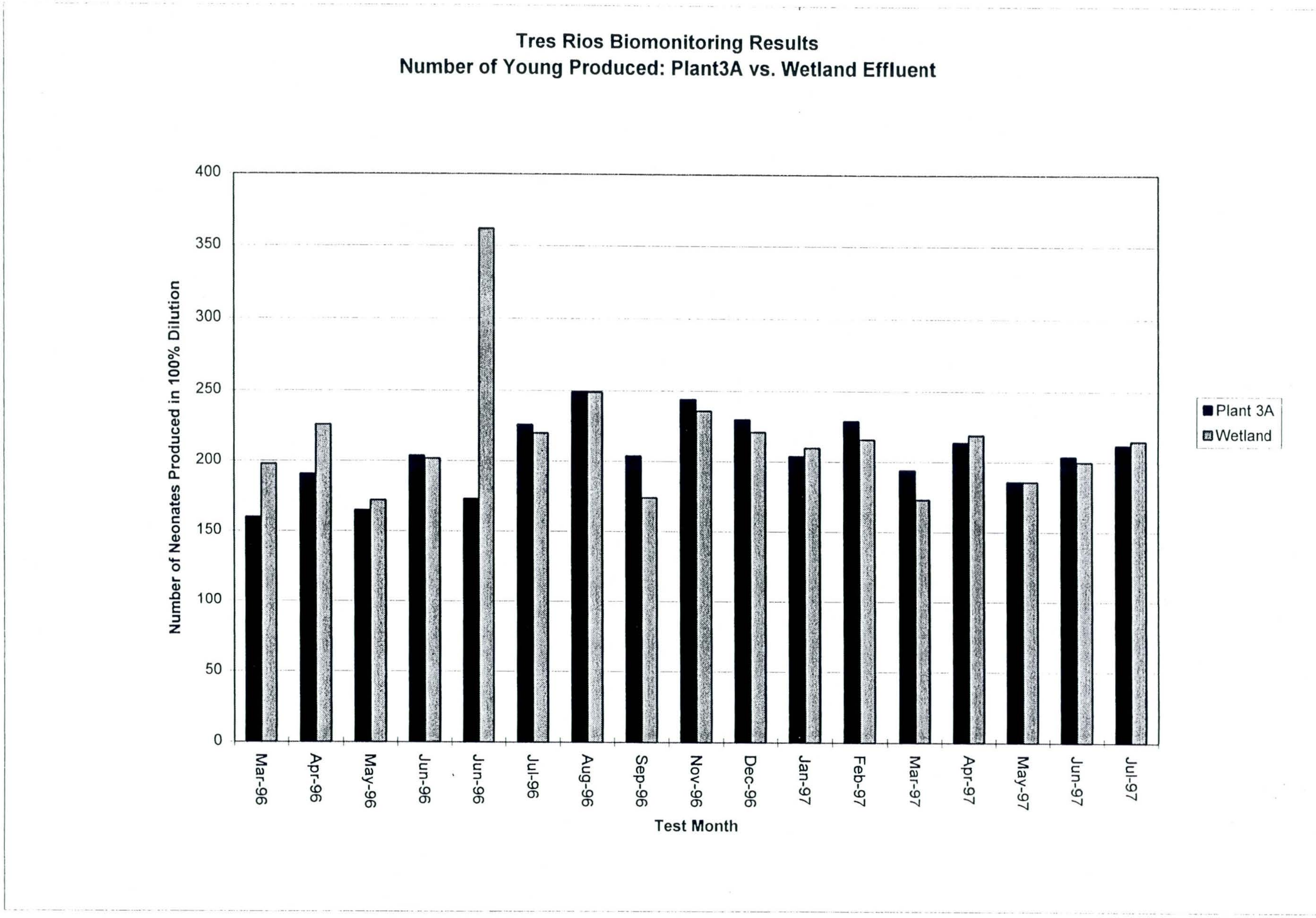
Month	NOEC	TUc	IC 50	IC 25	Basin
Nov-95	NO RESULT				
Jan-96	100%	1.00	> 100 %	> 100 %	C1
Jan-96	75%*	1.33*	> 100 %	> 100 %	C2
Feb-96	100%	1.00	> 100 %	> 100 %	H1
Feb-96	100%	1.00	> 100 %	> 100 %	H2
Mar-96	100%	1.00	> 100 %	> 100 %	C2
Apr-96	100%	1.00	> 100 %	> 100 %	H2
May-96	100%	1.00	> 100 %	> 100 %	C1
Jun-96	100%	1.00	> 100 %	> 100 %	H2
Jun-96	100%	1.00	> 100 %	> 100 %	H2
Jul-96	100%	1.00	> 100 %	> 100 %	C1
Aug-96	100%	1.00	> 100 %	> 100 %	H1
Sep-96	100%	1.00	> 100 %	> 100 %	C2
Oct-96	FOGGING: Test Orgainsms Crashed				
Nov-96	100%	1.00	> 100 %	> 100 %	H1
Dec-96	100%	1.00	> 100 %	> 100 %	C1
Jan-97	100%	1.00	> 100 %	> 100 %	H2
Feb-97	100%	1.00	> 100 %	> 100 %	C2
Mar-97	100%	1.00	> 100 %	> 100 %	H1
Apr-97	100%	1.00	> 100 %	> 100 %	C1
May-97	100%	1.00	> 100 %	> 100 %	H2
Jun-97	100%	1.00	> 100 %	> 100 %	C1
Jul-97	100%	1.00	> 100 %	> 100 %	H1

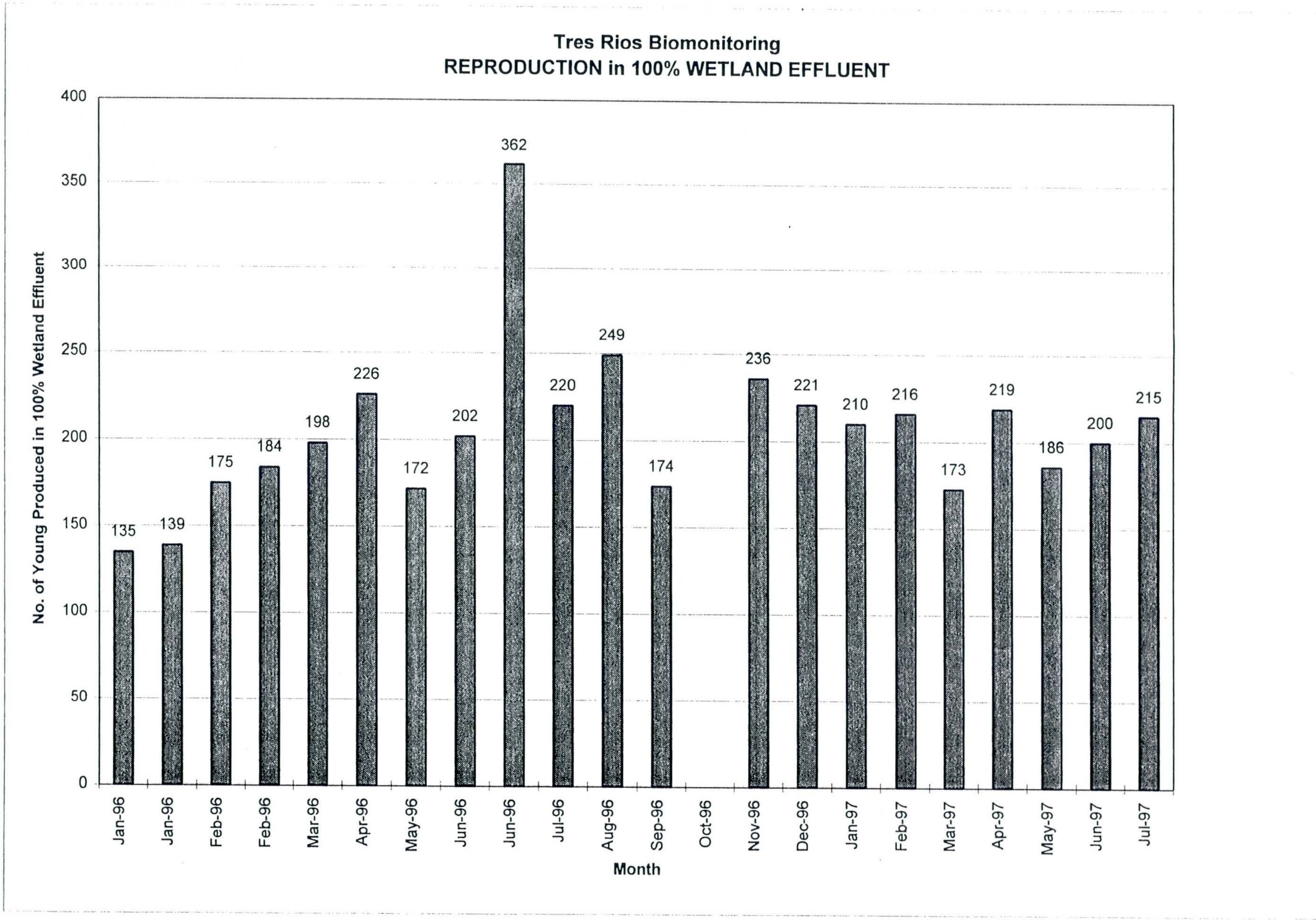
*** Data inversion at 90% and 100% dilutions.**
When inversion is eliminated, NOEC = 100% (TUc = 1).

Test Conducted by City of Phoenix 23rd Ave. Laboratory
All other testing conducted by AQUATIC CONSULTING & TESTING INC.

Tres Rios Demonstration Wetland Effluent
Chronic Biomonitoring Survival Results

Month	NOEC	LOEC	TUc	Basin
Nov-95	100	> 100	1	H2
Jan-96	100	> 100	1	C1
Jan-96	100	> 100	1	C2
Feb-96	100	> 100	1	H1
Feb-96	100	> 100	1	H2
Mar-96	100	> 100	1	C2
Apr-96	100	> 100	1	H1
May-96	100	> 100	1	C1
Jun-96	100	> 100	1	H2
Jun-96	100	> 100	1	H2
Jul-96	100	> 100	1	H1
Aug-96	100	> 100	1	C1
Sep-96	100	> 100	1	C2
Oct-96	FOGGING: Test Orgainsms Crashed			
Nov-96	100	> 100	1	H1
Dec-96	100	> 100	1	C1
Jan-97	100	> 100	1	H2
Feb-97	100	> 100	1	C2
Mar-97	100	> 100	1	H1
Apr-97	100	> 100	1	C1
May-97	100	> 100	1	H2
Jun-97	100	> 100	1	C1
Jul-97	100	> 100	1	H1


Tres Rios Biomonitoring Results
Number of Young Produced: Plant3A vs. Wetland Effluent
Number of Neonates Produced in 100% Dilution
400
350
300
250
200
150
100
50
0
Mar-96
Apr-96
May-96
Jun-96
Jun-96
Jul-96
Aug-96
Sep-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Test Month
Plant 3A
Wetland

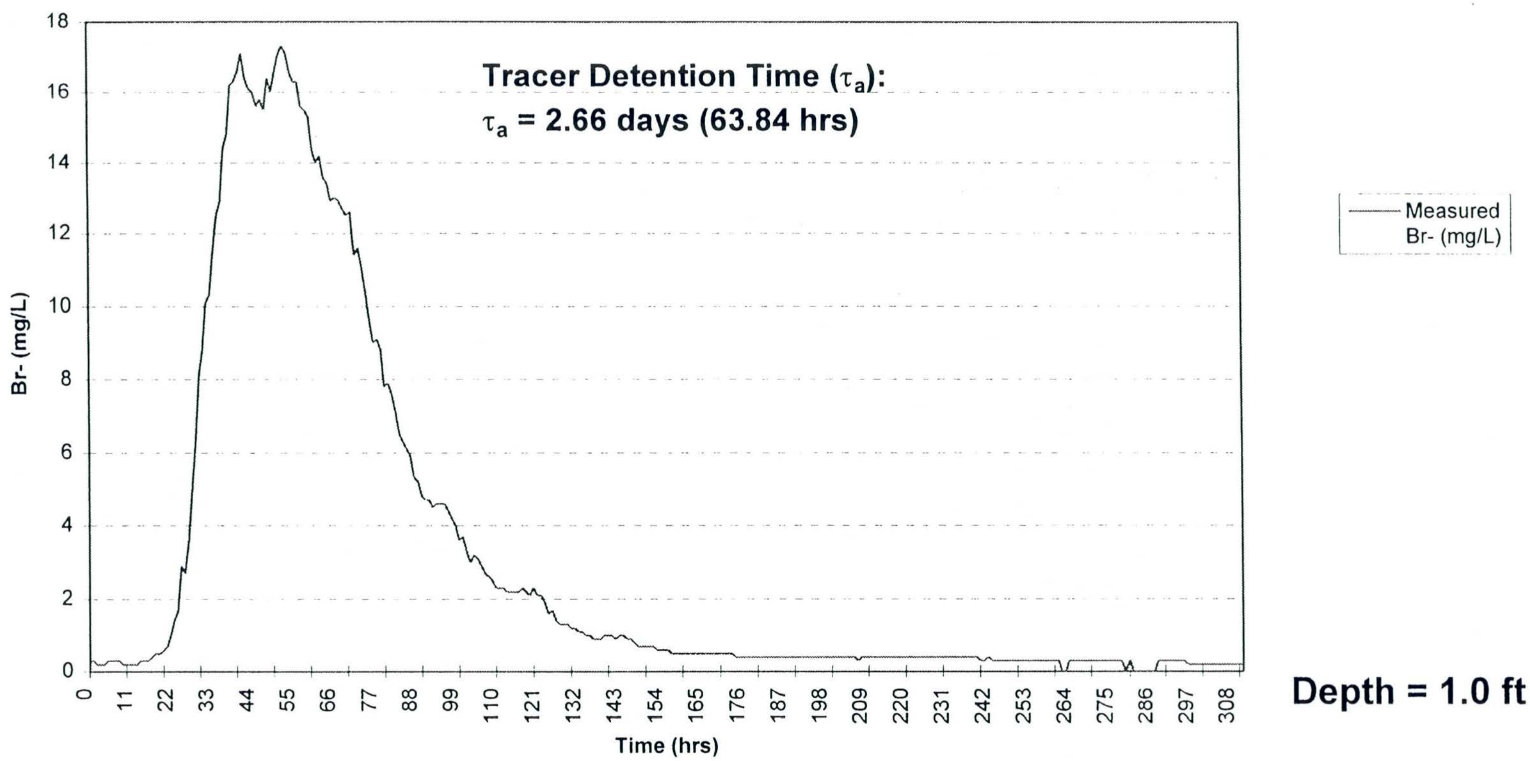

Tres Rios Biomonitoring
REPRODUCTION in 100% WETLAND EFFLUENT
No. of Young Produced in 100% Wetland Effluent
0
50
100
150
200
250
300
350
400
135
139
175
184
198
226
172
202
362
220
249
174
236
221
210
216
173
219
186
200
215
Jan-96
Jan-96
Feb-96
Feb-96
Mar-96
Apr-96
May-96
Jun-96
Jun-96
Jul-96
Aug-96
Sep-96
Oct-96
Nov-96
Dec-96
Jan-97
Feb-97
Mar-97
Apr-97
May-97
Jun-97
Jul-97
Month

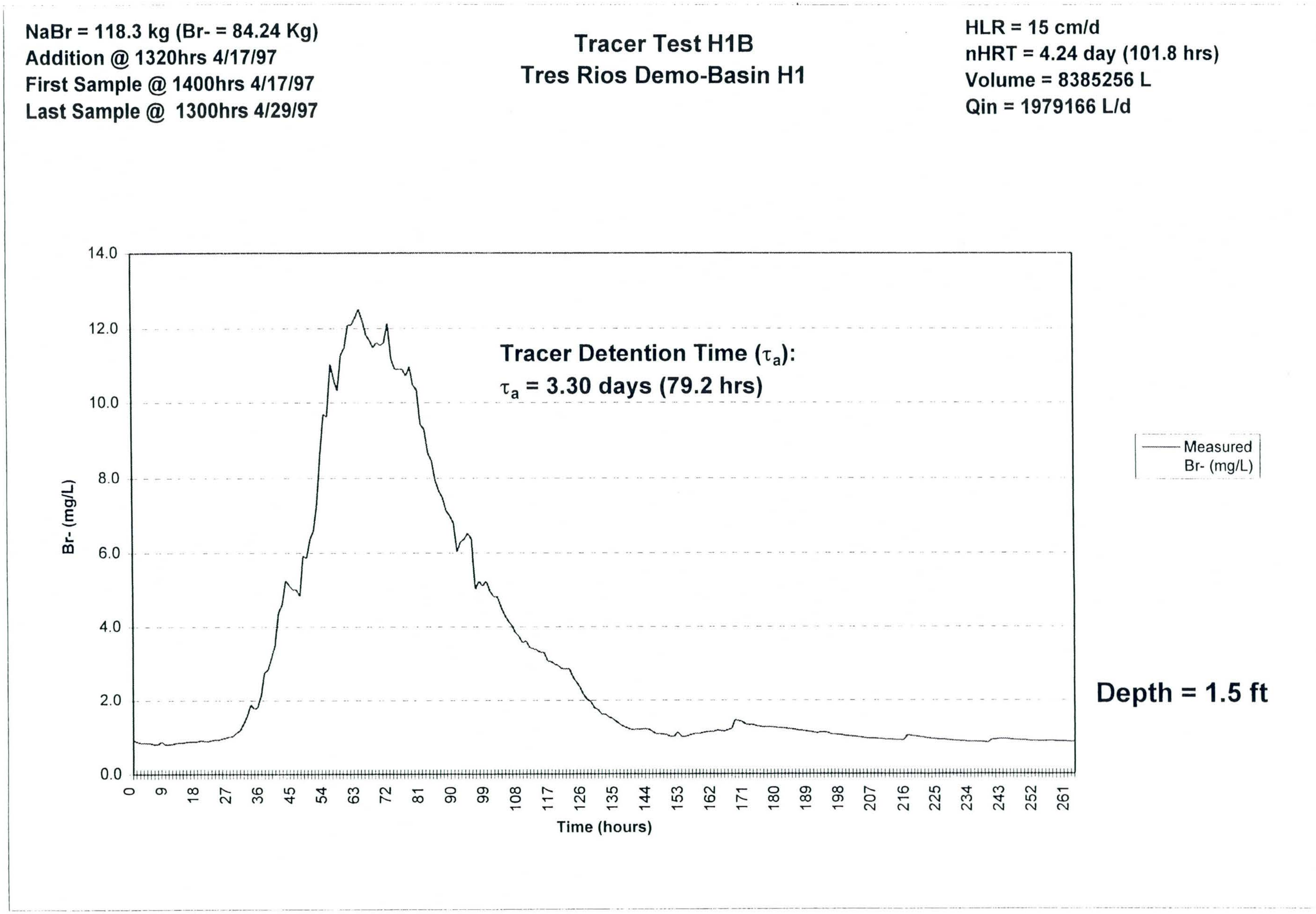
APPENDIX I - Hayfield Tracer Testing

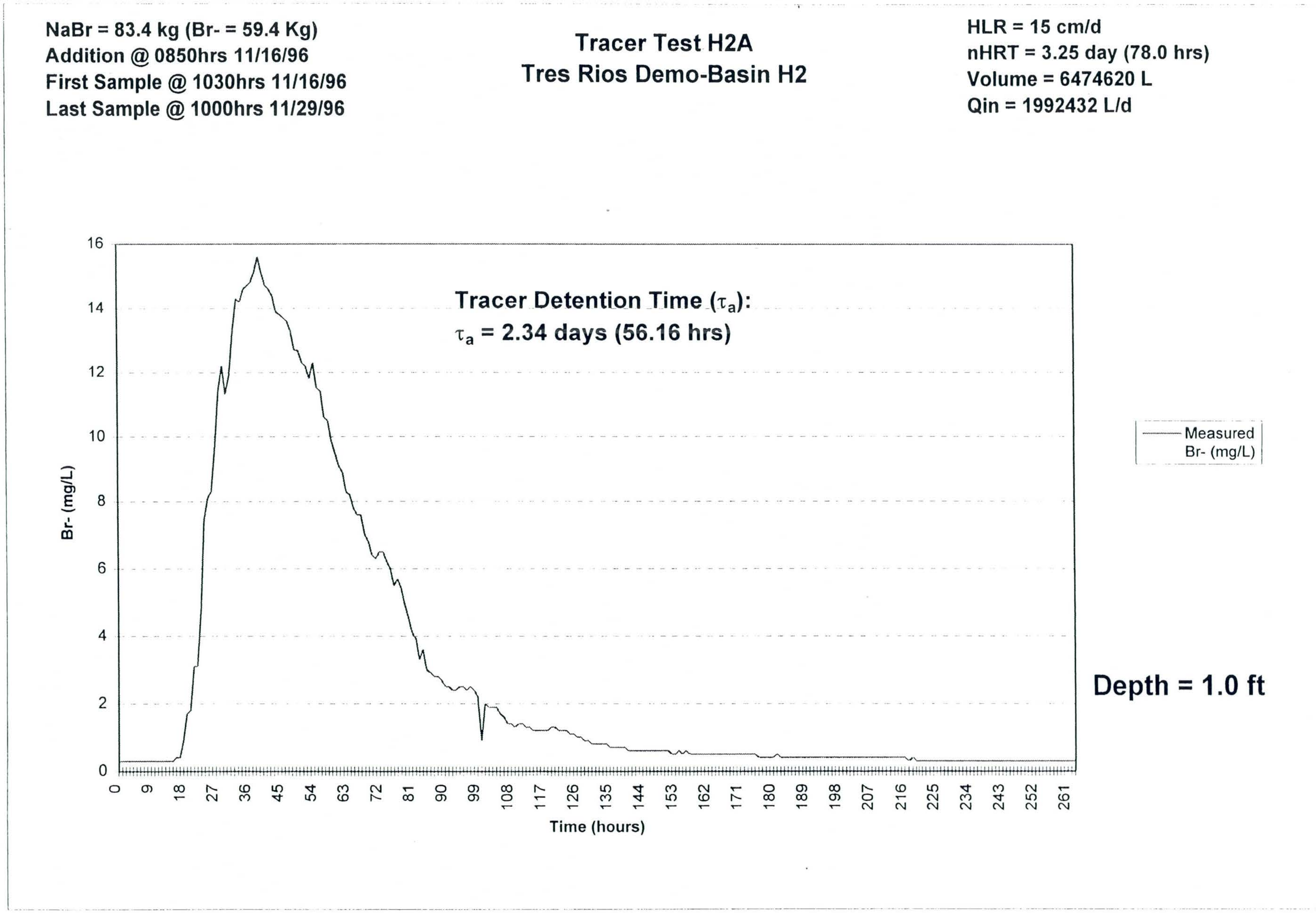
NaBr = 86.6 kg (Br- = 61.68 Kg)
Addition @ 1150hrs 10/10/96
First Sample @ 1300hrs 10/10/96
Last Sample @ 1000hrs 10/23/96

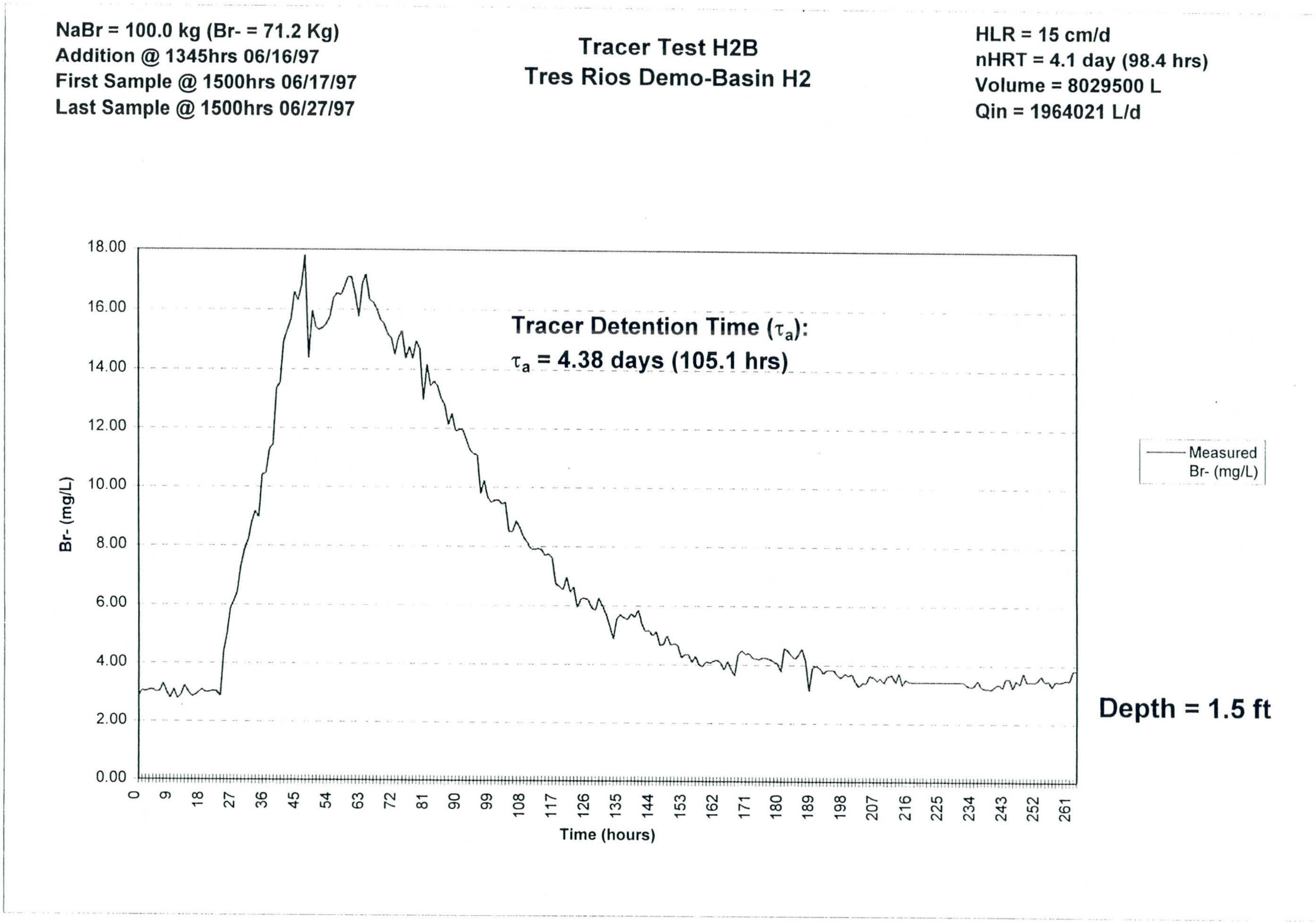
Tracer Test H1A
Tres Rios Demo-Basin H1

HLR = 15 cm/d
nHRT = 3.35 day (80.3 hrs)
Volume = 6761470 L
Qin = 2020683 L/d




NaBr = 118.3 kg (Br- = 84.24 Kg)
Addition @ 1320hrs 4/17/97
First Sample @ 1400hrs 4/17/97
Last Sample @ 1300hrs 4/29/97
Tracer Test H1B
Tres Rios Demo-Basin H1
HLR = 15 cm/d
nHRT = 4.24 day (101.8 hrs)
Volume = 8385256 L
Qin = 1979166 L/d
Tracer Detention Time (τ_a):
τ_a = 3.30 days (79.2 hrs)
Measured Br- (mg/L)
Depth = 1.5 ft
Br- (mg/L)
Time (hours)
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
0
9
18
27
36
45
54
63
72
81
90
99
108
117
126
135
144
153
162
171
180
189
198
207
216
225
234
243
252
261


NaBr = 83.4 kg (Br- = 59.4 Kg)
Addition @ 0850hrs 11/16/96
First Sample @ 1030hrs 11/16/96
Last Sample @ 1000hrs 11/29/96
Tracer Test H2A
Tres Rios Demo-Basin H2
HLR = 15 cm/d
nHRT = 3.25 day (78.0 hrs)
Volume = 6474620 L
Qin = 1992432 L/d
Tracer Detention Time (τ_a):
τ_a = 2.34 days (56.16 hrs)
Br- (mg/L)
Time (hours)
Measured Br- (mg/L)
Depth = 1.0 ft



NaBr = 100.0 kg (Br- = 71.2 Kg)
Addition @ 1345hrs 06/16/97
First Sample @ 1500hrs 06/17/97
Last Sample @ 1500hrs 06/27/97
Tracer Test H2B
Tres Rios Demo-Basin H2
HLR = 15 cm/d
nHRT = 4.1 day (98.4 hrs)
Volume = 8029500 L
Qin = 1964021 L/d
Tracer Detention Time (τa):
τa = 4.38 days (105.1 hrs)
Measured Br- (mg/L)
Depth = 1.5 ft
Br- (mg/L)
Time (hours)
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
0 9 18 27 36 45 54 63 72 81 90 99 108 117 126 135 144 153 162 171 180 189 198 207 216 225 234 243 252 261

APPENDIX J - Vector Control

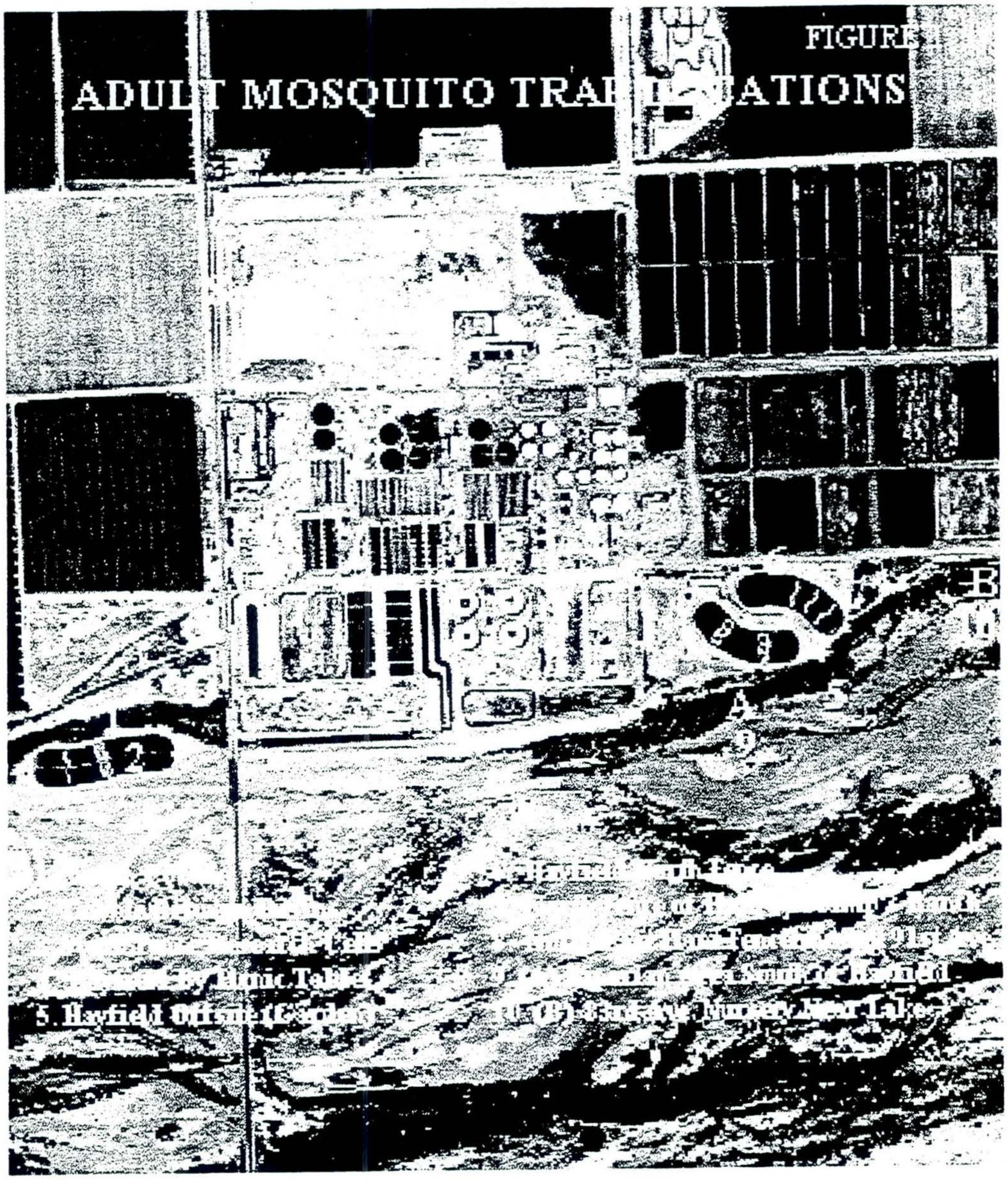


FIGURE
ADUL T MOSQUITO TRA ATIONS
5. Hayfield Offsite

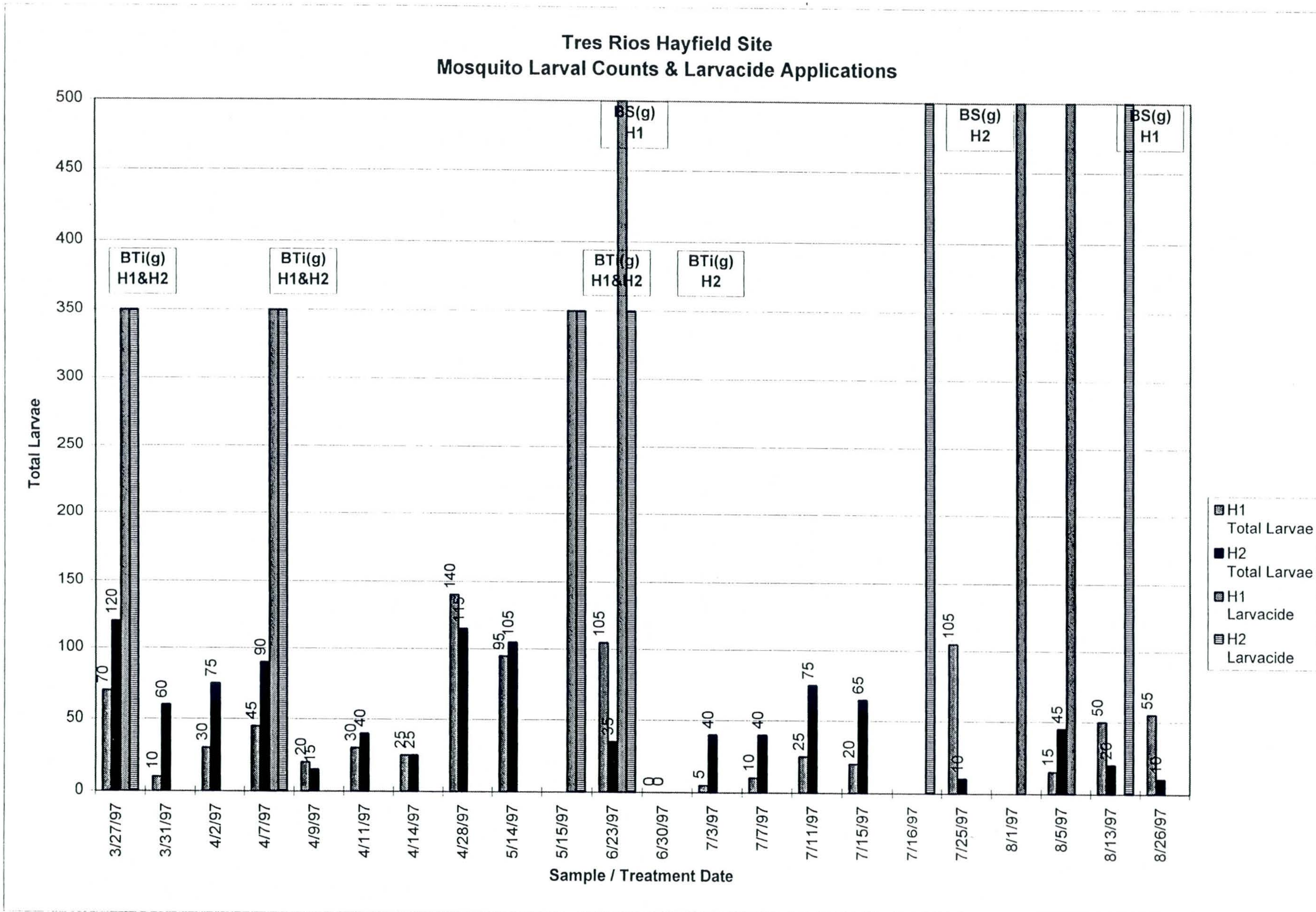

Tres Rios Hayfield Site
Mosquito Larval Counts & Larvacide Applications
Total Larvae
Sample / Treatment Date
BTi(g) H1&H2
BTi(g) H1&H2
BTi(g) H1&H2
BS(g) H1
BTi(g) H2
BS(g) H2
BS(g) H1
H1 Total Larvae
H2 Total Larvae
H1 Larvacide
H2 Larvacide
3/27/97
3/31/97
4/2/97
4/7/97
4/9/97
4/11/97
4/14/97
4/28/97
5/14/97
5/15/97
6/23/97
6/30/97
7/3/97
7/7/97
7/11/97
7/15/97
7/16/97
7/25/97
8/1/97
8/5/97
8/13/97
8/26/97

FIGURE 3

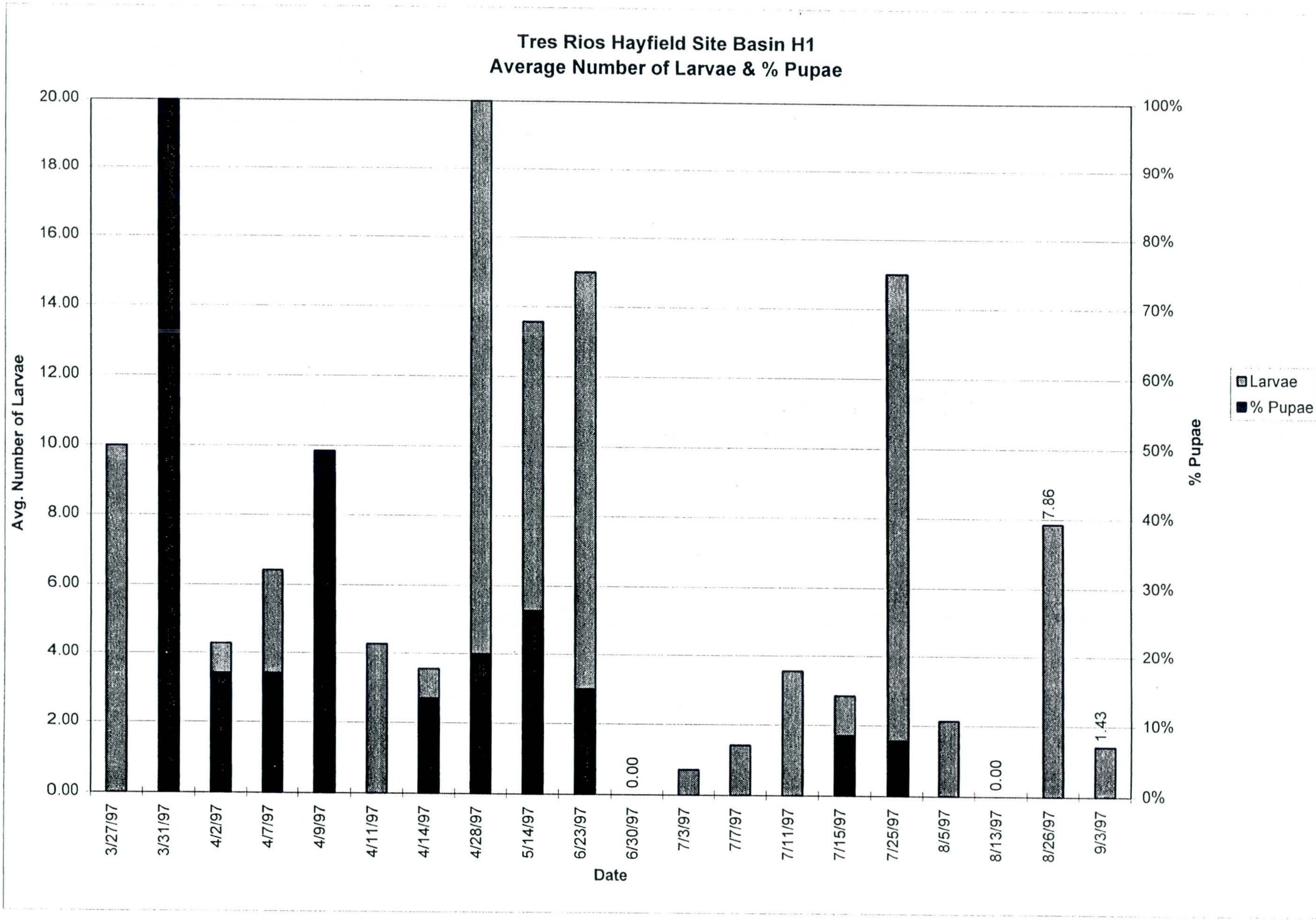
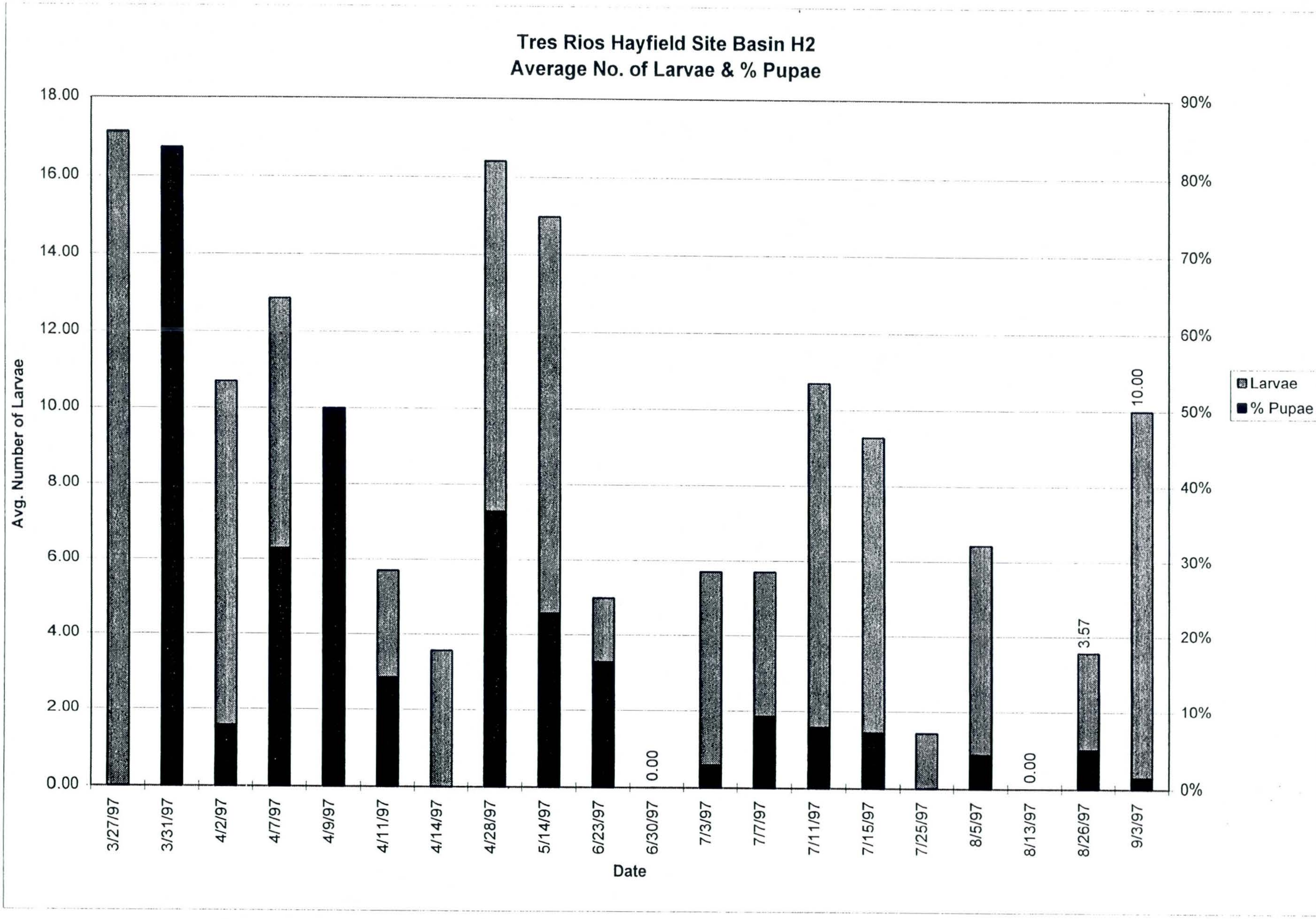
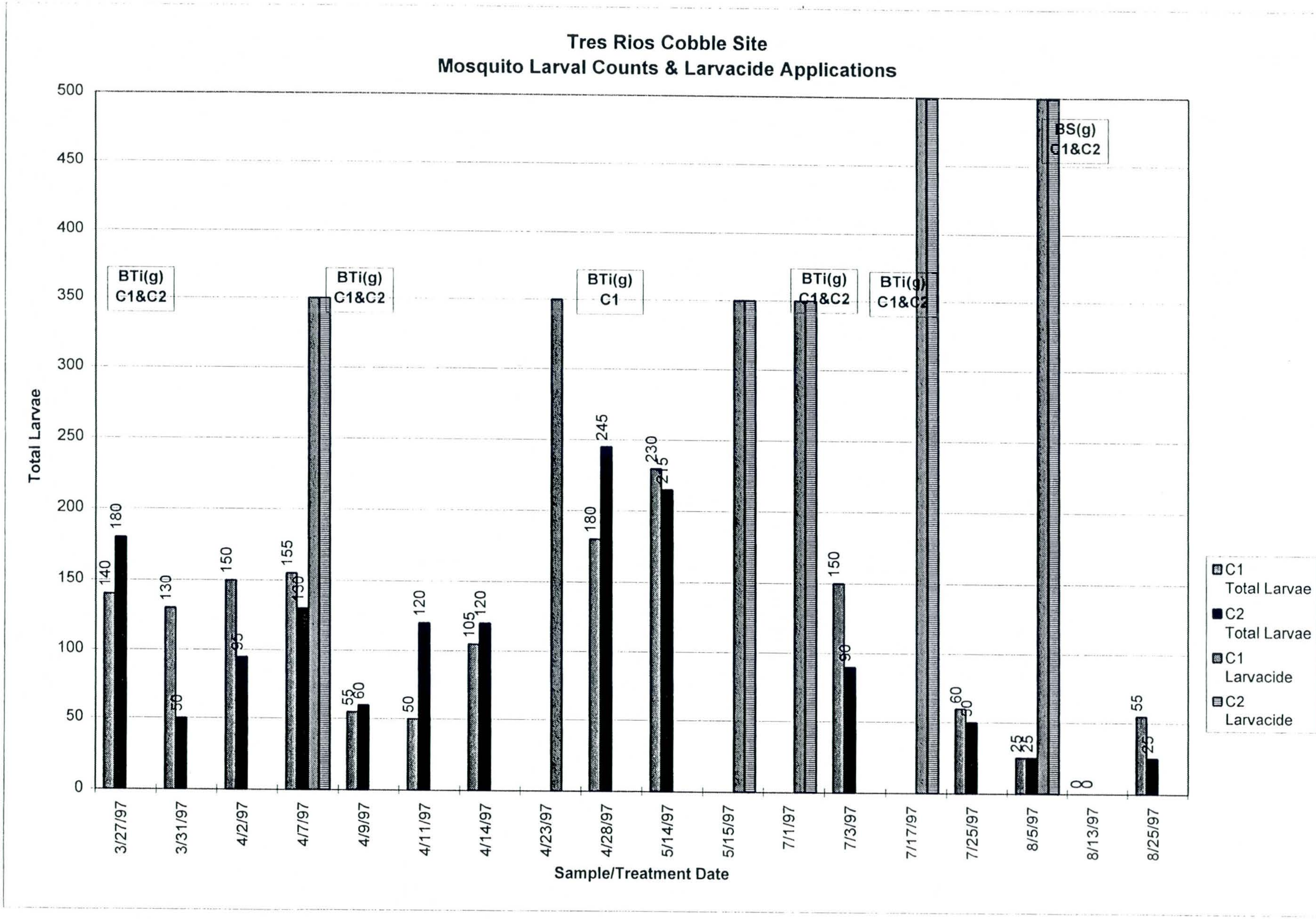

Tres Rios Hayfield Site Basin H1
Average Number of Larvae & % Pupae
Avg. Number of Larvae
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
% Pupae
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Larvae
% Pupae
7.86
1.43
0.00
0.00
3/27/97
3/31/97
4/2/97
4/7/97
4/9/97
4/11/97
4/14/97
4/28/97
5/14/97
6/23/97
6/30/97
7/3/97
7/7/97
7/11/97
7/15/97
7/25/97
8/5/97
8/13/97
8/26/97
9/3/97
Date

FIGURE 4



Tres Rios Hayfield Site Basin H2
Average No. of Larvae & % Pupae
Avg. Number of Larvae
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Larvae
% Pupae
10.00
3.57
0.00
0.00
3/27/97
3/31/97
4/2/97
4/7/97
4/9/97
4/11/97
4/14/97
4/28/97
5/14/97
6/23/97
6/30/97
7/3/97
7/7/97
7/11/97
7/15/97
7/25/97
8/5/97
8/13/97
8/26/97
9/3/97
Date

FIGURE 5


Tres Rios Cobble Site
Mosquito Larval Counts & Larvacide Applications
Total Larvae
Sample/Treatment Date
500
450
400
350
300
250
200
150
100
50
0
BTi(g) C1&C2
BTi(g) C1&C2
BTi(g) C1
BTi(g) C1&C2
BTi(g) C1&C2
BS(g) C1&C2
140
180
130
50
150
95
155
130
55
60
50
120
105
120
180
245
230
215
150
90
60
50
25
25
0
0
55
25
3/27/97
3/31/97
4/2/97
4/7/97
4/9/97
4/11/97
4/14/97
4/23/97
4/28/97
5/14/97
5/15/97
7/1/97
7/3/97
7/17/97
7/25/97
8/5/97
8/13/97
8/25/97
C1 Total Larvae
C2 Total Larvae
C1 Larvacide
C2 Larvacide

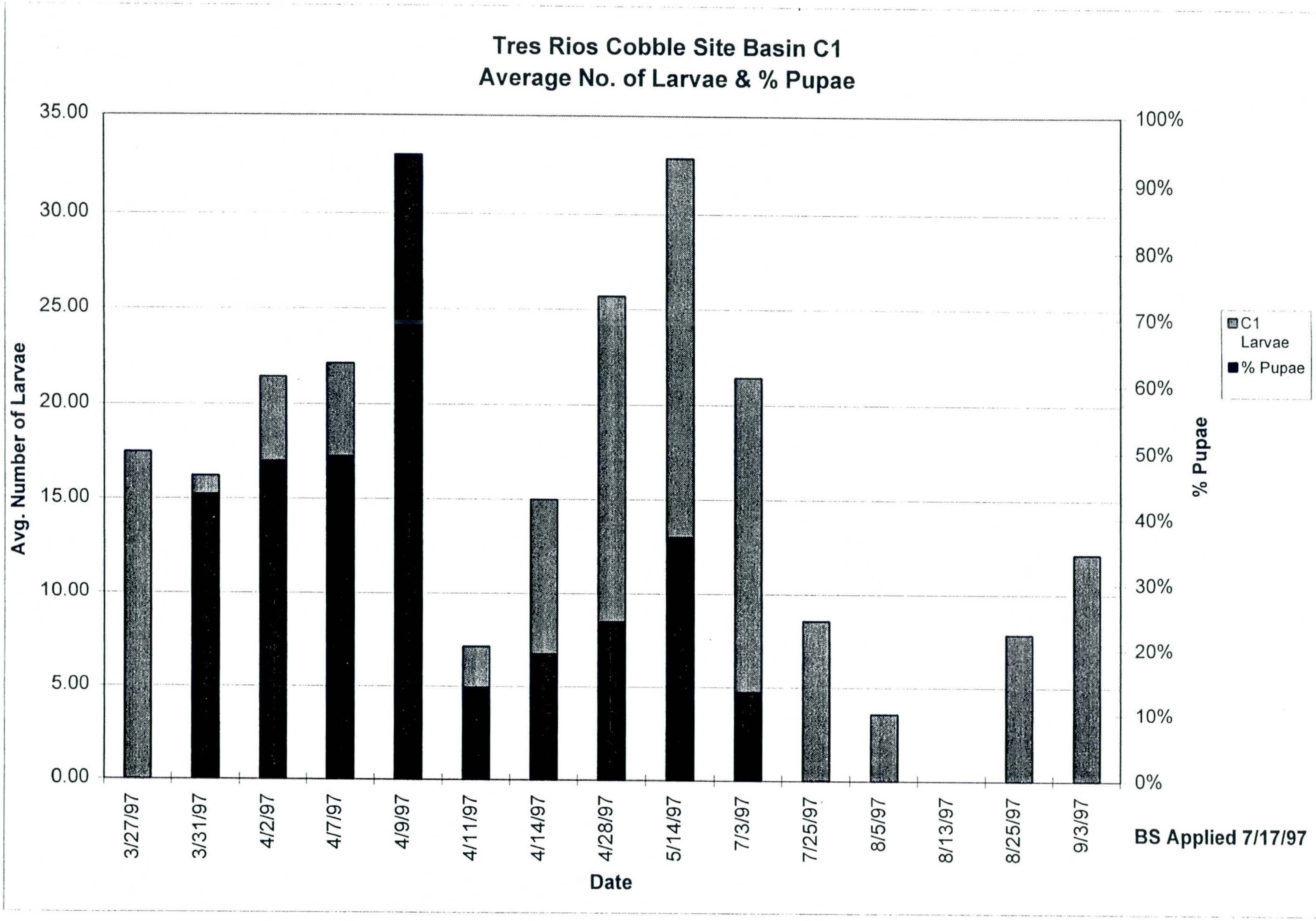

Tres Rios Cobble Site Basin C1
Average No. of Larvae & % Pupae
Avg. Number of Larvae
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Pupae
C1 Larvae
% Pupae
3/27/97
3/31/97
4/2/97
4/7/97
4/9/97
4/11/97
4/14/97
4/28/97
5/14/97
7/3/97
7/25/97
8/5/97
8/13/97
8/25/97
9/3/97
Date
BS Applied 7/17/97

FIGURE 7

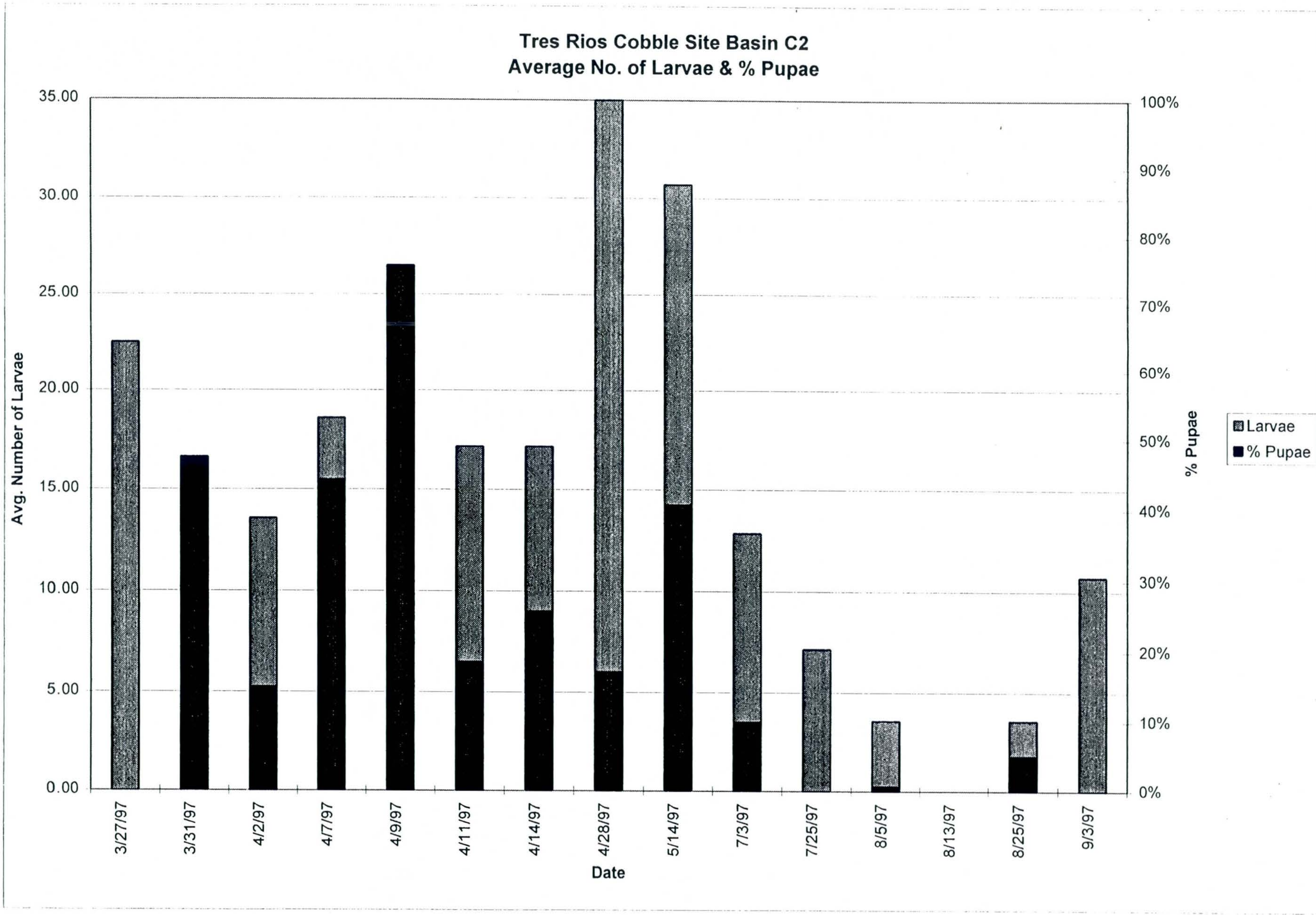
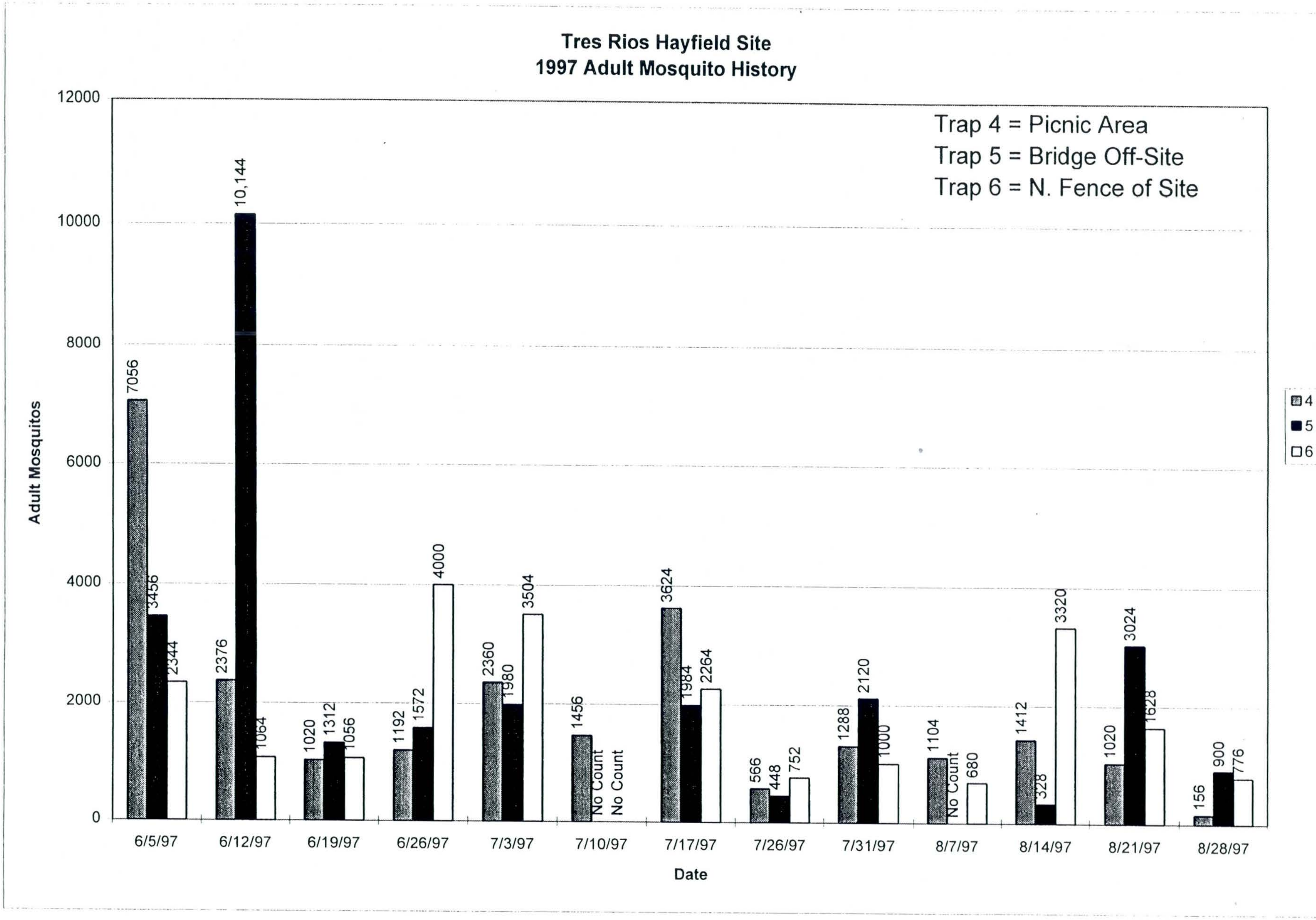

Tres Rios Cobble Site Basin C2
Average No. of Larvae & % Pupae
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Avg. Number of Larvae
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% Pupae
Larvae
% Pupae
3/27/97
3/31/97
4/2/97
4/7/97
4/9/97
4/11/97
4/14/97
4/28/97
5/14/97
7/3/97
7/25/97
8/5/97
8/13/97
8/25/97
9/3/97
Date

FIGURE 8



Tres Rios Hayfield Site
1997 Adult Mosquito History
Trap 4 = Picnic Area
Trap 5 = Bridge Off-Site
Trap 6 = N. Fence of Site
Adult Mosquitos
Date
0
2000
4000
6000
8000
10000
12000
6/5/97
6/12/97
6/19/97
6/26/97
7/3/97
7/10/97
7/17/97
7/26/97
7/31/97
8/7/97
8/14/97
8/21/97
8/28/97
7056
3456
2344
2376
10,144
1064
1020
1312
1056
1192
1572
4000
2360
1980
3504
1456
No Count
No Count
3624
1984
2264
566
448
752
1288
2120
1000
1104
No Count
680
1412
328
3320
1020
3024
1628
156
900
776
4
5
6

FIGURE 9

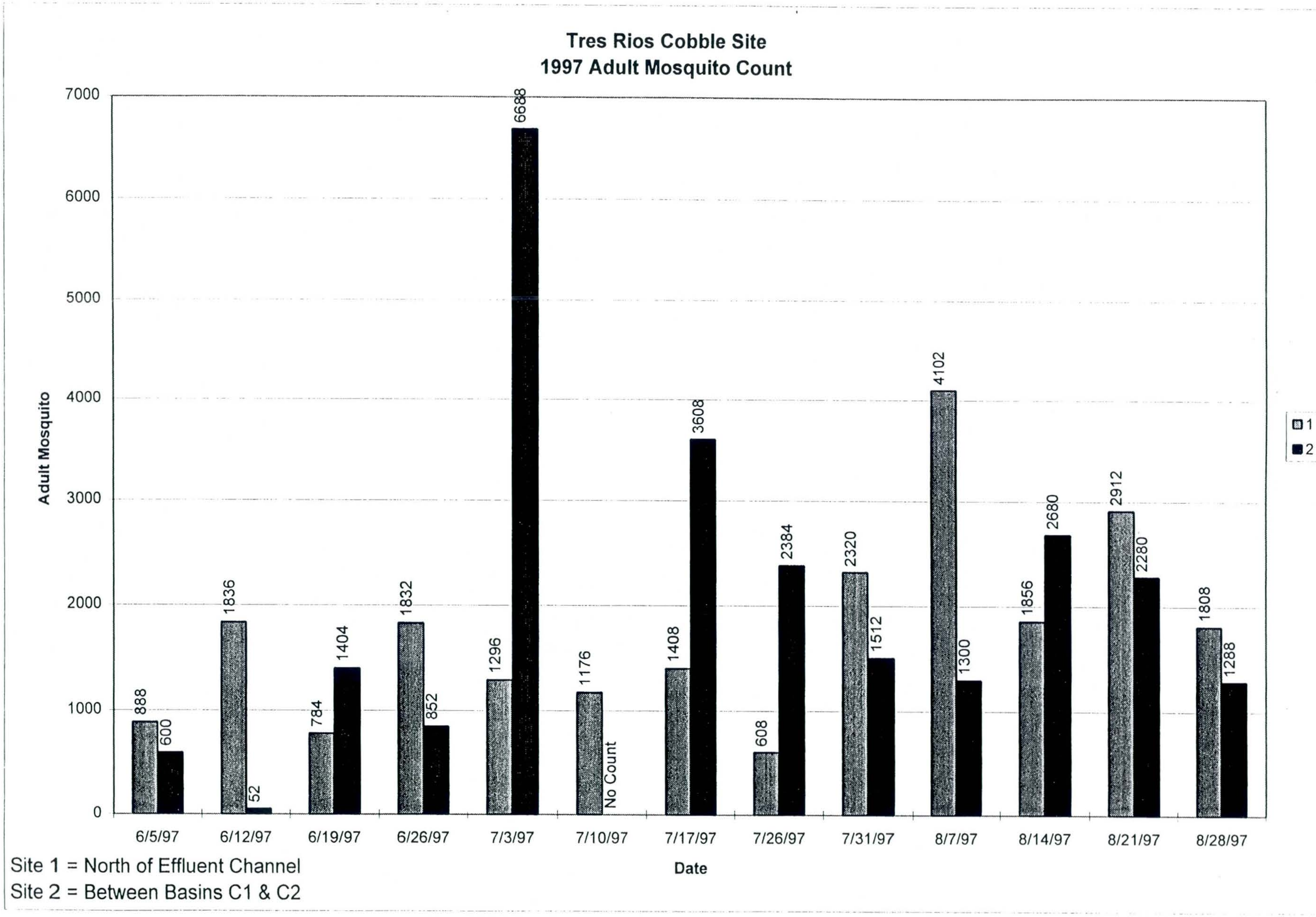
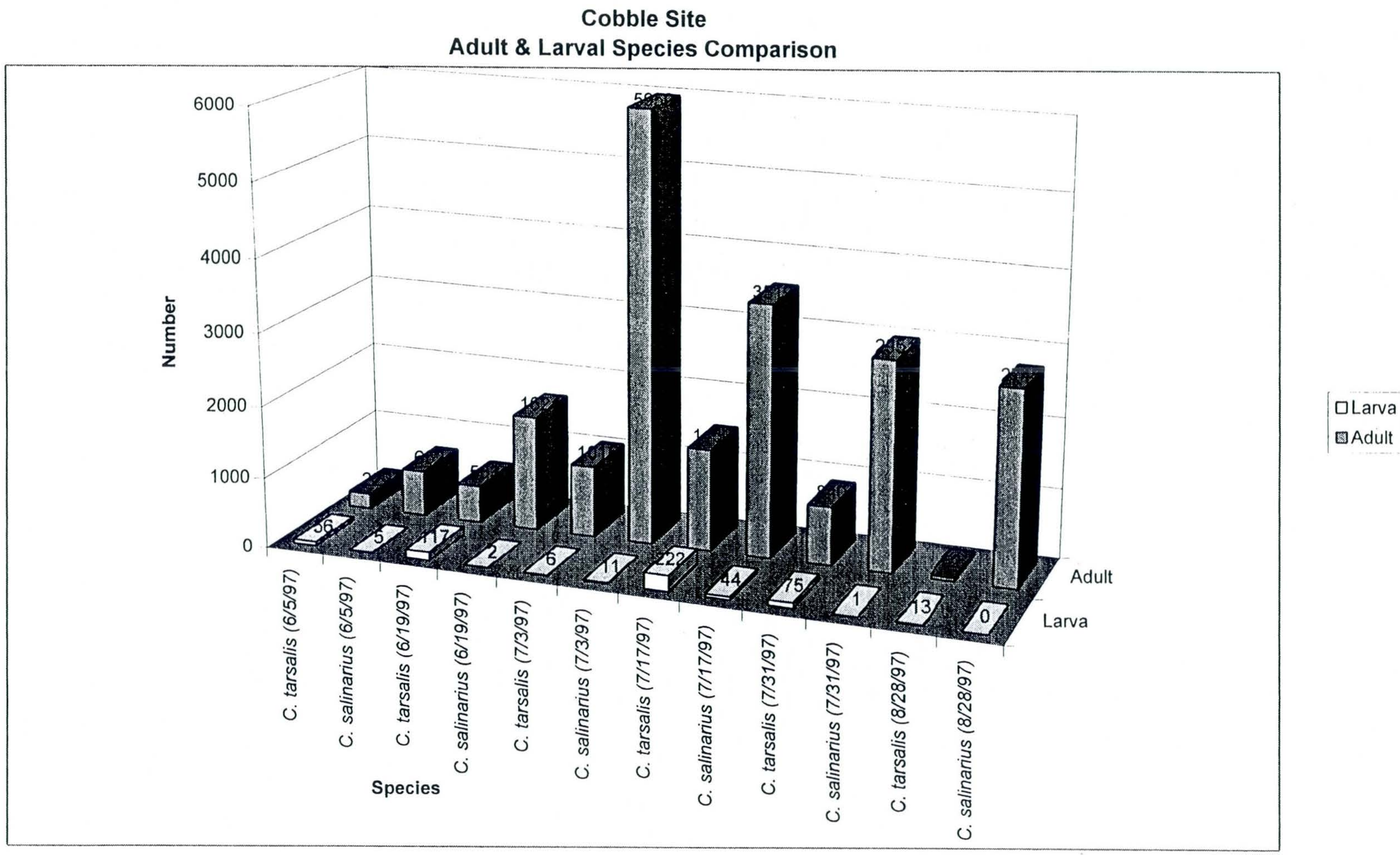

Tres Rios Cobble Site
1997 Adult Mosquito Count
Adult Mosquito
7000
6000
5000
4000
3000
2000
1000
0
888
600
1836
52
784
1404
1832
852
1296
6688
1176
No Count
1408
3608
608
2384
2320
1512
4102
1300
1856
2680
2912
2280
1808
1288
6/5/97
6/12/97
6/19/97
6/26/97
7/3/97
7/10/97
7/17/97
7/26/97
7/31/97
8/7/97
8/14/97
8/21/97
8/28/97
Date
1
2
Site 1 = North of Effluent Channel
Site 2 = Between Basins C1 & C2

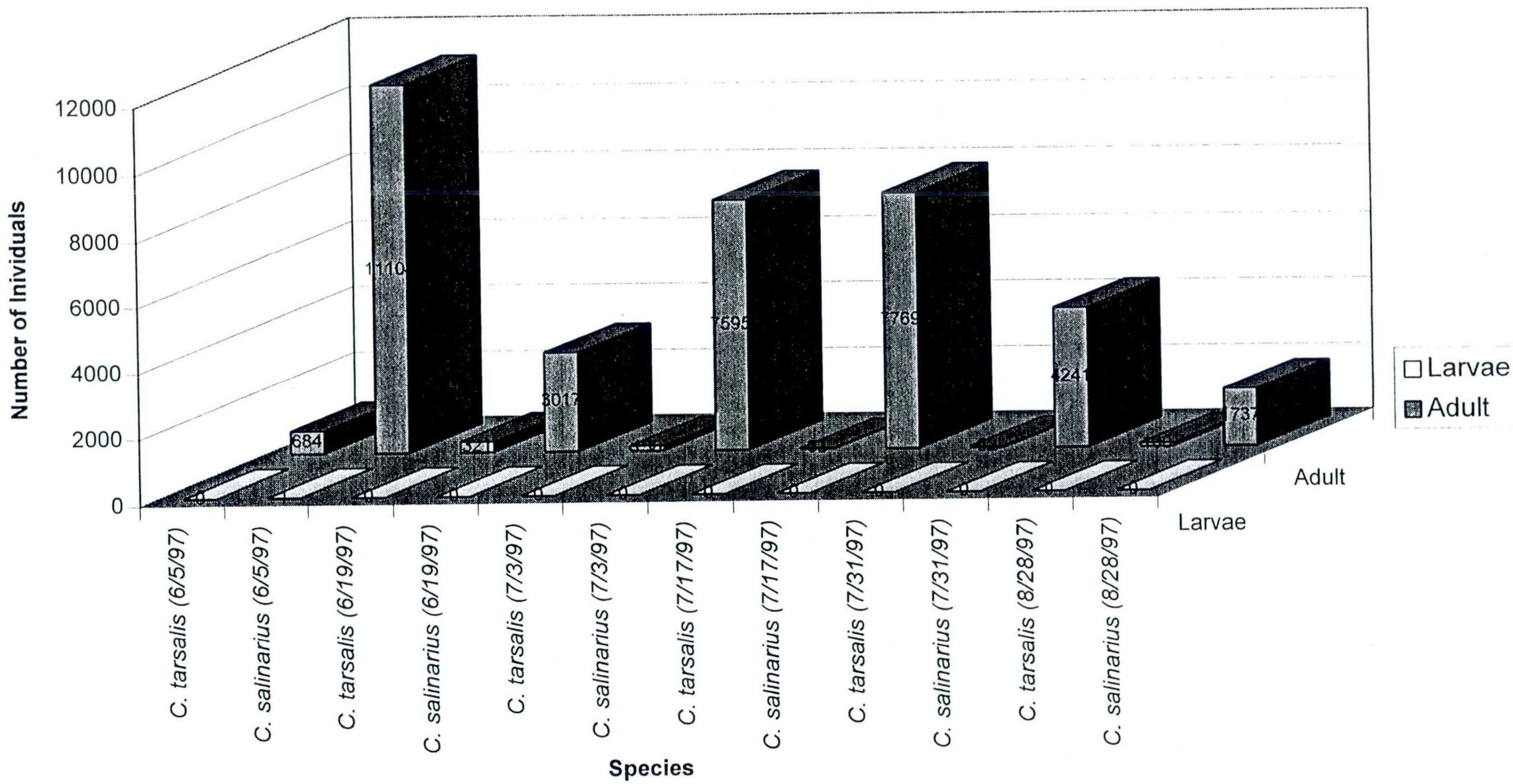
FIGURE 10



Cobble Site
Adult & Larval Species Comparison
6000
5000
4000
3000
2000
1000
0
Number
36
5
117
2
6
11
222
44
75
1
13
0
Adult
Larva
C. tarsalis (6/5/97)
C. salinarius (6/5/97)
C. tarsalis (6/19/97)
C. salinarius (6/19/97)
C. tarsalis (7/3/97)
C. salinarius (7/3/97)
C. tarsalis (7/17/97)
C. salinarius (7/17/97)
C. tarsalis (7/31/97)
C. salinarius (7/31/97)
C. tarsalis (8/28/97)
C. salinarius (8/28/97)
Species
Larva
Adult

FIGURE 11

Hayfield Site
Adult & Larval Species Comparison



APPENDIX K - Vegetation

Tres Rios Demonstration Wetlands
Vegetated Area (Acres) Summary
Compliments of the Bureau of Reclamation Phoenix Area Office

Cobble Site

C1 S. validus / **C1 S. olneyi**

Date	4/8/96	2/10/97	4/8/96	2/10/97
Sum	0.95	0.99	0.87	0.92

Total Vegetated Area = 1.82 Acres (4/8/96)
Total Vegetated Area = 1.91 Acres (2/10/97)

Cobble Site

C2 S. validus / **C2 S. olneyi**

Date	4/8/96	2/10/97	4/8/96	2/10/97
Sum	0.97	0.92	0.94	1.1

Total Vegetated Area = 1.91 Acres (4/8/96)
Total Vegetated Area = 2.02 Acres (2/10/97)

Hayfield Site

H1 S. validus / **H1 S. olneyi**

Date	4/8/96	8/8/96	2/10/97	4/8/96	8/8/96	2/10/97
Sum	0.94	0.99	0.76	1.54	1.30	1.91

Total Vegetated Area = 2.48 Acres (4/8/96)
Total Vegetated Area = 2.29 Acres (8/8/96)
Total Vegetated Area = 2.67 Acres (2/10/97)

Hayfield Site

H2 S. validus / **H2 S. olneyi**

Date	4/8/96	8/8/96	2/10/97	4/8/96	8/8/96	2/10/97
Sum	1.08	1.08	1.04	1.28	1.2	1.39

Total Vegetated Area = 2.36 Acres (4/8/96)
Total Vegetated Area = 2.28 Acres (8/8/96)
Total Vegetated Area = 2.43 Acres (2/10/97)

Summary STATISTICS

Scirpus validus per Square Meter
Hayfield Basin H1
Sample Date June 30, 1996

	North	Middle	South	Coverage
Inlet DZ	---	---	---	---
DZ1	174	212	195	open
DZ2	94	150	48	open
DZ3	---	---	---	---
DZ4	---	---	---	DW/ C demersum
DZ5	147	167	164	DW/ C demersum
H1 EFF	---	---	---	---
AVERAGE	**138.33**	**176.33**	**135.67**	
Median	**147.0**	**167.0**	**164.0**	
Standard Dev.	**40.7**	**32.0**	**77.5**	
Max	**174.0**	**212.0**	**195.0**	
Min	**94.0**	**150.0**	**48.0**	

Scirpus validus per Square Meter
Hayfield Basin H2
Sample Date June 30, 1996

	North	Middle	South	Coverage
Inlet DZ	---	---	---	---
DZ1	292	221	132	DW
DZ2	157	234	158	DW
H2 EFF	257	239	191	Filamentous / DW
AVERAGE	**235.33**	**231.33**	**160.33**	
Median	**257.0**	**234.0**	**158.0**	
Standard Dev.	**70.1**	**9.3**	**29.6**	
Max	**292.0**	**239.0**	**191.0**	
Min	**157.0**	**221.0**	**132.0**	

Summary STATISTICS

Scirpus olneyii per Square Meter
Hayfield Basin H1
Sample Date July 02, 1996

	North	Middle	South	Coverage
Inlet DZ	---	---	---	---
DZ1	527	740	619	open
DZ2	---	---	---	open
DZ3	---	---	---	---
DZ4	---	---	---	DW/ C demersum
DZ5	466	436	357	DW/ C demersum
H1 EFF	---	---	---	---
AVERAGE	**496.50**	**588.00**	**488.00**	
Median	**496.5**	**588**	**488**	
Standard Dev.	**43.13**	**214.96**	**185.26**	
Max	**527**	**740**	**619**	
Min	**466**	**436**	**357**	

Scirpus olneyii per Square Meter
Hayfield Basin H2
Sample Date July 3, 1996

	North	Middle	South	Coverage
Inlet DZ	---	---	---	---
DZ1	712	172	808	DW
DZ2	412	507	536	DW / C. demersum
H2 EFF	---	---	---	Filamentous / DW
AVERAGE	**562.00**	**339.50**	**672.00**	
Median	**562**	**339.5**	**672**	
Standard Dev.	**212.13**	**236.88**	**192.33**	
Max	**712**	**507**	**808**	
Min	**412**	**172**	**536**	

Basin H1: First Emergent Zone

S. olneyi	199			S. validus	70		
	123				85		
	187				77		
Avg. =		**169.67**	per 1/4 meter	Avg. =		**77.33**	per 1/4 meter
		679	per m^2			**309**	per m^2

Basin H1: Last emergent Zone

S. olneyi	185			S. validus	39		
	131				23		
	331				52		
Avg. =		**215.67**	per 1/4 meter	Avg. =		**38.00**	per 1/4 meter
		863	per m^2			**152**	per m^2